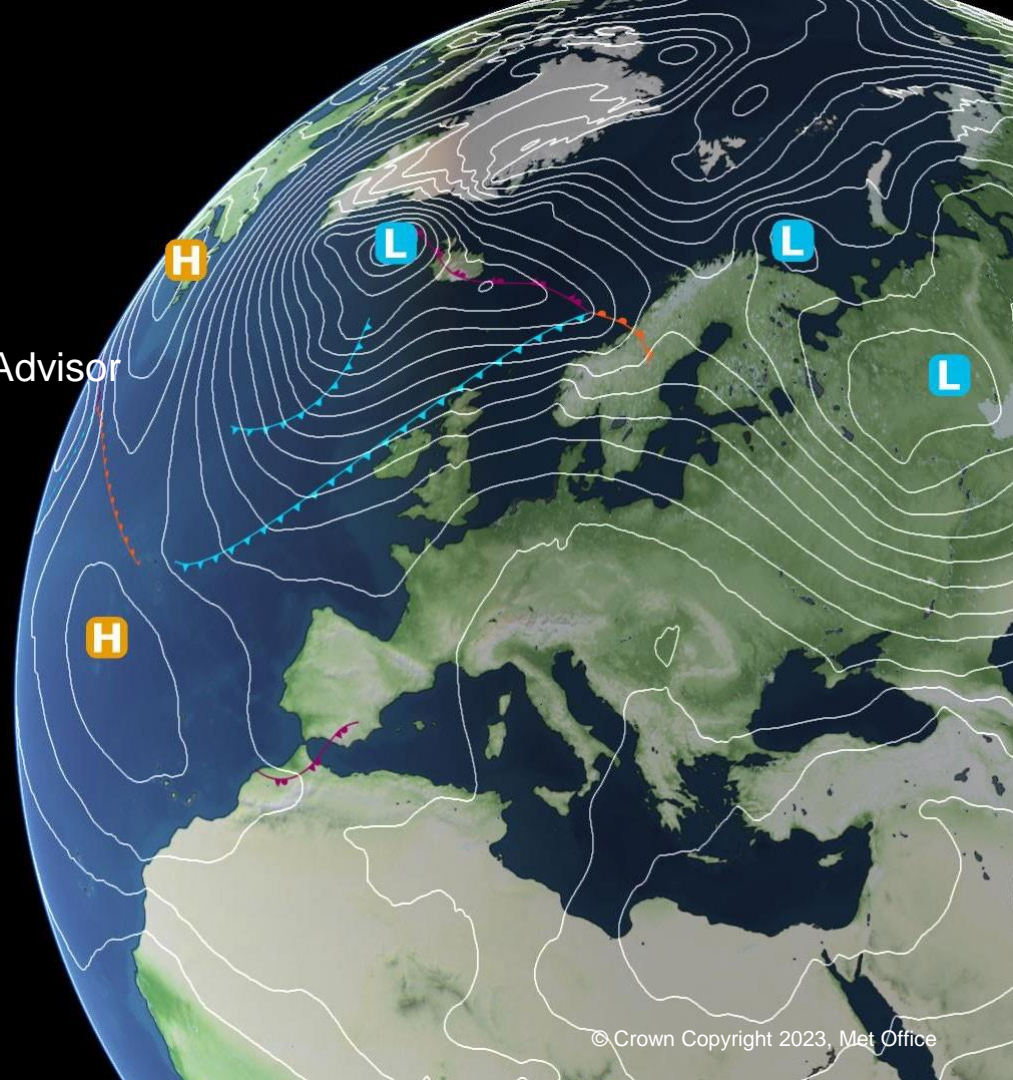


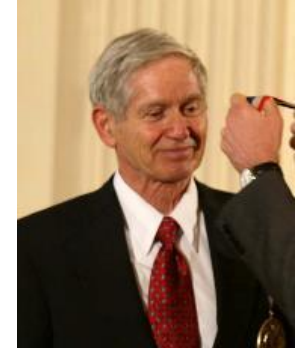
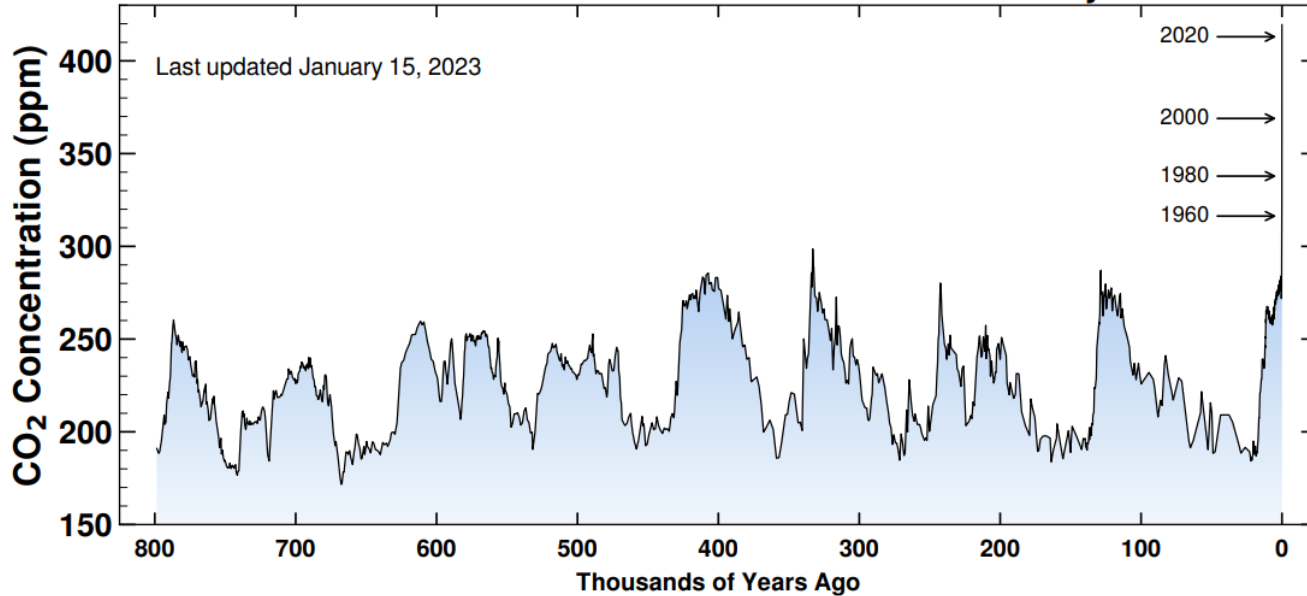
The Met Office and our Changing Climate

John Hammond, Met Office Civil Contingencies Advisor



A Changing Climate

Current levels of atmospheric CO₂ are unprecedented in 800,000 years or more



Charles David Keeling,
1928 – 2005

Since the Industrial Revolution in the 18th Century, the globally averaged concentration of CO₂ in the atmosphere has risen by around 50%, to over 415 parts per million (ppm).

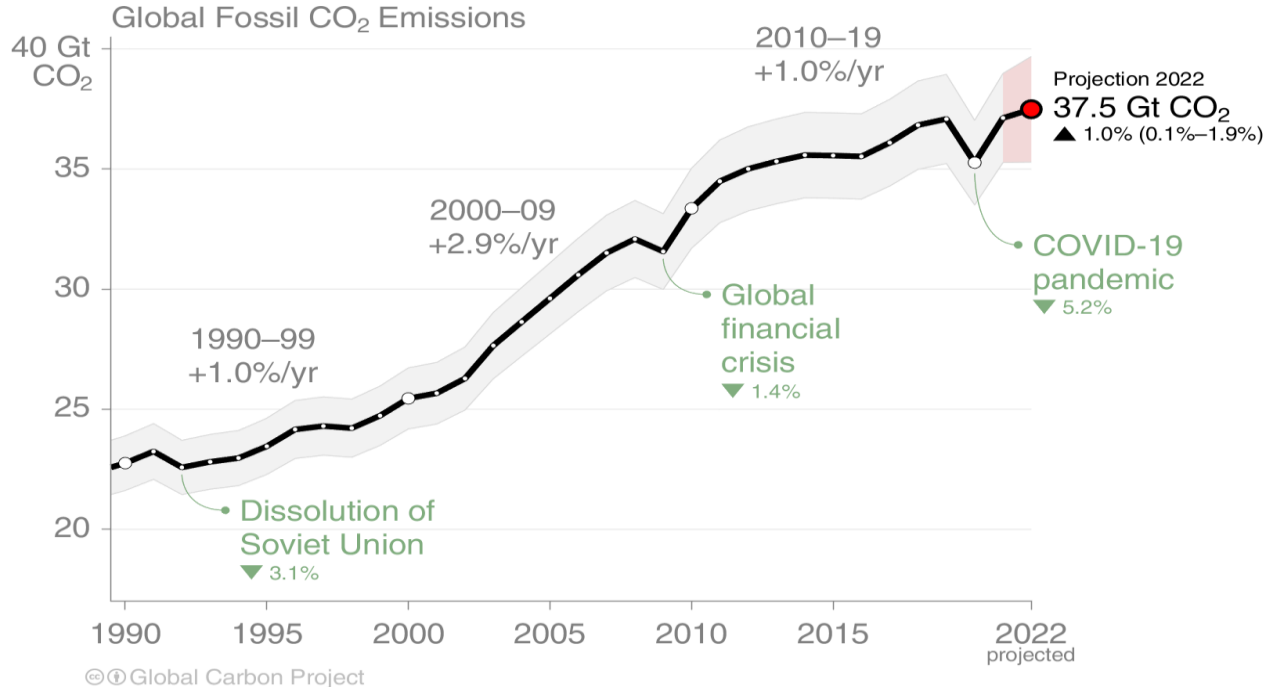
Records of Earth's climate, preserved in air bubbles trapped in Antarctic ice, show that the current level of CO₂ is unprecedented in at least 800,000 years.

<https://scripps.ucsd.edu/programs/keelingcurve/>

Global CO₂ emissions

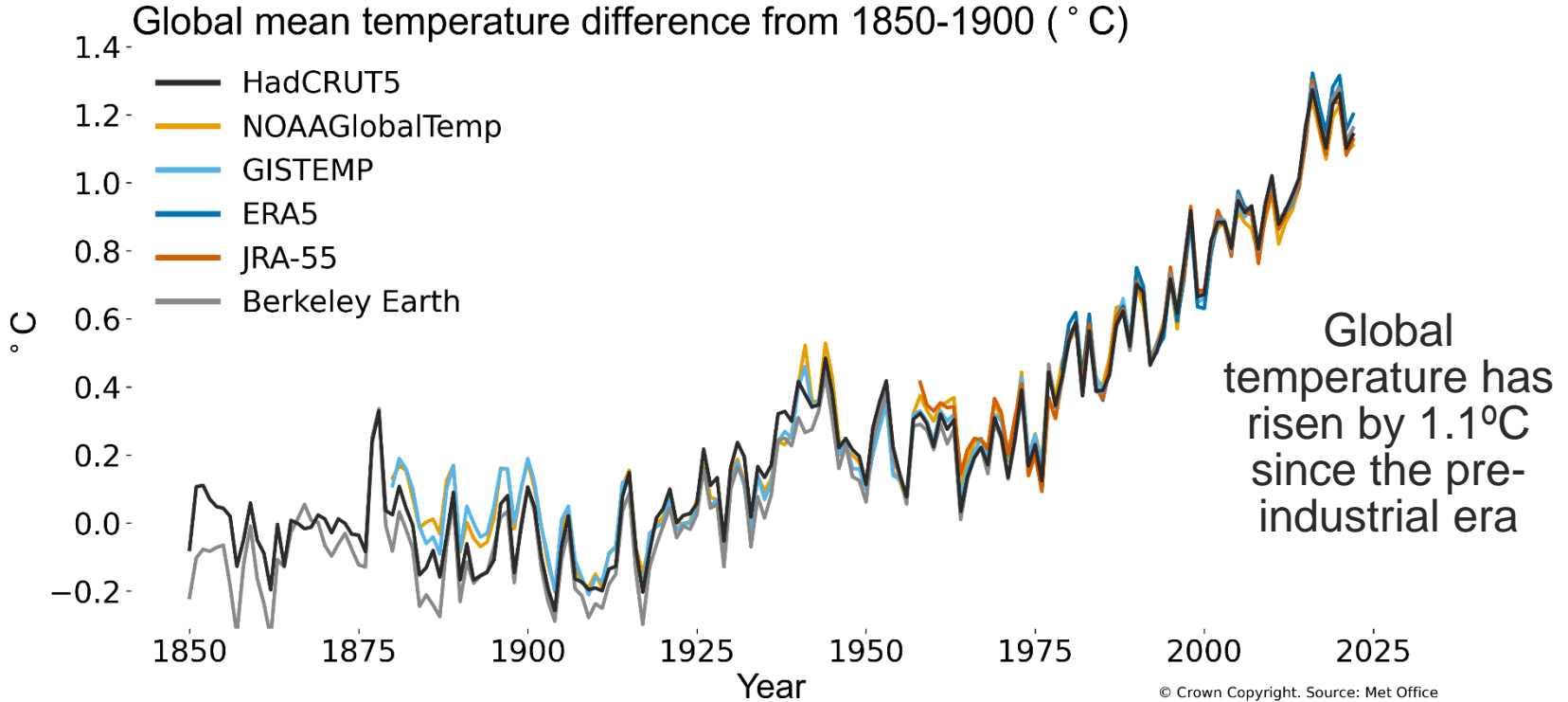
Emissions are set to grow 1% [0.1 to 1.9%] in 2022.

The rate of increase has slowed from 3% per year in the 2000s to about 0.5% per year in the past decade.



CO₂ emissions
cuts of 1.4 billion
tonnes are
needed each
year on average
to reach net zero
by 2050

Global average surface temperature change



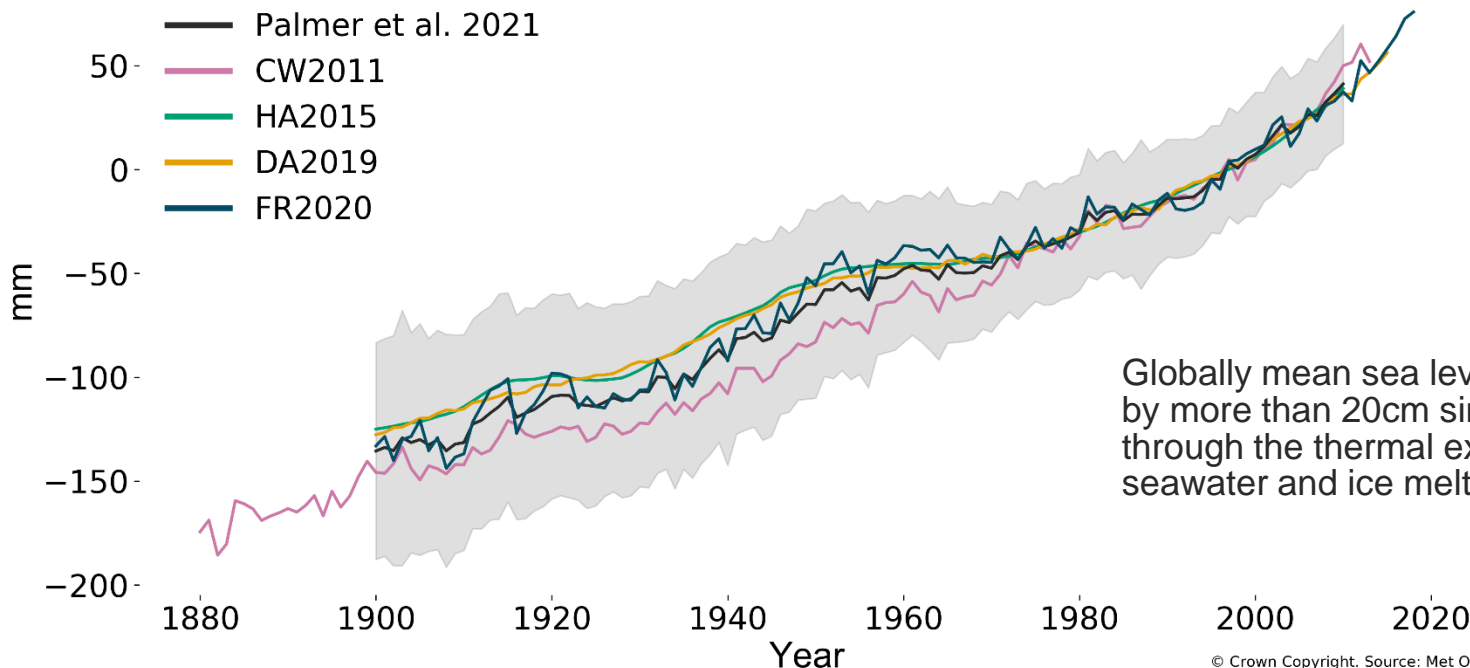
© Crown Copyright. Source: Met Office
Figure updated: 13/01/2023

<https://www.metoffice.gov.uk/hadobs/monitoring/dashboard.html>

Met Office Sea level has risen and continues to rise...

Met Office

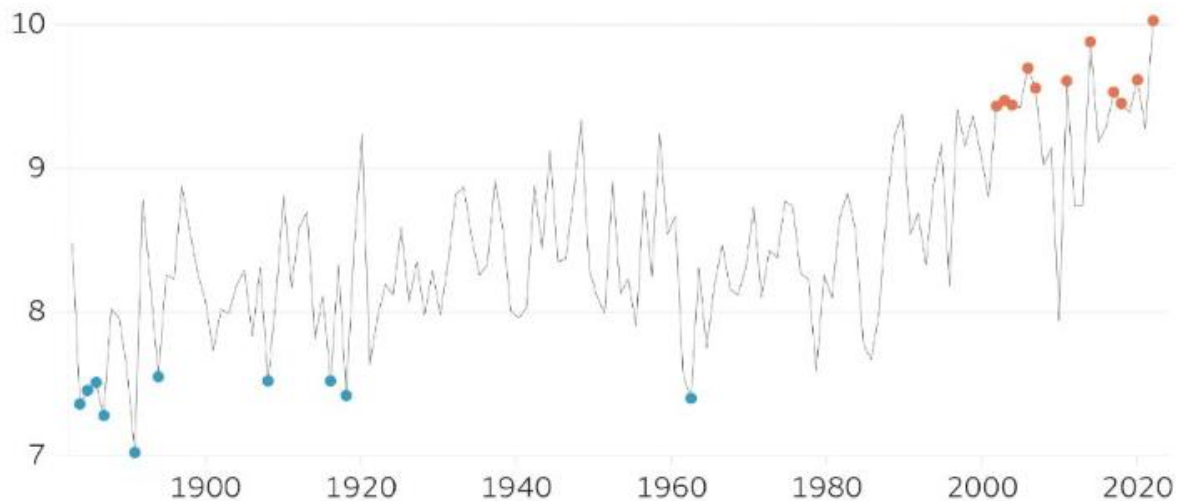
Global sea level difference from 1981-2010 (mm)



© Crown Copyright. Source: Met Office

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 2007 - 9.56 °C
2 2014 - 9.88 °C	7 2017 - 9.53 °C
3 2006 - 9.70 °C	8 2003 - 9.47 °C
4 2020 - 9.62 °C	9 2018 - 9.45 °C
5 2011 - 9.61 °C	10 2002/4 - 9.44 °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

Timeseries of UK annual average temperature from 1884 to 2022 with the hottest and coldest years in the series highlighted.
Credit: Met Office.

UK Climate Projections (UKCP18)

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”



Current risks: How will they change?

Hot Weather / Heatwaves

R73 – High temperatures and Heatwaves*

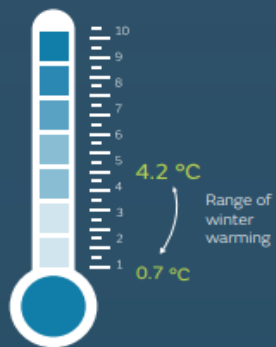
* The Scottish Risk Assessment includes a Heatwave Risk

FUTURE TEMPERATURE CHANGE

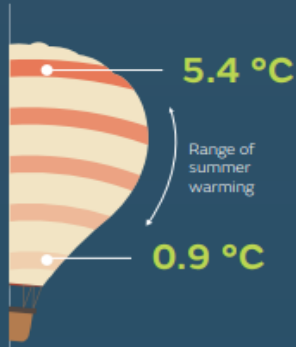
PROBABILISTIC PROJECTIONS

RISING SEASONAL TEMPERATURES*

UKCP Probabilistic (25km) projections show that by 2070, the range of average seasonal temperature changes are projected to increase*.



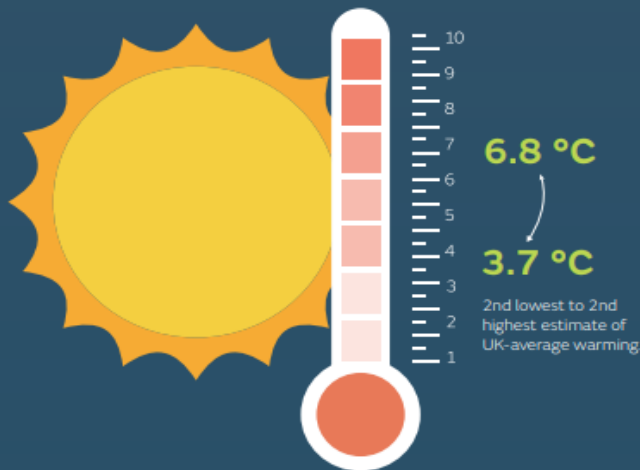
WINTER



SUMMER

HOT SUMMER DAYS

Temperature of hot summer days**, by 2070, is projected to increase in the Local (2.2km) projections.



UKCP LOCAL (2.2KM)

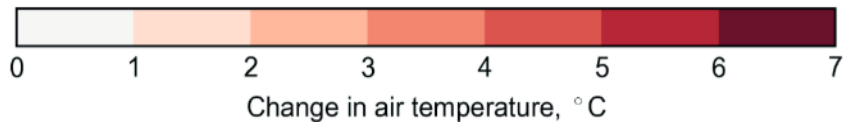
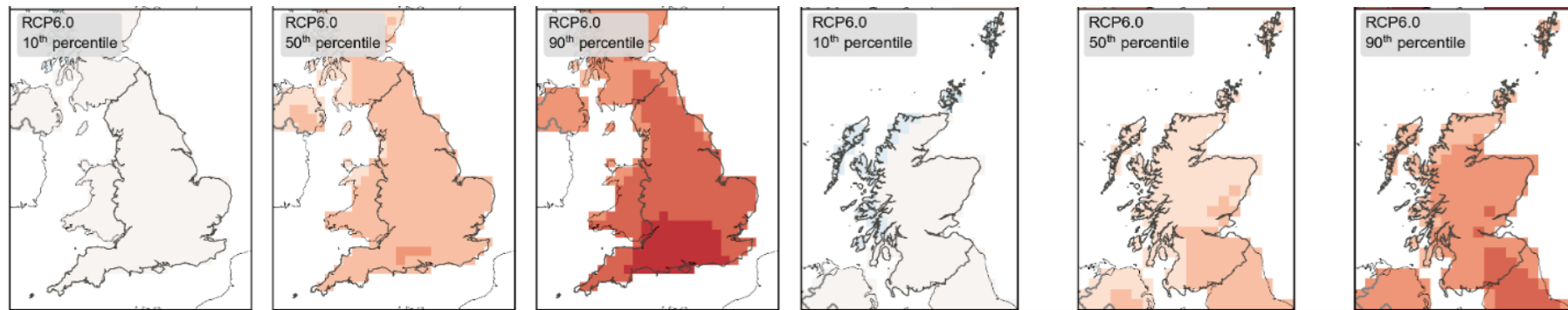
THE FREQUENCY OF HOT SPELLS*** IS PROJECTED TO INCREASE

The average frequency of hot spells, locally over the southern UK for the period 1981-2000, is once every 4 years.



By 2070, the average frequency of hot spells is projected to rise to about four times per year.

Summer Mean Daily Maximum Temperatures – 2060-2079



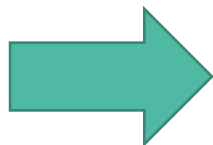
Met Office Changes in likelihood of UK Extreme Events due to man-made Greenhouse gases – extreme heat

Chances of seeing 40°C in the UK

Natural climate



Present



By 2100

1 in 100 -
1000 years

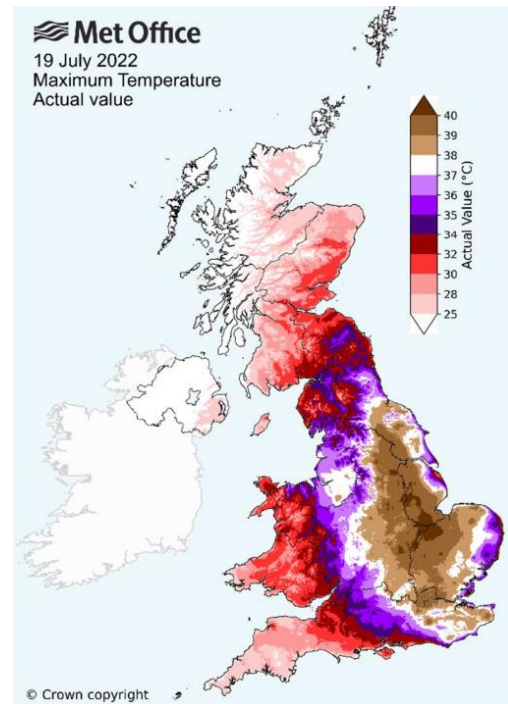
1 in 100 -
300 years

1 in 15
years
(medium
emissions
scenario)

1 in 3.5
years (high
emissions
scenario)



Wildfires during the July 2022 heatwave in Dartford



What are the impacts of this change?

Higher temperatures could include an increased risk of.....

- Excess Deaths / Health Issues
- Transport Disruption
- Water shortages / outages
- Water rescues
- Wildfires
- Drought?

Flooding

R75a – Coastal Flooding*

R75b – Fluvial Flooding*

R75c – Surface water Flooding*

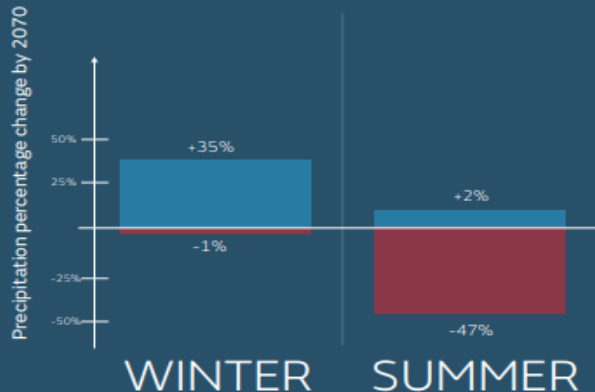
* The Scottish Risk Assessment includes a Fluvial and Surface Water Flood Risk

FUTURE PRECIPITATION CHANGE

PROBABILISTIC PROJECTIONS

WETTER WINTERS, DRIER SUMMERS*

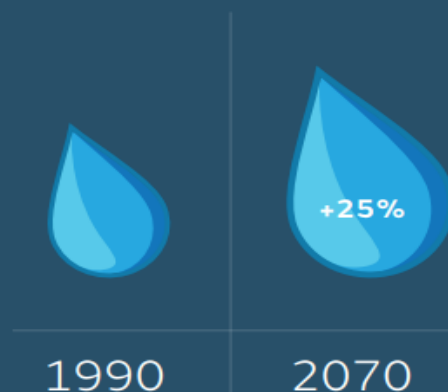
UKCP Probabilistic (25km) projections show that by 2070, under a high emission scenario, average winter precipitation is projected to increase, whilst average summer rainfall is projected to decrease.



UKCP LOCAL (2.2KM)

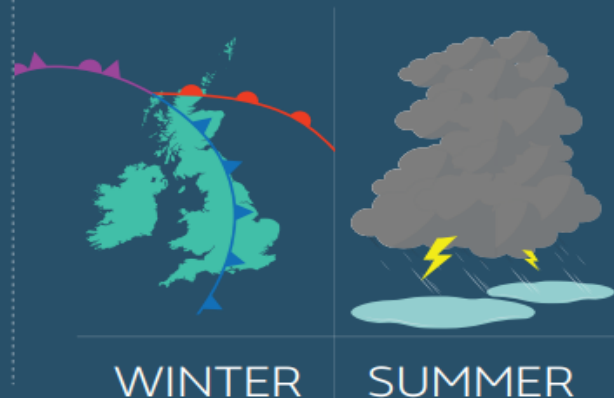
FUTURE INCREASES IN EXTREME HOURLY RAINFALL INTENSITY

By 2070, extreme hourly rainfall intensity associated with an event that typically occurs once every two years increases by 25%.



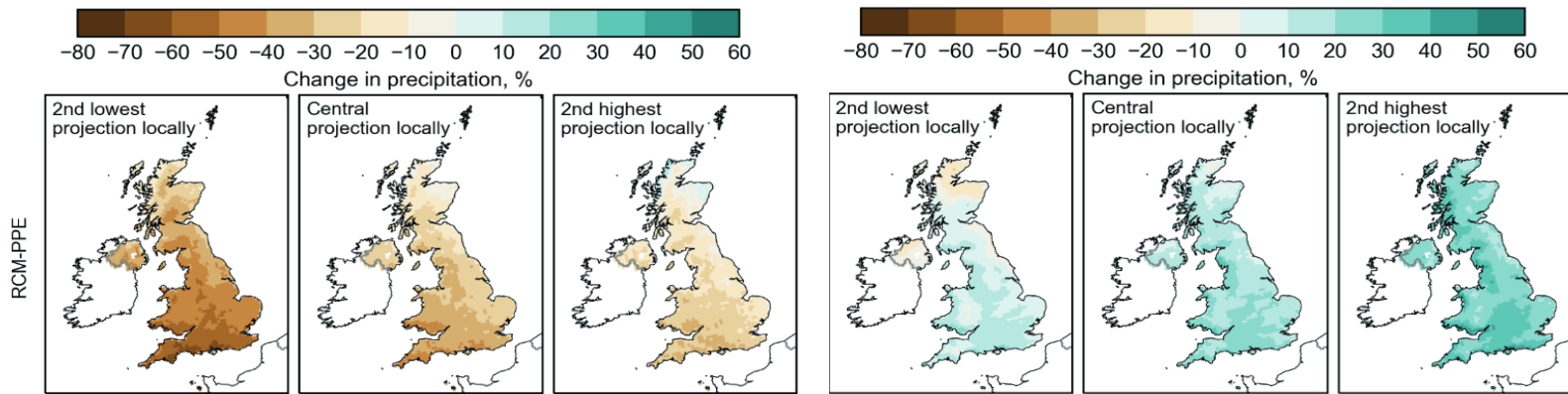
CHANGES IN THE TYPE OF RAINFALL

By 2070, Local (2.2km) projects more of the rain in winter will come from frontal rain events of higher intensity and in summer from short lived high intensity showers.



Met Office Future UK Probabilistic Projections for Precipitation

Changes for 2061-2080 relative to 1981-2000 for High emissions World (RCP8.5)



Precipitation is projected to **decrease** in the Summer

Precipitation is projected to **increase** in the winter

Changes in likelihood of UK Extreme Events due to man-made Greenhouse gases – extreme rainfall

The wettest day on record



Currently, such an event would happen every 100 years and this may decrease to every 30 years by the end of the century

Has become...

Natural
climate

2.5 times more likely

2020

And could become...

Natural
climate

10 times more likely

2100

Main Types of Winter Flooding



Coastal Flooding



Fluvial Flooding



Groundwater Flooding

Other types of flooding include: Surface water (Pluvial), sewerage and reservoir



Credit: Fruitnet.com



Credit: FloodList



Credit: Pitchcare.com

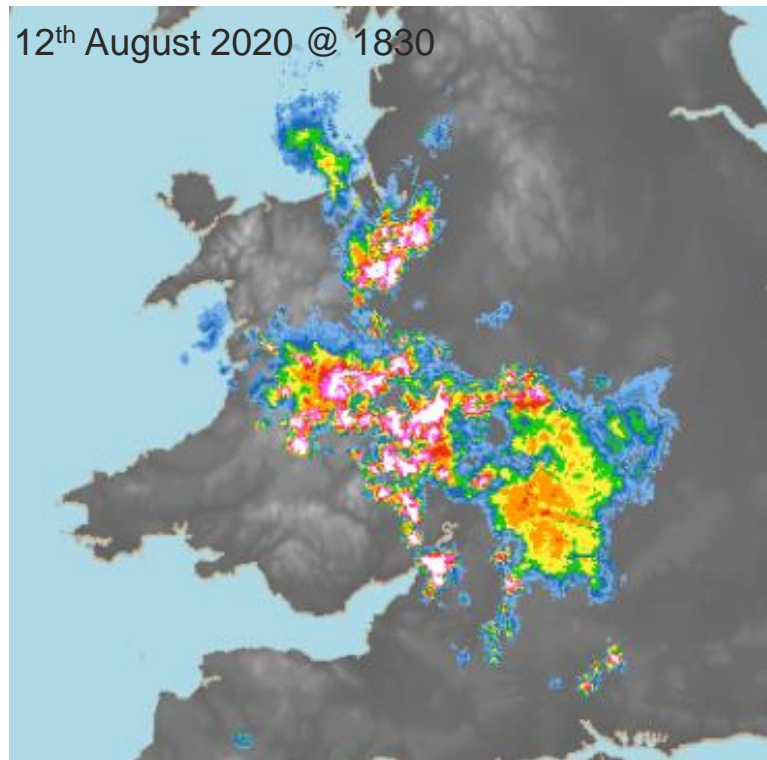


Credit: The telegraph

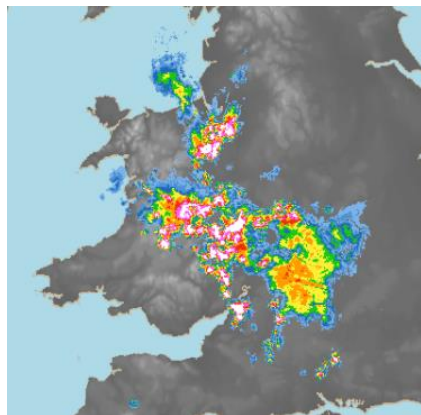
Thunderstorm Requirement

For thunderstorms to develop you need the following:

- Moisture
- Unstable Air (air that will keep rising once it starts)
- A trigger (for example, heat or converging winds)



Main Type of Summer Flooding



People in the area have been warned their homes and businesses are at risk (Picture: UKNIP; Rob Day; PA; Getty)

Surface Water Flooding

What are the impacts of this change?

Heavier rainfall in the future could lead to an increased risk of.....

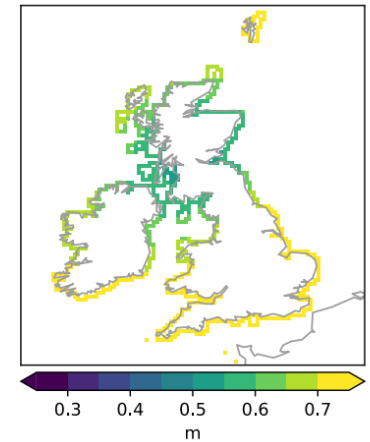
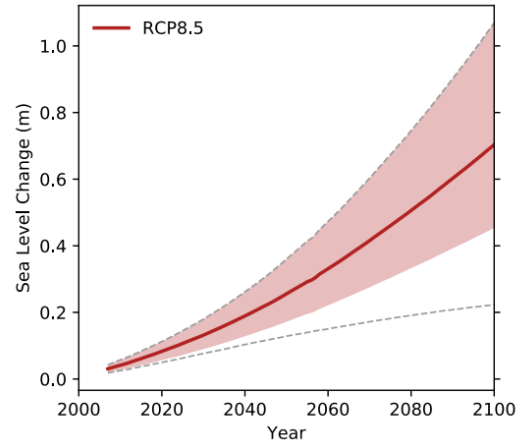
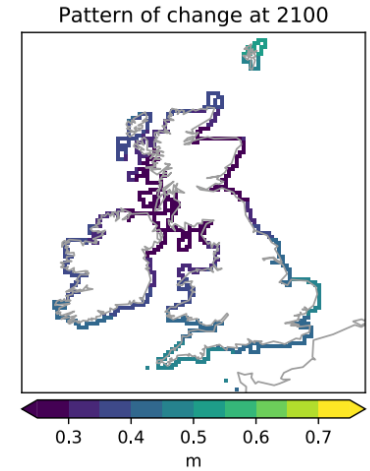
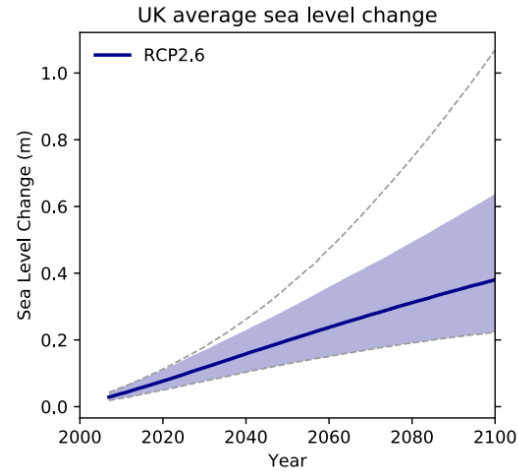
- River and groundwater flooding in the winter
- Surface water flooding in the summer

Sea Level

Sea level rise in the UK

- Sea levels will rise more in England/Wales than in Scotland/Northern Ireland. This is due to glacial isostatic adjustment.
- In a high emissions scenario, sea level could rise between 0.5-1.15m by 2100 in London. Under a low emission scenario this would be 0.3-0.7m*

* Relative to 1980-2000 average



What are the impacts of this change?

A rise in sea level in the future could lead to an increased risk of.....

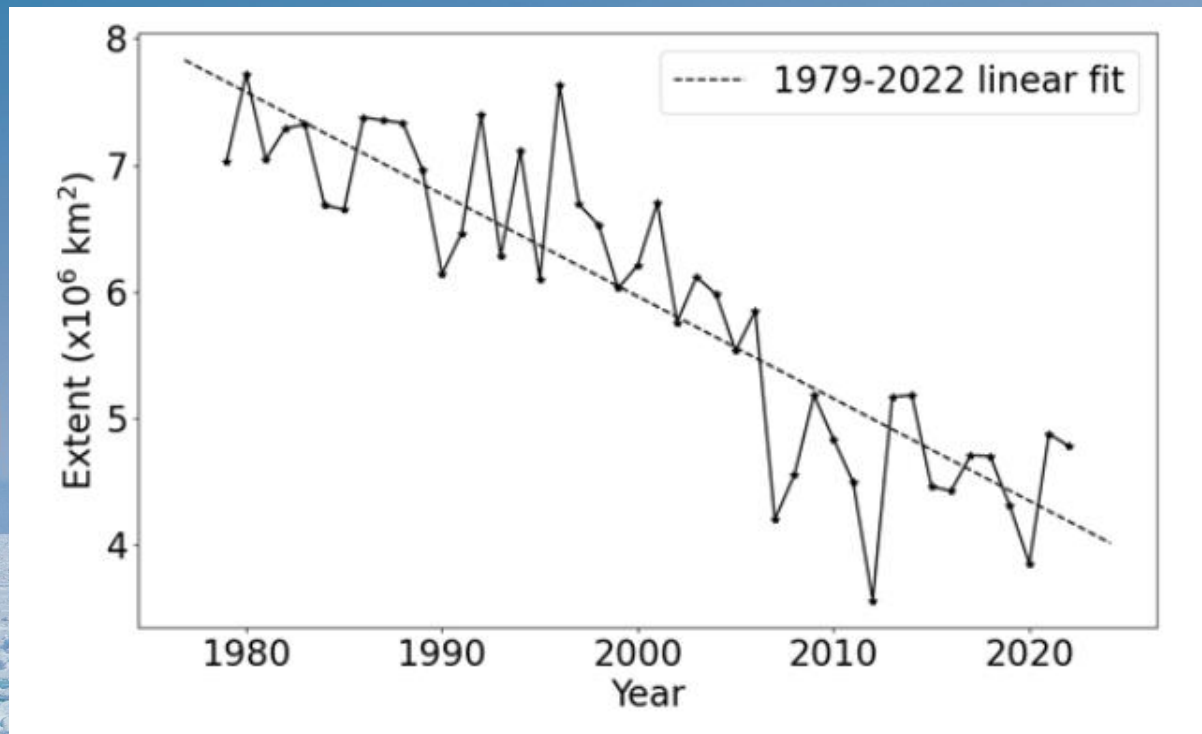
- Coastal flooding
- Coastal erosion

Arctic Sea Ice Loss

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



September Arctic sea ice extent







Wildfire

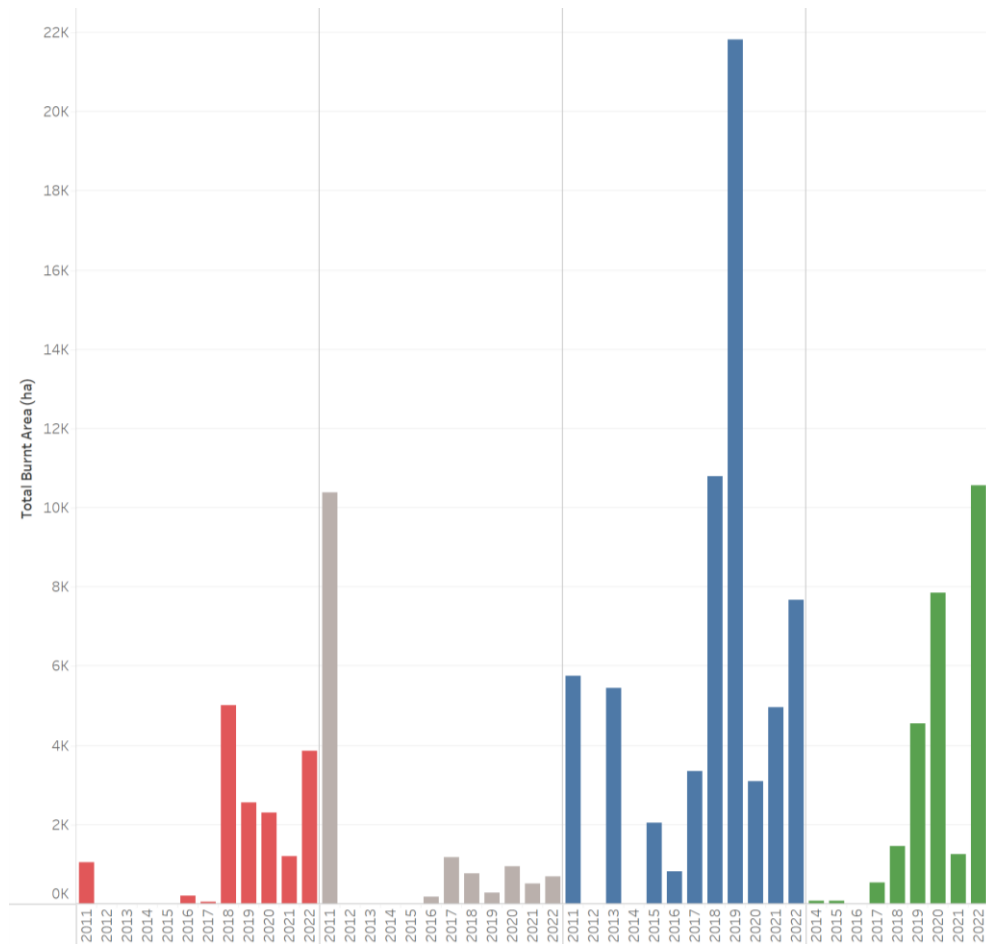
R66 - Wildfire

Climate impacts on wildfires

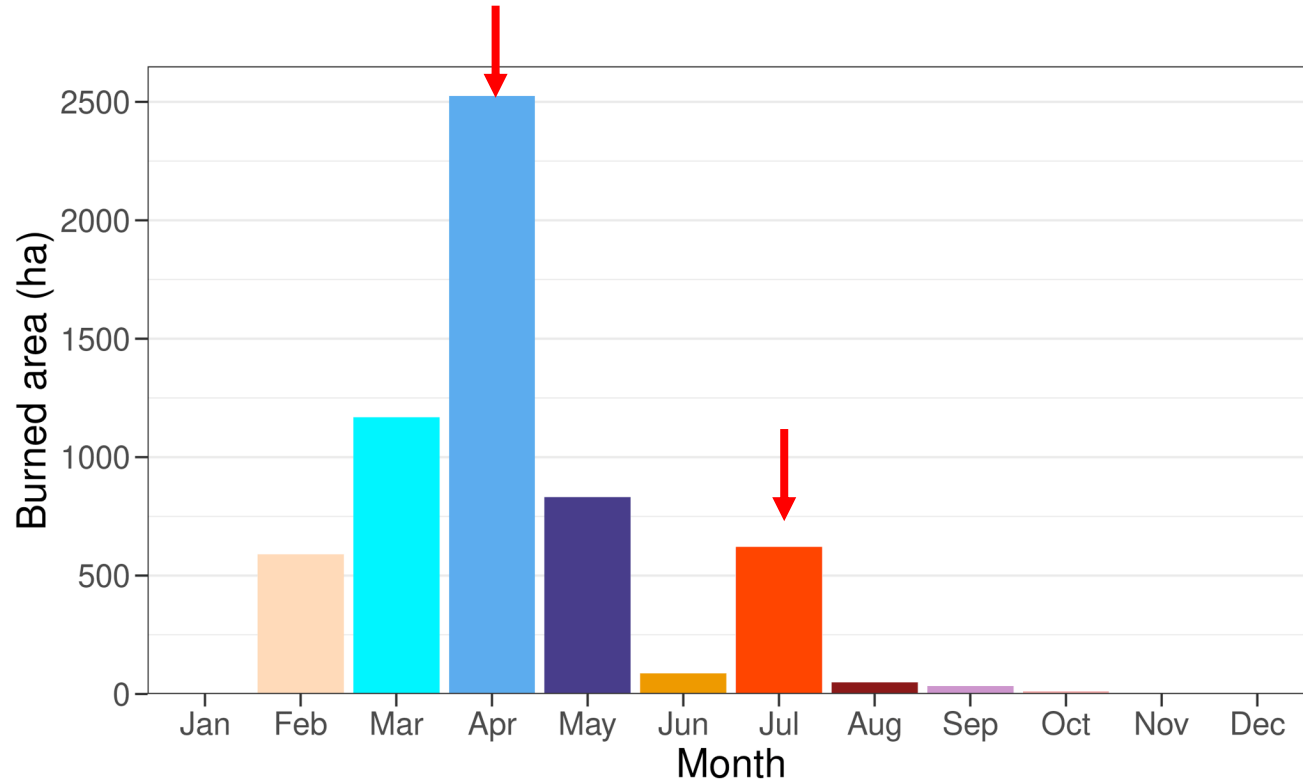
Graph showing total burnt area (ha) across the nations 2011 - 2022

Nation

-  England
-  NI
-  Scotland
-  Wales



UK Wildfire seasons



Monthly mean burned area (km²) for the UK from 2003 to 2020.

Wildfire Conditions

Considerations:

- Vegetation type and condition
- Ground conditions
- Weather conditions
 - Temperature
 - Relative Humidity
 - Precipitation
 - Wind speed



Dramatic pictures show wildfire at Quiraing mountain on the Isle of Skye on Saturday night picture: [BBC News](#)

Wildfire Risk

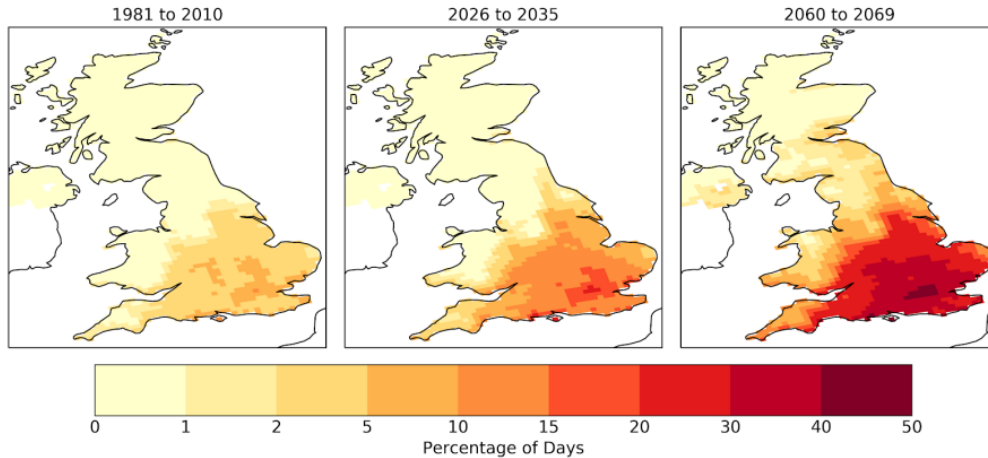


Figure D4: Annual occurrence (% of days) with Fire Weather Index (FWI) > 17.35 (Fire Danger Class 4/5) during summer (JJA) from the UKCP18 12km regional model averaged over the 12 ensemble members for a) 1981-2010 baseline period b) 2026-2035 (2 degC global warming level) and c) 2060-2069 (4 degC global warming level).

Belcher et al., (2021)

Combination of high temperatures, low humidity, low rainfall and often high winds

Wildfire risk does occur naturally but is increasing in frequency and severity due to climate change

Past Example – Summer 2022



What are the impacts of this change?

A future likelihood of seeing wildfire conditions could lead to an increased risk of.....

- Destruction of land
- Danger to buildings on the rural / urban boundary
- Poor air quality
- Impacts on FRS resources

Storms

R72 - Storms

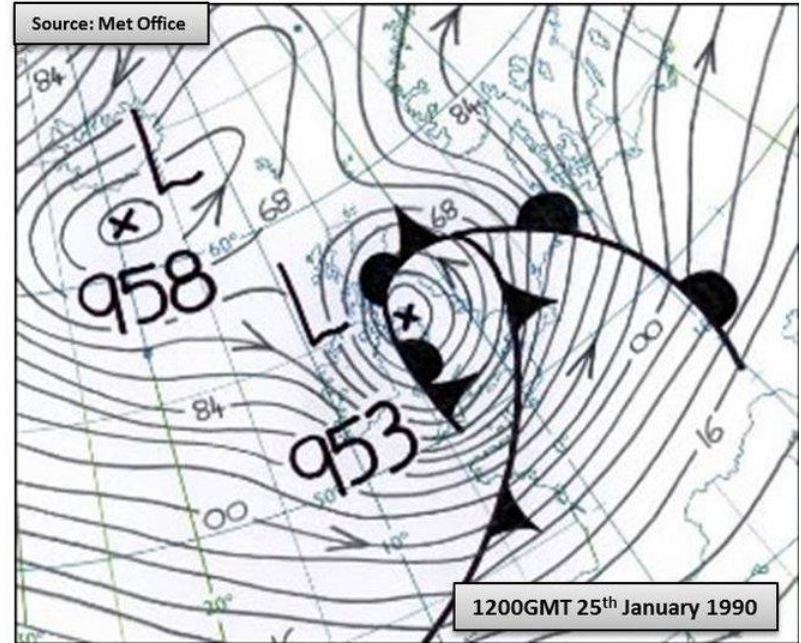
* The Scottish Risk Assessment includes a Storms and Gales Risk

Storms

Deep areas of low pressure can develop in the autumn to early spring period bringing very strong winds.

The wind flows anti-clockwise around the low pressure with the strongest winds generally on the southern and western sides.

Warnings for these type of events will be issued as Wind warnings.



Met Office Storm Eunice Impacts

- Danger to life – 4 fatalities
- Power Outages for several days
- Major transport disruption
- Thousands of fallen trees
- Schools and businesses closed.
- Significant flooding of properties and infrastructure

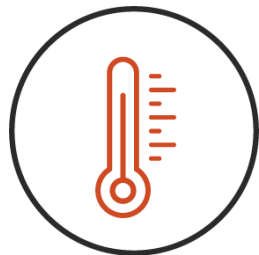


What are the impacts of this change?

More active storms could lead to an increased risk of.....

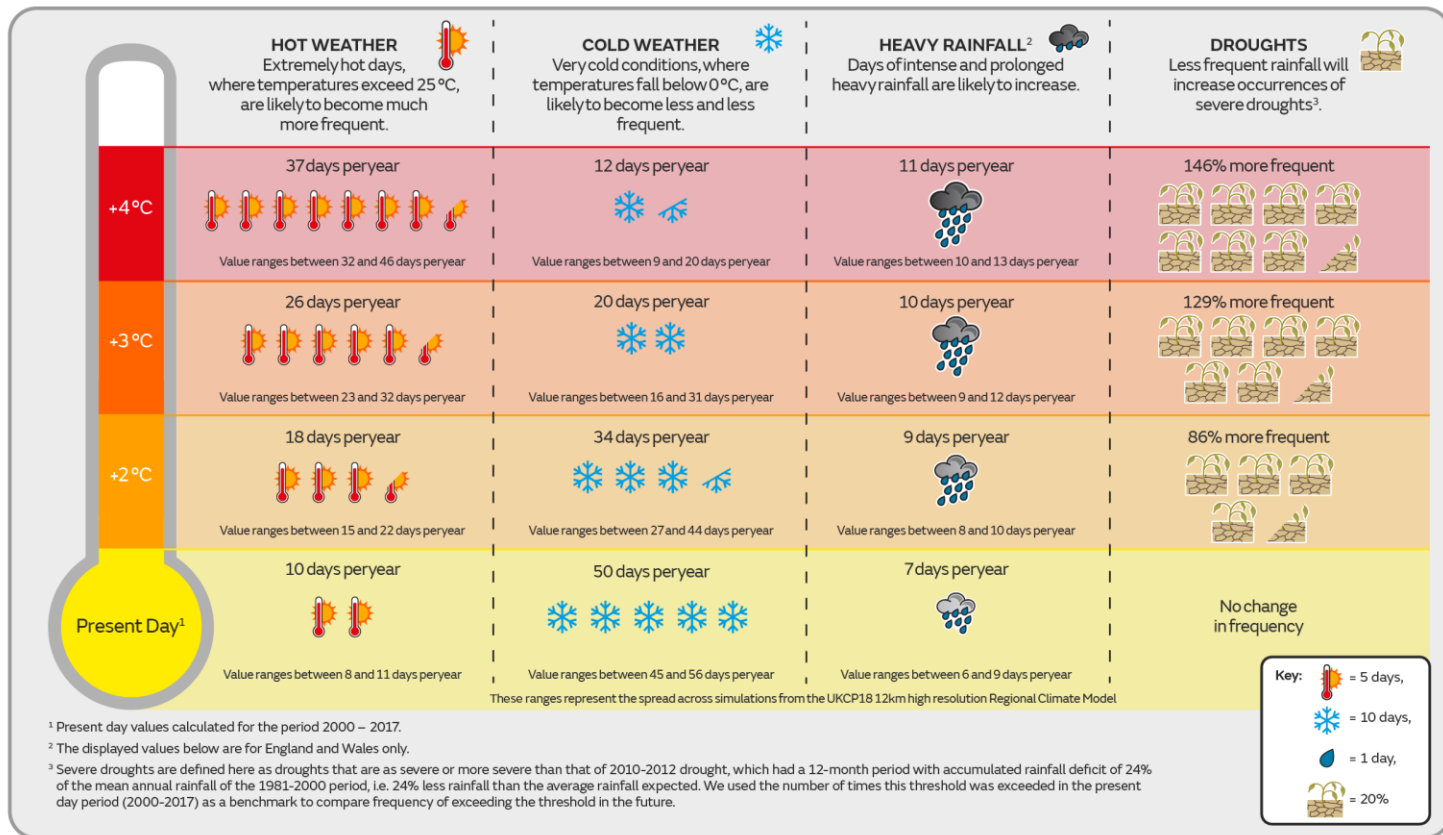
- Structural damage
- Environmental damage (e.g. fallen trees)
- Power outages
- Transport disruption
- Coastal flooding

UK climate change risks



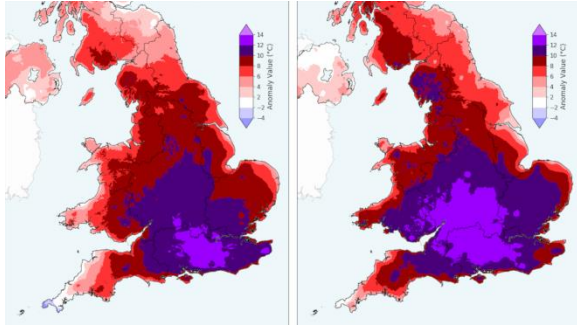
	Heat related deaths (per year)	Flooding (annual damages)	Water availability (low river flows)	Wildfires (% days with 'very high' fire risk)
Present day	2,000	£2 billion		9%
2°C warming	7,000	£2.7 - £3 billion	20% decrease	26%
4°C warming	13,000	£3.5 - £3.9 billion	50% decrease	50%
Impacts at 4°C vs 2°C	~86% worse	~30% worse	30% worse	~92% worse

Global warming and future high-impact weather in the UK



What have we already seen?

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 could happen **every other year**



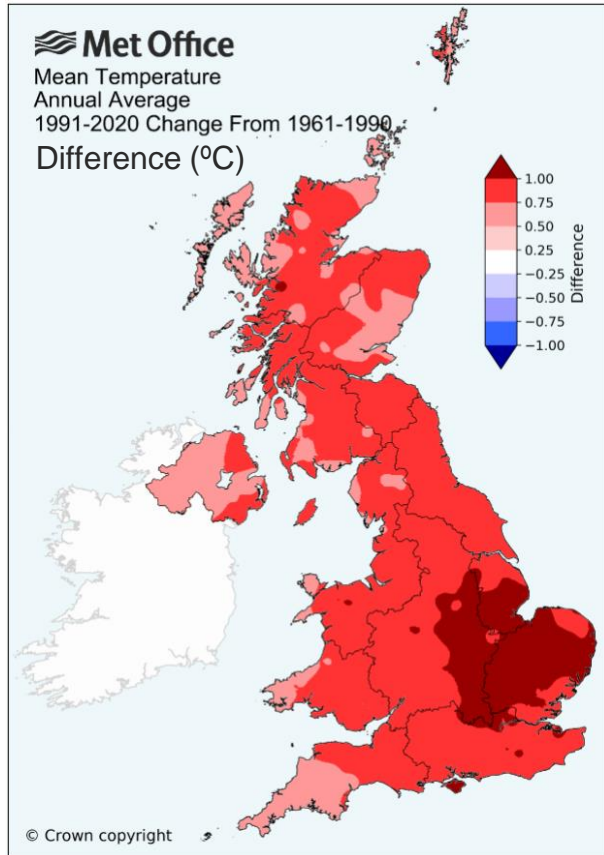
Heavy rainfall

- **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%**

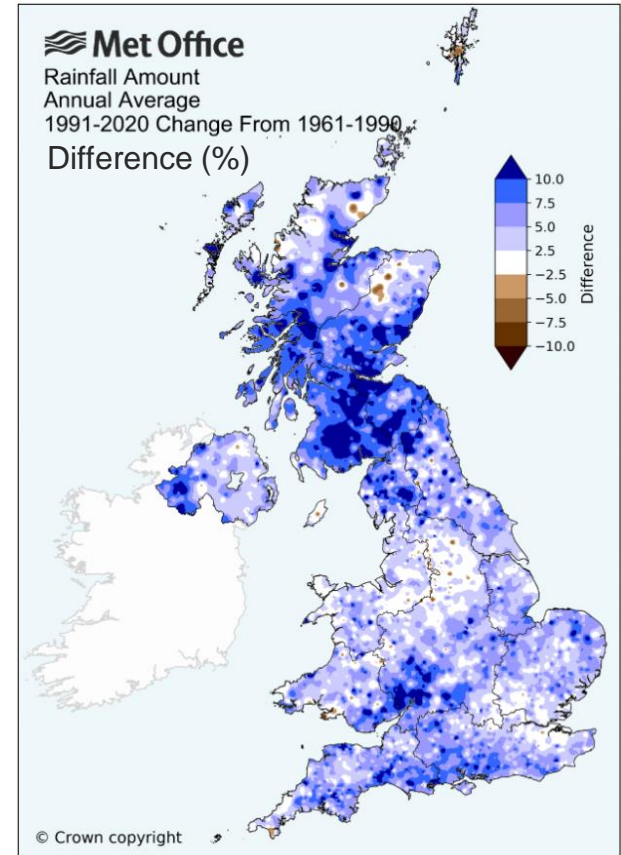


Wildfires

- 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



1991-2020
change from
1961-1990



Any Questions?