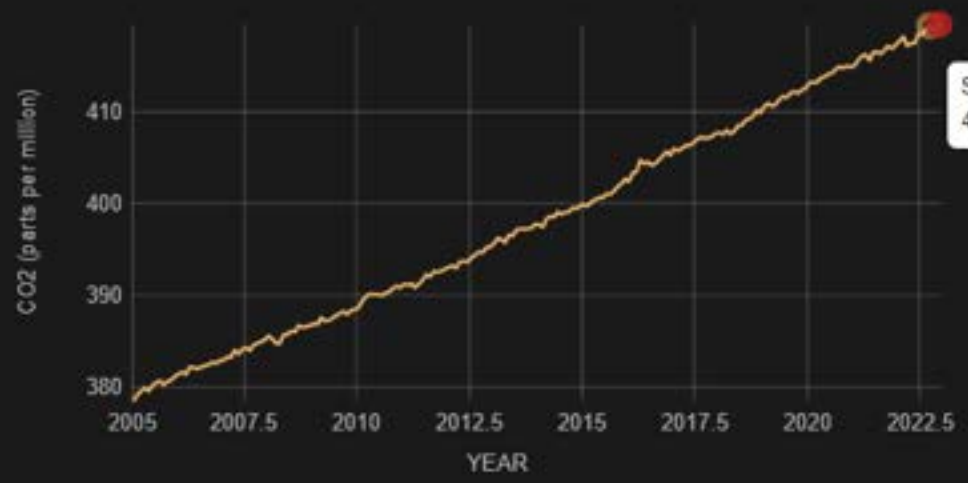
Carbon Dioxide

DIRECT MEASUREMENTS: 2005-PRESENT

Data source: Monthly measurements (average seasonal cycle removed). Credit: NOAA



Get Data: HTTPS | **Snapshot:** PNG

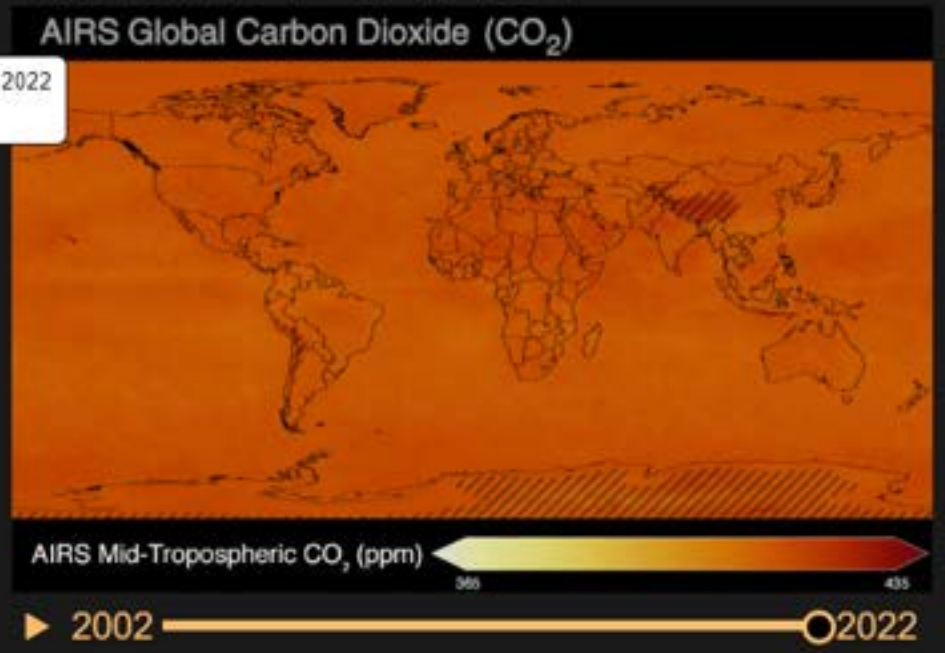
Carbon dioxide (CO_2) is an important heat-trapping gas, or greenhouse gas, that comes from the extraction and burning of fossil fuels (such as coal, oil, and natural gas), from wildfires, and from natural processes like volcanic eruptions. The first graph shows atmospheric carbon dioxide (CO_2) levels measured at Mauna Loa Observatory, Hawaii, in recent years, with natural, seasonal changes removed.

Since the beginning of industrial times (in the 18th century), human activities have raised atmospheric CO_2 by 50% – meaning the amount of CO_2 is now 150% of its value in 1750. This is greater than what naturally happened at the end of the last ice age 20,000 years ago.

TIME SERIES: 2002-2022

Data source: Atmospheric Infrared Sounder (AIRS). Credit: NASA

MAY
2022



The animated map shows how global carbon dioxide has changed over time. Note how the map changes colors as the amount of CO_2 rises from 365 parts per million (ppm) in 2002 to over 400 ppm currently. ("Parts per million" refers to the number of carbon dioxide molecules per million molecules of dry air.) These measurements are from the mid-troposphere, the layer of Earth's atmosphere that is 8 to 12 kilometers (about 5 to 7 miles) above the ground.

https://climate.nasa.gov/

Arctic Sea Ice Extent

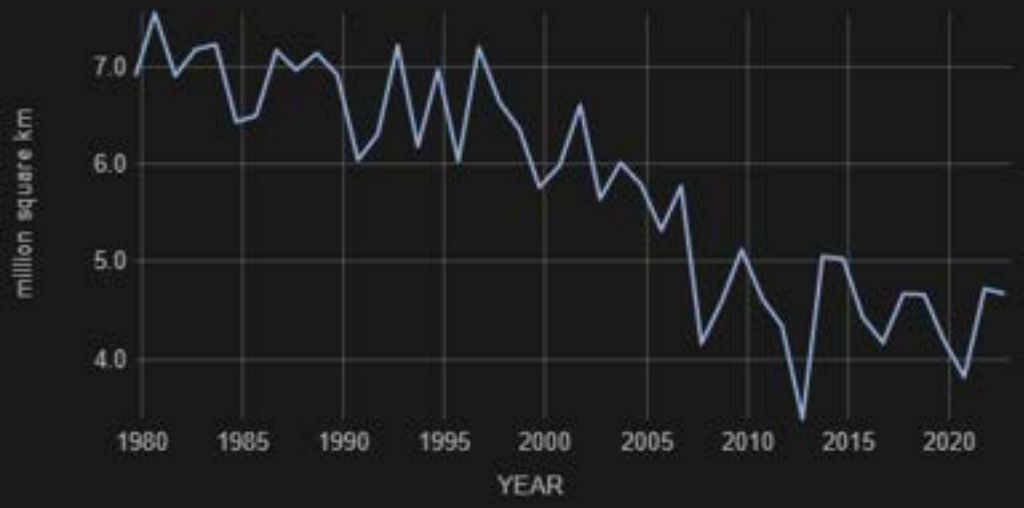
ANNUAL SEPTEMBER MINIMUM EXTENT

Data source: Satellite observations. Credit: NSIDC/NASA

RATE OF CHANGE

↓ 12.6

percent per decade



Click+drag to zoom RESET

Get Data: HTTPS | **Snapshot:** PNG

Arctic sea ice reaches its minimum extent (the area in which satellite sensors show individual pixels to be at least 15% covered in ice) each September. September Arctic sea ice is now shrinking at a rate of 13% per decade, compared to its average extent during the period of 1981 to 2010. This graph shows the size of the Arctic sea ice each September since satellite observations started in 1979. The monthly value shown is the average of daily observations across the month of September during each year and is measured from satellites.

TIME SERIES: 1979-2022

Data source: Satellite observations.
Credit: NASA Scientific Visualization Studio

2012

The animated map above shows the minimum size of the Arctic sea ice measured each year since 1979, based on satellite observations. The 2012 sea ice extent is the lowest in the satellite record.

full vital sign

https://climate.nasa.gov/

Ice Sheets

ANTARCTICA MASS VARIATION SINCE 2002

Data source: Ice mass measurement by NASA's GRACE satellites. **Gap represents time between missions.**
Credit: NASA

RATE OF CHANGE

↓ 151.0

billion metric tons per year since 2002

Click+drag to zoom RESET

Get Data: HTTP | **Snapshot:** PNG

GREENLAND MASS VARIATION SINCE 2002

Data source: Ice mass measurement by NASA's GRACE satellites. **Gap represents time between missions.**
Credit: NASA

RATE OF CHANGE

↓ 273.0

billion metric tons per year since 2002

Click+drag to zoom RESET

Get Data: HTTP | **Snapshot:** PNG

Data from NASA's GRACE and GRACE Follow-On satellites show that the land ice sheets in both Antarctica (left chart) and Greenland (right chart) have been losing mass since 2002.

The GRACE mission ended in June 2017. The GRACE Follow-On mission began collecting data in June 2018 and is continuing to monitor both ice sheets. This record includes new data-processing methods and is continually updated as more numbers come in, with a delay of up to two months.

Note: You now need to create an Earthdata account to access NASA's ice sheet data. Register here for free. Once logged in, click "HTTP" under the charts on this page to access the data.

full vital sign

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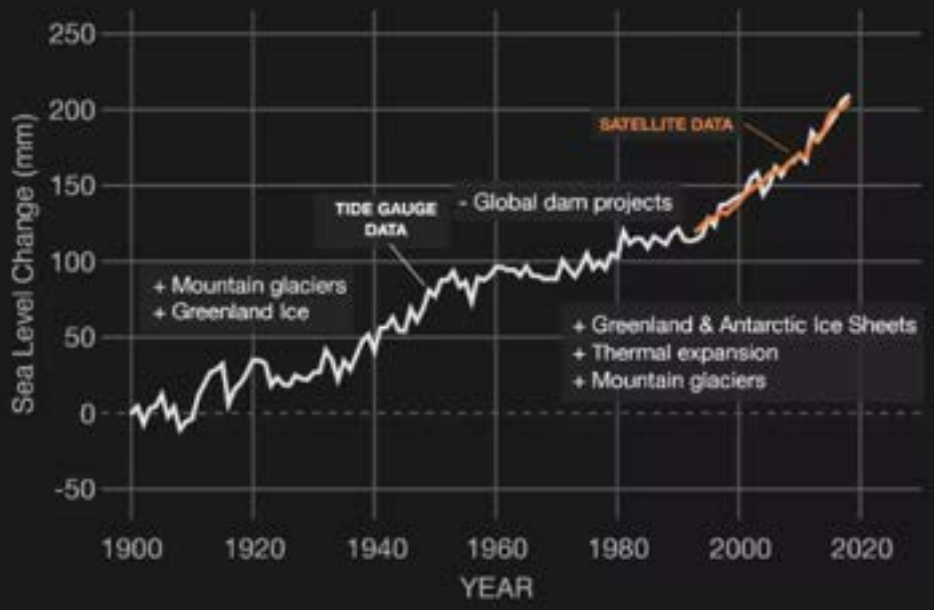
Sea Level

SOURCE DATA: 1900-2018

Data source: Frederikse et al. (2020)
Credit: NASA's Goddard Space Flight Center/PO.DAAC



Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers, and the expansion of seawater as it warms. The first graph tracks the change in global sea level since 1993, as observed by satellites.

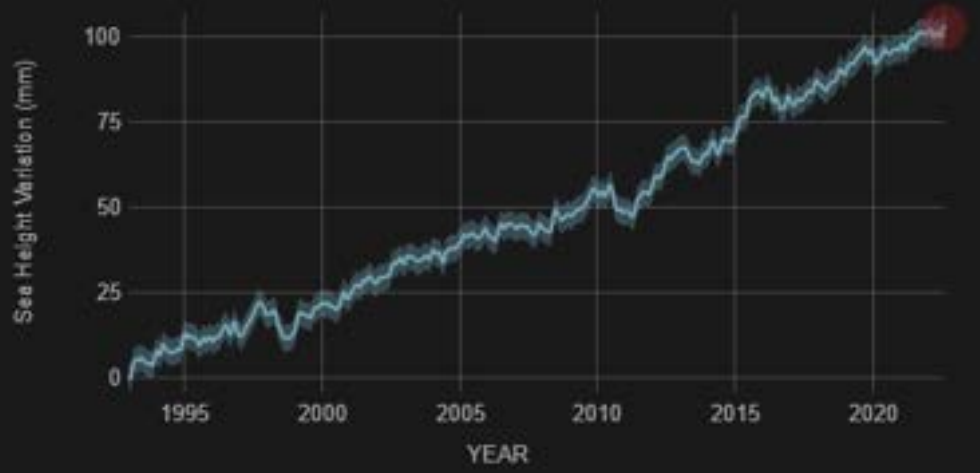
The graph on the left, which is from coastal tide gauge and satellite data, shows how much sea level changed from about 1900 to 2018. Items with pluses (+) are factors that cause global sea level to increase, while minuses (-) are what cause sea level to decrease. These items are displayed at the time they were affecting sea level.

SATELLITE DATA: 1993-PRESENT

Data source: Satellite sea level observations
Credit: NASA's Goddard Space Flight Center

RISE SINCE 1993

↑ 102.5 millimeters



Click+drag to zoom RESET

Get Data: HTTP | **Snapshot:** PNG

This graph tracks the change in sea level since 1993, as observed by satellites. The data shown are the latest available, with a four- to five-month delay needed for processing. (Source)

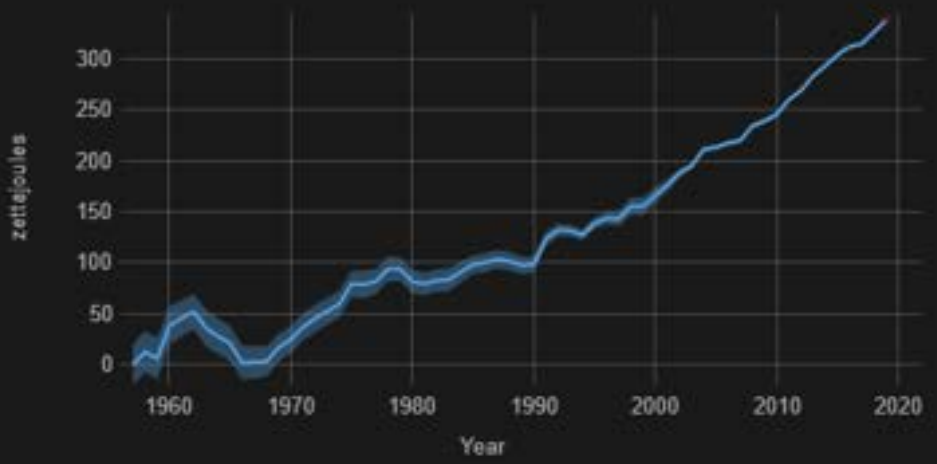
Note: You now need to create an Earthdata account to access NASA's sea level data. Register here for free. Once logged in, click "HTTP" under the "Satellite Data" chart on this page to access the data.

https://climate.nasa.gov/

Ocean Warming

OCEAN HEAT CONTENT CHANGES SINCE 1955 (NOAA)

Data source: Observations from various ocean measurement devices, including conductivity-temperature-depth instruments (CTDs), Argo profiling floats, and eXpendable BathyThermographs (XBTs). Credit: NOAA/NCEI World Ocean Database



Click+drag to zoom RESET

Get Data: HTTP | **Snapshot:** PNG

Ninety percent of global warming is occurring in the ocean, causing the water's internal heat to increase since modern recordkeeping began in 1955, as shown in the chart. (The shaded blue region indicates the 95% margin of uncertainty.)

Each data point in the chart represents a five-year average, expressed in zettajoules. For example, the 2018 value represents the average change in ocean heat content (since 1955) for the years 2016 to and including 2021.

Why Ocean Heat Matters

Coral bleaching is a consequence of a warming ocean. This image shows bleached coral off Islamorada, Florida. Credit: Kelsey Roberts/USGS

Covering more than 70% of Earth's surface, our global ocean has a very high heat capacity. It has absorbed 90% of the warming that has occurred in recent decades due to increasing greenhouse gases, and the top few meters of the ocean store as much heat as Earth's entire atmosphere.

The effects of ocean warming include sea level rise due to thermal expansion, coral bleaching, accelerated melting of Earth's major ice sheets, intensified hurricanes, and changes in ocean health and biochemistry.

https://climate.nasa.gov/

“Megafires may well become the new normal as global temperatures continue to rise,” says Niklas Hagelberg, a United Nations Environment Programme (UNEP) climate change expert.”

“Higher temperatures create, in some parts of the world, drier conditions, increasing the likelihood and intensity of wildfires, and megafires”

Drier and wetter

"Current climate models indicate that rising temperatures will intensify the Earth's water cycle, increasing evaporation. Increased evaporation will result in more frequent and intense storms, but will also contribute to drying over some land areas. As a result, storm-affected areas are likely to experience increases in precipitation and increased risk of flooding, while areas located far away from storm tracks are likely to experience less precipitation and increased risk of drought."

https://gpm.nasa.gov/resources/faq/how-does-climate-change-affect-precipitation

TIPPING POINT

When a temperature threshold is passed, leading to an *unstoppable change* in a climate system, **even if global heating ends**

- an uncontrollable domino effect

Thwaites 'Doomsday Glacier' is melting faster than expected: Concerns over sea level rise grow

Cracks and fractures beneath Thwaites Glacier could accelerate the breakup of the crucial Florida-sized ice sheet in West Antarctica, research shows.

George Petras and Janet Loehrke USA TODAY

Published 9:58 PM CET Feb. 16, 2023 | **Updated 10:27 PM CET Feb. 16, 2023**

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom

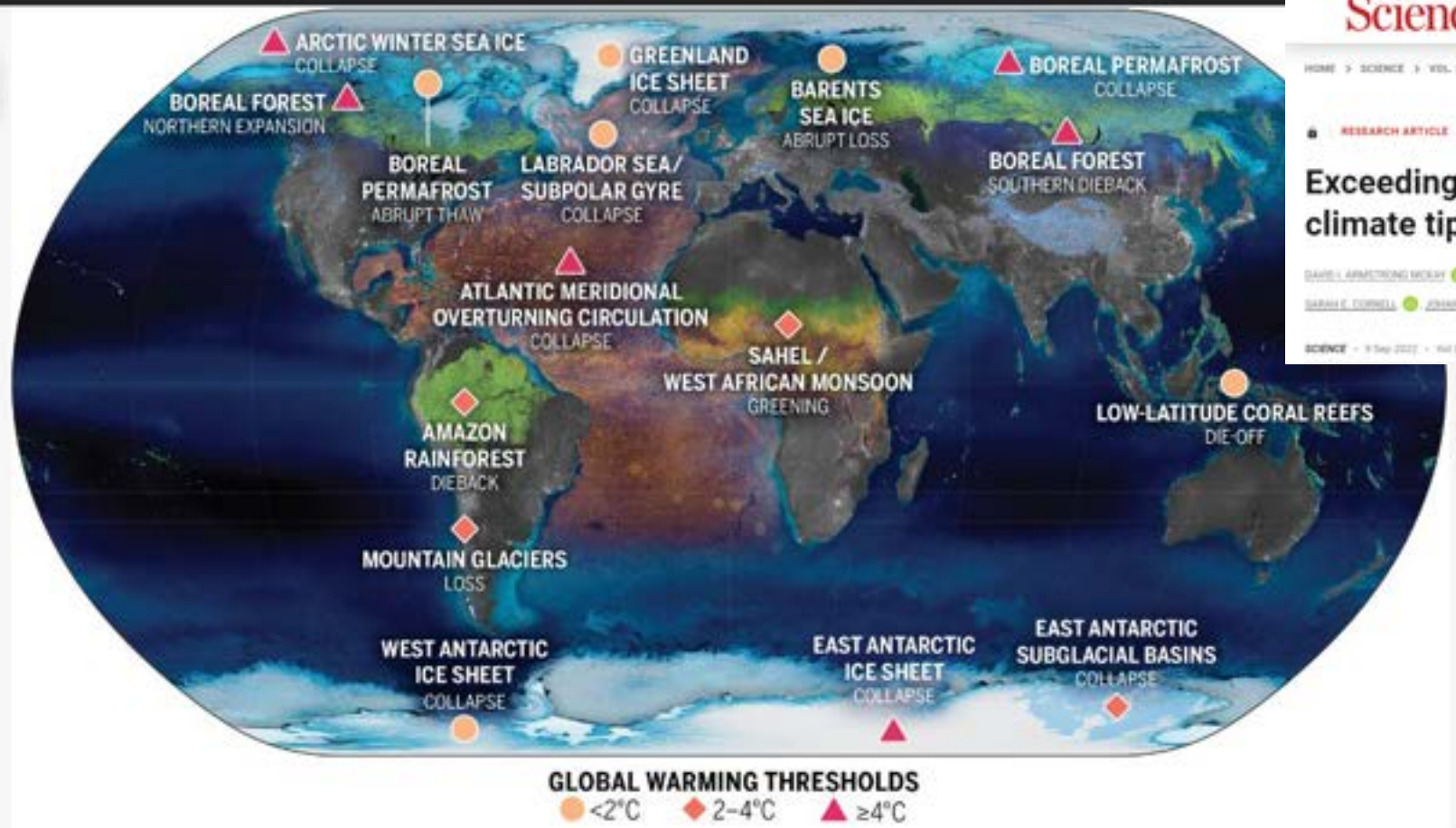
Nearly 30 dangerous feedback loops could permanently shift the Earth's climate, scientists say

By Laura Paddison, CNN

Published 11:00 AM EST, Fri February 17, 2023

"Climate feedback loops are cyclical chain reactions that happen when one change triggers further changes, in a process that keeps on repeating itself. Some of these feedback loops drive down warming, but others amplify it."

"Take Arctic ice, for example. Warming temperatures cause sea ice to melt, revealing the dark ocean water beneath. As dark surfaces absorb more heat than reflective surfaces like ice, the ocean warms and more ice melts."



The location of climate tipping elements in the cryosphere (blue), biosphere (green), and ocean/atmosphere (orange), and global warming levels at which their tipping points will likely be triggered.

Science

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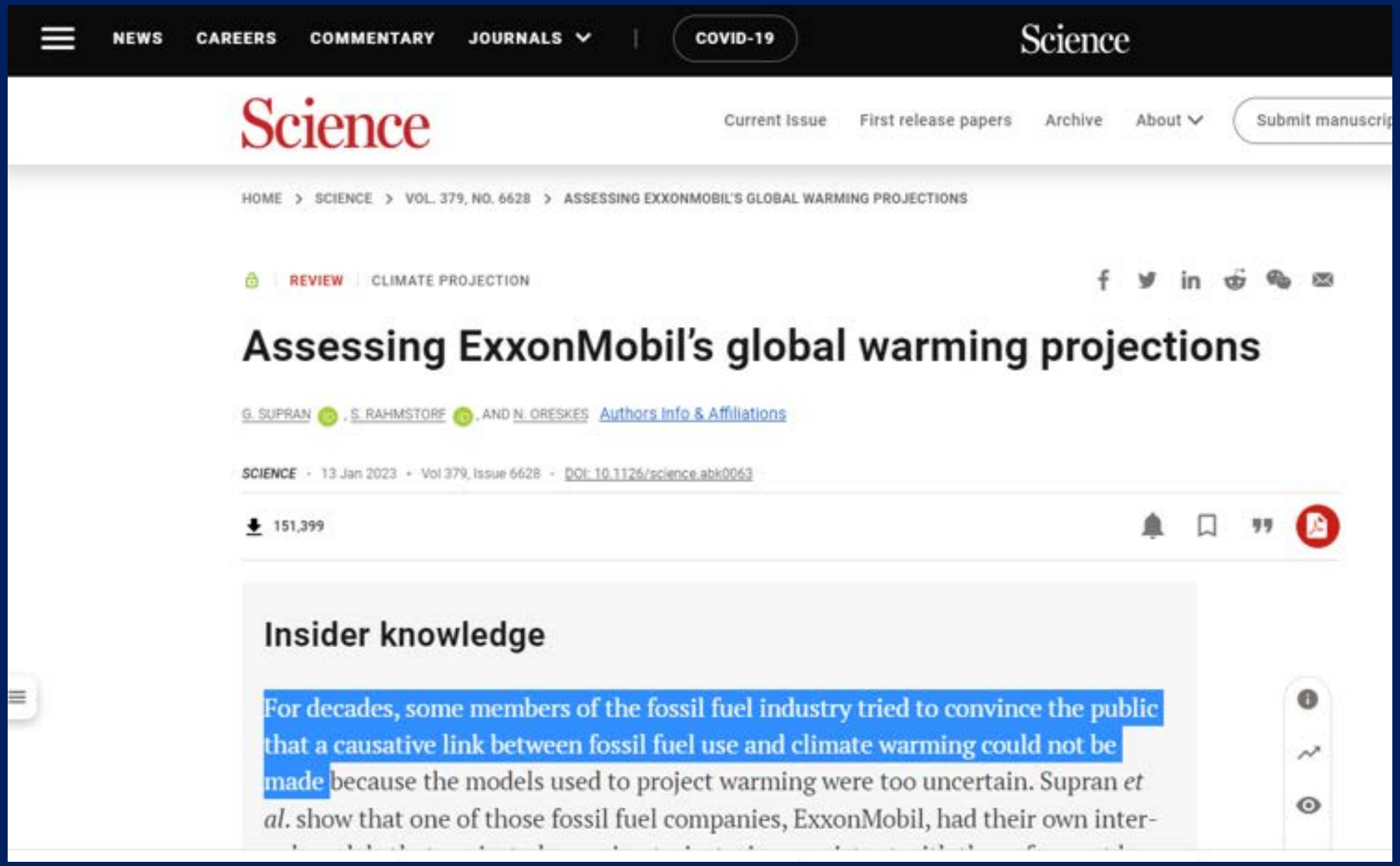
RESEARCH ARTICLE CLIMATE CHANGE

Exceeding 1.5°C global warming could trigger multiple climate tipping points

Authors Info & Affiliations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HOME > SCIENCE > VOL. 379, NO. 6628 > ASSESSING EXXONMOBIL'S GLOBAL WARMING PROJECTIONS
REVIEW | CLIMATE PROJECTION
Assessing ExxonMobil's global warming projections
G. SUPRAN , S. RAHMSTORF , AND N. ORESKES Authors Info & Affiliations
SCIENCE · 13 Jan 2023 · Vol 379, Issue 6628 · DOI: 10.1126/science.abk0063
151,399
Insider knowledge
For decades, some members of the fossil fuel industry tried to convince the public that a causative link between fossil fuel use and climate warming could not be made because the models used to project warming were too uncertain. Supran et al. show that one of those fossil fuel companies, ExxonMobil, had their own inter-

War

"Over 90% of the major armed conflicts between 1950 and 2000 occurred within countries containing biodiversity hotspots, and more than 80% took place directly within hotspot areas."

Data: The world's 34 biodiversity hotspots and the location of all armed conflicts with over 1000 casualties between 1950 and 2000

HANSON, T., BROOKS, T.M., DA FONSECA, G.A.B., HOFFMANN, M., LAMOREUX, J.F., MACHLIS, G., MITTERMEIER, C.G., MITTERMEIER, R.A. and PILGRIM, J.D. (2009), Warfare in Biodiversity Hotspots. Conservation Biology, 23: 578-587. https://doi.org/10.1111/j.1523-1739.2009.01166.x


euronews.green NEWS CLIMATE NATURE LIVING ECO-INNOVATION OPINION SERIE

By Rosie Frost & Euronews with Reuters • Updated: 04/10/2022

GREEN NEWS

Ukraine estimates more than €35bn of environmental damage has been done by Russia's invasion

The territory of Ukraine contains habitats that are home to 35% of Europe's biodiversity, including 70,000 plant and animal species, many of them rare, relict, and endemic.
(WWF: ASSESSING THE ENVIRONMENTAL IMPACTS OF THE WAR IN UKRAINE)

Increased greenhouse gases
Toxic elements in air, soil, food
Destruction of habitats
Landmines
Costs

- …millions of hectares of natural reserves under threat
  2,000 cases of environmental damages have already been recorded
  …the bill for air pollution caused by the war in Ukraine is so far about €25 billion.
- €11.4 billion is needed to address damage to the soil.
  …caused 31 million tonnes of CO2 emissions, roughly the amount produced by New Zealand annually.
- …another 79 million tons of greenhouse emissions could be produced for the reconstruction of infrastructure and buildings destroyed during the war.
  Russian gas pipe leaks could have an 'unprecedented' environmental impact
  …satellites detected more than 37,000 fires - a majority affecting forests and other natural ecosystems.
  Large volumes of military scrap containing chemicals that can pollute groundwater have been left behind.
  …. believe that 20 species native to the steppe may have disappeared completely due to the war.

GLOBAL CLIMATE CHANGE
Vital Signs of the Planet

FEATURE | January 9, 2023

NASA Space Missions Pinpoint Sources of CO2 Emissions on Earth

GLOBAL CLIMATE CHANGE
Vital Signs of the Planet

FACTS NEWS SOLUTIONS EXPLORE NA

NEWS | December 14, 2022

NASA Sensors to Help Detect Methane Emitted by Landfills

"Emissions from large facilities such as power plants and refineries account for about half of global carbon dioxide emissions from fossil fuels."

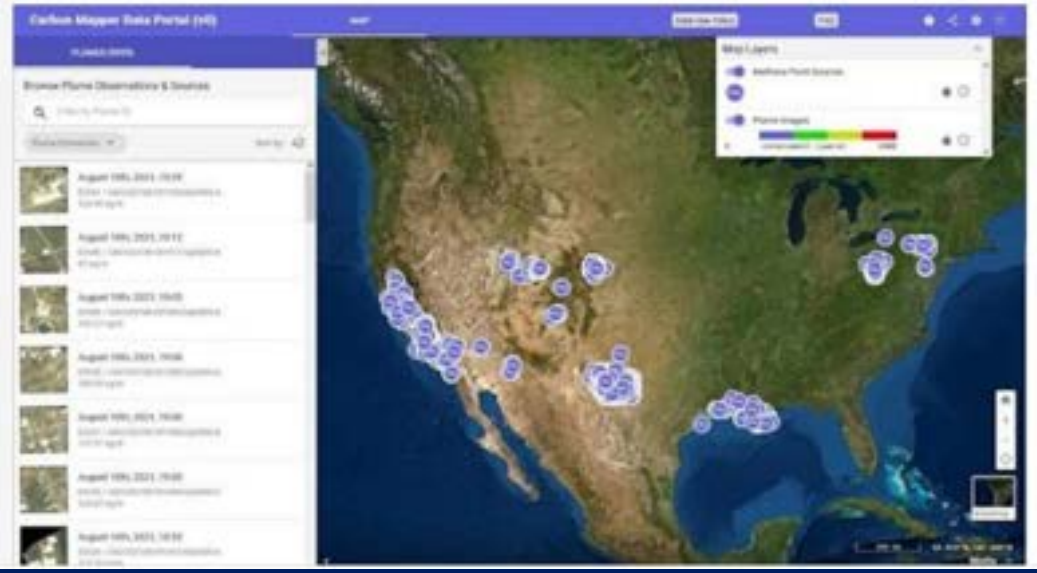
Methane from the waste sector makes up about 20% of human-caused methane emissions. A new project from a nonprofit group, Carbon Mapper, will use NASA instruments and data to measure emissions from landfills around the globe

"Methane produced by the waste sector contributes an estimated 20% of human-caused methane emissions. Ton for ton, methane is more than 80 times more potent than carbon dioxide in trapping heat in the atmosphere. But where carbon dioxide remains in the air for centuries, methane has an atmospheric lifetime of only about a decade or two."

ABOUT US OUR MISSION CASE STUDIES DATA RESOURCES NEWS & INSIGHTS

A critical component of Carbon Mapper's mission is to persistently pinpoint, quantify and track strong methane and carbon dioxide (CO_2) emissions at facility scale and to make this data free and open to the public, providing accessibility and transparency to maximize impact.

With its satellite plus airborne monitoring technology, Carbon Mapper shines a spotlight on where, when and how methane and CO_2 emissions are released. Its independent, facility-scale data insights increase global accessibility, transparency and understanding of methane and



ABOUT US ˅ OUR MISSION ˅ CASE STUDIES DATA RESOURCES NEWS & INSIGHTS

https://carbonmapper.org/our-mission/#overview

Oil well leak detection

Overview

There is an urgent need for a wide range of actions to accelerate methane (CH_4) and carbon dioxide (CO_2) mitigation, climate adaptation and conservation. Barriers include high costs for methane leak detection, gaps in self-reported CO_2 data for key emission sectors, incomplete observations of priority regions at scales relevant for decision making, and lack of data accessibility and transparency. Our airborne pilot projects, using advanced remote-sensing technology, are demonstrating the potential for an operational satellite data service that can help accelerate sub-national climate action. We plan to:

- Persistently pinpoint, quantify and track strong methane and CO_2 emissions at facility scale
- Offer a rapid methane leak detection service to facility operators and regulators
- Deliver independent data to help certify methane intensity for oil and gas supply chains
- Increase global accessibility, transparency and understanding of methane and CO_2 data
- Work with key partners to advance new data-driven emission mitigation strategies

Mapping forest biodiversity in Malaysia
…contrast between high-diversity natural forests and monocultures of oil palm plantation trees

Mapping drought impacts in California

Mapping coral reef health in Hawaii

Mapping biodiversity in Peru
….outputs of the richness and abundance of species across this Amazonian landscape

https://nsidc.org/home