### Framework

I value justice,

The value criterion is maximizing well being by promoting pleasure

#### Pleasure and pain are the starting points of moral reasoning. Every impact can be explained as good because it promotes pleasure, or bad bc it promotes pain. We know death is bad, bc it causes massive amounts of suffering, and we know saving lives is good bc it promotes pleasure. Therefore because pleasure is an intrinsic good, we should seek to maximize it in the world, and save the most amount of people possible.

**Moen ’16** – (Ole Martin, PhD, Research Fellow in Philosophy @ University of Oslo, "An Argument for Hedonism." Journal of Value Inquiry 50.2 (2016): 267). Modified for glang

Let us start by observing, empirically, that a widely shared judgment about intrinsic value and disvalue is that pleasure is intrinsically valuable and pain is intrinsically disvaluable. On virtually any proposed list of intrinsic values and disvalues (we will look at some of them below), pleasure is included among the intrinsic values and pain among the intrinsic disvalues**.** This inclusion makes intuitive sense, moreover, for **there is something undeniably good about the way pleasure feels and something undeniably bad about the way pain feels,** and neither the goodness of pleasure nor the badness of pain seems to be exhausted by the further effects that these experiences might have. “Pleasure” and “pain” are here understood inclusively, as encompassing anything hedonically positive and anything hedonically negative. 2 The special value statuses of pleasure and pain are manifested in how we treat these experiences in our everyday reasoning about values. If you tell me that you are heading for the convenience store, I might ask: “What for?” This is a reasonable question, for when you go to the convenience store you usually do so, not merely for the sake of going to the convenience store, but for the sake of achieving something further that you deem to be valuable. You might answer, for example: “To buy soda.” This answer makes sense, for soda is a nice thing and you can get it at the convenience store. I might further inquire, however: “What is buying the soda good for?” This further question can also be a reasonable one, for it need not be obvious why you want the soda. You might answer: “Well, I want it for the pleasure of drinking it.” If I then proceed by asking “But what is the pleasure of drinking the soda good for?” the discussion is likely to reach an awkward end. The reason is that the pleasure is not good for anything further; it is simply that for which going to the convenience store and buying the soda is good. 3 As Aristotle observes: “**We never ask what her**~~is~~ **end is in being pleased, because we assume that pleasure is choice worthy in itself.**”4 Presumably, a similar story can be told in the case of pains, for if someone says “This is painful!” we never respond by asking: “And why is that a problem?” We take for granted that if something is painful, we have a sufficient explanation of why it is bad. If we are onto something in our everyday reasoning about values, it seems that pleasure and pain are both places where we reach the end of the line in matters of value. Although pleasure and pain thus seem to be good candidates for intrinsic value and disvalue, several objections have been raised against this suggestion: (1) that pleasure and pain have instrumental but not intrinsic value/disvalue; (2) that pleasure and pain gain their value/disvalue derivatively, in virtue of satisfying/frustrating our desires; (3) that there is a subset of pleasures that are not intrinsically valuable (so-called “evil pleasures”) and a subset of pains that are not intrinsically disvaluable (so-called “noble pains”), and (4) that pain asymbolia, masochism, and practices such as wiggling a loose tooth render it implausible that pain is intrinsically disvaluable. I shall argue that these objections fail.

#### Death is the worst evil

Paterson 03 – Department of Philosophy, Providence College, Rhode Island. (Craig, “A Life Not Worth Living?”, Studies in Christian Ethics, <http://sce.sagepub.com>)

Contrary to those accounts, I would argue that it is death per se that is really the objective evil for us, not because it deprives us of a prospective future of overall good judged better than the alter- native of non-being. It cannot be about harm to a former person who has ceased to exist, for no person actually suffers from the sub-sequent non-participation. Rather, death in itself is an evil to us because it ontologically destroys the current existent subject — it is the ultimate in metaphysical lightening strikes.80 The evil of death is truly an ontological evil borne by the person who already exists, independently of calculations about better or worse possible lives. Such an evil need not be consciously experienced in order to be an evil for the kind of being a human person is. Death is an evil because of the change in kind it brings about, a change that is destructive of the type of entity that we essentially are. Anything, whether caused naturally or caused by human intervention (intentional or unintentional) that drastically interferes in the process of maintaining the person in existence is an objective evil for the person. What is crucially at stake here, and is dialectically supportive of the self-evidency of the basic good of human life, is that death is a radical interference with the current life process of the kind of being that we are. In consequence, death itself can be credibly thought of as a ‘primitive evil’ for all persons, regardless of the extent to which they are currently or prospectively capable of participating in a full array of the goods of life.81 In conclusion, concerning wille d human actions, it is justifiable to state that any intentional rejection of human life itself cannot therefore be warranted since it is an expression of an ultimate disvalue for the subject, namely, the destruction of the present person; a radical ontological good that we cannot begin to weigh objectively against the travails of life in a rational manner. To deal with the sources of disvalue (pain, suffering, etc.) we should not seek to irrationally destroy the person, the very source and condition of all human possibility.82

### Advantage 1

#### The advantage is space tourism

#### Every tourist we put in space kills the planet through black carbon and nitrogen oxides.

Ebbs 21 (Stephanie, reporter/producer @ ABC citing numerous climate experts and scientific models, 12-9-2021, "Experts say climate impact is a question mark if space tourism takes off," ABC News, <https://abcnews.go.com/Technology/experts-climate-impacts-question-mark-space-tourism-takes/story?id=81609878>) AG

That “space tourism” could add hundreds more rocket launches to the mix each year as companies like Virgin Galactic say they plan to expand flights to hundreds a year, and experts say those launches could generate more greenhouse gases amid the battle against global warming.One model published in the American Geophysical Union magazine found that 400 space flights per year over 40 years would generate enough greenhouse gas emissions to cause up to 1°C more warming in the Arctic than is already projected. “When you get to that kind of change, those are the kinds of changes that we worry about when it comes to impacts of climate change in general from other human emissions at the surface like CO2,” said Darin Toohey, a professor of atmospheric science at the University of Colorado- Boulder and one of the authors of the study. There isn’t a lot of research about the impact of space tourism on the environment, but Toohey says experts can make some estimates based on the type of fuel the rockets use and what happens when that fuel is burned. Toohey says he is especially concerned about carbon-based fuels like the ones used by SpaceX and Virgin Galactic because they generate soot or “black carbon” when they’re burned. Toohey said black carbon has the potential to be really problematic because it reflects sunlight and could amplify warming in the upper levels of the atmosphere. “If you look at kilogram per kilogram, the black carbon is between 100,000 and a million times more effective at heating the upper atmosphere,” he told ABC News. Representatives for Virgin Galactic and SpaceX did not respond to requests for comment. Blue Origin says the rocket taking the New Shepard capsule into space is fueled by liquid oxygen and hydrogen. The company says that during flight, the only byproduct of New Shepard’s engine combustion is water vapor with no carbon emissions. Eloise Marais, a professor of geography at University College London, said water vapor can still contribute to warming the atmosphere.”It’s not doing nothing up there. [Water vapor] can also actually contribute to the formation of clouds in the upper atmosphere where clouds are quite rare and clouds, also, unfortunately, have climate impacts. They change how much sun is reflected or reaches the surface of the earth,” she said. “So there's all these sort of complexities to consider in something like water vapor that sounds so innocuous.” "Good Morning America" co-anchor Michael Strahan is scheduled to participate in Saturday’s expected Blue Origin launch. Marais added that all types of space travel will generate nitrogen oxides, or NOx, from the high temperatures needed to re-enter the atmosphere. NOx are 300 times more potent than carbon dioxide at warming the atmosphere, according to the EPA. While researchers have begun to look into the impacts of rocket launches from private companies, it’s hard to estimate the impact on the climate without knowing how many flights there will be. Virgin Galactic has said the company hopes to launch 400 flights a year. Blue Origin and SpaceX have not indicated how many launches they hope to execute. But Marais said even if the industry is much smaller than commercial air travel, for example, there’s a big difference in that rockets fly at a higher altitude and release pollution directly into multiple layers of the atmosphere.“I think the huge difference that we have to take into account is the direct injection of these pollutants into multiple layers in the atmosphere and the impact that that has is completely different to aircraft which tend to fly, roughly, 10 to 12 kilometers depending on what kind of flight you’re taking, and that's that is really what separates them substantially,” she said.

#### The impact is warming. Space tourism is uniquely bad – destroys the ozone, causes permanent heating, and alters the jet stream.

Pultarova 21 (Tereza, MA Cultural Anthropology and science/tech journalist, 7-26-2021, "The rise of space tourism could affect Earth's climate in unforeseen ways, scientists worry," Space, <https://www.space.com/environmental-impact-space-tourism-flights>) AG

Northern Sky Research predicts that the number of space tourism flights will skyrocket over the next decade, from maybe 10 a year in the near future to 360 a year by 2030, Kasaboski said. This estimate is still far below the growth rate that space tourism companies like Virgin Galactic and Blue Origin envision for themselves. "Demand for suborbital tourism is extremely high," Kasaboski said. "These companies virtually have customers waiting in a line, and therefore they want to scale up. Ultimately, they would want to fly multiple times a day, just like short-haul aircraft do." The rate of rocket launches delivering satellites into orbit is expected to grow as well. But Kasaboski sees bigger potential for growth in space tourism. "It's like the difference between a cargo flight and a passenger flight," Kasaboski said. "There's a lot more passengers that are looking to fly." The problem is, according to Ross, that the scientific community has no idea and not enough data to tell at what point rocket launches will start having a measurable effect on the planet's climate. At the same time, the stratosphere is already changing as the number of rocket launches sneakily grows. "The impacts of these [rocket-generated] particles are not well understood even to an order of magnitude, the factor of 10," Ross said. "The uncertainty is large, and we need to narrow that down and predict how space might be impacting the atmosphere." Space shuttle's ozone holes So far, the only direct measurements of the effects of rocket launches on chemical processes in the atmosphere come from the space shuttle era. In the 1990s, as the world was coming together to salvage the damaged ozone layer, NASA, NOAA and the U.S. Air Force put together a campaign that looked at the effects of the emissions from the space shuttle's solid fuel boosters on ozone in the stratosphere. "In the 1990s, there were significant concerns about chlorine from solid rocket motors," Ross said. "Chlorine is the bad guy to ozone in the stratosphere, and there were some models which suggested that ozone depletion from solid rocket motors would be very significant." The scientists used NASA's WB 57 high-altitude aircraft to fly through the plumes generated by the space shuttle rockets in Florida. Reaching altitudes of up to 60,000 feet (19 km), they were able to measure the chemical reactions in the lower stratosphere just after the rockets' passage. "One of the fundamental questions was how much chlorine is being made in these solid rocket motors and in what form," David Fahey, the director of the Chemical Sciences Laboratory at NOAA, who led the study, told Space.com. "We measured it several times and then analyzed the results. At that time, there were not enough space shuttle launches to make a difference globally, but locally one could deplete the ozone layer due to this diffuse plume [left behind by the rocket]." The space shuttle retired 10 years ago, but rockets generating ozone-damaging substances continue launching humans and satellites to space today. In fact, in 2018, in its latest Scientific Assessment of Ozone Depletion, which comes out every four years, the World Meteorological Organization included rockets as a potential future concern. The organization called for more research to be done as the number of launches is expected to increase. Worse than geoengineering Rosenlof's team studies the broader effects of human-made substances in the higher layers of the atmosphere using powerful NOAA supercomputers. The work is akin to predicting the proverbial butterfly effect, the influence of minuscule changes in the chemistry of the air tens of miles above Earth on climate and weather patterns on the ground. For her, black carbon, or soot, emitted by rockets burning hydrocarbon fuels, is of particular concern. "The problem with soot is that it absorbs ultraviolet light, and that means that it could heat the stratosphere," Rosenlof said. "When you start heating the stratosphere, the layer above the troposphere [closest to the ground], you start changing the motion in the stratosphere. You are changing the energy transfer, and that could actually affect what is happening on the ground." Rosenlof points out that many of the particles generated by some rockets have been of interest to scientists due to the possible effects they could have on the global climate in a different context — that of geoengineering, the deliberate tampering with the atmosphere with the aim of stopping or mitigating global warming. Rosenlof recently co-authored a paper that used the same powerful NOAA supercomputers to model what the scientists call a climate intervention. The team was interested in the climate effects of dispersing sulfur dioxide particles, which are known to reflect light away from Earth, in combination with soot (which is also part of rocket emissions) in the lower stratosphere. Soot absorbs energy from sunlight and pushes the sulfur dioxide aerosol particles to a higher altitude by warming up the surrounding air. At that higher altitude, the sulfur dioxide can start its climate-cooling work. The experiment modeled what would happen when 1.1 million tons of sunlight-reflecting sulfur dioxide mixed with 11,000 tons of black carbon were released in the upper troposphere by aircraft over a 10-day period. The study didn't find any significant negative effects on weather on Earth. Yet, those results do not dispel Rosenlof's concerns about the possible risks associated with the growing number of rocket launches. Altering the jet stream "Black carbon in the geoengineering experiment that we did isn't as high as the stuff from these rockets," she said. "The problem is that the higher you go, the longer something lasts. Neither of them is ideal, because either of them would produce heating in places where we don't have heating right now." According to Maggi, the soot particles generated by hybrid rocket engines are extremely small and light-weight. In fact, when he and his colleagues tried to measure the soot output of hybrid rocket engines in a laboratory, they couldn't reliably do it with precision because of the particles' minuscule size. "We were able to measure the particle output from solid rocket motors," Maggi said. "These are about a micron in size, and there [are] a lot of them. But because they are large, they fall to the ground more quickly. In hybrid rocket engines, we were not able to collect the soot from the plume because it's extremely fine, a few nanometres in size." Maggi fears these particles could, in fact, stay in the stratosphere forever. "They have the same size as the carbon emitted by aircrafts," Maggi said. "And we know that there is a layer of carbon in the atmosphere at the flight level of aircrafts which is staying there. It's very likely that particles coming from rocket motors will do the same." The accumulation of these particles over years and decades is what worries the scientists. Just as the current climate crisis started relatively slowly as the amount of carbon released into the atmosphere grew, the pollution in the stratosphere may only start causing harm some years down the road. Rosenlof added that in the long term, injecting pollutants into the stratosphere could alter the polar jet stream, change winter storm patterns or affect average rainfall. "You might go from 25 inches [64 centimeters] a year to 20 inches [51 cm] a year in some places, which maybe doesn't sound like that big of a deal unless you are a farmer trying to grow your wheat right there," Rosenlof said. "Then a subtle change in rainfall can impact your crop yields.

#### The Montreal Protocol proves climate change can be solved through incremental reform. But further ozone layer damage will send us over the brink.

Mongabay 21 (nature news website citing a study published in Nature, 8-1-2021, "In saving the ozone layer, we avoided even more intense global warming," Mongabay Environmental News, <https://news.mongabay.com/2021/08/in-saving-the-ozone-layer-we-avoided-even-more-intense-global-warming/>) AG

Signed in 1987, the Montreal Protocol is best known as the agreement that got the world to stop using chemicals that deplete the ozone layer, the thin shield that keeps out the most harmful ultraviolet rays. But besides averting perhaps millions of excess deaths from skin cancer, the protocol has helped combat climate change by keeping global warming in check, the study published in Nature found. The main culprits that damage the planet’s ozone layer, chlorofluorocarbons (CFCs), are also potent greenhouse gases. Starting in the 1960s, CFCs came into widespread use in refrigeration and air-conditioning. Without the Montreal Protocol to get rid of these gases, the intensified UV radiation would have damaged plants and reduced their capacity to absorb carbon dioxide by as much as 690 billion metric tons by the end of this century, according to the analysis. In the grimmest scenario, that would mean an additional 1° Celsius (1.8° Fahrenheit) of warming. Sunlight is building block of life, but too much radiation is dangerous for life on Earth. Overexposure to it can cause health problems in humans from sunburns to more severe conditions like cataracts and cancers. Plants that are exposed continuously to sunlight can wither and die. The carbon cycle would look a lot different in such a situation: Plants that suffer damage from UV radiation would be a lot less effective at stashing carbon. Ozone is found in the stratosphere, 15-35 kilometers (9-22 miles) above the Earth’s surface. It’s a highly unstable gas molecule made up of three oxygen atoms. With the sun’s radiation acting on them, CFCs break down into compounds containing chlorine. This chlorine binds with the oxygen atoms in ozone, destroying it. The ozone hole isn’t really a hole; it refers to patches of the atmosphere where ozone concentration is low. This allows too much harmful UV radiation that would otherwise be reflected back into space to pass right through. What scientists hadn’t been able to capture fully until now were the co-benefits of the Montreal Protocol’s success. So they modeled what would have happened to ozone concentrations if the Montreal Protocol did not exist. In the worst-case scenario, the ozone layer would have collapsed by 2040. The dangerous thinning of the layer, especially over the Antarctic, where climatic conditions also favor ozone destruction, sparked alarm in the mid-1980s. The hole changes in size throughout the year, and is the widest in August and September. In 1984, climatologists found that the ozone layer above the Antarctic had slimmed to two-thirds of its thickness. This was shocking but not altogether unexpected. Scientists had been warning about the hazards of human-made CFCs for more than a decade before countries came together to sign the Montreal Protocol in 1987. The protocol is to the ozone hole what environmentalists hope the Paris Agreement will be to climate change. All U.N. member states ratified the protocol, agreeing to binding, time-bound and measurable targets. It limited the use of almost 100 synthetic chemicals that could destroy atmospheric ozone, banning some and requiring others to be phased out. And it appears to be working. Three decades after the protocol came into effect in 1989, the ozone shield is on its way to recovery. Some estimates suggest it could be back to pre-1980 levels as early as 2060. These actions did not happen all at once; there was a gradual phasing-out of CFCs. These were progressively replaced by hydrochlorofluorocarbons (HCFCs). HCFCs are less destructive to ozone but still cause warming. A newer generation of substances called hydrofluorocarbons (HFCs), which don’t contain chlorine and hence don’t impinge on the ozone layer, came next. However, HFCs still cause warming, so the Kigali Amendment to the Montreal Protocol, which came into effect in 2019, sought to curb their use, seeking a reduction of 80% by 2047. Even then, many of these substances persist in the atmosphere and the actual impact on ozone levels is visible only decades down the line. “Overall, using ozone depletion to explore the effects of delay or dilution of a global policy response to a global environmental challenge may have relevance well beyond the Montreal Protocol,” the authors write. A recent IPCC report says the planet has already warmed by about 1.1°C (2°F) since the 19th century. It warns that more warming is inevitable in the next 30 years. The experience with the Montreal Protocol shows that things can still change post-2050.

#### Climate change causes biodiversity loss, marine ecosystem collapse, resource wars, global food scarcity, and extreme weather events.

Pachauri and Meyer 15 (Rajendra K. Pachauri Chairman of the IPCC, Leo Meyer Head, Technical Support Unit IPCC were the editors for this IPCC report, “Climate Change 2014 Synthesis Report” <http://epic.awi.de/37530/1/IPCC_AR5_SYR_Final.pdf> IPCC, 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp)

SPM 2.3 Future risks and impacts caused by a changing climate

Climate change will **amplify existing risks** and **create new risks for natural and human systems**. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development. {2.3}

Risk of climate-related impacts results from the interaction of climate-related hazards (including hazardous events and trends) with the vulnerability and exposure of human and natural systems, including their ability to adapt. Rising rates and **magnitudes of warming** and other changes in the climate system, **accompanied by ocean acidification**, increase the risk of severe, pervasive and in some cases irreversible detrimental impacts. Some risks are particularly relevant for individual regions (Figure SPM.8), while others are global. The overall risks of future climate change impacts can be reduced by **limiting the rate and magnitude of climate change**, including ocean acidification. The precise levels of climate change sufficient to trigger abrupt and irreversible change remain uncertain, but the risk associated with **crossing such thresholds increases with rising temperature** (medium confidence). For risk assessment, it is important to evaluate the **widest possible range of impacts**, including low-probability outcomes with large consequences. {1.5, 2.3, 2.4, 3.3, Box Introduction.1, Box 2.3, Box 2.4}

A large fraction of species faces **increased extinction risk** due to climate change during and beyond the 21st century, especially as climate change interacts with other stressors (high confidence). Most plant species cannot naturally shift their geographical ranges sufficiently fast to keep up with current and high projected rates of climate change in most landscapes; most small mammals and freshwater molluscs will not be able to keep up at the rates projected under RCP4.5 and above in flat landscapes in this century (high confidence). Future risk is indicated to be high by the observation that natural global climate change at rates lower than current anthropogenic climate change caused significant ecosystem shifts and species extinctions during the past millions of years. **Marine organisms will face progressively low**er **oxygen levels** and high rates and magnitudes of ocean acidification (high confidence), with associated risks exacerbated by rising ocean temperature extremes (medium confidence). **Coral reefs and polar ecosystems are highly vulnerable**. Coastal systems and low-lying areas are at risk from sea level rise, which will continue for centuries even if the global mean temperature is stabilized (high confidence). {2.3, 2.4, Figure 2.5}

Climate change is projected to undermine food security (Figure SPM.9). Due to projected climate change by the mid-21st century and beyond, global marine species redistribution and marine biodiversity reduction in sensitive regions will **challenge the sustained provision of fisheries** productivity and other ecosystem services (high confidence). For wheat, rice and maize in tropical and temperate regions, climate change without adaptation is projected to negatively impact production for local temperature increases of 2°C or more above late 20th century levels, although individual locations may benefit (medium confidence). Global temperature increases of ~4°C or more 13 above late 20th century levels, combined with increasing food demand, would pose large risks to **food security globally** (high confidence). Climate change is projected to reduce renewable **surface water and groundwater resources** in most dry subtropical regions (robust evidence, high agreement), **intensifying competition for water among sectors** (limited evidence, medium agreement). {2.3.1, 2.3.2}

Until mid-century, projected climate change will impact human health mainly by exacerbating health problems that already exist (very high confidence). Throughout the 21st century, climate change is expected to lead to **increases in ill-health** in many regions and especially in developing countries with low income, as compared to a baseline without climate change (high confidence). By 2100 for RCP8.5, the combination of high temperature and humidity in some areas for parts of the year is expected to compromise common human activities, including growing food and working outdoors (high confidence). {2.3.2}

In urban areas climate change is projected to increase risks for people, assets, economies and ecosystems, including risks from **heat stress**, **storms** and **extreme precipitation**, **inland and coastal flooding,** **landslides**, **air pollution**, **drought**, **water scarcity**, **sea level rise** and storm surges (very high confidence). These risks are amplified for those lacking essential infrastructure and services or living in exposed areas. {2.3.2}

Rural areas are expected to experience major impacts on water availability and supply, food security, infrastructure and agricultural incomes, including shifts in the production areas of food and non-food crops around the world (high confidence). {2.3.2}

**Aggregate economic losses accelerate with increasing temperature** (limited evidence, high agreement), but global economic impacts from climate change are currently difficult to estimate. From a poverty perspective, **climate change impacts are projected to slow down economic growth**, make poverty reduction more difficult, further erode food security and prolong **existing and create new poverty traps**, the latter particularly in urban areas and emerging hotspots of hunger (medium confidence). International dimensions such as trade and relations among states are also important for understanding the risks of climate change at regional scales. {2.3.2}

Climate change is projected to increase displacement of people (medium evidence, high agreement). Populations that lack the resources for planned migration experience higher exposure to extreme weather events, particularly in developing countries with low income. **Climate change can indirectly increase risks of violent conflicts** by amplifying well-documented drivers of these conflicts such as poverty and economic shocks (medium confidence). {2.3.2}

### Advantage 2

#### Private space mining and ownership allowed now

Williams 20 [(Matt Williams, Reporter) “Trump signs an executive order allowing mining the moon and asteroids,” Phys Org, April 13, 2020, <https://phys.org/news/2020-04-trump-moon-asteroids.html>] TDI

Trump signs an executive order allowing mining the moon and asteroids

In 2015, the Obama administration signed the [U.S. Commercial Space Launch Competitiveness Act](https://www.congress.gov/bill/114th-congress/house-bill/2262/text) (CSLCA, or H.R. 2262) into law. This bill was intended to "facilitate a pro-growth environment for the developing commercial space industry" by making it legal for American companies and citizens to own and sell resources that they extract from asteroids and off-world locations (like the moon, Mars or beyond).

On April 6th, the Trump administration took things a step further by signing an [executive order](https://www.space.com/trump-moon-mining-space-resources-executive-order.html) that formally recognizes the rights of private interests to claim resources in [space](https://phys.org/tags/space/). This order, titled "[Encouraging International Support for the Recovery and Use of Space Resources](https://www.whitehouse.gov/presidential-actions/executive-order-encouraging-international-support-recovery-use-space-resources/)," effectively ends the decades-long debate that began with the signing of [the Outer Space Treaty](https://www.universetoday.com/20590/moon-for-sale/) in 1967.

#### New investments coming and companies are launching – economic incentives make it alluring

Tosar 20 [(Borja Tosar, reporter) “Asteroid Mining: A New Space Race,” OpenMind BBVA, May 18, 2020, <https://www.bbvaopenmind.com/en/science/physics/asteroid-mining-a-new-space-race/>] TDI

This is not science fiction. There are now space mining companies, such as [Planetary Resources,](https://www.consensys.space/pr) which has already launched several mini-satellites to test several of its patents. Other companies like [Asteroid Mining Corporation](https://asteroidminingcorporation.co.uk/) or [Trans Astronautica Corporation,](https://www.transastracorp.com/) although still far from their goal, are already attracting millions of dollars of private investment interested in being on the front line of a possible future space business.

Is asteroid mining possible? This new space race already began back when the Hayabusa missions successfully returned a few grams of an asteroid’s regolith, so the technology to harvest asteroid material exists, we just have to change the scale. It is no longer a technological problem.

Is it economically viable? We are increasingly dependent on rare elements (such as those in the palladium group), which are expensive to exploit on Earth and come with a high environmental cost, so the sum of these two factors could make it profitable to travel to the asteroids to extract these raw materials. Astrophysicist Neil deGrasse argues that [the planet’s first trillionaire will undoubtedly be a space miner.](https://www.cnbc.com/2015/05/01/build-the-economy-here-on-earth-by-exploring-space-tyson.html)

#### Asteroid mining spikes the risk of satellite-dust collisions

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)).

#### Space dust wrecks satellites and debris exponentially spirals

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/>] TDI

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](https://www.scientificamerican.com/article/orbital-debris-space-fence/) of debris, [according to NASA](https://www.orbitaldebris.jsc.nasa.gov/faq.html). 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](http://aip.scitation.org/doi/full/10.1063/1.4980833)]

#### Scenario 1 is Climate

#### Earth observation satellites key to warming adaptation

Alonso 18 [(Elisa Jiménez Alonso, communications consultant with Acclimatise, climate resilience organization) “Earth Observation of Increasing Importance for Climate Change Adaptation,” Acclimatise, May 2, 2018, <https://www.acclimatise.uk.com/2018/05/02/earth-observation-of-increasing-importance-for-climate-change-adaptation/>] TDI

Earth observation (EO) satellites are playing an increasingly important role in assessing climate change. By providing a constant and consistent stream of data about the state of the climate, EO is not just improving scientific outcomes but can also inform climate policy.

Managing climate-related risks effectively requires accurate, robust, sustained, and wide-ranging climate information. Reliable observational climate data can help scientists test the accuracy of their models and improve the science of attributing certain events to climate change. Information based on projections from models and historic data can help decision makers plan and implement adaptation actions.

Providing information in data-sparse regions

Ground-based weather and climate monitoring systems only cover about 30% of the Earth’s surface. In many parts of the world such data is incomplete and patchy due to poorly maintained weather stations and a general lack of such facilities.

EO satellites and rapidly improving satellite technology, especially data from open access programmes, offer a valuable source information for such data-sparse regions. This is especially important since countries and regions with a lack of climate data are often particularly vulnerable to climate change impacts.

International efforts for systematic observation

The importance of satellite-based observations is also recognised by the international community. Following the recommendations of the World Meteorological Organization’s (WMO) Global Climate Observing System (GCOS) programme, the UNFCCC strongly encourages countries that support space agencies with EO programmes to get involved in GCOS and support the programme’s implementation. The Paris Agreement highlights the need for and importance of effective and progressive responses to the threat of climate change based on the best available scientific knowledge. This implies that climate knowledge needs to be strengthened, which includes continuously improving systematic observations of the Earth’s climate.

To meet the need of such systematic climate observations, GCOS developed the concept of the Essential Climate Variable, or ECV. According to WMO, an ECV “is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth’ s climate.” In 2010, 50 ECVs which would help the work of the UNFCCC and IPCC were defined by GCOS. The ECVs, which can be seen below, were identified due to their relevance for characterising the climate system and its changes, the technical feasibility of observing or deriving them on a global scale, and their cost effectiveness.

The 50 Essential Climate Variables as defined by GCOS.

One effort supporting the systemic observation of the climate is the European Space Agency’s (ESA) Climate Change Initiative (CCI). The programme taps into its own and its member countries’ EO archives that have been established in the last three decades in order to provide a timely and adequate contribution to the ECV databases required by the UNFCCC.

Robust evidence supporting climate risk management

Earth observation satellites can observe the entire Earth on a daily basis (polar orbiting satellites) or continuously monitor the disk of Earth below them (geostationary satellites) maintaining a constant watch of the entire globe. Sensors can target any point on Earth even the most remote and inhospitable areas which helps monitor deforestation in vast tropical forests and the melting of the ice caps.

Without insights offered by EO satellites there would not be enough evidence for decision makers to base their climate policies on, increasing the risk of maladaptation. Robust EO data is an invaluable resource for collecting climate information that can inform climate risk management and make it more effective.

#### Scenario 2 is Miscalc

#### Early warning satellites going dark signals attacks – causes miscalc and war

Orwig 16 [(Jessica, MS in science and tech journalism from Texas A&M, BS in astronomy and physics from Ohio State) “Russia says a growing problem in space could be enough to spark a war,” Insider,’ January 26, 2016, <https://www.businessinsider.com/russia-says-space-junk-could-spark-war-2016-1>] TDI

NASA has already warned that the large amount of space junk around our planet is growing beyond our control, but now a team of Russian scientists has cited another potentially unforeseen consequence of that debris: War.

Scientists estimate that anywhere from 500,000 to 600,000 pieces of human-made space debris between 0.4 and 4 inches in size are currently orbiting the Earth and traveling at speeds over 17,000 miles per hour.

If one of those pieces smashed into a military satellite it "may provoke political or even armed conflict between space-faring nations," Vitaly Adushkin, a researcher for the Institute of Geosphere Dynamics at the Russian Academy of Sciences, reported in a paper set to be published in the peer-reviewed journal Acta Astronautica, which is sponsored by the International Academy of Astronautics.

Say, for example, that a satellite was destroyed or significantly damaged in orbit — something that a 4-inch hunk of space junk could easily do traveling at speeds of 17,500 miles per hour, Adushkin reported. (Even smaller pieces no bigger than size of a pea could cause enough damage to the satellite that it would no longer operate correctly, he notes.)

It would be difficult for anyone to determine whether the event was accidental or deliberate.

This lack of immediate proof could lead to false accusations, heated arguments and, eventually, war, according to Adushkin and his colleagues.

A politically dangerous dilemma

In the report, the Adushkin said that there have already been repeated "sudden failures" of military spacecraft in the last two decades that cannot be explained.

"So, there are two possible explanations," he wrote. The first is "unregistered collisions with space objects." The second is "machinations" [deliberate action] of the space adversary.

"This is a politically dangerous dilemma," he added.

But these mysterious failures in the past aren't what concerns Adushkin most.

It's a future threat of what experts call the cascade effect that has Adushkin and other scientists around the world extremely concerned.

The Kessler Syndrome

In 1978, American astrophysicist Donald Kessler predicted that the amount of space debris around Earth would begin to grow exponentially after the turn of the millennium.

Kessler 's predictions rely on the fact that over time, space junk accumulates. We leave most of our defunct satellites in space, and when meteors and other man-made space debris slam into them, you get a cascade of debris.

The cascade effect — also known as the Kessler Syndrome — refers to a critical point wherein the density of space junk grows so large that a single collision could set off a domino effect of increasingly more collisions.

For Kessler, this is a problem because it would "create small debris faster than it can be removed," Kessler said last year. And this cloud of junk could eventually make missions to space too dangerous.

For Adushkin, this would exacerbate the issue of identifying what, or who, could be behind broken satellites.

The future

So far, the US and Russian Space Surveillance Systems have catalogued 170,000 pieces of large space debris (between 4 and 8 inches wide) and are currently tracking them to prevent anymore dilemmas like the ones Adushkin and his colleagues cite in their paper.

But it's not just the large objects that concern Adushkin, who reported that even small objects (less than 1/3 of an inch) could damage satellites to the point they can't function properly.

Using mathematical models, Adushkin and his colleagues calculated what the situtation will be like in 200 years if we continue to leave satellites in space and make no effort to clean up the mess. They estimate we'll have:

1.5 times more fragments greater than 8 inches across

3.2 times more fragments between 4 and 8 inches across

13-20 times more smaller-sized fragments less than 4 inches across

"The number of small-size, non-catalogued objects will grow exponentially in mutual collisions," the researchers reported.