# **1AC Plan**

### **Plan – States ought to expand the Public Trust Doctrine to reduce private actor appropriation of Outer Space.**

**Babcock 19**

(, H., 2019. THE PUBLIC TRUST DOCTRINE, OUTER SPACE, AND THE GLOBAL COMMONS: TIME TO CALL HOME ET. [online] Lawreview.syr.edu. Available at: <https://lawreview.syr.edu/wp-content/uploads/2019/09/H-Babcock-Article-Final-Document-v2.pdf#page=67> [Accessed 15 December 2021] Professor Babcock served as general counsel to the National Audubon Society from 1987-91 and as deputy general counsel and Director of Audubon’s Public Lands and Water Program from 1981-87. Previously, she was a partner with Blum, Nash & Railsback, where she focused on energy and environmental issues, and an associate at LeBoeuf, Lamb, Leiby & MacRae where she represented utilities in the nuclear licensing process. From 1977-79, she served as a Deputy Assistant Secretary of Energy and Minerals in the U.S. Department of the Interior. Professor Babcock has taught environmental and natural resources law as a visiting professor at Pace University Law School and as an adjunct at the University of Pennsylvania, Yale, Catholic University, and Antioch law schools. Professor Babcock was a member of the Standing Committee on Environmental Law of the American Bar Association, and served on the Clinton-Gore Transition Team.)-rahulpenu

INTRODUCTION **Space** exploration is **heating up**. Governments and **private interests** are on a **fast track to develop tech**nologies to send people and equipment to celestial bodies, like the moon and asteroids, to extract their untapped resources.1 Near-space is rapidly filling up with public and private satellites, causing electromagnetic interference problems and dangerous space debris from collisions and earlier launches.2 The **absence of** a global **management** system for the private commercial development of outer space resources will allow these near space problems to be exported further into the galaxy.3 Moreover, **without** a governing authority or **rules** **controlling** entry **or limiting** despoliation, **outer space could turn into the “Wild West**” of the twenty-first century.4 Space treaties executed in the last century espoused the principle that space should be developed for the benefit of all mankind and banned both private ownership and militarization of space resources.5 But, they left development of a system for managing non-military activities in outer space to another day.6 Private commercial interests, which would be absorbing the risks and paying the high costs of space development, oppose any management scenario premised on that principle, as it would enable less developed countries to free ride on their investments.7 These interests, unsurprisingly, support privatizing outer space.8 But acceding to their wishes by establishing a system of property-based rules would transport Earth’s current division between haves and have-nots into outer space, and could lead to destabilizing hostilities—the exact consequences that the early treaty drafters hoped to avoid.9 To date, most scholars in this area have focused on developing management systems premised on private ownership or possession of the surface of some celestial body.10 This Article explores **an alternative concept, the commons**, in **which no individual owns the property** in question or can exclude others from it. Viewing property as a commons is closer to the principles set out in the various space treaties than implementation of a private property regime, and also **offers a workable property regime**. This Article demonstrates these conclusions by showing similarities between a large, Earth-bound commons, like the ocean and outer space, and how various **commons management** scenarios **allow equitable use of resources**, **while preventing** their **despoliation** **and devolution** into hostile disputes over entitlements to them. However, each of these commons management scenarios is flawed in some way and runs a similar risk to management approaches for private property of allowing the resource to be over-used or inequitably distributed. The public trust doctrine (**PTD**), an ancient doctrine that governments and individuals have **used effectively for centuries** to **protect the public’s interests** in terrestrial common pool resources (**CPR**) **and** to **fill** regulatory **gaps**, can be helpful in both respects.11 An examination of the doctrine identifies **commonalities** **between** outer **space** **and** **terrestrial** public trust **resources**.12 The **ease** and **low** **cost** of its implementation and enforcement, as well as its **infinite malleability**, are additional reasons to select it as a stopgap measure with some modification.13 This Article’s structure is straight forward. Part I acquaints the reader with the problem. It explains why the need to develop a management regime for space is becoming increasingly critical as advancing technology is allowing more and more private commercial interests to play at the edge of outer space with attendant negative externalities. 14 Soon these technological advances will allow **private** commercial **interests** to **invade** outer **space** with the potential for similar **adverse impacts**.15 Part II examines the international legal framework governing those activities and finds it lacks any capacity to regulate activities in outer space, in part because it is riddled with ambiguities and contradictions when it comes to ownership of outer space and its resources. Part III turns to that problem by discussing two types of property: private property and property owned in common with others. It examines the key features of each as well as their positive and negative attributes, how each might function in outer space, and what the consequences might be if one or the other prevailed. Because any property arrangement that results in its appropriation by the owner and the exclusion of others violates international space law, Part III also identifies various less-thanfull fee property arrangement, like leases and easements, to see if these problems can be avoided and concludes they cannot.16 It then examines property held in common to determine its viability under international space law and finds it consistent. Part IV investigates various approaches to managing property in outer space, be it held in private ownership or in common. Different approaches for managing private property in space are explored, including the right of first possession, tradable property claims, and establishing an exclusive economic zone, as well for managing an open access commons, such as the application of stewardship principles, norms, and the PTD. Each approach is evaluated in terms of its consistency with international law; its ability to promote and protect a sustainable, equitable, non-monopolistic, non-hostile environment in outer space; its efficiency; and its cost effectiveness. **Only** the **PTD**, which has been used for centuries to protect the public’s interests in CPRs and has **demonstrated** its **ability to adapt** to new circumstances, may be able to **meet** these **goals**.17 This Article finds commonalities between outer space and Earth-bound public trust resources, like the oceans. Additionally, the doctrine’s **open access** purpose **resonates with** language found in international **treaties** governing activities in outer space.18 This Article concludes that **using** the **PTD** will **lead to** a **durable, equitable management** regime in a commons where the wealthy are neither able to accumulate and control the resources that outer space has to offer nor over-exploit and deplete them. However, neither the doctrine nor ownership in common supplies any incentives for development, which may lead private enterprises to question whether development of outer space resources is worth the risks and costs.19 But, limited use of private property management approaches, like lotteries and tradable development claims—a form of overlapping hybridity between one type of property, a commons, and a management regime from another, private property—may fill this gap.20 This Article’s contribution to the literature on managing outer space resources and commons theory is using the PTD to bridge the gap between them and to suggest a hybrid management approach that melds commons theory with private property incentives.

## **Advantage: Sustainability**

### **Implementing the PTD for Private Appropriation results in a legally binding regime that curbs unsustainable development – ensures closing of legal loopholes.**

**Babcock 19** (, H., 2019. THE PUBLIC TRUST DOCTRINE, OUTER SPACE, AND THE GLOBAL COMMONS: TIME TO CALL HOME ET. [online] Lawreview.syr.edu. Available at: <https://lawreview.syr.edu/wp-content/uploads/2019/09/H-Babcock-Article-Final-Document-v2.pdf#page=67> [Accessed 15 December 2021] Professor Babcock served as general counsel to the National Audubon Society from 1987-91 and as deputy general counsel and Director of Audubon’s Public Lands and Water Program from 1981-87. Previously, she was a partner with Blum, Nash & Railsback, where she focused on energy and environmental issues, and an associate at LeBoeuf, Lamb, Leiby & MacRae where she represented utilities in the nuclear licensing process. From 1977-79, she served as a Deputy Assistant Secretary of Energy and Minerals in the U.S. Department of the Interior. Professor Babcock has taught environmental and natural resources law as a visiting professor at Pace University Law School and as an adjunct at the University of Pennsylvania, Yale, Catholic University, and Antioch law schools. Professor Babcock was a member of the Standing Committee on Environmental Law of the American Bar Association, and served on the Clinton-Gore Transition Team.)-rahulpenu

F. The Public Trust Doctrine (PTD) as a Gap Filling, Place-Holding Management Approach506 The **PTD** **offers** both an **approach for managing** **an open access commons** and a gap-filling tool until a regulatory regime is adopted.507 The doctrine is **based on** the idea that the “**sovereign holds certain common properties in trust** in perpetuity **for the free and unimpeded use of the general public**.”508 The public’s **r**ight **t**o **a**ccess and use trust resources is **never lost**, and **neither** the **government nor private individuals can alienate** or otherwise adversely affect **those resources** **unless for a comparable public purpose**.509 The **resources** the doctrine protects “have long been **part of** a ‘**taxonomy of property’** [that recognizes] the division of natural wealth into private and public property.”510 “The **doctrine places** on governments ‘an **affirmative**, ongoing **duty to safeguard** the **long-term preservation of** those **resources for the benefit of the general public**,’”511 thus limiting the sovereign’s power on behalf of both present and future individuals.512 It **directs** the **government to manage trust resources for public benefit, not private gain**.513 It applies to private as well as public resources and is used to preserve the public’s access to CPRs.514 Government agencies have the non-rescindable power to revoke uses of trust resources that are inconsistent with the doctrine.515 This effectively places a permanent easement over trust resources that burdens their ownership with an overriding public interest in the preservation of those resources.516 However, trust resources can be alienated in favor of private ownership, if the alienation will still serve the public’s interest in those resources and not interfere with trust uses of the remaining land.517 The **PTD**, therefore, **protects** the “**people’s common heritage**,”518 just as Article 11 of the Moon Treaty protects outer space as part of the common heritage of mankind.519 The doctrine also appears to be infinitely malleable. Original uses of the doctrine were restricted to only that “aspect of the public domain below the low-water mark on the margin of the sea and the great lakes, the waters over those lands, and the waters within rivers and streams of any consequence,”520 and covered only traditional uses of those lands, like fishing and navigation.521 Over time, the **scope** and **application of** the **doctrine broadened** to protect more public resources and different uses.522 Thus, the **doctrine** expanded **to protect new** trust **resources**, such as dry sand beaches, inland lakes, groundwater, dry riverbeds, and wildlife,523 **and passive uses** of those resources, like scientific study.524 The original link to navigable water and tidelands disappeared.525 Supporters of the doctrine successfully advocated that it be applied to “wildlife, parks, cemeteries, and even works of fine art,”526 while arguing more recently its application to the atmosphere.527 A doctrine that imposes a perpetual duty on the sovereign to preserve trust resources, prevents their alienation for private benefit, **assures public access** to them, **and can be invoked by anyone** seems particularly **useful as a management tool in outer space**.528 The fact that **public** **access** to trust resources is so **central** to the doctrine **makes** it **reflective**, not contradictory, **of** international space **law’s** **bar** **against** **appropriation** of outer space and of the principle of space being the “province of all mankind.”529 It **avoids** the problems of alienation and **exclusion** associated with any of the management approaches associated with some form of private property and requires neither the creation of a new administrative authority nor the presence of a close-knit group of like-minded people.530 Members of the public, both rich and poor, can invoke and enforce the doctrine as easily as the sovereign.531 It is cost effective to the extent that **no separate apparatus is required to implement** it, and the doctrine has shown itself to be **highly adaptable** and **innovative as different needs arise**.532 It could also fill the gap in international law with respect to managing celestial property. Therefore, of all the management approaches studied here, the **PTD** seems the **most suited to keep order in space** until a regulatory regime is imposed. However, the doctrine provides no incentives for development of trust resources; rather, it might be used to limit or curtail that development, making it an imperfect, perhaps even counter-productive solution by itself to the extent that such development might be beneficial.533 Modifying the doctrine to allow limited use of private property management approaches, like tradable development claims, might buffer that effect—a form of overlapping hybridity between one type of property, a commons, and a management regime from another, private property, enabled by application of the PTD. CONCLUSION “Only a legal system that accommodates both the human need for resources and the necessary preservation of mankind’s common heritage can fulfill these criteria.”534 The future is now with regard to the development of outer space and its resources—it is no longer a question of whether humans will engage in these activities, but how soon they will. Technically advanced countries and private commercial enterprises are probing outer space and preparing for landing on an asteroid or the moon to extract their resources.535 Speculators are selling deeds to the moon’s surface and preparing to exploit the tourism potential that space offers.536 But, the legal framework for managing these initiatives is almost nonexistent.537 International treaties came into being before all this activity began in earnest and national laws that might apply are stunted by jurisdictional quandaries like the absence of national boundaries in outer space.538 Thus, there is an urgency to figure out how to control what happens in outer space before its resources are irreparably damaged or permanently monopolized by powerful countries and individuals. In the absence of regulation, much of the current debate centers on what property regime should be applied in outer space.539 The assumption is that by only allowing private property rights in space, countries and commercial enterprises will undertake the risks and costs of space development.540 However, unless international space law changes, it may prevent this from happening. If it changes, strong management controls will be necessary to prevent destruction or over-consumption of celestial resources, as well as monopolization and competitive behavior by participants, which could lead to hostilities and inequities. This Article examines various private property regimes, including those of less than full fee ownership, to see if any would avoid the conflict with the international prohibition on appropriation of outer space and its resources. It concludes that none will because each retains the right to exclude and each is insensitive to the treaties’ equity concerns. In contrast, considering outer space to be common is consistent with international space law in both respects. Hypothesizing that private property in outer space may yet prevail, this Article investigates different private property management approaches, such as the right of first possession, lotteries, and tradable development rights, to see if any would be cost effective, easy to implement and equitable, and would also prevent over-consumption, monopolization or the slide into rivalrous behavior. The Article concludes that each comes up short in some respect. **Social norms as a management tool for property held in common,** although compliant with international law, are also not up to the task. Instead, although ancient, the PTD, with its malleability, easy and cost-effective implementation and enforcement, non-consumption principle, and consistency with the goals that animate international space treaties, seems best suited to the task of protecting the public’s interests in the global commons that is outer space as it has done for centuries in Earth-bound commons. But, as its principal terrestrial use has been to protect trust resources from development, the doctrine needs some modification to encourage development of celestial resources. Hence, this Article suggests that modifying **the PTD** to allow the application of private property management tools, like tradable development rights, **will** not only **allow development**, but also will **assure** that when it happens, **it will not be** just **profitable for a few**, **but will also be sustainable and equitable**.

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**States can pursue mutual benefits by viewing space as a commons**

**Silverstein & Panda ‘3/9 -** Benjamin Silverstein [research analyst for the Space Project at the Carnegie Endowment for International Peace. MA, International Relations, Syracuse University Maxwell School of Citizenship and Public Affairs BA, International Affairs, George Washington University] and Ankit Panda [Stanton Senior Fellow in the Nuclear Policy Program at the Carnegie Endowment for International Peace. AB, Princeton University], “Space Is a Great Commons. It’s Time to Treat It as Such.” *Carnegie Endowment for International Peace* (Web). March 9, 2021. Accessed Dec. 13, 2021. <<https://carnegieendowment.org/2021/03/09/space-is-great-commons.-it-s-time-to-treat-it-as-such-pub-84018>>

BUILDING ON PRIOR MODELS FOR MANAGING COMMONS¶ The histories of other great commons provide lessons on how to manage shared space resources meaningfully and effectively. Efforts to minimize damage to other great commons—like the Convention on Long-Range Transboundary Air Pollution and subsequent protocols—offer guidance on how to resolve compliance issues. Notably**, the negotiations on the original convention on air pollution in**volved, among others, the United States and the Soviet Union. Thi**s suggests that states can pursue mutual benefits in areas considered great commons even under competitive conditions.** More recent negotiations on the convention’s accompanying protocols show that these competing states can even agree on financing a monitoring regime to support progress.¶ Existing conventions and implementing agreements indicate that **states** can **reach valuable commitments to manage the Earth’s** grea**t commons. T**hese governance models protect state interests and preserve the commons themselves. These principles apply to space, but progress on establishing more encompassing space governance principles, enforcement mechanisms, and dispute resolution procedures hinges on states sharing the fundamental view that space is a great commons. Reaching such a consensus is an important first step.¶ New leadership in prominent spacefaring states can revitalize efforts to recognize space as a commons and can build on established legal standards to pursue commons-related principles for governing Earth orbits. Space actors do not have to resolve all their competing interests based on the debris problem. But negligence, mismanagement, or poorly designed rules may spell disaster for Earth orbits. As a more diverse range of actors with space-based interests emerges, no single actor will be able to unilaterally impose universal rules. States can, however, negotiate agreements to manage commons areas to better pursue national objectives. The only way to effectively govern state and commercial space activities is to settle on and abide by common norms or rules.¶ New conventions or regulatory mechanisms for governing Earth orbits will not appear overnight, but **states can build toward these goals by clarifying their commitments to treat space as a commons and pursuing governance arrangements that reflect this commitment.** New policies in the United States should reflect that Earth orbits are a great commons.

### **Its not too late to solve warming but PTD response is linear — delaying exponentially increases the likelihood of anthropogenic warming causing extinction.**

**Wood & Woodward ’16** — Mary Christina Wood, Philip H. Knight Professor at the University of Oregon School of Law and Faculty Director of the school’s Environmental and Natural Resources Law Program; Charles W. Woodward IV, J.D. University of Oregon School of Law; (2016; “ATMOSPHERIC TRUST LITIGATION AND THE CONSTITUTIONAL RIGHT TO A HEALTHY CLIMATE SYSTEM: JUDICIAL RECOGNITION AT LAST”; University of Michigan Libraries, Hein Online; *Washington Journal of Environmental Law & Policy*, Vol. 6, Issue 2, Article 14; //LFS—JCM)

Because humans today are both increasing **carbon emissions** into the atmosphere and also **destroying** the planet’s natural **carbon sinks**, the forests and oceans, the Earth’s climate system has lurched into a **perilous imbalance**.22 The dual, worsening crises of climate disruption and dying oceans cannot find relief without **slashing greenhouse gas emissions** across the globe. Though considerable climate harm is irrevocably underway, many leading scientists say **it is still possible** to restore climate equilibrium over the long term. Such an effort requires reducing atmospheric carbon dioxide levels to 350 parts per million (ppm), the uppermost level to limit total average **planetary heating** to a safe zone of one degree Celsius.23 In 2010, recognizing the need to quantify—for policymakers, judges, and citizens—the emissions reduction necessary to stay within the **safe zone**, NASA’s chief climate scientist, Dr. James Hansen, convened an international team of scientists to create a climate prescription for the planet.24

The resulting prescription addresses both carbon emissions and the planet’s natural carbon absorption mechanisms, as they are inextricably linked. The first part of the climate prescription calls for a dramatic slash of carbon emissions well beyond those targeted at COP21. The prescription presents a trajectory, or “glidepath,” of annual emissions reduction towards an ultimate goal of near-zero emissions.25 The team stated that global emissions reduction of six percent annually, beginning in year 2013, was required to reach 350 ppm by the end of the century.26 **Delaying** reduction in carbon emissions sharply **increases** the level of necessary yearly **reductions**—to a point at which the reductions ultimately become **too steep to plausibly salvage** a habitable planet.27 For example, the Hansen team estimated that, had concerted action started in 2005, emissions reduction of just 3.5% a year could have restored equilibrium by the end of the century, yet in just eight years of inaction, that figure climbed to six percent a year.28 The scientists project that, if emissions reduction is delayed until 2020, society would need to reduce emissions by fifteen percent a year.29 At some point, the necessary cuts become **too drastic** for global society **to accomplish**. As the Hansen team emphasized: “[I]t is **urgent** that large, long-term emissions **reductions begin soon**.” 30

Moreover, it is important to understand that **reducing emissions** alone is not adequate to restore **climate equilibrium**. Because approximately forty percent of emissions persist in the atmosphere for over a thousand years at present removal rates, any planetary atmospheric rescue effort must also focus on removing much of the carbon dioxide that has already accumulated in the atmosphere.31 Accordingly, the second part of the scientific climate prescription addresses the “drawdown” of carbon dioxide through massive **reforestation** (because trees naturally absorb carbon dioxide) and improved **agricultural measures** (because soil also absorbs carbon dioxide). The Hansen team calculated that a full-scale massive restoration program consisting of reforestation and soil measures can draw down about **100 gigatons of carbon dioxide** from the atmosphere, an amount key to restoring atmospheric carbon levels to 350 ppm.32

**<<<BEGIN FOOTNOTE 31>>>**

31. See William Moomaw, From Failure to Success: Reframing the Climate Treaty, THE FLETCHER FORUM OF WORLD AFFAIRS (Feb. 10, 2014), http://www.fletcherforum. org/2014/02/10/moomaw/. Only by restoring the Earth’s natural ability to remove carbon can overall atmospheric levels drop. As Professor William Moomaw explained, “We must not only **turn off the faucet** that is filling the atmosphere with heat trapping gases, but we must also **unclog the drain** that is removing them.” Id.

### **Warming causes extinction --- oxygen, disease, ice melt, and cognitive failure**

**McKibben 19** [Bill McKibben, Schumann Distinguished Scholar at Middlebury College, Fellow of the American Academy of Arts and Sciences, “This Is How Human Extinction Could Play Out,” Rolling Stone, April 9, 2019, https://www.rollingstone.com/politics/politics-features/bill-mckibben-falter-climate-change-817310]

Oh, it could get very bad.

In 2015, a study in the Journal of Mathematical Biology pointed out that if the world’s oceans kept **warm**ing, by 2100 they might become hot enough to “**stop oxygen production by phyto-plankton** by **disrupting the process of photosynthesis**.” Given that **two-thirds of the Earth’s oxygen** comes from phytoplankton, that would “likely **result in the mass mortality of animals and humans**.”

A year later, above the Arctic Circle, in Siberia, a heat wave thawed a reindeer carcass that had been trapped in the permafrost. The exposed body released anthrax into nearby water and soil, infecting two thousand reindeer grazing nearby, and they in turn infected some humans; a twelve-year-old boy died. As it turns out, permafrost is a “very good preserver of **microbes** and **viruses**, because it is cold, there is no oxygen, and it is dark” — scientists have managed to revive an eight-million-year-old bacterium they found beneath the surface of a glacier. Researchers believe there are fragments of the **Spanish flu** virus, **smallpox**, and **bubonic plague** buried in Siberia and Alaska.

Or consider this: as **ice sheets melt**, they take weight off land, and that can trigger **earthquakes** — seismic activity is already increasing in Greenland and Alaska. Meanwhile, the added weight of the new seawater starts to bend the Earth’s crust. “That will give you a massive increase in volcanic activity. It’ll activate faults to create earthquakes, submarine landslides, tsunamis, the whole lot,” explained the director of University College London’s Hazard Centre. Such a landslide happened in Scandinavia about eight thousand years ago, as the last Ice Age retreated and a Kentucky-size section of Norway’s continental shelf gave way, “plummeting down to the abyssal plain and creating a series of titanic waves that roared forth with a vengeance,” **wiping all** signs of **life** from coastal Norway to Greenland and “drowning the Wales-sized landmass that once connected Britain to the Netherlands, Denmark, and Germany.” When the waves hit the Shetlands, they were sixty-five feet high.

There’s even this: if we keep **rais**ing carbon dioxide levels, we **may not be able to think straight** anymore. At a thousand parts per million (which is within the realm of possibility for 2100), human **cognitive ability** falls 21 percent. “The largest effects were seen for Crisis Response, Information Usage, and Strategy,” a Harvard study reported, which is too bad, as those skills are what we seem to **need most**.

## **1AC Collisions**

### **Starlink is responsible for HALF of all dangerous space near-collisions – full mega constellation can make collisions ten times more likely and debris avoidance software doesn’t check.**

**Pultarova 21,** Tereza is a London-based science and technology journalist, aspiring fiction writer and amateur gymnast. Originally from Prague, the Czech Republic, she spent the first seven years of her career working as a reporter, script-writer and presenter for various TV programmes of the Czech Public Service Television. She later took a career break to pursue further education and added a Master's in Science from the International Space University, France, to her Bachelor's in Journalism and Master's in Cultural Anthropology from Prague's Charles University. She worked as a reporter at the Engineering and Technology magazine, freelanced for a range of publications including Live Science, Space.com, Professional Engineering, Via Satellite and Space News and served as a maternity cover science editor at the European Space Agency. “SpaceX Starlink satellites responsible for over half of close encounters in orbit, scientist says”, August 18, 2021,<https://www.space.com/spacex-starlink-satellite-collision-alerts-on-the-rise>, accessed 12/1/21,

Operators of satellite constellations are constantly forced to move their satellites because of encounters with other spacecraft and pieces of space junk. And, thanks to SpaceX's Starlink satellites, the number of such dangerous approaches will continue to grow, according to estimates based on available data. SpaceX's Starlink satellites alone are involved in about 1,600 close encounters between two spacecraft every week, that's about 50 % of all such incidents, according to Hugh Lewis, the head of the Astronautics Research Group at the University of Southampton, U.K. These encounters include situations when two spacecraft pass within a distance of 0.6 miles (1 kilometer) from each other. Lewis, Europe's leading expert on space debris, makes regular estimates of the situation in orbit based on data from the Socrates (Satellite Orbital Conjunction Reports Assessing Threatening Encounters in Space ) database. This tool, managed by Celestrack, provides information about satellite orbits and models their trajectories into the future to assess collision risk. Lewis publishes regular updates on Twitter and has seen a worrying trend in the data that reflects the fast deployment of the Starlink constellation. "I have looked at the data going back to May 2019 when Starlink was first launched to understand the burden of these megaconstellations," Lewis told Space.com. "Since then, the number of encounters picked up by the Socrates database has more than doubled and now we are in a situation where Starlink accounts for half of all encounters." The current 1,600 close passes include those between two Starlink satellites. Excluding these encounters, Starlink satellites approach other operators’ spacecraft 500 times every week. In comparison, Starlink's competitor OneWeb, currently flying over 250 satellites, is involved in 80 close passes with other operators' satellites every week, according to Lewis' data. And the situation is bound to get worse. Only 1,700 satellites of an expected constellation of tens of thousands have been placed into orbit so far. Once SpaceX launches all 12,000 satellites of its first generation constellation, Starlink satellites will be involved in 90% of all close approaches, Lewis’ calculations suggest. The risk of collision Siemak Hesar, CEO and co-founder of Boulder, Colorado, based Kayhan Space, confirms the trend. His company, which develops a commercial autonomous space traffic management system, estimates that on average, an operator managing about 50 satellites will receive up to 300 official conjunction alerts a week. These alerts include encounters with other satellites as well as pieces of debris. Out of these 300 alerts, up to ten might require operators to perform avoidance maneuvers, Hesar told Space.com. Kayhan Space bases their estimates on data provided by the U.S. Space Surveillance Network. This network of radars and telescopes, managed by the U.S. Space Force, closely monitors about 30,000 live and defunct satellites and pieces of debris down to the size of 4 inches (10 centimeters) and provides the most accurate location data of the orbiting objects. The size of this catalog is expected to increase ten times in the near future, Hesar added, partly due to the growth of megaconstellations, such as Starlink, and partly as sensors improve and enable detection of even smaller objects. The more objects in the catalog mean more dangerously close encounters. "This problem is really getting out of control," Hesar said. "The processes that are currently in place are very manual, not scalable, and there is not enough information sharing between parties that might be affected if a collision happens." Hesar compared the problem to driving on a highway and not knowing that there has been an accident a few miles ahead of you. If two spacecraft collide in orbit, the cloud of debris the crash generates would threaten other satellites travelling through the same area. "You want to have that situational awareness for the other actors that are flying in the neighbourhood," Hesar said. Bad decisions

Despite the concerns, only three confirmed orbital collisions have happened so far. Earlier this week, astrophysicist and satellite tracker Jonathan McDowell, who's based at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, found evidence in Space-Track data that the Chinese meteorological satellite Yunhai 1-02, which disintegrated in March this year, was actually hit by a piece of space debris. The worst known space collision in history took place in February 2009 when the U.S. telecommunication satellite Iridium 33 and Russia's defunct military satellite Kosmos-2251 crashed at the altitude of 490 miles (789 kilometres). The incident spawned over 1,000 pieces of debris larger than 4 inches (10 cm). Many of these fragments were then involved in further orbital incidents. Lewis is concerned that with the number of close passes growing, the risk of operators at some point making a wrong decision will grow as well. Avoidance maneuvers cost fuel, time and effort. Operators, therefore, always carefully evaluate such risks. A decision not to make an avoidance maneuver following an alert, such as that made by Iridium in 2009, could, however, clutter the orbital environment for years and decades. "In a situation when you are receiving alerts on a daily basis, you can't maneuver for everything," Lewis said. "The maneuvers use propellant, the satellite cannot provide service. So there must be some threshold. But that means you are accepting a certain amount of risk. The problem is that at some point, you are likely to make a wrong decision." Hesar said that uncertainties in the positions of satellites and pieces of debris are still considerable. In case of operational satellites, the error could be up to 330 feet (100 meters) large. When it comes to a piece of debris, the uncertainty about its exact position might be in the order of a mile or more. "This object can be anywhere in this bubble of multiple kilometres," Hesar said. "At this point, and for the foreseeable future, avoidance is our best recourse. People that say 'I'm going to take the risk', in my humble opinion, that's an irresponsible thing to do." Starlink monopoly Lewis is concerned about the growing influence of a single actor — Starlink — on the safety of orbital operations. Especially, he says, as the spaceflight company has entered the satellite operations world only recently. "We place trust in a single company, to do the right thing," Lewis said. "We are in a situation where most of the maneuvers we see will involve Starlink. They were a launch provider before, now they are the world's biggest satellite operator, but they have only been doing that for two years so there is a certain amount of inexperience." SpaceX relies on an autonomous collision avoidance system to keep its fleet away from other spacecraft. That, however, could sometimes introduce further problems. The automatic orbital adjustments change the forecasted trajectory and therefore make collision predictions more complicated, according to Lewis. "Starlink doesn't publicize all the maneuvers that they're making, but it is believed that they are making a lot of small corrections and adjustments all the time," Lewis said. "But that causes problems for everybody else because no one knows where the satellite is going to be and what it is going to do in the next few days."

### **Starlink generates aluminum oxide upon entry and reentry – that causes a new hole in the ozone**

**Delbert 21,** Caroline Delbert is a writer, book editor, researcher, and avid reader. “All the Satellites in Space Could Crack Open the Ozone Layer”, https://www.popularmechanics.com/space/satellites/a36651845/satellite-pollution-starlink-ozone/, JUN 17, 2021, accessed 12/1/21,

The hole in the ozone layer, Earth’s protective chemical shield that absorbs most of the sun’s ultraviolet rays, has slowly healed over the last few decades since the global ban of chlorofluorocarbons (CFCs). But scientists are now raising the alarm about puncturing a new hole in the ozone layer—this time without any noticeable CGCs in sight. Instead, the surprising cause is deterioration of the aluminum in megaconstellation satellites like SpaceX’s Starlink network. For our purposes, a satellite is a human-made object put into low-Earth orbit (LEO) for a planned lifespan. There are about 5,000 active and defunct satellite sin LEO, with over 40,000 Starlink sats planned in the future, plus satellite projects from national space agencies and private companies around the world, researchers from the University of British Columbia say in their new Scientific Reports study. The human-made distinction may seem obvious, but it hasn’t always been. That’s because, as Space.com reports, scientists spent decades favorably comparing satellite “junk” to the amount of material deposited and burned up in our atmosphere by meteorites. As long as meteorites were so much more of the material by volume while doing almost no harm to the planet, how bad could human-made satellites be? Well, as it turns out, it’s a matter of quality rather than quantity. That’s because meteorites are made of a different constellation of minerals and elements than our custom-manufactured sky robots. “We have 54 tonnes (60 tons) of meteoroid material coming in every day,” lead study author Aaron Boley told Space.com. “With the first generation of Starlink, we can expect about 2 tonnes (2.2 tons) of dead satellites reentering Earth’s atmosphere daily. But meteoroids are mostly rock, which is made of oxygen, magnesium and silicon. These satellites are mostly aluminum, which the meteoroids contain only in a very small amount, about 1 [percent].” Aluminum is key to everything at stake here. First, it burns into reflective aluminum oxide, or alumina, which could turn into an unwitting geoengineering experiment that could alter Earth’s climate. And second, aluminum oxide could damage and even rip a new hole in the ozone layer. Let’s look at each threat separately and try to figure it out. Misadventures in Geoengineering Geoengineering is the umbrella term for technologies that seek to alter the climate or other physical realities about the planet. The major meaning that most people associate with the word is solar geoengineering, an experimental idea to fight climate change. Yes, this includes launching reflective aerosols that will “block the sun” back into space and ostensibly cool the planet, which is what Bill Gates eventually wants to try. But we just don’t know how large-scale geoengineering could affect the planet’s climate. (In the sci-fi flick Snowpiercer, geoengineering has turned Earth into a lifeless iceball whose only survivors must crowd aboard an unceasing train. That’s probably our worst-case scenario.) Aluminum oxide scatters more light than glass, with a refractive index of about 1.76 compared with just 1.52 for glass and about 1.37 for plain aluminum. The researchers write: “Anthropogenic deposition of aluminum in the atmosphere has long been proposed in the context of geoengineering as a way to alter Earth’s albedo. These proposals have been scientifically controversial and controlled experiments encountered substantial opposition. Mega-constellations [of satellites] will begin this process as an uncontrolled experiment.” Another Hole in the Ozone? What, then, of the ozone layer? Once again, aluminum oxide comes to the forefront. As aluminum burns, it can chemically react with ozone in the air to form aluminum oxide, thereby depleting the naturally protective supply of ozone in the atmosphere. The atmosphere can absorb a small amount of these chemicals without ill effect, but with tens of thousands of satellites in play, the quantities will naturally go up. That’s in addition to the ozone damage done by each rocket launch to put satellites into LEO. “Rockets threaten the ozone layer by depositing radicals directly into the stratosphere, with solid-fueled rockets causing the most damage because of the hydrogen chloride and alumina they contain,” the researchers write. While satellites typically dissolve above the stratosphere where most ozone is contained, the particulate can drift down into the stratosphere in order to react there with ozone, scientist Gerhard Drolshagen, an expert on meteoroid material, told Space.com. Aluminum oxide will sink to that level and subsequently cause losses.

### **Ozone depletion causes extinction**

#### **Gareau,** B. J. (20**13,** February 8). *Whatever happened to ozone layer politics?* E. Retrieved December 2, 2021, from https://www.e-ir.info/2013/01/29/whatever-happened-to-ozone-layer-politics/.

The [Montreal Protocol on Substances that Depletes the Ozone Layer](http://ozone.unep.org/pdfs/Montreal-Protocol2000.pdf) (1997) is arguably the most successful global environmental agreement ever created. **The ozone layer is the Earth’s sunscreen, absorbing** up to **99 per cent of the sun’s** ultraviolet (**UV) radiation.** **Without it, life on earth would not exist.** The Montreal Protocol was created to eliminate human-made chemicals that destroy the ozone layer, what we call “ozone-depleting substances” (ODSs). ODSs destroy the ozone layer, thus allowing more UV radiation to hit the surface and increasing skin cancer and skin disease rates, eye cataracts, damage to the immune system, and sunburn in humans and other animals. The Protocol sought to put a halt to such harmful effects, chiefly to rid the world of chlorofluorocarbons, or CFCs.

The most famous ozone holes occur over the Antarctic. In 2006, an Antarctic ozone hole reached a record 11.4 million square miles wide, larger than all of North America. While it mostly covers uninhabited land, the Antarctic ozone hole does reach some populated areas in South America as it is quite mobile. The Arctic hole, a newer phenomenon, has a potentially larger impact on humans. The 2011 Arctic ozone hole moved from the North Pole into Scandinavia and Greenland. The World Meteorological Organization cautioned habitants to protect themselves from the strong UV rays. Parts of Canada and Russia have also been affected lately. It is possible that “ozone depleted air” will move south with the Arctic polar vortex, potentially reaching northern Italy, New York, and San Francisco.