

CLIMATE CHANGE: CAUSES, CONSEQUENCES & SOLUTIONS



Professor Richard Allan

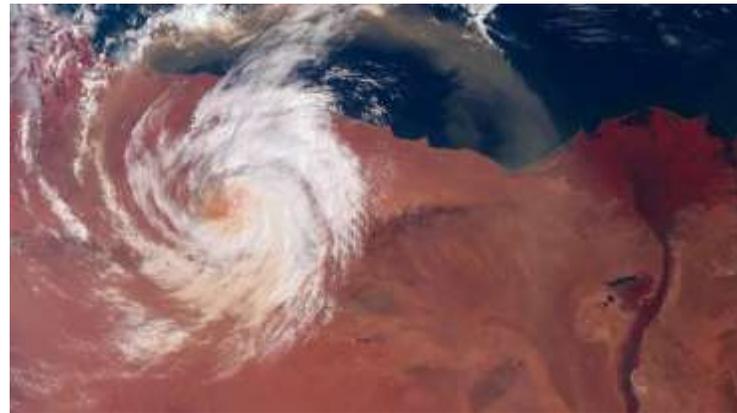
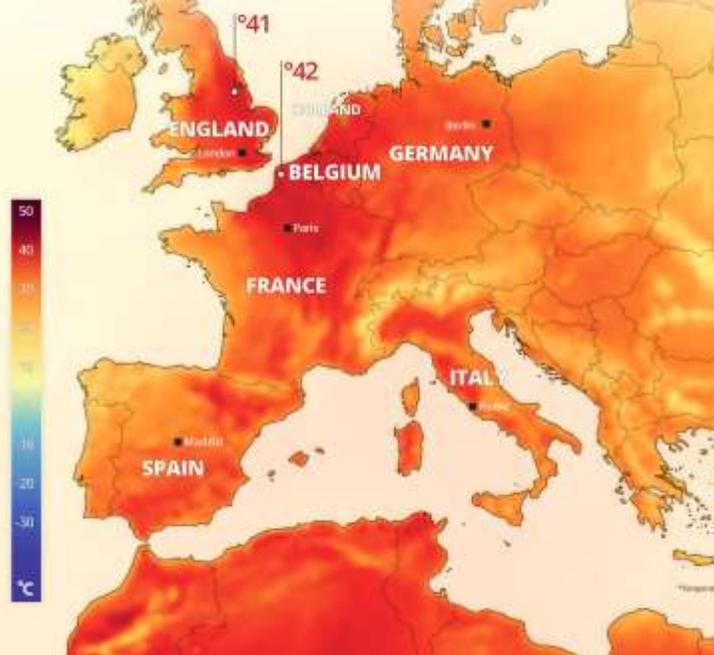
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BETS meeting, Oxford Belfry, 13th November 2024



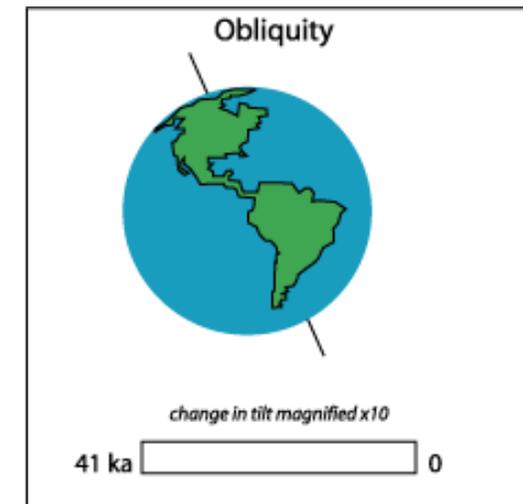
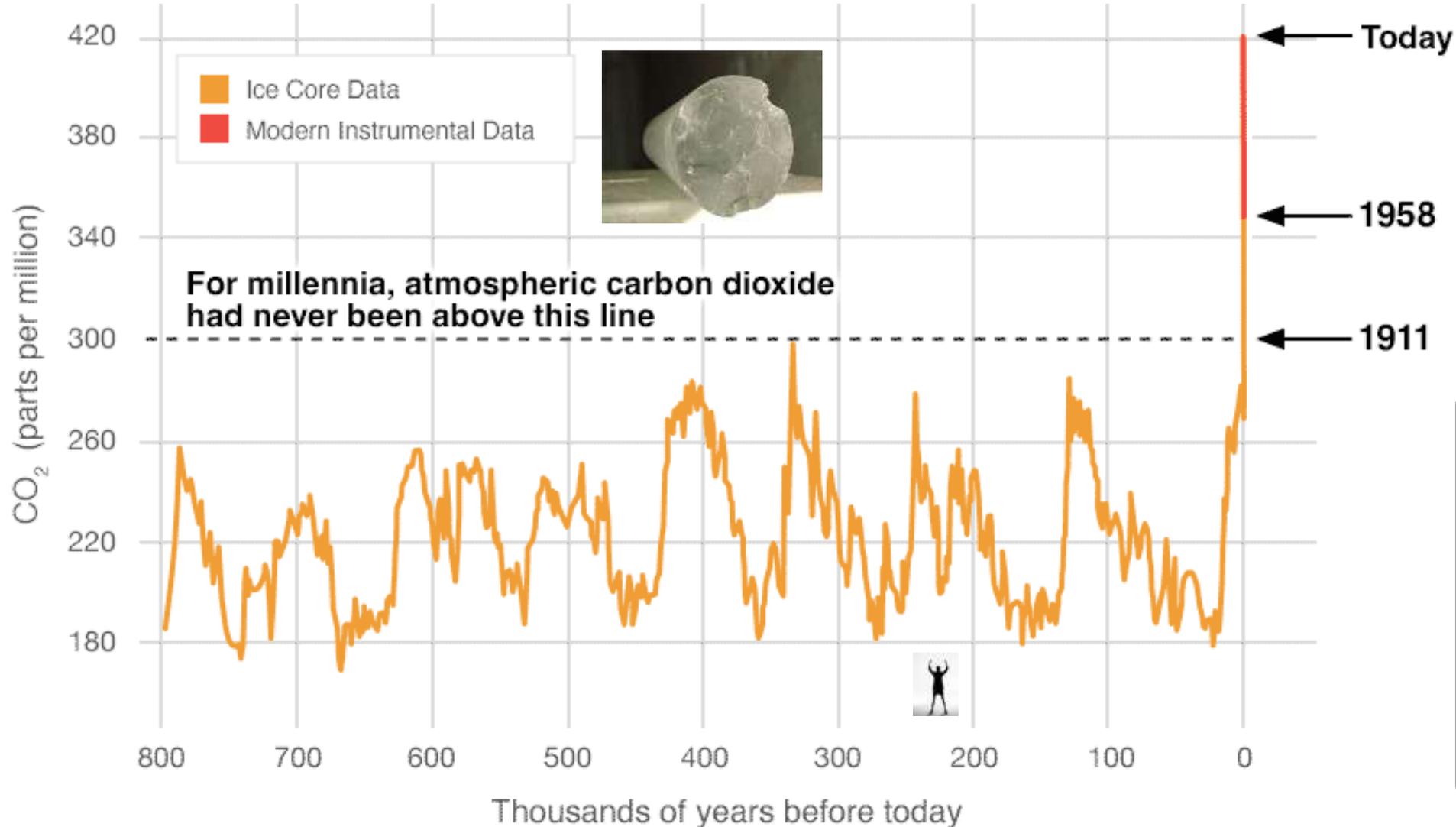
Europe hit by scorching heatwave



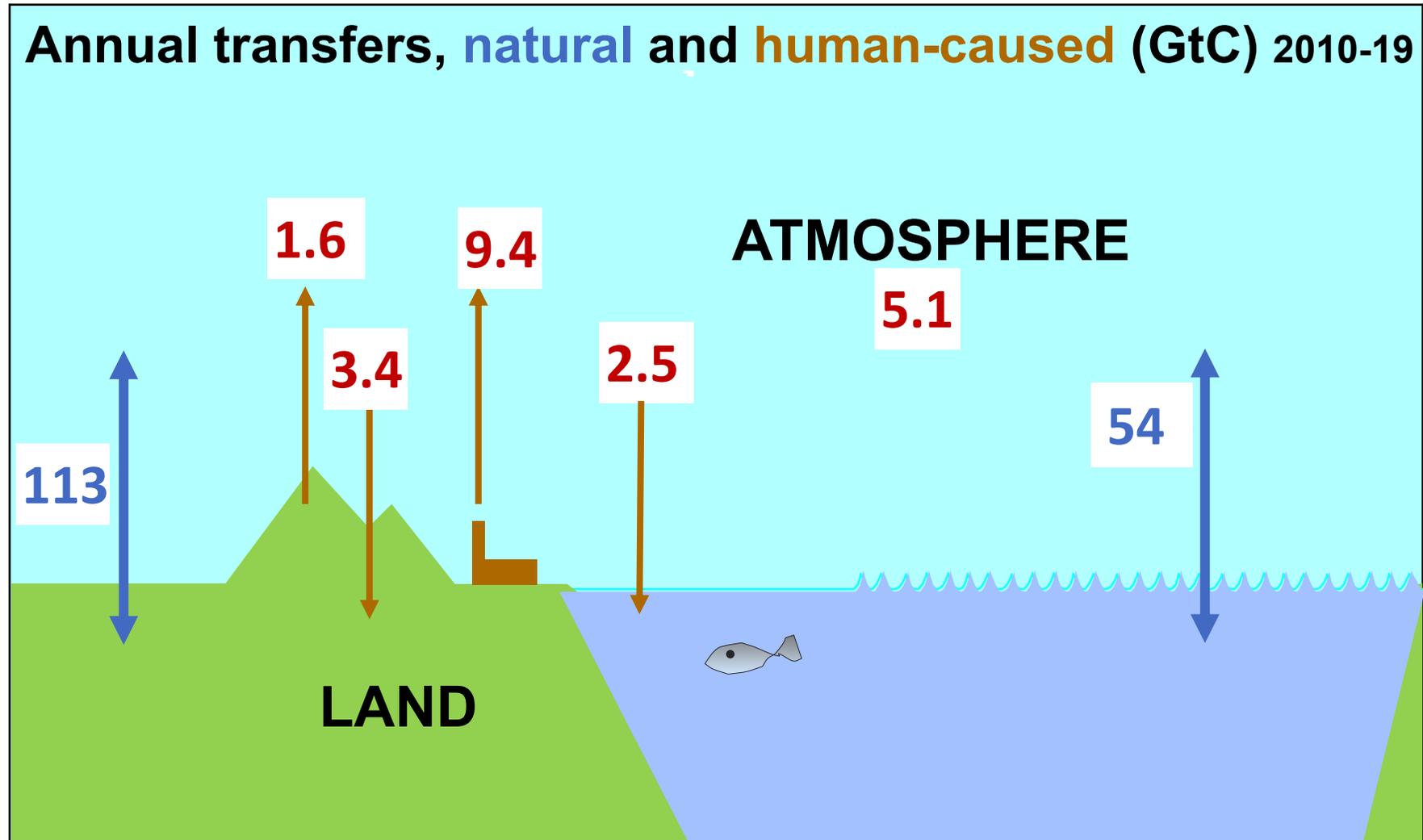
ONGOING CLIMATE CHANGE



The climate has always changed. But...



Natural & human-influenced carbon cycle

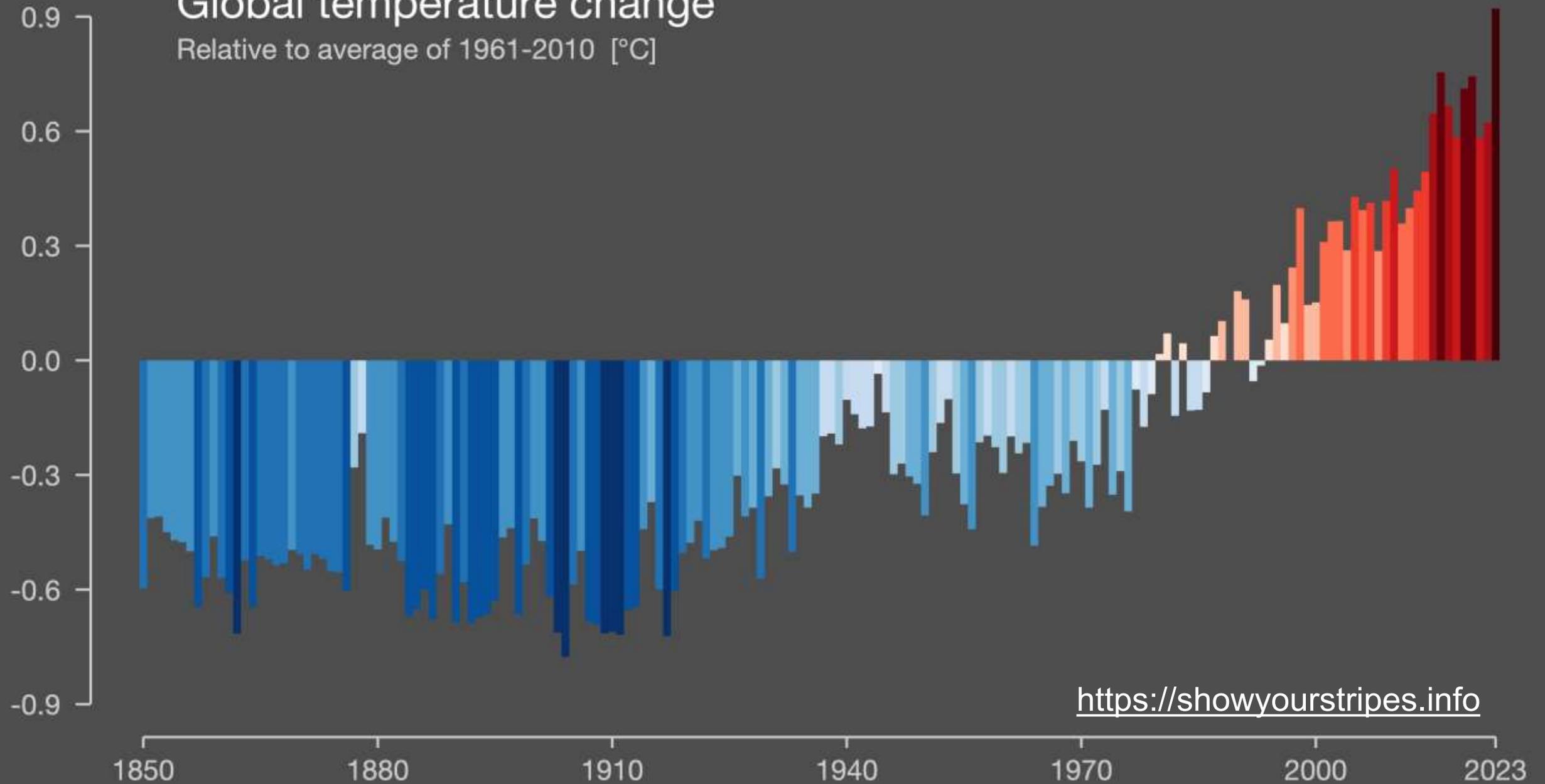


- Human activities have tipped the natural carbon cycle out of balance
- This is driving increases in atmospheric CO₂ concentrations
- CO₂ concentrations highest in at least 2 million years

Values in billions of tonnes of Carbon per year from [IPCC \(2021\) Chapter 5](#)

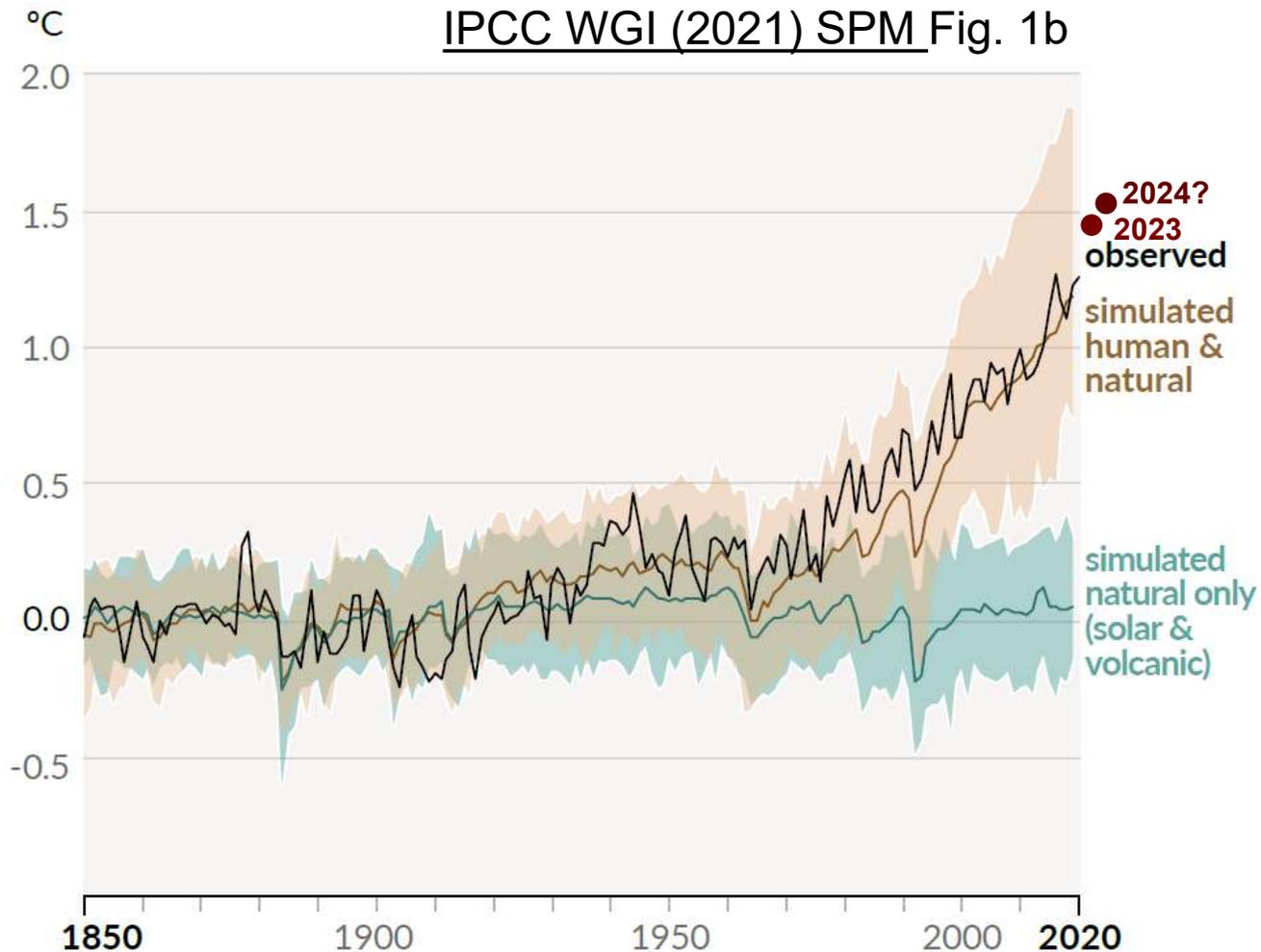
Global temperature change

Relative to average of 1961-2010 [°C]



<https://showyourstripes.info>

It is indisputable that human activities are causing climate change



► Observed warming is driven by emissions from human activities



► Natural factors do not contribute to rapid warming over past 5 decades

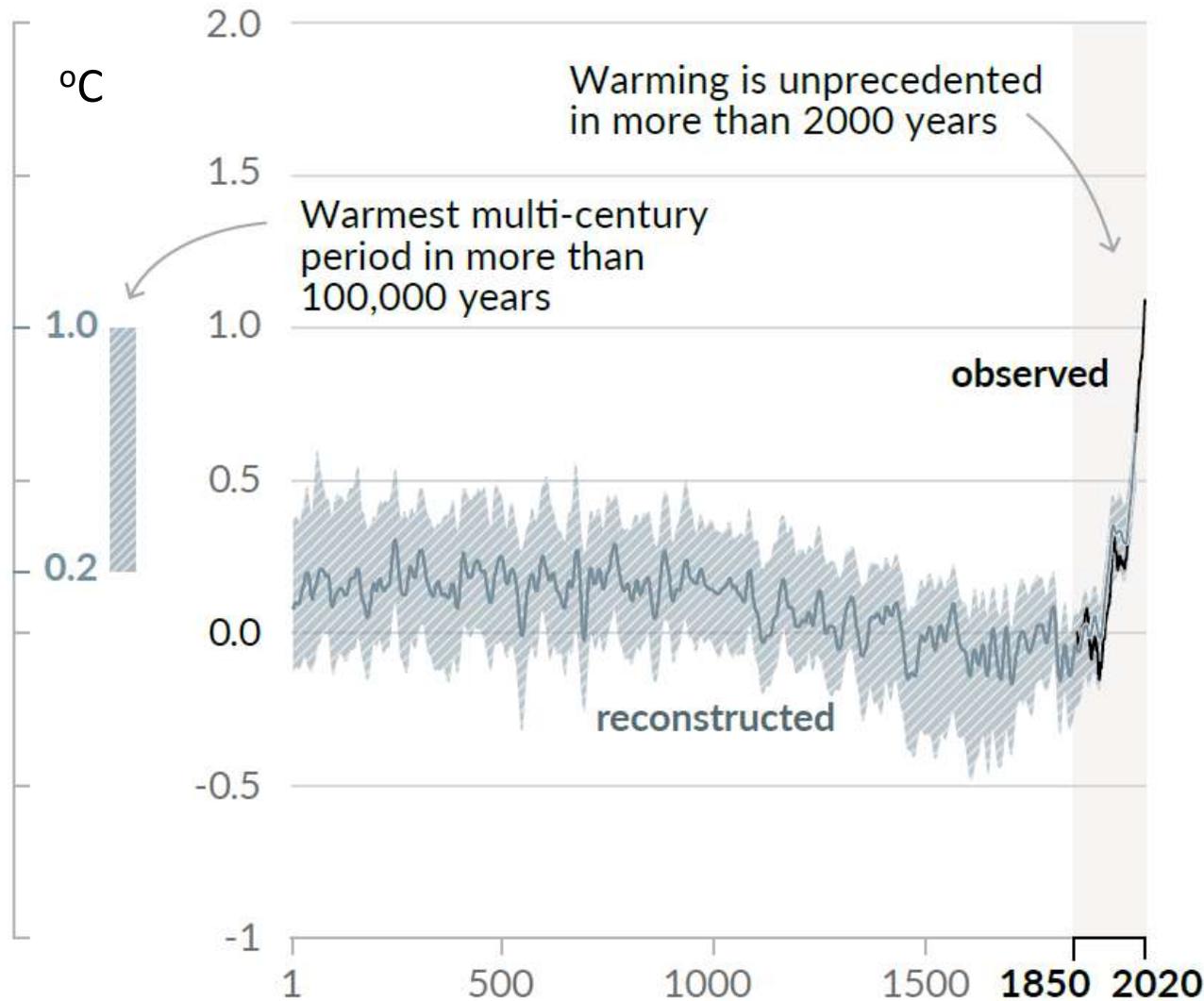


► Greenhouse gas warming has been partly masked by aerosol cooling



► Warming is amplified by feedback loops involving water vapour, ice & clouds

Recent changes in the climate are widespread, rapid and unprecedented in thousands of years



- Global mean surface temperature increased faster since 1970 than in any other 50 year period over at least the last 2000 years
- Warmth of past decade comparable to last interglacial 125,000 years ago [*when peak sea level was 5-10m higher than today*]

[IPCC WGI 2021 SPM]

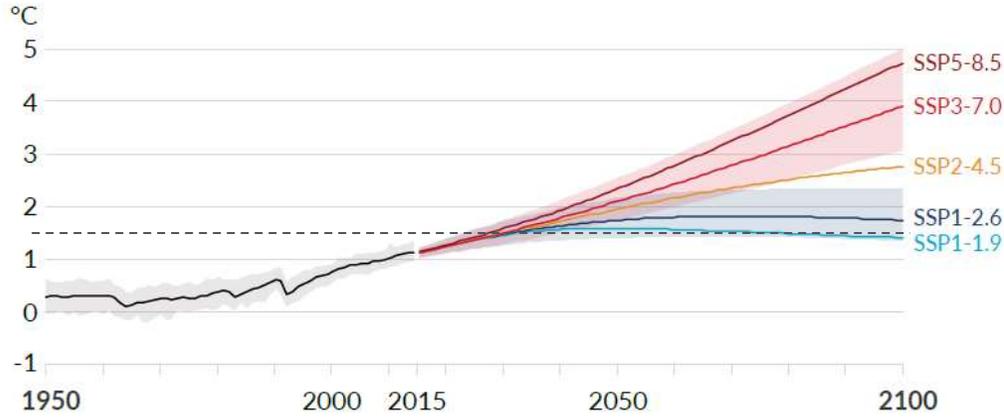


“ Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.

Some changes in the climate system are irreversible but many changes can be slowed or stopped by limiting warming



a) Global surface temperature change relative to 1850-1900

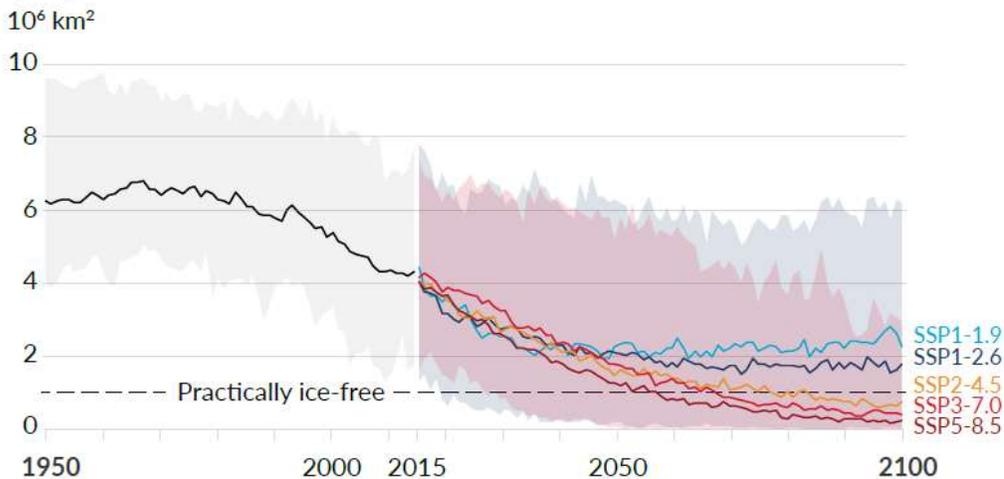


Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO₂ and other greenhouse gas emissions occur in the coming decades

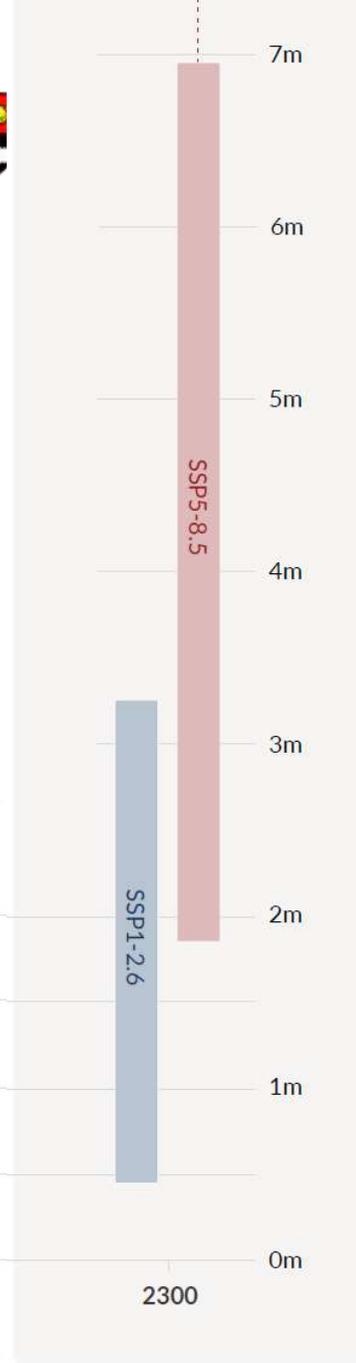
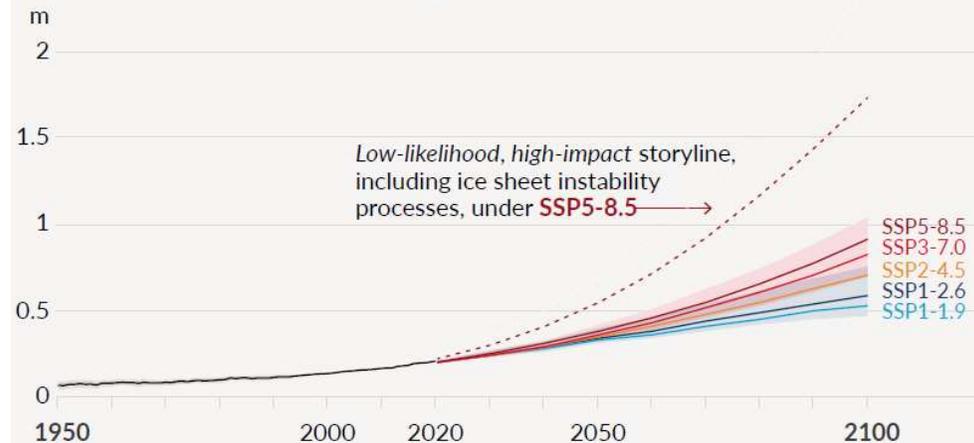
[IPCC (2021) WG1 SPM]

High emissions
Low emissions

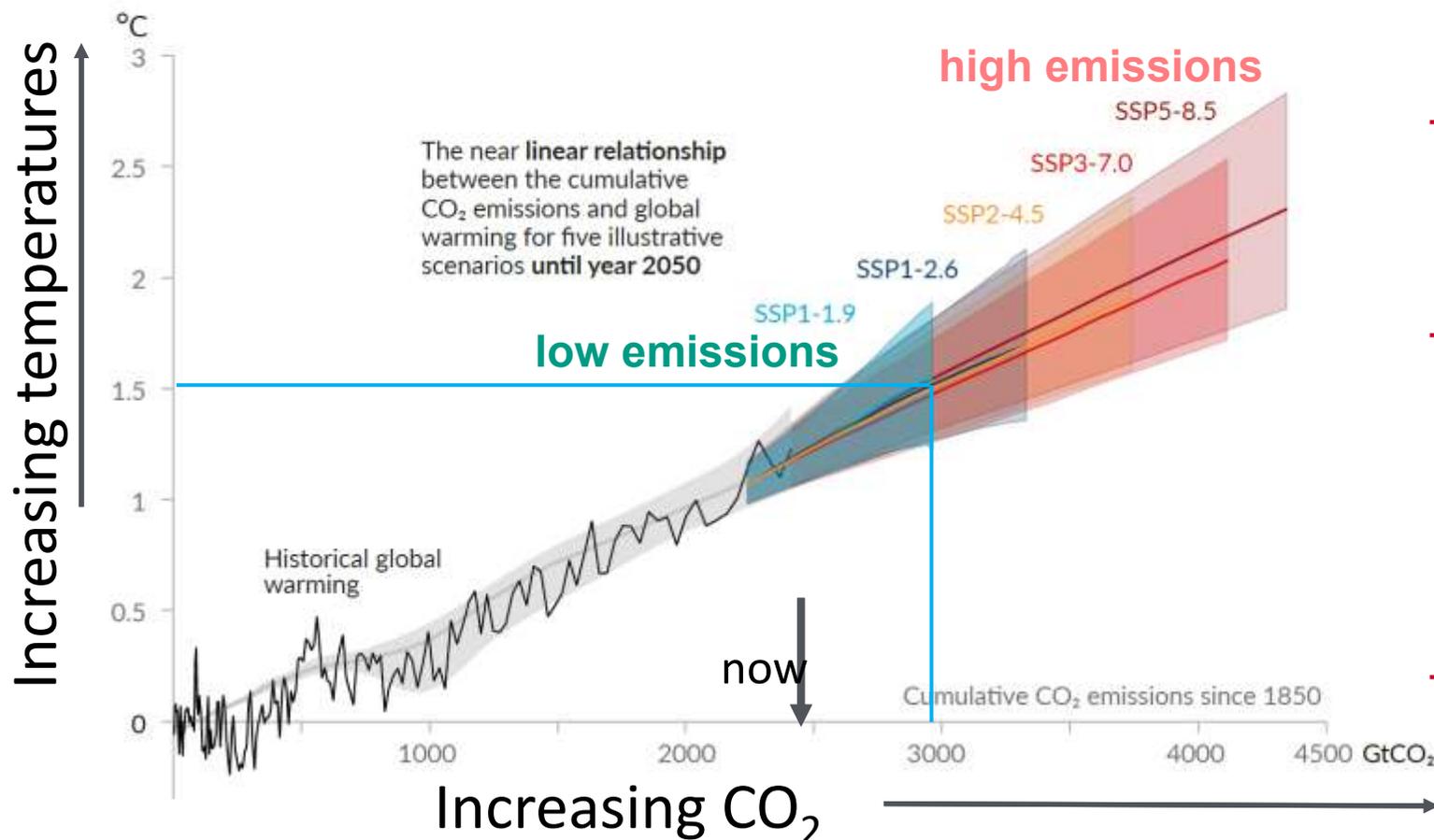
b) September Arctic sea ice area



d) Global mean sea level change relative to 1900



Limit Carbon Emissions to Avoid Dangerous Climate Change



[IPCC WGI 2021 SPM]

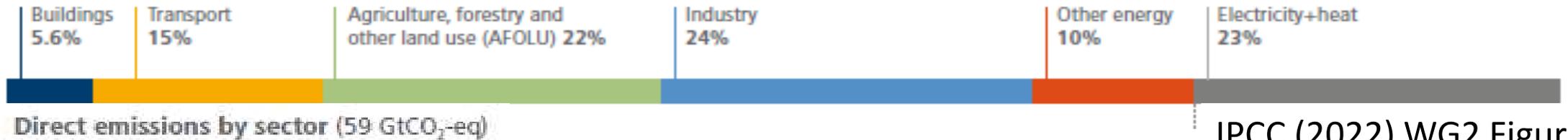
- Act now
 - To keep future options open
- Act everywhere
 - Efforts in all sectors are needed to reach global zero CO₂ emissions
- Act thoughtfully
 - Develop strategies maximising synergies and taking into account the local context, use a wide array of measures and actions
- Act jointly
 - Collaboratively and including national and sub-national authorities, civil society, the private sector and local communities

Joeri Rogelj (IPCC AR6 & SR1.5 author)

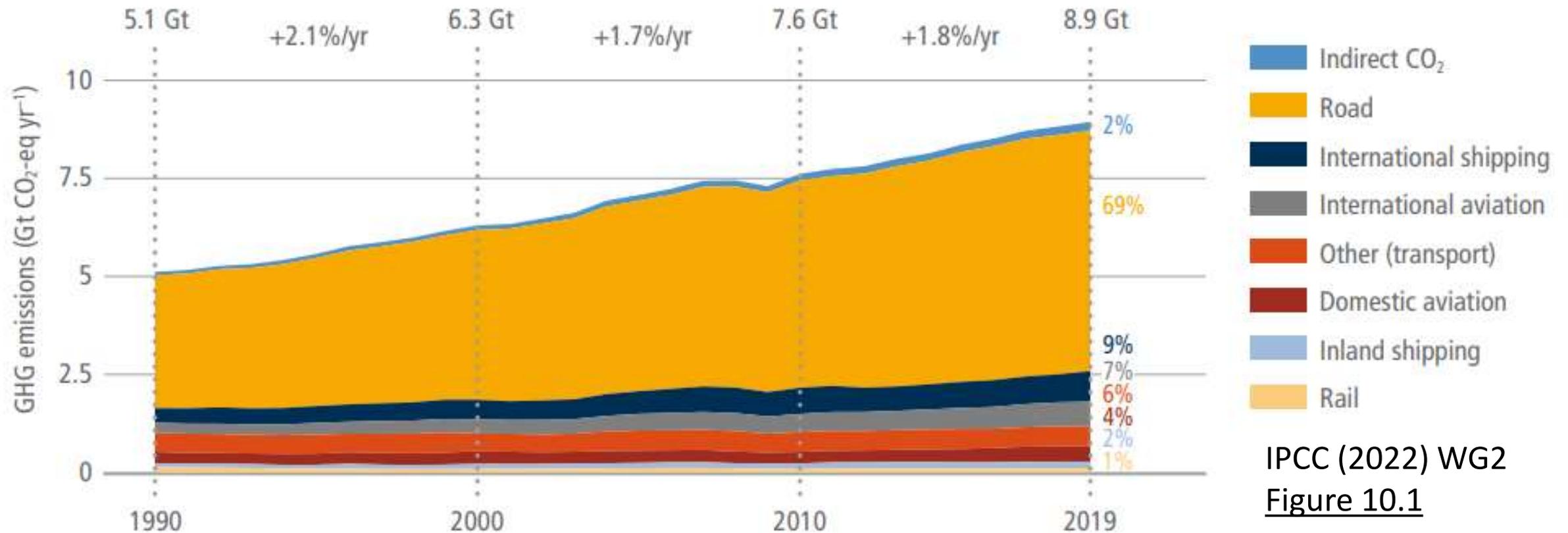
Transport emissions

15% of total GHG emissions; 23% of global energy-related CO₂ emissions.

70% of direct transport GHG emissions came from road vehicles



IPCC (2022) WG2 [Figure TS.6](#)



IPCC (2022) WG2 [Figure 10.1](#)

UK Transport emissions

“The domestic transport sector remained the largest emitting sector in the UK, accounting for 28% of all greenhouse gas emissions in 2022 (26% in 2021), of which 17% were emitted by HGVs (18% in 2021)”

Domestic transport sector Greenhouse gas (GHG) emissions in the UK

113.2 million tonnes
in 2022

↑ 2% from 2021



28% of total emissions

Source: Department for Energy Security and Net Zero

HGVs GHG emissions in the UK

19.1 million tonnes
in 2022

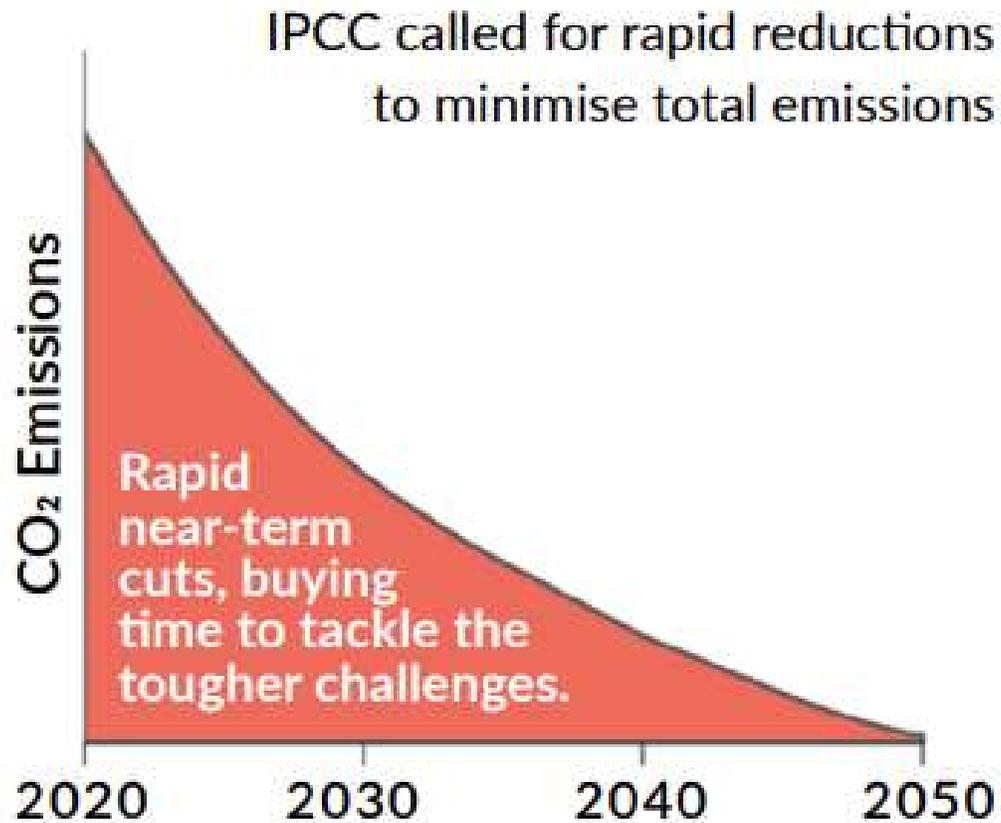
↓ 5% from 2021



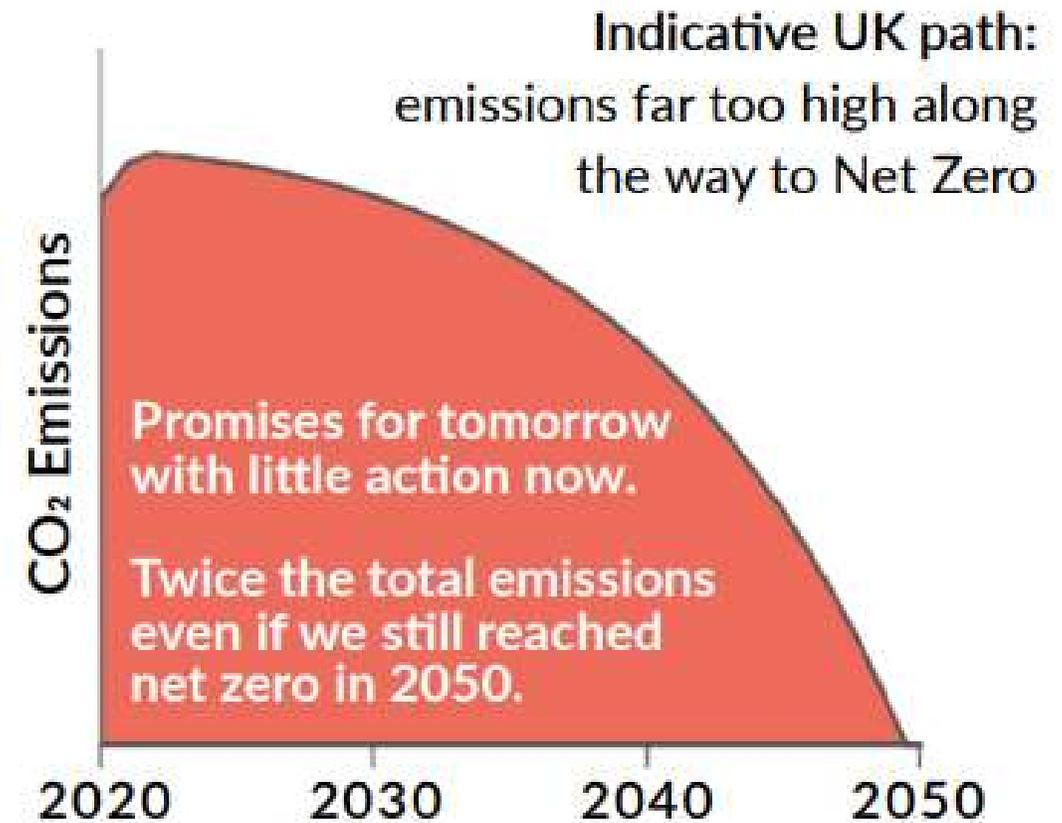
17% of domestic transport sector emissions

Source: Department for Energy Security and Net Zero

It's not when we reach net zero that matters, it's the path we take...

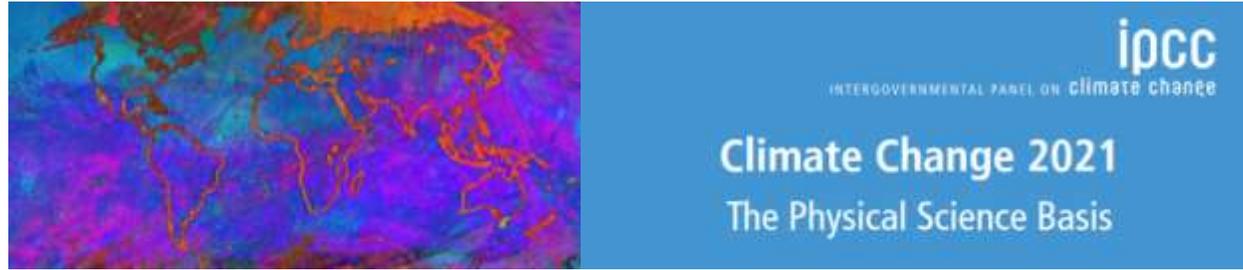


zerohour.uk



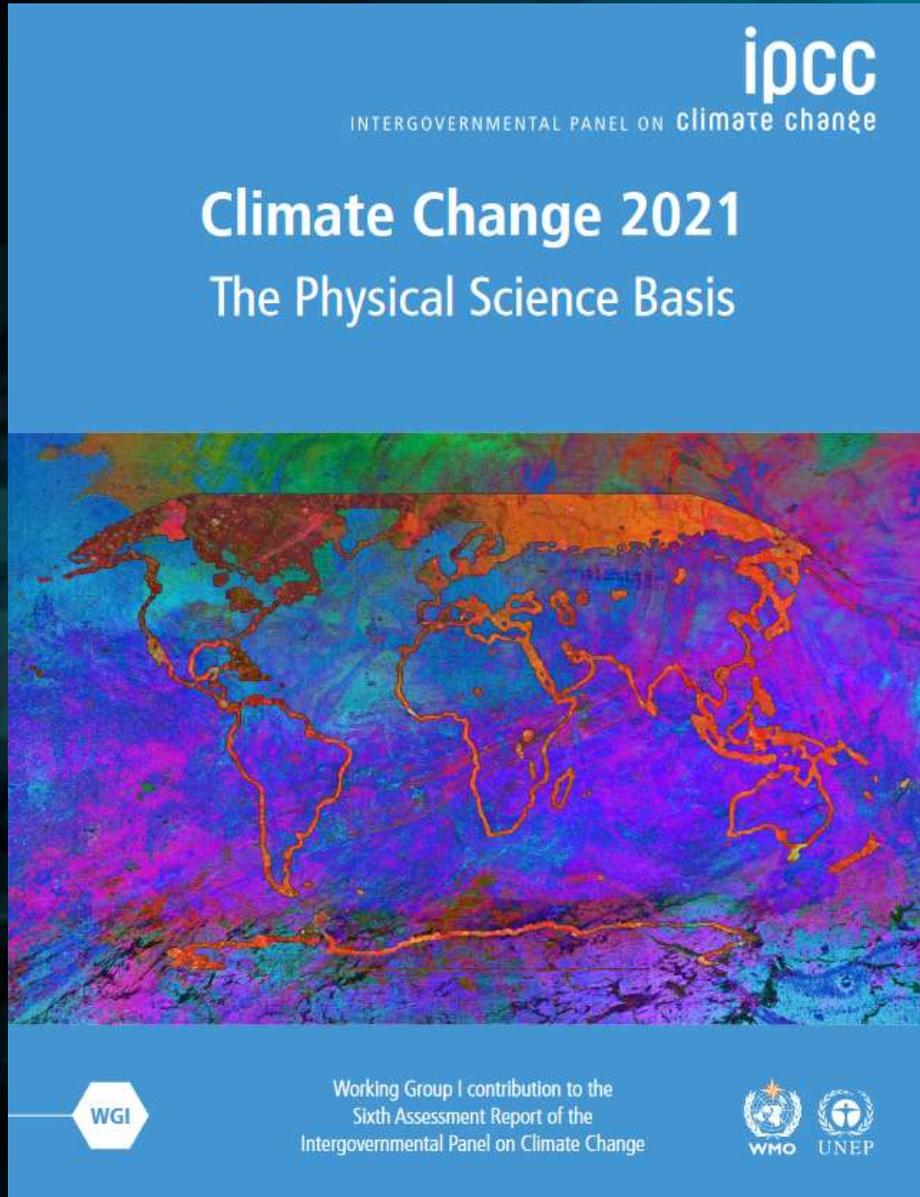
[See also carbonbrief.org](http://carbonbrief.org)

Key Messages



- Earth's climate has always varied but it is an established fact that human activities are now driving climate change
- Recent changes in climate are widespread, rapid and unprecedented in thousands of years.
- Human activities are intensifying extreme climate events, including heat waves, heavy rainfall, and droughts
- Every bit of global warming increases the magnitude of climate change including the severity of climate extremes
- Limiting warming to 1.5°C requires immediate, rapid, and large-scale reductions in greenhouse gas emissions





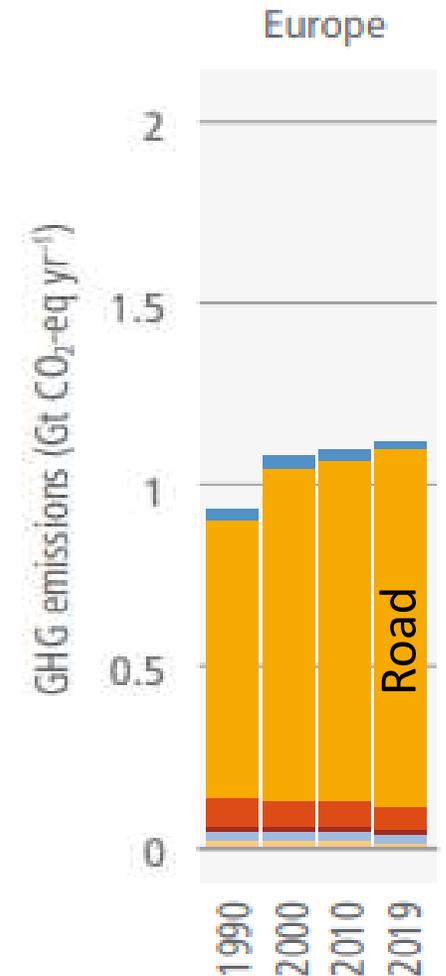
IPCC (2023) Synthesis Report



www.ipcc.ch/report/ar6/wg1

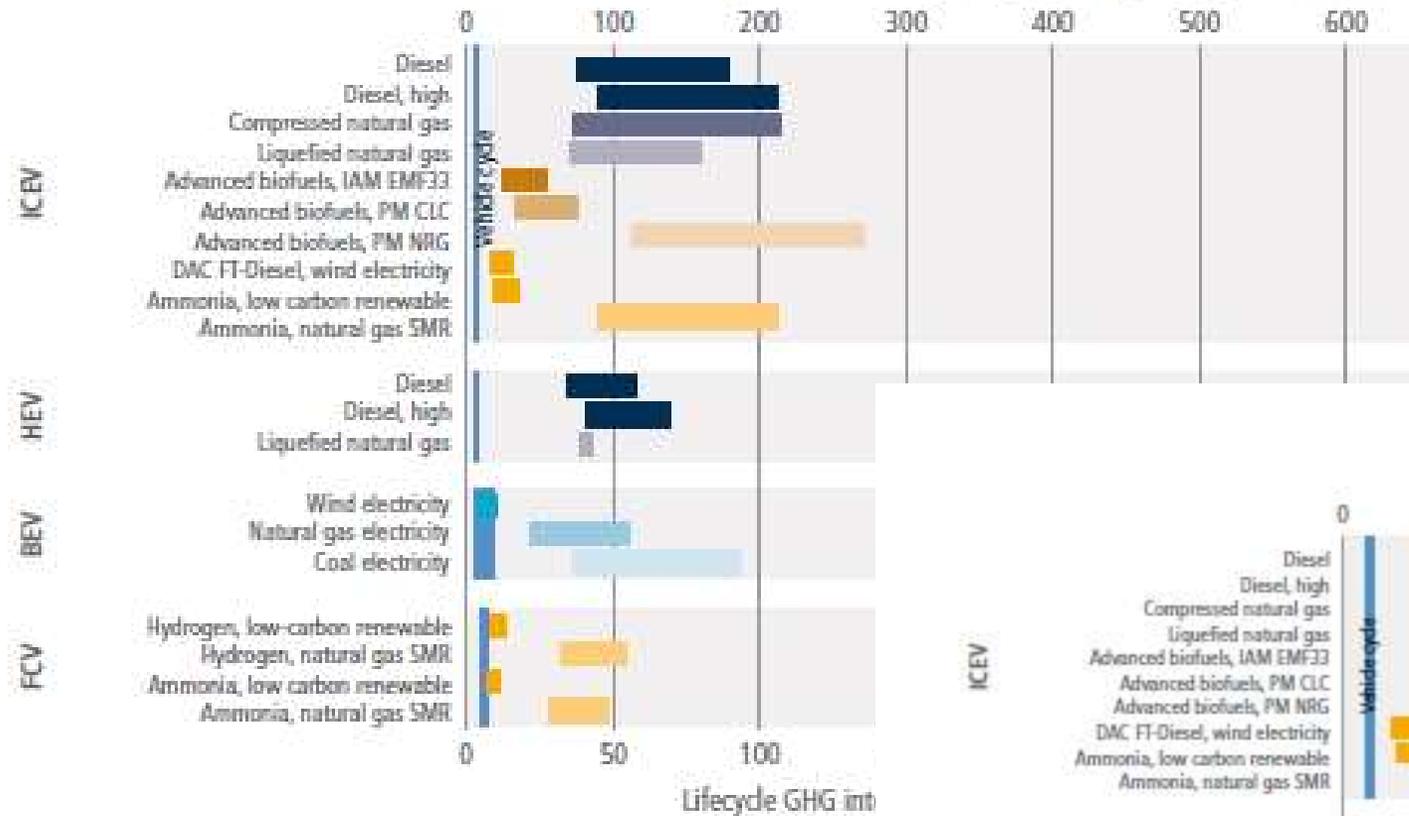
Mitigation of Transport emissions

- IPCC (2022) WG3, Chapter 10 Transport, Jaramillo et al.
- Transport 23% of global energy-related CO₂ emissions
- 70% of direct transport emissions came from road vehicles
- Growing need for systemic infrastructure changes that enable behavioural modifications
- Battery electric vehicles have lower lifecycle greenhouse gas emissions (~87 gCO₂-eq per vehicle-km) than internal combustion engine vehicles (~203 gCO₂-eq per vehicle-km) when charged with low-carbon electricity
- Limiting warming to 1.5°C with no overshoot requires 42-68% reduction in transport-related CO₂ emissions by 2050
- growing concerns about resource availability, labour rights, non-climate environmental impacts, and costs of critical minerals needed for lithium-ion batteries



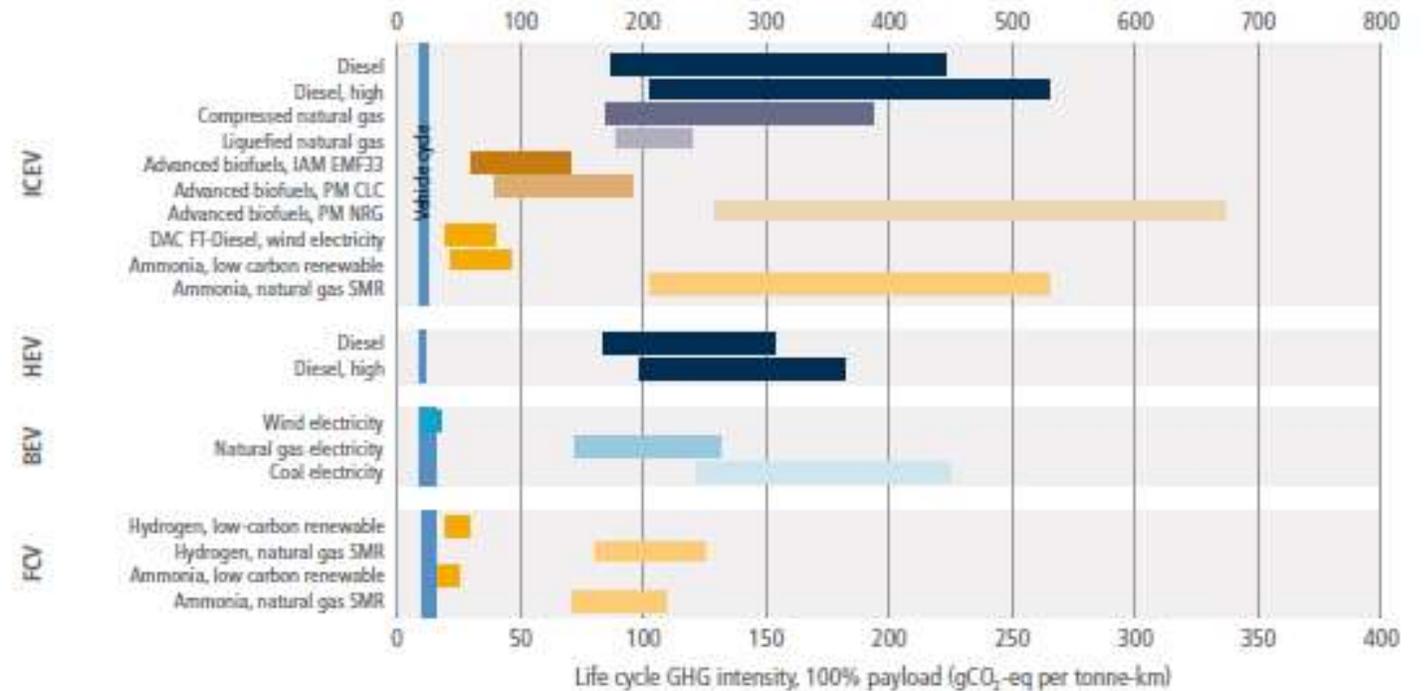
Heavy-duty trucks

Lifecycle GHG intensity, 50% payload (gCO₂-eq per tonne-km)



Medium-duty trucks

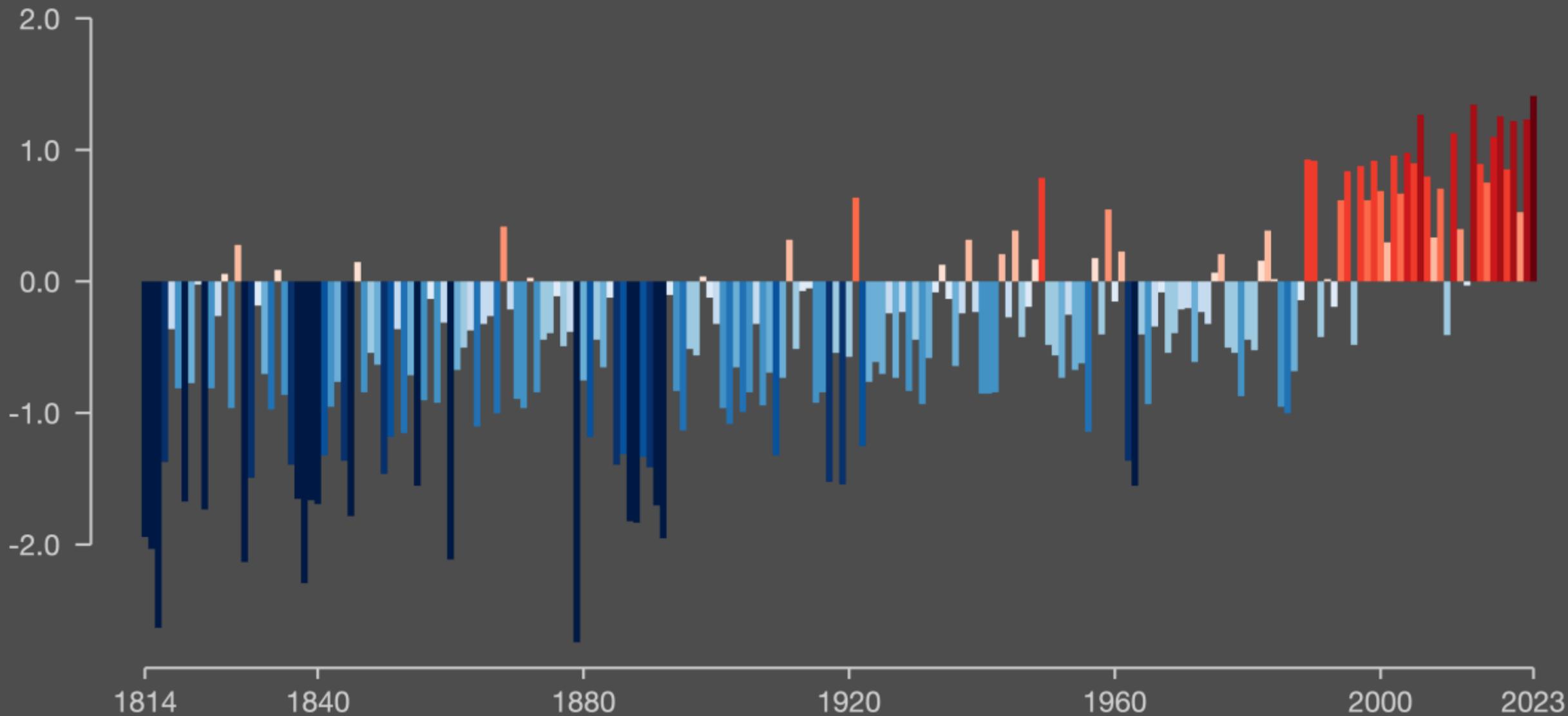
Lifecycle GHG intensity, 50% payload (gCO₂-eq per tonne-km)



Life cycle GHG intensity, 100% payload (gCO₂-eq per tonne-km)

Temperature change in Oxford

Relative to average of 1961-2010 [°C]

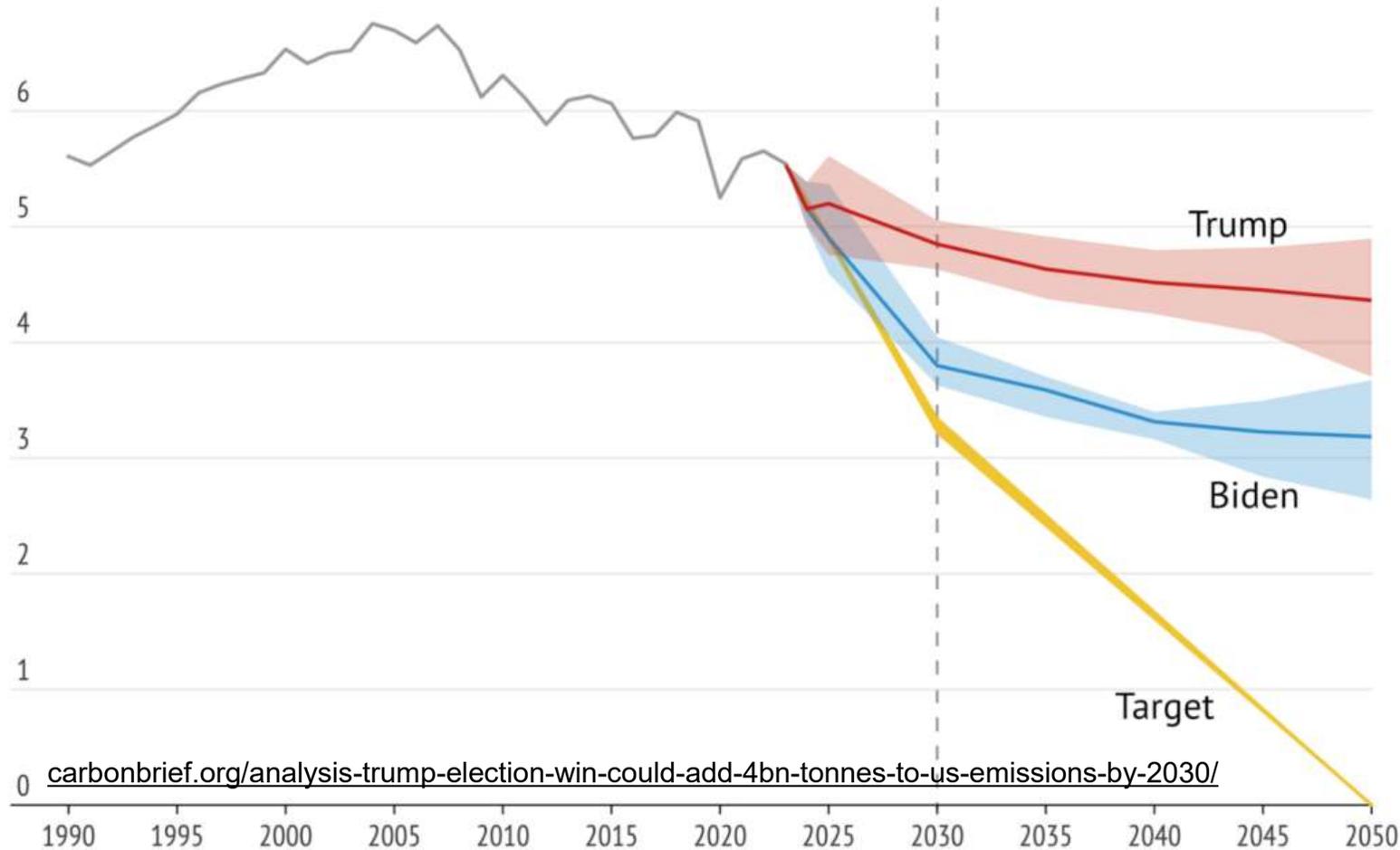


Implications of Trump Presidency

It's not when we reach net zero that matters - it's the path we take.

A Trump election win could add 4bn tonnes to US emissions by 2030

Greenhouse gas emissions, billion tonnes of CO₂e



carbonbrief.org/analysis-trump-election-win-could-add-4bn-tonnes-to-us-emissions-by-2030/

Source: Carbon Brief analysis of Bistline et al (2023) and Rhodium Group (2023)

