INTRODUCTION

This City Pack provides high level, non-technical summaries of climate change projections for an individual city or town. It uses scientific research to provide robust climate information to help decision makers plan for the future, enabling cities and towns to become more resilient to climate change.

Urban areas experience unique challenges from climate change. For example, urban environments contain surfaces which don't soak up and store rainfall, such as tarmac and paving, which might increase flood risk. Urban areas are also affected by the urban heat island effect, which results in higher urban temperatures compared with surrounding rural areas.

WHAT AFFECTS THE REGION'S WEATHER?

Liverpool is located within the 'North West' region of the UK, which includes includes Cheshire, Merseyside, Greater Manchester, Lancashire and Cumbria. Here are some of the types of weather that the region experiences across a year:

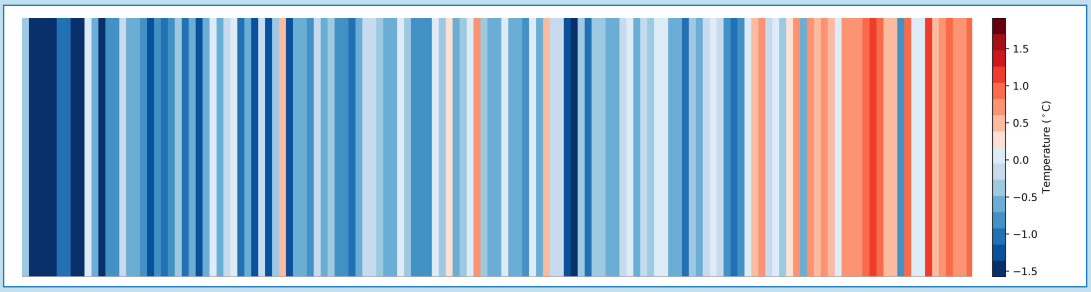
The range of topography and altitude in North West England provides a varied climate, which includes both the coldest (Cross Fell) and wettest (Lakeland fells) locations in England. In low-lying areas where most urban areas are found, mean annual temperatures are around 10°C.

Sunshine hours in North West England range from around 1200 hours in the higher Pennines to around 1500 hours at the coast, with values up to 1550 reached on the Isle of Man.

North West England includes some of the wettest places in the UK although this is localised to upland areas which are exposed to westerly maritime air masses. Areas in the lee of these uplands receive significantly less rainfall, including the large urban areas of Manchester, which receive around 800 mm per year.

North West England is one of the more exposed parts of the UK and may experience strong winds associated with the passage of deep lows. The frequency and strength of these depressions is greatest in the winter half of the year, with the strongest winds coming in off the Irish Sea from the SW to WNW.

HOW HAS LIVERPOOL'S CLIMATE CHANGED?



Temperature Difference (°C)
Data: HadUK-Grid
Concept: Ed Hawkins

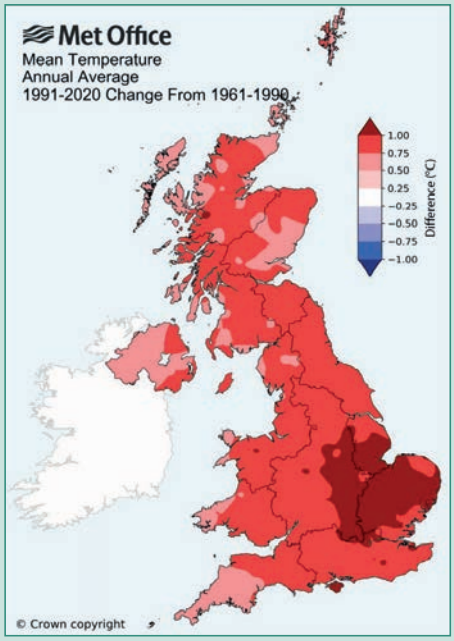
The stripes show how temperatures in Liverpool have increased from 1884-2020, with many of the hottest years occurring in the last few decades.

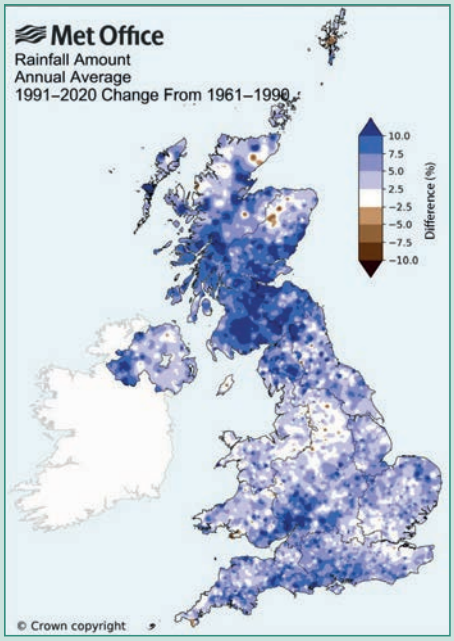
CLIMATE CHANGE IN THE UK

OBSERVED CHANGES

How are temperature and rainfall changing across the UK?

These maps show changes in temperature (left) and rainfall (right) from 1991-2020 compared to a baseline period of 1961-1990. We can see that temperatures have risen in all areas across the UK. We can also see that whilst some areas have become drier, more areas have become wetter.





IMPACTS

Cities and towns across the UK are already experiencing the impacts of climate change. The negative impacts of climate change for urban areas may include:

HEAT

Increased energy demand for summer cooling

SEA LEVEL RISE

Increased risk of coastal flooding

HEAVY RAINFALL

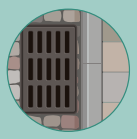
Increased risk of river and surface water flooding

HEALTH

Increased risk to health from heat stress

DROUGHT

Risk to water supplies from drought



DRAINAGE

Increased disruptions to urban drainage system

TRANSPORT

Increased disruption to transport due to heat e.g. rail buckling

ENVIRONMENT

Increased risk to biodiversity (plants and animals)

ENERGY

Infrastructure such as gas pipes are at high risk from flooding events.

FUTURE HEADLINES

The climate is already changing, and we are already seeing impacts. But how might the UK's climate change in the future? The statements below are headline statements from the UK Climate Projections – cutting-edge climate science which provide an up-to-date assessment of how the climate is expected to change in the future:

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

Although the trend is for drier summers in the future, there may be increases in the intensity of heavy summer rainfall events.

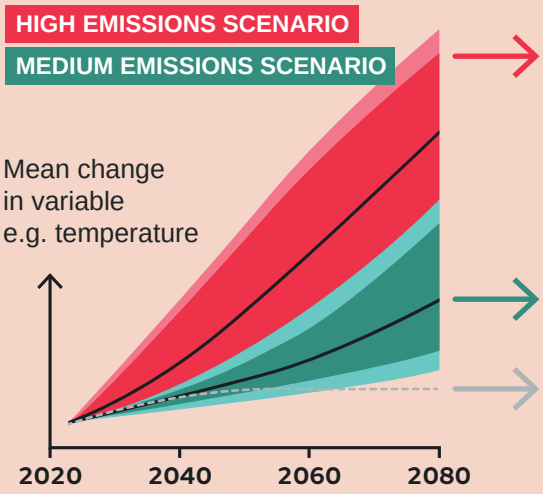
Hot summers are expected to become more common. By 2050, every other summer may be as hot as the record breaking summer of 2018.

Sea level will continue to rise in the 21st century even if greenhouse gas emissions are reduced rapidly.

SCIENCE EXPLAINED

PROJECTIONS USED IN THE CITY PACK

The City Pack uses the UK Climate Projections (UKCP) Probabilistic Projections at 25 km resolution.



RCP 8.5
90TH PERCENTILE
90% chance of being less than this result.

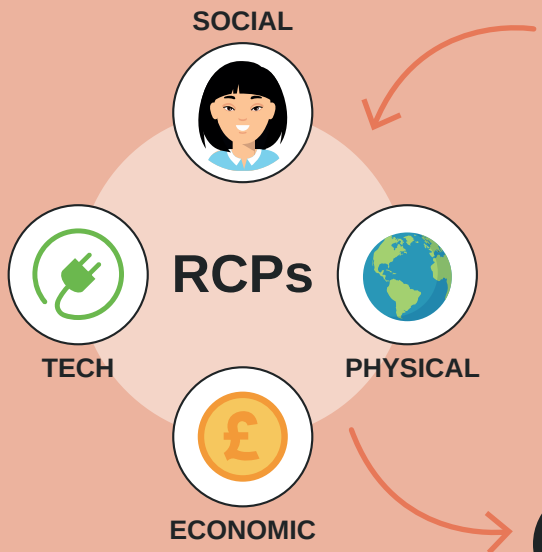
RCP 4.5
50TH PERCENTILE
50% chance of being less than this result.

RCP 2.6
RCP2.6 is not the focus of this City Pack, because, although the world aims to limit warming with emission reductions like those or even greater than RCP2.6, it is good practice to consider the risks if this is not achieved.

The projections are provided as a 'range':

- The first number in the range, is the median (50th percentile) result from RCP 4.5 (MEDIUM emission scenario).
- The second number in the range is from RCP 8.5 (HIGH emission scenario) and shows a more extreme result (90th percentile, except for summer rainfall rate which uses the 10th percentile, representing drought conditions).

EMISSIONS SCENARIOS



Our future climate is determined by ongoing and future greenhouse gas emissions, which are uncertain. To capture this uncertainty, we use emissions scenarios, such as the Representative Concentration Pathways (RCPs).

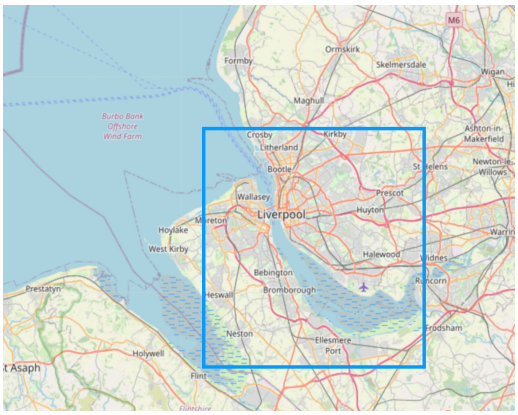
RCPs describe possible future emissions based on assumptions about human activity.

RCP8.5 (HIGH)
Global emissions grow unmitigated.

RCP4.5 and RCP6.0 (MEDIUM)
Global emissions are mitigated to varying levels.

RCP2.6 (LOW)
Global emissions are strongly mitigated and reduced. Global temperature rise is kept below 2°C.

The RCP pathways represent a broad range of possible futures and are neither forecasts nor policy recommendations.



This map shows the location of Liverpool and the area in focus for this City Pack. Projection information provided within this City Pack is calculated as the average (mean) value across the smaller inset box (a 25 km grid cell).

This box may include rural, coastal and mountainous areas as well as urban areas. As such, results for point locations within the grid box may differ from the average result of the box.

At 25 km resolution, detailed urban effects are not represented in the model. For urban representation, a higher resolution model is required. The use of UKCP Local (2.2 km) may be more appropriate.

UKCP RESULTS

GLOBAL WARMING LEVELS

Global Warming Level	Time Period
4°C	2065 to 2100+
2°C	2031 to 2056

Global warming levels tell us about future temperature change at the global scale. What about at changes at the local scale?

Under a high emission scenario (RCP8.5, 90th percentile) we could reach 4°C as soon as 2065. Under a medium emission scenario (RCP4.5, 50th percentile) we wouldn't expect to reach 4°C within this century. Under a low emissions scenario (RCP2.6), with stronger mitigation, we may not reach 2°C of global warming.

These dates are not forecasts, but simply offer possible futures for comparison. Global warming level dates may not always correspond with the City results below, due to differences in spatial scales.

	2030s	2050s	2080s	
Summer Average Air Temperature (°C)	+0.8 to +1.9	+1.4 to +3.1	+2.5 to +6.2	↑
Summer Maximum Air Temperature (°C)	+0.9 to +2.1	+1.5 to +3.6	+2.8 to +7.0	↑
Winter Average Air Temperature (°C)	+0.7 to +1.6	+1.1 to +2.5	+1.6 to +4.4	↑
Winter Minimum Air Temperature (°C)	+0.7 to +1.7	+1.2 to +2.8	+1.7 to +4.8	↑
Annual Average Air Temperature (°C)	+0.8 to +1.5	+1.2 to +2.4	+2.0 to +4.6	↑
Summer Precipitation Rate (%)	-1 to -20	-11 to -35	-19 to -52	↓
Winter Precipitation Rate (%)	+3 to +11	+4 to +16	+8 to +29	↑
Sea Level Change (m)	+0.11 to +0.16	+0.20 to +0.32	+0.35 to +0.65	↑

Results are calculated as change from the baseline period: 1981-2000.
Summer: June, July, August.
Winter: December, January, February.
Time periods are 20-year time slices: 2020-2039, 2040-2059, 2070-2089.
Precipitation is relative change (%) in mm per day.

1st number in the range is RCP4.5 at the 50th percentile. 2nd number in the range is RCP8.5 at the 90th (except summer rainfall, which is the 10th percentile), calculated from UKCP 25 km Probabilistic Projections.

Results show changes in variables averaged over a season, and as such do not represent possible extreme conditions. For assessment of possible extremes, the use of UKCP Local (2.2km) may be more appropriate.

UNDERSTANDING CLIMATE RISK

We are already witnessing the impacts of a global average temperature rise of over 1°C compared to pre-industrial levels.

Without global action to limit emissions, we may exceed even 4°C of global warming.

The Paris Agreement says that we must limit global warming to well below 2°C, whilst aiming for 1.5°C.

Following COP26, limiting warming to below 1.5°C above pre-industrial levels remains possible but will require bigger emission reductions than currently pledged by nations around the world. Current emission reduction pledges, made as part of nationally determined contributions, are likely to lead to warming above 2°C.

The Committee on Climate Change advises the UK to adapt to a 2°C rise in temperatures, whilst assessing the risk at 4°C.

To achieve Net Zero, and also prepare for the impacts of climate change, to which we are already committed, both mitigation and adaptation approaches are required.

MITIGATION
Efforts to reduce or prevent emissions of greenhouse gasses.

Mitigation reduces the need for adaptation

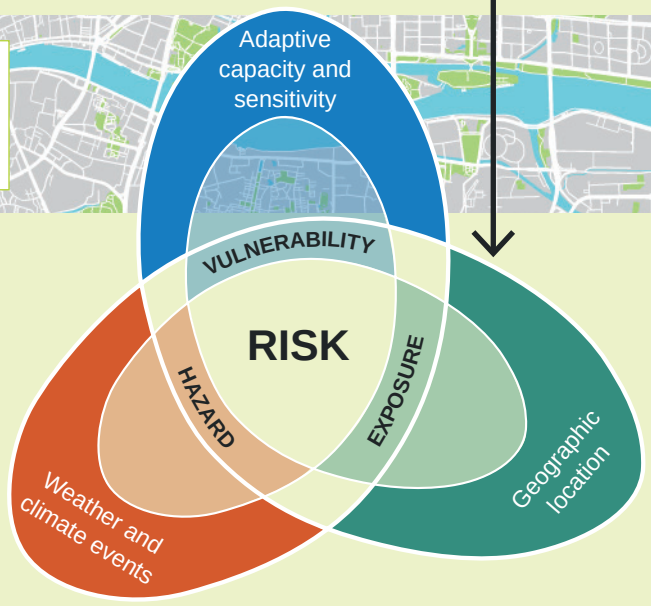
ADAPTATION
Action that helps cope with and reduce the impacts of climate change. Adaptation is essential to address the "locked-in" effects of climate change.

RESILIENCE

NET ZERO AND BEYOND
Ending contributions to global warming by balancing emissions released with emissions removed from the atmosphere.

CO-BENEFITS
The positive effects that taking climate action has on society

Adaptation and mitigation both help to reduce the risk a city will face from climate change. Mitigation will help to limit the hazard, whilst adaptation can help to reduce exposure and vulnerability.



RISK

The risk posed from a changing climate, and the potential for resultant impacts, depends on three key factors:

HAZARD: weather and climate events which may have adverse effects. The occurrence, duration and intensity of which may change due to climate change.

EXPOSURE: the location of people, property and other economic resource, relative to a hazard.

VULNERABILITY: the likelihood of the exposed people, property and other economic resources suffering adverse effects from the hazard. Vulnerability is in turn affected by the capacity of people and places to adapt or respond to the hazard.

This City Pack contains information about some of the climate and weather **HAZARDS** the city may face in the future. This helps to inform about risk within the city, which in turn provides an evidence base for decision making about adaptation and mitigation.

LINKS AND REFERENCES

DATASETS

UK Climate Projections – Land and Marine

Climate Stripe historical dataset

Regional Climate Summaries

UK State of the Climate Report 2020

Global Warming Levels and UK Impacts

CITY PACKS AND ACCOMPANYING RESOURCES

City Packs

Infographic on the co-production of the first City Pack with Bristol City Council

Case Study on the uses of the City Pack

FACTSHEET / EXPLANATION RESOURCES

Headline findings for the UK

How to download UKCP data using the UKCP User Interface

Factsheet – Representative Concentration Pathways

RESOURCE TO INFORM ADAPTATION AND RESILIENCE

Climate Change Committee Resources

UK Climate Resilience Programme

Core Cities Group

UK Government Green Book – Climate Change Supplement

If anyone would like to provide feedback or discuss the factsheets further with a member of the Urban Climate Services team, we can be contacted via email at: urbanclimateservices@metoffice.gov.uk

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