

# Building resilience along the pathway to net zero

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# We already experience damaging weather events

Storm Dennis, February 2020



UK flooding, 2007

defra Environment Agency

delivering benefits through evidence

source pathway receptor

The costs of the summer 2007 floods in England

Summer temperatures, 2018



# The global and UK climate is changing

Met Office State of the UK Climate

Changes in extremes from 1961-90 to 2008-17

**Higher maximum temperatures**  
The average hottest day of the year has increased by 0.8 °C

|                    |         |
|--------------------|---------|
| 2008-2017 average: | 26.8 °C |
| 1981-2010 average: | 26.7 °C |
| 1961-1990 average: | 26.0 °C |

**Longer warm spells**  
Warm spells have more than doubled in length – increasing from 5.3 days in 1961-90 to 13.2 days in 2008-2017

**Higher minimum temperatures**  
The average coldest day of the year has become 1.7 °C milder

|                    |         |
|--------------------|---------|
| 2008-2017 average: | -6.8 °C |
| 1981-2010 average: | -7.6 °C |
| 1961-1990 average: | -8.5 °C |

**Fewer very cold days**  
The number of days where max temps don't rise above 0 °C has been decreasing

|                    |          |
|--------------------|----------|
| 1961-1990 average: | 4.8 days |
| 1981-2010 average: | 3.6 days |
| 2008-2017 average: | 3.2 days |

**Shorter dry spells**  
Overall, the longest dry spells have decreased by 2.5 days on average

**More rain on wettest days**  
Total rainfall from extremely wet days\* has increased by about 17%

|                    |        |
|--------------------|--------|
| 1961-1990 average: | 64.0mm |
| 2008-2017 average: | 75.0mm |

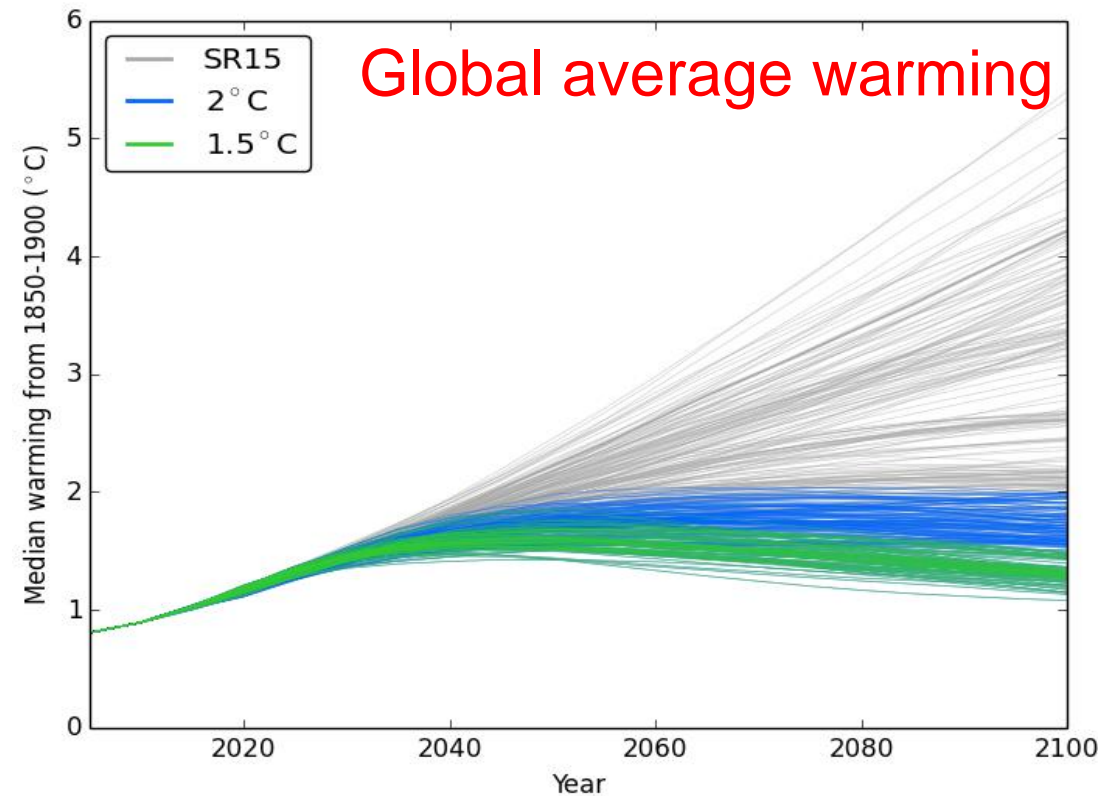
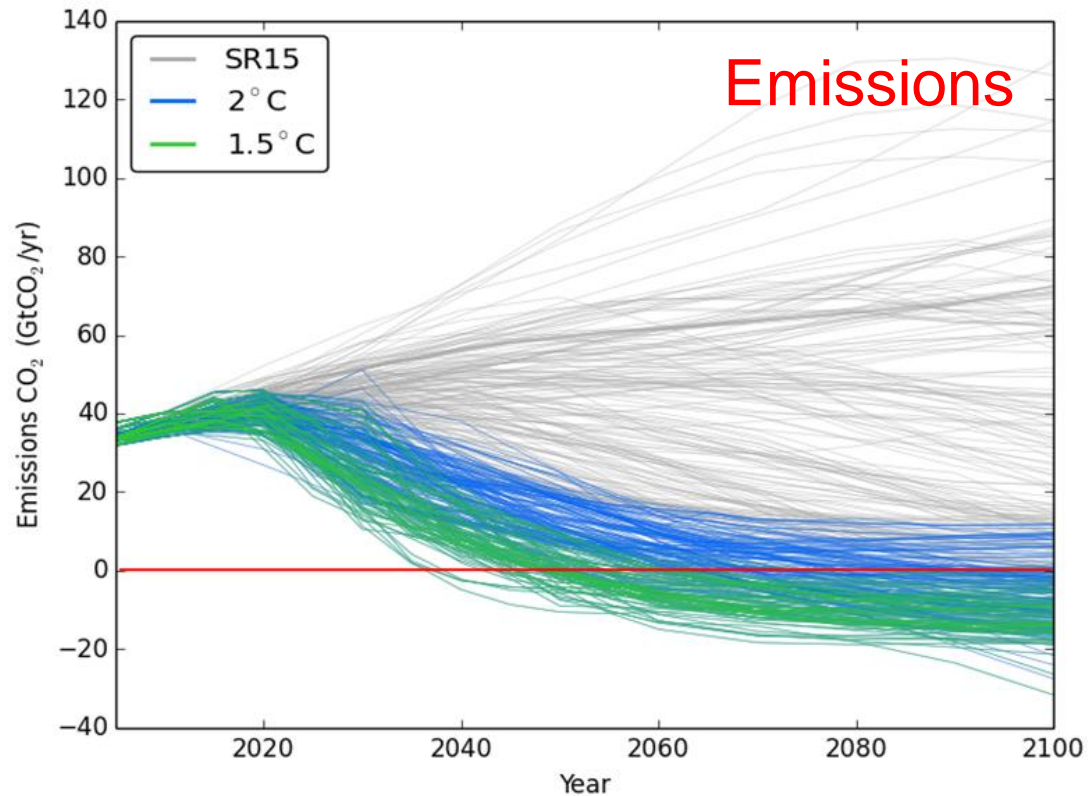
\*days exceeding the 99th percentile of 1961-90 rainfall

\*For detailed definitions about how these metrics are calculated please refer to the extremes supplement report

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For more information about climate science and climate change visit our climate guide [www.metoffice.gov.uk/climate-change](http://www.metoffice.gov.uk/climate-change)

# How much will climate change in the future?

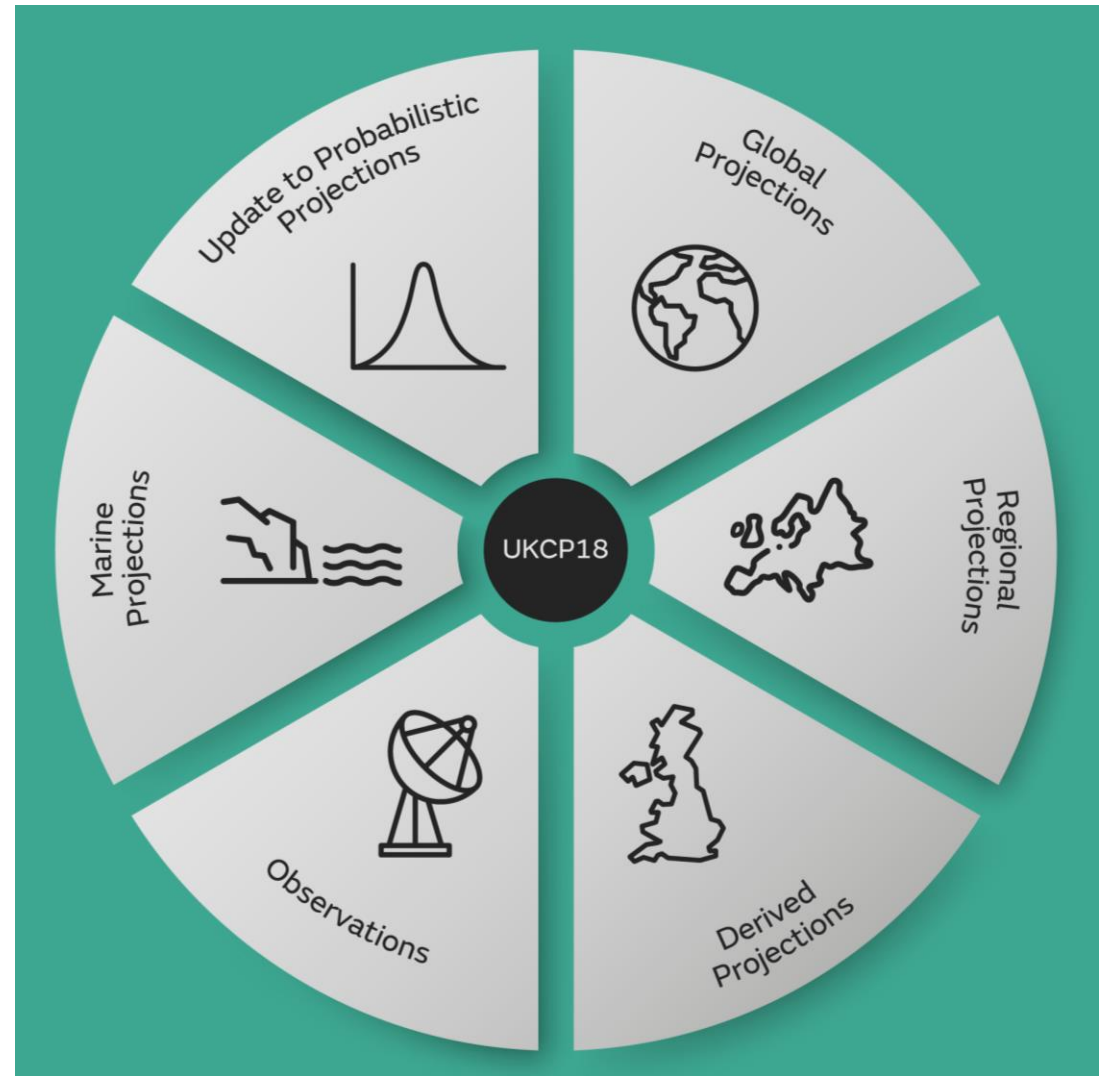


We examine many alternative views of how greenhouse gas emissions might change

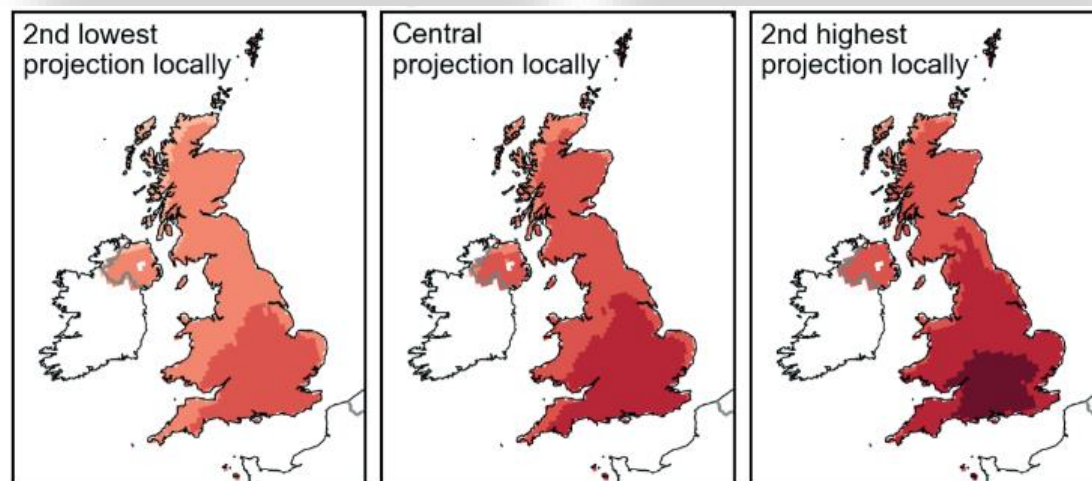
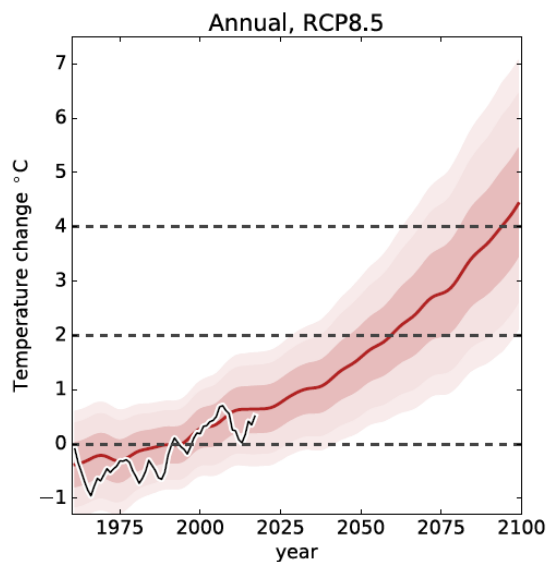
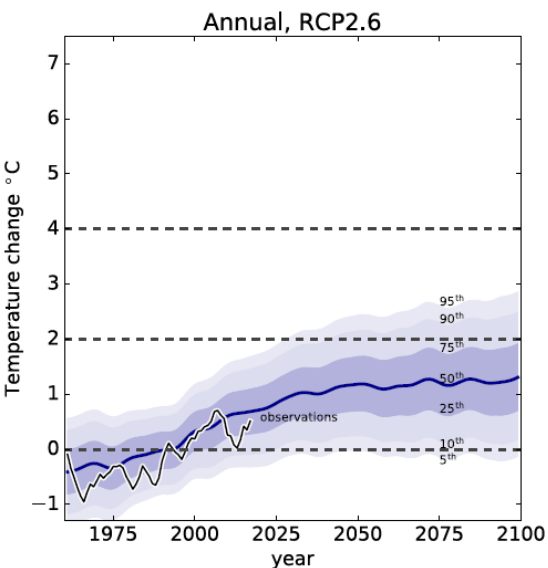
Then, we use models based on our physical understanding to project the climate changes

# Focus on UK:

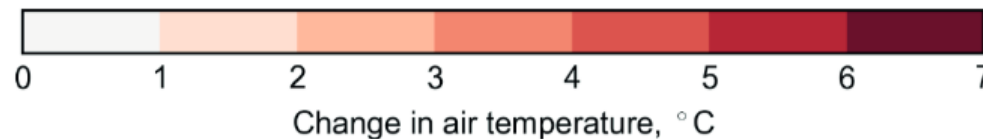
“a greater chance of warmer, wetter winters and hotter, drier summers”



# Future UK temperatures



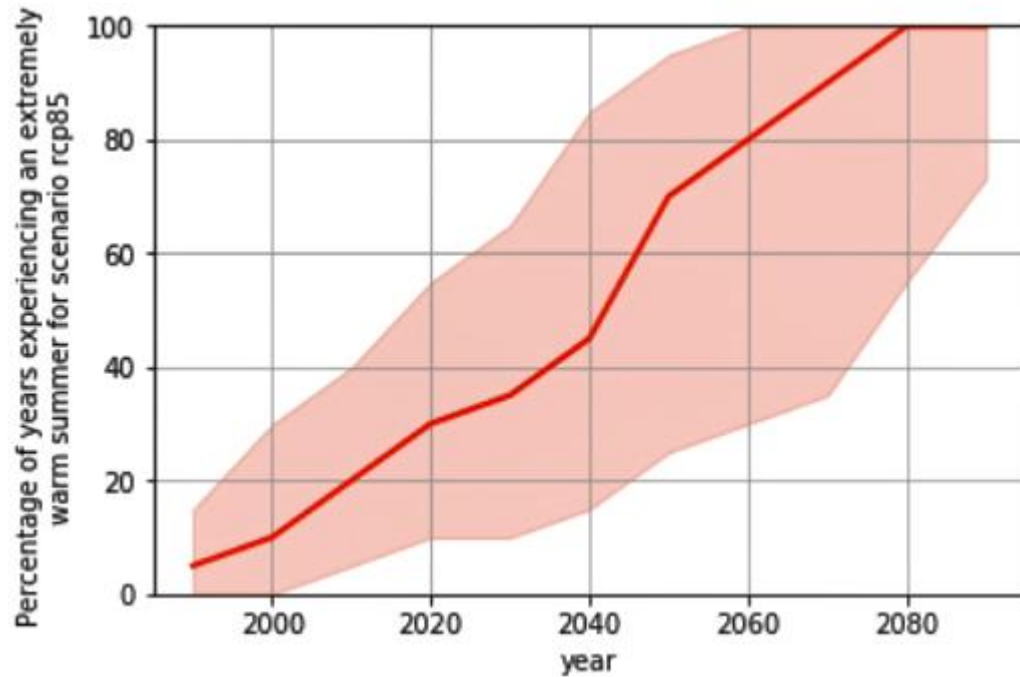
RCM-PPE



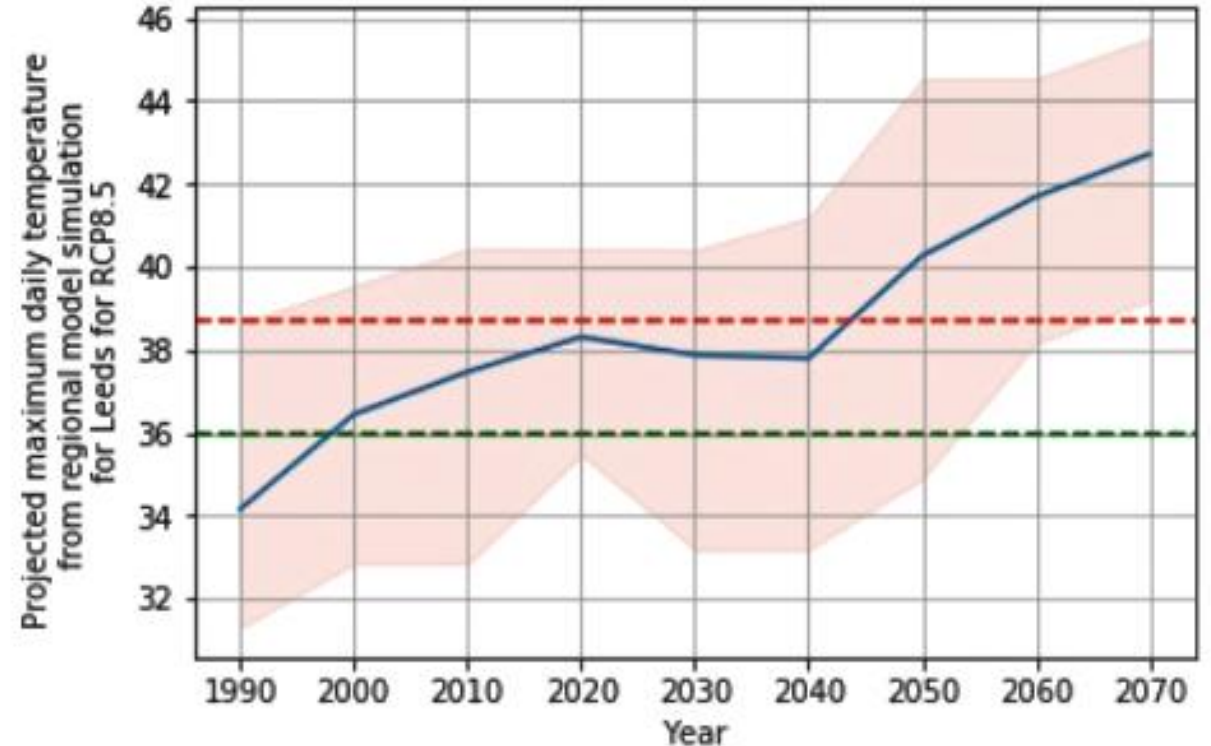
- All areas of the UK are projected to experience warming
- Warming is greater in the summer than the winter
- Future rise depends on the amount of greenhouse gases the world emits

# UKCP also projects changes to seasonal and daily extremes

High emissions scenario – RCP8.5

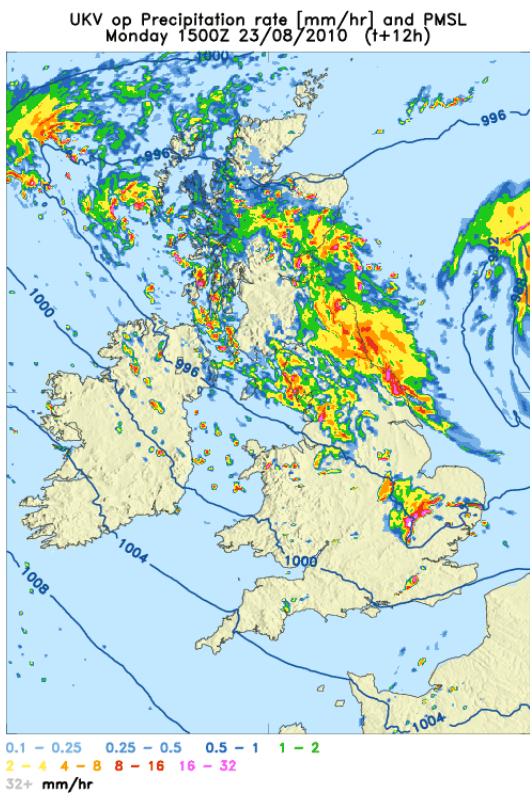


**Probability of an extremely warm summer**, like that of 2018. Defined here as the level of warming encountered with 5% chance in the 1981-2000 baseline period.



Summer daily maximum temperature change from 12km regional climate model simulations

# Future change in UK extreme summer rainfall



Hydrological impacts  
modelling e.g. flash floods



Climate change for cities  
e.g. urban extremes



The rainfall associated with a 2-year return period increases by 25% by 2070s



The frequency of days with hourly rainfall >30mm/h almost doubles by 2070s – increasing from UK-average of once every 10 years now to almost once every 5 years

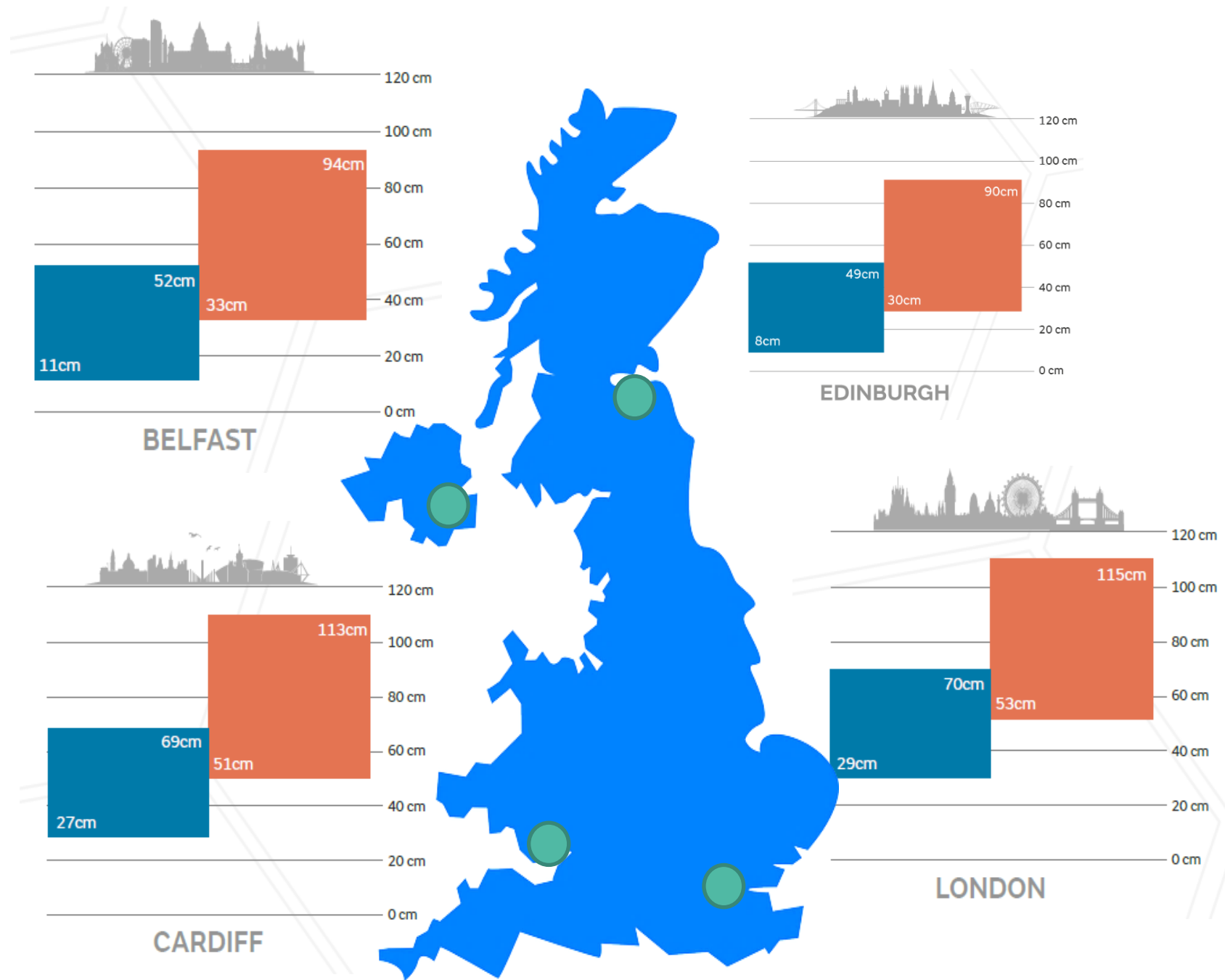
Exploring the new 2.2km projections

# Sea-level rise

Increase will generally be greater in the south than in the north

 Range in low emission scenario  Range in high emission scenario

(by 2100 relative to 1981-2000)





# Urban resilience application: phase 1 focused on user engagement and development of awareness



**Met Office**  
**BRISTOL CLIMATE CHANGE**  
**The Science**

**What affects Bristol's weather?**

**Time of day** – As temperatures cool overnight, the moist conditions around the Estuary can lead to fog.

**Wind direction** – Funneling along the Estuary, between the Welsh Mountains and Exmoor can result in stronger WSW winds. The Welsh Mountains to the NW, can also provide shelter from low cloud and surface winds.

**Tides** – The Bristol Channel and Severn Estuary cause a funneling of tides and consequently a high tidal range. Air pressure, wind speed and its direction can also influence the height and impact of a storm surge.

**Showers** – The Bristol Channel can create convergence, leading to heavy showers and thunderstorms.

The Bristol Channel and Severn Estuary provide suitable conditions for low cloud or sea fog. This can move inland, particularly in winter.

**How has Bristol's climate changed?**

The Bristol climate stripes show how annual average temperature has changed since 1887, compared with a baseline average between 1981 and 2000.

**Calculating Bristol's future climate**

The Met Office uses computer models to simulate decades into the future. These models let us that increasing greenhouse gas concentrations in the atmosphere leads to an increase in global temperature – the basis for climate change.

However, the climate is complex and small changes in global temperature can cause large changes to the weather patterns that we experience at a local level. To provide the best available information, multiple variations of the Met Office's latest global climate model are used to simulate the plausible future climate outcomes – this is known as a climate model ensemble.

**Turning data into a decision:**

The impact of a changing climate depends on three key factors – the hazard itself, exposure levels and vulnerability. Actions to reduce these could, for example, include...

- Mitigation & adaptation
- Climate emergency declaration
- Global emissions reductions
- Net-zero carbon neutral 2030
- Empowered & engaged communities
- Supporting livelihoods
- Tackling health inequalities
- Long-term & integrated planning
- Nature-based solutions
- Flood defence schemes

**RISK**

**VULNERABILITY**

**EXPOSURE**

**HAZARD**

**Geographic location**

**Geographic location**

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**The Results Explained**

**Representing Bristol's UKCP results for a range of global average temperature increases over the 21st century.**

The UK Climate Projections (UKCP) is a tool that provides information about future climate for the UK. It delivers cutting-edge climate science with the most up-to-date assessment of how the climate may change in the future.

**Main advances in UKCP:**

- State-of-the-art global climate models
- Innovative regional climate models
- Up-to-date observational data
- Significant user engagement
- Locally relevant climate information to enhance resilience

**Why are there a range of UKCP results?**

Our future climate is determined by ongoing and future greenhouse gas emissions. To capture this uncertainty about the future, the results for Bristol are from the UKCP probabilistic projections, which provide the most comprehensive assessment of uncertainty in UKCP.

**What are RCPs?**

Representative Concentration Pathways (RCPs) are used to describe possible futures based on assumptions about human activity and greenhouse gas emissions.

- RCP8.5: Global greenhouse gas emissions grow unmitigated.
- RCP4.5 and RCP2.6: Are two medium emission pathways, with varying levels of mitigation.
- RCP2.6: Global emissions are strongly reduced.

**How do these relate to changes in global temperature?**

| *RCP   | **Change in Global Average Temperature (°C) by 2061-2100 |
|--------|--|
| RCP8.5 | 4.3 (3.2 – 5.4)  |
| RCP4.5 | 2.8 (2.0 – 3.7)  |
| RCP4.5 | 2.4 (1.7 – 3.2)  |
| RCP2.6 | 1.6 (0.9 – 2.3)  |

\*The RCP pathways represent a broad range of climate outcomes and are neither forecasts nor policy recommendations, however they offer approximate penalties for initial competition.

\*\*This data is from the Intergovernmental Panel on Climate Change's Assessment Report (AR5), specifically WG1 Chapter 12 Table 12.3.

We are already witnessing the impacts of a global average temperature rise of 1°C compared to pre-industrial levels. The Paris Agreement aims to curtail greenhouse gas emissions so that the future global average temperature increase is capped at below 2°C, ideally at the lower limit of 1.5°C. Recent research by the UN suggests that rapid reductions in emissions, beyond those currently pledged as part of the Paris agreement, may be required to limit warming to well below 2°C. The Committee on Climate Change (CCC) has advised that the UK should plan for a 2°C rise as a minimum, whilst preparing for a 4°C rise.

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**UKCP Results**

**There is an increased chance of warmer, wetter winters and hotter, drier summers.**

Hot summers are expected to become more common. By 2050 there is a 50% chance of summers as hot as it was in 2018 (one of the warmest UK summers to date).

Although the trend is for drier summers in the future, the latest UKCP data suggests possible increases in the intensity of heavy summer rainfall events.

Sea levels will continue to rise under all emission pathways.

Under a high emissions pathway, the frequency of hot spells\* rises from an average of once every 4 years to about 4 times per year by 2070.

**The UKCP headlines for the UK, are consistent with these results for Bristol.**

**UKCP Headlines for the UK**

| Compared to a 1981-2000 baseline, the average change in: | 2030 (2020-2039) | 2050 (2040-2059) | 2080 (2070-2089) |
|--|------------------|------------------|------------------|
| Summer Air Temperature (°C)                              | +1.0 to +2.2     | +1.7 to +4.0     | +3.0 to +8.0     |
| Summer Maximum Air Temperature (°C)                      | +1.3 to +2.8     | +2.2 to +4.9     | +3.5 to +9.2     |
| Winter Air Temperature (°C)                              | +0.8 to +1.9     | +1.2 to +2.9     | +1.9 to +4.8     |
| Winter Minimum Air Temperature (°C)                      | +0.8 to +1.9     | +1.3 to +3.1     | +1.9 to +5.2     |
| Annual Mean Air Temperature (°C)                         | +0.8 to +1.7     | +1.3 to +2.8     | +2.2 to +5.4     |
| Summer Precipitation Rate** (%)                          | -12 to -34       | -18 to -45       | -26 to -68       |
| Winter Precipitation Rate** (%)                          | +6 to +18        | +9 to +28        | +17 to +48       |
| Sea Level Change (m)                                     | +0.14 to +0.19   | +0.24 to +0.36   | +0.42 to +0.72   |

Baseline = 1981-2000. Summer = Jun, Jul, Aug. Winter = Dec, Jan, Feb. \*\*Relative change (%) in mm per day

Please note that as high-resolution information becomes available following the release of the UKCP Local (2.2km) projections, the values quoted may change. In particular, upper end increases in winter mean precipitation may be revised upwards. However, in general the 2.2km projections reinforce the UKCP results in terms of seasonal-mean changes.

**How is the range calculated?**

The 1<sup>st</sup> number in the range, is the average result from RCP 4.5. To capture more extreme projections, the 2<sup>nd</sup> number is for RCP 8.5, where 90% of UKCP results lie below this. Average summer rainfall rate is one exception. As this is expected to decrease over time rather than increase, here the 2<sup>nd</sup> number is for RCP 2.6, where 10% of the results are below this value.

90% chance of being less than this result

50% chance of being less than this result

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Phase 2 involves developing a heat risk climate service (underway)

Phase 3 will focus on precipitation and flooding (when future-drainage or aquaCAT project results are available in 2021)

Visualisation tool being developed

Urban engagement with: Bristol, Manchester, Belfast, Glasgow, Leeds and London

# Mainstreaming resilience building and growing participation: Further examples from UKCR



**Review of climate resilience mainstreaming into regulatory and voluntary standards, national guidance, and other sectorial/industry codes of practice**



**Climacare: governing the climate adaptation of care settings**  
Understanding the human behaviour, organisational capacity and governance to enable the UK's care provision to develop adaptation pathways to rising heat stress under climate change.



**Mobilising Adaptation: Governance of Infrastructure through Co-Production (MAGIC)** Developing a community-led approach to reducing flood risk, whilst providing opportunities for flood-vulnerable urban residents to improve health and wellbeing, through better engagement with blue and green spaces.

# Mainstreaming resilience building and growing participation: Further examples from UKCR



Review of climate resilience mainstreaming into regulatory, voluntary standards, national guidance, and other sectorial/industry codes of practice



## Co-development:

- Brings the user into the process
- Requires new skill sets
- Is increasingly seen as essential practice but it is difficult to do!

and governance to enable the care provision to develop adaptation pathways to rising heat stress under climate change.



Utilising Adaptation: Governance infrastructure through Co-production (MAGIC) Developing a community-led approach to reducing flood risk, whilst providing

opportunities for flood-vulnerable urban residents to improve health and wellbeing, through better engagement with blue and green spaces.



# Thankyou for your time

