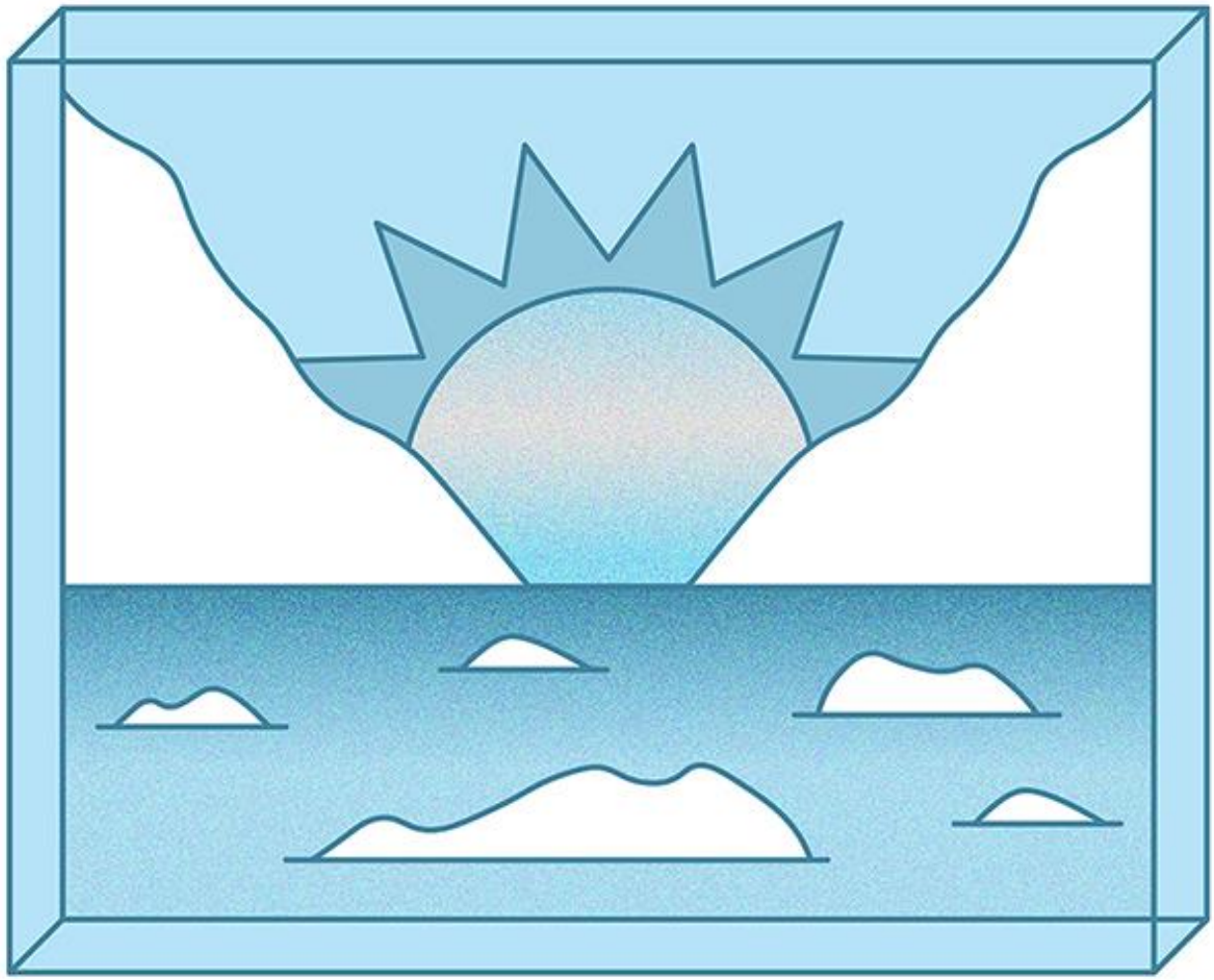
A crash course on climate change, 50 years after the first Earth Day

The science is clear: The world is warming dangerously, humans are the cause of it, and a failure to act today will deeply affect the future of the Earth.

This is a seven-day New York Times crash course on climate change, in which reporters from the Times's Climate desk address the big questions:

1.How bad is climate change now?2.How do scientists know what they know?3.Who is influencing key decisions?4.How do we stop fossil fuel emissions?5.Do environmental rules matter?6.Can insurance protect us?7.Is what I do important?



Ashley Olinger

1. How bad is climate change now?

By Henry Fountain, who has been a Times science writer for 20 years and has traveled to both the Arctic and Antarctica.

Amid the horror and uncertainty of a global health crisis it can be easy to forget that another worldwide disaster is unfolding, although much more slowly.

Global warming is happening, and its effects are being felt around the world. The only real debates are over how fast and how far the climate will change, and what society should do — the global-warming equivalents of lockdowns and social distancing — to slow or stop it and limit the damage.

As of now, the damage seems to be getting worse. As I wrote in December, impacts that scientists predicted years ago — including severe storms, heat waves and the melting of glaciers and ice sheets — are accelerating.

The coronavirus pandemic can seem overwhelming because of its sheer scope; so can climate change. As a science writer at The Times for more than 20 years, I've learned that, to avoid being overwhelmed, it helps to start by understanding one part of the larger problem.

So let's take a closer look at one piece: what's happening at the top of the world, the Arctic. It's a good place to understand the science of climate change, and, it turns out, a critically important one to understand its effects.

Since the mid-1990s, the Arctic has been warming faster than any other region of the planet: currently, at least two and a half times as fast. (Last year, average air temperatures were about 3.5 degrees

Fahrenheit, or 1.9 degrees Celsius, higher than the average from 1981-2010.)

In large part, the Arctic is warming the way the rest of the world warms, only up north the process has run amok.

As the concentration of carbon dioxide and other greenhouse gases increase in the atmosphere, so does the amount of heat they trap. But the source of that heat is sunlight striking the Earth, and the amount of heat radiated differs depending on the surface the sunlight hits. Just as a black car gets much hotter than a white car on a sunny day, darker parts of the planet absorb more sunlight, and in turn radiate more heat, than lighter parts.

The Central Arctic is all ocean — dark water that is covered, to a varying extent, by light ice. The ice absorbs only about 30 to 40 percent of the sunlight hitting it; the rest is reflected. Ocean, on the other hand, absorbs more than 90 percent.

As the Arctic warms more of the ice disappears, leaving more dark ocean to absorb more sunlight and radiate even more heat, causing even more loss of ice. It's a vicious cycle that contributes to rapid warming in the region.

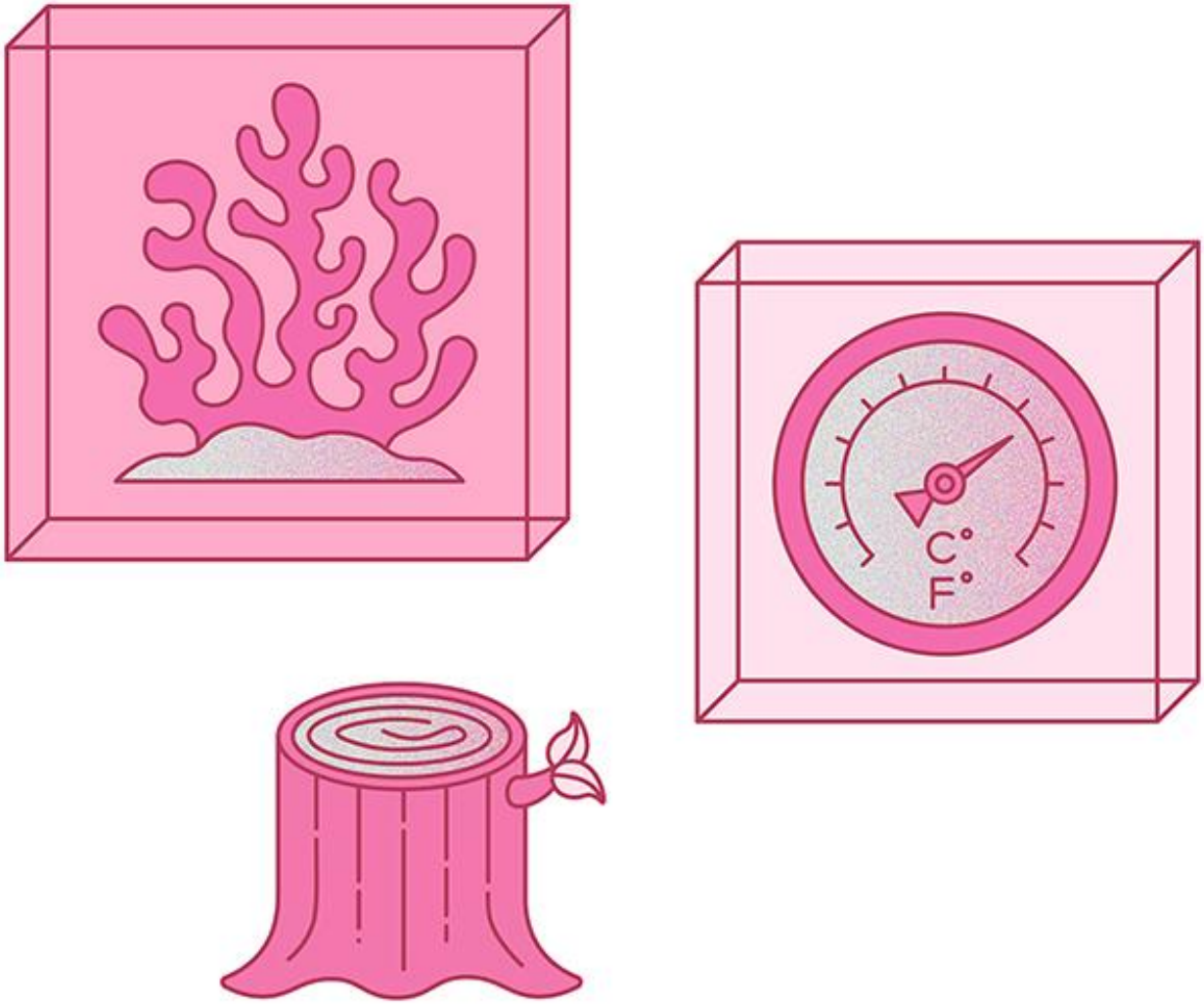
Is this happening at the South Pole as well? No, because while the Arctic is mostly water surrounded by land, Antarctica is the opposite, a huge land mass surrounded by ocean. Some of the ice that covers the continent is melting, but no dark ocean is being exposed. (That's not to say that the continent isn't losing ice: it is, mostly through calving of icebergs and melting of the undersides of ice shelves.)

In the Arctic, currents and winds flow out of the region and affect weather elsewhere.

Weakening of the high-altitude winds known as the polar jet stream can bring extra-frigid winter weather to North America and Europe. Cold snaps like these have occurred for a long time although, because of global warming, studies have found that they are not as cold as they used to be. But some scientists now say they think Arctic warming is causing the jet stream to wobble in ways that lead to more extreme weather year round, by creating zones of high-pressure air that can cause weather systems — the ones that bring extreme heat, for example — to stall.

Arctic warming may also be affecting climate over the longer term. As Greenland's ice sheet melts, the fresh water it releases lowers the saltiness of the nearby ocean. These salinity changes may eventually have an effect on some of the large ocean currents that help determine long-term climate trends in parts of the world.

As climate researchers are fond of saying, what happens in the Arctic doesn't stay in the Arctic.



Ashley Olinger

2. How do scientists know what they know?

By Kendra Pierre-Louis, who writes about climate change and its social and ecological consequences.

When it comes to climate, there's a lot that we know. The second warmest year on record was 2019, and it closed out the hottest recorded decade. Ocean temperatures are rising, too, hitting a high in 2019 as well, and increasing faster than previously estimated.

The changes over just the last few decades are stark, making plain that the planet's climate is warming and that it's human activity behind the temperature rise. But scientists can also look back even further to figure out temperatures on Earth before any humans were alive.

Understanding how scientists figure out what's going on with the climate is an interesting part of being a climate reporter. My favorite piece of equipment is arguably a bathythermograph, essentially an open water thermometer, simply because it's a fun word to say. Instruments like it, together with the GPS-connected devices in the global Argo floats network, are how researchers monitor ocean temperatures.

For annual temperature reports, scientists rely on a historical temperature record — someone or some machine taking daily temperatures. This is how we know, for example, that 2019 was hotter than 1942. But the temperature record only stretches back to the 1800s for much of the world, and has some gaps. To cover them, and to look back even further, researchers rely on proxy, or indirect, measures.

In much the same way that data on the daily consumption of chicken wings can help us suss out the dates of Super Bowl Sundays, things like ice core samples, tree rings, corals, pollen and cave deposits can help us understand how the climate behaved in the past, said Jacquelyn Gill, a paleoecologist and associate professor at the University of Maine.

"I like to think of it as environmental forensics," Dr. Gill said. "Rather than directly observe the past, we use some of the same tools that forensic scientists use to reconstruct the environment through time."

For example, some tree species can live for thousands of years. When cut into, their rings, which resemble a bull's-eye on a tree stump, can clue researchers into not only past temperatures but also moisture levels from year to year.

“We’re not just guessing about how trees record climate in their rings because we have a century or more of actual measurements that we can then compare to tree rings,” Dr. Gill said.

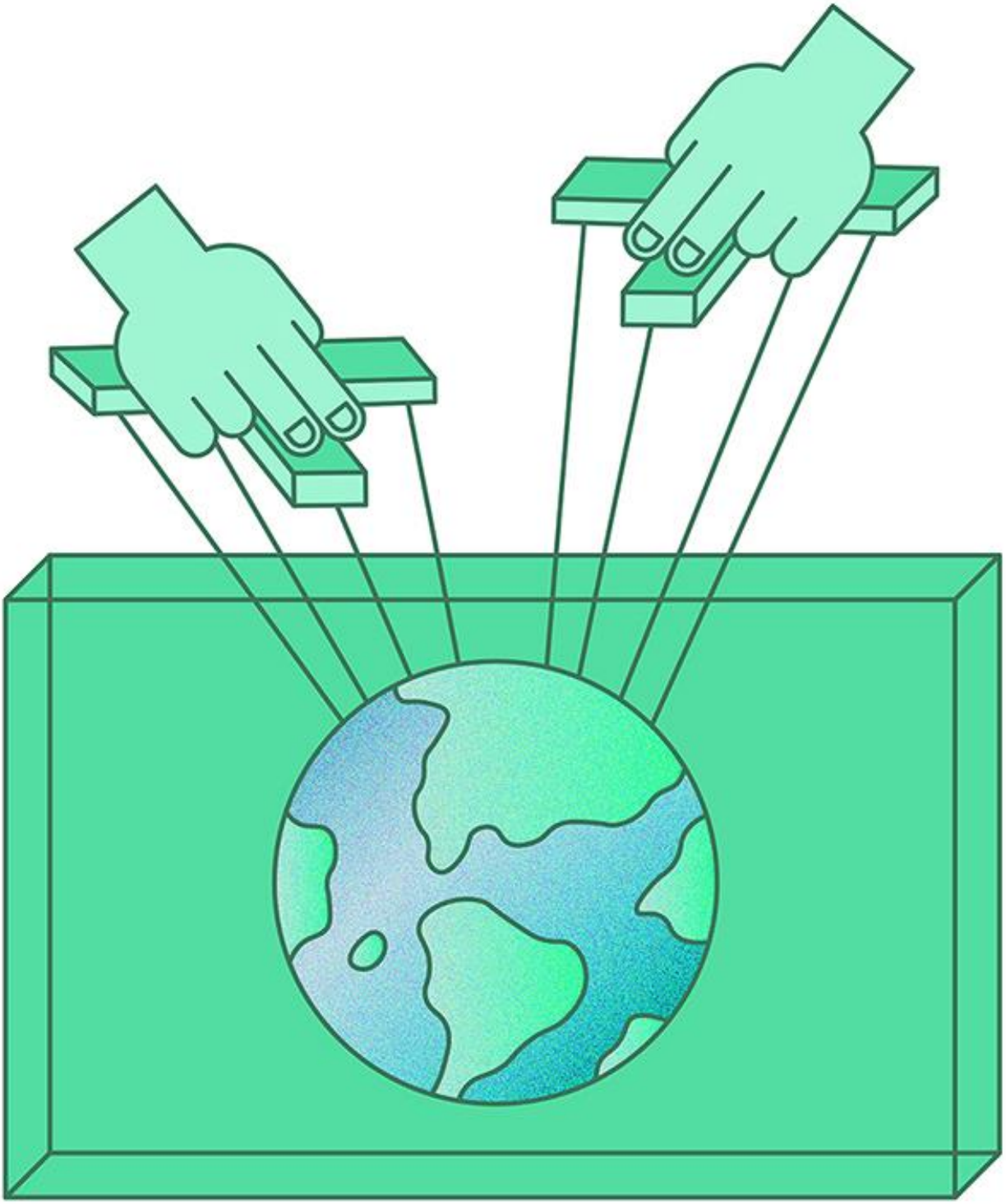
In northern regions like the Arctic, researchers rely on another life form: tiny non-biting midges that spend years living in lakes as larvae before turning into winged insects. As they grow they shed parts of their exoskeletons, which are well preserved in lake sediments. If sediment samples transition from layers that contain species that prefer cooler temperatures into layers with species that prefer warmer ones, it’s a signal that temperatures increased.

Using multiple records means scientists can validate their findings, Dr. Gill said. With tree rings, lake sediments and ice cores from the same region, you can “look across those different proxies and see where you have good agreement and where you don’t.”

But to measure the levels of human caused climate emissions, researchers have other tools.

Since 1958, an observatory near the top of the Mauna Loa volcano in Hawaii has been recording the amount of carbon dioxide in the air and, more recently, observatories in Alaska, Samoa and the South Pole have also been recording measurements. Data is also collected from eight tall towers located across the United States, small aircraft, and volunteers at some 50 locations worldwide. Because carbon dioxide that comes from burning oil and coal is slightly different than the carbon that comes from living animals and plants, researchers know burning fossil fuels is behind the increase.

If you’re noticing a lot of redundancy in how researchers make sense of the climate, that’s the point. They aren’t using a single piece of data, but lots of pieces to stitch together a comprehensive picture that points in a single direction: the climate is warming and humans are causing it.



Ashley Olinger

3. Who is influencing key decisions?

By Hiroko Tabuchi, an investigative reporter on the climate desk who focuses on the fossil fuel industry.

When an administration, Republican or Democratic, proposes a change to a federal rule, it can look like a cut-and-dried affair.

But behind the scenes, rule-making involves extensive lobbying. My job as a journalist looking at the intersection of climate and industry has been to follow the money trail to figure out who's asking for what, and who's getting what they want.

That often involves scrutinizing the powerful fossil fuels industry, which for years has lobbied against policies to tackle global warming, and funded efforts to obscure the well-established science that global warming is caused primarily by greenhouse gases generated by burning fossil fuels and other human activities. These efforts are often obscured from public view, but their influence becomes clear in regulatory and lobbying records and by piecing together information from insiders and other sources willing to talk to us.

The industry has gotten results. Since taking office, President Trump has begun withdrawing the United States from the landmark Paris climate accord, signed five years ago by almost 200 countries to help reduce global emissions. At the urging of coal companies like Peabody Energy, the president halted the Obama administration's Clean Power Plan, designed to rein in emissions from coal-fired power plants. (That hasn't halted the decline of the coal industry, now on even more precarious footing as the Covid-19 outbreak triggers a slump in coal use.)

A powerful oil and gas group also backed weaker oversight for emissions of methane, an invisible, particularly potent greenhouse gas; my video colleague Jonah Kessel and I made some of the gas leaks visible last year with the help of infrared technology.

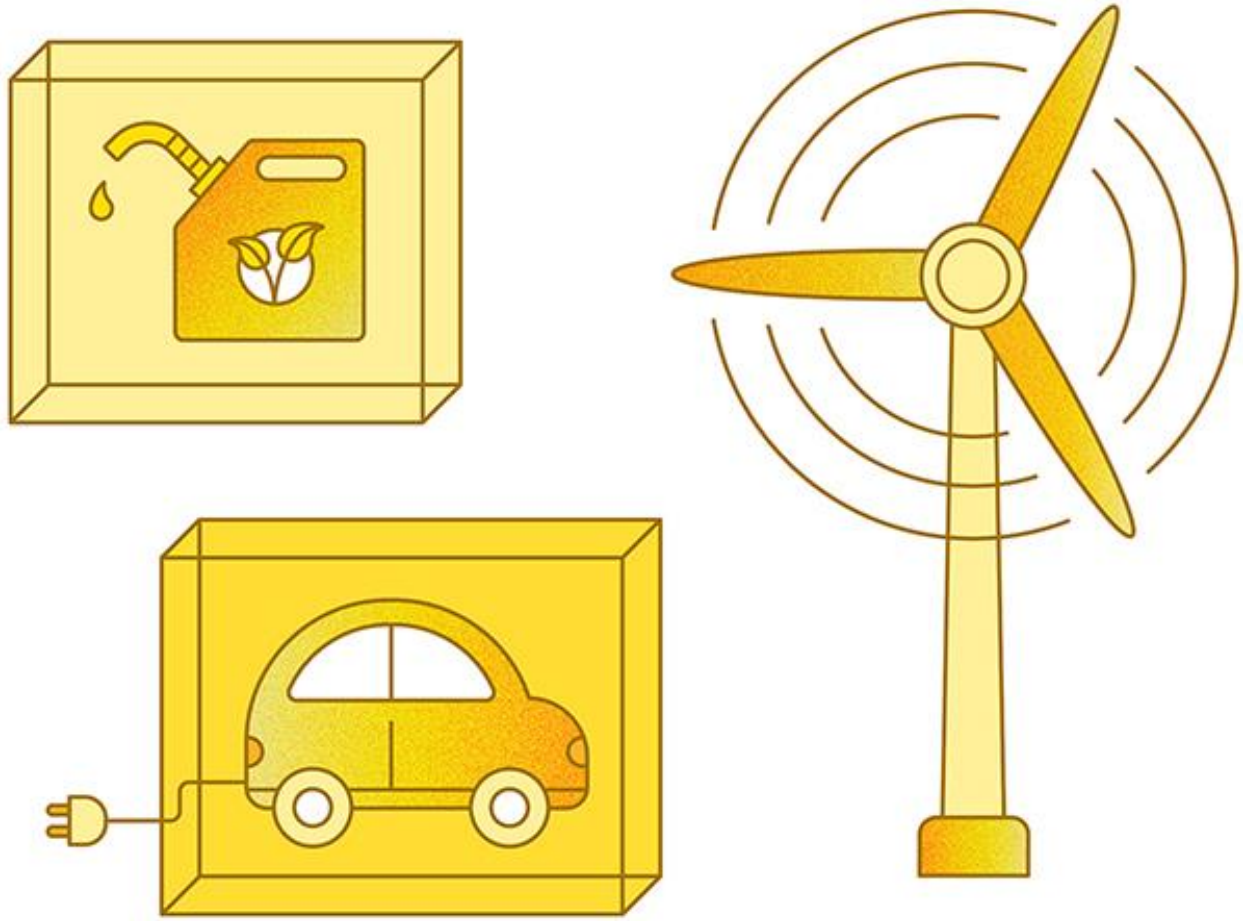
Led by Marathon Petroleum, the country's largest refiner, a separate group representing fuel and petrochemical manufacturersran a stealth campaign to roll back car tailpipe emissions standards, the biggest climate initiative ever adopted by the United States. The rollback has gone so far that it has alarmed even some of the carmakers the measure was supposed to help.

According to the nonpartisan Center for Responsive Politics, the oil and gas industry spent more than $125 million in lobbying at the federal level in 2019 alone. The coal mining industry spent close to an additional $7 million on lobbying. And together, fossil fuel companies have already made at least $50 million in political contributions this year, the vast majority to Republican politicians.

In recent years, as climate activism has gathered steam, oil and gas companies have made commitments to help combat climate change. As world leaders gathered at the United Nations climate summit last fall to discuss the urgency of slashing carbon emissions, for example, 13 of the world's biggest fossil fuel companies announced a set of wide-ranging pledges, from supporting a carbon tax, promising to cut down on methane leaks and investing in technology to scrub carbon dioxide from the air.

But there are concerns those efforts could fall by the wayside, as the oil and gas industry, reeling from the global pandemic, reins in spending. As the coronavirus has spread, industry groups have lobbied, successfully, for drastic rollbacks of environmental rules governing power plants and other industrial facilities. The Environmental Protection Agency has said it will temporarily halt fines for violations of certain air, water and hazardous waste reporting requirements.

As the historians Naomi Oreskes and Erik Conway argue in their seminal book, “Merchants of Doubt,” the methods used by industry to deny the harms of fossil fuel use were in many cases the same as those used by the tobacco industry to deny the harms of cigarettes.
At least in the United States, the tobacco industry is in a long decline. It remains to be seen whether the fossil fuel industry will tread a similar path.



Ashley Olinger

4. How do we stop fossil fuel emissions?

By Brad Plumer, a climate reporter specializing in policy and technology efforts to cut carbon dioxide emissions.

To stop global warming, we’ll need to zero out greenhouse gas emissions from billions of different sources worldwide: every coal

plant in China, every steel mill in Europe, every car and truck on American highways.

It's such an enormous task that it can be tough to figure out where to begin.

As a reporter covering climate policy, I've spoken to hundreds of experts and read through countless dense reports about how countries can slash their emissions. There's often fierce debate over the best path forward. But I've found it helpful to think about all the different proposals out there as essentially boiling down to four broad steps. Consider this a rough game plan for how the world might solve climate change.

Clean up electric power plants

Today, roughly one-quarter of humanity's emissions come from power plants that generate the electricity we use for our lights, air-conditioners and factories. Most power plants still burn coal, natural gas or oil, producing carbon dioxide that heats the planet.

The good news is there are lots of available technologies that can produce electricity without emissions. France cleaned up its grid with nuclear power. California is aiming for zero-emissions electricity by 2045 by installing solar panels and wind turbines. Some companies plan to capture carbon dioxide from existing coal plants and bury it underground.

Experts often disagree on which technologies are best, and technical hurdles remain in cutting emissions all the way to zero; better batteries to juggle wind and solar power would help. But there's broad agreement that we could greatly reduce power-plant emissions with the tools we have today.

Electrify much of our economy

As our power plants get greener, the next step is to rejigger big chunks of our economy to run on clean electricity instead of burning fossil fuels.

For example, we can replace cars that run on gasoline with electric vehicles charged by low-carbon grids. We can replace gas-burning furnaces with electric heat pumps. Instead of steel mills that burn coal, shift to electric furnaces that melt scrap. Roughly another one-quarter of global emissions could conceivably be electrified in this fashion. This daunting task of "electrifying everything" becomes easier if we're also curbing our energy use at the same time. That could entail making cities less dependent on cars, upgrading home insulation and boosting energy-efficiency in factories.

Develop new technology for the hard-to-electrify bits

Parts of the modern economy, alas, can't easily be electrified. Batteries are still too heavy for most airplanes or long-haul trucks. Many key industries, like cement or glass, require extreme heatand currently burn coal or gas.

One recent study concluded that about one-quarter of emissions fall into this "difficult to decarbonize" category.

Governments and businesses will need to invest in new technologies. Some possibilities: power airplanes with sustainable biofuels from crop waste; use green hydrogen, created from renewable energy, to produce industrial heat; or suck carbon dioxide out of the air to offset the emissions we can't eliminate. We'll have to get creative.

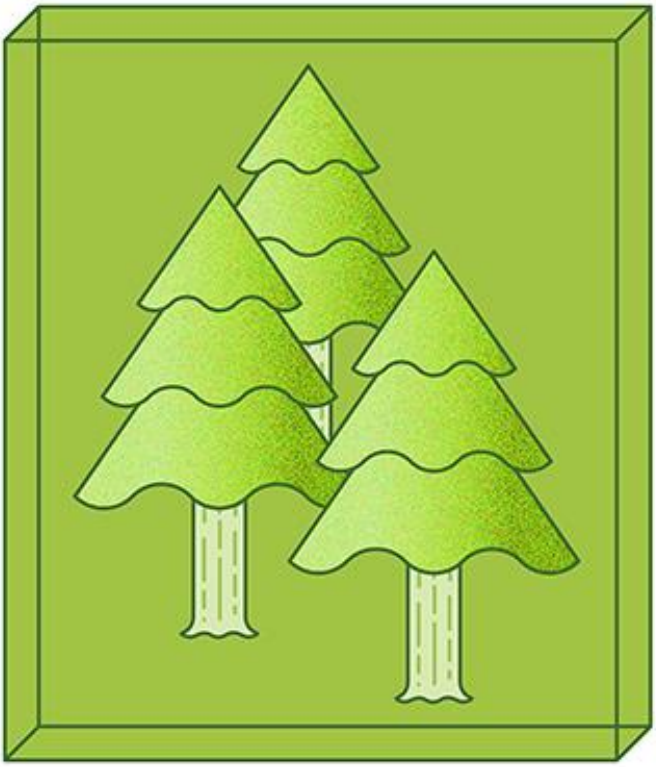
Fix farming

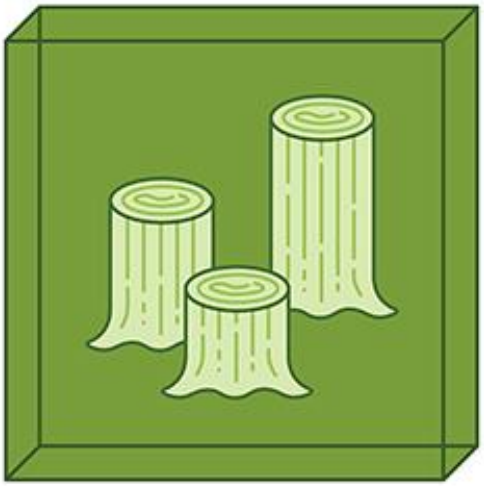
A final one-fourth of global emissions comes from agriculture and deforestation; think cows belching up methane or farmers clearing

swaths of the Amazon for cropland. Figuring out how to feed billions while using less land and producing fewer emissions will take an array of solutions, from improving ranching practices to reducing food waste, but it's crucial.

This list is simplified, of course, and figuring out how to actually achieve these four steps is the hard part. A tax on carbon emissionscould give businesses incentive to find fixes. Governments could ramp up spending on clean technologies. International cooperation and policies to help dislocated workers are vital. And powerful industry interests who prefer the status quo will fight major changes.

But it's a basic road map if we want to zero out emissions, which, scientists agree, is what is ultimately needed to keep the world from heating up endlessly.





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5. Do environmental rules matter?

By Lisa Friedman, who reports on federal climate and environmental policy.

As a reporter in Washington for more than 20 years, I've had a front-row seat to the gridlock that has gripped Congress on climate change.

By 2009, partisanship over the issue was already deeply entrenched. The House, then controlled by Democrats, passed a landmark bill that year that would have created a market-based system to cap greenhouse gas emissions. It died in the Senate. In 2010, amid a Tea Party wave that swept the G.O.P. back into power and many of the House Republicans who voted for the legislation either retired or were voted out of office.

In the words of one ousted Republican, it felt like even acknowledging climate change was "heresy."
That ushered in the era of climate policy by executive order.

Over the next several years, President Barack Obama's administration enacted a series of regulations cutting emissions from automobiles, oil and gas wells and power plants. He banned offshore drilling in parts of the Atlantic and the Arctic oceans, established national monuments across 1.7 million acres of federal land and linked climate change to national security policy.
In 2015, after covering more than seven years of negotiations toward a global agreement many thought would never come, I pushed my way into a crowded tent on the outskirts of Paris to watch world leaders ink a historic accord that was fundamentally shaped by the Obama administration.
"If Congress won't act, I will," Mr. Obama had declared. Unlike laws, however, regulations are highly vulnerable to political winds. And back

in Washington, the House and Senate, then Republican-controlled, were fighting many of the Obama administration's plans.

A few years later, voters elected President Trump. As a candidate Mr. Trump mocked climate change, and as president he quickly made good on promises to eliminate his predecessor's "job-killing" regulations, increase fossil fuel production and withdraw from the Paris Agreement. So far, the Trump administration has moved to eliminate nearly 100 environmental rules.

It's too soon to tell what the impact of the rollbacks will be on the climate. In 2017 the World Resources Institute estimated that if all Mr. Trump's policies were enacted, emissions in the United States by 2025 would range from the equivalent of 5.6 to 6.8 gigatons — compared with a range of about 5.0 to 6.6 gigatons if Mr. Obama's regulations had remained in place. A single gigaton is about the annual emissions of Italy, France and the United Kingdom combined.

Former Vice President Joseph R. Biden, the presumptive Democratic presidential nominee, has pledged to use the "full authority of the executive branch" to cut emissions and move the United States to clean energy by 2050.

His $1.7 trillion plan includes several major executive actions including "aggressive" methane pollution limits; cutting transportation emissions; enacting new efficiency standards for buildings and appliances; and halting new oil and gas permits on public lands and waters. Mr. Biden has not embraced a nationwide ban on fracking, for which he has been heavily criticized by climate activists.

Congress, though, remains stuck. Republicans have embraced some plans like planting trees and technology to capture carbon dioxide emissions, but agreements on broad solutions remain elusive.
Even Republicans who have opposed efforts to contain climate change acknowledge that Congress ultimately holds the key.

In a recent House hearing, Interior Secretary David Bernhardt noted that, among more than 600 laws mandating the agency "shall" do things, none orders it to respond to climate change.

"You know what, there's not a shall for 'I shall manage the land to stop climate change,' or something similar to that," Mr. Bernhardt told lawmakers. "You guys come up with the shalls."

Ashley Olinger

6. Can insurance protect us?

By Christopher Flavelle, who focuses on efforts to cope with global warming's effects.

So you just achieved your dream of becoming a homeowner. Congratulations! But climate change has added a new caveat to homeownership: Whether it's near the water or the woods, in a city or farther out, your home may be increasingly vulnerable to hurricanes, flooding or wildfire.

At least you can always buy insurance, right? About that: There's good news and bad news. But mostly it's bad.

While most of the climate debate is focused on how to curb greenhouse gas emissions, there's another fight going on over a seemingly simple question: As climate change increases the risk to American homeowners, should governments allow the cost of insurance to keep pace with that risk?

This is where regulators, lawmakers and budget officials start to cringe. During my years of reporting on global warming, I've watched the question of insurance become one of the most intractable policy dilemmas facing governments and homeowners — and one with no obvious solution.

The obvious approach might be to let insurance work the way it's meant to, with premiums that reflect the odds of getting hit by a disaster. That would let insurance companies — or, in the case of flood insurance, the federal government — collect enough money to pay out claims. Higher premiums are also a warning to homeowners to avoid living in risky areas.

But homeowners vote. Last year, the Trump administration proposed changing the deeply indebted federal flood insurance program in a way that would make premiums reflect actual risk. Members of Congress from both parties expressed alarm and the administration backed down, delaying the change until after this year's election — if it happens at all.

In California, which was hit by huge wildfires in recent years, regulators and lawmakers have made it harder for insurers to pass costs onto consumers and barred insurance companies from canceling coverage for homeowners in or alongside ZIP codes hit by fires.

The instinct to keep rates low reflects more than just political self-preservation. If costs go up too much, whole neighborhoods could become unaffordable — ruining home values, collapsing the local economy and shattering the tax base.

That leaves a second option: As risks increase, governments can keep subsidizing insurance either directly, through publicly funded programs like flood insurance, or indirectly, by forcing private insurers to spread the burden of high-risk coverage by raising prices elsewhere. Both approaches seek to shield people from the cost of their decisions.

That, dear homeowner, is the good news: At this point in the climate debate, officials have generally erred on the side of protecting at-risk homeowners, financially if not physically. A beach house or mountain home may put you in harm's way, but at least you should be able to afford your insurance premiums for a few more years.

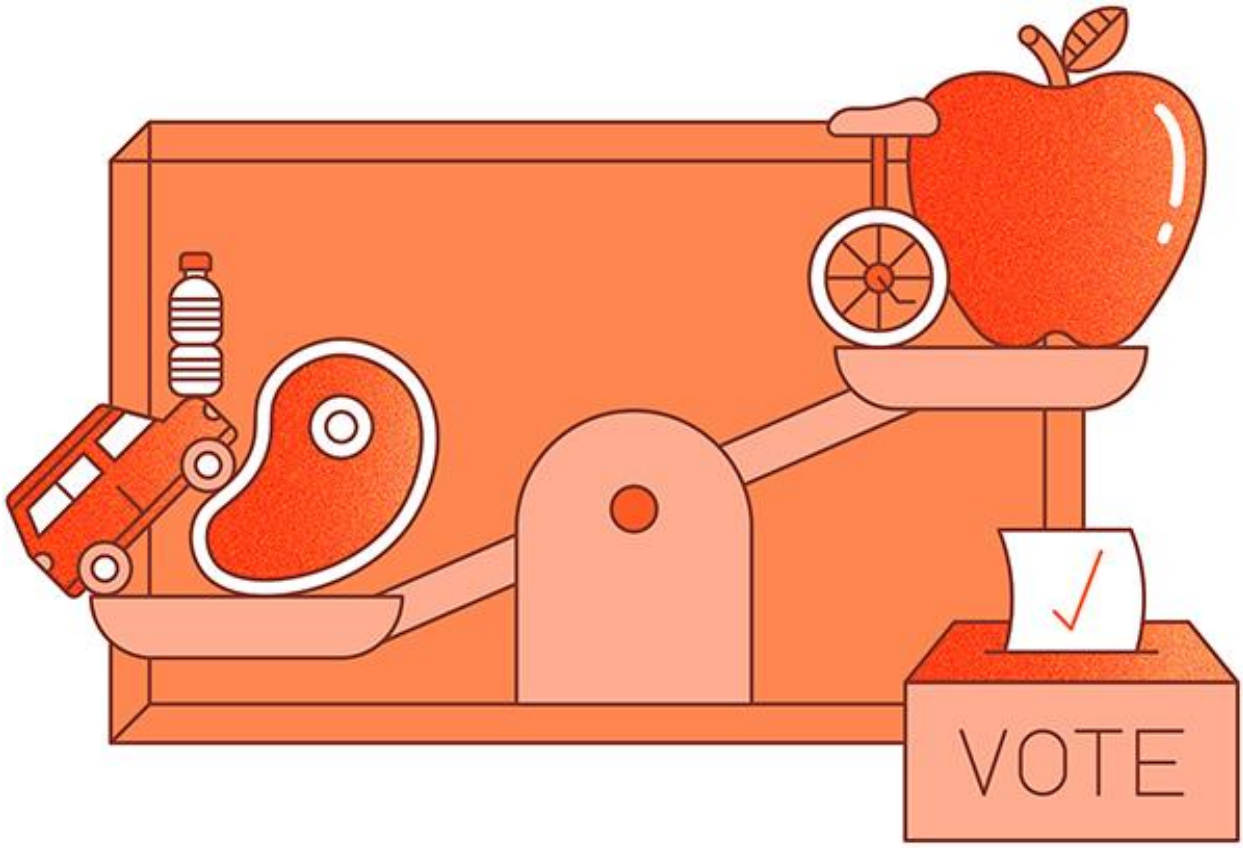
But by keeping premiums low, governments encourage more homes to go up in risky areas, which means more homeowners exposed to storms or fires. Call it the sympathy paradox: Actions intended to help people today by making it easier for them to stay in their homes risk hurting more people tomorrow.

This dilemma will only become harder to navigate. Growing risks will make governments even more reluctant to expose voters to the true cost of insurance. But voters far from flood zones will increasingly resent footing the bill for risky homes.

What does this mean for you? For now, maybe nothing: Congress continues to have little appetite for large increases to flood insurance costs, and most state regulators will resist insurers' demands for big rate hikes. And if they change their minds, armies of homeowners,

home builders, real estate agents and local officials are likely to push back.

But the cost of the current approach keeps growing with every disaster. If you want to follow a truly searing debate about climate change in the United States, watch this space.



Ashley Olinger

7. Is what I do important?

By Somini Sengupta, an international climate correspondent who has reported on warming around the world.

This is one of the most common and most vexing questions in the age of climate change: Can I address a problem so big, or can the world solve this only when powerful leaders in business and government make big structural changes?

It's impossible to separate the two. Personal actions and international cooperation are inextricably linked.

First, the answer depends on whose actions we're talking about. Those of a middle-class American matter a lot more than the actions of say, a farmer in Bangladesh. Why? Because we consume much more, and so our choices matter much more to global emissions: Per capita emissions in the United States are 30 times bigger than per capita emissions in Bangladesh.

Many of my consumption choices have large implications. What car I buy, or whether I buy one at all, matters hugely, because transportation is the single biggest source of emissions in most American cities. Same with how much I fly. Most lipsticks I impulse-buy contain palm oil, the production of which is linked to deforestation in Southeast Asia.

And what I eat has an enormous climate footprint. The average person in North America eats more than six times the recommended amount of red meat, a report published last yearfound, while the average person in South Asia eats half of what's recommended.Perhaps most important is what I don't eat and toss into the garbage. From farm to plate, food waste accounts for nearly 10 percent of global greenhouse gas emissions.

Is there one fix we can make to avert a climate catastrophe? No. It is inevitable we will have to change much about how we live, for our own survival and the survival of others we don't know. It's a bit like what we're doing to stop the coronavirus pandemic, except forever.

Second, individual behavior can influence others. One house with solar panels can lead to others in the neighborhood installing solar panels of

their own. Likewise, we tend to conserve our electricity consumption when our utility bills tell us how our usage compares with our neighbors.

Third, individual action is a prerequisite for collective action. Without young individual activists, there would be no Sunrise Movement to camp out in the halls of Congress, nor would millions of children fill the streets of major world capitals, demanding that the adults in charge take swift climate action.

On the whole, though, humans tend to be really bad at changing their behavior today to address risks tomorrow. This "present bias," as cognitive scientists call it, makes it hard for us, as individuals, to make lifestyle changes now to prevent a catastrophe down the road. So we need government policies to protect us from future risks.

Because the world has deferred climate action for so long, scientists estimate global emissions must be cut by half in the next 10 years in order to avoid the most catastrophic effects of global warming.

It's hard to imagine how such sharp emissions cuts can be made without ambitious government policies, including carbon prices that make it sufficiently costly to burn coal or oil, investments in public transportation, and enforceable energy efficiency standards.

And this is where the Paris Agreement comes in. Every country is supposed to set their own climate targets and figure out how to meet them. What one country does is supposed to inspire other countries. Peer pressure is built in.

Five years after that hard-won diplomatic pact, the world as a whole is not yet close to reining in global temperatures.

And so that raises the fourth and final dilemma: Is it too late to make a difference?

No. It's true that we have already warmed the planet by burning fossil fuels for a century and a half, setting in motion heat waves, wildfires and mass bleaching of coral reefs. But the future isn't set in stone. There are many futures possible, ranging from quite bad to really catastrophic. Which one plays out is up to us to decide. Each and every one of us.

More in Climate and Environment

"All the News That's Fit to Print"

The New York Times

LATE CITY EDITION

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PRICES CLIMB 0.4% BUT RATE OF RISE APPEARS TO SLOW

Gain in the Consumer Index for March Lags Behind the 4 Previous Months

INCREASE IS STEEP HERE

Medical Care and Mortgage Interest Are the Major Elements in Changes

Millions Join Earth Day Observances Across the Nation

Throngs jamming Fifth Avenue yesterday in response to a call for the organization of a polluted environment. View is north from 42d Street, with Central Park in background.

CAMBODIAN CRISIS GROWS AS TROOPS SEEM TO FALTER

With Reds Near, Pnompenh Is Gloomy Over Limited Response to Aid Pleas

CIVIL AVIATION CURBED

Aide Declines to State How Long Army Can Hold Out With the Arms It Has

U.S. CONCERN SUED WITH 2 IN JAPAN

Westinghouse and Mitsubishi Companies Are Accused in

Mood Is Joyful as City Gives Its Support

Activity Ranges From Oratory to Legislation

BACKERS OF ROJAS THREATEN REVOLT

But Colombian Government Appears in Full Control—

U.S. Plane Flies In Arms As Trinidad Fights Mutiny

How The Times Covered the First Earth Day, 50 Years Ago

April 21