



Aktuelle Erkenntnisse zur **Klimakrise**

Stefan Rahmstorf
Potsdam-Institut für
Klimafolgenforschung

**Der Mensch verändert das Klima „durch
Fällen der Wälder [...] und durch die
Entwicklung großer Dampf- und Gasmassen
an den Mittelpunkten der Industrie“.**

Alexander von Humboldt, 1843



Svante Arrhenius 1896

Klimasensitivität

4°C



THE
LONDON, EDINBURGH, AND DUBLIN
PHILOSOPHICAL MAGAZINE
AND
JOURNAL OF SCIENCE.

[FIFTH SERIES.]

APRIL 1896.

XXXI. *On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground.* By Prof. SVANTE ARRHENIUS *.

I. *Introduction : Observations of Langley on Atmospheric Absorption.*

A GREAT deal has been written on the influence of the absorption of the atmosphere upon the climate. Tyndall † in particular has pointed out the enormous importance of this question. To him it was chiefly the diurnal and annual variations of the temperature that were lessened by this circumstance. Another side of the question, that has long attracted the attention of physicists, is this: Is the mean temperature of the ground in any way influenced by the presence of heat-absorbing gases in the atmosphere? Fourier ‡ maintained that the atmosphere acts like the glass of a hot-house, because it lets through the light rays of the sun but retains the dark rays from the ground. This idea was elaborated by Pouillet §; and Langley was by some of his researches led to the view, that "the temperature of the earth under direct sunshine, even though our atmosphere were present as now, would probably fall to -200° C., if that atmosphere did not possess the quality of selective

* Extract from a paper presented to the Royal Swedish Academy of Sciences, 11th December, 1895. Communicated by the Author.

† 'Heat a Mode of Motion,' 2nd ed. p. 405 (Lond., 1865).

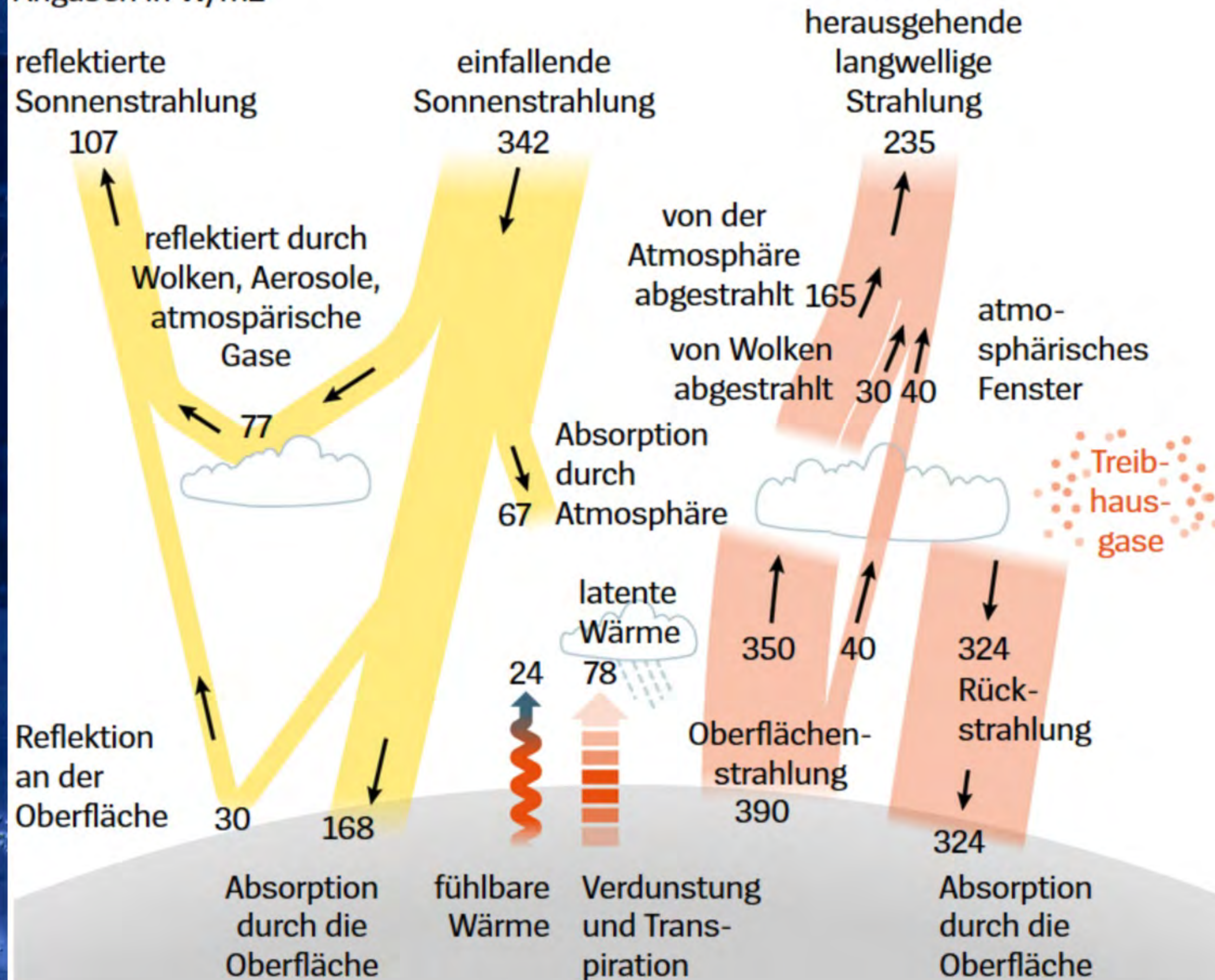
‡ *Mém. de l'Ac. R. d. Sci. de l'Inst. de France*, t. vii. 1827.

§ *Comptes rendus*, t. vii. p. 41 (1838).

Fragiles Gleichgewicht

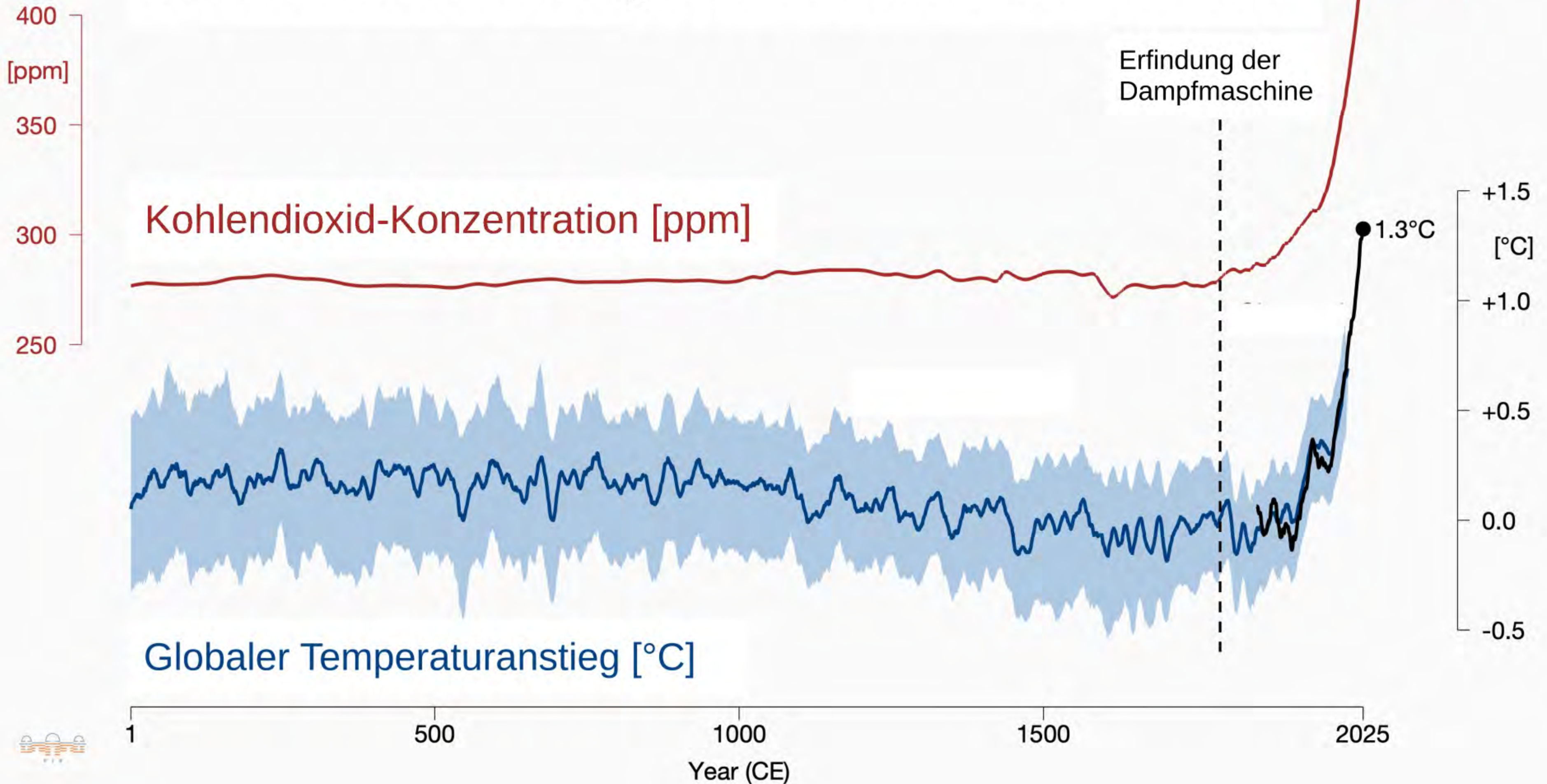
Die Energiebilanz der Erde

Angaben in W/m^2

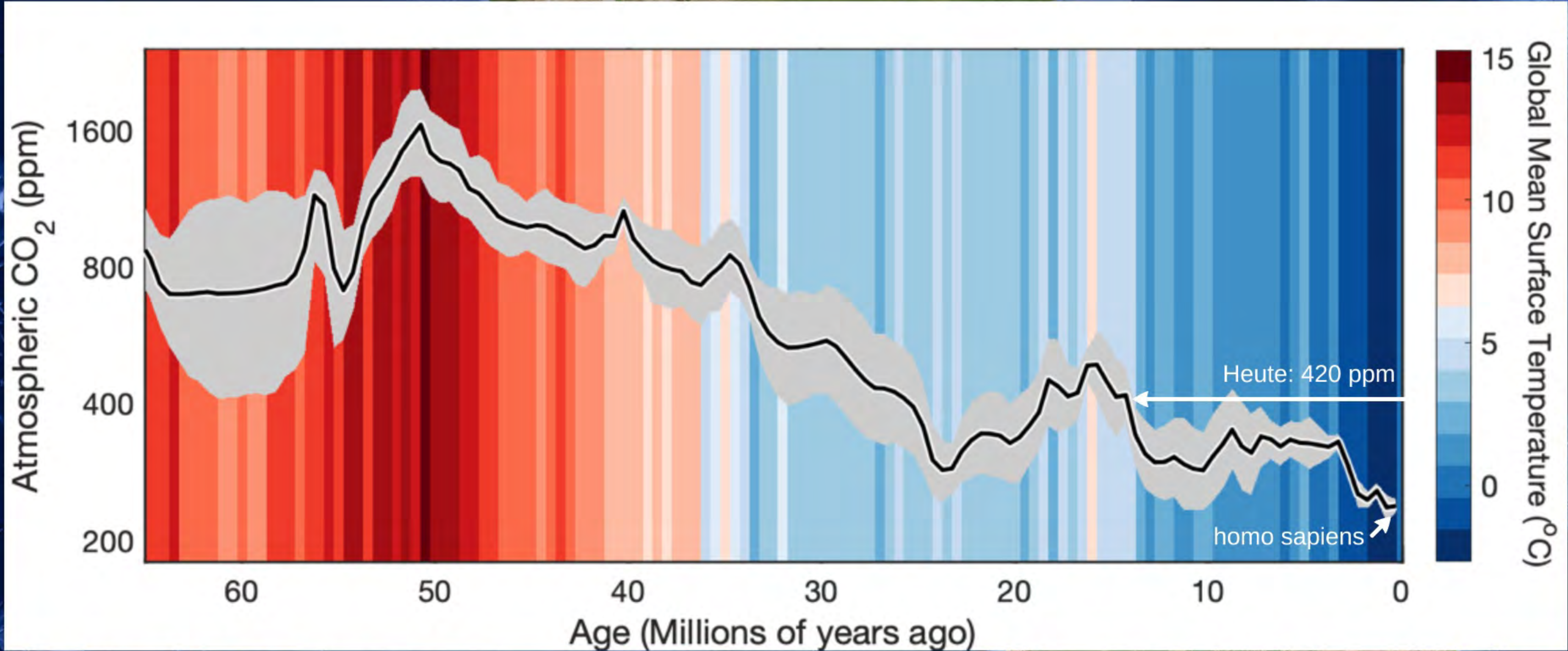


Quelle: IPCC

Klimaveränderung der letzten 2025 Jahre



Die letzten 66 Millionen Jahre



The Cenozoic CO₂ Proxy Integration Project Consortium, Science 2023

°C]

1.5

Temperatur

Jahr

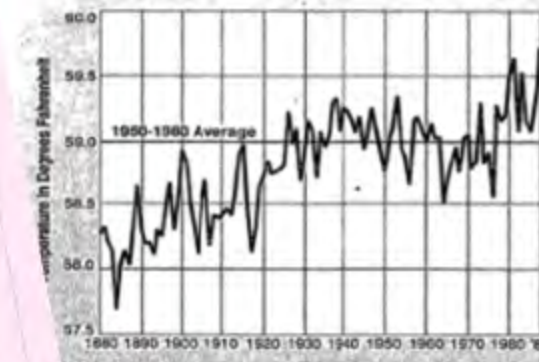
Steve Milloy @JunkScience · Jan 13
Normal 6%
NOAA makes it official.
Last 8 years... global cooling... at a rate of 0.11°C/decade.... despite 450+ billion tons of emissions worth 14% of total manmade CO2 in the atmosphere.
CO2 warming is a hoax.



The New York Times

VOL. CXXXVII... No. 47,346 Copyright © 1988 The New York Times NEW YORK, FRID

Global Warming Has Begun, Expert Tells Senate



Global Warming: Greenhouse Effect?

Average global temperatures through the first five months of 1988... as a baseline, scientists use the global average from 1950 to 1980.

Sharp Cut in Burning of Fossil Fuels Is Urged to Battle Shift in Climate

By PHILIP SHARCOFF

Special to The New York Times

WASHINGTON, June 23 — The earth has been warmer in the first five months of this year than in any comparable period since measurements began 130 years ago, and the higher temperatures can now be attributed to a long-expected global warming trend linked to pollution, a space agency scientist reported today.

Until now, scientists have been cautious about attributing rising global temperatures of recent years to the predicted global warming caused by pollutants in the atmosphere, known as the "greenhouse effect." But today Dr. James E. Hansen of the National Aeronautics and Space Administration told a Congressional committee that it was 99 percent certain that the warming trend was not a natural variation but was caused by a buildup of carbon dioxide and other artificial gases in the

IPCC 1990

"Sicher" dass THG Ausstoß zu Erderwärmung führt

Paris 2015

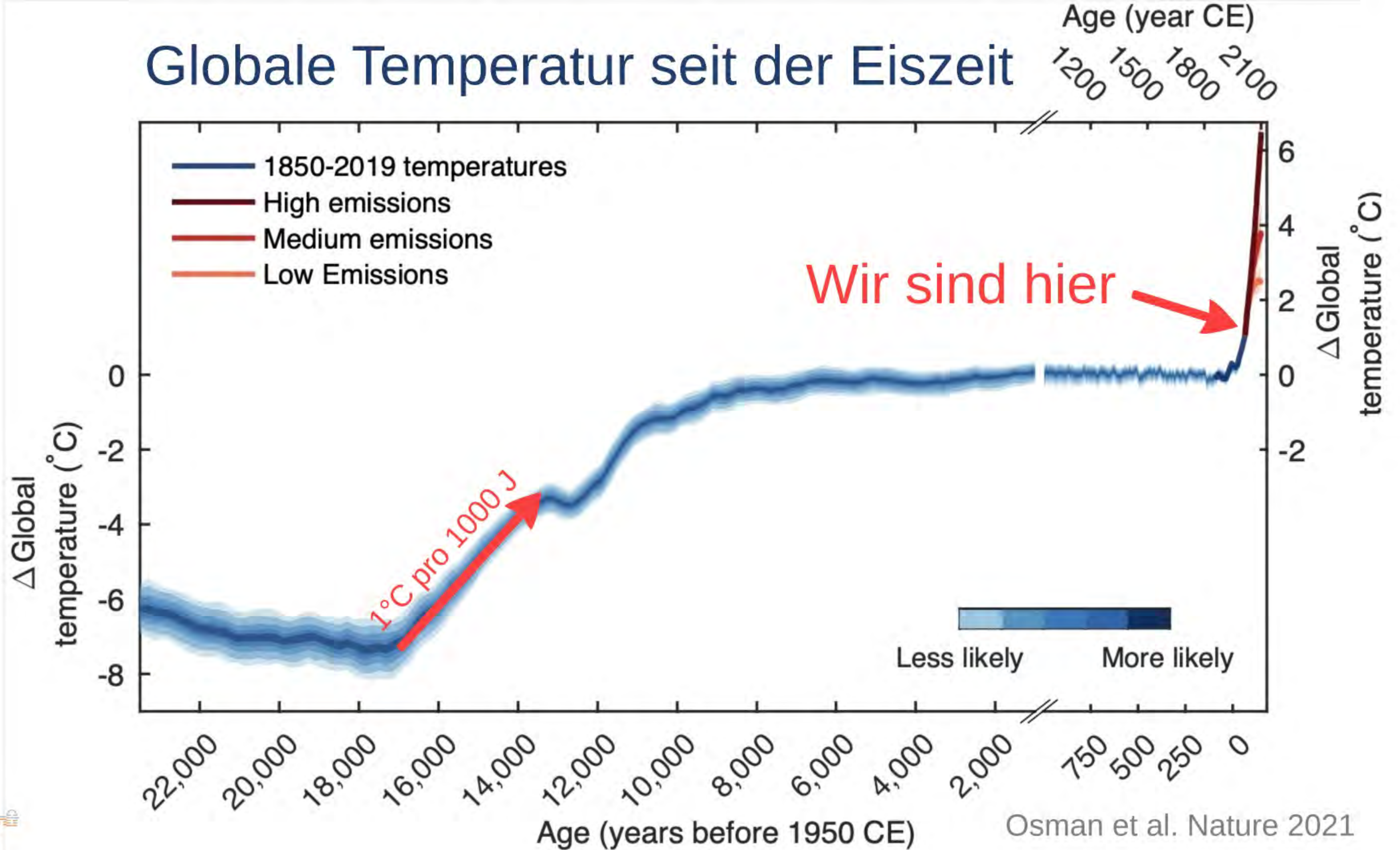
Erdgipfel Rio 1992

1965 Revelle Report

Man is unwittingly conducting a vast geophysical experiment... The climatic changes that may be produced by the increased CO₂ content could be deleterious from the point of view of human beings.



Globale Temperatur seit der Eiszeit



Globale Temperatur seit der Eiszeit

Age (year CE)

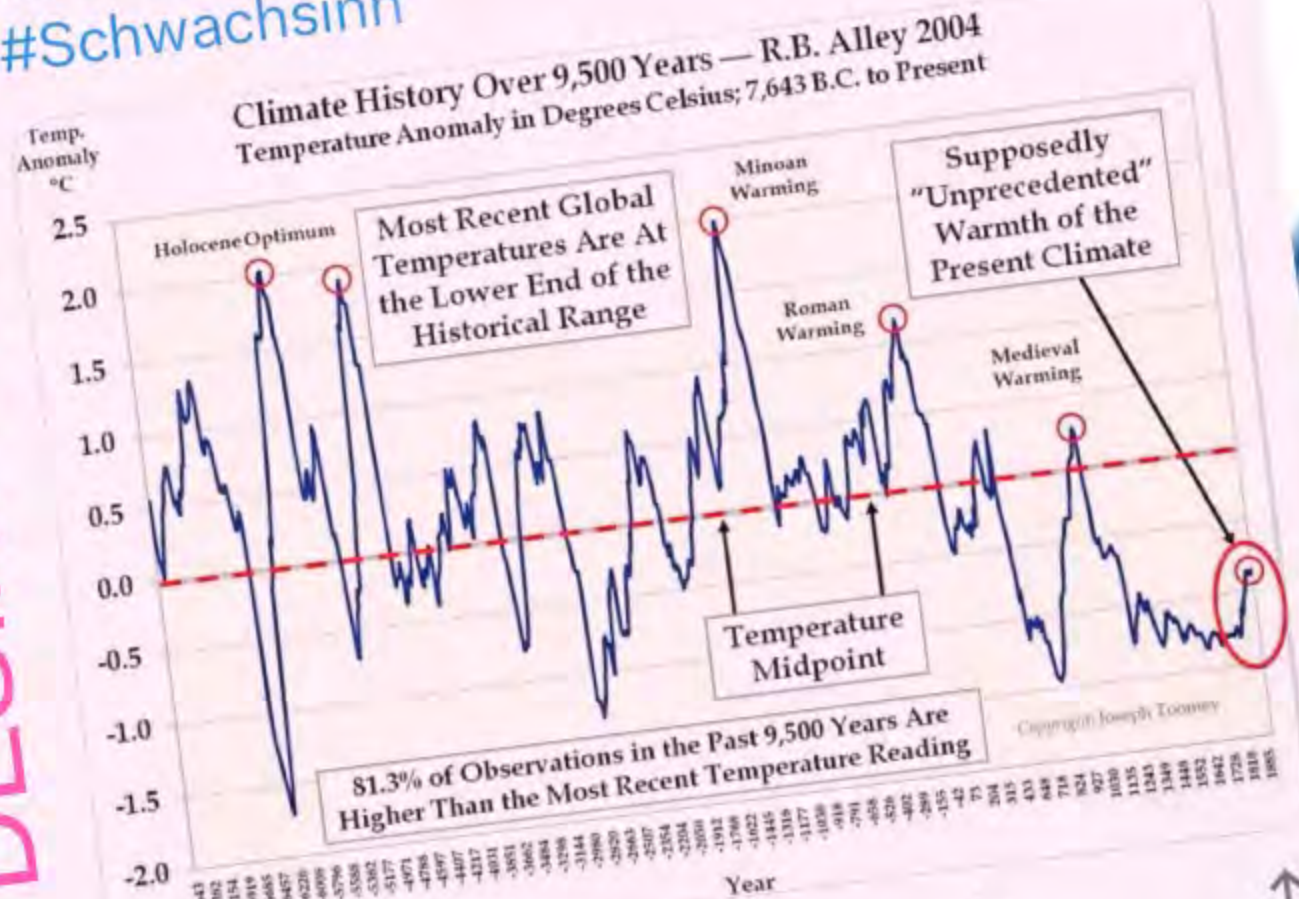
1200 1500 1800 2100



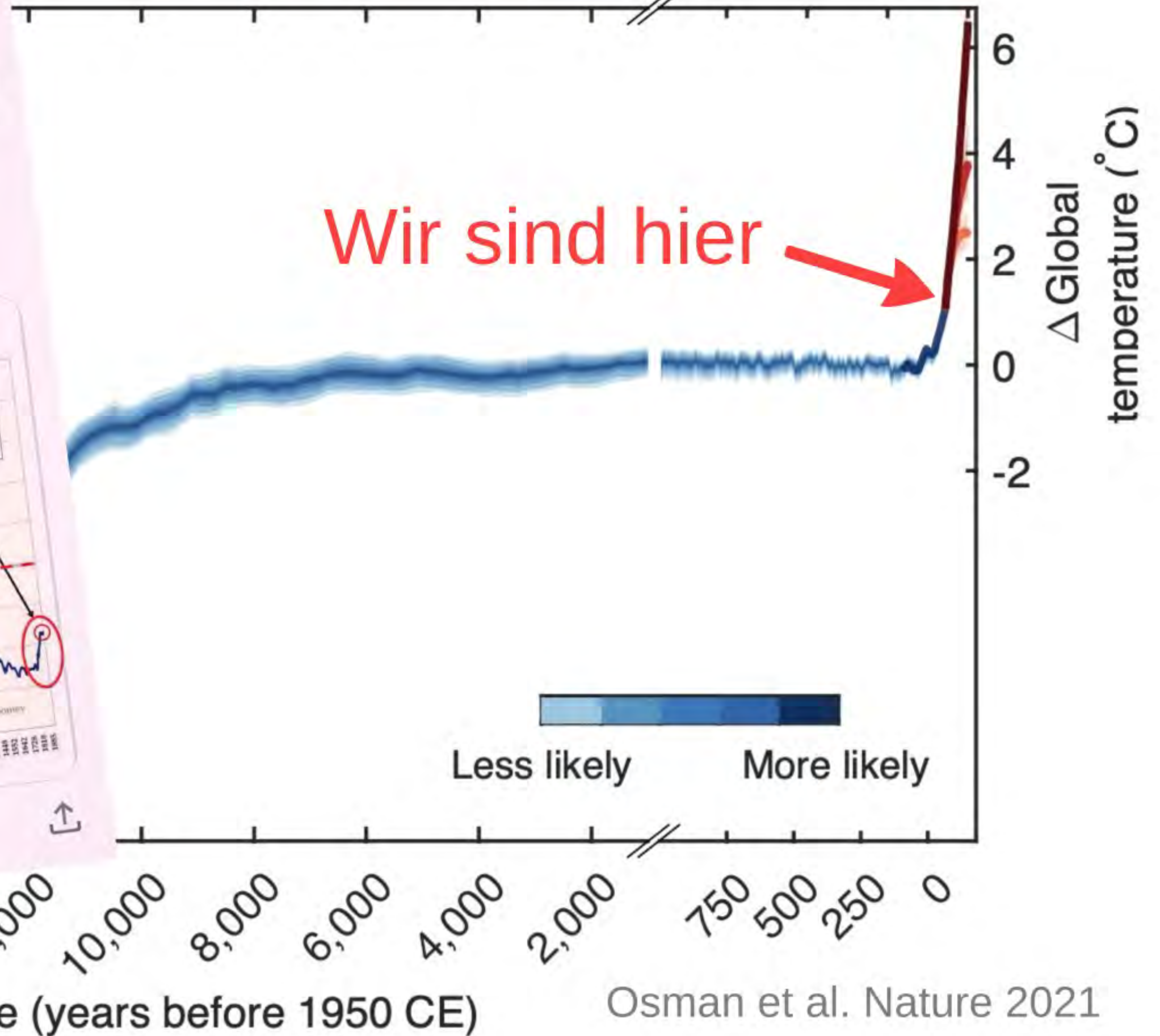
Dr. Markus Krall  @Markus... · 05.12.22 ...
Die Temperaturentwicklung der letzten
9.500 Jahre. Das kleine Päckchen da rechts
unten soll angeblich **die** "Klimakatastrophe"
darstellen. Klimawandel gibt es, nur ist er
weder neu, noch "menschengemacht".
[#Schwachsinn](#)

Over 9,500 Years — R.B. Alley 2004
7,613 B.C. to Present

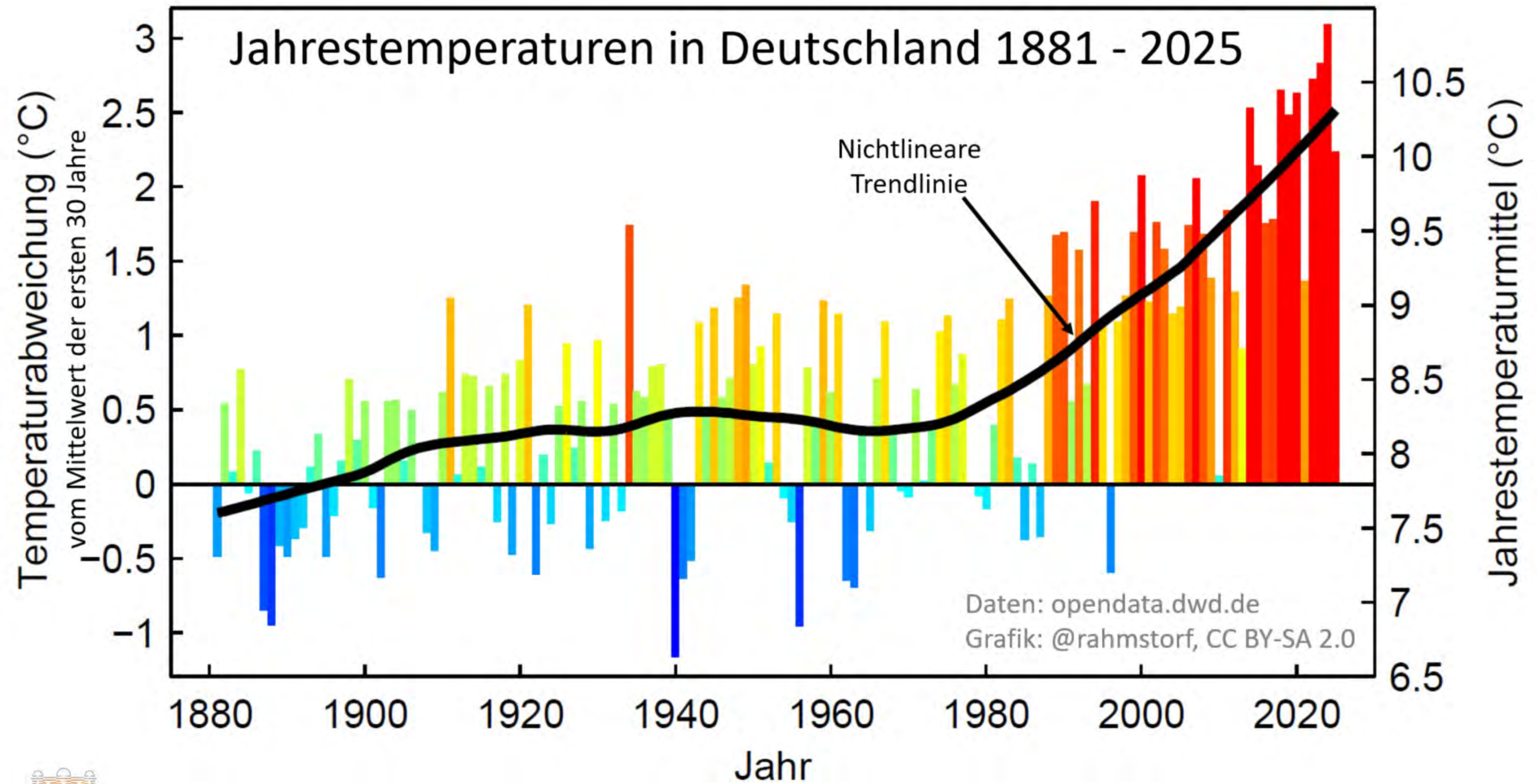
#Schwachsinn



Wir sind hier

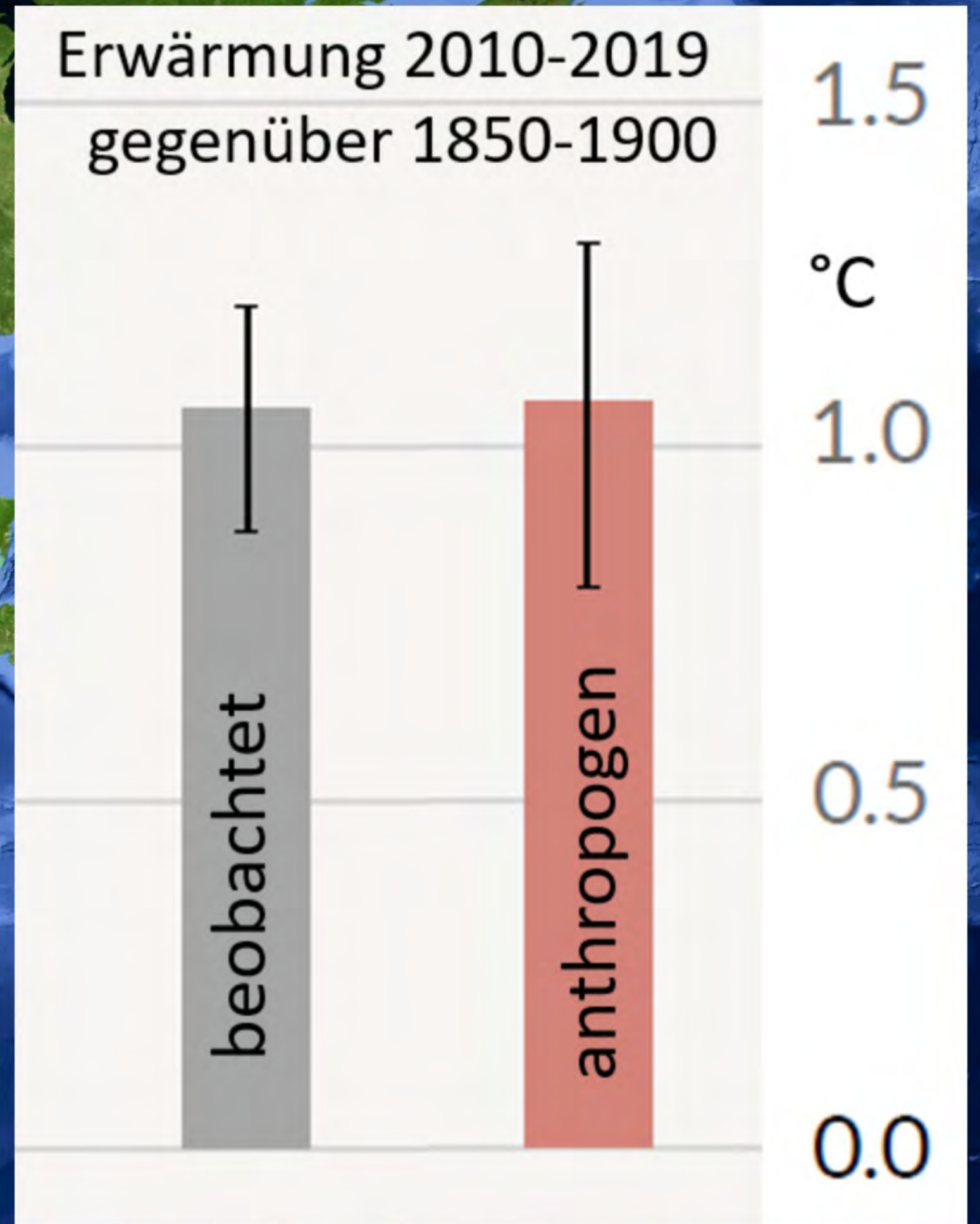


Osman et al. Nature 2021

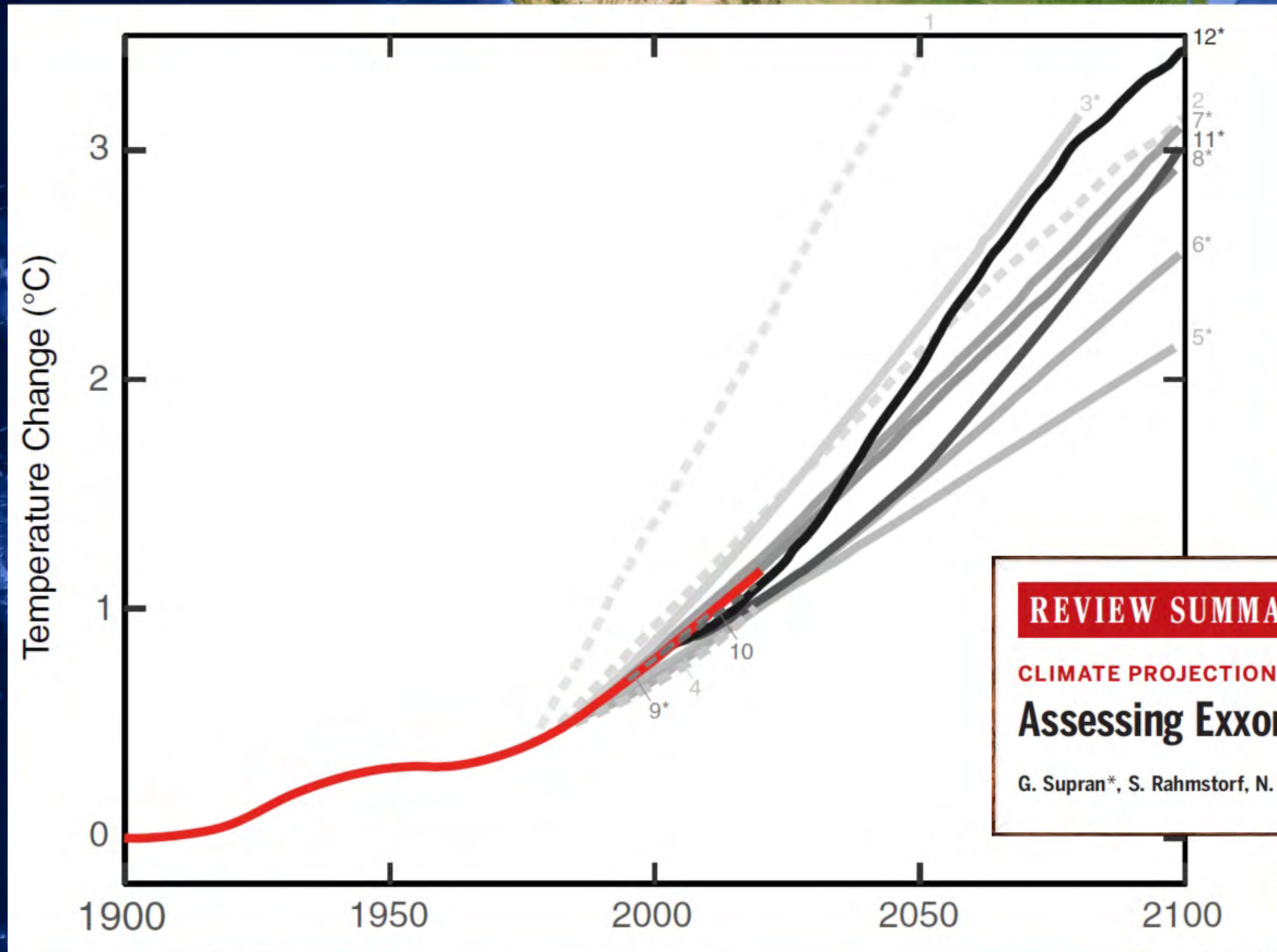


Die moderne Erwärmung ist komplett menschengemacht!

Quelle:
IPCC 2021



Auch Exxon-Forscher haben das vorhergesagt



REVIEW SUMMARY

CLIMATE PROJECTION

Assessing ExxonMobil's global warming projections

G. Supran*, S. Rahmstorf, N. Oreskes

Science

Science: what we know and don't know



As the debate over climate change heats up, science is being upstaged by the call for solutions. At stake is a complex issue with many questions. Some things we know for certain. Others are far from certain.

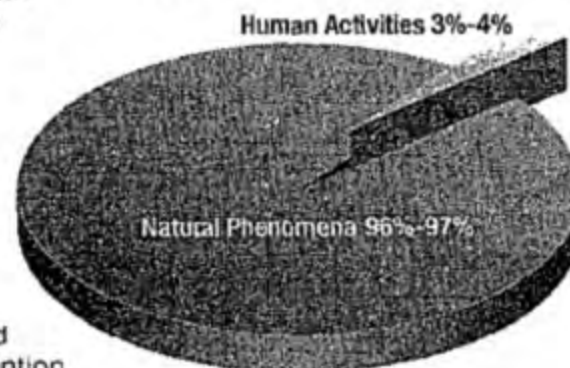
First, we know greenhouse gases account for less than one percent of Earth's atmosphere. The ability of these gases to trap heat and warm Earth is an important part of the climate system because it makes our planet habitable. Greenhouse gases consist largely of water vapor, with smaller amounts of carbon dioxide (CO₂), methane and nitrous oxide and traces of chlorofluorocarbons (CFCs).

The focus of concern is CO₂. While most of the CO₂ emitted by far is the result of natural phenomena—namely respiration and decomposition, most attention has centered on the three to four percent related to human activities—burning of fossil fuels, deforestation. The amount of carbon dioxide in the atmosphere has risen in the last 100 years, leading scientists to conclude that the increase is a result of man-made activities.

Although the linkage between the greenhouse gases and global warming is one factor, other variables could be much more important in the climate system than emissions produced by man.

The UN-sponsored Intergovernmental Panel on Climate Change (IPCC) thought it had found the magic bullet when it concluded that the one-degree Fahrenheit rise in global temperatures over

Carbon Dioxide Emissions



the past century may bear a "fingerprint" of human activity. The fingerprint soon blurred when an IPCC lead author conceded to the "uncertainty inherent in computer climate modeling."

Nonetheless, nations at Kyoto are being asked to embrace proposals that could have potentially huge impacts on economies and lifestyles. Nations are being urged to cut emissions without knowing either the severity of the problem—that is, will Earth's temperature increase over the next 50-100 years?—or the efficacy of the solution—will cutting CO₂ emissions reduce the problem?

Within a decade, science is likely to provide more answers on what factors affect global warming, thereby improving our decision-making. We just don't have this information today.

Answers to questions on climate change will require more reliable measurements of temperature at many places on Earth, better understanding of clouds and ocean currents along with greater computer power.

This process shouldn't be short-circuited to satisfy an artificial deadline, like the conference in Kyoto. Whatever effect increased concentrations of man-made gases may have, it will develop slowly over decades. Thus, there is time for scientists to refine their understanding of the climate system, while governments, industry and the public work to find practical means to control greenhouse gases, if such measures are called for. Adopting quick-fix measures at this point could pose grave economic risks for the world.

Was Exxon öffentlich sagte

SUCHE

Spektrum.de SciLogs

ASTRONOMIE | BIOLOGIE | CHEMIE | ERDE/UMWELT | IT/TECH | KULTUR | MATHEMATIK | MEDIZIN | PHYSIK | PSYCHOLOGIE/HIRNFORSCHUNG

HEIDELBERG LAUREATE FORUM

SciLogs » KlimaLounge » Uralte Exxon-Propaganda neu aufgelegt im deutschen Wahlkampf

18. Sep 2017

Von [Stefan Rahmstorf](#)

Lesedauer ca. 4

Minuten

[40 Kommentare](#)

Uralte Exxon-Propaganda neu aufgelegt im deutschen Wahlkampf

), methane oxide and chlorofluorocarbons (CFCs). The focus of concern is CO₂. While most of the CO₂ emitted by far is the result of natural phenomena—



problem?

Within a decade, science is likely to provide more answers on what factors affect global warming, thereby improving our decision-making. We just don't have this information today.

In den USA ermitteln Staatsanwälte gegen Exxon wegen systematischer Täuschung der Öffentlichkeit und seiner Kunden und Aktionäre über den Klimawandel. In Deutschland werden dagegen noch heute munter Märchen wiederholt, die Exxon vor Jahrzehnten in die Welt gesetzt hat. Zum Beispiel letzte Woche durch Alexander

Doubt over climate science is a product with an industry behind it

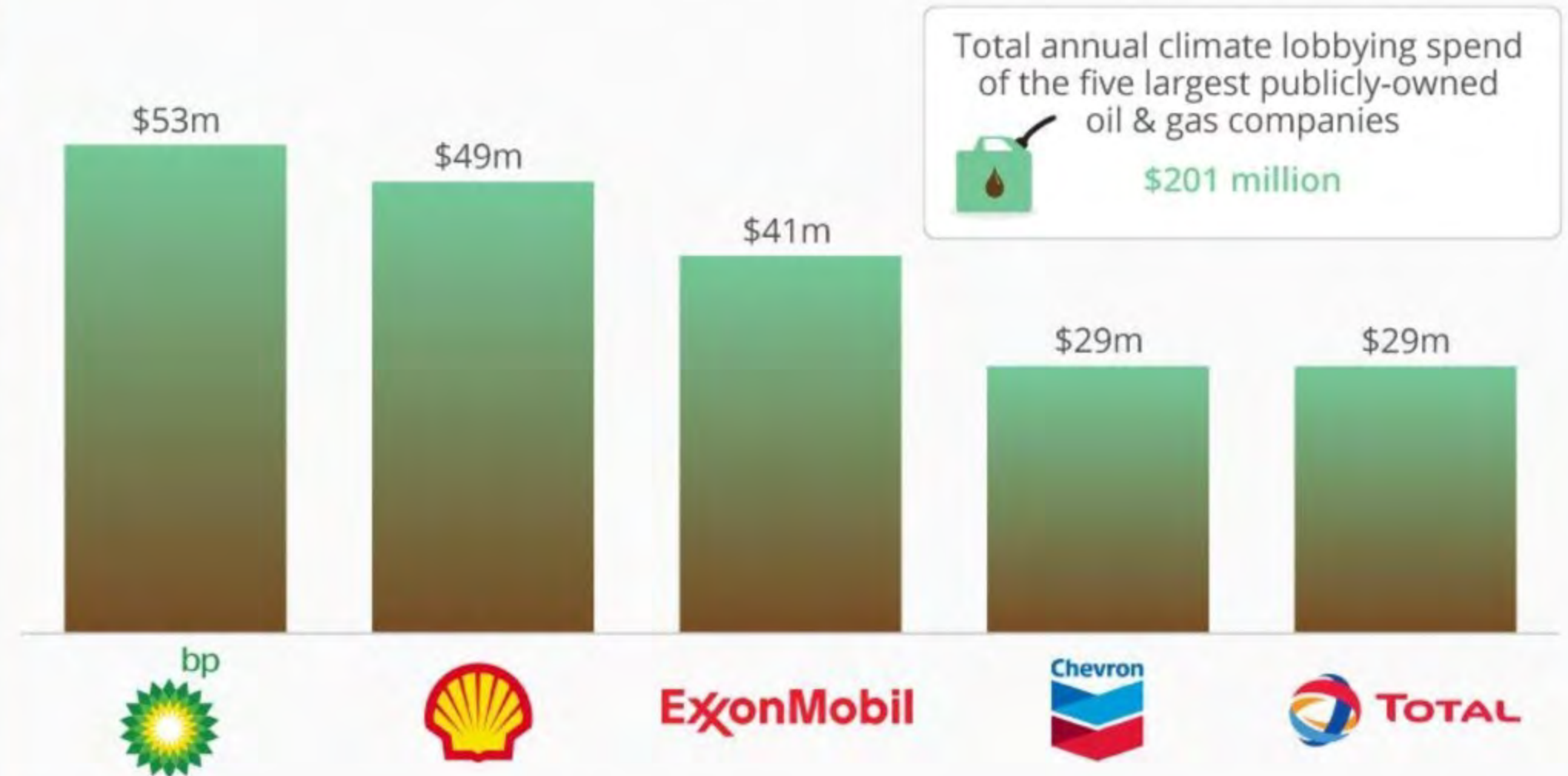
With its roots in the tobacco industry, climate science denial talking points can be seen as manufactured doubt



The manufacturing of doubt on climate change science, backed by the fossil fuel industry, has its roots with the tobacco industry's assault on climate science in the 1960s. Photograph: Richard Hamilton Smith/Richard Hamilton Smith/Corbis

Oil Firms Spend Millions On Climate Lobbying

Annual expenditure on climate lobbying by oil and gas companies*



CC BY ND
@StatistaCharts

* As of 2019. Climate lobbying means spending to delay, control or block policies to tackle climate change.

Source: InfluenceMap

Forbes statista

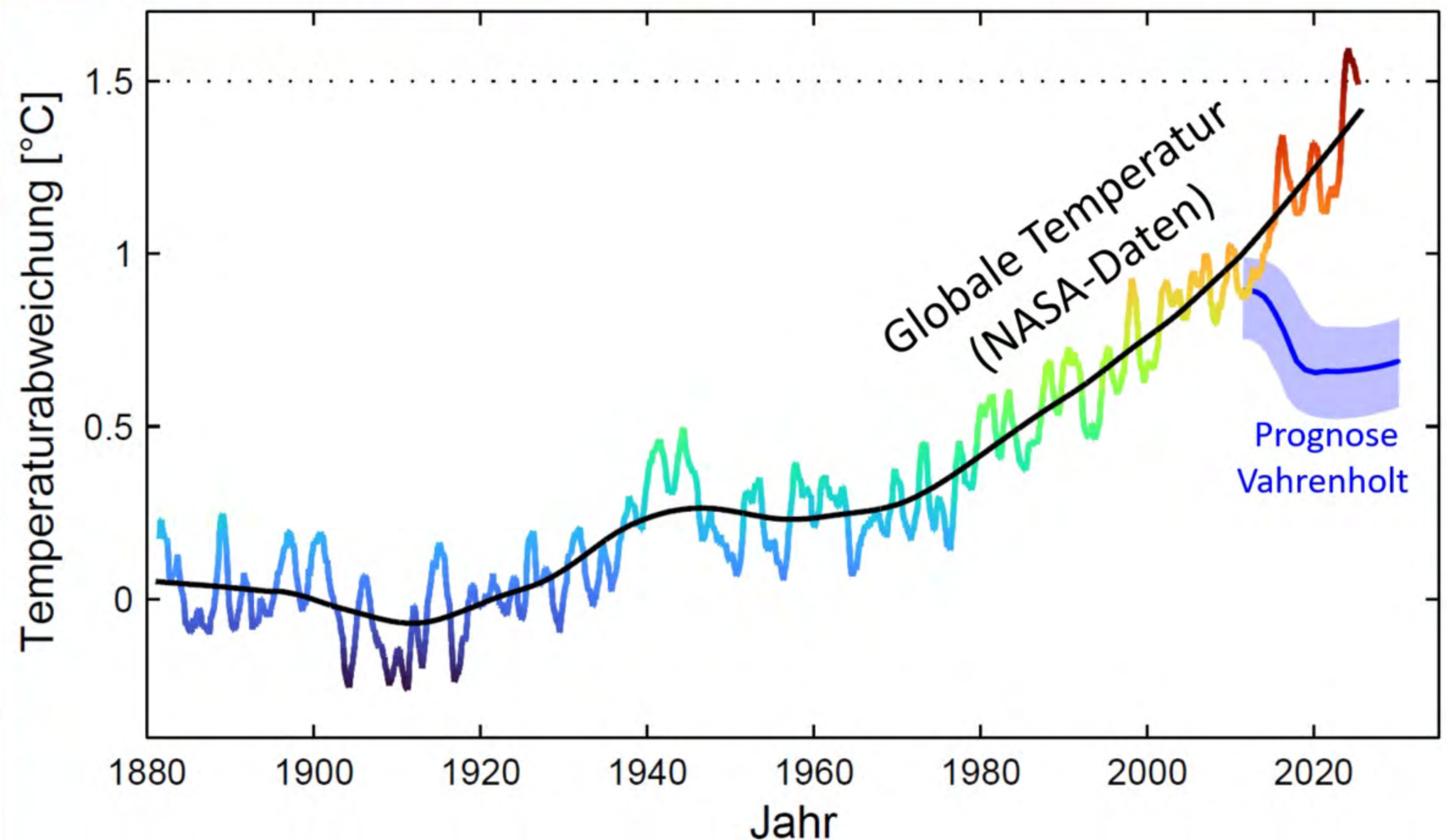
"It's the sun, stupid!"

Fritz Vahrenholt, RWE

Fritz Vahrenholt
Sebastian Lüning

Die kalte Sonne

Warum die
Klimakatastrophe
nicht stattfindet



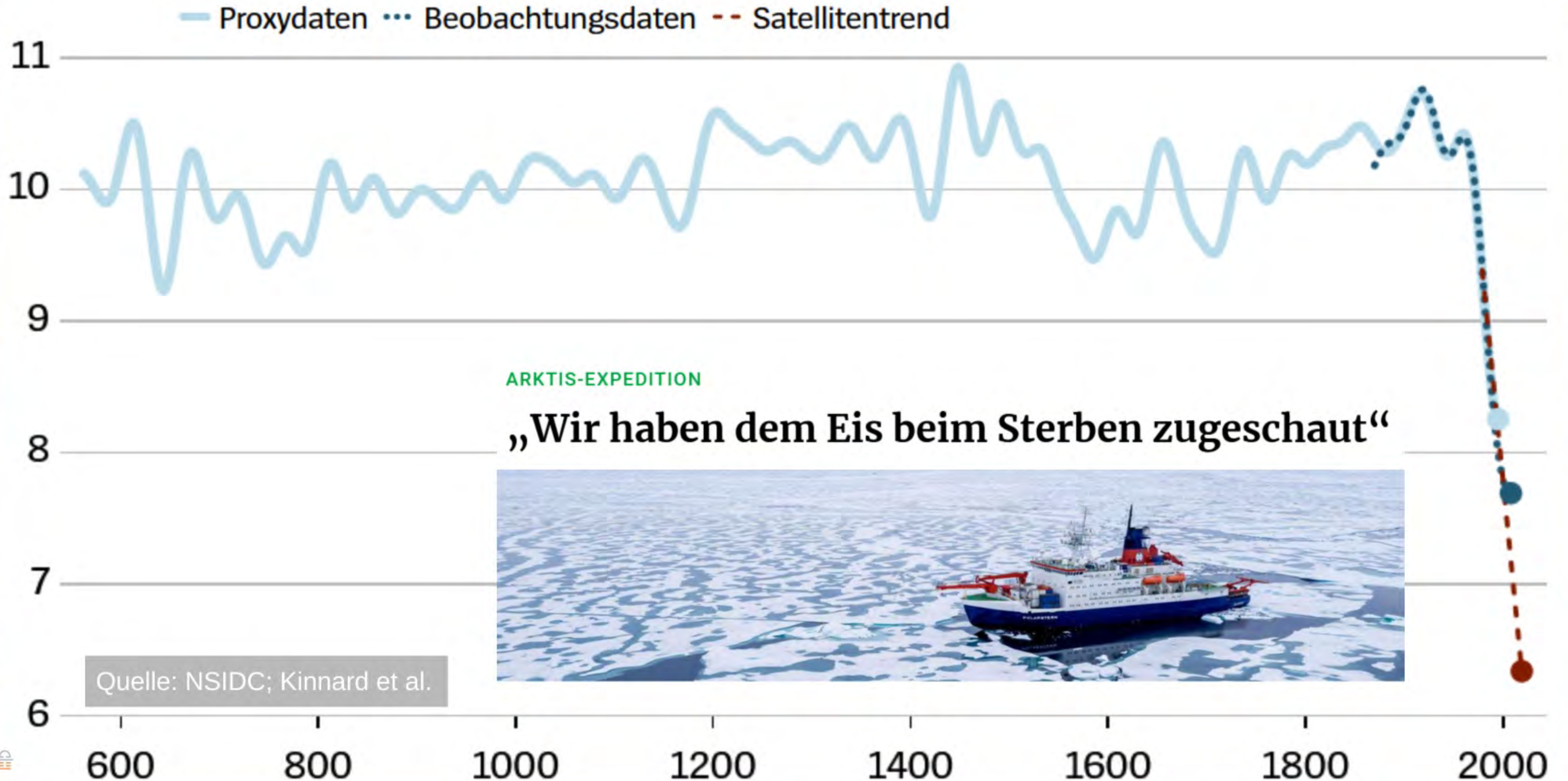






Arktische Meereisdecke im Spätsommer

Angabe in Millionen Quadratkilometern über die vergangenen 1450 Jahre

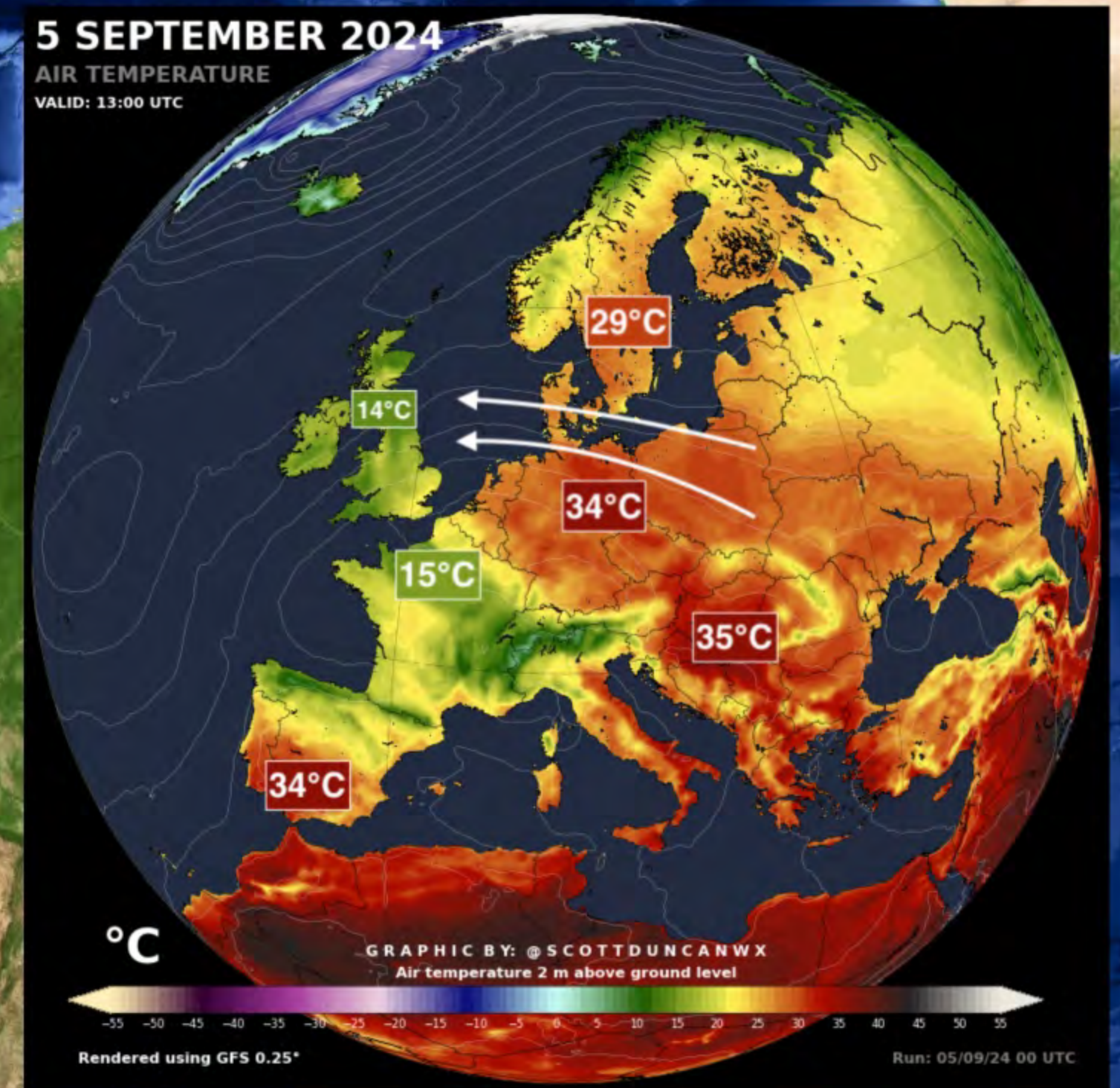
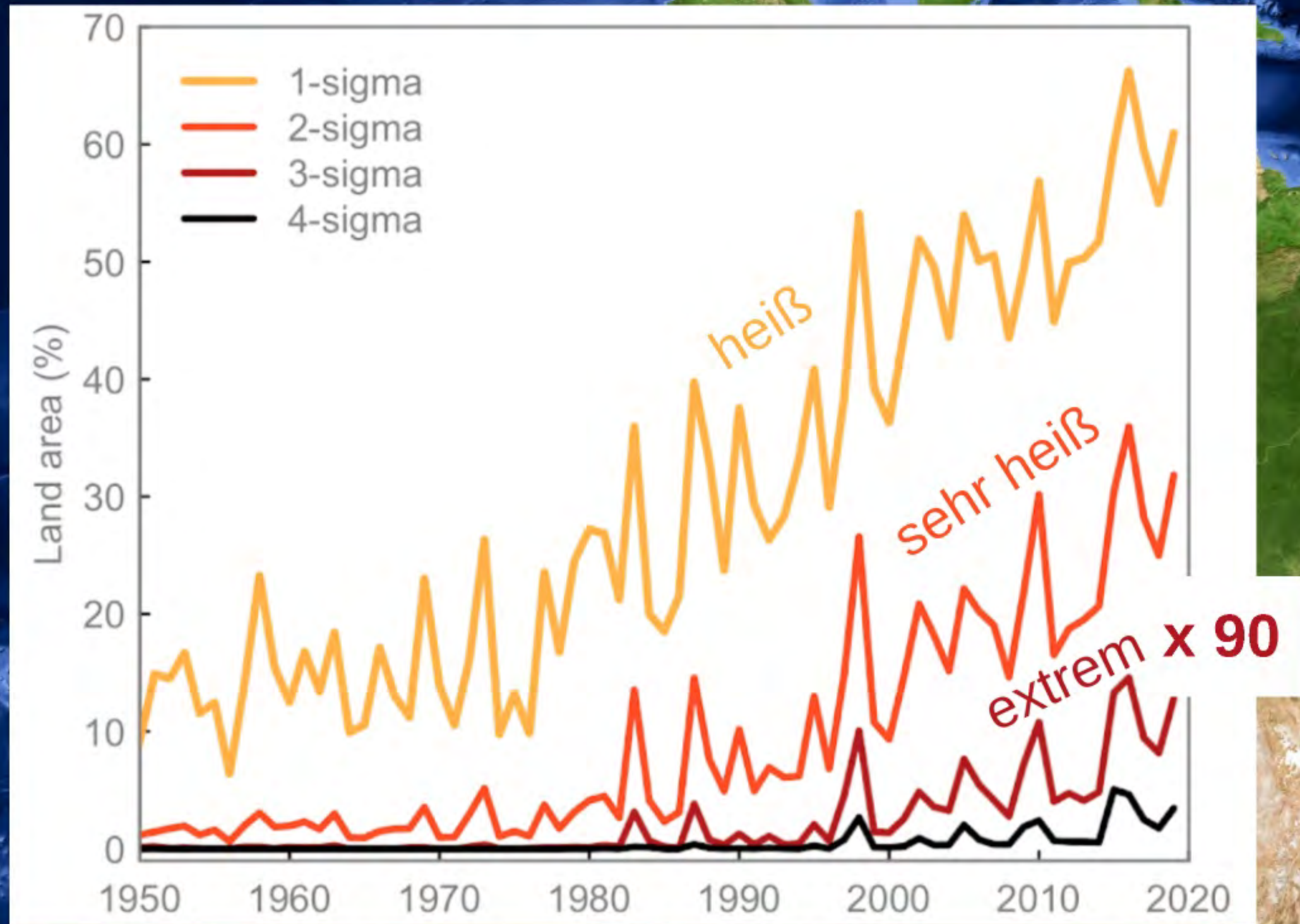


ARKTIS-EXPEDITION

„Wir haben dem Eis beim Sterben zugeschaut“



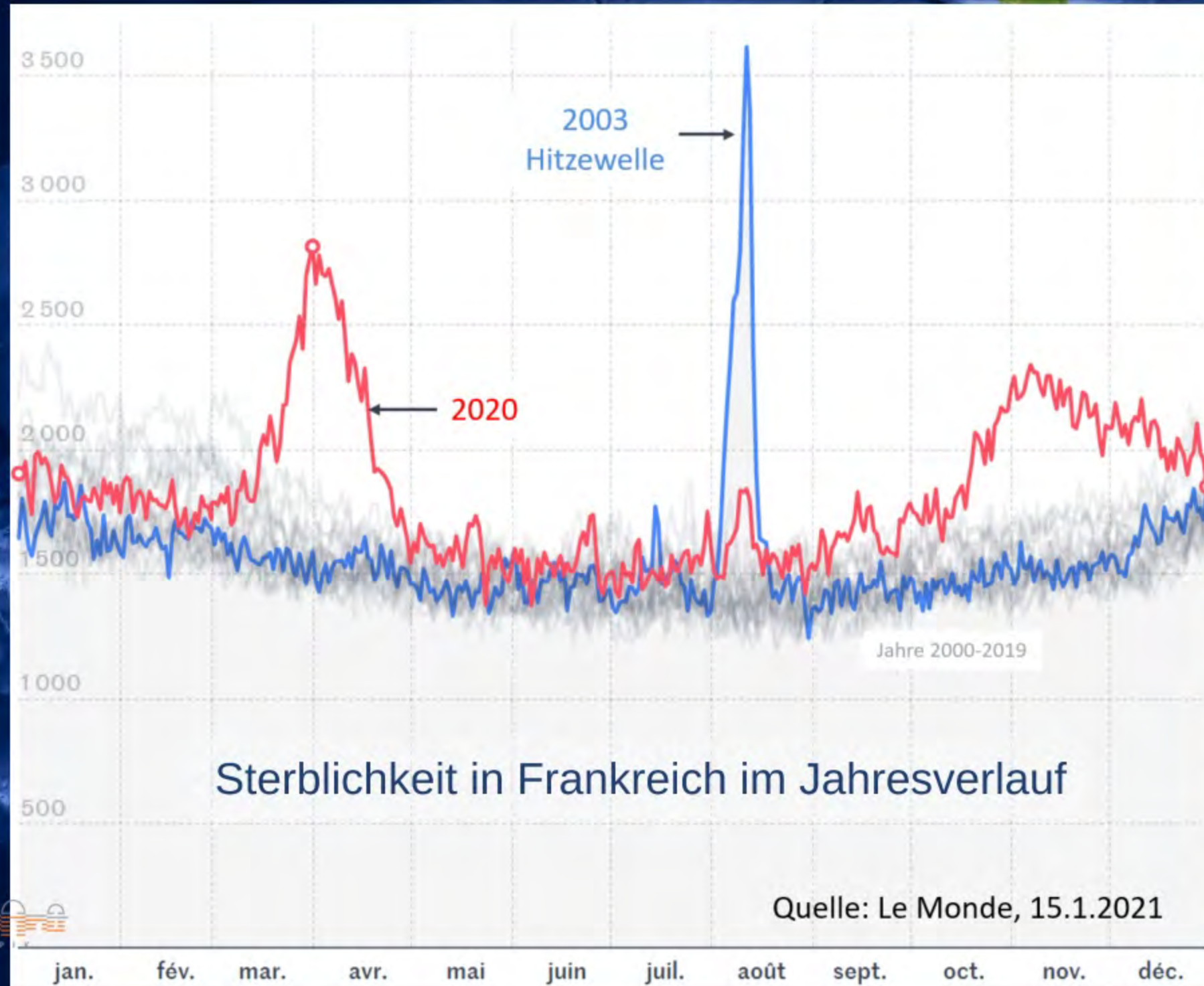
Extreme Hitze nimmt dramatisch zu



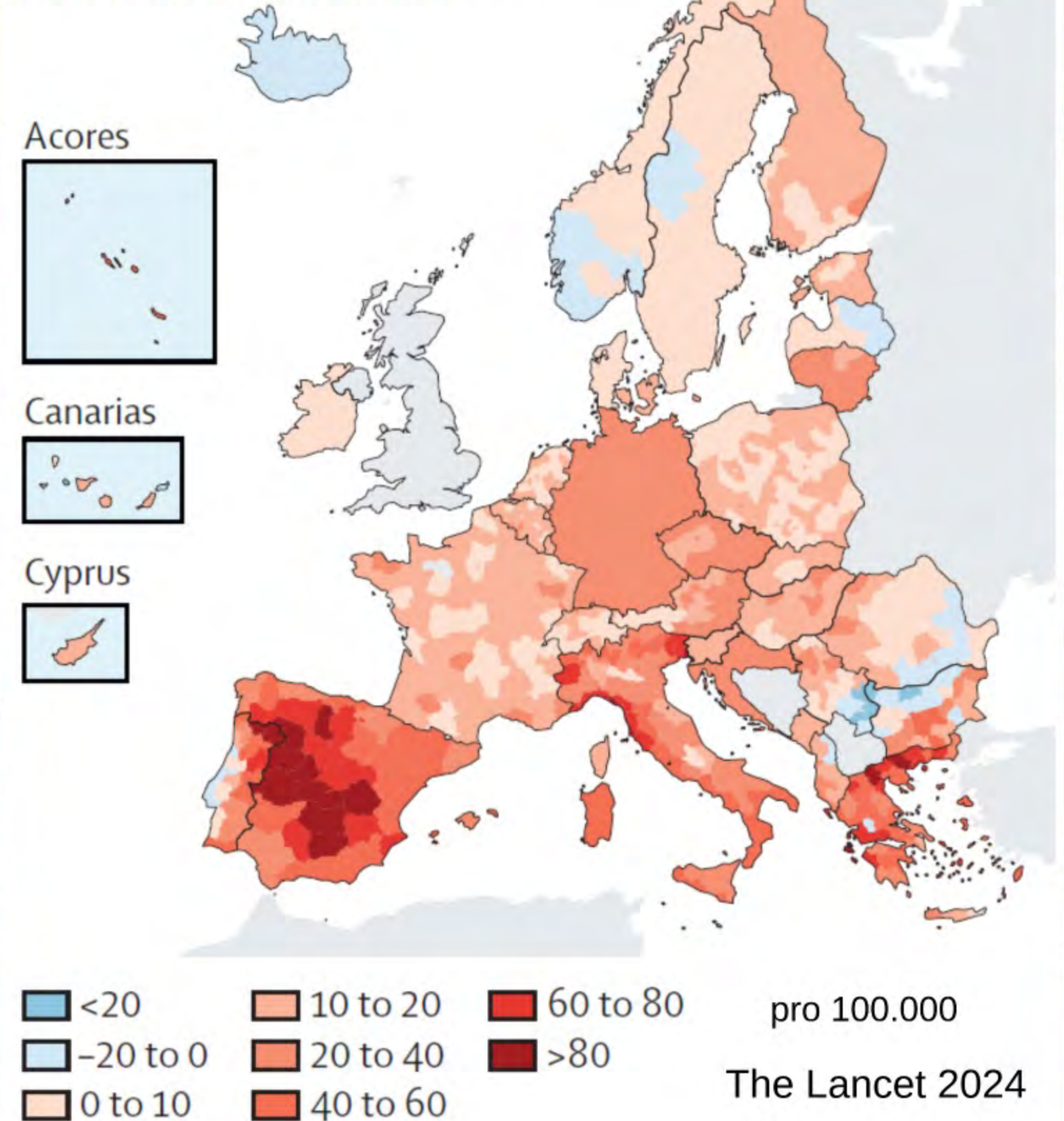
Robinson et al. 2021

Extreme Hitze ist tödlich

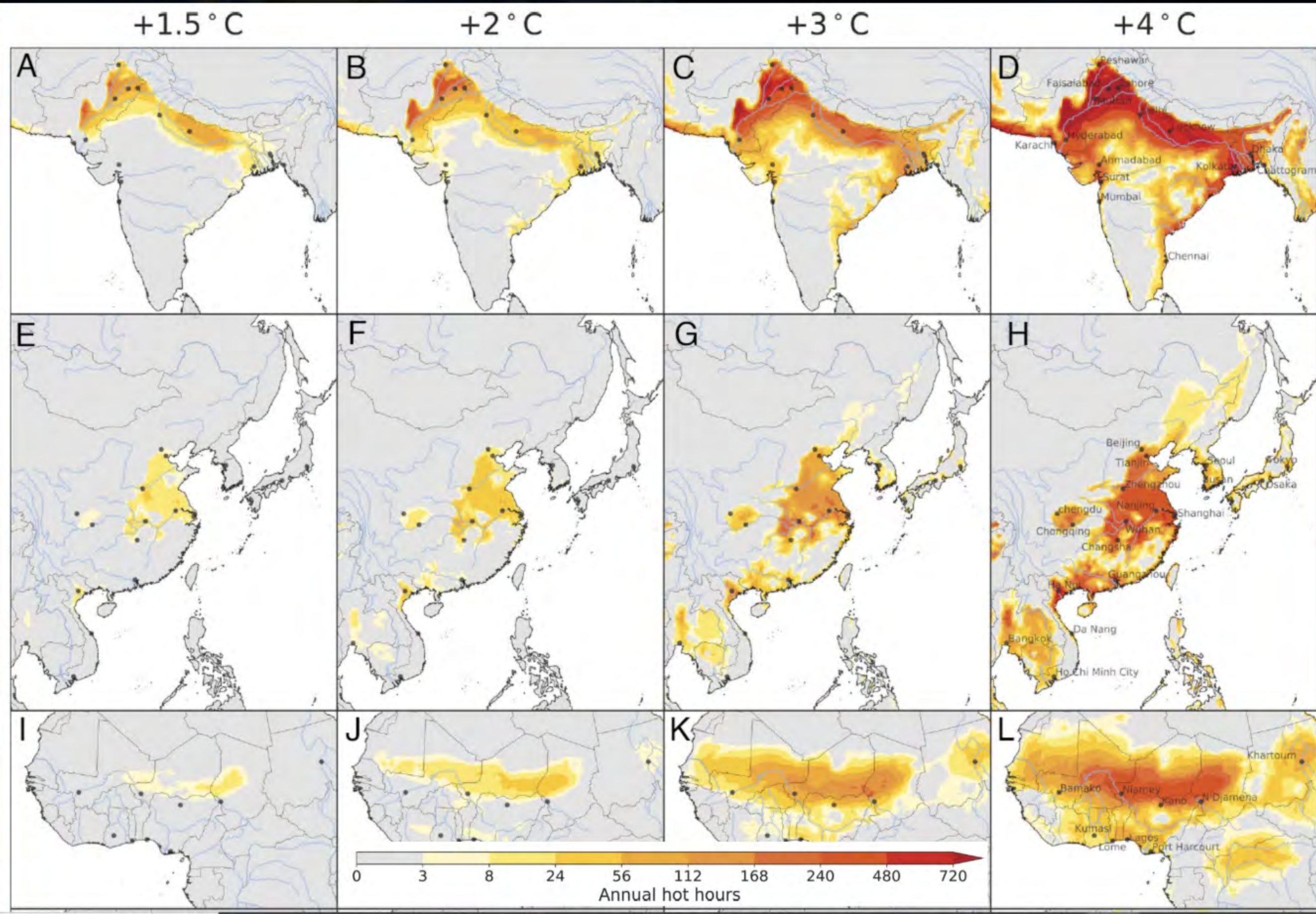
Sommer 2003: 70 000 Hitzetote
Sommer 2022: > 65 000 Hitzetote



Zunahme der Hitzesterblichkeit
von 2003-12 bis 2013-22



Große Teile der Erde werden zu heiß zum Leben



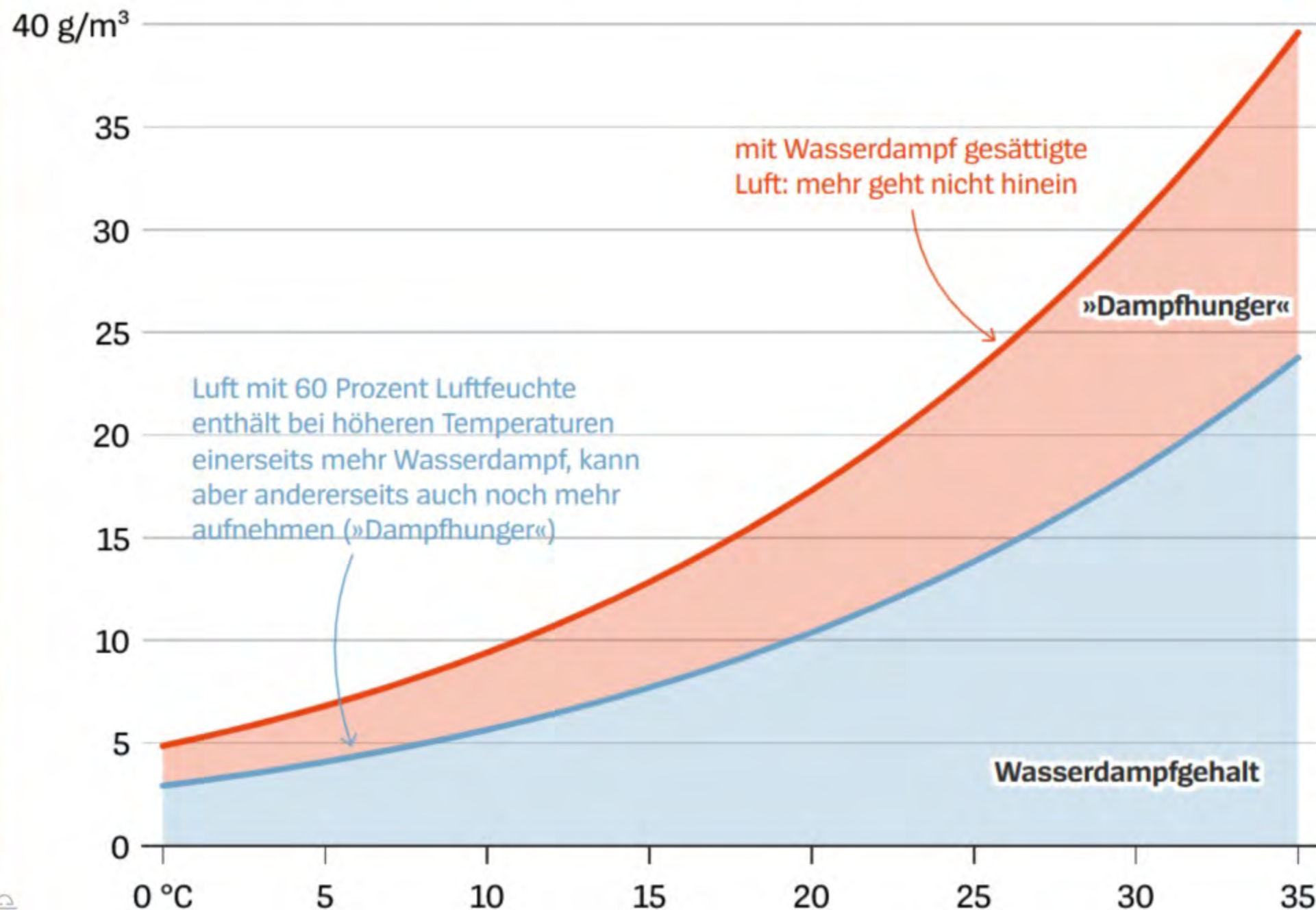
Vecellio et al
PNAS 2023

Extremregen und Dürre nehmen beide zu!

Wasserdampfgehalt der Luft

Der Wassergehalt der Luft steigt exponentiell mit der Temperatur.

100 % relative Luftfeuchte 60 % relative Luftfeuchte



Clausius-Clapeyron-Formel (1834)



J. KELLER, Phot. à Zurich.



Die Katastrophenformel

Ein Gastbeitrag von **Stefan Rahmstorf**

Hitze und Überschwemmungen, Dürre und Waldbrände verursachen weltweit großes Leid. Die Zunahme der Extreme wurde seit Jahrzehnten richtig vorhergesagt – dank einem einfachen physikalischen Gesetz.

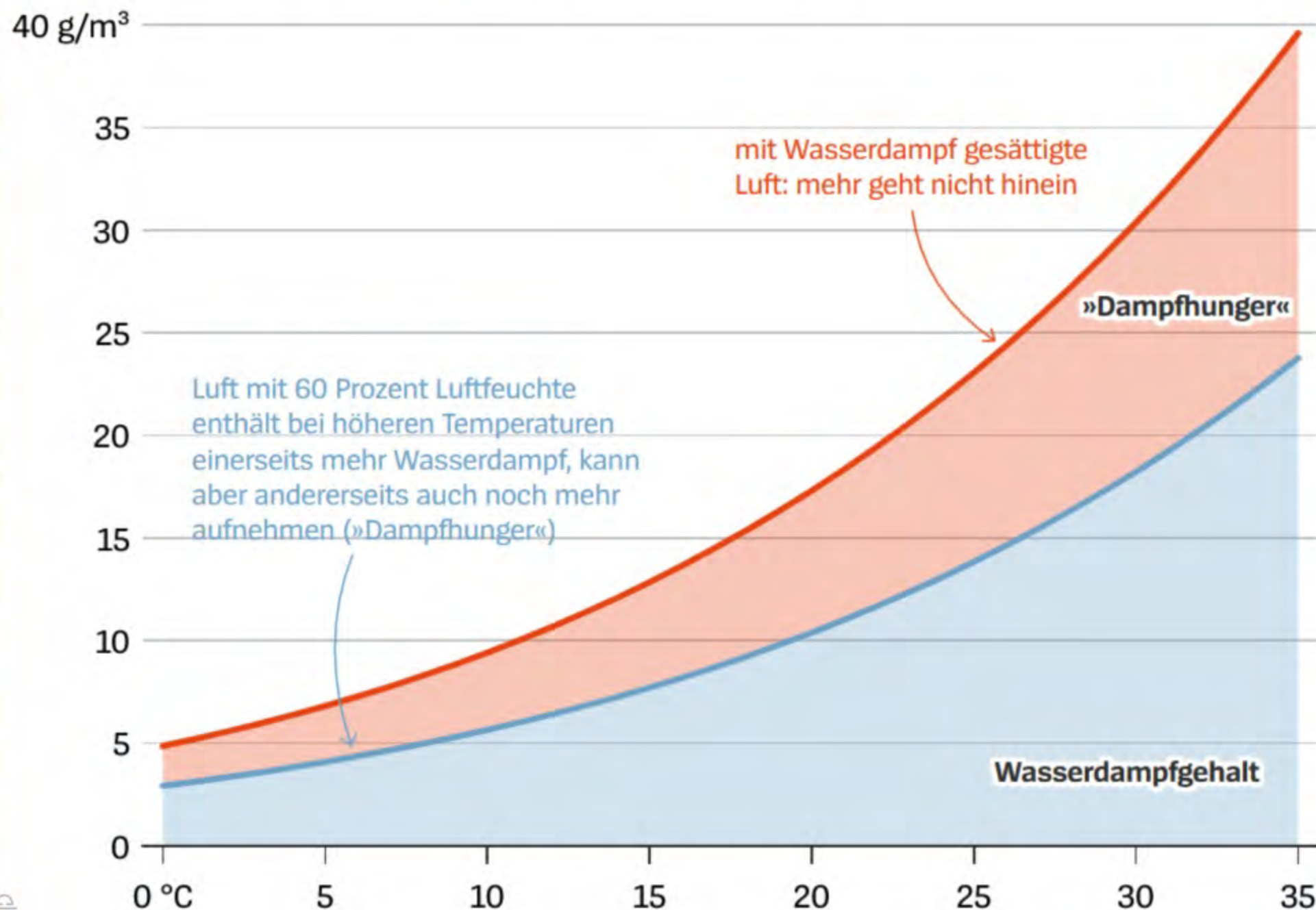
09.09.2023, 12.08 Uhr

Extremregen und Dürre nehmen beide zu!

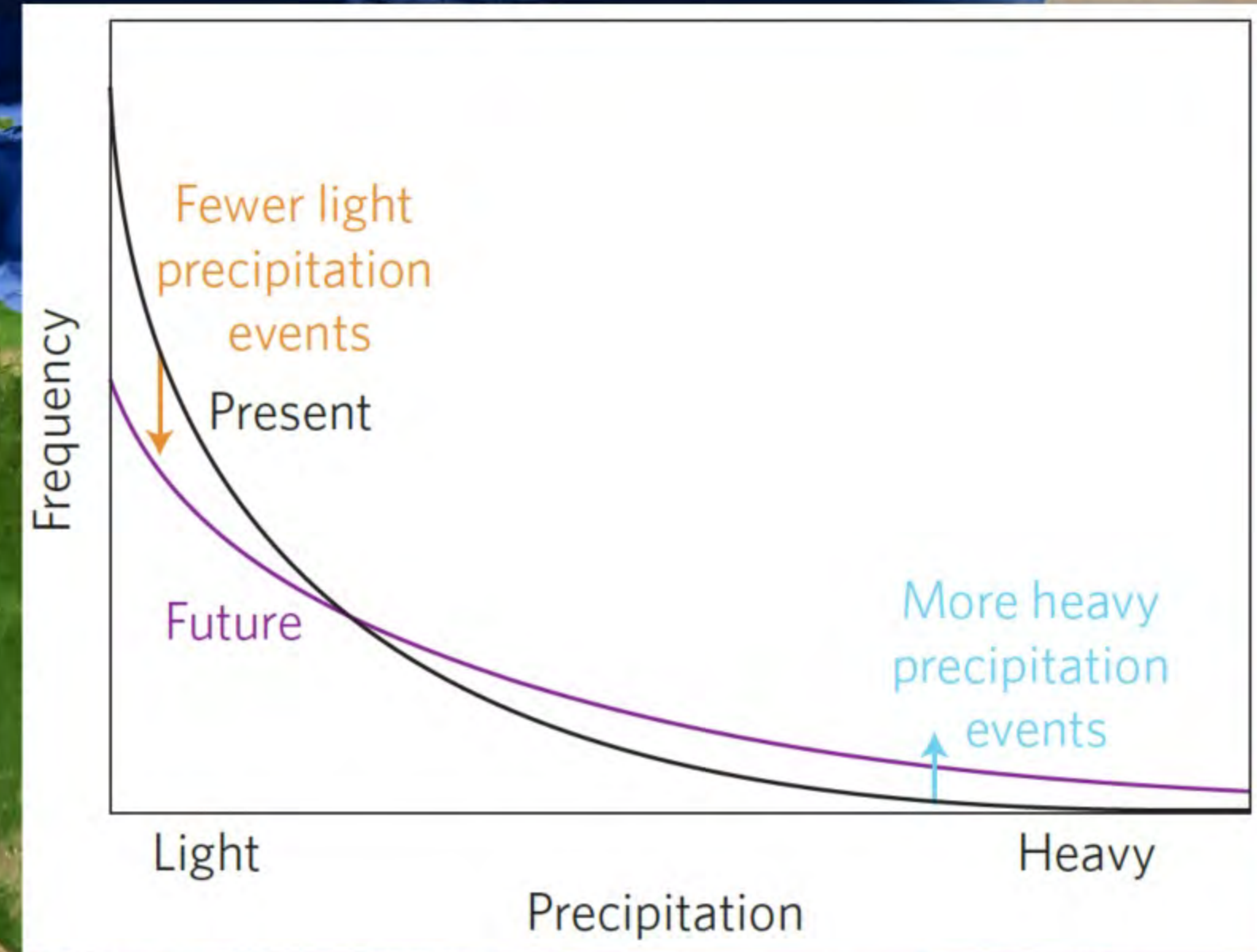
Wasserdampfgehalt der Luft

Der Wassergehalt der Luft steigt exponentiell mit der Temperatur.

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Quelle: Stefan Rahmstorf



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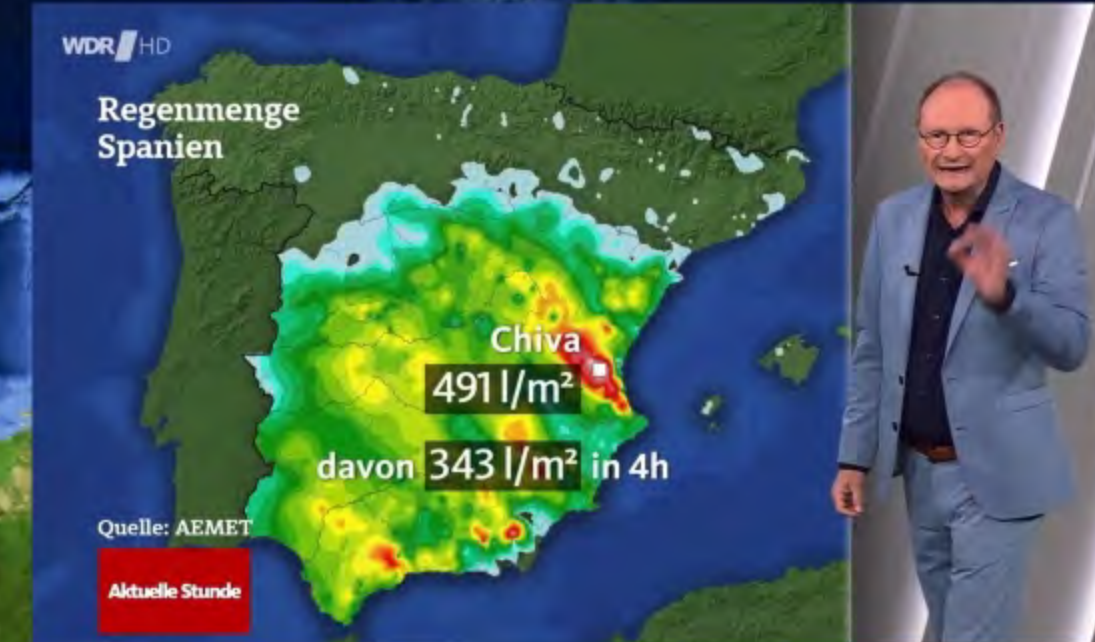
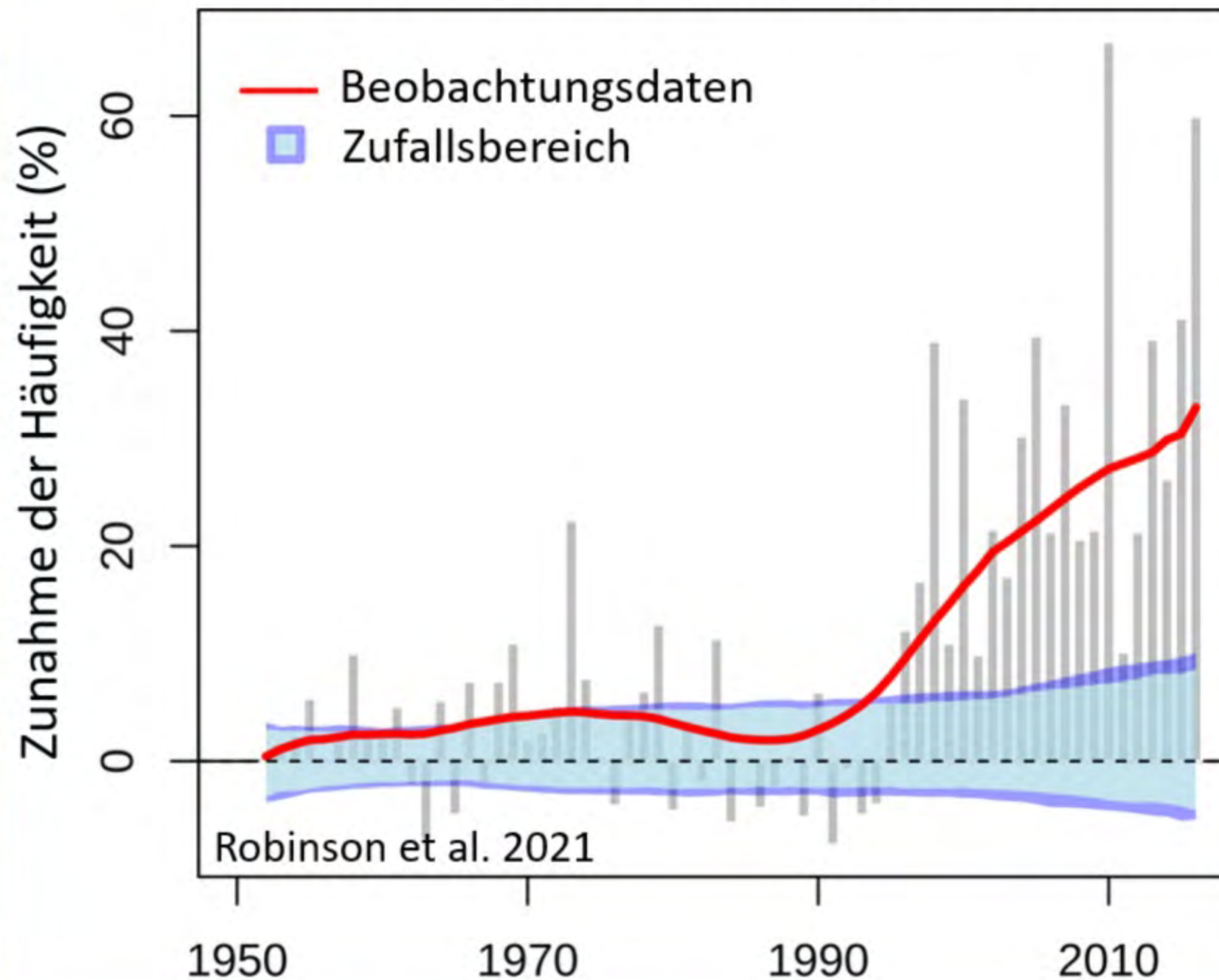
Extremregen nimmt zu - weltweit & in Europa

Brief Communication | [Open access](#) | Published: 05 October 2021

Increasing heat and rainfall extremes now far outside the historical climate

Alexander Robinson , Jascha Lehmann, David Barriopedro, Stefan Rahmstorf & Dim Coumou

Weltweite Zunahme der Niederschlags-Tagesrekorde



Valencia
Oktober 2024

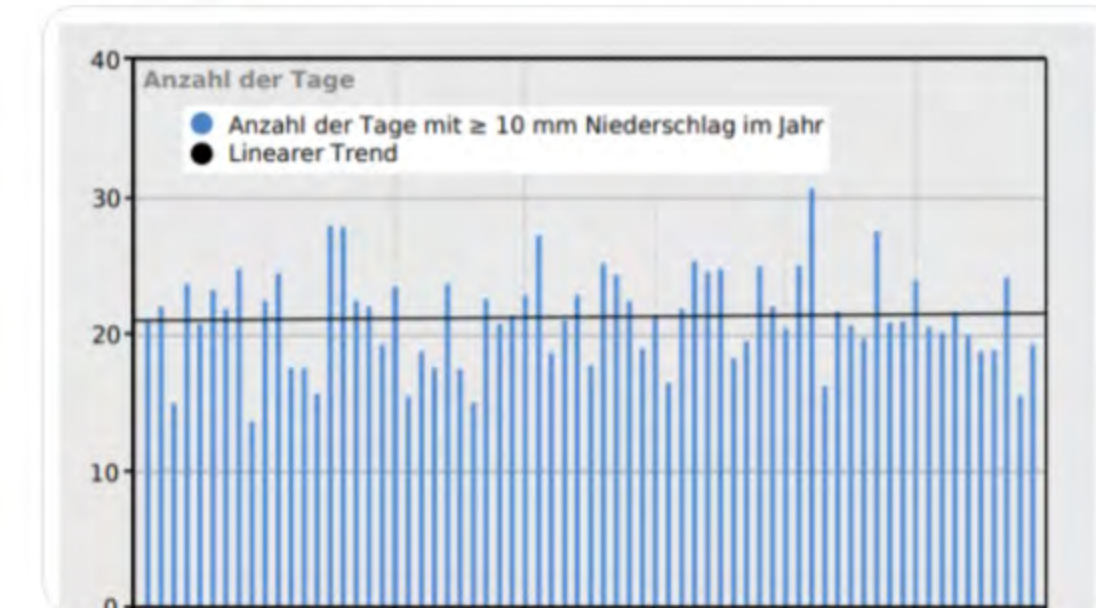
49 cm in 8 Stunden!



Axel Bojanowski  @Axel_Bojanowski · Jul 18

Normal 7%

Der Verweis auf den Klimawandel ist irreführend. Zwar macht die globale Erwärmung Starkregen wahrscheinlicher. Der Deutsche Wetterdienst kann aber noch keine Zunahme von Tagen mit Extremniederschlag in Deutschland feststellen.



28

49

187



IPCC- Bericht 2021

It is **extremely likely** that on most land regions **heavy precipitation** will become more frequent and more intense with additional global warming.

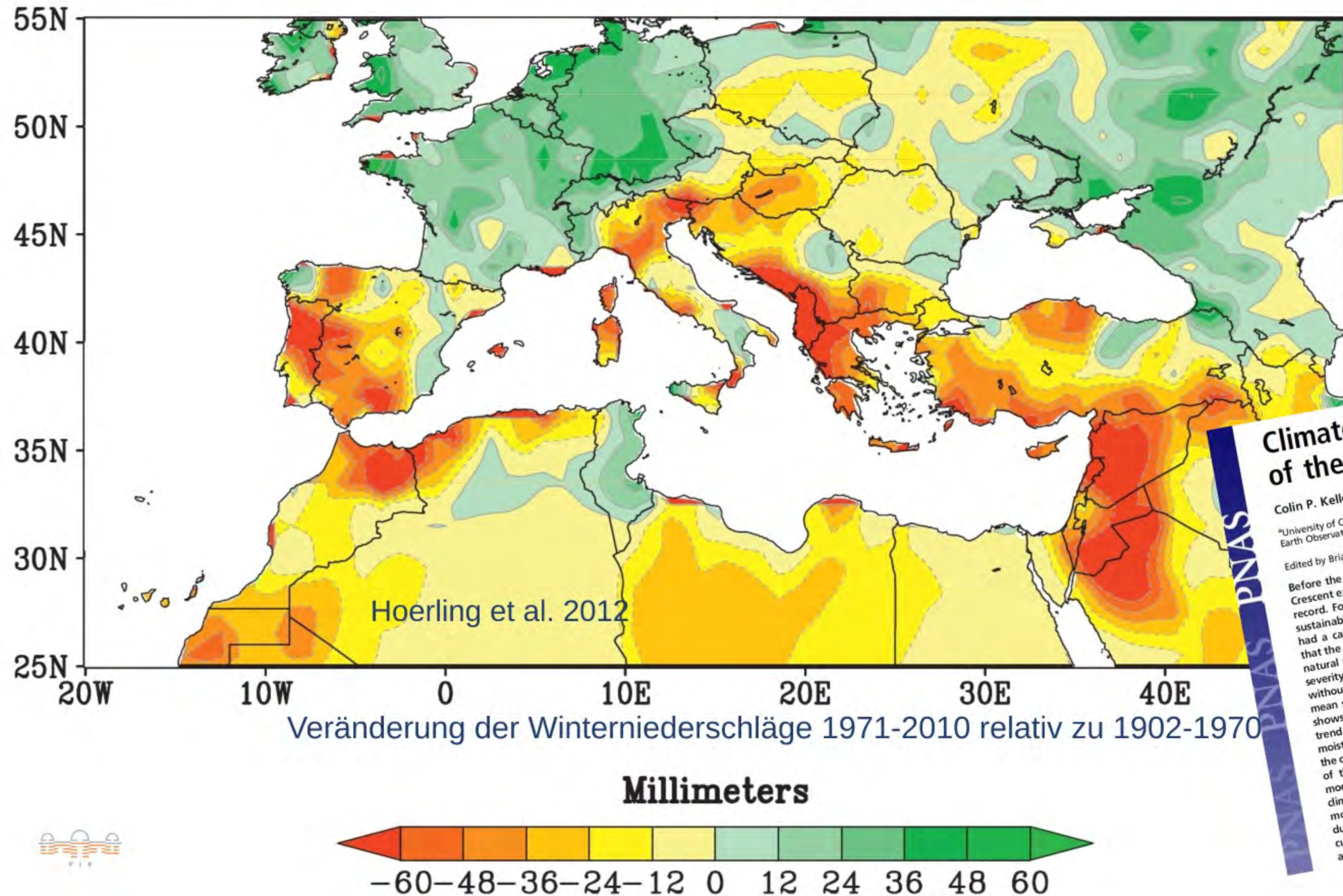
The projected increase in heavy precipitation extremes translates to an increase in the frequency and **magnitude of pluvial floods** (**high confidence**).

Hunderte Wissenschaftler aus aller Welt haben 8 Jahre an diesem Bericht gearbeitet.

Quelle: <https://www.ipcc.ch/report/ar6/wg1/chapter/technical-summary/>



Dürre



Climate change in the Fertile Crescent and Implications of the recent Syrian drought

Colin P. Kelley^{a,1}, Shahrzad Mohtadi^b, Mark A. Cane^c, Richard Seager^c, and Yochanan Kushnir^c

^aUniversity of California, Santa Barbara, CA 93106; ^bSchool of International and Public Affairs, Columbia University, New York, NY 10027; and ^cLamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964

Edited by Brian John Hoskins, Imperial College London, London, United Kingdom, and approved January 30, 2015 (received for review November 16, 2014)

Before the Syrian uprising that began in 2011, the greater Fertile Crescent experienced the most severe drought in the instrumental record. For Syria, a country marked by poor governance and unsustainable agricultural and environmental policies, the drought had a catalytic effect, contributing to political unrest. We show that the recent decrease in Syrian precipitation is a combination of natural variability and a long-term drying trend, and the unusual severity of the observed drought is here shown to be highly unlikely without this trend. Precipitation changes in Syria are linked to rising mean sea-level pressure in the Eastern Mediterranean, which also shows a long-term trend. There has been also a long-term warming trend in the Eastern Mediterranean, adding to the drawdown of soil moisture. No natural cause is apparent for these trends, whereas the observed drying and warming are consistent with model studies of the response to increases in greenhouse gases. Furthermore, model studies show an increasingly drier and hotter future mean climate for the Eastern Mediterranean. Analyses of the severity and duration of the recent Syrian drought, which is implicated in the current conflict, has become more than twice as likely as a consequence of human interference in the climate system.



Dürre

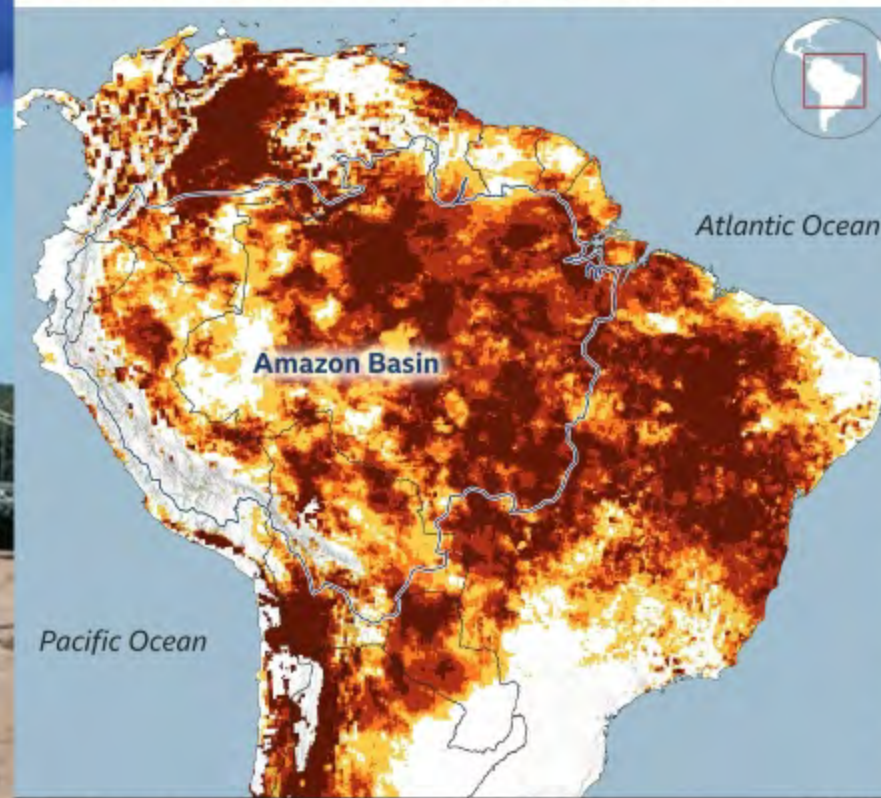


Loire 2022

Amazon's worst drought on record

Intensity of drought, June to November 2023

Moderate Severe Extreme Exceptional



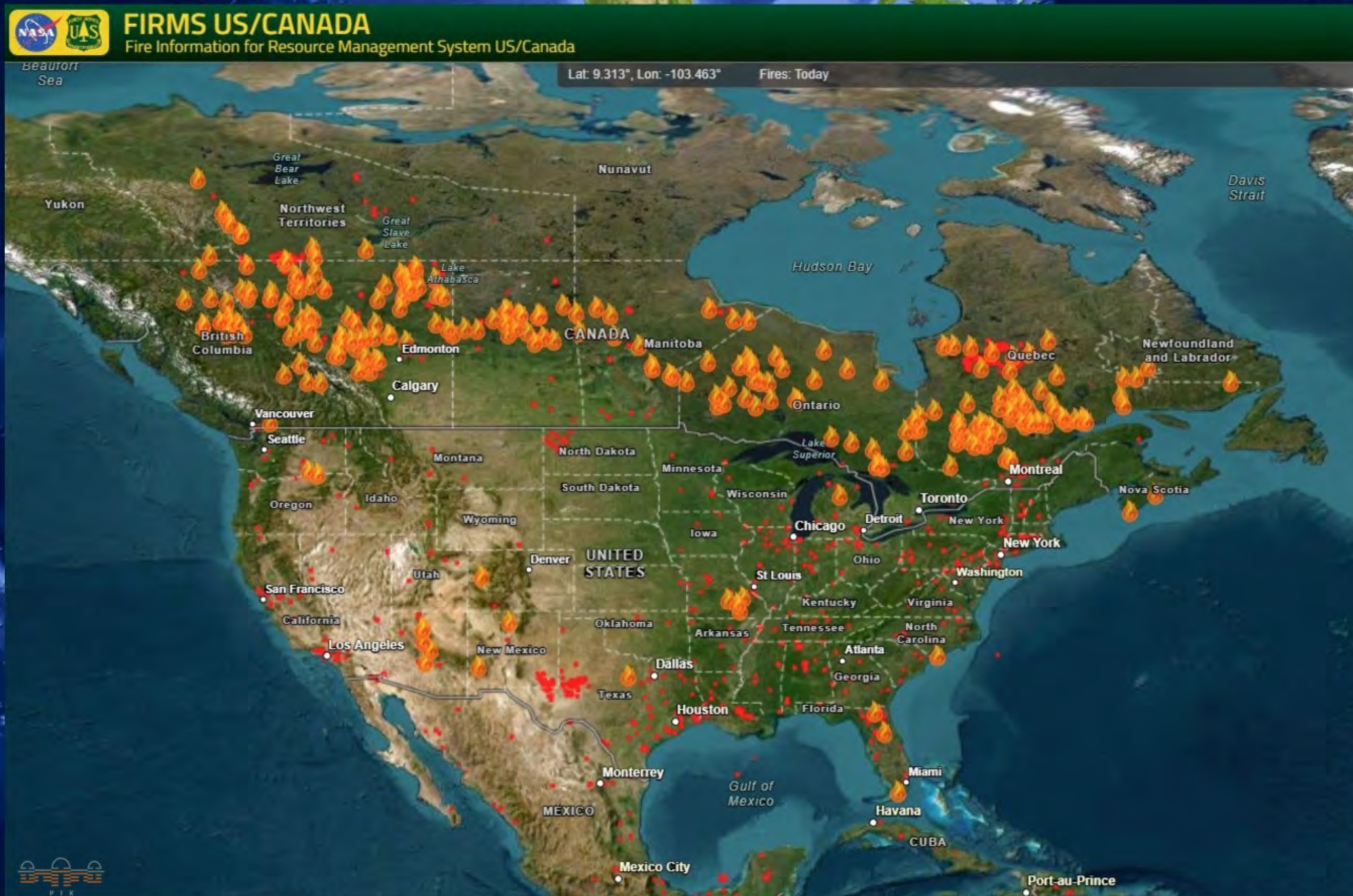
Source: World Weather Attribution (SPEI - Drought Index)

BBC

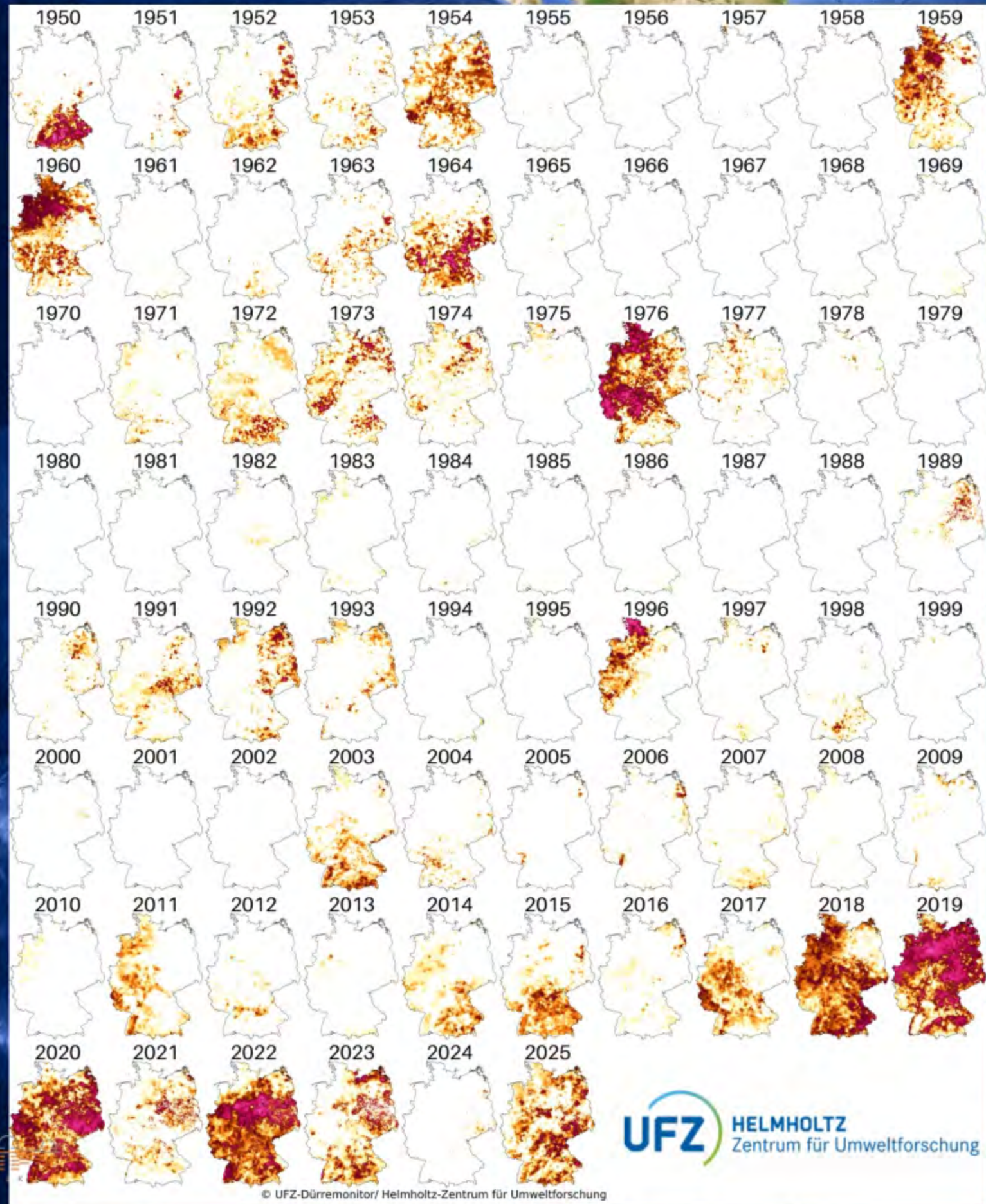
Amazonas 2023



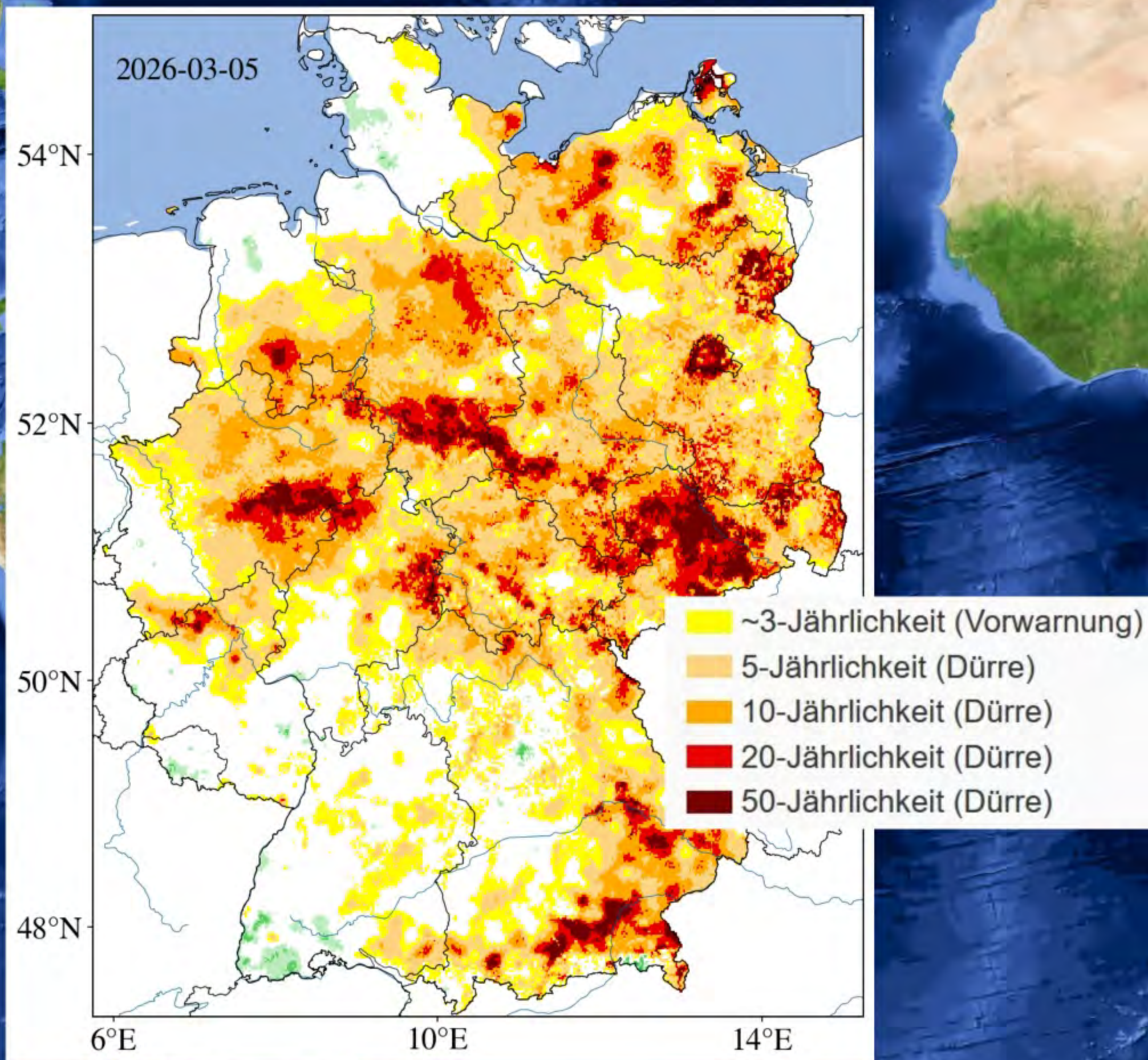
Kanada Brände 2023



Dürre bei uns: 1952-2025



Aktuelle Lage



Hauptaussagen des IPCC Klimaberichts 2023

„ Der vom Menschen verursachte Klimawandel wirkt sich bereits auf viele Wetter- und Klimaextreme in allen Regionen der Welt aus.
Dies hat zu weitverbreiteten nachteiligen Folgen und damit verbundenen Verlusten und Schäden für Natur und Menschen geführt (hohes Vertrauen). “

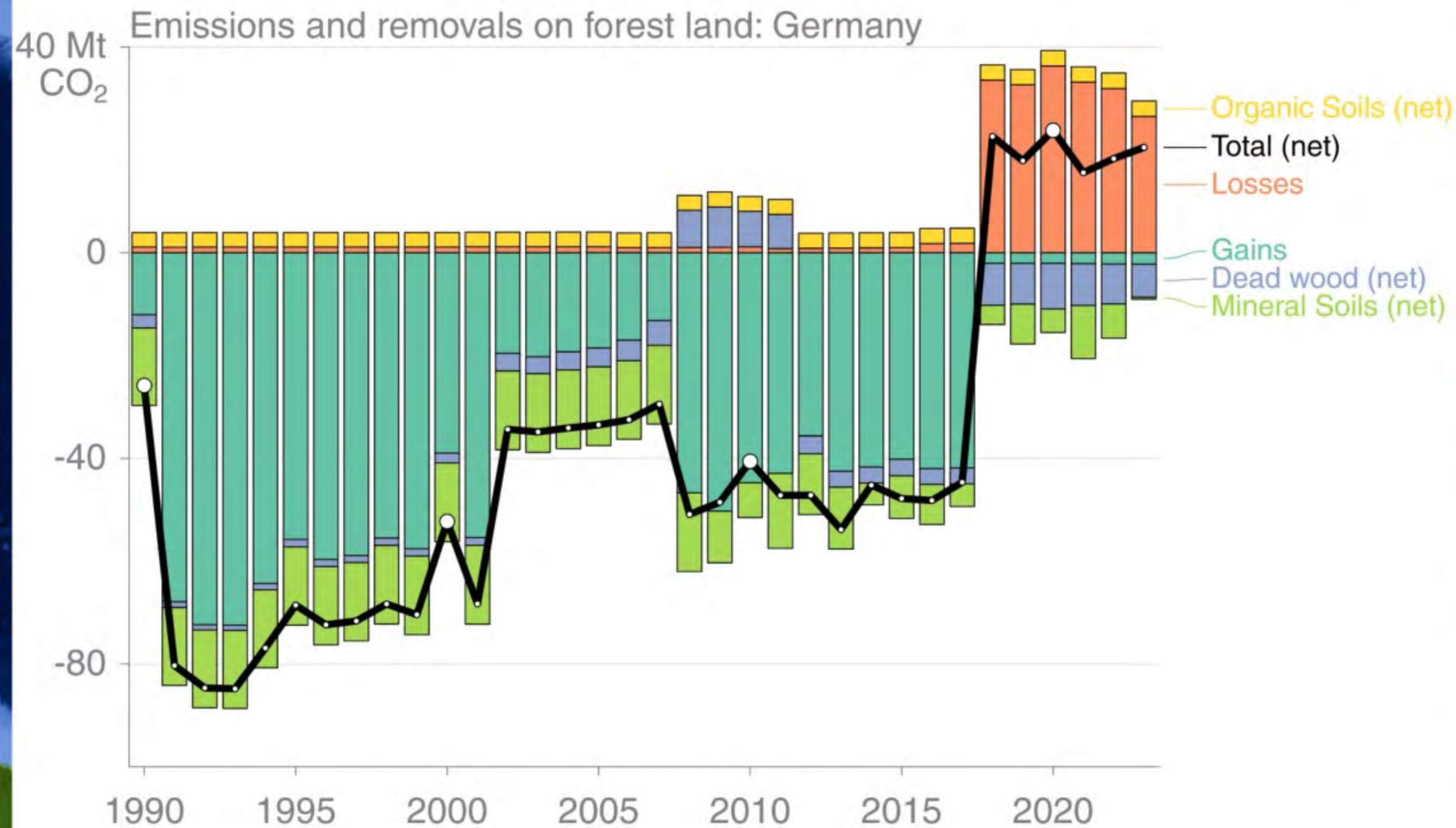
Hunderte Wissenschaftler aus aller Welt haben 8 Jahre an diesem Bericht gearbeitet.

Deutsche Übersetzung der Hauptaussagen: https://www.de-ipcc.de/media/content/Hauptaussagen_AR6-SYR.pdf



Das neue Waldsterben in Deutschland

Der deutsche Wald ist seit 2018 CO₂-Quelle

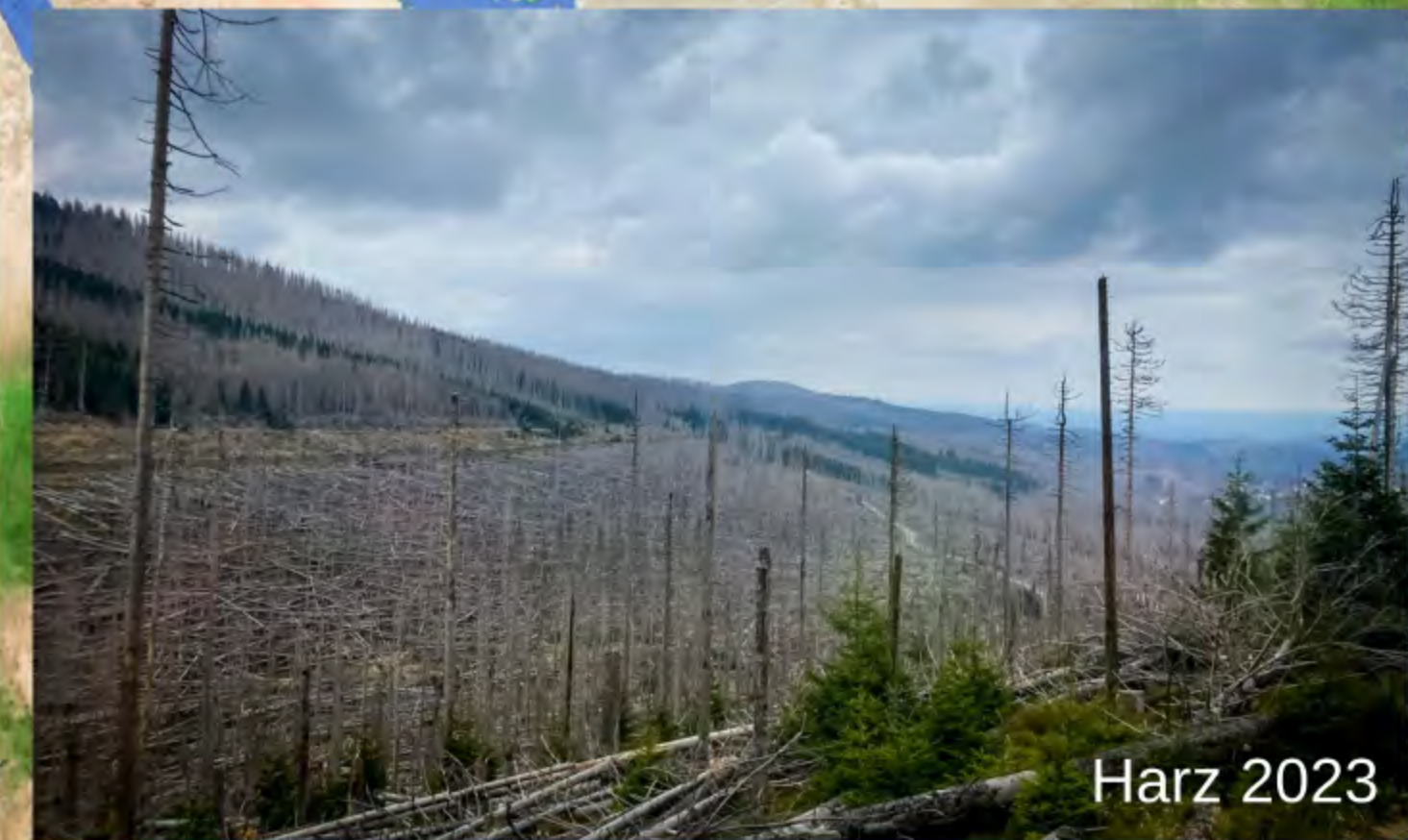


CICERO • Data: UNFCCC (2025)

Grafik: Walzustandsbericht

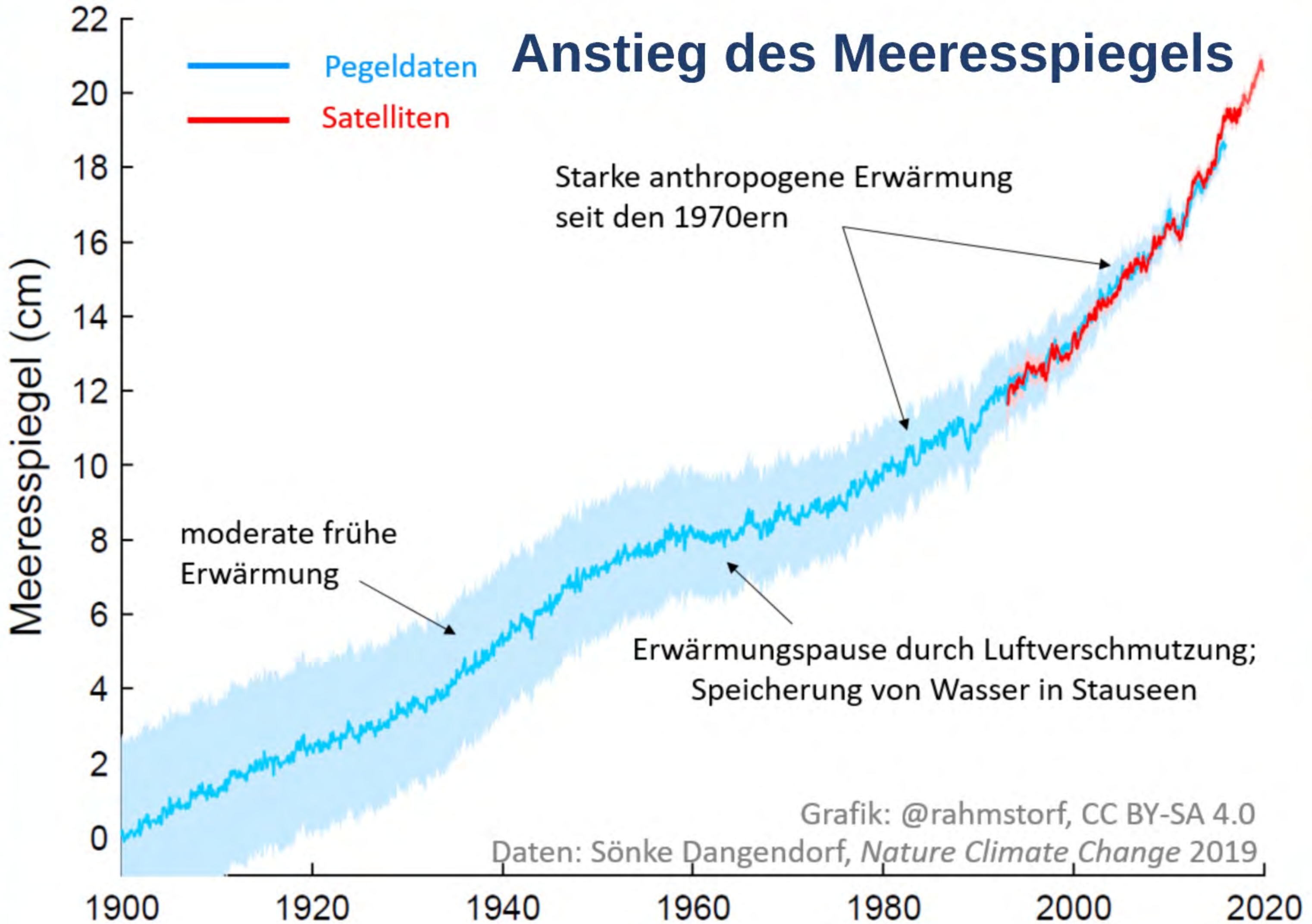


Brandenburg 2018



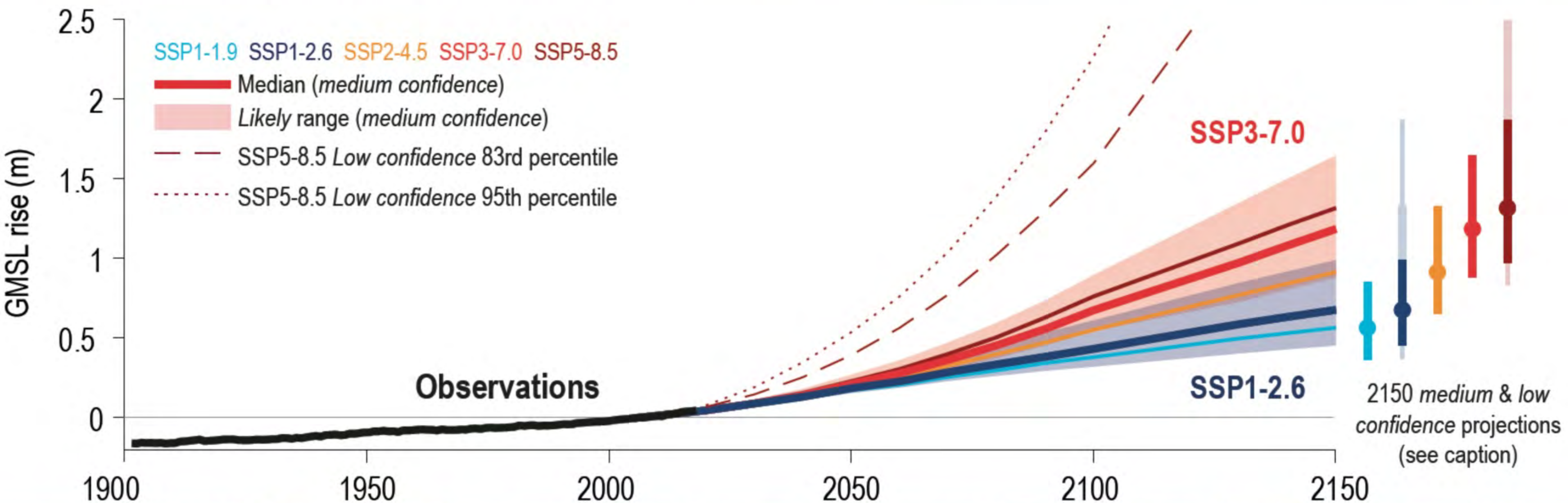
Harz 2023

Anstieg des Meeresspiegels



Zukunft des globalen Meeresspiegels...

(a) Global mean sea level rise from 1900–2150



Auf lange Sicht: 1.5°C Erwärmung: 6 - 7 Meter
2.0°C Erwärmung: 8 - 13 Meter

IPCC 2021

Es gibt genug Eis auf der Erde
für einen Meeresspiegelanstieg um

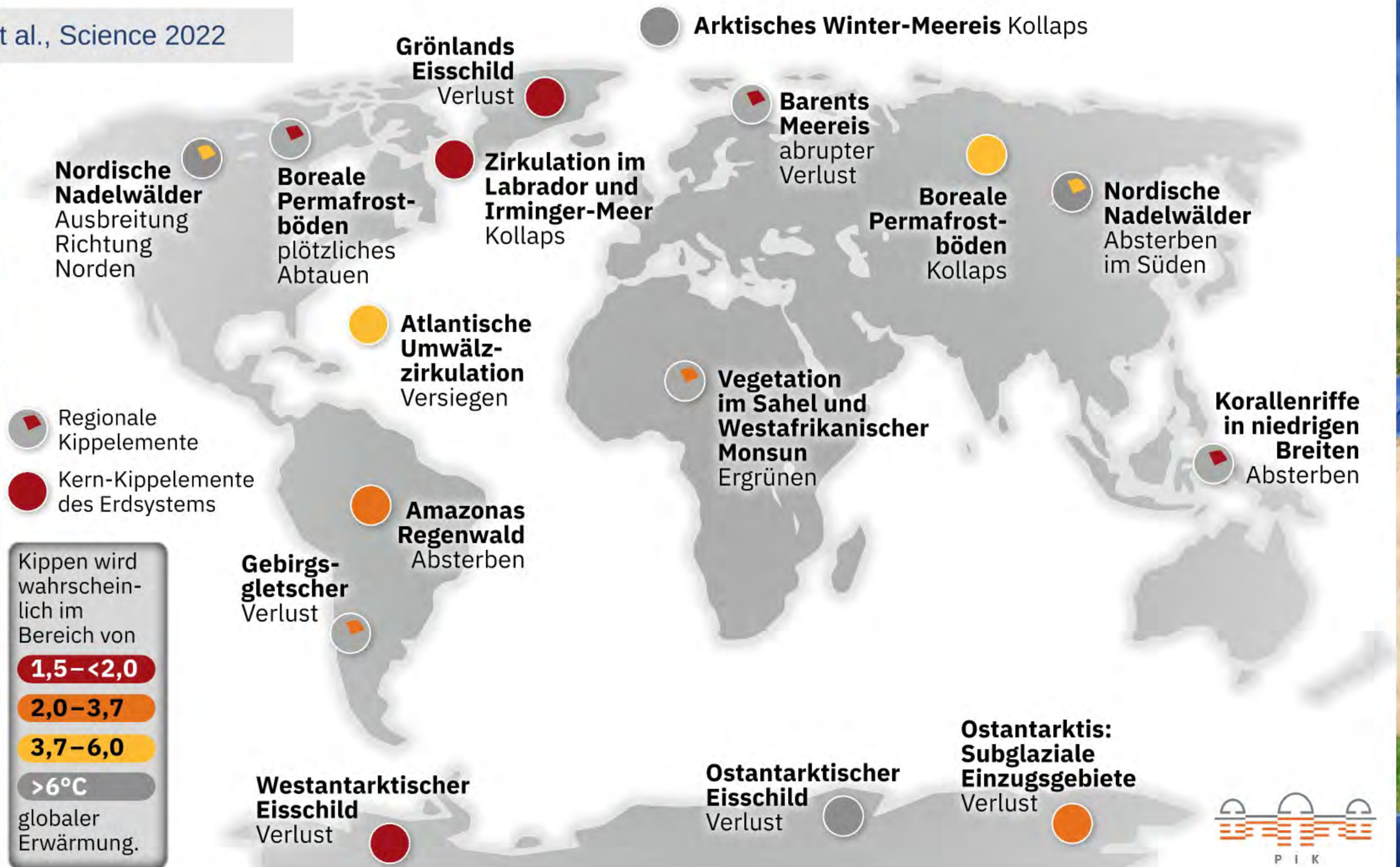
65 m







Kipppunkte im Klimasystem



IPCC Synthesebericht: **Klimawandel 2023**

"Die Wahrscheinlichkeit und die Auswirkungen abrupter und/oder irreversibler Veränderungen im Klimasystem, einschließlich Veränderungen, die durch das **Erreichen von Kipppunkten** ausgelöst werden, nehmen mit der weiteren globalen Erwärmung zu (hohes Vertrauen)."



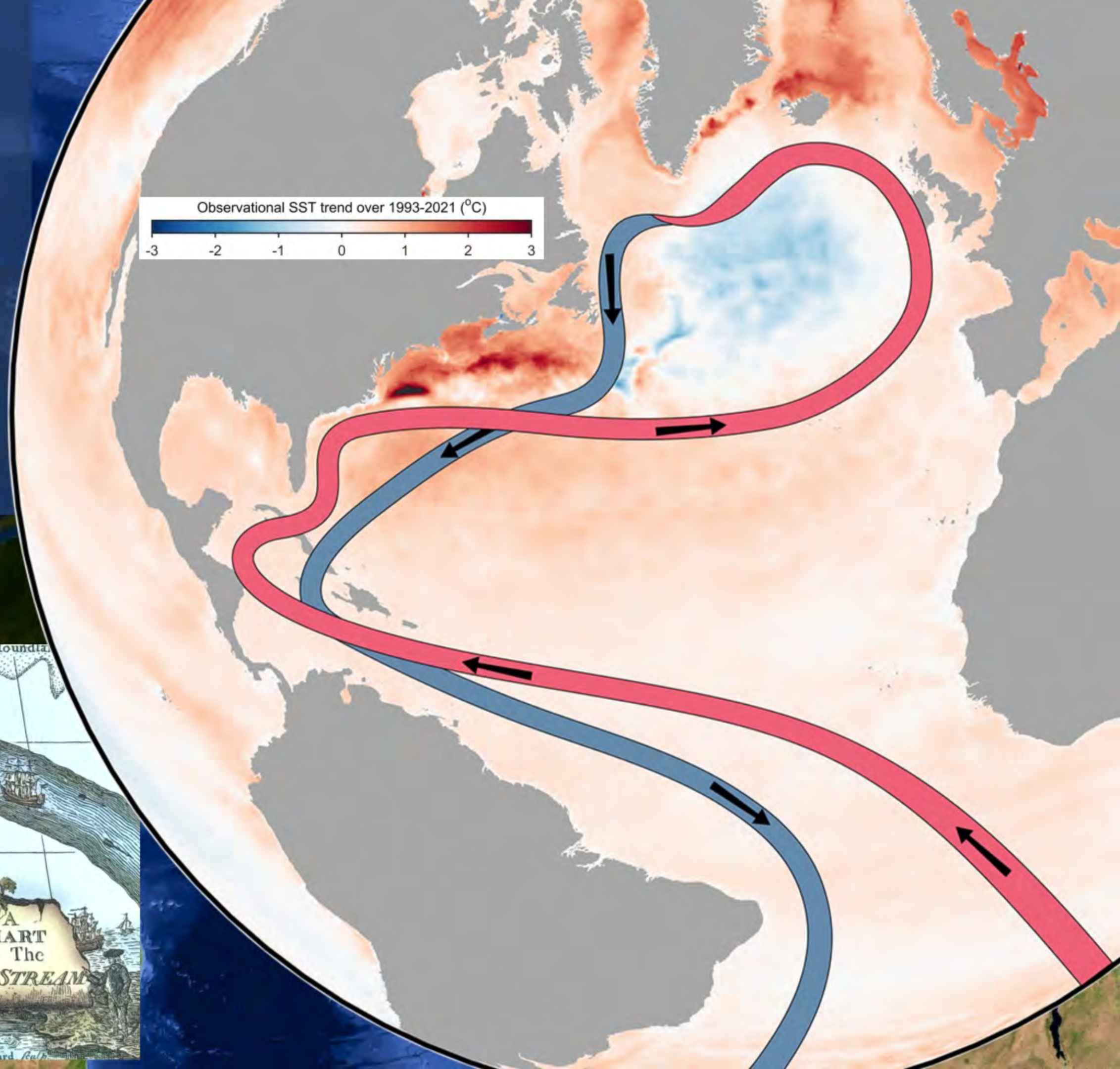
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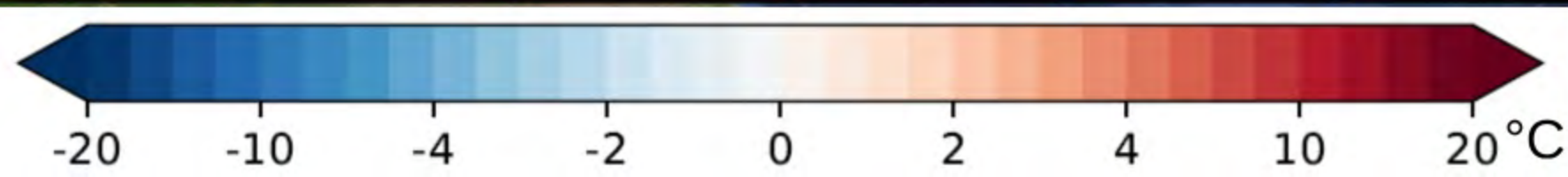
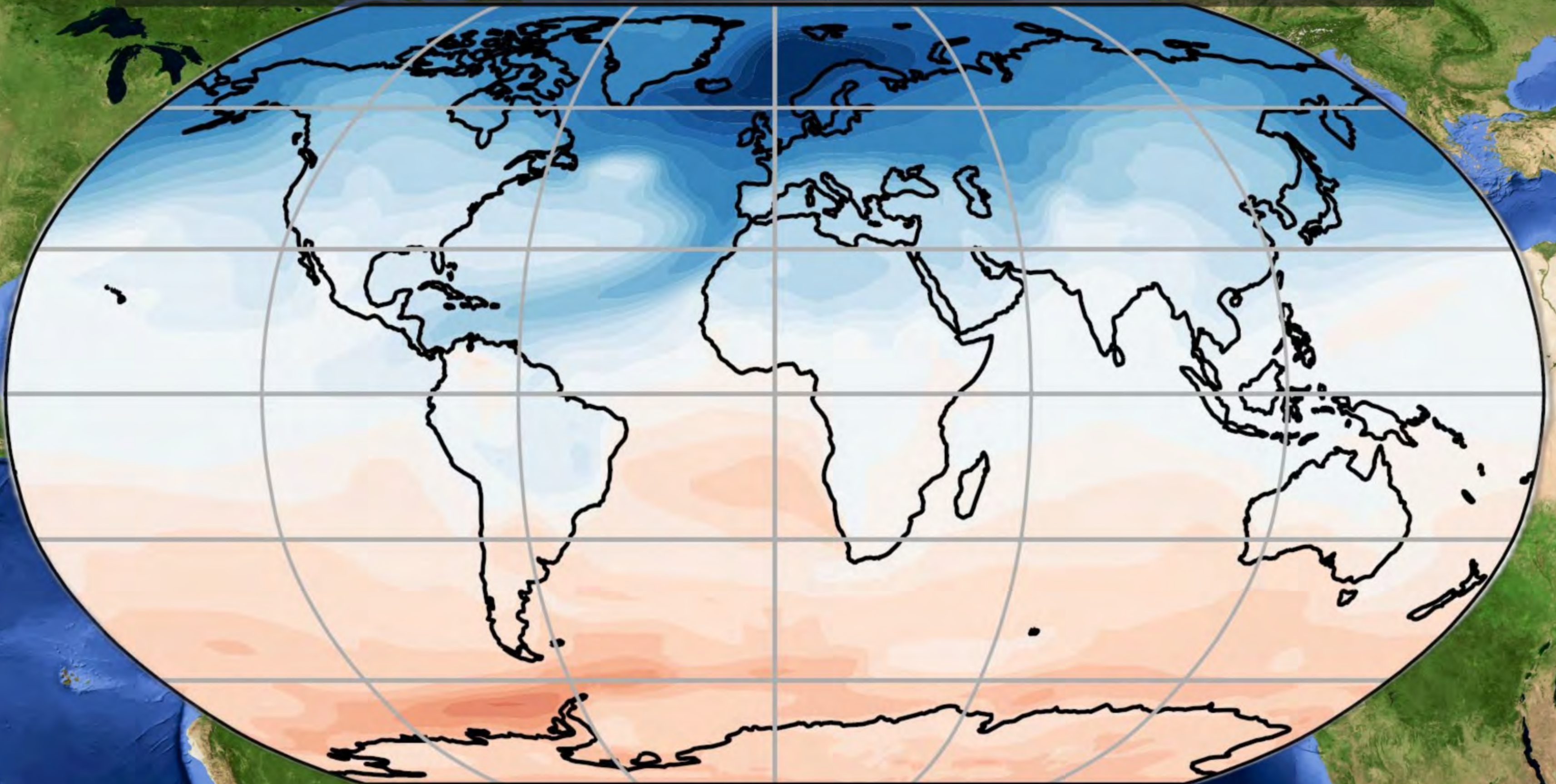
'AMOC'

Atlantic Meridional Overturning Circulation

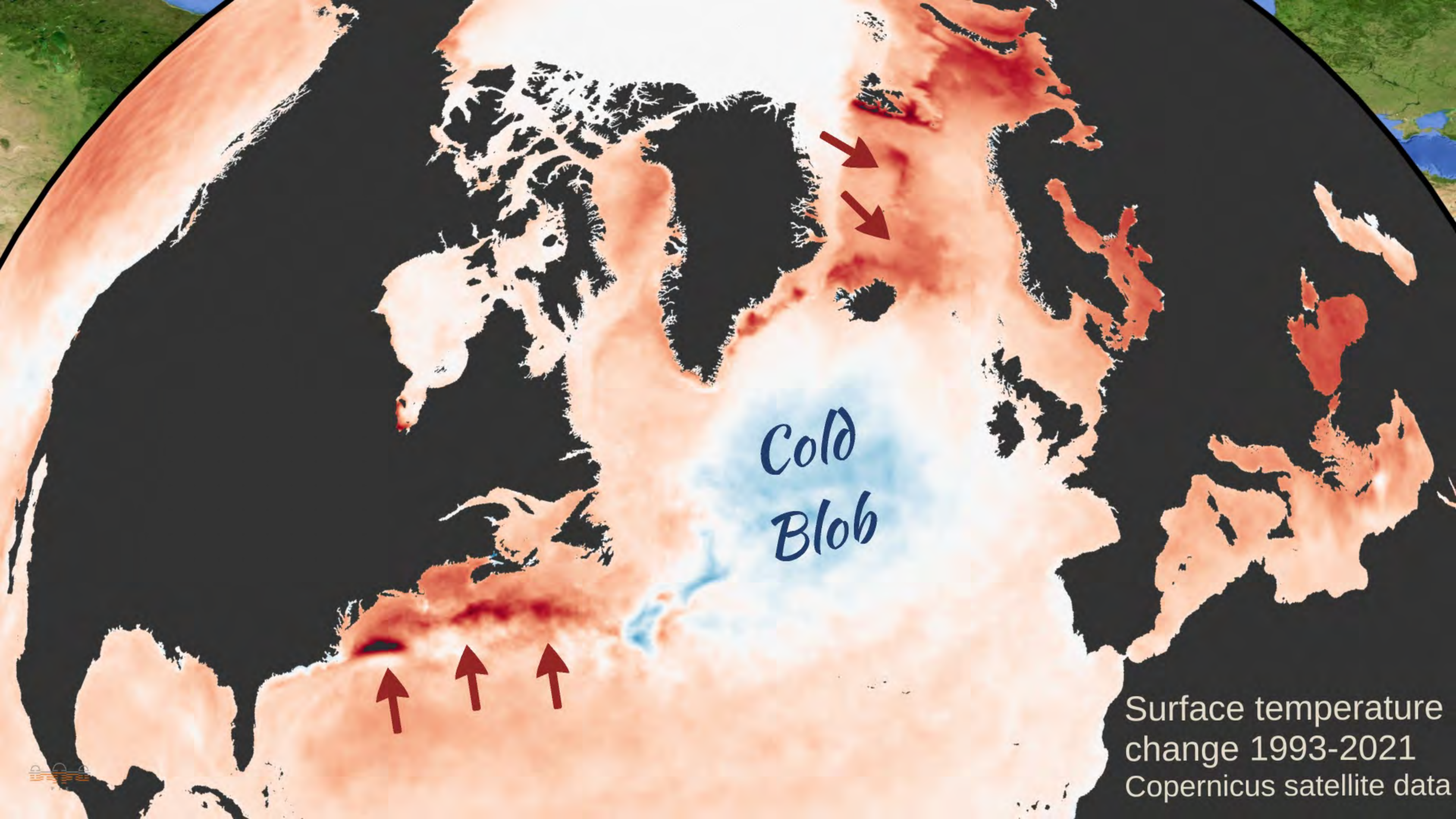
Golfstrom: Benjamin Franklin 1769



Die AMOC-Wirkung auf die Jahrestemperatur



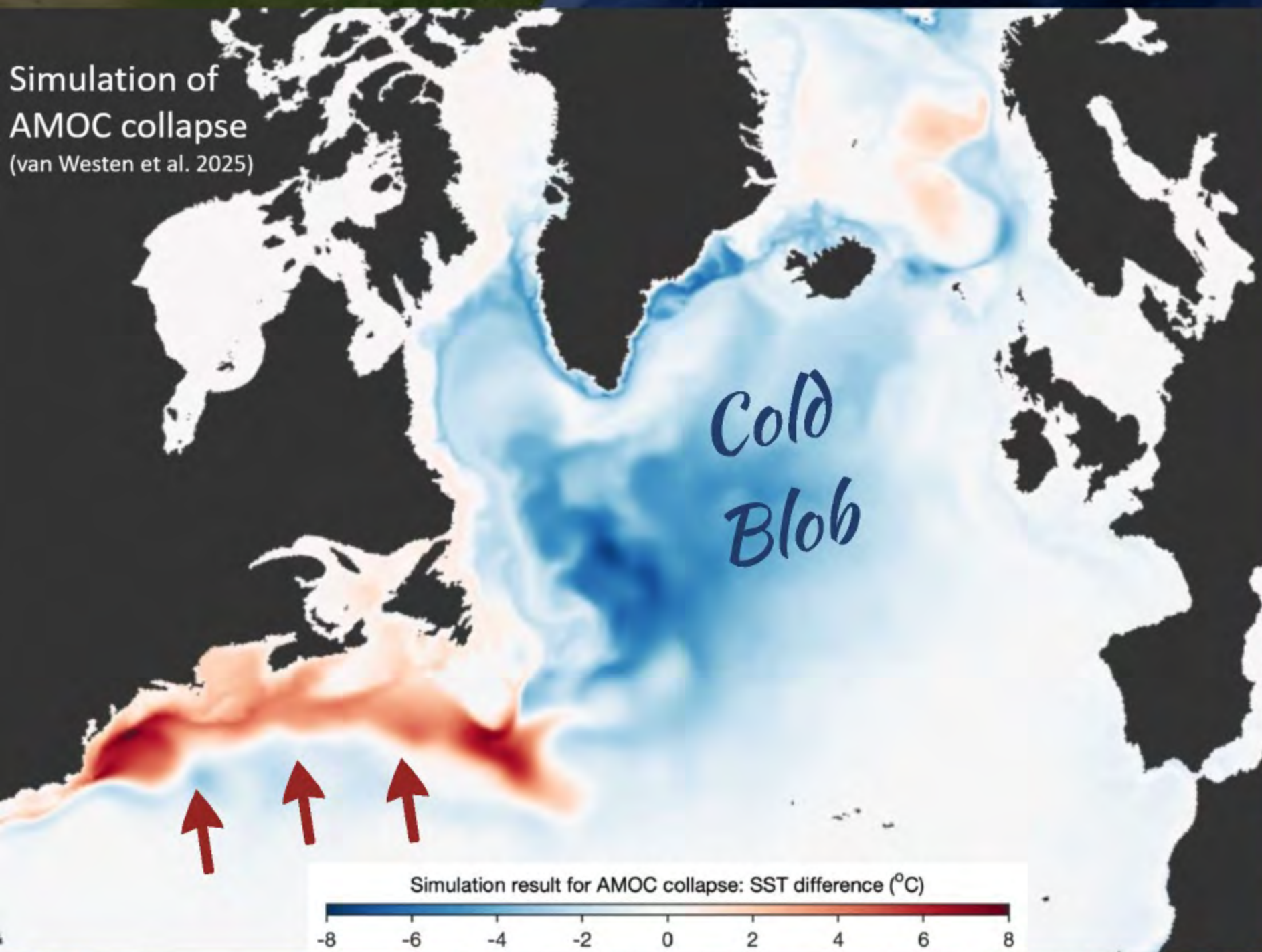
Van Westen et al. 2024



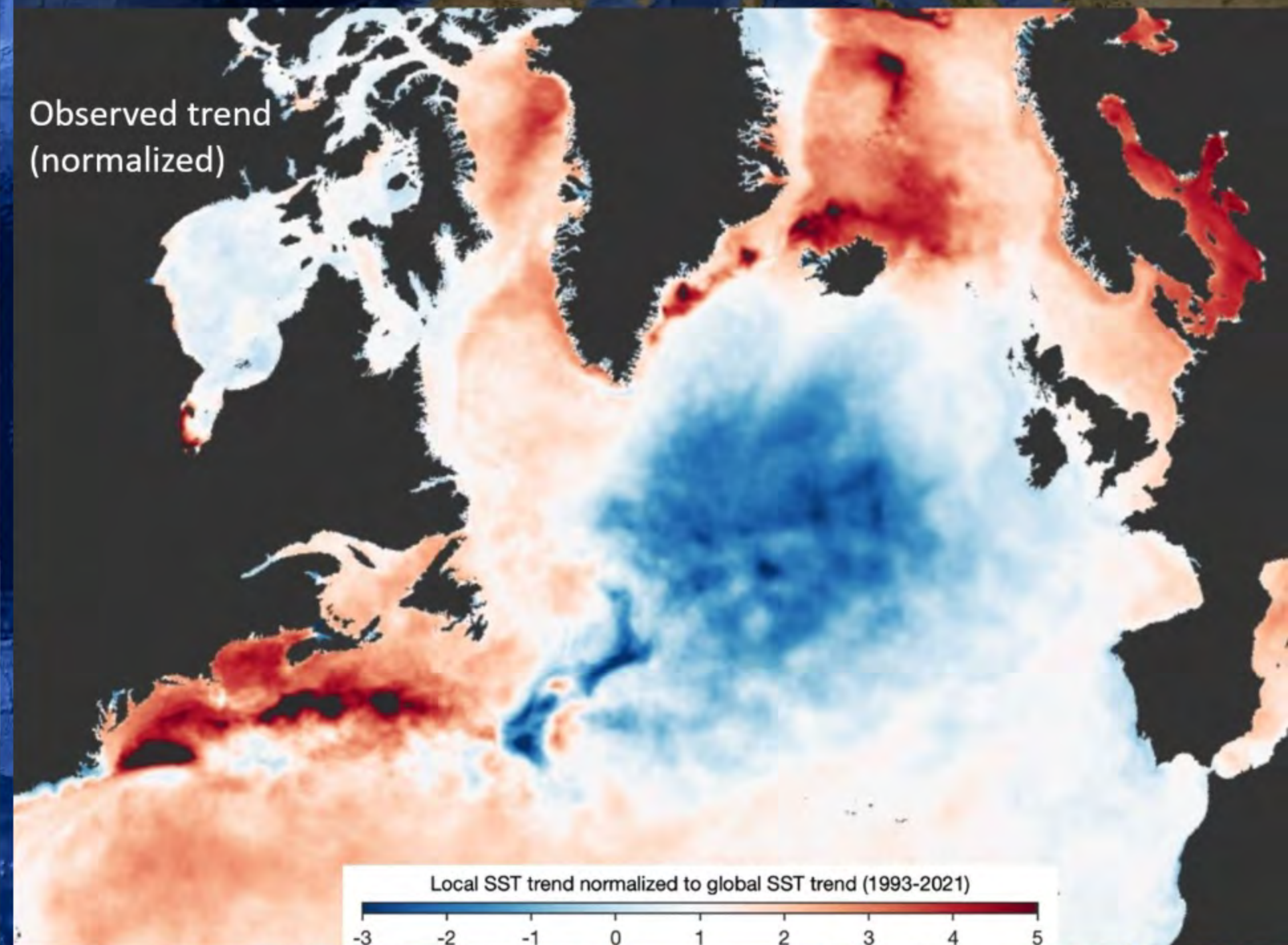
*Cold
Blob*

Surface temperature
change 1993-2021
Copernicus satellite data

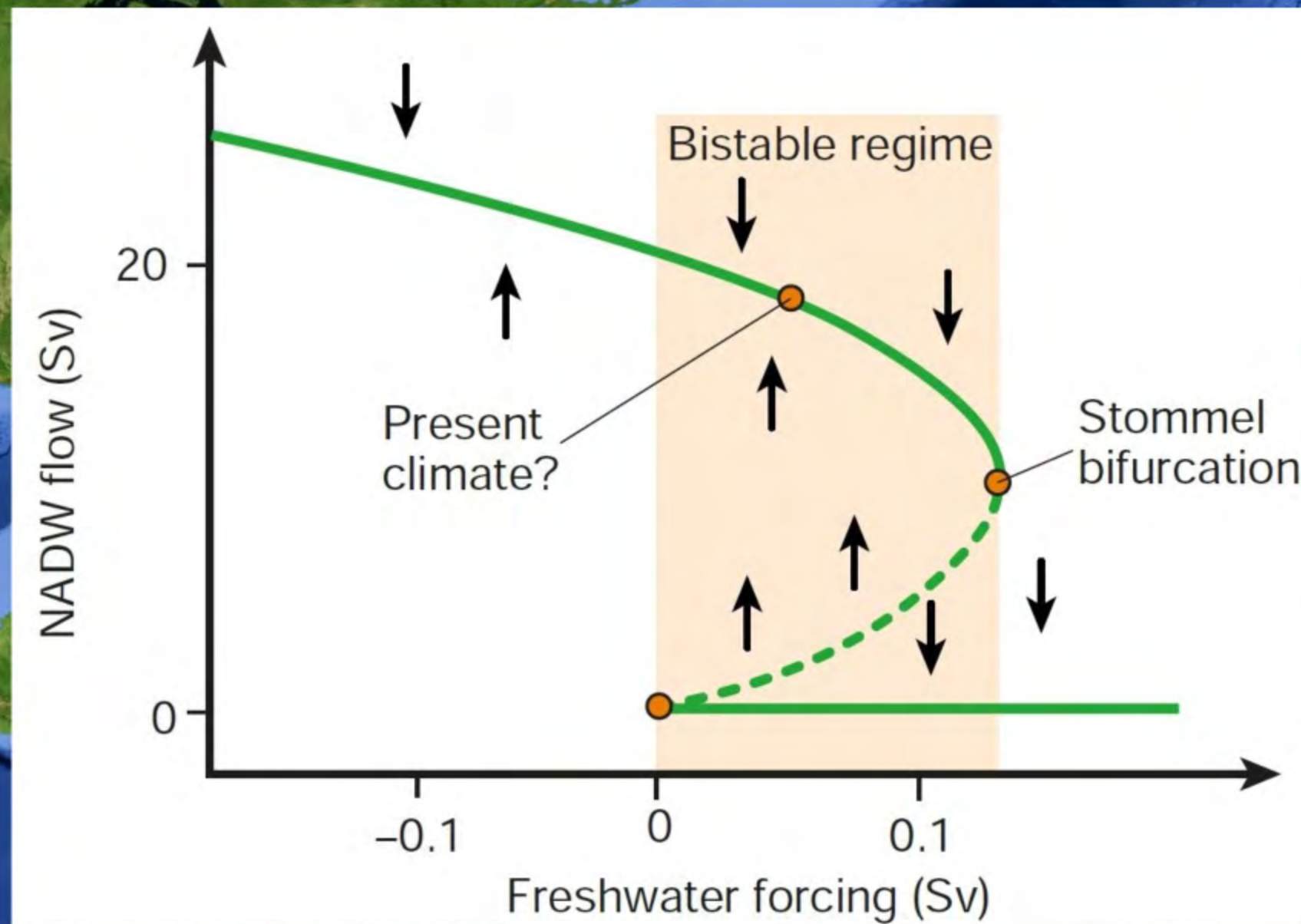
MODELL



MESSDATEN

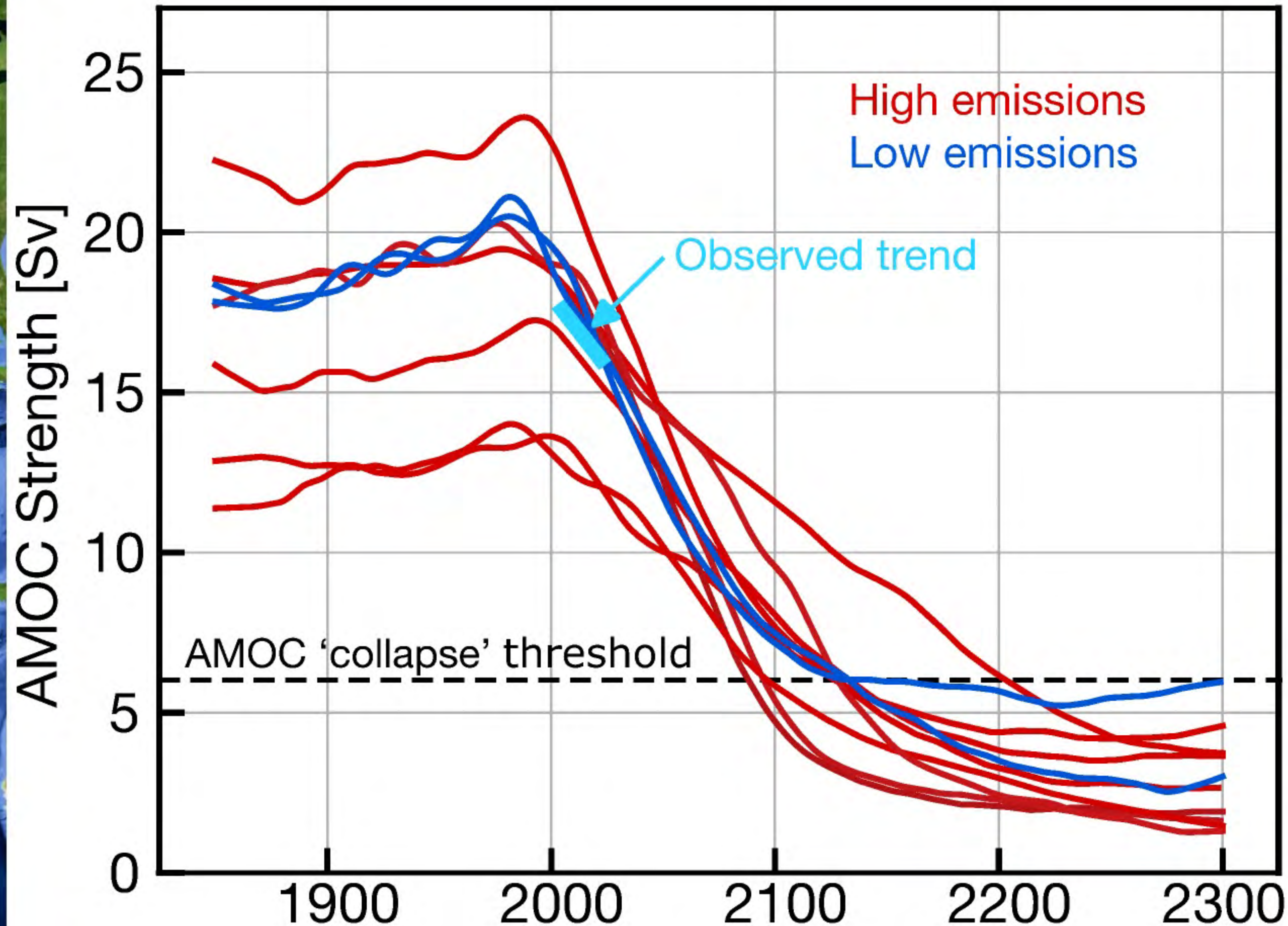


Wird die AMOC versiegen?



Seit 1961 ist bekannt, dass sie einen Kipppunkt hat!

AMOC in standard IPCC-Szenarien

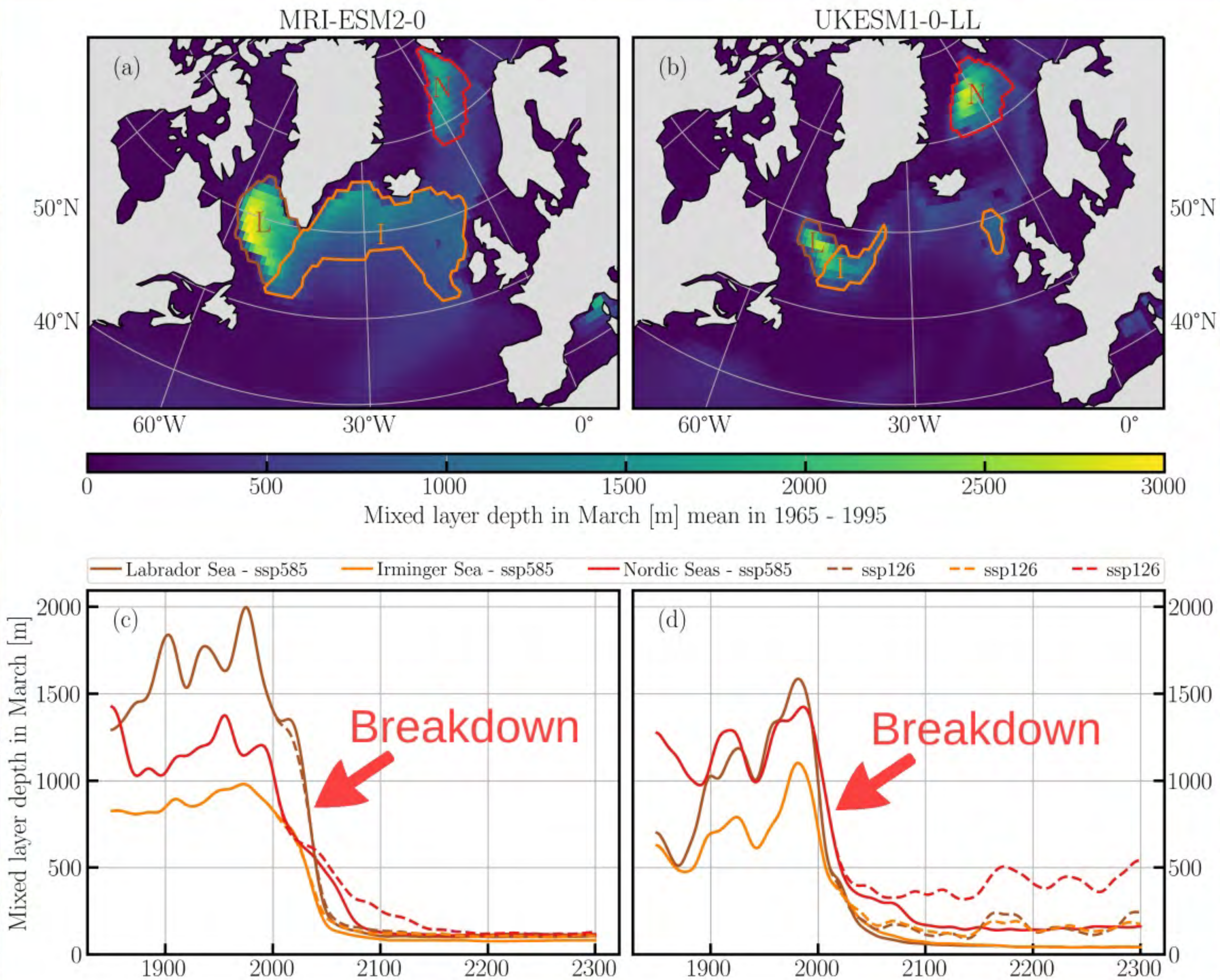


Vor dem Versiegen der AMOC ist endet die Konvektion!

Konvektion

Konvektionstiefe

Drijfhout et al. 2025



Der Klimavertrag von Paris

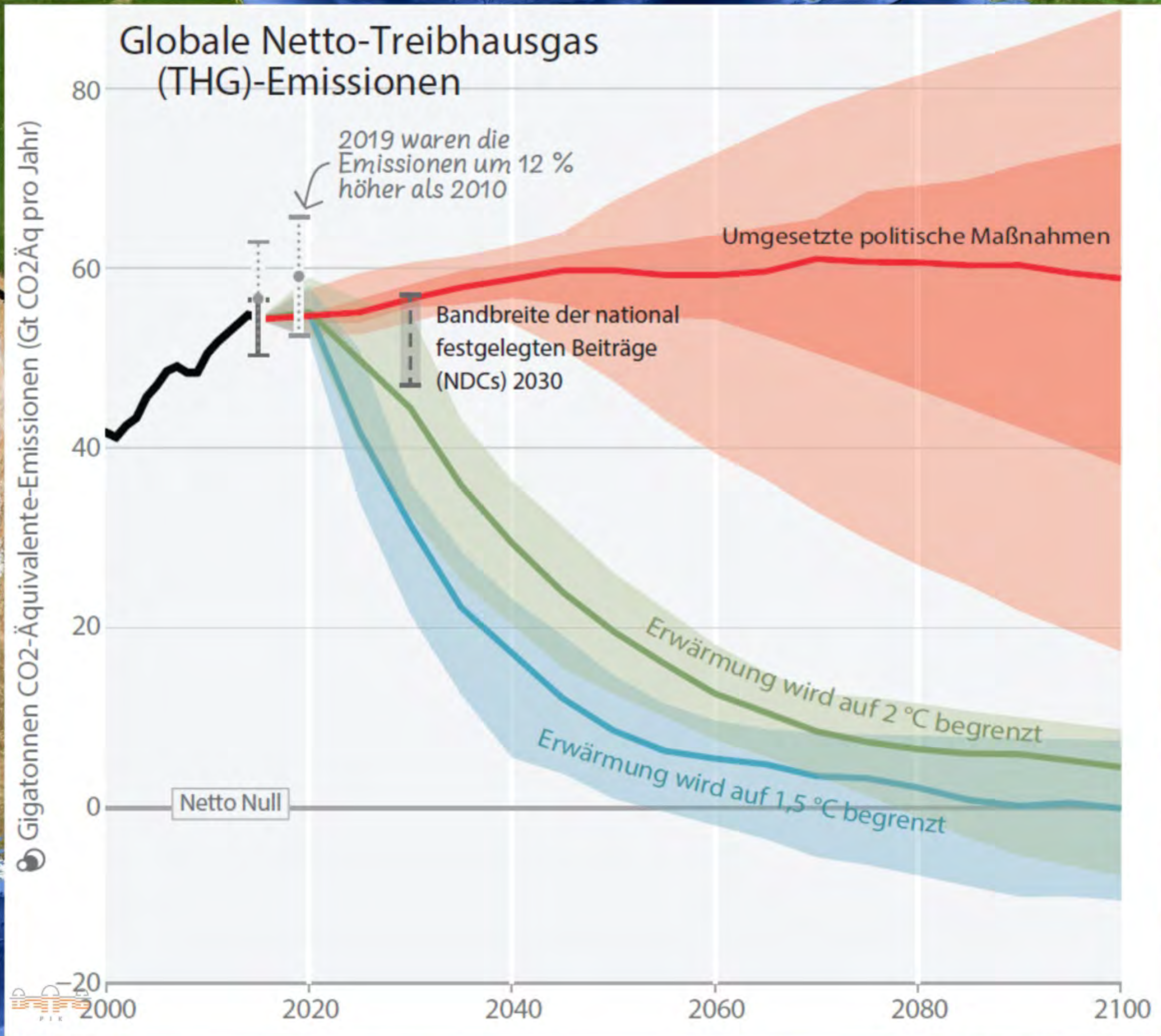
Conférence sur les Changements Climatiques 2015

COP21/CMP11

Paris France



“...der Anstieg der durchschnittlichen Erdtemperatur deutlich unter 2 °C über dem vorindustriellen Niveau gehalten wird und Anstrengungen unternommen werden, um den Temperaturanstieg auf 1,5 °C über dem vorindustriellen Niveau zu begrenzen”.



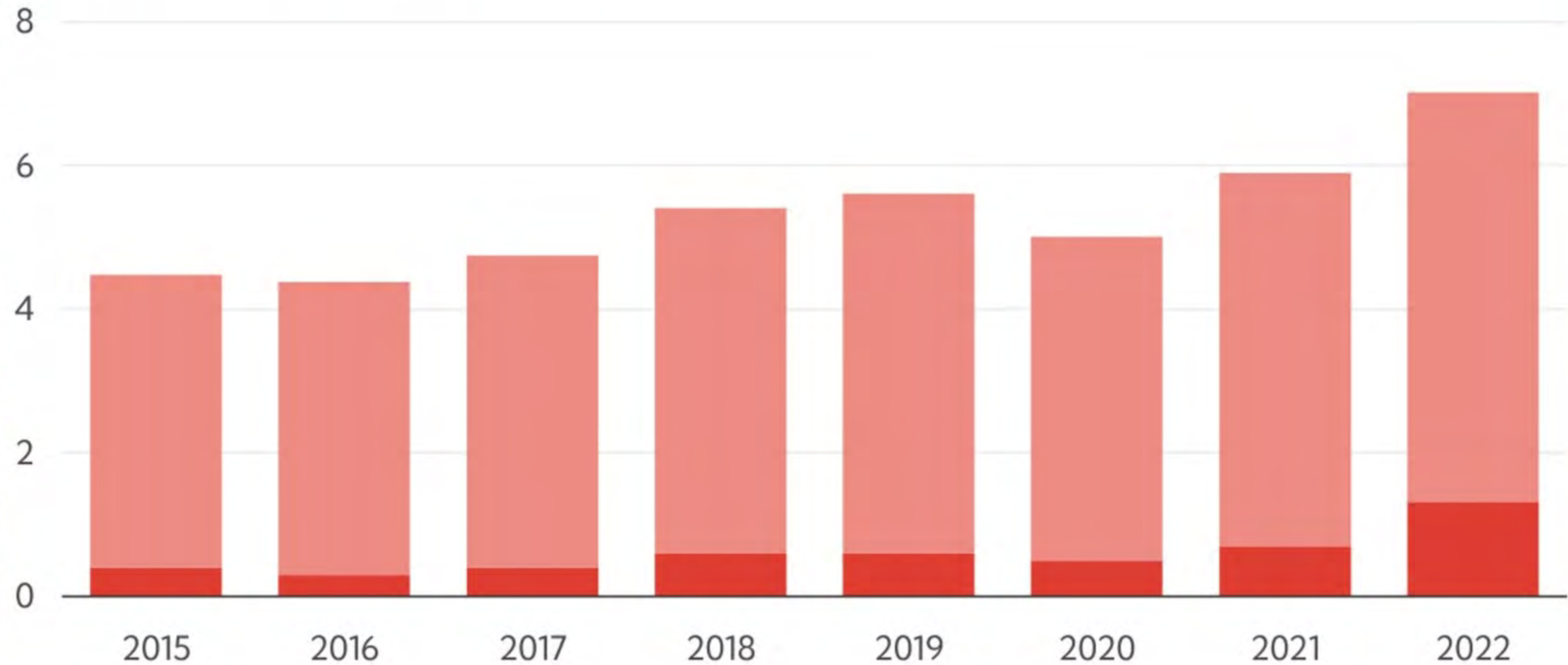
IPCC 2023:

"Die Begrenzung der Erwärmung auf 1,5°C und 2°C erfordert **schnelle** und **tiefgreifende** sowie in den meisten Fällen **sofortige** Senkungen der Treibhausgasemissionen in **allen Sektoren** in diesem Jahrzehnt."

Fossil fuel subsidies topped \$7 trillion last year

(total fossil fuel subsidies, trillions of USD)

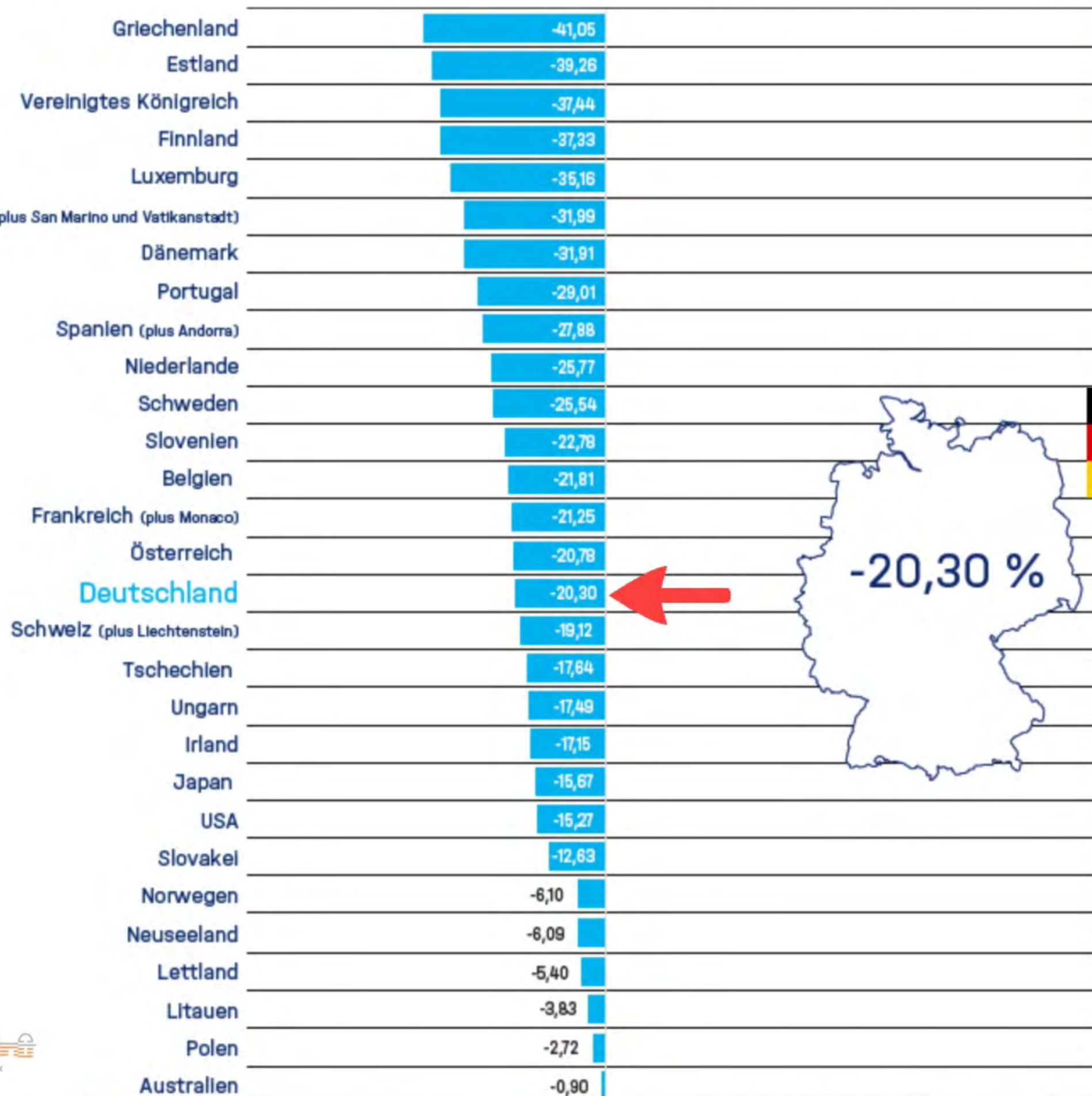
■ Explicit subsidies ■ Implicit subsidies



Source: IMF staff calculations.

Note: Figures from 2019 onwards use projections for fuel use. Explicit subsidies: undercharging for supply costs. Implicit subsidies: undercharging for environmental costs and forgone consumption taxes, after accounting for preexisting fuel taxes and carbon pricing.

Emissionsreduktionen in der OECD 2005 - 2022

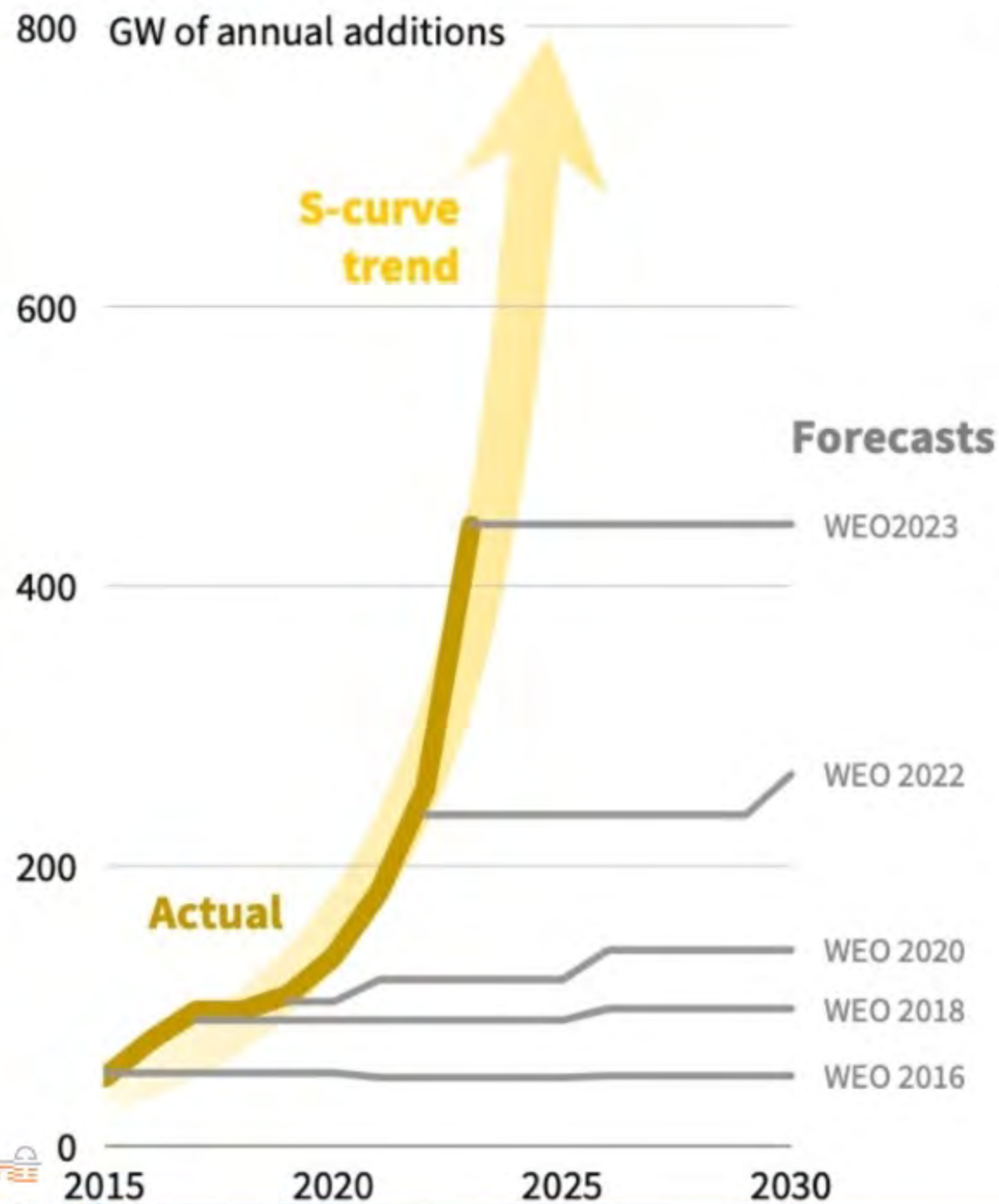


Deutschland im Mittelfeld!

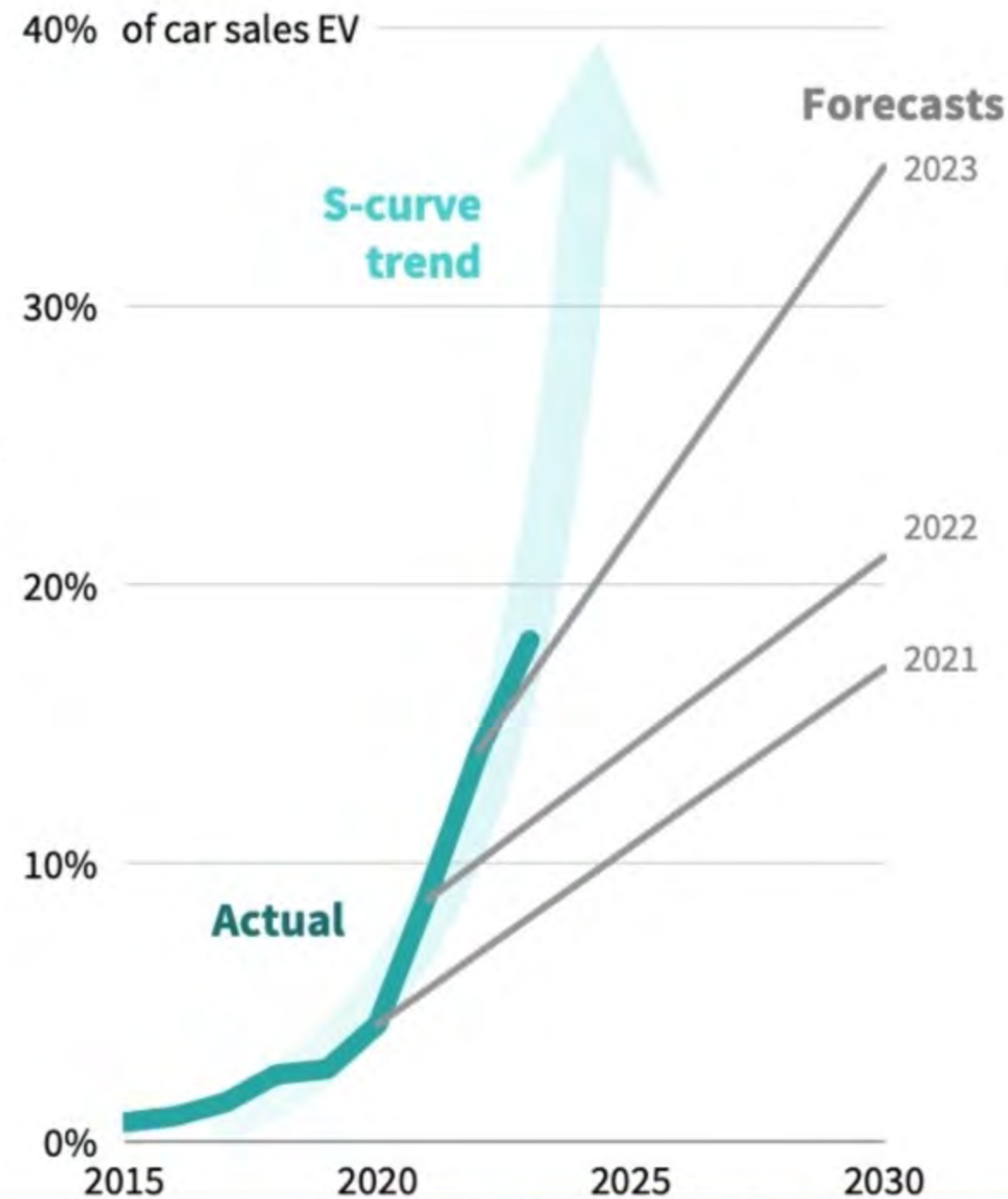
Die Lösungen werden unterschätzt

Even neutral actors modeled in **linear** terms. But change has been exponential

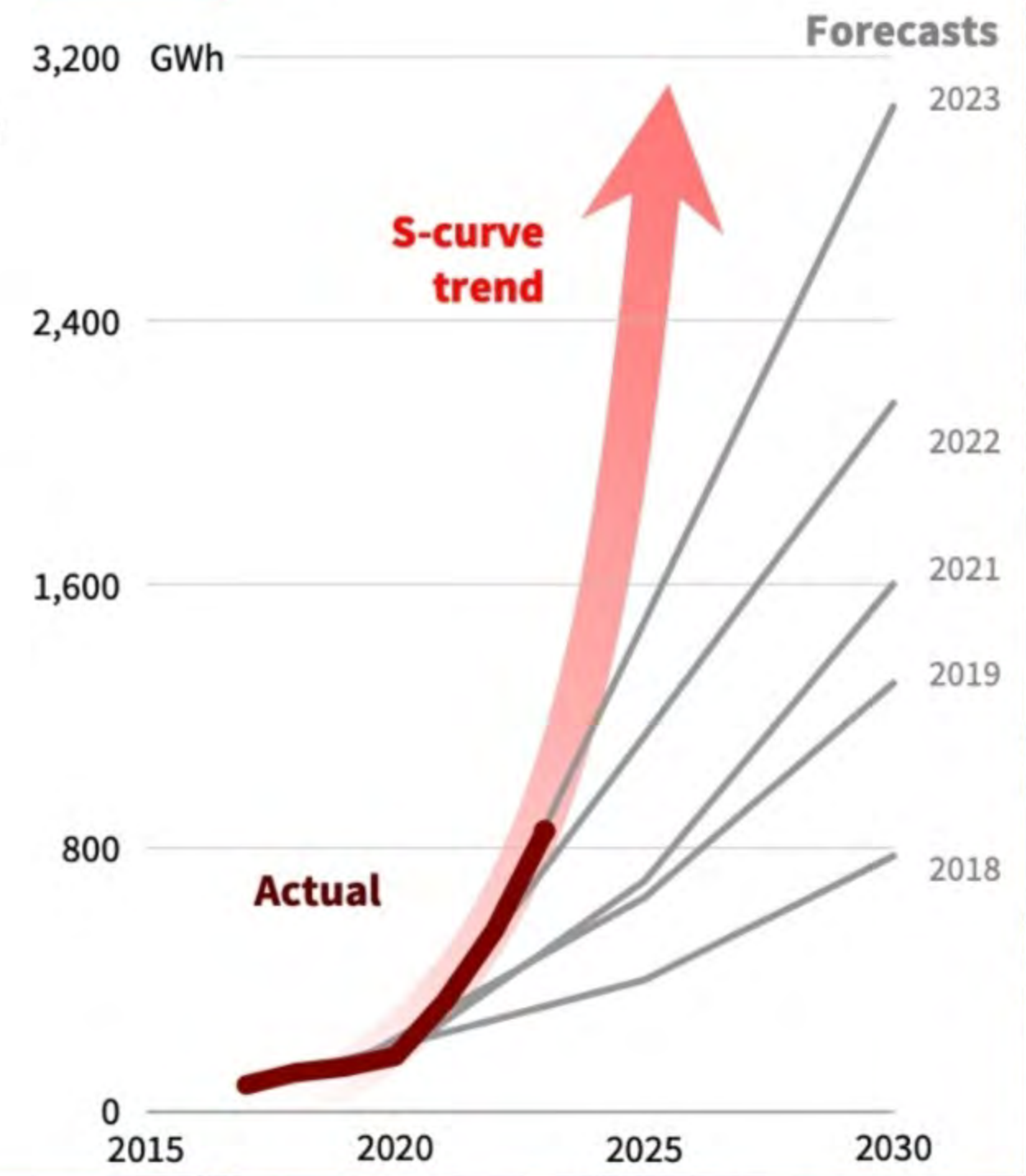
New solar additions



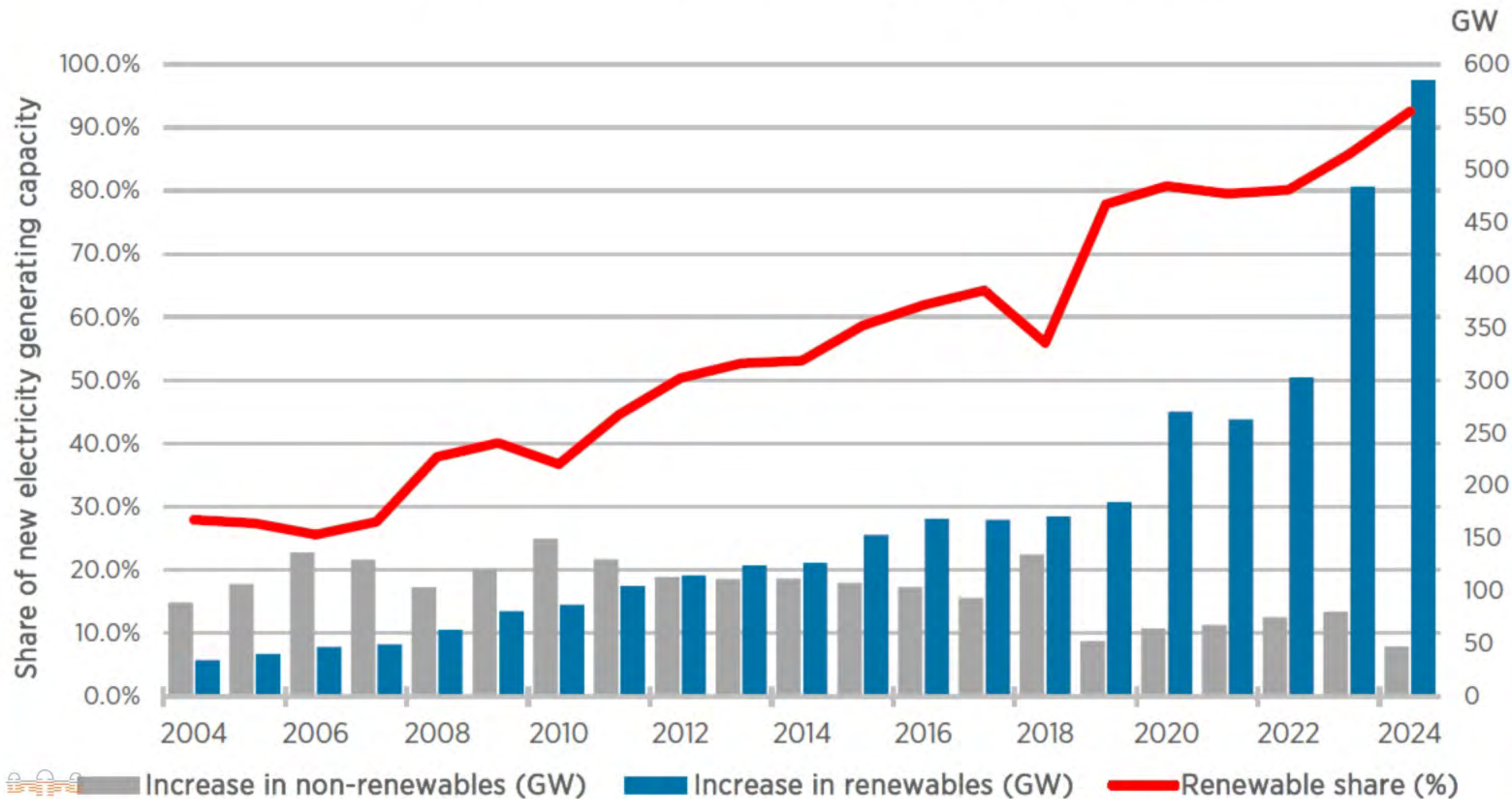
EV share of sales



Battery sales



Weltweiter Anteil der EE am Zubau der Stromerzeugungskapazität



93%
in 2024!

Hauptaussagen des IPCC Klimaberichts 2023

„Das Zeitfenster, in dem eine lebenswerte und nachhaltige Zukunft für alle gesichert werden kann, schließt sich rapide (*sehr hohes Vertrauen*).“

„Die in diesem Jahrzehnt getroffenen Entscheidungen und durchgeführten Maßnahmen werden sich jetzt und für Tausende von Jahren auswirken (hohes Vertrauen).“

Hunderte Wissenschaftler aus aller Welt haben 8 Jahre an diesem Bericht gearbeitet.

Deutsche Übersetzung der Hauptaussagen: https://www.de-ipcc.de/media/content/Hauptaussagen_AR6-SYR.pdf



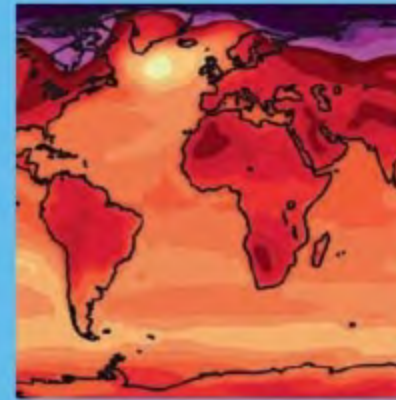
Herzlichen Dank für Ihr Interesse!



C.H. BECK WISSEN

S. Rahmstorf
H. J. Schellnhuber

DER KLIMAWANDEL



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