UK Climate Projections:
Headline Findings

August 2022

UKCP18

Update to Probabilistic Projections

Global Projections

Marine Projections

Regional Projections

Observations

Derived Projections
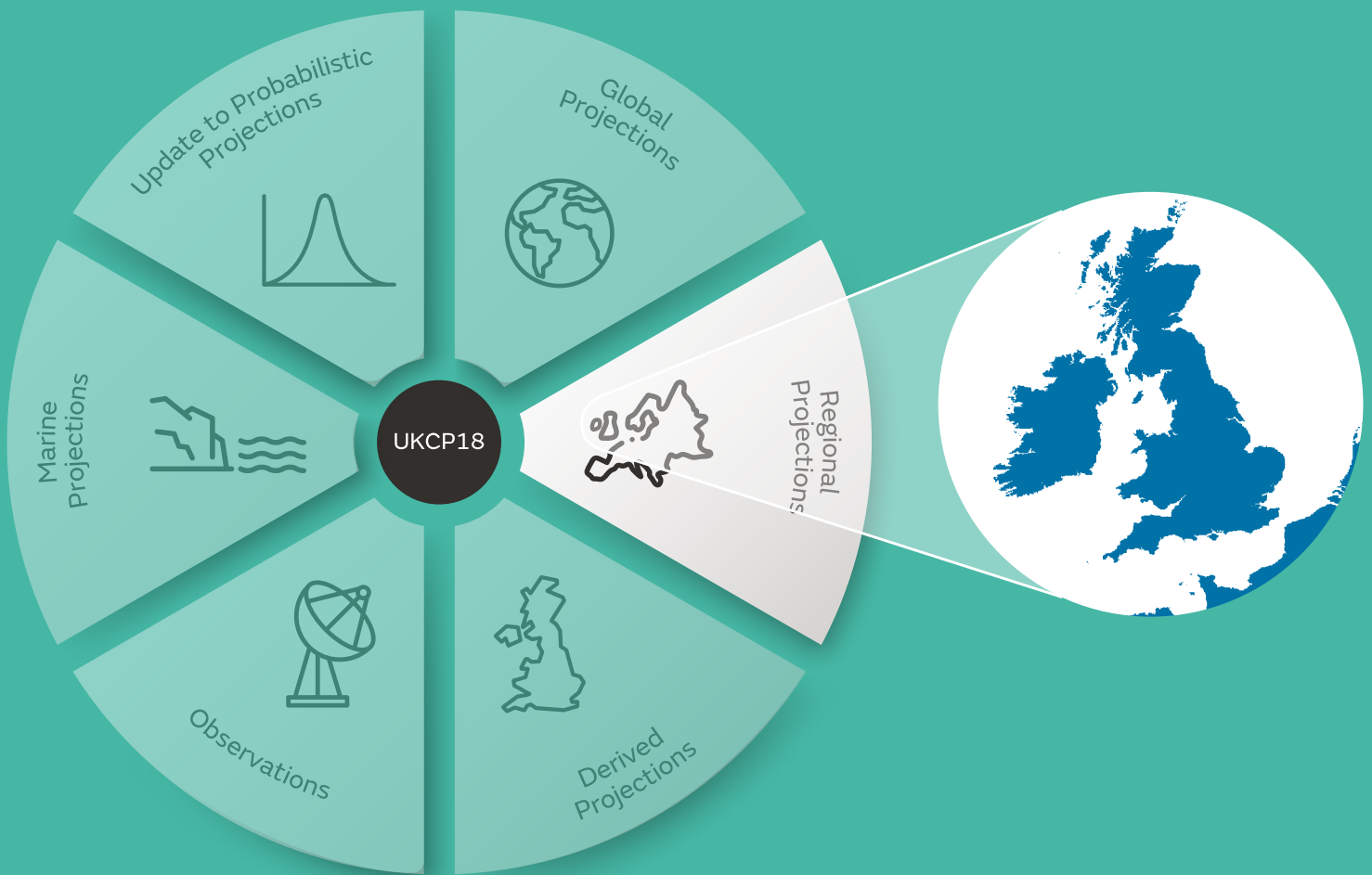
Version control

Revision History of the changes from the previous version of this document.			
Version	**Revision date**	**Modified sections**	**Modifier / Comments**
V1.0	26/11/2018	First publication	Publication as part of launch of UKCP18 projections
V2.0	16/09/2019	Changes made to all sections, with the exception of Section 4: Marine Projections	Updated to include details of UKCP Local (2.2km) climate projections
V3.0	22/07/2021	3.1.5, 3.1.6, 3.2.6	Updated using the new UKCP Local (2.2km) climate projections
V4.0	03/08/2022	3.1.2, 3.1.3, 3.2.2	Updated using the new UKCP Probabilistic (25km) climate projections

1.   Introduction

The climate is changing, and the UK needs to act. Part of this involves playing a leading role in global efforts to mitigate climate change by reducing emissions including implementing and delivering our own net zero target. Even given strenuous efforts to limit the cause of global warming, further climatic changes are inevitable in the future and the UK will need to manage the growing risks from climate change. To adapt and build resilience, up-to-date, credible and robust information on climate change and variability is needed to inform decision-making. UKCP18 is the latest generation of national climate projections for the United Kingdom and will provide users with the most recent scientific evidence on projected climate changes with which to plan.

It is a cornerstone principle of resilience preparation that we plan for a wide range of possible future changes, in parallel with taking actions to reduce the likelihood of the worst scenario becoming reality. So, while we continue to spearhead international efforts to keep the global temperature rise to well below 2 °C and pursue efforts to limit it to 1.5 °C (by reducing our own emissions, supporting the developing world to do the same and contributing to global diplomatic and scientific efforts), our adaptation plans should include preparation for worse climate change scenarios.

UKCP Probabilistic (25km) and Marine projections cover a range of future scenarios. UKCP Global (60km), Regional (12km) and Local (2.2km) focus on a high (RCP8.5) greenhouse gas emission scenario, but users can extract results at different warming levels including, 1.5 °C, 2 °C and 4 °C[1]. For more information on the new emission scenarios and how they compare to UKCP09 see the online explainer '[A guide to Representative Concentration Pathways (RCPs)](#)'.

This headline findings document is primarily intended to underpin messages, from the UKCP suite of tools, for the interested public and media. It also serves as a summary for users of UKCP18, although they are expected to get more detailed information from other sources, including the guidance and science reports on the UKCP18 website. This document has been refreshed to incorporate results from the new UKCP Local (2.2km) projections as well as providing an update to the latest observations. For a detailed description of the Local (2.2km) projections and their use in the context of other UKCP18 products, please see the Non-Technical Summary of the Local (2.2km) Science Report and the new user guidance, both available from the [Guidance and Science Reports page](#).

All original statements about Probabilistic (25km), Global (60km), Regional (12km) and Marine projections still stand.

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[1] This can be done directly in the Global and Regional cases, as these projections are provided as continuous 21st time series. Scaling may be needed to extract such information from the Local projections, as these are only available for three 20-year time slices.

1.1

The UK Climate Projections 2018 (UKCP18) are based on the latest developments in climate science and were subject to an independent peer review, from the commencement of the project, to assess the science that underpins UKCP18. The information available consists of historical observations and future projections for the UK, covering both its land and marine environments. The land projections include updated Probabilistic (maximum spatial resolution of 25km) scenarios for key climate variables to support assessments of uncertainty. The Marine projections include updated projections of time-average sea level rise around the UK coastline, and new projections of extreme water levels, including storm surges and tides. Together, the wider suite of UKCP products will equip government, businesses and other interested parties to assess the challenges and opportunities we face from our changing climate. For guidance on which set of projections to use, please consult UKCP18 Guidance: How to use the land projections?

1.2

Building on the learning from UKCP09, user groups from government and the wider society, along with the peer review panel, have helped to shape UKCP18, co-designing tools and capabilities to better meet user needs. For example, (i) changing the format of the data that is provided to the widely-used Ordnance Survey's coordinate system, (ii) an enhanced user interface that uses the latest web design and (iii) providing datasets that represent UK climate in scenarios of 2 °C and 4 °C of global warming.

1.3

UKCP18 adds tools and capabilities, providing new insight compared to the previous projections, thus enhancing capacity for analysing climate risks. For example, UKCP18 includes projections for the globe, enabling projected climate changes in the UK to be examined in a global context.

1.4

The Probabilistic projections (25km) typically provide the broadest ranges of uncertainty in future changes for key UK climate variables and global average temperature. These results are complemented by the other products in the UKCP suite that provide sets of plausible projections showing how climate might evolve within the range of uncertainty.

1.5

Global (60km) provides coverage of the entire planet, giving access to a range of plausible projections that includes worldwide regions, as well as the UK. Global (60km) provides information on large-scale drivers that affect the patterns of weather in the UK.

1.6

Regional (12km) provides coverage over the UK and Europe at higher spatial detail, giving an improved representation of daily extremes. However, there are fewer projections available that span a narrower range of uncertainty compared to the Global (60km) projections.

1.7

The new Local (2.2km) provides the most physically realistic projections of extremes in local areas for the coming decades and gives access to sub-daily information. But, like the Regional (12km), Local (2.2km) projections span a narrower range of uncertainty compared to the Global (60km) projections. Therefore, we advise using the Local (2.2km) projections in parallel with other products in the UKCP18 toolkit.

1.8

The new UKCP Local (2.2km) provides, for the first time, national climate change information on a similar resolution to that of current operational weather forecast models. Local (2.2km) allows us to simulate better the type of small-scale behaviour seen in the real atmosphere, including atmospheric convection[2], as well as the influence of mountains, coastlines and urban areas. Locally relevant information can help to inform decision-making on future climate change, to enhance resilience, and adds further capability to the UKCP18 suite of climate projection tools.

1.9

The new Local (2.2km) projections provide output at hourly scales which is needed for some user applications, better informing future risk assessments. Local (2.2km) provides data at kilometre and hourly scales that can be directly fed into impact models and local decision-making tools. For example, hourly rainfall data can be used to inform future changes in surface water flood risk for urban flood management schemes and contingency planners. Data on future extreme heat can be used for decision-making around key infrastructure including bridges, trainlines and thermal performance of buildings.

1.10

Climate science is continually advancing. We can expect new results to emerge during the coming years from observations, and from new generations of global, regional and local climate models. **The products and services will therefore continue to be developed over the coming months and years, informed by further user input as well as developments in modelling capability.**

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[2] Motion caused by the tendency of hotter, less dense fluid (liquid or gas) to rise, and cooler, more dense fluid to sink, under the influence of gravity. In the atmosphere, convection leads to vertical transfer of heat and moisture, driving the development of showers and thunderstorms.

2.   Observations

The latest State of the UK Climate 2018 report shows several indicators consistent with the expected effects of a warming climate, alongside evidence of considerable natural variability on annual to multi-decadal timescales.

2.1

The average temperature over the most recent decade (2009-2018) has been on average 0.3 °C warmer than the 1981-2010 average and 0.9 °C warmer than the 1961-1990 average. All the top ten warmest years for the UK, in the series from 1884, have occurred since 2002.

2.2

A recording of 38.7 °C at Cambridge Botanic Garden on 25th July 2019 became the highest summer temperature officially recorded in the UK, exceeding the previous record of 38.5 °C recorded at Faversham, Kent, in August 2003.

2.3

The longest running instrumental record of temperature in the world, the Central England Temperature dataset, shows that the most recent decade (2009-2018) was around 1 °C warmer than the pre-industrial period (1850-1900). This temperature rise in the UK is consistent with warming that has been observed at a global scale, of around 1 °C since pre-industrial. The 21st century so far, has been warmer than the previous three centuries.

2.4

The average hottest day of the year, in the decade (2008-2017)[3], was on average 0.1 °C warmer than the 1981-2010 average and 0.8 °C warmer than the 1961-1990 average hottest day of 26 °C.

2.5

The most recent decade (2009-2018) has been on average 1% wetter than 1981-2010 and 5% wetter than 1961-1990 for the UK overall.

2.6

Winters in the UK, for the most recent decade (2009-2018), have been on average 5% wetter than 1981-2010 and 12% wetter than 1961-1990. Summers in the UK have also been wetter, by 11% and 13% respectively. However, very long-period natural variations are also seen in the longer observational record. These show periods in earlier parts of the historical record with similar levels of UK summer rainfall to 2009-2018, illustrating the importance of considering long-period natural variations.

[3] Reference to the 2008-2017 decade comes from the State of the UK Climate 2017 report.

2.7

Total rainfall from extremely wet days (days exceeding the 99th percentile of the 1961-1990 rainfall) increased by around 17% in the decade (2008-2017)3, for the UK overall. However, changes are largest for Scotland and not significant for most of southern and eastern England.

2.8

Mean sea level around the UK has risen by about 17 cm since the start of the 20th century (when corrected for land movement).

3.   Projections Over Land

General climate change trends projected over UK land for the 21st century in UKCP18 are broadly consistent with earlier projections (UKCP09) showing an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of extremes. This is seen in the Probabilistic (25km), Global (60km), Regional (12km) and Local (2.2km) projections.

When we compare the full range of possible outcomes from UKCP09 and UKCP18 there is a great deal of overlap, although users may want to investigate the differences. For example, in the extreme ends of the ranges. For guidance on which set of projections to use, please consult UKCP18 Guidance: How to use the land projections?

3.1   Future Temperature Change

3.1.1

By the end of the 21st century, all areas of the UK are projected to be warmer, more so in summer than in winter. This projected temperature rise in the UK is consistent with future warming globally.

3.1.2

In UKCP18, the probabilistic projections provide local low, central and high changes across the UK, corresponding to 10%, 50% and 90% probability levels. These local values can be averaged over the UK to give a range of seasonal average warming between the 10% and 90% probability levels. By 2070, in the high emission scenario, this range amounts to 1.3 °C to 5.1 °C in summer, and 0.6 °C to 3.8 °C in winter.

3.1.3

Hot summers are expected to become more common. The summer of 2018 was the equal-warmest summer for the UK along with 2006, 2003 and 1976. Climate change has already increased the chance of seeing a summer as hot as 2018 to between 12-25%. With future warming, hot summers by mid-century could become even more common, with chances increasing further to around 50-60%.

3.1.4

The Global (60km), Regional (12km) and Local (2.2km) projections provide plausible projections for UK summer and winter temperature that can be used alongside the probabilistic information. They also provide extra information on metrics not covered by the probabilistic projections, such as daily temperature.

3.1.5

The temperature of hot summer days, by the 2070s, show increases of 3.8 °C to 6.8 °C[4], under a high emissions scenario, along with an increase in the frequency of hot spells. These results from UKCP Local (2.2km) projections reinforce the findings of the Regional (12km).

3.1.6

Hot spells, typically defined as maximum daytime temperatures exceeding 30 °C for two or more consecutive days[5], are largely confined to the south-east UK in the present-day. In the future (by 2070s), under a high emissions scenario, the frequency of hot spells increases. Rising from an average of 0.20 occurrences per year in the present-day to 4.1 by 2070 in UKCP Local (2.2km).

3.1.7

The Regional (12km) and Local (2.2km) projections are driven by a subset of the Global (60km) projections, in particular, those that simulate relatively high levels of global warming compared with other climate models. We would recommend placing the Regional (12km) and Local (2.2km) results in context of the Global (60km) projections and, where possible, the probabilistic projections.

3.2   Future Precipitation Change

3.2.1

Rainfall patterns across the UK are not uniform and vary on seasonal and regional scales and will continue to vary in the future.

3.2.2

In UKCP18, the probabilistic projections provide local low, central and high changes across the UK, corresponding to 10%, 50% and 90% probability levels. These local values can be averaged over the UK to give a range of seasonal average precipitation changes between the 10% and 90% probability levels. By 2070, in the high emission scenario, this range amounts to -45% to +5% in summer, and -3% to +39% in winter (where a negative change indicates less precipitation and a positive change indicates more precipitation).

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[4] Temperature values correspond to UK average of 2nd lowest to 2nd highest responses across 12 model variants of UKCP Local (2.2km) projections.
[5] Threshold used by the Met Office for issuing high temperature warnings for public health.

3.2.3

The Global (60km), Regional (12km) and Local (2.2km) projections provide plausible projections for UK summer and winter precipitation that can be used alongside the probabilistic information. They also provide extra information on metrics not covered by the probabilistic projections, such as, daily precipitation. UKCP Local (2.2km) can also provide sub-daily information.

3.2.4

Despite overall summer drying trends in the future, new data from UKCP Local (2.2km) suggests future increases in the intensity of heavy summer rainfall events. These increases in UKCP Local (2.2km) are typically greater than those in the Regional (12 km). For urban areas particularly, this will impact on the frequency and severity of surface water flooding.

3.2.5

Future climate change is projected to bring about a change in the seasonality of extremes. UKCP Local (2.2km) projects an extension of the convective season from summer into autumn, with significant increases in heavy hourly rainfall intensity in the autumn.

3.2.6

UKCP Local (2.2km) suggests significant increases in hourly precipitation extremes in the future. For example, rainfall associated with an event that occurs typically once every 2 years increases by 29% (central estimate). This has several implications for how we manage water. It is worth noting that whilst the intensity of hourly rainfall is projected to increase in the future, overall summers are projected to become drier.

3.2.7

As an example of using the UKCP18 products together we highlight the change in average winter precipitation. The different sets of simulations and the probabilistic projections all show an increase. However, the increase projected by the Local (2.2km) simulations is greater than in the Regional (12km) simulations, and for one member is of a magnitude that has only a very low likelihood in the probabilistic results. We would advise those planning adaptations that critically depend on winter precipitation to consider their resilience against the range of winter seasonal projections from all the UKCP18 products. Users may wish to take the precautionary approach of considering the implications of a very large winter precipitation increase being more likely than the probabilistic projections suggest.

For a more detailed breakdown of future seasonal changes in temperature and precipitation across the four constituent countries of the United Kingdom please see the land infographic here.

3.3   Other Metrics

3.3.1

In addition, UKCP18 enables users to explore projected climate variability and changes for a greater range of metrics using new global, regional and local climate model outputs. These products allow users to study flexibly the nature of future climate impacts and events, using time series of climate model output containing physically consistent representations of spatial, temporal and inter-variable characteristics.

3.3.2

The Global (60km), Regional (12km) and Local (2.2km) models provide alternative views of the climate in the future. This enables users to look at meteorological phenomena that drive UK impacts (such as looking at the drivers of North Atlantic storm systems in the Global simulations).

3.3.3

UKCP Global (60km), Regional (12km) and Local (2.2km) all project a decrease in soil moisture during summers in the future, consistent with the reduction in summer rainfall. Locally this could lead to an exacerbation of the severity of hot spells, although large-scale warming and circulation changes are expected to be the primary driver of increases in the occurrence of hot spells.

3.3.4

By the end of the 21st century, lying snow decreases by almost 100% over much of the UK, although smaller decreases are seen over mountainous regions in the north and west.

4.   Marine Projections

A new set of marine projections show that sea level around the UK will continue to rise to 2100 under all emission pathways.

4.1

The pattern of sea level rise is not uniform across the UK. Sea level rise is less in the north and more in the south, this is mainly due to the movement of land, up and down.

4.2

For London, sea level rise by the end of the century (when compared to 1981-2000), for the low emission scenario is very likely[6] to be in the range 0.29 m to 0.70 m.For a high emission scenario, the range is very likely to be 0.53 m to 1.15 m.

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[6] The IPCC use likelihood to provide a standardised language for describing quantified uncertainty. It can be used to express a probabilistic estimate of the occurrence of a single event or of an outcome (e.g., a climate parameter, observed trend, or projected change lying in a given range). A statement that an outcome is 'very likely' means that the probability of this outcome can range from ≥90% to 100% probability. This implies that all alternative outcomes are 'very unlikely' (0-10%).

4.3

For Edinburgh, sea level rise by the end of the century (when compared to 1981-2000), for the low emission scenario is very likely to be in the range 0.08 m to 0.49 m. For a high emission scenario this range is very likely to be 0.30 m to 0.90 m.

4.4

We can continue to expect increases to extreme coastal water levels driven mainly by increases in mean sea level rise, although we cannot rule out additional changes in storm surges.

4.5

UKCP18 includes exploratory estimates of sea level rise out to 2300, which show continued rise beyond 2100. Sea level rise is a long-term challenge that initial results suggest varies substantially depending on how successful we are at curbing global greenhouse gas emissions in the coming years.

4.6

UKCP18 sea level rise is projected to be higher than in UKCP09, but this increase has already been factored into current adaptation planning. Due to the new treatment of land ice contribution to sea level rise, UKCP18 is higher than UKCP09. For example, the upper end of the range of sea level rise in UKCP18, for the high emission scenario for London, is around 25 cm higher than in UKCP09 at 2100. This is not unexpected and has been factored into adaptation planning.

5.   What does this mean?

The headline results in the latest set of climate projections are broadly consistent with UKCP09, although there are some differences (e.g. temperature and rainfall) that may be important for climate risk assessments. The differences between UKCP09 and UKCP18 depend on season, location and greenhouse gas emission scenario. Risk assessments and adaptation decisions should use these new projections but will also need to be regularly reviewed to ensure they take account of the latest scientific understanding, longstanding and emerging vulnerabilities, as well as changing socio-economics for example.

5.1

Government will make use of UKCP18 to inform its adaptation and mitigation planning and decision-making.

5.2

The previous set of projections, UKCP09, were used to assess climate risks for the 2017 UK Climate Change Risk Assessment and inform how to respond to these risks (National Adaptation Programme**).** UKCP18 will provide the most up-to-date assessment of how climate in the UK is expected to change over the coming century and will be used to inform the next CCRA, due in 2022.

5.3

UKCP18 will help businesses and individuals to take action to improve resilience. Web pages have been designed and tested to enable users to access information quickly depending on what people want to use it for, as well as being able to visualise the results. Guidance materials describe the different components of the project in detail and explain how to use them.

5.4

UKCP Local (2.2km) provides enhanced detail that can help inform future risk assessments and local decision-making on future climate change. For example, it can be used as a tool to explore change in urban climate, where projected increases in the frequency and intensity of hot summer days and duration of hot spells in the future, along with urban development and increasing population density will exacerbate the risks of heat exposure to the most vulnerable members of society.