UKCP18 Factsheet: Temperature

This factsheet summarises the key information currently available on the UKCP18 projections over land for temperature metrics. Read this before using any products as it describes the data availability, the key future climate changes (if any) that you should see and the caveats and limitations.

We recommend that you read the UKCP18 Science Overview (Lowe et al, 2018) to understand the different components of the projections. For a comprehensive description of the underpinning science, evaluation and results see the UKCP18 Land Science Projections Report (Murphy et al, 2018).
Please note that the land projections consist of the following:

- **Probabilistic projections** that combine climate model data, observations and advanced statistical methods to simulate a wide range of climate outcomes for five emission scenarios (RCP2.6, RCP4.5, RCP6.0, RCP8.5 and SRESA1B).

- **Global (60km) projections** - a set of 28 climate futures at 60km grid resolution, showing how the 21st Century climate may evolve under the highest emission scenario, RCP8.5. They assess the uncertainty across different models from different modelling centres as well as the parameter uncertainty. It incorporates 15 members of the Met Office Hadley Centre model, HadGEM3-GC3.05 (PPE -15), and 13 other climate models selected from the climate models that informed the Intergovernmental Panel on Climate Change's 5th Assessment Report (CMIP5-13).

- **Regional (12km) projections** - a set of 12 high resolution projections at 12km (RCM-PPE) downscaled from the PPE-15 over the UK and Europe. They assess the uncertainty in the regional model parameters, as well as uncertainty in the large-scale conditions from the driving global model.

- **Local (2.2km) projections** – a set of 12 very high resolution projections at 2.2km (CPM-12) downscaled from the regional projections over the UK. They assess different local conditions given the uncertainty in the driving information.

- **Derived projections** – a set of climate futures for the UK at 60km grid resolution for a low emissions scenario, RCP2.6 and a global warming level of 2 °C and 4 °C. These have been derived from the global projections using statistical techniques.

Results overview

- Observations show an overall annual warming in the UK during recent decades.

- Over land the projected general trends of climate changes in the 21st century are similar to UKCP09, with a move towards warmer, wetter winters and hotter, drier summers. However, natural variations mean that some cold winters, some dry winters, some cool summers and some wet summers will still occur.

- The probabilistic projections show:

  - There is more warming in the summer than in the winter.

  - In summer there is a pronounced north/south contrast, with greater increases in maximum summer temperatures over the southern UK compared to northern Scotland (Figure 1). This spatial pattern is also apparent in the global and regional projections.

- The global projections for the UK show:

  - The spread of the global projections is slightly narrower than the range of the probabilistic projections over the UK, with this especially notable at the lower end of the distribution in summer and winter, and at the higher end of the distribution in winter.

  - The regional projections also cover a sizeable part of the probabilistic range but the spread tends to be lower than for the global projections because the regional simulations are only driven from the a subset of the PPE-15, which means they are not able to sample the lowest levels of warming at a given time in the future.

  - More information on the differences between the PPE-15 and the CMIP5-13 temperature projections can be found in the Science Overview report (Lowe et al, 2018) and the UK Land Projections Report (Murphy et al, 2018).

- The regional projections show a high degree of consistency with the coarser global projections, with more spatial detail associated with aspects such as better simulation of the topography and coastlines.

- Further results for the Regional (12km) and Local (2.2km) projections can be found in the UKCP Local (2.2km) factsheet.

Summer mean maximum temperature anomaly
for 2080-2099 minus 1981-2000
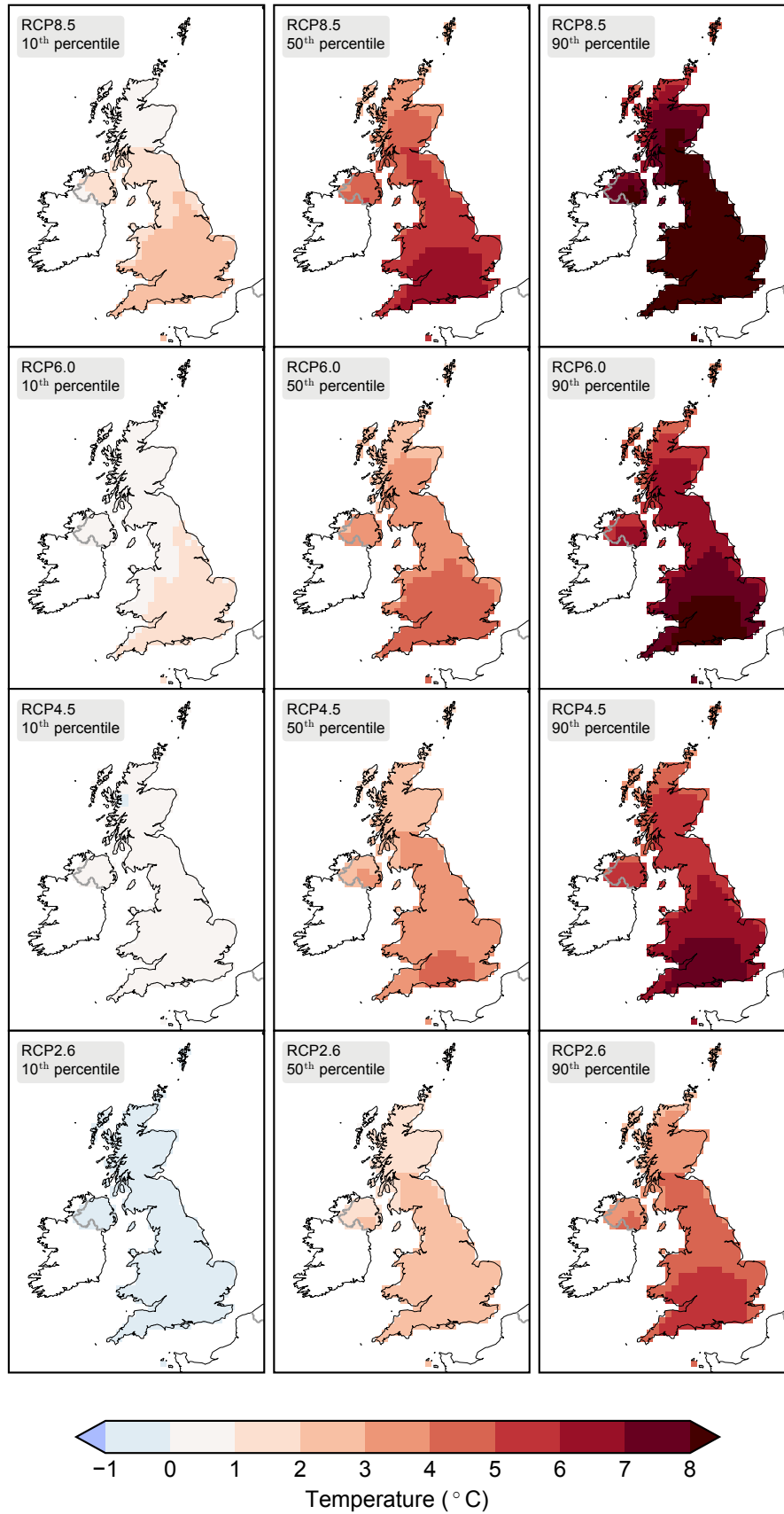
Figure 1. Projected annual temperature changes for the UK for the range of emissions scenarios for the probabilistic projections.

Importance of temperature

Surface air temperature is a key indicator of global, regional and local climate change that has implications for the built and natural environment, human health and critical infrastructure.

Extreme heat can have a range of impacts. Brief hot spells can lead to impacts on human health, especially in urban areas where buildings retain heat, resulting in higher night time temperatures. Impacts on transport can include buckling of rail tracks and reductions in the safe loading of aircraft. More prolonged heat can result in strong demands on water resource, cause pipe movement and breakages due to soil shrinkage and create favourable conditions for wildfire.

The impacts from extreme cold include a risk to health, particularly for vulnerable individuals, disruption to utility supplies from ice build-up on electricity cables and freezing of water pipes and disruption to road, rail and air transport.

Global temperature in any given year is affected by factors such as the concentration of greenhouse gases in the atmosphere and natural processes within the climate system. Regionally, factors including circulation patterns and the land-sea contrast strongly affect temperature. Locally, land height and land use have an influence on temperature, such as sea breezes and frost hollows.

You may want to consider more than one variable together when analysing future climate change for risk assessment and decision making, for example, simultaneous changes in temperature and precipitation that may have implications for water resource management.

What data are available and where can you find it?

You can find the data availability summarised in Table 1. All temperature data are in degrees celsius (°C).

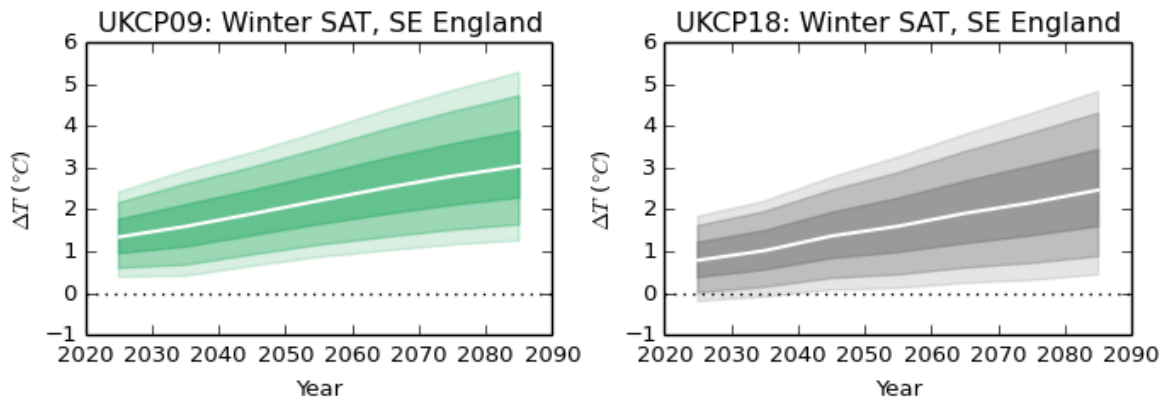|	Observations	Probabilistic projections	Global (60km) projections	Regional (12km) projections	Local (2.2km) projections	Derived projections
Temperature variables near the surface	Mean Maximum Minimum	Mean Maximum Minimum	Mean Maximum Minimum	Mean Maximum Minimum	Mean Maximum Minimum	Mean Maximum Minimum
Geographical extent	UK	UK	UK Global	UK Europe	UK	UK
Spatial resolution	12km† 25km† 60km†	25km	60km	12km	2.2km (5km in OSGB)	60km
Temporal resolution	Daily Monthly	Monthly Seasonal Annual	Daily Monthly Seasonal Annual	Daily Monthly Seasonal Annual	Hourly (mean) Monthly Seasonal Annual	Daily Monthly
Period of data	1960-2017 daily 1914-2017 monthly	1960-2100	1900-2100	1980-2080	1981-2000 2021-2040 2061-2080	1900-2100
Emissions scenarios	n/a	RCP2.6 RCP4.5 RCP6.0 RCP8.5 SRES A1B	RCP8.5	RCP8.5	RCP8.5	RCP2.6 2°C world 4°C world

Table 1. Summary of available temperature variables for UKCP18. Data is provided in (i) the Ordnance Survey's British National Grid (OSGB) for UK areas and (ii) in the climate models' original grid for areas outside of the UK (see UKCP18 Guidance: data availability, access and formats). †based on observation network.

You can access the data and visualisations via the [UKCP18 User Interface](.).

You can access the simulations and all other datasets via the CEDA Data Catalogue (http://catalogue.ceda.ac.uk) but note that this requires the technical skill to analyse large datasets.

How do the results compare to other models?

Figure 2 shows a like-for-like comparison for winter average temperature over the South East England administrative region for the SRES A1B emissions scenario. It indicates substantial overlap between the distributions of the two sets of projections. However, median winter warming in UKCP18 is approximately 0.5°C lower than UKCP09, due in part to the new constraint on CO_2 concentration (Figure 2).

Figure 2: Probabilistic projections of winter average temperature (°C) from UKCP09 (left) and UKCP18 (right), for the SRES A1B emissions scenario for the Southeast England administrative region. The white line shows the median of the probability distribution and shading shows the 5th, 10th, 25th, 75th, 90th and 95th percentiles. Changes in 30-year averages are shown relative to the UKCP09 baseline of 1961-1990, for the seven overlapping future periods provided in UKCP09: 2011-2040, 2021-2050,..,2071-2100.

We have compared the global and regional projections with observations to understand how consistent they are. On the European scale, the PPE-15 and the set of regional projections display systematic differences from the observations (biases) for the period 1981-2000, especially in the winter season. Similar but considerably smaller differences from observations are shown in CMIP5-13 where it is colder over Scandinavia and warmer over south-eastern Europe in winter. The biases are much smaller for the European summer seasons across all of the global and regional simulations.

You may wish to consider adjusting the climate model data for the "biases" and apply bias-correction techniques before using UKCP18 data in your analysis. Further information on what bias correction is, common approaches and the caveats and limitations are described in the UKCP18 guidance on How to Bias Correct.

The comparisons presented in this factsheet show that there are similarities and differences between UKCP18 projections and other sources of data. The reasons for the differences are often complex and not easily summarised in this format of document. For further discussion of this topic and some of the explanations for the difference please refer to Section 2 of the Science Overview report (Lowe et al, 2018) in the first instance.

What do you need to be aware of?

Whilst the projections represent the latest scientific understanding and the results have been peer reviewed by independent experts, keep in mind the caveats and limitations of the projections. Although our understanding and ability to simulate the climate is advancing all the time, our models are not able to represent all of the features seen in the present day real climate. This means that when including the climate projections in your decision-making, consider how best to factor the capabilities and limitations of UKCP18. This should be informed by a thorough understanding of the consequences of different climate outcomes – perhaps including those beyond the ranges of uncertainty presented in UKCP18.

See UKCP18 Guidance: How to Use the Land Projections for further information on the caveats and limitations and appropriate use.

Where can you find more information?

For further information on UKCP18:

- Find a summary of the key results for temperature metrics from the UKCP18 website

- Download the temperature data from the UKCP18 User Interface and the CEDA Data Catalogue

- Find out more on the regional (12km) and local (2.2km) projections in the UKCP Local (2.2km) Factsheet.

- Find out more on the underpinning science from the UKCP18 Land Projections Report and UKCP Convection Permitting Model Projections science report (Murphy et al, 2018, Kendon et al, 2019).

- Find out more about the UKCP18 Derived Projections (Gohar et al, 2018) that provide results at the 60km scale over the UK for RCP2.6 and 2°C and 4°C worlds.

This document is citable as Fung F, Bett P, Maisey P, Lowe J, McSweeney C, Mitchell JFB Murphy J, Rostron J, Sexton D and Yamazaki K. UKCP18 Factsheet: Temperature. Met Office Hadley Centre, Exeter.

References

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