

# CLIMATE CHANGE: CAUSES, CONSEQUENCES & SOLUTIONS



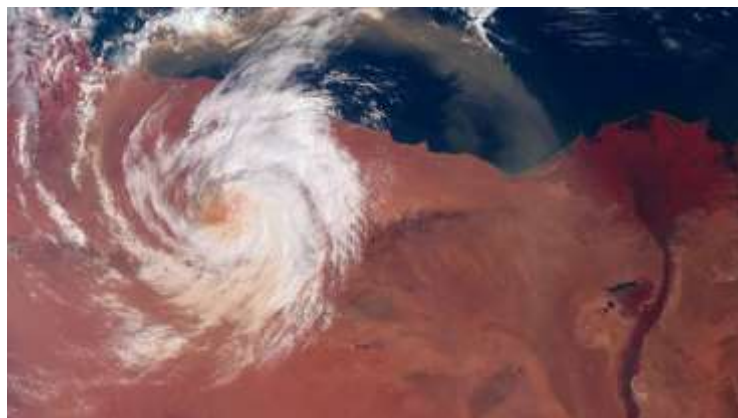
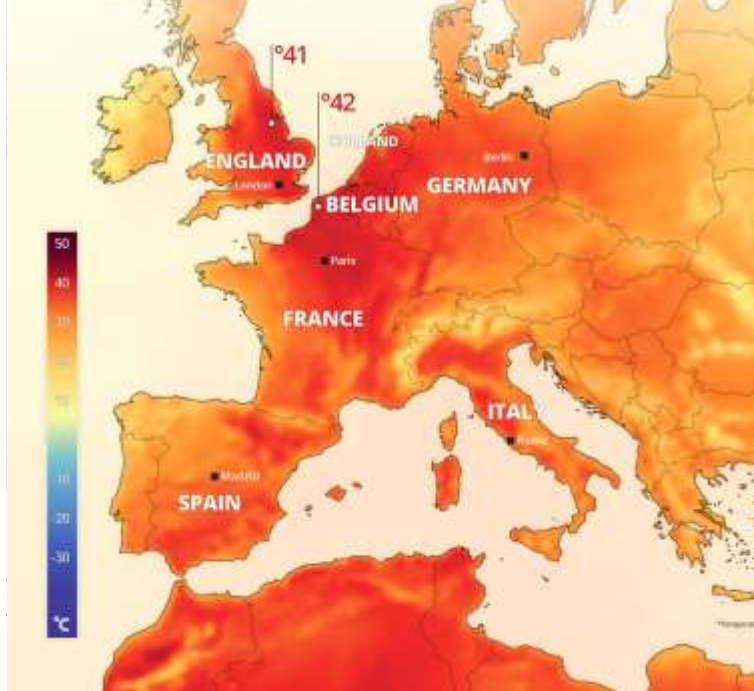
Professor Richard Allan      [@rpallanuk](https://twitter.com/rpallanuk)  
BETS meeting, Oxford Belfry, 13th November 2024

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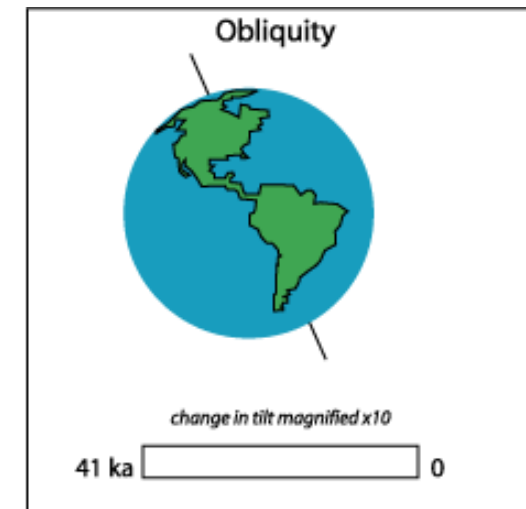
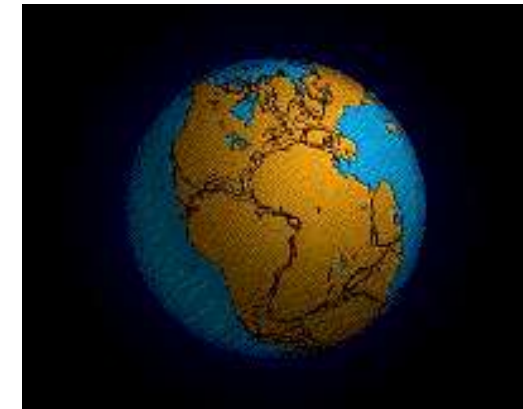
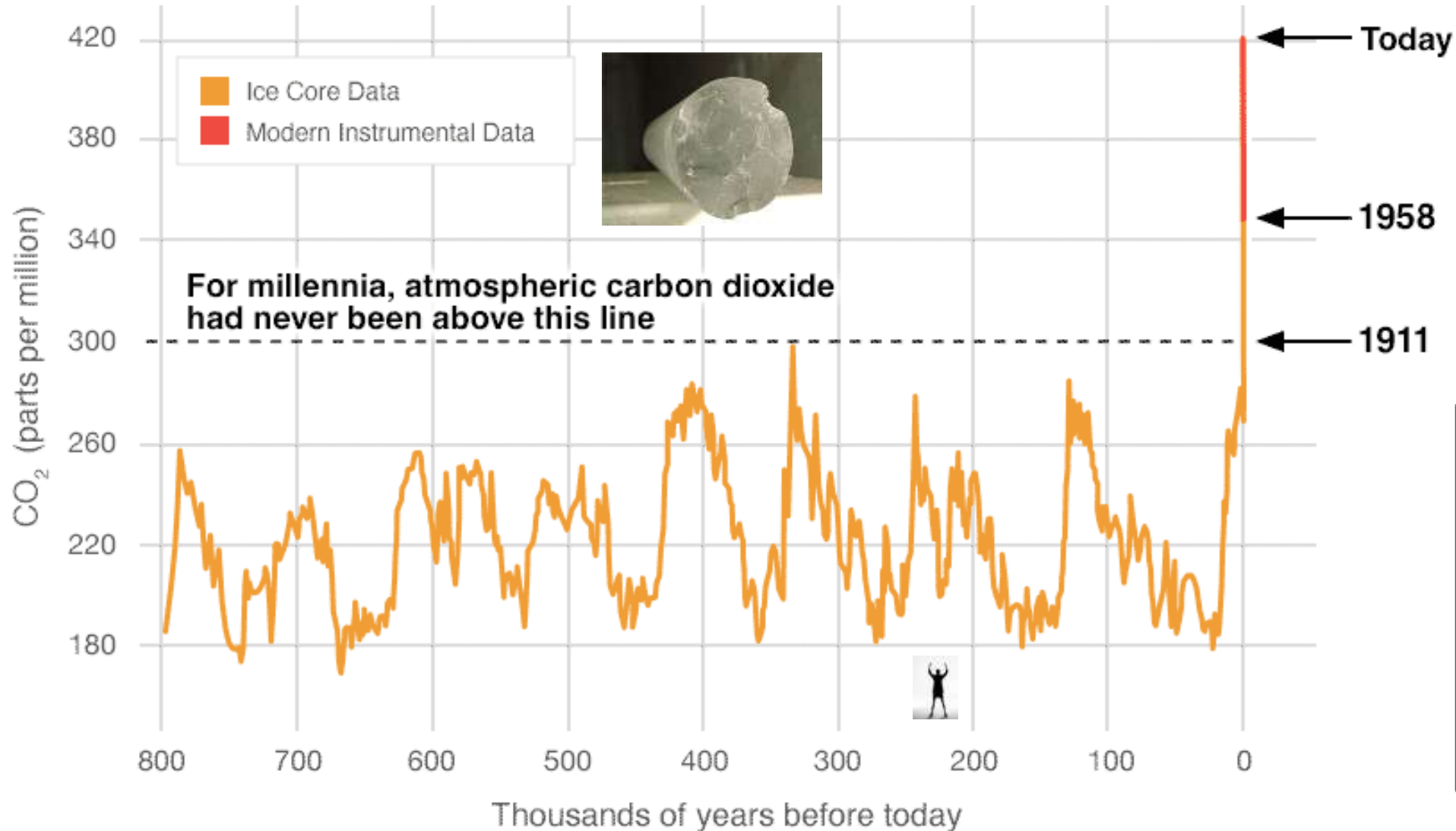
## Europe hit by scorching heatwave



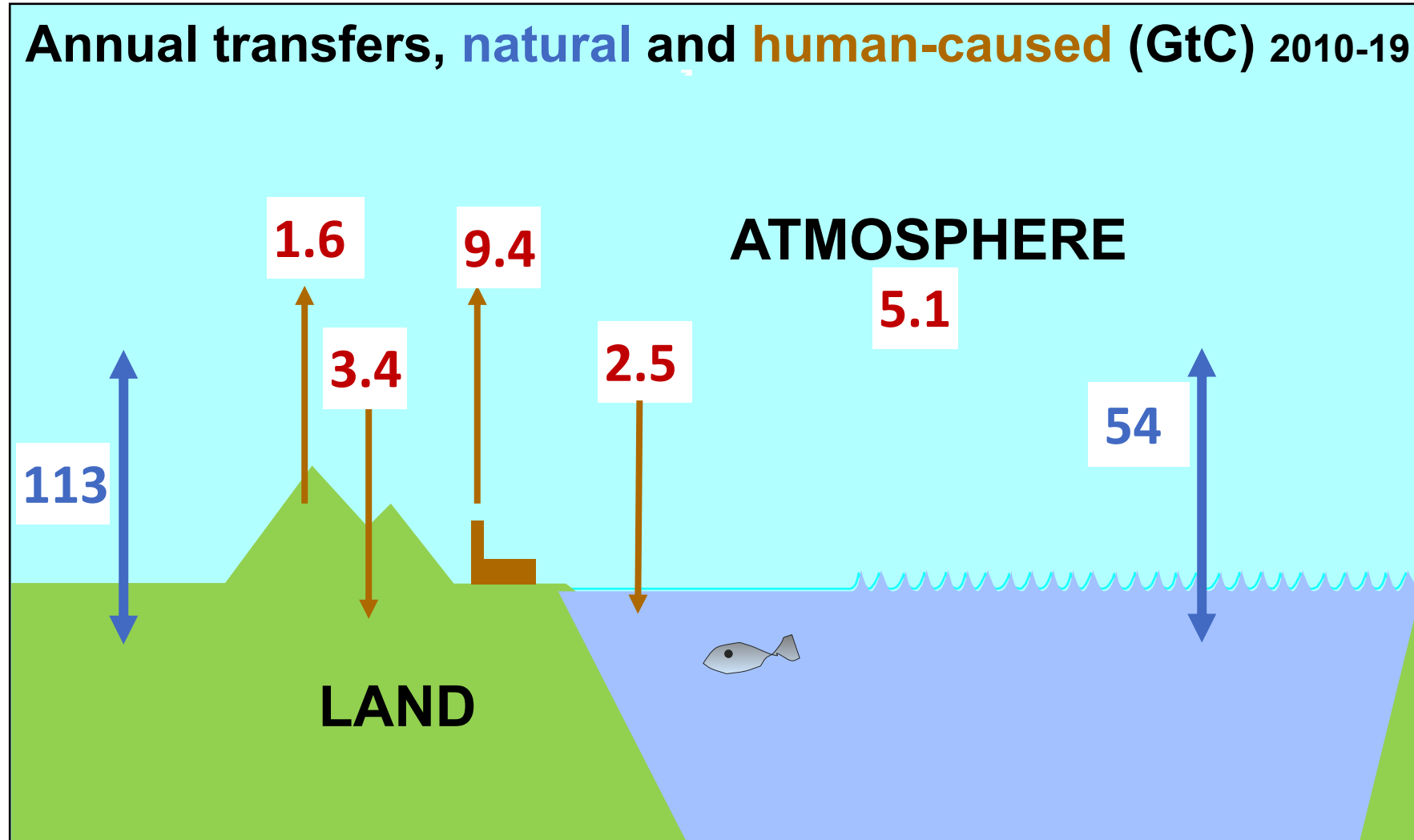
# ONGOING CLIMATE CHANGE



# The climate has always changed. But...



# Natural & human-influenced carbon cycle



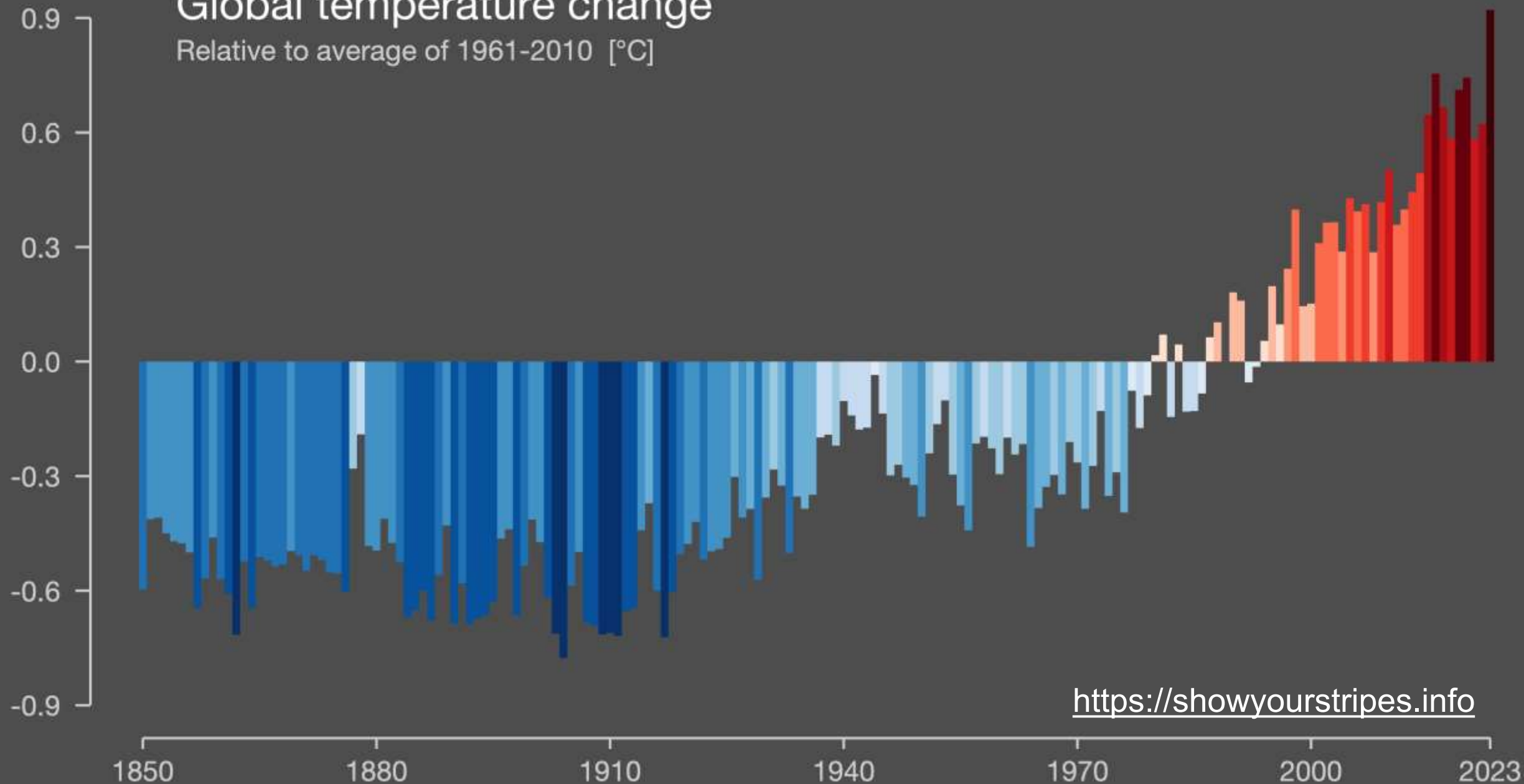
- Human activities have tipped the natural carbon cycle out of balance
- This is driving increases in atmospheric CO<sub>2</sub> concentrations
- CO<sub>2</sub> concentrations highest in at least 2 million years

Values in billions of tonnes of Carbon per year from IPCC (2021) Chapter 5



# Global temperature change

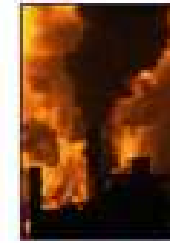
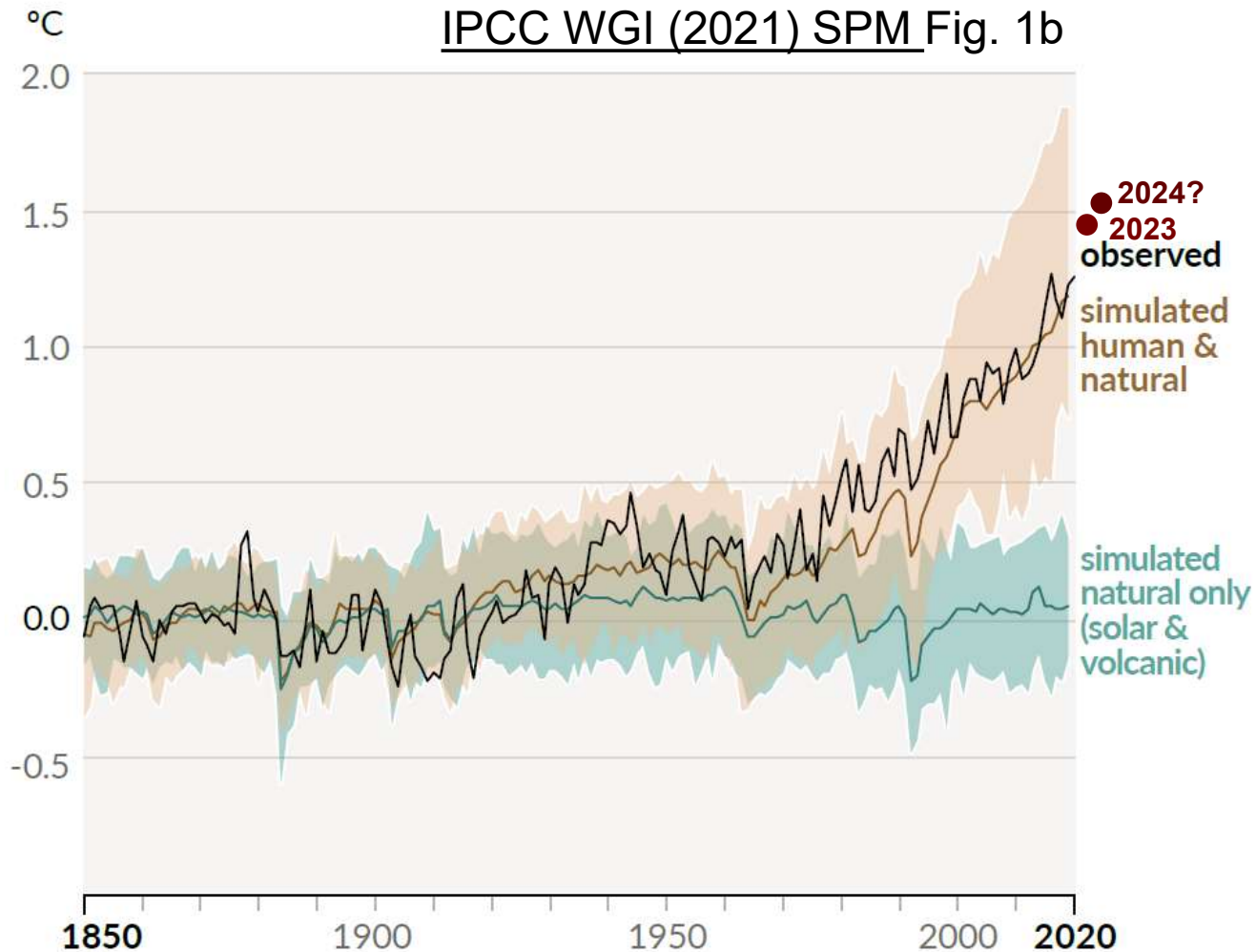
Relative to average of 1961-2010 [°C]



<https://showyourstripes.info>

# It is indisputable that human activities are causing climate change

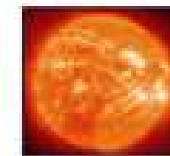
IPCC WGI (2021) SPM Fig. 1b



► Observed warming is driven by emissions from human activities



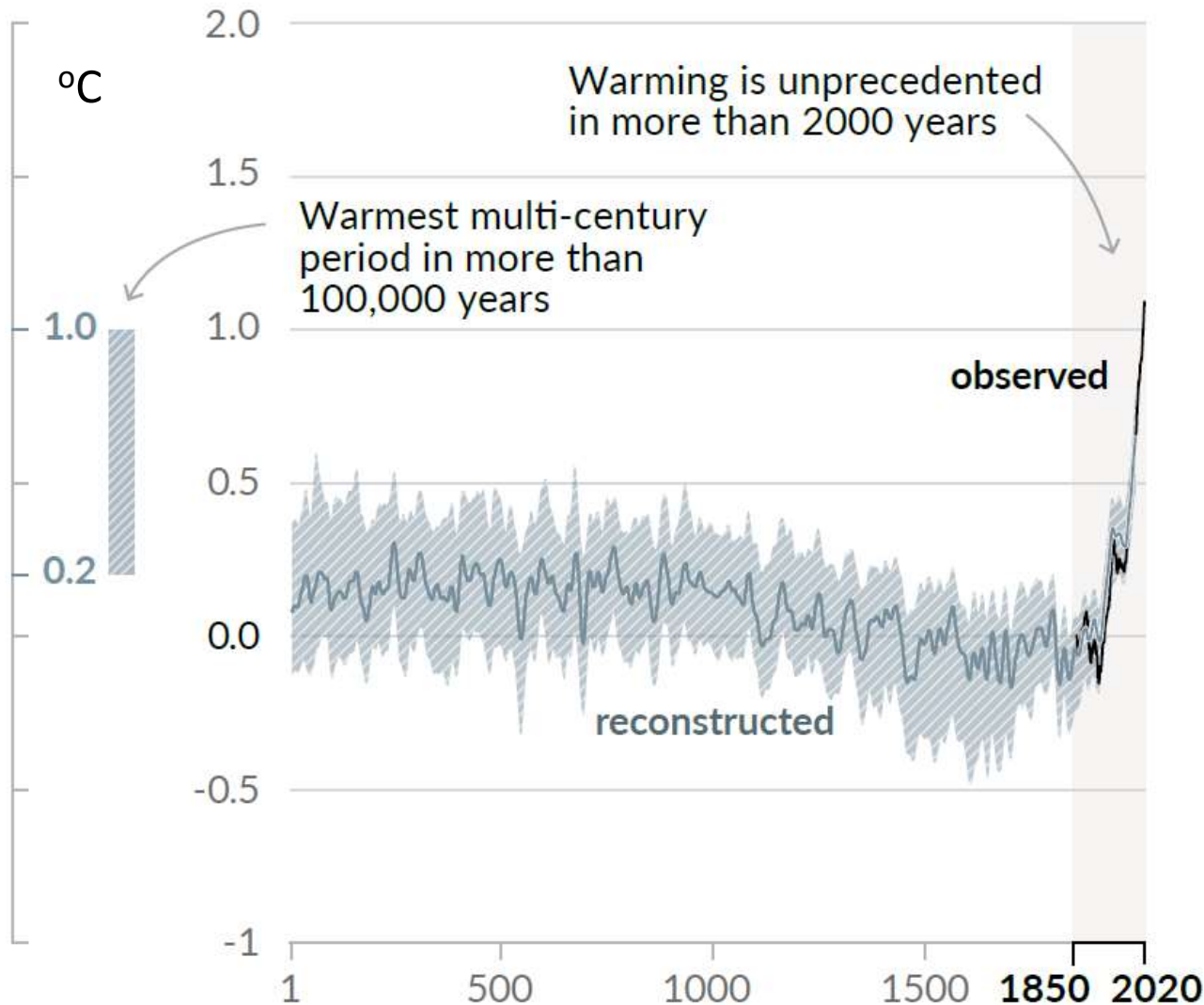
► Natural factors do not contribute to rapid warming over past 5 decades



► 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]



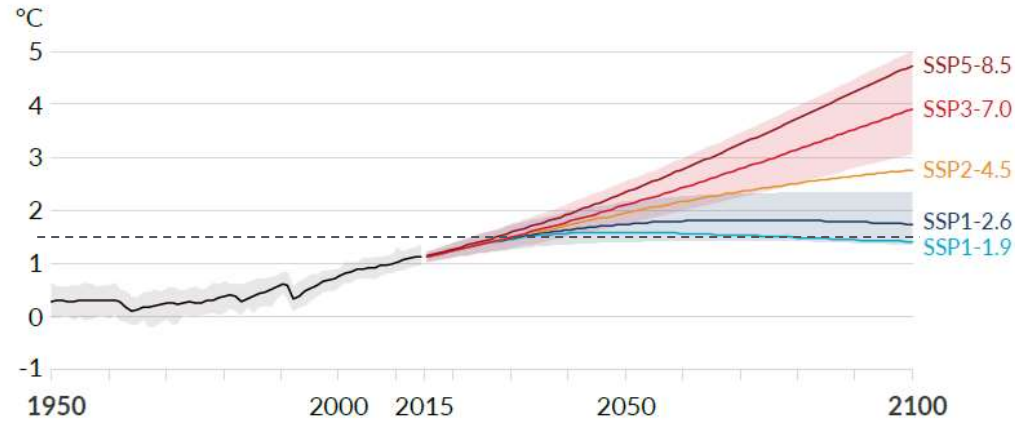
“ Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.



# 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

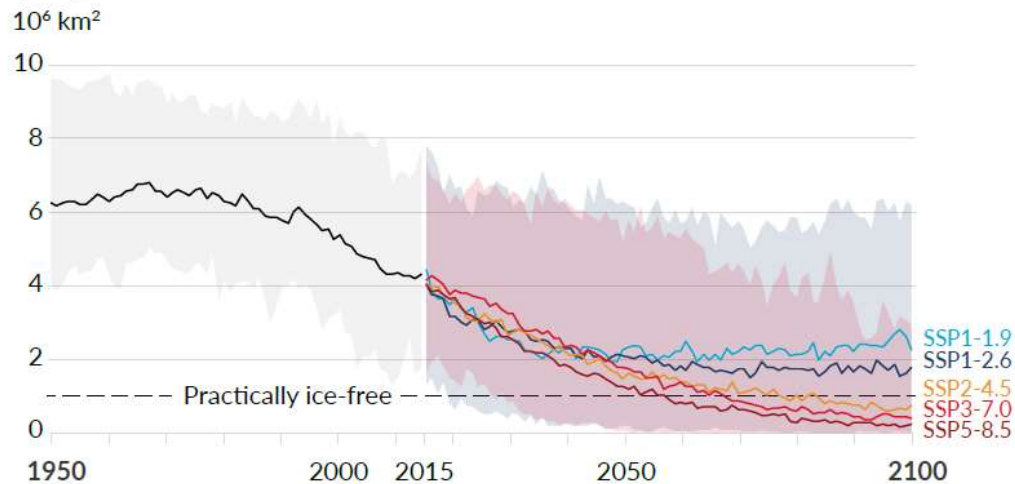


Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO<sub>2</sub> and other greenhouse gas emissions occur in the coming decades

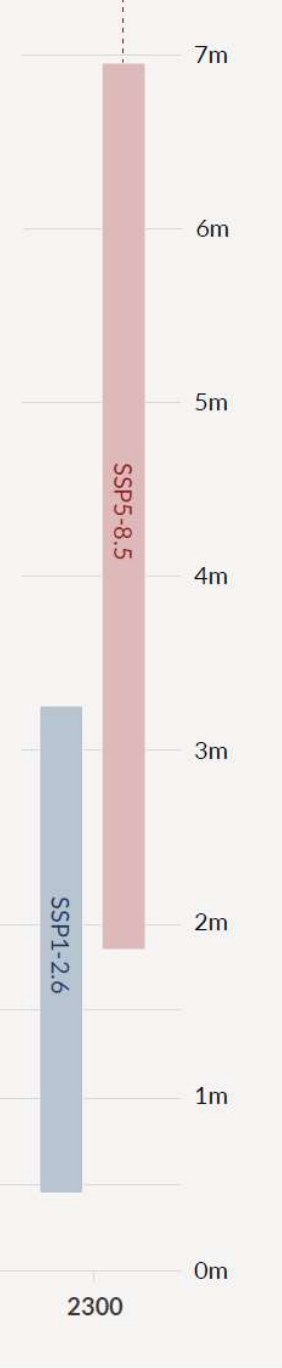
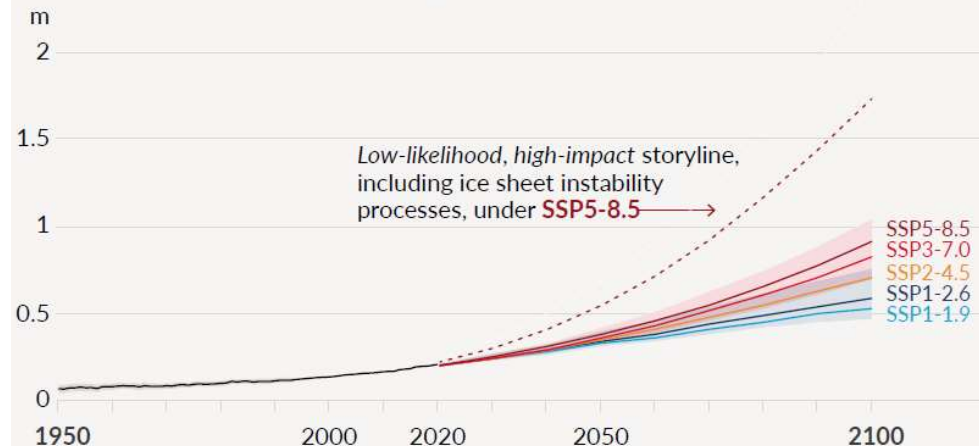
[IPCC (2021) WG1 SPM]

High emissions  
Low emissions

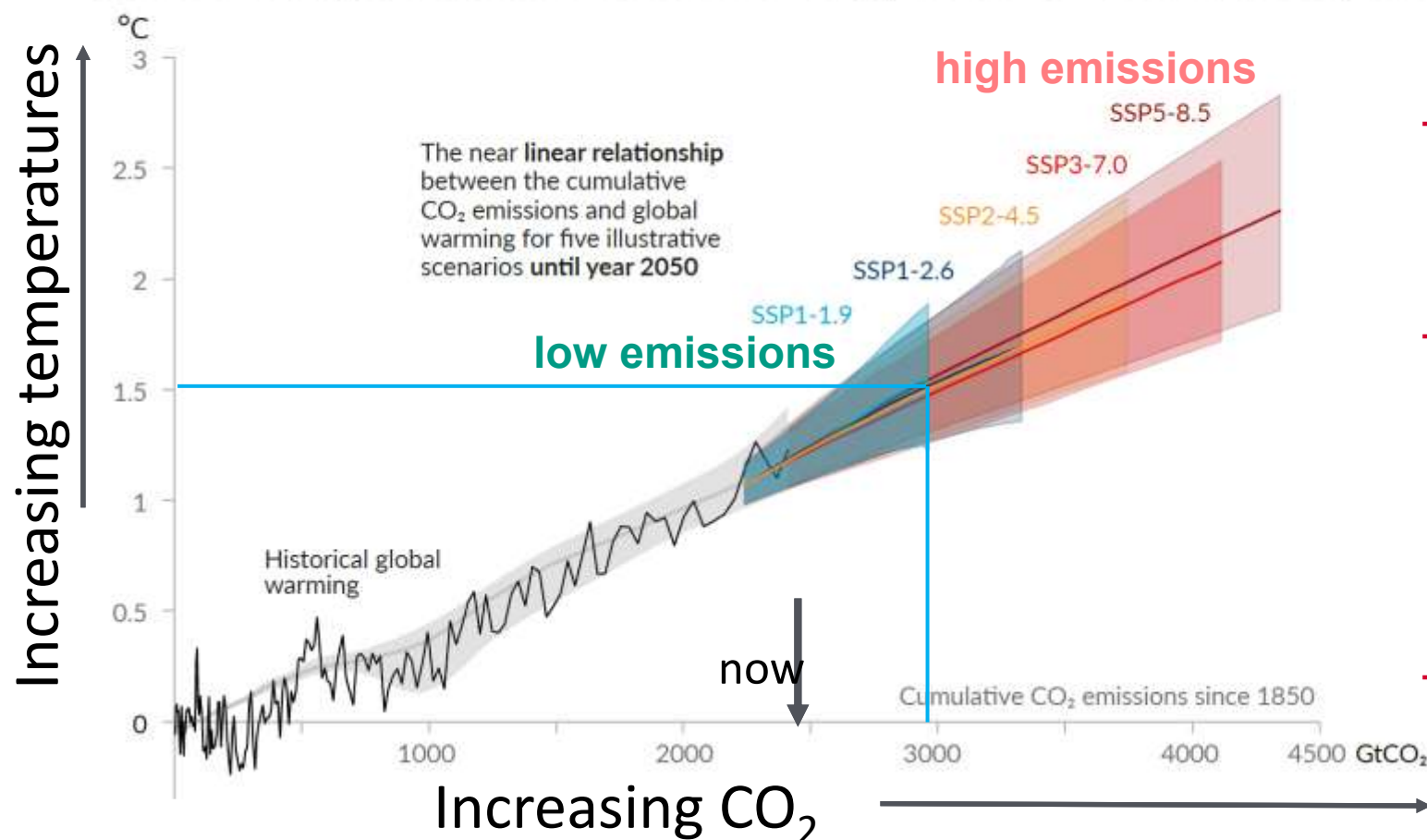
b) September Arctic sea ice area



d) Global mean sea level change relative to 1900



# Limit Carbon Emissions to Avoid Dangerous Climate Change



[IPCC WGI 2021 SPM]

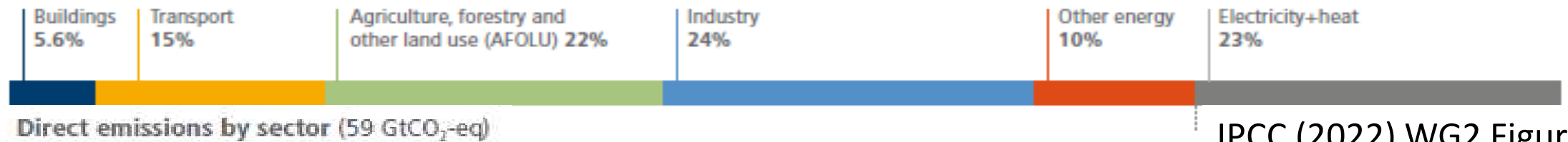
- Act now
  - To keep future options open
- Act everywhere
  - Efforts in all sectors are needed to reach global zero CO<sub>2</sub> emissions
- Act thoughtfully
  - Develop strategies maximising synergies and taking into account the local context, use a wide array of measures and actions
- Act jointly
  - Collaboratively and including national and sub-national authorities, civil society, the private sector and local communities

Joeri Rogelj (*IPCC AR6 & SR1.5* author)

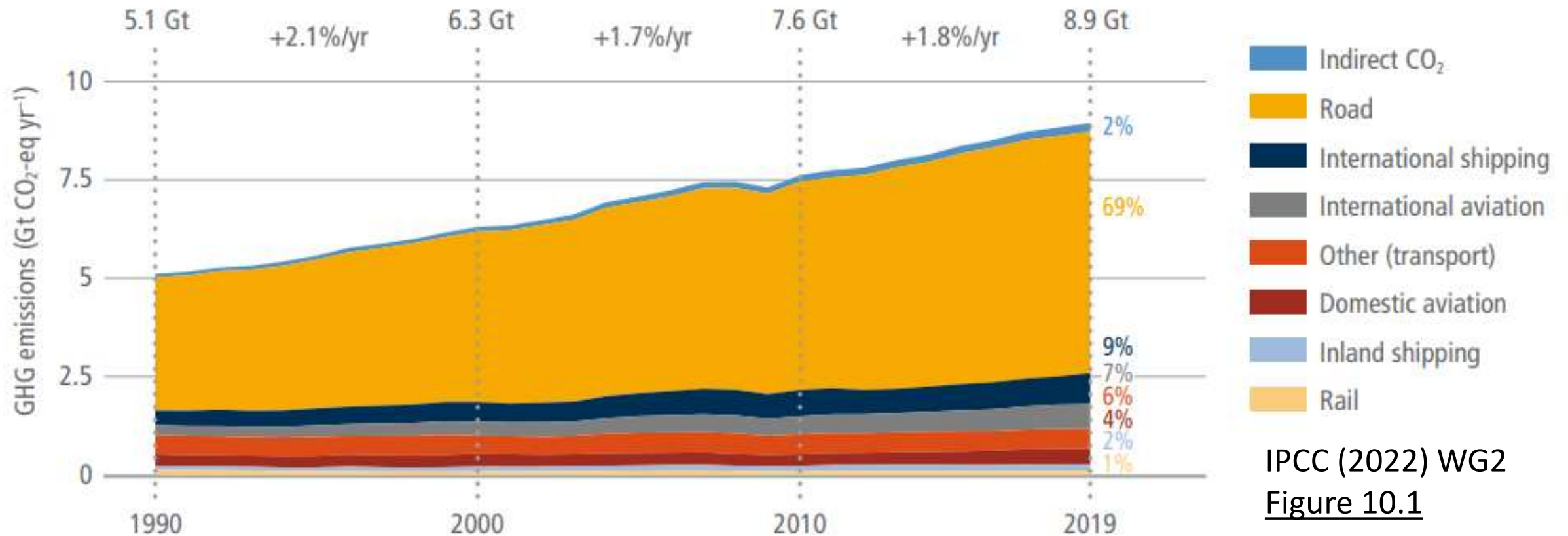
# Transport emissions

15% of total GHG emissions; 23% of global energy-related CO<sub>2</sub> 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

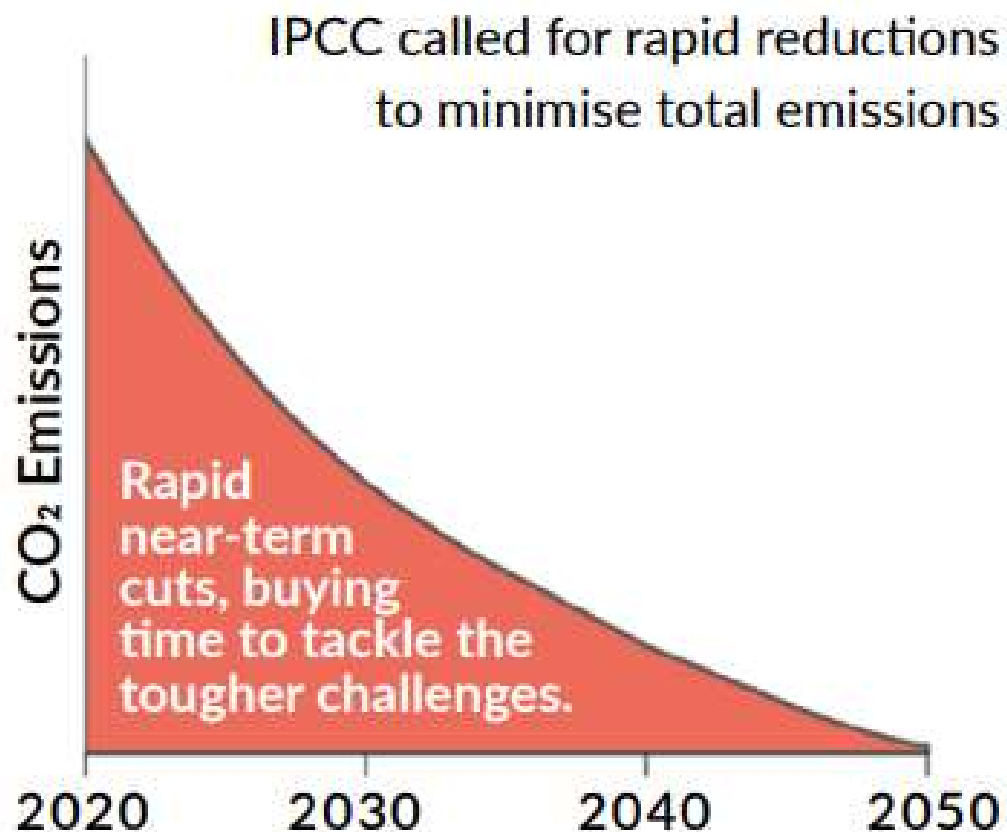
↓ 5% from 2021



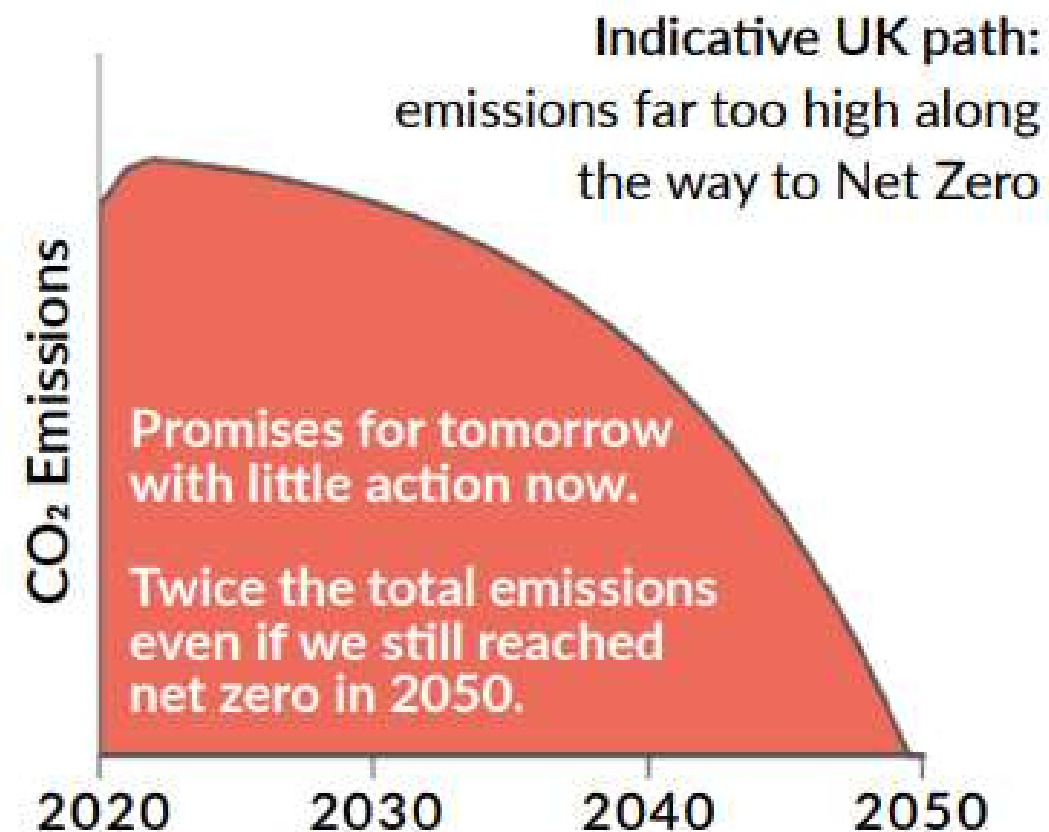
**17%** of domestic transport sector emissions

Source: Department for Energy Security and Net Zero

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

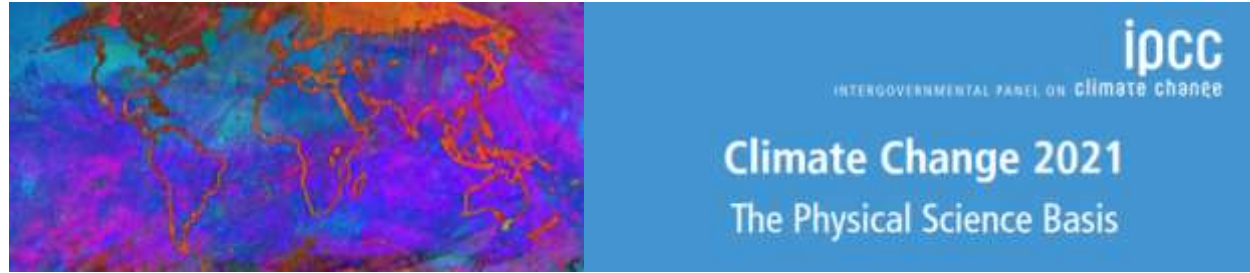


[zerohour.uk](https://www.zerohour.uk)



[See also carbonbrief.org](https://www.carbonbrief.org)

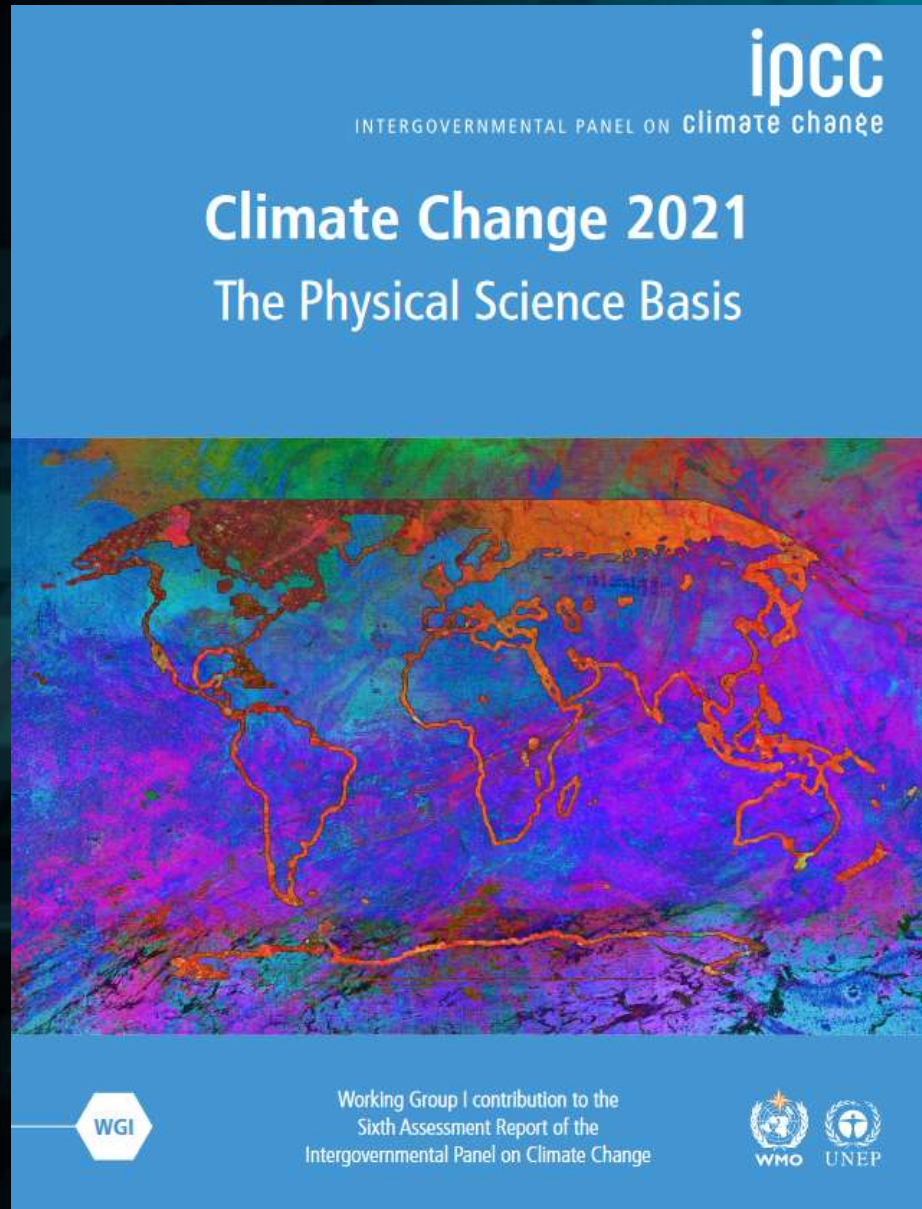
# Key Messages



- 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

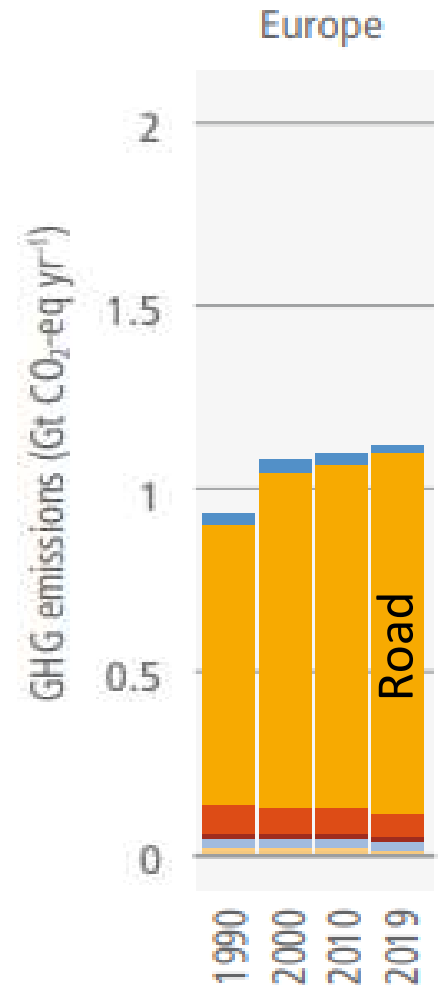


[www.ipcc.ch/report/ar6/wg1](https://www.ipcc.ch/report/ar6/wg1)



# Mitigation of Transport emissions

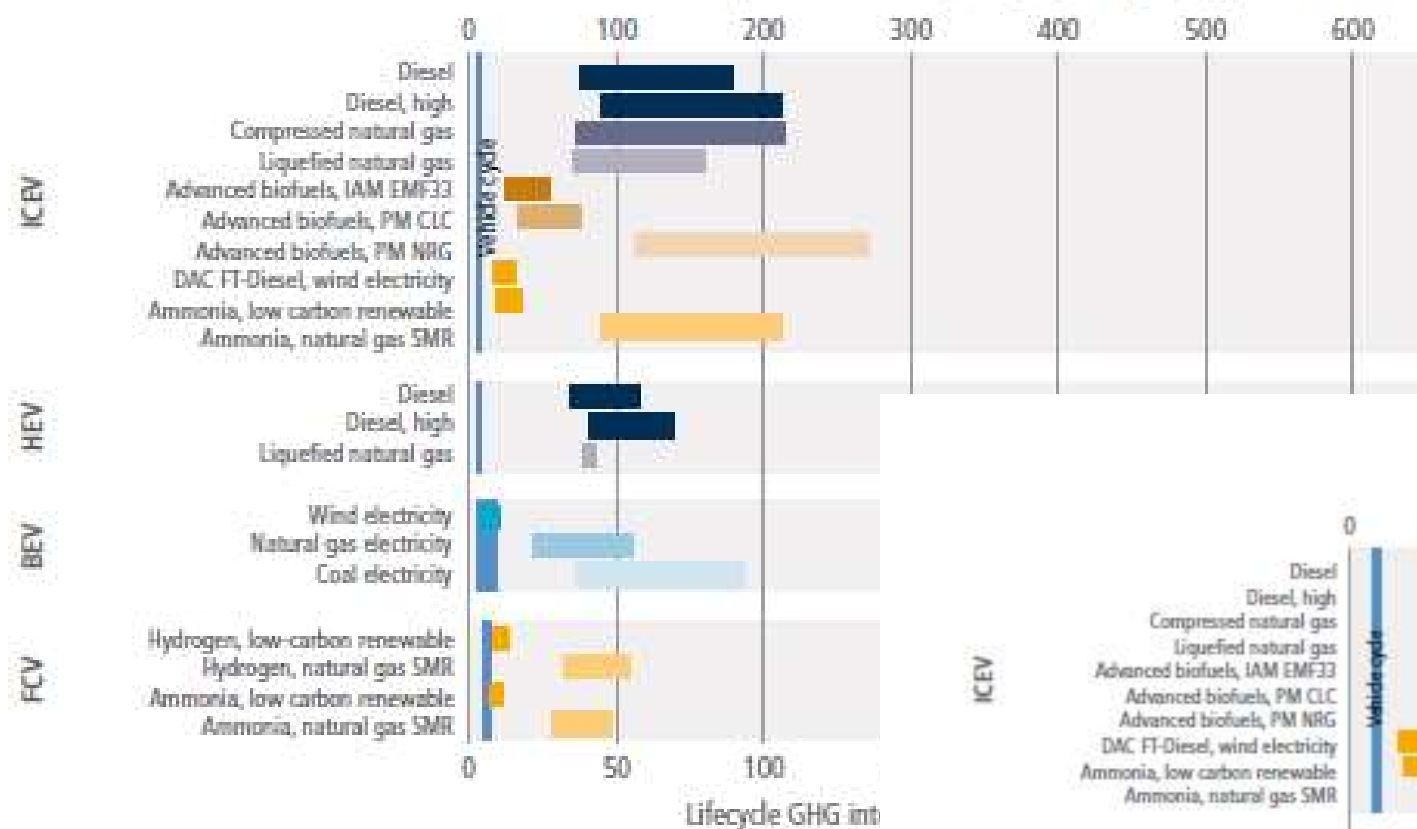
- IPCC (2022) WG3, Chapter 10 Transport, Jaramillo et al.
- Transport 23% of global energy-related CO<sub>2</sub> emissions
- 70% of direct transport emissions came from road vehicles
- Growing need for systemic infrastructure changes that enable behavioural modifications
- Battery electric vehicles have lower lifecycle greenhouse gas emissions (~87 gCO<sub>2</sub>-eq per vehicle-km) than internal combustion engine vehicles (~203 gCO<sub>2</sub>-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 CO<sub>2</sub> emissions by 2050
- growing concerns about resource availability, labour rights, non-climate environmental impacts, and costs of critical minerals needed for lithium-ion batteries





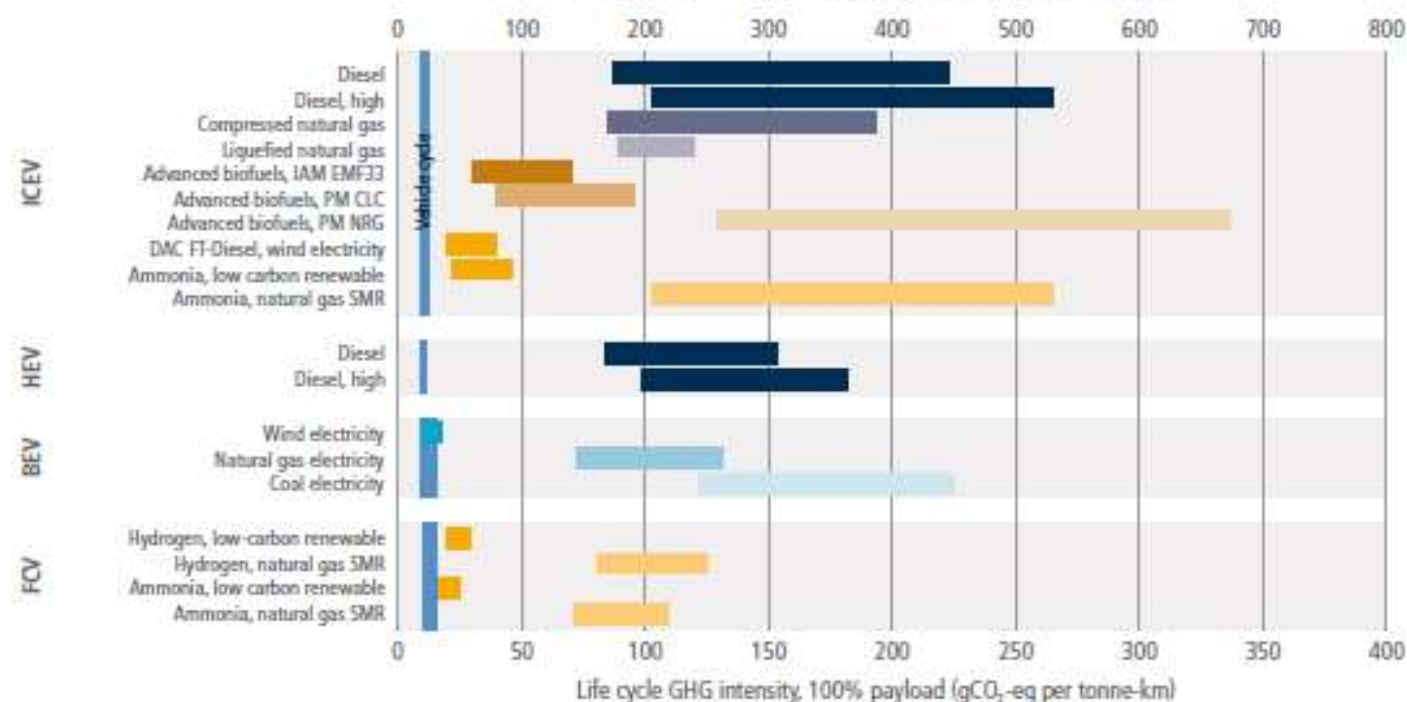
## Heavy-duty trucks

Lifecycle GHG intensity, 50% payload (gCO<sub>2</sub>-eq per tonne-km)



## Medium-duty trucks

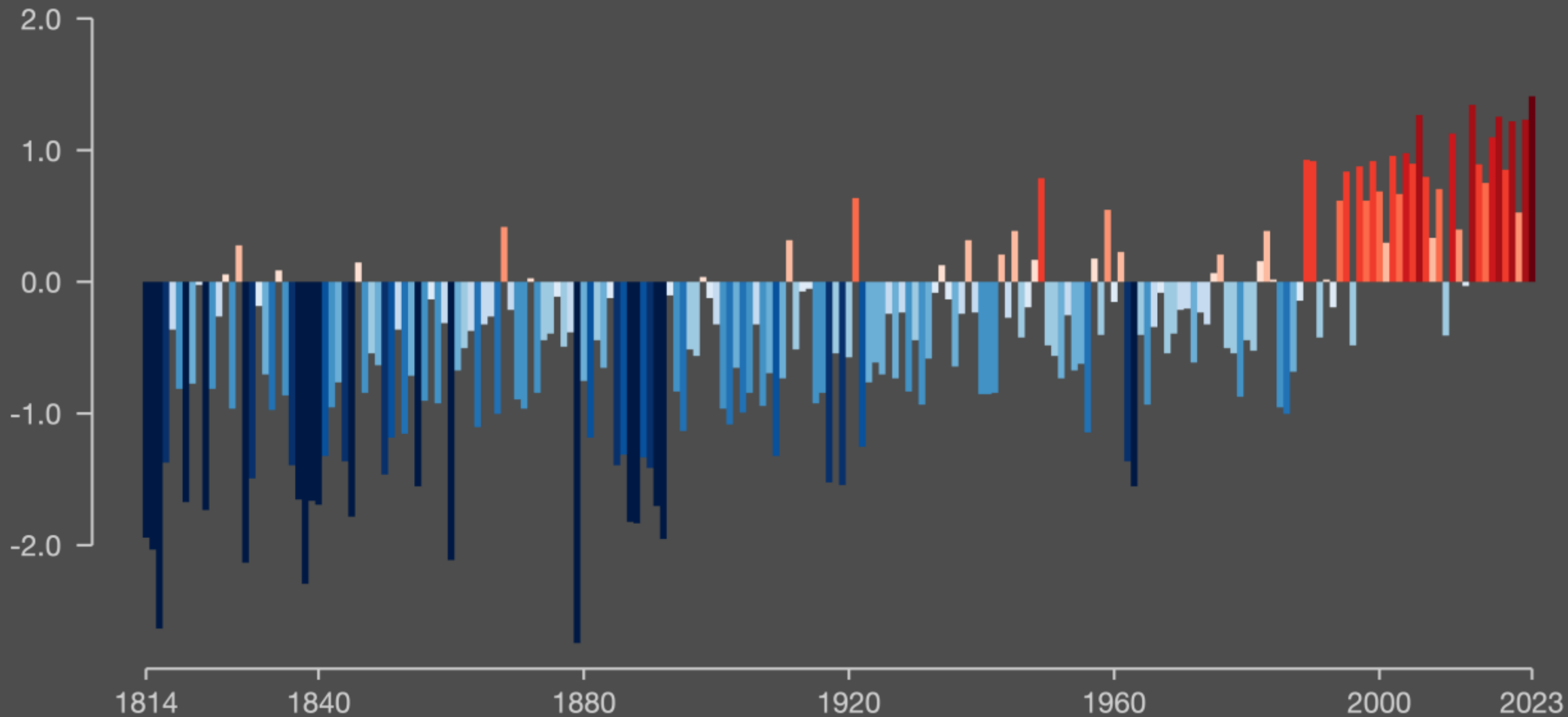
Lifecycle GHG intensity, 50% payload (gCO<sub>2</sub>-eq per tonne-km)



Life cycle GHG intensity, 100% payload (gCO<sub>2</sub>-eq per tonne-km)

# Temperature change in Oxford

Relative to average of 1961-2010 [°C]

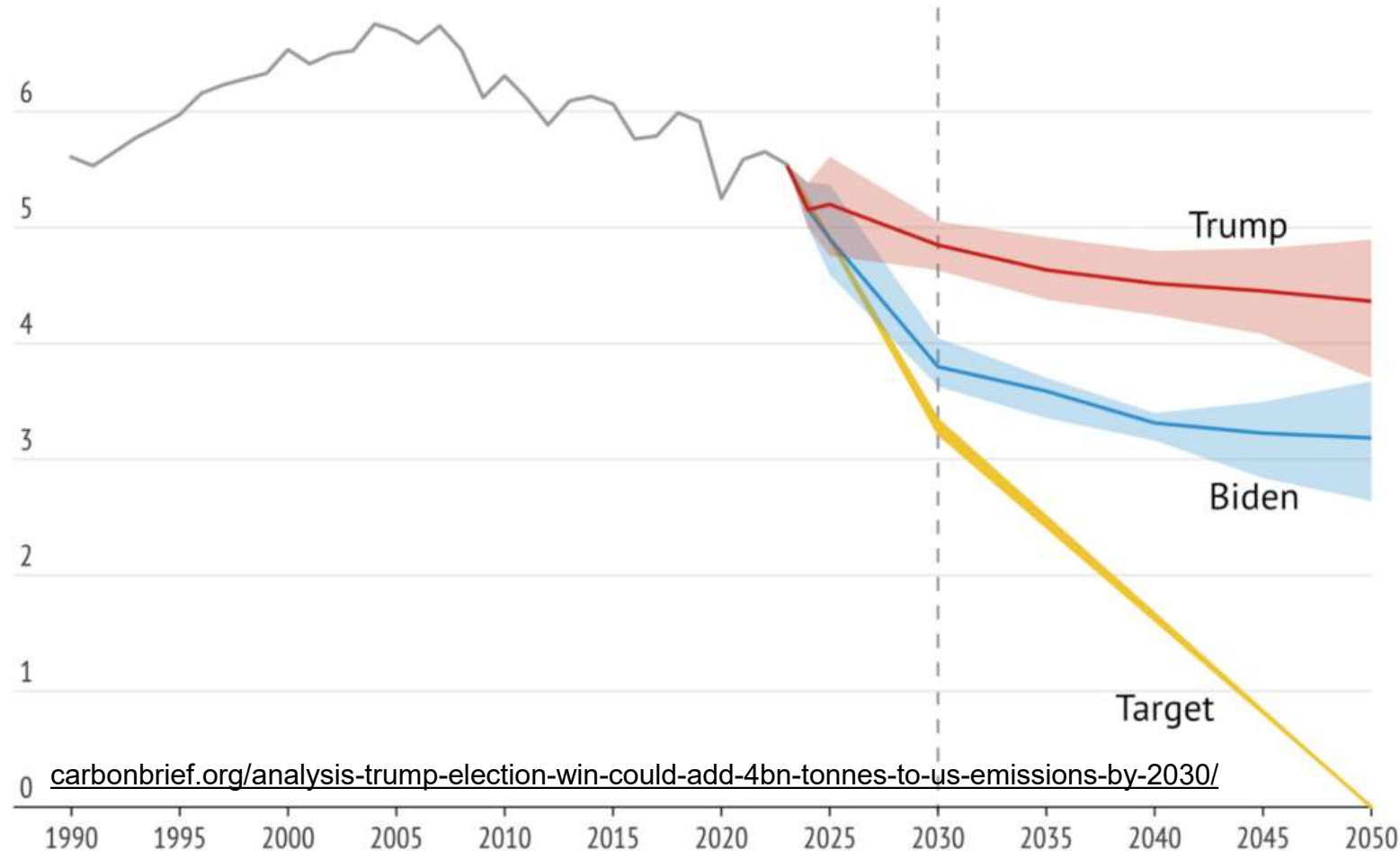


# Implications of Trump Presidency

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 CO<sub>2</sub>e



[carbonbrief.org/analysis-trump-election-win-could-add-4bn-tonnes-to-us-emissions-by-2030/](https://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)

