Department for Environment Food & Rural Affairs

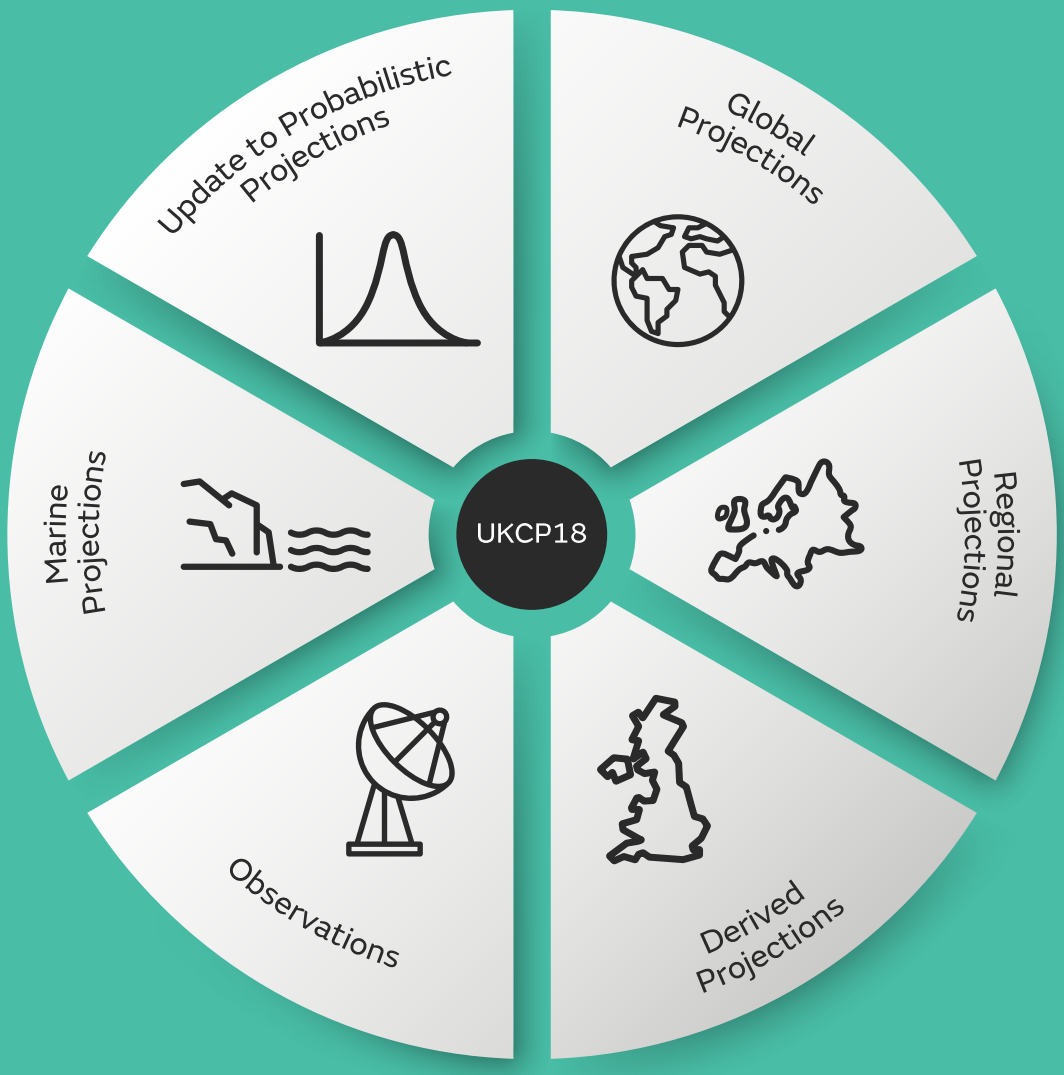
Department for Business, Energy & Industrial Strategy

Met Office Hadley Centre

Environment Agency

UKCP18 Science Overview Executive Summary

January 2019



UKCP18 provides a new set of climate projections and tools to access climate data. The major innovations in UKCP18 include the use of new observations of weather and climate, inclusion of a more recent generation of climate models from around the world and the results from latest Met Office global and regional climate models. The involvement of users in the design of UKCP18 has been greater than for previous UK climate projections, such as UKCP09.

UKCP18 climate projections consist of: updated probabilistic projections, giving estimates of different future climate outcomes; a new set of global climate model projections, comprising simulations from both the latest Met Office Hadley Centre climate model and global climate models from around the world; and a set of regional climate model projections on a finer scale (12km) for the UK and Europe. The global and regional model projections offer users the ability to better explore climate variability and changes, including retaining spatial coherence and the relationship between different climate metrics. Whilst these are not intended to be used to derive a probability distribution of model response, they will allow users to explore alternative climate futures in more detail than the probabilistic projections. Later we will provide a further set of projections produced with a model of horizontal scale 2.2km, which is better able to represent some smallscale processes seen in the atmosphere, such as those important for large convective storms in the summer. UKCP18 projections for the seas around the UK comprise: new estimates of the time-mean sea level rise around the UK coastline; exploration of the possible changes in future storm surge and tides and new information on the change in sea surface waves. Alongside the projections are new observations of UK climate, which are described in the State of the UK Climate 2017 report (Kendon et al, 2018). These observations and linked attribution studies show that the UK climate has already changed, with evidence that some changes over the UK are at least partly connected to increases in greenhouse gas concentrations in the atmosphere.

Some of the UKCP18 products provide results for a range of future emission scenarios going from a situation where global emissions of greenhouse gases rapidly peak and decline towards the ambitious climate targets in the Paris climate agreement, to a case where increased use of fossil fuels leads to higher greenhouse gas emissions.

The main findings from an initial analysis of UKCP18:

- Observations for the UK show that the most recent decade (2008-2017) has been on average 0.3 °C warmer than the 1981-2010 average and 0.8 °C warmer than 1961-1990. All of the top ten warmest years have occurred since 1990.
- In the past few decades there has been an increase in annual average rainfall over the UK, particularly over Scotland for which the most recent decade (2008–2017) has been on average 11% wetter than 1961–1990 and 4% wetter than 1981-2010. However, natural variations are also seen in the longer observational record. The observations made in the future will be dependent on both long-term climate trends and natural variability.

Projected future changes over land areas:

- Overall the probabilistic projections in UKCP18 show ranges that have a large overlap with those from UKCP09, but with some notable differences in the tails of the projected distributions. 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 and users may need to factor this into decision-making.

- 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 average warming between the 10% and 90% probability levels. By 2070, in the high emission scenario, this range amounts to 0.7°C to 4.2°C in winter, and 0.9°C to 5.4°C, in summer. For precipitation, corresponding ranges of UK average changes are -1% to +35% for winter, and -47% to +2% for summer, where positive values indicate more precipitation and negative values indicate reduced precipitation.
- Hot summers are expected to become more common. In the recent past (1981-2000) the probability of seeing a summer as hot as 2018 was low (<10%). The probability has already increased due to climate change and is now estimated to be between 10-20%. With future warming, hot summers by mid-century could become even more common (with probabilities of the order of 50% depending on the emissions scenario followed).

Additionally, UKCP18 simulates sub-seasonal and sub-monthly extremes of climate and their changes, such as daily extreme temperature and rainfall. There is also the potential for future changes in the time spent experiencing different types of weather regimes. These can be examined using the new global and regional projections.

Future changes at the coast and in the sea:

- UK coastal flood risk is expected to increase over the 21st century and beyond under all emission scenarios considered. This means that we can expect to see both an increase in the frequency and magnitude of extreme water levels around the UK coastline. This increased future flood risk will be dominated by the effects of time-mean sea level rise, rather than changes in atmospheric storminess associated with extreme coastal sea level events. There may also be changes in tidal characteristics.
- 21st century projections of time-mean sea level change around the UK vary substantially by emissions change scenario and geographic location. The very likely ranges for UK capital cities at 2100 are summarised below for each scenario included in this report.

	Sea level change at 2100 (m) relative to 1981-2000 average		
	RCP2.6	**RCP4.5**	**RCP8.5**
London	0.29-0.70	0.37-0.83	0.53-1.15
Cardiff	0.27-0.69	0.35-0.81	0.51-1.13
Edinburgh	0.08-0.49	0.15-0.61	0.30-0.90
Belfast	0.11-0.52	0.18-0.64	0.33-0.94

The risk of coastal flood events will rise with the projections of increase in time-mean sea level. However, based on storm surge modelling work, we suggest a best estimate of no significant additional increase in the statistics of extreme water levels associated with atmospheric storminess change. The largest trend found in our set of surge simulations of this additional component corresponds to a change of approximately 10 cm per century for the 1-year return level, which is considerably less than the timemean sea level change under the same emission scenario. However, we cannot rule out larger trends in storm surge due to this additional component. The additional component could be either positive (augmenting the mean sea level change) or negative (partially offsetting the mean sea level change).

- 21st century projections of average wave height suggest changes of the order 10-20% and a general tendency towards lower wave heights. Changes in extreme waves are also of order 10-20%, but there is little agreement in the sign of change among the model projections. High resolution wave simulations suggest that the changes in wave climate over the 21st century on exposed coasts will be dominated by the large-scale response to climate change. However, more sheltered coastal regions are likely to remain dominated by local weather variability.
- Exploratory, time-mean sea level projections to 2300 suggest that UK sea levels will continue to rise over the coming centuries under all emission scenarios considered. For London the projection ranges at 2300 are approximately 0.5 - 2.2m and 1.4 - 4.3m for the lowest and highest emission scenarios, respectively. The values for Edinburgh and Belfast are lower. The projections extending beyond 2100 should be considered as illustrative of the potential future changes.

Users of UKCP18 are provided with a number of web-based tools to access the knowledge and data. All users will have access to a website containing high-level statements on future climate, similar to and expanding on those in this summary, alongside guidance notes on different climate metrics and how to use the different UKCP18 products. This website also contains more detailed reports on the land and sea projections, the limitations of the climate information and FAQs. More technical users can choose to access a user interface to interrogate aspects of the UKCP18 data and tailor the outputs to their needs, such as choosing to look at a particular region. The most advanced technical users and the research community can also directly access climate model output, and are recommended to read both the land and marine science reports (Murphy et al, 2018; Palmer et al, 2018).