Post-printing additions to the book, *The Science of Global Warming*

So many new things relevant to this book kept coming up that I have initiated this service to cover them. I will divide the reports by season, i.e. Fall, Winter, Spring and Summer, by month, equinox and solstice)

Fall (Autumn): September (22nd), October, November
Winter: December (21), January, February
Spring: March (20th), April, May
Summer: June (21st), July, August.

So, this site is basically a continuous, running account of the latest literature on climate change and global warming and on Trump's anti-climate change and anti-science policies.

WINTER

Table of Contents

1. A historic year of dismantling climate policies [1]

International Diplomacy

• Withdrawl of the United States from the Paris Agreement.
• Canceled U.S. contribution of $4 billion to the Green Climate Fund, which helps poor countries adapt to climate change.
• Dismantled the U.S. Agency for International Development, which funded climate programs around the globe.
• Pressured other companies to buy American oil and gas as part of trade negotiations.
• Sent no representatives to COP30, the United Nations climate summit in Brazil.

Environmental Regulations

• Reframed the mission of the EPA to focus on promoting economic activity rather than regulating pollution. Since then, • Unleashed changes that have curtailed the government's ability to limit dangerous pollutants.
• Revoked the scientific determination that underpins the government's legal authority to combat climate change.
• Repealed Biden-era regulation that required coal-burning power plants to cut emissions of mercury, a neurotoxin.

• It proposed freezing anti-pollution and fuel-efficiency standards for cars.
• The E.P.A. strips federal protection from millions of acres of wetlands and streams.
• Gives utilities an extra year to clean up coal ash landfills, which can leach toxic metals into nearby waterways.
• Delays deadlines for utilities to control two harmful "forever chemicals" and roll back limits on four other related chemicals.

Energy

• declaring an "energy emergency" expanded support for fossil fuels, while curtailing support for clean energy.
• opened up more than one billion acres of federal lands and waters for oil and gas drilling.
• The E.P.A. revoked regulations of natural gas-fired power plants.
• The Energy Department has intervened to stop aging coal plants from being shut down.
• Trump and Republicans in Congress have repealed subsidies for solar panels, wind turbines and electric vehicles.
• Agencies have slowed or stopped federal approvals for new wind and solar projects.
• Repealed or blocked vehicle efficiency standards to shift away from gasoline-burning cars.
• Companies canceled more than $32 billion in planned clean energy investments in 2025.

Climate science

• Defunded climate research, erased scientific data and removed terms like "climate change" from federal websites.
• Closed the independent research arm of the E.P.A.
• Cancel funds for NOAA, eliminate climate laboratories and research on severe storms.
• Slashed funding and staffing for the National Climate Assessment, the federal government's premier report on how global warming is affecting the country.
• Appointed Chris Wright, former chief executive of the fracking company Liberty Energy, head of the Department of Energy.
• Compare that to Obama's choice of Steven Chu, Ph.D., former head the Livermore Berkely National Laboratory and Nobel Prize winner in Physics!! During Chu's tenure from 2009 to 2013, his focus was on climate change. That is the way to appoint qualified people.
• Chris Wright, the energy secretary, selected five skeptics of climate science to write their own assessment of global warming, which was criticized by dozens of climate researchers who accused them of mischaracterizing scientific findings.
• Broke up the National Center for Atmospheric Research in Colorado, a world-leading Earth science research institution.

Reference

1 David Gelles (2025) **A historic year of dismantling climate policies**. NY Times based on an article by Brad Plumer, Lisa Friedman, Maxine Joselow and Scott Dance (2025) **How Trump's First Year Reshaped U.S. Energy and Climate Policy**. NY Times December 22, 2025

2. Protecting the Whooping Crane from Climate Change.

The Whooping Crane is one of the most threatened bird species in the U.S.
As of February 2015, the total population was 603 including 161 captive birds. Several years ago, my wife and I had the opportunity to photograph Whooping Cranes at the Aransas National Wildlife Preserve, near Rockport, Texas (see www.ComingsBirds.com. Click on the Flickr link and go to Whooping Crane album. This is one of the photos.

Whooping Crains at Aransas National Wildlife Preserve, Texas c/o David Comings

Its habitats are currently being threatened by climate change. To counteract this a 3,300-acre new sanctuary has been set up in Texas, called the WOLFBERRY WHOOPING CRANE SACTUARY south of Huston, with funds from grants and private donations.

3. China's emissions are leveling off.

China is the world's greatest emitter of CO_2 so any progress on cutting its emissions would be a significant contribution to attaining worldwide net zero. As shown in Figure 1, China's emissions have been leveling off since March 2024[1]

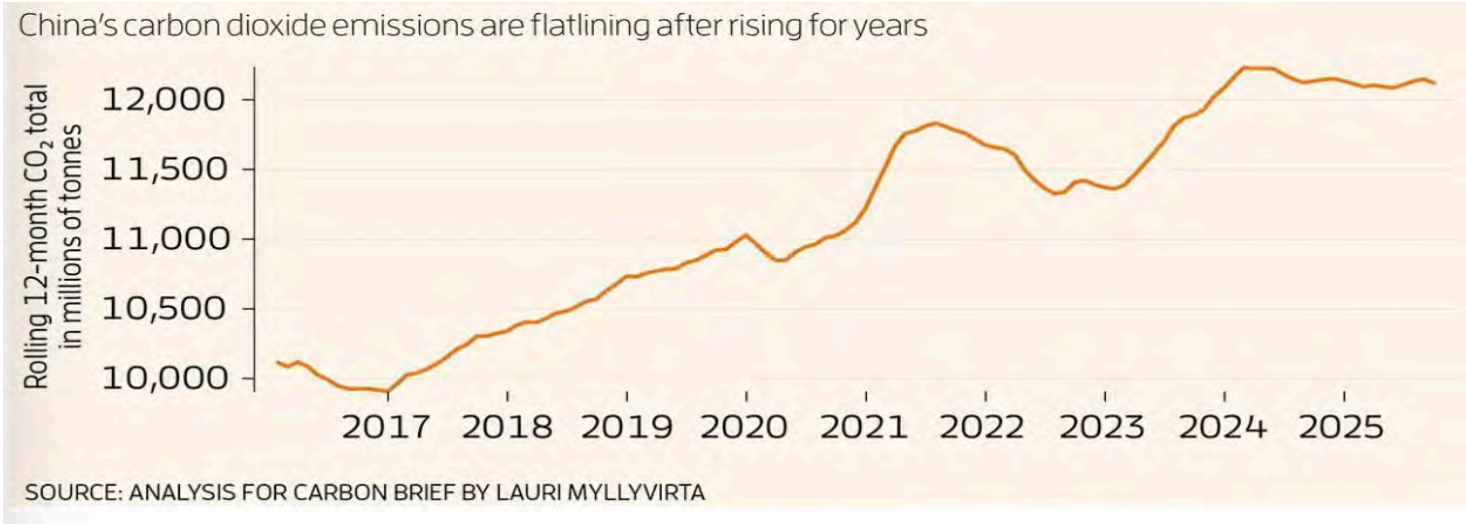

Figure 1. China's emissions since 2017.[1]

Lauri Myllyvirta at the Centre for Research on Energy and Clean Air in Finland, for Carbon Brief said, "the rapid growth of solar and wind power generation is the main force bringing emissions down, but fossil fuel demand has risen in other sectors."[1] Compare this effort to the non-efforts of the U.S.

China's dramatic results also show how effective a concerted effort at controlling global warming can be when the seriousness of the problem is accepted instead of denied.

Reference

1 **James Woodford China's emissions may have finally peaked. New Scientist December 13-26, 2025**

4. Renewable Energy in 2025 (Quotes from Jennifer McDermott, (2025))[1]

With Trump calling wind and solar power "the scam of the century" and vowing not to approve new projects and canceling others, how did we do in 2025?[1]

Solar and battery storage are booming. Solar and storage accounted for 85% of the power added to the grid in the first nine months of the Trump administration, Wood Mackenzie research shows. "The year began with ample federal subsidies for clean energy technologies, a growing number of U.S.-based companies making parts and materials for projects and a lot of demand from states
and corporations, said Tom Harper, partner at global consultant Baringa. paradigm shifting."

The Republicans' tax bill reversed, or steeply curtailed clean energy programs established through the Democrats' flagship climate and healthcare bill in 2022. Wayne Winegarden of the Pacific Research Institute think tank said the time has come for alternative energy to demonstrate viability without subsidies.

Companies can't make billion-dollar investments with so much policy uncertainty, said Jason Grumet, chief executive of the American Clean Power Assn. Consequently, U.S. greenhouse gas emissions will fall at a much lower rate than projected, said Brian Murray, director of the Nicholas Institute for Energy, Environment and Sustainability at Duke University.

Solar and storage accounted for 85% of the power added to the grid in the first nine months of the Trump administration, Wood Mackenzie research shows. **That's because the economics remain strong, demand is high, and the technologies can be**

deployed quickly, said Mike Hall, chief executive of Anza Renewables. Solar energy company Sol Systems said it had a record year as it brought its largest utility-scale project online and grew its business. Energy storage systems company CMBlu Energy said

storage clearly stands out as a winner this year too, moving from optional to essential.

"**Trump's effort to manipulate government regulation to harm clean energy just isn't enough to offset the natural advantages that clean energy has,"** Sen. Sheldon Whitehouse (D-R.I.) said. "The direction is still all good."

Good year for nuclear and geothermal

Democrats and Republicans have supported investing to keep **nuclear reactors online**, restart previously closed reactors and deploy new, advanced reactor designs. Nuclear power is a carbon free source of electricity, though not typically labeled as green energy like other renewables.

"Who had 'restart Three Mile Island' on their 2025 Bingo card?" questioned Baringa partner David Shepheard. The Pennsylvania plant was the site of the nation's worst commercial nuclear power accident, in 1979. The Energy Department is lending $1 billion to help finance a restart.

Everyone loves nuclear, said Darrin Kayser, executive vice president at communications company Edelman. It helps that the technology for small, modular reactors is starting to come to fruition, Kayser added. Benton Arnett, a senior director at the Nuclear Energy Institute, said that as the need for clean, reliable power intensifies, "we will look back on the actions being taken now as laying the

foundation."

The Trump administration also supports geothermal energy, and the tax bill largely preserved geothermal tax credits. The Geothermal Rising association said technologies continue to mature and produce, making 2025 a breakthrough year.

Offshore wind had a terrible year. **Momentum for offshore wind in the United States came to a grinding halt just as the industry was starting to gain traction**, said Joey Lange, a senior managing director at Trio, a global sustainability and energy advisory company. The Trump administration stopped construction on major offshore wind farms, revoked wind energy permits and paused permitting, canceled plans to use large areas of federal waters for new offshore wind development and stopped federal funding for offshore wind projects. That has decimated the projects, developers and tech innovators, and no one in wind is raising corresponding capital, said Eric Fischgrund, founder and CEO at Fisch Tank PR. Still, Fischgrund said he is optimistic because the world is transitioning to cleaner energy. More clean energy needed in 2026

An energy strategy with a diverse mix of sources is the only way forward as demand grows from data centers and other sources, and as people demand affordable, reliable electricity, said former Sen. Mary Landrieu (D-La.). Landrieu, now with Natural Allies for a Clean Energy Future, said **promoting or punishing specific energy technologies on ideological grounds is unsustainable.**

Experts expect solar and battery storage to continue growing in 2026 to add a lot of power to the grid quickly and cheaply. The market will continue to ensure that most new electricity is renewable, said Amanda Levin, policy analysis director at the Natural Resources Defense Council.

Hillary Bright, executive director of Turn Forward, thinks offshore wind will still play an important role. It is ready and needed to help address the demand for electricity in the new year, which will become increasingly clear "to all audiences," she said. Turn Forward advocates for offshore wind. That skyrocketing demand "is shaking up the political calculus that drove the administration's

early policy decisions around renewables," she said.

Blue Wave CEO Sean Finnerty thinks that states, feeling the pressure to deliver affordable, reliable electricity, will increasingly drive clean energy momentum in 2026 by streamlining permitting and the process of connecting to the grid, and by reducing costs for things like permits and fees.

Reference

1. McDermott, Jennifer (2025) Clean energy optimism for 2026? Despite obstacles posed by President Trump, the sector made some notable. progress this year, advocates say. L.A.T Times December 26.

5. Experts blame warming for intensifying global drought-to-deluge cycle

On page 41 of *The Science if Global Warming* book, I described a Weather Whiplash and Wildfires situation

which explained how climate change contributes to wildfires by producing an alternation between droughts and excess rain. The excess rain stimulates the growth of plants and undergrowth, while the drought dries it out, setting it up to contribute to wildfires.

Lin II and others (2025)[1] describe similar whip lash but focus on the excessive rain and resulting floods and mud slides. California has recently experienced both ends of the whiplash. In January 2025, the drying part of the whiplash, combined with 100 mph Santa Ana winds, to destroy the Pacific Palisades and Altadena by wildfires (page 41- 44). Christmas Eve and Christmas Day were the rainiest in the modern record for many parts of Southern California, Thus, in December of the same year as the massive wildfires, the mudslide half of the whiplash has destroyed parts of the mountain town of Wrightwood, CA.

Flooding and Mudslides in Wrightwood, CA, December 2025

Damage was reported across the state, with flooding, landslides and fallen trees also reported in the Central Valley and the San Francisco Bay Area. Tornado

Reference

Rong-Gong Lin II (2025) ***Unwrapping a Wet Christmas.*** *Experts blame warming for intensifying global drought-to-deluge cycle. LA Times December 24.*

6. Judge's Ruling repeals Trump moratorium on wind energy projects

This article in the LA Times, is so important in trying to understand Trumps policies on wind energy, that I am reproducing the whole article.

President Trump issued the ban on his first day back in office through an executive order that called for the temporary withdrawal of nearly all federal land and waters from new or renewed wind energy leasing. The president said such leases "may lead to grave harm" including negative effects on national security, transportation and commercial interests, among other justifications.

A federal judge struck down the Trump administration's ban on federal permits for wind energy projects in what supporters said was an important victory for the embattled industry. U.S. District Judge Patti B. Saris of the District of Massachusetts ruled Monday that **the ban is "Arbitrary and capricious and contrary to law**," and that the concern about "grave harm" was insufficient to justify the immense scope of a moratorium on all wind energy. The challenge was brought by attorneys general in 17 states, including California, and Washington,
D.C.

In it, they argued that halting federal wind permits created an "existential threat" to the wind industry that could erase billions of dollars in investments and tens of thousands of jobs. A court has agreed with

California and our sister states nationwide: **The Trump Administration's attempt to thwart states' efforts to make energy more clean, reliable, and affordable for our residents is unlawful and cannot stand**," California Atty. Gen. Rob Bonta said in a statement, "**The Trump Administration seems intent on raising costs on American families at every juncture** — and California is equally committed to challenging every one of its illegal attempts to make life more
expensive for Californians."

At least seven major offshore wind projects were paused as a result of the federal permitting ban, according to the nonprofit Natural Resources Defense Council, plus several more that were in early phases of development.

"This ban on wind projects was illegal, as this court has now declared. **The administration should use this as a wake-up call, stop its illegal actions and get out of the way of the expansion of renewable energy," Kit Kennedy**, the council's managing director for power, said in a statement.

The lawsuit noted the president's executive order was issued the same day as his National Energy Emergency Declaration, which encouraged domestic energy development not tied to wind and other renewables. Trump has heavily supported fossil fuel production including oil, gas and coal. In a statement to The Times, White House spokeswoman Taylor Rogers said offshore wind projects were given "unfair, preferential treatment" under the Biden administration while the rest of the energy industry was "hindered by burdensome regulations."

"President Trump's Day one executive order instructed agencies to review leases and permitting practices for wind projects with consideration for our country's growing demands for reliable energy, effects on energy costs for American families, the importance of marine life and fishing industry, and the impacts on ocean currents and wind patterns," Rogers said. "President Trump has ended Joe Biden's war on American energy and unleashed America's energy dominance to protect our economic and national security."

California has vowed to stay the course on offshore wind despite the federal challenges. The state has an ambitious goal of 25 gigawatts of floating offshore wind energy by 2045, by which point California officials say offshore wind could represent 10% to 15% of the Golden State's energy portfolio. Five ocean leases have already been granted to energy companies off Humboldt County and Morro Bay.

In August, the Trump administration said it was cutting $679 million for "doomed" offshore wind projects, including $427 million that had been earmarked for California.
Ted Kelly, director and lead counsel of U.S. clean energy at the nonprofit Environmental Defense Fund, said obstructing the build-out of clean power is the wrong move as the country's need for electricity is surging from data centers, industry and other demands.

Wind, solar and battery storage offer the most affordable ways to get more reliable power on the grid, Kelly said. "**We should not be kneecapping America's largest source of renewable power," he said, "especially when we need more cheap, homegrown electricity.**

Conclusion: Trump's ruling against wind and solar energy is blatantly wrong. Wind and solar energy are significantly cheaper than oil or coal, so if Trumps goal with his National Energy Emergency Declaration, was to increase the Nation's energy supply, he certainly should not have excluded these renewables. The only thing that makes sense is that the fossil fuel industry has given him so much money, and Harold Hamm has so much influence, that Trump is blatantly attempting to crush these two critical renewables, which are such a threat to the fossil fuel industry. Hardly a decision that has the best interests of U.S. citizens.

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Reference

Hayley Smith (2025) Ruling repeals Trump moratorium on wind energy projects. Judge calls executive order arbitrary and unlawful. California, part of group that challenged the ban, plans to forge ahead despite federal funding cuts. LA Times December

7. Some of the Nonsense in Trump's Order

This section illustrates some of the bogus excuses Trump used in his above executive order.

Trump relied on his appointed Secretary of the Interior, Doug Burgum, to provide excuses for his actions. Burgum said, "offshore wind turbines and towers create radar interference called "clutter," which "obscures legitimate moving targets and generates false targets in the vicinity of the wind projects," posing a threat to national security. He also said, Trump's "action addresses emerging national security risks, including the rapid evolution of the relevant adversary technologies, and the vulnerabilities created by large-scale offshore wind projects with proximity near our east coast population centers. The Trump administration will always prioritize the security of the American people."

Kirk Lippold, a national security expert and former Navy commander of the USS Cole, said invoking national security on this matter is akin to **"blowing smoke at the American people." The issue of clutter has been known for years and can be resolved through software and firmware changes on weapons systems and radars, as well as proper training for their operators, he said. "Citing national security in this case is a false and specious argument that once again demonstrates that the administration really is not interested in developing the energy dominance portfolio that President Trump advocated for from his first day in office," Lippold told The Times. "Having energy dominance means you have a wide variety and depth of energy sources, from fossil fuels to nuclear to wind to solar, everything."**

Lippold noted that Burgum also cited national security threats in August when the administration issued a stop-work order on the Revolution wind project, which was 80% complete. The Interior secretary told CNN at the time that bad actors could take advantage of radar distortion to "launch a swarm drone attack through a wind farm," **which Lippold said is laughable.** He added that a "Drone swarm" getting that close to the U.S. coast would mark an immense intelligence failure.

Concern about clutter is also something that would have been addressed much earlier in the planning process for the individual projects, said John Conger, director emeritus of the Center for Climate and Security who oversaw the Defense Department's clearinghouse for energy siting under the Obama administration.

For example, officials might require certain turbines to be relocated or require additional radars to fill in gaps in coverage before signing off on an offshore wind project, Conger said. He said the projects paused on Monday would have been evaluated and cleared previously by the Defense Department, so he found it odd that the current administration would find issue with all five of them at once.

"It's curious that they've decided to change multiple sites at the same time, which makes it sound like they have not individually evaluated them," Conger said. "If there was new information that came up, it would have been individual information."

Dave Belote, former director of the Defense Department's energy siting agency, also questioned the administration's claims in a statement Monday. "**I find Secretary Burgum's claims of national security-related risks and vulnerabilities to be bogus**," Belote, now chief executive of solar energy consulting firm DARE Strategies, said. North American Aerospace Defense Command "has technical fixes in place today to edit interference out of its radar displays, and wind project developers have been paying for these fixes since 2013."

Experts said the administration's move also has implications for energy affordability, grid reliability and the economy. "Electricity prices are climbing, and our grid is facing rising demand from data centers, industry and homes," said Ted Kelly, director and lead counsel of U.S. clean energy with the nonprofit Environmental Defense Fund. "**Wind — when allowed to move forward — offers some of the most affordable, reliable power**."

Energy affordability has become a major issue across the nation this year, with residential electric bills increasing about 13% nationwide since January, according to the U.S. Energy Information Administration. **Wind and solar remain the least expensive forms of new build electricity generation**, according to the financial advisory firm Lazard.

The suspended projects were fully permitted, nearly complete **and represented tens of billions of dollars in infrastructure investment that has employed thousands of workers to date**, said Hillary Bright, executive director of the wind advocacy group Turn Forward. What's more, they are poised to deliver "much-needed power to regions already struggling to keep up with rising electricity demand."

"Suspending legitimate permits approved after years of rigorous consultation with expert federal agencies — including the Department of War — does nothing to advance our country's longterm economic or energy security," Bright said in a statement.

Even with Vineyard Wind only partially completed, it saved New England residents roughly $2 million a day during a cold snap this month, according to a report in the Boston Globe.

This well illustrates that once Trump decides to do something to help the fossil fuel industry, he will use any level of b.s. to justify his orders.

Reference

Hayley Smith (2025) **Trump suspends major wind projects, cites national security**. L A. Times December

8. Air Conditioning – A positive feedback loop.

According to a report from the International Energy Agency last year, AI data centers will make up less than 10% of the increase in energy demand between now and 2030, far less than the energy demand from space cooling - mostly air conditioning.

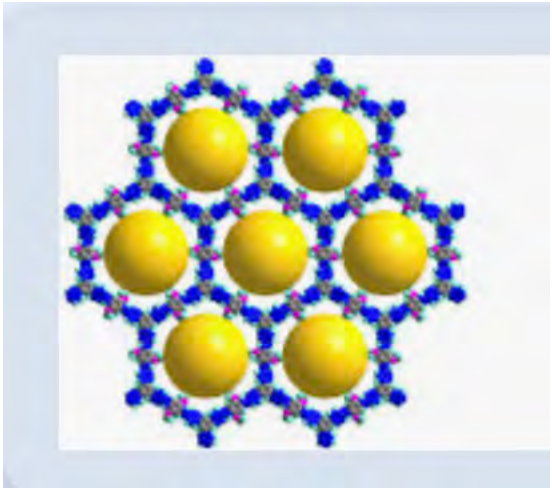
There were fewer than 2 billion AC units in the world in 2016. By 2050, that could be nearly 6 billion, according to a 2018 report from the IEA. It's a vicious cycle. As temperatures rise, the need for cooling technologies increases. In turn, more fossil-fuel power plants are firing up to meet that demand, turning up the temperature of the planet in the process.

9. 47,690 heat related deaths in 2023

A study by Gallo, E (2024)[1] estimated 47,690 (confidence interval 28,853 to 66,525) people died of heat related causes in 2024. The study was based on mortality records in 823 contiguous regions from 35 countries to estimate sex- and age-specific heat-related mortality in Europe during 2023. They estimated that the heat-related mortality burden would have been +80.0% higher in absence of present-century adaptation, especially in the elderly. Their results highlight the importance of historical and ongoing adaptations in saving lives during recent summers and the urgency for more effective strategies to further reduce the mortality burden of forthcoming hotter summers.

10. MOFs to Pull water out of the air.

Omar Yaghi is one of three scientists that won the 2025 Nobel Prize for their discovery of metal-organic frameworks, or **MOF**s. They consisted of metal ions bound to organic molecules that form repeating structural landscapes. They had an enormous internal surface area over 6,000 m^2/gm. This makes them quite suitable for storing gases such as hydrogen and methane.



A MOF (in blue).

in 2014, Yaghi's team of researchers at UC Berkeley had an epiphany. The tiny pores in MOFs could be designed so the material would pull water molecules from the air around them, like a sponge—and then, with just a little heat, give back that water as if squeezed dry. Just one gram of a water absorbing MOF has an internal surface area of roughly 7,000 square meters.

The company he founded, called Atoco, is racing to demonstrate a pair of machines that Yaghi believes could produce clean, fresh, drinkable water virtually anywhere on Earth, without even hooking up to an energy supply. One of the reasons MOFs are relevant to climate change is that **it can be an alternative to dehumidification to produce water for the HnOAE technology (p 126) as well as for capturing CO_2.**

Reference

Kaufman, A C (2026) Omar Yajhi is still thirsty. MIT Technology Review 129, January-February

11. CO_2 Sink to Source in Africa

Forests and shrubby woodlands on the continent have previously been one of the world's biggest carbon sinks, accounting for 20 per cent of all the CO_2 taken up by plants. The lion's share of this is in the Congo rainforest, the second largest in the world after the Amazon. Sometimes called the "lungs of Africa", it absorbs an estimated 600 million tons of CO_2 per year.

Logging and mining are destroying swathes of the Congo rainforest, with the result that African forests went from being a carbon sink to a carbon source in 2010 to 2017.

African forests lost 106 million tons of biomass per year from 2011 to 2017. That is equivalent to roughly 200 million tons of CO_2 emissions per year.

References

Luhn, Alec (2025) *Africa's forests are now emitting more CO_2 than they Absorb. New Scientist.*

Rodriquez-Veiga, P. (2025) *Loss of tropical moist broadleaf forest has turned Africa's forests from a carbon sink into a source.* Nature Portfolio 15,41-47.

12. Arctic Warming will Persist.

Because of the warming of the oceans, the warming of the arctic of 1.5ºC over preindustrial levels, will persist even after cutting emissions and CDR. This was the conclusion of a study by Dong et al, 2025. They also concluded that average sea ice extent would remain 1

million square kilometers smaller, even if excess CO_2 was removed. These findings highlight the irreversible nature of Arctic climate change even under aggressive CDR scenarios and emphasize the need for improved representation of Arctic processes in climate models to reduce uncertainties in climate projection and mitigation strategy design.

References

Dong, X. et al Warm and wet anomalies persist across the pan-Arctic after carbon dioxide removal Environ. Res. Lett. 20 (2025) 124052

Luhn, A. *Some Arctic warming 'irreversible' even if we cut atmospheric CO_2* New Scientist December 2025

13. Global Ocean Warming Hits New Record

"Global ocean warming continued unabated in 2025 in response to increased greenhouse gas concentrations and recent reductions in sulfate aerosols, reflecting the long-term accumulation of heat within the climate system, with conditions evolving toward La Niña during the year. In 2025, global upper 2000 m ocean heat content (OHC) increased by ~23 ± 8 ZJ relative to 2024 according to IAP/CAS estimates." [1]

The progressive increase in ocean temperature is shown in Figure 1, from Pan et al, 2026 [1]

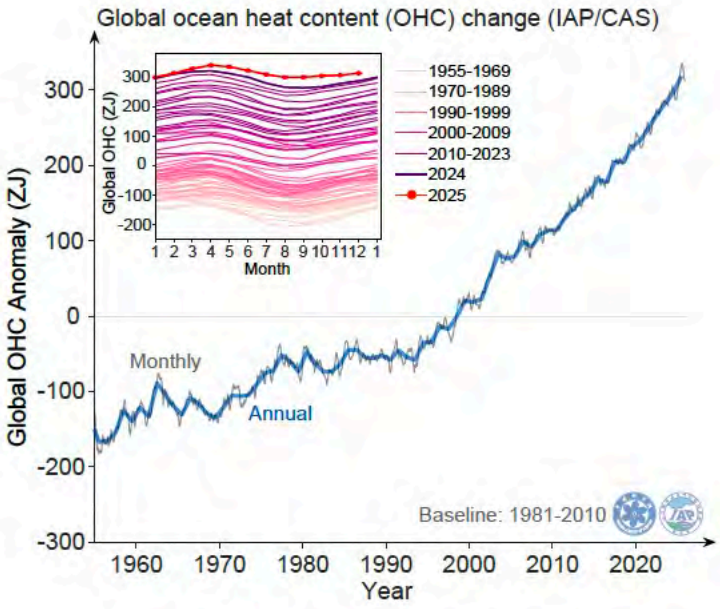


Fig. 1. Global upper 2000 m OHC changes from 1955 through 2025 (units: ZJ). The thick lines denote the annual values, while the thin lines represent the monthly values. The OHC anomalies are relative to the 1981–2010 baseline. The inner box shows the intra-annual variation of OHC, with 2025 values highlighted in red.

In a situation analogous to atmospheric CO_2 levels where both the amount and the rate of increase are increasing, for the oceans, both the temperature increase (Figure 1) and the rate of the temperature increase, are increasing (Figure 2).

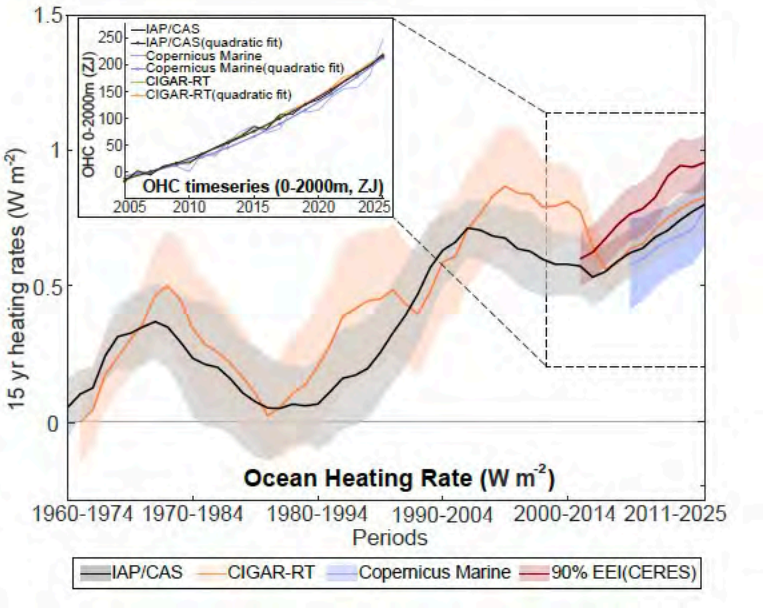


Fig. 2. Running 15-year ocean heating rates and uncertainties for the IAP/CAS, CIGAR-RT, Copernicus Marine, and CERES satellite observations of the net TOA radiation (units: Wm−2). For the observational datasets and reanalysis data, uncertainties are represented by twice the standard deviation of ensemble warming rates for each product. All heating rates are expressed per unit area of Earth's surface (5.1 × 1014 m2). The inset displays the annual

OHC time series (colored solid lines) and the quadratic fits to the OHC (colored solid lines with circle markers) over 2005–2025, relative to the 2005–2009 baseline (units: ZJ).

Highlights:[1]

• In 2025, the global upper 2000 m OHC (Ocean Heat Content) was the highest recorded by modern instruments, ~23 ZJ higher than the 2024 value.
• Record-high OHC in 2025 arose in the tropical and South Atlantic, Mediterranean Sea, North Indian, and Southern Oceans.
• The results show that the global ocean continued to warm in 2025, with the upper 2000 m OHC **reaching the highest value ever observed.**

References

1. Pan Y, et al (2026) Ocean Heat Content Sets Another Record in 2025. Advances in Atmospheric Sciences. Jan 9:1-23. https://doi.org/10.1007/s00376-026-5876-0

2. Ocean Temperatures Just Hit a Dire New Record. Scientific American Newsletter JANUARY 09, 2026

14. U.S. Greenhouse Gas Emissions Are Rising for the First Time in Two Years—They Could Climb Far Higher

After more than two years of progress on reducing greenhouse gas (GHG) emissions, the U.S. is on track to record an estimated 2.4 percent increase in 2025 compared with 2024, according to a new Rhodium Group report. The findings indicate the energy costs of the rapidly expanding artificial intelligence data center industry and cryptocurrencies, with emissions tied to the power sector rising by an estimated 3.8 percent in 2025.

Trumps emphasis on coal did not help.

Today in Science Newsletter Jan 13, 2026

15. China built massive solar and wind renewables.

China built more solar and wind power in 2025 (well over 300 gigawatts of capacity – equivalent to about 300 nuclear power plants) than the U.S. has in its entire history. China built so much new clean energy that it exceeded its power demand growth. As a result, the country burned less fossil fuel for electricity this year than in 2024. And China exported over $200 billion in clean energy technologies to other countries in 2025, increasing their adoption around the world.

Yale Climate Connections, 2026

16. Deforestation of Amazon Deceases Rainfall

The amount of rainfall in the southern Amazon basin has declined by 8 to 11 per cent since 1980, largely due to the impact of deforestation interacting with climate change. As a result, the rainforest could reach a catastrophic tipping point sooner than expected. Deforestation has significantly increased surface air temperatures and reduced precipitation during the Amazonian dry season. While the study[1] linked deforestation to drier weather within 300 kilometers, the new research found this connection across a basin more than 3000 kilometers wide. Thus, destroying rainforest hurts nearby ranches and soy farms.

1. Franco et al. How climate change and deforestation interact in the transformation of the Amazon rainforest. *Nature Communications*. 2025 Sep 2,16, 7944.

17. Trump reverses EPA Endangerment finding

The EPA Endangerment Finding, originally issued in 2009, is a legal and scientific determination **that greenhouse gases (GHGs)—including carbon dioxide and methane and others—threaten public health and welfare, forming the foundation for U.S. climate regulations under the Clean Air Act.** It established that emissions from fossil fuels drive climate change, causing risks like extreme heat and disease. Note: As of February 2026, the Trump administration has finalized a repeal of this finding to eliminate vehicle and industrial emission regulations, characterizing it as a "scam".

Key Aspects of the Endangerment Finding (2009–2026):

Legal Basis: Following the Massachusetts v. EPA Supreme Court ruling, the EPA determined that six key greenhouse gases constitute air pollution that endangers public health and welfare.

Scientific Backing: The finding was based on overwhelming evidence from the EPA, the U.S. National Academies of Sciences, and other experts regarding risks from climate change.

Regulatory Impact: It authorized the EPA to set standards for greenhouse gas emissions from cars, trucks, power plants, and oil/gas operations.

Repeal (2026): Thursday, Feb 12, 2026, The EPA, under the Trump administration, reversed this finding, arguing that previous climate models were inaccurate and that reducing U.S. emissions would have no significant impact on global climate indicators. Trump claimed the 2009 ruling was "a disastrous Obama era policy that severely damaged the American auto industry and massively drove up prices for American consumers". This reversal removes the legal requirement for federal limits on tailpipe emissions and other climate-related pollution, significantly impacting U.S. environmental policy. "This radical rule became the legal foundation for the Green New Scam, one of the greatest scams in history," added the Republican president, about the Democrats' climate agenda.

Former President Barack Obama said that repealing the finding would make Americans more vulnerable. **"Without it, we'll be less safe, less healthy and less able to fight climate change — all so the fossil fuel industry can make even more money,"** he wrote on X.

With a divided Congress unable to agree on legislation to tackle rising global temperatures, the EPA finding became central to federal efforts to rein in emissions in the years that followed.

"The endangerment finding has really served as the lynchpin of US regulation of greenhouse gases," said Meghan Greenfield, a former EPA and Department of Justice attorney. "So that includes motor vehicles, but it also includes power plants, the oil and gas sector, methane from

landfills, even aircraft. So, it really runs the gamut, all of the standards for each of the sectors is premised on this one thing."

Trump administration officials are stressing that overturning the regulation will save more than $1tn and will help cut the price of energy and transport. Reversing the finding would reduce automobile manufacturers' spending by $2,400 per vehicle, White House press secretary Karoline Leavitt told reporters. Many environmentalists are skeptical of the potential cost savings being touted by the Trump team. "It's going to force Americans to spend more money, around $1.4tn in additional fuel costs to power these less efficient and higher polluting vehicles," said Peter Zalzal from the Environmental Defense Fund. "**We've also analyzed the health impacts and found that the action would result in up to 58,000 additional premature deaths, 37 million more asthma attacks," he said.**

For some in the US car industry there will be uncertainty about the rollback as manufacturing less fuel-efficient vehicles might limit their sales overseas.

"This rollback is sort of cementing things that have already been done, such as the relaxation of the fuel economy standards," said Michael Gerrard, a climate law expert from Columbia University. "But it really does put the US automakers in a bind, because **nobody else is going to want to buy American cars."**

18. China built more solar and wind power in 2025

Well over 300 gigawatts of capacity – equivalent to about 300 nuclear power plants, more than the U.S. has in its entire history. China built so **so much new clean energy that it exceeded its power demand growth**. As a result, result country burned less fossil fuel for electricity this year than in 2024. And China exported over $200 billion in clean energy technologies to other countries in 2025, increasing their adoption around the world.

This makes Trump's anti-climate change policies look pathetic.

Yale Climate Connections, 2026

19. Penguins vs Climate Change

Climate change has had a deleterious effect on several penguin species. **Adelie Penguins** migration has likely changed since withdrawal of the West Antarctic Ice Sheet across the Ross Sea.

Emperor Penguins[2] The population dynamics of all 45 known emperor penguin colonies were examined using a sea-ice-dependent demographic model with local, colony-specific, sea ice conditions projected through to the end of the twenty-first century.[3] Dynamics differ among colonies, but by 2100 all populations are projected to be declining. At least two-thirds are projected to have declined by>50%from their current size and the global population is projected to have declined by at least 19%. Emperor penguins breed and raise their o spring almost exclusively on sea ice and changes in sea ice cover impacts the

entire Antarctic food web through key organisms.

All Penguins. A review[4] of all 18 penguin species by 49 scientists examined

the range, distribution, population trends, and main anthropogenic threats over the past approximately 250 years. The major threats were marine pollution, environmental variability, climate change, toxic algal poisoning and disease. Their future resilience to further climate change impacts will depend on addressing current threats to existing habitat degradation on land and at sea.

Winners and Losers. Climate change produces 'winners', species that benefit from these events and 'losers', species that decline or become extinct. Using molecular techniques, the authors [5] assessed several species. Comparing historical responses with the literature on current trends, they saw the Southern gentoo penguins are responding to current warming as they did during post-LGM (Last Glacial Maximum) warming, expanding their range southwards. Conversely, Adelie and Chinstrap penguins are experiencing a 'reversal of fortunes' as they are now declining in the Antarctic Peninsula, the opposite of their response to post-LGM warming.

This suggests current climate warming has decoupled historic population responses in the Antarctic Peninsula, favoring generalist gentoo penguins as

climate change 'winners', while Adelie and chinstrap penguins have become climate change 'losers.'

1. Toniolo V, et al.(2025) Responding to Climate Change: Adelie Penguins Confront Astronomical and Ocean Boundaries. Pre-published report.

2. Jenouvrier S. et al. Projected continent-wide declines of the emperor penguin under climate change. *Nature Climate Change*. 4:715-8, 2014.

3. Barbraud, C & Weimerskirch, H. Emperor penguins and climate change. *Nature* 411: p183-186, 2025.

4. Trathan PN et al. Pollution, habitat loss, fishing, and climate change as critical threats to penguins. *Conservation Biology* 29:31-41.2015.

5. Clucas GV et al A reversal of fortunes: climate change ‘winners’ and ‘losers’ in Antarctic Peninsula penguins. *Scientific reports*. 4:5024, 2014

20. NOx -> increased OH radicals -> increased breakdown of methane

Thus, a decrease in NOx -> increase in methane. In 2020-2022, the increase in atmospheric methane unexpectedly surged from about 20 million tons per year to about 40 million tons per year, before returning to about 20 million in 2023. Research suggests the main reason is that covid lockdowns reduced emissions from sectors like transportation, aviation and shipping, including emissions of nitrogen oxides (NOx). These compounds catalyze reactions in the atmosphere that produce hydroxyl radicals (OH), which break down methane. Less NOx means more methane. Methane lasts only about a decade in the atmosphere compared to many hundreds of years for CO_2. However, it heats the Earth far more than CO_2. Its concentrations have been increasing since the 1980s, initially due mostly to venting and leaks during fossil fuel production. In the past two decades, these emissions have been compounded by a rise in microbes decomposing organic material in wetlands, agriculture and landfills.

21. Tree Bark microbes eat Methane

Methane is 20 times more potent greenhouse gas as CO_2. As such, it is important to find ways of removing CO_2 from the atmosphere. Studies show that microbes in tree bark eat hydrogen, carbon monoxide and methane.

An estimated 143 million square kilometers of tree bark exist worldwide — roughly equivalent to the combined area of all seven continents — and about six trillion microbes inhabit every square meter of tree bark. This newly discovered bark microbiome was “hidden in plain sight,” says Jonathan Gewirtzman, a forest ecologist at Yale University.

Experiments on live trees showed that bark microbes don’t just eat these gases as they diffuse up through the trees; they also suck in methane, hydrogen, and carbon monoxide from the surrounding air. These gases exist in the atmosphere at only trace levels, ranging from 2 parts per million to 40 parts per billion. But multiplied across the entire world, tree microbes are consuming vast amounts of them – an estimated 25 to 50 million tons of methane alone, according to a 2024 study.

It had been thought that soil was the primary source of methane, dependent on water content. The global surface area of bark is 143 million miles, almost as much as the global land

surface. Leung et al (2026) reported that bark microbes adsorb hydrogen, carbon monoxide and methane. Over a 100-year time span methane, hydrogen and carbon monoxide trap 27.9, 12.8 and 3 times as much heat as corona monoxide. Methane is responsible for 0.5oC of the global heating since preindustrial times.

One clear message from these studies is that reforestation is a critical tool for fighting global warming.

Gauci, V. (2026) Tree bark microbes for climate management. Science p129, Jan 8.

Leung, P.M. et al (2026) Bark microbiota modulate climate-active gas fluxes in Australian forests. Science 391. eadu2182.

Leung, P. et al Bark microbiota modulate climate-active gas fluxes in Australian forests Science 391. eadu2182.

Fox, D. (2026) Hidden tree bark microbes munch on important climate gases. Science News 208: March, p22-23

Damien E. Barrett, D. E al (2026) Barking up the right tree: ecological insights into the microbiome of bald cypress tree bark. Environmental Microbiome . https://doi.org/10.1186/s40793-026-00862-2

22. Trump rolls back anti-pollution controls.

These are the ways he did it:

1. **Repeal of the EPA "Endangerment Finding"**

In February 2026, the Trump administration repealed the 2009 EPA Endangerment Finding, which had concluded that greenhouse gases threaten public health and welfare.

This finding is the legal basis for regulating emissions from cars, power **plants, and industry under the Clean Air Act**.
Repealing it effectively removes the federal government's authority to regulate many forms of air pollution linked to climate change.

Experts describe this as the **largest single rollback of U.S. climate and air-pollution regulation**.

2. Elimination of Federal Vehicle Emissions Standards

After removing the endangerment finding, the administration **eliminated federal greenhouse-gas emissions standards for vehicles**, affecting cars and trucks built after 2012.

Vehicle emissions are a major source of:

nitrogen oxides (NOx)
particulate matter
ozone-forming pollutants
Removing these standards could increase both **climate pollution and conventional air pollutants**.

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3. Weakening the Mercury and Air Toxics Standards (Coal Plants)

The administration weakened stricter **Mercury and Air Toxics Standards (MATS)** that had been adopted to reduce emissions from coal-fired power plants.

These standards limit emissions of:

mercury
lead
arsenic
other hazardous air pollutants
Coal plants are the **largest U.S. source of airborne mercury**, a neurotoxin linked to neurological damage and developmental problems.

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4. Rolling Back Limits on Fine Particulate Matter (PM2.5)

The EPA moved to abandon a rule that would have tightened national limits on **PM2.5 (fine particulate pollution)**.

PM2.5 is widely considered the most dangerous air pollutant, associated with:

heart attacks
strokes
asthma
dementia and cognitive decline
The proposed tighter rule was projected to prevent **thousands of premature deaths annually**.

5. Exemptions for Polluting Industrial Facilities

The administration granted exemptions allowing **over 100 industrial facilities** (including chemical plants and coal power plants) to bypass certain clean-air rules.

Facilities included:

coal-fired power plants
chemical manufacturers
coke ovens
metal processing plants
These exemptions allowed higher emissions of toxic pollutants in much of the United States.

---

6. Rolling Back Methane Controls for Oil and Gas

The EPA rolled back methane-emissions rules for oil and gas production that had required monitoring and control of leaks.

Methane is a potent greenhouse gas, and oilfield leaks also release **volatile organic compounds (VOCs)** that contribute to:

smog
ozone formation
respiratory disease.

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7. Changing Cost–Benefit Calculations for Pollution Rules

The EPA also changed how it evaluates regulations by **no longer calculating the economic value of health benefits** from reduced air pollution (e.g., avoided deaths and hospitalizations).

Critics say this makes it easier to weaken pollution standards because the **health benefits of cleaner air are excluded from cost-benefit analyses**.

Scale of the Deregulation Effort

Analyses of regulatory changes have identified **dozens of environmental rollbacks**, including **more than 30 environmental rules affecting air, water, and climate protections.**

These actions were framed by the administration as part of a broader effort to:

reduce regulatory burdens on industry
expand fossil-fuel production
lower energy costs.

Bottom Line

Trump's environmental policy has largely focused on **reducing federal regulation of air pollution**, especially from:

vehicles
coal-fired power plants
oil and gas operations
heavy industry.
Critics argue these changes **increase pollution and public-health risks**, while supporters argue they **reduce economic costs and regulatory burdens on industry**.

The next section shows the risks of these actions.

23. Air pollution linked to dementia

So, what are the risks of these rollbacks?

Growing evidence suggests that long-term exposure to ambient air pollution, particularly fine particulate matter ($PM_{2.5}$), is associated with an increased risk of dementia and Alzheimer disease. Several large cohort studies and systematic reviews have reported consistent associations between chronic exposure to $PM_{2.5}$ and incident dementia. In a systematic review of epidemiologic studies, Peters et al. concluded that higher exposure to $PM_{2.5}$, nitrogen dioxide (NO_2), and traffic-related pollutants was associated with an increased risk of cognitive decline and dementia across multiple populations (Peters, et al 2019). A subsequent meta-analysis of longitudinal studies found that each 10 $\mu g/m^3$ increase in $PM_{2.5}$ exposure was associated with approximately a 40 % increase in the risk of all-cause dementia and an even greater increase for vascular dementia (Cheng et al, 2022). More recent analyses using burden-of-proof meta-analytic approaches have confirmed a significant relationship between $PM_{2.5}$ exposure and dementia incidence across large cohorts, with risk increasing even at exposure levels below current regulatory standards (Haung et al 2025) These epidemiologic findings are supported by biologically plausible mechanisms. Fine particles can enter the brain through the olfactory nerve or systemic circulation, leading to oxidative stress, neuroinflammation, cerebrovascular injury,

and blood–brain barrier dysfunction, processes that may accelerate neurodegenerative pathology including amyloid deposition and tau pathology (Huels A., et al. (2024)). Neuropathological studies have also reported associations between traffic-related air pollution exposure and increased Alzheimer-type brain pathology (Huels A., et al. (2024). Based on the accumulating evidence, the 2024 **Lancet Commission on dementia prevention identified air pollution as a modifiable environmental risk factor for dementia, suggesting that reducing population exposure could contribute to lowering future dementia incidence (Livingston et al, 2024).**

References

Peters R., Ee N., Peters J., Booth A., Mudway I., and Anstey K.J. (2019). Air pollution and dementia: A systematic review. J. Alzheimer's Dis. 70(S1), S145–S163. https://doi.org/10.3233/JAD-180631

Cheng S., Li G., Liu W., et al. (2022). Long-term particulate matter exposure and dementia: A systematic review and meta-analysis. Public Health 214, 150158. https://doi.org/10.1016/j.puhe.2022.10.006

Huang X., et al. (2025). Health effects of long-term ambient $PM_{2.5}$ exposure on dementia: A burden-of-proof meta-analysis. Nat. Aging. https://doi.org/10.1038/s43587-025-00844-y

Block M.L., and Calderón-Garcidueñas L. (2009). Air pollution: Mechanisms of neuroinflammation and CNS disease. Trends Neurosci. 32, 506–516. https://doi.org/10.1016/j.tins.2009.05.009

Huels A., et al. (2024). Traffic-related fine particulate matter exposure and Alzheimer disease neuropathology. Neurology 102, e209512. https://doi.org/10.1212/WNL.0000000000209512

Livingston G., Huntley J., Liu K.Y., et al. (2024). Dementia prevention, intervention, and care: 2024 report of the Lancet Commission. Lancet 404, 572–628. https://doi.org/10.1016/S0140-6736(24)01296-0

Here are **additional major cohort studies** frequently cited in reviews of **air pollution and dementia risk**. These strengthen the evidence because they involve **very large populations and longitudinal follow-up**.

Major Cohort Studies Linking Air Pollution and Dementia

1. Ontario Population Cohort (Canada)

This was one of the first very large population-based studies linking traffic pollution to dementia.

Key finding:
Living close to major roads was associated with a **higher incidence of dementia**, particularly within **50–200 meters of heavy traffic corridors**.

Reference (AJHG style)
Chen H., Kwong J.C., Copes R., Hystad P., van Donkelaar A., Tu K., Brook J.R., Goldberg M.S., Martin R.V., Murray B.J., et al. (2017). Living near major roads and the incidence of dementia, Parkinson's disease, and multiple sclerosis: A population-based cohort study. Lancet 389, 718–726. https://doi.org/10.1016/S0140-6736(16)32399-6

Population: **~6.6 million adults in Ontario**

2. U.S. Women's Health Initiative Memory Study

A highly cited prospective cohort of older women.

Key finding:
Women exposed to the highest levels of $PM_{2.5}$ had approximately 80–90% higher risk of dementia compared with those with lower exposure.

Reference

Cacciottolo M., Wang X., Driscoll I., Woodward N., Saffari A., Reyes J., Serre M.L., Vizuete W., Sioutas C., Morgan T.E., et al. (2017). Particulate air pollutants, APOE alleles and their contributions to cognitive impairment in older women. PLoS Med. 14, e1002354. https://doi.org/10.1371/journal.pmed.1002354

Population: **~3,600 women aged 65–79**

3. U.S. Medicare Cohort

One of the **largest dementia studies ever performed**.

Key finding:
Higher long-term exposure to **$PM_{2.5}$ and NO_2** was associated with a **significant increase in incident dementia**.

Reference

Kioumourtzoglou M.A., Schwartz J.D., Weisskopf M.G., Melly S.J., Wang Y., Dominici F., and Zanobetti A. (2016). Long-term $PM_{2.5}$ exposure and neurological hospital admissions in the United States. Environ. Health Perspect. 124, 23–29. https://doi.org/10.1289/ehp.1408973

Population: **~9 million Medicare beneficiaries**

4. UK Biobank Cohort

A large prospective cohort with detailed health and environmental data.

Key finding:
Higher exposure to **$PM_{2.5}$ and NO_2** was associated with increased **risk of incident dementia**.

Reference

Carey I.M., Anderson H.R., Atkinson R.W., Beevers S.D., Cook D.G., Strachan D.P., and Dajnak D. (2018). Are noise and air pollution related to the incidence of dementia? A cohort study in London, England. BMJ Open 8, e022404. https://doi.org/10.1136/bmjopen-2018-022404

Population: **~130,000 adults**

5. U.S. National Cohort of Older Adults

This study examined air pollution and dementia hospitalization.

Key finding:
Each **1 $\mu g/m^3$ increase in $PM_{2.5}$** was associated with **increased dementia hospitalization risk**, even below current EPA limits.

Reference

Shi L., Wu X., Danesh Yazdi M., Braun D., Awad Y.A., Wei Y., Liu P., Di Q., Wang Y., Schwartz J., and Dominici F. (2020). Long-term effects of $PM_{2.5}$ on neurological disorders in the American Medicare population. Lancet Planet Health 4, e557–e565. https://doi.org/10.1016/S2542-5196(20)30227-8

Population: **~63 million older adults**

Overall Interpretation of the Evidence

Across multiple **large cohort studies involving tens of millions of individuals**, the general pattern is consistent:

Exposure	Approximate dementia risk increase
+1 μg/m³ $PM_{2.5}$	~5–10%
+5 μg/m³ $PM_{2.5}$	~20–40%
Residence near major roads	~7–12% higher dementia incidence

The evidence is strengthened by:

- Consistency across countries
- Dose–response relationships
- Biological plausibility
- Large prospective cohorts

These factors are why the 2024 Lancet Commission on dementia prevention added air pollution as a modifiable dementia risk factor.

This makes one wonder how many cases of dementia Trump has caused?

24. Trump challenges California's clean car rules.

Since 1960 Calafornia has set it's own emission standards for cars. Since such a large proportion of total U.S. cars are in California that hese standards have set the standards for the whole coutry and hae led to the development of hybrid and EV cars.

In a new lawsuit, the Trump admnistration challanged California's ability to to set its own standards, claiming it increased the price of cars. California's response was that Trump's

starting a war with Iran has resulted in sky rocketing oil prices and the California standards actually save people money.

25. Scaling up Enhanced Weathering (EW)

A paper by Tu et al, (2026) stated that ER could remove 0.35-0.76 gigatons of carbon dioxide per year by 2050, and 0.7-1.1 gigatons per year by 2100, with divergent outcomes across scenarios. While high-income countries lead in early deployment, countries like India and Brazil will overtake them by mid-century driven by accelerated uptake and favorable biophysical conditions. The share of carbon removal from low- and lower-middle-income countries is projected to rise from 20–29% in 2040 to ~60% by 2100.

Our belief is that these are minimal figures. With a global push, starting by 2030 the yearly figues could be much higher than this estimate.

Tu Y, Rafols R, Xu Y, Butler N, Ababneh L, Tao F, Ramanathan V, Houlton BZ, Liao C. Scaling up enhanced rock weathering for equitable climate change mitigation. Communications Sustainability. 2026 Feb 16;1(1):32.

26. Sucking CO_2 out of seawater a success.

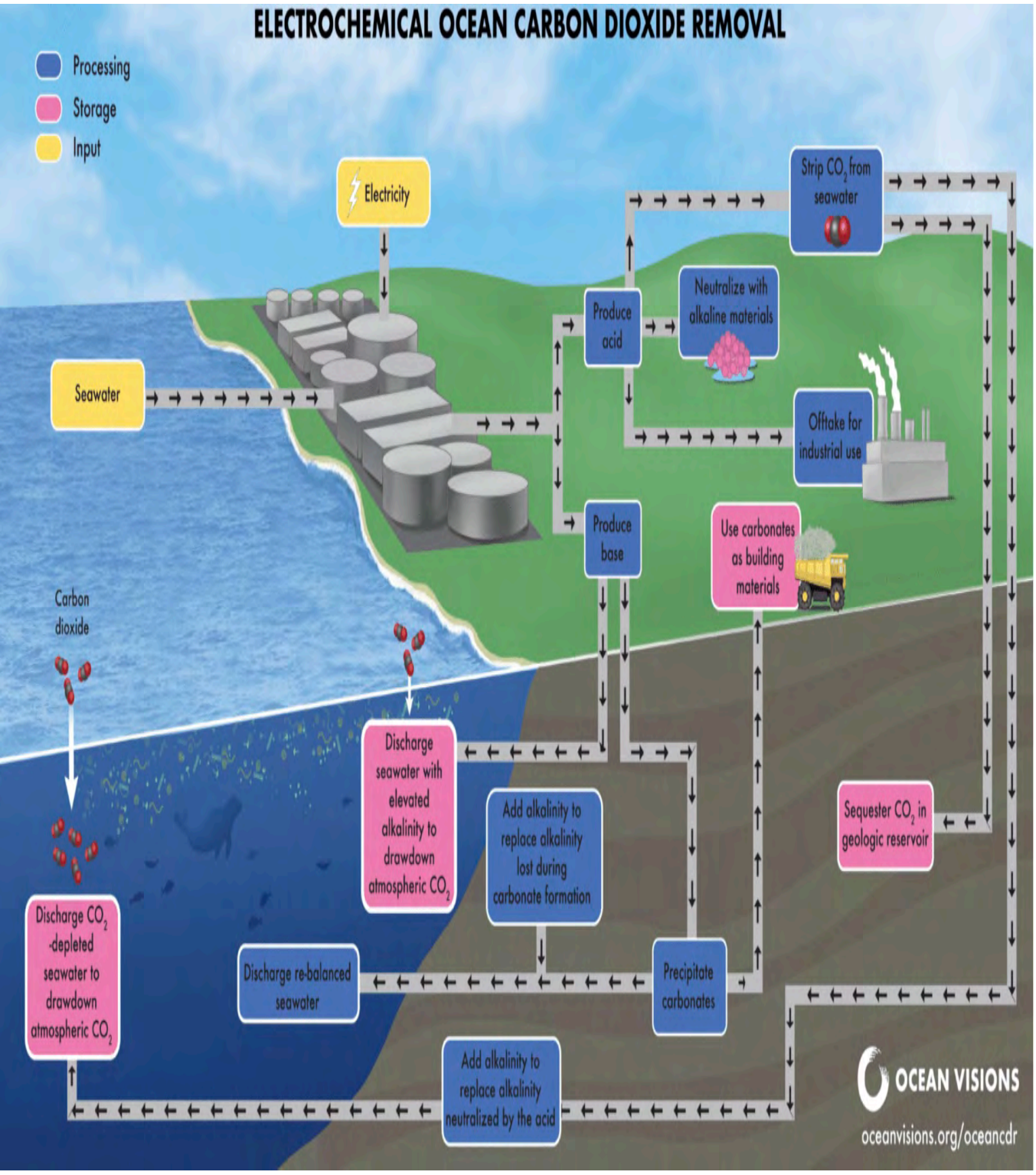
Stripping carbon dioxide out of the ocean is much more efficient than capturing it from the air. Researchers are hoping to show its potential at a pilot plant in Weymouth.

An English facility called Plymouth Marine Laboratory, opeating at the Sea Life aquarium in Weymouth on England's south coast, has been successfully sucking CO_2 from seawater, using a process called SeaCURE.

SeaCure uses electricity to adjust seawater pH, removing carbon and releasing low-carbon water to absorb atmospheric CO2.

For more details see next paragraph.

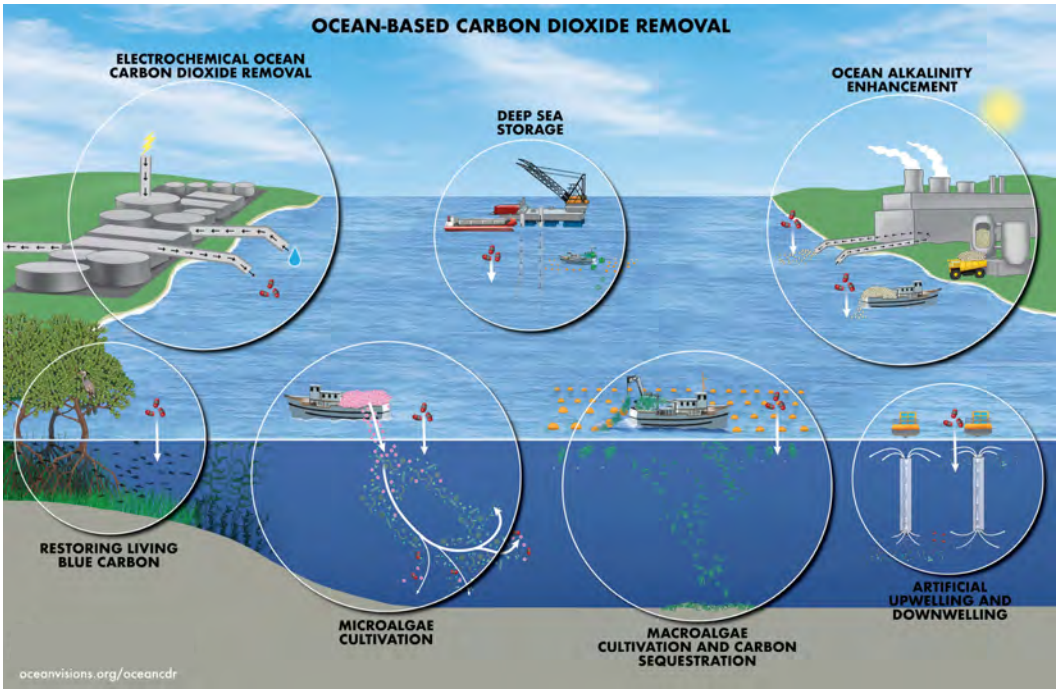
27. Electrochemical Removal of CO_2.


ELECTROCHEMICAL OCEAN CARBON DIOXIDE REMOVAL
Processing
Storage
Input
Electricity
Strip CO_2 from seawater
Neutralize with alkaline materials
Produce acid
Seawater
Offtake for industrial use
Produce base
Use carbonates as building materials
Carbon dioxide
Discharge seawater with elevated alkalinity to drawdown atmospheric CO_2
Add alkalinity to replace alkalinity lost during carbonate formation
Sequester CO_2 in geologic reservoir
Discharge CO_2 -depleted seawater to drawdown atmospheric CO_2
Discharge re-balanced seawater
Precipitate carbonates
Add alkalinity to replace alkalinity neutralized by the acid
OCEAN VISIONS
oceanvisions.org/oceancdr

28. A Comprehensive Program of CO_2 Removal

OCEAN VISIONS

A Comprehensive Program to Prove or Disprove Marine Carbon Dioxide Removal Technologies by 2030



Introduction[1]

The last three years have seen a tremendous growth in the level of awareness, interest, and engagement with carbon dioxide removal (CDR) broadly and especially with marine carbon dioxide removal (mCDR, sometimes also called ocean-based carbon dioxide removal). This interest stems from the increasing recognition that CDR is now an essential part of the path to achieving a safe climate. Hundreds of billions to a trillion tons of CDR by 2100 is necessary to achieve the goals set out in the Paris agreement, and far more CDR will be needed for future generations to have any chance to reverse temperature increases that are already pushing many human and natural populations and systems to the limits of their viability.

Marine-based pathways for CDR offer some significant potential advantages, given the scale of the ocean and the existing biological and chemical processes it already contains that cycle carbon over long periods of time. However, while there has been a rapid growth in understanding of some of these pathways, and in small-scale testing and development, it is necessary to significantly ramp up the scale and pace of research, development, and demonstration (RD&D) to answer fundamental questions about both the additionality and durability of carbon sequestered using mCDR approaches, and their environmental and social impacts.

1 This document was written in October 2023. It is intended to be a living document that evolves as more members of a global community contribute to the activities and initiatives described here. Think this document is missing something? We'd love to hear from you at info@oceanvisions.org.

29. Global Warming Has Accelerated Significantly

The temperature of the earth increased by **0.18 ºC per decade before 2013-2014**. Since then it has been warming at **0.36 ºC per decade,** twice the rate..

Foster, G., & Rahmstorf, S. (2026). Global warming has accelerated significantly. Geophysical Research Letters, 53, e2025GL118804. https://doi.org/10.1029/ 2025GL118804

30. Climate change has now shrunk salaries by 12%.

A study by Derek Lemoine, reported in PNAS, shows that climate change has already affected the U.S. economy. The results indicate that climate change is reducing annual U.S. income by altering current, local temperatures, with losses concentrated in the Great Plains and Midwest. Accounting for effects on past temperatures and on temperatures in other counties increases income losses to 12% [2.0 to 22%] and makes them more widely distributed, with suggestive evidence that trade networks propagate effects around the United States. Central estimates can change with different indices of nonlocal weather or models of cross-county heterogeneity. Calculations like those developed here could be updated annually as a way of measuring and communicating the progress of climate change.

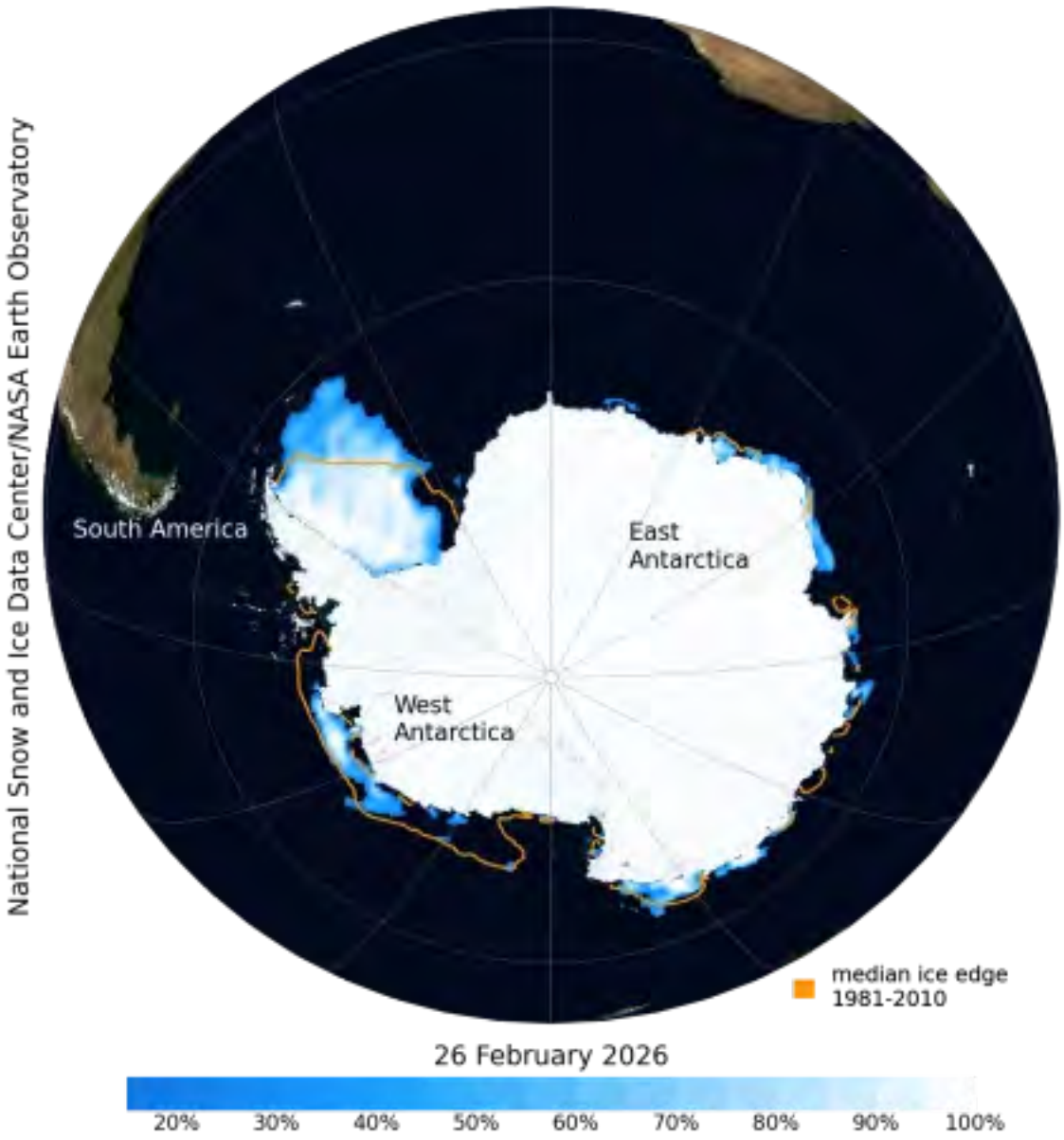
Most of those costs are not driven by changes in weather where you live but by how changes in weather everywhere else affect supply chains and the cost of products you buy from elsewhere in the US.

Lemoine, D. (2025) Climate Change Has Already Made the United States Poorer. *Proceedings of the National Academy of Sciences,*122:e2504376122. doi:10.1073/pnas.2504376122

31. Antarctic sea ice extent arrives at a near-average minimum

MONDAY, MARCH 9, 2026

Antarctic sea ice has likely reached its minimum extent for the year, at 2.58 million square kilometers (996,000 square miles) on February 26, 2026, according to scientists at the National Snow and Ice Data Center (NSIDC) at the University of Colorado Boulder. The 2026 minimum ranks sixteenth lowest in the 48-year satellite record. This year's minimum is much closer to average than the past four years, albeit still 260,000 square kilometers (100,000 square miles) below the 1981 to 2010 average. It is 730,000 square kilometers (282,000 square miles) above the record low set on February 21, 2023.



This NASA Blue Marble image shows Antarctic sea ice on February 26, 2026, when sea ice likely reached its minimum extent for the year. Sea ice extent for February 26 averaged 2.58 million square kilometers (996,000 square miles)—settling at sixteenth lowest in the 48-year satellite record. — Credit: NSIDC/NASA Earth Observatory

“Through most of the year, Antarctic sea ice was well below the daily average,” said Ted Scambos, senior research scientist at the Cooperative Institute for Research in the Environmental Sciences (CIRES) and contributor to NSIDC’s Sea Ice Today and Ice Sheets Today projects. “Then in January and February, strong winds from the south pushed sea ice outward in the Weddell Sea. This slowed the overall decline in extent, leading to a near-average minimum."

NASA NSIDC Distributed Active Archive Center (DAAC) scientist Walt Meier added, “This year’s return to less extreme conditions is not unexpected given the large year-to-year variation of Antarctic sea ice seen in the satellite record."

NSIDC scientists stress that the Antarctic sea ice extent number is preliminary—continued melt conditions or strong onshore winds could still push the ice extent lower.

Thus, while this minium seems like good news, because it is less than pevious minimiums, scientists say, “It gives relief after a streak of alarming lows, but does not prove the system is stable.”

32. Heat wave is latest event linked to climate change.

By Clara Harter, LA Times, March 21, 2026

1.The most destructive wildfires in Southern California history.
2.The region’s wettest holiday season.
3.The hottest March heat wave on record.

In the last 15 months, Southern California has seen a trio of extreme weather events, and UC climate scientist Daniel Swain says there’s one clear line connecting them all, “All of the superlative extremes we’ve seen in recent years — from extreme heat to extreme dryness to extreme wetness, and even the severe wildfires — they all have clear links to climate change,” he said.

The ongoing heat wave shattering dozens of temperature records in Southern California is no exception, Swain said. This unseasonable March streak of scorching heat is not only notable in its intensity, but also in its duration and its scale.

“It extends from Southern California all the way to the Great Plains and from Canada to Mexico,” Swain said. “I’m struggling to find the right superlative, because it is that extreme.”

It’s also paving the way for the state to head back into drought conditions.

In January, California achieved zero areas of abnormal dryness for the first time in 25 years thanks to a deluge of winter storms, according to the U.S. Drought Monitor. But now, just over two months later, abnormal dryness has returned to areas of Northern California.