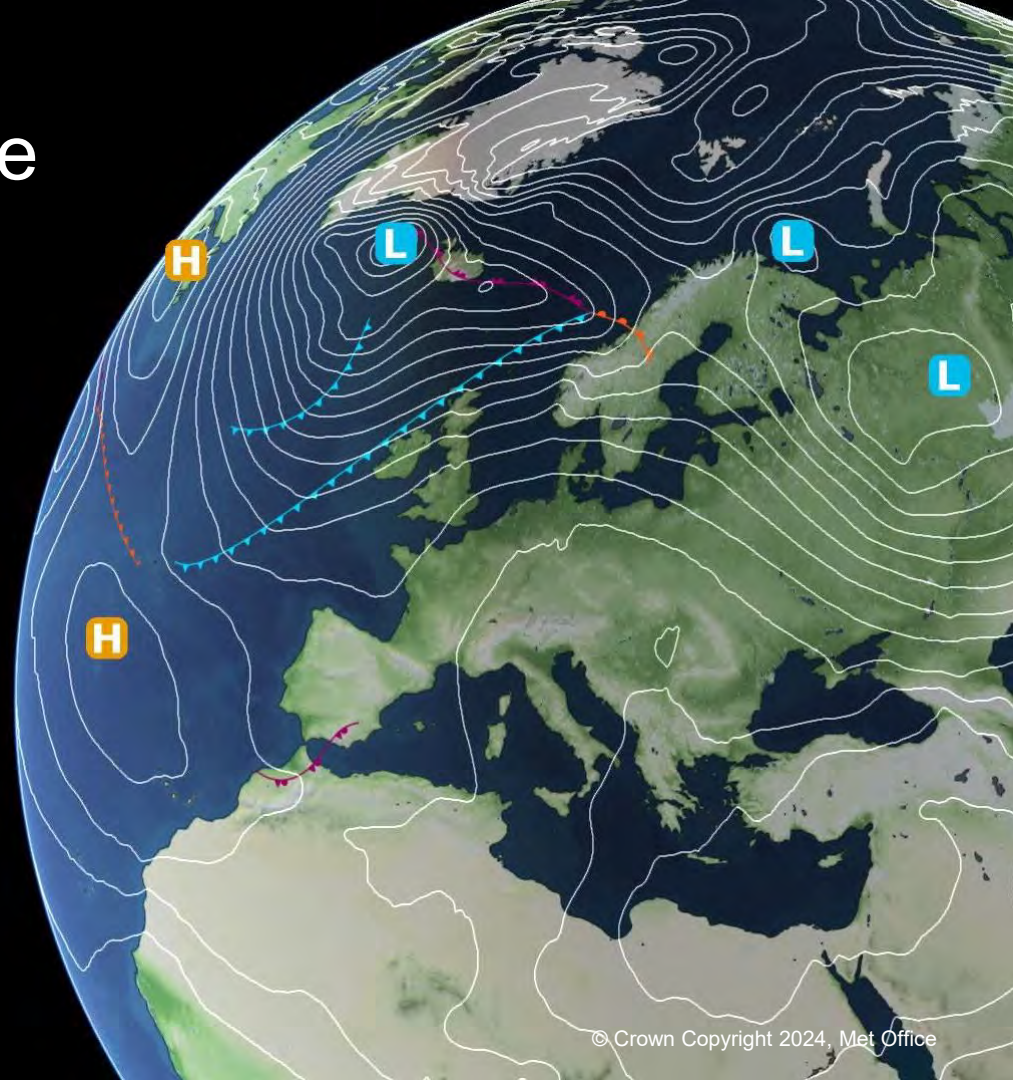


Welcome to the Met Office Climate Change & Community Course

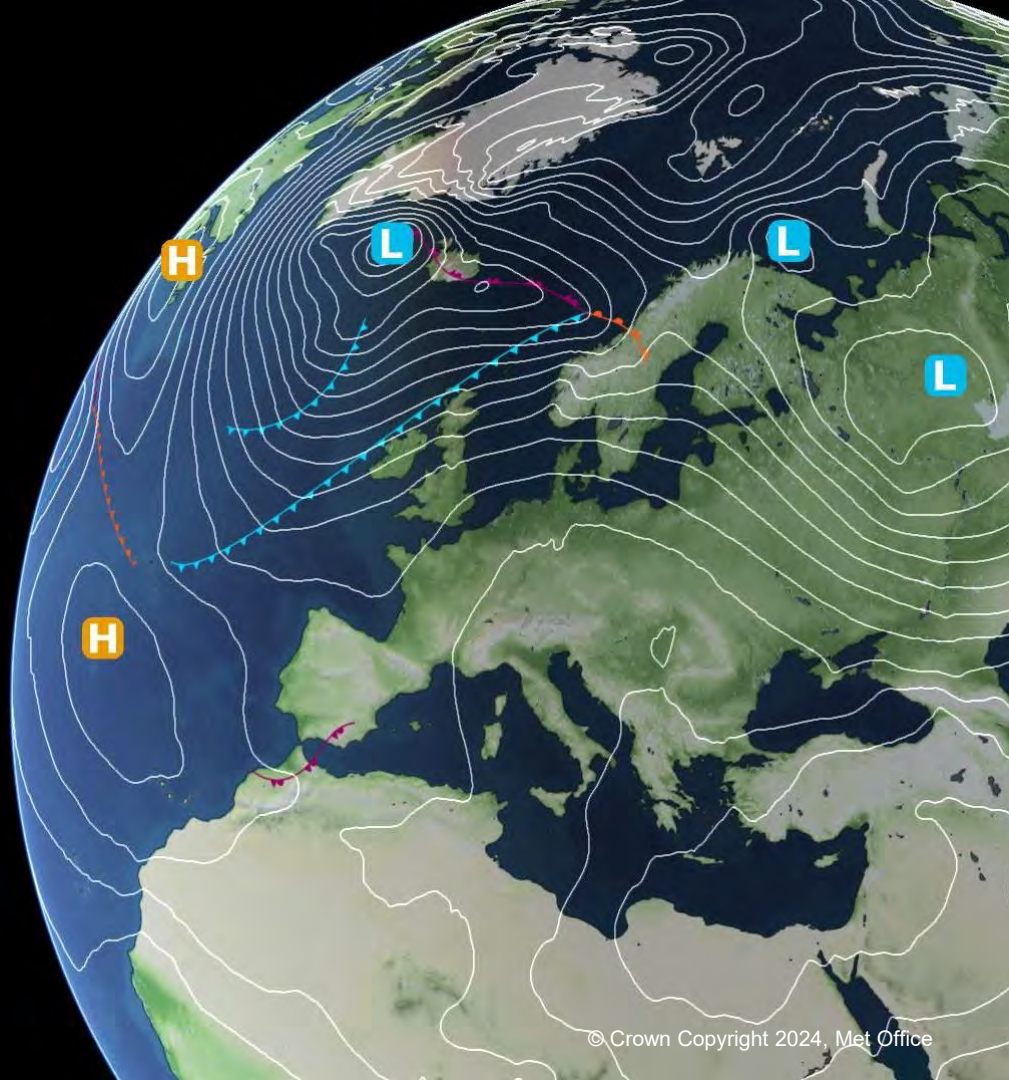
We are glad you could join us today.

Please ensure your video is off and
your microphone is muted.

If you have any questions during the
course please use the chat function.



Climate Science & Projections



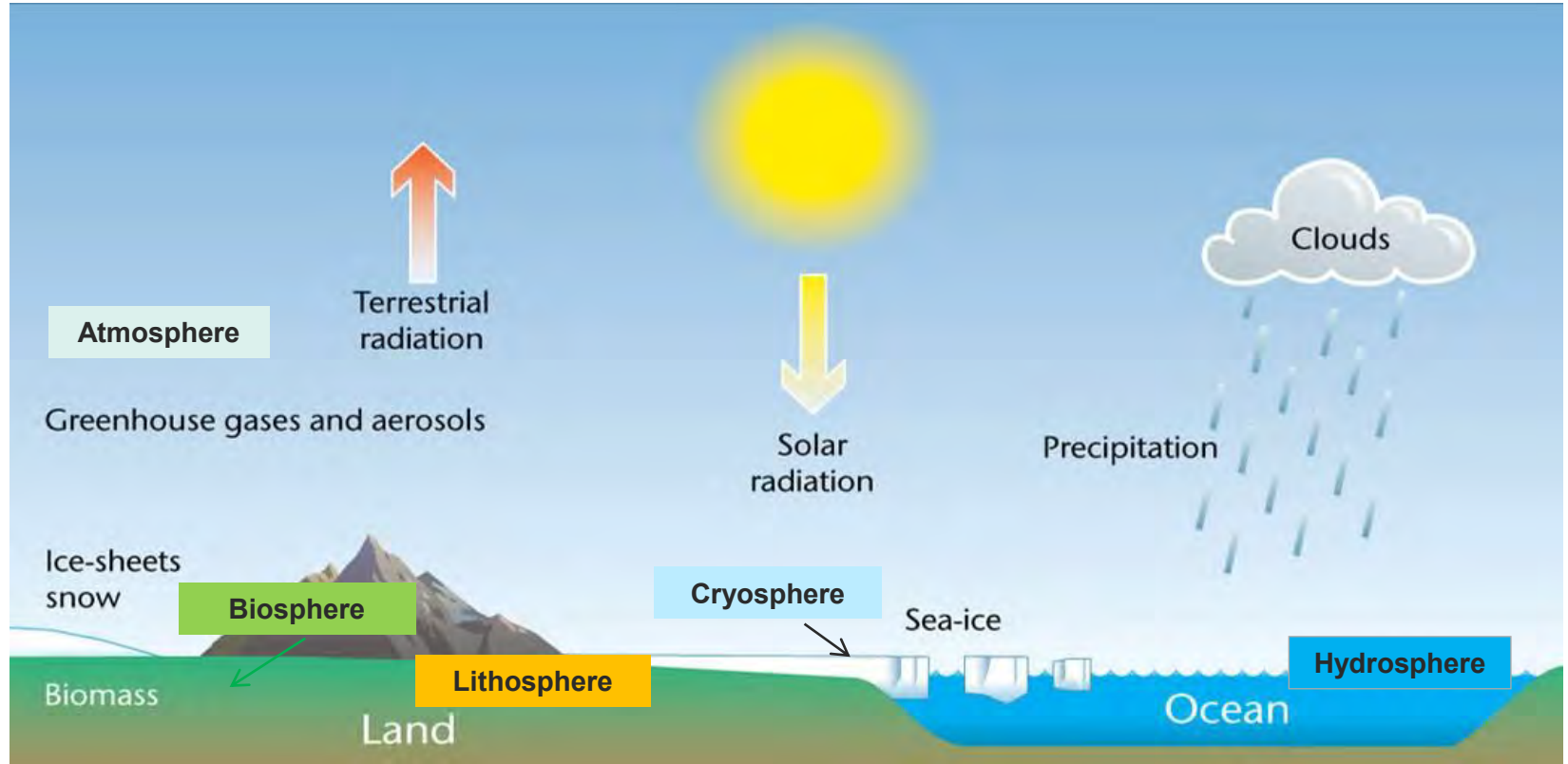
Fundamentals of climate science



“Climate is what
we expect,
weather is
what we get”

Robert Heinlein





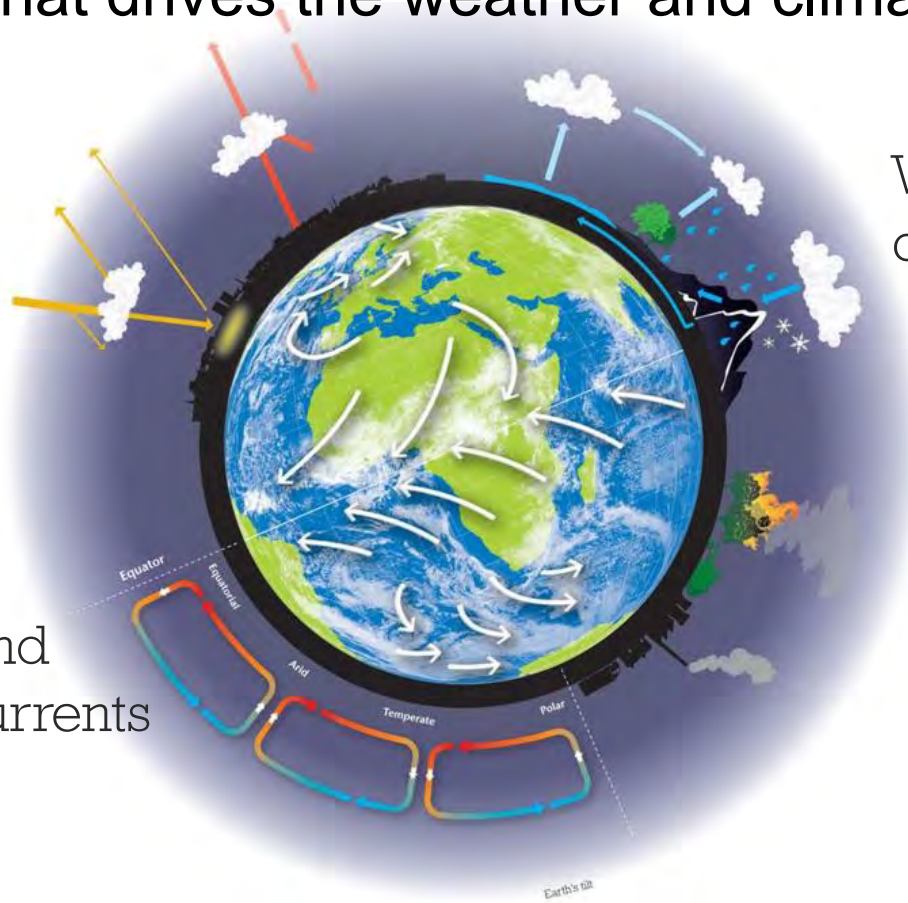
Met Office OFFICIAL What drives the weather and climate

Energy cycle

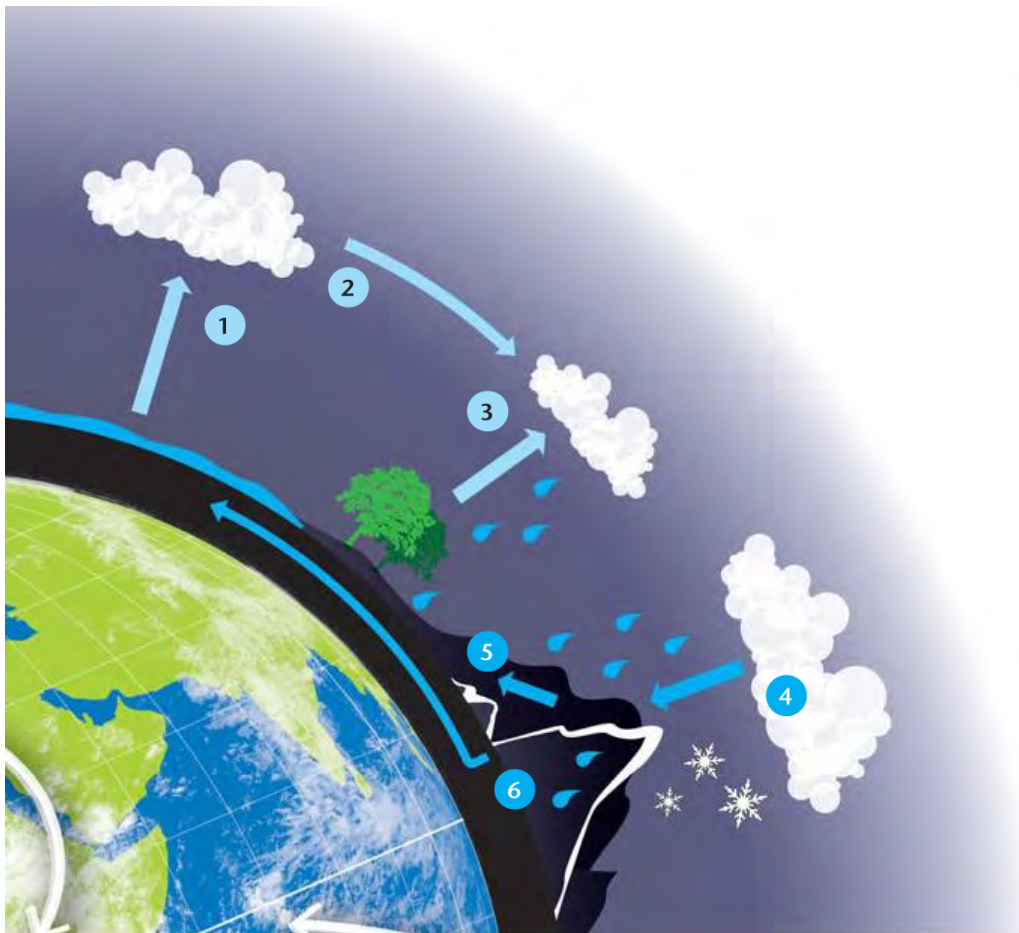
Water cycle

Winds and ocean currents

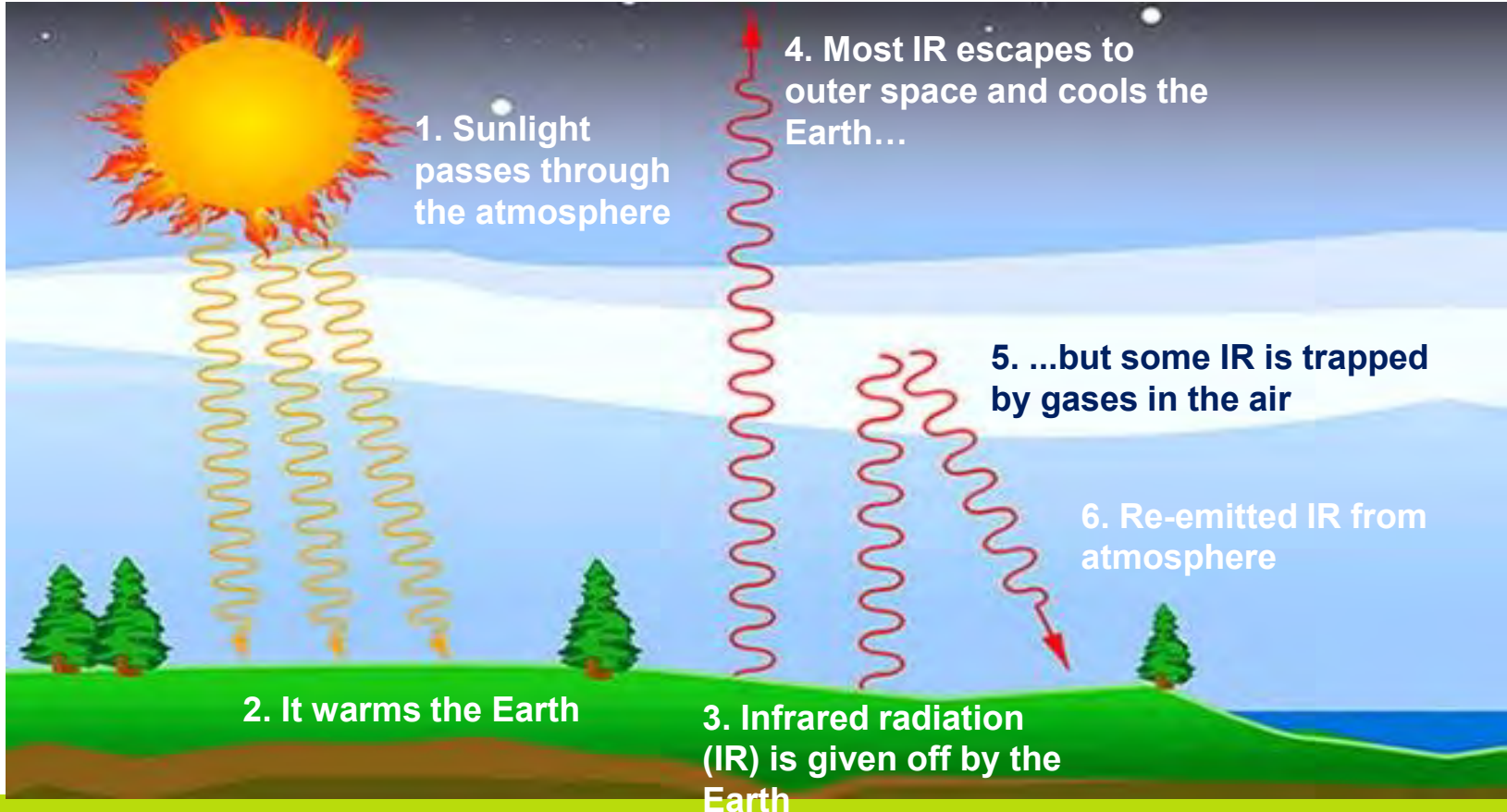
Change



The Water Cycle



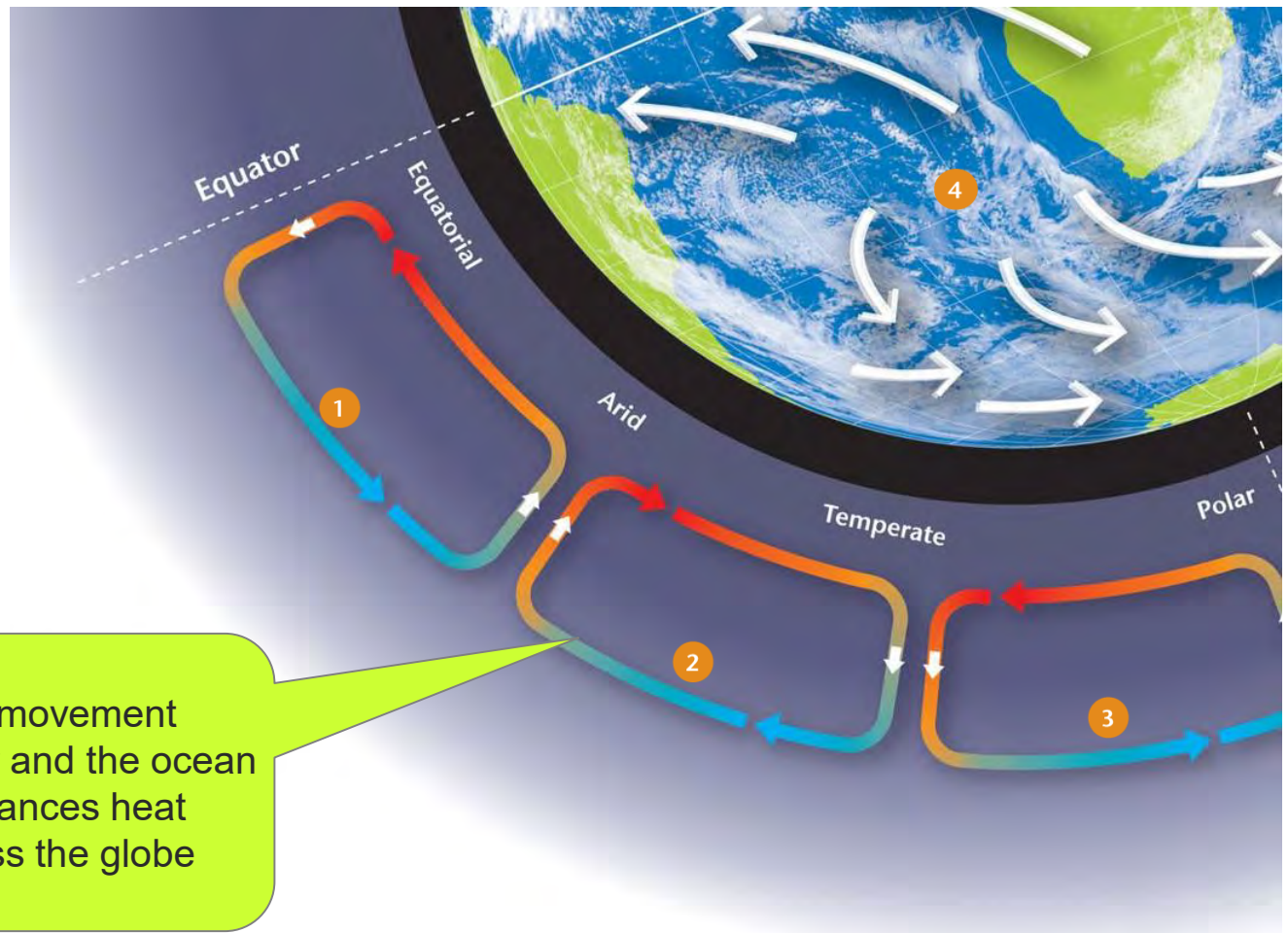
- 1 Water evaporates from rivers, lakes and the ocean
- 2 Water condenses to form clouds
- 3 Loss of water from plants, soil, animals and people
- 4 Water returns to land as precipitation
- 5 Water carried downhill by rivers
- 6 Water seeps into ground and flows to sea



Winds and ocean currents

- 1 Hadley cell
- 2 Ferrel cell
- 3 Polar cell
- 4 Trade winds

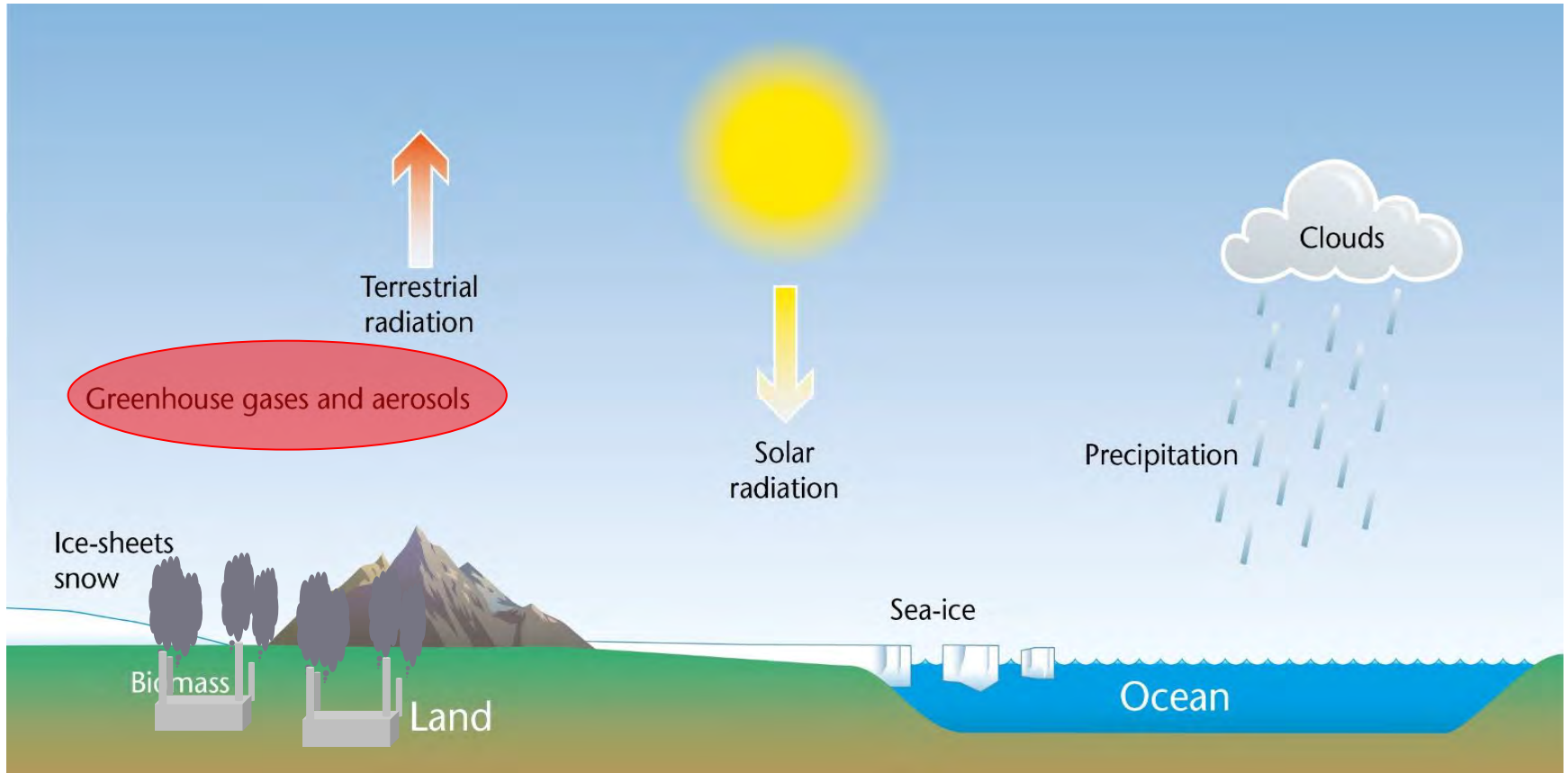
The movement of the air and the ocean rebalances heat across the globe



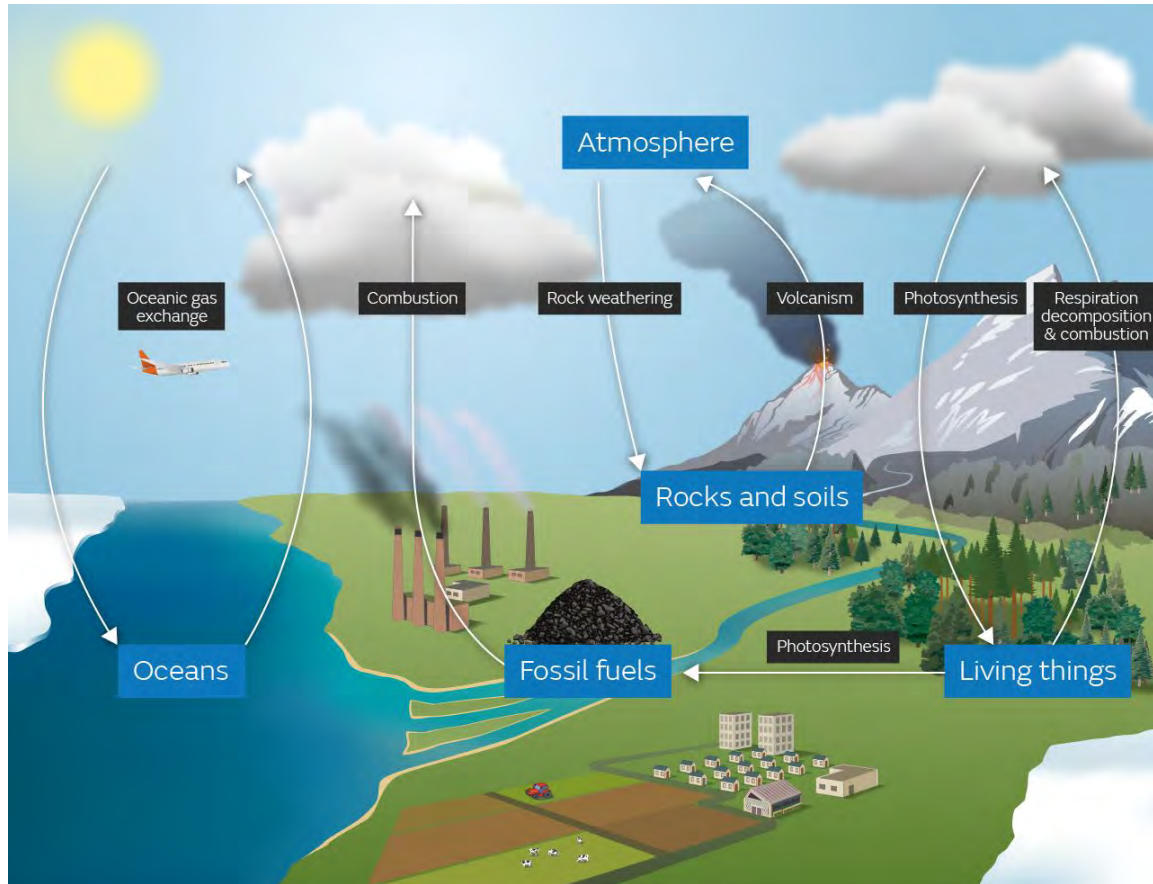
One thing changes everything



OFFICIAL
Unbalancing the Climate System



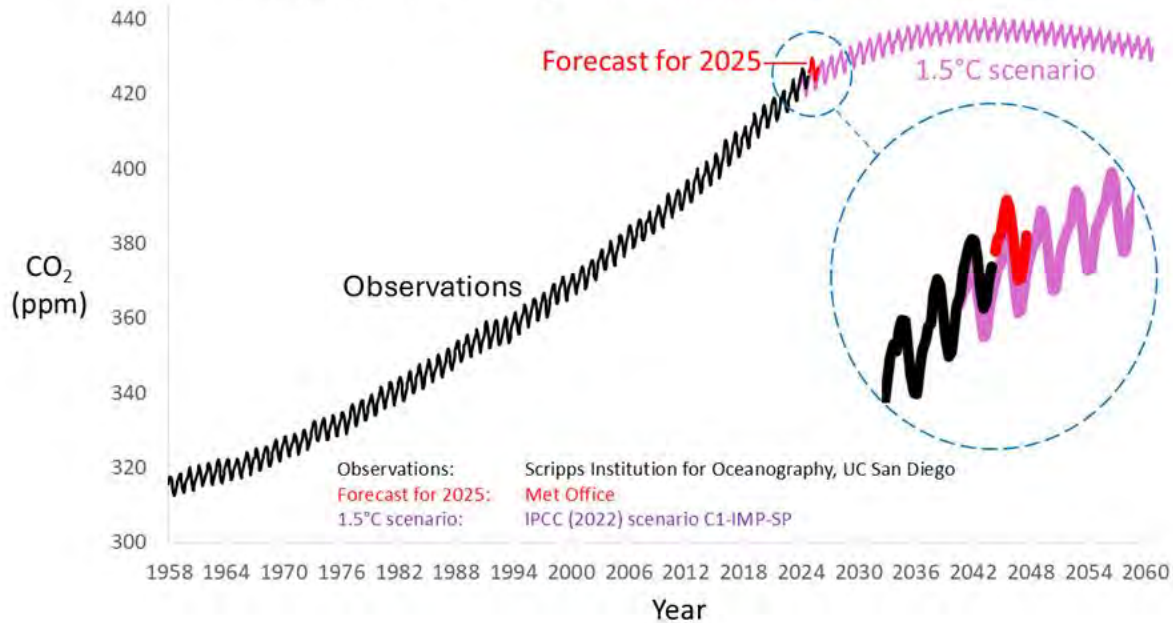
OFFICIAL The Carbon Cycle



Greenhouse Gas Emissions

Atmospheric CO₂ continues to rise

Atmospheric CO₂ concentration at Mauna Loa

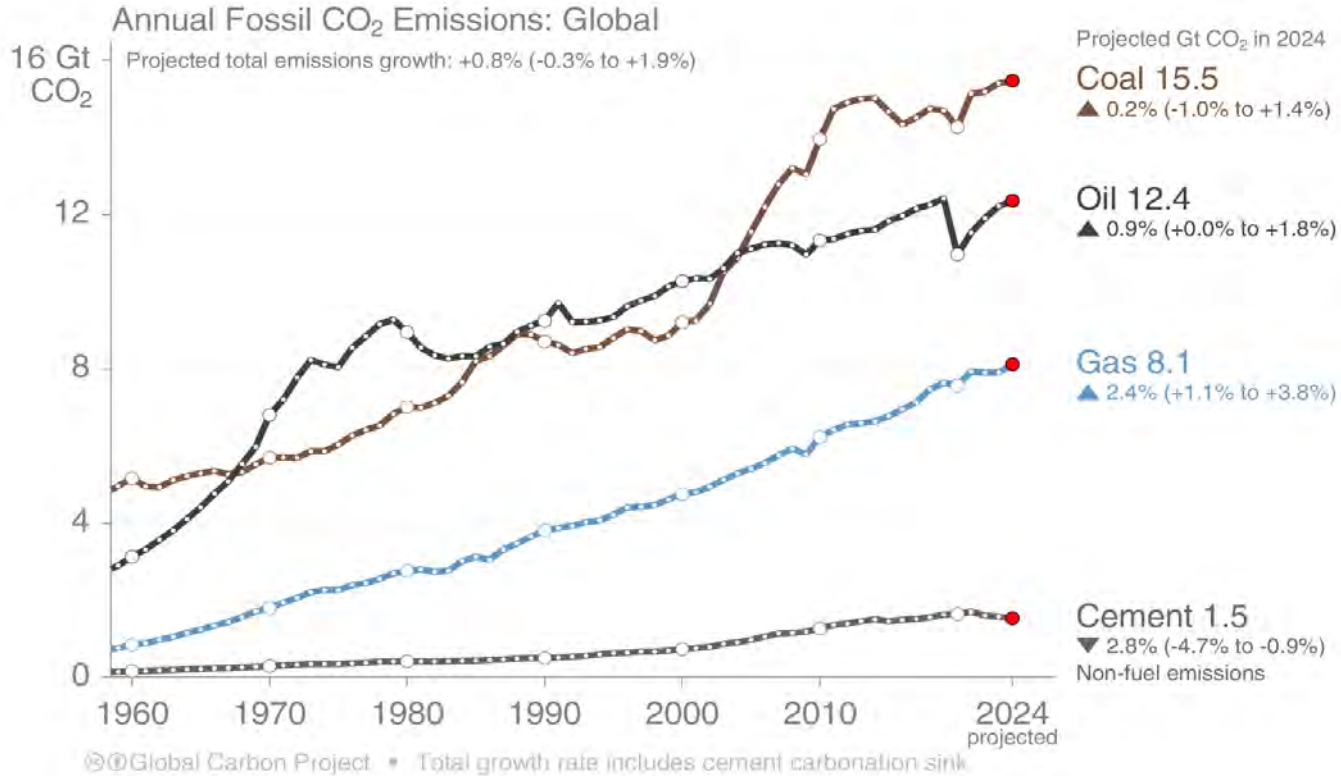


February 2025: 427.09 ppm

February 2024: 424.55 ppm

Last updated: Mar 05, 2025

CO₂ Emission Sources

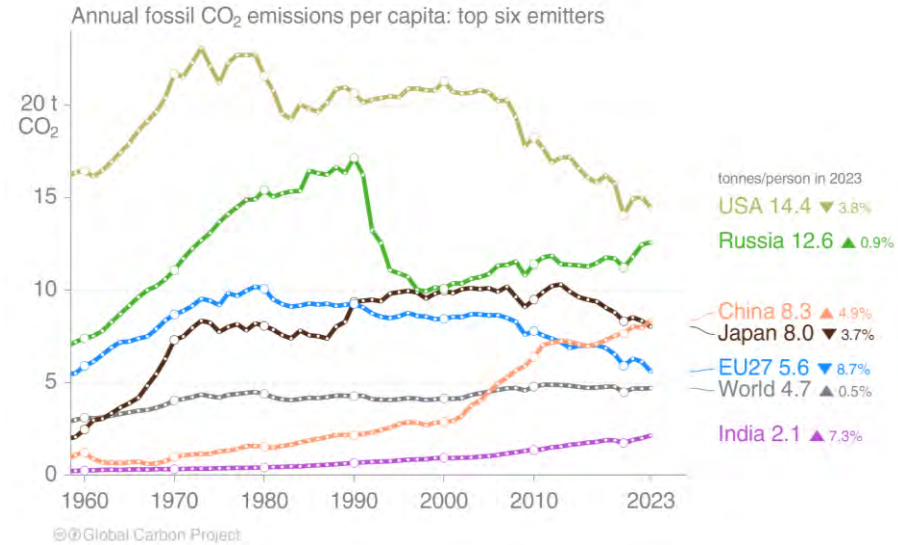
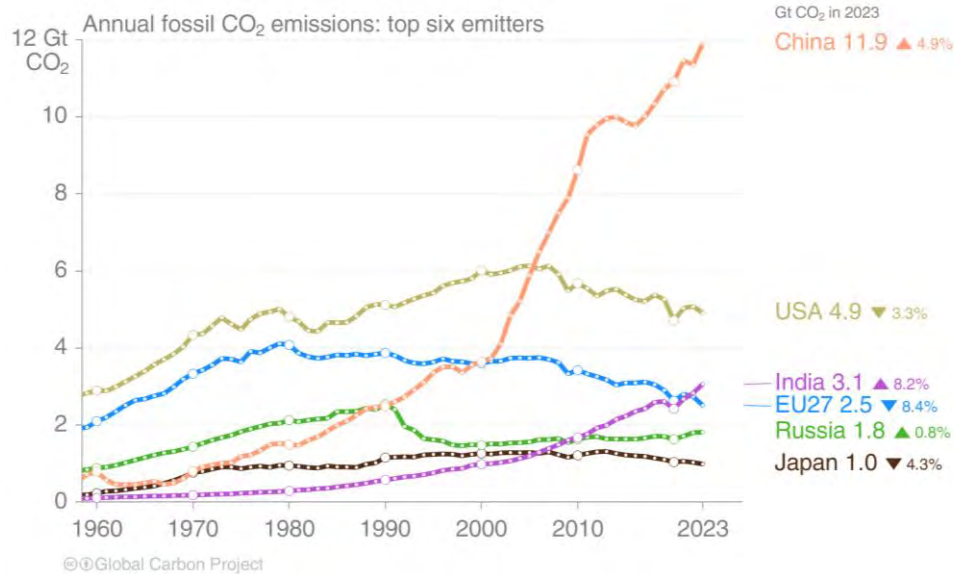


<https://globalcarbonbudget.org/carbonbudget2024/>

6 Top CO₂ emitters

6 Top CO₂ emitters by country / region

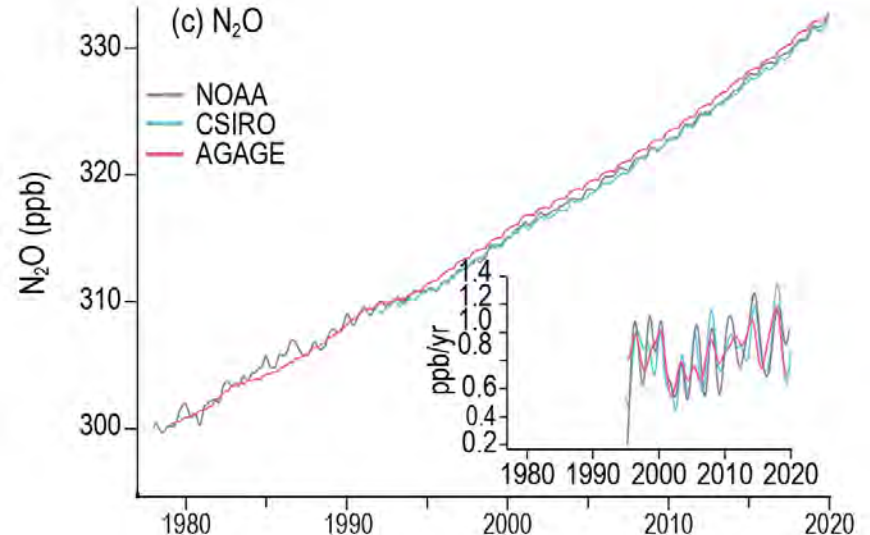
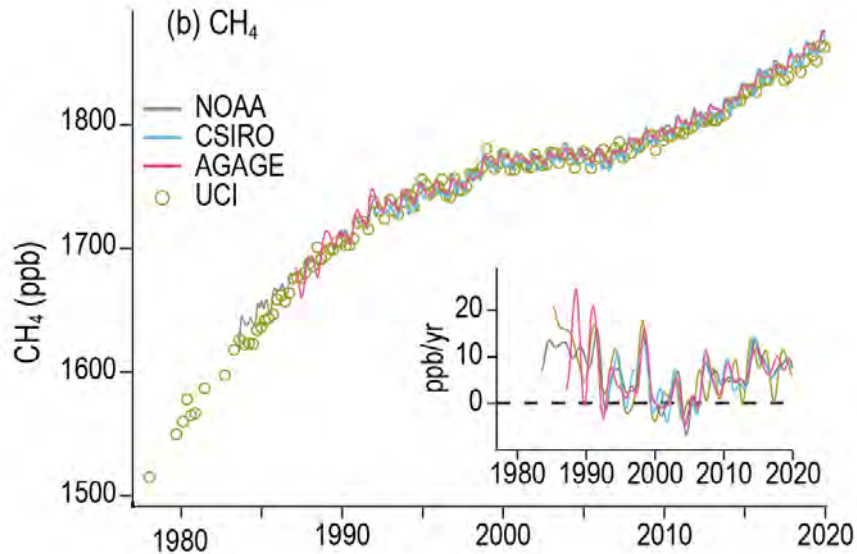
6 Top CO₂ emitters per capita



<https://globalcarbonbudget.org/carbonbudget2024/>

CO₂ is not the only greenhouse gas

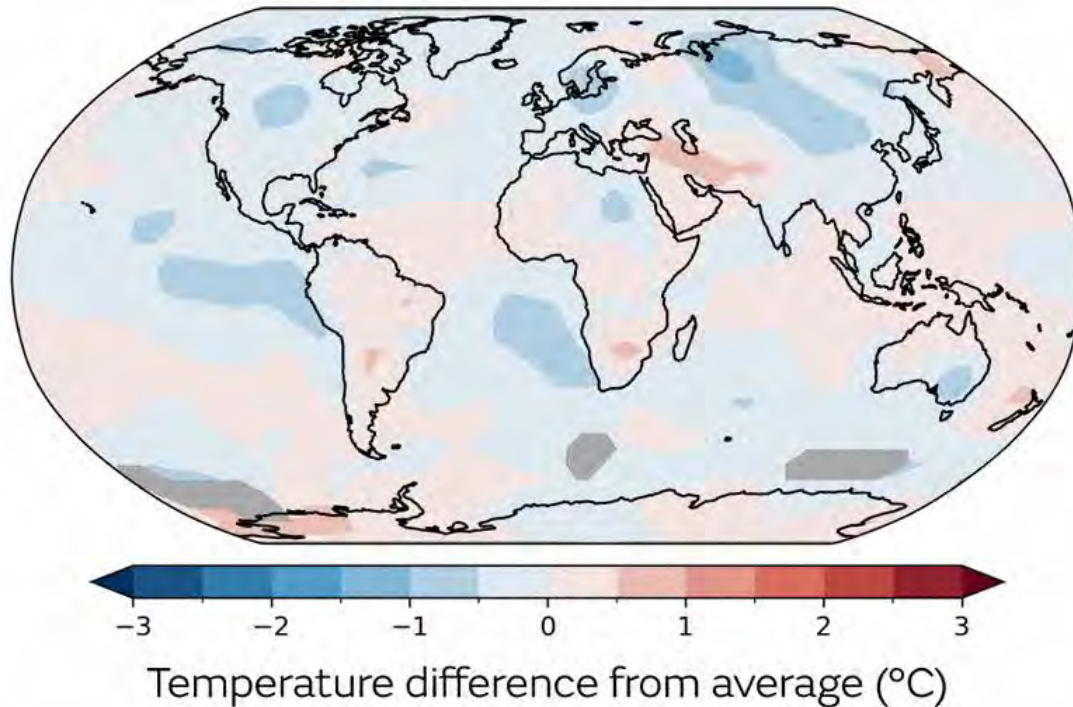
Methane (CH₄) and Nitrous Oxide (N₂O) are the most important greenhouse gases of many.



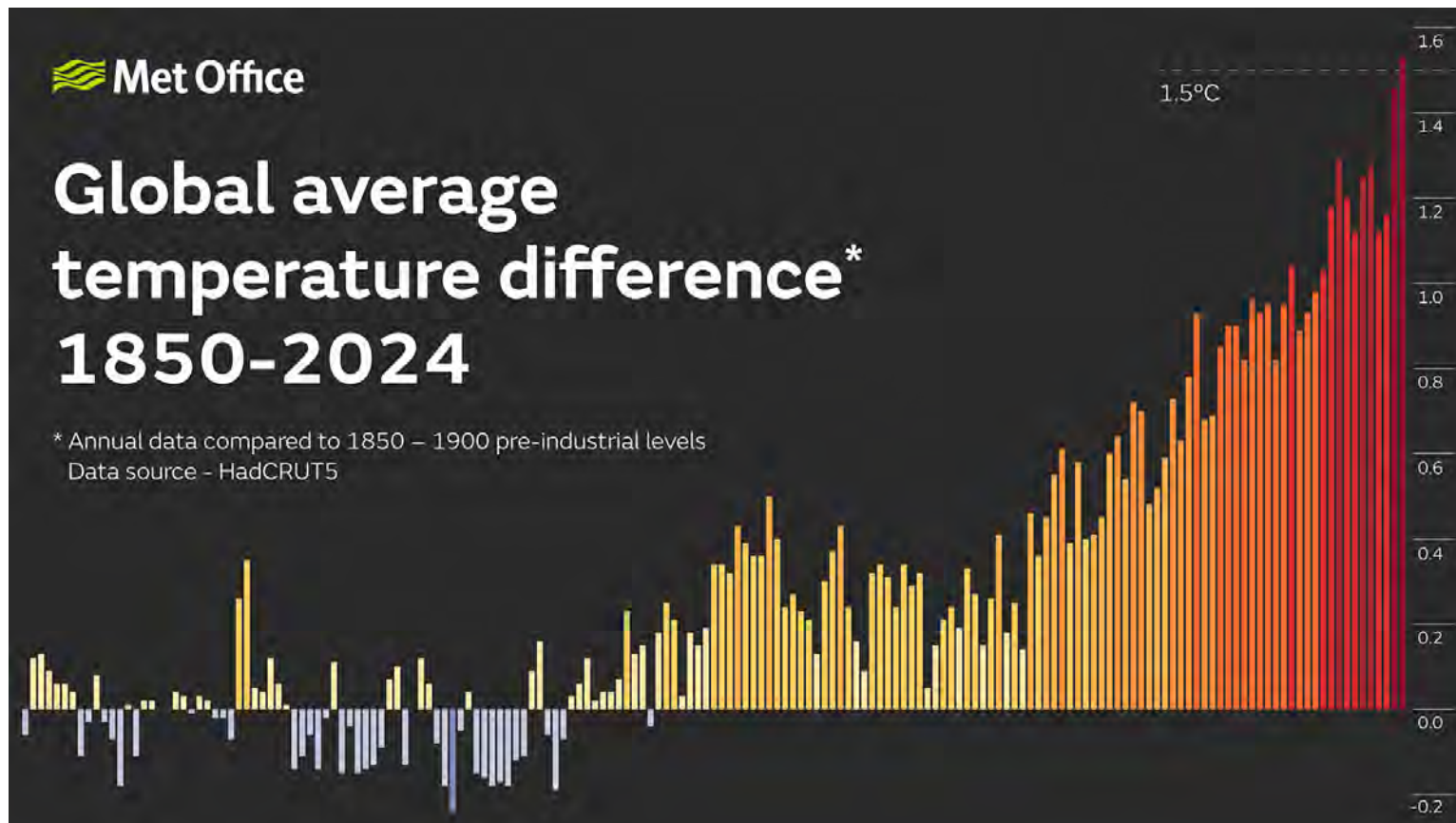
<https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-2/#figure-2-5>

Current changes observed in global climate

Near surface temperature in **1970**

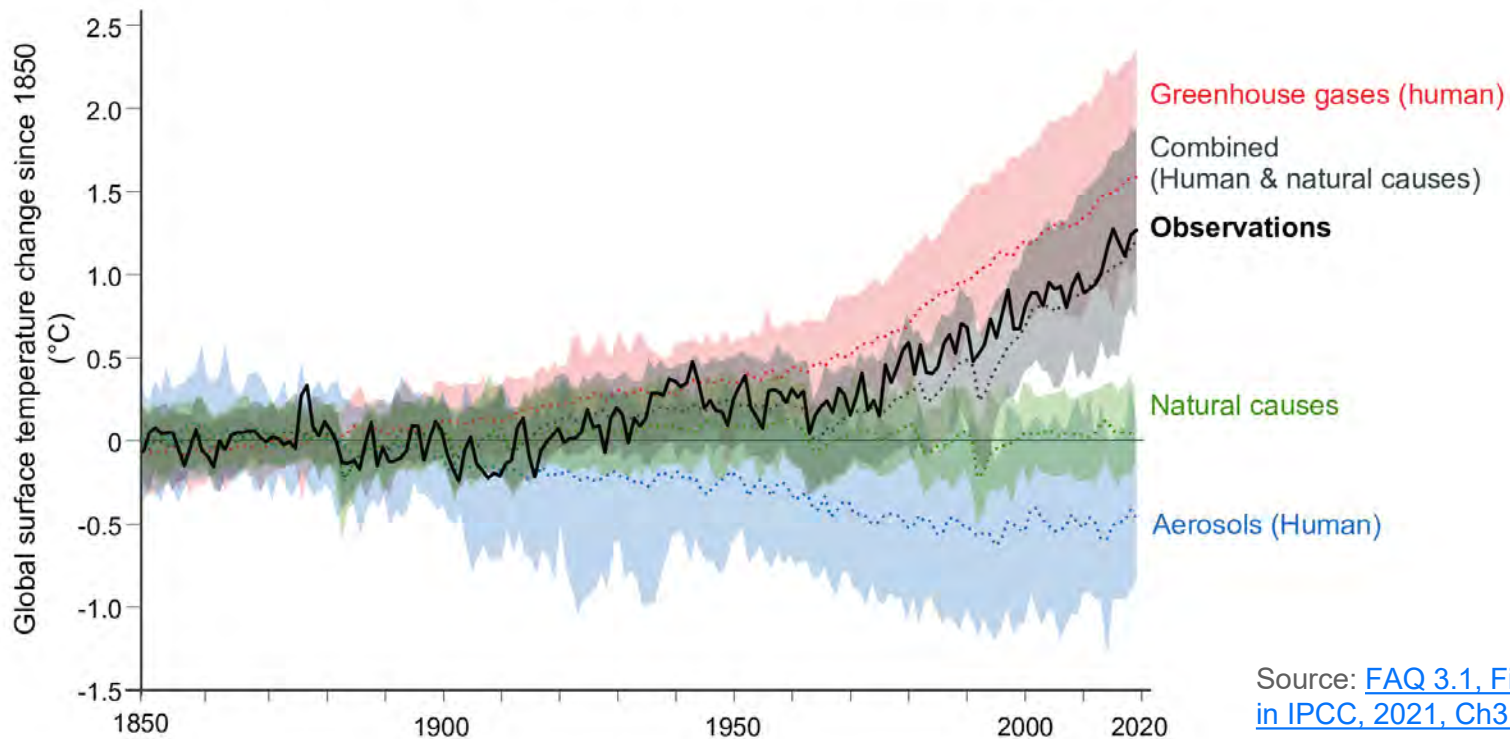


Data: HadCRUT5, Reference period: 1961-1990



FAQ 3.1: How do we know humans are causing climate change?

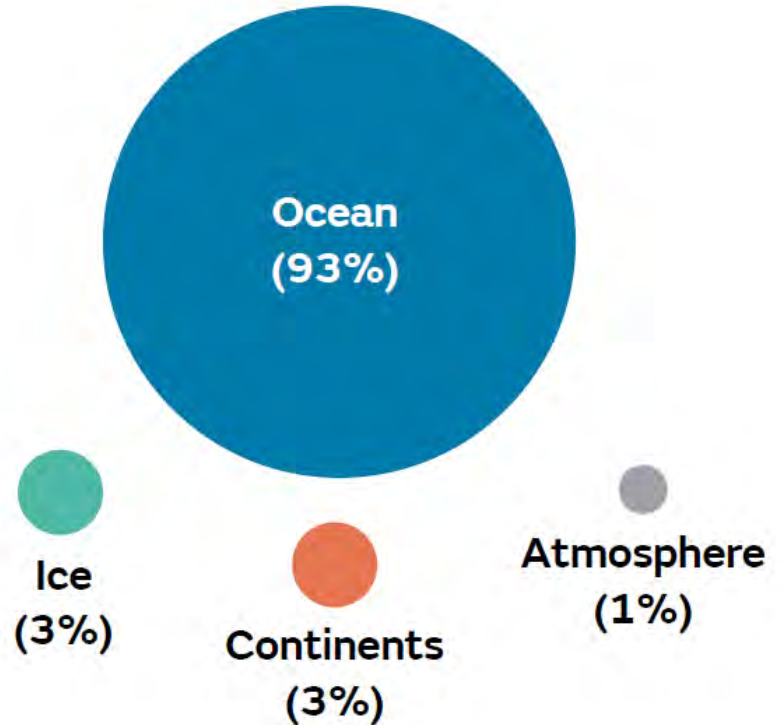
Observed warming (1850-2019) is only reproduced in simulations including human influence.



Source: [FAQ 3.1, Figure 1 in IPCC, 2021, Ch3.](#)

Where is the additional heat in the climate system going?

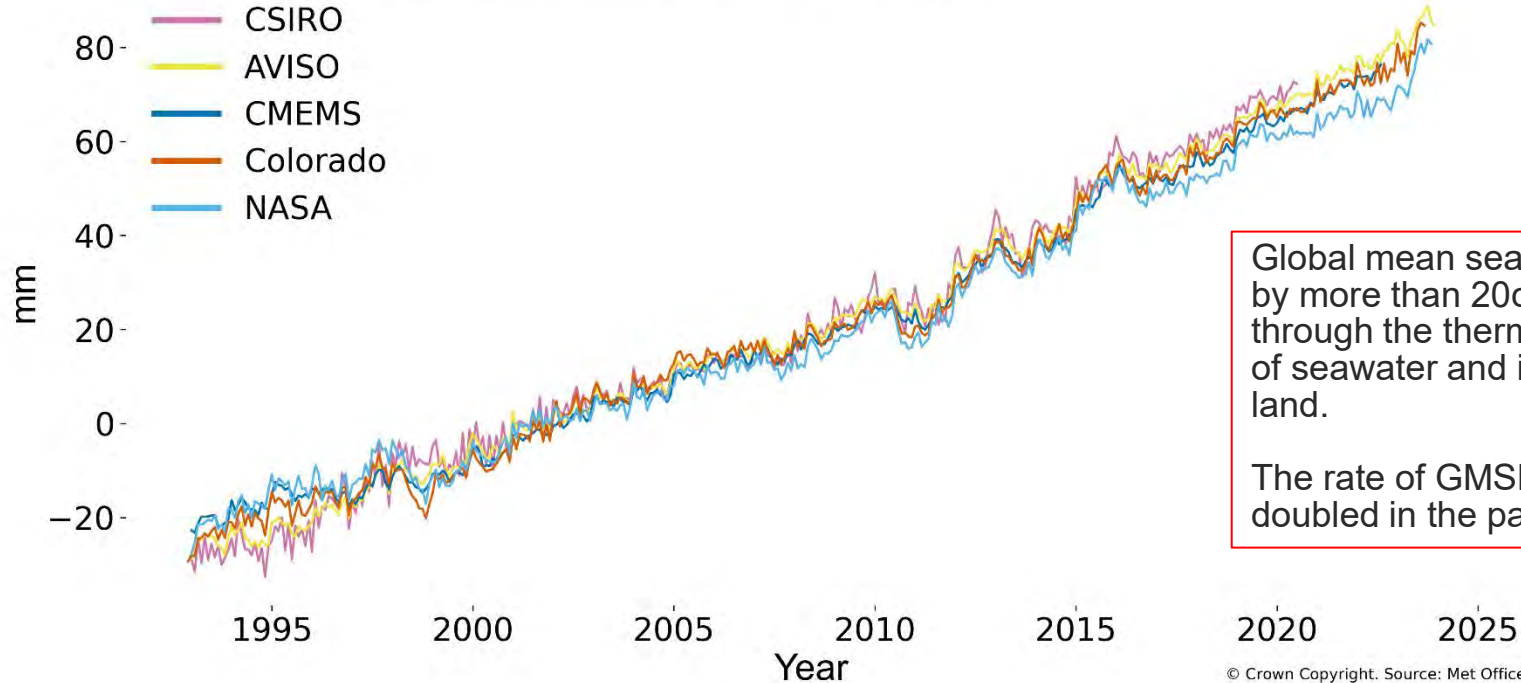
Research has found that since the 1970s more than 90% of the excess energy stored in the climate system has been absorbed by the oceans.



Sea level has risen and continues to rise...

 Met Office

Global sea level difference from 1993-2010 (mm)



Global mean sea level has risen by more than 20cm since 1901 through the thermal expansion of seawater and ice melt on land.

The rate of GMSLR has doubled in the past 30 years.

© Crown Copyright. Source: Met Office
Figure updated: 29/01/2024

Arctic Sea Ice Loss

The September minimum Arctic sea ice extent in 2019 was the 2nd lowest on record.



September Arctic sea ice extent

Over the last four decades, September Arctic sea ice extent has declined by over 87,000 km² per year equating to an average of 12% per decade.*

Annual loss

1980

2019

87,055 km²

An area greater than Scotland.

Surface area of Scotland = 80,226km² (World Bank)

Decadal loss

870,550 km²

An area greater than the UK, Ireland and France combined.

Surface area of UK, Ireland & France = 862,977km² (World Bank)

40 year loss

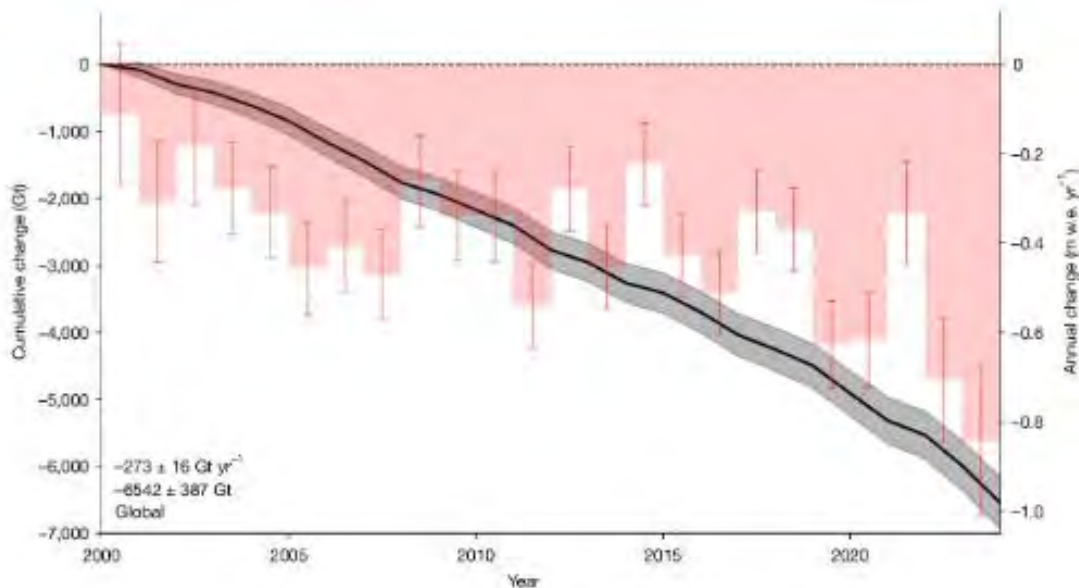
3.48 million km²

An area greater than India, Bangladesh and Bhutan combined.

Surface area of India, Bangladesh & Bhutan = 3,473,263 km² (World Bank)

<https://nsidc.org/arcticseaicenews>

Melting of Glaciers



Source: [Community estimate of global glacier mass changes from 2000 to 2023 | Nature](#)

“Human-induced climate change is already affecting weather and climate extremes in every region across the globe.”

“Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5.”

[IPCC AR6 WG1 SPM A3 \(2021\).](#)

Climate change is already impacting on extreme weather across the planet



Siberian heatwave

- Widespread, prolonged event over the first 6 months of 2020 resulting in **wildfires** and **loss of permafrost**
- Event was **600 times more likely** due to climate change

European flooding

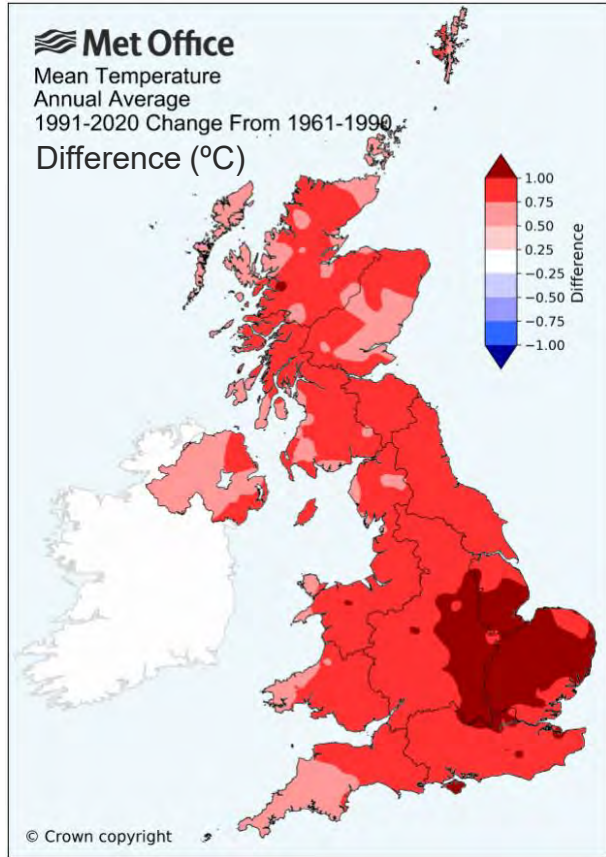
- July 2021 **heavy rainfall event** resulted in extreme impacts, and led to over **200 deaths**
- Event was **1.2 to 9 times more likely** and **rainfall intensity 3-19% higher** due to climate change

North America heatwave

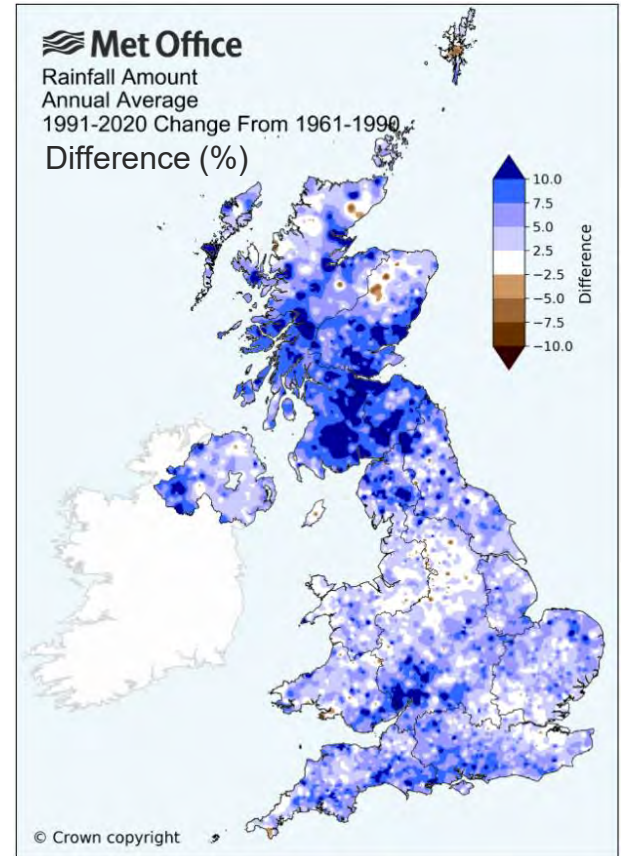
- Record breaking temperatures in June 2021, **49.6°C recorded in Canada**
- **Almost impossible** to hit such record-breaking temperatures in the Western United States **without human-caused climate change**

Current state of the UK climate

UK Climate Changes

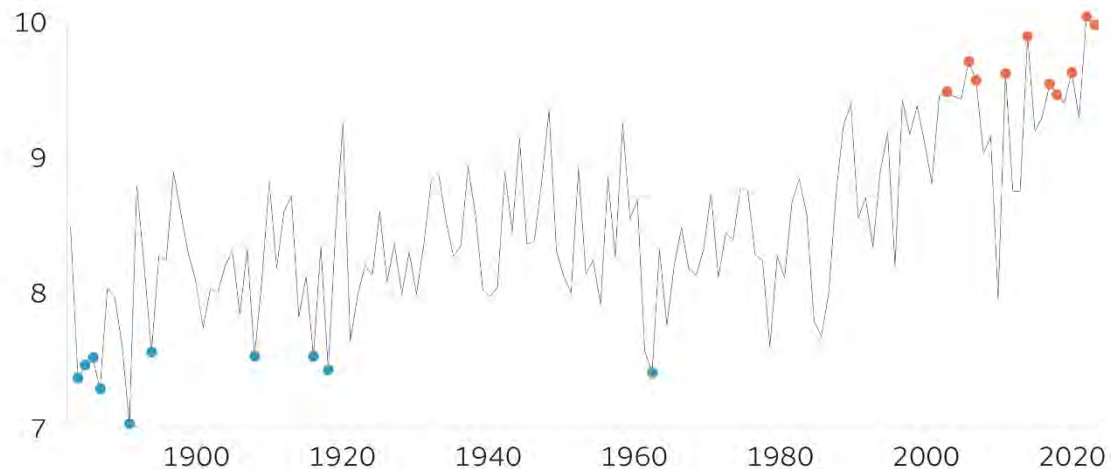


1991-2020
change from
1961-1990



What is the difference between climate variability and change?

Hottest and coldest UK years (°C)



Data: HadUK Grid mean annual UK temperature

10 HOTTEST UK YEARS

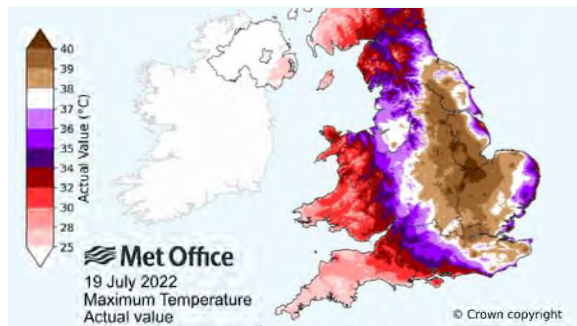
1	2022 - 10.03 °C	6	2011 - 9.61 °C
2	2023 - 9.97 °C	7	2007 - 9.56 °C
3	2014 - 9.88 °C	8	2017 - 9.53 °C
4	2006 - 9.70 °C	9	2003 - 9.47 °C
5	2020 - 9.62 °C	10	2018 - 9.45 °C

10 COLDEST UK YEARS

1	1892 - 7.02 °C	6	1886 - 7.45 °C
2	1888 - 7.28 °C	7	1887 - 7.51 °C
3	1885 - 7.36 °C	8	1917 - 7.52 °C
4	1963 - 7.40 °C	9	1909 - 7.52 °C
5	1919 - 7.42 °C	10	1895 - 7.55 °C

Left: Timeseries of UK annual average temperature from 1884-2023 with the hottest and coldest years in the series highlighted. Credit: Met Office.

Extreme events are also impacting the UK



Heatwaves

- **July 2022** UK exceeded 40°C for the first time on record in the UK.
- The **Summer 2020 heatwave** was the most significant heatwave of the last 60 years, leading to over **2500 excess deaths** across the UK
- By **2050** hot summers (like 2018) could happen **every other year**.



Heavy rainfall

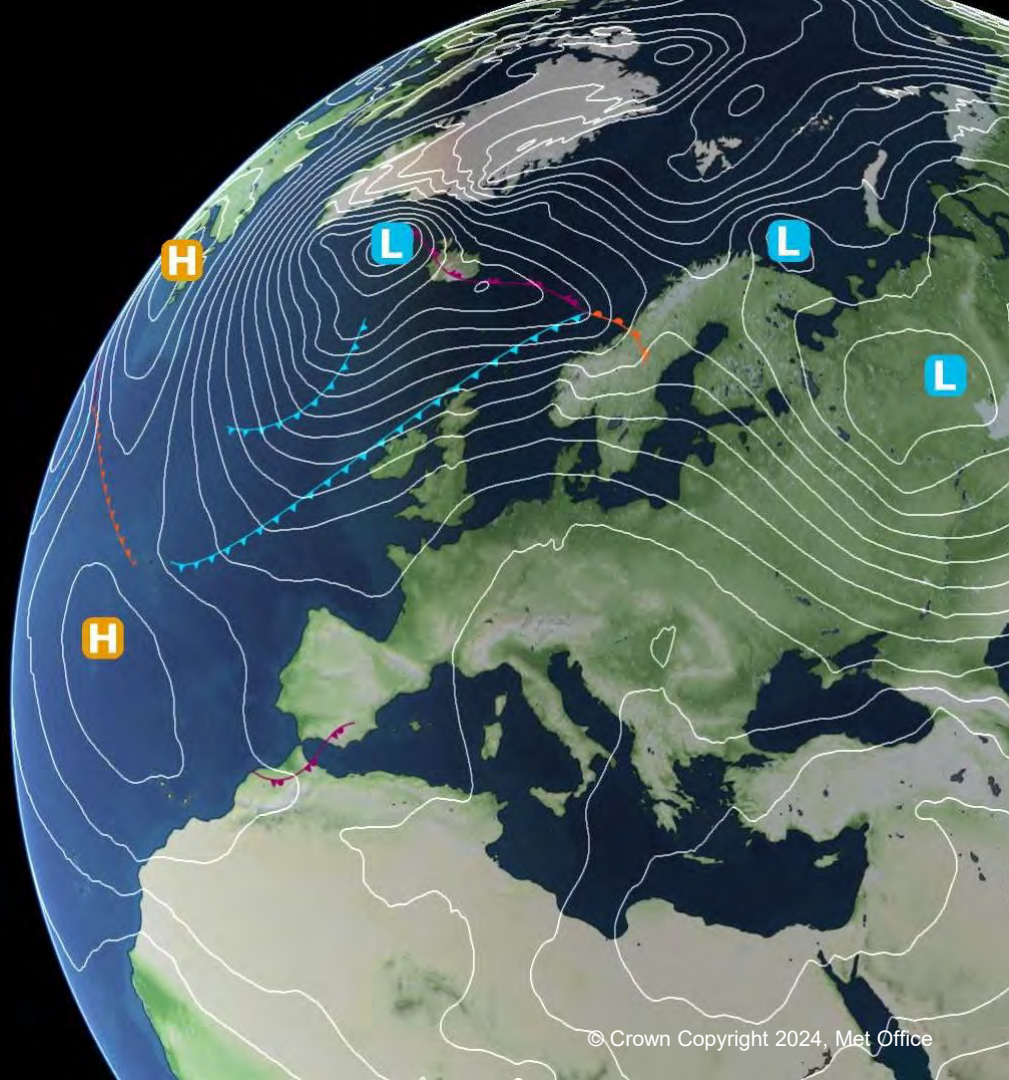
- **February 2020** was the wettest February on record
- **Storm Ciara** saw a month's worth of rain fall across parts of West Yorkshire in just 18 hours, leading to **widespread flooding**
- By **2070**, winter rainfall events, similar to these, are expected to **increase by up to 25%**



Wildfires

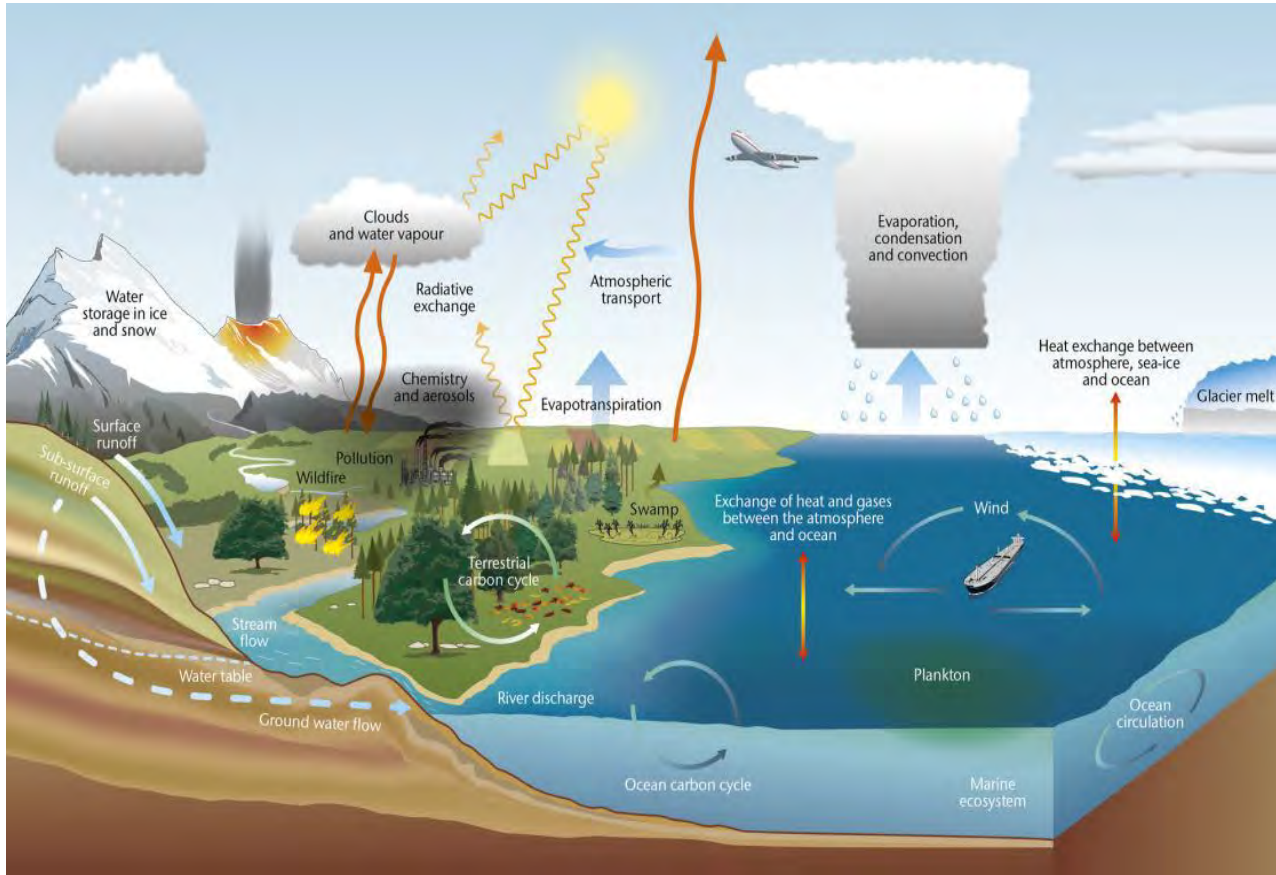
- Figures suggest the number of **UK wildfires has been increasing** in recent years
- Wildfires could be **5 times more likely** by 2100 due to increases in high temperatures and low summer rainfall; conditions highly conducive to wildfires.

Climate Projections



Climate modelling

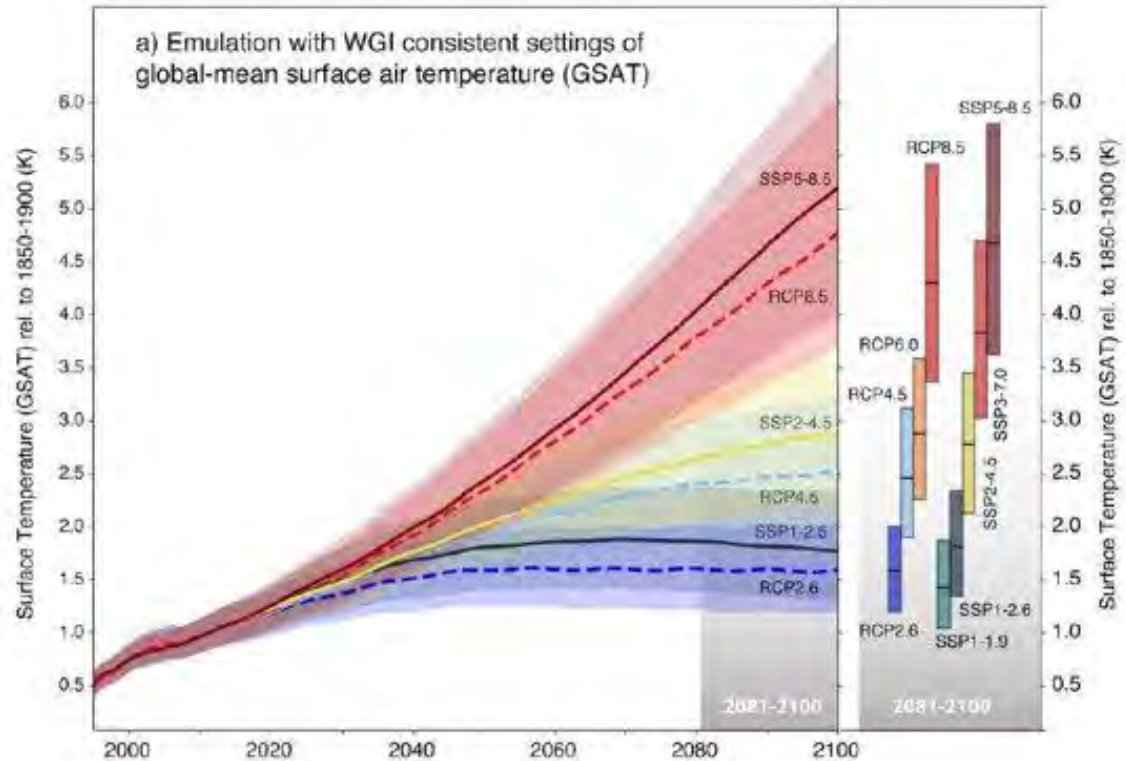
What is in a Climate model?



Emission scenarios

Intergovernmental
Panel on Climate
Change

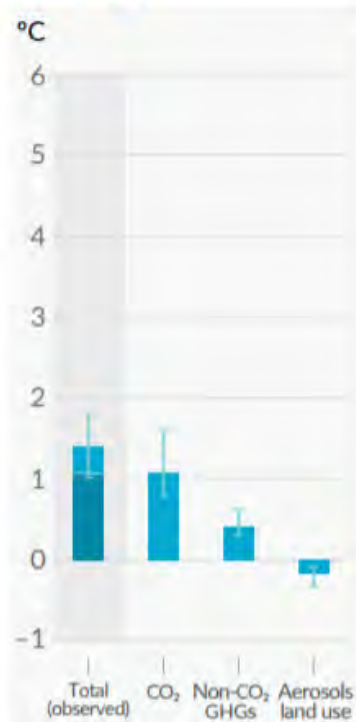
Representative
Concentration
Pathways (RCP) &
Shared Socioeconomic
Pathways (SSPs)



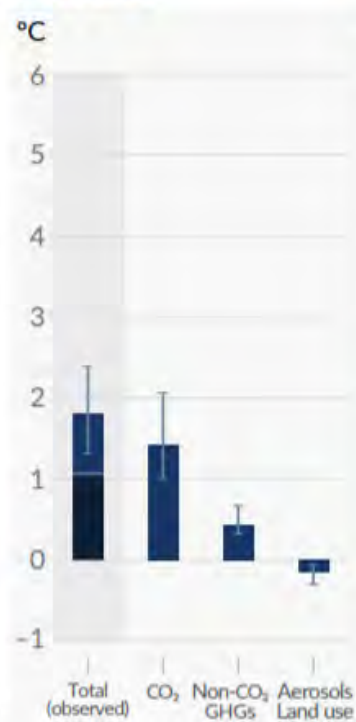
Projections of future Global temperature

Change in global surface temperature in 2081–2100 relative to 1850–1900 (°C)

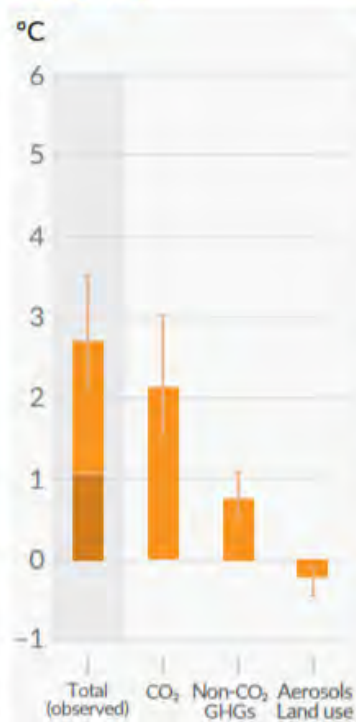
SSP1-1.9



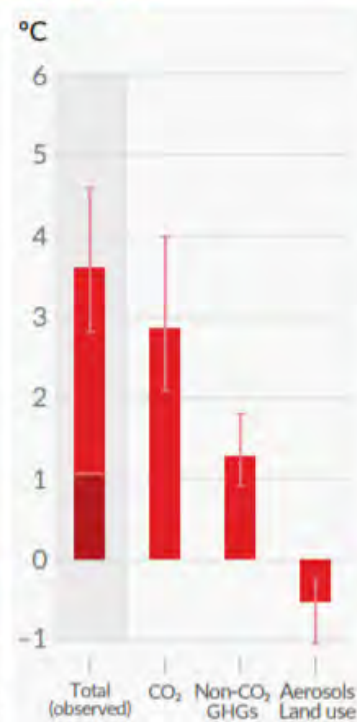
SSP1-2.6



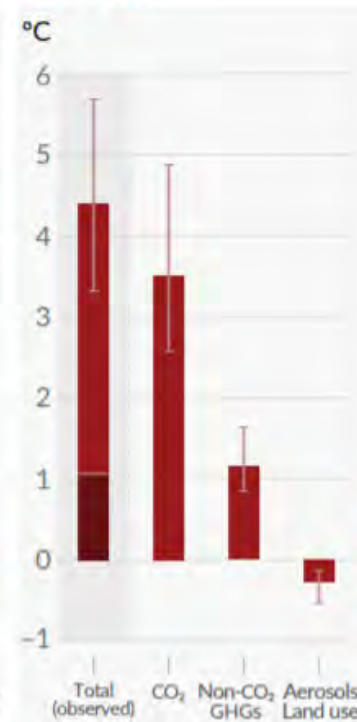
SSP2-4.5



SSP3-7.0



SSP5-8.5

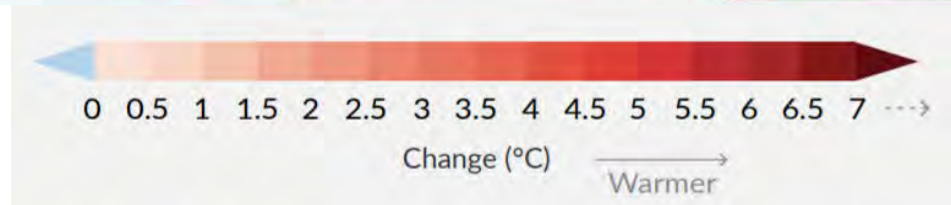
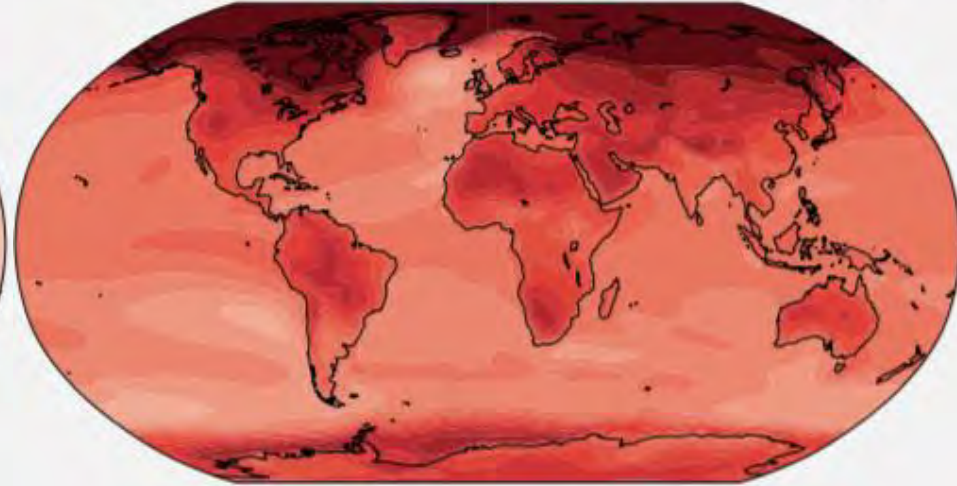
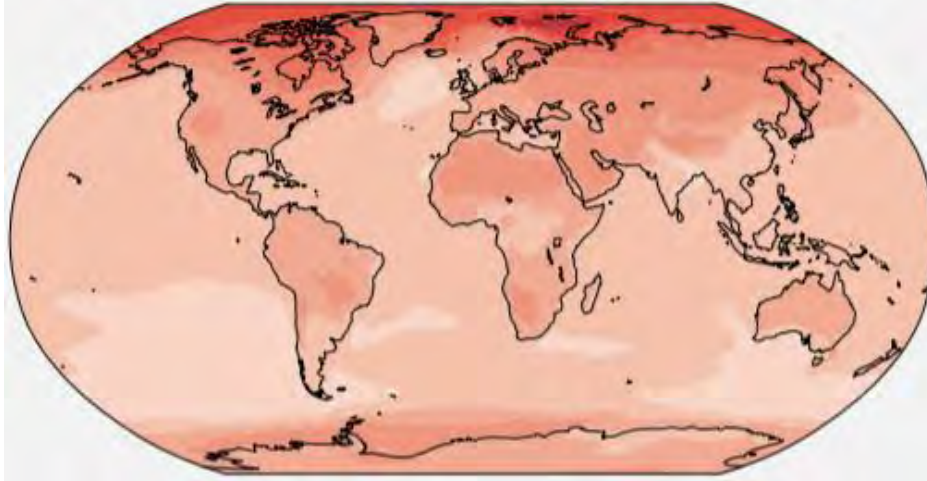


Projections

OFFICIAL
Warming will not be the same everywhere

Simulated change at 1.5°C global warming

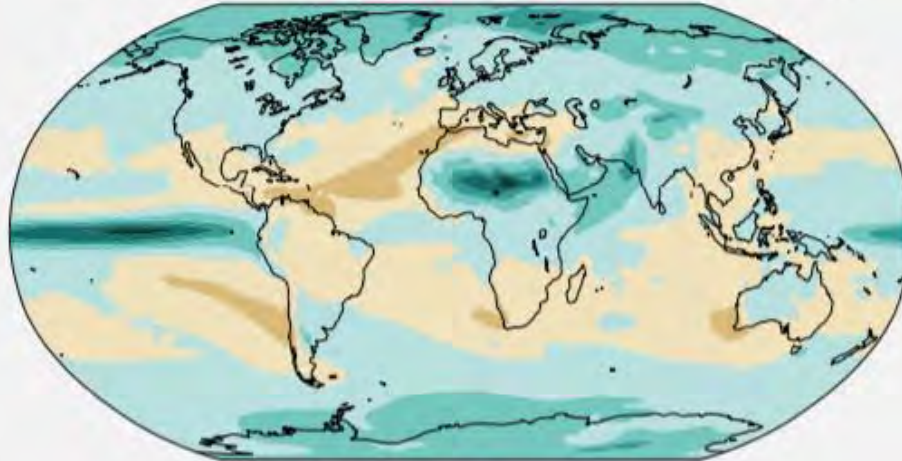
Simulated change at 4°C global warming



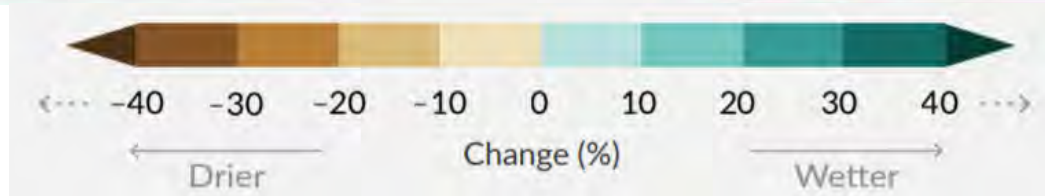
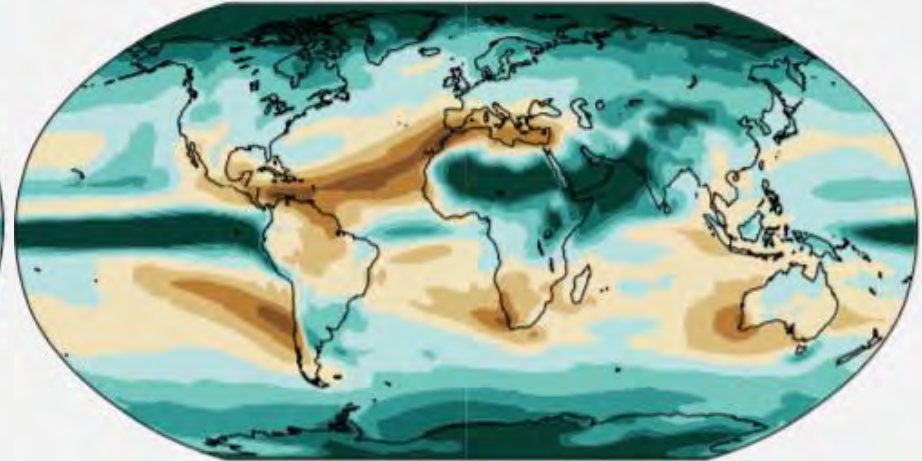
From IPCC AR6 WG1

Rainfall changes will vary too

Simulated change at 1.5°C global warming



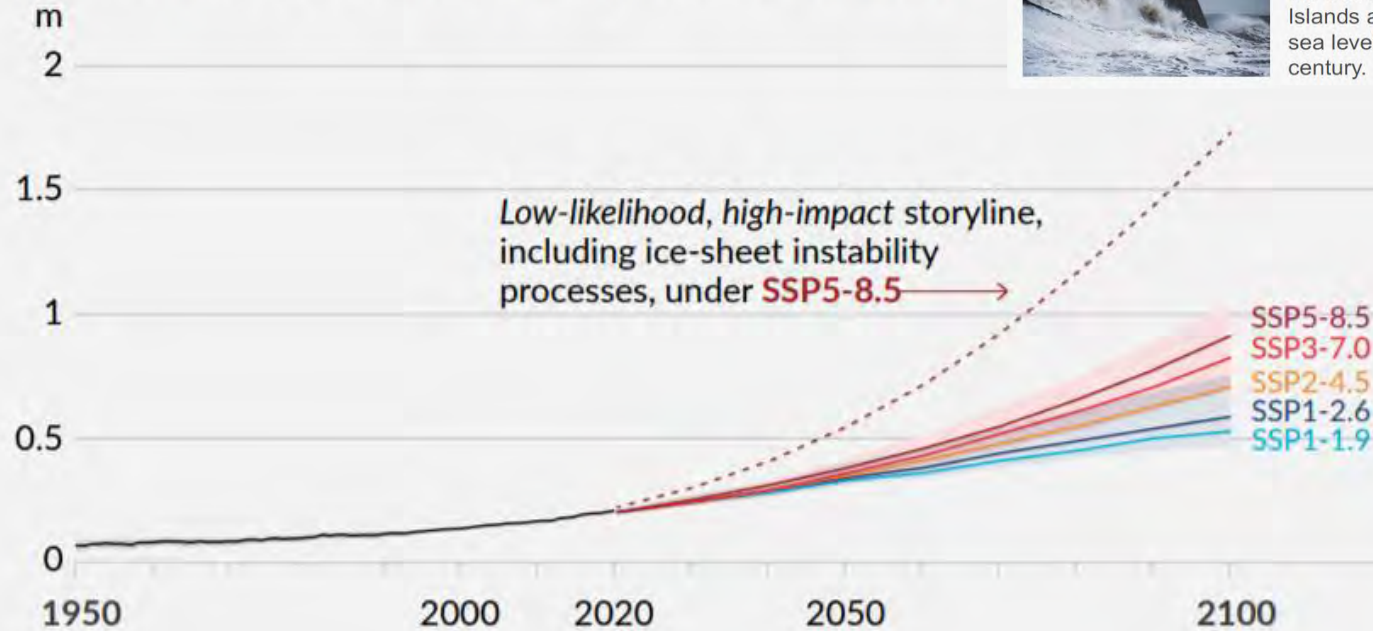
Simulated change at 4°C global warming



From IPCC AR6 WG1

Future sea level

(d) Global mean sea level change relative to 1900



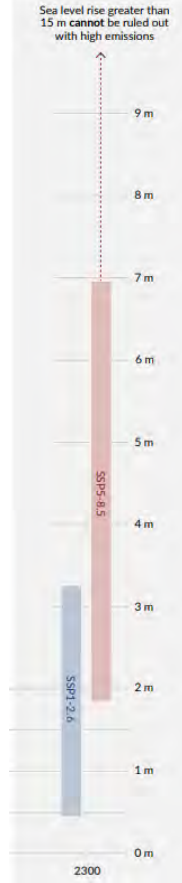
From IPCC AR6 WG1



Flood risk

About a billion people in low-lying cities by the sea and on Small Islands at risk from sea level rise by mid-century.

(e) Global mean sea level change in 2300 relative to 1900



UK Climate Projections (UKCP 18)

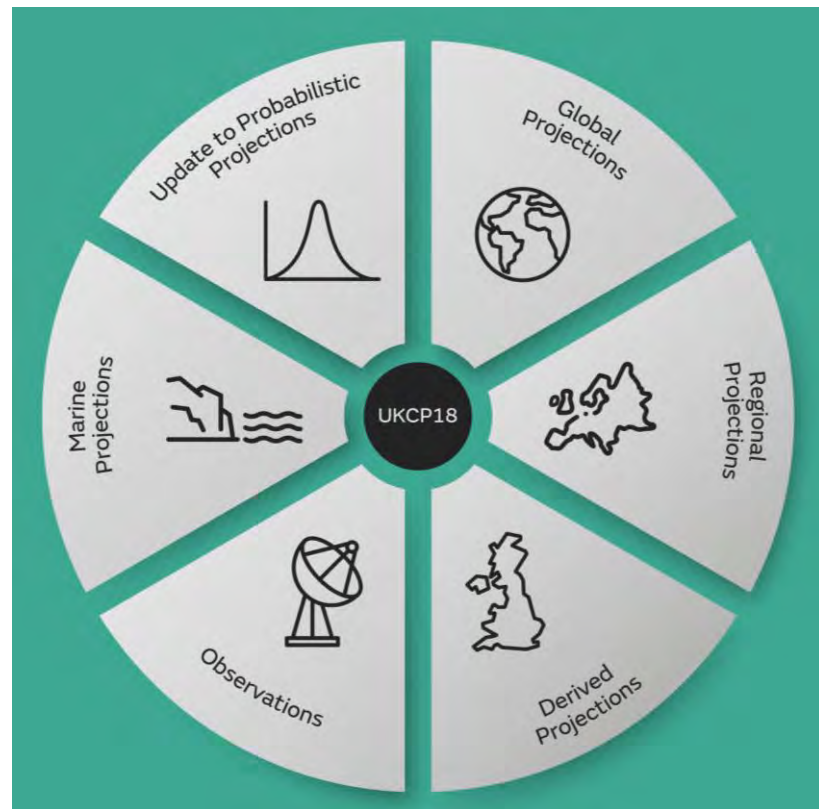
A diverse set of climate projections:

Global (60km)	Observations
Regional (12km)	Marine
Local (2.2km)	Probabilistic

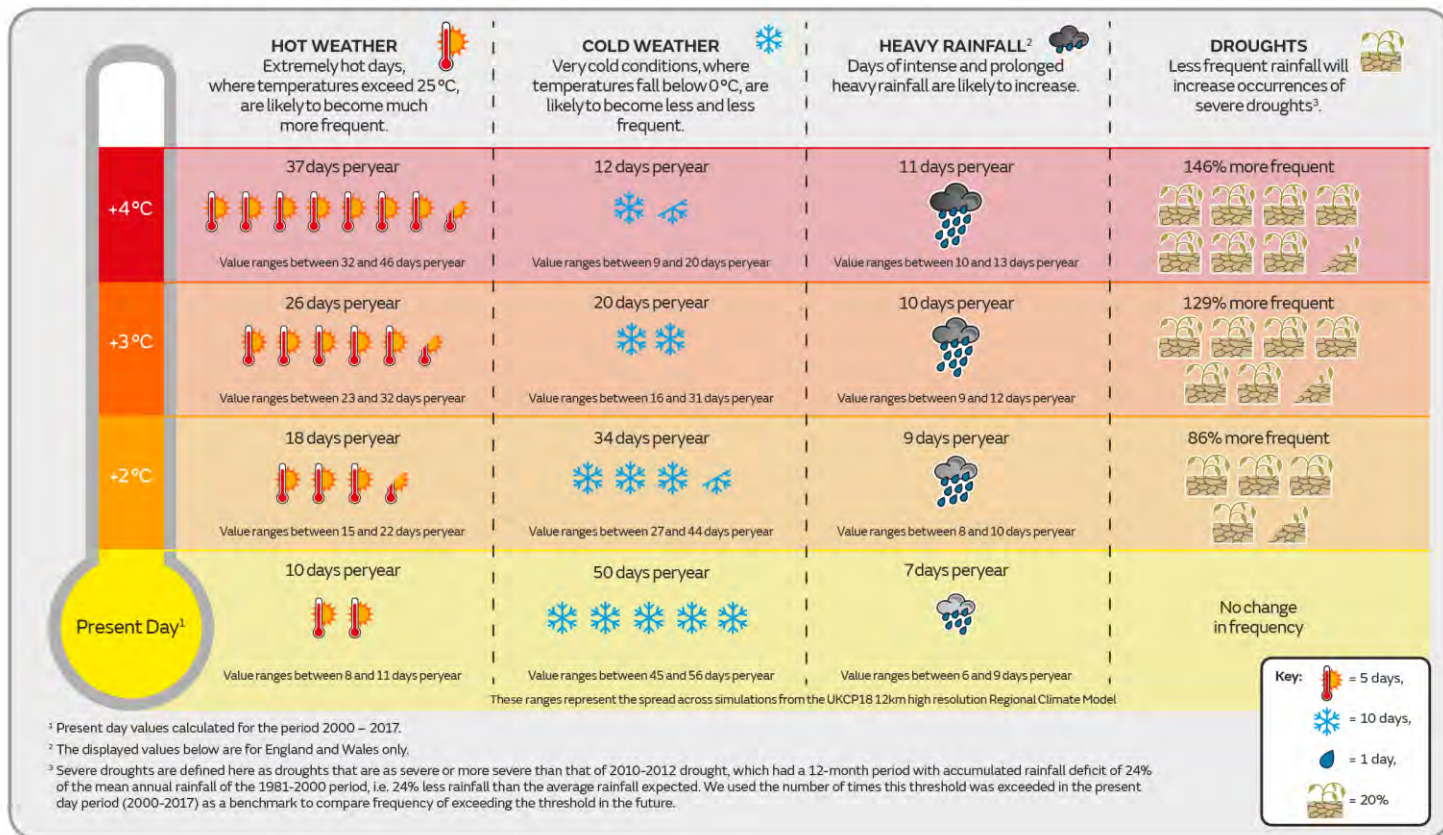
Headline results:

“a greater chance of warmer, wetter winters and hotter, drier summers”

“Sea levels have been rising and will continue to rise”



Global warming and future high-impact weather in the UK

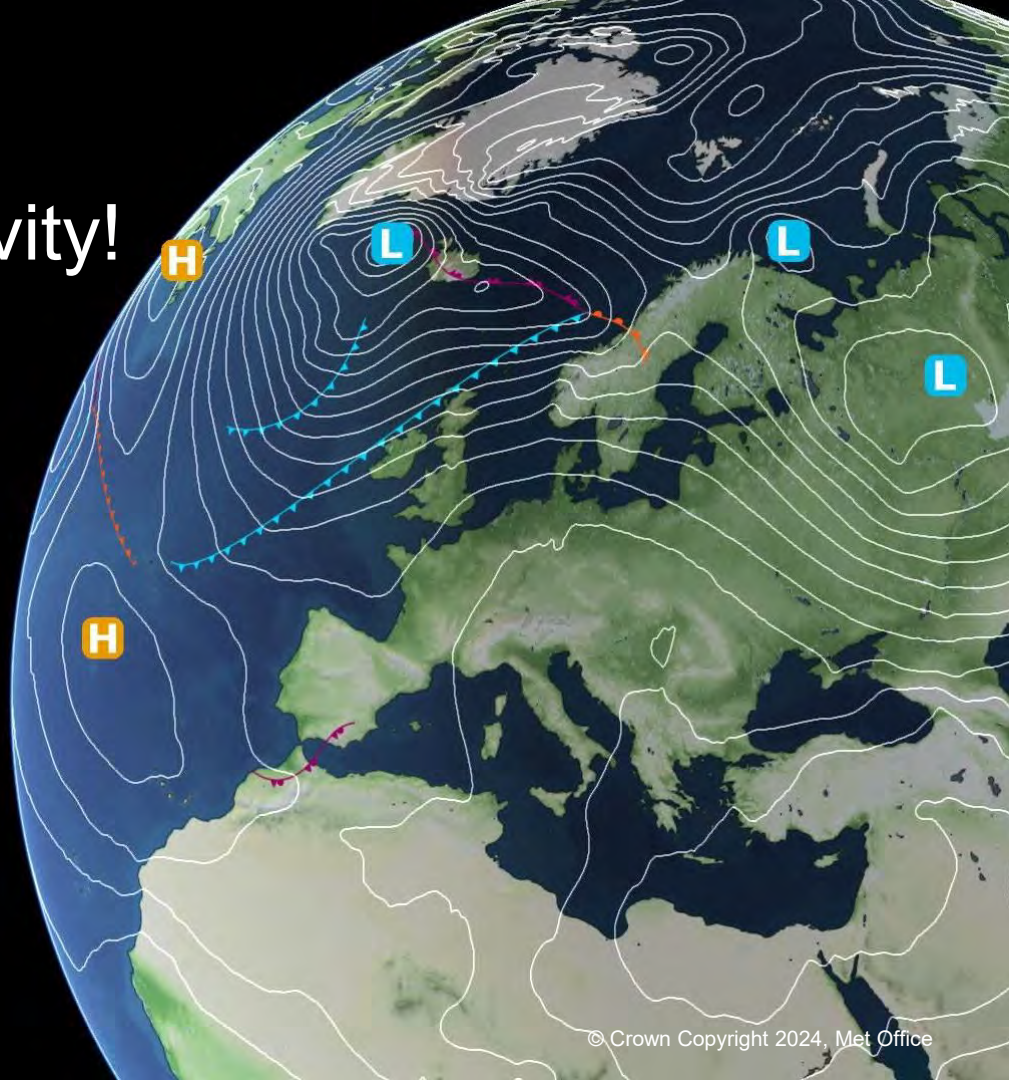


¹ Present day values calculated for the period 2000 – 2017.

² The displayed values below are for England and Wales only.

³ Severe droughts are defined here as droughts that are as severe or more severe than that of 2010-2012 drought, which had a 12-month period with accumulated rainfall deficit of 24% of the mean annual rainfall of the 1981-2000 period, i.e. 24% less rainfall than the average rainfall expected. We used the number of times this threshold was exceeded in the present day period (2000-2017) as a benchmark to compare frequency of exceeding the threshold in the future.

Time for a break and activity!



Via the teams' poll, what do you think the main effects of climate change will be on your community in the next 10 years?