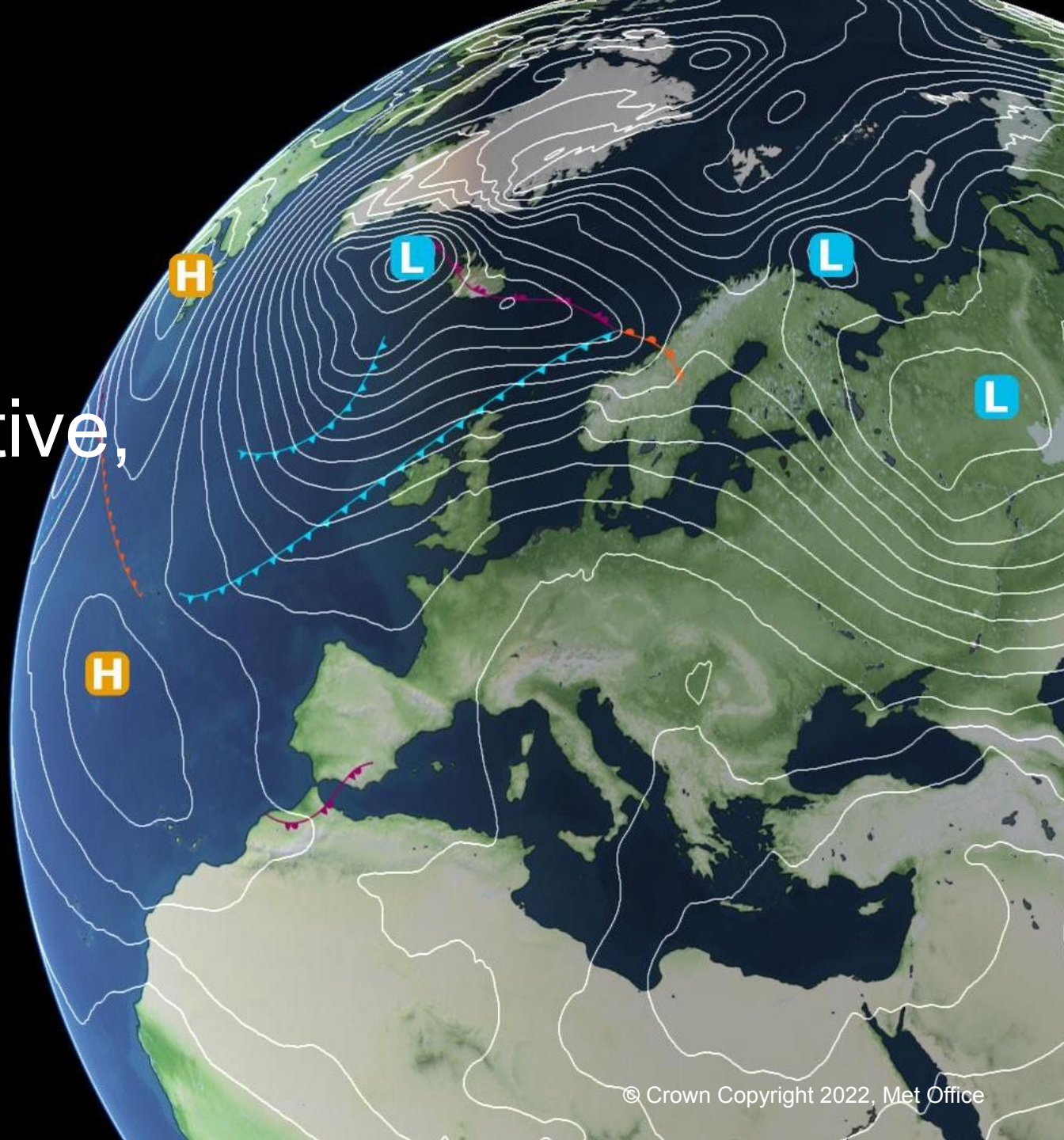
Met Office
Hadley Centre

Reassessing the carbon budget and net zero narrative, scientific progress and knowledge gaps



Prof Jason A. Lowe OBE
Met Office and University of Leeds
9th September 2025

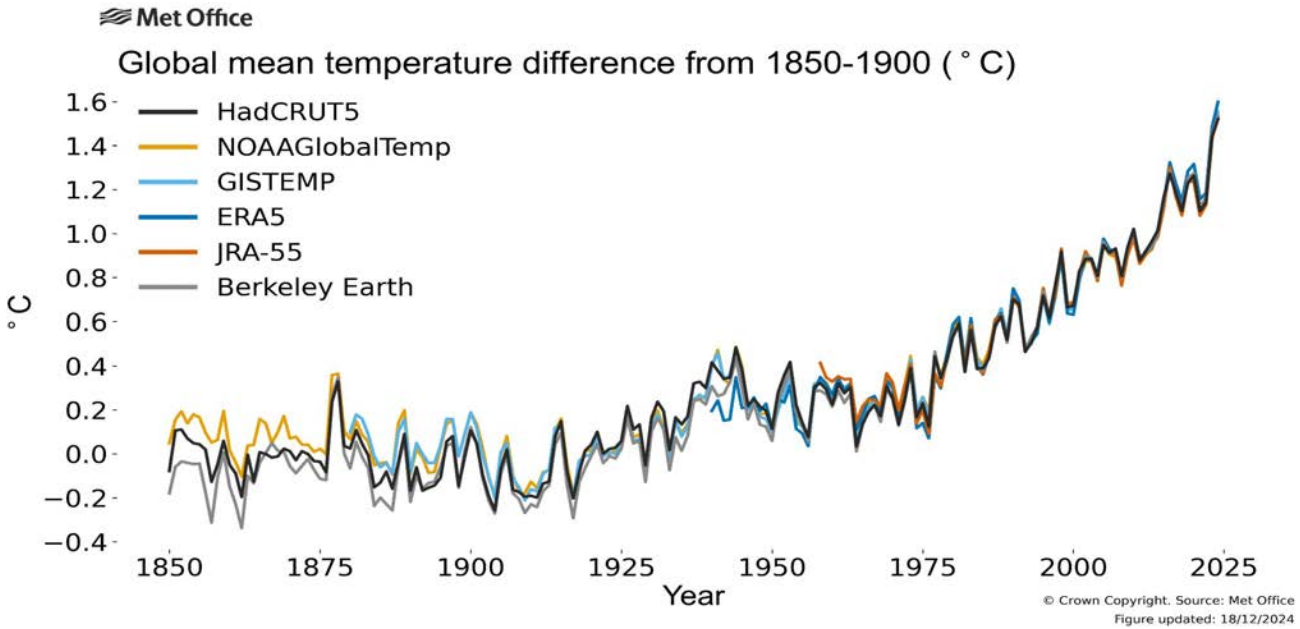
From the Rio earth summit (1992) to the Paris Agreement and beyond…..

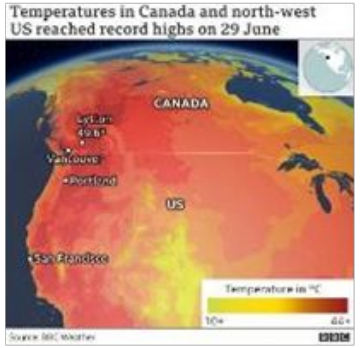
UNFCCC Article 2: "The ultimate objective of this Convention …… is to achieve …. **stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference** with the climate system. Such a level should be achieved **within a time-frame sufficient to allow ecosystems to adapt naturally to climate change**, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Paris Agreement 2015 article 2: "Holding the **increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C** above pre-industrial levels"

Article 4: ".. **achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**"

Global climate has changed in significantly

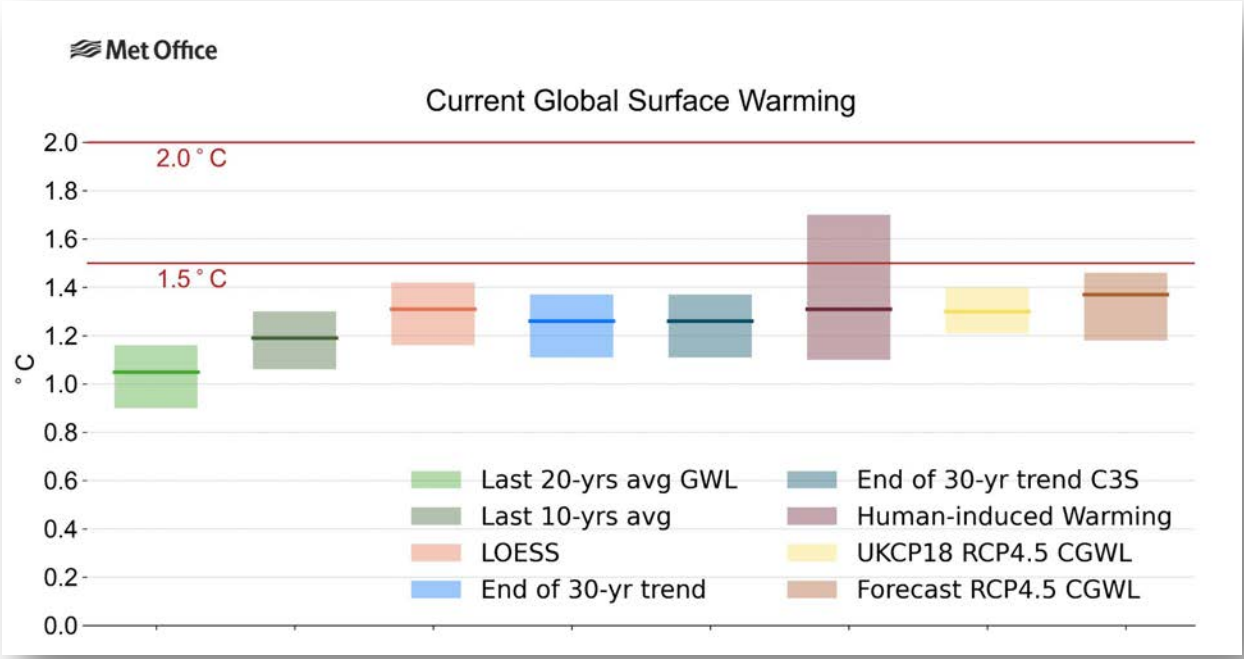




2024 was 1.53°C above the 1850-1900 global average, according to the HadCRUT5 dataset, and is therefore the warmest year on record. 2023's value of 1.46°C

Also focus on the **rate of climate change**. E.g. the chance of a summer day in UK warmer than 40°C became 4x more likely between 1990 and 2020.

“Paris warming” has reached around 1.35°C



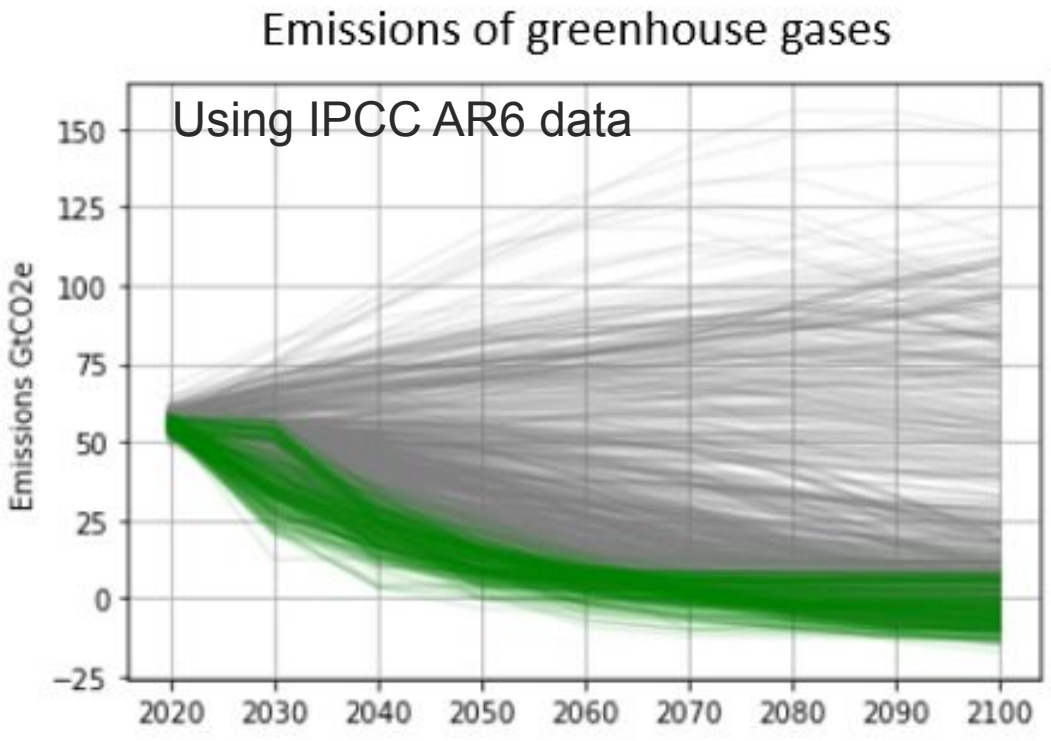
“For the 2015–2024 decade average, observed warming relative to 1850–1900 was 1.24 [1.11 to 1.35] °C, of which 1.22 [1.0 to 1.5] °C was human-induced.” “The best estimate of human-caused warming is 1.36 °C”.

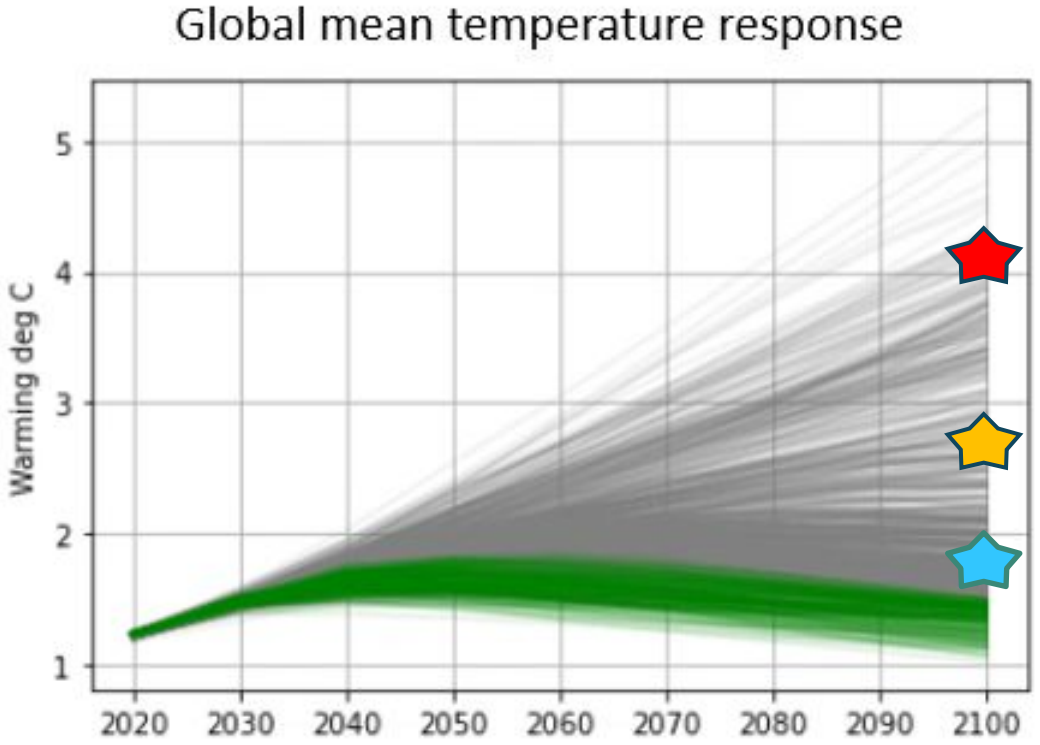
Met Office
Hadley Centre

How much will the climate warm in future?

Met Office Hadley Centre

Climate change in the future: is it still possible to limit warming to 1.5°C?





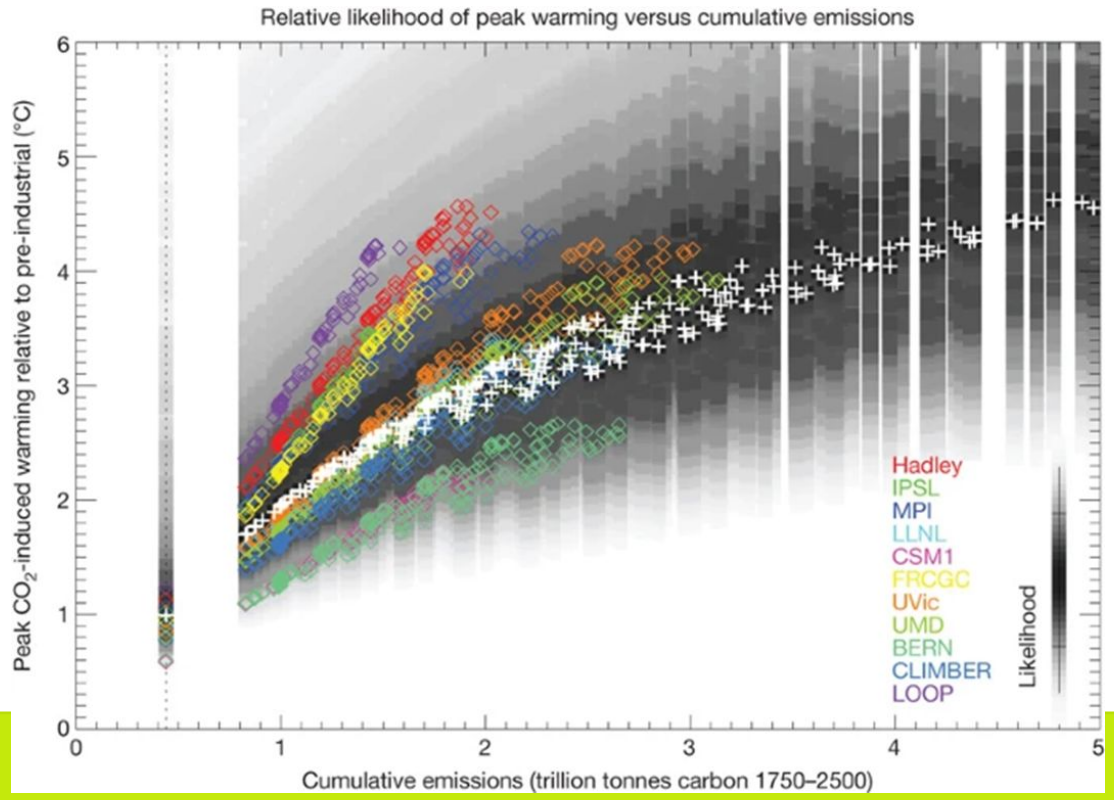
Current policies Net zero announcements Backtracking

Updated IPCC emissions scenarios no longer limit warming to 1.5°C

Chris Smith[1,2], Benjamin Sanderson[3], and Marit Sandstad[3]
[1]Vrije Universiteit Brussel, Department of Water and Climate, Brussels, Belgium (chris.smith@vub.be)
[2]International Institute for Applied Systems Analysis (IIASA), Energy, Climate and Environment Programme, Laxenburg, Austria
[3]Center for International Climate Research in Oslo (CICERO), Oslo, Norway

The global carbon budget approach

- 2009ish: several paper identified the almost linear relationship between global warming and CO2 emissions



Letter | Published: 11 June 2009

The proportionality of global warming to cumulative carbon emissions

H. Damon Matthews, Nathan P. Gillett, Peter A. Stott & Kirsten Zickfeld

Nature **459**, 829–832 (2009) | Cite this article

RESEARCH ARTICLE

Setting cumulative emissions targets to reduce the risk of dangerous climate change

Kirsten Zickfeld, Michael Eby, H. Damon Matthews, and Andrew J. Weaver Authors Info & Affiliations

Edited by Hans Joachim Schellnhuber, Potsdam Institute for Climate Impact Research, Potsdam, Germany, and approved July 20, 2009

September 22, 2009 | 106 (38) 16129-16134 | https://doi.org/10.1073/pnas.0805800106

Letter | Published: 30 April 2009

Greenhouse-gas emission targets for limiting global warming to 2 °C

Malte Meinshausen, Nicolai Meinshausen, William Hare, Sarah C. B. Raper, Katja Frieler, Reto Knutti, David J. Frame & Myles R. Allen

Nature **458**, 1158–1162 (2009) | Cite this article

Warming caused by cumulative carbon emissions towards the trillionth tonne

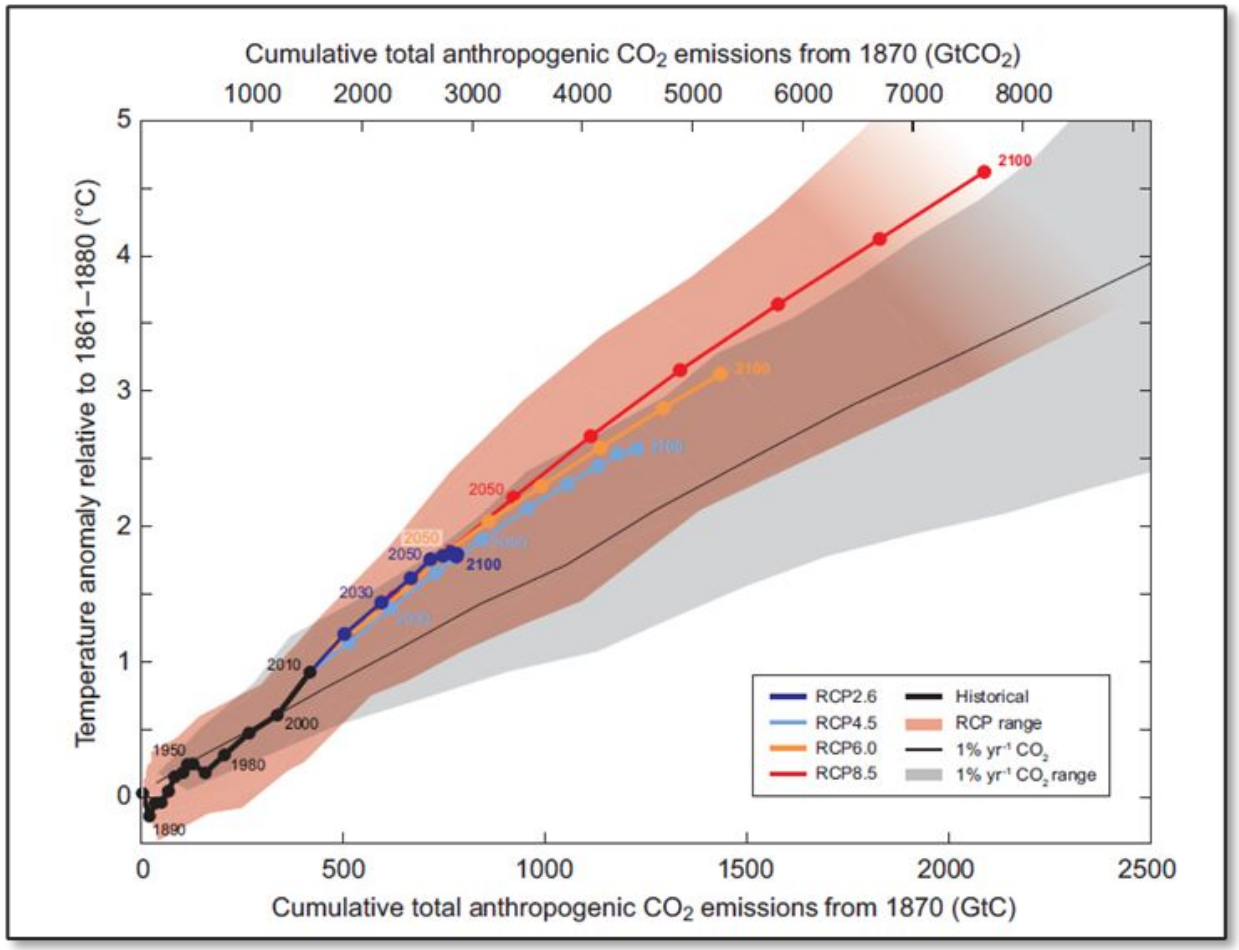
Myles R. Allen, David J. Frame, Chris Huntingford, Chris D. Jones, Jason A. Lowe, Malte Meinshausen & Nicolai Meinshausen

Nature **458**, 1163–1166 (2009) | Cite this article

The global carbon budget approach

- 2009ish: several paper identified the almost linear relationship between global warming and CO2 emissions

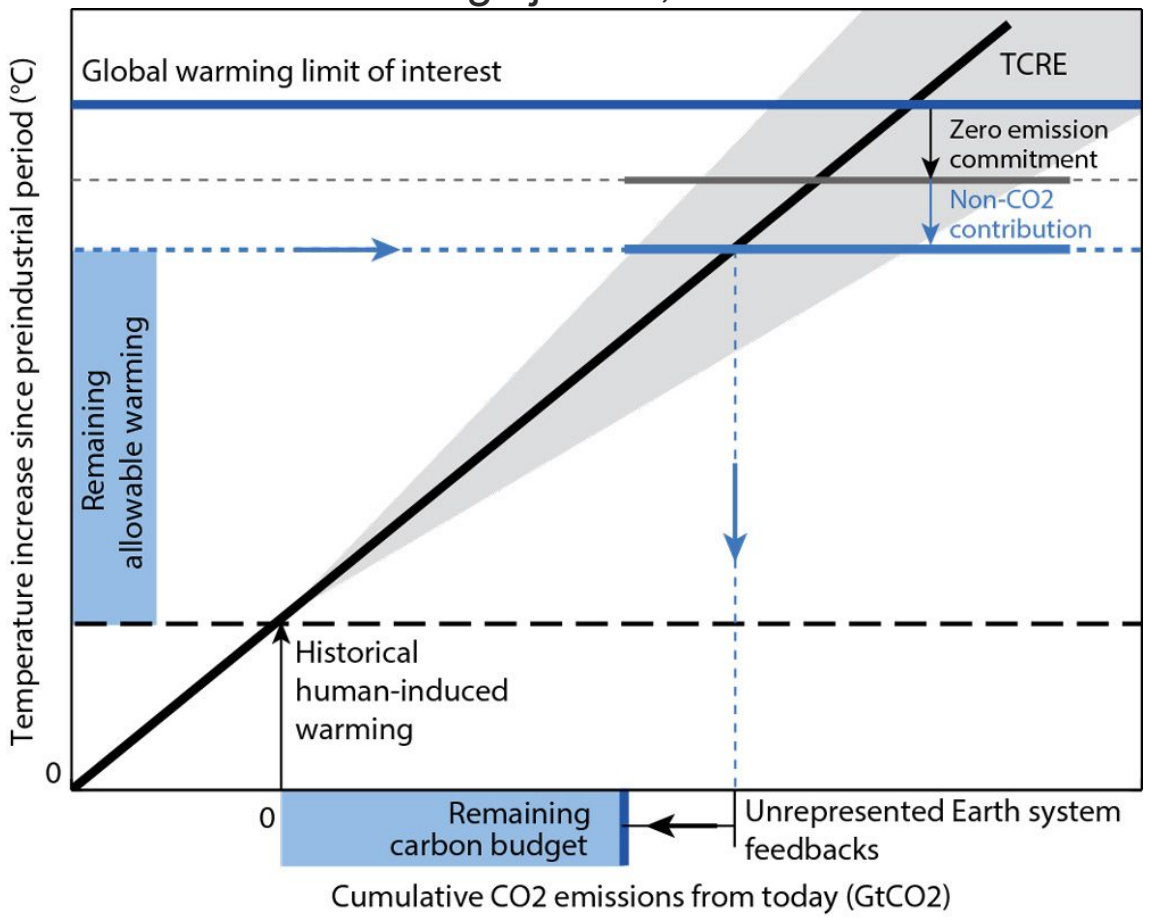
- One of main advances in IPCC AR5
- The concept of net zero is clear from this relationship



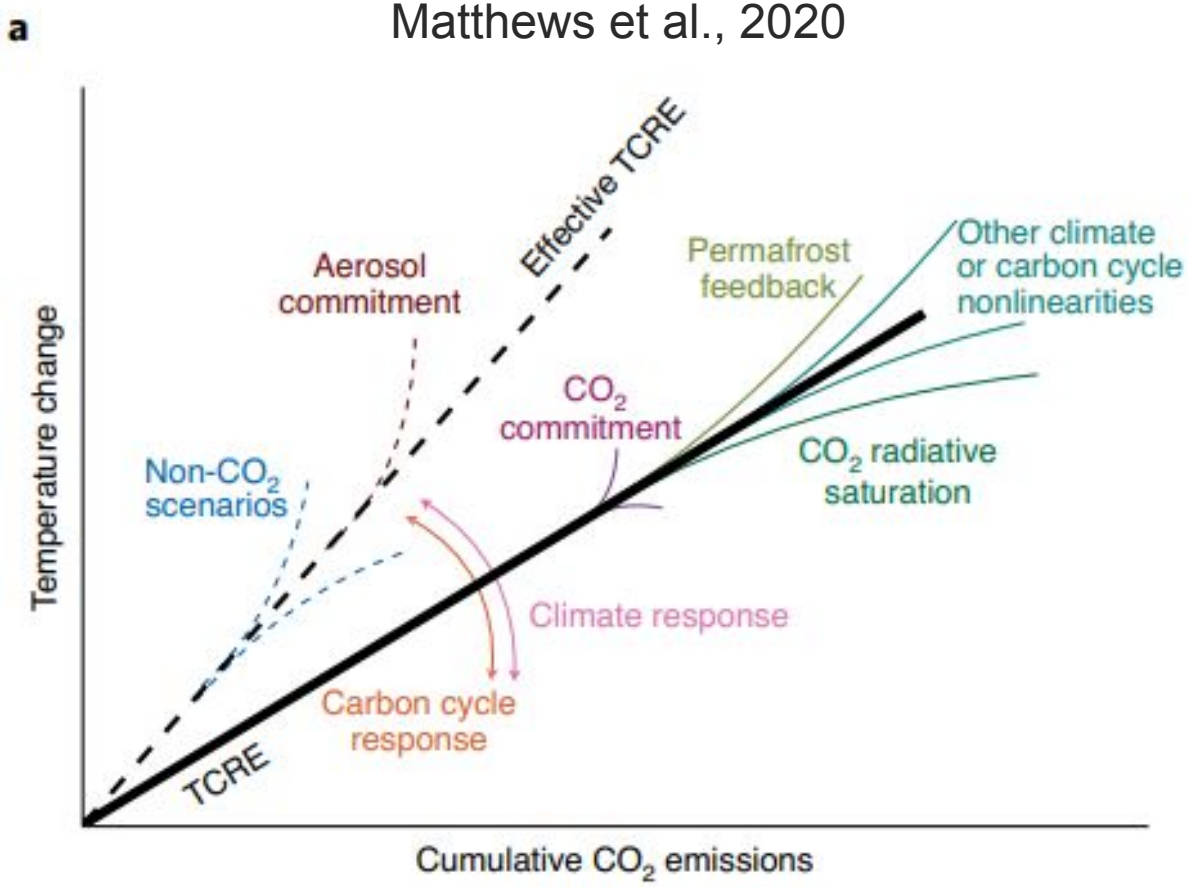
IPCC AR5, SPM.10

The global carbon budget approach

Rogelj et al., 2019



Matthews et al., 2020



But, we need to understand the uncertainty budget

The global carbon budget approach

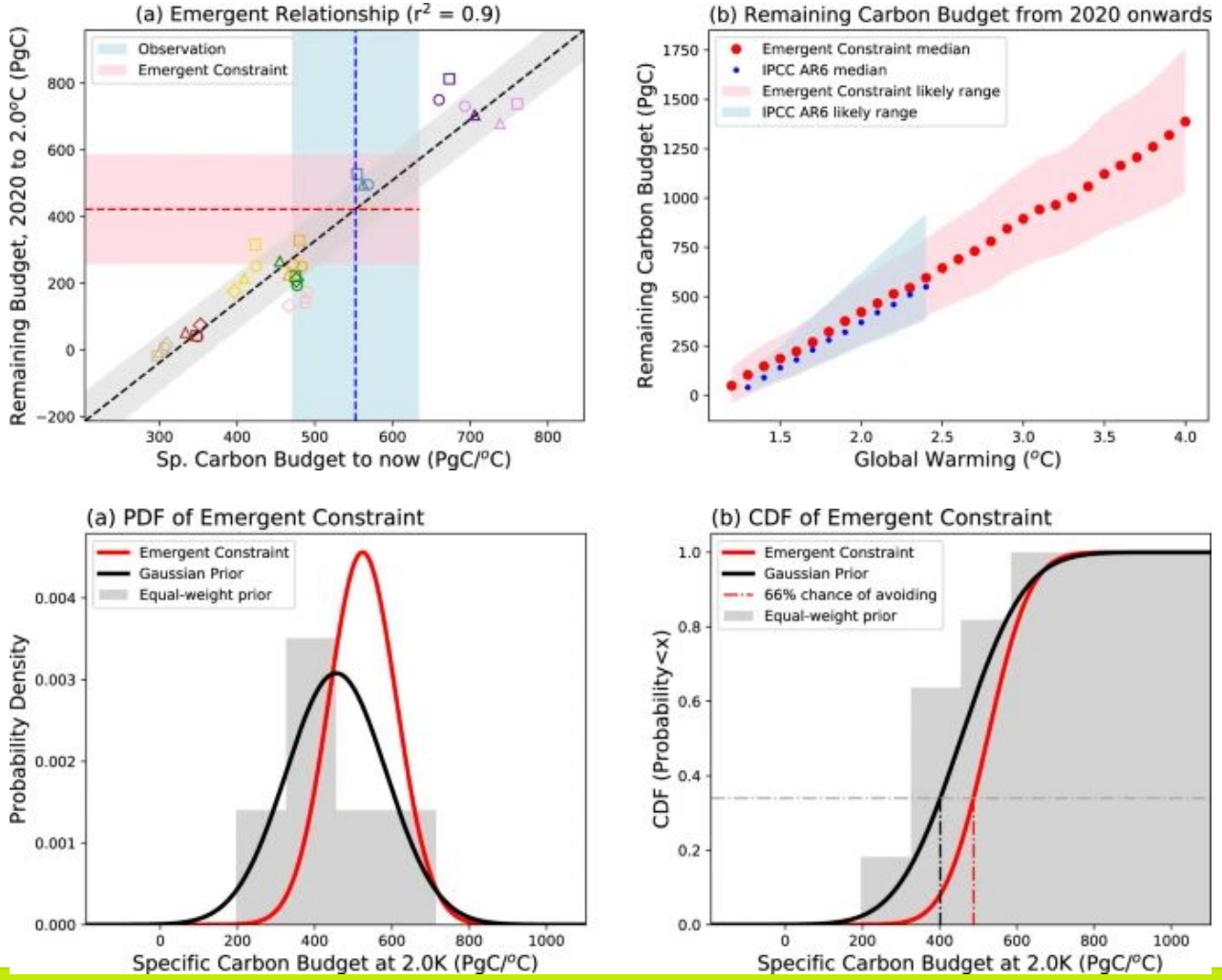
Can we constrain TCRE (the relationship between emissions and warming)?

Article | Open access | Published: 29 February 2024

Emergent constraints on carbon budgets as a function of global warming

Peter M. Cox, Mark S. Williamson, Pierre Friedlingstein, Chris D. Jones, Nina Raoult, Joeri Rogelj & Rebecca M. Varney

Nature Communications **15**, Article number: 1885 (2024) | Cite this article



The global carbon budget approach

- 2009ish: several paper identified the almost linear relationship between global warming and CO2 emissions

How difficult is it to recover from dangerous levels of global warming?

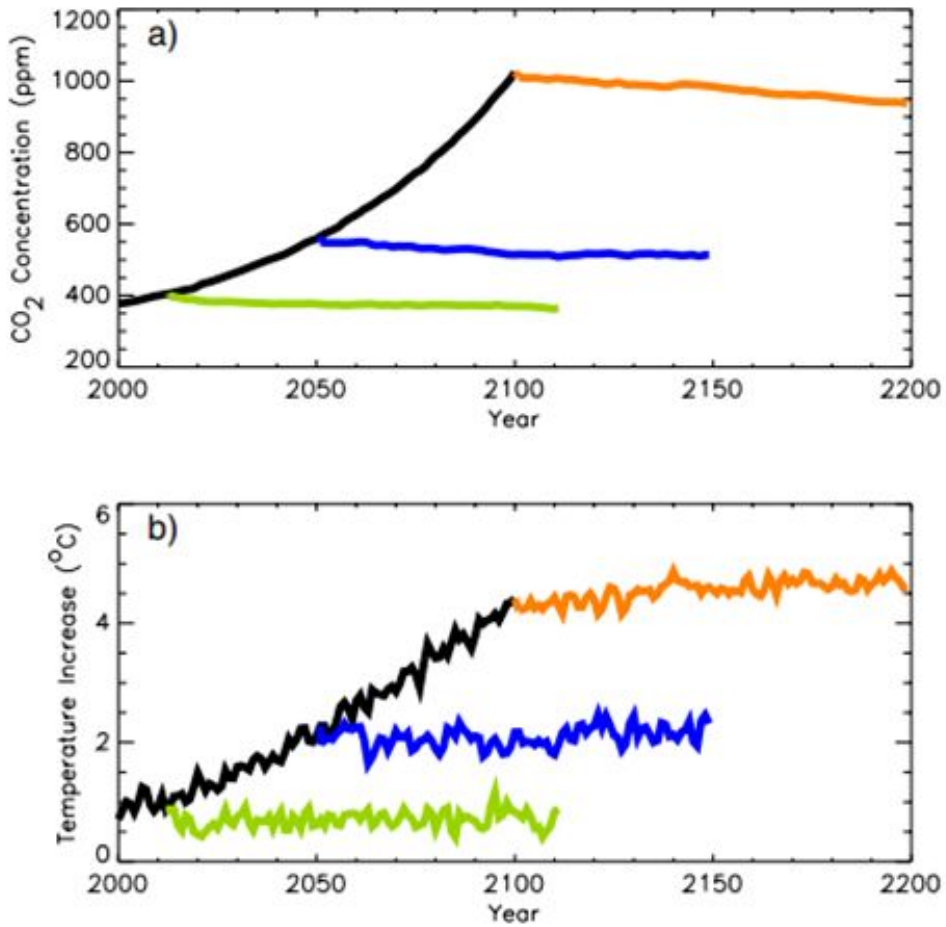
J A Lowe, C Huntingford, S C B Raper, C D Jones, S K Liddicoat and L K Gohar

Published 11 March 2009 • Published under licence by IOP Publishing Ltd

Environmental Research Letters, Volume 4, Number 1

Citation J A Lowe *et al* 2009 *Environ. Res. Lett.* **4** 014012

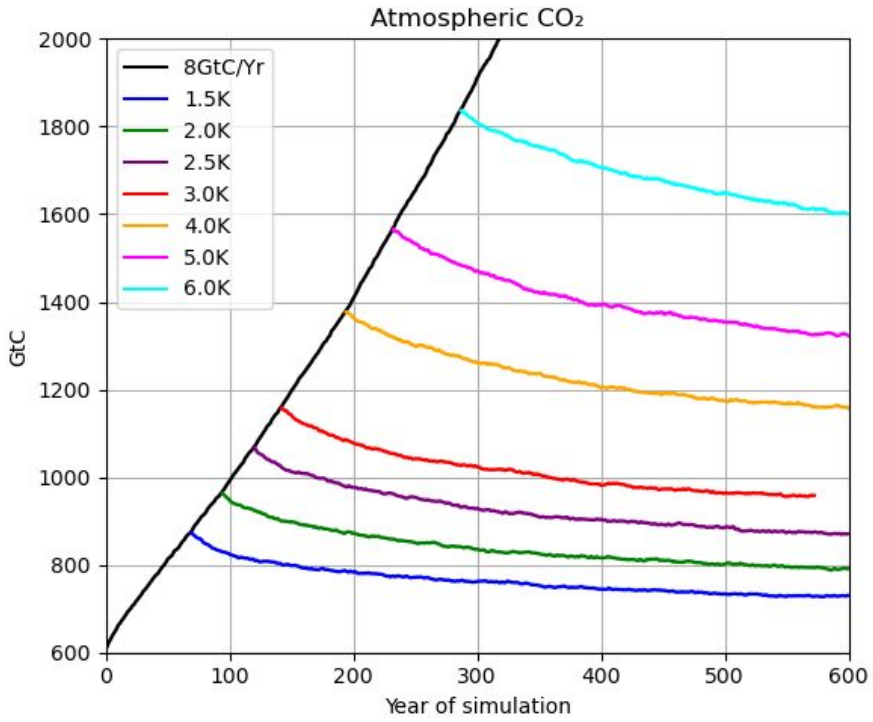
DOI 10.1088/1748-9326/4/1/014012

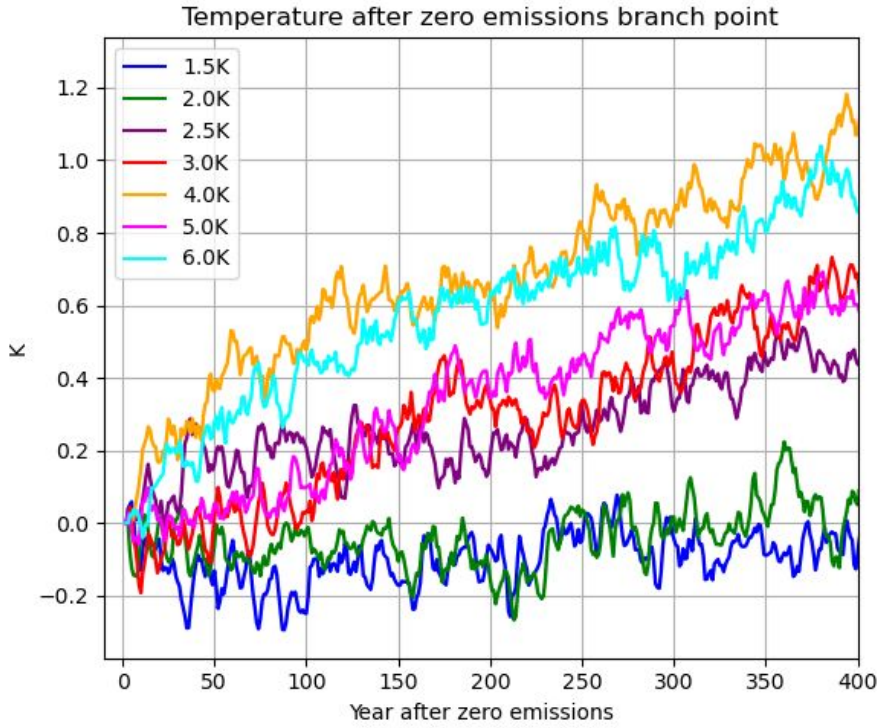


An early view of Zero emission commitment (ZEC)

The global carbon budget approach

Does warming really halt soon after we stop carbon emissions?





Plots from Laura Gibbs EGU presentation, 2025

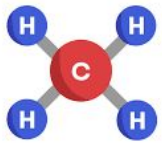
UKESM experiments that zero emissions are a range of warming levels

The global carbon budget approach

What about earth system feedbacks?







Fire weakens land carbon sinks before 1.5 °C

Chantelle A. Burton, Douglas I. Kelley, Eleanor Burke, Camilla Mathison, Chris D. Jones, Richard A. Betts, Eddy Robertson, João C. M. Teixeira, Manoel Cardoso & Liana O. Anderson

Nature Geoscience **17**, 1108–1114 (2024) | Cite this article

Earth's Future

Research Article | Open Access

Permafrost Thaw Impact on Remaining Carbon Budgets and Emissions Pathways in 2°C and 3°C Global Warming Scenarios

Goran Georgievski, Thomas Kleinen, Philipp de Vrese, Victor Brovkin, Yona Silvy, Thomas L. Frölicher

shed: 05 July 2025 | https://doi.org/10.1029/2024EF005153

Effect of terrestrial nutrient limitation on the estimation of the remaining carbon budget

Makcim L. De Sisto[1,2] and Andrew H. MacDougall[1]

[1]Climate and Environment, St. Francis Xavier University, Antigonish, NS, Canada
[2]Faculty of Engineering and Applied Science, Memorial University of Newfoundland, NL, St. John's, Canada

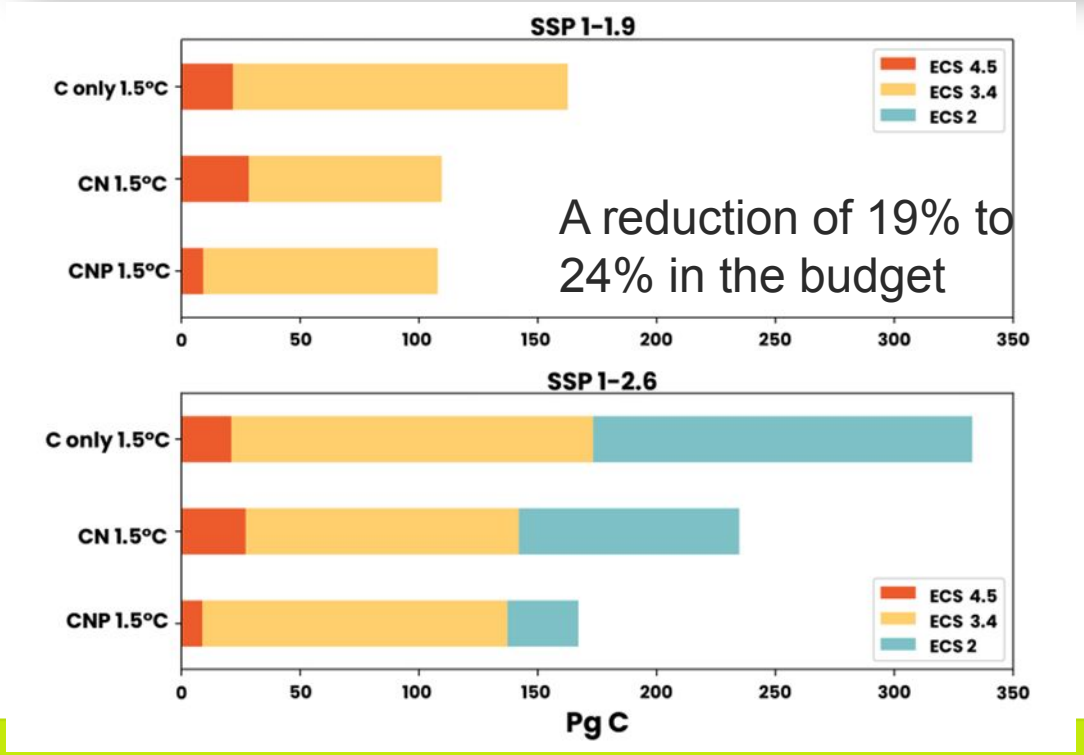
How to cite. Steinert, N. J. and Sanderson, B. M.: Normalizing the permafrost carbon feedback contribution to TCRE and ZEC, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-1714, 2025.

The global carbon budget approach

Effect of terrestrial nutrient limitation on the estimation of the remaining carbon budget

Makcim L. De Sisto[1,2] and Andrew H. MacDougall[1]

[1]Climate and Environment, St. Francis Xavier University, Antigonish, NS, Canada
[2]Faculty of Engineering and Applied Science, Memorial University of Newfoundland, NL, St. John's, Canada



A reduction of 19% to 24% in the budget

Fire weakens land carbon sinks before 1.5 °C

Chantelle A. Burton, Douglas I. Kelley, Eleanor Burke, Camilla Mathison, Chris D. Jones, Richard A. Betts, Eddy Robertson, João C. M. Teixeira, Manoel Cardoso & Liana O. Anderson

Nature Geoscience **17**, 1108–1114 (2024) | Cite this article

Reduction in carbon budget due to fire ($GtCO_2$) in JULES driven with four ESMs

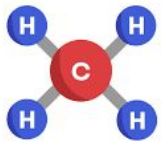
	HadGEM2	GFDL	IPSL	MIROC	Mean
1.3°C	−7	−40	7	−18	−15
1.5°C	−26	−40	4	−37	−25
1.7°C	−33	−59	−18	−37	−37
2°C	−62	−92	−22	−81	−64

The global carbon budget approach

What about earth system feedbacks?



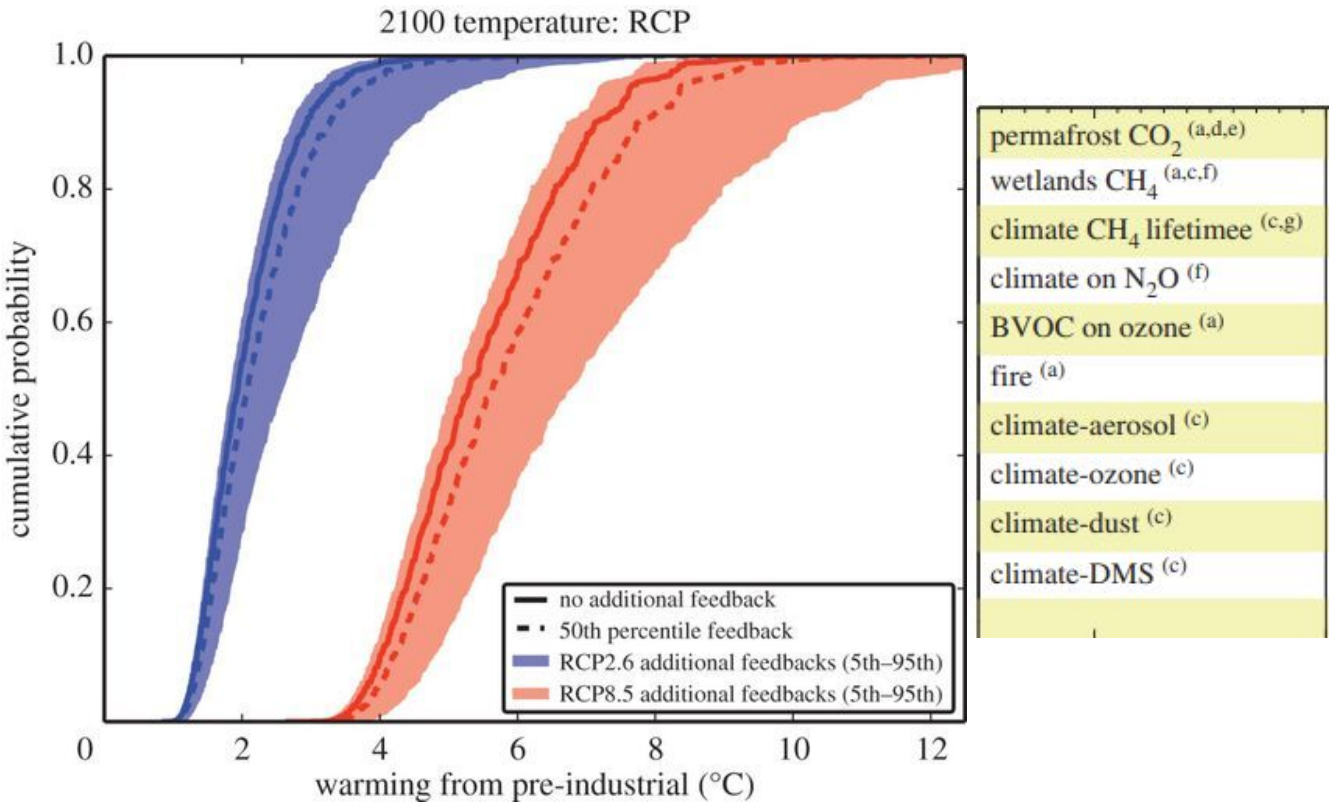




The impact of Earth system feedbacks on carbon budgets and climate response

Jason A. Lowe and Daniel Bernie

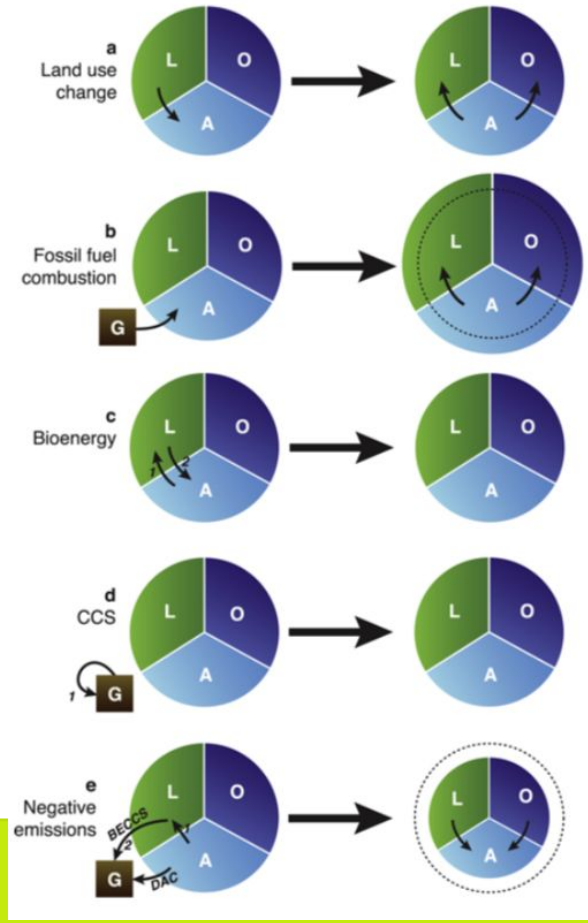
Published: 02 April 2018 https://doi.org/10.1098/rsta.2017.0263



Now being explored in more complex earth system models: Recent Met Office results by **Liddicoat et al., 2025** suggest reduction in carbon budgets of up to 25%

The global carbon budget approach

Is the linear relationship the same if we remove carbon?



Simulating the Earth system response to negative emissions

C D Jones, P Ciais, S J Davis, P Friedlingstein, T Gasser, G P Peters, J Rogelj, D P van Vuuren, J G Canadell, A Cowie, R B Jackson, M Jonas, E Kriegler, E Littleton, J A Lowe, J Milne, G Shrestha, P Smith, A Torvanger and A Wiltshire ▲ Hide full author list

Published 20 September 2016 • © 2016 Crown copyright and IOP Publishing Ltd

Environmental Research Letters, Volume 11, Number 9

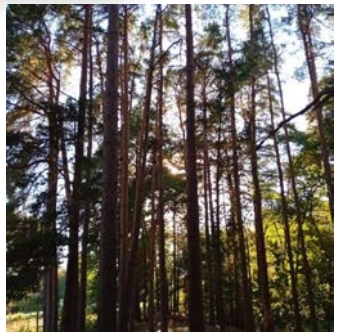
Focus on Negative Emissions Scenarios and Technologies

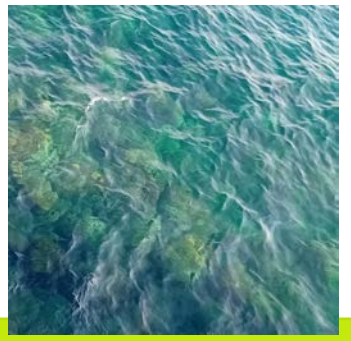
Citation C D Jones *et al* 2016 *Environ. Res. Lett.* **11** 095012

DOI 10.1088/1748-9326/11/9/095012

"Earth system models suggest significant weakening, even potential reversal, of the ocean and land sinks under future low emission scenarios."

"…will hinder the effectiveness of negative emissions technologies and therefore increase their required deployment to achieve a given climate stabilisation target."





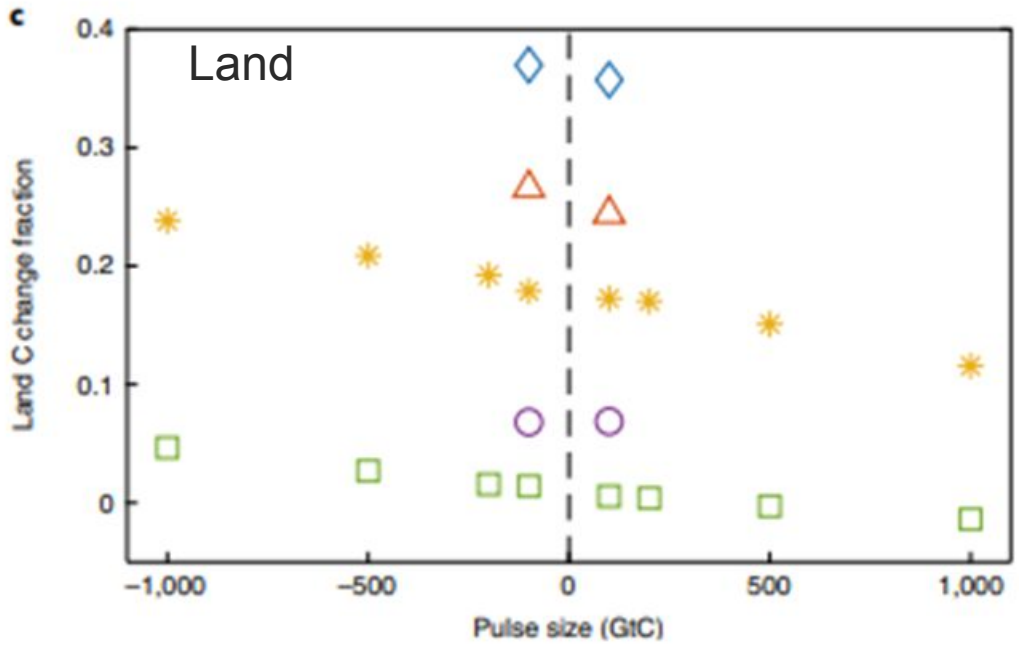
The global carbon budget approach

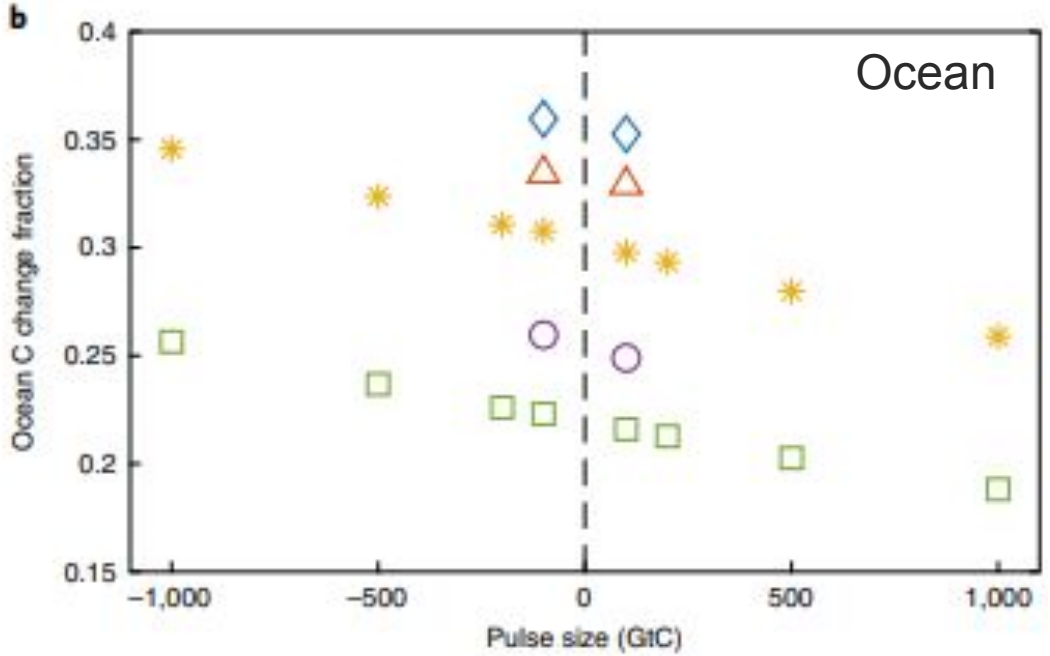
Is the linear relationship the same if we remove carbon?

Asymmetry in the climate–carbon cycle response to positive and negative CO_2 emissions

Kirsten Zickfeld ✉, Deven Azevedo, Sabine Mathesius & H. Damon Matthews

Nature Climate Change **11**, 613–617 (2021) | Cite this article



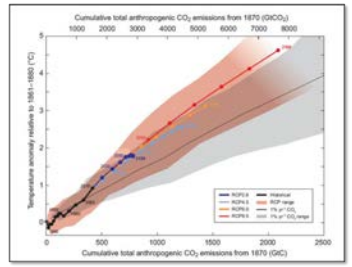


Is limiting warming to below 1.5°C feasible?

Climate constraints: Given an emissions pathway, what happens to climate?

Economic and technological constraints: on achieving an emission pathway

Political and social constraints: Creating the situation to drive emission reductions.



Is limiting warming to below 1.5°C feasible?

Carbon budget perspective

Temperature (°C)	Estimated remaining carbon budgets from the beginning of 2025 ($GtCO_2$)				
Avoidance probability:	17%	33%	50%	67%	83%
1.5	320	200	130	80	30
1.6	620	420	310	240	160
1.7	910	640	490	390	290
2.0	1790	1310	1050	870	690

Indicators of Global Climate Change 2024: annual update of key indicators of the state of the climate system and human influence

May 2025

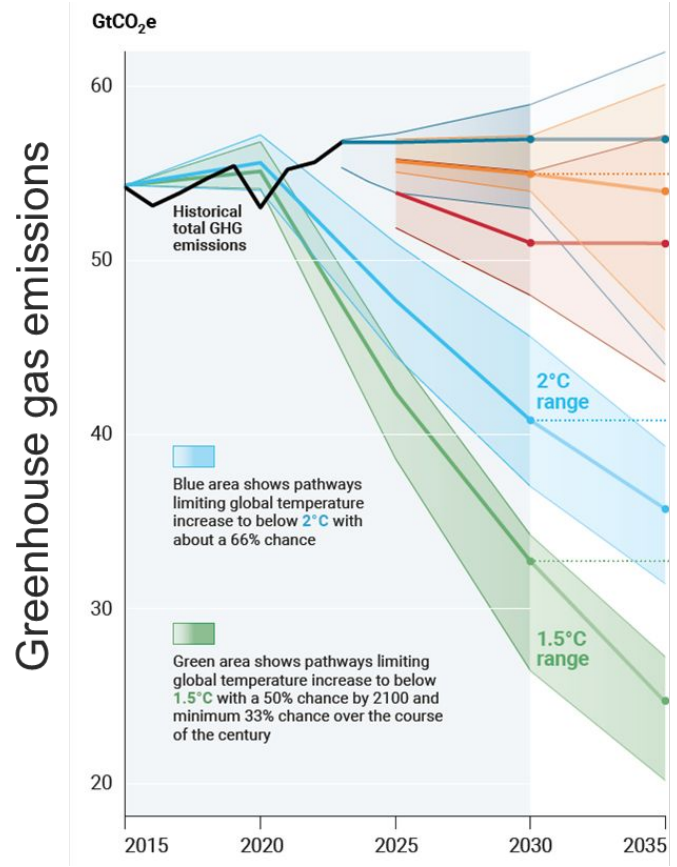
DOI: 10.5194/essd-2025-250

License · CC BY 4.0

Piers Forster Piers Forster · Chris Smith · Tristram Walsh · Show all 61 authors · Panmao Zhai

For at least a 50% chance of limiting peak long-term warming to below 1.5°C there is less than 3 years of emission budget left!

Emission scenario perspective



Current policies and NDCs

"Technically feasible" 2°C and 1.5°C pathways

But are integrated assessment models covering a wide enough range of scenarios?

Adjusting 1.5 degree C climate change mitigation pathways in light of adverse new information

Ajay Gambhir, Shivika Mittal, Robin D. Lamboll, Neil Grant, Dan Bernie, Laila Gohar, Adam Hawkes, Alexandre Köberle, Joeri Rogelj & Jason A. Lowe

Nature Communications **14**, Article number: 5117 (2023) | Cite this article

Within IAMs there are many routes to low temperature rise outcomes: but many “choices” push up the costs.

Surprises around lack of technology solution coming later is more problematic.

Fig. 9: Summary indicators across 2030 pathway adjustment scenarios.

	CO_2 Emissions (average 2030-2040 %/yr reduction)	Transport final energy (average 2030-2040 %/yr reduction)	Buildings final energy (average 2030-2040 %/yr reduction)	Industry final energy (average 2030-2040 %/yr reduction)	Electricity share of final energy (2040)	Geothermal (EJ of generation in 2040)	Hydro (EJ of generation in 2040)	Nuclear (EJ of generation in 2040)	Carbon price (2010$/tCO$_2$ in 2040)	BECCS (MtCO$_2$ removed in 2040)	DAC (MtCO$_2$ removed in 2040)	Total CDR (cumulative GtCO$_2$ removed over period 2050-2100)	Probability of exceeding 1.5°C
1p5_ref	1.9%	0.3%	-0.7%	-0.8%	27%	5.0	18.8	13.6	114	851	0	622	0.63
1p5_lowBudget_30	2.4%	0.7%	-0.6%	-0.7%	28%	5.7	20.2	13.6	176	795	115	617	0.62
1p5_limAFOLU_30	2.7%	0.7%	-0.6%	-0.7%	28%	5.7	20.2	13.6	177	881	115	640	0.63
1p5_limRNW_30	1.9%	0.3%	-0.7%	-0.8%	27%	5.2	19.7	13.6	118	847	0	622	0.63
1p5_limCCS_30	3.7%	1.3%	-0.2%	-0.7%	31%	5.9	22.9	14.6	361	160	115	383	0.61
1p5_limDAC_30	3.8%	1.1%	-0.3%	-0.8%	30%	5.5	21.9	13.8	297	923	40	338	0.61
1p5_limBundleLD_30	6.8%	2.4%	1.6%	0.9%	38%	6.4	26.7	18.1	1101	275	40	200	0.56
1p5_limBundle_30	7.3%	2.1%	1.0%	0.1%	38%	18	27.2	18.1	3902	278	40	209	0.55

Cell rank value (1 = Lowest; 8 = Highest): 1 2 3 4 5 6 7 8

Experiments with reduced renewables, CCS, DAC, nuclear and remaining carbon budget

What about overshoot scenarios?

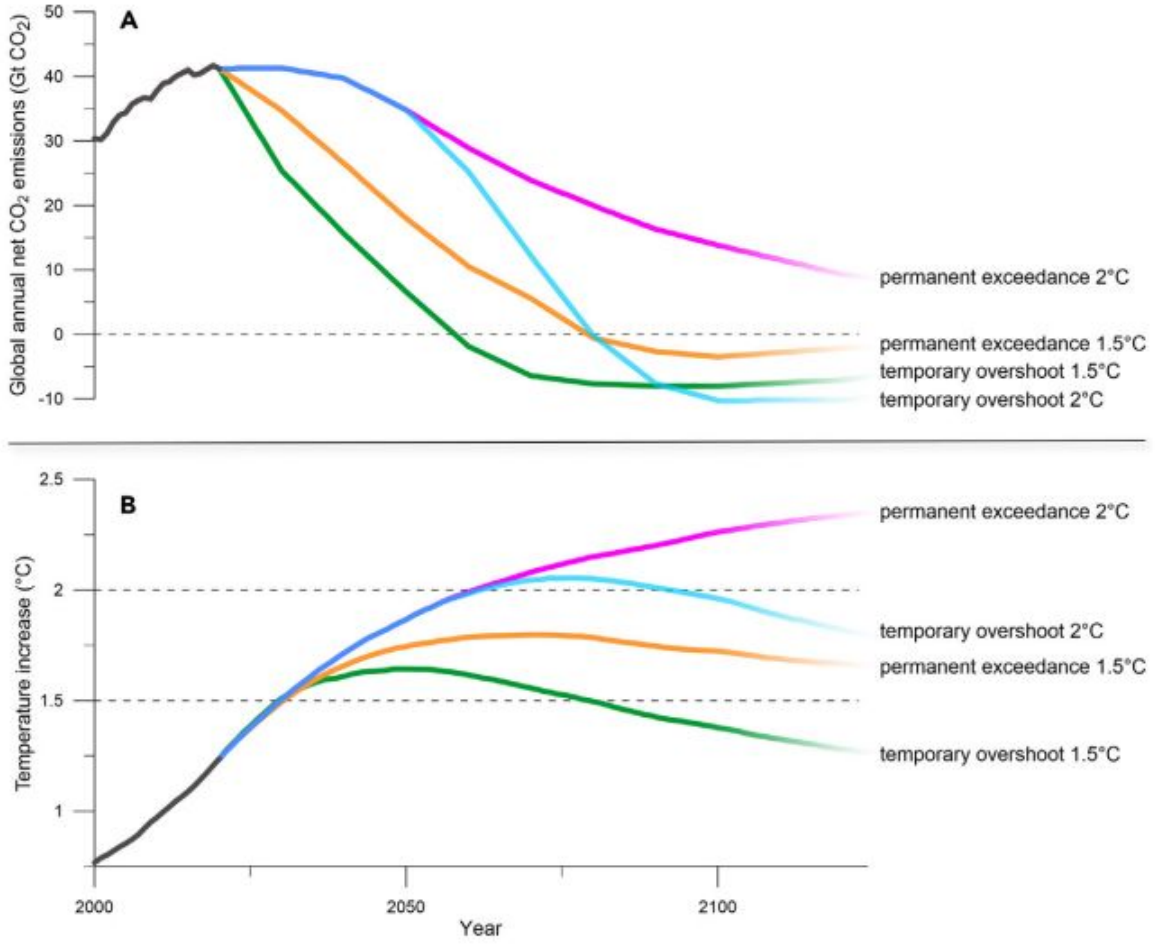
Temporary overshoot: Origins, prospects, and a long path ahead

Andy Reisinger[1,*] and Oliver Geden[2]
[1]Institute for Climate, Energy and Disaster Solutions (IECDS), Australian National University, Canberra, ACT, Australia
[2]German Institute for International and Security Affairs (SWP), Berlin, Germany
*Correspondence: andy.reisinger@anu.edu.au
https://doi.org/10.1016/j.oneear.2023.11.008

Annual Review of Environment and Resources

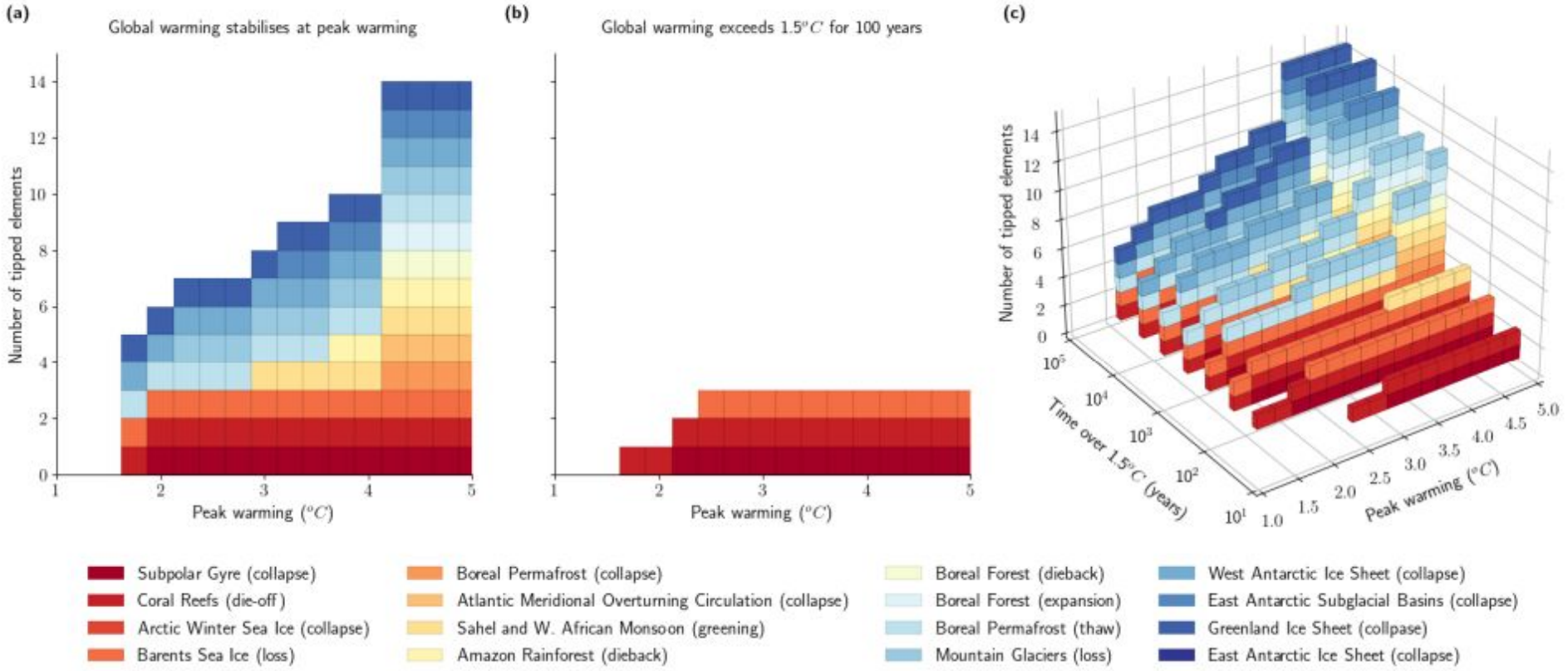
Overshoot: A Conceptual Review of Exceeding and Returning to Global Warming of 1.5°C

Andy Reisinger,[1] Jan S. Fuglestvedt,[2] Anna Pirani,[3] Oliver Geden,[4] Chris D. Jones,[5,6] Shobha Maharaj,[7,8] Elvira S. Poloczanska,[9,10] Angela Morelli,[11] Tom Gabriel Johansen,[11] Carolina Adler,[12] Richard A. Betts,[5,13] and Sonia I. Seneviratne[14]



Overshoot scenarios need more investigation

Overshooting may enable us to avoid many earth system tipping points

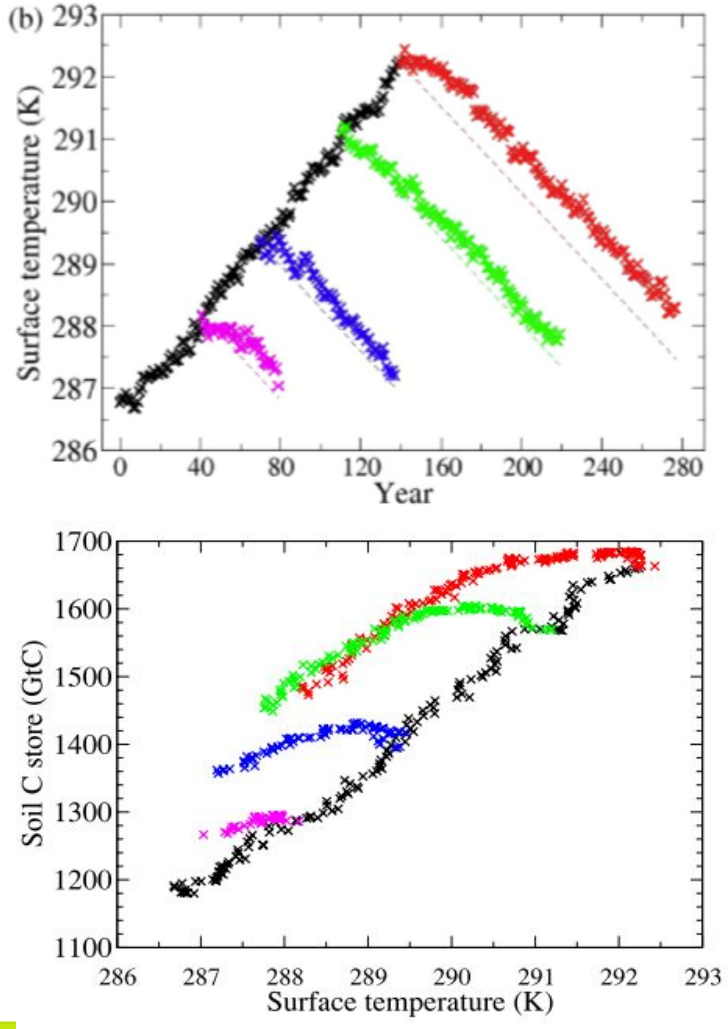


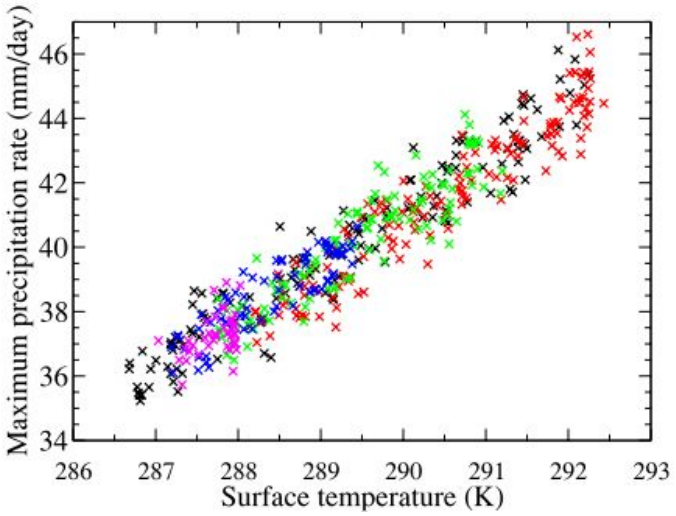
How to cite. Ritchie, P. D. L., Huntingford, C., and Cox, P.: ESD Ideas: Climate tipping is not instantaneous – the duration of an overshoot matters, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2024-3023, 2024.

Overshoot scenarios need more investigation

Overshooting a given warming level doesn't need to be permanent

But some consequences might be!





LETTER • FREE ARTICLE

Reversibility in an Earth System model in response to CO_2 concentration changes

O Boucher, P R Halloran, E J Burke, M Doutriaux-Boucher, C D Jones, J Lowe, M A Ringer, E Robertson and P Wu

Published 9 May 2012 • © 2012 IOP Publishing Ltd

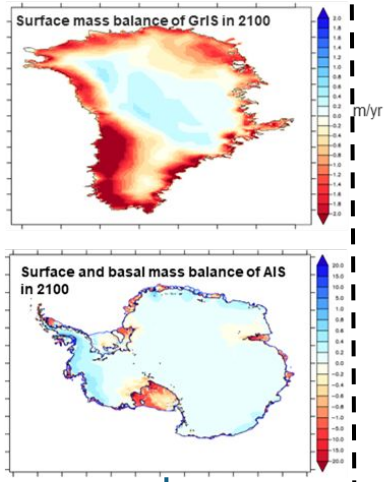
Newer studies

- CSNOW
- TerraFIRMA

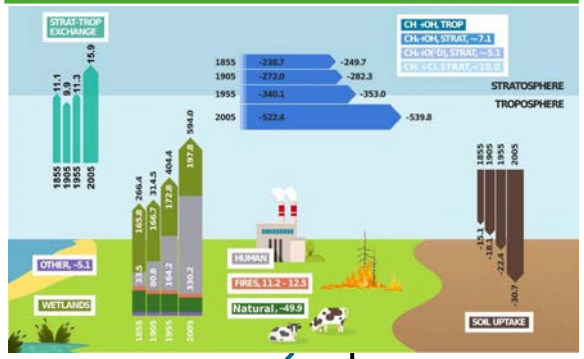
2019 2023 2024 2025 2026 2027/28 2029

New HPC

Interactive Greenland and Antarctic Ice Sheets



Interactive Methane



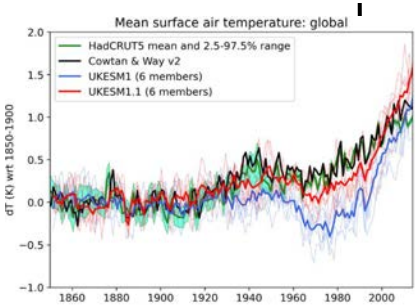
Interactive Fire

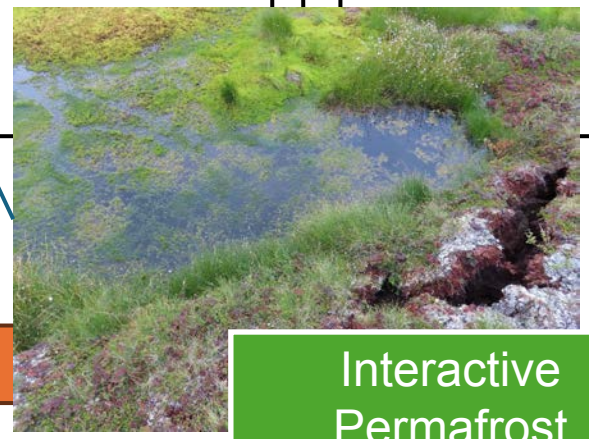
GC3.1

GC5-central

GC7

UKESM1 → UKESM1.1 → UKESM1.2 → UKESM1.3 Emissions Model → UKESM2 → UKESM3





CMIP6

CMIP7 FastTrack

CMIP7

Interactive Permafrost

Met Office Hadley Centre

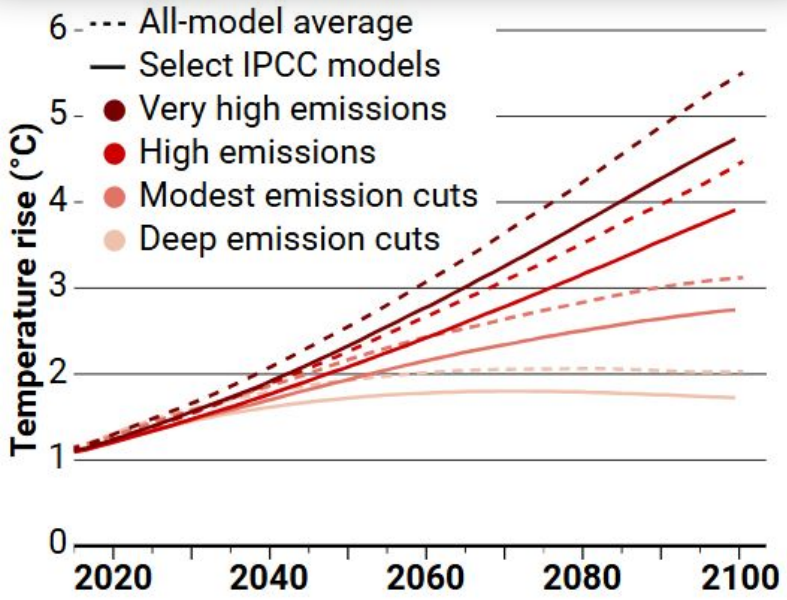
can simulate many aspects of the observations BUT must be used cautiously

HOME > NEWS > SCIENCEINSIDER > USE OF 'TOO HOT' CLIMATE MODELS EXAGGERATES IMPACTS OF GLOBAL WARMING

SCIENCEINSIDER | CLIMATE

Use of 'too hot' climate models exaggerates impacts of global warming

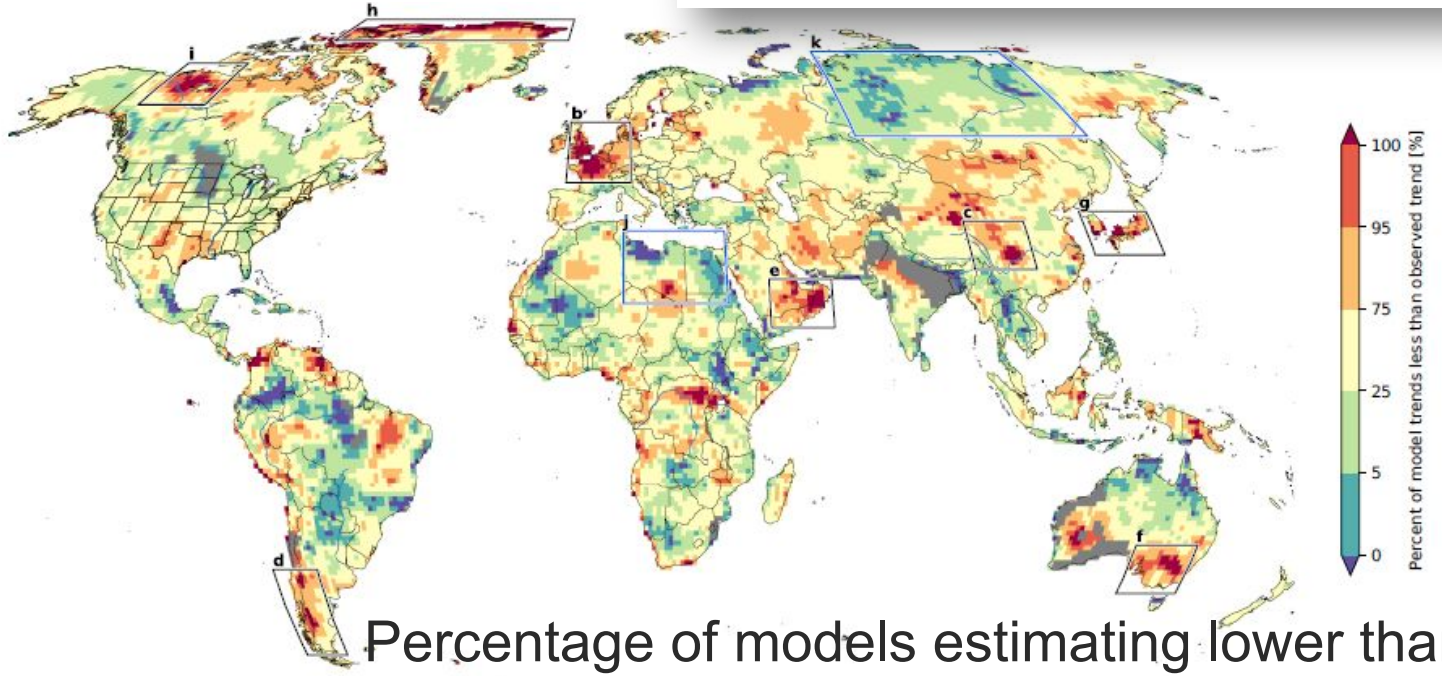
U.N. report authors say researchers should avoid suspect models



PNAS RESEARCH ARTICLE | EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES | OPEN ACCESS

Global emergence of regional heatwave hotspots outpaces climate model simulations

Kai Kornhuber[a,b,c,1], Samuel Bartusek[b,d], Richard Seager[b], Hans Joachim Schellnhuber[a,1], and Mingfang Ting[b,c]



Percentage of models estimating lower than observed trend in “tail widening” in temperature

Met Office
Hadley Centre

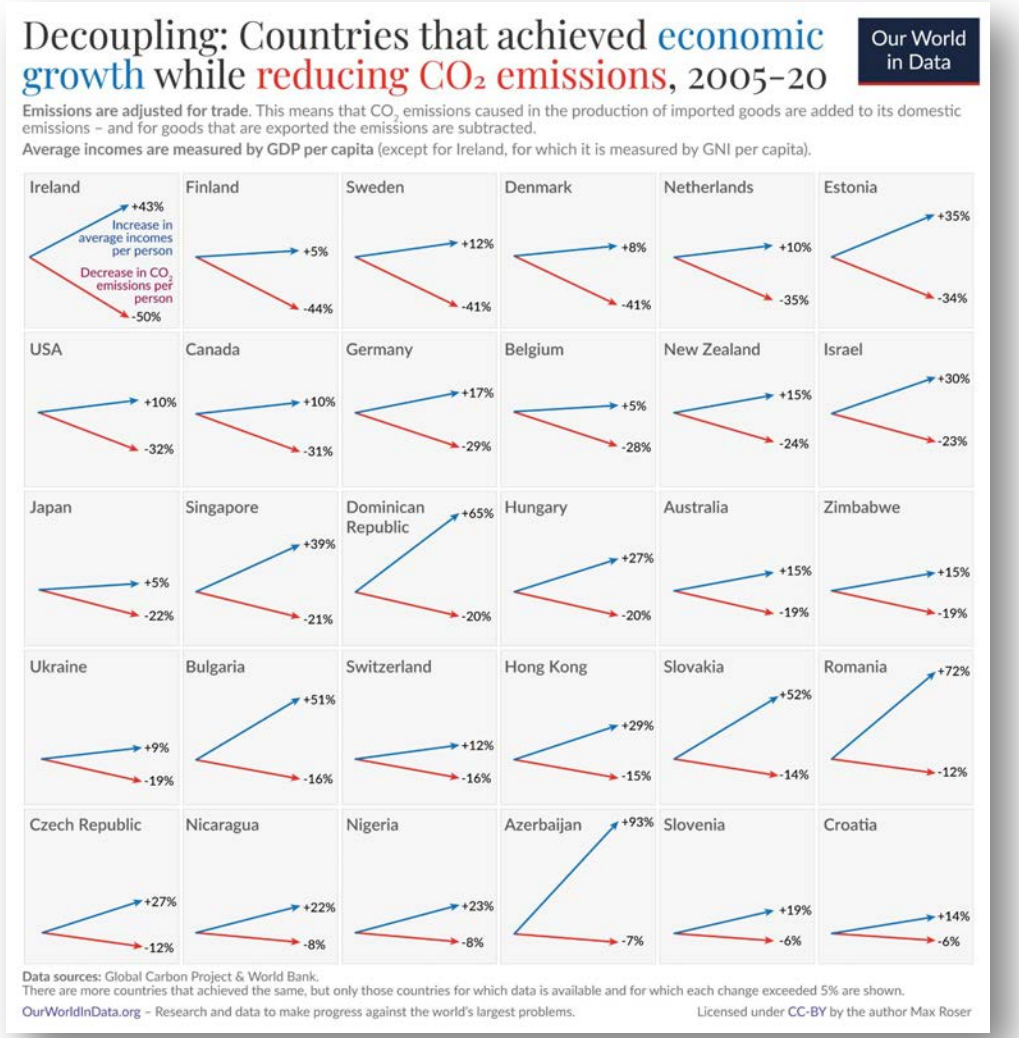
Towards an updated narrative for responding to climate change

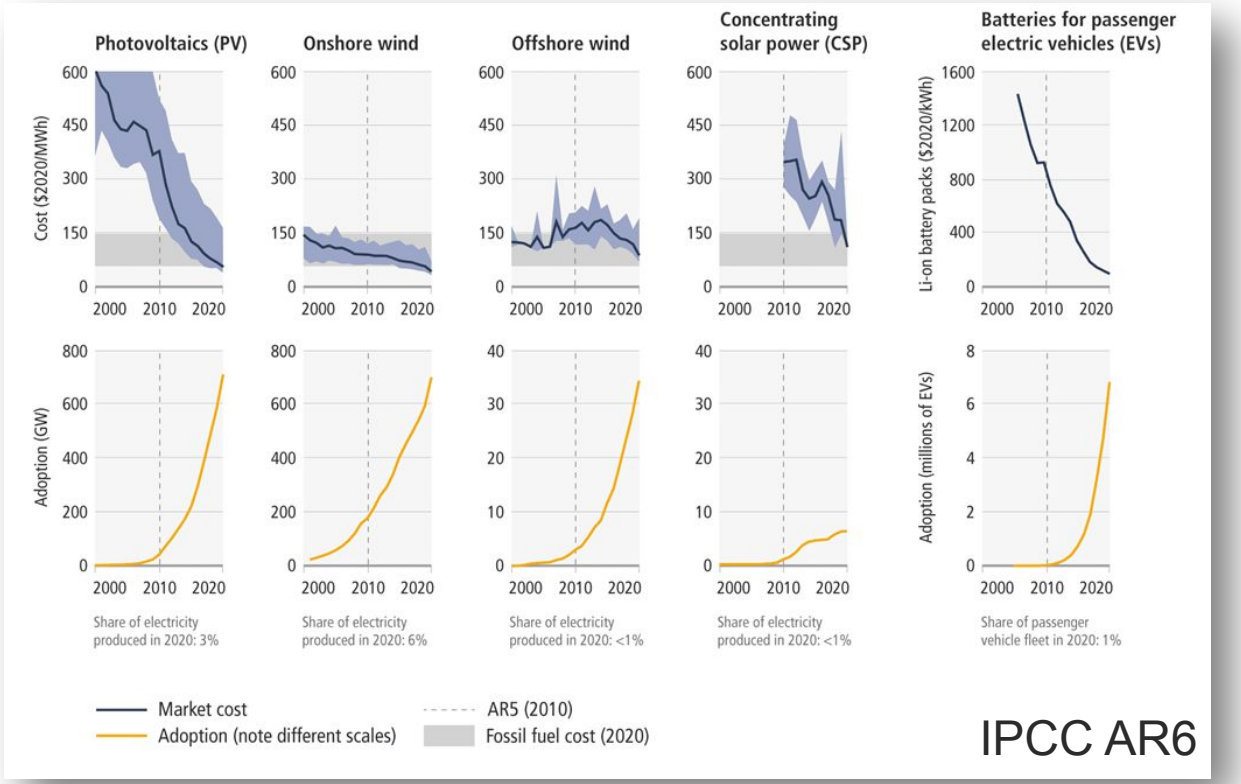
Towards an updated narrative for responding to climate change

- The climate has changed, and the rate of many changes are accelerating
- The risks and impacts of climate change increase with warming – every fraction of a degree leads to more impacts and a greater chance of earth system tipping points. We need a global risk assessment alongside the science assessment
- To halt long term climate change (at any level) we will need net zero emissions (with permanent removals)
- How quickly we reach net zero will determine the level of climate change and climate impacts – how quickly we do this has costs and implications and it is a legitimate debate to discuss this
- Climate actions have co-benefits and trade-offs – these are not visible enough in current discussions. The low carbon transition is an opportunity to reconfigure our future
- We will need to adapt – to climate change that has happened and climate change to which we are now committed. Consider adaptation, mitigation and co-benefits together
- **We need to consider a positive narrative framing for the future**

Met Office Hadley Centre

Cautious optimism for the future





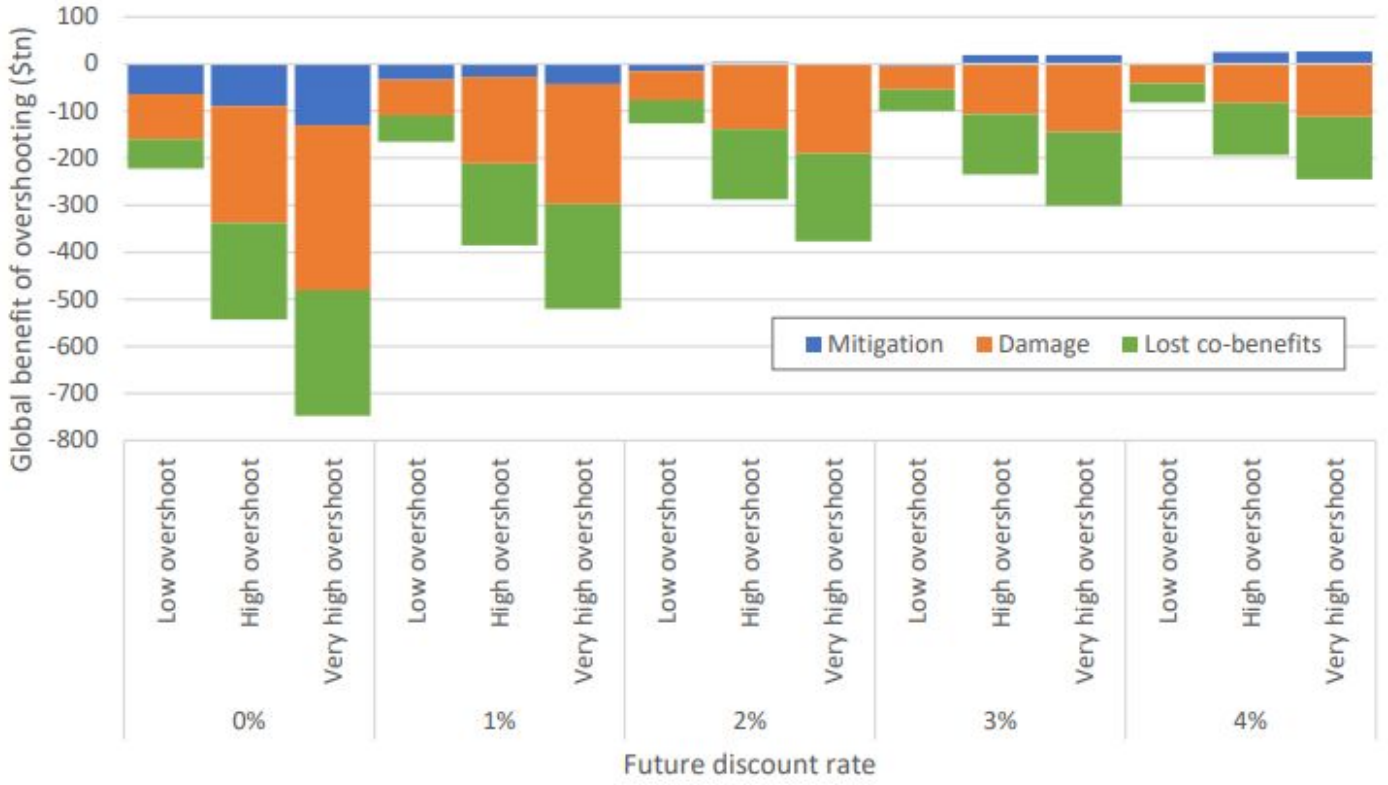
Met Office
Hadley Centre

Discussion

Overshoot scenarios need more investigation

Costs of avoided damages might be very large!

But can it be achieved!



Overshoot scenarios need more investigation

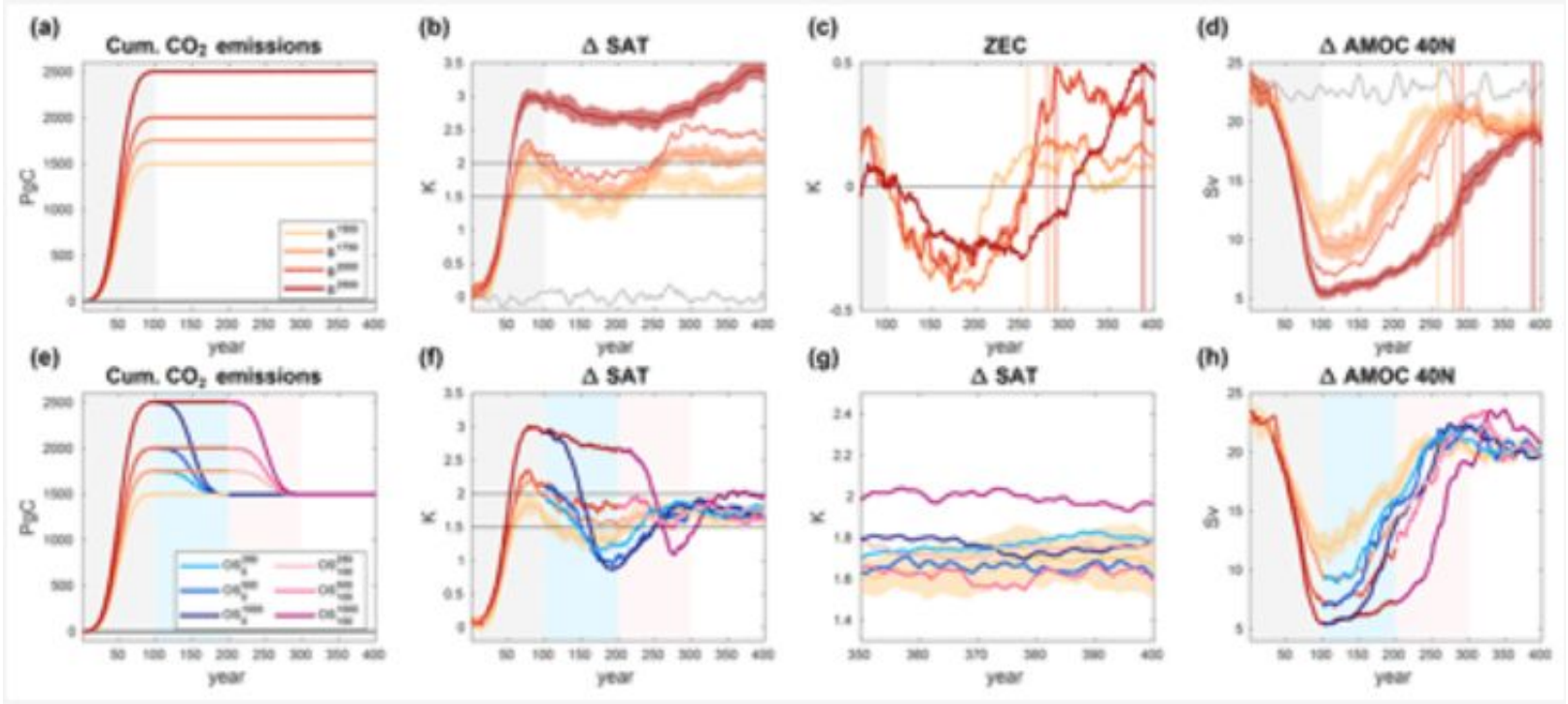
Many projects looking at overshoot issues:

- CSNOW
- TerraFIRMA
- RESCUE
- TiPMIP

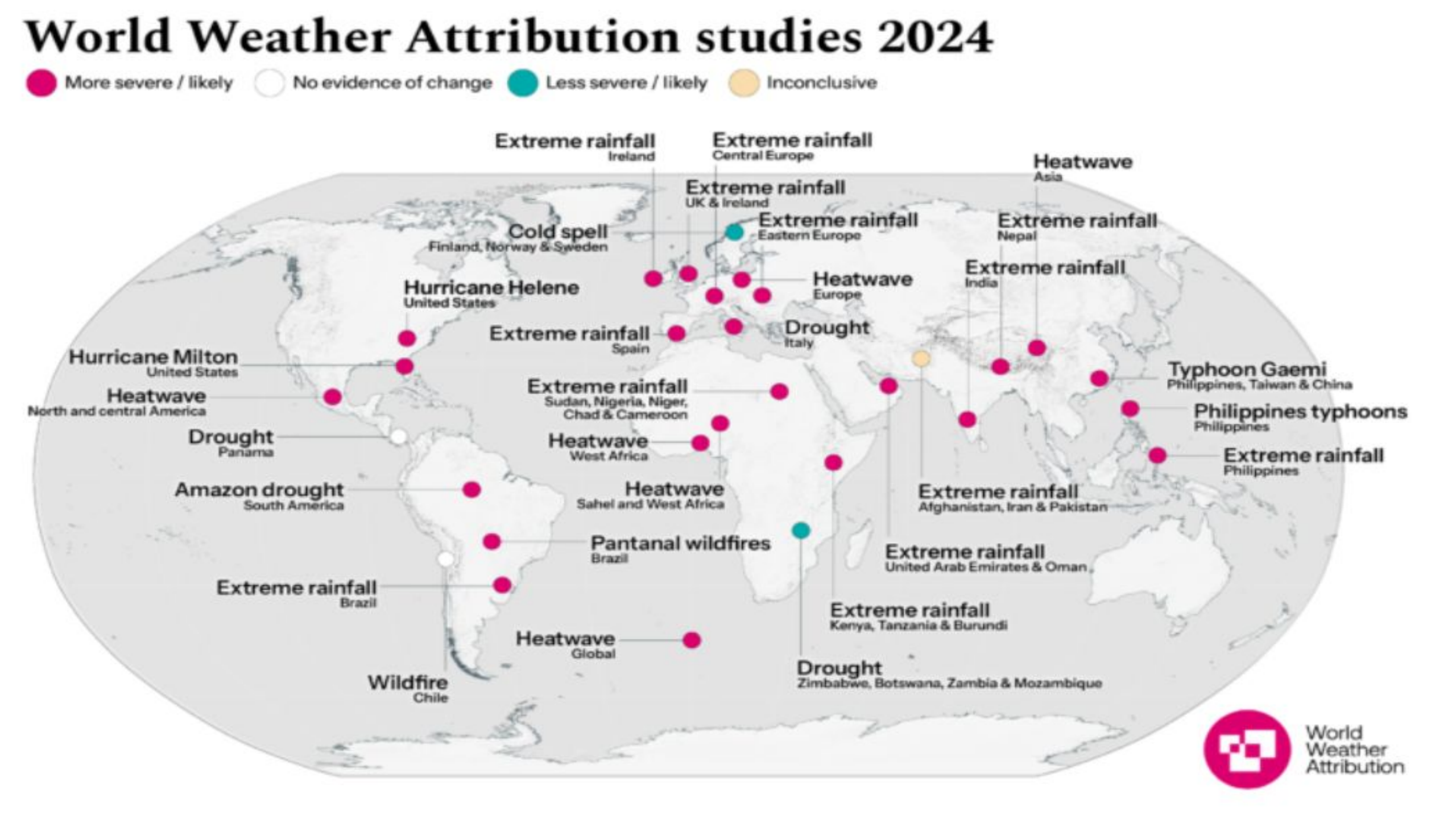
Emit now, mitigate later? Earth system reversibility under overshoots of different magnitudes and durations

Jörg Schwinger[1], Ali Asaadi[1], Norman Julius Steinert[1], and Hanna Lee[1,2]

Articles / Volume 13, issue 4 / ESD, 13, 1641–1665, 2022



World Weather Attribution studies 2024



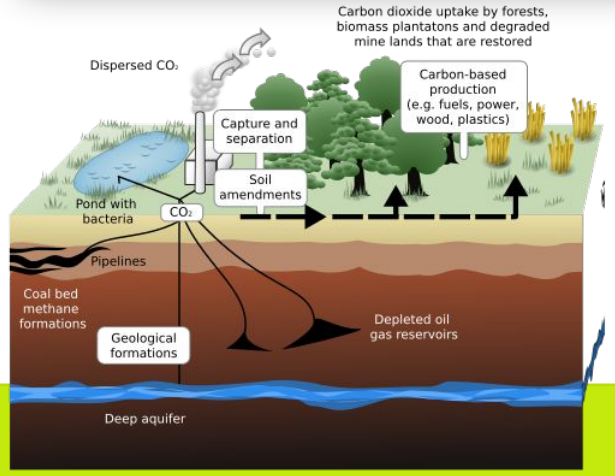
Evolving the global carbon budget approach – the relationship is uncertain

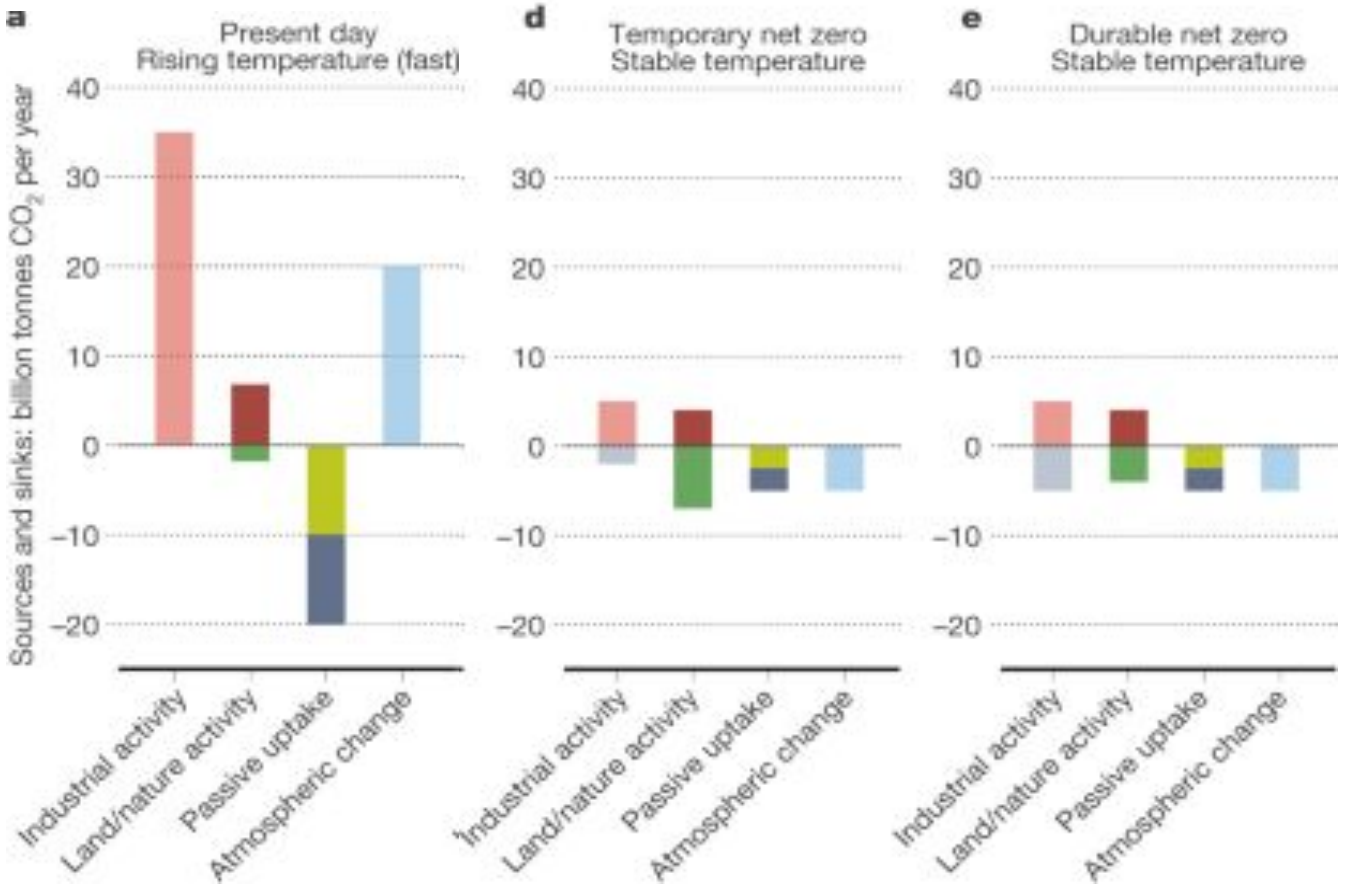
Does it matter where carbon removal goes?

Geological Net Zero and the need for disaggregated accounting for carbon sinks

Myles R. Allen, David J. Frame, Pierre Friedlingstein, Nathan P. Gillett, Giacomo Grassi, Jonathan M. Gregory, William Hare, Jo House, Chris Huntingford, Stuart Jenkins, Chris D. Jones, Reto Knutti, Jason A. Lowe, H. Damon Matthews, Malte Meinshausen, Nicolai Meinshausen, Glen P. Peters, Gian-Kasper Plattner, Sarah Raper, Joeri Rogelj, Peter A. Stott, Susan Solomon, Thomas F. Stocker, Andrew J. Weaver & Kirsten Zickfeld

Nature **638**, 343–350 (2025) | Cite this article



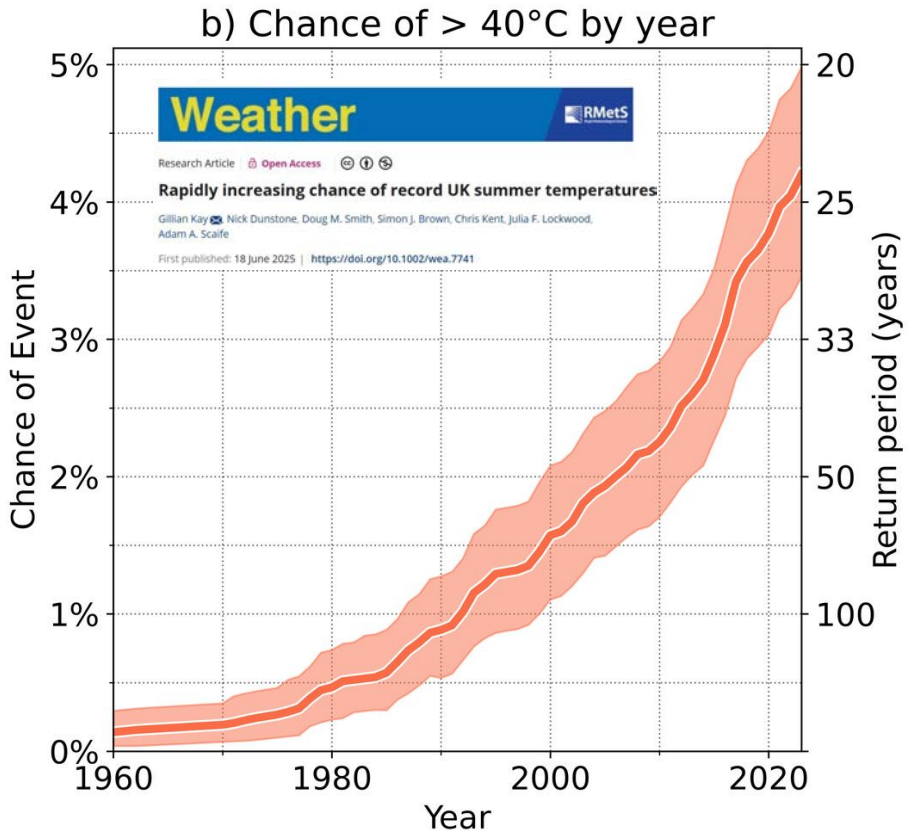


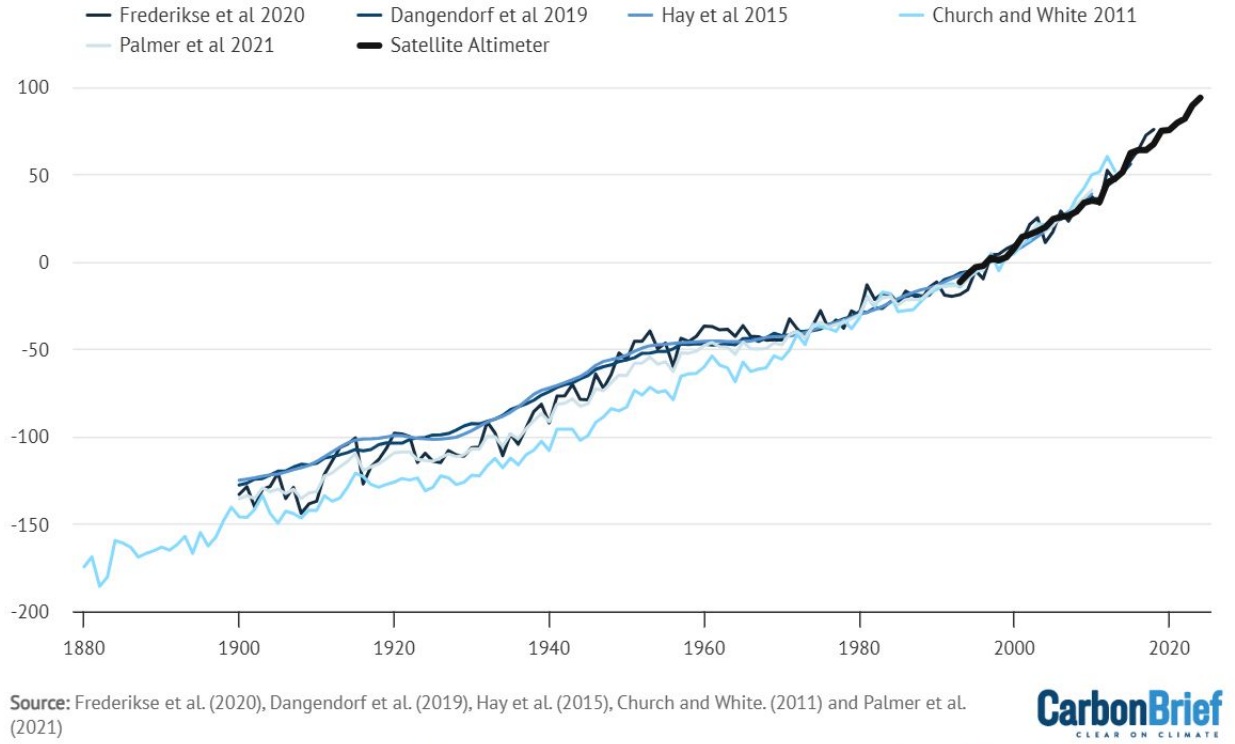
Atmospheric CO_2 fluxes

- Energy and industrial emissions
- Removal to geological storage
- Land use and deforestation
- Active nature-based removals
- Passive uptake on land
- Passive uptake by oceans
- Net atmospheric change

Towards an updated narrative for responding to climate change

- **The climate has changed, and the rate of many changes are accelerating**





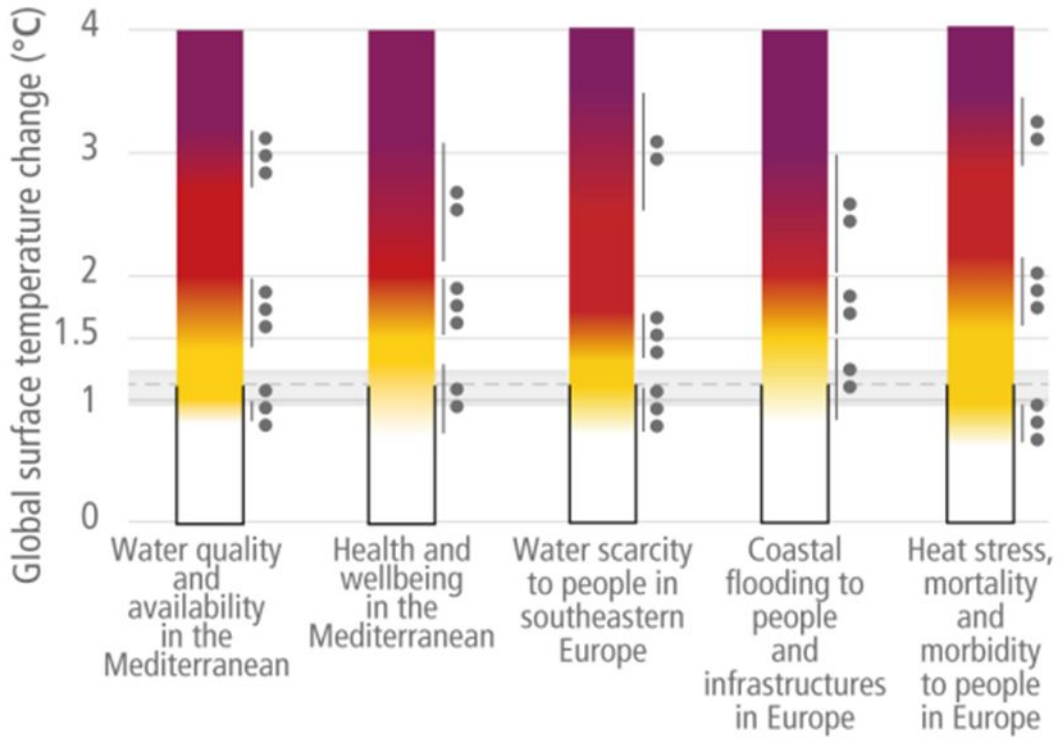
Source: Frederikse et al. (2020), Dangendorf et al. (2019), Hay et al. (2015), Church and White. (2011) and Palmer et al. (2021)

CarbonBrief
CLEAR ON CLIMATE

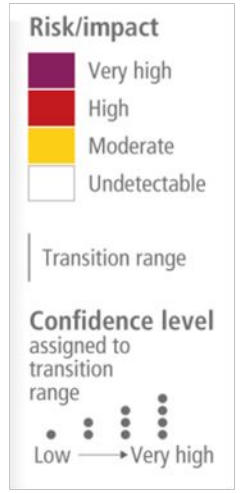
Global average sea level rise reconstructed from tide gauge data between 1880 and 2024 from Frederikse et al 2020, Dangendorf et al 2019, Hay et al 2015, Church and White 2011, and Palmer et al 2021. Satellite altimeter data from 1993 (black) to present is taken from NASA. Chart by Carbon Brief.

Towards an updated narrative for responding to climate change

- **The risks and impacts of climate change increase with warming – every fraction of a degree leads to more impacts and a greater chance of earth system tipping points. We need a global risk assessment**

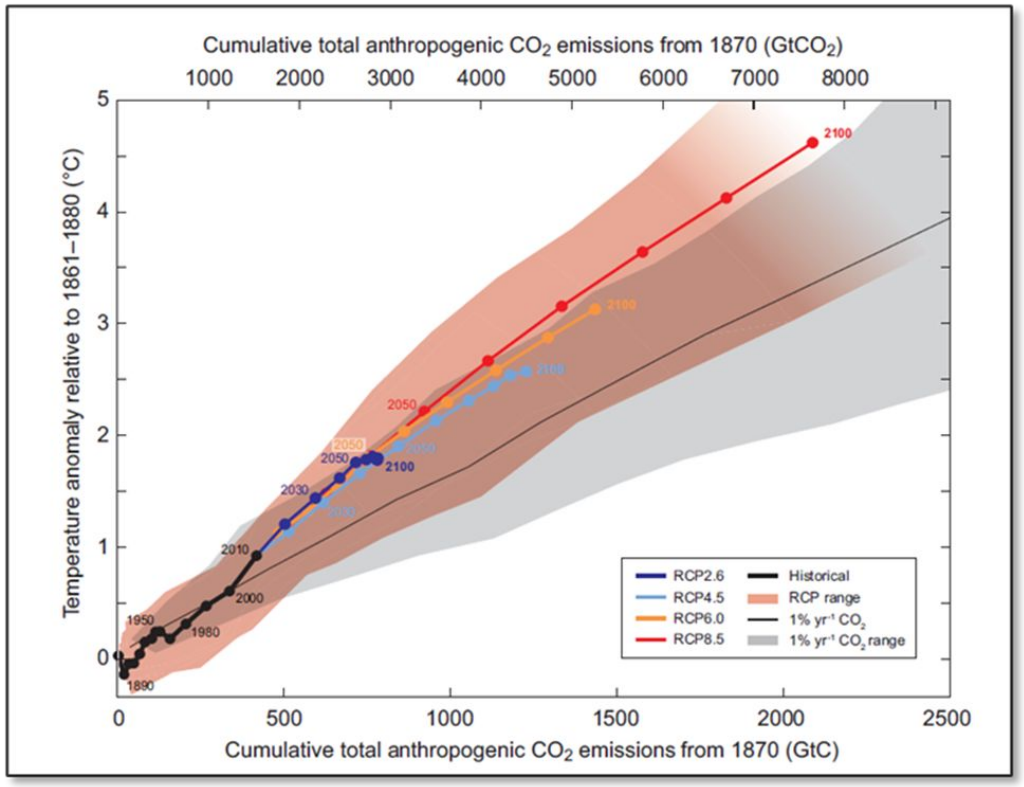


Multiple impacts on people and ecosystems transition to high risk in the 1.5°C to 2°C range



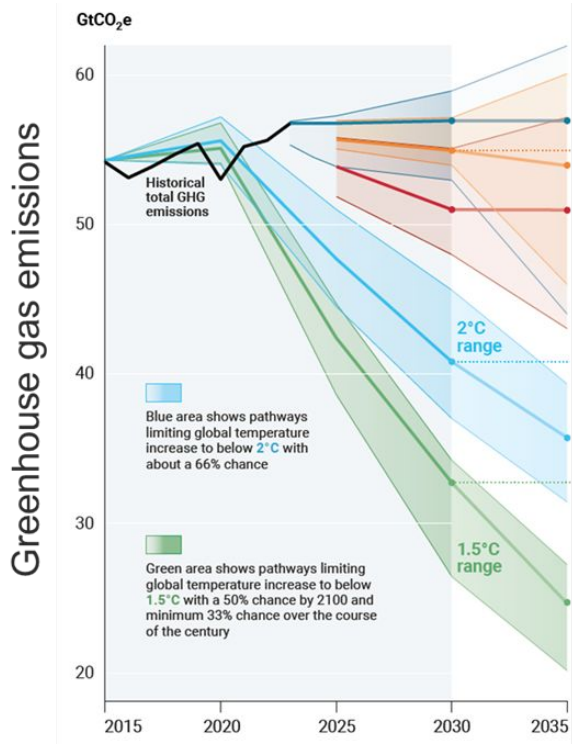
Towards an updated narrative for responding to climate change

- **To halt long term climate change (at any level) we will need net zero emissions**



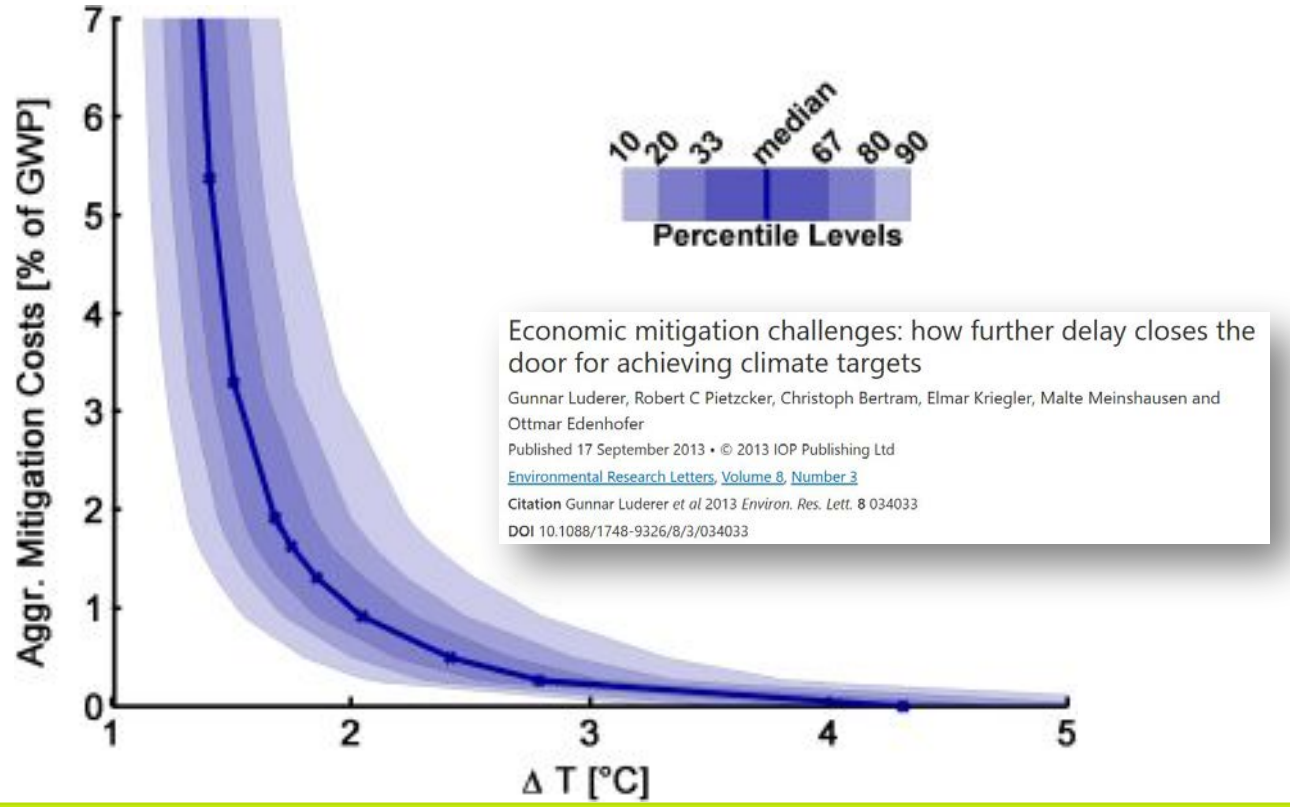
Towards an updated narrative for responding to climate change

- **How quickly we reach net zero will determine the level of climate change and climate impacts – how quickly we do this has costs and implications and it is a legitimate debate to discuss this**



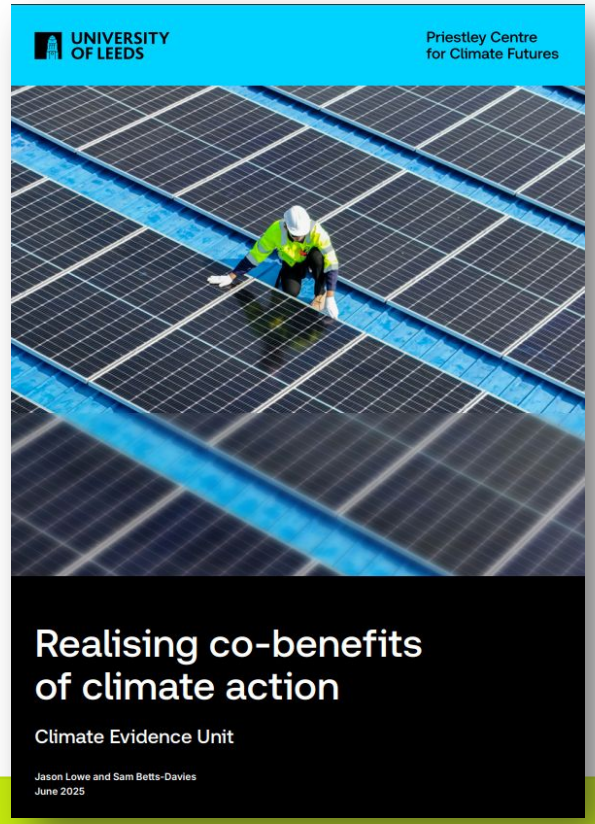
Current policies and NDCs

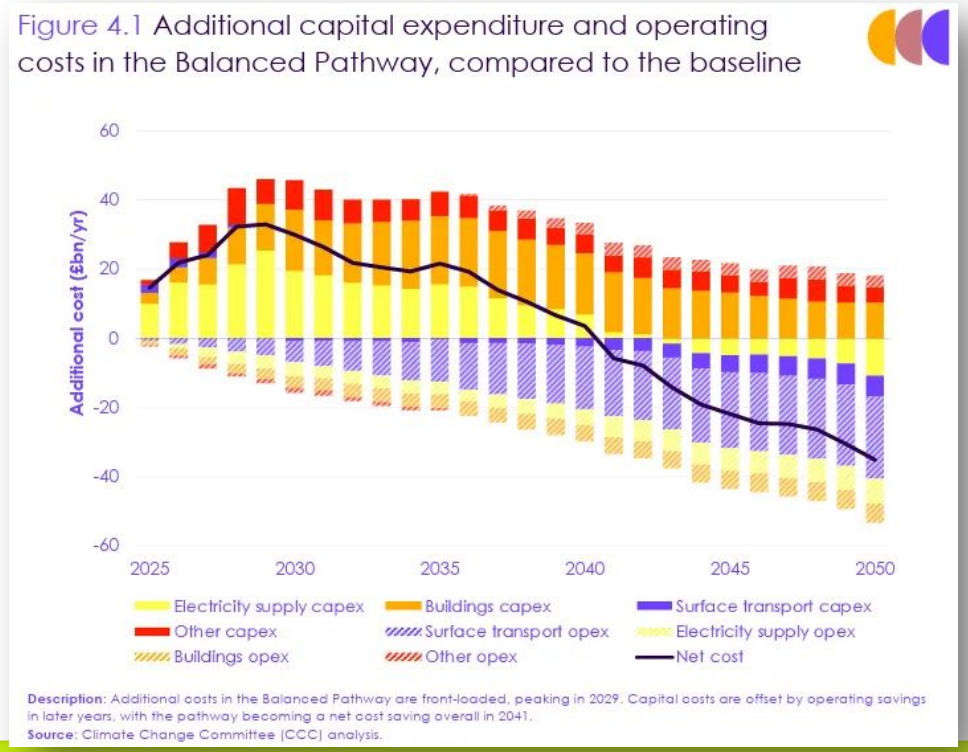
"Technically feasible" 2°C and 1.5°C pathways



Towards an updated narrative for responding to climate change

- **All climate actions have co-benefits and trade-offs – these are not visible enough in current discussions and should be central. The net zero transition is an opportunity to reconfigure our future**





Towards an updated narrative for responding to climate change

- The climate has changed, and the rate of many changes are accelerating
- The risks and impacts of climate change increase with warming – every fraction of a degree leads to more impacts and a greater chance of earth system tipping points. We need a global risk assessment alongside the science assessment
- To halt long term climate change (at any level) we will need net zero emissions (with permanent removals)
- How quickly we reach net zero will determine the level of climate change and climate impacts – how quickly we do this has costs and implications and it is a legitimate debate to discuss this
- Climate actions have co-benefits and trade-offs – these are not visible enough in current discussions. The low carbon transition is an opportunity to reconfigure our future
- We will need to adapt – to climate change that has happened and climate change to which we are now committed. Consider adaptation, mitigation and co-benefits together
- **We need to consider a positive narrative framing for the future**

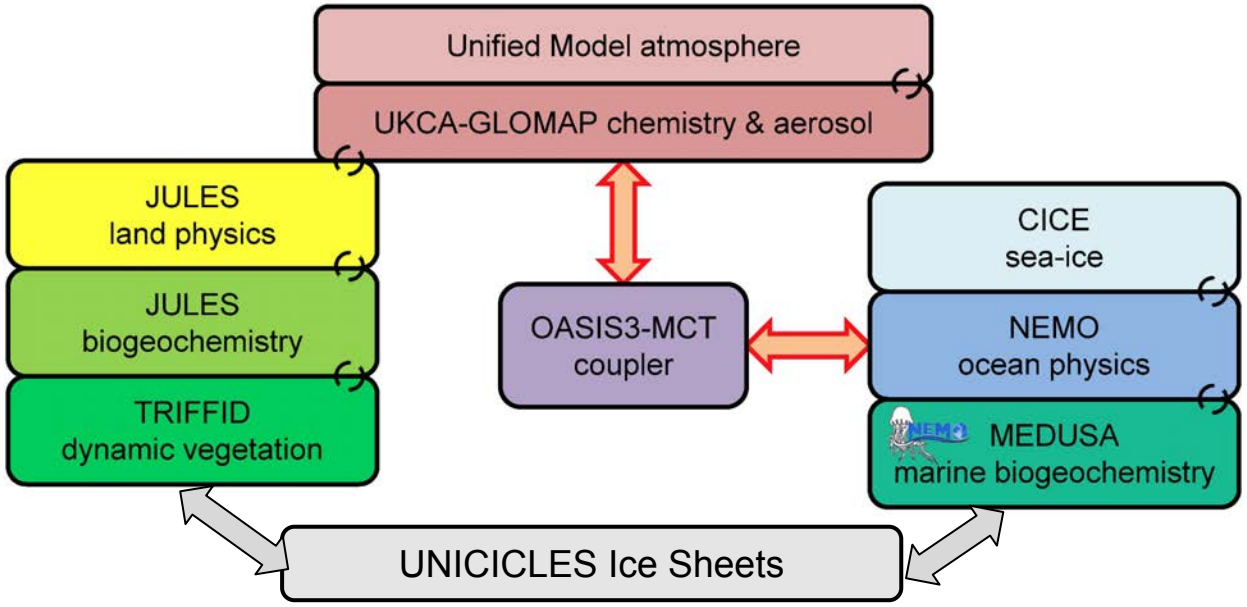
Towards an updated narrative for responding to climate change

- **We will need to adapt – to climate change that has happened and climate change to which we are now committed. Consider adaptation, mitigation and co-benefits together**

Met Office Hadley Centre

Natural Environment Research Council

UKESM



A world-leading community Earth System Model developed in partnership

National Centre for Atmospheric Science NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre

UK Centre for Ecology & Hydrology

National Centre for Earth Observation NATURAL ENVIRONMENT RESEARCH COUNCIL

PML Plymouth Marine Laboratory

British Antarctic Survey NATURAL ENVIRONMENT RESEARCH COUNCIL

cpom Centre for Polar Observation and Modelling Natural Environment Research Council

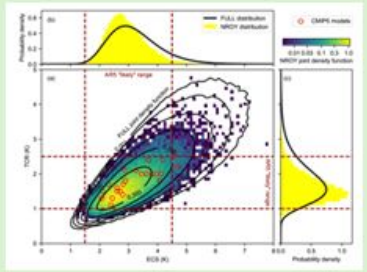
Traceable set of Earth System Modelling Tools

Earth System Emulators

PRIME

Probabilistic Regional Impacts from Model patterns and Emissions

FaIR



JULES
Joint UK Land Environment Simulator

Met Office Unified Model™
Global Atmosphere

UKCA

UKESM

MEDUSA

NEMO

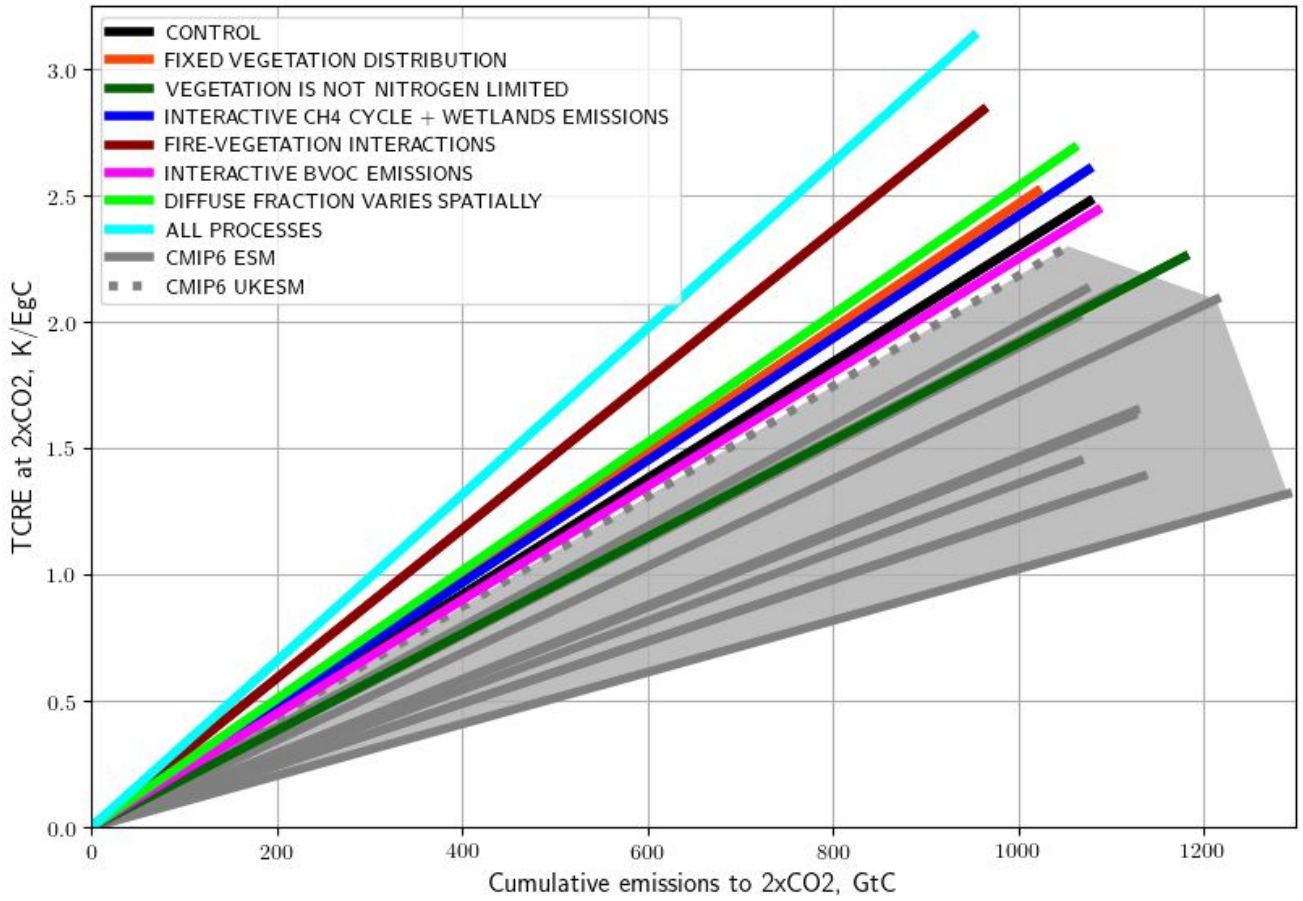
InTEM Greenhouse Gas Inversion

UKESM-Hybrid Resolution

UKESM-Fast: Constrained PPE

UKESM-Regional

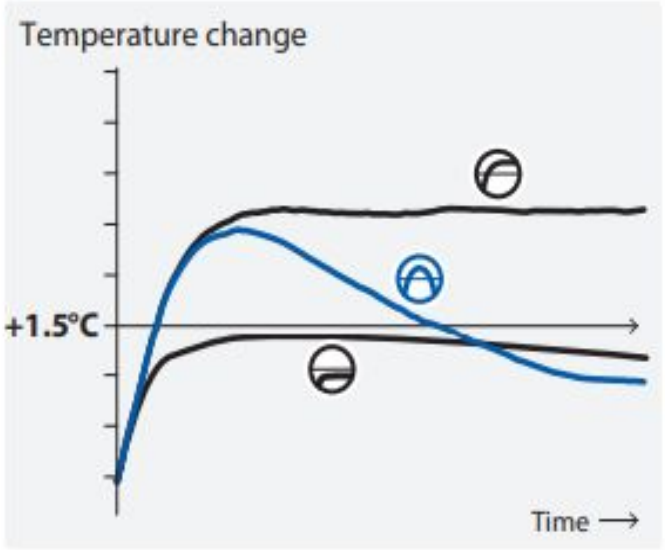
Application Highlights – Remaining Carbon Budget

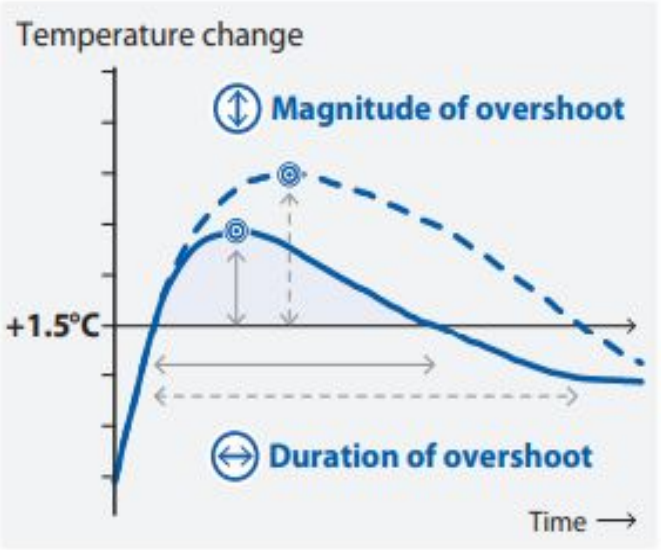


- Quantifying long standing missing processes in the carbon budget
  - Fire-vegetation interactions (-14.6%)
  - Nitrogen limitation (-9.7%)
  - Diffuse radiation (-8.5%)
  - Dynamic Vegetation (+1.5%)
  - Wetland methane emissions (-5.1%)
  - BVOCs (+1.4%)
- Applying to CMIP6 multi-model ensemble implies remaining carbon budget to 2°C may be up to 25% too high.

Spencer Liddicoat

What about overshoot scenarios?





Annual Review of Environment and Resources

Overshoot: A Conceptual Review of Exceeding and Returning to Global Warming of 1.5°C

Andy Reisinger,[1] Jan S. Fuglestvedt,[2] Anna Pirani,[3]
Oliver Geden,[4] Chris D. Jones,[5,6] Shobha Maharaj,[7,8]
Elvira S. Poloczanska,[9,10] Angela Morelli,[11]
Tom Gabriel Johansen,[11] Carolina Adler,[12]
Richard A. Betts,[5,13] and Sonia I. Seneviratne[14]