Department for Environment Food & Rural Affairs

Department for Business, Energy & Industrial Strategy

Met Office Hadley Centre

Environment Agency

UKCP18 Fact Sheet: Weather Types

This factsheet summarises the key information currently available on the UKCP18 projections over land for atmospheric pressure at sea level representing different weather types. 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 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

- Weather types are a tool to aid the understanding of the local changes in future weather and climate in terms of the larger-scale changes, in which there may be more confidence.
- The changes in characteristics of the weather types shown by the global projections indicate that, on average, UK winter weather conditions are expected to become milder and for certain weather types, wetter. We focus here on the UK winter season when specific conditions are expected to have more significant impacts.
- The UK experiences two dominant weather types:
  - Weather Type 1 (WT1): Cold and dry conditions resulting from an increased frequency of northerly and easterly winds due to a weak pressure difference over the Atlantic (or negative NAO).
  - Weather Type 2 (WT2): Warm and wet conditions resulting from strong westerly winds due to strong pressure difference over the Atlantic (or positive NAO).
- There is significant year-to-year variability in the number of days of each weather type in both the observed period and future projections. Over the observed period, the frequency of days of weather type 1 and 2 vary between 0 to 60% of each winter model.
- The PPE-15 shows an increase in the frequency of warm and wet days (weather type 2) and fewer cold and dry days (weather type 1) in winter throughout the 21st Century. This climate change signal is not replicated in the average response from the CMIP-13.
- Future warming means that by the 2080s, the temperature levels experienced during 'cold' weather type 1 winter events will be similar to temperature levels currently experienced under weather type 2. (Figure 1).

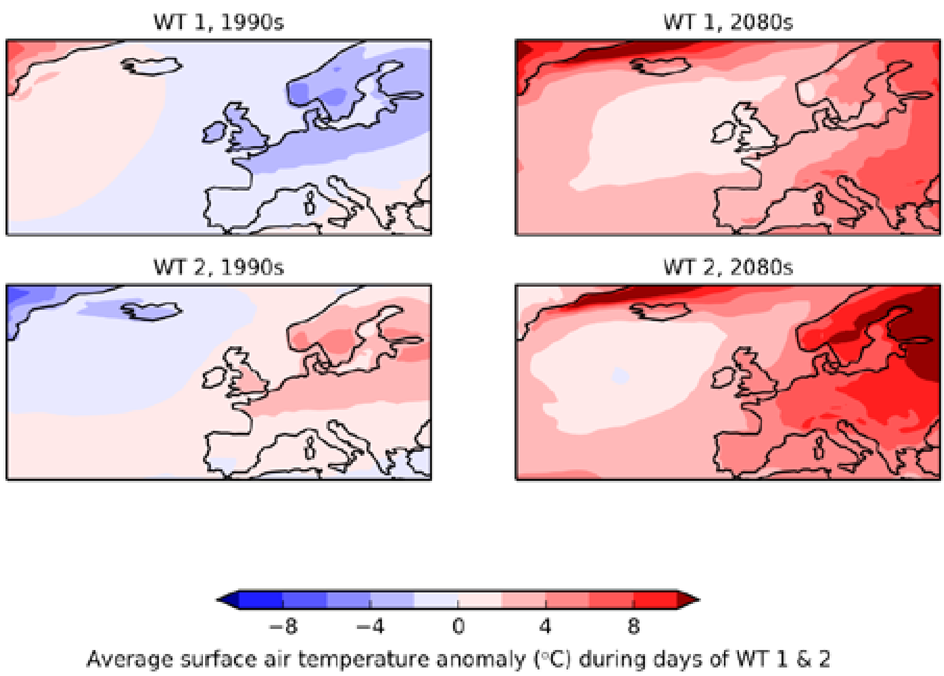

Figure 1. Average modelled surface air temperature changes from 1981-2000 observations (°C) on winter days when the atmospheric circulation in the North Atlantic/Europe sector corresponds to weather type 1 (WT1 or negative phase of the North Atlantic Oscillation) and weather type 2 (WT2 or positive phase of the North Atlantic Oscillation). Results are for the 1990s (left) and 2080s (right) for the PPE-15 global projections.

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What are weather types?

Sea level pressure is a fundamental atmospheric variable and a key element of the UKCP18 projections. We can classify different patterns of surface atmospheric pressure to gain a clearer picture of the likely conditions associated with a particular weather situation. These patterns are called 'weather types'.

For example, a wintertime weather situation in which an area of high pressure (anticyclone) sits over the northern UK and low pressure (cyclone) sits over the south can draw in air from continental Europe which is often characterised by low temperatures and little precipitation. In summer this same pressure pattern might bring warm air from continental Europe, still often dry but sometimes with thunderstorms.

Projections of future changes in atmospheric pressure over the UK are important as a potential indicator of general weather conditions including temperature, precipitation and storminess that have a direct impact on public and private sector organisations planning for changes in these variables.

The location of the UK in relation to the North Atlantic storm track and the European land mass plays a key role in determining the contrasting characteristics associated with different weather types.

We use eight weather types in UKCP18 and these have been associated with temperature and precipitation differences from long-term average conditions. We highlight weather type 1 and weather type 2, which account for 43% of all winter days (for the period 1900-1999). They relate to the two phases of the North Atlantic Oscillation (NAO), an important feature in the North Atlantic that is characterised by lower pressure over Iceland and higher pressure over the Azores in its positive phase and with a reduced pressure difference in its negative phase:

- Weather type 1 (-NAO): weak pressure difference over the Atlantic results in an increased frequency of northerly and easterly winds over the UK giving cold and dry conditions.
- Weather type 2 (+NAO): strong pressure difference over the Atlantic gives strong westerly winds over the UK and warm and wet conditions.

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What data are available and where can you find it?

You can find the data availability summarised in Table 1.

	Observations	Probabilistic projections	Global (60km) projections	Regional (12km) projections	Local (2.2km) projections
Variables available	Sea level pressure Weather types* NAO index*	Sea level pressure	Sea level pressure Weather types* NAO index*	Sea level pressure	Sea level pressure
Geographical extent	UK	UK	UK Global	UK Europe	UK
Spatial resolution	12km† 25km† 60km†	25km	60km	12km	60km
Temporal resolution	Monthly	Monthly Seasonal Annual	Daily Monthly Seasonal Annual	Daily Monthly Seasonal Annual	Daily Monthly
Period of data	1961-2017	1960-2100	1900-2100	1980-2080	1900-2100
Emissions scenarios	n/a	RCP2.6 RCP4.5 RCP6.0 RCP8.5 SRES A1B	RCP8.5	RCP8.5	RCP2.6 2°C world 4°C world

Table 1: Summary of available pressure-related variables for UKCP18. Note that the results from the 2.2km model will be available at a later date; these will downscale the regional projections at 12km for 1981-2080, 2021-2040, 2061-2080. Data is provided in (i) the Ordnance Survey's British National Grid 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. *These datasets will be available shortly after the launch of UKCP18.

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 but note that this requires the technical skill to analyse large datasets.

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How do the results compare to other models?

Long-term average occurrence rates for weather types over the UK in the 28 global projections show good agreement with observations with a small systematic difference resulting in more frequent occurrences of weather type 1 in the PPE-15 relative to the observations. The model variability is similar to that of the observations (1900-2017). More extreme seasons can be found in the models compared to the observations which is expected given the greater sample size of the ensemble sets (Figure 2).

The increase in occurrence of weather type 2 by the end of the 21st Century seen in the global projections is not replicated in the average of the CMIP5 ensemble. This result shows the importance of considering additional, alternative model data in order to avoid an overconfident interpretation of the shift towards a predominance of positive NAO conditions.

We are unable to look at weather types for the probabilistic projections.

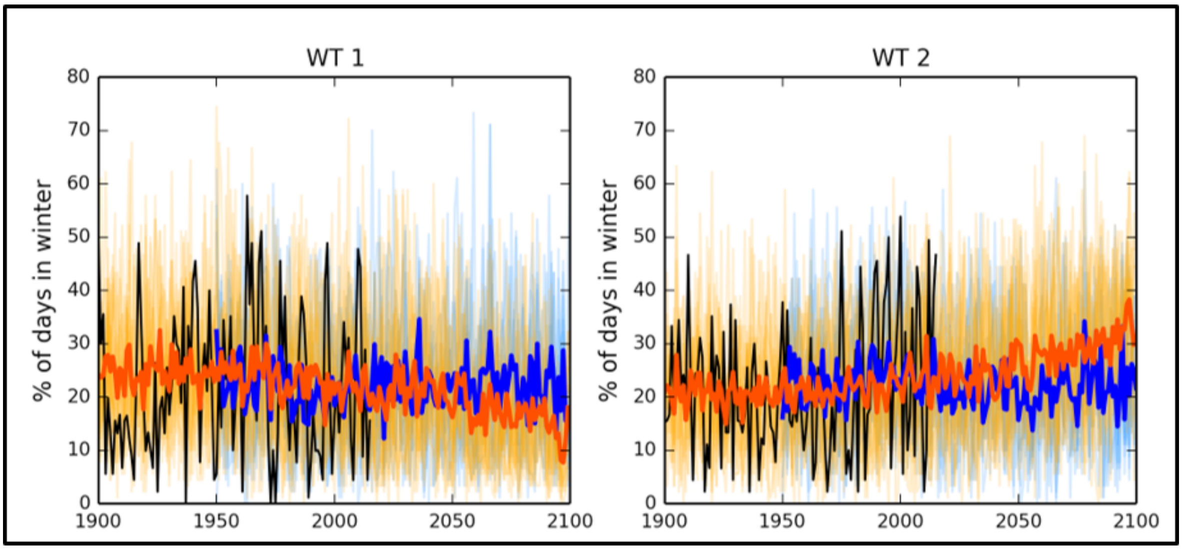

Figure 2. Percentage of days during winter (DJF) assigned to weather type 1 (WT 1, left) and weather type 2 (WT 2, right) during 1900-2100 in members of the PPE-15 (orange, ensemble mean in red) and in 9 of the CMIP5-13 members for which daily weather typing is available (pale blue, ensemble mean in darker blue). Black line shows observed historical values based on Ansell et al, 2006.

The comparisons presented in this fact sheet show that there are similarities and differences between UKCP18 projections and other sources of data. The reasons for the differences are often complex and have not yet been fully explored. For further discussion of this topic and some of the explanations for the difference please refer to Section 2 of the Science Overview (Lowe et al, 2018) in the first instance.

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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 applying the climate projections to 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.

Weather types are a classification of patterns of atmospheric pressure that, by design, aggregate over a range of conditions. For this reason any analysis of extreme outcomes should consider using the pressure data directly.

Local variability dominates any climate change signal for pressure and weather types, indicating that you can still expect significantly different weather from winter to winter in the future.

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

Where can I find more information?

You can find further details about the eight weather types used in UKCP18 in Neal et al, (2016).
For further information on UKCP18:

- Download sea level pressure and other metrics in Table 1 from the UKCP18 User Interface and the CEDA Data Catalogue.
- Find out more on the underpinning science from the UKCP18 Land Projections Report (Murphy et al, 2018).
- 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 Maisey P, Thornton H, Fung F, Harris G, Lowe J, McSweeney C, Mitchell JFB, Murphy J, Rostron J, Sexton D and Yamazaki K. UKCP18 Factsheet: Weather Types. Met Office Hadley Centre, Exeter.

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