# 1NC vs Peninsula RM

## OFF

### 1NC - OFF

Nationalization CP

#### CP Text: The appropriation of outer space by private entities ought to be nationalized.

**Nationalizing space industries socializes risk and reward- public funding is the basis of most innovation, private space guts progress through brain drain**

**Aronoff 18**

(KATE ARONOFF is a staff writer at The New Republic and author of Overheated: How Capitalism Broke the Planet — And How We Fight Back. <https://inthesetimes.com/article/elon-musk-spacex-tesla-falcon-heavy-launch> , 2-8)

Scientific American gawked, ​“Elon Musk Does It Again,” praising the ​“bold technological innovations and newfound operational efficiencies that allow SpaceX to not only build its rockets for less money, but also reuse them.” That view — shared by several other outlets — fits comfortably with **the Tony Stark-like image** Musk has crafted for himself over the years: a quirky and slightly off-kilter playboy genius inventor capable of conquering everything from outer space to the climate crisis with the sheer force of his imagination. One of Musk’s long-term goals is to create a self-sustaining colony on Mars, and make humanity an interplanetary species. He hopes to shoot two very wealthy people around the moon at some point this year. Musk has invested an awful lot of public money into making those dreams a reality. But why should Americans keep footing the bill for projects where only Musk and his wealthy friends can reap the rewards? Enter: **the case for nationalizing** Elon Musk, and making the U.S. government a major stakeholder in his companies. The common logic now holds that the private sector — and prodigies like Musk, in particular — are better at coming up with world-changing ideas than the public sector, which is allegedly bloated and allergic to new, outside-the-box thinking. Corporations’ hunt for profits and lack of bureaucratic constraints, it’s said, compel cutting-edge research and development in a way that the government is simply incapable of. With any hope, more of these billionaires’ breakthroughs than not will be in the public interest. The reality, as economist Mariana Mazzucato argues in her 2013 book The Entrepreneurial State: Debunking Public vs. Private Sector Myths**, is very different**. Many of the companies that are today considered to be headed by brilliant savants — people like Steve Jobs and, yes, Elon Musk — owe much of their success to **decades of public sector innovation**, through repackaging technologies developed over the course of several decades into new products. Take the iPhone, essentially a collection of Defense Department research and National Science Foundation-grant projects packed into one shiny machine. “The prospect of the State owning a stake in a private corporation may be anathema to many parts of the capitalist world,” Mazzucato writes, ​“but given that governments are already investing in the private sector, they may as well earn a return on those investments.” As she notes, Musk’s future-oriented empire — Tesla Motors, SolarCity and SpaceX — has benefitted from around $5 billion in local, state and federal government support, not to mention many years of foundational public research into programs like rocket technology. SpaceX itself exists largely for the sake of competing for government contracts, like its $5.5 billion partnership with NASA and the U.S. Air Force. The U.S. Department of Energy invested directly in that company, as well as in Tesla’s work on battery technology and solar panels. The latter is perhaps the biggest success story of the Department of Energy stimulus grant that also supported Solyndra, a solar energy company reliably held up by the Right as an example of the government’s failure to make wise investment decisions. ​“Taxpayers footed the bill for Solyndra’s losses — yet got hardly any of Tesla’s profits,” Mazzucato notes. As Mazzucato finds, the private sector hasn’t done much to earn its reputation as a risk-taker. **Corporations and venture capitalists often adopt conservative thinking and fall into ​“path dependency,” and are generally reluctant to invest in important early-stage research that won’t necessarily turn a profit in the short-run**. This kind of research is inherently risky, and the vast majority of this kind of protean R&D (research and development) fails. For every internet — birthed in the Defense Department — there are a well over a dozen Solyndras, but it’s virtually impossible to have one without the other. The problem runs deeper still. Whereas in the past public sector research has been able to attract top-tier talent, the myth that the private sector can do what the State can’t has created **a negative feedback loop** whereby bright young scientists and engineers flock toward a private sector that goes on to further its reputation for being the place where the real innovation is happening. The alternative Mazzucato suggests **is to socialize risk and reward alike**, rather than simply allowing companies that enjoy the benefits of public innovation to funnel their profits into things like stock buybacks and tax havens — or, for that matter, flamethrowers. When companies like SpaceX make it big, they’d be obligated to return some portion of their gains to the public infrastructure that helped them succeed, **expanding the government’s capacity to facilitate more innovative development.** All this is not to say that there isn’t a critical role to play for people like Jobs and Musk in bringing new technology to the market. In all likelihood, Tesla’s Powerwall and SolarCity panels will play a key role in our transition off of fossil fuels. But lionizing Musk as the sole creator of the Powerwall and this week’s space launch stands to perpetuate a **dangerous series of myths about who’s responsible** for such cutting-edge development. Through smart supply-and-demand-side policy, states can play a **crucial role in shaping and creating markets** for the technologies we’ll need to navigate the 21st century. This can happen not just through R&D but also through developments like fuel efficiency standards, which encourage carmakers to prioritize vehicles that run off of renewable energy. Given the mounting reality of climate change and the necessity to rapidly switch over to a clean energy economy, there’s also a bigger question about how actively the state should be encouraging certain kinds of research and manufacturing. During World War II, the United States essentially had a planned economy: By 1945, around a quarter of manufacturing in the country was under state control. The reason for that was simple — the U.S. government saw an existential threat, and directed some of its biggest corporations to pitch in to stop it or else risk getting taken over by the state. There’s some Cold War nostalgia to hoisting shiny objects into orbit — a telegenic show of America’s technological supremacy. But it may not be much solace to coastal residents forced to flee in the coming decades, whose homes are rendered unlivable by a mixture of extreme weather and crumbling, antiquated infrastructure. And if you’ve watched any number of big-budget sci-fi productions over the last several years, it’s not hard to imagine Musk’s Martian colony spinning off into some Elysium-style eco-apartheid, where the rich — for the right price — can escape to new worlds while the rest of us make do on a planet of dystopian slums, swamps and deserts. Today, the risk posed by climate change is greater still than that posed by fascism on the eve of World War II, threatening to bring about a planet that’s uninhabitable for humans, and plenty hostile to them in the meantime. In such a context, do we need to launch cars into space? Maybe not. If the public sector is going to continue footing the bill for Elon Musk’s fantasies, though, he should at least have to give back some credit, and a cut of the profits.

#### CP competes --- unjust only refers to a negative action

Black Laws No Date "What is Unjust?" <https://thelawdictionary.org/unjust/> //Elmer

Contrary to right and justice, or to the enjoyment of his rights by another, or to the standards of conduct furnished by the laws.

## CASE

### 1NC - Cap Good - T/L

#### Tech innovation and profit motives are driving the Second Machine Age, which dematerializes capitalism and makes growth sustainable.

McAfee, 19—cofounder and codirector of the MIT Initiative on the Digital Economy at the MIT Sloan School of Management, former professor at Harvard Business School and fellow at Harvard’s Berkman Center for Internet and Society (Andrew, “Looking Ahead: The World Cleanses Itself This Way,” *More from Less: The Surprising Story of How We Learned to Prosper Using Fewer Resources—and What Happens Next*, Chapter 14, pg 278-292, Kindle, dml)

The decreases in resource use, pollution, and other exploitations of the earth cataloged in the preceding chapters are great news. But are they going to last? It could be that we're just living in a pleasant interlude between the Industrial Era and another rapacious period during which we massively increase our footprint on our planet and eventually cause a giant Malthusian crash.

It could be, but I don't think so. Instead, I think we're going to take better care of our planet from now on. I'm confident that the Second Machine Age will mark the time in our history when we started to progressively and permanently tread more lightly on the earth, taking less from it and generally caring for it better, even as we humans continue to become more numerous and prosperous. The work of Paul Romer, who shared the 2018 Nobel Prize in economics, is one of the sources of this confidence.

Growth Mindset

Romer's largest contribution to economics was to show that it's best not to think of new technologies as something that companies buy and bring in from the outside, but instead as something they create themselves (the title of his most famous paper, published in 1990, is "Endogenous Technological Change"). These technologies are like designs or recipes; as Romer put it, they’re "the instructions that we follow for combining raw materials." This is close to the definitions of technology presented in chapter 7.

Why do companies invent and improve technologies? Simply, to generate profits. They come up with instructions, recipes, and blueprints that will let them grow revenues or shrink costs. As we saw repeatedly in chapter 7, capitalism provides ample incentive for this kind of tech progress.

So far, all this seems like a pretty standard argument for how the first two horsemen work together. Romer's brilliance was to highlight the importance of two key attributes of the technological ideas companies come up with as they pursue profits. The first is that they're nonrival, meaning that they can be used by more than one person or company at a time, and that they don't get used up. This is obviously not the case for most resources made out of atoms—I can't also use the pound of steel that you've just incorporated into the engine of a car—but it is the case for ideas and instructions. The Pythagorean theorem, a design for a steam engine, and a recipe for delicious chocolate chip cookies aren't ever going to get "used up" no matter how much they're used.

The second important aspect of corporate technologies is that they're partially excludable. This means that companies can kind of prevent others from using them. They do this by keeping the technologies secret (such as the exact recipe for Coca-Cola), filing for patents and other intellectual-property protection, and so on. However, none of these measures is perfect (hence the words partially and kind of). Trade secrets leak. Patents expire, and even before they expire, they must describe the invention they're claiming and so let others study it.

Partial excludability is a beautiful thing. It provides strong incentives for companies to create useful, profit-enhancing new technologies that they alone can benefit from for a time, yet it also ensures that the new techs will eventually "spill over"—that with time they’ll diffuse and get adopted by more and more companies, even if that's not what their originators want.

Romer equated tech progress to the production by companies of nonrivalrous, partially excludable ideas and showed that these ideas cause an economy to grow. What's more, he also demonstrated that this idea-fueled growth doesn't have to slow down with time. It's not constrained by the size of the labor force, the amount of natural resources, or other such factors. Instead, economic growth is limited only by the idea-generating capacity of the people within a market. Romer called this capacity "human capital" and said at the end of his 1990 paper, "The most interesting positive implication of the model is that an economy with a larger total stock of human capital will experience faster growth."

This notion, which has come to be called "increasing returns to scale," is as powerful as it is counterintuitive. Most formal models of economic growth, as well as the informal mental ones most of us walk around with, feature decreasing returns—growth slows down as the overall economy gets bigger. This makes intuitive sense; it just feels like it would be easier to experience 5 percent growth in a $1 billion economy than a $1 trillion one. But Romer showed that as long as that economy continued to add to its human capital—the overall ability of its people to come up with new technologies and put them to use—it could actually grow faster even as it grew bigger. This is because the stock of useful, nonrivalrous, nonexcludable ideas would keep growing. As Romer convincingly showed, economies run and grow on ideas.

The Machinery of Prosperity

Romer's ideas should leave us optimistic about the planetary benefits of digital tools—hardware, software, and networks—for three main reasons. First, countless examples show us how good these tools are at fulfilling the central role of technology, which is to provide "instructions that we follow for combining raw materials." Since raw materials cost money, profit-maximizing companies are particularly keen to find ways to use fewer of them. So they use digital tools to come up with beer cans that use less aluminum, car engines that use less steel and less gas, mapping software that removes the need for paper atlases, and so on and so on. None of this is done solely for the good of the earth—it's done for the pursuit of profit that's at the heart of capitalism—yet it benefits the planet by, as we've seen, causing us to take less from it.

Digital tools are technologies for creating technologies, the most prolific and versatile ones we've ever come up with. They're machines for coming up with ideas. Lots of them. The same piece of computer-aided design software can be used to create a thinner aluminum can or a lighter and more fuel-efficient engine. A drone can be used to scan farmland to see if more irrigation is needed, or to substitute for a helicopter when filming a movie. A smartphone can be used to read the news, listen to music, and pay for things, all without consuming a single extra molecule.

In the Second Machine Age, the global stock of digital tools is increasing much more quickly than ever before. It's being used in countless ways by profit-hungry companies to combine raw materials in ways that use fewer of them. In advanced economies such as America's, the cumulative impact of this combination of capitalism and tech progress is clear: absolute dematerialization of the economy and society, and thus a smaller footprint on our planet.

The second way Romer's ideas about technology and growth are showing up at present is via decreased excludability. Pervasive digital tools are making it much easier for good designs and recipes to spread around the world. While this is often not what a company wants—it wants to exclude others from its great cost-saving idea— excludability is not as easy as it used to be.

This isn't because of weaker patent protection, but instead because of stronger digital tools. Once one company shows what's possible, others use hardware, software, and networks to catch up to the leader. Even if they can't copy exactly because of intellectual-property restrictions, they can use digital tools to explore other means to the same end. So, many farmers learn to get higher yields while using less water and fertilizer, even though they combine these raw materials in different ways. Steve Jobs would certainly have preferred for Apple to be the only provider of smartphones after it developed the iPhone, but he couldn't maintain the monopoly no matter how many patents and lawsuits he filed. Other companies found ways to combine processors, memory, sensors, a touch screen, and software into phones that satisfied billions of customers around the world.

The operating system that powers most non-Apple smartphones is Android, which is both free to use and freely modifiable. Google's parent company, Alphabet, developed and released Android without even trying to make it excludable; the explicit goal was to make it as widely imitable as possible. This is an example of the broad trend across digital industries of giving away valuable technologies for free.

The Linux operating system, of which Android is a descendant, is probably the best-known example of free and open-source software, but there are many others. The online software repository GitHub maintains that it's "the largest open source community in the world" and hosts millions of projects. The Arduino community does something similar for electronic hardware, and the Instructables website contains detailed instructions for making equipment ranging from air-particle counters to machine tools, all with no intellectual-property protection. Contributors to efforts such as these have a range of motivations (Alphabet's goals with Android were far from purely altruistic—among other things, the parent of Google wanted to achieve a quantum leap in mobile phone users around the world, who would avail themselves of Google Search and services such as YouTube), but they're all part of the trend of technology without excludability, which is great news for growth.

As we saw in chapter 10, smartphone use and access to the Internet are increasing quickly across the planet. This means that people no longer need to be near a decent library or school to gain knowledge and improve their abilities. Globally, people are taking advantage of the skill-building opportunities of new technologies. This is the third reason that the spread of digital tools should make us optimistic about future growth: these tools are helping human capital grow quickly.

The free Duolingo app, for example, is now the world's most popular way to learn a second language. Of the nearly 15 billion Wikipedia page views during July of 2018, half were in languages other than English. Google's chief economist, Hal Varian, points out that hundreds of millions of how-to videos are viewed every day on YouTube, saying, "We never had a technology before that could educate such a broad group of people anytime on an as-needed basis for free."

Romer's work leaves me hopeful because it shows that it's our ability to build human capital, rather than chop down forests, dig mines, or burn fossil fuels that drives growth and prosperity. His model of how economies grow also reinforces how well capitalism and tech progress work together, which is a central point of this book. The surest way to boost profits is to cut costs, and modern technologies, especially digital ones, offer unlimited ways to combine and recombine materials—to swap, slim, optimize, and evaporate—in cost-reducing ways. There's no reason to expect that the two horsemen of capitalism and tech progress will stop riding together anytime soon. Quite the contrary. Romer's insights reveal that they're likely to gallop faster and farther as economies grow.

Our Brighter, Lighter Future

The world still has billions of desperately poor people, but they won't remain that way. All available evidence strongly suggests that most will become much wealthier in the years and decades ahead. As they earn more and consume more, what will be the impact on the planet?

The history and economics of the Industrial Era lead to pessimism on this important question. Resource use increased in lockstep with economic growth throughout the two centuries between James Watt's demonstration of his steam engine and the first Earth Day. Malthus and Jevons seemed to be right, and it was just a question of when, not if, we'd run up against the hard planetary limits to growth.

But in America and other rich countries something strange, unexpected, and wonderful happened: we started getting more from less. We decoupled population and economic growth from resource consumption, pollution, and other environmental harms. Malthus's and Jevons's ideas gave way to Romer's, and the world will never be the same.

This means that instead of worrying about the world's poor becoming richer, we should instead be helping them upgrade economically as much and as quickly as possible. Not only is it the morally correct thing to do, it's also the smart move for our planet. As today’s poor countries get richer, their institutions will improve and most will eventually go through what Ricardo Hausmann calls "the capitalist makeover of production." This makeover doesn't enslave people, nor does it befoul the earth.

As today’s poor get richer, they'll consume more, but they'll also consume much differently from earlier generations. They won't read physical newspapers and magazines. They'll get a great deal of their power from renewables and (one hopes) nuclear because these energy sources will be the cheapest. They’ll live in cities, as we saw in chapter 12; in fact, they already are. They'll be less likely to own cars because a variety of transportation options will be only a few taps away. Most important, they'll come up with ideas that keep the growth going, and that benefit both humanity and the planet we live on.

Predicting exactly how technological progress will unfold is much like predicting the weather: feasible in the short term, but impossible over a longer time. Great uncertainty and complexity prevent precise forecasts about, for example, the computing devices we’ll be using thirty years from now or the dominant types of artificial intelligence in 2050 and beyond.

But even though we can't predict the weather long term, we can accurately forecast the climate. We know how much warmer and sunnier it will be on average in August than in January, for example, and we know that global average temperatures will rise as we keep adding greenhouse gases to the atmosphere. Similarly, we can predict the "climate" of future technological progress by starting from the knowledge that it will be heavily applied in the areas where it can affect capitalism the most. As we've seen over and over, tech progress supplies opportunities to trim costs (and improve performance) via dematerialization, and capitalism provides the motive to do so.

As a result, the Second Enlightenment will continue as we move deeper into the twenty-first century. I'm confident that it will accelerate as digital technologies continue to improve and multiply and global competition continues to increase. We’ll see some of the most striking examples of slim, swap, evaporate, and optimize in exactly the places where the opportunities are biggest. Here are a few broad predictions, spanning humanity's biggest industries.

Manufacturing. Complex parts will be made not by the techniques developed during the Industrial Era, but instead by three- dimensional printing. This is already the case for some rocket engines and other extremely expensive items. As 3-D printing improves and becomes cheaper, it will spread to automobile engine blocks, manifolds and other complicated arrangements of pipes, airplane struts and wings, and countless other parts. Because 3-D printing generates virtually no waste and doesn't require massive molds, it accelerates dematerialization.

We'll also be building things out of very different materials from what we're using today. We're rapidly improving our ability to use machine learning and massive amounts of computing power to screen the huge number of molecules available in the world. Well use this ability to determine which substances would be best for making flexible solar panels, more efficient batteries, and other important equipment. Our search for the right materials to use has so far been slow and laborious. That's about to change.

So is our ability to understand nature's proteins, and to generate new ones. All living things are made out of the large biomolecules known as proteins, as are wondrous materials such as spiders' silk. The cells in our bodies are assembly lines for proteins, but we currently understand little about how these assembly lines work—how they fold a two-dimensional string of amino acids into a complicated 3-D protein. But thanks to digital tools, we're learning quickly. In 2018, as part of a contest, the AlphaFold software developed by Google DeepMind correctly guessed the structure of twenty-five out of forty-three proteins it was shown; the second-place finisher guessed correctly three times. DeepMind cofounder Demis Hassabis says, "We [haven't] solved the protein-folding problem, this is just a first step... but we have a good system and we have a ton of ideas we haven't implemented yet." As these good ideas accumulate, they might well let us make spider-strength materials.

Energy. One of humanity's most urgent tasks in the twenty-first century is to reduce greenhouse gas emissions. Two ways to do this are to become more efficient in using energy and, when generating it, to shift away from carbon-emitting fossil fuels. Digital tools will help greatly with both.

Several groups have recently shown that they can combine machine learning and other techniques to increase the energy efficiency of data centers by as much as 30 percent. This large improvement matters for two reasons. First, data centers are heavy users of energy, accounting for about 1 percent of global electricity demand. So efficiencies in these facilities help. Second, and more important, these gains indicate how much the energy use of all our other complicated infrastructures— everything from electricity grids to chemical plants to steel mills—can be trimmed. All are a great deal less energy efficient than they could be. We have both ample opportunity and ample incentive now to improve them.

Both wind and solar power are becoming much cheaper, so much so that in many parts of the world they're now the most cost-effective options, even without government subsidies, for new electrical generators. These energy sources use virtually no resources once they're up and running and generate no greenhouse gases; they're among the world champions of dematerialization.

In the decades to come they might well be joined by nuclear fusion, the astonishingly powerful process that takes place inside the sun and other stars. Harnessing fusion has been tantalizingly out of reach for more than half a century—the old joke is that it's twenty years away and always will be. A big part of the problem is that it's hard to control the fusion reaction inside any human- made vessel, but massive improvements in sensors and computing power are boosting hope that fusion power might truly be only a generation away.

Transportation. Our current transportation systems are chronically inefficient. Most vehicles aren't used much of the time, and even when they’re in use, they're not nearly full. Now that we have technologies that let us know where every driver, passenger, piece of cargo, and vehicle is at all times, we can greatly increase the utilization and efficiency of every element of transportation.

Renting instead of owning transportation is a likely consequence of this shift. Instead of owning cars, which typically sit idle more than 90 percent of the time, more people will choose to access transportation as needed. We're already seeing this with car-hailing companies such as Uber and Lyft. These services are quickly spreading around the world, and expanding to cover more modes of transportation, from motorbikes to bicycles to electric scooters. They're also moving into commercial applications such as long- and short-haul trucking. As this shift continues, we’ll need fewer tons of steel, aluminum, plastic, gasoline, and other resources to move the world's people and goods around.

We might also experience less congestion and gridlock as we try to get around. Bikes and scooters take up little space compared to cars, so streets can accommodate many more of them. Technology also gives us the ability to implement many forms of "congestion pricing," which has been shown to reduce gridlock by making car access to busy streets expensive enough that people use other options. The most intriguing future transportation platform of all might be the sky. The same technologies that power today's small drones can be scaled up to build "air taxis" with as many as eight propellers and no pilot. Such contraptions sound like science fiction today, but they might be carrying us around by midcentury.

Agriculture. As we saw in chapter 5, leading farms have demonstrated an ability to increase their tonnage of output year after year while decreasing their use of inputs such as land, water, and fertilizer. This trend toward optimization will continue thanks to a set of innovations under the label precision agriculture. The precision comes from many sources, including better sensors of plant and animal health, soil quality and moisture, and so on; the ability to deliver fertilizer, pesticides, and water just where they're needed; and machinery that adapts itself to each plant or animal. All these varieties of precision will combine to allow traditional farms to generate more from less.

So will changes to the genomes of plants and animals. DNA modifications will increase disease and drought tolerance, expand where crops can be grown, and allow us to get more of what we want from each crop or herd. As we saw in chapter 9, they'll also allow us to take better care of vulnerable populations such as infants in poor countries by creating golden rice and other nutrition enhancers. We'll also be able to make much more precise and targeted genetic modifications thanks to a new crop of gene-editing tools that are large improvements over their more scattershot predecessors. Opposition to genetically modified organisms is fierce in some quarters, but isn't based on reason or science. This opposition will, one hopes, fade.

Throughout human history, just about all farming has been done in fields. For some crops, this is now changing. Agriculture has moved indoors, where parameters such as light, humidity, fertilizer, and even the composition of the atmosphere can be precisely monitored and controlled. In everything from urban buildings to shipping containers, crops are now being grown with progressively less labor and fewer material inputs. These completely contained farms will spread and help reduce the planetary footprint of our agriculture.

These examples aren't intended to be comprehensive, and I don't have precise estimates of how likely each innovation is, or when it's most likely to occur. I offer them only to indicate how broad and exciting are the possibilities offered by the two horsemen of capitalism and technological progress, and how they’ll continue to dematerialize our consumption and let us increase our prosperity while treading more lightly on our planet.

#### Private development and expansion makes the system sustainable

Collins 10

Patrick Collins, professor of economics at Azabu University in Japan, and a Collaborating Researcher with the Institute for Space & Astronautical Science, as well as adviser to a number of companies, Adriano V. Autino is President of the Space Renaissance International; Manager, CEO/CTO, Systems Engineering Consultant / Trainer at Andromeda Systems Engineering LLC; and Supplier of methodological tools and consultancy at Intermarine S.p.A, Acta Astronautica, Volume 66, Issues 11–12, June–July 2010, “What the growth of a space tourism industry could contribute to employment, economic growth, environmental protection, education, culture and world peace”, Pages 1553–1562

4. Environmental protection

Economic development in space based on low launch costs could contribute greatly, even definitively, to solving world environmental problems. As a first step, substantially reducing the cost of space travel will reduce the cost of environment-monitoring satellites, thereby improving climate research and environmental policy-making.

4.1. Space-based solar power supply

A second possibility, which has been researched for several decades but has not yet received funding to enable testing in orbit, is the delivery of continuous solar-generated power from space to Earth. Researchers believe that such space-based solar power (SSP) could supply clean, low-cost energy on a large scale, which is a prerequisite for economic development of poorer countries, while avoiding damaging pollution. However, realisation of SSP requires much lower launch costs, which apparently only the development of a passenger space travel industry could achieve. Hence the development of orbital tourism could provide the key to realising SSP economically [14].

4.2. Carbon-neutral space travel

Clean energy produced by SSP could eliminate the environmental impact of space travel, and even make it “carbon neutral” if this is considered desirable [25]. Moreover, SSP has a much shorter energy pay-back time than terrestrial solar energy, due to the almost continuous supply of power which it can generate, rather than only in day-time during clear weather. Some critics claim that space travel will become a significant environmental burden [26]. However, while superficially correct in the short term, this is the opposite of the truth over the longer term. It would be a dangerous error to prevent the growth of space tourism in order to avoid its initial, minor environmental impact, since this would prevent a range of major benefits in the future, including the supply of low-cost, carbon-neutral SSP, and other space-based industry.

4.3. Space-based industry

If orbital travel grows to a scale of millions of passengers/year—as it could by the 2030s, with vigorous investment—it will stimulate the spontaneous growth of numerous businesses in space. These will grow progressively from simple activities such as maintenance of orbiting hotels, to in-space manufacturing using asteroidal minerals. For example, the development of SSP would enable a range of industrial processes using the advantages of space, including high vacuum, weightlessness, low-cost electricity and sources of both minerals and volatile chemicals in shallow gravitational wells.

If SSP grows to supply a significant share of the terrestrial energy market, more and more industry would operate outside the Earth's ecological system. While most industries cause growing damage to the Earth's environment as they grow in scale, industrial activities which are outside the Earth's ecosystem need not cause any such damage. Hence the growth of space-based industry to large scale offers the longer-term possibility of decoupling economic growth from the limits of the terrestrial environment. Indeed, it has been convincingly argued that only the use of space resources, including especially SSP, offers the possibility of protecting the Earth's environment while enabling sufficient economic growth to preserve civilised society [22] and [27].

4.4. Severe weather amelioration and climate stabilisation

The use of solar power satellites for reducing the severity of hurricanes and typhoons, and/or ameliorating severe snow conditions has been discussed for some years. In the extreme case this application of SSP might even include a role in the stabilisation of climate. Earth's climate system is extremely complex, and is the subject of a great deal of ongoing scientific research, including collection of an ever-wider range of data, and ever-more detailed analysis of climate change in the past.

A positive-feedback cycle causing sudden onset of the cooling phase of the long-term cycle of “ice ages” has been hypothesized, whereby a winter with unusually low temperatures and/or unusually widespread and/or long-lasting snow cover would increase the probability of the following winter being even more severe [28] and [29]. The beginning of such a trend would be similar to the sharply more severe winters seen over the two last years in North America (as well as the unusually cool 2009 summer).

Consequently, although such a possibility may seem remote, and although there are thorny legal problems concerning deliberate weather modification, it is nevertheless noteworthy that satellite power stations may be the only practical means of selectively melting snow over areas of thousands of square kilometres, possibly sufficient to prevent such a vicious circle, even in the event of terrestrial energy shortages.

4.5. Ethical consumption

Passenger space travel and its numerous spinoff activities have the important potential to escape the limitations of the “consumerism” which governments in the rich countries have encouraged in recent decades in order to stimulate economic growth, defined as GDP. Researchers now understand that this is resulting in “excess consumption” which causes unnecessary environmental damage [30], while reducing rather than increasing popular satisfaction [31]. That is, “first world” citizens are increasingly trapped in a culturally impoverished “consumer” lifestyle which reduces social capital, social cohesion and happiness, while damaging the environment. By contrast, expenditure on the unique experience of space travel promises to play a more positive role in the economy and society, enriching customers culturally without requiring mass production of consumer goods and corresponding pollution. As such it could be a harbinger of a future “open world” economy [27].

### 1NC - Cap Good - Enviro

#### Growth is sustainable – innovation is key to solve the climate and they can’t solve

Karlsson 21 – (Rasmus, "Learning in the Anthropocene" Soc. Sci. 10, no. 6: 233. <https://doi.org/10.3390/socsci10060233> 18 June 2021)// gcd

Unpacking this argument, it is perhaps useful to first recognize that, stable as the Holocene may have seemed from a human perspective, life was always vulnerable to a number of cosmic risks, such as bolide collisions, risks that only advanced technologies can mitigate. Similarly, the Black Death of the 14th century should serve as a powerful reminder of the extreme vulnerability of pre-industrial societies at a microbiological level. Nevertheless, it is reasonable to think of the Holocene as providing a relatively stable baseline against which the ecological effects of technological interventions could hypothetically be evaluated. With most human activities being distinctively local, nature would for the most part “bounce back” (even if the deforestation of the Mediterranean basin during the Roman period is an example of that not always being the case) while larger geophysical processes, such as the carbon cycle, remained entirely beyond human intentional control. Even if there has been some debate about what influence human activities had on the preindustrial climate (Ruddiman 2007), anthropogenic forcing was in any case both marginal and gradual. All this changed with the onset of the Great Acceleration by which humans came to overwhelm the great forces of nature, causing untold damage to fragile ecosystems and habitats everywhere, forever altering the trajectory of life on the planet (Steffen et al. 2011b). In a grander perspective, humanity may one day become an interplanetary species and thus instrumental in safeguarding the long-term existence of biological life, but for the moment, its impact is ethically dubious at best as the glaciers melt, the oceans fill up with plastics, and vast number of species are driven to extinction. Faced with these grim realities, it is of course not surprising that the first impulse is to seek to restore some kind primordial harmony and restrain human activities. Yet, it is important to acknowledge that, even if their aggregate impact may have been within the pattern of Holocene variability, pre-modern Western agricultural societies were hardly “sustainable” in any meaningful sense. Experiencing permanent scarcity, violent conflict was endemic (Gat 2013), and as much as some contemporary academics like to attribute all evils to “capitalism” (Malm 2016), pre-capitalist societies exhibited no shortage of religious intolerance and other forms of social domination. It is thus not surprising that some have argued the need to reverse the civilizational arc further yet and return to a preliterate hunter-gather existence (Zerzan 2008) even if this, obviously, has very little to do with existing political realities and social formations. Under Holocene conditions, the short-term human tragedy may have been the same, but it did not undermine the long-term ability of the planet to support life. In a world of eight billion people, already accumulated emissions in the atmosphere have committed the planet to significant warming under the coming centuries, with an increasing probability that committed warming already exceeds the 1.5-degree target of the Paris Agreement even if all fossil-fuel emissions were to stop today (Mauritsen and Pincus 2017). This means that sustained negative emissions, presumably in combination with SRM, will most likely be needed just to stabilize global temperatures, not to mentioning countering the flow of future emissions. According to the Intergovernmental Panel on Climate Change (IPCC), assuming that all the pledges submitted under the Paris Agreement are fulfilled, limiting warming to 1.5 degrees will still require negative emissions in the range of 100—1000 gigatons of CO2 (Hilaire et al. 2019, p. 190). The removal of carbon dioxide at gigaton scales from the atmosphere will presumably require the existence of an advanced industrial society since low-tech options, such as afforestation, will be of limited use (Gundersen et al. 2021; Seddon et al. 2020), especially in a future of competing land-uses. It is against this backdrop of worsening climate harms that the limits of “precaution”, at least as conventionally understood, become apparent. While degrowth advocates tend to insist that behavioral change, even explicitly betting on a “social miracle” (Kallis 2019, p. 195), is always preferable to any technological risk-taking (Heikkurinen 2018), that overlooks both the scope of the sustainability challenge and the lack of public consent to any sufficiently radical political project (Buch-Hansen 2018). While there may be growing willingness to pay for, say, an electric vehicle (Hulshof and Mulder 2020), giving up private automobile use altogether is obviously a different animal, to say nothing about a more fundamental rematerialization of the economy (Hausknost 2020). Again, the problem is one in which change either (a) remains marginal yet ecologically insufficient or (b) becomes sufficiently radical yet provokes a strong political counterreaction. A similar dynamic can be expected to play out at the international level where countries that remain committed to growth would quickly gain a military advantage. To make matters worse, there is also a temporal element to this dynamic since any regime of frugality and localism would have to be policed indefinitely in order to prevent new unsustainable patterns of development from re-emerging later on. All this begs the obvious question, if the political and economic enforcement of the planetary boundaries are fraught with such political and social difficulties, would it not be better to instead try to transcend them through technological innovation? Surprisingly, any high-energy future would most likely be subject to many of the same motivational and psychological constraints that hinder a low-energy future. While history shows that existing nuclear technologies could in theory displace all fossil fuels and meet the most stringent climate targets (Qvist and Brook 2015), it seems extremely unlikely, to put it mildly, that thousands of new reactors will be built over the course of the coming decades in response to climate change. Outside the world of abstract computer modelling, real world psychological and cultural inertia tends to ensure that political decision-making, at least for the most part, gravitates to what is considered “reasonable” and “common sense”—such as medium emissions electricity grids in which wind and solar are backed by biomass and gas—rather than what any utilitarian optimization scenario may suggest. Even if the global benefits of climate stabilization would be immense, the standards by which local nuclear risks are assessed, as clearly illustrated by the Fukushima accident which led to a worldwide retreat from nuclear energy despite only causing one confirmed death (which, though obviously regrettable, has to be put in relation to the hundred and thousands of people dying every year from the use of fossil fuels), underscores the uneven distribution of perceived local risks versus global benefits and the associated problem of socio-political learning across spatial scales. Almost two decades ago, Ingolfur Blühdorn identified “simulative eco-politics” as a key strategy by which liberal democracies reconcile an ever-heightened rhetoric of environmental crisis with their simultaneous defense of the core principles of consumer capitalism (Blühdorn 2007). Since then, declarations that we only have “ten years to save the planet” have proliferated, and so have seemingly bold investments in renewable energy, most recently in the form of US President Joseph Biden’s USD 2.25 trillion climate and infrastructure plan. Still, without a meaningful commitment to either radical innovation or effective degrowth, it is difficult to see how the deployment of yet more wind turbines or the building of new highways will in any way be qualitatively different from what Blühdorn pertinently described as sustaining “what is known to be unsustainable” (Blühdorn 2007, p. 253). However, all is not lost in lieu of more authentic forms of eco-politics. Independent of political interventions, accelerating technological change, in particular with regard to computing and intelligent machine labor, may one day make large-scale precision manipulation of the physical world possible in ways that may solve many problems that today seem intractable (Dorr 2016). Similarly, breakthroughs in synthetic biology may hold the key to environmentally benign biofuels and carbon utilization technologies. Yet, all such progress remains hypothetical and uncertain for now. Given what is at stake, there is an obvious danger in submitting to naïve technological optimism. What is less commonly recognized is that naïve optimism with regard to the prospects of behavioral change may be equally dangerous. While late-capitalist affluence has enabled many postmaterial identities and behaviors, such as bicycling, hobby farming, and other forms of emancipatory self-expression, a collapsing economy could quickly lead to a reversal back to survivalist values, traditional hierarchical forms of domination, and violence (Quilley 2011, p. 77). As such, it is far from obvious what actions would actually take the world as a whole closer to long-term sustainability. If sustainability could be achieved by a relatively modest reduction in consumption rates or behavioral changes, such as a ban on all leisure flights, then there would be a strong moral case for embracing degrowth. Yet, recognizing how farreaching measures in terms of population control and consumption restrictions that would be needed, the case quickly becomes more ambiguous. While traditional environmentalism may suggest that retreating from the global economy and adopting a low-tech lifestyle would increase resilience (Alexander and Yacoumis 2018), it may do very much the opposite by further fragmenting global efforts and slowing the pace of technological innovation. Without an orderly and functioning world trade system, local resources scarcities would be exacerbated, as seen most recently with the different disruptions to vaccine supply chains. In essence, given the lack of a stable Holocene baseline to revert to, it becomes more difficult to distinguish proactionary “risk-taking” from “precaution”, especially as many ecosystems have already been damaged beyond natural recovery. In this context, it is noteworthy that many of the technologies that can be expected to be most crucial for managing a period of prolonged overshoot (such as next-generation nuclear, engineering biology, large-scale carbon capture and SRM) are also ones that traditional environmentalism is most strongly opposed to. 3. Finding Indicators From the vantage point of the far-future, at least the kind depicted in the fictional universe of Star Trek, human evolution is a fairly straightforward affair along an Enlightenment trajectory by which ever greater instrumental capacity is matched by similar leaps in psychological maturity and expanding circles of moral concern. With the risk of sounding Panglossian, one may argue that the waning of interstate war in general and the fact that there has not been any major nuclear exchange in particular, does vindicate such an optimistic reading of history. While there will always be ups and downs, as long as the most disastrous outcomes are avoided, there will still be room for learning and gradual political accommodation. Taking such a longer view, it would nevertheless be strange if development was simply linear, that former oppressors would just accept moral responsibility or that calls for gender or racial justice would not lead to self-reinforcing cycles of conservative backlash and increasingly polarizing claims. Still, over the last couple of centuries, there is little doubt that human civilization has advanced significantly, both technologically and ethically (Pinker 2011), at least from a liberal and secular perspective. However, unless one subscribes to teleology, there is nothing inexorable with this development and, it may be that the ecological, social, and political obstacles are simply too great to ever allow for the creation of a Wellsian borderless world (Pedersen 2015) that would allow everyone to live a life free from material want and political domination. On the other hand, much environmental discourse tends to rush ahead in the opposite direction and treat the c limate crisis as ultimate evidence of humanity’s fallen nature when the counter-factual case, that it would be possible for a technological civilization to emerge without at some point endangering its biophysical foundations, would presumably be much less plausible. From an astrobiological perspective, it is easy to imagine how the atmospheric chemistry of a different planet would be more volatile and thus more vulnerable to the effects of industrial processes (Haqq-Misra and Baum 2009), leaving a shorter time window for mitigation. Nick Bostrom has explored this possibility of greater climate sensitivity further in his “vulnerable world hypothesis” (Bostrom 2019) and it begs to reason that mitigation efforts would be more focused in such a world. However, since climate response times are longer and sensitivity less pronounced, climate mitigation policies have become mired in culture and media politics (Newman et al. 2018) but also a statist logic (Karlsson 2018) by which it has become more important for states to focus on their own marginal emission reductions in the present rather than asking what technologies would be needed to stabilize the climate in a future where all people can live a modern life.

#### Growth solves climate – try or die

Azevedo et al. 20, Associate Professor of Energy Resources Engineering @ Stanford (Inês, Michael R. Davidson, Jesse D. Jenkins, Valerie J. Karplus, and David G. Victor, May/June Issue, “The Paths to Net Zero: How Technology Can Save the Planet,” *Foreign Affairs*, https://www.foreignaffairs.com/articles/2020-04-13/paths-net-zero)

For 30 years, diplomats and policymakers have called for decisive action on climate change—and for 30 years, the climate crisis has grown worse. There are a multitude of reasons for this failure. The benefits of climate action lie mostly in the future, they are diffuse and hard to pin down, and they will accrue above all to poor populations that do not have much of a voice in politics, whether in those countries that emit most of the world’s warming pollution or at the global level. The costs of climate action, on the other hand, are evident here and now, and they fall on well-organized interest groups with real political power. In a multipolar world without a responsible hegemon, any collective effort is difficult to organize. And the profound uncertainty about what lies ahead makes it hard to move decisively. These political hurdles are formidable. The good news is that technological progress can make it much easier to clear them by driving down the costs of action. In the decades to come, innovation could make severe cuts in emissions, also known as “deep decarbonization,” achievable at reasonable costs. That will mean reshaping about ten sectors in the global economy—including electric power, transportation, and parts of agriculture—by reinforcing positive change where it is already happening and investing heavily wherever it isn’t. In a few sectors, especially electric power, a major transformation is already underway, and low-emission technologies are quickly becoming more widespread, at least in China, India, and most Western countries. The right policy interventions in wind, solar, and nuclear power, among other technologies, could soon make countries’ power grids far less dependent on conventional fossil fuels and radically reduce emissions in the process. Technological progress in clean electricity has already set off a virtuous circle, with each new innovation creating more political will to do even more. Replicating this symbiosis of technology and politics in other sectors is essential. In most other high-emission industries, however, deep decarbonization has been much slower to arrive. In sectors such as transportation, steel, cement, and plastics, companies will continue to resist profound change unless they are convinced that decarbonization represents not only costs and risks for investors but also an opportunity to increase value and revenue. Only a handful have grasped the need for action and begun to test zero-emission technologies at the appropriate scale. Unless governments and businesses come together now to change that—not simply with bold-sounding international agreements and marginal tweaks such as mild carbon taxes but also with a comprehensive industrial policy—there will be little hope of reaching net-zero emissions before it’s too late. THE FUTURE IS ELECTRIC From today’s vantage point, no single domain offers greater opportunities for deep decarbonization than electric power. The use of electricity does not increase or reduce emissions in itself; electricity delivers energy that may or may not be clean depending on how it was generated. An electric car, for instance, doesn’t do much good against global warming if all the electricity comes from conventional coal plants. Still, electrifying the economy—in other words, designing more processes to run on electricity rather than the direct combustion of fuels—is essential. This is because, compared with trying to reduce emissions in millions of places where they might occur, it is far easier and more efficient to reduce emissions at a modest number of power plants before distributing the clean electricity by wire. Today, Western economies convert about 30 percent of their energy into electric power. If they want to get serious about decarbonization, that fraction will need to double or more. Getting there will require progress on two fronts. The first is the electrification of tasks that use vast amounts of energy but still rely on fossil fuels, such as transportation and heating. Overall, transportation accounts for 27 percent of global energy use, and nearly all of it relies on oil. The car industry has had some success in changing this: the latest electric vehicles rival high-end conventional cars in performance and cost, and electric cars now make up around eight percent of new sales in California (although only 1.3 percent nationwide) and nearly 56 percent in Norway, where the government offers massive subsidies to buyers. With improved batteries, heavier-duty vehicles, including buses and trucks, could soon follow. In fact, China already fields a fleet of over 420,000 electric buses. By contrast, aviation—which makes up only two percent of global emissions but is growing rapidly and creates condensation trails in the sky that double its warming effect—presents a tougher challenge. A modern battery can store only two percent of the energy contained in a comparable weight of jet fuel, meaning that any electric airplane would need to carry an extremely heavy load in batteries to travel any reasonable distance. Even in the best-case scenario, commercial electric aviation at significant scale is likely decades away, at least for long-haul flights. Long-distance shipping also faces challenges so daunting that electrification is unlikely to be the best route. And in each of these areas, electrification is all the more difficult because it requires not only changing the conveyances but also building new charging infrastructures. Besides transportation, the most important electrification frontier is heating—not just in buildings but as part of industrial production, too. All told, heating consumes about half the raw energy that people and firms around the world use. Of that fraction, some 50 percent goes into industrial processes that require very high temperatures, such as the production of cement and steel and the refining of oil (including for plastics). These sectors will continue to rely on on-site fossil fuel combustion for the foreseeable future, since electricity cannot match the temperature and flexibility of direct fuel combustion. Yet in other areas, such as lower-temperature industrial processes and space heating for buildings, electrification is more practical. Heat pumps are a case in point: whereas conventional heaters work by heating up indoor air, heat pumps act like reversible air conditioners, moving heat (or, if necessary, cold) indoors or outdoors—a far more efficient approach. Electrification, of course, will not on its own reduce emissions by much unless the power grid that generates and distributes the electricity gets cleaner, too. Ironically, some countries have made modest progress on this front even as they have doubled down on fossil fuels. China, for instance, has swapped out aging coal plants with newer, more efficient ones, cutting emission rates in the process. (The country’s most efficient coal plants now emit less carbon dioxide per unit of electricity than comparable U.S. plants.) The United States, for its part, has cut down on its emissions thanks to innovations in horizontal drilling and fracking that have made it economically viable to extract shale gas. In 2005, when this technology first became commercially relevant, coal accounted for half of all the electricity produced in the United States; today, coal’s share is down to one-quarter, with much cleaner and inexpensive natural gas and renewables making up the difference. In theory, fossil fuels could still become much cleaner, even nearly emission free. This could be possible with the help of so-called carbon capture and storage (CCS) technologies, which capture the carbon dioxide emissions created by industrial processes and pump it safely underground. In practice, investors have remained wary of this approach, but in both the United States and some European countries, recently introduced subsidies are expected to unleash a wave of new CCS projects in the years ahead. One CCS scheme, currently being tested by a group of engineering and energy firms, completely rethinks the design of power plants, efficiently generating electricity from natural gas while capturing nearly all the carbon dioxide produced in the process at little extra cost. In regions where natural gas is cheap and abundant, this technology could be a game changer. For now, improved fossil fuel technology has amounted to shallow decarbonization: it has reduced emissions enough to slow the rate of climate change—in the United States, emissions from the power sector have dropped by 29 percent since 2005 thanks mainly to the shale gas revolution and growth of renewables—but not enough to stop it. To prevent the world from warming further will require much more focus on technologies that have essentially zero emissions, such as wind, solar, hydroelectric, and nuclear power, in addition to CCS, if it proves commercially scalable. According to the United Nations’ Intergovernmental Panel on Climate Change, these low-carbon technologies would need to generate 80 percent of the world’s electricity by 2050 (up from about one-third today) in order to limit warming to two degrees Celsius above preindustrial levels. Renewables, in particular, will play a central role. Thanks to decreases in the cost of wind and solar power equipment—and thanks to a mature hydroelectric power industry—renewable energy already accounts for over one-quarter of global electricity production. (Nuclear provides another ten percent.) In the United States, the cost of electricity from large solar farms has tumbled by 90 percent since 2009, and wind energy prices have fallen by nearly 70 percent—and both continue to drop. Given those plunging costs, the main challenge is no longer to make renewables cheap; it is to integrate them into the power grid without disruptions. To avoid blackouts, a power grid must align supply and demand at all times. Energy output from wind and solar plants, however, varies with the weather, the season, and the daily rise of the sun. The more a power grid relies on renewables, then, the more often the supply will not match the demand. In the extreme, extra power must be dumped—meaning that valuable capital and land were used inefficiently. To be less vulnerable to such shocks, utility companies will need to expand the size of their power grids, so that each can draw on a larger and more diverse array of energy sources. In order to deal with excess supply from renewables—a condition that will become much more frequent as the share of renewables rises—they must also create incentives for users to vary their demand for power more actively and find ways to store surplus electricity on a much larger scale. Today, nearly all bulk storage capacity takes the form of hydroelectric pumps, which store electricity by moving water uphill and recovering about 80 percent of the power when it flows back down. In the years ahead, soaring demand for electric vehicles will drive down the cost of lithium-ion batteries; those batteries could become an affordable way to store energy at the grid level, too. And as the need for storage increases, even cheaper methods may come on the market. To better integrate renewables, policymakers can also rely on the strategic use of another zero-emission technology: nuclear energy. Although most efficient when running flat out 24 hours a day, nuclear power plants can also operate flexibly to cover the supply gaps from wind and solar power. Some of France’s nuclear reactors, for instance, already cycle from about one-quarter to full power and back again, sometimes twice a day, to compensate for fluctuations in the supply and demand of renewables. Independent of renewables, nuclear power already contributes massively to cleaner grids. Every year, some 440 operational nuclear reactors account for lower global carbon dioxide emissions of an estimated 1.2 billion metric tons. In the United States, research suggests that keeping most existing nuclear plants open would be far less expensive than many other policy options. In fact, most countries would do well to expand their nuclear power even further to cut back on their emissions. In the West, however, major expansions are not on the horizon: public opposition is strong, and the cost of building new reactors is high, in part because countries have built too few reactors to benefit from the savings that come with repetition and standardization. Yet in other parts of the world—especially China and South Korea, which have more active nuclear power programs—the costs are much lower and public opposition is less pronounced. Moreover, whereas countries once designed and built their own reactors, today many simply import them. That model can create new risks—the sector’s leading exporter today is Russia, a country not renowned for its diligence regarding reactor safety or the security of nuclear materials—but it also has the potential to make commercial nuclear technology available to many countries that could not develop and deploy it safely on their own. Abu Dhabi’s purchase of four gigantic South Korean–built reactors, the first of which is set to start operating next year, shows the promise of this model. The same approach could work for other countries that currently satisfy their large energy needs with fossil fuels, such as Saudi Arabia. When it comes to the precise technological makeup of a future decarbonized economy, expert opinions diverge. Engineers and economists, for the most part, imagine solutions that bundle several approaches, with both CCS and nuclear power acting as important complements to renewables. Political scientists, on the other hand, tend to see a bigger role for renewables—one of the few areas in energy policy that usually garners support from across the ideological spectrum, including in the United States. Yet even this rather popular solution can prove divisive. Fierce debates rage over where to locate generators such as wind turbines, including among putative environmentalists who support the technology only if they don’t have to look at it. Public opposition to new wind turbines in Norway—even in already industrialized areas—and to offshore wind parks in the eastern United States are harbingers of tough siting fights to come. The same issue arises when it comes to power lines: making the most of renewables requires longer, more numerous power lines that can move renewable power wherever it will be needed, but public opposition can make such grid expansions a bureaucratic nightmare. In California, for example, the most recent big power line designed to move renewable power where it will be useful—in that case, from the sunny desert to San Diego—took a decade to build, even though the technical engineering and construction portion of the project should have consumed no more than two years. China, by contrast, has blown past the efforts of the United States and Europe, with dozens of ultrahigh-voltage lines, most of them built in the last decade, crisscrossing the country. THE GREAT UNKNOWNS Political obstacles notwithstanding, expanding the electrification of transportation and heat and the production of low-carbon electricity offers the surest path to a clean economy to date. The latest analysis by the Intergovernmental Panel on Climate Change, for instance, suggests that more pervasive use of clean electricity in the global economy would cover more than half the cuts needed for deep decarbonization. Yet just how big a role electrification will ultimately play is hard to predict—in part because its impact will depend on the future trajectory of rival solutions that are only just beginning to emerge and whose potential is impossible to assess precisely. Hydrogen, in particular, could serve much the same function as electricity does now in carrying energy from producers to users—and it offers crucial advantages. It is easier to store, making it ideal for power systems dependent on ever-fluctuatingsupplies of renewable energy. And it can be burned—without producing any new emissions—to generate the high levels of heat needed in heavy industry, meaning that it could replace on-site fossil fuel combustion in sectors that are hard to electrify. Hydrogen (either in its pure form or mixed with other chemicals) could also serve as liquid fuel to power cars, trucks, ships, and airplanes. A zero-emission economy could integrate the two carriers—electricity and hydrogen—using each depending on its suitability for different sectors. The technology needed to turn hydrogen into an energy carrier already exists in principle. One option is to break up (or electrolyze) water into its constituent elements, hydrogen and oxygen. The hydrogen could then be stored or transported through the natural gas pipeline networks that already string across all advanced economies. Once it reached its user, it would be burned for heat or used as an input for a variety of chemical processes. So far, this approach is too expensive to be viable on a large scale, but growing investment, especially in Europe, is poised to drive down the cost rapidly. Initial tests, including planned networks of hydrogen pipelines outside Stockholm (for making steel), Port Arthur in Texas (for industrial chemistry), the British city of Leeds (for residential heat), and the Teesside area (for several applications, including power generation) and numerous other ventures, will soon yield more insights into how a real-world hydrogen economy would fare. CCS is somewhat of a wildcard, too. Some industrial processes produce prodigious and highly concentrated streams of carbon dioxide emissions that should be relatively easy to isolate and capture. The production of cement, which accounts for a whopping four percent of global carbon dioxide emissions, is a good example. But firms operating in global commodity markets, where missteps can be economically disastrous, are hesitant to invest in fledgling systems such as CCS. To change that, state-supported real-world testing is overdue. A nascent Norwegian project to collect carbon dioxide from various industrial sources in several northern European countries and inject it underground may provide some answers. Another promising area for reducing emissions is agriculture, a field in which advances on the horizon could yield large cuts. More precise control over the diets of animals raised for food—which will probably require more industrial farming and less free grazing—could lead cows, sheep, and other livestock to emit less methane, a warming gas that, pound for pound, is 34 to 86 times as bad as carbon dioxide. (It would also help if people ate less meat.) Meanwhile, a host of changes in crop cultivation—such as altering when rice fields are flooded to strategically determining which engineered crops should be used—could also lower emissions. Agriculture’s biggest potential contribution, however, lies belowground. Plants that engage in photosynthesis use carbon dioxide from the air to grow. The mass cultivation of crops that are specially bred to grow larger roots—a concept being tested on a small scale right now—along with farming methods that avoid tilling the soil, could store huge amounts of carbon dioxide as underground biomass for several decades or longer. As the hard reality of climate change has set in, some have begun to dream of technologies that could reverse past emissions, such as “direct air capture” machines, which would pull carbon dioxide from the atmosphere and store it underground. Pilot projects suggest that these options are very costly—in part because it is thermodynamically difficult to take a dilute gas from the atmosphere and compress it into the high concentrations needed for underground storage. But cost reductions are likely, and the more dire the climate crisis becomes, the more such emergency options must be taken seriously.

### 1NC - Cap Good - Space Col

#### Privatization is necessary for space colonization – disruptions kill that potential

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It was one small step for man, one giant leap for capitalism. Only three countries have ever launched human beings into orbit. This past weekend, SpaceX became the first private company ever to do so, when it sent its Crew Dragon capsule into space aboard its Falcon 9 rocket and docked with the International Space Station. This was accomplished by a company Elon Musk started in 2002 in a California strip mall warehouse with just a dozen employees and a mariachi band. At a time when our nation is debating the merits of socialism, SpaceX has given us an incredible testament to the power of American free enterprise. While the left is advocating unprecedented government intervention in almost every sector of the U.S. economy, from health care to energy, today Americans are celebrating the successful privatization of space travel. If you want to see the difference between what government and private enterprise can do, consider: It took a private company to give us the first space vehicle with touch-screen controls instead of antiquated knobs and buttons. It took a private company to give us a capsule that can fly entirely autonomously from launch to landing — including docking — without any participation by its human crew. It also took a private company to invent a reusable rocket that can not only take off but land as well. When the Apollo 11 crew reached the moon on July 20, 1969, Neil Armstrong declared “the Eagle has landed.” On Saturday, SpaceX was able to declare that the Falcon had landed when its rocket settled down on a barge in the Atlantic Ocean — ready to be used again. That last development will save the taxpayers incredible amounts of money. The cost to NASA for launching a man into space on the space shuttle orbiter was $170 million per seat, compared with just $60 million to $67 million on the Dragon capsule. The cost for the space shuttle to send a kilogram of cargo into to space was $54,500; with the Falcon rocket, the cost is just $2,720 — a decrease of 95 percent. And while the space shuttle cost $27.4 billion to develop, the Crew Dragon was designed and built for just $1.7 billion — making it the lowest-cost spacecraft developed in six decades. SpaceX did it in six years — far faster than the time it took to develop the space shuttle. The private sector does it better, cheaper, faster and more efficiently than government. Why? Competition. Today, SpaceX has to compete with a constellation of private companies — including legacy aerospace firms such as Orbital ATK and United Launch Alliance and innovative start-ups such as Blue Origin (which is designing a Mars lander and whose owner, Jeff Bezos, also owns The Post) and Virgin Orbit (which is developing rockets than can launch satellites into space from the underside of a 747, avoiding the kinds of weather that delayed the Dragon launch). In the race to put the first privately launched man into orbit, upstart SpaceX had to beat aerospace behemoth Boeing and its Starliner capsule to the punch. It did so — for more than $1 billion less than its competitor. That spirit of competition and innovation will revolutionize space travel in the years ahead. Indeed, Musk has his sights set far beyond Earth orbit. Already, SpaceX is working on a much larger version of the Falcon 9 reusable rocket called Super Heavy that will carry a deep-space capsule named Starship capable of carrying up to 100 people to the moon and eventually to Mars. Musk’s goal — the reason he founded SpaceX — is to colonize Mars and make humanity a multiplanetary species. He has set a goal of founding a million-person city on Mars by 2050 complete with iron foundries and pizza joints. Can it be done? Who knows. But this much is certain: Private-sector innovation is opening the door to a new era of space exploration. Wouldn’t it be ironic if, just as capitalism is allowing us to explore the farthest reaches of our solar system, Americans decided to embrace socialism back here on Earth?

#### Happens by 2050s---solves every impact BUT private sector key to progress

Drake '16 – a science journalist and contributing writer at National Geographic. She earned an A.B. in biology, psychology, and dance at Cornell University, worked in a clinical genetics lab at The Johns Hopkins University School of Medicine, then returned to Cornell for her Ph.D. in genetics and development. (Bynadia, "Elon Musk: A Million Humans Could Live on Mars By the 2060s," Science, 9-27-2016, https://www.nationalgeographic.com/science/article/elon-musk-spacex-exploring-mars-planets-space-science, Accessed 6-10-2021, LASA-SC)

In perhaps the most eagerly anticipated aerospace announcement of the year, SpaceX founder Elon Musk has revealed his grand plan for establishing a human settlement on Mars. In short, Musk thinks it’s possible to begin shuttling thousands of people between Earth and our smaller, redder neighbor sometime within the next decade or so. And not too long after that—perhaps 40 or a hundred years later, Mars could be home to a self-sustaining colony of a million people. “This is not about everyone moving to Mars, this is about becoming multiplanetary,” he said on September 27 at the International Astronautical Congress in Guadalajara, Mexico. “This is really about minimizing existential risk and having a tremendous sense of adventure.” Musk’s timeline sounds ambitious, and that's something he readily acknowledges. “I think the technical outline of the plan is about right. He also didn’t pretend that it was going to be easy and that they were going to do it in ten years,” says Bobby Braun, NASA’s former chief technologist who’s now at Georgia Tech University. “I mean, who’s to say what’s possible in a hundred years?” And for those wondering whether we should go at all, the reason for Musk making Mars an imperative is simple. “The future of humanity is fundamentally going to bifurcate along one of two directions: Either we’re going to become a multiplanet species and a spacefaring civilization, or we’re going be stuck on one planet until some eventual extinction event,” Musk told Ron Howard during an interview for National Geographic Channel’s MARS, a global event series that premieres worldwide on November 14. “For me to be excited and inspired about the future, it’s got to be the first option. It’s got to be: We’re going to be a spacefaring civilization.” Mars Fleet Though he admitted his exact timeline is fuzzy, Musk thinks it’s possible humans could begin flying to Mars by the mid-2020s. And he thinks the plan for getting there will go something like this: It starts with a really big rocket, something at least 200 feet tall when fully assembled. In a simulation of what SpaceX calls its Interplanetary Transport System, a spacecraft loaded with astronauts will launch on top of a 39-foot-wide booster that produces a whopping 28 million pounds of thrust. Using 42 Raptor engines, the booster will accelerate the assemblage to 5,374 miles an hour. Overall, the whole thing is 3.5 times more powerful than NASA’s Saturn V, the biggest rocket built to date, which carried the Apollo missions to the moon. Perhaps not coincidentally, the SpaceX rocket would launch from the same pad, 39A, at Kennedy Space Center in Cape Canaveral, Florida. The rocket would deliver the crew capsule to orbit around Earth, then the booster would steer itself toward a soft landing back at the launch pad, a feat that SpaceX rocket boosters have been doing for almost a year now. Next, the booster would pick up a fuel tanker and carry that into orbit, where it would fuel the spaceship for its journey to Mars. Once en route, that spaceship would deploy solar panels to harvest energy from the sun and conserve valuable propellant for what promises to be an exciting landing on the Red Planet. As Musk envisions it, fleets of these crew-carrying capsules will remain in Earth orbit until a favorable planetary alignment brings the two planets close together—something that happens every 26 months. “We’d ultimately have upward of a thousand or more spaceships waiting in orbit. And so the Mars colonial fleet would depart en masse,” Musk says. The key to his plan is reusing the various spaceships as much as possible. “I just don’t think there’s any way to have a self-sustaining Mars base without reusability. I think this is really fundamental,” Musk says. “If wooden sailing ships in the old days were not reusable, I don’t think the United States would exist.” Musk anticipates being able to use each rocket booster a thousand times, each tanker a hundred times, and each spaceship 12 times. At the beginning, he imagines that maybe a hundred humans would be hitching a ride on each ship, with that number gradually increasing to more than 200. By his calculations, then, putting a million people on Mars could take anywhere from 40 to a hundred years after the first ship launches. And, no, it would not necessarily be a one-way trip: “I think it’s very important to give people the option of returning,” Musk says. Colonizing Mars After landing a few cargo-carrying spacecraft without people on Mars, starting with the Red Dragon capsule in 2018, Musk says the human phase of colonization could begin. For sure, landing a heavy craft on a planet with a thin atmosphere will be difficult. It was tough enough to gently lower NASA’s Curiosity rover to the surface, and at 2,000 pounds, that payload weighed just a fraction of Musk’s proposed vessels. For now, Musk plans to continue developing supersonic retrorockets that can gradually and gently lower a much heavier spacecraft to the Martian surface, using his reusable Falcon 9 boosters as a model. And that’s not all these spacecraft will need: Hurtling through the Martian atmosphere at supersonic speeds will test even the most heat-tolerant materials on Earth, so it’s no small task to design a spacecraft that can withstand a heated entry and propulsive landing—and then be refueled and sent back to Earth so it can start over again. The first journeys would primarily serve the purpose of delivering supplies and establishing a propellant depot on the Martian surface, a fuel reservoir that could be tapped into for return trips to Earth. After that depot is set up and cargo delivered to the surface, the fun can (sort of) begin. Early human settlers will need to be good at digging beneath the surface and dredging up buried ice, which will supply precious water and be used to make the cryo-methane propellant that will power the whole enterprise. As such, the earliest interplanetary spaceships would probably stay on Mars, and they would be carrying mostly cargo, fuel, and a small crew: “builders and fixers” who are “the hearty explorer type,” Musk said to Howard. “Are you prepared to die? If that’s OK, then you’re a candidate for going.” While there will undoubtedly be intense competition and lots of fanfare over the first few seats on a Mars-bound mission, Musk worries that too much emphasis will be placed on those early bootprints. “In the sort of grander historical context, what really matters is being able to send a large number of people, like tens of thousands if not hundreds of thousands of people, and ultimately millions of tons of cargo,” he says.

#### Massive spillover effects, solves resources and extinction risks

Green 21 [Brian Patrick Green, director of technology ethics at the Markkula Center for Applied Ethics, Santa Clara University, “Space Ethics,” 2021, Rowman, pp. 4-5, EA]

In favor of going into space are such basics as gaining scientific knowledge and developing beneficial new technologies, both of which space exploration and use have already begun to accomplish with dramatic and sometimes unexpected effects for humankind. Scientific advancements include astronomical and cosmological knowledge from various orbiting experiments and telescopes that have let us gain unprecedented understanding about our universe. But space activities have also contributed to a great deal of scientific knowledge about our Earth, including measurements of environmental status, habitat conversion and destruction, detailed knowledge of anthropogenic climate change, and much about Earth’s chemistry and geology. We have also learned a great deal about our local planets, for example, that a runaway “greenhouse effect” in the atmosphere of Venus makes the surface scorchingly hot, while too little greenhouse effect on Mars leaves the surface quite cold. There have also been significant contributions made to medical science, especially concerning the behavior of the human body when subjected to radiation, microgravity, nutritional restrictions, and so on.

On the technological side, everything with American global positioning system (GPS), Russian Glonass, or other global navigation systems—from smartphones to military vehicles—relies on a network of satellites above us, placed there by rocketry and painstakingly tracked with instruments developed for the task. So many technologies have been pioneered by space exploration and use that it is hard to list them all, but some of the more important ones include weather satellites (which are not only convenient but also allow preparation for and evacuation from severe weather), communication satellites, solar photovoltaic (PV) cells, advances in electronics and computers, advances in materials science, and so on.

Gaining access to new critical resources may be another reason to go into space. Earth is a finite planet, and certain elements on Earth are very rare in the planetary crust, particularly platinum group metals that are very dense and siderophilic (iron-loving) and so have tended to sink toward the core over the natural history of the planet. However, asteroids and other objects in space (for example, planets, comets, and moons) can sometimes have these elements in abundance and in more available locations, making them potentially excellent sources for these valuable materials. Now-defunct asteroid-mining startup Planetary Resources once estimated that one “platinum-rich 500 meter wide asteroid contains . . . 1.5 times the known world-reserves of platinum group metals (ruthenium, rhodium, palladium, osmium, iridium, and platinum).” 7 In addition to returning elements to a resource-hungry Earth, further exploration and development of space will require access to resources that are not purely sourced from Earth. In particular, it will be necessary to gain access to water, which is relatively rare in the inner solar system and which would be far too costly to transport in any significant amounts from the Earth’s surface.

Another reason that humans may want to explore space would be to create a “backup Earth” to hedge against global catastrophic and existential risks (risks that may cause widespread disaster or human extinction, respectively) on our home planet. 8 Earth has always been a dangerous place for humans, with asteroid impacts, supervolcanic eruptions, pandemic disease, and other natural hazards threatening civilization. Now, in addition to these natural threats, human-made hazards such as nuclear weapons, climate change, biotechnology, nanotechnology, and artificial intelligence may threaten not only the viability of technological civilization but perhaps the survival of human life itself. A serious global-scale catastrophe could set back civilization many decades or centuries, and the worst disasters could cause human extinction. In one scenario, in which 100 percent of humanity dies, all of human effort for all of history would be for nothing. However, were the same global catastrophe to happen to Earth, yet humans were a multiplanetary species with just one self-sustaining settlement off-Earth, it would not result in the end of human civilization or human extinction. Instead while the same unimaginable fate would befall the Earth (certainly no mere triviality, with perhaps the deaths of 99.999 percent of all humans and possibly the destruction of the ecosphere and everything in it), at least all of human and planetory history would not be for nothing. Human life and culture would go on elsewhere, as well as other Earth species. This is a dire fate, but less terrible than the first.

### 1NC - Cap Good - Space War

#### Private actors solve space war and specifically ASAT restraint.

Cobb 21 [Wendy N. Whitman Cobb, Associate Professor of Strategy and Security Studies at the School of Advanced Air and Space Studies, “Privatizing Peace: How Commerce Can Reduce Conflict in Space,” 2021, Routledge, pp. 68-69, EA]

Finally, given the involvement of an ever-larger number of private actors in space, states also need to consider the lost opportunity costs if private actors choose to forego research, development, and deployment of new technologies because the danger in space is too high. As space becomes more commercialized, these private actors can exert pressure on states to behave peacefully in order to promote further economic development. Gartzke and Quan Li argue that this can happen through the movement of capital from conflict-prone states or areas to non-conflictual states.50 This is not necessarily applicable to space because there is no area in space which is formally protected, but commercial space actors may choose not to engage in new economic investment which can in turn affect a state’s economic performance. To date, the size of the space sector is comparatively small, so, arguably, the potential economic loss would not be that great. Where the harm comes from is state reliance on private actors for military and national security space services. As states contract out space services to a greater extent, private actors exert an even greater influence over the state by having a capability they do not.

Why might private companies want a more conflict-free space? If there is weaponized conflict in space, they could potentially benefit through new launches to send up replacement satellites; this is similar to an argument that war can actually be beneficial to an economy because companies are needed to create materiel and weapons.51 But, in a debris filled environment, sending replacements is more difficult and dangerous. Some private companies want to engage in human spaceflight; a conflictual or more dangerous orbital environment would likely prevent those activities or increase their costs to such an extent that it becomes economically infeasible. James Clay Moltz argues specifically that “the growing presence of space tourists in low-Earth orbit would greatly increase the incentives for restraint in any future [ASAT] test programs.”52 Those foregone development costs and commercial activities can have a similar cost to states simply by discouraging private actors from participating in the market.

#### Creating space dependence through corporations, jobs, and resources deters war

--dependence means deterrence because no one wants to destroy space

--rapid economic expansion has made space domain of commerce that has created dependence in squo

--Satellites are necessary to GPS, weather monitoring and only 16% have strictly military use

Triezenberg, 17

Bonnie Triezenberg, Senior engineer at RAND. Previously, she was the senior technical fellow at the Boeing Company, specializing in agile systems and software development. “Deterring Space War: An Exploratory Analysis Incorporating Prospect Theory into a Game Theoretic Model of Space Warfare,” RAND Corporation. 2017. <https://www.rand.org/pubs/rgs_dissertations/RGSD400.html>

The above discussion suggests that a likely means to achieve deterrence of acts of war in outer space is to increase civilian dependence on space to support day-to-day life—if everyone on earth is equally dependent on space, no one has an incentive to destroy space. Largely by accident, this dependence appears to have, in fact, occurred. The space age was born in an age of affluence and rapid economic expansion; space quickly became a domain of international commerce as well as a domain of national military use. Space assets and the systems they enable have transformed social, infrastructure and information uses perhaps more visibly than they have transformed military uses. In fact, in the current satellite database published by the Union of Concerned Scientists, of the 1461 satellites in orbit 40% support purely commercial ventures, while only 16% have a strictly military use.46 The first commercial broadcast by a satellite in geo-synchronous orbit was of international news between Europe and the United States.47 The first telephony uniting the far flung islands of Indonesia was enabled by satellite48. Those of us who are old enough remember the 1960s “magic” of intercontinental phone calls and international “breaking news” delivered by satellite. Today, most social and infrastructure uses of space are taken for granted – even in remote locales of Africa, people expect to be able to monitor the weather, communicate seamlessly with colleagues and to find their way to new and unfamiliar locations us[e]ing the GPS in their phones. All of us use space every day.49 These unrestricted economic and social uses of space may be the best deterrent, making everyone on all sides of combat equally dependent on space and heightening the taboo against weaponizing space or threatening space assets with weapons.

### 1NC - Cap Good - Disease

#### Capitalism’s key to *global medical innovation* --- only the profit motive solves

**Norberg 3** – Fellow at Timbro and CATO[Johan Norberg, In Defense of Global Capitalism, pg. 186]

One common objection to the market economy is that it causes people and enterprises to produce for profit, not for needs. This means, for example, pharmaceutical companies devoting huge resources to research and medicines to do with obesity, baldness, and depression, things that westerners can afford to worry about and pay for, whereas only a fraction is devoted to attempting to cure tropical diseases afflicting the poorest of the world's inhabitants, such as malaria and tuberculosis. This criticism is understandable. The unfairness exists, but capitalism is not to blame for it. Without capitalism and the lure of profit, we shouldn't imagine that everyone would have obtained cures for their illnesses. In fact, far fewer would do so than is now the case. If wealthy people in the West demand help for their problems, their resources can be used to research and eventually solve those problems, which are not necessarily trivial to the people afflicted with them. Capitalism gives companies economic incentives to help us by developing medicines and vaccines. That westerners spend money this way does not make things worse for anyone. This is not money that would otherwise have gone to researching tropical diseases—the pharmaceutical companies simply would not have had these resources otherwise. And, as free trade and the market economy promote greater prosperity in poorer countries, their needs and desires will play a larger role in dictating the purposes of research and production.

#### Commercial space manufacturing is booming --- solves disease and tissue innovation

Giulianotti et. al 21 [Marc A. Giulianotti1\*, Arun Sharma2,3, Rachel A. Clemens4 , Orquidea Garcia5 , D. Lancing Taylor6, Nicole L. Wagner7 , Kelly A. Shepard8 , Anjali Gupta4, Siobhan Malany9 , Alan J. Grodzinsky10, Mary Kearns‐Jonker11, Devin B. Mair12, Deok‐Ho Kim12,13, Michael S. Roberts1, Jeanne F. Loring14, Jianying Hu15, Lara E. Warren1 , Sven Eenmaa1, Joe Bozada16, Eric Paljug16, Mark Roth17, Donald P. Taylor18, Gary Rodrigue1, Patrick Cantini19, Amelia W. Smith1, William R. Wagner19,20\* 1 Center for the Advancement of Science in Space, Melbourne, FL, USA 2 Board of Governors Regenerative Medicine Institute, Cedars‐Sinai Medical Center, Los Angeles, CA, USA 3 Smidt Heart Institute, Cedars‐Sinai Medical Center, Los Angeles, CA, USA 4 Axiom Space, Inc., Houston, TX, USA 5 Johnson & Johnson 3D Printing Innovation & Customer Solutions, Johnson & Johnson Services, Inc., Irvine, CA , USA. 6 University of Pittsburgh Drug Discovery Institute and Department of Computational and Systems Biology, University of Pittsburgh, Pittsburgh, PA, USA 7 LambdaVision Inc., Farmington, CT, USA 8 California Institute for Regenerative Medicine, Oakland, California, USA 9 Department of Pharmacodynamics, College of Pharmacy, University of Florida, Gainesville, FL USA 10 Departments of Biological Engineering, Mechanical Engineering and Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, MA, USA 11 Department of Pathology and Human Anatomy, Loma Linda University School of Medicine, Loma Linda, CA, USA 12 Department of Biomedical Engineering, Johns Hopkins University School of Medicine, Baltimore, MD, USA 13 Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD, USA 14 Scripps Research Institute, San Diego, CA, USA 15 Center for Computational Health IBM Research, Yorktown Heights, NY, USA 16 Joseph M. Katz Graduate School of Business, University of Pittsburgh, Pittsburgh, PA, USA 17 Pittsburgh, PA, USA 18 The Ohio State University, Columbus, OH, USA 19 McGowan Institute for Regenerative Medicine, Pittsburgh, PA, USA 20 Departments of Surgery, Bioengineering, Chemical Engineering, University of Pittsburgh, Pittsburgh, PA, USA. “Opportunities for Biomanufacturing in Low Earth Orbit: Current Status and Future Directions.” August 2, 2021. https://www.preprints.org/manuscript/202108.0044/v1/download]

The use of LEO by governments and commercial enterprises is a complex ecosystem for providing opportunities and financing. In the last two decades, governments around the world, led by the U.S. and China, have heavily supported private space companies (2019 Report). These investments have focused on launch technologies, as high launch costs are perceived to be the greatest limiting factor to expanded space exploration and utilization (Werzt et al., 1996) and have led to recent reductions in the cost of transporting cargo to LEO by a factor of more than 20. Between 1970 and 2020, the average cost to launch a kilogram of payload into LEO on the space shuttle remained constant at about $54,500. Now, the cost per kilogram is $2,720 on a SpaceX Falcon 9 rocket (Figure 1) (Jones, H. W. et al., 2020). Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2021 doi:10.20944/preprints202108.0044.v1 4 Figure 1: The cost of launching payloads to LEO has dropped considerably over the last 50 years. Note: Data is not to scale. Additionally, several private companies are now pursuing commercial space stations. Axiom Space, headquartered in Houston, is currently developing what promises to be the first‐ever privately operated space station, with the initial module scheduled to launch to the ISS in 2024. Axiom plans to dock multiple modules to the ISS that will eventually detach to become a standalone station. As the cost of transport to LEO has decreased—and is expected to decrease further—and plans for new platforms in LEO continue to advance (Dinkin S., 2019), opportunities in areas such as satellite deployment, biomedical research, in‐space manufacturing, and space tourism increase. Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 2 August 2021 doi:10.20944/preprints202108.0044.v1 5 As the past half century has witnessed the opening of space for exploration and commercial opportunities, in this same period, we have experienced exponential growth in our understanding of biology and physiology. This knowledge has been translated and commercialized for the benefit of human health and continues to accelerate as new technologies create additional tools to explore and cure. One aspect of this biomedical revolution is in the field of regenerative medicine, built upon advances in stem cell biology, biomaterials, and bioengineering. Remarkable advancements have been made in the design of MPS, also called tissue chips or organs‐on‐chips, and organoids that can mimic complex organ systems outside of the body for drug development or potential implantation to restore function. Stem cell isolation, characterization, and manipulation is advancing, with target applications broadly spread across tissues impacted by disease, trauma, and congenital conditions. Biomaterials and bioengineering advances have created new medical devices, targeted drug delivery platforms, biosensors and new imaging modalities, and the bioprinting of tissue constructs. To take advantage of these significant advances—more frequent and more affordable access to LEO and exponential progress in biomedical technology—the question is: How do these intersect, and what new opportunities arise as both advance? How can the unique LEO environment be leveraged to further advance biomanufacturing? Compelling answers to these questions will introduce economic drivers for investment in space‐based R&D that extend beyond the initial focus on pure discovery and into the expansion of commercial development in LEO. Over the past decade, the ISS National Lab has supported important space‐based research in the areas of tissue engineering and regenerative medicine that lays the groundwork for more complex studies and future investment. This critical research addressed fundamental questions such as: How does the LEO environment affect the organ function mimicked by tissue chips, and how do these changes relate to human disease? How does microgravity affect stem cell proliferation and differentiation? And how might 3D bioprinting benefit from the absence of gravity? Continued access to LEO through the ISS National Lab provides a unique opportunity for R&D that enables the jump from this initial work to the development of a sustainable market for biomanufacturing in space. The ISS is a powerful platform with a limited lifetime and thus limited time left for utilization; therefore, now is the time to leverage this invaluable orbiting laboratory to conduct R&D that demonstrates the value of biomanufacturing in space. This work will set the stage for increased private investment and the transition to larger and more numerous platforms in LEO that can support further discovery and development in the coming decades.

#### Solves global food security

Mark **Post 14**, MD, PhD in Pharmacology from Utrecht University, Professor of Vascular Physiology and Chair of Physiology at Maastricht University, and Cor van der Weele, Prof and bioethicist in the Dept of Applied Philosophy at Wageningen University, PhD in philosophy of Biology, “Principles of Tissue Engineering for Food,” Ch 78 in Principles of Tissue Engineering (Fourth Edition), 2014, Pages 1647–1662, Science Direct

Most techniques in tissue engineering were developed for medical applications. The potential benefits of tissue engineering and regenerative medicine for the repair of non-regenerative organs in the human body have not really been questioned. It is generally accepted that these technologies offer therapeutic opportunities where very limited alternatives are at hand to improve quality of life. Therefore, a tremendous amount of government funded research and business R&D has been and continues to be devoted to tissue engineering. Still, 25 years after its introduction, regenerative medicine by tissue engineering is not yet part of mainstream medical therapy [1]. This suggests that the technical challenges to generate tissues that are fully functional and can immediately replace damaged tissue are substantial.¶ **As a spin off from this research activity**, techniques in tissue engineering and regenerative medicine may be used to **produce organs to produce food**. This idea is not new and had in fact been proposed by Winston Churchill in his 1932 book ‘Thoughts and adventures' [2] and by Alexis Carrel [3]. Although the biological principles of tissue engineering of food are **very similar to the medical application** there are also differences in goals, scale of production, cost-benefit ratio, ethical-psychological considerations and regulatory requirements.¶ In this chapter the distinctions between the challenges of tissue engineering for food production are highlighted and discussed. The focus will be mainly on tissue engineering of meat as a particularly attractive and suitable example.¶ Why Tissue Engineering of Food?¶ Growing food through domestication of grasses, followed by other crops and livestock has a 13,000 years head start. The success of economical food production likely determined the growth and sophistication of our civilization [4]. Why would we try to replace the relatively low-tech, cheap and easy natural production of food by a high-tech complicated engineering technology that is likely to be more expensive? There are two main reasons why current ways of food production need to be reconsidered.¶ First, with growth of the world population to **9.5 billion** and an even faster growth in global economy, traditional ways of producing food, and in particular meat, **may no longer suffice to feed the world** [5]. Food security is already an issue for some populations, but absence of this security may spread **across all civilizations** due to **generalized scarcity of food**. Meat production through livestock for example **already seems maximized** by the occupation of 70% of current arable land surface, yet the demand for meat **will double** over the next four decades [6]. Without change, this will lead to **scarcity** and high prices. Likely, the high prices will be an incentive for intensification of meat production, which will increase the pressure of using crops for **feed for livestock instead of feeding people**. The arable land surface could be increased but this would occur at the expense of forests with predictable unfavorable climate consequences. Lifestyle changes that include the reduction of meat consumption per capita would also solve the problem, but historically this **seems unlikely to happen**. A technological alternative such as **tissue engineering of meat** might offer a solution. In fact, the production of meat is a good target for tissue engineering. Pigs and cows are the major sources of the meat we consume, and these animals are very inefficient in transforming vegetable proteins into edible animal proteins, with an average bioconversion rate of 15% [7]. If this efficiency can be **improved through tissue engineering**, this will predictably lead to **less land, water and energy use for the production of meat** [8], which introduces the second major reason why alternatives and more efficient meat production should be considered.

#### Extinction

**FDI 12** – Future Directions International ’12 (“International Conflict Triggers and Potential Conflict Points Resulting from Food and Water Insecurity Global Food and Water Crises Research Programme”, May 25, <http://www.futuredirections.org.au/files/Workshop_Report_-_Intl_Conflict_Triggers_-_May_25.pdf>,)

There is a growing appreciation that the conflicts in the next century will **most likely** be fought over a lack of **resources**. Yet, in a sense, this is not new. Researchers point to the French and Russian revolutions as conflicts induced by a lack of food. More recently, Germany’s World War Two efforts are said to have been inspired, at least in part, by its perceived need to gain access to more food. Yet the general sense among those that attended FDI’s recent workshops, was that the scale of the problem in the future could be significantly greater as a result of population pressures, changing weather, urbanisation, migration, loss of arable land and other farm inputs, and increased affluence in the developing world.¶ In his book, Small Farmers Secure Food, Lindsay Falvey, a participant in FDI’s March 2012 workshop on the issue of food and conflict, clearly expresses the problem and why countries across the globe are starting to take note. .¶ He writes (p.36), “…if people are hungry, especially in cities, the state is not stable – riots, violence, breakdown of law and order and migration result.” “Hunger feeds anarchy.” This view is also shared by Julian Cribb, who in his book, The Coming Famine, writes that if “large regions of the world run short of food, land or water in the decades that lie ahead, then wholesale, **bloody wars are liable to follow**.” He continues: “An increasingly credible scenario for **World War 3** is not so much a confrontation of super powers and their allies, as a festering, self-perpetuating chain of resource conflicts.” He also says: “The wars of the 21st Century are **less likely** to be global conflicts with sharply defined sides and huge armies, than a scrappy mass of failed states, rebellions, civil strife, insurgencies, terrorism and genocides, sparked by bloody competition over dwindling resources.” As another workshop participant put it, people do not go to war to kill; **they go to war over resources**, either to protect or to gain the resources for themselves. Another observed that hunger results in passivity not conflict. Conflict is over resources, not because people are going hungry. A study by the International Peace Research Institute indicates that where food security is an issue, it is more likely to result in some form of conflict. Darfur, Rwanda, Eritrea and the Balkans experienced such wars. Governments, especially in developed countries, are increasingly aware of this phenomenon.¶ The UK Ministry of Defence, the CIA, the US **C**enter for **S**trategic and **I**nternational **S**tudies and the Oslo Peace Research Institute, all identify famine as **a potential trigger for** conflicts and possibly even **nuclear war**.

### 1NC - AT: Ozone

#### Ozone worsening

**Horton 21** Helena Horton 9-15-2021 "‘Larger than usual’: this year’s ozone layer hole bigger than Antarctica"<https://www.theguardian.com/environment/2021/sep/16/larger-than-usual-ozone-layer-hole-bigger-than-antarctica> (Environmental Journalist for the Guardian)//Elmer

The hole in the ozone layer that develops annually is “rather larger than usual” and is currently bigger than Antartica, say the scientists responsible for monitoring it. Researchers from the Copernicus Atmosphere Monitoring Service say that this year’s hole is growing quickly and is larger than 75% of ozone holes at this stage in the season since 1979. Ozone exists about seven to 25 miles (11-40km) above the Earth’s surface, in the stratosphere, and acts like a sunscreen for the planet, shielding it from ultraviolet radiation. Every year, a hole forms during the late winter of thesouthern hemisphere as the sun causes ozone-depleting reactions, which involve chemically active forms of chlorine and bromine derived from human-made compounds. In a statement Copernicus said that this year’s hole “has evolved into a rather larger than usual one”. Vincent-Henri Peuch, the service’s director, told the Guardian: “We cannot really say at this stage how the ozone hole will evolve. However, the hole of this year is remarkably similar to the one of 2020, which was among the deepest and the longest-lasting – it closed around Christmas – in our records since 1979.

#### Thumpers:

#### Copper

**Berkeley 1/13** (Robert Rhew and Berkeley geo chemists, [UC Berkeley professor of geography and of environmental science, policy and management], 1-13-2022, “Copper-based chemicals may be contributing to ozone depletion: Some ozone-destroying chemicals are unaccounted for. Are copper-based fungicides producing them?“, ScienceDaily, accessed: 1-15-2022, https://www.sciencedaily.com/releases/2022/01/220113151441.htm) ajs

In a paper appearing this week in the journal Nature Communications, UC Berkeley geochemists show that copper in soil and seawater acts as a catalyst to turn organic matter into both methyl bromide and methyl chloride, two potent halocarbon compounds that destroy ozone. Sunlight worsens the situation, boosting production of these methyl halides by a factor of 10. The findings answer, at least in part, a long-standing mystery about the origin of much of the methyl bromide and methyl chloride in the stratosphere. Since the worldwide ban on chlorofluorocarbon (CFC) refrigerants and brominated halons used in fire extinguishers starting in 1989, these methyl halides have become the new dominant sources of ozone-depleting bromine and chlorine in the stratosphere. As the long-lived CFCs and halons slowly disappear from the atmosphere, the role of methyl halides increases. "If we don't know where methyl bromide and methyl chloride are coming from, then how can we make sure that those compounds are reduced along with CFCs?" said the paper's senior author, Robert Rhew, UC Berkeley professor of geography and of environmental science, policy and management. "By 2050, we should be back to relatively normal ozone, but things like the continued emissions of methyl bromide and methyl chloride are road bumps in the road to recovery. Copper usage in the environment is projected to increase rapidly in the next few years, and this should be considered when predicting future halogen load and ozone recovery."

#### Dichloromethane

**Perkins 17** Sid Perkins 6-27-2017 "New threat to ozone layer found"<https://www.science.org/content/article/new-threat-ozone-layer-found> (Sid is a freelance science journalist based in Crossville, Tennessee. He specializes in earth sciences and paleontology but often tackles topics such as astronomy, planetary sciences, materials sciences, and engineering. Sid has a bachelor’s degree in natural science from Christian Brothers College in Memphis, Tennessee; bachelor’s and master’s degrees in aeronautical engineering from the Air Force Institute of Technology in Ohio; and a master’s degree in journalism from the University of Missouri in Columbia)//Elmer

The ozone layer—a high-altitude expanse of oxygen molecules that protects us from the sun's ultraviolet rays—has been on the mend for the past decade or so. But a newly discovered threat could delay its recovery. Industrial emissions of a chemical commonly used in solvents, paint removers, and the production of pharmaceuticals have doubled in the past few years, researchers have found, which could slow the healing of the ozone layer over Antarctica anywhere between 5 and 30 years—or even longer if levels continue to rise. The findings are "frightening" and "a big deal," says Robyn Schofield, an environmental scientist at the University of Melbourne in Australia who was not involved with the work. The chemical in question is called dichloromethane (CH2Cl2). Natural sources of this substance are small, says Ryan Hossaini, an atmospheric chemist at Lancaster University in the United Kingdom. Thus, he notes, the increase in emissions seen in recent years likely stems from human sources. Between 2000 and 2012, low-altitude concentrations of CH2Cl2 vapor rose, on average, about 8% per year, he adds. Globally, concentrations of CH2Cl2 approximately doubled between 2004 and 2014. Current CH2Cl2 emissions are about 1 million metric tons per year, Hossaini and his team estimate. Like chlorofluorocarbons (CFCs) and several other ozone-destroying chemicals you may have heard of, CH2Cl2 breaks apart when struck by sunlight. The chlorine atoms that are released then dismantle any ozone molecules they interact with. In 1987, an international agreement known as the Montreal Protocol led to a ban on the production and use of CFCs and many related compounds in industrial nations, but it ignored CH2Cl2 because researchers thought it didn't stay intact in the atmosphere long enough to rise into the stratosphere. Recent evidence now suggests, however, that the molecules can reach the lower edge of the stratosphere, which includes the ozone layer, despite its height 8 kilometers above the poles. To gauge the current and future threat to high-altitude ozone from CH2Cl2, Hossaini and his colleagues used computer simulations. In 2016, their analyses suggest, about 3% of the summer ozone loss in the Antarctic could be traced to CH2Cl2. That seems small, but in 2010 the substance was responsible for only 1.5% of the region's summer ozone loss, Hossaini says. If CH2Cl2 emissions continue to rise at the rate seen in the last decade, recovery of the ozone hole would be delayed about 30 years, the researchers estimate in Nature Communications. But if emissions of CH2Cl2 are held to current levels, healing of the ozone hole would be delayed only 5 years or so, the team finds. Simulations that don't include the effect of CH2Cl2 suggest that high-altitude ozone in the Antarctic will return to pre-1980 levels, the concentration measured before CFCs and other ozone-destroying chemicals were recognized as a problem, in 2065. The team's analyses "are quite important," says Björn-Martin Sinnhuber, an atmospheric scientist at Karlsruhe Institute of Technology in Germany. "It's clear that concentrations [of CH2Cl2] have increased quite a lot," he notes. But one critical question, he contends, is what will happen to emissions over the long term: "They've been quite variable in recent years, and it's difficult to say how they might evolve." Although the rapid rise in CH2Cl2 emissions may one day level off, it's also possible that emissions of this multipurpose chemical may accelerate even further. Hossaini and his team also assessed what would happen to high-altitude ozone if CH2Cl2 emissions rose at twice the rate seen in the past decade. The answer? Not good. Antarctic ozone wouldn't recover to pre-1980 levels until well after the year 2100, the analyses suggest. All this means that scientists now reviewing the Montreal Protocol should consider expanding the agreement to also regulate substances like CH2Cl2 that have atmospheric lifetimes of less than 6 months, Schofield says. Possibly as important, however, the team's results might also help other researchers identify which sources of CH2Cl2 are contributing most to the recent rise in emissions. That sort of information, Hossaini admits, is sadly lacking as of now.

#### Tourism stops warming and ozone depletion, BUT, their links are out of proportion

​​Sarah **Kessler**, 7-21-**2021**, "Jeff Bezos vows to fight climate change, but space tourism could do more harm, critics say.," No Publication, <https://www.nytimes.com/2021/07/21/business/space-tourism-climate-change.html> //SR

Upon descending from his trip to the edge of space on Tuesday, Jeff Bezos, the richest person on the planet, reaffirmed his commitment to fight climate change. “We have to build a road to space so that our kids and their kids can build a future,” he told MSNBC. Mr. Bezos says space tourism is a first step toward moving people (and heavy industry) into space to avert an energy crisis on Earth. His fellow billionaire space entrepreneurs, like Richard Branson and Elon Musk, have also said their companies are an answer to climate change: Mr. Musk wants to colonize Mars in case we ruin Earth. Critics argue that space tourism will add to emissions rather than save the planet. But the industry is still low on the list of polluters. The global space industry uses less than a tenth of a percent of propellant than the aviation industry does. What’s more, the amount used for rockets like those that carried Mr. Branson and Mr. Bezos to space is a tiny portion of that, said Martin Ross, a scientist at the Aerospace Corporation, a federally funded research and development center. In a recent study, Mr. Ross found that space tourism companies could launch as many as 10,000 suborbital flights per year before the effect of their emissions on the atmosphere would begin to approach that of orbital rockets. It is not yet understood exactly how an increasing number of rocket launches would affect the planet. The space industry is the only direct source of emissions into the stratosphere above 20 kilometers. Particles that rockets leave behind can absorb sunlight or reflect sunlight, potentially changing the climate of the stratosphere or affecting the ozone layer. “We know it’s not a problem now,” Mr. Ross said, “but we can’t predict how much of that up-and-down you can do before it does become a problem.”

#### Grush concludes it functions as geoengineering --- solves warming --- Haven reads blue.

Grush 17 [Loren Grush, Loren Grush is a science reporter for The Verge, the technology and culture brand from Vox Media, where she specializes in all things space—from distant stars and planets to human space flight and the commercial space race. The daughter of two NASA engineers, she grew up surrounded by space shuttles and rocket scientists—literally. She is also the host of Space Craft, an original online video series that examines what it takes to send people to space. Before joining The Verge, Loren published stories in Popular Science, The New York Times, Nautilus Magazine, Digital Trends, Fox News, and ABC News.) “Why it’s time to study how rocket emissions change the atmosphere: Get the data now before the problem gets worse” The Verge, May 31, 2018] RM

Every time a rocket launches, it produces a plume of exhaust in its wake that leaves a mark on the environment. These plumes are filled with materials that can collect in the air over time, potentially altering the atmosphere in dangerous ways. It’s a phenomenon that’s not well-understood, and some scientists say we need to start studying these emissions now before the number of rocket launches increases significantly.

It’s not the gas in these plumes that’s most concerning. Some rockets do produce heat-trapping greenhouse gases, like carbon dioxide, but those emissions are negligible, according to experts. “The rocket business could grow by a factor of 1,000 and the carbon dioxide and water vapor emissions would still be small compared to other industrial sources,” Martin Ross, a senior project engineer at the Aerospace Corporation who studies the effects of rockets on the atmosphere, tells The Verge.

Instead, it’s tiny particles that are produced inside the trail that we need to watch out for, Ross says. Small pieces of soot and a chemical called alumina are created in the wakes of rocket launches. They then get injected into the stratosphere, the layer of Earth’s atmosphere that begins six miles up and ends around 32 miles high. Research shows that this material may build up in the stratosphere over time and slowly lead to the depletion of a layer of oxygen known as the ozone. The ozone acts like a big shield, protecting Earth against the Sun’s harmful ultraviolet radiation. However, the magnitude of this ozone depletion isn’t totally known, says Ross.

“IT’S A CALL FOR MORE RESEARCH IN THIS AREA TO KNOW EXACTLY WHAT WE’RE PUTTING INTO THE UPPER ATMOSPHERE AND IN WHAT QUANTITIES.”

That’s why he and others at the Aerospace Corporation, a nonprofit that provides research and guidance on space missions, are calling for more studies. They say it’s especially important now since the private space industry is at the early stages of a launch revolution. Currently, the number of launches each year is relatively small, around 80 to 90, so the aerospace industry’s impact on the atmosphere is not much of a concern. But in a new paper published in April, Ross and his colleague Jim Vedda argue that as launches increase, policymakers will eventually want to know what kind of damage these vehicles are causing to the environment and if regulations are necessary. When that time comes, it will be better to have as much data as possible to make the best decisions.

“It’s a call for more research in this area to know exactly what we’re putting into the upper atmosphere and in what quantities,” Vedda, a senior policy analyst at the Aerospace Corporation, tells The Verge. “So when the debates start, we have the good hard data that says, ‘Here’s a well-defined model of what’s actually happening.’”

So far, the research we have about these emissions mostly comes from lab experiments, modeling, and some direct detections of rocket plumes. At the turn of the century, a few high-altitude planes equipped with sensors flew through plumes created by the Space Shuttle and other vehicles to figure out what was inside.

It turns out that all kinds of rockets produce these emissions, but some types of vehicles produce more than others. Rockets that run on solid propellants produce a higher amount of alumina particles, a combination of aluminum and oxygen that is white and reflective. Most orbital rockets don’t run on solid propellants these days, though some launch companies like the United Launch Alliance do add solid rocket boosters to vehicles to give them extra thrust. Meanwhile, rockets that run on liquid kerosene, a type of refined oil, produce more of the dark soot particles, what is known as black carbon. Kerosene is used as a propellant for rockets such as ULA’s Atlas V and SpaceX’s Falcon 9.

ALL KINDS OF ROCKETS PRODUCE THESE EMISSIONS, BUT SOME TYPES OF VEHICLES PRODUCE MORE THAN OTHERS

Alumina and black carbon from rockets can stick around in the stratosphere for three to five years, according to Ross. As these materials collect high above the Earth, they can have interesting effects on the air. Black carbon forms a thin layer that intercepts and absorbs the sunlight that hits Earth. “It would act as a thin, black umbrella,” says Ross. That may help keep the lower atmosphere cool, but the intercepted energy from the Sun doesn’t just go away; it gets deposited into the stratosphere, warming it up. This warming ultimately causes chemical reactions that could lead to the depletion of the ozone layer.

The reflective alumina particles can also affect the ozone but in a different way. Whereas the soot acts like a black umbrella, the alumina acts like a white one, reflecting sunlight back into space. However, chemical reactions occur on the surface of these white particles, which, in turn, destroy the ozone layer, Ross says.

Black carbon and alumina have actually been proposed by scientists as possible geoengineering agents or tools for cooling down our warming climate. But while they may keep the lower atmosphere cool, geoengineering agents may have other unwanted side effects, too. They might interact with jet streams, causing droughts or more tropical storms. That’s why many scientists have criticized the idea of geoengineering to combat climate change.

However, rockets are putting these particles into the air no matter what, and this byproduct of ozone loss is particularly concerning for Ross and Vedda. As the ozone diminishes, more of the Sun’s harmful radiation could reach the ground. These UVB rays can cause skin cancer and cataracts. “That’s what we need to understand — the ozone depletion aspect of this because protection of the ozone layer is an international imperative,” says Ross. The 1987 Montreal Protocol, for example, is an international agreement to phase out materials that deplete the ozone.

Right now, Ross estimates that rocket launches around the world inject 10 gigagrams, or 11,000 tons, of soot and alumina particles into the atmosphere each year. But that number could be going up. SpaceX has vowed to increase the number of launches it does each year, and numerous other companies are going to start launching their own vehicles soon. What kind of impact that will have on the atmosphere is unclear. That’s why Ross and Vedda suggest the government and universities invest in a series of research programs, in which scientists collect more data on rocket particles from aircraft and satellites.

“WE WANT TO BE PROACTIVE BEFORE THIS TIPPING POINT OCCURS.”

### 1NC - AT: Space War

#### X/app commercialization turns from cap good

1. **Space cooperation doesn’t lead to broader relations.**

**Sterner 15** (Eric Sterner is a fellow at the George C. Marshall Institute. He held senior staff positions for the U.S. House Science and Armed Services committees and served in DoD and as NASA’s associate deputy administrator for policy and planning, “Talk and Cooperation in Space” 8/6/2015 <https://spacenews.com/op-ed-china-talk-and-cooperation-in-space/>)

How might cooperation with China benefit the United States? Some hold that cooperation in space helps promote cooperation on Earth. Writing in SpaceNews in 2013, Michael Krepon argued “The more they cooperate in space, the less likely it is that their competition on Earth will result in military confrontation. The reverse is also true.” That sentiment is widespread and flows from the nobility of exploration. **If only it were so.** Unfortunately, a country’s space behavior appears to have little affect on its terrestrial actions. Russia’s multidecadal human spaceflight partnership with the United States did not prevent it from invading and destabilizing Ukraine when it moved toward a closer relationship with the European Union, many of whose members are Russian partners in the International Space Station. Space cooperation **has not, and will not**, prevent the continued worsening of the security environment in Europe, which flows from Russian behavior on Earth, not in space. **Space cooperation with China is similarly unlikely to moderate its behavior**. Tensions in Asia derive from China’s insistence on pressing unlawful territorial claims in the Pacific, most recently by transforming disputed coral reefs into would-be military bases. Ironically, civilian space technology has proved critical in documenting these aggressive moves. To further demonstrate the civil space cooperation does not promote cooperation on Earth, we need look no further than recent history. The NASA administrator’s visit to China in the fall of 2014 nearly coincided with China’s hacking of NOAA, with whom Beijing has a “partnership” in studying climate change. Military confrontation flows from the interaction of hard power in pursuit of competing national interests. Space cooperation falls into the realm of soft power. It has value in strengthening relationships among like-minded states with similar interests. China’s aggressiveness toward its neighbors, its human rights record and its cyberattacks on the United States strongly demonstrate that it and the United States are **not of like minds**. This is not the result of insufficient space cooperation, but of divergent national interests. The United States is a status quo power; China is not.

#### Gov to gov cooperation and extenral mechanisms solve --- Haven reads blue.

CSIS 18 [(Center for Strategic and International Studies), “Why Human Space Exploration Matters,” August 21, 2018 https://www.csis.org/blogs/post-soviet-post/space-cooperation] TDI

U.S.-Russian space cooperation continues to be a stated mutual goal. In April 2018, President Putin said of space, “Thank God, this field of activity is not being influenced by problems in politics. Therefore, I hope that everything will develop, since it is in the interests of everyone…This is a sphere that unites people. I hope it will continue to be this way.” During his statement at a recent event at CSIS, NASA Administrator Jim Bridenstine said, “[space] is our best opportunity to dialogue when everything else falls apart. We’ve got American astronauts and Russian cosmonauts dependent on each other on the International Space Station, which enables us to ultimately maintain that dialogue.” The U.S. and Russia both benefit from the ISS partnership. Russia provides transportation to the ISS for U.S. astronauts, from which Russia receives an average of $81 million per seat on the Soyuz (and recognition of its status as a space power). The U.S. also benefits from Russia’s technical contributions to the ISS while Russia benefits The U.S. and Russia signed a joint statement in 2017 in support of the idea of collaborating on deep space exploration, including the construction of the Lunar Orbital Platform-Gateway, a research-focused space station orbiting the moon. Through agreements on civilian space exploration, such as the Lunar Orbital Platform-Gateway or future Mars projects, that have clear benefits to both sides, some degree of cooperation will remain in both countries’ interest. The high price tag for pursuing space exploration alone and opportunities for sharing and receiving technical expertise encourages international partnerships like the ISS.

However, at least three factors, apart from the overall deterioration of U.S.-Russia relations, threaten this cooperation. First, growth of the private sector space industry may alter the economic arrangement between the U.S. and Russia, and ultimately lower the benefits of cooperation to both countries. The development of advanced technologies by private companies will give NASA new options to choose from and reduce the need to depend on (and negotiate with) Russia. If NASA and its Russian counterpart, Roskosmos, have no need to talk with one another, they probably won’t in the face of tense political relations. The U.S. intends to use Boeing and SpaceX capsules for human spaceflight beginning in 2020, and a Congressional plan in 2016 set a phase out date of Russian RD-180 rocket engines by 2022.

#### Independently, this is ludicruous --- US/Russia conflict over Ukraine and Baltics which are territorial expansion --- dialogue and collaboration is not enoug hto tangibly alter geoptx gains

#### Russia cheats – gives an asymmetric advantage – constitutional and political constraints prevent US reciprocation

Lambakis 17 [Dr. Steven Lambakis is a national security and international affairs analyst specializing in space power and policy studies. Dr. Lambakis serves as the Editor-in-Chief of Comparative Strategy, a leading international journal of global affairs and strategic studies whose readership includes key policymakers, academics, and other leaders. Dr. Lambakis was educated in the fields of international politics, with special emphasis on arms control and intelligence issues, American government, and U.S. foreign policy at Northern Illinois University in DeKalb, Illinois (B.A., 1982) and the Catholic University of America in Washington D.C. (M.A., 1984, and Ph.D., 1990). Foreign Space Capabilities: Implications for U.S. National Security. September 2017. www.nipp.org/wp-content/uploads/2017/09/Foreign-Space-Capabilities-pub-2017.pdf]

While Russia is making strong technical strides toward having weapons capable of damaging or destroying U.S. satellites, it is using its foreign policy to try to hobble potential U.S. space weapons. For example, Russia (along with China) has advocated for a treaty preventing the placement of weapons in outer space and the threat or use of force against space-based assets. Russia is fully aware that there are no known technologies or capabilities to verify compliance with such a treaty. The purpose in pursuing such arms control agreements is to hobble U.S. weapons and technology development, because of the domestic political opposition such rhetoric might generate and because the United States will comply with any arms control agreement that it signs. The Russians do not have the same constitutional and political constraints in place as the United States to restrain its development of ASATs. Moreover, the Russians are accustomed to violating arms control agreements that it they have signed. Writes defense analyst Mark Schneider: “There is no reason to expect Russia to break a habit of ignoring its arms control and treaty obligations. By doing this, it has gained military advantages for decades.”119

#### Russia uses non-compliance to expand military power at the expense of the US.

Payne & Foster 17 – \*Keith, PhD in IR @ USC, Professor of Defense and Strategic Studies @ Mo State, \*\*John, PhD, Director of Defense Research and Engineering, Department of Defense; Director of the Lawrence Livermore National Laboratory (“Russian strategy Expansion, crisis and conflict,” Comparative Strategy, 36.1)

Russian arms control behavior, including the desire to limit U.S. military capabilities through legally binding agreements while violating those agreements when convenient, is an element of Russia’s overall strategy for accomplishing Moscow’s expansionist goals outlined in Chapter One. Russia sees arms control, including noncompliance with its treaty obligations, as a tool to be employed as necessary to obtain military advantage, convey strength, compel respect as a superpower, deter Western challenges, enhance its freedom of action and leverage over others, and bolster the regime’s respect and domestic legitimacy by demonstrating toughness and a willingness to confront the West. Moscow views arms control not as a cooperative activity to create a more benign world. It is another arena in which to reinforce President Putin’s statement that, “It’s best not to mess with us.”1 Too often there is a tendency in the West to dismiss individual Russian arms control violations as mere “technical” violations that are not “militarily significant.” This approach ignores the broader role that arms control and a policy of arms control noncompliance play in helping Russia to achieve its strategic objectives and the military capabilities possible as a result of noncompliance. Soviet/Russian arms control violations generally are not accidents, one-time incidents, misunderstandings or legitimate disputes concerning the technical meaning of treaty obligations. More often, they are directly related to Russian military objectives, which in turn are related to achieving foreign policy goals such as: 1) recovering Russia’s great power status through enhanced nuclear capability; 2) extending its sphere of influence over (i.e., dominating) former Soviet space by enhancing Russia’s political and military power in Europe; 3) constraining U.S. military capabilities; and, 4) undermining NATO’s will and capability to resist. If an arms control commitment—either legal or political—comes to interfere with an important Russian objective, it is simply ignored. Significantly, Russia has violated arms control agreements even when it was clear the violations would be detected.

#### Russian expansionism leads to nuclear use.

Payne & Foster 17 – \*Keith, PhD in IR @ USC, Professor of Defense and Strategic Studies @ Mo State, \*\*John, PhD, Director of Defense Research and Engineering, Department of Defense; Director of the Lawrence Livermore National Laboratory (“Russian strategy Expansion, crisis and conflict,” *Comparative Strategy*, 36.1)//BB

Russian nuclear and conventional force programs and Russia grand strategy Russia clearly attributes political and military value to its nuclear arsenal, and the threat of limited nuclear first use more specifically, as a means to support its efforts to reassert its dominance over the post-Soviet space. Moscow’s strategy is intended to intimidate neighbors and deter outside interference in Russian activities through the threat of nuclear first use. Russia’s apparently low nuclear threshold raises the stakes in any conflict, and compels adversaries to confront the possibility that should they become involved, so too would Russian nuclear weapons. This has been prominently displayed throughout hostilities in Ukraine, as Russian nuclear exercises, official statements, and bomber patrols are intended to intimidate Western states. First and foremost, Russia’s strategy couples multidimensional operations with overt nuclear threats for the purpose of precluding retaliation by the aggrieved party and/or its allies—thus giving Russia a free hand to pursue its expansionist goals. Moscow seeks this seemingly ultimate trump card within its “near abroad.” This use of nuclear weapons is not a replay of Cold War notions of mutual nuclear deterrence. It is a strategy of nuclear coercion to support expansionist goals. As noted in Chapter Three, Deputy Commander of NATO Forces in Europe General Sir Adrian Bradshaw, concluded in this regard that Russia’s “threat of escalation might be used to prevent reestablishment of territorial integrity.”125 Acclaimed Russian analyst Pavel Felgenhauer agreed, suggesting Moscow is becoming comfortable with using the threat of nuclear war to “scare the West into concessions.”126 This continued approach could lead to an “emboldened Russia brandishing nuclear weapons each time it wants something.”127 Despite describing its policy as purely defensive, it is clear that Russia considers nuclear coercion as a great power instrument to be leveraged during periods of hostilities to protect a potential fait accompli. If, as seems to be the case, Moscow views this as a viable strategy, Russia may continue to act more aggressively toward post-Soviet states, potentially including the eastern portion of NATO, backed up by nuclear threats. At the very least, if the Kremlin feels threatened, it will display its nuclear sabre to escalate the conflict to a nuclear level others would simply be unwilling to match. During a meeting at the Valdai Club in October 2014, Putin himself gave a history lesson on the power of nuclear intimidation, stating: True, the Soviet Union was referred to as “the Upper Volta with missiles.” Maybe so, and there were loads of missiles. Besides, we had such brilliant politicians like Nikita Khrushchev, who hammered the desk with his shoe at the UN. And the whole world, primarily the United States, and NATO thought: this Nikita is best left alone, he might just go and fire a missile, they have lots of them, we should better show some respect for them.128 The danger in this Russian view is obvious: nuclear brinksmanship could trigger a chain of events that leads to a nuclear confrontation or conflict.129 Should a confident and “bold” Putin severely miscalculate a NATO response, he could believe nuclear escalation of a conflict to be a viable option. In addition, if a conflict erupts, Russia’s flexible and discriminate nuclear systems may afford Moscow the ability to frustrate NATO war-planning. By employing specific, specialized systems against high-value target sets, such as aircraft carriers, critical command and control nodes, and long-range air bases, Russia could effectively carry out an offset strategy using both non-nuclear and nuclear means to negate NATO’s conventional superiority by destroying the alliance’s most prized assets. This could cause enormous losses for NATO military personal and infrastructure, and constrain NATO’s ability to conduct offensive operations to dislodge an occupying Russian force. As is intended, Moscow’s threat to use nuclear weapons could result in coercive pressure to prevent certain conventional NATO actions during the course of a conflict as well—essentially a form of intra-war nuclear coercion.130 This could consist of nuclear threats to prevent NATO from targeting supply hubs, air bases, or sophisticated air and missile defenses located just inside Russia’s borders, which could be critical targets during an operation to remove Russian forces. By threatening nuclear escalation, Moscow could force NATO to choose between limiting its response or nuclear war. Thus, NATO must prepare for not just a miscalculated Russian nuclear strike, but a calculated one as well. Finally, should deterrence fail and a crisis escalate, Russian leaders could believe that limited nuclear use would localize and terminate a conflict on advantageous terms, as is suggested by its nuclear escalation strategy. Moscow appears to believe that it can control escalation by restraining the types of nuclear weapons used, their targets, and under what circumstances each weapon is used, while threatening the possibility of further nuclear escalation, up to global nuclear war. Essentially, by credibly threatening to break the long revered nuclear taboo, Russia appears to anticipate being able to coerce NATO into submission or acquiescence to Russian domination of the post-Soviet space. In short, Russian nuclear strategy envisions the threat of and possible employment of nuclear weapons to achieve military and political objectives. As Sergei Ivanov once told the state Duma, “As regard to use of nuclear weapons in case of aggression, of course [we will use them in this case]. What else were they built for?131 The Times of London reported in April 2015 that retired Russian generals, who had been briefed by Ivanov and approved by Putin, met with a group of retired U.S. generals and warned that if NATO builds up its forces in the Baltics, Russia would respond by increasing its “nuclear posture” and that, “Russia will use its nuclear weapons against NATO.”132 However, the core of Russia’s nuclear strategy does not appear to anticipate a general nuclear war with NATO. The Kremlin appears to believe that NATO’s greatest strength is also its most exploitable weakness: dependence on unanimity among its 28 members.133 Following the great Chinese strategist Sun Tzu’s teaching on the value of disrupting an enemy’s alliances, Russian limited nuclear use threats appear intended to divide NATO by threatening greater destruction and loss should the bloc fail to yield during a conflict. The Russian leadership appears to assume that French, British, American, and German leaders will be divided in their willingness to risk nuclear retaliation over distant regions such as Warsaw, Narva, or Daugavpils. As U.S. Amb. Robert Joseph has noted, “Russia’s doctrine assumes an asymmetry of interests and a lack of willingness on the part of the enemy to risk nuclear war (emphasis added).”134 A fundamental component of Russia’s nuclear strategy is to challenge NATO’s resolve. Indeed, the Russian leadership has seemingly come to see limited nuclear threats as a viable policy option specifically fashioned to challenge NATO, based on the presumption that most NATO members ultimately will be unwilling to defend their Eastern-most allies in the face of Russian nuclear escalation threats.135 Conclusion The Russian leadership undoubtedly views nuclear weapons as an essential coercive instrument to accomplish both political and military objectives related to securing Moscow’s goals. By developing a spectrum of nuclear threats and capabilities, and a strategy to employ nuclear weapons, Russia clearly backstops its expansionist campaigns. Whether it be covering hybrid operations, intimidating European states, or potentially employing nuclear strikes to defeat a conventionally superior adversary, nuclear weapons and the threat of their use are likely to remain, if not grow, in importance for Russia. In short, Russia’s nuclear strategy is in line with the Putin regime’s worldview and grand strategy discussed in Chapter One, the goal of which is to establish a new Eurasian security order based on Russian hegemony at the expense of NATO, and more importantly, the United States. More disturbingly, the Kremlin appears to believe that actual nuclear employment is a realistic option in support of expansion. Should Putin determine a major confrontation probable, he could conclude that launching a limited nuclear strike would be an advantageous option. Given Putin’s apparent propensity for risk-taking and his absolute desire to reestablish a greater Russia, he could find himself in a situation where he greatly miscalculates either his own forces’ abilities or NATO’s willingness to capitulate. If Russia’s nuclear exercises are an indication, the threat of Russian nuclear first use is real in a European contingency that is itself the result of Russian expansionism and aggression.

### 1NC - AT: Debris

#### No debris cascades, but even a worst case is confined to low LEO with no impact

Fange 17 [Daniel Von Fange, Web Application Engineer, Founder and Owner of LeanCoder, Full Stack, Polyglot Web Developer, “Kessler Syndrome is Over Hyped”, 05/21/17, *Braino*, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/]

Kessler Syndrome is overhyped. A chorus of online commenters great any news of upcoming low earth orbit satellites with worry that humanity will to lose access to space. I now think they are wrong. What is Kessler Syndrome? Here’s the popular view on Kessler Syndrome. Every once in a while, a piece of junk in space hits a satellite. This single impact destroys the satellite, and breaks off several thousand additional pieces. These new pieces now fly around space looking for other satellites to hit, and so exponentially multiply themselves over time, like a nuclear reaction, until a sphere of man-made debris surrounds the earth, and humanity no longer has access to space nor the benefits of satellites. It is a dark picture. Is Kessler Syndrome likely to happen? I had to stop everything and spend an afternoon doing back-of-the-napkin math to know how big the threat is. To estimate, we need to know where the stuff in space is, how much mass is there, and how long it would take to deorbit. The orbital area around earth can be broken down into four regions. Low LEO - Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over. High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue. Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here. GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here. How bad could Kessler Syndrome in High LEO be? Let’s imagine a worst case scenario. An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space? I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000. So even in the worst case, we don’t lose access to space. Now though you can travel through the debris, you couldn’t keep a satellite alive for long in this orbit of death. Kessler Syndrome at its worst just prevents us from putting satellites in certain orbits. In real life, there’s a lot of factors that make Kessler syndrome even less of a problem than our worst case though experiment. Debris would be spread over a volume of space, not a single orbital surface, making collisions orders of magnitudes less likely. Most impact debris will have a slower orbital velocity than either of its original pieces - this makes it deorbit much sooner. Any collision will create large and small objects. Small objects are much more affected by atmospheric drag and deorbit faster, even in a few months from high LEO. Larger objects can be tracked by earth based radar and avoided. The planned big new constellations are not in High LEO, but in Low LEO for faster communications with the earth. They aren’t an issue for Kessler. Most importantly, all new satellite launches since the 1990’s are required to include a plan to get rid of the satellite at the end of its useful life (usually by deorbiting) So the realistic worst case is that insurance premiums on satellites go up a bit. Given the current trend toward much smaller, cheaper micro satellites, this wouldn’t even have a huge effect. I’m removing Kessler Syndrome from my list of things to worry about.

#### 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.

#### 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.

#### 1AC Scoles is about government missions --- public sector thumps --- Haven reads blue.

Scoles 15 ~~[(Sarah Scoles, freelance science writer, contributor at Wired and Popular Science, author of the books Making Contact and They Are Already Here) "Dust from asteroid mining spells danger for satellites," New Scientist, May 27, 2015, <https://www.newscientist.com/article/mg22630235-100-dust-from-asteroid-mining-spells-danger-for-satellites/>~~] TDI

* Study this is citing – Javier Roa, Space Dynamic Group, Applied Physics Department, Technical University of Madrid. Casey J Handmer, Theoretical Astrophysics, California Institute of Technology. Both PhD Candidates. "Quantifying hazards: asteroid disruption in lunar distant retrograde orbits," arXiv, Cornell University, May 14, 2015, <https://arxiv.org/pdf/1505.03800.pdf>

NASA chose the second option for its [Asteroid Redirect Mission](http://www.nasa.gov/content/what-is-nasa-s-asteroid-redirect-mission/), which aims to [pluck a boulder from an asteroid’s surface](https://www.newscientist.com/article/dn27243-rock-grab-from-asteroid-will-aid-human-mission-to-mars) and relocate it to a stable orbit around the moon. But an asteroid’s gravity is so weak that it’s not hard for surface particles to escape into space. Now a new model warns that debris shed by such transplanted rocks could intrude where many defence and communication satellites live – in geosynchronous orbit.

According to [Casey Handmer](http://www.caseyhandmer.com/) of the California Institute of Technology in Pasadena and Javier Roa of the Technical University of Madrid in Spain, 5 per cent of the escaped debris will end up in regions traversed by satellites. Over 10 years, it would cross geosynchronous orbit 63 times on average. A satellite in the wrong spot at the wrong time will suffer a damaging high-speed collision with that dust.

The study also looks at the "catastrophic disruption" of an asteroid 5 metres across or bigger. Its total break-up into a pile of rubble would increase the risk to satellites by more than 30 per cent ([arxiv.org/abs/1505.03800](http://arxiv.org/abs/1505.03800)).

#### AT: Thompson --- Government launches to ISS, Soyuz, etc. are a/c to debris

#### Don’t solve Rauenzhan 20 --- a. powertagged --- just says companies want profit, b. no ind. impacts, c. just because of a dearth of ilaw --- the 1AC doesn’t solve

#### No impact to dust --- millions of particles already in the atmosphere and thumped --- mechanical failures in the squo. Haven reads green.

Intagliata 17, [(Christopher Intagliata, MA Journalism from NYU, Editor for NPRs All Things Considered, Reporter/Host for Scientific American’s 60 Second Science) “The Sneaky Danger of Space Dust,” Scientific American, May 11, 2017, https://www.scientificamerican.com/podcast/episode/the-sneaky-danger-of-space-dust/] Recut Sachin

When tiny particles of space debris slam into satellites, the collision could cause the emission of hardware-frying radiation, Christopher Intagliata reports.

Aside from all the satellites, and the space station orbiting the Earth, there's a lot of trash circling the planet, too. Twenty-one thousand baseball-sized chunks of debris, according to NASA. But that number's dwarfed by the number of small particles. There's hundreds of millions of those.

"And those smaller particles tend to be going fast. Think of picking up a grain of sand at the beach, and that would be on the large side. But they're going 60 kilometers per second."

Sigrid Close, an applied physicist and astronautical engineer at Stanford University. Close says that whereas mechanical damage—like punctures—is the worry with the bigger chunks, the dust-sized stuff might leave more insidious, invisible marks on satellites—by causing electrical damage.

"We also think this phenomenon can be attributed to some of the failures and anomalies we see on orbit, that right now are basically tagged as 'unknown cause.'"

Close and her colleague Alex Fletcher modeled this phenomenon mathematically, based on plasma physics behavior. And here's what they think happens. First, the dust slams into the spacecraft. Incredibly fast. It vaporizes and ionizes a bit of the ship—and itself. Which generates a cloud of ions and electrons, traveling at different speeds. And then: "It's like a spring action, the electrons are pulled back to the ions, ions are being pushed ahead a little bit. And then the electrons overshoot the ions, so they oscillate, and then they go back out again.”

That movement of electrons creates a pulse of electromagnetic radiation, which Close says could be the culprit for some of that electrical damage to satellites. The study is in the journal Physics of Plasmas. [Alex C. Fletcher and Sigrid Close, Particle-in-cell simulations of an RF emission mechanism associated with hypervelocity impact plasmas]