

# THE PHYSICAL SCIENCE BASIS FOR CLIMATE CHANGE: CAUSES & CONSEQUENCES

Professor Richard Allan

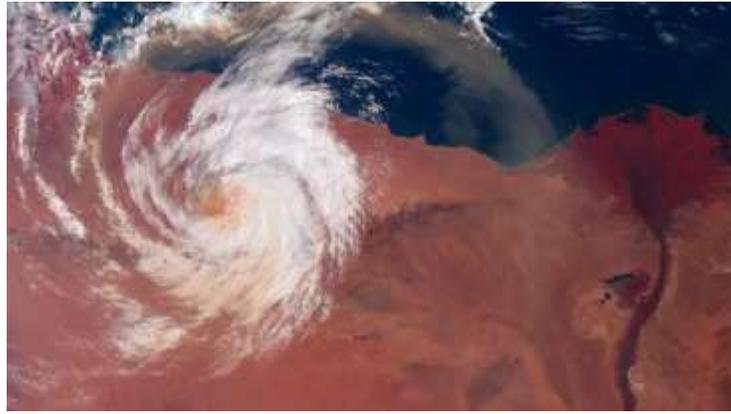
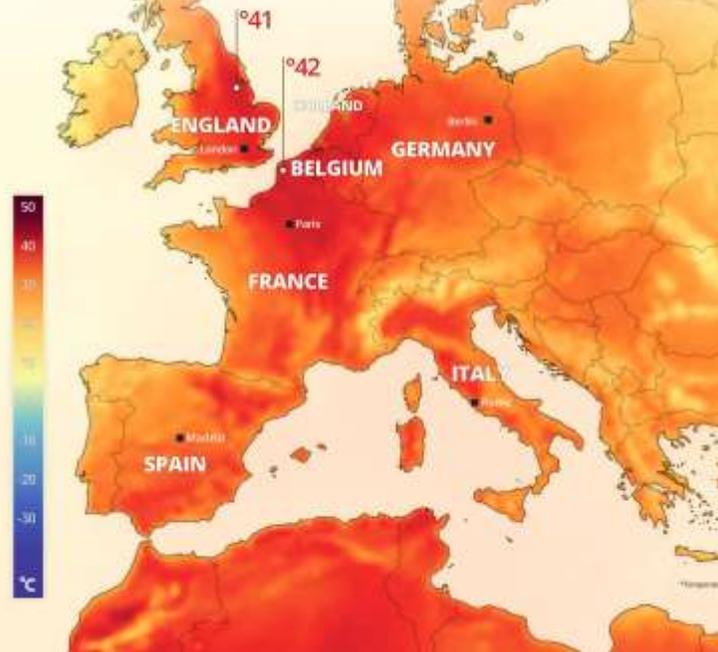
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EV Café Partnership Day, AA Oldbury, 27th September 2023



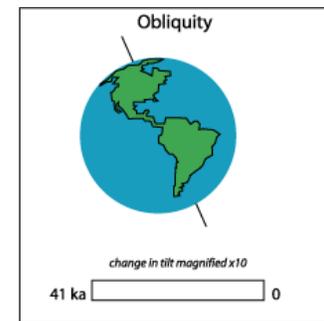
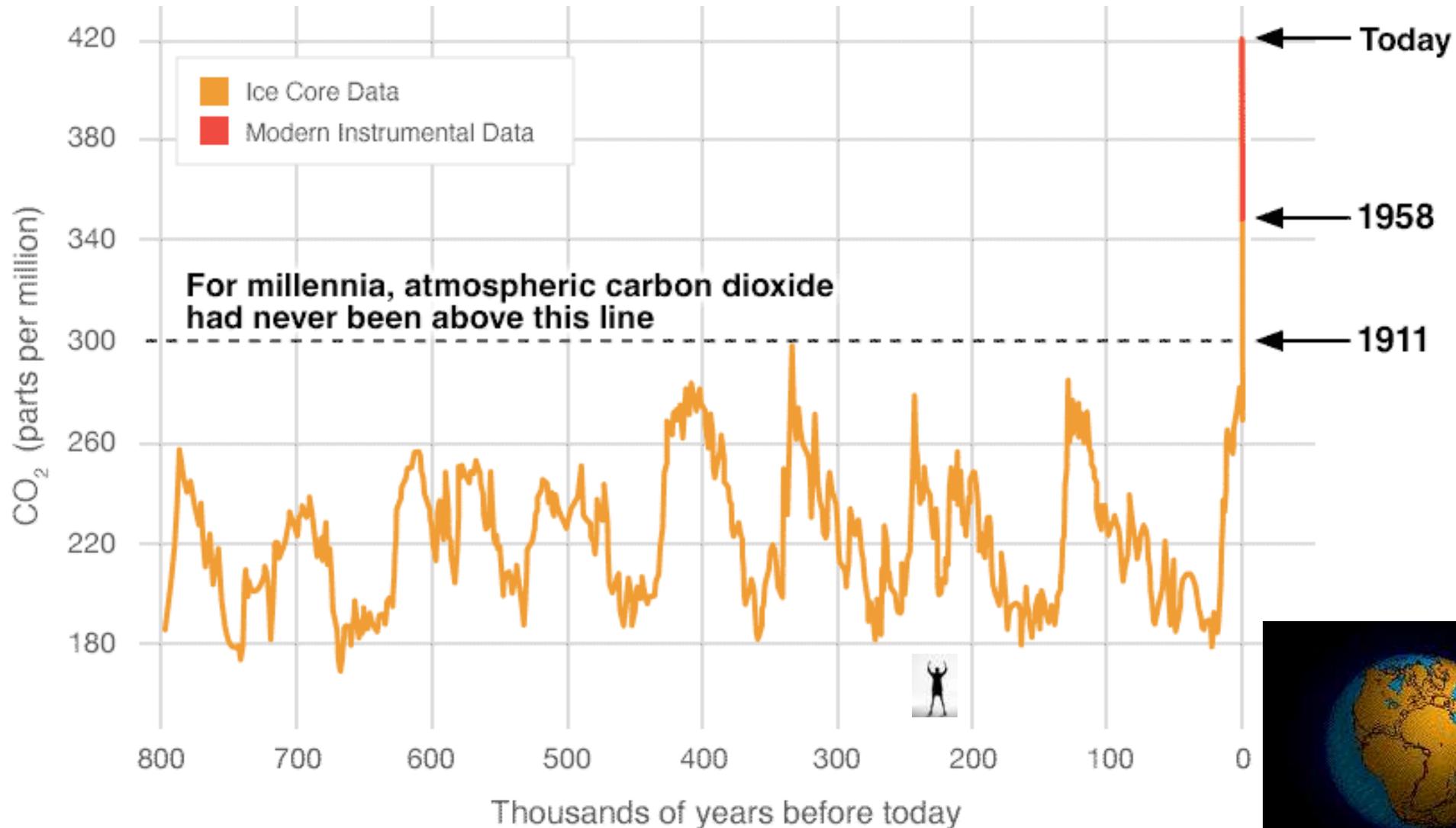
# Europe hit by scorching heatwave



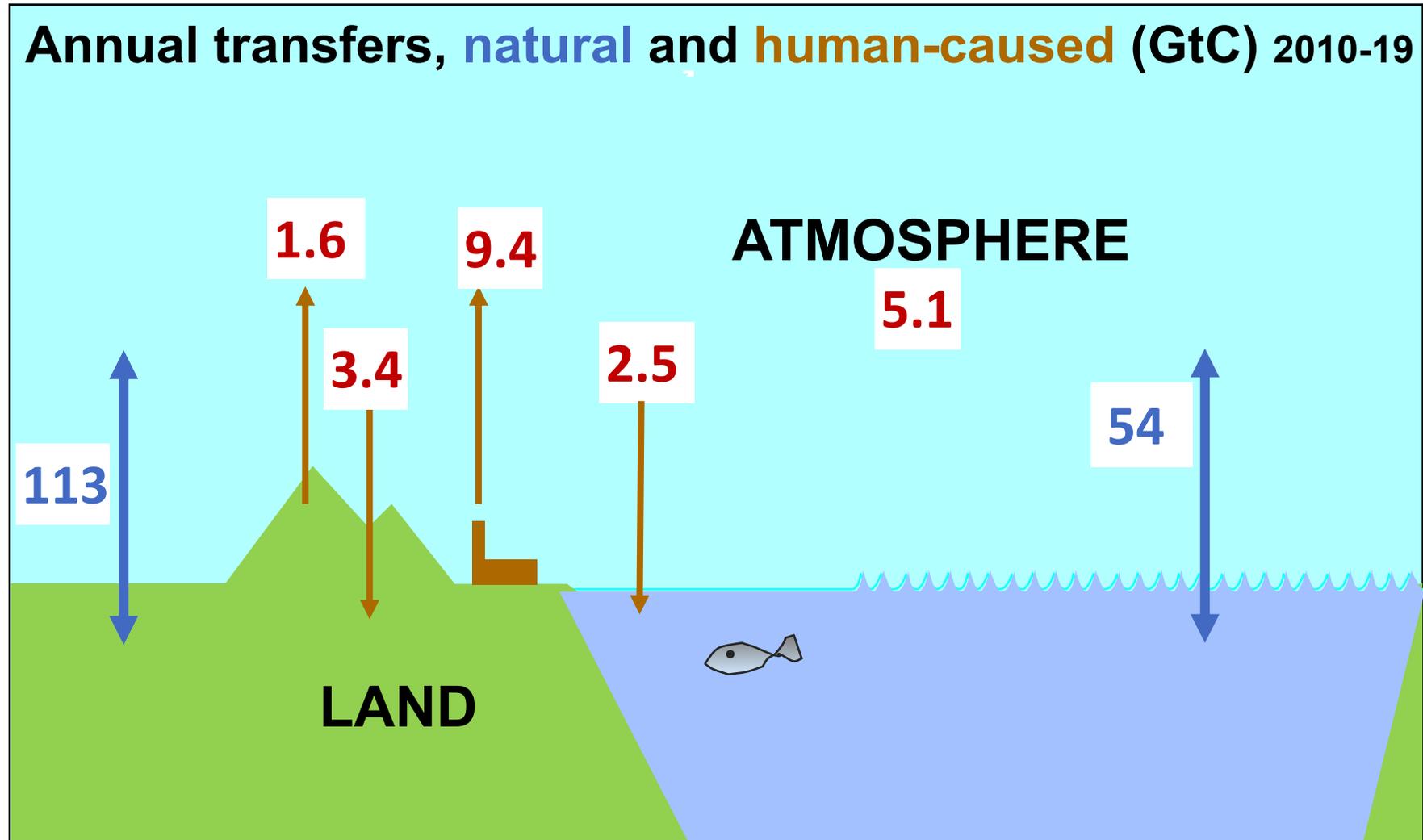
# ONGOING CLIMATE CHANGE



# The climate has always changed. But...



# Natural & human-influenced carbon cycle

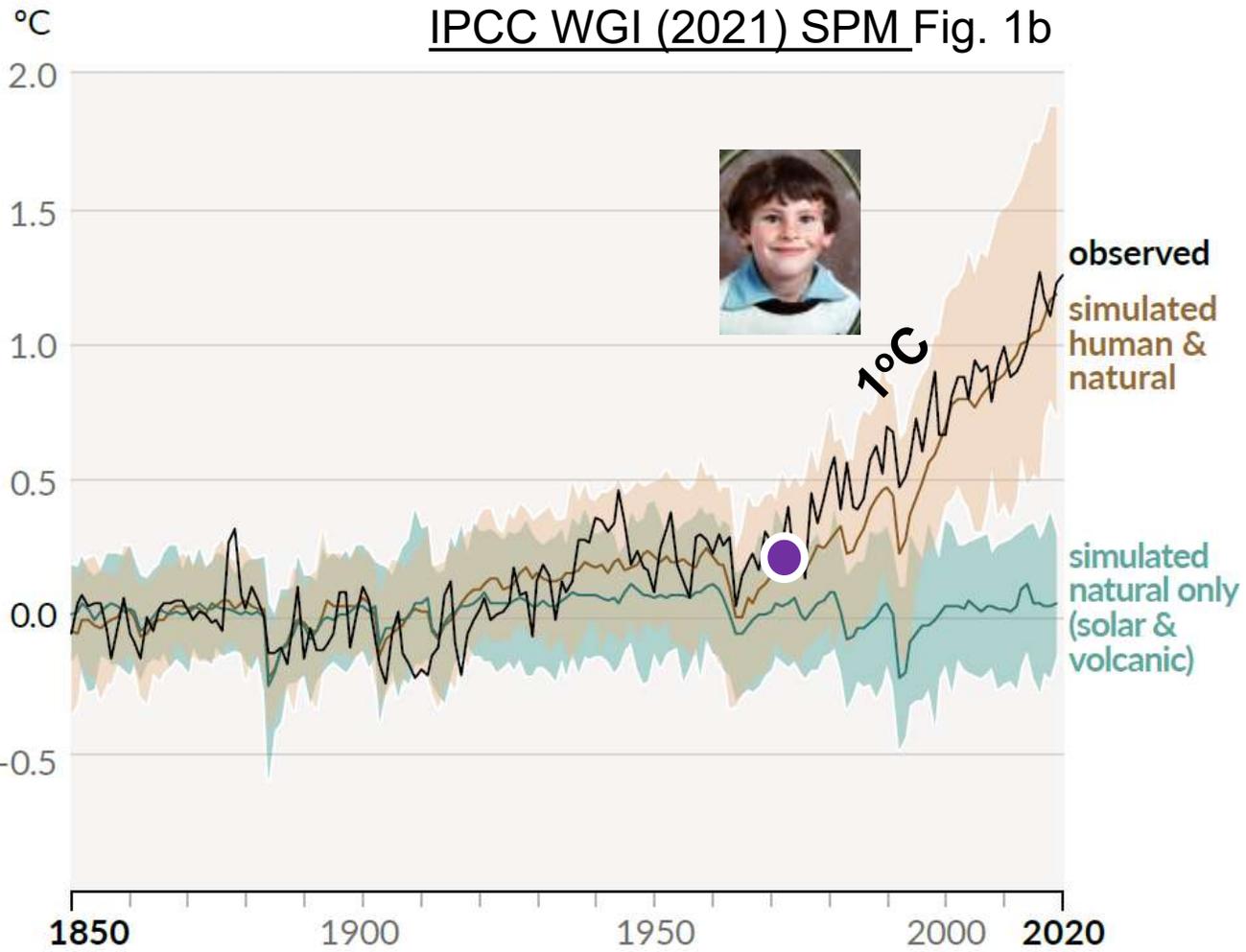


- Human activities have tipped the natural carbon cycle out of balance
- This is driving increases in atmospheric CO<sub>2</sub> concentrations
- CO<sub>2</sub> concentrations highest in at least 2 million years

Values in billions of tonnes of Carbon per year from [IPCC \(2021\) Ch5](#)

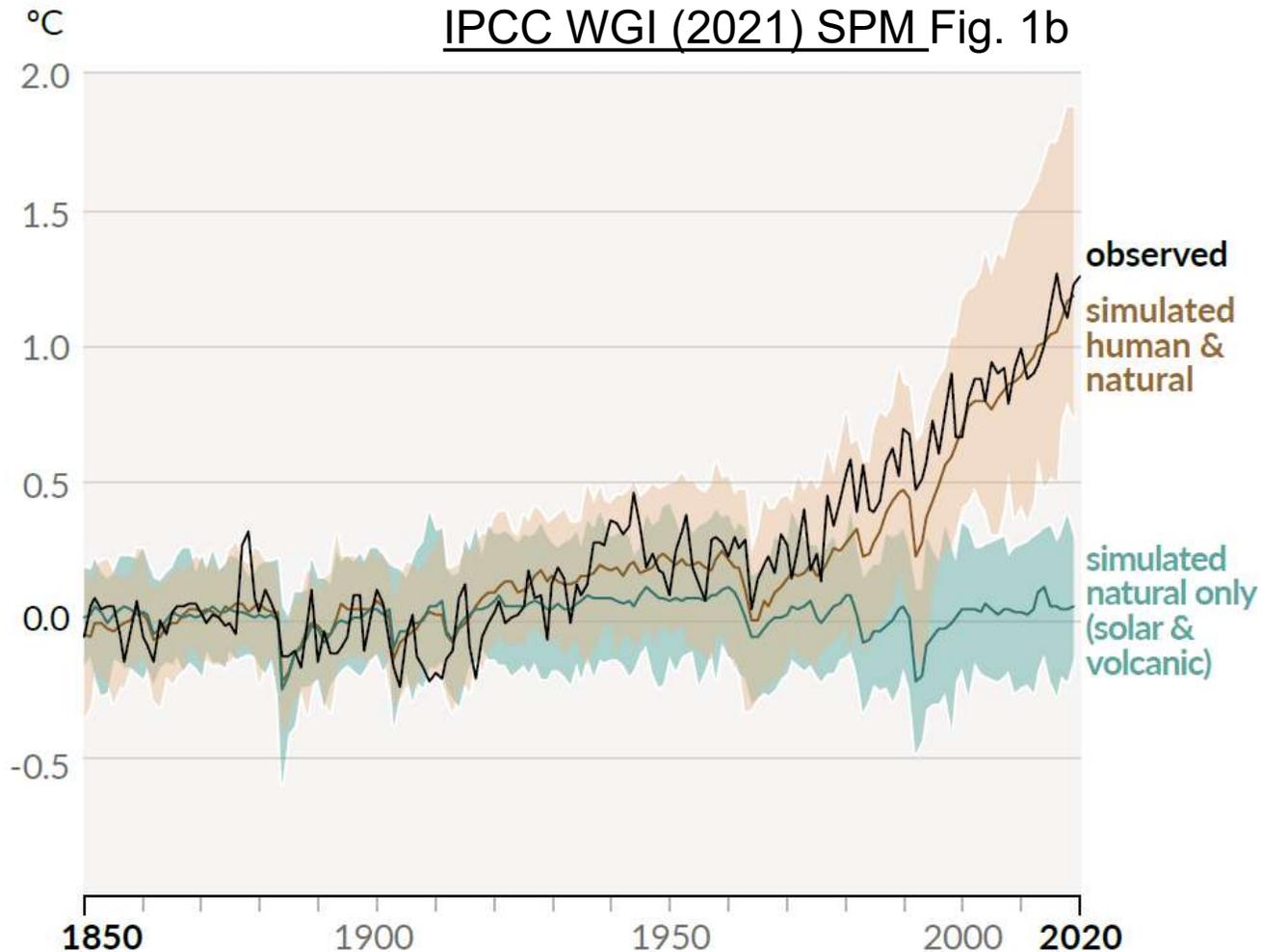
# The planet has warmed by 1°C in last 50 years

I have only moved 7km...



# 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

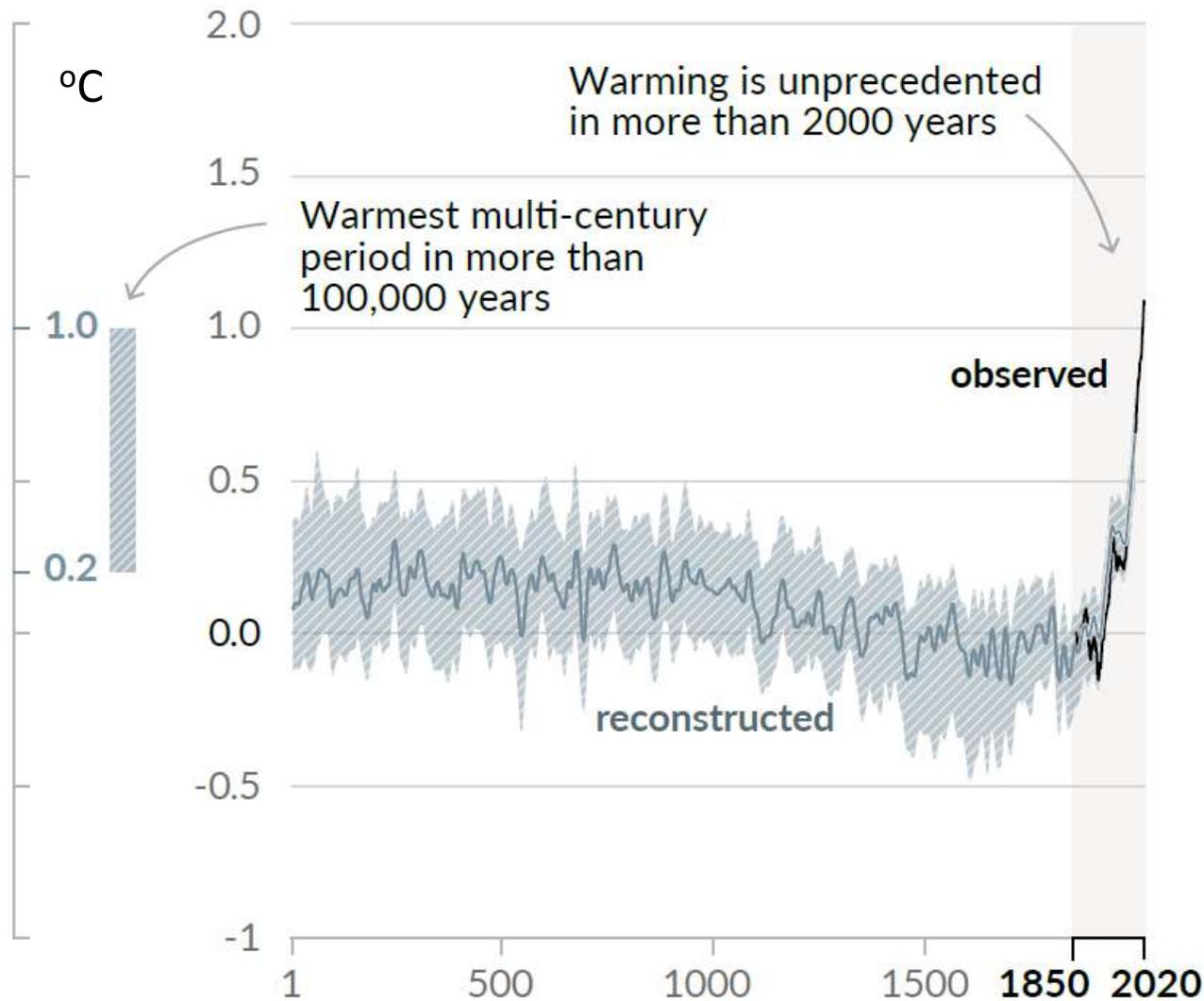


► Greenhouse gas warming has been partly masked by aerosol cooling



► 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]

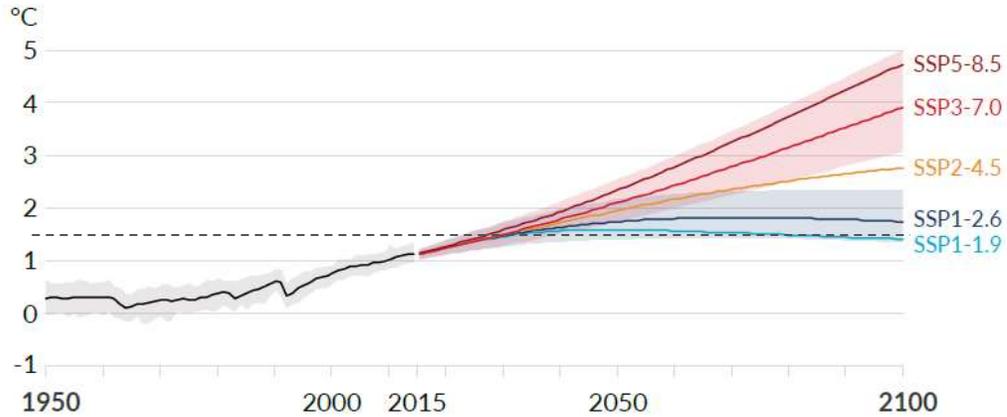


“ Continued global warming is projected to further intensify the global water cycle, including its variability, global monsoon precipitation and the severity of wet and dry events.

# 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

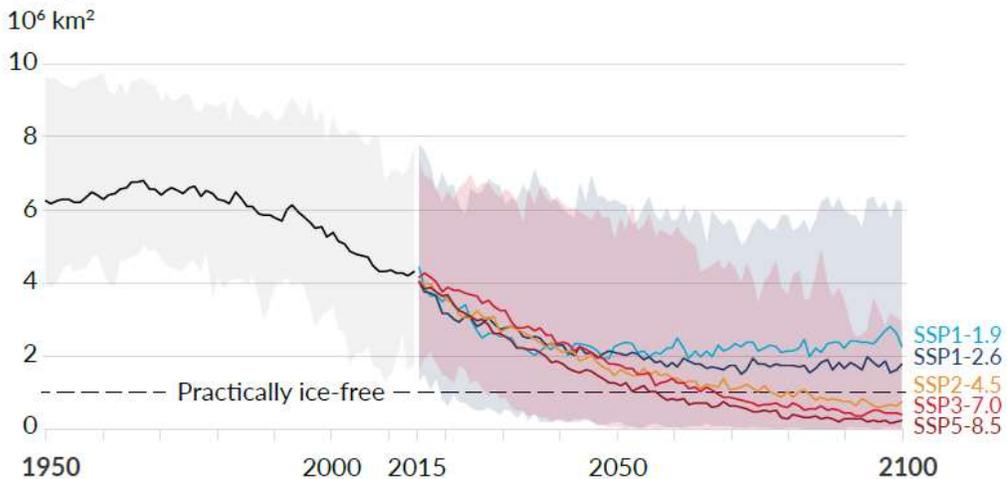


Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in CO<sub>2</sub> and other greenhouse gas emissions occur in the coming decades

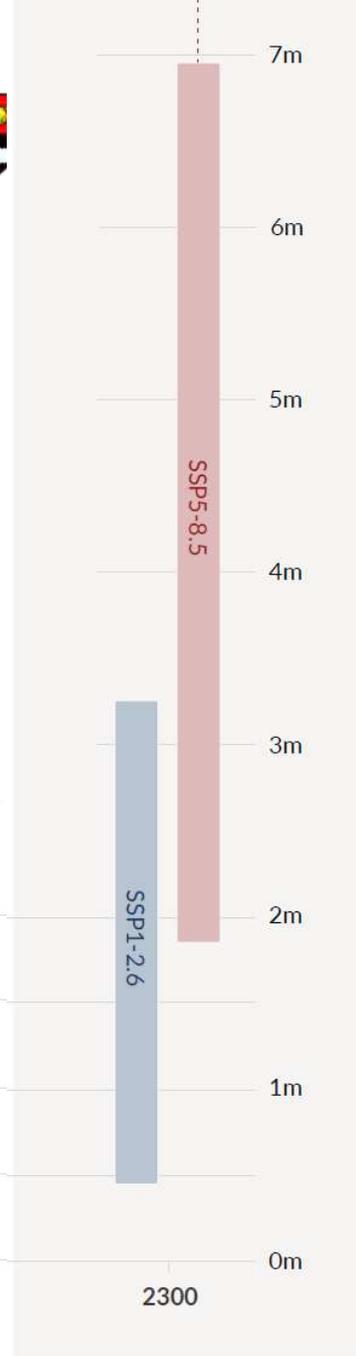
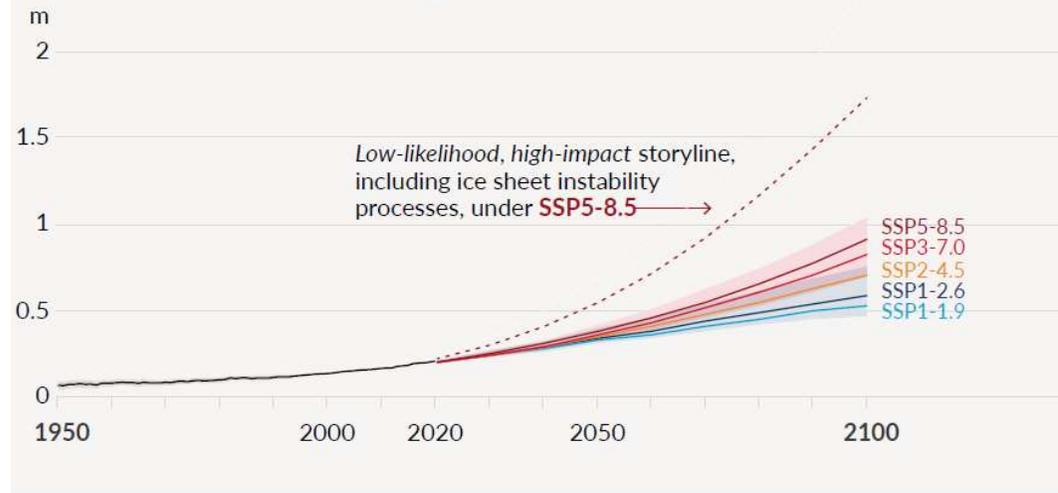
[IPCC (2021) WG1 SPM]

High emissions  
Low emissions

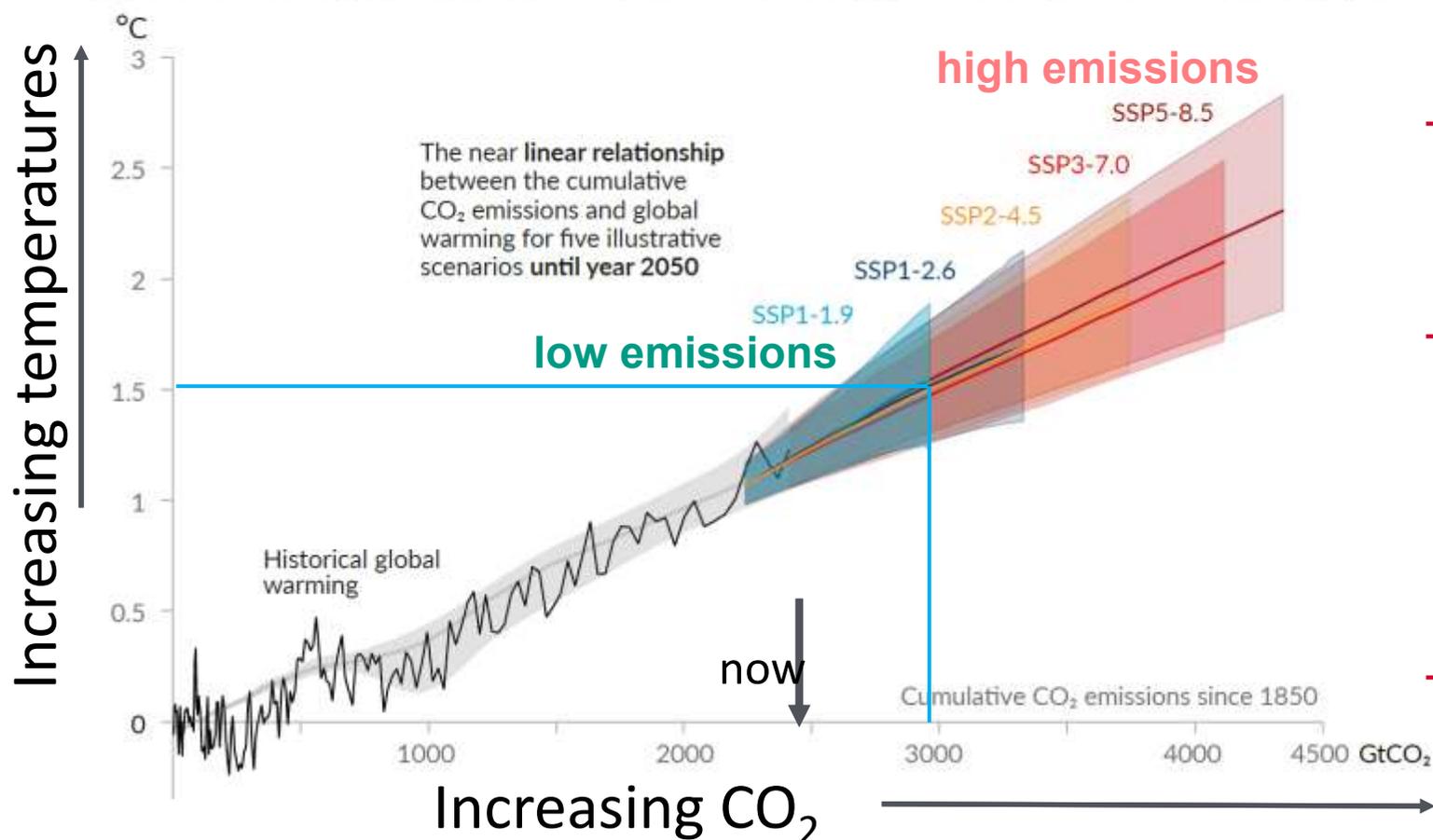
b) September Arctic sea ice area



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

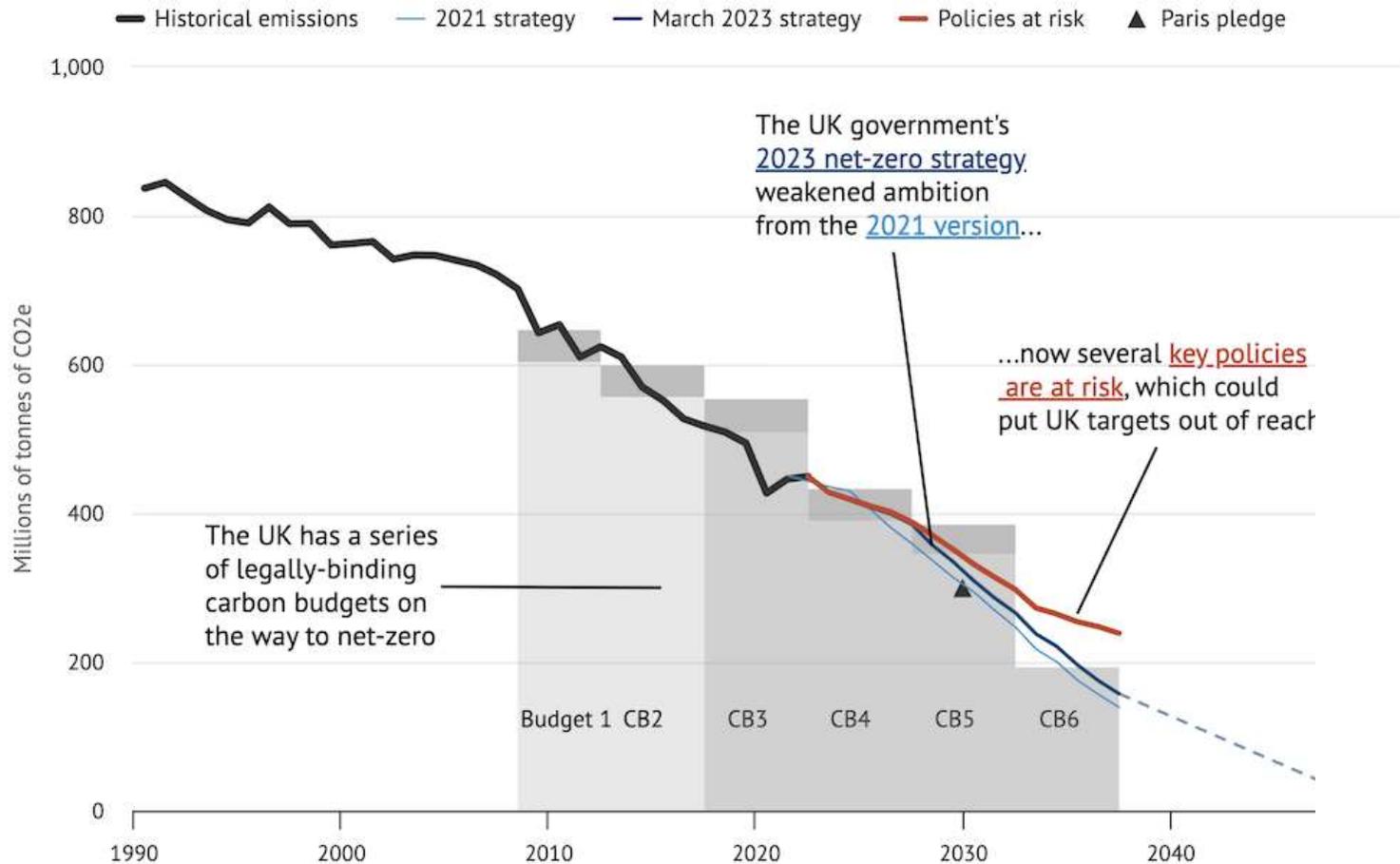
Joeri Rogelj (*IPCC AR6 & SR1.5 author*)

# Implications of UK Government U-turns

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

## UK government's climate policy U-turns could put legal targets out of reach

The government had already weakened its ambition in its March 2023 net-zero strategy



IPCC called for rapid reductions to minimise total emissions

CO<sub>2</sub> Emissions

Rapid near-term cuts, buying time to tackle the tougher challenges.

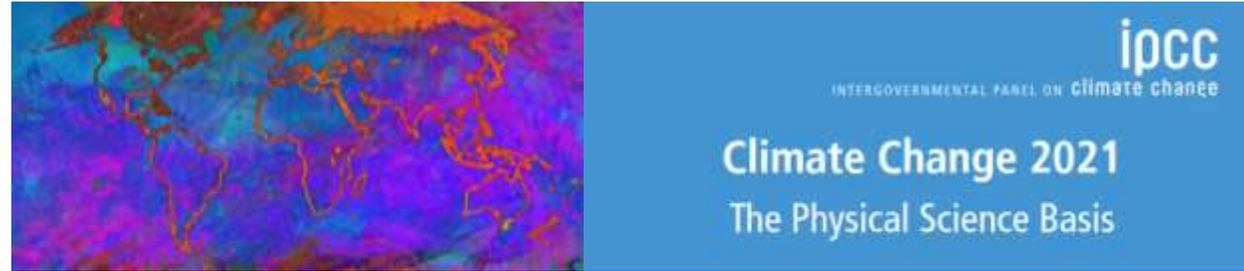
Indicative UK path: emissions far too high along the way to Net Zero

CO<sub>2</sub> Emissions

Promises for tomorrow with little action now.  
Twice the total emissions even if we still reached net zero in 2050.

2020 2030 2040 2050

# Key Messages

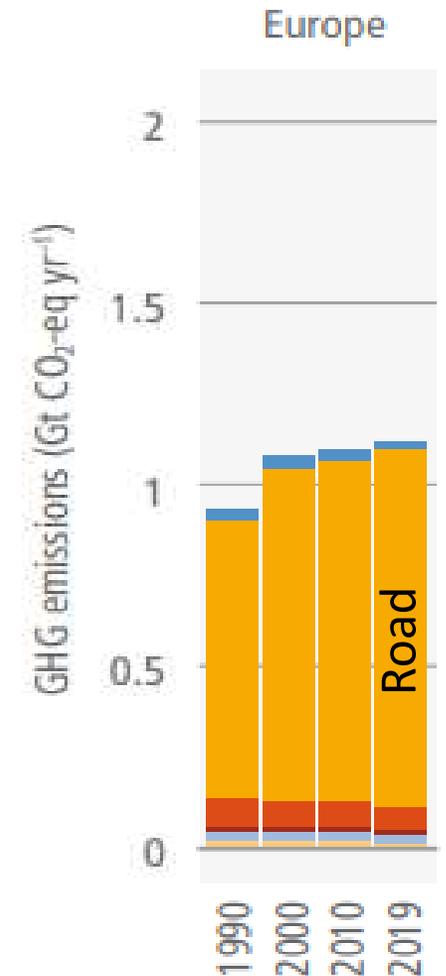


- Earth's climate has always varied but it is an established fact that human activities are now driving climate change
- Recent changes in climate are widespread, rapid and unprecedented in thousands of years.
- Human activities are intensifying extreme climate events, including heat waves, heavy rainfall, 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



# 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

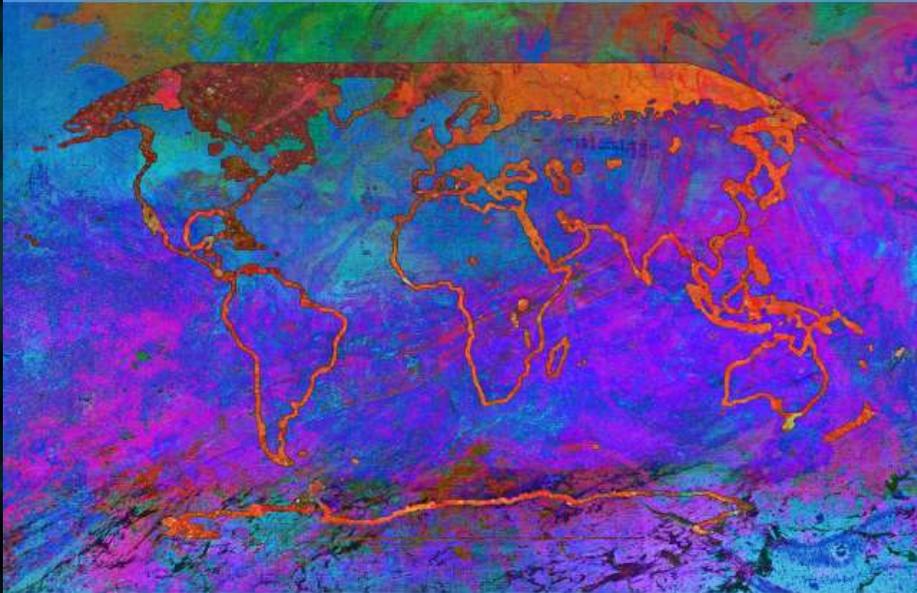


ipcc

INTERGOVERNMENTAL PANEL ON climate change

# Climate Change 2021

The Physical Science Basis



WGI

Working Group I contribution to the  
Sixth Assessment Report of the  
Intergovernmental Panel on Climate Change



IPCC (2023)  
Synthesis Report  
published Monday  
20<sup>th</sup> March

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