## 1

#### Interp – space mining isn’t appropriation – its not permanent and OST consensus.

Hofmann and Bergamasco 19 [Mahulena Hofmann (SES Chair in Space, SatCom and Media Law at the University of Luxembourg) and Federico Bergamasco (PhD Researcher in aviation, telecommunication and space law University of Luxembourg). “Space resources activities from the perspective of sustainability: legal aspects”. Global Sustainability. 9 December 2019. Accessed 12/18/21. <https://www.cambridge.org/core/services/aop-cambridge-core/content/view/DF153F4A77970AC9E12444EC2B001F8A/S2059479819000279a.pdf/div-class-title-space-resources-activities-from-the-perspective-of-sustainability-legal-aspects-div.pdf> //Xu]

However, the purpose of space mining activities is considered to be neither any ‘appropriation’ of parts of outer space nor of space resources in situ. Instead, the sole aim of any such activities is their extraction, use and commercialization, without any territorial demands or titles as to the celestial bodies (or parts thereof) concerned (Mizushima et al., 2017). The argument, which sees in the use or exploitation of a space mineral by one subject a limitation of the same right of another subject, is difficult to contest by other means than analogy with space exploration. As has been recognized by the drafters of the OST in its Articles IX and XII, a purely scientific project in one area of outer space could de facto prevent research at the same site by a subject from another State. To avoid such situations, the Treaty pre-envisages a system of international consultations aimed at avoiding any harmful interference with operations.

#### OST is the standard for space law.

Wikipedia No Date [Wikipedia. “Outer Space Treaty.” No Date. Accessed 12/18/21. <https://en.wikipedia.org/wiki/Outer_Space_Treaty> //Xu]

The Outer Space Treaty, formally the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, is a multilateral treaty that forms the basis of international space law. Negotiated and drafted under the auspices of the United Nations, it was opened for signature in the United States, the United Kingdom, and the Soviet Union on 27 January 1967, entering into force on 10 October 1967. As of February 2021, 111 countries are parties to the treaty—including all major spacefaring nations—and another 23 are signatories.[1][5][note 1]

#### Semantics o/w –

#### a] Precision – they can arbitrarily jettison words which decks ground and preparation because there is no stasis point

#### b] Jurisdiction – the judge doesn’t have the authority to vote aff if it wasn’t legitimate

#### Vote for predictable limits – their aff explodes the object of the resolution to include random space activities from tourism to research to satellite surveillance – that allows them to cherry-pick the best aff with no neg ground – also kills predictable advocacies which decks prepared engagement.

#### Fairness – a) you conceded the judge will fairly evaluate your argument

#### Education – a) it’s the only reason why schools fund debate

#### CI – a) brightlines are arbitrary and self-serving which doesn’t set good norms b) it collapses since weighing between brightlines rely on offense defense

#### DOD – a) it’s the only way to deter future abuse

#### No RVI’s- a) logic – you shouldn’t win for being fair b) clash – people go all in on theory which decks substance engagement

## 2

#### Space Commercialization is key to Space Deterrence – Commercial Flexibility is key to deterrence by denial.

Klein 19, John J. Understanding space strategy: the art of war in space. Routledge, 2019. (a Senior Fellow and Strategist at Falcon Research, Inc. and Adjunct Professor at George Washington University’s Space Policy Institute)//Elmer

Recent U.S. space policy initiatives underscore the far-reaching benefits of commercial space activities. The White House revived the National Space Council to foster closer coordination, cooperation, and exchange of technology and information among the civil, national security, and commercial space sectors.1 National Space Policy Directive 2 seeks to promote economic growth by streamlining U.S. regulations on the commercial use of space.2 While the defense community generally appreciates the value of services and capabilities derived from the commercial space sector—including space launch, Earth observation, and satellite communications—it often overlooks one area of strategic importance: deterrence. To address the current shortcoming in understanding, this paper first describes the concept of deterrence, along with how space mission assurance and resilience fit into the framework. After explaining how commercial space capabilities may influence the decision calculus of potential adversaries, this study presents actionable recommendations for the U.S. Department of Defense (DoD) to address current problem areas. Ultimately, DoD—including the soon-to-be reestablished U.S. Space Command and possibly a new U.S. Space Force—should incorporate the benefits and capabilities of the commercial space sector into flexible deterrent options and applicable campaign and contingency plans. Deterrence, Mission Assurance, and Resilience Thomas Schelling, the dean of modern deterrence theory, held that deterrence refers to persuading a potential enemy that it is in its interest to avoid certain courses of activity.3 One component of deterrence theory lies in an understanding that the threat of credible and potentially overwhelming force or other retaliatory action against any would-be adversary is sufficient to deter most potential aggressors from conducting hostile actions. This idea is also referred to as deterrence by punishment.4 The second salient component of deterrence theory is denial. According to Glenn Snyder’s definition, deterrence by denial is “the capability to deny the other party any gains from the move which is to be deterred.”5 The 2018 U.S. National Defense Strategy (NDS) highlights deterrence, and specifically deterrence by denial, as a vital component of national security. The NDS notes that the primary objectives of the United States include deterring adversaries from pursuing aggression and preventing hostile actions against vital U.S. interests.6 The strategy also observes that deterring conflict necessitates preparing for war during peacetime.7 For the space domain, the peacetime preparedness needed for deterrence by denial occurs in the context of space mission assurance and resilience. Mission assurance entails “a process to protect or ensure the continued function and resilience of capabilities and assets—including personnel, equipment, facilities, networks, information and information systems, infrastructure, and supply chains—critical to the performance of DoD mission essential functions in any operating environment or condition.”8 Similar to mission assurance but with a different focus, resilience is an architecture’s ability to support mission success with higher probability; shorter periods of reduced capability; and across a wider range of scenarios, conditions, and threats, despite hostile action or adverse conditions.9 Resilience may leverage cross-domain solutions, along with commercial and international capabilities.10 Space mission assurance and resilience can prevent a potential adversary from achieving its objectives or realizing any benefit from its aggressive action. These facets of U.S. preparedness help convey the futility of conducting a hostile act. Consequently, they enhance deterrence by denial. Commercial Space Enables Deterrence The commercial space sector directly promotes mission assurance and resilience efforts. This is in part due to the distributed and diversified nature of commercial space launch and satellites services. Distribution refers to the use of a number of nodes, working together, to perform the same mission or functions as a single node; diversification describes contributing to the same mission in multiple ways, using different platforms, orbits, or systems and capabilities.11 The 2017 U.S. National Security Strategy, in noting the benefits derived from the commercial space industry, states that DoD partners with the commercial sector’s capabilities to improve the U.S. space architecture’s resilience.12 Although U.S. policy and joint doctrine frequently acknowledge the role of the commercial space sector in space mission assurance and resilience, there is little recognition that day-to-day contributions from the commercial industry assists in deterring would-be adversaries. The commercial space sector contributes to deterrence by denial through multi-domain solutions that are distributed and diversified. These can deter potential adversaries from pursuing offensive actions against space-related systems. Commercial launch providers enhance deterrence by providing options for getting payloads into orbit. These include diverse space launch capabilities such as small and responsive launch vehicles, along with larger, reusable launch vehicles; launch rideshares for secondary payloads; and government payloads on commercial satellites. Various on-orbit systems also promote deterrence. For example, if an aggressor damages a commercial remote sensing satellite during hostilities, similar commercial satellites in a different orbital regime, or those of the same constellation, may provide the needed imagery. If satellite communications are jammed or degraded, commercial service providers can reroute satellite communications through their own networks, or potentially through the networks of another company using a different portion of the frequency spectrum. Regarding deterrence by punishment efforts, the commercial space sector can play a role, albeit an indirect one, through improved space situational awareness (SSA) and space forensics (including digital forensics and multispectral imagery). The commercial industry may support the attribution process following a hostile or illegal act in space through its increasingly proliferating network of SSA ground telescopes and other terrestrial tracking systems. The DoD may also leverage the commercial space sector’s cyber expertise to support digital forensic efforts to help determine the source of an attack. By supporting a credible and transparent attribution process, commercial partners may cause a would-be adversary to act differently if it perceives that its aggressive, illegal, or otherwise nefarious actions will be disclosed. Doing so can help bolster the perceived ability to conduct a legitimate response following a hostile attack, which may improve deterrence by punishment efforts. Commercial space capabilities may also facilitate the application of force to punish a potential aggressor. In addition to traditional military space systems, commercial satellite imagery and communication capabilities may be used in cueing and targeting for punitive strikes against an aggressor. Although the commercial space sector is not expected to be involved directly in the use of retaliatory force following a hostile act, commercial partners may help in providing the information used to identify those responsible and to facilitate any consequent targeting efforts.

#### Space Deterrence Breakdowns causes War and Extinction.

Parker 17 Clifton Parker 1-24-2017 “Deterrence in space key to U.S. security” <https://cisac.fsi.stanford.edu/news/deterrence-space-key-us-security> (Policy Analyst at the Stanford Center for International Security and Cooperation)//Elmer

Space is more important than ever for the security of the United States, but it’s almost like the Wild West in terms of behavior, a top general said today. Air Force Gen. [John Hyten](http://www.af.mil/AboutUs/Biographies/Display/tabid/225/Article/108115/general-john-e-hyten.aspx), commander of the U.S. Strategic Command, spoke Jan. 24 at Stanford’s [Center](http://cisac.fsi.stanford.edu/) for International Security and Cooperation. His [talk](http://cisac.fsi.stanford.edu/events/us-strategic-command-perspectives-deterrence-and-assurance) was titled, “U.S. Strategic Command Perspectives on Deterrence and Assurance.” Hyten said, “Space is fundamental to every single military operation that occurs on the planet today.” He added that “there is no such thing as a war in space,” because it would affect all realms of human existence, due to the satellite systems. Hyten advocates “strategic deterrence” and “norms of behavior” across space as well as land, water and cyberspace. Otherwise, rivals like China and Russia will only threaten U.S. interests in space and wreak havoc for humanity below, he said. Most of contemporary life depends on systems connected to space. Hyten also addressed other topics, including recent proposals by some to upgrade the country’s missile defense systems. “You just don’t snap your fingers and build a state-of-the-art anything overnight,” Hyten said, adding that he has not yet spoken to Trump administration officials about the issue. “We need a powerful military,” but a severe budget crunch makes “reasonable solutions” more likely than expensive and unrealistic ones. On the upgrade front, Hyten said he favors a long-range strike missile system to replace existing cruise missiles; a better air-to-air missile for the Air Force; and an improved missile defense ground base interceptor. ‘Critically dependent’ From satellites to global-positioning systems GPS, space has transformed human life – and the military – in the 21st century, Hyten said. In terms of defining "space," the U.S. designates people who travel above an altitude of 50 miles as astronauts. As the commander of the U.S. Strategic Command, Hyten oversees the control of U.S. strategic forces, providing options for the president and secretary of defense. In particular, this command is charged with space operations (such as military satellites), information operations (such as information warfare), missile defense, global command and control, intelligence, surveillance, and reconnaissance, global strike and strategic deterrence (the U.S. nuclear arsenal), and combating weapons of mass destruction. Hyten explained that every drone, fighter jet, bomber, ship and soldier is critically dependent on space to conduct their own operations. All cell phones use space, and the GPS command systems overall are managed at Strategic Command, he said. “No soldier has to worry about what’s over the next hill,” he said, describing GPS capabilities, which have fundamentally transformed humanity’s way of life. Space needs to be available for exploration, he said. “I watch what goes on in space, and I worry about us destroying that environment for future generations.” He said that too many drifting objects and debris exist – about 22,000 right now. A recent Chinese satellite interception created a couple thousand more debris objects that now circle about the Earth at various altitudes and pose the risk of striking satellites. “We track every object in space” now, Hyten said, urging “international norms of behavior in space.” He added, “We have to deter bad behavior on space. We have to deter war in space. It’s bad for everybody. We could trash that forever.” But now rivals like China and Russia are building weapons to deploy in the lower levels of space. “How do we prevent this? It’s bigger than a space problem,” he said. Deterring conflict in the cyber, nuclear and space realms is the strategic deterrence goal of the 21st century, Hyten said. “The best way to prevent war is to be prepared for war,” he said. Hyten believes the U.S. needs a fundamentally different debate about deterrence. And it all starts with nuclear weapons. “In my deepest heart, I wish I didn’t have to worry about nuclear weapons,” he said. Hyten described his job as “pretty sobering, it’s not easy.” But he also noted the mass violence of the world prior to 1945 when the first atomic bomb was used. Roughly 80 million people died from 1939 to 1945 during World War II. Consider that in the 10-plus years of the Vietnam War, 58,000 Americans were killed. That’s equivalent to two days of deaths in WWII, he said. In a world without nuclear weapons, a rise in conventional warfare would produce great numbers of mass casualties, Hyten said. About war, he said, “Once you see it up close, no human will ever want to experience it.” Though America has “crazy enemies” right now, in many ways the world is more safe than during WWII, Hyten said. The irony is that nuclear weapons deterrence has kept us from the type of mass killings known in events like WWII. But the U.S. must know how to use its nuclear deterrence effectively. Looking ahead, Hyten said the U.S. needs to think about space as a potential war environment. An attack in space might not mean a response in space, but on the Earth. Hyten describes space as the domain that people look up at it and still dream about. “I love to look at the stars,” but said he wants to make sure he’s not looking up at junk orbiting in the atmosphere.

## 3

#### Space Commercialization drives Tech Innovation in the Status Quo – it provides a unique impetus.

Hampson 17 Joshua Hampson 1-25-2017 “The Future of Space Commercialization” <https://republicans-science.house.gov/sites/republicans.science.house.gov/files/documents/TheFutureofSpaceCommercializationFinal.pdf> (Security Studies Fellow at the Niskanen Center)//Elmer

The size of the space economy is far larger than many may think. In 2015 alone, the global market amounted to $323 billion. Commercial infrastructure and systems accounted for 76 percent of that 9 total, with satellite television the largest subsection at $95 billion. The global space launch market’s 10 11 share of that total came in at $6 billion dollars. It can be hard to disaggregate how space benefits 12 particular national economies, but in 2009 (the last available report), the Federal Aviation Administration (FAA) estimated that commercial space transportation and enabled industries generated $208.3 billion in economic activity in the United States alone. Space is not just about 13 satellite television and global transportation; while not commercial, GPS satellites also underpin personal navigation, such as smartphone GPS use, and timing data used for Internet coordination.14 Without that data, there could be problems for a range of Internet and cloud-based services.15 There is also room for growth. The FAA has noted that while the commercial launch sector has not grown dramatically in the last decade, there are indications that there is latent demand. This 16 demand may catalyze an increase in launches and growth of the wider space economy in the next decade. The Satellite Industry Association’s 2015 report highlighted that their section of the space economy outgrew both the American and global economies. The FAA anticipates that growth to 17 continue, with expectations that small payload launch will be a particular industry driver.18 In the future, emerging space industries may contribute even more the American economy. Space tourism and resource recovery—e.g., mining on planets, moons , and asteroids—in particular may become large parts of that industry. Of course, their viability rests on a range of factors, including costs, future regulation, international problems, and assumptions about technological development. However, there is increasing optimism in these areas of economic production. But the space economy is not just about what happens in orbit, or how that alters life on the ground. The growth of this economy can also contribute to new innovations across all walks of life. Technological Innovation Innovation is generally hard to predict; some new technologies seem to come out of nowhere and others only take off when paired with a new application. It is difficult to predict the future, but it is reasonable to expect that a growing space economy would open opportunities for technological and organizational innovation. In terms of technology, the difficult environment of outer space helps incentivize progress along the margins. Because each object launched into orbit costs a significant amount of money—at the moment between $27,000 and $43,000 per pound, though that will likely drop in the future —each 19 reduction in payload size saves money or means more can be launched. At the same time, the ability to fit more capability into a smaller satellite opens outer space to actors that previously were priced out of the market. This is one of the reasons why small, affordable satellites are increasingly pursued by companies or organizations that cannot afford to launch larger traditional satellites. These small 20 satellites also provide non-traditional launchers, such as engineering students or prototypers, the opportunity to learn about satellite production and test new technologies before working on a full-sized satellite. That expansion of developers, experimenters, and testers cannot but help increase innovation opportunities. Technological developments from outer space have been applied to terrestrial life since the earliest days of space exploration. The National Aeronautics and Space Administration (NASA) maintains a website that lists technologies that have spun off from such research projects. Lightweight 21 nanotubes, useful in protecting astronauts during space exploration, are now being tested for applications in emergency response gear and electrical insulation. The need for certainty about the resiliency of materials used in space led to the development of an analytics tool useful across a range of industries. Temper foam, the material used in memory-foam pillows, was developed for NASA for seat covers. As more companies pursue their own space goals, more innovations will likely come from the commercial sector. Outer space is not just a catalyst for technological development. Satellite constellations and their unique line-of-sight vantage point can provide new perspectives to old industries. Deploying satellites into low-Earth orbit, as Facebook wants to do, can connect large, previously-unreached swathes of 22 humanity to the Internet. Remote sensing technology could change how whole industries operate, such as crop monitoring, herd management, crisis response, and land evaluation, among others. 23 While satellites cannot provide all essential information for some of these industries, they can fill in some useful gaps and work as part of a wider system of tools. Space infrastructure, in helping to change how people connect and perceive Earth, could help spark innovations on the ground as well. These innovations, changes to global networks, and new opportunities could lead to wider economic growth.

#### Strong Innovation solves Extinction.

Matthews 18 Dylan Matthews 10-26-2018 “How to help people millions of years from now” <https://www.vox.com/future-perfect/2018/10/26/18023366/far-future-effective-altruism-existential-risk-doing-good> (Co-founder of Vox, citing Nick Beckstead @ Rutgers University)//Re-cut by Elmer

If you care about improving human lives, you should overwhelmingly care about those quadrillions of lives rather than the comparatively small number of people alive today. The 7.6 billion people now living, after all, amount to less than 0.003 percent of the population that will live in the future. It’s reasonable to suggest that those quadrillions of future people have, accordingly, hundreds of thousands of times more moral weight than those of us living here today do. That’s the basic argument behind Nick Beckstead’s 2013 Rutgers philosophy dissertation, “On the overwhelming importance of shaping the far future.” It’s a glorious mindfuck of a thesis, not least because Beckstead shows very convincingly that this is a conclusion any plausible moral view would reach. It’s not just something that weird utilitarians have to deal with. And Beckstead, to his considerable credit, walks the walk on this. He works at the Open Philanthropy Project on grants relating to the far future and runs a charitable fund for donors who want to prioritize the far future. And arguments from him and others have turned “long-termism” into a very vibrant, important strand of the effective altruism community. But what does prioritizing the far future even mean? The most literal thing it could mean is preventing human extinction, to ensure that the species persists as long as possible. For the long-term-focused effective altruists I know, that typically means identifying concrete threats to humanity’s continued existence — like unfriendly artificial intelligence, or a pandemic, or global warming/out of control geoengineering — and engaging in activities to prevent that specific eventuality. But in a set of slides he made in 2013, Beckstead makes a compelling case that while that’s certainly part of what caring about the far future entails, approaches that address specific threats to humanity (which he calls “targeted” approaches to the far future) have to complement “broad” approaches, where instead of trying to predict what’s going to kill us all, you just generally try to keep civilization running as best it can, so that it is, as a whole, well-equipped to deal with potential extinction events in the future, not just in 2030 or 2040 but in 3500 or 95000 or even 37 million. In other words, caring about the far future doesn’t mean just paying attention to low-probability risks of total annihilation; it also means acting on pressing needs now. For example: We’re going to be better prepared to prevent extinction from AI or a supervirus or global warming if society as a whole makes a lot of scientific progress. And a significant bottleneck there is that the vast majority of humanity doesn’t get high-enough-quality education to engage in scientific research, if they want to, which reduces the **odds that we have enough trained scientists to come up with the breakthroughs** we need as a civilization to survive and thrive. So maybe one of the best things we can do for the far future is to improve school systems — here and now — to harness the group economist Raj Chetty calls “lost Einsteins” (potential innovators who are thwarted by poverty and inequality in rich countries) and, more importantly, the hundreds of millions of kids in developing countries dealing with even worse education systems than those in depressed communities in the rich world. What if living ethically for the far future means living ethically now? Beckstead mentions some other broad, or very broad, ideas (these are all his descriptions): Help make computers faster so that people everywhere can work more efficiently Change intellectual property law so that technological innovation can happen more quickly Advocate for open borders so that people from poorly governed countries can move to better-governed countries and be more productive Meta-research: improve incentives and norms in academic work to better advance human knowledge Improve education Advocate for political party X to make future people have values more like political party X ”If you look at these areas (economic growth and technological progress, access to information, individual capability, social coordination, motives) a lot of everyday good works contribute,” Beckstead writes. “An implication of this is that a lot of everyday good works are good from a broad perspective, even though hardly anyone thinks explicitly in terms of far future standards.” Look at those examples again: It’s just a list of what normal altruistically motivated people, not effective altruism folks, generally do. Charities in the US love talking about the lost opportunities for innovation that poverty creates. Lots of smart people who want to make a difference become scientists, or try to work as teachers or on improving education policy, and lord knows there are plenty of people who become political party operatives out of a conviction that the moral consequences of the party’s platform are good. All of which is to say: Maybe effective altruists aren’t that special, or at least maybe we don’t have access to that many specific and weird conclusions about how best to help the world. If the far future is what matters, and generally trying to make the world work better is among the best ways to help the far future, then effective altruism just becomes plain ol’ do-goodery.

## 4

#### Statesought to call a global constitutional convention and establish a constitution reflecting intergenerational concern with exclusive authority to ban appropriation of outer space by private entities and bind participating bodies to its result

#### That solves the aff – it addresses shared anxieties while building political consensus

Gardiner 14 1 [Stephen M. Gardiner, Professor of Philosophy and Ben Rabinowitz Endowed Professor of Human Dimensions of the Environment at the University of Washington, Seattle, “A Call for a Global Constitutional Convention Focused on Future Generations,” 2014, *Ethics & International Affairs*, Vol. 28, Issue 3, pp. 299-315, https://doi.org/10.1017/S0892679414000379, EA]

A Constitutional Convention

In my view, the above line of reasoning leads naturally to a more specific proposal: that we—concerned individuals, interested community groups, national governments, and transnational organizations—should initiate a call for a global constitutional convention focused on future generations. This proposal has two components. The first component is procedural. The proposal takes the form of a “call to action.” It is explicitly an attempt to engage a range of actors, based on a claim that they have or should take on a set of responsibilities, and a view about how to go about discharging those responsibilities. The second component is substantive. The main focus for action is a push for the creation of a constitutional convention at the global level, whose role is to pave the way for an overall constitutional system that appropriately embodies intergenerational concern.

The substantive idea rests on several key ideas. Still, for the purposes of a basic proposal, I suggest that these be understood in a relatively open way that, as far as is practicable, does not prejudge the outcome of the convention, and especially its main recommendations. First, the convention itself should be understood as “a representative body called together for some occasional or temporary purpose” and “constituted by statute to represent the people in their primary relations.”14 Second, a constitutional system should be thought of in a minimalist sense as “a set of norms (rules, principles or values) creating, structuring, and possibly defining the limits of government power or authority.”15 Third, the “instigating” role of the convention should be to discuss, develop, make recommendations toward, and set in motion a process for the establishment of a constitution. Fourth, its primary subject matter should be the need to adequately reflect and embody intergenerational concern, where this would include at least the protection of future generations, the promotion of their interests (where “interests” is to be broadly conceived so as to include rights, claims, welfare, and so on), and the discharging of duties with respect to them. It may also (and in my view should) include some way of reflecting concern for past generations, including responsiveness to at least certain of their interests and views. However, I will leave that issue aside in what follows.

The proposal to initiate a call for a global constitutional convention has at least two attractive features. First, it is based in a deep political reality, and does not underplay the challenge. It acknowledges the problem as it is, both specific and general, and calls attention to the heart of that problem, including to the failures of the current system, the need for an alternative, and the background issue of responsibility. Moreover, though the proposal is dramatic and rhetorically eye-catching, it is so in a way that is appropriately responsive to the seriousness of the issue at hand, the persistent political inertia surrounding more modest initiatives, and the fact that (grave though concerns about it are) climate change is only one instance of the tyranny of the contemporary (and the wider perfect moral storm), and we should expect others to arise over the coming decades and centuries.

The second attractive feature of the proposal is that, though ambitious, it is not alienating. While it does not succumb to despair in the face of the challenge, neither does it needlessly polarize and divide from the outset (for example, by leaping to specific recommendations about how to fill the institutional gap). Instead, it acknowledges that there are fundamental difficulties and anxieties, but uses them to start the right kind of debate, rather than to foreclose it. As a result, the proposal is a promising candidate to serve as the subject of a wide and overlapping political consensus, at least among those who share intergenerational concern.

Selective Mirroring

To quell some initial anxieties, it is perhaps worth clarifying the open-ended and non-alienating character of the proposal. One temptation would be to view the call for a global constitutional convention as a fairly naked plea for world government, a prospect that would be deeply alienating—indeed anathema—to many. However, that is not my intention. Though it is possible that a global constitutional convention would lead in this direction, it is by no means certain.

At a minimum, no such body could plausibly recommend any form of “world government” without simultaneously advancing detailed suggestions about how to avoid the standard threats such an institution might pose. Moreover, it seems perfectly conceivable, even likely under current ways of thinking, that a global constitutional convention would pursue what we might call a selective mirroring strategy. Specifically, a convention would seek to develop a broader system of institutions and practices that reflected the desirable features of a powerful and highly centralized global authority but neutralized the standing threats posed by it (for example, it might employ familiar strategies such as the separation of powers). In all likelihood, one feature of a selective mirroring approach would be the significant preservation of existing institutions to serve as a bulwark against the excesses of any newly created ones. Whether and how such a strategy might be made effective against the perfect moral storm, and whether something closer to a “world government” would do better, would be a central issue for discussion by the convention.

#### It spills over to foster broader intergenerational representation, but independence is key

Gardiner 14 2 [Stephen M. Gardiner, Professor of Philosophy and Ben Rabinowitz Endowed Professor of Human Dimensions of the Environment at the University of Washington, Seattle, “A Call for a Global Constitutional Convention Focused on Future Generations,” 2014, *Ethics & International Affairs*, Vol. 28, Issue 3, pp. 299-315, https://doi.org/10.1017/S0892679414000379, EA]

One set of guidelines concerns how the global constitutional convention relates to other institutions. The first guideline concerns relative independence:

(1) Autonomy: Any global constitutional convention should have considerable autonomy from other institutions, and especially from those dominated by factors that generate or facilitate the tyranny of the contemporary (and the perfect moral storm, more generally).

Thus, for example, attempts should be made to insulate the global constitutional convention from too much influence from short-term and narrowly economic forces.

The second guideline concerns limits to that independence:

(2) Mutual Accountability: Any global constitutional convention should be to some extent accountable to other major institutions, and they should be accountable to it.

Thus, for example, though the global constitutional convention should not be able to decide unilaterally that national institutions should be radically supplanted, nevertheless such institutions should not have a simple veto on the recommendations of the convention, including those that would result in sharp limits to their powers.

A third guideline concerns adequacy:

(3) Functional Adequacy: The global constitutional convention should be constructed in such a way that it is highly likely to produce recommendations that are functionally adequate to the task.

Thus, for example, the tasks of the global constitutional convention should not be assigned to any currently existing body whose design and authority is clearly unsuitable. In my view, this guideline rules out proposals such as the Royal Society’s suggestion that governance of geoengineering should be taken up by the United Nations’ Commission on Sustainable Development,20 or the Secretary-General’s recommendation of a new United Nations’ High Commissioner for Future Generations.21 Though such proposals may have merit for some purposes (for example, as pragmatic, incremental suggestions to highlight the importance of intergenerational issues), they are too modest, in my opinion, to reflect the gravity of the threats posed by climate change in particular, and the perfect moral storm more generally.

Aims

A second set of guidelines concerns the aims of the global constitutional convention. Here, the perfect moral storm analysis would suggest:

(4) Comprehensiveness: The convention should be under a mandate to consider a very broad range of global, intergenerational issues, to focus on such issues at a foundational level, and to recommend institutional reform accordingly.

(5) Standing Authority: Though the convention may recommend the establishment of some temporary and issue-specific bodies, its focus should be on the establishment of institutions with standing authority over the long term.

These guidelines are significant in that they stand against existing issue-specific approaches to global and intergenerational problems, and encourage not only a less ad hoc but also a more proactive approach. In particular, the global constitutional convention might be expected to recommend institutions that would be charged with identifying, monitoring, and taking charge of intergenerational issues as such. For example, such institutions should address not only specific policy issues (such as climate change, large asteroid detection, and long-term nuclear waste) but also the need to identify similar threats before they arise.

#### Proactive measures mitigate a laundry list of emerging catastrophic risks – extinction

Beckstead et al. 14 [Nick Beckstead, Nick Bostrom, Niel Bowerman, Owen Cotton-Barratt, William MacAskill, Seán Ó hÉigeartaigh, Toby Ord, \* Future of Humanity Institute, University of Oxford, \*\* Director, Future of Humanity Institute, University of Oxford, \*\*\* Global Priorities Project, Centre for Effective Altruism; Department of Physics, University of Oxford, \*\*\*\* Global Priorities Project, Centre for Effective Altruism; Future of Humanity Institute, University of Oxford, \*\*\*\*\* Uehiro Centre for Practical Ethics, University of Oxford, \*\*\*\*\*\* Cambridge Centre for the Study of Existential Risk; Future of Humanity Institute, University of Oxford, \*\*\*\*\*\*\* Programme on the Impacts of Future Technology, Oxford Martin School, University of Oxford, “Policy Brief: Unprecedented Technological Risks,” 2014, *The Global Priorities Project, The Future of Humanity Institute, The Oxford Martin Programme on the Impacts of Future Technology, and The Centre for the Study of Existential Risk*, https://www.fhi.ox.ac.uk/wp-content/uploads/Unprecedented-Technological-Risks.pdf, Accessed: 03/13/21, EA]

In the near future, major technological developments will give rise to new unprecedented risks. In particular, like nuclear technology, developments in synthetic biology, geoengineering, distributed manufacturing and artificial intelligence create risks of catastrophe on a global scale. These new technologies will have very large benefits to humankind. But, without proper regulation, they risk the creation of new weapons of mass destruction, the start of a new arms race, or catastrophe through accidental misuse. Some experts have suggested that these technologies are even more worrying than nuclear weapons, because they are more difficult to control. Whereas nuclear weapons require the rare and controllable resources of uranium-235 or plutonium-239, once these new technologies are developed, they will be very difficult to regulate and easily accessible to small countries or even terrorist groups.

Moreover, these risks are currently underregulated, for a number of reasons. Protection against such risks is a global public good and thus undersupplied by the market. Implementation often requires cooperation among many governments, which adds political complexity. Due to the unprecedented nature of the risks, there is little or no previous experience from which to draw lessons and form policy. And the beneficiaries of preventative policy include people who have no sway over current political processes — our children and grandchildren.

Given the unpredictable nature of technological progress, development of these technologies may be unexpectedly rapid. A political reaction to these technologies only when they are already on the brink of development may therefore be too late. We need to implement prudent and proactive policy measures in the near future, even if no such breakthroughs currently appear imminent.

#### Maintaining sustainable use of outer space is key to future generations

**Islam 18** [Mohammad Saiful Islam, Mohammad works for the Institute of Advanced Judicial Studies and the Beijing Institute of Technology. 4-27-2018, "The Sustainable Use of Outer Space: Complications and Legal Challenges to the Peaceful Uses and Benefit of Humankind," Beijing Law Review, <https://www.scirp.org/journal/paperinformation.aspx?paperid=85201> accessed 12/12/21] Adam

4.2. Ensure the Rights of Future Generations in Outer Space

Sustainable development is the establishing principle for achieving present human needs without damaging the demands of future generations maintaining integrity and constancy of the natural systems. The modern idea of sustainable development is derived from the Brundtland Report in 1987. Generally considered in modern application and exploration of outer space, fundamental elements are the area must be dedicated to peaceful purposes; and the area must be preserved for future generations [(Heim, 1990)](https://www.scirp.org/journal/paperinformation.aspx?paperid=85201#ref17). It is an indispensable and inordinate challenge to confirm uphold the healthy environment and make sure development without destroying the rights of future generations in space. Article IX of The Outer Space Treaty provided, in the exploration and use of outer space, States should pursue studies and conduct exploration of outer space so as to avoid harmful contamination and also adverse changes in the environment of the Earth [(Outer Space Treaty, 1967)](https://www.scirp.org/journal/paperinformation.aspx?paperid=85201#ref35). The issues of what constitutes harmful contamination in Earth’s environment have yet to be interpreted. The legal definition of “adverse” and “harmful” will also modification as Earth, indigenous sciences progress, separately or in concert, with the planetary exploration space sciences [(Robinson, 2005)](https://www.scirp.org/journal/paperinformation.aspx?paperid=85201#ref38). As a result of multifaceted political, economic, scientific, technological, educational, and other global problems, there has been practicing exclusively only international cooperation for sustainable space development among the developed countries [(Noichim, 2005)](https://www.scirp.org/journal/paperinformation.aspx?paperid=85201#ref34). The space faring nations should promote a supportive environment for peaceful and sustainable use of space, decrease environmental effects on Earth and protect the terrestrial environment. We should escape a regime that will ultimately reflect the over-exploitation of resources and environmental havoc [(Fountain, 2002)](https://www.scirp.org/journal/paperinformation.aspx?paperid=85201#ref9).

## Case

### Offense

#### Commercial mining solves extinction from scarcity, climate, terror, war, and disease.

Pelton 17—(Director Emeritus of the Space and Advanced Communications Research Institute at George Washington University, PHD in IR from Georgetown).. Pelton, Joseph N. 2017. The New Gold Rush: The Riches of Space Beckon! Springer. Accessed 8/30/19.

Are We Humans Doomed to Extinction? What will we do when Earth’s resources are used up by humanity? The world is now hugely over populated, with billions and billions crammed into our overcrowded cities. By 2050, we may be 9 billion strong, and by 2100 well over 11 billion people on Planet Earth. Some at the United Nations say we might even be an amazing 12 billion crawling around this small globe. And over 80 % of us will be living in congested cities. These cities will be ever more vulnerable to terrorist attack, natural disaster, and other plights that come with overcrowding and a dearth of jobs that will be fueled by rapid automation and the rise of artifi cial intelligence across the global economy. We are already rapidly running out of water and minerals. Climate change is threatening our very existence. Political leaders and even the Pope have cautioned us against inaction. Perhaps the naysayers are right. All humanity is at tremendous risk. Is there no hope for the future? This book is about hope. We think that there is literally heavenly hope for humanity. But we are not talking here about divine intervention. We are envisioning a new space economy that recognizes that there is more water in the skies that all our oceans. Th ere is a new wealth of natural resources and clean energy in the reaches of outer space—more than most of us could ever dream possible. There are those that say why waste money on outer space when we have severe problems here at home? Going into space is not a waste of money. It is our future. It is our hope for new jobs and resources. The great challenge of our times is to reverse public thinking to see space not as a resource drain but as the doorway to opportunity. The new space frontier can literally open up a “gold rush in the skies.” In brief, we think there is new hope for humanity. We see a new a pathway to the future via new ventures in space. For too long, space programs have been seen as a money pit. In the process, we have overlooked the great abundance available to us in the skies above. It is important to recognize there is already the beginning of a new gold rush in space—a pathway to astral abundance. “New Space” is a term increasingly used to describe radical new commercial space initiatives—many of which have come from Silicon Valley and often with backing from the group of entrepreneurs known popularly as the “space billionaires.” New space is revolutionizing the space industry with lower cost space transportation and space systems that represent significant cost savings and new technological breakthroughs. “New Commercial Space” and the “New Space Economy” represent more than a new way of looking at outer space. These new pathways to the stars could prove vital to human survival. If one does not believe in spending money to probe the mysteries of the universe then perhaps we can try what might be called “calibrated greed” on for size. One only needs to go to a cubesat workshop, or to Silicon Valley or one of many conferences like the “Disrupt Space” event in Bremen, Germany, held in April 2016 to recognize that entrepreneurial New Space initiatives are changing everything [ 1 ]. In fact, the very nature and dimensions of what outer space activities are today have changed forever. It is no longer your grandfather’s concept of outer space that was once dominated by the big national space agencies. The entrepreneurs are taking over. The hopeful statements in this book and the hard economic and technical data that backs them up are more than a minority opinion. It is a topic of growing interest at the World Economic Forum, where business and political heavyweights meet in Davos, Switzerland, to discuss how to stimulate new patterns of global economic growth. It is even the growing view of a group that call themselves “space ethicists.” Here is how Christopher J. Newman, at the University of Sunderland in the United Kingdom has put it: Space ethicists have offered the view that space exploration is not only desirable; it is a duty that we, as a species, must undertake in order to secure the survival of humanity over the longer term. Expanding both the resource base and, eventually, the habitats available for humanity means that any expenditure on space exploration, far from being viewed as frivolous, can legitimately be rationalized as an ethical investment choice. (Newman) On the other hand there are space ethicists and space exobiologists who argue that humans have created ecological ruin on the planet—and now space debris is starting to pollute space. Th ese countervailing thoughts by the “no growth” camp of space ethicists say we have no right to colonize other planets or to mine the Moon and asteroids—or at least no right to do so until we can prove we can sustain life here on Earth for the longer term. However, for most who are planning for the new space economy the opinion of space philosophers doesn’t really fl oat their boat. Legislators, bankers, and aspiring space entrepreneurs are far more interested in the views of the super-rich capitalists called the space billionaires. A number of these billionaires and space executives have already put some very serious money into enterprises intent on creating a new pathway to the stars. No less than five billionaires with established space ventures—Elon Musk, Paul Allen, Jeff Bezos, Sir Richard Branson, and Robert Bigelow—have invested millions if not billions of dollars into commercializing space. They are developing new technologies and establishing space enterprises that can bring the wealth of outer space down to Earth. This is not a pipe dream, but will increasingly be the economic reality of the 2020s. These wealthy space entrepreneurs see major new economic opportunities. To them space represents the last great frontier for enterprising pioneers. Th us they see an ever-expanding space frontier that offers opportunities in low-cost space transportation, satellite solar power satellites to produce clean energy 24h a day, space mining, space manufacturing and production, and eventually space habitats and colonies as a trajectory to a better human future. Some even more visionary thinkers envision the possibility of terraforming Mars, or creating new structures in space to protect our planet from cosmic hazards and even raising Earth’s orbit to escape the rising heat levels of the Sun in millennia to come. Some, of course, will say this is sci-fi hogwash. It can’t be done. We say that this is what people would have said in 1900 about airplanes, rocket ships, cell phones and nuclear devices. The skeptics laughed at Columbus and his plan to sail across the oceans to discover new worlds. When Thomas Jefferson bought the Louisiana Purchase from France or Seward bought Alaska, there were plenty of naysayers that said such investment in the unknown was an extravagant waste of money. A healthy skepticism is useful and can play a role in economic and business success. Before one dismisses the idea of an impending major new space economy and a new gold rush, it might useful to see what has already transpired in space development in just the past five decades. The world’s first geosynchronous communications satellite had a throughput capability of about 500 kb / s. In contrast, today’s state of the art Viasat 2 —a half century later— has an impressive throughput of some 140 Gb/s. Th is means that the relative throughput is nearly 300,000 greater, while its lifetime is some ten times longer (Figs. 1.1 and 1.2 ). Each new generation of communications satellite has had more power, better antenna systems, improved pointing and stabilization, and an extended lifetime. And the capabilities represented by remote sensing satellites , meteorological satellites , and navigation and timing satellites have also expanded their capabilities and performance in an impressive manner. When satellite applications first started, the market was measured in millions of dollars. Today commercial satellite services exceed a quarter of a billion dollars. Vital services such as the Internet, aircraft traffi c control and management, international banking, search and rescue and much, much more depend on application satellites. Th ose that would doubt the importance of satellites to the global economy might wish to view on You Tube the video “If Th ere Were a Day Without Satellites?” [ 2 ]. Let’s check in on what some of those very rich and smart guys think about the new space economy and its potential. (We are sorry to say that so far there are no female space billionaires, but surely this, too, will come someday soon.) Of course this twenty-fi rst century breakthrough that we call the New Space economy will not come just from new space commerce. It will also come from the amazing new technologies here on Earth. Vital new terrestrial technologies will accompany this cosmic journey into tomorrow. Information technology, robotics, artificial intelligence and commercial space travel systems have now set us on a course to allow us humans to harvest the amazing riches in the skies—new natural resources, new energy, and even totally new ways of looking at the purpose of human existence. If we pursue this course steadfastly, it can be the beginning of a New Space renaissance. But if we don’t seek to realize our ultimate destiny in space, Homo sapiens can end up in the dustbin of history—just like literally millions of already failed species. In each and every one of the five mass extinction events that have occurred over the last 1.5 billion years on Earth, some 50–80 % of all species have gone the way of the T. Rex, the woolly mammoth, and the Dodo bird along with extinct ferns, grasses and cacti. On the other hand, the best days of the human race could be just beginning. If we are smart about how we go about discovering and using these riches in the skies and applying the best of our new technologies, it could be the start of a new beginning for humanity. Konstantin Tsiokovsky, the Russian astronautics pioneer, who fi rst conceived of practical designs for spaceships, famously said: “A planet is the cradle of mankind, but one cannot live in a cradle forever.” Well before Tsiokovsky another genius, Leonardo da Vinci, said, quite poetically: “Once you have tasted flight, you will forever walk the earth with your eyes turned skyward, for there you have been, and there you will always long to return.” The founder of the X-Prize and of Planetary Resources, Inc., Dr. Peter Diamandis, has much more brashly said much the same thing in quite diff erent words when he said: “The meek shall inherit the Earth. The rest of us will go to Mars.” The New Space Billionaires Peter Diamandis is not alone in his thinking. From the list of “visionaries” quoted earlier, Elon Musk, the founder of SpaceX; Sir Richard Branson, the founder of Virgin Galactic; and Paul Allen, the co-founder of Microsoft and the man who financed SpaceShipOne, the world’s first successful spaceplane have all said the future will include a vibrant new space economy. Th ey, and others, have said that we can, we should and we soon shall go into space and realize the bounty that it can offer to us. Th e New Space enterprise is today indeed being led by those so-called space billionaires , who have an exciting vision of the future. They and others in the commercial space economy believe that the exploitation of outer space may open up a new golden age of astral abundance. They see outer space as a new frontier that can be a great source of new materials, energy and various forms of new wealth that might even save us from excesses of the past. Th is gold rush in the skies represents a new beginning. We are not talking about expensive new space ventures funded by NASA or other space agencies in Europe, Japan, China or India. No, these eff orts which we and others call New Space are today being forged by imaginative and resourceful commercial entrepreneurs. Th ese twenty-fi rst century visionaries have the fortitude and zeal to look to the abundance above. New breakthroughs in technology and New Space enterprises may be able to create an “astral life raft” for humanity. Just as Columbus and the Vikings had the imaginative drive that led them to discover the riches of a new world, we now have a cadre of space billionaires that are now leading us into this New Space era of tomorrow. These bold leaders, such as Paul Allen and Sir Richard Branson, plus other space entrepreneurs including Jeff Bezos of Amazon and Blue Origin, and Robert Bigelow, Chairman of Budget Suites and Bigelow Aerospace, not only dream of their future in the space industry but also have billions of dollars in assets. These are the bright stars of an entirely new industry that are leading us into the age of New Space commerce. These space billionaires, each in their own way, are proponents of a new age of astral abundance. Each of them is launching new commercial space industries. They are literally transforming our vision of tomorrow. These new types of entrepreneurial aerospace companies—the New Space enterprises—give new hope and new promise of transforming our world as we know it today. The New Space Frontier What happens in space in the next few decades, plus corresponding new information technologies and advanced robotics, will change our world forever. These changes will redefi ne wealth, change our views of work and employment and upend almost everything we think we know about economics, wealth, jobs, and politics. Th ese changes are about truly disruptive technologies of the most fundamental kinds. If you thought the Internet, smart phones, and spandex were disruptive technologies, just hang on. You have not seen anything yet. In short, if you want to understand a transition more fundamental than the changes brought to the twentieth century world by computers, communications and the Internet, then read this book. There are truly riches in the skies. Near-Earth asteroids largely composed of platinum and rare earth metals have an incredible value. Helium-3 isotopes accessible in outer space could provide clean and abundant energy. There is far more water in outer space than is in our oceans. In the pages that follow we will explain the potential for a cosmic shift in our global economy, our ecology, and our commercial and legal systems. These can take place by the end of this century. And if these changes do not take place we will be in trouble. Our conventional petro-chemical energy systems will fail us economically and eventually blanket us with a hydrocarbon haze of smog that will threaten our health and our very survival. Our rare precious metals that we need for modern electronic appliances will skyrocket in price, and the struggle between “haves” and “have nots” will grow increasingly ugly. A lack of affordable and readily available water, natural resources, food, health care and medical supplies, plus systematic threats to urban security and systemic warfare are the alternatives to astral abundance. The choices between astral abundance and a downward spiral in global standards of living are stark. Within the next few decades these problems will be increasingly real. By then the world may almost be begging for new, out of- the-box thinking. International peace and security will be an indispensable prerequisite for exploitation of astral abundance, as will good government for all. No one nation can be rich and secure when everyone else is poor and insecure. In short, global space security and strategic space defense, mediated by global space agreements, are part of this new pathway to the future.

#### Asteroid mining’s key to Space Colonization – anything else risks extinction from an existential crisis

Williams ’17 [Matt Williams, Writer for Universe Today. Citing A. J. Berliner, UC Berkeley; C. P. McKay. Space Sciences Division, NASA Ames Research Center; Valeriy Yakovlev, an astrophysicist and hydrogeologist from Laboratory of Water Quality in Kharkov, Ukraine. 3/10/17, “The future of space colonization – terraforming or space habitats?” [https://phys.org/news/2017-03-future-space-colonization-terraforming-habitats.html Accessed 1/2/20](https://phys.org/news/2017-03-future-space-colonization-terraforming-habitats.html%20Accessed%201/2/20) \*edited for gendered language]

In light of this, Yakolev presents what he considers to be the most likely prospects for humanity's exit to space between now and 2030. This will include the creation of the first space biospheres with artificial gravity, which will lead to key developments in terms of materials technology, life support-systems, and the robotic systems and infrastructure needed to install and service habitats in Low Earth Orbit (LEO). These habitats could be serviced thanks to the creation of robotic spacecraft that could harvest resources from nearby bodies – such as the Moon and Near-Earth Objects (NEOs). This concept would not only remove the need for planetary protections – i.e. worries about contaminating Mars' biosphere (assuming the presence of bacterial life), it would also allow human beings to become accustomed to space more gradually. As Yakovlev told Universe Today via email, the advantages to space habitats can be broken down into four points: "1. This is a universal way of mastering the infinite spaces of the Cosmos, both in the Solar System and outside it. We do not need surfaces for installing houses, but resources that robots will deliver from planets and satellites. 2. The possibility of creating a habitat as close as possible to the earth's cradle allows one to escape from the inevitable physical degradation under a different gravity. It is easier to create a protective magnetic field. "3. The transfer between worlds and sources of resources will not be a dangerous expedition, but a normal life. Is it good for sailors without their families? 4. The probability of death or degradation of [hu]mankind as a result of the global catastrophe is significantly reduced, as the colonization of the planets includes reconnaissance, delivery of goods, shuttle transport of people – and this is much longer than the construction of the biosphere in the Moon's orbit. Dr. Stephen William Hawking is right, a person does not have much time." And with space habitats in place, some very crucial research could begin, including medical and biologic research which would involve the first children born in space. It would also facilitate the development of reliable space shuttles and resource extraction technologies, which will come in handy for the settlement of other bodies – like the Moon, Mars, and even exoplanets. Ultimately, Yakolev thinks that space biospheres could also be accomplished within a reasonable timeframe – i.e. between 2030 and 2050 – which is simply not possible with terraforming. Citing the growing presence and power of the commercial space sector, Yakolev also believed a lot of the infrastructure that is necessary is already in place (or under development). "After we overcome the inertia of thinking +20 years, the experimental biosphere (like the settlement in Antarctica with watches), in 50 years the first generation of children born in the Cosmos will grow and the Earth will decrease, because it will enter the legends as a whole… As a result, terraforming will be canceled. And the subsequent conference will open the way for real exploration of the Cosmos. I'm proud to be on the same planet as Elon Reeve Musk. His missiles will be useful to lift designs for the first biosphere from the lunar factories. This is a close and direct way to conquer the Cosmos." With NASA scientists and entrepreneurs like Elon Musk and Bas Landorp looking to colonize Mars in the near future, and other commercial aerospace companies developing LEO, the size and shape of humanity's future in space is difficult to predict. Perhaps we will jointly decide on a path that takes us to the Moon, Mars, and beyond. Perhaps we will see our best efforts directed into near-Earth space. Or perhaps we will see ourselves going off in multiple directions at once. Whereas some groups will advocate creating space habitats in LEO (and later, elsewhere in the Solar System) that rely on artificial gravity and robotic spaceships mining asteroids for materials, others will focus on establishing outposts on planetary bodies, with the goal of turning them into "new Earths". Between them, we can expect that humans will begin developing a degree of "space expertise" in this century, which will certainly come in handy when we start pushing the boundaries of exploration and colonization even further.

#### That outweighs every impact

Bostrom ’03 [Nick Bostrom, 3. Professor, University of Oxford; Director, Future of Humanity Institute, University of Oxford; Director, Governance of AI program. Former lecturer at Yale. PhD, Philosophy, LSE; Studied Astrophysics & General Relativity (Dept. of Physics) and completed MSc-thesis in Computational neuroscience (Dept. of Math), King’s College, London; MA, Philosophy and Physics, University of Stockholm; BA, Philosophy, Mathematics, Mathematical Logic, Artificial Intelligence, University of Goteborg. “Astronomical Waste: The Opportunity Cost of Delayed Technological Development” <https://nickbostrom.com/astronomical/waste.html> Accessed 12/27/19]

ABSTRACT. With very advanced technology, a very large population of people living happy lives could be sustained in the accessible region of the universe. For every year that development of such technologies and colonization of the universe is delayed, there is therefore an opportunity cost: a potential good, lives worth living, is not being realized. Given some plausible assumptions, this cost is extremely large. However, the lesson for utilitarians is not that we ought to maximize the pace of technological development, but rather that we ought to maximize its safety, i.e. the probability that colonization will eventually occur. I. THE RATE OF LOSS OF POTENTIAL LIVES As I write these words, suns are illuminating and heating empty rooms, unused energy is being flushed down black holes, and our great common endowment of negentropy is being irreversibly degraded into entropy on a cosmic scale. These are resources that an advanced civilization could have used to create value-structures, such as sentient beings living worthwhile lives. The rate of this loss boggles the mind. One recent paper speculates, using loose theoretical considerations based on the rate of increase of entropy, that the loss of potential human lives in our own galactic supercluster is at least ~10^46 per century of delayed colonization.[1] This estimate assumes that all the lost entropy could have been used for productive purposes, although no currently known technological mechanisms are even remotely capable of doing that. Since the estimate is meant to be a lower bound, this radically unconservative assumption is undesirable. We can, however, get a lower bound more straightforwardly by simply counting the number or stars in our galactic supercluster and multiplying this number with the amount of computing power that the resources of each star could be used to generate using technologies for whose feasibility a strong case has already been made. We can then divide this total with the estimated amount of computing power needed to simulate one human life. As a rough approximation, let us say the Virgo Supercluster contains 10^13 stars. One estimate of the computing power extractable from a star and with an associated planet-sized computational structure, using advanced molecular nanotechnology[2], is 10^42 operations per second.[3] A typical estimate of the human brain’s processing power is roughly 10^17 operations per second or less.[4] Not much more seems to be needed to simulate the relevant parts of the environment in sufficient detail to enable the simulated minds to have experiences indistinguishable from typical current human experiences.[5] Given these estimates, it follows that the potential for approximately 10^38 human lives is lost every century that colonization of our local supercluster is delayed; or equivalently, about 10^29 potential human lives per second. While this estimate is conservative in that it assumes only computational mechanisms whose implementation has been at least outlined in the literature, it is useful to have an even more conservative estimate that does not assume a non-biological instantiation of the potential persons. Suppose that about 10^10 biological humans could be sustained around an average star. Then the Virgo Supercluster could contain 10^23 biological humans. This corresponds to a loss of potential equal to about 10^14 potential human lives per second of delayed colonization. What matters for present purposes is not the exact numbers but the fact that they are huge. Even with the most conservative estimate, assuming a biological implementation of all persons, the potential for one hundred trillion potential human beings is lost for every second of postponement of colonization of our supercluster.[6] II. THE OPPORTUNITY COST OF DELAYED COLONIZATION From a utilitarian perspective, this huge loss of potential human lives constitutes a correspondingly huge loss of potential value. I am assuming here that the human lives that could have been created would have been worthwhile ones. Since it is commonly supposed that even current human lives are typically worthwhile, this is a weak assumption. Any civilization advanced enough to colonize the local supercluster would likely also have the ability to establish at least the minimally favorable conditions required for future lives to be worth living. The effect on total value, then, seems greater for actions that accelerate technological development than for practically any other possible action. Advancing technology (or its enabling factors, such as economic productivity) even by such a tiny amount that it leads to colonization of the local supercluster just one second earlier than would otherwise have happened amounts to bringing about more than 10^29 human lives (or 10^14 human lives if we use the most conservative lower bound) that would not otherwise have existed. Few other philanthropic causes could hope to mach that level of utilitarian payoff. Utilitarians are not the only ones who should strongly oppose astronomical waste. There are many views about what has value that would concur with the assessment that the current rate of wastage constitutes an enormous loss of potential value. For example, we can take a thicker conception of human welfare than commonly supposed by utilitarians (whether of a hedonistic, experientialist, or desire-satisfactionist bent), such as a conception that locates value also in human flourishing, meaningful relationships, noble character, individual expression, aesthetic appreciation, and so forth. So long as the evaluation function is aggregative (does not count one person’s welfare for less just because there are many other persons in existence who also enjoy happy lives) and is not relativized to a particular point in time (no time-discounting), the conclusion will hold. These conditions can be relaxed further. Even if the welfare function is not perfectly aggregative (perhaps because one component of the good is diversity, the marginal rate of production of which might decline with increasing population size), it can still yield a similar bottom line provided only that at least some significant component of the good is sufficiently aggregative. Similarly, some degree of time-discounting future goods could be accommodated without changing the conclusion.[7]

### Advantage 1

#### Their models are old and don’t assume appropriate solar activity decay – debris is stable

**Wang and Liu 19** – Advances in Astronomy(Xiao-wei and Jing, PhDs, National Astronomical Observatories, Chinese Academy of Sciences, “An Introduction to a New Space Debris Evolution Model: SOLEM”, https://www.hindawi.com/journals/aa/2019/2738276/)

1. Introduction During the past decades, the number of space objects has been growing rapidly. Until now, the cataloged in-orbit space objects number has reached about 24,000, about 19000 of which are publicly listed at Space Track [1]. Uncataloged objects number with smaller size has approximately reached hundreds of millions. These space objects, mostly space debris, pose great threats to operational safety of in-orbit spacecraft. Adopting space debris mitigation measures is an important way to relieve the threats from space debris and prevent the number of resident space objects from growing. However, some studies indicated that the space debris environment would be stable for only 50 years under current mitigation measures, even without new launches in future [2]. This statement has aroused widespread concern over the world. In order to check and quantify the effectiveness of mitigation measures on controlling the growth of space debris in future, many space debris evolution models are established and compared to study the long-term stability of the future space environment. At present, the well-known space debris evolution models mainly include the LEGEND model from National Aeronautics and Space Administration (NASA) [3], DAMAGE model from United Kingdom Space Agency (UKSA) [4], MEDEE model from Centre National d’Etudes Spatiales (CNES) [5], DELTA model from European Space Agency (ESA) [6], LUCA model from Technische Universität Braunschweig [7], and NEODEEM model from Kyushu University and the Japan Aerospace Exploration Agency (JAXA)[8]. Some of these models have been used to study the stability of the future space environment in the joint research organized by Inter-Agency Space Debris Coordination Committee (IADC) [9, 10]. Besides, further work on the uncertainties affecting the long-term evolution of space debris is encouraged in international community to better assess the uncertainty induced by the modelling assumptions [11]. Therefore, more space debris evolution models are welcomed to participate in such research activities, which may provide the technical support for making new space debris mitigation guidelines as well as other related policies for space traffic management to guarantee the long-term sustainability of outer space activities. SOLEM (Space Objects Long-term Evolution Model) is a Low Earth Orbit (LEO) space debris long-term evolution model established by China. It has participated in the joint researches of IADC as a representative of China National Space Administration (CNSA). SOLEM is capable of predicting the number evolution trends of space debris, estimating the rate of collision events of space objects during the evolution in future, and analyzing the effects of different mitigation and remediation measures or other potential uncertainties on the long-term evolution of space debris. The reliability of SOLEM has been validated during the joint research of IADC. This paper introduces the components, algorithms, and workflow of SOLEM. After that, the effects of different mitigation measures based on SOLEM model are analyzed. 2. The SOLEM Model The space debris evolution model is expected to predict the evolution of space debris population and possible collision rates for a long period in future, usually for decades and even centuries. It can be used to study the evolution processes with various assumptions. The future evolution of space debris is affected by natural factors such as various perturbations, atmosphere evolutions, periodic solar activities, accidental explosions, and even the surface degradations. In fact, it could also be affected by human space activities such as launches, collision avoidance manoeuvres, mitigation and remediation measures. In space debris evolution model, usually the most important source and sink mechanisms are considered. Generally, a space debris evolution model is composed of orbital propagation model, collision probability estimation model, fragment generation model, future launch model, postmission disposal model, and active debris removal model (if the active debris removal measures are considered). These components will significantly affect the model evolution results if some key parameters are changed. The composition of space debris evolution model is illustrated in Figure 1. Figure 1: The general components of space debris evolution models. The left components are the main source mechanisms, and the right components are the main sink mechanisms. 3. Orbital Propagation Orbital propagation is to project the current orbits of space objects to the future. It is the core component of space debris evolution model. Through orbital propagation, the space debris evolution model is able to obtain the space objects orbital distribution at any moment in future. There are three basic orbital prediction algorithms: numerical method, analytical method, and semianalytical method. Numerical method has the highest precision but takes the most time in orbit propagation. Due to the long evolution time of space debris, usually from decades to hundreds of years, moreover, the high-precision position has no practical significance in long-term evolution; it is more appropriate to use analytical method or semianalytical method. SOLEM model adopts a simplified semianalytical orbital propagator, in which the integration is done on the perturbation functions with the short-periodic terms removed. Essentially, it is performed on the averaged orbital dynamic system. At present, SOLEM covers only LEO region, including objects residing in LEO with near-circular orbits and those crossing LEO with high eccentricity orbits. For near-circular orbits, the main perturbations considered include the Earth’s nonspherical gravity perturbation J2, J3, J4, J2,2, and atmospheric drag. For high eccentricity orbits, besides the Earth’s nonspherical gravity and atmospheric drag, the perturbations due to solar radiation pressure and gravity of the Sun and Moon are also considered. The atmosphere density model used for drag calculation is the NRLMSIS00 model. The values of solar radiation flux at 10.7 cm and the geomagnetic index can be read from a configuration file which can be replaced according to assumptions. In order to verify this orbital propagator of SOLEM, we conducted an experiment on the evolution of a small population. It is to compare the SOLEM propagation results with historical data for the number evolution of a small population in a statistical view. We used all the 1021 cataloged LEO-crossing objects on 1980.01.01 to do the experiment. It includes 38 objects with high eccentricity orbits () and 983 objects with near-circular orbits (). The area-to-mass ratio of these objects is calculated according to the UNW type of perturbed motion equation together with the method of least squares, using the orbital data for months previously. For SOLEM propagation, we used historical solar activities recorded in CelesTrak website [12] considering no collision avoidance and station keeping manoeuvres. The real decay information of the 1021 objects is drawn from SSR on the Space Track website [13]. The propagation result of SOLEM orbital propagator and the real data of historical evolution of the 1021 objects are compared in Figure 2, which shows a high consistency with a relative error of about 2%. Figure 2: The statistical results comparison of SOLEM propagation (denoted as test) and historical evolution (denoted as real). The semianalytical method has a limit precision in orbit propagation. However, comparing with the evolution of a single orbit, the space debris long-term evolution model cares more about the number evolution of the whole population in statistics. Considering the experiment above, we think the SOLEM orbital propagator is applicable to space debris long-term evolution model. 4. Fragment Generation Model In-orbit breakup is one important source of space debris growth. Therefore, the accuracy of fragment generation model simulating the breakup events has an important impact on the simulation results of space debris evolution model. The fragment generation model is to simulate the space debris collisions or explosions and give the instantaneous information of generated fragments which is necessary for the subsequent evolution prediction. The information includes the fragments number and each fragment’s mass, size, velocity, etc. In SOLEM, we adopt NASA’s standard breakup model to simulate the generation of fragments produced by in-orbit breakups. NASA’s standard breakup model is the most popular fragment generation model at present. The implementation is following the process presented in paper [14, 15]. 5. Collision Probability Estimation When considering the fragmentation due to in-orbit collisions, there is a key component in the space debris evolution model, that is, the collision probability estimation algorithm. In SOLEM, we adopt an Improved-CUBE (I-CUBE) model to do the calculation of collision probabilities. It is based on the CUBE method proposed by NASA [16, 17]. In CUBE model, the evolution system is uniformly sampled in time. At each sampling moment, the space around the Earth is discretized in small cubes in geocentric Cartesian coordinates. By obtaining updated orbital elements, the location of each space objects is calculated. CUBE model assumes that the collision probability only exists between objects residing in the same cube. And the collision probability is calculated by where and are the spatial densities of objects and in the cube, is the collision cross-section, is collision speed, is the volume of the cube, and is the time interval between two sampling moments. Actually, calculated by (1) is the mean number of collisions between objects and in the volume during the propagation time interval . The time interval is given as 5 days, i.e., seconds. As it does not approach 0, for some objects with collision cross-section large enough, will reach a value greater than 1. That is not reasonable. To avoid this, in I-CUBE model, we used (2) to express the collision probability with the consideration that the collision process follows a Poisson distribution. where represents the collision probability and is the mean number of collisions between objects and in the volume during the propagation time interval . According to Heiner Klinkrad [18], the approximation yields results with less than 10% error for . That means, for , the approximation will bring error bigger than 10%. For most space objects, the approximation is well suited. But for those with collision cross-sections large enough (dozens or even hundreds of square meters), the collision probability may be greatly overestimated if still using the approximation. Besides, CUBE model assumes that only the objects residing in the same cube are considered for collisions. For space debris evolution, the divided cube size is given as 10 km. However, it has been queried by CNES for the effects on evolution results from the divided cube size [19, 20]. In I-CUBE model, we assume that collision probability exists in all close approaches with a distance from the target satisfying the threshold. The distance threshold is the diagonal of the divided cube. Thus, the value of in (1) is no longer the volume of cube, but the volume of a sphere with radius equal to the distance threshold; i.e., where is the divided cube size. As relates to the spatial densities, and are now the spatial densities of objects and in the volume of the sphere. The two-dimensional representation is illustrated in Figure 3. Figure 3: Two-dimensional representation for considering possible collisions between debris residing in neighbouring cubes. In this approach, the divided cube size will never influence the evolution result of space debris evolution models. The comparison results using CUBE and I-CUBE model running by SOLEM are presented in Figure 4. The divided cube size varies from 5 km to 50 km. Except for the divided cube size, all the other configurations are the same. Every curve is the average result of 50 Monte Carlo runs. Figure 4: Comparison of simulation results with different cube size. (a) Using CUBE model. (b) Using I-CUBE model. 6. Future Launch Activities The launch of spacecraft in future is another important source of space debris increase. However, it is highly related to technical development and space policies which cannot be predicted. Therefore, the future launch model usually takes the current launch level as a reference. The data of a launch model includes all the characteristics of launched objects, such as the launched number, each object’s type, mass, area, or/and size, target orbit, and launch time. In SOLEM model, we adopt the launch traffic during the last 8 years, from September 1, 2009, to August 31, 2017, as future launch model. It will be repeated during the overall simulation time. The traffic data is collected mainly from websites of Space Launch Report [21], Space Track [22], and Union of Concerned Scientists [23]. It is prepared previously as a configuration file containing the information of launched numbers, types (including satellites, rocket bodies, and mission-related objects), each object’s mass, area (or/and size), target orbit, launch date, etc. 7. Postmission Disposal Postmission Disposal (PMD) is an important mitigation measure to stop space debris population from growing. In SOLEM model, PMD measures are implemented on nonfunctional satellites and rockets launched during the evolution time. For newly launched satellites, the mission life is uniformly set as 8 years by default. It can also be set as other values by user. For rockets, the mission life will end at once when the carried satellites are sent into the target orbits. When the mission life of a satellite or rocket ends, the natural orbital lifetime will be estimated. If the natural orbital lifetime exceeds 25 years, the satellite or upper stage of the rocket will be deorbited to a disposed orbit that will naturally decay within 25 years, complying with the 25-year rule. The PMD success rate in SOLEM can be set freely by users. Currently this value is estimated to be lower than 20% for region above 600 km. The procedure of PMD is shown in Figure 5. Figure 5: The procedure of PMD. For mission ended satellites or rockets (R/Bs), if the evaluated natural orbital lifetime exceeds 25 years, it will be disposed to a new orbit complying with the 25-year rule. 8. Active Debris Removal To better limit the growth of LEO space debris populations, measures of active debris removal (ADR) are suggested. Although the ADR has not become practical due to the technical difficulties and high costs, its effects on space debris evolution have been proved through computer simulations. Considering the developing technology, ADR will be another important measure in stopping the growth of the space debris population in future. As suggested, ADR measure is to remove existing large and massive objects from regions where high collision activities are expected [24]. The selection criterion that should be used in choosing which objects to remove has also been researched, and the criterion based on the mass and collision probability of each object has been proposed [25–27]. By annually removing several targets, the space environment can be stabilized according to computer simulations. In SOLEM model, the selection criterion is implemented as follows: where is the mass of object and is the cumulated collision probabilities between object and object , where during the last year. Their product is the selection index for ADR. The larger the value of , the more dangerous the object . At the beginning of each projection year, all objects in orbit are sorted in descending order by the value of . A predefined number of space debris objects with the largest s will be immediately removed from orbits. Only the operating satellites and objects with high eccentricity orbits are excluded. The beginning year of implementing ADR measures is set by users. In SOLEM, it is set as 2030 by default. 9. The Initial Population Space objects initial population is the baseline of space debris evolution model. It is the description of current space environment. For SOLEM, the population data on 2017.09.01 is used as initial population. Just like the future launch model, the information of space objects is obtained from Space Track, Space Launch Report, and Union of Concerned Scientists. The orbital distribution and the area-to-mass ratio (A/M) versus size distribution are shown in Figures 6 and 7. Figure 6: The semimajor axis versus eccentricity distribution of population data of 2017.09.01. Figure 7: The A/M versus size distribution of population data of 2017.09.01. 10. The Workflow of SOLEM Model The workflow of SOLEM model is simply represented by Figure 8. As presented, before projection, initialization will be done first by setting key parameters which are based on simulated assumptions, taking prepared initial population data as input. All space objects contained in the initial population are propagated after initialization. As time evolves, the newly launched objects from future launch model will also be propagated. If the newly launched active satellite or rocket ends its mission, the PMD measure will be done. All space objects with size over 10 cm are included for collision consideration. Once a collision happens, the breakup model will be used to generate new fragments. And the population for next propagation step will be updated. Figure 8: The workflow of SOLEM model. 11. Model Application As key parameters of each module are flexible to users, SOLEM model is able to simulate the evolution of space debris under various assumptions with high flexibility. Since 2015, SOLEM, as a representative of CNSA, has participated in a joint research of IADC. With uniform input data and assumptions, SOLEM has achieved results consistent with other space debris evolution models (IADC internal reports). In this paper, the effects of different mitigation measures on space debris evolution are analyzed with the SOLEM model. 11.1. Input Data The initial input data and relevant assumptions are shown in Table 1. Three scenarios are performed with PMD rate set as 30%, 60%, and 90%, and the other input data and assumptions are all the same. For each scenario, 50 Monte Carlo simulation runs are performed to obtain the averages. Table 1: Assumptions of scenarios simulated by SOLEM model. The solar activity used in SOLEM for future evolution is shown in Figure 9. It is generated according to the monthly fit formula offered by CelesTrak website [12]. The geomagnetic index is set as a constant median value of Ap=9. Figure 9: The solar activity recorded in history (green line, denoted as real) and the solar activity model adopted in SOLEM (purple line). 11.2. Simulation Results In the evolution results, space objects are classified into three types: intact objects include all satellites, R/Bs, and mission-related objects; old fragments are all the DEB already existing in the initial population; new fragments are all the DEB generated during the evolution time. Separating new fragments from old fragments can help us have a clear view of the increasing process of space debris population. The space debris evolution results of the scenario setting PMD rate as 30% is presented in Figure 10. It is the average result of 50 Mont-Carlo runs by SOLEM. As Figure 10 shows, the total number of objects in LEO shows a decrease in the first two decades, then turns into increase throughout the evolution time, and finally reaches more than 115% of the initial population. This scenario predicts 34 catastrophic collisions and 25 noncatastrophic collisions in average in future 200 years. Figure 10: The evolution results of scenario 1, with PMD rate of 30%. (a) The population evolution. The line of total is plotted with the error bar of 1 σ standard deviation. (b) The cumulative number of collisions. Figure 11 shows the evolution results of the scenario setting PMD rate as 60%. The reinforcement of such mitigation measure makes the final effective number of LEO objects in future 200 years decrease greatly comparing with the baseline scenario. The final total effective number of LEO objects is only 23% more than the initial population. And the cumulative number of collisions also decreases greatly in both collision types. Figure 11: The evolution results of scenario 2, with PMD rate of 60%. (a) The population evolution. The line of total is plotted with the error bar of 1 σ standard deviation. (b) The cumulative number of collisions. In Figure 12, the evolution result shows, with PMD rate of 90%, there is a clear decrease by approximately 30% in the total effective number of space objects crossing LEO orbits for the next 50 years, and then the population remains at a long-term stable level. The decrease in the first 50 years is mainly due to the natural decay of old fragments. The number of new fragments generated by breakup events increases in nearly the whole evolution time with a low rate and finally seems to stop increasing at the end of evolution. The cumulative number of catastrophic collisions is decreased down to 15, and for noncatastrophic collisions the number is only 7. Generally, this scenario predicts a space debris environment becoming better with PMD rate as high as 90%. Figure 12: The evolution results of scenario 3, with PMD rate of 90%. (a) The population evolution. The line of total is plotted with the error bar of 1 σ standard deviation. (b) The cumulative number of collisions. Simulation results of the three scenarios are quantified in Table 2. It can be seen that, with PMD rate increasing, the space debris population after 200 years will greatly decrease, as well as the average catastrophic collision rates. High PMD rates will make the current space environment better and safer. Table 2: Quantification of evolution results of the three scenarios simulated by SOLEM model. Taking the IADC comparison study about “Stability of the Future LEO Environment” [9, 10] as a reference, the evolution results shown above look rather optimistic. The IADC comparison study predicted about +30% changes in population after 200 years and one catastrophic collision every 5 to 9 years with PMD rate of 90%. And we predict -30% change in population and one catastrophic collision every 13 years with the same PMD compliance level. That might be mainly due to the differences in solar activity model and the input initial population used for simulation. The solar activity used in this paper (Figure 9) is in a higher level than those used in [9, 10], which is shown in Figure 13. This will make more objects decay during the evolution. Besides, the initial population we used in this paper is obtained from the public data on 2017.09.01, which is about 13000 space objects. While the initial population used in [9, 10] is the reference population of MASTER2009 on 2009.05.01, which is about 17000 space objects, the difference in initial population is as high as about 24%. Additionally, the area-to-mass ratio distribution of the initial population in this paper (Figure 7) is also different from [9, 10], which is shown in Figure 14. From the area-to-mass ratio distribution of the initial population, it can be seen that the initial population we used does not exclude those objects with high area-to-mass ratio. Figure 13: Solar flux projections used in IADC comparison study. Figure 14: Area-to-mass ratio distributions of the initial population used in IADC comparison study. The differences in solar activity projection and initial population including both the number and area-to-mass ratio finally lead to a very different evolution result. 12. Summary and Future Work This paper mainly introduced the composition, submodel algorithm, and workflow of SOLEM, the space debris long-term evolution model of China. The reliability of SOLEM has been validated during the joint research of IADC. After that, the application work of SOLEM model on analyzing the effects of different mitigation measures on the evolution of space environment is presented. The result shows, with higher PMD rate, the current space environment will become better and safer. SOLEM is a LEO space debris evolution model with high flexibility. It is capable of simulating the space environment evolution with various assumptions. Therefore, it can be used to simulate and analyze the uncertainties affecting the space debris evolution, such as the future launches, solar activities, manual collision avoidance measures, and mitigation and remediation measures. Through simulation and analysis, SOLEM can help us to deeply understand the evolution process of space environment and provides technical support for making space policies and laws to guarantee the sustainability of space activities in future. At present, the orbital range covered by SOLEM is limited to LEO region from 200 km to 2000 km. In the next step, the orbital range covered by SOLEM will be expanded from LEO region to GEO (Geostationary Earth Orbit) region. Besides, the postmission disposal model will be optimized, including the disposed orbit selection process and the computation time.

#### Either the asteroids are small and not existential OR we’d have forever to prepare.

Martin Rees 18. Astronomer Royal, founded the Centre for the Study of Existential Risk, Fellow of Trinity College and Emeritus Professor of Cosmology and Astrophysics at the University of Cambridge. 10/16/2018. On the Future: Prospects for Humanity. Princeton University Press.

You may guess that, being an astronomer, anxiety about asteroid collisions keeps me awake at night. Not so. Indeed, this is one of the few threats that we can quantify— and be confident is unlikely. Every ten million years or so, a body a few kilometres across will hit the Earth, causing global catastrophe— so there are a few chances in a million that such an impact occurs within a human lifetime. There are larger numbers of smaller asteroids that could cause regional or local devastation. The 1908 Tunguska event, which flattened hundreds of square kilometres of (fortunately unpopulated) forests in Siberia, released energy equivalent to several hundred Hiroshima bombs. Can we be forewarned of these crash landings? The answer is yes. Plans are afoot to create a data set of the one million potential Earth- crossing asteroids larger than 50 metres and track their orbits precisely enough to identify those that might come dangerously close. With the forewarning of an impact, the most vulnerable areas could be evacuated. Even better news is that we could feasibly develop spacecraft that could protect us. A ‘nudge’, imparted in space several years before the threatened impact, would only need to change an asteroid’s velocity by a few centimetres per second to deflect it from a collision course with the Earth.

### Climate

#### Solar flares will end satellites inevitably – no defense

Wild 15 (Jim Wild, Professor of Space Physics at Lancaster University, “With So Much Vested In Satellites, Solar Storms Could Bring Life To A Standstill,” July 30, 2015, https://theconversation.com/with-so-much-vested-in-satellites-solar-storms-could-bring-life-to-a-standstill-45204)

These can disrupt satellite operations by depositing electrical charge within the on-board electronics, triggering phantom commands or overloading and damaging sensitive components. The effects of space weather on the Earth’s upper atmosphere disrupts radio signals transmitted by navigation satellites, potentially introducing positioning errors or, in more severe cases, rendering them unusable.

These are not theoretical hazards: in recent decades, solar storms have caused outages for a number of satellites services – and a handful of satellites have been lost altogether. These were costly events – satellite operator losses have run into hundreds of millions of dollars. The wider social and economic impact was relatively limited, but even so it’s unclear how our growing amount of space infrastructure would fare against the more extreme space weather that we might face.

When Space Weather Becomes A Hurricane

The largest solar storm on record was the Carrington event in September 1859, named after the British astronomer who observed it. Of course there were no Victorian satellites to suffer the consequences, but the telegraph systems of the time were crippled as electrical currents induced in the copper wires interfered with signals, electrocuted operators and set telegraph paper alight. The geomagnetic storm it triggered was so intense that the northern lights, usually a polar phenomenon, were observed as far south as the Bahamas.

Statistical analysis of this and other severe solar storms suggests that we can expect an event of this magnitude once every few hundred years – it’s a question of “when” rather than “if”. A 2007 study estimated a Carrington event today would cause US$30 billion in losses for satellite operators and threaten vital infrastructure in space and here on the ground. It’s a risk taken sufficiently seriously that it appears on the UK National Risk Register and has led the government to draw up its preparedness programme.

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### Miscalc

#### Sat attacks don’t cause nuke war

Zarybnisky 18 [Eric J. Zarybnisky, MA in National Security Studies from the Naval War College, PhD in Operations Research from the MIT Sloan School of Management, Lt Col, USAF. Celestial Deterrence: Deterring Aggression in the Global Commons of Space. March 28, 2018. <https://apps.dtic.mil/dtic/tr/fulltext/u2/1062004.pdf>]

PREVENTING AGGRESSION IN SPACE

While deterrence and the Cold War are strongly linked in the public’s mind through the nuclear standoff between the United States and the Soviet Union, the fundamentals of deterrence date back millennia and deterrence remains relevant. Thucydides alludes to the concept of deterrence in his telling of the Peloponnesian War when he describes rivals seeking advantages, such as recruiting allies, to dissuade an adversary from starting or expanding a conflict.6F 6 Aggression in space was successfully avoided during the Cold War because both sides viewed an attack on military satellites as highly escalatory, and such an action would likely result in general nuclear war.7F 7 In today’s more nuanced world, attacking satellites, including military satellites, does not necessarily result in nuclear war. For instance, foreign countries have used highpowered lasers against American intelligence-gathering satellites8F 8 and the United States has been reluctant to respond, let alone retaliate with nuclear weapons. This shift in policy is a result of the broader use of gray zone operations, to which countries struggle to respond while limiting escalation. Beginning with the fundamentals of deterrence illuminates how it applies to prevention of aggression in space.

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### Africa

#### Squo barriers prevent utilization of metals in Africa which proves mining space rocks wont make a difference – Memorial reads blue

1AC Oni 19 [(David, a space industry and technology analyst at Space in Africa. He’s a graduate of Mining Engineering from the Federal University of Technology Akure.) “The Effect of Asteroid Mining on Mining Activities in Africa,” Africa News, 9/24/19, <https://africanews.space/the-effect-of-asteroid-mining-on-mining-activities-in-africa/>] recut srey

At the moment, Asteroid mining poses no threat to terrestrial mining; however, this will not hold for long. The space industry is progressing at such a rapid pace, and the prospects are unequivocally mouth-watering. The big question is, will asteroid mining lure away investors in Africa? The planetary resources company estimates that a single 30-m asteroid may contain 30 billion dollars in platinum alone and a 500m rock could contain half the entire world resources of PGM. Considering the abundance of minerals in asteroids, once asteroid mining materialises, it will severely affect the precious metals market, usurp the prices of rare earth minerals, and a whole lot more because minerals that are usually somewhat scarce on earth will be easily accessible on asteroids. While foreign investors run the majority of the large-scale mining activities in the region, reports say that many African countries are dangerously dependent on mining activities. For some African countries, despite massive mineral wealth, their mining sectors are underdeveloped, and this is as a result of much focus on oil resources and a couple of other challenges. The million-dollar question is, what will become of the mining activities in Africa?

#### No great power war over Africa---deterrence solves, and resource interests don’t cause escalation

Lloyd Thrall 15, Associate at the RAND corporation, M.A. in international studies and diplomacy, SOAS, University of London, PhD student in War Studies at King’s College London, "China’s Expanding African Relations Implications for U.S. National Security," 2015, http://www.rand.org/content/dam/rand/pubs/research\_reports/RR900/RR905/RAND\_RR905.pdf

There is little credible potential for a Sino-American conflict over resources in Africa. Contrary to popular and perennial assumptions about resource wars, industry and energy analysis sources project adequate supply of conventional hydrocarbons beyond 2035.6 Given reservoir depletion curves, any tightening of supply would be gradual. The adequacy of supply is further augmented when tertiary production and unconventional sources are considered (such as shale and tar sands). U.S. strength in unconventional sources, and potential energy independence, further reduces the likelihood of a conflict. Even in a future with vastly inflated hydrocarbon prices, these costs pale in comparison to those associated with a Sino-American war, the economic costs of which likely fall more heavily on China than the United States.7 Global hydrocarbon resources are distributed via a fungible global market, with many stakeholders and moderate diversity of supply. This enables importing states to buy a predictable supply of hydrocarbons at reasonable and competing prices over long contracts. African sources do not constitute a majority of this supply chain, and supposed victory in a theoretical great-power resource war would not guarantee security of resource supply. In sum, the potential for either China or the United States to be willing to enter war with a nuclear adversary over African oil, let alone other, less valuable resources, is extraordinarily small.8

#### Covid thumps