Bristol Heat Pack

Cities can be impacted by a range of weather and climate hazards including extreme heat, heavy rainfall and sea level rise. The Heat Pack provides information on how extreme heat events in your city may change this century due to climate change, the impacts, and how to build resilience to extreme heat.

WHY ARE CITIES PARTICULARLY VULNERABLE TO HEAT?

Built up urban areas have large amounts of tarmac, concrete and other dark surfaces that absorb heat during the day and release it at night causing cities to be warmer than surrounding rural areas. This Urban Heat Island effect can increase already high background temperatures.

Cities generally have less green and blue spaces, compared to more suburban and rural areas, such as parks, forests, ponds and wetlands that act to cool their surroundings.

Heat emissions from transport and air conditioning units add excess heat into urban environments increasing already high background temperatures by ~1°C*.

Cities are home to large populations and critical infrastructure such as transport hubs, key government buildings, water and energy supplies. Often these systems are interconnected.

WHAT ARE THE IMPACTS OF EXTREME HEAT?

Increased heat related illnesses and mortality, particularly among the most vulnerable.

Overheating of buildings and thermal discomfort of inhabitants.

Increased pressure on city services, including green spaces, energy for cooling, water demand and health and social care services.

Disruption to transport from overheating of signalling equipment, buckling of railway lines or damage to road surfaces.

Air quality issues can become worse as air stagnates causing increased health risks.

Reduced staff productivity from negative effects on employee health and wellbeing.

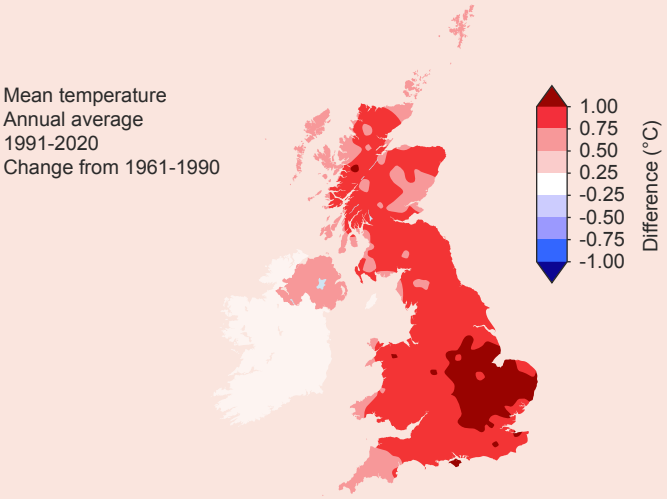
*Oke et al (2017), Urban Climates. Available at: https://doi.org/10.1017/9781139016476 & Bohnenstengel, S. et al (2014) Available at: https://doi.org/10.1002/qj.2144

HOW IS TEMPERATURE CHANGING ACROSS THE UK?

CURRENT TRENDS*

ANNUAL AVERAGE TEMPERATURE

Since the 1961-1990 period annual average temperatures have increased by 1°C in some parts of the UK.



AVERAGE SUMMER TEMPERATURE

Average summer temperatures have also increased:

0.9 °C

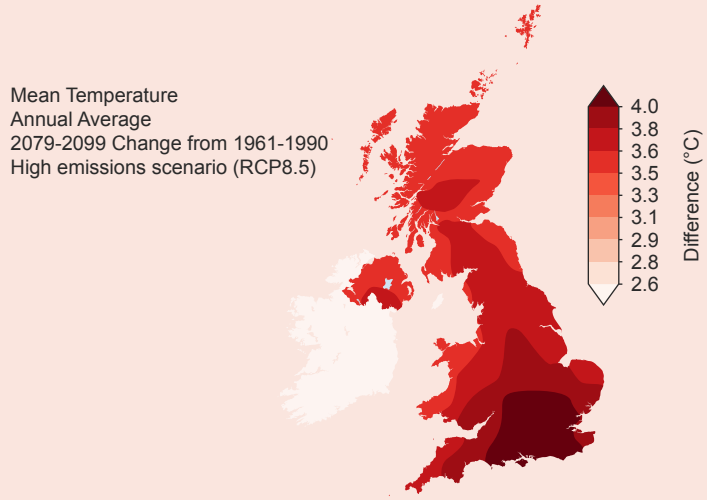
1991-2020 change from 1961-1990

Hot spells*** are largely confined to the south-east UK in the present-day and occur on average once every 5 years.

FUTURE TRENDS**

ANNUAL AVERAGE TEMPERATURE

In a low emissions scenario†, the annual average temperature of the UK is expected to increase between 0.7-2.5°C* by the 2080s. In a high emissions scenario, this change could be between 2.2-5.5°C*. The rate of change will vary across the UK.



AVERAGE SUMMER TEMPERATURE

By the 2080s average summer temperatures are projected to increase by:

Low emission scenario

0.9-3.1°C

RCP† 2.6

High emission scenario

2.4-6.7°C

RCP† 8.5

Under a high emissions scenario, the frequency of hot spells*** increases to 4 occurrences per year and become more widespread.

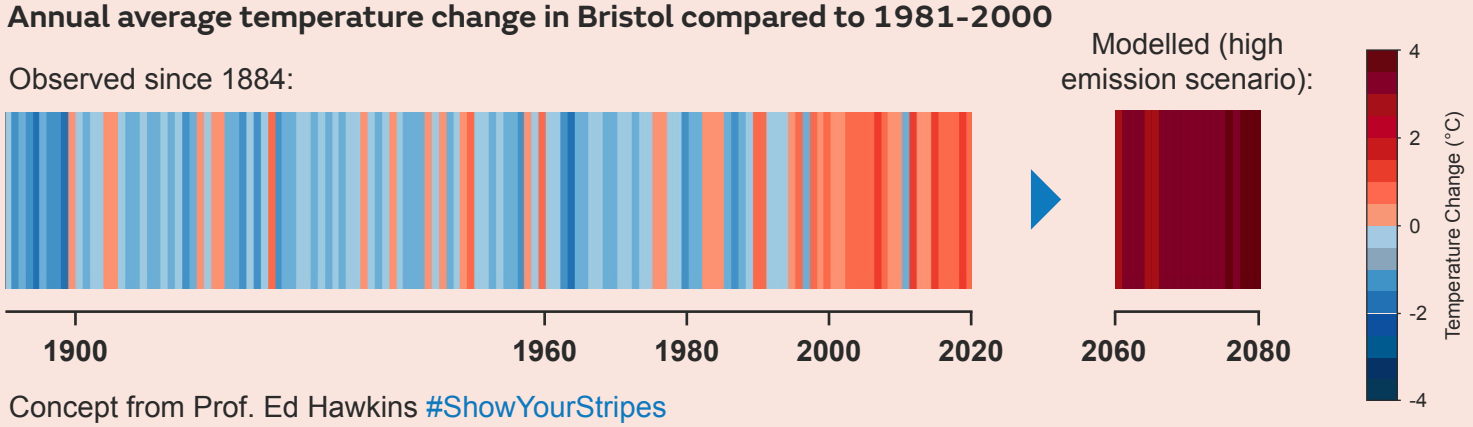
* Compared to 1961-1990 period.
**Results from UKCP 25km probabilistic projections and compared to 1961-1990 period. The first value in the rage represents the 10th percentile (90% chance of being higher than this result) and 90th percentile (10% chance of being higher than this result).
***Maximum day time temperatures >30°C for two or more consecutive days

†Emissions scenarios refer to the Representative Concentration Pathways (RCPs) used in climate modelss to describe possible futures based on assumptions about green house gas emissions. In RCP2.6 global emissions are strongly mitigated and reduced. Global temperature rise is kept below 2°C. In RCP8.5 global emissions grow unmitigated and global temperature rise exceeds 4°C.

HOW IS TEMPERATURE CHANGING IN BRISTOL?

Observations show that average temperatures in Bristol have increased since the middle of the 20th century. This trend is in line with the rest of UK. Most of this warming has occurred in the last two decades and is projected to continue throughout this century as shown by the warming stripes:

Annual average temperature change in Bristol compared to 1981-2000



Concept from Prof. Ed Hawkins #ShowYourStripes

FREQUENCY OF EXTREME HEAT EVENTS

Below are examples of the heat events in Bristol that have occurred in the last 5 years and their impacts:

Summer 2018
Temperatures reached 29°C causing several roads to melt and delays in road maintenance**.

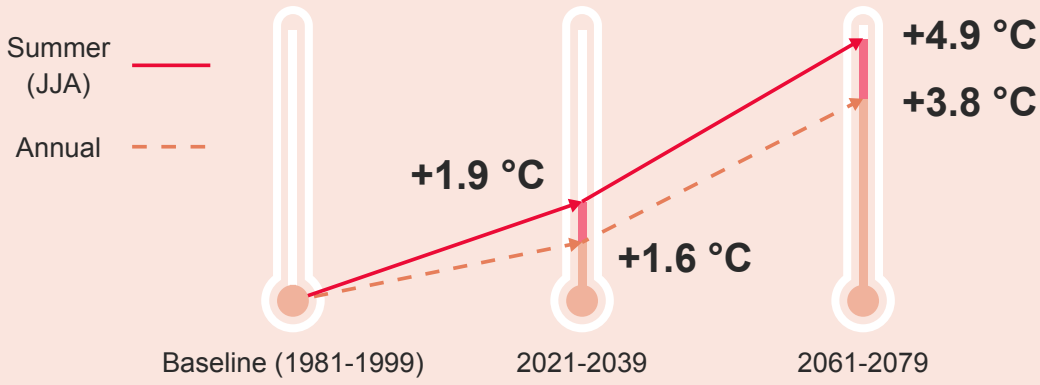
July 2019
Rail services in Bristol were disrupted as track temperatures reached 44°C causing delays and cancellations*.

August 2020
A level 3 heat-health alert was issued by the Met Office and Public Health England for Bristol as temperatures reached 34°C.

July 2021
The Met Office issued an amber extreme heat warning as temperatures in Bristol reached over 30°C.

FUTURE CHANGE IN BRISTOL'S TEMPERATURE

The thermometers show the projected*** change in average annual and summer temperatures for Bristol over the 21st century, which are in line with projected trends for the UK on page 2.



*ITV (2019): https://www.itv.com/news/westcountry/2019-07-25/west-country-heatwave-how-trains-might-be-affected
**Bristol Live (2018): https://www.bristolpost.co.uk/news/bristol-news/its-hot-bristol-tarmac-melting-1718025
***Projections based on high resolution UK Climate Projections (UKCP Local) for a high emissions scenario (RCP8.5) and is the average change across the city. See page 8 for more details.

FUTURE TRENDS IN IMPACT BASED HEAT INDICATORS*

Global warming levels are used to estimate the date at which global temperatures may reach a certain temperature in the future**.

Heatwaves will happen more frequently, be longer in duration and hotter when they occur.

Global warming level	0.5°C 1981-1999	2°C 2021-2039	4.5°C 2061-2079
Heatwave length (Range)	**5 days** (4-5)	**6 days** (5-6)	**9 days** (7-9)
Heatwave frequency	**~1 per year** (0.6-1)	**~2 per year** (2-3)	**~5 per year** (4-6)
Heatwave peak temperature	**30°C** (30-31°C)	**32°C** (31-32°C)	**33°C** (33-34°C)
Days >35°C (Range)	**0** (0)	**0.4** (0-2)	**5** (2-10)
Days >30°C	**1** (0.7-1)	**5** (3-12)	**25** (12-33)
Days >25°C	**12** (11-13)	**31** (25-45)	**74** (57-87)
Nights >20°C	**0** (0)	**1** (0-1)	**10** (4-13)

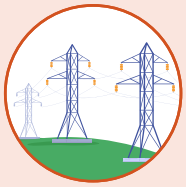
Proportion of days falling in:
Spring Summer Autumn

The number of hot days and nights is projected to increase throughout the 21st century.

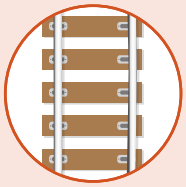
Most hot days still happen in summer, but there are also increases in hot days occurring in spring and autumn.

EXAMPLES OF IMPACTS AT DIFFERENT TEMPERATURE THRESHOLDS

Days above 25°C
Increased risk of heat-related health conditions and mortality. Rail network begins to implement staged precautions to avoid buckling of tracks.



Days above 30°C
Overhead power lines become less efficient.



Days above 35°C
Increased transport disruption as extreme precautions, e.g. speed restrictions, implemented to prevent rail buckling and overheating of power sources.

Nights above 20°C
Prevent the human body cooling down, leading to thermal discomfort, heat related illnesses and mortality, particularly among the vulnerable.

Heatwaves
3 consecutive days when maximum temperature meets or exceeds 27°C.

Summer 2020 heatwaves in England are estimated to have caused over 2500 excess deaths, with most observed in the 65+ age group.

(See page 9 for further resources on temperature thresholds)

*Results based on UKCP Local projections, for a high emissions scenario (RCP8.5) and are the average across the city.
The climate model ensemble median is shown along with the range from the 10th & 90th percentiles.
The results should be interpreted as an approximation of the projected number of days when temperature thresholds are exceeded.
There will be many factors influencing this value including natural variability and local scale processes of a higher resolution than the climate model is able to represent.
**Global warming levels based on UKCP Global projections, for a high emissions scenario (RCP8.5) and relative to pre-industrial period (1850-1900).
The ensemble median is presented. See supplementary document for further information.

HEAT IMPACTS VARY SPATIALLY ACROSS A CITY

The age, condition and type of building fabric can cause some neighbourhoods to be warmer than others.

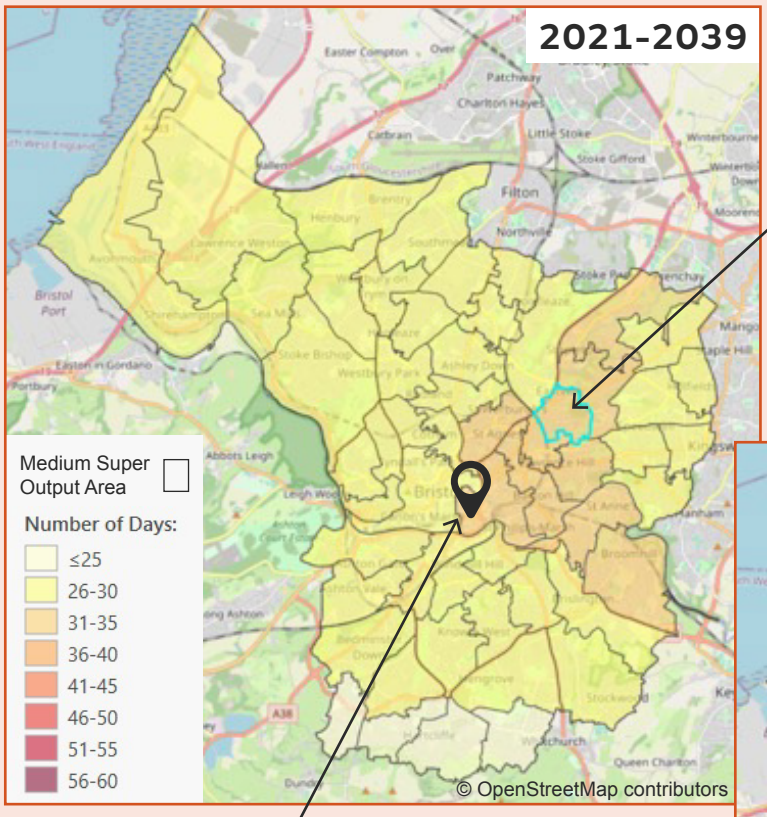
The presence of green spaces and bodies of water have a cooling effect.

The positioning of buildings can promote or inhibit air flow.

All of these factors will determine how heat is distributed across the city under both current and future climate.

WARM DAYS >25°C IN SUMMER

The average number of days in summer when daily maximum temperatures are greater than 25°C, under a high emissions scenario*.

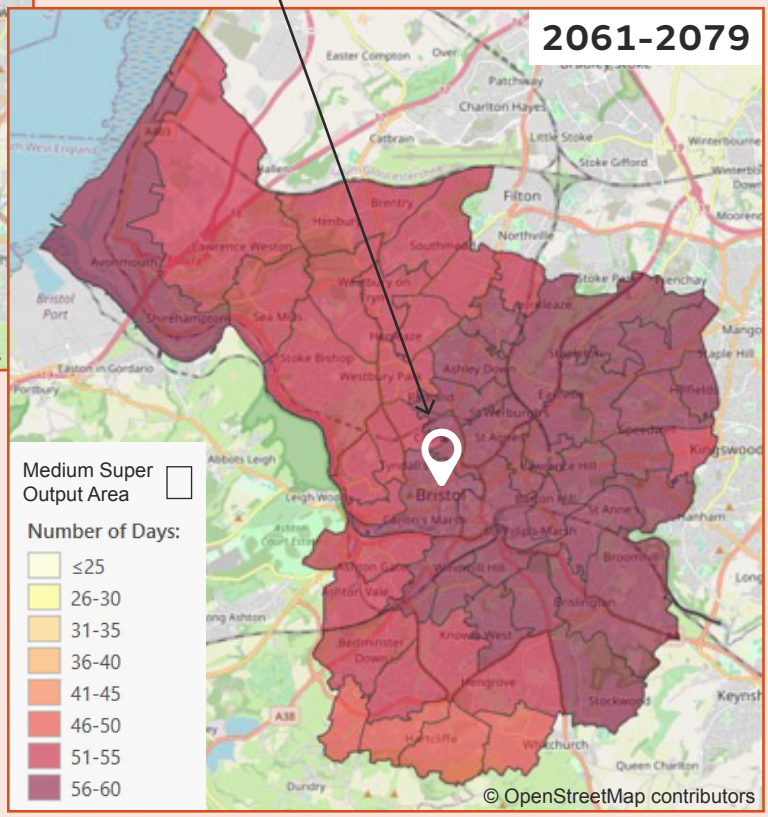


In parts of the city almost one in three days could exceed 25°C in the summer

This area has one of the highest proportions of south facing homes, which can get much hotter on sunny days**.

Later this century in the east of the city almost two in three days could exceed 25°C in summer.

Bristol Royal Infirmary



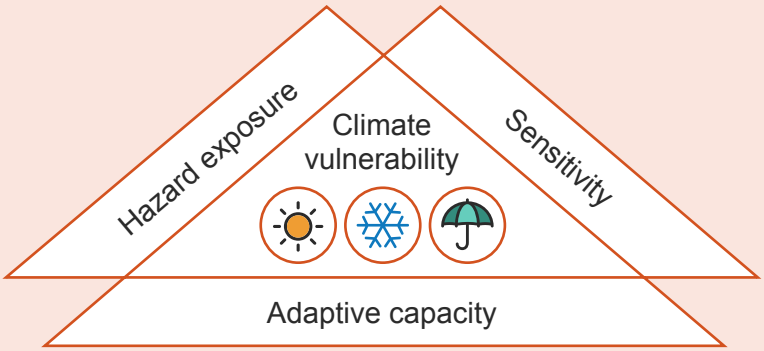
Bristol Temple Meads Station

Some of Bristol's key infrastructure and services may be impacted by more extreme temperatures.

*Results based on UKCP Local projections, for a high emissions scenario (RCP8.5) and the ensemble median. The results should be interpreted as an approximation of the projected number of days when temperature thresholds are exceeded. There will be many factors influencing this value including natural variability and local scale processes of a higher resolution than the climate model is able to represent.

**Results from Bristol City Council Heat Vulnerability Index

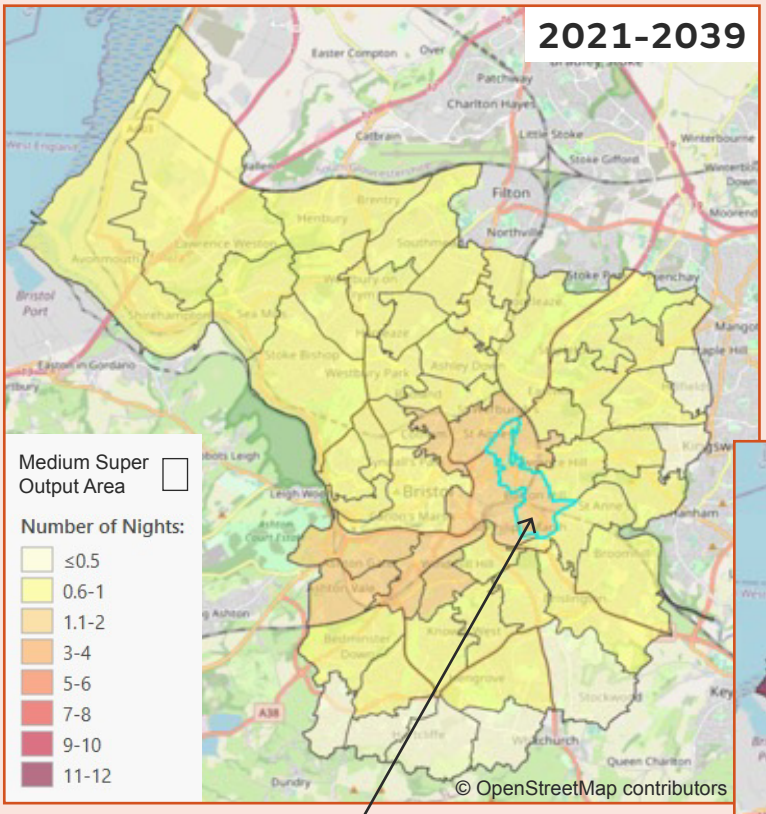
HEAT IMPACTS VARY SPATIALLY ACROSS A CITY



Climate information can be combined with data on population, socio-economics, health and built environment and infrastructure to understand the city's exposure and vulnerability to heat hazards.

TROPICAL NIGHTS >20°C IN SUMMER

The average number of days in summer when daily minimum temperatures are greater than 20°C under a high emissions scenario*.



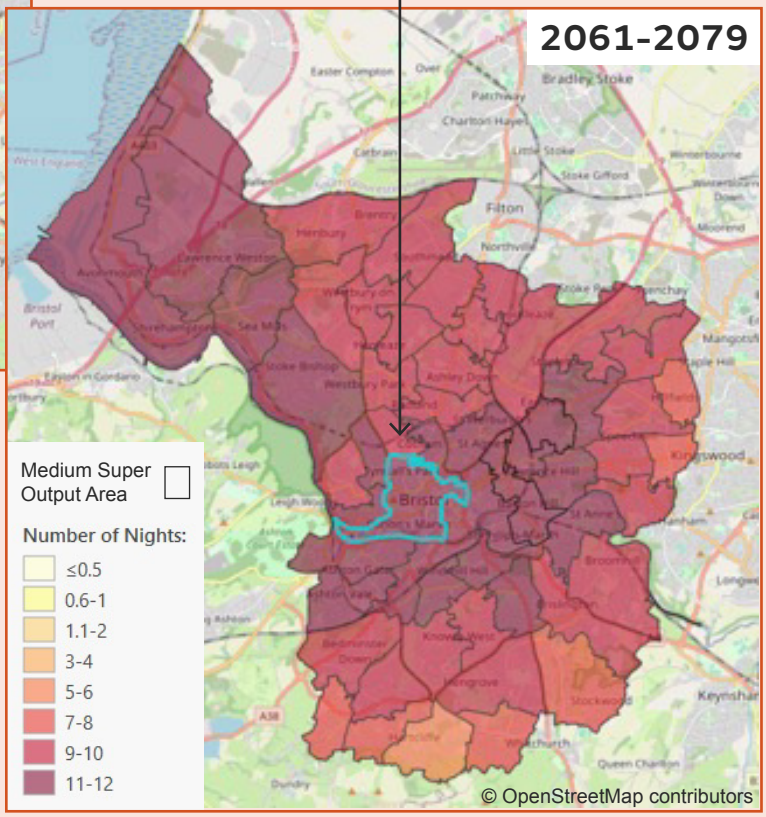
One of the most deprived parts of Bristol which may reduce inhabitants ability to adapt to heat events**.

Towards the end of the century central and north-western parts of the city are worst affected by tropical nights.

Tropical nights are an important factor for heat-health impacts.

The Urban Heat Island effect can be seen with central areas of the city experiencing greater numbers of tropical nights than the city edges.

This area has one of the highest proportion of flats in Bristol where the impacts of high temperatures can be felt particularly in upper floors**.



*Results based on UKCP Local projections, for a high emissions scenario (RCP8.5) and the ensemble median. The results should be interpreted as an approximation of the projected number of days when temperature thresholds are exceeded. There will be many factors influencing this value including natural variability and local scale processes of a higher resolution than the climate model is able to represent.
**Results from Bristol City Council Heat Vulnerability Index

HEATWAVE PLANNING, CO-ORDINATION & RESPONSE

RESOURCES FOR HEATWAVE PREPARATION

Early warning

- Met Office extreme heat warnings for the public.
- Heat-Health Alert Service for health and social care professionals in England.
- Met Office heatwave forecasts.

Planning

- Regional severe weather plans and the Heatwave Plan for England set out coordinating actions for organisations and individuals.
- The Health & Safety Executive provide guidance for working in hot weather.

Action

- The UK Health Security Agency, NHS, Met Office, Age UK and British Red Cross provide information and useful resources on how to cope in hot weather.

ADVICE FOR DURING A HEATWAVE

Look out for those who may struggle to keep themselves cool and hydrated. Older people, under 5's, those with underlying conditions and those who live alone are particularly at risk.

Close curtains on rooms that face the sun to keep indoor spaces cooler. It may be cooler outdoors than indoors.

Drink plenty of fluids and avoid excess alcohol.

Never leave anyone in a closed, parked vehicle, especially infants, young children or animals.

Walk in the shade, use cool spaces, apply sunscreen and wear a wide-brimmed hat, if you have to go out in the heat.

Avoid physical exertion and try to keep out of the sun between 11am to 3pm, when the UV rays are strongest.

BUILDING LONGER TERM URBAN HEAT RESILIENCE

The UK Climate Change Risk Assessment sets out actions for the next 5 years to tackle risks from high temperatures:

- Updating building regulations to address overheating.
- Retrofitting of existing buildings e.g. green roofs, shading, reflective surfaces.
- Coordination between decarbonisation and adaptation strategies.
- Adaptation reporting by businesses and collection of business continuity information.
- Implementing green infrastructure.
- Mainstreaming climate change adaptation into planning and design of new transport infrastructure.

Bristol City Council has developed strategies, plans, evidence and initiatives to address the climate emergency and guide climate action within the city:

- Preliminary Climate Resilience Assessment
- One City Climate Strategy
- The Bristol Climate Hub
- For further information see the Council's action on climate change page.

PROVIDE YOUR FEEDBACK

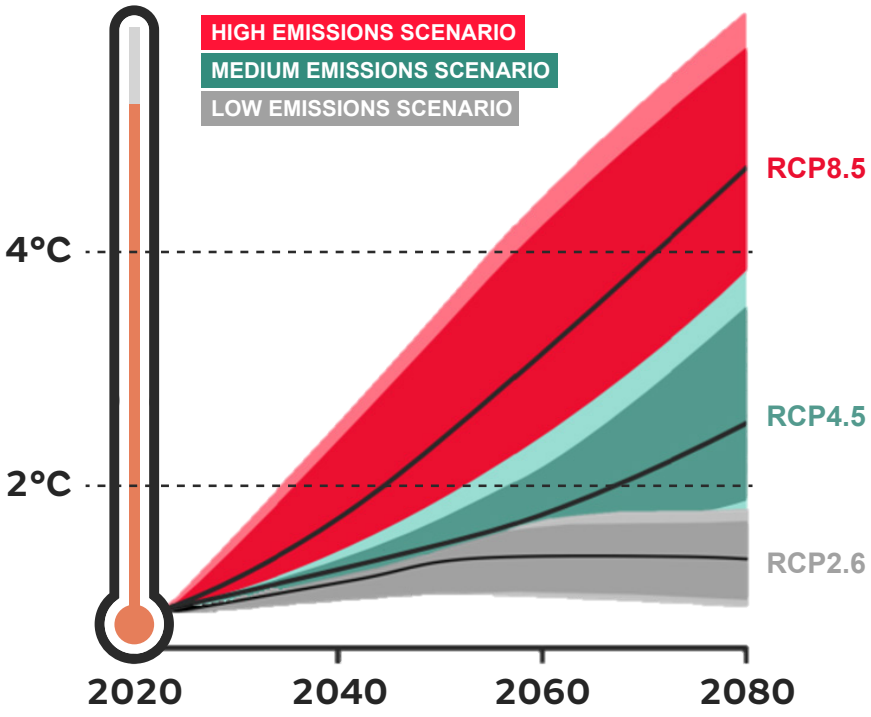
We'd like to hear your feedback on the Heat Pack to understand how it is being used. Please fill in the short form using this link or QR code to share your thoughts.

THE SCIENCE BEHIND THE HEAT PACK

Local-scale information from high resolution climate projections are extremely useful for understanding climate change in cities. This Heat Pack uses the Met Office's state of the art high resolution UK Climate Projections (UKCP Local) to understand how heat hazards may change in UK cities over the 21st century.

The UKCP Local projections include a more detailed urban land surface compared to other climate model projections, giving a better representation of urban climate effects, such as the urban heat island.

UKCP Local is driven by the Met Office's Hadley Centre Global Climate model, which has a higher climate sensitivity to greenhouse gases compared to other models and therefore tends to be on the warmer end of the warming climate response. Furthermore, UKCP Local is driven by a high emissions scenario called RCP8.5. This represents a future where global greenhouse gas emissions continue to grow beyond current policy commitments, leading to a large global temperature rise sooner rather than later under lower emissions scenarios as illustrated below. The heat pack therefore helps decision makers adopt a precautionary approach.



UKCP Local provides information for two future time periods, 2021-2040 and 2061-2080, which reflect global warming levels of 2°C and 4.5°C warming, respectively.

The Committee on Climate Change (CCC) advises the UK to adapt to a 2°C rise in global temperatures, whilst assessing the risk for 4°C*.

The Heat Pack therefore provides a useful comparison of impacts that could be expected at 2°C and at a more precautionary 4.5°C.

Graph for illustrative purposes only.

*Committee on Climate Change (2021) Independent Assessment of UK Climate Risk.
Available at: https://www.theccc.org.uk/wp-content/uploads/2021/07/Independent-Assessment-of-UK-Climate-Risk-Advice-to-Govt-for-CCRA3-CCC.pdf

FIND OUT MORE

Current Trends in UK Climate

Latest State of the UK Climate 2020 report:
https://www.metoffice.gov.uk/research/climate/maps-and-data/about/state-of-climate

Future Trends in UK Climate

UK Climate Projections Headline Findings report:
https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp-headline-findings-v2.pdf

Observation data used in climate stripes

HadUK Grid:
https://www.metoffice.gov.uk/research/climate/maps-and-data/data/haduk-grid/haduk-grid

UK Climate Projections (UKCP) Local 2.2km

https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-factsheet-local-2.2km.pdf

Convection-permitting model projections – science report:
https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP-Convection-permitting-model-projections-report.pdf

UKCP18 Science Overview Report:
https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

Extreme Heat Indicators

Public Health England (2018) Heatwave Plan for England
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/888668/Heatwave_plan_for_England_2020.pdf

London Climate Change Partnership / Environment Agency (2012) Heat Thresholds Report
http://climatelondon.org/wp-content/uploads/2013/01/LCCP_HeatThresholds_final-report-PUBLIC.pdf

Public Health England (2020) Heatwave mortality monitoring report: 2020
https://www.gov.uk/government/publications/phe-heatwave-mortality-monitoring/heatwave-mortality-monitoring-report-2020

N.W. Arnell, A.L. Kay, A. Freeman, A.C. Rudd, J.A. Lowe, (2021) Changing climate risk in the UK: A multi-sectoral analysis using policy-relevant indicators. Climate Risk Management, Vol 31
https://doi.org/10.1016/j.crm.2020.100265

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