# NC

## China DA

#### China challenging US dominance in space – private sector maintains the US’s preeminence

Harding 21 Harding, Luke. "The Space Race Is Back On – But Who Will Win?". The Guardian, 2021, <https://www.theguardian.com/science/2021/jul/16/the-space-race-is-back-on-but-who-will-win>. Luke Harding is a Guardian foreign correspondent. His book [Shadow State](https://guardianbookshop.com/shadow-state-9781783352050.html) is published by Guardian Faber.

Liu Boming took in the dizzy view. Around him lay the inky vastness of space. Below was the Earth. “Wow,” he said, laughing. “It’s too beautiful out here.” Over the next seven hours Liu and his colleague Tang Hongbo carried out China’s second spacewalk, helped along by a giant robotic arm. Mission accomplished, the two taikonauts – China’s astronauts – clambered back into their home for the next three months: Beijing’s new space station. The core module of the station, named Tiangong, meaning “heavenly palace”, was launched in April. “There will be more spacewalks. The station will keep growing,” Liu said. Meanwhile, on Mars, a Chinese rover was exploring. Video shows the [vehicle trundling over a rocky surface](https://www.theguardian.com/world/video/2021/jun/27/china-releases-footage-from-its-mars-rover-video). There is even sound: an eerie mechanical groaning. Since landing in May the Zhurong probe has been busy seeking clues as to whether Mars once supported life. There is no answer yet: so far it has travelled just over 410 metres. China is only the second country to land and operate a rover on the red planet, after the US. The frantic tempo of the China National [Space](https://www.theguardian.com/science/space) Administration’s (CNSA) recent programme is reminiscent of the cold war, when Moscow and Washington were superpower rivals scrambling to put the first man in space and land on the moon. Half a century on, space has opened up. It is less ideological and a lot more crowded. About 72 countries have space programmes, including India, Brazil, Japan, Canada, South Korea and the UAE. The European Space Agency is active too, while the UK boasts the most private space startups after the US. Space today is also highly commercial. On Sunday [Richard Branson](https://www.theguardian.com/business/richard-branson) flew to the edge of space and back again in his Virgin Galactic passenger rocket. On Tuesday, Branson’s fellow billionaire Jeff Bezos is due to travel in his own reusable craft, New Shepard, built by the Amazon founder’s company Blue Origin and launched from west Texas. Non-state actors play an increasingly important role in space exploration. Elon Musk’s SpaceX vehicles have made numerous flights to the International Space Station (ISS), and [since last year they have transported people as well as cargo](https://www.spacex.com/human-spaceflight/iss/index.html). Later this year Musk is due to send his own all-civilian crew into orbit – though he isn’t going himself. Even so, space still reflects tensions on Earth. “Astropolitics follows terrapolitics,” says [Mark Hilborne](https://twitter.com/space_security?lang=en), a lecturer in defence studies at King’s College London. Up there anything goes, he adds. “Space governance is a bit fuzzy. Laws are few and very old. They are not written for asteroid mining or for a time when companies dominate.” The biggest challenge to US space supremacy comes not from [Russia](https://www.theguardian.com/world/russia) – heir to the Soviet Union’s pioneering space programme, which launched the Sputnik satellite and got the first human into space in the form of Yuri Gagarin – but from China. In 2011 Congress prohibited US scientists from cooperating with Beijing. Its fear: scientific espionage. Taikonauts are banned from visiting the ISS, which has hosted astronauts from 19 countries over the past 20 years. The station’s future beyond 2028 is uncertain. Its operations may yet be extended in the face of increasing Chinese competition. In its annual threat assessment this April, the office of the US Director of National Intelligence (DNI) described China as a “near-peer competitor” pushing for global power. It warns: “Beijing is working to match or exceed US capabilities in space to gain the military, economic, and prestige benefits that Washington has accrued from space leadership.” The Biden administration suspects Chinese satellites are being used for non-civilian purposes. The People’s Liberation Army integrates reconnaissance and navigation data in military command and control systems, the DNI says. “Satellites are inherently dual use. It’s not like the difference between an F15 fighter jet and a 737 passenger plane,” Hilborne says. Once China completes the Tiangong space station next year, it is likely to invite foreign astronauts to take part in missions. One goal: to build new soft-power alliances. Beijing says interest from other countries is enormous. The low Earth orbit station is part of an ambitious development strategy in the heavens rather than on land – a sort of belt and rocket initiative. According to Alanna Krolikowski, an assistant professor at the Missouri University of Science and Technology, a “bifurcation” of space exploration is under way. In one emerging camp are states led by China and Russia, many of them authoritarian; in the other are democracies and “like-minded” countries aligned with the US. Russia has traditionally worked closely with the Americans, even when terrestrial relations were bad. Now it is moving closer to Beijing. In March, China and Russia [announced plans to co-build an international lunar research station](https://www.theguardian.com/science/2021/mar/10/china-and-russia-unveil-joint-plan-for-lunar-space-station). The agreement comes at a time when Vladimir Putin’s government has been increasingly isolated and subject to western sanctions. In June, Putin and his Chinese counterpart Xi Jinping renewed a friendship treaty. Moscow is cosying up to Beijing out of necessity, at a time of rising US-China bipolarity. These rival geopolitical factions are fighting over a familiar mountainous surface: the moon. In 2019 a Chinese rover landed on its far side – a first. China is now planning a mission to the moon’s south pole, to establish a robotic research station and an eventual lunar base, which would be intermittently crewed. Nasa, meanwhile, has said it intends to put a woman and a person of colour on the moon by 2024. SpaceX has been hired [to develop a lander](https://www.theguardian.com/science/2021/apr/17/nasa-spacex-moon-spacecraft-elon-musk). The return to the moon – after the last astronaut, commander Eugene Cernan, said goodbye in December 1972 – would be a staging post for the ultimate “giant leap”, Nasa says: sending astronauts to Mars. Krolikowski is sceptical that China will quickly overtake the US to become the world’s leading spacefaring country. “A lot of what China is doing is a reprisal of what the cold war space programmes did in the 1960s and 1970s,” she said. Beijing’s recent feats of exploration have as much to do with national pride as scientific discovery, she says. But there is no doubting Beijing’s desire to catch up, she adds. “The Chinese government has established, or has plans for, programmes or missions in every major area, whether it’s [Mars](https://www.theguardian.com/science/mars) missions, building mega constellations of telecommunications satellites, or exploring asteroids. There is no single area of space activity they are not involved in.” “We see a tightening of the Russia-China relationship,” Krolikowski says. “In the 1950s the Soviet Union provided a wide range of technical assistance to Beijing. Since the 1990s, however, the Russian space establishment has experienced long stretches of underfunding and stagnation. China now presents it with new opportunities.” Russia is poised to benefit from cost sharing, while China gets deep-rooted Russian technical expertise. At least, that’s the theory. “I’m sceptical this joint space project will materialise anytime soon,” says Alexander​ Gabuev, a senior fellow at the Carnegie Moscow Centre. Gabuev says both countries are “techno-nationalist”. Previous agreements to develop helicopters and wide-bodied aircraft saw nothing actually made, he says. The Kremlin has been a key partner in managing and resupplying the ISS. US astronauts used Russian Soyuz rockets to reach the station, taking off from a cosmodrome in Kazakhstan, after the Space Shuttle programme was phased out. But this epoch seems to be coming to an end as private companies such as [SpaceX](https://www.theguardian.com/science/spacex) take over. “I expect US-Russian relations to get worse,” Gabuev says, adding that Americans “no longer need” Russia’s help. Moscow’s state corporation for space activities, Roscosmos, has faced accusations of being more interested in politics than space research. Last month the newspaper Novaya Gazeta reported that Roscosmos’s executive director of manned space programmes, former cosmonaut Sergei Krikalev, had been fired. His apparent crime: questioning an official decision to shoot a film on the Russian section of the ISS. The film, Challenge, is about a female surgeon operating on a cosmonaut in space, and has been backed and financed by Roscosmos . It stars Yulia Peresild, who is due to head to space in October with director Klim Shipenko. The launch seems timed to beat Tom Cruise, who is due to shoot his own movie on board the ISS with director Doug Liman[.](https://www.theguardian.com/science/2021/may/13/russia-send-actor-director-iss-shoot-first-movie-space) Krikalev, who spent more than 800 days in space and was in orbit when the USSR collapsed, apparently told Roscomos’s chief, Dmitry Rogozin, that the film was pointless. Rogozin – its co-producer – has called on the west to drop sanctions in return for Russia’s cooperation on space projects. Putin, Rogozin’s boss, appears to not be very interested in other planets, though, and is more concerned with [nature and the climate crisis](https://www.reuters.com/article/us-russia-putin-idUSKCN1LC1X0) these days. “Space is one of the areas that has traditionally transcended politics. The Mir space station worked at a time of east-west tensions. There was symbolic cooperation. Whether this will continue in the future is really up for debate,” Hilborne says. “The US is very sensitive about what happens in space.” Most observers think the US will remain the world’s pre-eminent space power, thanks to its innovative and flourishing private sector. China’s Soviet-style state programme appears less nimble. Despite ambitious timetables, and billions spent by Beijing, it is unclear when – or even if – an astronaut will return to the moon. The 2030s, perhaps? Will they be American or Chinese? Or from a third country? It may well be that the first person to boldly go again doesn’t merely represent a nation or carry a flag. More likely, they will emerge from a lunar lander wearing a spacesuit with a SpaceX logo on the back – a giant leap not only for mankind, but for galactic marketing.

#### US space dominance prevents war with China – deters anti-satellite use and Taiwan intervention

Chow and Kelley 21 Chow, Brian, and Brandon Kelley. "China’S Anti-Satellite Weapons Could Conquer Taiwan—Or Start A War". The National Interest, 2021, <https://nationalinterest.org/feature/china%E2%80%99s-anti-satellite-weapons-could-conquer-taiwan%E2%80%94or-start-war-192135.Brian> Chow is an independent policy analyst (Ph.D. physics, MBA with Distinction, Ph.D. finance) with over 160 publications in space and other national security policies and Brandon Kelley

On July 1, 2021—the one-hundredth birthday of the Chinese Communist Party—[President Xi Jinping](https://asia.nikkei.com/Politics/Full-text-of-Xi-Jinping-s-speech-on-the-CCP-s-100th-anniversary) declared that China will “[advance peaceful national reunification](https://nationalinterest.org/blog/reboot/could-taiwan%E2%80%99s-terrain-stop-chinese-invasion-its-tracks-191919)” with Taiwan. It would be easy to dismiss such statements as mere political rhetoric: certainly, Taiwan would never willingly accede to Chinese demands to rejoin the fold. But China’s rapidly advancing anti-satellite (ASAT) capabilities could open up another avenue: deterring United States intervention on Taiwan’s behalf in order to coerce reunification without firing a shot. If current trends hold, then China’s [Strategic Support Force](https://ndupress.ndu.edu/Portals/68/Documents/stratperspective/china/china-perspectives_13.pdf) will be capable by the late 2020s of holding key U.S. space assets at risk. [Chinese military doctrine](https://nationalinterest.org/blog/reboot/nowhere-earth-will-be-safe-us-china-war-172523), statements by senior officials, and past behavior all suggest that China may well believe threatening such assets to be an effective means of deterring U.S. intervention. If so, then the United States would face a type of “Sophie’s Choice”: decline to intervene, potentially leading allies to follow suit and Taiwan to succumb without a fight, thereby enabling Xi to achieve his goal of “peacefully” snuffing out Taiwanese independence; or start a war that would at best be long and bloody and might well even cross the nuclear threshold. This emerging crisis has been three decades in the making. In 1991, China watched from afar as the United States used space-enabled capabilities to obliterate the Iraqi military from a distance in the first Gulf War. The People’s Liberation Army quickly set to work developing capabilities targeted at a perceived Achilles’ heel of this new [American way of war](https://nationalinterest.org/feature/secrets-and-lies-role-truth-great-power-information-warfare-170579): reliance on vulnerable space systems. This project came to fruition with a direct ascent [ASAT weapons test](https://fas.org/sgp/crs/row/RS22652.pdf) in 2007, but the test was limited in two key respects. First, it only reached low Earth orbit. Second, it generated thousands of pieces of long-lasting space junk, provoking immense [international ire](https://spacenews.com/u-s-official-china-turned-to-debris-free-asat-tests-following-2007-outcry/). This backlash appears to have taken China by surprise, driving it to seek new, more usable ASAT types with minimal debris production. Now, one such ASAT is nearing operational status: spacecraft capable of rendezvous and proximity operations (RPOs). Such spacecraft are [inevitable](https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-12_Issue-2/Chow.pdf#page=22) and cannot realistically be limited. The United States, European Union, China, and others are developing them to provide a range of satellite services essential to the [new space economy](https://www.morganstanley.com/ideas/space-economy-themes-2021), such as in situ repairs and refueling of satellites and active removal of space debris. But RPO capabilities are dual-use: if a satellite can grapple space objects for servicing, then it might well be capable of grappling an adversary’s satellite to move it out of its servicing orbit. Perhaps it could degrade or disable it by bending or disconnecting its solar panels and antennas all while producing minimal debris. This is [a serious threat](https://nationalinterest.org/feature/can-america-lose-china-189020), primarily because no international rules presently exist to limit close approaches in space. Left unaddressed, this lacuna in international law and space policy could enable a prospective attacker to pre-position, during peacetime, as many spacecraft as they wish as close as they wish to as many high-value targets as they wish. The result would be an ever-present possibility of sudden, bolt-from-the-blue attacks on vital space assets—and worse, on many of them at once. China has conducted at least [half a dozen tests of RPO](https://swfound.org/media/207179/swf_chinese_rpo_fact_sheet_apr2021.pdf#page=3) capabilities in space since 2008, two of which went on for years. Influential space experts have noted that these tests have plausible peaceful purposes and are in many cases similar to those conducted by the United States. This, however, does not make it any less important to establish effective legal, policy, and technical counters to their offensive use. Even if it were certain that these capabilities are intended purely for peaceful applications—and it is not at all clear that that is the case—China (or any other country) could at any time decide to repurpose these capabilities for ASAT use. There is still time to get out ahead of this threat, but likely not for much longer. China’s RPO capabilities have, thus far, lagged about five years behind those of the United States. There are reasons to believe this gap may close, but even assuming that it holds, we should expect to see China demonstrate an operational dual-use rendezvous spacecraft by around 2025. (The first instance of a U.S. commercial satellite docking with another satellite to change its orbit occurred in [February 2020](https://news.northropgrumman.com/news/releases/northrop-grumman-successfully-completes-historic-first-docking-of-mission-extension-vehicle-with-intelsat-901-satellite).) At the same time, China is expanding its capacity for rapid spacecraft manufacturing. The [Global Times](https://www.globaltimes.cn/page/202101/1213345.shtml) reported in January that China’s first intelligent mass production line is set to produce 240 small satellites per year. In April, [Andrew Jones](https://spacenews.com/china-is-developing-plans-for-a-13000-satellite-communications-megaconstellation/#:~:text=China%20is%20developing%20plans%20for%20a%2013%2C000%2Dsatellite%20megaconstellation,-by%20Andrew%20Jones&text=HELSINKI%20%E2%80%94%20China%20is%20to%20oversee,the%20country's%20major%20space%20actors.) at SpaceNews reported that China is developing plans to quickly produce and loft a thirteen thousand-satellite national internet megaconstellation. It is not unreasonable to assume that China could manufacture two hundred small rendezvous ASAT spacecraft by 2029, possibly more. If this happens, and Beijing was to decide in 2029 to launch these two hundred small RPO spacecraft and position them in close proximity to strategically vital assets, then China would be able to simultaneously threaten disablement of the entire constellations of U.S. satellites for missile early warning (about a dozen satellites with spares included); communications in a nuclear-disrupted environment (about a dozen); and positioning, navigation, and timing (about three dozen); along with several dozen key communications, imagery, and meteorology satellites. Losing these assets would severely degrade U.S. deterrence and warfighting capabilities, yet once close pre-positioning has occurred such losses become almost impossible to prevent. For this reason, such pre-positioning could conceivably deter the United States from coming to Taiwan’s aid due to the prospect that intervention would spur China to disable these critical space systems. Without their support, the war would be much bloodier and costlier—a daunting proposition for any president. Should the United States fail to intervene, the consequences would be disastrous for both Washington and its allies in East Asia, and potentially the credibility of U.S. defense commitments around the globe. Worse yet, however, might be what could happen if China believes that such a threat will succeed but proves to be wrong. History is rife with examples of major wars arising from miscalculations such as this, and there are many pathways by which such a situation could easily escalate out of control to a full-scale conventional conflict or even to nuclear use. This Catch-22 of so-called “peaceful reunification” on the one hand and catastrophic miscalculation on the other is entirely preventable. To do so, however, the United States must act now. To deter such pre-positioning and provide a clear framework for how to handle it if it does occur, the United States should immediately begin coordinating with its allies to establish shared understandings for the rules and operations of [warning](http://npolicy.org/article_file/Space_and_Missile_Wars.pdf#page=136)/[self-defense](https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-14_Issue-4/Chow.pdf#page=5) zones in orbit. Additionally, the United States should develop and deploy [bodyguard spacecraft](https://www.airuniversity.af.edu/Portals/10/SSQ/documents/Volume-14_Issue-4/Chow.pdf#page=6) to monitor and enforce such rules. The United States cannot afford to wait; once the potential threat arrives, it will already be too late.

#### US-China war goes nuclear – leads to power vacuum, econ collapse and extinction

Sharman 17 (Jon Sharman, “US would go into any war with China with 'unparalleled violence', warn experts’” 2017. The Independent. February 5, 2017. http://www.independent.co.uk/news/world/americas/us-china-war-be-end-of-life-earth-nuclear-weapons-apocalypse-steve-bannon-donald-trump-white-house-a7561821.html.)

While the prospect remains relatively remote, experts have told The Independent they believe such a conflict would be catastrophic, throwing the entire globe into turmoil and potentially ending "life as we know it on Earth". The United States would likely win because sending China's untested forces against the might of America's military would be like pitching farmers against Achilles and his warriors, said one, but even a conventional military victory would be a strategic disaster. It would set off a global economic crisis and create a potential power vacuum inside defeated China "the like of which we can't imagine". Mr Bannon said war would erupt in the South China Sea in "five to 10 years". He said: "They’re taking their sandbars and making basically stationary aircraft carriers and putting missiles on those. They come here to the United States in front of our face—and you understand how important face is—and say it’s an ancient territorial sea." The US and China have been engaged in a back-and-forth dispute over military build-up and territorial claims in the region for some years. In December the US said it would base its deadliest fighter jets in Australia, and days later China seized an unmanned US Navy drone. It followed a diplomatic spat around then-President-elect Trump's congratulatory phone call with Taiwan's Prime Minister Tsai Ing-wen, which broke with decades of US policy. Mr Trump has been forthright about China's influence, blaming it for the loss of American jobs. The war of words recently heated up when a Chinese military official was quoted as saying talk of war with the US under Mr Trump "are not just slogans, they are becoming a practical reality". Trevor McCrisken, associate professor of politics and international studies at the University of Warwick, said that if war broke out "we would be looking, I would imagine, at World War Three". He said: "I really do think that would be the end of life as we know it on Earth. "From a global strategic risk level I would say the last thing you want is war between the United States and any of the major powers because of the risks of escalation, obviously the potential for nuclear weapons to be used. The likelihood of nuclear exchange between the two principals involved is high."

## Contention Two

#### CP: The United Nations should establish an orbital use fee for all satellites and use the money received to pay for debris cleanup

Vergoth 20 Vergoth, Karin. "Solving The Space Junk Problem". CU Boulder Today, 2020, <https://www.colorado.edu/today/2020/05/26/solving-space-junk-problem>. Karin Vergoth is a CIRES-NOAA Science Writer.

Space is getting crowded. Aging satellites and space debris crowd low-Earth orbit, and launching new satellites adds to the collision risk. The most effective way to solve the space junk problem, according to a new study, is not to capture debris or deorbit old satellites: it’s an international agreement to charge operators “orbital-use fees” for every satellite put into orbit. Orbital use fees would also increase the long-run value of the space industry, said economist Matthew Burgess, a [CIRES Fellow and co-author of the new paper](https://cires.colorado.edu/news/solving-space-junk-problem). By reducing future satellite and debris collision risk, an annual fee rising to about $235,000 per satellite would quadruple the value of the satellite industry by 2040, he and his colleagues concluded in a paper published today in the [Proceedings of the National Academy of Sciences](https://www.pnas.org/content/early/2020/05/20/1921260117). “Space is a common resource, but companies aren’t accounting for the cost their satellites impose on other operators when they decide whether or not to launch,” said Burgess, who is also an assistant professor in environmental studies and an affiliated faculty member in economics at CU Boulder. “We need a policy that lets satellite operators directly factor in the costs their launches impose on other operators.” Currently, an estimated 20,000 objects—including satellites and space debris—are crowding low-Earth orbit. It’s the latest tragedy of the commons, the researchers said: Each operator launches more and more satellites until their private collision risk equals the value of the orbiting satellite. So far, proposed solutions have been primarily technological or managerial, said Akhil Rao, assistant professor of economics at Middlebury College and the paper’s lead author. Technological fixes include removing space debris from orbit with nets, harpoons, or lasers. Deorbiting a satellite at the end of its life is a managerial fix. Ultimately, engineering or managerial solutions like these won’t solve the debris problem because they don’t change the incentives for operators. For example, removing space debris might motivate operators to launch more satellites—further crowding low-Earth orbit, increasing collision risk, and raising costs. “This is an incentive problem more than an engineering problem. What’s key is getting the incentives right,” Rao said. A better approach to the space debris problem, Rao and his colleagues found, is to implement an orbital-use fee—a tax on orbiting satellites. “That’s not the same as a launch fee,” Rao said, “Launch fees by themselves can’t induce operators to deorbit their satellites when necessary, and it's not the launch but the orbiting satellite that causes the damage.” Orbital-use fees could be straight-up fees or tradeable permits, and they could also be orbit-specific, since satellites in different orbits produce varying collision risks. Most important, the fee for each satellite would be calculated to reflect the cost to the industry of putting another satellite into orbit, including projected current and future costs of additional collision risk and space debris production—costs operators don’t currently factor into their launches. “In our model, what matters is that satellite operators are paying the cost of the collision risk imposed on other operators,” said Daniel Kaffine, professor of economics and RASEI Fellow at CU Boulder and co-author on the paper. And those fees would increase over time, to account for the rising value of cleaner orbits. In the researchers’ model, the optimal fee would rise at a rate of 14 percent per year, reaching roughly $235,000 per satellite-year by 2040. For an orbital-use fee approach to work, the researchers found, all countries launching satellites would need to participate—that's about a dozen that launch satellites on their own launch vehicles and more than 30 that own satellites. In addition, each country would need to charge the same fee per unit of collision risk for each satellite that goes into orbit, although each country could collect revenue separately. Countries use similar approaches already in carbon taxes and fisheries management. In this study, Rao and his colleagues compared orbital-use fees to business as usual (that is, open access to space) and to technological fixes such as removing space debris. They found that orbital use fees forced operators to directly weigh the expected lifetime value of their satellites against the cost to industry of putting another satellite into orbit and creating additional risk. In other scenarios, operators still had incentive to race into space, hoping to extract some value before it got too crowded. With orbital-use fees, the long-run value of the satellite industry would increase from around $600 billion under the business-as-usual scenario to around $3 trillion, researchers found. The increase in value comes from reducing collisions and collision-related costs, such as launching replacement satellites. Orbital-use fees could also help satellite operators get ahead of the space junk problem. “In other sectors, addressing the tragedy of the commons has often been a game of catch-up with substantial social costs. But the relatively young space industry can avoid these costs before they escalate,” Burgess said.

## Contention Three

#### CP: The United Nations should

#### Give the World Bank authority to sell and lease resources in outer space

#### Invest revenue from the leasing and selling of outer space in an “Outer Space Resource Fund”

#### Establish a global dividend from that investment to be distributed directly to every adult individual on the planet

Sterling et al. 18 Sterling Saletta, M., & Orrman-Rossiter, K. (2018). Can space mining benefit all of humanity?: The resource fund and citizen’s dividend model of Alaska, the “last frontier.” Space Policy, 43, 1–6. doi:10.1016/j.spacepol.2018.02.00 Morgan Sterling works at the Department of Management and Marketing and, School of Historical and Philosophical Studies, The University of Melbourne, Victoria

In exploring how a pragmatic system might be created by which the exploitation of outer space benefits all of humanity, it is prudent to thoroughly examine terrestrial models which might provide a model and/or mechanism for such a regime. Alaska, sometimes known as the ‘last frontier’, provides a unique example, in the form of the Alaska Permanent Fund, of a democratic, market-based and economically viable model that can inform efforts to establish an international regime for an eventual exploitation of the ‘high frontier’ that benefits all of humanity while also encouraging profit-making ventures and insures, as René Lefeber [5] has argued, that the mechanism for sharing benefits with humanity also provide preferential treatment of investors as motors of human expansion into space. The Alaska Permanent Fund is an example of a natural resource fund (NRF), one type of public trust fund of which nationally controlled sovereign wealth funds are but one, albeit well known, example. NRF's are financed with revenues from the sale of mineral, gas or oil resources or by royalties collected from leasing arrangements. While natural resource funds and sovereign wealth funds have proliferated since 2000, they are not new, with trillions of dollars invested in such funds globally. The oldest continually operating fund is the Texas Permanent University Fund founded in 1876. Such funds, the majority of which are NRF's, are now in use by many nation states as well as sub-national entities including the U.S states of Alaska, Wyoming, Texas and Alabama. The new millennium has seen proliferation of natural resource funds, with some 34 created since 2000 [49]. The well-established and accelerating trend of creating these types of funds provides a clear method to manage the revenue from the leasing of outer space resources consistent both with the needs of profit driven commercial entities and with the OST. In short, the authors propose that the eventual creation of an international space resource fund, managed, for example, under the aegis of the World Bank or similar institution might provide a pragmatic and market-based mechanism by which benefits of space resource exploitation could accrue to all of humanity without stifling commercial and entrepreneurial ventures. The question remains, however, what to do with the returns on such a potential investment fund. Here again, the Alaska Permanent Fund (APF) offers a unique and time-tested mechanism. To understand its origins, and potential appeal for an outer space resource exploitation management regime, some historical and political context is needed. The Alaska Permanent Fund was proposed by then Governor Jay Hammond and established in 1976 by a constitutional amendment with the purpose of investing a portion of the royalty payments from oil production on state owned land. The purpose of the fund was twofold: to create a sustainable investment fund with the revenues from a depleting non-renewable resource, but also to limit the ability of politicians to spend these revenues on wasteful projects. Indeed, it is important to note that while the APF is considered a model in terms of its transparency, in some countries resource funds have undermined the public interest and contributed to nepotism and corruption [49]. The creation of the Alaska Permanent Fund was motivated by libertarian principles rather than 'socialist' ideology. In 1977 Gov. Hammond proposed that a portion of the investment proceeds be payed as dividends to all Alaskan residents as part of his “Alaska, Inc.” plan [50]. This is a unique feature of the APF- although many states have created wealth funds for various purposes, none pays a dividend to all residents, regardless of age. Indeed, the fund is a unique and democratic experiment in “intergenerational transfer of wealth and in the redistribution of public funds back to the private sector [[51], p. 139].” Many, if not most, Alaskans view the dividend as their right as shareholders in the natural resources of the state [52]. In keeping with the desire to shield the Fund from politicians, the establishment of an independent trust corporation and a mandated ‘prudent investor' policy (adopted in 1980) means that the Fund is insulated from political pressure to invest in pet projects, and the dividend has created a vested and personal interest on the part of Alaskan residents in the health of the fund [50]. The APF is now worth some 63 billion dollars and recent payments from the Alaska Permanent Fund Dividend (APFD) to each Alaskan resident have ranged from $2072 (US) in 2015 to $1100 in 2017 [53,54]. As the size of the dividends has generally grown over time and become an expected component of household budgets, there is active political support for the APFD across the political spectrum with active proponents including former Governor Sarah Palin. By investing the revenue from resource leasing rights in the global commons of outer space, and paying a ‘citizens’ dividend’ to all eligible residents of Earth, a hypothetical 'outer space resource fund' modelled on the APF could create a vested public and international interest in its management. By bypassing national governments and paying a dividend directly and equally to all eligible individuals (for example, adults over the age of 18) such an approach could help prevent the potential mismanagement by politicians of funds from leasing outer space resources. Most importantly, such a system would provide a framework encouraging commercial exploitation of outer space by ensuring legal clarity while simultaneously ensuring that the exploitation of “the common province of all mankind” [27] accrues tangible benefit to all of humanity. Such a system would also be consistent with the Moon Treaty should it gain renewed interest and increased participation by space faring nations. By accruing tangible benefits equally to all eligible human beings directly, a properly adapted Alaska Permanent Fund and citizen's dividend model applied to outer space resource licensing fees offers one possible means with which to ensure future benefits from resource exploitation in outer space accrue to all of humanity-indeed such a model might very well be applicable to analogous terrestrial ommons such as the Sea Floor and Antarctica. While the technological challenges in creating a payment system for all eligible members of the Earth's population are significant, they are probably less than the technological challenges in successfully mining asteroids or other celestial bodies. Technological innovations such as mobile banking are rapidly penetrating the developing world [55,56] and represent one way that challenges to creating and distributing a ‘space dividend’ to all eligible members of the Earth's population could be overcome. Alternatively, as previously mentioned, the international community might implement a system in which royalties on production from outer space resource exploitation were apportioned to national governments rather than to individual citizens. That such an approach might be pragmatically more acceptable in the current international environment neither means that this will necessarily be the case in the future, nor should it preclude the serious discussion of alternatives such as we have outlined here from informing the discussion concerning the elaboration of future international regimes for managing the exploitation of resources in outer space. Furthermore, because even moderate dividends by developed countries standards would be proportionally much more significant in developing nations, such dividends, whether payed to nation states or to individual citizens, could be instrumental in achieving some of the most urgent goals of sustainable global development, goals embodied in the UN's Sustainable Development Goals.

# Case

### AT: Exploitation

#### My contention three solves better because it allows for better development and innovation of space which benefits everyone and also ensures that everyone takes part in the profits from space.

#### Public is still exploitative because only developed countries will have access – not developing

### AT: Environment

#### Turn – private sector key to making space travel more sustainable

Verbeek and Fouquet 20 Verbeek, David, and Helene Fouquet. "Can We Get To Space Without Damaging The Earth Through Huge Carbon Emissions?". Los Angeles Times, 2020, <https://www.latimes.com/business/story/2020-01-30/space-launch-carbon-emissions>. Helene Fouquet has been a science and technology reporter for the New York Times and Bloomberg since 2006.

When a SpaceX Falcon Heavy rocket blasts off on a plume of white smoke, hot gases shoot out of its 27 engines, creating a thrust equal to 18 Boeing 747 aircraft. Upon reaching orbit, the world’s heaviest operational rocket will have burned about 400 metric tons of kerosene and emitted more carbon dioxide in a few minutes than an average car would in more than two centuries. That kind of shock to the atmosphere is stoking concerns about the effect that launching into orbit has on Earth, and it’s about to get worse. Fueled by surging data transmissions and the race for commercial space flights between Elon Musk’s Space Exploration Technologies Corp., Jeff Bezos’ Blue Origin and Richard Branson’s Virgin Galactic Holdings Inc., the number of launches — including giants such as the Falcon Heavy and new mini-rockets — is expected to increase tenfold to roughly 1,000 annually in the coming years. Although there are no regulations on rocket emissions, new space pioneers are taking it upon themselves to develop launchers that make leaving the atmosphere less damaging to the planet. It’s less space cowboy and more space boy scout. “Climate change is real, and we don’t want to make it worse,” said Chris Larmour, chief executive of British rocket maker Orbex. The start-up, founded in 2015 and which has a contract with U.S. launch integrator TriSept Corp., uses bio-propane that it says can cut CO2 emissions by 90% compared with traditional launch fuel. Besides greenhouse gas pollution, kerosene-fueled rockets transport large amounts of black carbon, also known as soot, into the upper layers of the atmosphere. There, it remains for a long time, creating an umbrella that may add to global warming. The fuel is widely used because it’s easier to handle than fuels such as hydrogen. “So far the only criteria for everyone to build rockets was performance and cost,” said Jean-Marc Astorg, director for launch vehicles at French space agency CNES. “Environment was not a priority at all. That’s changing.” The urgency to clean up rocket emissions is intensifying. Last year, the space industry launched 443 satellites, more than three times as many as a decade earlier, according to the United Nations Office for Outer Space Affairs. Planned missions to the moon and Mars will increase the strain on the environment. SpaceX alone is planning to launch 12,000 satellites in the next seven years for its [Starlink internet constellation](https://www.latimes.com/business/story/2019-12-07/spacex-starlink-service). The company is developing the methane-powered Raptor engine, burning the greenhouse gas with a view to refueling on Mars. Blue Origin’s strategy is potentially more environmentally friendly, with plans for liquid hydrogen to propel its reusable rockets. [Building a rocket is hard. But building a parachute is boggling](https://www.latimes.com/business/story/2019-12-19/boeing-spacex-spacecraft-parachutes) Even SpaceX and Boeing, which have accomplished great engineering feats, are still grappling with the tech. Virgin Galactic says its plans represent a “new age of clean and sustainable access to space.” The company relies on lightweight spaceships that can fly hundreds of times to mitigate its environmental effect and says its rockets burn for only 60 seconds. The carbon footprint for passengers will be in line with a transatlantic business-class seat, it says. ArianeGroup is going a step further. Europe’s biggest launch company is working on a rocket that aims to be carbon-neutral by running on methane produced from biomass. Dubbed Ariane Next, the heavy-launcher project targets liftoff in 2030. “The rest of the world is lagging Europe so far on the environment performance of their future engines and launchers,” Astorg said. Smaller challengers such as Orbex are moving quickly. The company, which is funded by a mix of venture capital and public funds, plans to have its Prime rocket take its maiden flight at the end of 2021. In addition to cutting CO2, the rocket will completely avoid black carbon, which is a “much bigger climate problem,” Larmour said. Reducing soot and CO2 by 25% to 40% is more realistic, said Daniel Metzler, CEO of the German rocket start-up ISAR Aerospace, founded in 2018. His rocket — also scheduled to lift off in late 2021 — will decrease soot pollution by using a liquid fuel based on a light hydrocarbon, Metzler said, declining to provide specifics. Such aggressive reductions in soot pose design and production challenges because the fuel residue has the positive side effect of protecting the inner surface of the combustion chamber against heat, the 27-year-old engineer said. ISAR addresses the problem by guiding the in-flowing fuel through a system of channels to cool the engine. Like Orbex, the company relies on 3-D printers to create the complex structures. [SpaceX faces daunting challenges if it’s going to win the internet space race](https://www.latimes.com/business/la-fi-spacex-starlink-constellation-20190628-story.html) Elon Musk and SpaceX have staked their legacy on a spaceship capable of carrying a hundred passengers to Mars. Rocket Factory Augsburg, a unit of German satellite maker OHB, took environmental issues into account from the start in developing its “mini-launcher,” an emerging trend in the aerospace industry. The rocket — developed for transporting small satellites and scheduled to perform its maiden flight next year — is using a new environmentally friendly propellant. All of the ingredients are “available in a do-it-yourself-store,” and the design has the potential to avoid hydrazine, a highly toxic liquid used to fuel upper stages and satellites, Chief Engineer Stefan Brieschenk said. The RFA launcher is designed to “avoid CO2 and soot as much as possible” because it’s the right thing to do, the 34-year-old said. “We are all young people, and we want to make a change now.” Joern Spurmann, RFA program manager, sums up the new approach to the space race: “We’re following the boy scout rule that says: Leave the campground cleaner than you found it.”

#### Disregard aff evidence – lack of high-quality research regarding rocket’s impacts

Ross and Vedda 18 Ross, Martin, and James Vedda. "Op-Ed | Time To Clear The Air About Launch Pollution - Spacenews". Spacenews, 2018, <https://spacenews.com/op-ed-time-to-clear-the-air-about-launch-pollution/>. Martin Ross is a senior project engineer in civil and commercial launch programs at the Aerospace Corporation. James Vedda is a senior policy analyst at the Aerospace Corporation’s Center for Space Policy & Strategy*.*

In recent years, governments, intergovernmental organizations, and businesses have begun to focus on the challenge posed by orbital debris. As often seems to be the case, we appear to be a decade or two too slow in coming to consensus on the risks. If we had foreseen a half-century ago the challenges that orbital debris presents today, what would we have done differently? Combustion emissions from launch vehicles present the space industry with a comparable concern that we can begin to address now, before it grows and becomes a potential impediment to space access. Most human-generated pollution is concentrated on or near the surface of the Earth, whether on land, sea, or in the troposphere, the lowest layer of the atmosphere. However, rockets emit a variety of gases and particles directly into all levels of the stratosphere, the only industrial activity to do so. The stratosphere extends roughly from 10 to 50 kilometers above the Earth’s surface and contains the Earth’s ozone layer. The global civil aviation fleet generally cruises in the troposphere, only occasionally polluting the stratosphere directly. Among the most consequential emissions are soot and alumina, which are long-lived and accumulate in the stratosphere. These accumulations promote chemical reactions and absorption and scattering of sunlight that modify the composition and flow of radiation in the stratosphere. Ultimately, these processes reduce stratospheric ozone, warm the stratosphere, and cool the Earth’s surface. Little is known about these particle accumulations and their contributions to stratospheric ozone depletion and thermal perturbations because of a lack of consistent and focused research. Since 1987, emissions of ozone-depleting pollutants are highly regulated by international agreement through the Montreal Protocol on Substances That Deplete the Ozone Layer. Even with recent advances in reusability and the introduction of large launch vehicles and new launch sites around the globe, rocket launches occur irregularly so that concerns about the damage done to the ozone layer by rocket emissions have not elicited regulation. But with projections that the global launch rate will at least double in the coming decade, increased scrutiny under the Montreal Protocol is likely. Increased concerns about the environmental impact of rocket launches, provoked by perceptions of a rapidly growing launch industry, could result in international calls for launch limitations or the phase-out of propellants that the launch industry has come to depend on. The timing and intensity of a regulatory backlash as launch rates increase is impossible to predict accurately, especially because the science of rocket emissions is still not well understood. Rather than allow a legal and regulatory process to unfold in the absence of high-quality, peer-reviewed data, governments and the launch industry should conduct the scientific research needed to fill the knowledge gaps. This will allow the launch community to engage in future far reaching discussions regarding the impacts of rocket emissions with the support of empirical data and computer models that carry the imprimatur of the rocket engineering and atmospheric science communities. The launch industry has enjoyed freedom of action with respect to rocket engine emissions since the start of the space age. Studies of future launch architectures, market demand, and lifecycle costs rarely consider regulation of emissions as a potential future risk factor. Even when emissions are considered, the impacts are examined on a system-by-system basis; the cumulative impact of the global launch fleet is not acknowledged. The net impacts of the global launch industry, across all propellant types, are the parameters of interest to international regulators and, therefore, the global impacts create the regulatory risk. In addition to acknowledging the risks and potential unintended consequences of launch emissions for ozone and the flow of radiation in the atmosphere, the space industry must recognize the extent that other emerging actors may interact with the stratosphere. For example, so-called “geoengineering” or “climate intervention” schemes propose to inject particles into the stratosphere to intercept sunlight and mitigate the warming effects of carbon dioxide and other greenhouse gases. Regulation of such geoengineering activity is already under discussion. Space launch operators, as contributors of stratospheric emissions, could get swept up into these discussions, which involve the same types of particulate matter associated with rocket emissions. Any resulting regulations or guidelines must include adequate consideration of launch activities, which will require a better understanding of rocket emissions than we have today. To improve that understanding, industry should encourage and support scientific research on rocket engine emissions and how they affect the atmosphere. There has been little research to date. The few research papers that have appeared in recent decades mostly point out the knowledge gaps rather than add to the knowledge base. The research has been unfocused, disorganized, and not suited to the needs of the launch industry. As it stands today, the scientific community can predict ozone depletion attributable to rocket emissions to no better than an order of magnitude. In an environment of growing launch rates, new propellants, larger, reusable launch vehicles, and the emergence of other stratospheric polluters, this is not sufficient. Lack of accurate information inevitably invites distorted competitive claims and unwarranted and overly restrictive regulation. A vigorous research program would be guided by the goal to collect high confidence information and data that describe rocket emissions as inputs into global atmosphere models and would include the following components: Stratospheric plume measurements using in situ and remote sensing instrumentation. Laboratory measurements of particulate emission microphysics. Test stand measurements of engine exit plane exhaust composition. Modern rocket engine combustion, plume chemistry, and global atmosphere models. All of the instrumentation, models, and expertise to carry out this research already exists within the engineering and scientific communities. The in situ and test stand measurements would validate combustion and plume models. Validated models permit the development of emission profiles for particular rocket engine types. These profiles, with various growth assumptions, would be used to construct global emission projections. Finally, the global emissions scenarios would provide data to construct input profiles for modern three-dimensional whole atmospheric chemistry and climate models in order to estimate ozone loss, climate forcing, and a variety of secondary effects such as changes in the global circulation and cloud formation. A policy to promote objective and vigorous research, across the full range of propellant types, will provide the space industry with the information required to take ownership of the problem and exert strong influence on the future debate. By accepting the reality of the risk to freedom of action presented by rocket emissions, and promoting a full and complete scientific understanding of the global impacts, the industry can best inoculate itself from attempts to regulate or limit launch development and operations and disassociate itself from other polluters. There is historical precedent for such an approach. In order to promote supersonic civil aviation development, during the 1990s NASA partnered with the aviation industry to carry out the High Speed Research (HSR) program. One of the goals of HSR was to understand how High Speed Civil Transport (HSCT) aircraft would affect stratospheric ozone. Earlier HSCT efforts in the 1970s were severely and wrongly hampered by knowledge gaps with respect to ozone depletion. HSR demonstrated the airframe, engine, and operational combinations that would minimize ozone impacts and permit (if the economics had been convincing) unregulated development and deployment. The launch industry should organize around a similar approach and partner with the scientific and regulatory communities to determine how space launch can freely develop while minimizing the risks of regulatory intervention. As launch rates and launch vehicle sizes increase, the impact of rocket emissions approaches a “tipping point” when international regulation becomes likely, probably beginning with efforts to protect the ozone layer or limit stratospheric pollution to ward off geoengineering. If the launch industry moves quickly to support the necessary scientific research and fully understand these impacts – in concert with other private-sector and government stakeholders – it is more likely that future regulation will be well-informed and as limiting as possible. As with other large-scale ventures, the application of specialized expertise is essential to anticipating the risks and needs of the enterprise and to managing the impacts on society. With irrefutable data, modeling, and analyses, emissions-related regulations or limitations can be anticipated and configured to ensure that space-based capabilities and systems continue to enhance and improve human life and extend the space industry’s progress made over the past six decades.

### AT: Climate Change

#### Climate solutions rely on REMs

Arrobas et al 17 [(Daniele La Porta Arrobas is a senior mining specialist with the World Bank based in Washington DC and has degrees in Geoscience and Environmental Management, Kirsten Hund is a senior mining specialist with the Energy and Extractives Global Practice of the World Bank and holds a Master’s in IR from the University of Groningen in the Netherlands, Michael Stephen McCormick, Jagabanta Ningthoujam has an MA in international economics and international development from JHU and a BS in MechE from Natl University of Singapore, John Drexhage also works at the Intl Institute for Sustainable Development) “The Growing Role of Minerals and Metals for a Low Carbon Future,” World Bank, June 30, 2017, <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/207371500386458722/the-growing-role-of-minerals-and-metals-for-a-low-carbon-future>]

Full report - https://documents1.worldbank.org/curated/en/207371500386458722/pdf/117581-WP-P159838-PUBLIC-ClimateSmartMiningJuly.pdf

Climate and greenhouse gas (GHG) scenarios have typically paid scant attention to the metal implications necessary to realize a low/zero carbon future. The 2015 Paris Agreement on Climate Change indicates a global resolve to embark on development patterns that would significantly be less GHG intensive. One might assume that nonrenewable resource development and use will also need to decline in a carbon-constrained future. This report tests that assumption, identifies those commodities implicated in such a scenario and explores ramifications for relevant resource-rich developing countries. Using wind, solar, and energy storage batteries as proxies, the study examines which metals will likely rise in demand to be able to deliver on a carbon-constrained future. Metals which could see a growing market include aluminum (including its key constituent, bauxite), cobalt, copper, iron ore, lead, lithium, nickel, manganese, the platinum group of metals, rare earth metals including cadmium, molybdenum, neodymium, and indium—silver, steel, titanium and zinc. The report then maps production and reserve levels of relevant metals globally, focusing on implications for resource-rich developing countries. It concludes by identifying critical research gaps and suggestions for future work.

#### Mining solves climate better

Roberts et al 18 [Siobhan Roberts (Roberts has won a number of Canadian National Magazine Awards,[2] and she is the winner of the Communications Award of the Joint Policy Board for Mathematics "for her engaging biographies of eminent mathematicians and articles about mathematics".She earned a degree in history at Queen's University, then a graduate degree in journalism from Ryerson University in 1997.) et al, 10-19-2018, "Asteroid mining might actually be better for the environment," MIT Technology Review, <https://www.technologyreview.com/2018/10/19/139664/asteroid-mining-might-actually-be-better-for-the-environment/> ]/

For a certain kind of investor, asteroid mining is a path to untold riches. Astronomers have long known that asteroids are rich in otherwise scarce resources such as platinum and water. So an obvious idea is to mine this stuff and return it to Earth—or, in the case of water, to a moon base or Earth-orbiting space station. There is no shortage of interest in these ventures. In the last decade, investors have funded half a dozen companies that have set their sights on various nearby rocks. To many observers, it’s only a matter of time before such a mission gets the green light. But profit margins are only part of the picture. A potentially more significant aspect of these missions is the impact they will have on Earth’s environment. But nobody has assessed this environmental impact in detail. Today, that changes thanks to the work of Andreas Hein and colleagues at the University of Paris-Saclay in France. These guys have calculated the greenhouse-gas emissions from asteroid-mining operations and compared them with the emissions from similar Earth-based activities. Their results provide some eyebrow-raising insights into the benefits that asteroid mining might provide. The calculations are relatively straightforward. Rocket launches release significant amounts of greenhouse gases into the atmosphere. The fuel on board the first stage of a rocket burns in Earth’s atmosphere to form carbon dioxide. For kerosene-burning rockets, one kilogram of fuel creates three kilograms of CO2. (The second and third stages operate outside the Earth’s atmosphere and so can be ignored.) Reentries are just as damaging. That’s because a significant mass of a re-entering vehicle ablates in the upper atmosphere, producing NOx such as nitrous oxide (N2O), a greenhouse gas that is about 300 times more potent than CO2. By one estimate, the space shuttle released about 20% of its mass in the form of N2O every time it returned to Earth. Hein and co use these numbers to calculate that a kilogram of platinum mined from an asteroid would release some 150 kilograms of CO2 into Earth’s atmosphere. However, economies of scale from large asteroid-mining operations could lower this to about 60 kilograms of CO2 per kilogram of platinum. That needs to be compared with the emission from Earth-based mining. Here, platinum mining generates significant greenhouse gases, mostly from the energy it takes to remove this stuff from the ground. Indeed, the numbers are huge. The mining industry estimates that producing one kilogram of platinum on Earth releases around 40,000 kilograms of carbon dioxide. “The global warming effect of Earth-based mining is several orders of magnitude larger,” say Hein and co. The figures for water are also encouraging. In this case, the authors calculate the greenhouse-gas emissions from an asteroid-mining operation that returns water to anywhere within the moon’s orbit, a so-called cis-lunar orbit. They compare this to the emissions from sending the same volume of water from Earth into orbit. The big difference is that a water-carrying vehicle from Earth can haul only a small percentage of its mass as water. But an asteroid-mining spacecraft can transport a significant multiple of its mass as water to cis-lunar orbit. “Substantial savings in greenhouse gas emissions can be achieved,” say Hein and co. This interesting work should help to focus minds on the environmental impacts of mining, which are rapidly increasing in profile. But it is only a first step. There is significant uncertainty in the numbers here, so these will need to be better understood. Other factors will also eventually need to be taken into account. The Earth-bound mining industry could become more environmentally friendly by using renewable energy rather than burning coal to generate power (as it does in South Africa). Rocket launching could also become greener if more eco-friendly fuels are developed. Both these things would change the numbers. There are also emissions that this analysis does not take into account. For example, it does not include the emissions from mission control on Earth or from launch-pad construction. Then there are the ongoing effects of rocket launches on the ozone layer, which also need to be considered. So there is more work to be done. But Hein and co have taken a significant first step toward realistic environmental life-cycle assessments for asteroid mining, a task that will surely become more pressing as this industry matures.

#### Extinction from warming requires 12 degrees and intervening actors will solve before then

Farquhar 17 [(Sebastian, leads the Global Priorities Project (GPP) at the Centre for Effective Altruism) “Existential Risk: Diplomacy and Governance,” 2017, <https://www.fhi.ox.ac.uk/wp-content/uploads/Existential-Risks-2017-01-23.pdf>]

The most likely levels of global warming are very unlikely to cause human extinction.15 The existential risks of climate change instead stem from tail risk climate change – the low probability of extreme levels of warming – and interaction with other sources of risk. It is impossible to say with confidence at what point global warming would become severe enough to pose an existential threat. Research has suggested that warming of 11-12°C would render most of the planet uninhabitable,16 and would completely devastate agriculture.17 This would pose an extreme threat to human civilisation as we know it.18 Warming of around 7°C or more could potentially produce conflict and instability on such a scale that the indirect effects could be an existential risk, although it is extremely uncertain how likely such scenarios are.19 Moreover, the timescales over which such changes might happen could mean that humanity is able to adapt enough to avoid extinction in even very extreme scenarios. The probability of these levels of warming depends on eventual greenhouse gas concentrations. According to some experts, unless strong action is taken soon by major emitters, it is likely that we will pursue a medium-high emissions pathway.20 If we do, the chance of extreme warming is highly uncertain but appears non-negligible. Current concentrations of greenhouse gases are higher than they have been for hundreds of thousands of years,21 which means that there are significant unknown unknowns about how the climate system will respond. Particularly concerning is the risk of positive feedback loops, such as the release of vast amounts of methane from melting of the arctic permafrost, which would cause rapid and disastrous warming.22 The economists Gernot Wagner and Martin Weitzman have used IPCC figures (which do not include modelling of feedback loops such as those from melting permafrost) to estimate that if we continue to pursue a medium-high emissions pathway, the probability of eventual warming of 6°C is around 10%,23 and of 10°C is around 3%.24 These estimates are of course highly uncertain. It is likely that the world will take action against climate change once it begins to impose large costs on human society, long before there is warming of 10°C. Unfortunately, there is significant inertia in the climate system: there is a 25 to 50 year lag between CO2 emissions and eventual warming,25 and it is expected that 40% of the peak concentration of CO2 will remain in the atmosphere 1,000 years after the peak is reached.26 Consequently, it is impossible to reduce temperatures quickly by reducing CO2 emissions. If the world does start to face costly warming, the international community will therefore face strong incentives to find other ways to reduce global temperatures.

#### Climate doesn’t cause extinction.

Dr. Amber Kerr et al. 19, Energy and Resources PhD at the University of California-Berkeley, known agroecologist, former coordinator of the USDA California Climate Hub; Dr. Daniel Swain, Climate Science PhD at UCLA, climate scientist, a research fellow at the National Center for Atmospheric Research; Dr. Andrew King, Earth Sciences PhD, Climate Extremes Research Fellow at the University of Melbourne; Dr. Peter Kalmus, Physics PhD at the University of Colombia, climate scientist at NASA’s Jet Propulsion Lab; Professor Richard Betts, Chair in Climate Impacts at the University of Exeter, a lead author on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) in Working Group 1; Dr. William Huiskamp, Paleoclimatology PhD at the Climate Change Research Center, climate scientist at the Potsdam Institute for Climate Impact Research; 6/4/2019, “Claim that human civilization could end in 30 years is speculative, not supported with evidence,” <https://climatefeedback.org/evaluation/iflscience-story-on-speculative-report-provides-little-scientific-context-james-felton/>,

There is no scientific basis to suggest that climate breakdown will “annihilate intelligent life” (by which I assume the report authors mean human extinction) by 2050.

However, climate breakdown does pose a grave threat to civilization as we know it, and the potential for mass suffering on a scale perhaps never before encountered by humankind. This should be enough reason for action without any need for exaggeration or misrepresentation!

A “Hothouse Earth” scenario plays out that sees Earth’s temperatures doomed to rise by a further 1°C (1.8°F) even if we stopped emissions immediately.

Peter Kalmus, Data Scientist, Jet Propulsion Laboratory:

This word choice perhaps reveals a bias on the part of the author of the article. A temperature can’t be doomed. And while I certainly do not encourage false optimism, assuming that humanity is doomed is lazy and counterproductive.

Fifty-five percent of the global population are subject to more than 20 days a year of lethal heat conditions beyond that which humans can survive

Richard Betts, Professor, Met Office Hadley Centre & University of Exeter:

This is clearly from Mora et al (2017) although the report does not include a citation of the paper as the source of that statement. The way it is written here (and in the report) is misleading because it gives the impression that everyone dies in those conditions. That is not actually how Mora et al define “deadly heat”---they merely looked for heatwaves when somebody died (not everybody) and then used that as the definition of a “deadly” heatwave.

North America suffers extreme weather events including wildfires, drought, and heatwaves. Monsoons in China fail, the great rivers of Asia virtually dry up, and rainfall in central America falls by half.

Andrew King, Research fellow, University of Melbourne:

Projections of extreme events such as these are very difficult to make and vary greatly between different climate models.

Deadly heat conditions across West Africa persist for over 100 days a year

Peter Kalmus, Data Scientist, Jet Propulsion Laboratory:

The deadly heat projections (this, and the one from the previous paragraph) come from Mora et al (2017)1.

It should be clarified that “deadly heat” here means heat and humidity beyond a two-dimension threshold where at least one person in the region subject to that heat and humidity dies (i.e., not everyone instantly dies). That said, in my opinion, the projections in Mora et al are conservative and the methods of Mora et al are sound. I did not check the claims in this report against Mora et al but I have no reason to think they are in error.

1- Mora et al (2017) Global risk of deadly heat, Nature Climate Change

The knock-on consequences affect national security, as the scale of the challenges involved, such as pandemic disease outbreaks, are overwhelming. Armed conflicts over resources may become a reality, and have the potential to escalate into nuclear war. In the worst case scenario, a scale of destruction the authors say is beyond their capacity to model, there is a ‘high likelihood of human civilization coming to an end’.

Willem Huiskamp, Postdoctoral research fellow, Potsdam Institute for Climate Impact Research:

This is a highly questionable conclusion. The reference provided in the report is for the “Global Catastrophic Risks 2018” report from the “Global Challenges Foundation” and not peer-reviewed literature. (It is worth noting that this latter report also provides no peer-reviewed evidence to support this claim).

Furthermore, if it is apparently beyond our capability to model these impacts, how can they assign a ‘high likelihood’ to this outcome?

While it is true that warming of this magnitude would be catastrophic, making claims such as this without evidence serves only to undermine the trust the public will have in the science.

Daniel Swain, Researcher, UCLA, and Research Fellow, National Center for Atmospheric Research:

It seems that the eye-catching headline-level claims in the report stem almost entirely from these knock-on effects, which the authors themselves admit are “beyond their capacity to model.” Thus, from a scientific perspective, the purported “high likelihood of civilization coming to an end by 2050” is essentially personal speculation on the part of the report’s authors, rather than a clear conclusion drawn from rigorous assessment of the available evidence.

### AT Debris

#### Ban on appropriation prevents solutions

Trapp 13 Trapp, Timothy. TAKING UP SPACE BY ANY OTHER MEANS: COMING TO TERMS WITH THE NONAPPROPRIATION ARTICLE OF THE OUTER SPACE TREATY. UNIVERSITY OF ILLINOIS LAW REVIEW, 2013, https://www.illinoislawreview.org/wp-content/ilr-content/articles/2013/4/Trapp.pdf, Accessed 4 Jan 2022. Justin received his B.A. in Creative Writing from North Carolina State University in 2008 and his J.D., summa cum laude, from The University of Illinois College of Law in 2013, where he was elected to the Order of the Coif, a Rickert Award Recipient, and served as articles editor of the University of Illinois Law Review.

In general, space debris consists of “man-made objects in outer space, other than active or otherwise useful satellites, when no change can reasonably be expected in these conditions in the foreseeable future.”46 As of January 2011, there were approximately 16,000 space objects catalogued by the U.S. Space Surveillance Network, only about 3,500 of which were functional spacecraft.47 This leaves approximately 12,500 pieces of catalogued debris.48 Interestingly, though spacecraft, mission-related objects, and rocket bodies increased fairly linearly since the start of the space age, fragmentation debris has drastically increased since 2007, jumping from approximately 4,000 pieces to approximately 7,000 pieces in the span of a year.49 While this is due in large part to China’s testing of an anti-satellite weapon in space,50 it is also certainly due in part to the replicating nature of fragmentation debris.51 For instance, in February 2009, an operational commercial U.S. satellite collided with a defunct Russian satellite, resulting in about 400 pieces of new debris.52 This, intuitively, creates about 400 new chances for functional spacecraft to be damaged or destroyed. For something to stay in orbit, it has to move very, very fast (from three to eight kilometers per second, or about 6,700 to 18,000 miles per hour, depending on the altitude of the object).53 This is due to the physics that governs orbital mechanics.54 Even in orbit, objects still feel the pull of Earth’s gravity.55 In essence, objects in orbit are constantly falling. Because the Earth is round, however, an object is able to counterbalance the effect of gravity by moving forward fast enough to match the rate of its fall.56 But this requires a fantastic amount of speed, up to about thirty times that of a commercial airliner.57 While intuitive that a collision between two satellites travelling at this speed would be catastrophic, it is also the case that a small object could cause massive damage at this speed.58 The amount of damage caused by the collision of two objects is a function of the objects’ momentum, which is the product of an object’s mass and velocity.59 Because of this, even a very small object can be extremely damaging if it is travelling fast enough.60 For example, an average sized brick travelling at three kilometers per second (or about 6,600 miles per hour), which is on the lower end of the orbital speeds, would have as much momentum as a large horse travelling at about thirty-three mph.61 Not only does space debris carry a large amount of momentum, but it is also often small enough that its impact will be concentrated into a small area, thus maximizing damage to that area.62 This makes debris very dangerous to sophisticated machinery, such as satellites and spaceships that have various small parts that can be incredibly vulnerable. Furthermore, debris does not vanish when it impacts or destroys a functional spacecraft. Instead, it multiplies: the collision creates more debris, and these new pieces of debris will fly out in multiple directions, cluttering space even more.63 This, in turn, makes orbital space that much more cluttered and dangerous, which leads to more collisions, and the cycle continues.64 If this problem is not dealt with, the amount of orbital debris could continue to increase until it makes certain parts of orbit unusable or unnavigable, even without the addition of more functioning spacecraft into orbit.65 The costs of space debris are not limited to merely the loss of functioning spacecraft. There is also the cost of shielding spacecraft from possible debris collisions.66 This cost is two-fold: not only do launching parties have to spend the money to actually research and develop adequate shielding for their spacecraft, they also have to spend extra money for fuel to carry the objects into space.67 The cost of maneuvering out of the path of debris similarly enters into the equation in two ways.68 Maneuvering requires extra fuel and thus detracts from what could have been used to further the actual purpose of the spacecraft.69 Furthermore, for maneuvering to even be effective, there must be prior warning that a collision with debris is imminent.70 This requires a monitoring system, which requires its own resources to develop the necessary surveillance technology as well as to catalog and monitor debris.71 Though the dangerous and replicative nature of the space debris problem is well understood, the nature of the space resource makes it difficult to regulate this problem. First, space is a common resource, which subjects it to falling into a tragedy of the commons.72 Second, because entities are not allowed to appropriate property in space, governing bodies find it difficult to enforce regulations in space that may help to stem the debris problem.

**Low Probability – 0.1% chance of a collision.**

**Salter 16** [(Alexander William, Economics Professor at Texas Tech) “SPACE DEBRIS: A LAW AND ECONOMICS ANALYSIS OF THE ORBITAL COMMONS” 19 STAN. TECH. L. REV. 221 \*numbers replaced with English words] TDI

The probability of a collision is currently low. Bradley and Wein estimate that the maximum probability in LEO of a collision over the lifetime of a spacecraft remains below one in one thousand, conditional on continued compliance with NASA’s deorbiting guidelines.3 However, the possibility of a future “snowballing” effect, whereby debris collides with other objects, further congesting orbit space, remains a significant concern.4 Levin and Carroll estimate the average immediate destruction of wealth created by a collision to be approximately $30 million, with an additional $200 million in damages to all currently existing space assets from the debris created by the initial collision.5 The expected value of destroyed wealth because of collisions, currently small because of the low probability of a collision, can quickly become significant if future collisions result in runaway debris growth.

#### Non-unique – anti-satellite tests main source of debris

Pultarova 21 Pultarova, T., 2021. Space debris from Russian anti-satellite test will be a safety threat for years. [online] Space.com. Available at: <https://www.space.com/russia-anti-satellite-test-space-debris-threat-for-years> [Accessed 12 January 2022].  She later took a career break to pursue further education and added a Master's in Science from the International Space University, France, to her Bachelor's in Journalism and Master's in Cultural Anthropology from Prague's Charles University.

Space debris created by a Russian anti-satellite missile test will pose a threat to satellites in low Earth orbit as well as astronauts aboard the International Space Station for years to come, experts reveal. The anti-satellite (ASAT) test targeted the defunct Soviet surveillance satellite Cosmos 1408, which orbited at an altitude of about 404 miles (650 kilometers) above Earth. The 2-ton spacecraft, dead since the mid-1980s, broke apart into at least 1,500 trackable fragments immediately upon the strike, creating a large cloud of debris. The space debris has forced the astronauts and Russian cosmonauts aboard the International Space Station (ISS) to repeatedly take refuge in their transport vehicles. Experts now warn that this space debris will remain a danger for years to come, threatening satellites in low Earth orbit (LEO), the heavily used region of space closest to Earth, as well as space station crews. In addition to the 1,500 trackable fragments generated by the test, the event also created hundreds of thousands of smaller pieces that are invisible to Earth-based observers, the U.S. Space Command (USSC), which is responsible for military operations in outer space, said in a statement.  "USSPACECOM's initial assessment is that the debris will remain in orbit for years and potentially for decades, posing a significant risk to the crew on the International Space Station and other human spaceflight activities, as well as multiple countries' satellites," USSPACECOM said in the statement. In fact, about half of the fragments might fall to Earth "within the next couple of years" but the remainder might remain hurtling through space for "more than a decade," Hugh Lewis, head of the Astronautics Research Group at the University of Southampton, the U.K., and Europe's leading space debris expert told Space.com. "Once the fragments are catalogued, I am expecting to see many close passes with satellites and other objects across quite a wide range of LEO, demonstrating the consequences for space safety," Lewis said. "I would not be surprised if the ISS had to make collision avoidance maneuvers for at least the next couple of years as a direct result." Preliminary calculations suggest that the cloud of debris will increase the number of avoidance maneuvers performed by satellite operators all over the world by more than 100% in the next few years, Tim Flohrer, head of the European Space Agency's (ESA) Space Debris Office, told Space.com.  "The peak can be even significantly higher than 100%," Flohrer added. "In this 400 to 500 kilometer altitude, the fragments will not survive long. We expect them to decay slowly over months and years so the risk increase will still be significant after one or two years." In addition to the impact that this debris will continue to have on the International Space Station, SpaceX's internet-beaming mega-constellation Starlink, currently comprising nearly 1,850 satellites, also orbits in the affected region, Flohrer added.  Experts and military leaders appeared shocked by the act, which will affect long-term safety of all operations in low Earth orbit. "Russia has demonstrated a deliberate disregard for the security, safety, stability, and long-term sustainability of the space domain for all nations," U.S. Army General James Dickinson and U.S. Space Command commander, said in the USSC statement. "The debris created by Russia's DA-ASAT will continue to pose a threat to activities in outer space for years to come, putting satellites and space missions at risk, as well as forcing more collision avoidance maneuvers." In a statement to Russia's news agency Interfax, the Russian Defense Ministry confirmed the test but claimed its debris does not present any risk to orbiting spacecraft. "On November 15 of this year, the Russian Defense Ministry successfully conducted a test, as a result of which the inoperative Russian Tselina-D spacecraft, which had been in orbit since 1982, was struck," the Russian Defense Ministry said, according to Interfax. "The United States knows for certain that the resulting fragments did not represent and will not pose a threat to orbital stations, spacecraft and space activities in terms of test time and orbit parameters." Russia's space agency Roscosmos issued a separate statement on Tuesday (Nov. 16) morning, which, however, does not directly mention the ASAT test. "For us, the main priority has been and remains to ensure the unconditional safety of the crew," Roscosmos said in the statement. "Adherence to this principle is laid both in the basis for the production of space technology in Russia and in the program of its operation." While its impact and consequences has drawn far more concern, this is not the first ASAT test in recent years. In 2019, India conducted an anti-satellite missile test, which, however, targeted a satellite much closer to Earth, at about 175 miles (282 km). Most of the debris created by that strike therefore entered Earth's atmosphere within weeks or months, according to the Carnegie Endowment for International Peace.  The impact of the Russian ASAT test, however, will be much more serious due to the higher altitude of the target satellite. Debris from an ASAT test conducted by China in 2007, which targeted a satellite at an even higher altitude of 540 miles (865 km), is still a major source of collision hazard in low Earth orbit today.