

1AC

1AC---Debris

Incoming mega-constellations of satellites ensure unmanageable space debris, triggering the Kessler Syndrome. No alt causes---current debris is being managed but constellations push Kessler over the brink.

Boley & Byers 21 [Aaron C., Department of Physics and Astronomy @ The University of British Columbia*, and Michael, Department of Political Science @ The University of British Columbia; Published: 20 May 2021; Scientific Reports; "Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth," <https://www.nature.com/articles/s41598-021-89909-7>] brett

Companies are placing satellites into orbit at an unprecedented frequency to build 'mega-constellations' of communications satellites in Low Earth Orbit (LEO). In two years, the number of active and defunct satellites in LEO has increased by over 50%, to about 5000 (as of 30 March 2021). SpaceX alone is on track to add 11,000 more as it builds its Starlink mega-constellation and has already filed for permission for another 30,000 satellites with the Federal Communications Commission (FCC)¹. Others have similar plans, including OneWeb, Amazon, Telesat, and GW, which is a Chinese state-owned company². The current governance system for LEO, while slowly changing, is ill-equipped to handle large satellite systems. Here, we outline how applying the consumer electronic model to satellites could lead to multiple tragedies of the commons. Some of these are well known, such as impediments to astronomy and an increased risk of space debris, while others have received insufficient attention, including changes to the chemistry of Earth's upper atmosphere and increased dangers on Earth's surface from re-entered debris. The heavy use of certain orbital regions might also result in a de facto exclusion of other actors from them, violating the 1967 Outer Space Treaty. All of these challenges could be addressed in a coordinated manner through multilateral law-making, whether in the United Nations, the Inter-Agency Debris Committee (IADC), or an ad hoc process, rather than in an uncoordinated manner through different national laws. Regardless of the law-making forum, mega-constellations require a shift in perspectives and policies: from looking at single satellites, to evaluating systems of thousands of satellites, and doing so within an understanding of the limitations of Earth's environment, including its orbits.

Thousands of satellites and 1500 rocket bodies provide considerable mass in LEO, which can break into debris upon collisions, explosions, or degradation in the harsh space environment. Fragmentations increase the cross-section of orbiting material and with it, the collision probability per time. Eventually, collisions could dominate on-orbit evolution, a situation called the Kessler Syndrome³. There are already over 12,000 trackable debris pieces in LEO, with these being typically 10 cm in diameter or larger. Including sizes down to 1 cm, there are about a million inferred debris pieces, all of which threaten satellites, spacecraft and astronauts due to their orbits crisscrossing at high relative speeds. Simulations of the long-term evolution of debris suggest that LEO is already in the protracted initial stages of the Kessler Syndrome, but that this could be managed through active debris removal⁴. The addition of satellite mega-constellations and the general proliferation of low-cost satellites in LEO stresses the environment further^{5,6,7,8}.

Results

The overall setting

The rapid development of the space environment through mega-constellations, predominately by the ongoing construction of Starlink, is shown by the cumulative payload distribution function (Fig. 1). From an environmental perspective, the slope change in the distribution function defines NewSpace, an era of dominance by commercial actors. Before 2015, changes in the total on-orbit objects came principally from fragmentations, with effects of the 2007 Chinese anti-satellite test and the 2009 Kosmos 2251/Iridium 33 collisions being evident on the graph.

Figure 1

(Figure 1 omitted)

Cumulative on-orbit distribution functions (all orbits). Deorbited objects are not included. The 2007 and 2009 spikes are a Chinese anti-satellite test and the Iridium 33-Kosmos 2251 collision, respectively. The recent, rapid rise of the orange curve represents NewSpace (see "Methods").

Full size image

Although the volume of space is large, individual satellites and satellite systems have specific functions, with associated altitudes and inclinations (Fig. 2). This increases congestion and requires active management for station keeping and collision avoidance⁹, with automatic collision-avoidance technology still under development. Improved space situational awareness is required, with data from operators as well as ground- and space-based sensors being widely and freely shared¹⁰. Improved communications between satellite operators are also necessary: in 2019, the European Space Agency moved an Earth observation satellite to avoid colliding with a Starlink satellite, after failing to reach SpaceX by e-mail. Internationally adopted 'right of way' rules are needed¹⁰ to prevent games of 'chicken', as companies seek to preserve thruster fuel and avoid service interruptions. SpaceX and NASA recently announced¹¹ a cooperative agreement to help reduce the risk of collisions, but this is only one operator and one agency.

Figure 2

(Figure 2 omitted)

Orbital distribution and density information for objects in Low Earth Orbit (LEO). (Left) Distribution of payloads (active and defunct satellites), binned to the nearest 1 km in altitude and 1° in orbital inclination. The centre of each circle represents the position on the diagram, and the size of the circle is proportional to the number of satellites within the given parameter space. (Right) Number density of different space resident objects (SROs) based on 1 km radial bins, averaged over the entire sky. Because SRO objects are on elliptical orbits, the contribution of a given object to an orbital shell is weighted by the time that object spends in the shell. Despite significant parameter space, satellites are clustered in their orbits due to mission requirements. The emerging Starlink cluster at 550 km and 55° inclination is already evident in both plots (Left and Right).

Full size image

When completed, Starlink will include about as many satellites as there are trackable debris pieces today, while its total mass will equal all the mass currently in LEO—over 3000 tonnes. The satellites will be placed in narrow orbital shells, creating unprecedented congestion, with 1258 already in orbit (as of 30 March 2021). OneWeb has already placed an initial 146 satellites, and Amazon, Telesat, GW and other companies, operating under different national regulatory regimes, are soon likely to follow.

Enhanced collision risk

Mega-constellations are composed of mass-produced satellites with few backup systems. This consumer electronic model allows for short upgrade cycles and rapid expansions of capabilities, but also considerable discarded equipment. SpaceX will actively de-orbit its satellites at the end of their 5–6-year operational lives. However, this process takes 6 months, so roughly 10% will be de-orbiting at any time. If other companies do likewise, thousands of de-orbiting satellites will be slowly passing through the same congested space, posing collision risks. Failures will increase these numbers, although the long-term failure rate is difficult to project. Figure 3 is similar to the righthand portion of Fig. 2 but includes the Starlink and OneWeb mega-constellations as filed (and amended) with the FCC (see "Methods"). The large density spikes show that some shells will have satellite number densities in excess of $n=10^{-6} \text{ km}^{-3}$.

Figure 3

[Figure 3 omitted]

Satellite density distribution in LEO with the Starlink and OneWeb mega constellations as filed (and amended) with the FCC. Provided that the orbits are nearly circular, the number densities in those shells will exceed 10–6 km⁻³. Because the collisional cross-section in those shells is also high, they represent regions that have a high collision risk whenever debris is too small to be tracked or collision avoidance manoeuvres are impossible for other reasons.

Full size image

Deorbiting satellites will be tracked and operational satellites can manoeuvre to avoid close conjunctions. However, this depends on ongoing communication and cooperation between operators, which at present is ad hoc and voluntary. A recent letter¹² to the FCC from SpaceX suggests that some companies might be less-than-fully transparent about events¹³ in LEO.

Despite the congestion and traffic management challenges, FCC filings by SpaceX suggest that collision avoidance manoeuvres can in fact maintain collision-free operations in orbital shells and that the probability of a collision between a non-responsive satellite and tracked debris is negligible. However, the filings do not account for untracked debris⁶, including untracked debris decaying through the shells used by Starlink. Using simple estimates (see “Methods”), the probability that a single piece of untracked debris will hit any satellite in the Starlink 550 km shell is about 0.003 after one year. Thus, if at any time there are 230 pieces of untracked debris decaying through the 550 km orbital shell, there is a 50% chance that there will be one or more collisions between satellites in the shell and the debris. As discussed further in “Methods”, such a situation is plausible. Depending on the balance between the de-orbit and the collision rates, if subsequent fragmentation events lead to similar amounts of debris within that orbital shell, a runaway cascade of collisions could occur.

Fragmentation events are not confined to their local orbits, either. The India 2019 ASAT test was conducted at an altitude below 300 km in an effort to minimize long-lived debris. Nevertheless, debris was placed on orbits with apogees in excess of 1000 km. As of 30 March 2021, three tracked debris pieces remain in orbit¹⁴. Such long-lived debris has high eccentricities, and thus can cross multiple orbital shells twice per orbit. A major fragmentation event from a single satellite could affect all operators in LEO.

Even if debris collisions were avoidable, meteoroids are always a threat. The cumulative meteoroid flux¹⁵ for masses $m > 10^{-2}$ g is about 1.2×10^{-4} meteoroids m^{-2} year⁻¹ (see “Methods”). Such masses could cause non-negligible damage to satellites¹⁶. Assuming a Starlink constellation of 12,000 satellites (i.e. the initial phase), there is about a 50% chance of 15 or more meteoroid impacts per year at $m > 10^{-2}$ g. Satellites will have shielding, but events that might be rare to a single satellite could become common across the constellation.

One partial response to these congestion and collision concerns is for operators to construct mega-constellations out of a smaller number of satellites. But this does not, individually or collectively, eliminate the need for an all-of-LEO approach to evaluating the effects of the construction and maintenance of any one constellation.

No alt causes or thumpers---absent megaconstellations, LEO debris would increase slowly for decades, eventually stabilizing after 200 years. Prefer NASA studies that assume our plan.

---1 collision a decade is hardly enough to trigger Kessler syndrome.

Liou et al. 18 [Dr. J.-C. Liou is the NASA Chief Scientist for Orbital Debris; Matney M., NASA Johnson Space Center; Vavrin A., GeoControl Systems – Jacobs JETS Contract; Manis A., HX5 – Jacobs JETS Contract, NASA Johnson Space Center; Gates D., Jacobs Technology, NASA Johnson Space Center, Orbital Debris Quarterly News, 2018; “NASA ODPO’s Large Constellation Study,” <https://www.orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv22i3.pdf>] brett

In recent years, several commercial companies have proposed telecommunications constellations consisting of hundreds to thousands of 100-to-300-kg class spacecraft in low Earth orbit (LEO, the region below 2000-km altitude). If deployed, such large constellations (LCs) will dramatically change the landscape of satellite operations in LEO. Fig. 1 shows the current mass distribution in LEO. The top blue histogram shows the total and the three curves below show a breakdown by object type (spacecraft, rocket bodies, or other). The mass distribution is dominated by spacecraft and upper stages (i.e., rocket bodies). The yellow bars from 1100 km to 1300 km altitudes show the notional mass distribution from 8000 150 kg LC spacecraft or, equivalently, 4000 300 kg LC spacecraft. From the large amount of mass involved, it is clear that the deployment, operations, and frequent de-orbit and replenishment of the proposed LCs could significantly contribute to the existing orbital debris problem.

To better understand the nature of the problem, the NASA Orbital Debris Program Office (ODPO) recently completed a parametric study on LCs. The objective was to quantify the potential negative debris-generation effects from LCs to the LEO environment and provide recommendations for mitigation measures. The tool used for the LC study was the ODPO’s LEO-to-GEO Environment Debris (LEGEND) numerical simulation model, which has been used for various mitigation and remediation studies in the past [1, 2]. For the LC study, more than 300 scenarios based on different user-specified assumptions and parameters were defined. Selected results from key scenarios are summarized in this article.

The LEO Environment without Large Constellations

To establish a benchmark to assess the effects from LCs, several baseline scenarios were completed first. Fig. 2 shows the environment projection without LCs. The historical curve reflects the documented launches and breakup events between 1957 and 2015. The antisatellite test conducted by China and the accidental collision between Iridium 33 and Cosmos 2251 were the reasons for the jump in 2007 and 2009, respectively. Future launch traffic is a repeat of the launches over the last 8 years of the historical space activities (2008-2015). The environment is projected 200 years into the future, through the year 2215.

Each future projection curve is the average of 100 LEGEND Monte Carlo (MC) simulation runs. The top red curve is the result of a non-mitigation scenario where LEO-crossing upper stages and spacecraft are left at mission altitudes at the end of mission operations rather than conducting postmission disposal (PMD) maneuvers to lower their orbits to follow the 25-year decay rule. Upper stages and spacecraft are also assumed to explode in the future with accidental explosion probabilities derived from the historical explosion events. The middle black-dashed curve is the result of a scenario where LEO-crossing upper stages and spacecraft are assumed to follow the 25-year decay rule at the end of their missions with a PMD reliability of 90%. The bottom blue-dotted curve is the result of a scenario where, in addition to the 90% PMD success rate, no explosions occur in the future.

As expected, the non-mitigation scenario leads to a rapid LEO population increase over time, with an approximately 330% increase in 200 years, i.e., from the beginning of 2016 to the end of 2215. The non-linear increase is also an indication of the collision feedback effect in the environment. With a global 90% PMD implementation of the 25-year decay rule, however, the debris population growth is reduced to about a 110% linear increase in 200 years. If explosions can be eliminated, the population growth is further reduced to 40% in 200 years.

Fig. 3 shows the cumulative numbers of catastrophic collisions involving 10 cm and larger objects over time. A catastrophic collision occurs when the ratio of impact kinetic energy to target mass exceeds 40 J/g. The outcome of a catastrophic [FIGURES OMITTED] collision is the total fragmentation of the target, whereas a non-catastrophic collision only results in minor damage to the target and generates a small amount of debris that should have negligible contribution to the long-term debris population increase. Again, the non-mitigation scenario leads to a non-linear increase of catastrophic collisions, a total of 61 in 200 years, whereas the effective implementation of PMD and additionally, elimination of future explosions can reduce the numbers of catastrophic collisions to 27 and 21, respectively, in 200 years. The increases in effective number of objects and catastrophic collisions for the 90% PMD scenarios, with future explosions, are used to benchmark the effects when LCs are added to the simulated environment as described in the sections below.

Increasing debris triggers miscalculated war. The internal link is linear---any reduction in debris reduces the risk.

Dockrill 16 [Peter; 2016; Award-winning science & technology journalist. "Space Junk Accidents Could Trigger Armed Conflict, Study Finds." <https://www.sciencealert.com/space-junk-accidents-could-trigger-armed-conflict-expert-warns>] brett

The increasingly crowded space in Earth's low orbit could set the stage for an international armed conflict, says a new study. Researchers from the Russian Academy of Sciences warn that accidents stemming from the steady rise in space junk floating around the planet could incite political rows and even war, with nations potentially mistaking debris-caused incidents as the results of intentional aggressive acts by others. In a paper published in Acta Astronautica, the team suggests that space debris in the form of spent rocket parts and other fragments of hardware hurtling at high speed pose a "special political danger" that could dangerously escalate tensions between nations. According to the study, destructive impacts caused by random space junk cannot easily be told apart from military attacks. "The owner of the impacted and destroyed satellite can hardly quickly determine the real cause of the accident," the authors write. The risks of such an event occurring are compounded by the sheer volume of debris now orbiting Earth. Recent figures from NASA indicate that there are more than 500,000 pieces of space junk currently being tracked in orbit, travelling at speeds up to 28,160 km/h (17,500 mph). The majority of those objects are small – around the size of a marble – but some 20,000 of them are bigger than a softball. In addition to these 500,000 or so fragments – which are big enough for scientists to know about them – NASA estimates that there are millions of undetectable pieces of debris in orbit that are too small to be monitored. But even extremely small fragments such as these pose a threat – in fact, they're considered a greater risk than trackable debris, as their invisible status means spacecraft and satellites can't do anything to avoid them until it's too late. As NASA observed in 2013: "Even tiny paint flecks can damage a spacecraft when travelling at these velocities. In fact a number of space shuttle windows have been replaced because of damage caused by material that was analysed and shown to be paint flecks... With so much orbital debris, there have been surprisingly few disastrous collisions." While we may have been lucky in the past, we can't rely on that to continue. The study by the Russian team cites the repeated sudden failures of defence satellites in past decades that were never explained. The researchers attribute two possible causes: either unrecorded collisions with space junk, or aggressive actions from adversaries. "This is a politically dangerous dilemma," the authors write.

It goes nuclear.

Johnson 14 [Les, Baen science fiction author, popular science writer, and NASA technologist. "Living without satellites".

https://www.baen.com/living_without_satellites.] brett

Satellite imagery is used by the military and our political leaders to maintain the peace. When your potential adversaries can't hide what they're doing, where their armies are moving and what they are doing with their civilian and military infrastructure, then the danger of surprise attack is diminished. In our nuclear age with instant death only minutes away by missile attack, the doctrine of Mutual Assured Destruction (MAD) only works if both sides know whether or not they are being attacked. The launch of missiles or a bomber fleet can easily be seen from space far in advance of either reaching their potential targets halfway around the globe. The danger of surprise attack is therefore small, making an accidental war far less likely. So what does all this mean? And what do we do about it? First of all, it means that the advocates of space development, exploration and commercialization have succeeded far beyond their initial expectations and dreams. The economies and security of countries in the developed world are now dependent on space satellites. We space advocates should celebrate our success and be terrified of it at the same time. Should we lose these fragile assets in space, our economy would experience a disruption like no other: ship, air and train travel would stop and only restart/operate in a much-reduced capacity for years (GPS loss). Many banking and retail transactions would cease (VSAT loss). Distribution of news and vital national information would be crippled (communications satellite loss). Lives would be put at risk and the productivity of our farming would dramatically decrease (weather satellite loss). The risk of war, including nuclear war, would increase (loss of spy satellites) and our military's ability to react to crises would be significantly reduced (loss of military logistics and intelligence gathering satellites).

Nuclear war causes extinction.

Trevithick and Rogoway '19 [Joseph and Tyler; February 27; Military Analyst, M.A. in Conflict Resolution from Georgetown

University, B.A. in the History and Policy of International Relations at Carnegie-Mellon University; Defense Journalist; The Drive, "Yes, India And Pakistan Could End The World As We Know It Through A Nuclear Exchange,"

<https://www.thedrive.com/the-war-zone/26674/yes-india-and-pakistan-could-end-the-world-as-we-know-it-through-a-nuclear-exchange>
e] brett

A global threat

India and Pakistan's nuclear arsenals are tiny compared to those of the United States and Russia, and these weapons are focused primarily on deterring each other, but that does not mean they're purely regional threats. Unlike conventional weapons, nuclear weapons create lasting and far-reaching effects that scientists have posited could upend life on Earth if warring parties were to use them in sufficient numbers.

In 2012, Alan Robock, a distinguished professor in the Department of Environmental Sciences and Associate Director of the Center for Environmental Prediction at Rutgers University, and Owen Brian Toon, a professor in the Department of Atmospheric and Oceanic Sciences and a research associate at the Laboratory for Atmospheric and Space Physics at the University of Colorado, Boulder, argued that it might not take a large amount of nuclear weapons to create a scenario commonly known as "Nuclear Winter."

In general, this hypothesized event occurs when smoke and soot from nuclear explosions block significant amounts of sunlight from reaching the earth's surface, leading to a precipitous drop in temperatures that results in mass crop failure and widespread famine.

Robcock and Toon summarized their findings, which were based in part on their previous work, in an article in the Bulletin of The Atomic Scientists, writing:

"Even a 'small' nuclear war between India and Pakistan, with each country detonating 50 Hiroshima-size atom bombs – only about 0.03 percent of the global nuclear arsenal's explosive power – as airbursts in urban areas, could produce so much smoke that temperatures would fall below those of the little ice age of the fourteenth to nineteenth centuries, shortening the growing season around the world and threatening the global food supply. Furthermore, there would be massive ozone depletion, allowing more ultraviolet radiation to reach Earth's surface. Recent studies predict that agricultural production in parts of the United States and China would decline by about 20 percent for four years, and by 10 percent for a decade.

The bomb the United States dropped on Hiroshima Japan, known as Little Boy, was an inefficient and essentially experimental design with a yield of around 15 kilotons. The reported results from Indian and Pakistani nuclear testing indicate that both countries can meet this threshold and both countries' weapons programs have almost certainly matured in the decades since.

In previous studies, Robcock, working with others, postulated that temperature changes could begin within 10 days of a limited nuclear exchange and the effects from the detonations of 100 nuclear weapons in the 15-kiloton class would directly result in the deaths of at least 20 million people. The second order impacts would be even worse in the years that followed.

In 2014, Michael Mills and Julia Lee-Taylor, both then working at the federally-funded National Center for Atmospheric Research's (NCAR) Earth System Laboratory, authored another paper with Robcock and Toon. This study concluded again that detonation of 100 15-kiloton yield bombs in a purely regional conflict would result in "multi-decadal global cooling" and "would put significant pressures on global food supplies and could trigger a global nuclear famine."

It is important to note that critics have questioned whether the Nuclear Winter concept relies on too many assumptions and would ever actually occur. At the center of many of these rebuttals are debates about whether the nuclear explosions would truly create the amount of smoke and soot necessary for major climate change, as well as the specific conditions for those particles to remain in the atmosphere for a prolonged period of time.

The studies here do indicate significant impacts based on a relatively limited number of nuclear detonations of smaller yield devices, though. But even if the impacts are less pronounced than projected in this particular scenario, they could be far more severe if India and Pakistan were to use a larger number weapons and/or ones of higher yields, which both belligerents readily have.

In addition, Nuclear Winter is just one of the potential things that might happen following a nuclear exchange between the longtime foes. A detonation of dozens of nuclear weapons, even small ones, would throw hazardous nuclear fallout into the air that, depending on the weather pattern, could carry that material far and wide, causing both near- and short-term health impacts. The various ground zeroes themselves would be irritated and potentially hazardous for many years to come.

Depending on where the detonations occur, a nuclear exchange could potentially cut people off from critical water and food supplies, putting increased and potentially unsustainable strains on uncontaminated areas. After the Chernobyl nuclear power plant, situated in Ukraine, melted down and exploded in 1986, authorities established a 1,000 square mile restricted access "exclusion zone" that remains in place today.

There would also be a major danger of second-order "spillover" effects, as individuals fled affected areas, putting economic and political strains on neighboring regions. This could inflame existing tensions not directly related to the inter-state conflict between India or Pakistan or lead to all new and potentially violent competition for what might already be limited resources. India has already threatened to weaponize water access in its latest spat with the Pakistanis.

Any serious impacts on food and water supplies, or other economic upheavals as a direct or indirect result of the conflict, would have cascading impact across South Asia and beyond, as well. The very threat of a potential India-Pakistan war of any kind already caused some negative reactions in regional financial markets. Those

markets would certainly collapse after an unprecedented nuclear exchange actually occurred, and that is before the long-term physical impacts of such an event would even manifest themselves.

Overall, we are talking about a sudden and dramatic geopolitical, financial, and environmental shift that would change our reality in a matter of hours. Even then, the darkness, both figuratively and literally, that could propagate over the weeks, months, and years would be far more damaging.

How great is the risk?

So far, India and Pakistan have not made any clear indications that the fighting is close to crossing their nuclear thresholds. Pakistan's warnings about the risks of escalation seem more calculated to try and prompt India to back down.

India itself has a so-called "no first use" policy, which means it has publicly pledged to use its nuclear weapons only in retaliation to a nuclear strike. However, experts have increasingly called into question whether this is truly the case and whether India might be developing delivery systems more suited to a first strike should there be a need to shift policies.

Pakistan, however, does not have a no first use policy and has insisted on its right to employ nuclear weapons to defend itself even in the face of purely conventional threat. Pakistani officials have, in the past, specifically cited this policy as way of deterring India, which has a much larger and in some cases more advanced conventional force, and preventing larger wars.

The concern, then, is that this policy appears to have failed, at least to some degree, with India's strike on undisputed Pakistani territory on Feb. 26, 2019. India, however, did not target Pakistani forces in that instance and exchanges between the two countries have been limited, at least so far, to the disputed Jammu and Kashmir region, where violent skirmishes occur semi-regularly without precipitating a larger confrontation.

We can only hope that the two countries will find a diplomatic solution to this latest conflict and avoid any further escalation. If things were to spiral out of control and lead to the use of nuclear weapons, it would be something that would threaten all of humanity.

Cascading debris collapses satellites.

Kessler et al., 18 [Donald J. Kessler* American astrophysicist and former NASA scientist known for his studies regarding space debris. Kessler has received numerous awards for his pioneering work, the most recent being the 2010 Dirk Brower Award for his half-century career in astrodynamics. Dr. Holder Krag** Head of the Space Debris Office at the European Space Agency and has been a Space Debris Analyst in the Space Debris Office since 2006. Asher Isbrucker***, Writer & Video Producer; 11-2-2018; "Kessler Syndrome: What Happens When Satellites Collide," Medium, <https://asherkaye.medium.com/kessler-syndrome-what-happens-when-satellites-collide-1b571ca3c47e>] brett

Donald Kessler: The worst case scenario is that you end up creating enough debris that it's not cost-effective to depend on space. Now, that may take a long time, but because it's a non-reversible process once you've reached a certain threshold where you're generating debris from these collisions faster than it can be cleaned out, it'll just continually get worse unless you can do something drastic. Holger Krag: If we continue operating the way we do today, we will have a disaster in 50 years, in 100 years. It compares quite nicely to the CO2 issue, and the climate on ground, so it's not our generation suffering from all the CO2 released into the atmosphere, it is future generations, but it is our generation that has to take the action. And the space debris problem is quite similar. DK: My name's Don Kessler, I worked for NASA till 1996 as the senior researcher for orbital debris. I started the program back in 1979, and the program is still very active today. In the 1960s my main job was to define the interplanetary meteoroid environment. At the time, the only space debris NASA had to be concerned about were meteoroids, many of which are generated from collisions in the asteroid belt. These asteroid collisions are a cascading phenomenon, meaning every collision creates more ammunition for future collisions. It's a positive feedback loop. Don was studying this phenomenon when he started to consider an interesting question: DK: When will the same phenomenon start happening in the Earth's orbit? When will this same kind of cascading occur with satellites? And it was just a matter of curiosity as to what that number may be, and actually when I did the calculations, I was really shocked at the answer that it would happen so soon. Don published a paper in 1978 proposing this scenario, predicting that we'd start to see satellite collisions in Earth orbit by the year 2000 Just like in the asteroid belt, these satellite collisions would trigger a domino effect: creating a whole bunch of debris which causes more collisions, creating more debris, and so on. His main point: once the process starts, it'll be nearly impossible to stop This self-perpetuating phenomenon, this domino effect, became known as Kessler Syndrome. The first accidental collision occurred in 1996, when a French satellite was struck by a piece of a rocket thruster that had exploded ten years earlier, severing its stabilization boom and, for the first time, demonstrating how entangled the orbital environment has become. HK: In 2009 a collision happened that was by far more dramatic. The event he's referring to was the first collision between two intact satellites: the Russian satellite Kosmos and an American Iridium. And that was the first catastrophic accidental collision that got everybody's attention because not only did they realize how much debris is generated when something like that occurs but that we are now entering this phase of what we're calling the Kessler Syndrome. Just two years earlier the Chinese military conducted a controversial anti-satellite test, intercepting one of their own defunct weather satellites with a kinetic kill vehicle — a non-explosive missile which relies on sheer speed of impact to destroy its target. It blew the satellite to smithereens and created just a huge mess, it was really bad. DK: And unfortunately it was something they should have known not to do. Yeah, that's because the US did the same thing back in 1985 — the first anti-satellite test, with more or less the same results. DK: We at NASA tried to delay that or stop that because, we said it's going to create enough debris that we'll have to add more shielding to the space station which was planned to be launched a few years later. And nobody believed it would make that much debris, but it did. All of these collisions, accidental or otherwise, make a big mess of junk zipping around the Earth called space debris. It accounts for 95% of the objects in Low Earth orbit, and comes in all shapes and sizes. It's technically defined as any nonfunctional object in orbit, so there's big stuff like rocket thrusters and defunct satellites, but the vast majority are little bits and pieces called fragmentation debris. Many of these fragments come from explosions caused by residual fuel and other explosive energy sources self-igniting under the extreme conditions of space. These explosions happen more often than you might think, and as catastrophic and messy as these explosions are, collisions are even worse due to the incredible amount of kinetic energy involved. At the velocities objects travel in Lower Earth Orbit (speeds known as hypervelocity) even an object as tiny as a screw can deliver an incapacitating strike to a satellite. In fact, NASA has repeatedly had to replace shuttle windows due to hypervelocity impacts by flecks of paint. HK: These are velocities, we have no example nor anything that compares to that on ground. So the energy involved in these collisions is extremely high. A 1 cm object that size like a cherry hitting a satellite with 10 km/s, the energy released by this corresponds roughly to an exploding grenade. You can imagine what the satellite looks like after that. DK: Yes, let me know show you something. This is something that was shot in the lab, it's a projectile about the size of a BB, and it makes a crater into, this is solid aluminum, and this was only going about 5 km/s, about half the speed of what you would expect in space. Most of this is happening in Low Earth Orbit, the 2000 km strip of space above our heads where we've packed the vast majority of our satellites, including the International Space Station and the Hubble Space Telescope. The most crowded section is between 500 and 1000 km up. It's the densest region, it's the Highway 401 of space. DK: And that's what's creating the problem because we've crowded so much stuff in that small region. And the probability of collision goes as the square of the spatial density. So you double the number of satellites, you get four times as many collisions. Now, the space station usually flies

around 300 km but the debris that's generated at that higher altitude is being thrown down and drifting down to the lower altitudes.^{HK:} If you look at the space station surface you will find craters everywhere, impact craters caused by debris everywhere. Whenever you bring hardware down and inspect it on ground you find craters of all sizes. What do we do with this? How do you protect the life of the astronauts? The only thing you can do is shielding. And to protect against a hypervelocity impact you need a special type of lightweight shielding, called Whipple shielding. ^{DK:} Let me show you something else. The same particle that caused this kind of damage [image below, left] only caused this kind of damage [image below, right] on a surface with a very minor amount of shielding on it. And that's, it's almost a liquid splattered onto that. Most spacecraft utilize this type of shielding, which can withstand impacts from objects up to about one centimeter. Objects larger than a softball are catalogued and tracked by the US Space Surveillance Network. Tracking is imprecise, but allows spacecraft to dodge some of the debris that comes too close. This only works for objects larger than 10 cm or so. Anything smaller can't be reliably tracked. For that reason, the most concerning objects are those between 1 and 10 cm; too large for shielding to withstand and too small to be tracked. These objects could incapacitate any spacecraft in their path, or worse. And with every future explosion and collision there will be more and more of these invisible projectiles going around. The problem gets worse when you consider how long objects can remain in orbit. Depending on altitude, debris in Low Earth Orbit may remain there for years, decades, or centuries before their orbit naturally decays enough to re-enter the Earth's atmosphere. For example, look no further than ENVISAT; a defunct 8-tonne satellite operated by the European Space Agency until it lost contact in 2012, becoming a massive piece of space junk in the densest region of Earth orbit. ENVISAT will remain in orbit for 200 years if not removed. Experts hope to avoid an encore of ENVISAT and to mitigate Kessler Syndrome through the international adoption of two clean space policies. The first will prevent explosions by requiring so-called passivation of onboard energy sources. ^{HK:} Meaning, residual fuel must be either depleted, burned, released through a valve, whatever. That's number one: no more explosions. ^{DK:} And the other is what we call a 25 year rule. Once you put something in orbit, after you finish using it you have 25 years to get it out. Either by moving up to a designated "graveyard orbit" where it will pose minimal risk to active spacecraft or more ideally, lowering its altitude so it will burn up in the atmosphere sooner. These policies aren't difficult to follow and are beginning to be adopted internationally. ^{HK:} When we do these two things that would already make space flight pretty safe for the future. It would mean, if we do this systematically, the risk in the future would be almost the same as it is today. The mitigation measures they help to dampen the effect of the Kessler Syndrome, we are not talking about stopping it, we are talking about maintaining it on an acceptable level, the growth. But it will grow, even if we implement these two measures strictly. If we want to even prevent this growth, then we need to do active removal. ^{DK:} We've already concluded that it's going to take something like removing 500 intact objects over the next 100 years in order to stabilize the Low Earth Orbit environment again. That works out to five objects per year for the next century, which at least seems achievable, right? The challenge though is that there's no easy way to remove space debris. ^{HK:} We need to approach the object that are not under control anymore, and attach to them, dock with them, rendezvous them, capture them somehow, and then get rid of them in a controlled way. You can imagine this is not so easy. Experts are working on ways to remove debris, and there are several promising ideas in early development. There are reusable concepts like tethers and space tugs which can grab multiple objects per launch, which saves money. There are ground- or space-based lasers which can deorbit objects by kind of shooting them down, but these face political challenges. There are actually active satellites in space right now, the University of Surrey is controlling a spacecraft called RemoveDEBRIS which will use a harpoon to grab on to debris, that's promising. And there's another single-use option like ESA's e.Deorbit, currently planned to retrieve and deorbit ENVISAT in 2023. Many of these ideas aren't scalable, though, that's the problem, they're expensive and complicated, and missions like these are almost completely unprecedented. The pressure is on, though, because Kessler Syndrome isn't waiting, and the consequences for space infrastructure are dire. ^{HK:} Today only half of the satellites actually disappear from space within the 25 years that are recommended as the maximum on orbit time. We still have five explosions every year. If we continue and not improve the way we do spaceflight, then in a few decades some regions of space might not be useable anymore for spaceflight, or it might be much too risky to go there. And that might mean that we either lose services from space that we rely on today, or they get more expensive. ^{AI:} Do you think something like Kessler Syndrome is inevitable? Are you optimistic that this can be managed properly, or do you think this is an inevitable issue for a spacefaring society? ^{HK:} I think it can be managed, it can be managed. I do believe it's time for young people to take charge and there's a lot of work to be done, and there's enough people involved today that I'm confident that it's going to be done. Much like other environmental and generational problems, Kessler Syndrome is invisible to us. When you look up at the night sky, you don't see collisions and explosions and fragments of debris. If you're lucky and the conditions are right, you might see one white speck drifting across the sky, a tiny testament to humankind's highest collective ambitions. But that speck is at risk, along with all it represents, if we don't address this invisible problem — because Kessler Syndrome isn't waiting.

Tele-health sats solve pandemics.

Krishnamurthy 18 [Ramesh, researcher in Health Systems and Innovation Cluster, World Health Organization, with; Jason Hatton; 1/1/18, "Space science and technologies to advance health-related sustainable development goals," <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5791876/>] brett

Space science and technologies have wide applications, for example in managing public health emergencies, forecasting epidemics, facilitating early warning and disaster management plans, as well as monitoring environmental parameters.⁵ The by-products of space-based technologies and innovations can make substantial contributions to injury prevention from road crashes.

In health services delivery, innovative space technologies are now applied in assistive robotic surgeries, predictive diagnosis, compact water filtration systems, injection safety devices and precision medicine. Furthermore, satellite communications-based tele-health, telemedicine services and tele-guided ultrasound systems now connect patients and caregivers in hard-to-reach or resource-constrained settings. In addition, satellite images can assist in delivering vaccines or accessing health-care facilities by rapidly allowing the detection of road features of an image through feature extraction, producing a map of road networks where maps are either not available or inexistent.

In health systems research, space-based research, such as on the International Space Station⁶ can provide unique data on physiologic and biological processes, which may allow potential novel therapeutic approaches to identify diseases. Space science and technology thus contribute to epidemic intelligence, health emergencies and the research agenda on the benefits to public health.

Extinction.

Dhillon 17 [Ranu; 2017; instructor at Harvard Medical School and a physician at Brigham and Women's Hospital in Boston. He works on building health systems in developing countries and served as an advisor to the president of Guinea during the Ebola epidemic

instructor at Harvard Medical School and a physician at Brigham and Women's Hospital in Boston. He works on building health systems in developing countries and served as an advisor to the president of Guinea during the Ebola epidemic, Harvard Business Review; "The World Is Completely Unprepared for a Global Pandemic", <https://hbr.org/2017/03/the-world-is-completely-unprepared-for-a-global-pandemic>] brett

We fear it is only a matter of time before we face a deadlier and more contagious pathogen. yet the threat of a deadly pandemic remains dangerously overlooked. Pandemics now occur with greater frequency due to factors such as climate change, urbanization, and international travel. Other factors, such as a weak World Health Organization and potentially massive cuts to funding for U.S. scientific research and foreign aid, including funding for the United Nations, stand to deepen our vulnerability. We also face the specter of novel and mutated pathogens that could spread and kill faster than diseases we have seen before. With the advent of genome-editing technologies, bioterrorists could artificially engineer new plagues, a threat that Ashton Carter, the former U.S. secretary of defense, thinks could rival nuclear weapons in deadliness. The two of us have advised the president of Guinea on stopping Ebola. In addition, we have worked on ways to contain the spread of Zika and have informally advised U.S. and international organizations on the matter. Our experiences tell us that the world is unprepared for these threats. We urgently need to change this trajectory. We can start by learning four lessons from the gaps exposed by the Ebola and Zika pandemics. Faster Vaccine Development The most effective way to stop pandemics is with vaccines. However, with Ebola there was no vaccine, and only now, years later, has one proven effective. This has been the case with Zika, too. Though there has been rapid progress in developing and getting a vaccine to market, it is not fast enough, and Zika has already spread worldwide. Many other diseases do not have vaccines, and developing them takes too long when a pandemic is already under way. We need faster pipelines, such as the one that the Coalition for Epidemic Preparedness Innovations is trying to create, to preemptively develop vaccines for diseases predicted to cause outbreaks in the near future. Point-of-Care Diagnostics Even with such efforts, vaccines will not be ready for many diseases and would not even be an option for novel or artificially engineered pathogens. With no vaccine for Ebola, our next best strategy was to identify who was infected as quickly as possible and isolate them before they infected others. Because Ebola's symptoms were identical to common illnesses like malaria, diagnosis required laboratory testing that could not be easily scaled. As a result, many patients were only tested after several days of being contagious and infecting others. Some were never tested at all, and about 40% of patients in Ebola treatment centers did not actually have Ebola. Many dangerous pathogens similarly require laboratory testing that is difficult to scale. Florida, for example, has not been able to expand testing for Zika, so pregnant women wait weeks to know if their babies might be affected. What's needed are point-of-care diagnostics that, like pregnancy tests, can be used by frontline responders or patients themselves to detect infection right away, where they live. These tests already exist for many diseases, and the technology behind them is well-established. However, the process for their validation is slow and messy. Point-of-care diagnostics for Ebola, for example, were available but never used because of such bottlenecks. Greater Global Coordination We need stronger global coordination. The responsibility for controlling pandemics is fragmented, spread across too many players with no unifying authority. In Guinea we forged a response out of an amalgam of over 30 organizations, each of which had its own priorities. In Ebola's aftermath, there have been calls for a mechanism for responding to pandemics similar to the advance planning and training that NATO has in place for its numerous members to respond to military threats in a quick, coordinated fashion. This is the right thinking, but we are far from seeing it happen. The errors that allowed Ebola to become a crisis replayed with Zika, and the WHO, which should anchor global action, continues to suffer from a lack of credibility. Stronger Local Health Systems International actors are essential but cannot parachute into countries and navigate local dynamics quickly enough to contain outbreaks. In Guinea it took months to establish the ground game needed to stop the pandemic, with Ebola continuing to spread in the meantime. We need to help developing countries establish health systems that can provide routine care and, when needed, coordinate with international responders to contain new outbreaks. Local health systems could be established for about half of the \$3.6 billion ultimately spent on creating an Ebola response from scratch. Access to routine care is also essential for knowing when an outbreak is taking root and establishing trust. For months, Ebola spread before anyone knew it was happening, and then lingered because communities who had never had basic health care doubted the intentions of foreigners flooding into their villages. The turning point in the pandemic came when they began to trust what they were hearing about Ebola and understood what they needed to do to halt its spread: identify those exposed and safely bury the dead. With Ebola and Zika, we lacked these four things — vaccines, diagnostics, global coordination, and local health systems — which are still urgently needed. However, prevailing political headwinds in the United States, which has played a key role in combatting pandemics around the world, threaten to make things worse. The Trump administration is seeking drastic budget cuts in funding for foreign aid and scientific research. The U.S. State Department and U.S. Agency for International Development may lose over one-third of their budgets, including half of the funding the U.S. usually provides to the UN. The National Institutes of Health, which has been on the vanguard of vaccines and diagnostics research, may also face cuts. The Centers for Disease Control and Prevention, which has been at the forefront of responding to outbreaks, remains without a director, and, if the Affordable Care Act is repealed, would lose \$891 million, 12% of its overall budget, provided to it for immunization programs, monitoring and responding to outbreaks, and other public health initiatives. Investing in our ability to prevent and contain pandemics through revitalized national and international institutions should be our shared goal. However, if U.S. agencies become less able to respond to pandemics, leading institutions from other nations, such as Institut Pasteur and the National Institute of Health and Medical Research in France, the Wellcome Trust and London School of Hygiene and Tropical Medicine in the UK, and nongovernmental organizations (NGOs have done instrumental research and response work in previous pandemics), would need to step in to fill the void. There is no border wall against disease. Pandemics are an existential threat on par with climate change and nuclear conflict. We are at a critical crossroads, where we must either take the steps needed to prepare for this threat or become even more vulnerable. It is only a matter of time before we are hit by a deadlier, more contagious pandemic. Will we be ready?

1AC---Ozone

Ozone is recovering now, breakdown causes existential environmental disaster.

WMO 21 [World Meteorological Organization; 2021; "Ozone layer recovery is an environmental success story,"

<https://public.wmo.int/en/media/news/ozone-layer-recovery-environmental-success-story>] brett

The ozone layer in the upper atmosphere blocks ultraviolet (UV) radiation that harms living tissue, including humans and plants. The ozone "hole," which was discovered in 1985 is the result of human emitted chlorofluorocarbons (CFCs), which are ozone-depleting chemicals and greenhouse gases used as coolants in refrigerators and in aerosol spray. Nearly 200 countries signed the Montreal Protocol in 1987, which phased out the production and consumption of CFCs.

A new study in Nature demonstrates that by protecting the ozone layer, which blocks harmful UV radiation, the Montreal Protocol also protects plants and their ability to pull carbon from the atmosphere.

The Montreal Protocol began life as a mechanism to protect and heal the ozone layer. It has done its job well over the past three decades. The ozone layer is on the road to recovery. The cooperation we have seen under the Montreal Protocol is exactly what is needed now to take on climate change, an equally existential threat to our societies," said UN Secretary-General Antonio Guterres in a message.

The most recent WMO /UN Environment Programme Scientific Assessment of Ozone Depletion, issued in 2018, concluded that the measures under the protocol will lead to the ozone layer on the path of recovery and to potential return of the ozone in the Arctic and Northern Hemisphere mid-latitude ozone before the middle of the century (~2035) followed by the Southern Hemisphere mid-latitude around mid-century, and Antarctic region by 2060.

Although the use of halons and chlorofluorocarbons has been discontinued, they will remain in the atmosphere for many decades. Even if there were no new emissions, there is still more than enough chlorine and bromine present in the atmosphere to destroy ozone at certain altitudes over Antarctica from August to December. The formation of the ozone hole is still expected to be an annual spring event. Its size and depth are governed to a large degree by the meteorological conditions particular for the year.

As of the first week of August 2021, the ozone hole reappeared and is rapidly growing and has extended to 23 million square kilometers on 13 September which is above the average since the mid 1980s. The lowest ozone value in the during this seasons was around 140 DU. The hole fluctuates in size annually and it usually reaches its largest area during the coldest months in the southern hemisphere, from late September to early October.

Its evolution is monitored by satellites and ground-based observing stations of WMO's Global Atmosphere Watch Programme. Those observations are being combined with numerical modelling by different organizations and institutions (NASA, the Copernicus Atmospheric Monitoring Service implemented by ECMWF, ECCO, KNMI and others) to provide near -real time information and analyses on the ozone levels at different parts of the stratosphere, the location and dimensions of the ozone depleted area.

In 2020, there were exceptionally large ozone holes over the Antarctic and Arctic, reflecting extreme meteorological conditions. Specific dynamic conditions in the stratosphere in 2019 led to the smallest Antarctic ozone hole since its discovery. This shows the need for continued vigilance and observations.

Ozone and climate

The theme for this year is Montreal Protocol – keeping us, our food and vaccines cool.

Ozone depleting substances (ODS) are also greenhouse gases (GHG) and their abundance in atmosphere over the years has made an important contribution to the radiative forcing of climate.

While ODS concentrations are expected to keep decreasing, the concentrations of long-lived greenhouse gases have been increasing.

The distribution and amount of stratospheric ozone depends on temperature and circulation, so that changes in climate will affect the distribution of ozone. Long-lived greenhouse gases warm the troposphere, but cool the stratosphere, leading to changes of the global circulation, affecting the stability of the polar winter vortices, and changing weather patterns.

Therefore, the future evolution of the ozone layer will be influenced by the concentrations of these long-lived greenhouse gases, and by climate change.

The Montreal Protocol has led to very significant avoided warming and the Kigali amendment which regulates the hydrofluorocarbons (HFCs), CFCs and hydrochlorofluorocarbons (HCFCs) replacement gases, adds a further layer of important climate protection. The avoided ultraviolet radiation and climate change also have co-benefits for plants and their capacity to store carbon through photosynthesis.

Some recent scientific findings point that the ozone depletion in the Arctic polar vortex could intensify by the end of the century unless global greenhouse gases are rapidly and systematically reduced. In the future, this could also mean more UV radiation exposure in Europe, North America and Asia when parts of the polar vortex drift south.

Scientists are monitoring the extent to which climate change is leading to stratospheric cooling, which enhances the possibilities for observing temperatures under -78°C especially in the Arctic where there is evidence that the coldest stratospheric winters are becoming colder. Those temperatures are needed for the polar stratospheric cloud formation where the destruction of the ozone takes place.

UV Radiation

Several feedbacks to climate change occur from the effects of UV radiation on the biosphere. For example, the breakdown or photodegradation of dead plant material releases carbon to the atmosphere, increasing the amount of carbon dioxide and other greenhouse gases.

Increased thawing or melting of snow, ice and permafrost in the Arctic also releases GHGs and has a negative effect on the exposed ecosystems.

Studies are showing that temperature, UV radiation and frequency of rainfall are key factors that determine the availability or range of suitable habitats for certain plant species to survive.

UV-B radiation and factors associated with climate change affect plant growth, pathogen and pest defence, and food crop quality.

For human health, UV radiation can have significant negative effects, for example, in causing skin cancers and certain eye diseases, such as cataract. However, the Montreal Protocol has played a major role in avoiding large numbers of cases and deaths.

With regard to pollution, UV radiation can have a substantial impact on the composition and quality of the atmosphere; on human, terrestrial and aquatic environment health. It drives the breakdown of plastic pollutants with implications for human health and the environment.

Megaconstellations of satellites and frequent re-entry causes Ozone Hole 2.0

Tereza 21 [Tereza; June 07, 2021; Bachelor's in Journalism and Master's in Cultural Anthropology from Prague's Charles University, Master's in Science from the International Space University. Space.com, “Air pollution from reentering megaconstellation satellites could cause ozone hole 2.0,” <https://www.space.com/starlink-satellite-reentry-ozone-depletion-atmosphere>] Brett

Chemicals released as defunct satellites burn in the atmosphere could damage Earth's protective ozone layer if plans to build megaconstellations of tens of thousands of satellites, such as SpaceX's Starlink, go ahead as foreseen, scientists warn.

Researchers also caution that the poorly understood atmospheric processes triggered by those chemicals could lead to an uncontrolled geoengineering experiment, the consequences of which are unknown.

For years, the space community was content with the fact that the amount of material that burns in the atmosphere as a result of Earth's encounters with meteoroids far exceeds the mass of defunct satellites meeting the same fate. Even the rise of megaconstellations won't change that. The problem, however, is in the different chemical composition of natural

meteoroids compared to artificial satellites, according to Aaron Boley, an associate professor of astronomy and astrophysics at the University of British Columbia, Canada.

"We have 54 tonnes (60 tons) of meteoroid material coming in every day," Boley, one of the authors of a paper published May 20 in the journal Scientific Reports, 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%."

Related: SpaceX's Starlink satellite megaconstellation launches in photos

Uncontrolled geoengineering

The scientists realised that megaconstellations have a significant potential to change the chemistry of the upper atmosphere compared to its natural state. But not only that. The burning of aluminum is known to produce aluminum oxide, also known as alumina, which can trigger further unexplored side effects.

"Alumina reflects light at certain wavelengths and if you dump enough alumina into the atmosphere, you are going to create scattering and eventually change the albedo of the planet," Boley said.

Albedo is the measure of the amount of light that is reflected by a material. In fact, increasing Earth's albedo by pumping certain types of chemicals into the higher layers of the atmosphere has been proposed as a possible geoengineering solution that could slow down global warming. However, Boley said, the scientific community has rejected such experiments because not enough is known about their possible side effects.

"Now it looks like we are going to run this experiment without any oversight or regulation," Boley said. "We don't know what the thresholds are, and how that will change the upper atmosphere."

The Cygnus re-supply vehicle, which delivers cargo to the International Space Station, burning up in the atmosphere during its reentry. (Image credit: ESA/Alexander Gerst)

Ozone hole 2.0

The aluminum from re-entering satellites also has a potential to damage the ozone layer, a problem well known to humanity, which has been successfully solved by widespread bans on the use of chlorofluorocarbons, chemicals used in the past in aerosol sprays and refrigerators.

In their paper, Boley and his colleague Michael Byers cite research by their counterparts from the Aerospace Corporation, a U.S. non-profit research organization, which identified local damage to the planet's ozone layer triggered by the passage of polluting rockets through the atmosphere.

"We know that alumina does deplete ozone just from rocket launches themselves because a lot of solid-fuel rockets use, or have, alumina as a byproduct," Boley said. "That creates these little temporary holes in the stratospheric ozone layer. That's one of the biggest concerns about compositional changes to the atmosphere that spaceflight can cause."

The ozone layer protects life on Earth from harmful UV radiation. The depletion of ozone in the stratosphere, the second lowest layer of the atmosphere extending between altitudes of approximately 7 to 40 miles (10 to 60 kilometers), led to an increased risk of cancer and eye damage for humans on Earth.

Gerhard Drolshagen, of the University of Oldenburg, Germany, who has published papers about the effects of meteoroid material on Earth, told Space.com that reentering satellites usually evaporate at altitudes between 55 and 30 miles (90 and 50 km), just above the ozone-rich stratosphere. However, he added, the particles created as a result of the satellites' burning will eventually sink to the lower layers.

Boley said that as the alumina sinks into the stratosphere, it will cause chemical reactions, which, based on existing knowledge, will likely trigger ozone destruction.

Drolshagen, who wasn't involved in the recent study, agreed that because "satellites are mostly made of aluminum, the amount of aluminum deposited in the atmosphere will certainly increase."

Concerns about the effects of aluminium oxides on the atmosphere have been cited by U.S. telecommunications operator Viasat in its request to the US Federal Communications Commission to suspend launches of SpaceX's Starlink megaconstellation until a proper environmental review of its possible impacts is conducted.

Spectacular stratospheric clouds are linked to ozone destruction. (Image credit: NASA/Lamont Poole)

Learning from past mistakes

In their study, Boley and his colleagues looked only at the effects of the first generation of the Starlink megaconstellation, which is expected to consist of 12,000 satellites. More than 1,700 of these have already been launched. As a result of SpaceX's activities (and to a lesser extent those of other constellation operators), the number of active and defunct satellites in low Earth orbit, the region of space below the altitude of 620 miles (1,000 km), has increased by 50% over the past two years, according to the paper.

"The problem is that there are now plans to launch about 55,000 satellites," Boley said. "Starlink second generation could consist of up to 30,000 satellites, then you have StarNet, which is China's response to Starlink, Amazon's Kuiper, OneWeb. That could lead to unprecedented changes to the Earth's upper atmosphere."

Megaconstellation operators, inspired by the consumer technology model, expect fast development of new satellites and frequent replacement, thus the high amount of satellites expected to be burning in the atmosphere on a daily basis.

Extinction.

Skudlarek 16 [Cooper, pollution writer for L2P, "The Ozone Layer," <https://letters2president.org/letters/24312>] brett

We have a problem- a big problem (a 518,000,000 square kilometer problem to be exact). The ozone layer is a belt of naturally occurring gas that protects us from harmful radiation and it is at risk. We need to regulate the amount of air pollution produced and fossil fuels burned to prevent the formation of ozone holes which allow radiation to seep into the troposphere.

The Earth's stratosphere is a part of our atmosphere that houses the earth's ozone layer. The ozone layer is a belt of naturally occurring gas called ozone (hence the name ozone layer) that sits 15 kilometers above earth's surface and shields us from a form of a form of radiation produced by the sun known as ultraViolet B radiation. Over the next 14 years the levels of carbon dioxide seeping into our atmosphere will have increased by nearly 40 percent. According to the website Conserve Energy Future, "An essential property of ozone molecule is its ability to block solar radiations of wavelengths less than 290 nanometers from reaching Earth's surface. In this process, it also absorbs ultraviolet radiations that are dangerous for most living beings. UV radiation could injure or kill life on Earth. Though the absorption of UV radiations warms the stratosphere but it is important for life to flourish on planet Earth. Research scientists have anticipated disruption of susceptible terrestrial and aquatic ecosystems due to depletion of ozone layer." This means that although it is necessary to keep our planet habitable it is only helpful if we have the right amount and we have far too much.

This is a major issue because the excess radiation caused by holes in the ozone layer is allowing immense amounts of solar radiation to seep into the troposphere (where we live). If humans (or any species for that matter) are exposed to too much of this radiation, then we can develop serious skin diseases including cancer. In addition, to that if the plants at the bottom of the food chain receive too much solar radiation, then they will die out causing waves of distortion to ripple up the food chain and the catastrophic extinction of many species that are vital to our survival. Finally, the constant decay of our ozone layer is exponentially accelerating climate change. This leads to things such as: global warming, Arctic Circle thawing, stronger hurricanes, sea level rising, and more.

Empirics---Ozone depletion is existential.

Martin 18 [Sean, a Science Reporter for Express.co.uk, "Ozone layer DECAYING as scientists fear Earth 'heading towards MASS-EXTINCTION'", via Express, Feb 8, <https://www.express.co.uk/news/science/916405/ozone-layer-destroyed-recovering-mass-extinction-dinosaurs>] brett

News in January broke that the ozone was on its way to recovering as Earth cuts down on CO2 emissions. However, on closer inspection, scientists now say the ozone layer – the part of the atmosphere which protects us from harmful radiation – is continuing to deplete over major cities, and is only really recovering over Antarctica. Chemicals known as CFCs, which are found in aerosols for example, have been destroying the ozone layer since the 1970s. The Montreal Protocol was agreed in 1987 to phase out CFCs, but researchers say it may be too late. Study co-author Professor Joanna Haigh, co-director of the Grantham Institute for Climate Change and the Environment at Imperial College London, said of the study published in Atmospheric Chemistry and Physics: "Ozone has been seriously declining globally since the 1980s, but while the banning of CFCs is leading to a recovery at the poles, the same does not appear to be true for the lower latitudes. "The potential for harm in lower latitudes may actually be worse than at the poles. "The decreases in ozone are less than we saw at the poles before the Montreal Protocol was enacted, but UV radiation is more intense in these regions and more people live there." In a separate study, researchers have found a thinning ozone layer could have led to a mass extinction 252 million years ago – meaning a depletion of the protective layer of the atmosphere could be more catastrophic than previously thought. During the Permian-Triassic extinction, 75 percent of land animals and 95 percent of marine life died. At the same time, there was a massive volcanic event occurring in a region known as the Siberian Traps. Scientists state the huge eruption, which lasted for a staggering one million years, virtually destroyed the ozone layer which allowed more UV radiation to pierce Earth. Graduate student Jeffrey Benca of the University of California, Berkeley, said of his research published in Science Advances: "During the end-Permian crisis, the forests may have disappeared in part or fully because of increased UV exposure. "With pulses of volcanic eruptions happening, we would expect pulsed ozone shield weakening, which may have led to forest declines previously observed in the fossil record. "If you disrupt some of the dominant plant lineages globally repeatedly, you could trigger trophic cascades by destabilising the food web base, which doesn't work out very well for land animals." As the ozone layer continues to be destroyed in modern times, scientists warn another catastrophic mass extinction could be on the cards. Co-author Cindy Looy of the Science Advances study said: "Palaeontologists have come up with various kill scenarios for mass extinctions, but plant life may not be affected by dying suddenly as much as through interrupting one part of the life cycle, such as reproduction, over a long period of time, causing the population to dwindle and potentially disappear."

Plan

Resolved: States ought to prohibit the appropriation of Low Earth Orbit by private entities.

The plan clarifies customary law to ban private satellite mega-constellations that appropriate Low Earth Orbit and solves otherwise detrimental space debris.

Johnson 20 [Chris, Space Law Advisor for Secure World Foundation, 9 years of professional experience in international space law and policy. J.D. from New York Law School; 2020; "The Legal Status of MegaLEO Constellations and Concerns About Appropriation of Large Swaths of Earth Orbit," https://swfound.org/media/206951/johnson2020_referenceworkentry_thelegalstatusofmegaleoconstel.pdf] brett

Yes, **This Is Impermissible Appropriation**

Article II of the Outer Space Treaty, discussed above, is clear on the point that the appropriation of outer space, including the appropriation of either void space or of celestial bodies, is an impermissible and prohibited action under international law. No means or methods of possession of outer space will legitimize the appropriation or ownership of outer space, or subsections thereof.

Excludes Others

The **constellations** above, because they seem to so overwhelmingly possess particular orbits through the use of multiple satellites to occupy orbital planes, and in a manner that precludes other actors from using those exact planes, **constitute an appropriation** of those orbits.

While the access to outer space is nonrivalrous – in the sense that anyone with the technological capacity to launch space objects can therefore explore space – it is also true that **orbits closer to Earth are unique**, and when any actor utilizes that orbit to such an extent to these proposed constellations will, it means that other actors simply cannot go there.

To allow SpaceX, for example, to so overwhelmingly occupy a number of altitudes with so many of their spacecraft, essentially **means that SpaceX will henceforth be the sole owner** and user of that orbit (at least until their satellites are removed). No other actors can realistically expect to operate there until that time. No other operator would dare run the risk of possible collision with so many other spacecraft in that orbit. Consequently, the sole occupant will be SpaceX, and if “possession is 9/10th of the law,” then SpaceX appears to be the owner of that orbit.

Done Without Coordination

Additionally, SpaceX and other operators of megaconstellations are doing so without any real international conversation or agreement, which is especially egregious and transgressive of the norms of outer space. Compared to the regime for GSO, as administered by the ITU and national frequency administrators, Low Earth Orbit is essentially ungoverned, and SpaceX and others are attempting to seize this lack of authority to claim entire portions of LEO for itself; and before any international agreement, consensus, or even discussion is had. They are operating on a purely “first come, first served” basis that smacks of unilateralism, if not colonialism.

Governments Are Ultimately Implicated

As we know, under international space law, what a nongovernmental entity does, a State is responsible for. Article VI of the Outer Space Treaty requires that at least one State authorize and supervise its nongovernmental entities and assure their continuing compliance with international law. As such, the prohibition on nonappropriation imposed upon States under Article II of the Outer Space Treaty **applies equally to nongovernmental private entities such as SpaceX**.

Nevertheless, through the launching and bringing into use of the Starlink constellation, SpaceX will be the sole occupant, and thereby, possessor, both fact and in law, of 550 km, 1100 km, 1130 km, 1275 km, and 1325 km above our planet (or whatever orbits they finally come to occupy). The same is true for the other operators of these large constellations which will be solely occupying entire orbits.

Long-Term Occupation Constitutes Appropriation

These **altitudes** are additionally significant, as nonfunctional spacecraft in orbits lower than around 500 km will re-enter the Earth’s atmosphere in months or a few years, but the **altitudes** selected for the Starlink constellation, while technologically desirable for their purposes, also **mean that any spacecraft which are not de-orbited from these regions may be there for decades, or possibly even hundreds of years**. By comparison, the granting of rights for orbital slots at GSO is in 15-year increments, a length of time much less than what the altitudes of the megaconstellations threaten. Such long spans of time at these altitudes by these megaconstellations further bolster the contention **that this occupation rises to the level of appropriation** of these orbits.

Prevents Others from Using Space

Article I of the Outer Space Treaty establishes that the exploration and use of outer space is “the province of all mankind.” It further requires that this exploration and use shall be by all States “without discrimination of any kind, on a basis of equality and in accordance with international law...”

However, when one private corporation so overwhelmingly possesses entire portions of outer space, their use is discriminatory to other potential users and interferes with their freedom to access, explore, and use outer space. So long as **these actors** are so dominantly possessing and occupying those orbits, their actions exclude others from using them. What other operator would dare use orbits where there are already hundreds of satellites operating as part of a constellation? It would be an extremely unwise and risky decision to try to share these orbits with a mega constellation, so they will likely choose other altitudes and orbits. This **massive occupation** of particular orbits effectively defeats others from enjoying the use of outer space. While a State can issue permits for one of its corporations allowing them to launch and operate satellites to this extent, that does not automatically mean that their activities in outer space, an area beyond national sovereignty, are therefore in perfect accordance with the strictures of international law. Indeed, national permissions offer no such guarantee.

No Due Regard for Others

That these megaconstellations violate the prohibition on appropriation in Article II is additionally supported by Article IX of the Outer Space Treaty. Article IX requires that in the exploration and use of outer space, States “shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space... with due regard to the corresponding interests of other States...” There is hardly any way to view this deployment of megaconstellations as showing any type of due regard to the corresponding interests of others. This lack of regard further supports the notion of their unilateral transgressive violations of the purposes of space law norms.

Harmful Contamination

The impacts of the spacecraft on the pressing issue of space debris need not be gone into detail here. Suffice it to say, **megaconstellations threaten mega-debris**. The **failure rate of these comparatively cheap satellites should give pause**, because if 5% of a constellation of 100 satellites fails, this is 5 guaranteed new pieces of debris intentionally introduced to the fragile space domain. Article IX of the Outer Space Treaty warns of harmful contamination of the space environment and requires States to take appropriate measures to prevent this harmful contamination. A responsible government could not, in all seriousness, permit the intentional release of such amounts of space debris, especially in the already fraught orbits that many megaconstellations are headed towards. While the threat of space debris is not directly relevant to the accusation of

appropriation of outer space, it goes towards the argument that these actors are conducting activities in a manner lacking in regard to others, and in fact, amounts to excluding others from using the space domain. By excluding others, this has the effect of taking orbits for themselves, which IS occupation.

If This Isn't Appropriation, Then What Is?

Arguing in the alternative, if these megaconstellations — in their dominant occupation of entire orbits in orbital planes with numerous satellites — could be considered (merely for the sake of argument) to not be appropriation, we must therefore ask: what would be appropriation? What use of void space, including orbits of the Earth, would constitute actual appropriation? What further, additional fact of these uses of space, if added to the scenario, would cause that constellation to cross over the line into clearly prohibited appropriation? Perhaps the exact same scenario, but supplemented with an actual, formal claim of sovereignty, issued by a government, is the only element which could be added to megaconstellations which would then cross the threshold into appropriation. However, a formal claim of sovereignty would be merely an act occurring on Earth and would not change any actual facts in the space domain. Consequently, the lack of a formal claim of sovereignty should not be the deciding criteria in arriving at the conclusion that megaconstellations constitute appropriation of orbits.

Conclusion

In conclusion, these megaconstellations effectively occupy entire orbital regions with their vast fleet of spacecraft and in so doing effectively preclude other actors from sharing those domains. They have done so, or are attempting to do so, without any international consensus or discussion, which is most egregious for a domain outside of State sovereignty and which no State can own. Governments will ultimately be responsible for this appropriation, and both are prohibited from appropriating space. In distinction to GSO, their permission to go there means that they could occupy these regions for incredibly long periods — which again shows their appropriation. These constellations significantly prevent others from using those regions, which therefore interferes with others' right to explore and use space. And ultimately, this reckless ambition shows absolutely no due regard (as per Article IX) for the corresponding rights of others. As such, these megaconstellations constitute an impermissible appropriation of particular regions of outer space, regardless of any formal, official claim of such by a responsible, authorizing government.

No circumvention. Authorization, supervision, and liability ensure compliance -- potential for liability causes self-regulation.

Johnson 20 [Chris, Space Law Advisor for Secure World Foundation, 9 years of professional experience in international space law and policy. J.D. from New York Law School; 2020; "The Legal Status of MegaLEO Constellations and Concerns About Appropriation of Large Swaths of Earth Orbit," https://swfound.org/media/206951/johnson20_referenceworkentry_thelegalstatusofmegaleoconstel.pdf]
brett

Authorization and Continuing Supervision

The second sentence of **Article VI** then gives States a positive obligation to undertake authorization and continuing supervision of nongovernmental entities.

The activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty.

Consequently, it is not merely sufficient that governments allow private actors to access and explore space. States have a duty to authorize and supervise them. Looking again at the first sentence of **Article VI**, above, gives some indication as to what standard this supervision must meet. The first sentence of **Article VI** ends with "... and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty." Consequently, States must authorize and supervise private entities to make sure that these private entities conform with the Outer Space Treaty.

Additionally, Article III of the Outer Space Treaty creates a link between the treaty and the rest of international law, including the UN Charter. Therefore, and to the extent that other sources of international law create norms applicable for private entities in outer space, all national activities — including private, nongovernmental activities — must conform with said laws. Some of these other sources include the other UN treaties on outer space, such as the 1968 Astronaut Rescue and Return Agreement, the 1972 Liability Convention, and the 1975 Registration Convention. Other specialized treaties on outer space, like the international telecommunications regime of the International Telecommunications Union Convention and Constitution, international environmental law, international humanitarian law, and other special regimes also form the rest of the normative order for outer space.

Potential Liability

Supplemental to international responsibility for acts in space committed by private entities is the potential for liability for damage resulting from their activities. Article VIII of the Outer Space Treaty establishes a liability provision, and the 1972 Liability Convention expands the mechanisms for dealing with liability claims. Liability is a requirement to pay compensation to an injured party for the damage or suffering that has been caused to them. In space law, liability is for physical damage to a space object by another space object. These provisions on liability have not yet been enforced relating to any actual claims of damage in space. However, and just like the obligation to be internationally responsible for private actors mentioned in Article VI, the potential for liability serves as a strong motivator and incentive for States to oversee, monitor, and regulate what private actors are doing in space.

Space debris and the potential for collisions dooms LEO spaceflight.

Moltz, 14 [James Clay; chairman of the Department of National Security Affairs at the Naval Postgraduate School, where he also holds a joint faculty appointment in the Space Systems Academic Group., “Crowded orbits Conflict and Cooperation in Space,” Columbia University Press, <https://www.istor.org/stable/10.7312/molt15912>] Brett

As noted above, **space tourism will become** a much **more robust** industry **by 2020** and especially in the decade after that, **when such services might become accessible** to those who fall below the top one percent of earners in the developed world. Indeed, much like air travel after World War II, **it is foreseeable that suborbital flight will become affordable to tens of thousands of people in upper-income brackets by 2030, with a range of new services available as technology develops further. Hundreds may be able to visit orbital hotels or stations within ten years, and a growing number of people will be working in space, tending tourist facilities as well as various industrial and manufacturing enterprises.**

Another factor that might change the direction of current activities in Earth orbit is the expansion of national military programs in space. To date, only three countries carry out significant military activities beyond reconnaissance: the United States, Russia, and China. But this group will likely expand further in the coming two decades. The list of militaries that might decide they have a strategic interest in testing kinetic, laser, or other active space defenses includes India, Pakistan, Japan, Iran, Israel, France, Brazil, and North Korea. Additional types of weapons that might be developed and tested against space objects in the coming two decades by various militaries—assuming new arms control mechanisms are not developed—include microwave systems, particle beams, space mines, and Earth-, sea-, air-, and space-based electronic jammers. **At present, no treaty forbids these technologies and there are strong military-industrial lobbies in a number of countries supporting space-based weapons, despite their possibly disruptive effects on space commerce, science, and passive military operations in the same regions of space.** In all likelihood, the growing population in the lower reaches of space will force some sort of decision regarding priorities:

either to allow countries to test and deploy large-scale orbital defenses or to strictly limit destructive weapons and emphasize commercial development of low-Earth orbit, including expanded human spaceflight. **Active defenses and commerce probably will not be compatible in crowded orbits because of the linkage between space weapons and harmful debris, particularly since such military tests and related onorbit deployments—once begun by one country for missile defense, ASAT, or space-to-ground attack options—are likely to be met with countermeasures by other militaries. Under such conditions, the development of commercial human spaceflight in low-Earth orbit will become too unsafe to continue. In this regard, successful space traffic management will be essential to the ability of people, companies, and countries to enjoy future services. This improved policing must include preventing orbital collisions with debris and other spacecraft as well as avoiding radio frequency conflicts. To date, success has arguably been possible less because of effective international management and more because of the lack of crowding in space. These conditions will no longer hold in the future. Given these challenges, it seems unlikely that current space governance mechanisms will be adequate to the task of managing foreseeable space risks across the range of new actors and activities.** For this reason, we next look at three alternative mechanisms for managing space over the next two decades: military hegemony, piecemeal global engagement, and enhanced international institutions.

1AC--- Framing

The standard is maximizing expected wellbeing- aka hedonistic act util. Pleasure and pain are intrinsic value and disvalue – everything else regresses – robust neuroscience.

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Pleasure is not only one of the three **primary reward functions** but **it also defines reward.** As homeostasis explains the **functions of** only a limited number of **rewards, the principal reason why particular stimuli, objects, events, situations, and activities are rewarding** may be **due to pleasure.** This applies first of all to sex and to the primary homeostatic rewards of food and liquid and extends to money, taste, beauty, social encounters and nonmaterial, internally set, and intrinsic rewards. **Pleasure, as the primary effect of rewards,** drives the prime reward functions of learning, approach behavior, and decision making and **provides the basis for hedonic theories of reward function. We are attracted by most rewards and exert intense efforts to obtain them just because they are enjoyable** [10]. Pleasure is a passive reaction that derives from the experience or prediction of reward and may lead to a long-lasting state of happiness. The word happiness is difficult to define. In fact, just obtaining physical pleasure may not be enough. One key to happiness involves a network of good friends. However, it is not obvious how the higher forms of satisfaction and pleasure are related to an ice cream cone, or to your team winning a sporting event. Recent multidisciplinary research, **using both humans and detailed invasive brain analysis of animals has discovered some critical ways that the brain processes pleasure** [14]. **Pleasure as a hallmark of reward is sufficient for defining a reward,** but it may not be necessary. **A reward may generate positive learning and approach behavior simply because it contains substances that are essential for body function.** When we are hungry, we may eat bad and unpleasant meals. A monkey who receives hundreds of small drops of water every morning in the laboratory is unlikely to feel a rush of pleasure every time it gets the 0.1 ml. Nevertheless, with these precautions in mind, we may define any stimulus, object, event, activity, or situation that has the potential to produce pleasure as a reward. In the context of reward deficiency or for disorders of addiction, homeostasis pursues pharmacological treatments: drugs to treat drug addiction, obesity, and other compulsive behaviors. The theory of allostasis suggests broader approaches - such as re-expanding the range of possible pleasures and providing opportunities to expend effort in their pursuit. [15]. It is noteworthy, the first animal studies eliciting approach behavior by electrical brain stimulation interpreted their findings as a discovery of the brain's pleasure centers [16] which were later partly associated with midbrain dopamine neurons [17–19] despite the notorious difficulties of identifying emotions in animals. Evolutionary theories of pleasure: The love connection BO:D Charles Darwin and other biological scientists that have examined the biological **evolution and its basic principles found** various **mechanisms that steer behavior and biological development.** Besides their theory on natural selection, it was particularly the sexual selection process that gained significance in the latter context over the last century, especially when it comes to the question of what makes us “what we are,” i.e., human. However, the capacity to sexually select and evolve is not at all a human accomplishment alone or a sign of our uniqueness; yet, we humans, as it seems, are ingenious in fooling ourselves and others—when we are in love or desperately search for it. It is well established that modern biological theory conjectures that **organisms are the result of evolutionary competition.** In fact, Richard Dawkins stresses

gene survival and propagation as the basic mechanism of life [20]. Only genes that lead to the fittest phenotype will make it. It is noteworthy that the phenotype is selected based on behavior that maximizes gene propagation. To do so, the phenotype must survive and generate offspring, and be better at it than its competitors. Thus, the ultimate, distal function of rewards is to increase evolutionary fitness by ensuring the survival of the organism and reproduction. It is agreed that learning, approach, economic decisions, and positive emotions are the proximal functions through which phenotypes obtain other necessary nutrients for survival, mating, and care for offspring. Behavioral reward functions have evolved to help individuals to survive and propagate their genes. Apparently, people need to live well and long enough to reproduce. Most would agree that homo-sapiens do so by ingesting the substances that make their bodies function properly. For this reason, foods and drinks are rewards. Additional rewards, including those used for economic exchanges, ensure sufficient palatable food and drink supply. Mating and gene propagation is supported by powerful sexual attraction. Additional properties, like body form, augment the chance to mate and nourish and defend offspring and are therefore also rewards. Care for offspring until they can reproduce themselves helps gene propagation and is rewarding; otherwise, many believe mating is useless. According to David E Comings, as any small edge will ultimately result in evolutionary advantage [21], additional reward mechanisms like novelty seeking and exploration widen the spectrum of available rewards and thus enhance the chance for survival, reproduction, and ultimate gene propagation. These functions may help us to obtain the benefits of distant rewards that are determined by our own interests and not immediately available in the environment. Thus the distal reward function in gene propagation and evolutionary fitness defines the proximal reward functions that we see in everyday behavior.

That is why foods, drinks, mates, and offspring are rewarding. There have been theories linking pleasure as a required component of health benefits (eugenesis, [eugenesis]). In essence, under these terms, pleasure is described as a state or feeling of happiness and satisfaction resulting from an experience that one enjoys. Regarding pleasure, it is a double-edged sword, on the one hand, it promotes positive feelings like mindfulness and even better cognition, possibly through the release of dopamine [22]. But on the other hand, pleasure simultaneously encourages addiction and other negative behaviors, i.e., motivational toxicity. It is a complex neurological phenomenon, relying on reward circuitry or limbic activity. It is important to realize that through the "Brain Reward Cascade" (BRC) endogenous and exogenous morphogenic mechanisms may play a role [23]. While natural rewards are essential for survival and appetitive motivation leading to beneficial biological behaviors like eating, sex, and reproduction, crucial social interactions seem to further facilitate the positive effects exerted by pleasurable experiences. Indeed, experimentation with addictive drugs is capable of directly acting on reward pathways and causing deterioration of these systems promoting hypodopaminergia [24]. Most would agree that pleasurable activities can stimulate personal growth and may help to induce healthy behavioral changes, including stress management [25]. The work of Fish and Stefano [26] concerning the link between compassion and love implicate the brain reward system, and pleasure induction suggests that social contact in general, i.e., love, attachment, and compassion, can be highly effective in stress reduction, survival, and overall health. Understanding the role of neurotransmission and pleasurable states both positive and negative have been adequately studied over many decades [26–37], but comparative anatomical and neurobiological function between animals and homo sapiens appear to be in an infancy stage. Finding happiness is different between apes and humans. As stated earlier in this expert opinion one key to happiness involves a network of good friends [38]. However, it is not entirely clear exactly how the higher forms of satisfaction and pleasure are related to a sugar rush, winning a sports event or even sky diving, all of which augment dopamine release at the reward brain site. Recent multidisciplinary research, using both

humans and detailed invasive brain analysis of animals has discovered some critical ways that the brain processes pleasure. Remarkably, there are pathways for ordinary liking and pleasure, which are limited in scope as described above in this commentary. However, there are many brain regions, often termed hot and cold spots, that significantly modulate (increase or decrease) our pleasure or even produce the opposite of pleasure—that is disgust and fear [39]. One specific region of the nucleus accumbens is organized like a computer keyboard, with particular stimulus triggers in rows—producing an increase and decrease of pleasure and disgust. Moreover, the cortex has unique roles in the cognitive evaluation of our feelings of pleasure [40]. Importantly, the interplay of these multiple triggers and the higher brain centers in the prefrontal cortex are very intricate and are just being uncovered. Desire and reward centers. It is surprising that many different sources of pleasure activate the same circuits between the mesocorticolimbic regions (Figure 1). Reward and desire are two aspects pleasure induction and have a very widespread, large circuit. Some part of this circuit distinguishes between desire and dread. The so-called pleasure circuitry called "REWARD" involves a well-known dopamine pathway in the mesolimbic system that can influence both pleasure and motivation. In simplest terms, the well-established mesolimbic system is a dopamine circuit for reward. It starts in the ventral tegmental area (VTA) of the midbrain and travels to the nucleus accumbens (Figure 2). It is the convenient target to all addictions. The VTA is encompassed with neurons using glutamate, GABA, and dopamine. The nucleus accumbens (NAc) is located within the ventral striatum and is divided into two sub-regions—the motor and limbic regions associated with its core and shell, respectively. The NAc has spiny neurons that receive dopamine from the VTA and glutamate (or dopamine drive) from the hippocampus, amygdala and medial prefrontal cortex. Subsequently, the NAc projects GABA signals to an area termed the ventral pallidum (VP). The region is a relay station in the limbic loop of the basal ganglia, critical for motivation, behavior, emotions and the "Feel Good" response. This defined system of the

brain is involved in all addictions—substance, and non—substance related. In 1995, our laboratory coined the term "Reward Deficiency Syndrome" (RDS) to describe genetic and epigenetic induced hypodopaminergia in the "Brain Reward Cascade" that contribute to addiction and compulsive behaviors [3,6,41]. Furthermore, ordinary "liking" of something, or pure pleasure, is represented by small regions mainly in the limbic system (old reptilian part of the brain). These may be part of larger

neural circuits. In Latin, hedus is the term for "sweet"; and in Greek, hodone is the term for "pleasure." Thus, the word Hedonic is now referring to various subcomponents of pleasure: some associated with purely sensory and others with more complex emotions involving morals, aesthetics, and social interactions. The capacity to have pleasure is part of being healthy and may even extend life, especially if linked to optimism as a dopaminergic response [42]. Psychiatric illness often includes symptoms of an abnormal inability to experience pleasure, referred to as anhedonia. A negative feeling state is called dysphoria, which can consist of many emotions such as pain, depression, anxiety, fear, and disgust. Previously many scientists used animal research to uncover the complex mechanisms of pleasure, liking, motivation and even emotions like fear, as discussed above [43]. However, as a significant amount of related research about the specific brain regions of pleasure/reward circuitry has been derived from invasive studies of animals, these cannot be directly compared with subjective states experienced by humans. In an attempt to resolve the controversy regarding the causal contributions of mesolimbic dopamine systems to reward, we have previously evaluated the three main competing explanatory categories: "liking," "wanting," and "wanting" [3]. That is, dopamine may mediate (a) liking: the hedonic impact of reward, (b) wanting: learned predictions about rewarding effects, or (c) wanting: the pursuit of rewards by attributing incentive salience to reward-related stimuli [44]. We have evaluated these hypotheses, especially as they relate to the RDS, and we find that the incentive salience or "wanting" hypothesis of dopaminergic functioning is supported by a majority of the scientific evidence. Various neuroimaging studies have shown that anticipated behaviors such as sex and gaming, delicious foods and drugs of abuse all affect brain regions associated with reward networks, and may not be unidirectional. Drugs of abuse enhance dopamine signaling which sensitizes mesolimbic brain mechanisms that apparently evolved explicitly to attribute incentive salience to various rewards [45]. Addictive substances are voluntarily self-administered, and they enhance (directly or indirectly) dopaminergic synaptic function in the NAc. This activation of the brain reward network (producing the ecstatic "high" that users seek). Although these circuits were initially thought to encode a set of hedonic tone, it is now being considered to be far more complicated in function, also encoding attention, reward expectancy, discrimination of reward expectancy, and incentive motivation [46]. The argument about addiction as a disease may be confused with a predisposition to substance and nonsubstance rewards relative to the extreme effect of drugs of abuse on brain neurochemistry. The former sets up an individual to be at high risk through both genetic polymorphisms in reward genes as well as harmful epigenetic insult. Some Psychologists, even with all the data, still infer that addiction is not a disease [47]. Elevated stress levels, together with polymorphisms (genetic variations) of various dopaminergic genes and the genes related to other neurotransmitters (and their genetic variants), and may have an additive effect on vulnerability to various addictions [48]. In this regard, Vanyukov et al. [48] suggested based on review that whereas the gateway hypothesis does not specify mechanistic connection between "signs" and does not extend to the risks for addictions the concept of common liability to addictions may be more parsimonious. The latter theory is grounded in genetic theory and supported by data identifying common sources of variation in the risk for specific addictions (e.g., RDS). This commonality has identifiable neurobiological substrate and plausible evolutionary explanations. Over many years the controversy of dopamine involvement in especially "pleasure" has led to confusion concerning separating motivation from actual pleasure (wanting versus liking) [49]. We take the position that animal studies cannot provide real clinical information as described by self-reports in humans. As mentioned earlier and in the abstract, on November 23rd, 2017, evidence for our concerns was discovered [50]. In essence, although nonhuman primate brains are similar to our own, the disparity between other primates and those of human cognitive abilities tells us that surface similarity is not the whole story. Sousa et al. [50] small case found various differentially expressed genes, to associate with pleasure related systems. Furthermore, the dopaminergic interneurons located in the human neocortex were absent from the neocortex of nonhuman African apes. Such differences in neuronal transcriptional programs may underlie a variety of neurodevelopmental disorder. In simpler terms, the system controls the production of dopamine, a chemical messenger that plays a significant role in pleasure and rewards. The senior author, Dr.

Nenad Sestan from Yale, stated: "Humans have evolved a dopamine system that is different than the one in chimpanzees." This may explain why the behavior of humans is so unique from that of non-human primates, even though our brains are so surprisingly similar, Sestan said: "It might also shed light on why people are vulnerable to mental disorders such as autism (possibly even addiction)." Remarkably, this research finding emerged from an extensive, multicenter collaboration to compare the brains across several species. These researchers examined 247 specimens of neural tissue from six humans, five chimpanzees, and five macaque monkeys. Moreover, these investigators analyzed which genes were turned on or off in 16 regions of the brain, while the differences among species were subtle, there was a remarkable contrast in the neocortices, specifically in an area of the brain that is much more developed in humans than in chimpanzees. In fact, these researchers found that a gene called tyrosine hydroxylase (TH) for the enzyme, responsible for the production of dopamine, was expressed in the neocortex of humans, but not chimpanzees. As discussed earlier, dopamine is best known for its essential role within the brain's reward system; the very system that responds to everything from sex, to gambling, to food, and to addictive drugs. However, dopamine also assists in regulating emotional responses, memory, and movement. Notably, abnormal dopamine levels have been linked to disorders including Parkinson's, schizophrenia and spectrum disorders such as autism and addiction or RDS. Nora Volkow, the director of NIDA, pointed out that one alluring possibility is that the neurotransmitter dopamine plays a substantial role in humans' ability to pursue various rewards that are perhaps months or even years away in the future. This same idea has been suggested by Dr. Robert Sapolsky, a professor of biology and neurology at Stanford University. Dr. Sapolsky cited evidence that dopamine levels rise dramatically in humans when we anticipate potential rewards that are uncertain and even far off in our futures, such as retirement or even the possible afterlife. This may explain what often motivates people to work for things that have no apparent short-term benefit [51]. In similar work, Volkow and Bale [52] proposed a model in which dopamine can favor NOW processes through phasic signaling in reward circuits or LATER processes through tonic signaling in control circuits. Specifically, they suggest that through its modulation of the orbitofrontal cortex, which processes salience attribution, dopamine also enables shifting from NOW to LATER, while its modulation of the insula, which processes interoceptive information, influences the probability of selecting NOW versus LATER actions based on an individual's physiological state. This hypothesis further supports the concept that disruptions along these circuits contribute to diverse pathologies, including obesity and addiction or RDS.

Extinction must outweigh – moral uncertainty demands we preserve the conditions for life, even a tiny risk outweighs, and future gains in quality of life ensure it's a prior question

Todd 17 [Ben has a 1st from Oxford in Physics and Philosophy, has published in Climate Physics, once kick-bought for Oxford, and speaks Chinese, badly. "The case for reducing extinction risk." <https://80000hours.org/articles/extinction-risk/>] brett

In this new age what should be our biggest priority, as a civilisation? Improving technology? Helping the poor? Changing the political system? Here's a suggestion that's not so often discussed our first priority should be to survive So long as civilisation continues to exist, we'll have the chance to solve all our other problems, and have a far better future. But if we go extinct, that's it

Why isn't this priority more discussed? Here's one reason: many people don't yet appreciate the change in situation, and so don't think our future is at risk. Social science researcher Spencer Greenberg surveyed Americans on their estimate of the chances of human extinction within 50 years. The results found that many think the chances

Should we do these things? Answering this all-important question requires ethics. Therefore, just as consequentialists should pay attention to outer space, so too should outer space analysts pay attention to consequentialism, and indeed to ethics in general. Defensible forms of consequentialism will generally conclude that (1) humanity today should focus on avoiding global catastrophe, (2) space colonization should proceed with caution, but ultimately should proceed at immense scale, and (3) high-power/long-duration METI should not be conducted until more effort is put to assessing whether the consequences are likely to be good.

The ethical arguments and empirical analyses in this paper are quite brief and are not the final word on the subject. I have said little in defense of consequentialism and my preferred form of it. The analyses of space colonization and ETI encounter are likewise at best only approximate and leaving much for future work. Some of it is due to space constraints in this paper, but much of it is due to the fact that the research simply has not yet been performed. Outer space consequentialism could make for a fruitful line of inquiry.

The merits of this line of inquiry are diminished by the conclusion to focus on avoiding global catastrophe. Any global catastrophe would preclude the possibility of future research on all topics, including outer space consequentialism. Likewise, any hopes of resolving the ethical dilemmas and empirical uncertainties depend on us surviving long enough to do the research. An argument can thus be made against any work on outer space in favor of work on the global catastrophic risks. My own view is that work on outer space should be pursued mainly to the extent that it is instrumentally valuable towards reducing the global catastrophic risks. To that end it can be quite instrumentally valuable. Outer space can offer great motivation due to its immense opportunities, and it can be deeply inspirational due to its beauty and wonder and the big-picture perspective it offers. While attention to outer space should not distract humanity from the urgent threats that it faces, some attention is very much worthwhile.

That outweighs -- util is key to research around space because analysis of consequences is critical to any research about the big picture of space exploration, mining, satellites, etc. Two impacts: 1] Fairness, as it's most predictable to topic-oriented prep, so any alternative framework throws away the hard work of novices and well-prepared debaters, 2] Education, absent an incentive to go deep into the topic literature we lose out on research skills that we take out of this space and benefit us for our entire lives.

1AC – Underview

1] 1AR theory is legit – anything else means infinite abuse – drop the debater – 1AR is too short to make up for the time trade-off – no RVIs – 6 min 2NR means they can brute force me every time – competing interps – otherwise the 2NR could drown the aff in arguments while playing defense