Department for Environment Food & Rural Affairs

Department for Business, Energy & Industrial Strategy

Met Office Hadley Centre

Environment Agency

UKCP18 Factsheet: Derived projections

This factsheet summarises the key information currently available on the UKCP18 Derived projections. Read this before using the Derived Projections 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 how the results relate to the other components of the projections. For a comprehensive description of the underpinning science, evaluation and results see the UKCP18 Derived Projections report (Gohar et al, 2018).

Please note that these projections are statistically derived from the global model projections to produce data for alternative scenarios:

- **Projections of RCP2.6** – a set of 28 climate futures for the UK at 60km grid resolution, showing how the 21st Century climate may evolve under the low emission scenario RCP2.6. It incorporates 15 projections derived from the Met Office Hadley Centre model, HadGEM3-GC3.05 (PPE-15), and 13 others derived from climate models selected from the climate models that informed the Intergovernmental Panel on Climate Change's 5th Assessment Report (CMIP5-13);
- **Projections at global mean warming of 2°C and 4°C** - a set of climate futures for the UK at 60km grid resolution for global warming levels of 2°C and 4°C. These have also been derived from the global projections using statistical techniques.

Key messages

- 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.
- At 2°C of global mean warming;
  - For temperature:
    - The largest warming in the UK will be in the South East where summer temperatures may increase another 3 to 4°C relative to present day (1981-2000) (Figure 1)
    - Median warming will be at least 1 to 2°C throughout the year across the whole of the UK

- Winter cool days will warm by 1 to 1.5°C across the country, whilst temperatures on warmer winter days increase by less than 1°C
- In summer both hot and cool days warm by 1 to 1.5°C across Scotland and 1.5 to 2°C across England

- For precipitation:
  - Changes are uncertain, but suggest slightly wetter winters and drier summers, with summer drying more in the South (Figure 2)
  - Dry days in summer have 30% less precipitation in parts of the south west

- At 4°C of global warming, changes compared to present day have a similar spatial pattern to those at 2°C but larger;
  - For temperature:
    - All seasons warm, but summers warmer than winters
    - Summer temperatures rise by another 4 to 5°C in the south of England and 3 to 4°C elsewhere in the country (Figure 3)
    - Hot summer days warm by 4.5 to 5°C compared to present day (1981-2000), across much of Southern England, possibly exceeding 5°C in some locations (Figure 5)
    - Cooler summer days warm by 4 to 4.5°C across England and up to 5°C in the south east. Increases reduce toward to north to under 3°C in the far North West of Scotland
    - Cool winter days warm by 2.5 to 3°C across the country
    - Warm winter days warm by 2.5 to 3°C in England but by 2 to 2.5°C in Wales and Scotland
  - For precipitation:
    - Median winter precipitation increases by up to 20% across most of the country (Figure 4)
    - Median summer precipitation decreases most in the south with median reductions of up to 20 to 30% across much of the England and Wales
    - Dry summer days decrease in precipitation by up to 50% in summer across much of Southern Wales and England. This drying reducing toward the north to under 20% in Northern Scotland
    - The wettest summer days dry by up to 40% on parts of the south coast. This decreases toward zero in the north.

- Global mean warming in the last 20 years of RCP2.6 (2081-2100) is close to 2°C and projections for all variables are similar to those for the 2°C time slice.

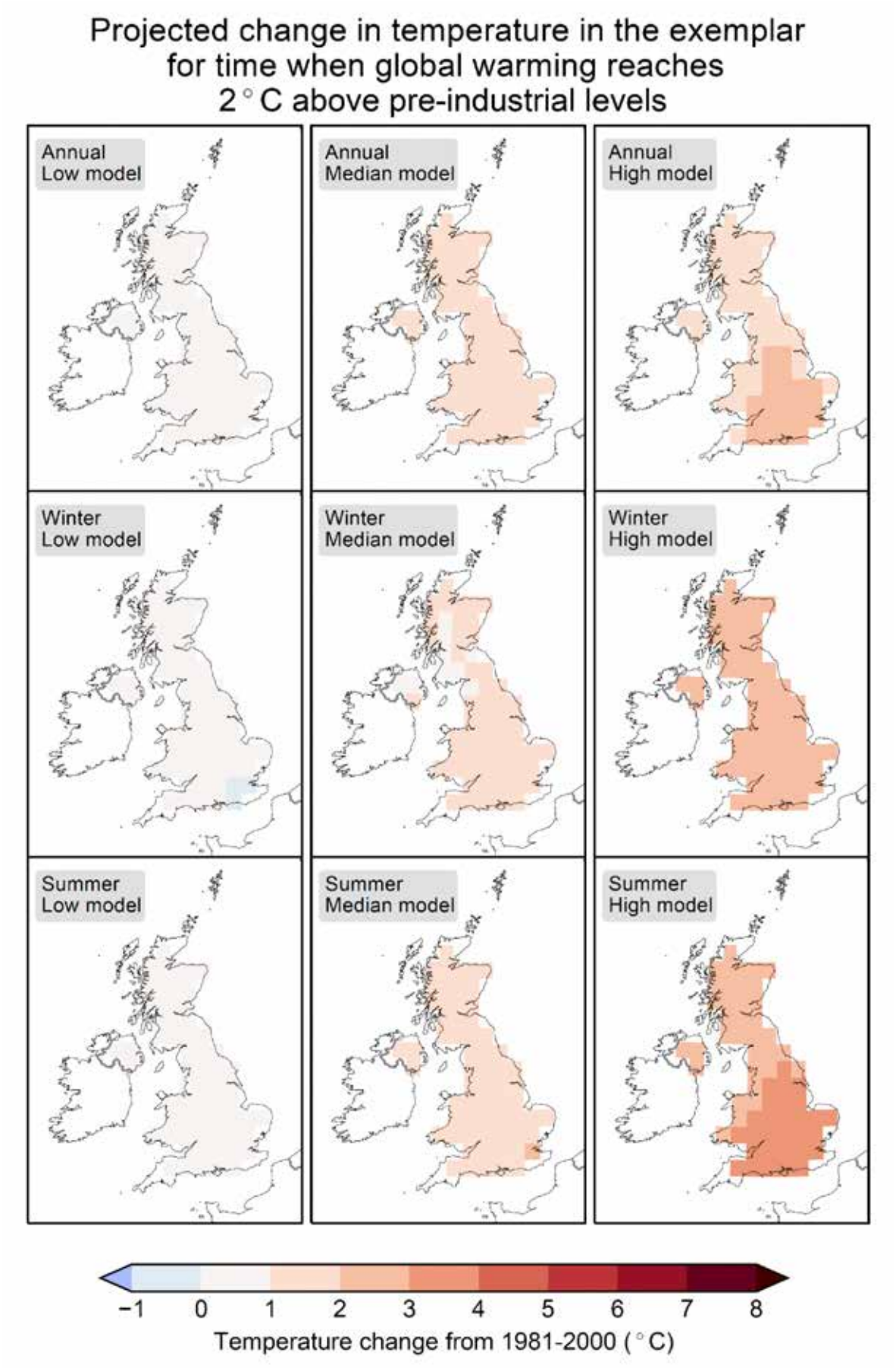

Figure 1 Projected changes in UK temperatures at a global mean warming of 2°C (GWL2) above pre-industrial (1850-1900). Changes are shown relative to present day (1981-2000). Rows show annual (top), winter (December-February; middle) and summer (June-August; bottom) changes. Columns shows maps for the model projection with a UK mean temperature changes which are relatively low (left), high (right) or median (centre).

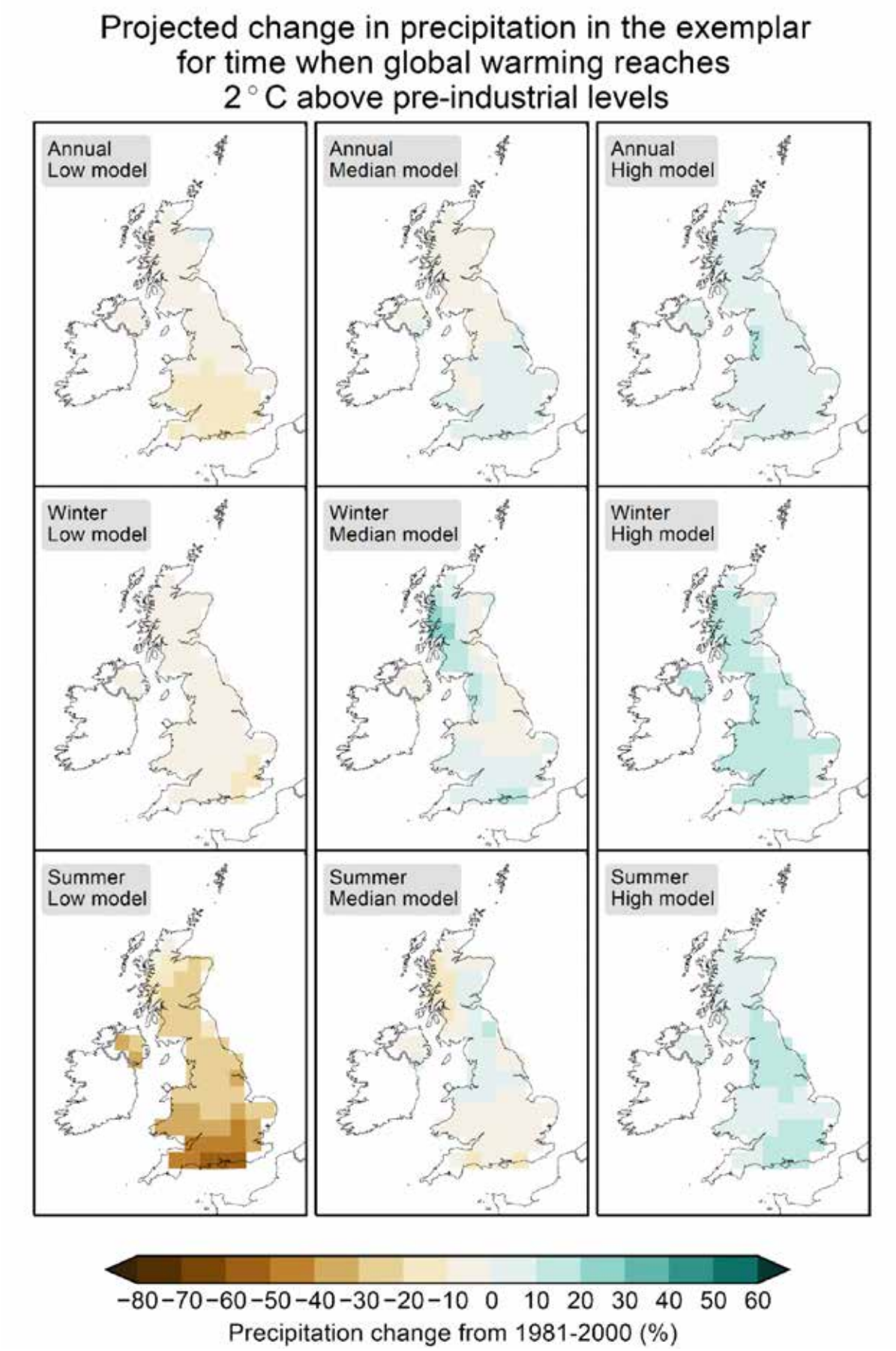

Figure 2 Projected changes in UK precipitation at a global mean warming of 2°C (GWL2) above pre-industrial (1850-1900). Changes are shown relative to present day (1981-2000). Rows show annual (top), winter (December-February; middle) and summer (June-August; bottom) changes. Columns shows maps for the model projection with a UK mean precipitation changes which are relatively low (left), high (right) or median (centre).

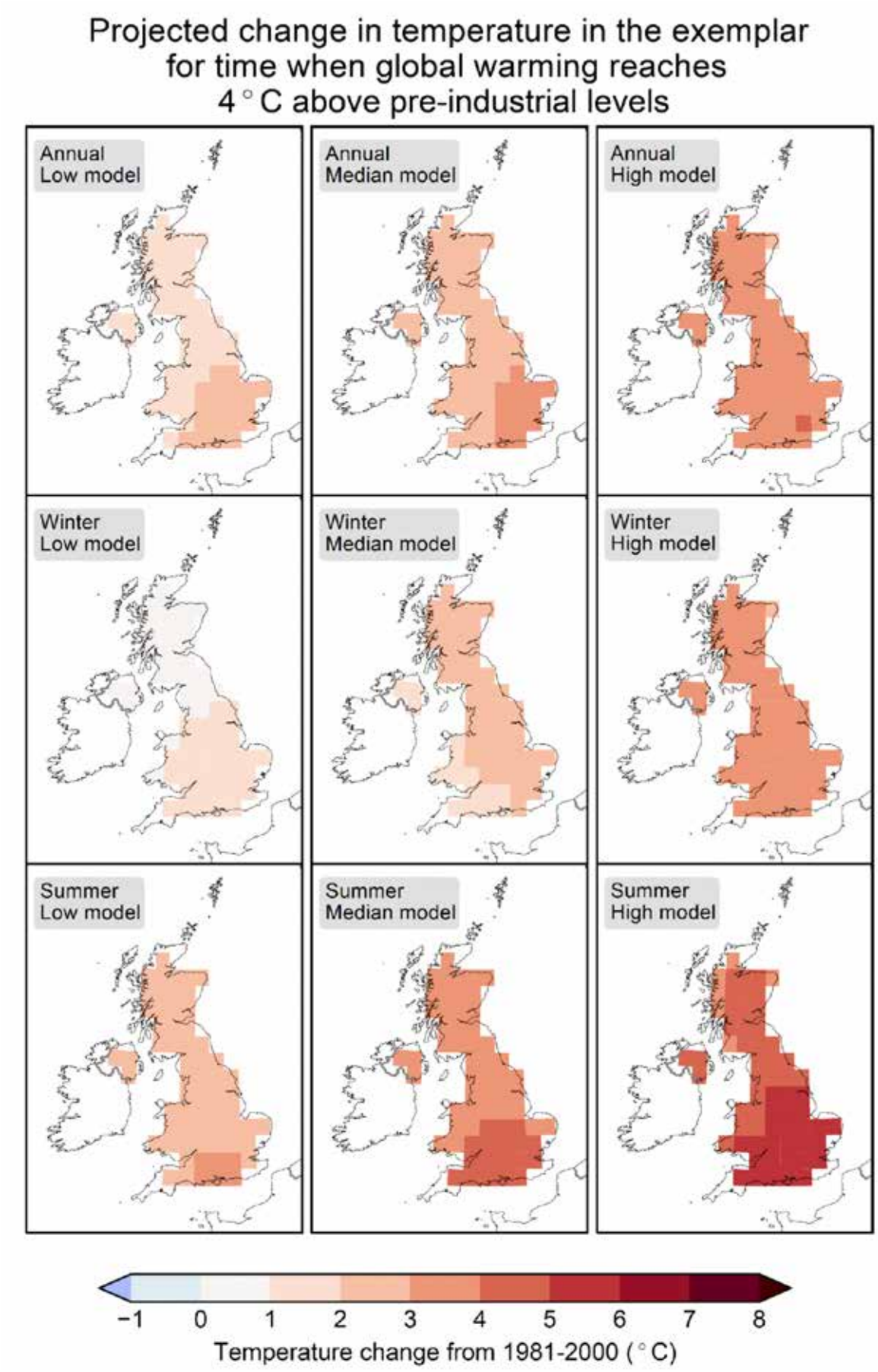

Figure 3 Projected changes in UK temperatures at a global mean warming of 4°C (GWL4) above pre-industrial (1850-1900). Changes are shown relative to present day (1981-2000). Rows show annual (top), winter (December-February; middle) and summer (June-August; bottom) changes. Columns shows maps for the model projection with a UK mean temperature changes which are relatively low (left), high (right) or median (centre).

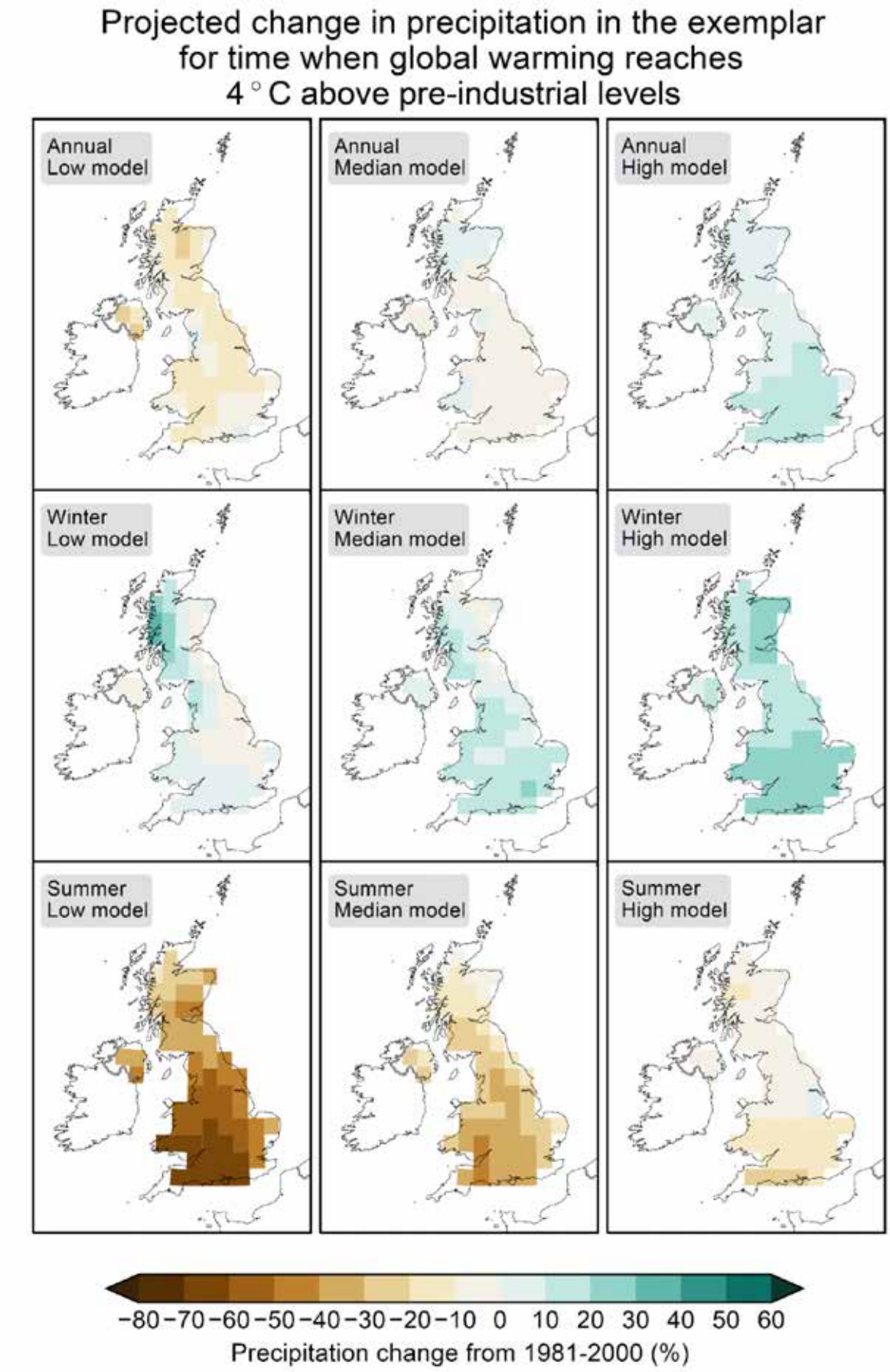

Figure 4 Projected changes in UK precipitation at a global mean warming of 4°C (GWL4) above pre-industrial (1850-1900). Changes are shown relative to present day (1981-2000). Rows show annual (top), winter (December-February; middle) and summer (June-August; bottom) changes. Columns shows maps for the model projection with a UK mean precipitation changes which are relatively low (left), high (right) or median (centre).

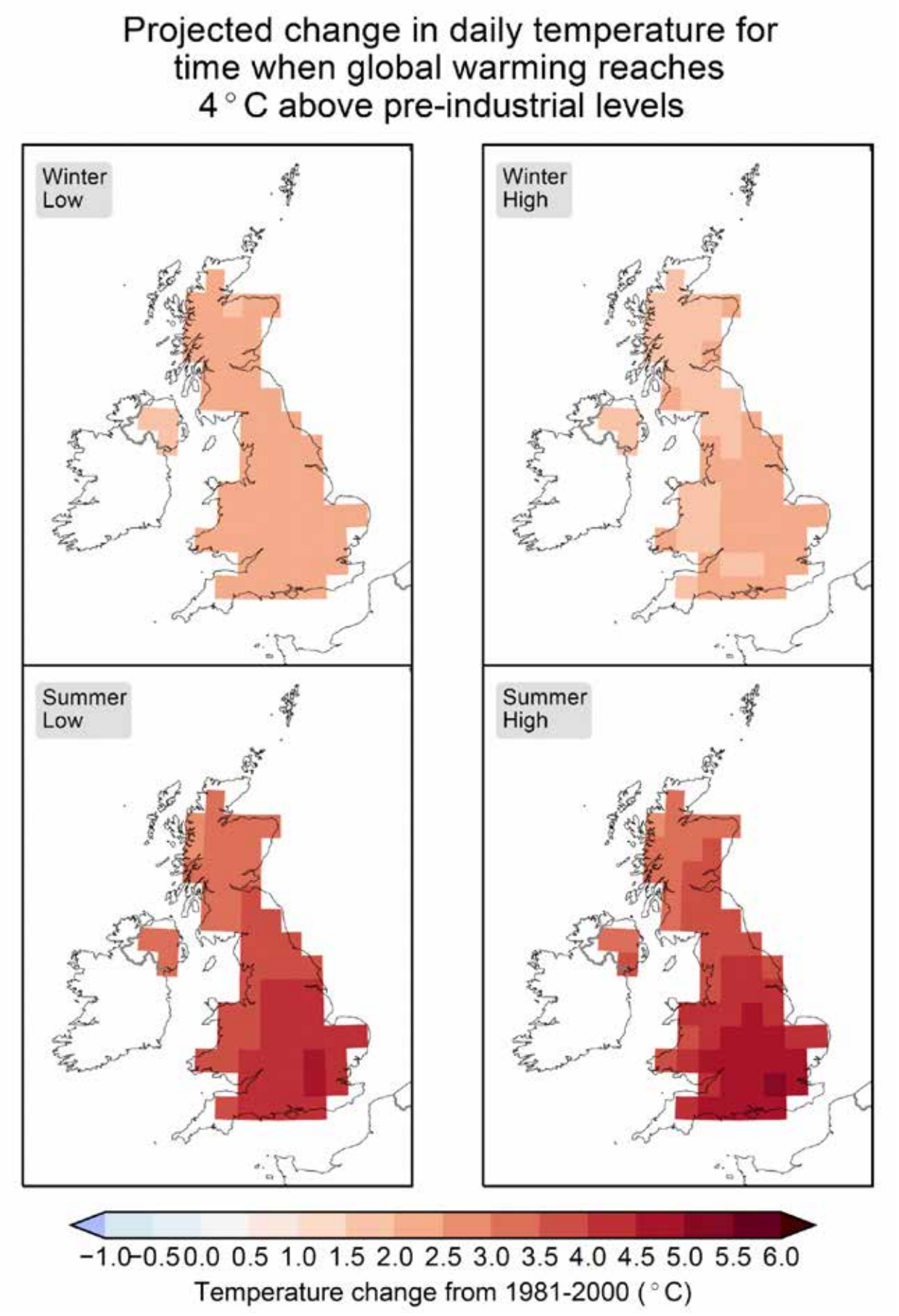

Figure 5 Temperature changes on cool and hot days, relative to present day (1981-2000), at a global mean warming level of 4°C. The mean change from all models is shown. Changes in winter are averages over December, January and February. Changes in summer are averages over June, July and August.

Why are derived projections needed?

It is important that UKCP18 take into account the uncertainty regarding the amount of greenhouse gas emissions emitted into the atmosphere in the future. In the probabilistic projections of UKCP18 this is addressed by using several emission pathways, ranging from RCP2.6 (strong global mitigation policy with falling emissions) to RCP8.5 (minimal mitigation policy with rising emissions with increasing global wealth and population).

However, in the UKCP Global (60km) projections (Murphy et al, 2018) only one emission scenario was considered due to the large amount of supercomputer resource required. RCP8.5 was chosen to allow users to test their vulnerability with a plausible but high emissions future.

Following feedback from UKCP18 users the decision was taken to include a second future emissions pathway, the strong mitigation RCP2.6, using an approximation approach based on the RCP8.5 projections. Two further scenarios are also developed which are 50 year time slices with global mean warming stabilised at 2°C and 4°C relative to 1981-2000.

How are the derived projections produced?

The UKCP Global (60km) projections of RCP8.5 have been used to produce the derived projections for RCP2.6 and, where possible, two 50-year time-slices at 2°C and 4°C of global mean warming. The methodology is based on a combination of approaches: a method built on the approach of time-shifting to produce time-mean climate changes; a method related to pattern scaling to extract time series of variability; and assumptions about the relative warming of particular models between scenarios.

What data are available and where can you find it?

Derived projections data for the RCP2.6 scenario consists of 28 projections for the UK land region. These consists of 15 derived from RCP8.5 projections of the UK Met Office's HadGEM3-GC3.05 and 9 taken directly from the set of models that informed the latest assessment report from the Intergovernmental Panel on Climate Change, CMIP5. Four other models from CMIP5 used in the global model projections either did not run RCP2.6 or else had no data available. For these CMIP5 models, derived data is produced from their RCP8.5 projection in the same way as for GC3.05-PPE.

The two 50-year time slices for global mean warming levels of 2°C and 4°C are provided for the 15 projections of the GC3.05-PPE along with those of the 13 CMIP5 model used in UKCP18 which pass global mean warming levels of 2°C or 4°C. In some cases the CMIP5 models did not report all the variables requested for the derived projections, and so in these cases the actual number of derived projections available is reduced.

For both the time-slices and RCP2.6, continuous monthly data is available for temperature, precipitation, relative humidity, net downward shortwave radiation and surface wind. Continuous daily data is also provided for temperature and precipitation.

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.

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. As the derived projections are based on model simulations the same considerations apply. 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.

While evaluation has demonstrated skill in deriving projections from CMIP5 models it was not possible to demonstrate that the approach works well specifically for GC3.05-PPE as no RCP2.6 simulations were available for evaluation.

The derived daily data is coherent spatially, between variables and within months. However month to month coherence is not assured so caution should be used where applying duration based measure for events which may last longer than a month.

Methodological choices have slightly reduced consistency between variables for monthly data which are also provided at daily frequencies that those only provided at monthly frequency.

The same monthly variability, derived from RCP8.5, is used for RCP2.6 and the time-slices. As such there is a correlation between the variability in the corresponding ensemble members in all these products.

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 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:

Bernie D, Gohar G, Good P and Lowe JA, 2018. UKCP18 Applied Projections of Future Climate over the UK, Met Office.

References

Gohar G, Bernie D, Good P and Lowe JA, 2018. UKCP18 Derived Projections of Future Climate over the UK, Met Office.

Lowe JA, Bernie D, Bett PE, Bricheno L, Brown S, Calvert D, Clark RT, Eagle KE, Edwards T, Fosser G, Fung F, Gohar L, Good P, Gregory J, Harris GR, Howard T, Kaye N, Kendon EJ, Krijnen J, Maisey P, McDonald RE, McInnes RN, McSweeney CF, Mitchell JFB, Murphy JM, Palmer M, Roberts C, Rostron JW, Sexton DMH, Thornton HE, Tinker J, Tucker S, Yamazaki K, and Belcher S, 2018. UKCP18 Science Overview report. Met Office.

Murphy JM, Harris GR, Sexton DMH, Kendon EJ, Bett PE, Clark RT, Eagle KE, Fosser G, Fung F, Lowe J, McDonald RE, McInnes RN, McSweeney CF, Mitchell JFB, Rostron JW, Thornton HE, Tucker S and Yamazaki K, 2018. UKCP18 Land Projections: Science Report. Met Office.