# Climate Innovation DA

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### NC – Regular

#### The private sector is essential for space exploration – competition is key and government development is not effective, efficient, or cheap enough. Thiessen 21:

Marc Thiessen, 6-1, 21, Washington Post, Opinion: SpaceX’s success is one small step for man, one giant leap for capitalism, https://www.washingtonpost.com/opinions/2020/06/01/spacexs-success-is-one-small-step-man-one-giant-leap-capitalism/

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?

#### Continued private space development is the only way to make sustainable energy feasible – empirics prove. Autry 19:

Greg Autry {the director of the Southern California Commercial Spaceflight Initiative at the University of Southern California, vice president at the National Space Society, and chair of the International Space Development Conference, }, 19 - ("Space Research Can Save the Planet—Again," Foreign Policy, 7-20-2019, [https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/)//marlborough-wr/](https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/)/marlborough-wr/)

Today conservationists and other critics are more likely to see space programs as militaristic splurges that squander billions of dollars better applied to solving problems on Earth. These well-meaning complaints are misguided, however. Earth’s problems—most urgently, climate change—can be solved only from space. That’s where the tools and data already being used to tackle these issues were forged and where the solutions of the future will be too. Space research has already been critical in averting one major environmental disaster. It was NASA satellite data that revealed a frightening and growing hole in the ozone layer over the South Pole, galvanizing public concern that, in 1987, produced the Montreal Protocol: the first international agreement addressing a global environmental problem. Since then, thanks to worldwide restrictions on damaging chlorofluorocarbons, the ozone situation has stabilized, and a full planetary recovery is expected. As this case showed, space can provide the vital information needed to understand a problem—and a surprising range of ways to solve it. Climate change is a poster child for the critical role of space data. Trekking across the globe to measure ice sheets with drills and gauge sea temperatures from the sides of ships is an expensive, slow, and insufficient way to assay the state of the planet. Satellites operated by NASA, the U.S. National Oceanic and Atmospheric Administration, and an increasing number of commercial firms provide a plethora of multispectral imaging and radar measurements of developments such as coral reef degradation, harmful plankton blooms, and polar bears negotiating thinning ice. Much of the technology involved in observing the Earth today was initially developed for probes sent to explore other planets in our solar system. Indeed, understanding the evolution of other planets’ climates is essential for modeling possible outcomes on Earth. NASA probes revealed how, roughly 4 billion years ago, a runaway greenhouse gas syndrome turned Venus into a hot, hellish, and uninhabitable planet of acid rain. Orbiters, landers, and rovers continue to unravel the processes that transformed a once warm and wet Mars into a frigid, dry dust ball—and scientists even to conceive of future scenarios that might terraform it back into a livable planet. Discovering other worlds’ history and imagining their future offers important visions for climate change mitigation strategies on Earth, such as mining helium from the moon itself for future clean energy. Spinoff technologies from space research, from GPS to semiconductor solar cells, are already helping to reduce emissions; the efficiency gains of GPS-guided navigation shrink fuel expenditures on sea, land, and air by between 15 and 21 percent—a greater reduction than better engines or fuel changes have so far provided. Modern solar photovoltaic power also owes its existence to space. The first real customer for solar energy was the U.S. space program; applications such as the giant solar wings that power the International Space Station have continually driven improvements in solar cell performance, and NASA first demonstrated the value of the sun for powering communities on Earth by using solar in its own facilities. Promisingly, space-based solar power stations could overcome the inconvenient truth that wind and solar will never get us anywhere near zero emissions because their output is inherently intermittent and there is, so far, no environmentally acceptable way to store their power at a global scale, even for one night. Orbital solar power stations, on the other hand, would continually face the sun, beaming clean power back through targeted radiation to Earth day or night, regardless of weather. They would also be free from clouds and atmospheric interference and therefore operate with many times the efficiency of current solar technology. Moving solar power generation away from Earth—already possible but held back by the current steep costs of lifting the materials into space—would preserve land and cultural resources from the blight of huge panel farms and save landfills from the growing problem of discarded old solar panels. Sustainable energy advocates in the U.S. military and the Chinese government are actively pursuing space-based solar power, but just making solar cells damages the environment due to the caustic chemicals employed. Space technology offers the possibility of freeing the Earth’s fragile biosphere and culturally important sites from the otherwise unavoidable damage caused by manufacturing and mining. The U.S. start-up Made in Space is currently taking the first steps toward manufacturing in orbit. The company’s fiber-optic cable, produced by machinery on the International Space Station, is orders of magnitude more efficient than anything made on Earth, where the heavy gravity creates tiny flaws in the material. Made in Space and others are eventually planning to build large structures, such as solar power stations, in space. As these technologies develop, they will augment each other, bringing costs down dramatically; space manufacturing, for instance, slashes the cost of solar installations in space. Eventually, firms will be able to supply endeavors in space with materials from the moon and asteroids, avoiding the cost and environmental impact of lifting them into orbit. Mining the solar system comes with its own potential impacts, but extracting resources from distant and lifeless worlds is clearly preferable to the continued degradation of the Earth.

#### Warming causes extinction – outweighs all aff impacts

Miller-McDonald, 18 – (Samuel, Master of Environmental Management at Yale University studying energy politics and grassroots innovations in the US. 5-2-2018. "Extinction vs. Collapse." Resilience. https://www.resilience.org/stories/2018-05-02/extinction-vs-collapse/)

Climate twitter – the most fun twitter – has recently been reigniting the debate between human extinction and mere civilizational collapse, between doom and gloom, despair and (kind of) hope. It was sparked by an interview in The Guardian with acclaimed scientist Mayer Hillman. He argues that we’re probably doomed, and confronting the likelihood that we’re rushing toward collective death may be necessary to save us. The headline alone provoked a lot of reactions, many angered by the ostensible defeatism embedded in Hillman’s comments. His stated view represents one defined camp that is mostly convinced of looming human extinction. It stands in contrast to another group that believes human extinction is highly unlikely, maybe impossible, and certainly will not occur due to climate change in our lifetimes. Collapse maybe, but not extinction. Who’s more right? Let’s take a closer look. First, the question of human extinction is totally bounded by uncertainty. There’s uncertainty in climate data, uncertainty in models and projections, and even more uncertainty in the behavior of human systems. We don’t know how we’ll respond to the myriad impacts climate change is beginning to spark, and we don’t know how sensitive industrial civilization will be to those impacts. We don’t really know if humans are like other apex predators highly sensitive to ecological collapse, or are among the most adaptable mammals to ever walk the earth. One may be inclined to lean toward the latter given that humans have colonized every ecological niche on the planet except Antarctica. That bands of people can survive in and around deserts as well as the Arctic as well as equatorial rainforests speaks to the resilience of small social groups. It’s why The Road is so disturbingly plausible; there could be a scenario in which basically everything is dead but people, lingering in the last grey waste of the world. On the other hand, we’ve never lived outside of the very favorable conditions of the Holocene, and past civilizational and population collapses suggest humans are in fact quite sensitive to climatic shifts. Famed climate scientist James Hansen has discussed the possibility of “Venus syndrome,” for instance, which sits at the far end of worst case scenarios. While a frightening thought experiment, it is easily dismissed as it’s based on so many uncertainties and doesn’t carry the weight of anything near consensus. What’s more frightening than potentially implausible uncertainties are the currently existing certainties. For example: Ecology + The atmosphere has proven more sensitive to GHG emissions than predicted by mainstream science, and we have a high chance of hitting 2oC of warming this century. Could hit 1.5C in the 2020s. Worst-case warming scenarios are probably the most likely. + Massive marine death is happening far faster than anyone predicted and we could be on the edge of an anoxic event. + Ice melt is happening far faster than mainstream predictions. Greenland’s ice sheet is threatening to collapse and already slowing ocean currents, which too could collapse. + Which also means predictions of sea level rise have doubled for this century. + Industrial agriculture is driving massive habitat loss and extinction. The insect collapse – population declines of 75% to 80% have been seen in some areas – is something no one predicted would happen so fast, and portends an ecological sensitivity beyond our fears. This is causing an unexpected and unprecedented bird collapse (1/8 of bird species are threatened) in Europe. + Forests, vital carbon sinks, are proving sensitive to climate impacts. + We’re living in the 6th mass extinction event, losing potentially dozens of species per day. We don’t know how this will impact us and our ability to feed ourselves. Energy + Energy transition is essential to mitigating 1.5+C warming. Energy is the single greatest contributor to anthro-GHG. And, by some estimates, transition is happening 400 years too slowly to avoid catastrophic warming. + Incumbent energy industries (that is, oil & gas) dominate governments all over the world. We live in an oil oligarchy – a petrostate, but for the globe. Every facet of the global economy is dependent on fossil fuels, and every sector – from construction to supply chains to transport to electricity to extraction to agriculture and on and on – is built around FF consumption. There’s good reason to believe FF will remain subsidized by governments beholden to their interests even if they become less economically viable than renewables, and so will maintain their dominance. + We are living in history’s largest oil & gas boom. + Kilocalorie to kilocalorie, FF is extremely dense and extremely cheap. Despite reports about solar getting cheaper than FF in some places, non-hydro/-carbon renewables are still a tiny minority (~2%) of global energy consumption and will simply always, by their nature, be less dense kcal to kcal than FF, and so will always be calorically more expensive. + Energy demand probably has to decrease globally to avoid 1.5C, and it’s projected to dramatically increase. Getting people to consume less is practically impossible, and efficiency measures have almost always resulted in increased consumption. + We’re still setting FF emissions records. Politics + Conditions today resemble those prior to the 20th century’s world wars: extreme wealth inequality, rampant economic insecurity, growing fascist parties/sentiment, and precarious geopolitical relations, and the Thucydides trap suggests war between Western hegemons and a rising China could be likely. These two factors could disrupt any kind of global cooperation on decarbonization and, to the contrary, will probably mean increased emissions (the US military is one of the world’s single largest consumers/emitters of FF). + Neoliberal ideology is so thoroughly embedded in our academic, political, and cultural institutions, and so endemic to discourse today, that the idea of degrowth – probably necessary to avoid collapse – and solidarity economics isn’t even close to discussion, much less realization, and, for self-evident reasons, probably never will be. + Living in a neoliberal culture also means we’ve all been trained not to sacrifice for the common good. But solving climate change, like paying more to achieve energy transition or voluntarily consuming less, will all entail sacrificing for the greater good. Humans sometimes are great at that; but the market fundamentalist ideology that pervades all social, commercial, and even self relations today stands against acting for the common good or in collective action. + There’s basically no government in the world today taking climate change seriously. There are many governments posturing and pretending to take it seriously, but none have substantially committed to a full decarbonization of their economies. (Iceland may be an exception, but Iceland is about 24 times smaller than NYC, so…) + Twenty-five years of governments knowing about climate change has resulted in essentially nothing being done about it, no emissions reductions, no substantive moves to decarbonize the economy. Politics have proven too strong for common sense, and there’s no good reason to suspect this will change anytime soon. + Wealth inequality is embedded in our economy so thoroughly – and so indigenously to FF economies – that it will probably continue either causing perpetual strife, as it has so far, or eventually cement a permanent underclass ruled by a small elite, similar to agrarian serfdom. There is a prominent view in left politics that greater wealth equality, some kind of ecosocialism, is a necessary ingredient in averting the kind of ecological collapse the economy is currently driving, given that global FF capitalism by its nature consumes beyond carrying capacities. At least according to one Nasa-funded study, the combination of inequality and ecological collapse is a likely cause for civilizational collapse. Even with this perfect storm of issues, it’s impossible to know how likely extinction is, and it’s impossible to judge how likely or extensive civilizational collapse may be. We just can’t predict how human beings and human systems will respond to the shocks that are already underway. We can make some good guesses based on history, but they’re no more than guesses. Maybe there’s a miracle energy source lurking in a hangar somewhere waiting to accelerate non-carbon transition. Maybe there’s a swelling political movement brewing under the surface that will soon build a more just, ecologically sane order into the world. Community energy programs are one reason to retain a shred of optimism; but also they’re still a tiny fraction of energy production and they are not growing fast, but they could accelerate any moment. We just don’t know how fast energy transition can happen, and we just don’t know how fast the world could descend into climate-driven chaos – either by human strife or physical storms. What we do know is that, given everything above, we are living through a confluence of events that will shake the foundations of civilization, and jeopardize our capacity to sustain large populations of humans. There is enough certainty around these issues to justify being existentially alarmed. At this point, whether we go extinct or all but a thousand of us go extinct (again), maybe that shouldn’t make much difference. Maybe the destruction of a few billion or 5 billion people is morally equivalent to the destruction of all 7 billion of us, and so should provoke equal degrees of urgency. Maybe this debate about whether we’ll go completely extinct rather than just mostly extinct is absurd. Or maybe not. I don’t know. What I do know is that, regardless of the answer, there’s no excuse to stop fighting for a world that sustains life.

## AT: Focusing on Earth

#### 1. Space exploration and research is crucial to solving climate change on earth

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The first glimpse humanity got of the world from above was transformative. In 1968, the U.S. astronaut William Anders returned from circling the moon in Apollo 8 with a photograph. It was a simple snapshot of the Earth, the whole Earth, rising above the desolate lunar surface. But it was also momentous, representing the very first time anyone had gotten far enough away to view how fragile the world was. The contrast between the lone blue-and-green marble and the cold emptiness of space was beautiful and shocking. As Anders later remarked, “We came all this way to explore the moon, and the most important thing is that we discovered the Earth.” Anders’s Earthrise photo provided conservationists with the iconic illustration they needed. On April 22, 1970, 20 million people turned out for the largest civic event in U.S. history: Earth Day. Today conservationists and other critics are more likely to see space programs as militaristic splurges that squander billions of dollars better applied to solving problems on Earth. These well-meaning complaints are misguided, however. Earth’s problems—most urgently, climate change—can be solved only from space. That’s where the tools and data already being used to tackle these issues were forged and where the solutions of the future will be too. Space research has already been critical in averting one major environmental disaster. It was NASA satellite data that revealed a frightening and growing hole in the ozone layer over the South Pole, galvanizing public concern that, in 1987, produced the Montreal Protocol: the first international agreement addressing a global environmental problem. Since then, thanks to worldwide restrictions on damaging chlorofluorocarbons, the ozone situation has stabilized, and a full planetary recovery is expected. As this case showed, space can provide the vital information needed to understand a problem—and a surprising range of ways to solve it. Climate change is a poster child for the critical role of space data. Trekking across the globe to measure ice sheets with drills and gauge sea temperatures from the sides of ships is an expensive, slow, and insufficient way to assay the state of the planet. Satellites operated by NASA, the U.S. National Oceanic and Atmospheric Administration, and an increasing number of commercial firms provide a plethora of multispectral imaging and radar measurements of developments such as coral reef degradation, harmful plankton blooms, and polar bears negotiating thinning ice. Much of the technology involved in observing the Earth today was initially developed for probes sent to explore other planets in our solar system. IT WAS NASA SATELLITE DATA THAT REVEALED A FRIGHTENING AND GROWING HOLE IN THE OZONE LAYER OVER THE SOUTH POLE, GALVANIZING PUBLIC CONCERN THAT, IN 1987, PRODUCED THE MONTREAL PROTOCOL: THE FIRST INTERNATIONAL AGREEMENT ADDRESSING A GLOBAL ENVIRONMENTAL PROBLEM. Indeed, understanding the evolution of other planets’ climates is essential for modeling possible outcomes on Earth. NASA probes revealed how, roughly 4 billion years ago, a runaway greenhouse gas syndrome turned Venus into a hot, hellish, and uninhabitable planet of acid rain. Orbiters, landers, and rovers continue to unravel the processes that transformed a once warm and wet Mars into a frigid, dry dust ball—and scientists even to conceive of future scenarios that might terraform it back into a livable planet. Discovering other worlds’ history and imagining their future offers important visions for climate change mitigation strategies on Earth, such as mining helium from the moon itself for future clean energy. 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Promisingly, space-based solar power stations could overcome the inconvenient truth that wind and solar will never get us anywhere near zero emissions because their output is inherently intermittent and there is, so far, no environmentally acceptable way to store their power at a global scale, even for one night. Orbital solar power stations, on the other hand, would continually face the sun, beaming clean power back through targeted radiation to Earth day or night, regardless of weather. They would also be free from clouds and atmospheric interference and therefore operate with many times the efficiency of current solar technology. Moving solar power generation away from Earth—already possible but held back by the current steep costs of lifting the materials into space—would preserve land and cultural resources from the blight of huge panel farms and save landfills from the growing problem of discarded old solar panels. Sustainable energy advocates in the U.S. military and the Chinese government are actively pursuing space-based solar power, but just making solar cells damages the environment due to the caustic chemicals employed. Space technology offers the possibility of freeing the Earth’s fragile biosphere and culturally important sites from the otherwise unavoidable damage caused by manufacturing and mining. The U.S. start-up Made in Space is currently taking the first steps toward manufacturing in orbit. The company’s fiber-optic cable, produced by machinery on the International Space Station, is orders of magnitude more efficient than anything made on Earth, where the heavy gravity creates tiny flaws in the material. Made in Space and others are eventually planning to build large structures, such as solar power stations, in space. As these technologies develop, they will augment each other, bringing costs down dramatically; space manufacturing, for instance, slashes the cost of solar installations in space. MINING THE SOLAR SYSTEM COMES WITH ITS OWN POTENTIAL IMPACTS, BUT EXTRACTING RESOURCES FROM DISTANT AND LIFELESS WORLDS IS CLEARLY PREFERABLE TO THE CONTINUED DEGRADATION OF THE EARTH. Eventually, firms will be able to supply endeavors in space with materials from the moon and asteroids, avoiding the cost and environmental impact of lifting them into orbit. Mining the solar system comes with its own potential impacts, but extracting resources from distant and lifeless worlds is clearly preferable to the continued degradation of the Earth. Perhaps the most powerful role space can play is as inspiration. Space tourism might seem like a frivolity for the rich, but it can be so much more. I’ve spent some time with astronauts, and they all report that seeing the Earth without borders and observing its fragile atmosphere shook them to their core, inspiring in them a powerful sense of connection and respect for the environment. As Andrew Newberg, a neuroscientist and physician who has studied this “overview effect,” put it, “You can often tell when you’re with someone who has flown in space. It’s palpable.” Subjecting thousands of the world’s wealthiest and most powerful individuals to a transcendent experience couldn’t hurt—especially if less wealthy Earthlings soon get a chance to follow them. The leaders of the biggest space firms are already thinking way beyond tourism. Tory Bruno, the CEO of United Launch Alliance, envisions a future in which a thousand or more people work in Earth and moon orbits. These people would build stations, conduct research, and produce goods for use in space and on Earth. The Amazon mogul Jeff Bezos imagines a spacefaring civilization that keeps our home planet pristine and protected, as a sort of national park, while dirty extractive and manufacturing processes take place in orbital facilities. SpaceX’s Elon Musk wants to transform Mars back into the healthy world it once was and then fill it with life-forms from Earth—including a significant human population. Some experts have mocked this idea. But experts also lampooned Musk’s plans for reusing rocket boosters and building a high-performance electric car for the masses. The fact is that while some of the plans described by Musk, Bezos, and others might seem utopian or hubristic, given the realities of climate change, humanity needs hope. A future that concentrates only on managing apocalypse, without offering the potential for something better, is no future at all. In the worst scenario, our precious blue-and-green marble will end up looking like its neighbors Venus or Mars simply because we chose not to learn from them.

#### 2. Non-unique - We have past the breaking point and current climate change is irrevirsible

Brad **Plumer** **and** Henry **Fountain 8/9** (Brad Plumer is a climate reporter specializing in policy and technology efforts to cut carbon dioxide emissions. Henry Fountain covers climate change, with a focus on the innovations that will be needed to overcome it.), 8-9-2021, "A Hotter Future Is Certain, Climate Panel Warns. But How Hot Is Up to Us.," NY Times, https://www.nytimes.com/2021/08/09/climate/climate-change-report-ipcc-un.html

Nations have delayed curbing their fossil-fuel emissions for so long that they can no longer [stop global warming from intensifying](https://www.nytimes.com/2021/11/13/climate/cop26-glasgow-climate-agreement.html) over the next 30 years, though there is still a short window to prevent the most harrowing future, a [major new United Nations scientific report](https://www.ipcc.ch/report/ar6/wg1/)has concluded. Humans have already heated the planet by roughly 1.1 degrees Celsius, or 2 degrees Fahrenheit, since the 19th century, largely by burning coal, oil and gas for [energy](https://www.nytimes.com/2021/10/29/business/greece-green-energy-climate-eu.html). And the consequences [can be felt across the globe](https://www.nytimes.com/2021/07/17/climate/heatwave-weather-hot.html?searchResultPosition=5): This summer alone blistering heat waves have killed hundreds of people in the United States and Canada, floods have devastated Germany and China, and wildfires have raged out of control in Siberia, Turkey and [Greece](https://www.nytimes.com/2021/10/29/business/greece-green-energy-climate-eu.html). But that’s only the beginning, according to the report, issued on Monday by the Intergovernmental Panel on [Climate Change](https://www.nytimes.com/2021/10/22/world/europe/russia-arctic-climate-change-putin.html), a body of scientists convened by the [United Nations](https://www.nytimes.com/2021/10/26/climate/greenhouse-gas-emissions-un-climate-report.html). Even if nations started sharply cutting emissions today, total [global warming](https://www.nytimes.com/2021/11/01/world/europe/cop26-glasgow-biden-climate.html) is likely to rise around 1.5 degrees Celsius within the next two decades, a hotter future that is now essentially locked in. At 1.5 degrees of warming, scientists [have found](https://www.nytimes.com/interactive/2018/10/07/climate/ipcc-report-half-degree.html), the dangers grow considerably. Nearly 1 billion people worldwide could swelter in more frequent life-threatening heat waves. Hundreds of millions more would struggle for water because of severe droughts. Some animal and plant species alive today will be gone. Coral reefs, which sustain fisheries for large swaths of the globe, will suffer more frequent mass die-offs. “We can expect a significant jump in extreme weather over the next 20 or 30 years,” said Piers Forster, a [climate scientist](https://www.nytimes.com/2021/11/10/climate/climate-cop26-glasgow.html) at the University of Leeds and one of hundreds of international experts who helped write the report. “Things are unfortunately likely to get worse than they are today.” Not all is lost, however, and humanity can still prevent the planet from getting even hotter. Doing so would require a coordinated effort among countries to stop adding carbon dioxide to the atmosphere by around 2050, which would entail a rapid shift away from fossil fuels starting immediately, as well as potentially removing [vast amounts of carbon from the air](https://www.nytimes.com/2021/01/18/climate/carbon-removal-technology.html). If that happened, global warming would likely halt and level off at around 1.5 degrees Celsius, the report concludes. But if nations fail in that effort, global average temperatures will keep rising — potentially passing 2 degrees, 3 degrees or even 4 degrees Celsius, compared with the preindustrial era. The report describes how every additional degree of warming brings far greater perils, such as ever more vicious floods and heat waves, worsening droughts and accelerating sea-level rise that could threaten the existence of some island nations. The hotter the planet gets, the greater the risks of crossing dangerous “tipping points,” like the irreversible collapse of the immense ice sheets in Greenland and [West Antarctica](https://www.nytimes.com/interactive/2020/04/30/climate/antarctica-ice-climate-change.html). “There’s no going back from some changes in the [climate system](https://www.nytimes.com/2021/11/10/climate/climate-cop26-glasgow.html),” said Ko Barrett, a vice-chair of the panel and a senior adviser for [climate](https://www.nytimes.com/2021/11/10/climate/climate-cop26-glasgow.html) at the National Oceanic and Atmospheric Administration. But, she added, immediate and sustained emissions cuts “could really make a difference in the climate future we have ahead of us.” The report, approved by 195 governments and based on more than 14,000 studies, is the most comprehensive summary to date of the physical science of [climate change](https://www.nytimes.com/2021/10/07/climate/climate-threats-federal-government.html). It will be a focal point when diplomats gather in November at a [U.N. summit in Glasgow](https://www.nytimes.com/article/what-is-cop26-climate-change-summit.html) to discuss how to step up their efforts to reduce emissions. A growing number of world leaders, including President Biden, have endorsed the goal of limiting global warming to 1.5 degrees Celsius, though current policies in the major polluting countries are still far off-track from achieving that target. The 10 biggest emitters of greenhouse gases are China, the United States, the European Union, India, [Russia](https://www.nytimes.com/2021/10/22/world/europe/russia-arctic-climate-change-putin.html), Japan, Brazil, Indonesia, Iran and Canada. The new report leaves no doubt that humans are responsible for global warming, concluding that essentially all of the rise in global average temperatures since the 19th century has been driven by nations burning fossil fuels, clearing forests and loading the atmosphere with greenhouse gases like carbon dioxide and methane that trap heat.