CORNWALL COUNCIL
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Cornwall Climate Change Risk Assessment

Section 2 Cornwall's Climate Profile

Produced by
CCRM CLIMATE CHANGE RISK MANAGEMENT

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Executive Overview of the Cornwall Climate Profile

Introduction

This overview provides a summary of the main outcomes of the Cornwall Climate Profile project, as well as providing a brief within a wider context including the recent CoP26 in Glasgow and the GoUK Energy Compact.

Detailed results are presented in the Main document, in which there is also a discussion on the use of emissions scenarios (treated also in Annex I). In addition, Annex I covers a number of the technical aspects of the work that provide a more thorough scientific background to the results. A Glossary includes lists of the IPCC Climate Impacts Indicators (CIDs), the Risks and Opportunities considered in the Climate Change Risk Assessment 3 (CCRA3), and a comprehensive overview of acronyms used.

This document does not include the more detailed assessment of heatwaves required under Task 2. Nor does it include any assessment in terms of impacts other than basic indicators summarised through the CIDs and CCRA3.

The UK Climate Resilience Programme (UKCRP) is a relatively recent development to assist stakeholders in identifying and managing impacts from climate change. To date it has focussed mainly on providing guidance to stakeholders; available, and future, guidance might be helpful to decision making for Cornwall. One immediate tangible benefit of UKCRP is that the project has developed a web site, https://uk-cri.org/, built from UKCP18, that provides access, albeit simplified in comparison to the assessments used here, to the projections with graphics that might assist in providing additional details for adaptation planning. A factsheet for Bristol is available online and might be useful as a comparison to the results provided here.

Background

Results have been built around the CIDs introduced in the recent IPCC WGI AR6; a basic list of the CIDs is provided in the Glossary. These are an attempt to identify those climate variables that impact on societies, the environment and economies, not only in the future but also historically, and to provide context in the climate projections for potential consequences of change. There are 33 CIDs in total, covering basic atmospheric and oceanic parameters such as temperature and salinity, plus a few environmental factors, such as coastal erosion. Most CIDs are directly or partially pertinent to Cornwall; in the Main document the few CIDs not relevant for Cornwall have been filtered out.

Within the CCRA3 is a stratification of climate impacts on the UK (society, environment, economy, international) in terms of associated risks, of risks plus opportunities, and of opportunities. Note that climate change might offer new opportunities in a number of regards. There are 61 such indicators, listed in the Glossary. A generic assessment, an 'urgency score', has been attached under CCRA3 to each of these indicators as to whether current management positions require "more action needed" (34 indicators), "further investigation" (20 indicators), "sustain current action" (4 indicators), or "watching brief" (3 indicators, all under international dimensions). Note that the international aspects have been ignored in general as having limited direct relevance to Cornwall.

There is no direct mapping between the independently derived CIDs and the CCRA3 indicators, but an attempt to do so has been included in a matrix within the Main document. A quick glance at this matrix will indicate the complexity and overlap between the various climate parameters and their impacts; changes in mean temperatures, for example, impact on numerous areas of the environment, of society and of the economy, offering risks as well as opportunities. In header information for each section based on the CIDs in the Main document are summaries of some of these impacts pertinent to Cornwall; the lists provided should not be considered comprehensive nor final but simply provide initial guidance.

In the next Section is an overall summary of the climate and related results detailed in the Main document in terms of the CIDs. For brevity these summaries do not include all details of the uncertainties involved, and therefore should not be read as if deterministic. These details are intended mainly to provide a quick guide to the results, but it is recommended that the Main document be consulted prior to considering any management responses. Full definitions of each CID are provided in the Main document.

Finally, there is a section below dealing with the wider context of the GoUK Energy Compact, and CoP26.

Climate and Related Summaries in terms of the CIDs

- **Hot and Cold**
  - *Mean Air Temperature*
    - The atmosphere over Cornwall has been warming since the 19th Century, not uniformly, but at increased rate since about 1980; the recent rate has been about 0.3ºC per decade building on an approximate 1.2ºC risein mean temperature since pre-industrial times
    - Temperatures are certain to continue to rise, dependent upon emissions, perhaps reaching a worst case further increase by the end of the century of 5ºC or more under unchecked emissions, but more in the range 1ºC to 2ºC under the Paris Agreement
    - Highest increases are expected in summer, lowest in spring
    - Multiple potential impacts
  - *Extreme Heat*
    - Maximum temperatures have been rising faster than mean temperatures except in summer, increasing the frequency of UK heatwaves
    - Maximum temperatures and heatwaves will become more frequent in future, more so under higher emissions
    - It is plausible, but not certain, that daily temperatures above 40ºC may occur over the UK
    - Multiple potential impacts
  - *Cold Spell*
    - Cold spells have decreased in frequency and severity in line with increasing mean temperatures, but minimum temperatures have risen more slowly than mean and maximum temperatures
    - The trend to reductions in frequency and severity of cold spells will continue, but they may still occur through the century
    - Multiple potential impacts, including a number of opportunities
  - *Frost*
    - Frosts have decreased in frequency and severity

        - Frost frequency/severity will continue to decrease, more so under higher emissions
        - Multiple potential impacts, including a number of opportunities
- **Wet and Dry**
    - *Mean Precipitation*
        - Estimations of past trends in rainfall may be influenced by the period assessed and the situation for Cornwall is unclear: some analyses suggest no trends, some possible increasing trends in annual and winter totals, others decreases – no conclusions are drawn here
        - There is some consistency in projections of future increases in winter rainfall and decreases in summer rainfall (resulting in enhanced seasonality), but relatively little change in spring and autumn, although the spread across the projections is wide making planning difficult
        - Multiple potential impacts
    - *River Flood*
        - Some evidence that flooding over southern UK has increased in recent decades
        - Projections are difficult given the variety of climate and local factors involved, but the potential exists for more events in winter given the likely trend in mean rainfall for that season
        - Events such as Lynmouth 1952, Boscastle 2004 and Coverack 2017 will recur in future; both were summer events but the projected decrease in average summer rainfall will not produce a barrier to these; perhaps greater likelihood of such events in winter in the future
        - Most impacts appear to be risks rather than opportunities
    - *Heavy Precipitation and Fluvial Flood*
        - Determination of trends is complex and uncertain, but it is noted that the IPCC WGI AR6 provides evidence for increases in heavy rainfall over NEU while the CCRA3 states that the UK has experienced unprecedented heavy rainfall events
        - No trends have been detected in fluvial flooding
        - Much evidence points to future increases in heavy rainfall events throughout the year, including summer, perhaps more so with higher emissions; fluvial flooding is likely to increase correspondingly
        - Multiple potential impacts
    - *Landslide*
        - Limited information on any trends
        - Multiple factors are involved, but it is surmised that increases in heavy rainfall events would lead to more landslides
        - Impacts especially on, but not limited to, infrastructure
    - *Aridity*
        - Interpreted here as meteorological drought
        - No evidence for trends in meteorological drought frequency or severity over Cornwall, with the same issues as under Mean Precipitation
        - Summer is the season most likely to see increased aridity given the projections of likely decreased rainfall; increases in aridity and seasonality are more likely under higher emissions
        - Multiple potential impacts

- *Hydrological Drought*
    - Similar to meteorological drought but includes additional non-climate factors and therefore the two do not necessarily occur simultaneously
    - No trends have been detected
    - The consensus is that the severity of hydrological droughts will increase, with greatest risk in, but not limited to, summer
    - Impacts especially on water supply and dependent areas
- *Agricultural and Ecological Drought*
    - No trends detected, but see the earlier sections under "Wet and Dry"
    - The consensus is that the severity of agricultural and ecological droughts will increase, with greatest risk in, but not limited to, summer; drought intensity over Cornwall may be similar to elsewhere in the UK
    - Impacts especially on, but not limited to, food supply
- *Fire Weather*
    - No trends have been detected
    - Limited information on projections but the CCRA3 position is that fires will become more likely and more severe
    - Multiple potential impacts

- **Wind**
  - *Mean Wind Speed*
    - Trend information on winds is mixed and period dependent, with high interannual variability, but increases have possibly occurred in winter with stronger storminess
    - Possible future increases in winter with further increases in storminess, but most likely decreases in the other seasons
    - Impacts particularly on, but not limited to, infrastructure
  - *Severe Wind Storm*
    - Insufficient evidence for any trends, including those for tornadoes
    - No projections, but an indication that there may be increased clustering of storms in the future
    - Impacts particularly on, but not limited to, infrastructure
  - *Tropical Cyclone*
    - This section included because of impacts from ex tropical cyclones that reach the UK in autumn
    - Projections are that in the tropics these might become less frequent but more severe, and that they will travel further north as temperatures increase; thus, the possibility exists of exacerbated impacts on the UK, including Cornwall
  - *Sand and Dust Storms*
    - This section included noting that the risks of sand falls from the Sahara Desert might increase as southern Europe likely becomes drier
- **Snow and Ice**
  - *Snow, Glacier and Ice Sheet*
    - Only snow is relevant to Cornwall
    - Trends in snow cover over the UK are downwards
    - Given rising temperatures the number of snow falls and the length of periods of lying snow are expected to decrease
    - Multiple potential impacts

- *Permafrost*
  - Permafrost is not directly relevant to Cornwall, but indirect impacts of loss of permafrost will be felt through enhanced climate change
- *Lake, River and Sea Ice*
  - Lake, River and Sea Ice is not directly relevant to Cornwall, but indirect impacts of loss will be felt through enhanced climate change (ie changes in storminess as high latitude climates change)
- *Heavy Snowstorm and Ice Storm*
  - Only heavy snowfall is relevant to Cornwall as ice storms are rare
  - Both may be assumed to become less frequent as temperatures rise
- *Hail*
  - Minimal information available on this episodic event, relatively rare in Cornwall, but projections suggest that more favourable atmospheric conditions for producing hail will occur in future
- *Snow Avalanche*
  - Snow Avalanche is not directly relevant to Cornwall

- **Coastal**
  - *Relative Sea Level*
    - Relative Sea Level (RSL) takes into additional consideration rises/falls in land elevation
    - Certain that RSL has been increasing for at least 100 years, with over 150mm of rise during that period
    - Cornwall will see amongst the highest of the likely future increases around the UK, in the range 0.2m to 1m by the end of the century dependent upon emissions
    - The increases do not include additional amounts from ice sheet collapses, although these are unlikely this century
    - Multiple potential impacts, mainly in the coastal zones
  - *Coastal Flood*
    - Probably more important than RSL rise as most coastal flooding is caused by extreme total water levels which are substantially greater than average rises
    - Trends locally dependent but clear evidence for an increase in recent decades
    - Further increases are projected
    - Multiple potential impacts, mainly in the coastal zones
  - *Coastal Erosion*
    - No clear picture on trends
    - Erosion expected to increase in general, with the possibility of 10s of metres lost locally to the sea
    - Multiple potential impacts, mainly in the coastal zones
- **Oceanic**
  - *Mean Ocean Temperature*
    - Ocean surface temperatures have been rising steadily
    - No projections for the UK coastal zones but globally rises will continue at rates determined by emissions
    - Impacts mainly on the ecology and uses of coastal waters, and on related activities
  - *Marine Heatwave*
    - More significant than rises in mean ocean temperature, with heatwaves more extensive in size and time than in the atmosphere

        - Strong evidence for increases in the frequencies, severities and lengths of heatwaves
        - The increasing trend is expected to continue
        - Impacts mainly on ocean and coastal ecology, and on related activities
    - *Ocean Acidity*
        - Almost certain that acidity has increased
        - The increasing trend is expected to continue but may reverse around mid-century under lowest emissions
        - Impacts mainly on ocean and coastal ecology and related activities
    - *Ocean Salinity*
        - Trends are ocean basin dependent, with the majority of the global ocean seeing increases but decreases in the North Atlantic
        - Positive trends are expected to continue
        - The situation in the North Atlantic is important as it might see a reduction or switch-off of the Atlantic Meridional Overturning Circulation (AMOC – see the Main document for details), although this is not anticipated this century; should it happen then northern Europe will probably experience a return towards Ice Age conditions moderated by warming to that point
        - Impacts mainly on ocean and coastal ecology, and on related activities, assuming no major change in the AMOC
    - *Dissolved Oxygen*
        - Oxygen levels have been decreasing in general
        - Deoxygenation is expected to continue
        - Impacts mainly on ocean and coastal ecology, and on related activities
- **Other**
    - *Air Pollution Weather*
        - Depends upon multiple factors, many non-climatic
        - No clear direction of change in projections, with local dependencies
        - Impacts mainly risks on health and ecology, and on related activities
    - *Atmospheric CO_2 at Surface*
        - Surface concentrations have been increasing in general
        - Further increases are expected associated with warming
        - Multiple potential impacts
    - *Radiation at Surface*
        - Drivers include amounts, thicknesses and types of clouds and also degrees of atmospheric turbidity
        - Sunshine has in general increased in recent decades over Cornwall, i.e. cloudiness has decreased and Radiation at Surface has increased
        - Further increases are expected in Cornwall, particularly in summer
        - Multiple potential impacts

The Wider Contexts

The Energy Compact of the GoUK is one of a number of such prepared for and presented at CoP26, although not a requirement as such under the UNFCCC. In itself it does not deal with climate aspects but with planning for adaptation and mitigation in response to climate change. No doubt Cornwall will play a role in meeting the Compact, a role that could take into consideration climate change over the county. Targets in the Compact are listed to be achieved by 2030, to be updated in due course, although longer-term objectives, such as aligning with the 2030 agenda for the Sustainable Development Goals, and for net-zero by 2050 alongside alignment with the Paris Agreement, are included.

The impacts discussed based on CCRA3 are relevant to a number of the 2030 targets, and these are listed below without specific assumptions for Cornwall:

- Increase substantially the share of renewable energy in the global energy mix
- Double the global rate of improvement in energy efficiency
- Quadruple offshore wind capacity

It can be argued that these activities in energy generation and energy efficiency are necessary given that the UK is not yet on target to achieve its contribution to the Paris Agreement 1.5C target, although it is better placed than other G20 countries according to Climate Transparency, https://www.climate-transparency.org. Similarly, UK actions are 'almost sufficient' according to Climate Action Tracker, https://climateactiontracker.org/, with few other countries rated as highly.

Actions are required to address the Paris Agreement target of 1.5ºC and also to undertake necessary adaptation to past and future climate change, with some of the latter to continue for decades even were emissions switched off today. Views differ as to whether the CoP26 was a success or not; the stated objective was to obtain agreements not to surpass 1.5ºC, but commitments by the end of the conference were estimated still to lead to a final rise up to 2.4ºC. In that respect CoP26 was not successful, and more work is required to increase mitigation ambition ahead of CoP27 later in 2022, work from which no country is excluded. There were clear successes with UK involvement, including the Declaration on Forests and Land Use, with its objective to halt and reverse forest loss and land degradation by 2030, and the Global Methane Pledge, with 30% reductions targeted by 2030.

It is not the objective of this report to advise on actions that might be taken by Cornwall. But these summaries of the wider contexts indicate that further work is required in terms of both adaptation and mitigation.

Structure of the Assessment of Climate Change impacting Cornwall

The documents and information sources collated to provide this assessment of climate change over Cornwall are:

- The UK Climate Change Risk Assessment No. 3, CCRA3, 2021
- The UK Climate Projections 2018, UKCP18
- The Working Group I Report to the Intergovernmental Panel on Climate Change Assessment Report No. 6, WGI IPCC AR6, 2021

These reports are summarised in Annex I, where main details and differences that might affect any interpretations are discussed. These include the climate models, the emissions scenarios, the base periods and the information scales (spatial and temporal) used.

There is a substantial amount of information within the documents reviewed as part of this status report on past and projected climate change with respect to Cornwall. In this review the structure has been provided by the Climate Impacts Drivers (CIDs) introduced in Chapter 12 of the 2021 Report of Working Group I to the Assessment Report 6 (AR6) of the IPCC, as listed in the Table below. CIDs are devised to provide straightforward and structured links between climate variables and their impacts, and in succeeding sections of this report each CID relevant to Cornwall is treated separately. The Table has been prepared by collating Table 12.2, Table 12.7 and Table 12.10 from the WGI Report, omitting aspects not relevant to Cornwall.

The first part of Table 1, from Table 12.2, includes along the top row the CIDs under generic groupings, together with their sectoral impacts down the first column. All sectors have been included in the latter but some assets (second column) not relevant to Cornwall have been omitted (from Terrestrial and Freshwater Ecosystems – tropical forests, deserts, mountains, polar: from Water – Cryosphere Reservoir, the water locked in ice; from Ocean and Coastal Ecosystems – polar seas, open ocean, deep sea). Dark colouring in the matrix indicates *high confidence* by the IPCC that the CID impacts a particular asset, light colouring *medium or low confidence* in any impacts, and no colouring *no impact or low confidence*.

The final two rows are regional summaries from Table 12.7 (Northern Europe) and Table 12.10 (North Atlantic) of Chapter 12, with other continental and oceanic regions omitted. Regional summaries cover large areas but these have been filtered in the following to focus on Cornwall. Blue/red/no shading indicates high (dark colouring)/ medium (light colouring)/ no (no shading) confidence levels for decreases (blue)/increases (red) of a CID together with symbols indicating whether a change has already been detected, whether it is expected before 2050, or is expected after 2050. **Note:** the indications of changes before/after 2050 are given provided these are indicated at least under scenarios RCP8.5 or SSP5-8.5, the two highest emissions scenarios, with *medium* to *high confidence*. This does not preclude that such changes may not occur with lower emissions scenarios, but given that both RCP8.5 and SSP5-8.5 are now considered to be higher than is to be reasonably expected during the 22nd Century these indications should be viewed accordingly.

A different approach to categorisation from the CIDs has been taken in the CCRA3. Here 61 risks and opportunities related to climate change have been identified; these are reproduced in the Glossary. There is no direct mapping of the CCRA3 categories to the CIDs, but a first attempt at doing so has been included in the second column of the following table based on the CCRA3 report for England. The ripple effects of impacts have been considered while developing these indications. While these indications may not be complete, or perhaps not even agreed by all, they at least provide some indication of the mapping between the two approaches, including illustrating the complexities of, and the inter-relationships between, the issues involved. For reference, the main headers used by CCRA3 (see Glossary for the full details):

- B1…B7 – Business and Industry
- H1…H13 – Health, Communities and the Built Environment
- I1…I13 – Infrastructure
- ID1…ID10 – International Dimensions (mostly not relevant to Cornwall)
- N1…N18 – Natural Environment and Assets

Within CCRA3 each aspect has been identified, and is colour-coded in the table, as a Risk, a Risk and an Opportunity, or as an Opportunity. Each risk/opportunity assessed within the England section of the CCRA3 report has been further categorised (note that these categories apply to England as a whole and may, or may not, be applicable in Cornwall):

- FI – Requires Further Investigation
- MAN – More Action Needed
- SCA – Sustain Current Action
- WB – Maintain Watching Brief

		Heat and Cold				Wet and Dry								Wind				Snow and Ice						Coastal			Oceanic					Other		
		1	2	3	4	1	2	3	4	5	6	7	8	1	2	3	4	1	2	3	4	5	6	1	2	3	1	2	3	4	5	1	2	3
		Mean air temperature	Extreme heat	Cold spell	Frost	Mean precipitation	River flood	Heavy precipitation and pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural and ecological drought	Fire weather	Mean wind speed	Severe wind storm	Tropical cyclone	Sand and dust storm	Snow, glacier and ice sheet	Permafrost	Lake, river and sea ice	Heavy snowfall and ice storm	Hail	Snow avalanche	Relative sea level	Coastal flood	Coastal erosion	Mean ocean temperature	Marine heatwave	Ocean acidity	Ocean salinity	Dissolved oxygen	Air pollution weather	Atmospheric CO_2 at surface	Radiation at surface
Sector	Asset																																	
Terrestrial and freshwater ecosystems	**Temperate and boreal forests** N3 – FI, N5 – MAN, N6 – MAN, N8 – MAN, N9 – FI, N18 – FI																																	
	Lakes, rivers and wetlands B1 – MAN, B3 – FI, I1 – MAN, I2 –																																	

	MAN, I4 – FI, I6 – FI, I8 – MAN, I9 – FI, N1 – MAN, N3 – FI, N4 – MAN, N6 - MAN, N10 – FI, N11 – MAN, N12 – MAN, N13 – SCA, N18 – FI																																	
	Grasslands and savannah I7 – FI, ID1 – MAN, ID2 – WB, N1 – MAN, N2 – MAN, N3 – FI, N4 – MAN, N5 – MAN, N6 – MAN, N7 – MAN, N9 – FI, N18 – FI																																	

Ocean and coastal ecosystems	**Coastal land and inertial zones** B1 – MAN, B2 – MAN, I1 – MAN, I2 – MAN, I3 – FI, I4 – FI, I5 – MAN, I7 – FI, I12 – MAN, ID2 – WB, H3 – MAN, H4 – MAN, H11 – MAN, N3 – FI, N5 – MAN, N6 – MAN, N9 - FI, N10 – FI, N17 – MAN, N18 – FI
	Coastal seas B2 – MAN, I3 – FI, I11 – SCA, H3 – MAN, H4 – MAN, H11 – MAN, ID1 – MAN, N10 – FI, N14 – MAN, N15 – FI, N16 – MAN, N17 - MAN
	Shelf seas and upwelling zones N5 – MAN, N14 – MAN, N15 – FI, N16 – MAN

Water	**Aquifers and groundwater** B1 – MAN, B3 – FI, H3 – MAN, H10 – FI, H11 – FI, I2 – MAN, I4 – FI, I7 – FI, I8 – MAN, I9 – FI, ID1 – MAN, ID9 – MAN, N1 – MAN, N3 – FI, N6 – MAN, N9 – FI, N10 – FI, N11 – MAN, N12 – MAN, N13 – SCA, N18 – FI	
	Streamflow and surface water B1 – MAN, B3 – FI, H3 – MAN, H8 – MAN, H10 – FI, H11 – MAN, I2 – MAN, I4 – FI, I6 – FI, I7 – FI, I8 – MAN, I9 – FI, ID1 – MAN, ID9 – MAN, N1 – MAN, N2 – MAN, N3 – FI, N4 – MAN, N6 – MAN, N7 – MAN, N8 – MAN, N9 – FI, N11 – MAN, N12 – MAN, N13 – SCA, N18 – FI	
	Water quality B3 – FI, H1 – MAN, H7 – FI, H8 – MAN, H10 – FI, H11 – MAN, I1 – MAN, I2 – MAN, I8 – MAN, ID1 – MAN, ID2 – WB, N1 – MAN, N3 – FI, N4 – MAN, N6 – MAN, N7 – MAN, N9 – FI, N10 – FI, N11 – MAN, N12 – MAN, N13 – SCA, N18 – FI	

Food, fibre and other ecosystems products	**Crop systems** B1 – MAN, B3 – FI, B6 – MAN, B7 – FI, H1 – MAN, H9 – FI, ID2 – WB, ID9 – MAN, N3 – FI, N4 – MAN, N5 – MAN, N6 – MAN, N7 – MAN, N9 – FI, N18 - FI
	Livestock and pasture systems B3 – FI, B6 – MAN, B7 – FI, H9 – FI, H11 – MAN, ID1 – MAN, N1 – MAN, N2 – MAN, N3 – FI, N4 – MAN, N5 – MAN, N6 – MAN, N7 – MAN, N9 – FI, N18 – FI
	Forestry systems B1 – MAN, B3 – FI, B6 – MAN, H11 – MAN, I2 – MAN, I4 – FI, N1 – MAN, N2 – MAN, N3 – FI, N4 – MAN, N5 – MAN, N6 – MAN, N8 – MAN, N9 – FI, N11 – MAN, N12 – MAN, N13 – SCA, N18 - FI
	Fisheries and aquaculture systems H9 – FI, ID1 – MAN, N14 – MAN, N15 – FI, N16 – MAN, N17 – MAN

Cities, settlements, and key infrastructure	**Cities** B1 – MAN, B2 – MAN, B3 – FI, B4 – SCA, B5 – FI, B6 – MAN, B7 – FI, H1 – MAN, H2 – FI, H3 – MAN, H4 – MAN, H5 – FI, H6 – MAN, H7 – FI, H10 – FI, H11 – MAN, H12

	– MAN, H13 – MAN, I1 – MAN, I2 – MAN, I4 – FI, I5 – MAN, I7 – FI, I8 – MAN, I9 – FI, I10 – FI, I12 – MAN, I13 – FI, ID3 – WB, ID9 – MAN, ID10 – MAN, N18 – FI
	Land and water transportation B1 – MAN, B2 – MAN, B3 – CI, B6 – MAN, B7 – FI, I1 – MAN, I2 – MAN, I3 – FI, I4 – FI, I5 – MAN, I7 – FI, I11 – FCA, I12 – MAN, ID1 – MAN, ID7 – MAN, ID10 – MAN, N18 – FI
	Energy infrastructure B2 – MAN, B3 – FI, B6 – MAN, B7 – FI, H1 – MAN, H2 – FI, H3 – MAN, H4 – MAN, H6 – MAN, H10 – FI, H11 – MAN, H12 – MAN, H13 – MAN, I1 – MAN, I2 – MAN, I3 – FI, I4 – FI, I6 – FI, I7 – FI, I9 – FI, I10 – FI, I11 – SCA, I12 – MAN, I13 – FI, N18 – FI
	Built environment B1 – MAN, B2 – MAN, B5 – FI, H2 – FI, H3 – MAN, H4 – MAN, H5 – FI, H6 – MAN, H11 – MAN, H12 – MAN, H13 – MAN, I1 – MAN, I2 – MAN, I3 – FI, I4 – FI, I7 – FI, I11 - SCA

Health, wellbeing and communities	**Labour productivity** B1 – MAN, B2 – MAN, B3 – FI, B4 – SCA, B5 – FI, B6 – MAN, B7 – FI, I1 – MAN, I5 – MAN, I6 – FI, I9 – FI, I10 – FI, I12 – MAN, I13 – FI, H1 – MAN, H2

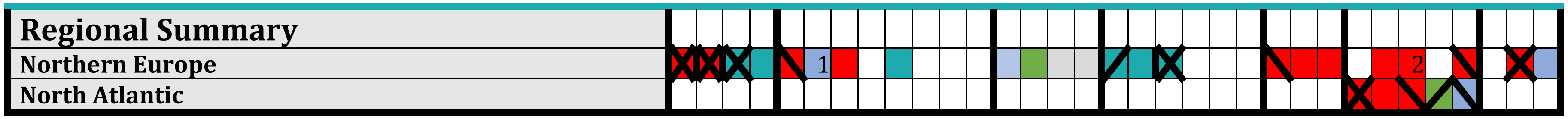
	– FI, H3 – MAN, H4 – MAN, H6 – MAN, H7 – FI, H8 – MAN, H9 – FI, H10 – FI, H11 – MAN, H12 – MAN, H13 – MAN, ID1 – MAN, ID2 – WB, ID3 – WB, ID8 – SCA, ID9 – MAN, ID10 – MAN
	Morbidity H1 – MAN, H2 – FI, H3 – MAN, H6 – MAN, H7 – FI, H8 – MAN, H9 – FI, H10 – FI, H12 – MAN, I8 – MAN, I9 – FI, I10 – FI, ID1 – MAN, ID2 – WB, ID9 – MAN, N6 – MAN, N7 – MAN, N9 – FI, N11 – MAN, N14 – MAN, N16 – MAN
	Mortality H1 – MAN, H2 – FI, H6 – MAN, H7 – FI, H8 – MAN, H9 – FI, H10 – FI, H12 – MAN, I8 – MAN, ID1 – MAN, ID2 – WB, ID9 – MAN
	Recreations and tourism B2 – MAN, H1 – MAN, H2 – FI, H3 – MAN, H4 – MAN, H5 – FI, H7 – FI, H8 – MAN, H9 – FI, H10 – FI, H11 – MAN, H12 – MAN, I1 – MAN, I5 – MAN, I8 – MAN, I9 – FI, I10 – FI, I12 – MAN, I13 – FI, ID1 – MAN, ID9 – MAN, N18 – FI

Poverty, livelihoods and sustainable development	**Housing stock** B1 – MAN, B2 – MAN, H3 – MAN, H4 – MAN, H5 – FI, H6 – MAN, H11 – MAN, H12 – MAN, H13 – MAN, I1 – MAN, I2 – MAN, I3 – FI, I7 – FI, ID3 – WB, N10 – FI, N18 - FI

	Farmland B1 – MAN, B2 – MAN, B3 – FI, B4 – SCA, H3 – MAN, H4 – MAN, H11 – MAN, ID1 – MAN, ID2 – WB, N1 – MAN, N2 – MAN, N4 – MAN, N5 – MAN, N6 – MAN, N9 – FI, N10 – FI, N18 – FI
	Livestock mortality H9 – FI, ID1 – MAN, ID2 – WB, N1 – MAN, N2 – MAN, N4 – MAN, N5 – MAN, N7 - MAN
	Indigenous traditions H3 – MAN, H4 – MAN, H7 – FI, H11 – MAN, H13 – MAN, ID3 – WB, ID4 – MAN, ID5 – MAN, N1 – NAM, N2 – NAM, N3 – FI, N4 – NAM, N7 – NAM, N8 – NAM, N11 – NAM, N13 – SCA, N14 – NAM, N15 – FI, N17 – NAM, N18 - FI

KEY	
	Heat & Cold
1	Mean air temperature
2	Extreme heat
3	Cold spell
4	Frost
	Wet & Dry
1	Mean precipitation
2	River flood
3	Heavy precipitation and pluvial flood
4	Landslide
5	Aridity
6	Hydrological drought
7	Agricultural and ecological drought
8	Fire weather
	Wind
1	Mean wind speed
2	Severe wind storm
3	Tropical cyclone
4	Sand and dust storm

	Snow & Ice
1	Snow, glacier and ice sheet
2	Permafrost
3	Lake, river and sea ice
4	Heavy snowfall and ice storm
5	Hail
6	Snow avalanche
	Coastal
1	Relative sea level
2	Coastal flood
3	Coastal erosion
	Oceanic
1	Mean ocean temperature
2	Marine heatwave
3	Ocean acidity
4	Ocean salinity
5	Dissolved oxygen
	Other
1	Air pollution weather
2	Atmospheric CO_s at surface
3	Radiation at surface



For the impacts section:

IPCC Impacts and Risk Relevance		CCRA3 Risk/Opportunity Assessment	
	None/low confidence	e.g. H1	Risk
	Low/moderate confidence	e.g. N17	Risk and Opportunity
	High confidence	e.g. ID2	Opportunity

For the Regional Summaries:

Key	
	High confidence of decrease
	Medium confidence of decrease
	Low confidence in direction of change
	Medium confidence of increase
	High confidence of increase
	Not broadly relevant
	Already emerged in the historical period (medium to high confidence)
	Emerging by 2050 at least in Scenarios RCP8.5/SSP5-8.5 (medium to high confidence)
	Emerging after 2050 and by 2100 at least in Scenarios RCP8.5/SSP5-8.5 (medium to high confidence)
1	Excluding southern UK
2	Along sandy coasts and in the absence of additional sediment sinks/sources or any physical barriers to shoreline retreat

One frequent key question is "which emissions scenario to use?". The scenarios, their histories and uses, are summarised in Annex I, but the recommendation is to use all. The reason is that by using projections from all scenarios a view is gained on the uncertainties involved and on the range of possible outcomes (although it can be argued that the range across CMIP6 as a whole is too narrow). Results for Cornwall have been provided for various emissions scenarios.

In some projects the focus for adaptation planning has been to use RCP8.5 as it provides the expected worst-case position, and thus gives planning that should be robust. Of course, it might introduce also over- and mal-adaptation, together with associated costs. RCP7.0 is probably the better choice for "worst case" given the latest position regarding mitigation, with RCP8.5 now viewed by some as being too high. At the other end of the scale RCP2.6 is the only one with a substantial number of projections available that offers a reasonable prospect of meeting the Paris Agreement. RCP1.9, introduced in CMIP6, is an even more certain guide to achieving the Agreement, but only limited model results are available at present. RCP4.5 is often used as a middle-of-the-road scenario.

The recommendation is to consider all data provided from all scenarios.

CID Grouping – Heat and Cold

Mean Air Temperature - Mean surface temperature and its diurnal and seasonal cycles

High confidence impacts (dark shading in Table 1 from AR6 Ch. 12) on: *temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; forestry systems; energy infrastructure; built environment.*

Low/moderate confidence impacts (light shading in Table 1 from AR6 Ch. 12) on*: crop systems; livestock and pasture systems; fisheries and aquaculture systems; land and water transportation; morbidity; mortality; recreations and tourism; indigenous traditions.*

Overall Summary for Mean Air Temperature

Trends:

- By and large the UK, including SWESW, has been warming since the 19th Century, although not uniformly so, with periods of stability or even reductions in temperatures
- Estimates of seasonal temperature trends vary according to the data processed, but all agree that trends are highest in winter and weakest in spring
- Trends over SWESW are weaker than those of NEU, as result of the maritime location of SWESW, which also moderates increases to values closer to the global average than to values typical within continental interiors

Projections:

- Temperatures are set to increase throughout the century, the more so with the higher emissions
- Highest projected changes are foreseen in summer, adding to existing heat loads, and are least in spring
- Differences in temperature increases according to the various emissions scenarios become more substantial in the second half of the century
- Given that the current global temperature rise compared to the pre-industrial period is about 1.2ºC, and in light of the similarity between global and Cornwall changes, even the lowest emissions modelled will still provide further increases according to the median projections; under the RCP6.0 scenario (perhaps a reasonable highest emissions scenario) median annual rises reach 3.2ºC and 4.6ºC in summer

Examples of impacts based on CIDs:

- On many aspects of the environment and ecology, and on energy use/production, plus on the built environment (HC)
- On agricultural and aquacultural production, on transportation, health and recreation (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: building and energy infrastructures, industrial and environmental production, health
- Areas carrying risks and opportunities include: building fabric, energy demand, agricultural and forestry production, changes to landscape character

- Areas carrying opportunities include: new species colonisation, new cropping and aquaculture opportunities, food availability, new business demands for goods and services

More Detail on Trends for Mean Air Temperature

Main Points from IPCC WGI AR6 for the Globe and for NEU for Mean Air Temperature

- For NEU increases in mean air temperatures have already emerged (HC)
- Rates of increases have accelerated since about 1980 and are faster over land than over the oceans
- Nonetheless mean temperature increases over Cornwall are more similar to those of the global mean rather than of continental interiors, a consequence of the county's maritime location
- Trends listed in the following table from various data sets for 1980 to 2015 as ºC per decade are all positive and significant at least at the 5% level

Data Set	Trend Period	Annual	DJF	MAM	JJA	SON
ERA5	1980-2015	0.394	0.471	0.284	0.367	0.449
W5E5	1980-2015	0.441	0.501	0.352	0.400	0.485
E-OBS	1980-2015	0.498	0.623	0.386	0.440	0.537
CRU TS	1980-2015	0.439	0.507	0.344	0.399	0.487

- All estimates in the above table indicate lowest seasonal trends in spring and highest in winter

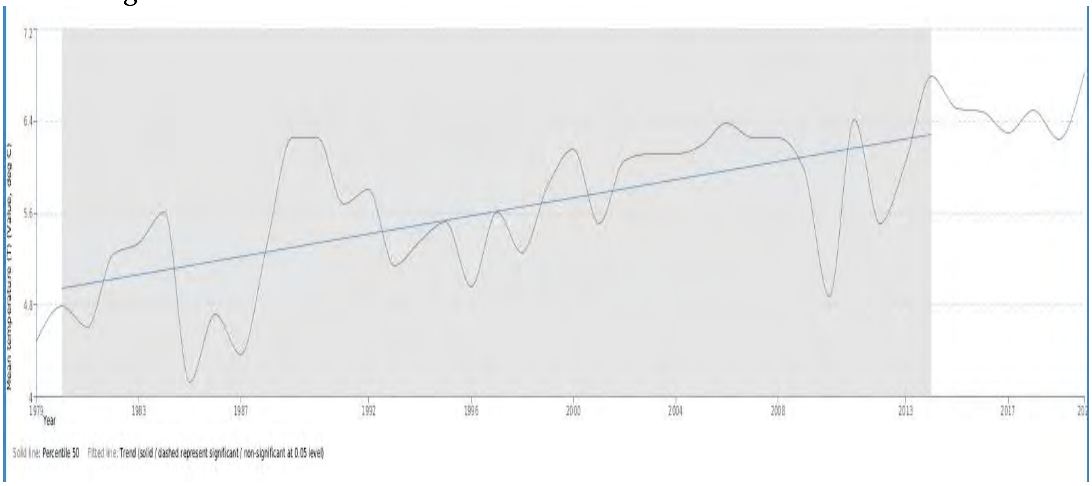


Figure 1. Mean Temperature Trend 1979 to 2020 in ºC for NEU from ERA5 from the AR6 Atlas; for 1979 to 2014 (shaded) the trend is 0.394ºC/decade, significant at the 5% level.

Main Points from MONCIC for South-West England and South Wales for Mean Air Temperature

- All temperature trends examined from MONCIC are statistically significant, most at the 1% level
- Mean annual temperatures have been rising over SWESW since perhaps the 1880s, although not uniformly throughout and including a period of relative stability during the 1920s to 1950s and of cooling during the 1960s and 1970s

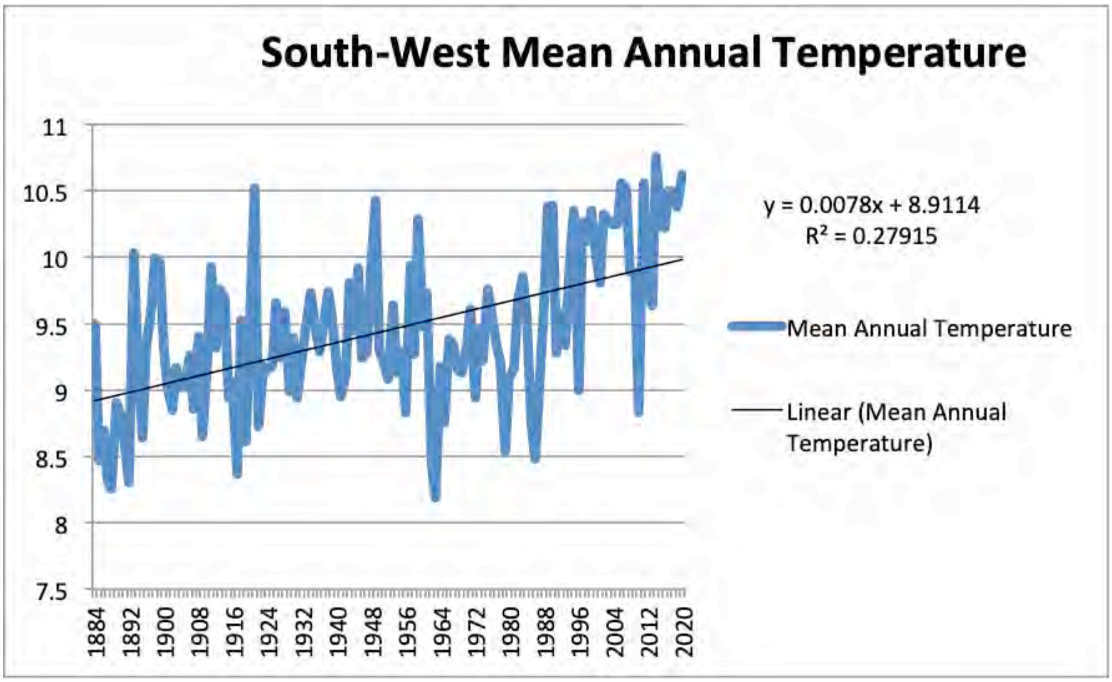


Figure 2. Annual temperature trend 1884 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.078ºC/decade, significant at the 1% level.

- The warming trend has increased since about 1980, being about 0.078ºC/decade over 1884 to 2020 but about 0.312ºC/decade since 1979
- Seasonal trends across 1979 to 2020 are:
  - Winter: 0.354ºC/decade
  - Spring: 0.206ºC/decade
  - Summer: 0.247ºC/decade
  - Autumn: 0.289ºC/decade
- Hence temperature trends have been strongest in winter and weakest in spring

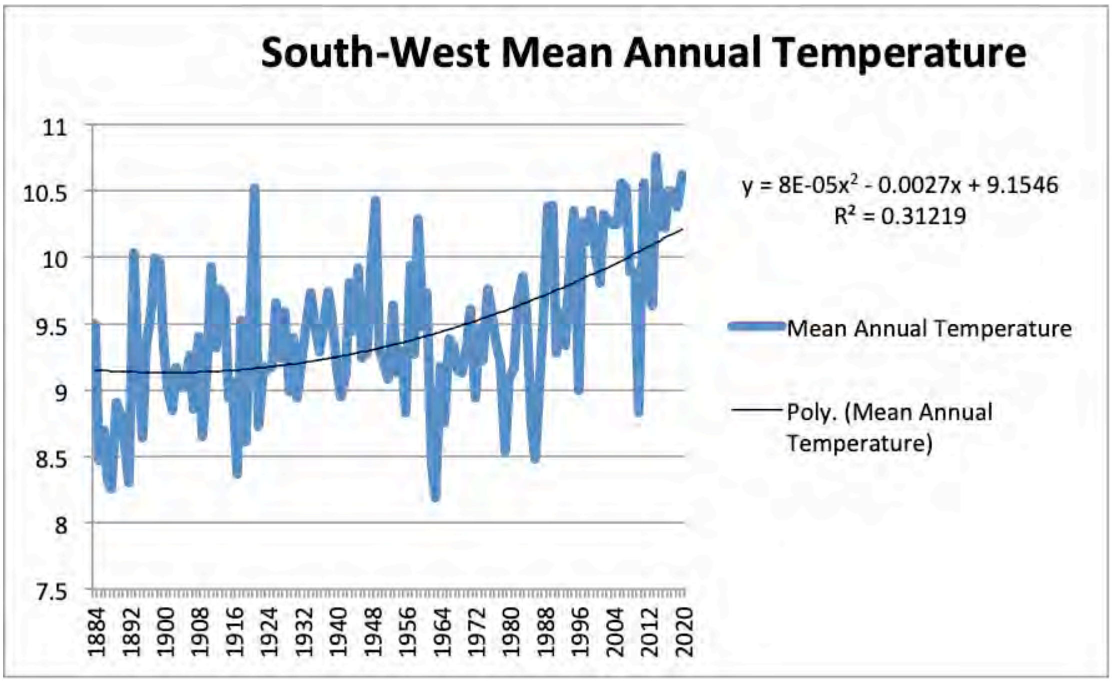


Figure 3. Annual temperature trend 1884 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a polynomial trend line.

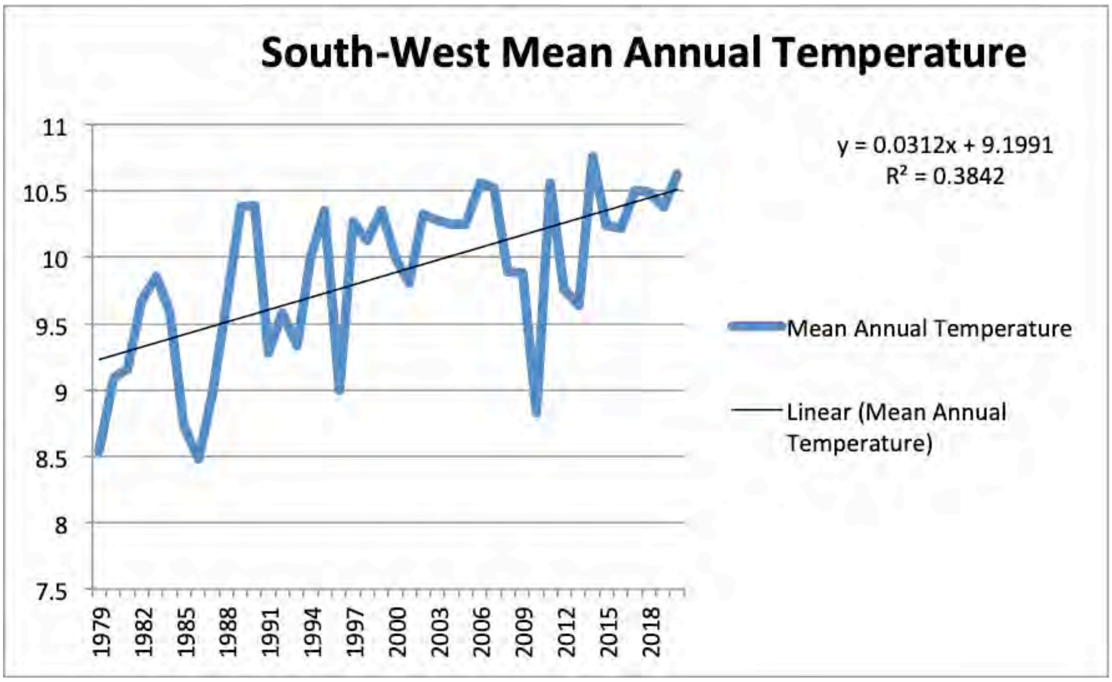


Figure 4. Annual temperature trend 1979 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.312ºC/decade, significant at the 1% level.

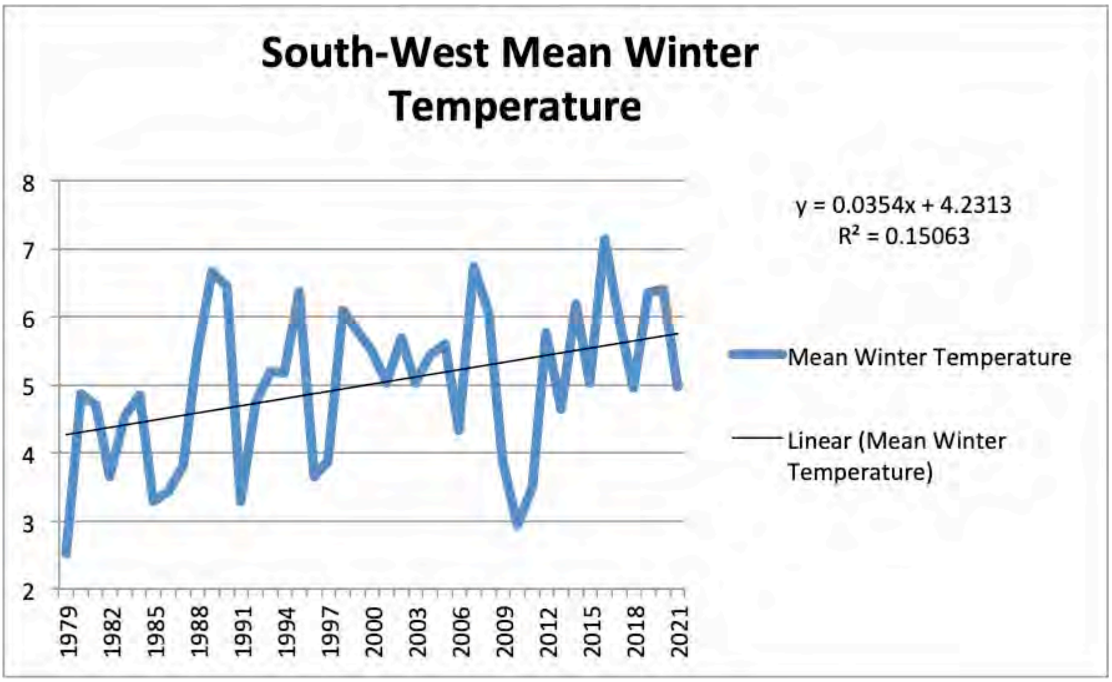


Figure 5. Winter (DJF) temperature trend 1979 to 2021 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.354ºC/decade, significant at the 2% level.

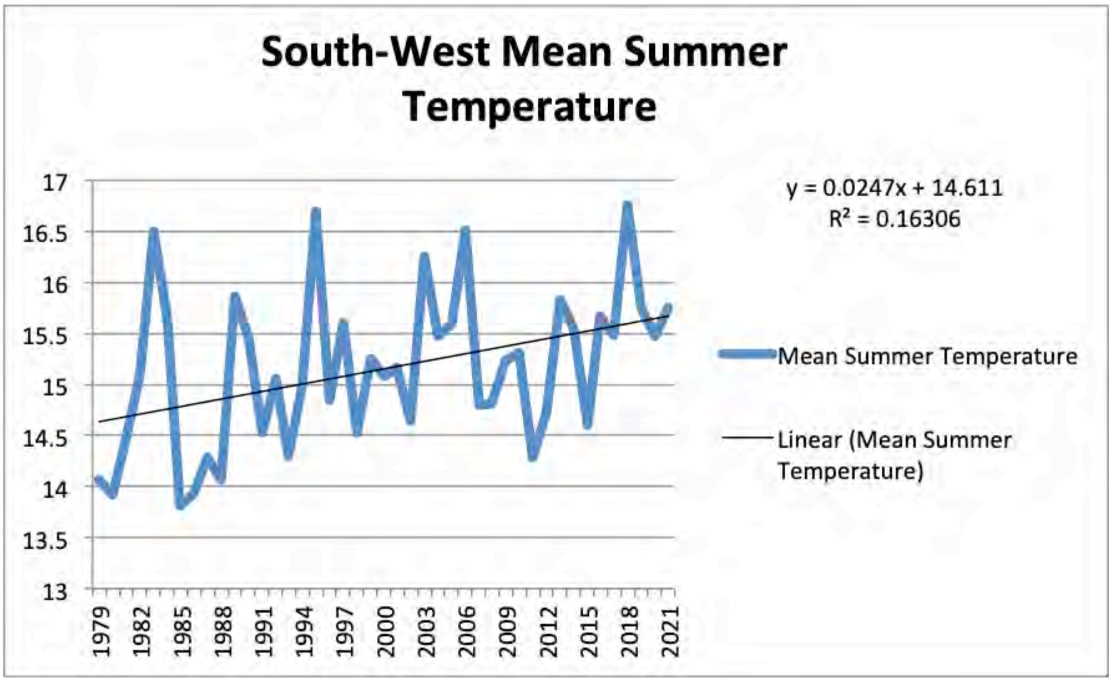


Figure 6. Summer (JJA) temperature trend 1979 to 2021 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.247ºC/decade, significant at the 1% level.

- UKCP18 Summary Statements:
  - At 2ºC of global warming: Relative to present day, there is little spatial variation in the median annual mean warming, with a uniform warming

of 1 to 2°C across the country. Warming is slightly larger in summer than winter, with summers warming more in the south east, by up to 4°C, decreasing toward the north and west.
    - At 4ºC of global warming: Changes to UK climate include summers warming more than winters, but the uncertainty in winter "warming" is larger. Summer warming is largest in the south with median temperature increases of up to 5°C. Warming in winter is more uniform across the country and is limited to under 4°C.

Main Points from CCRA3 for Mean Air Temperature

- Warming continues globally and over the UK with impacts becoming more evident
- The decade 2010 to 2019 was second recorded warmest such following the decade 2000 to 2009; temperatures were cooler in the later decade primarily because of the cold winter of 2010

More Detail on Projections for Mean Air Temperature

Main Points from IPCC WGI AR6 for the globe and for NEU for Mean Air Temperature

- By 2081 to 2100 as compared to 1995 to 2014 annual mean temperatures may have risen by within the range of 0.5ºC to 1.0ºC under SSP1-2.6 (although results are not robust) and within the range 2ºC to 3ºC under SSP3-7.0 (robust)
- Temperature increases are higher with higher emissions
- Inter-annual temperature variability by the end of the century might reduce in DJF but increase in JJA
- Mean annual temperature change over Cornwall relative to 1850 to 1900 at different levels of global warming are (all robust):
    - At global temperature increase of 1.5ºC Cornwall temperature rises in the range 0.0ºC to 1.5ºC
    - At global temperature increase of 2.0ºC Cornwall temperature rises in the range 1.5ºC to 2.0ºC
    - At global temperature increase of 3.0ºC Cornwall temperature rises in the range 2.0ºC to 3.0ºC
    - At global temperature increase of 4.0ºC Cornwall temperature rises in the range 3.0ºC to 4.0ºC

Main Points from UKCP18 for Mean Air Temperature

- Annual mean temperature changes at 2100 as compared to 1981 to 2000 for all RCPs at various percentiles across the ensembles are presented in the table following; **NB:** the values are point values at 2100 whereas normally values are presented as averages over the final two or three decades of the century, and thus the values in the table are somewhat noisy and are higher than would be found in decadal averages, and should be used indicatively only
- Temperature changes increase, as to be expected, with emissions
- Note that under RCP2.6 some models suggest temperatures might decline by a fraction of a degree by the end of the century (see also the diagram below); further

the median projected value is only marginally above the estimated actual global temperature rise at the time of CoP26 (1.2ºC)

Annual	5%	25%	50%	75%	95%
RCP2.6	-0.4	+0.7	+1.4	+2.2	+3.3
RCP4.5	+0.7	+1.9	+2.8	+3.7	+4.9
RCP6.0	+1.0	+2.3	+3.2	+4.2	+5.7
RCP8.5	+1.9	+3.4	+4.6	+5.7	+7.5

- Annual and seasonal median temperature changes at 2100 as compared to 1981 to 2000 for all RCPs at various percentiles are presented in the table following; **NB:** the values are point values at 2100 whereas normally values are presented as averages over the final two or three decades of the century, and thus the values in the table are somewhat noisy and are higher than would be found in decadal averages, and should be used indicatively only
- Note that annual values in the table following are the same as those for the median in the previous table
- Although the table does not give the ideal overview as it contains point values nevertheless it indicates that greatest temperature increases are to be expected in JJA, and least in MAM, followed by DJF; changes in SON are similar to those across the year as a whole

	Annual	DJF	MAM	JJA	SON
RCP2.6	+1.4	+1.2	+0.8	+2.2	+1.4
RCP4.5	+2.8	+2.2	+1.8	+4.0	+2.9
RCP6.0	+3.2	+2.7	+2.1	+4.6	+3.3
RCP8.5	+4.6	+3.8	+2.9	+6.4	+4.7

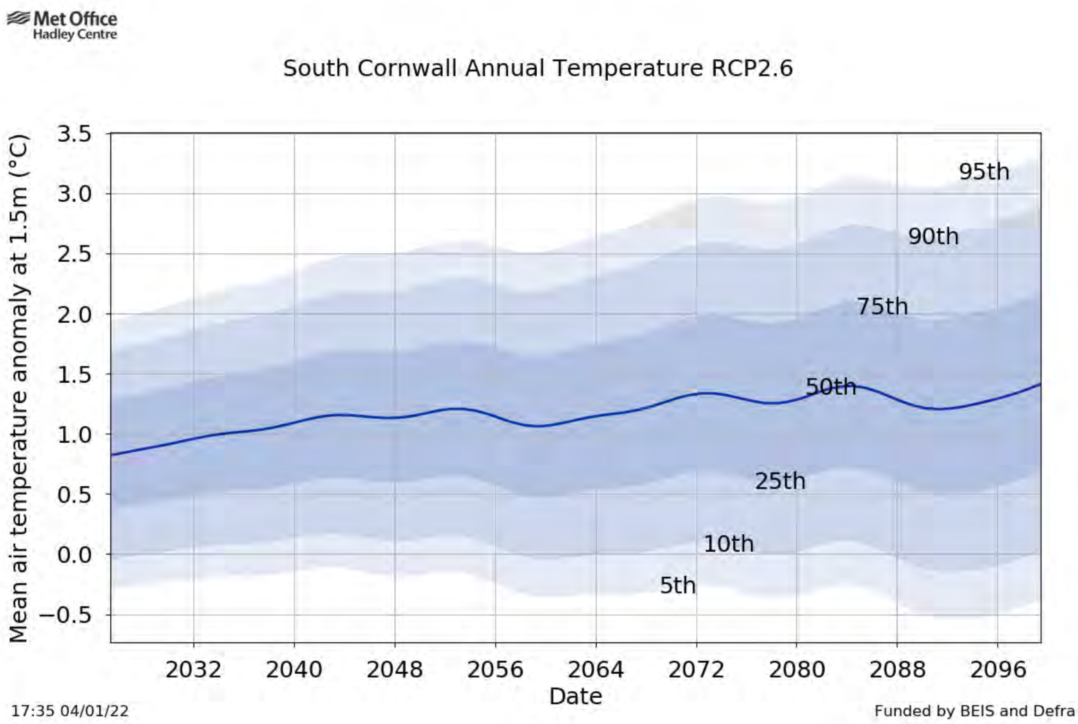


Figure 7. Sample of a projected temperature plume for annual values under RCP2.6

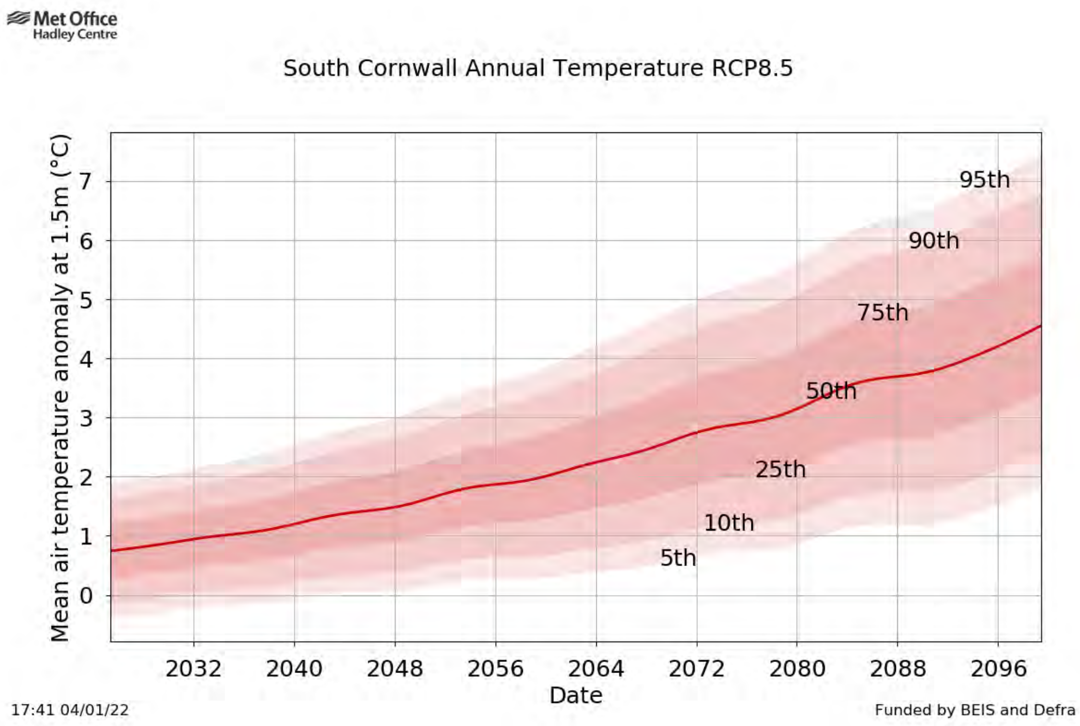


Figure 8. Sample of a projected temperature plume for annual values under RCP8.5

- There is consistency between projections at the different spatial scales used in UKCP18, but with more detail for areas of topography and for coastlines, as to be expected (comment: increased detail does not necessarily translate into improved absolute information)
- Selected distributions for future temperature increases over South Cornwall for all emissions scenarios – see diagram below; for all emissions scenarios the pdfs indicate mainly positive changes, changes that increase with emissions and with time:

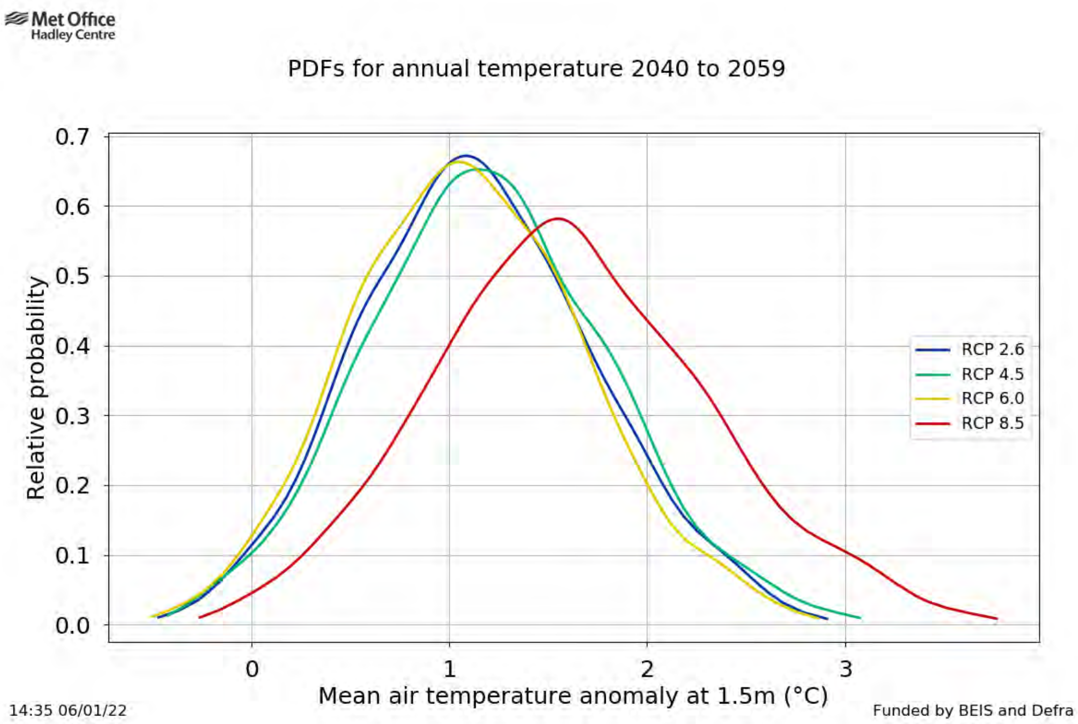


Figure 9. Future annual mean temperature change distributions compared to 1981 to 2000 by 2040 to 2059 under all four RCPs.

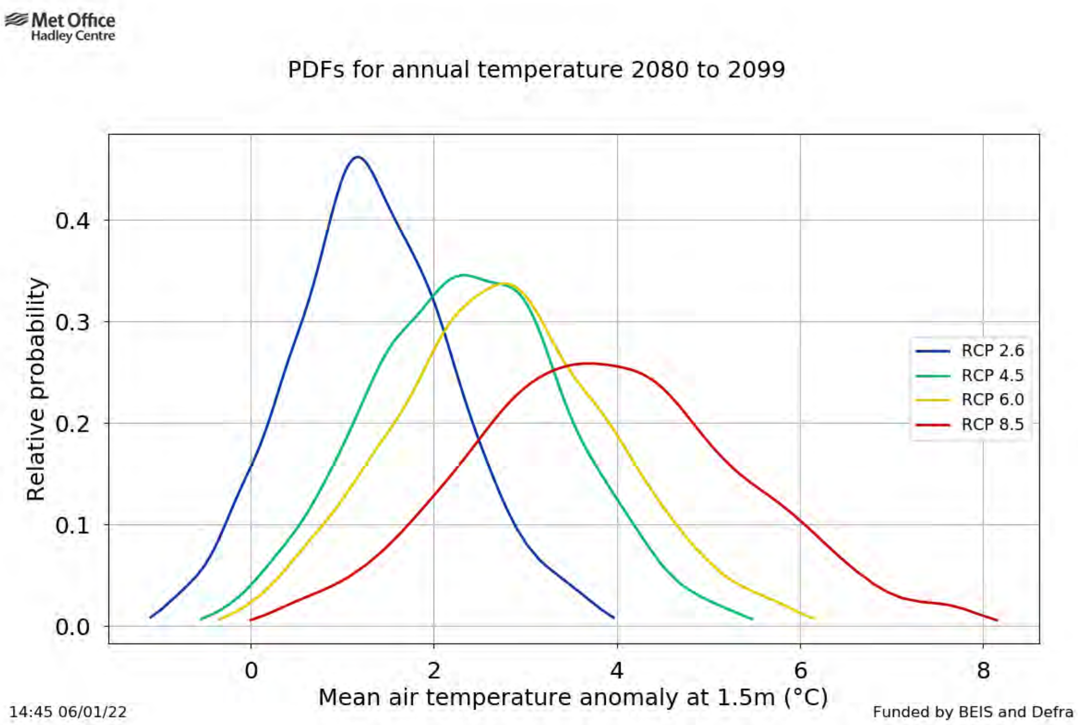


Figure 10. Future annual mean temperature change distributions compared to 1981 to 2000 by 2080 to 2099 under all four RCPs.

Main Points from CCRA3 for Mean Air Temperature

- Up until mid-century the response to warming over the UK is dependent more on regional climate dynamics than on emissions, but in the second half of the century, while regional climate dynamics will continue to play a role, differences between pathways dependent on emissions become more important
- Recent projections suggest more warming over the UK than earlier ones
- Nevertheless relatively cool summers will still occur in future
- The distribution of summer temperatures will shift towards higher values

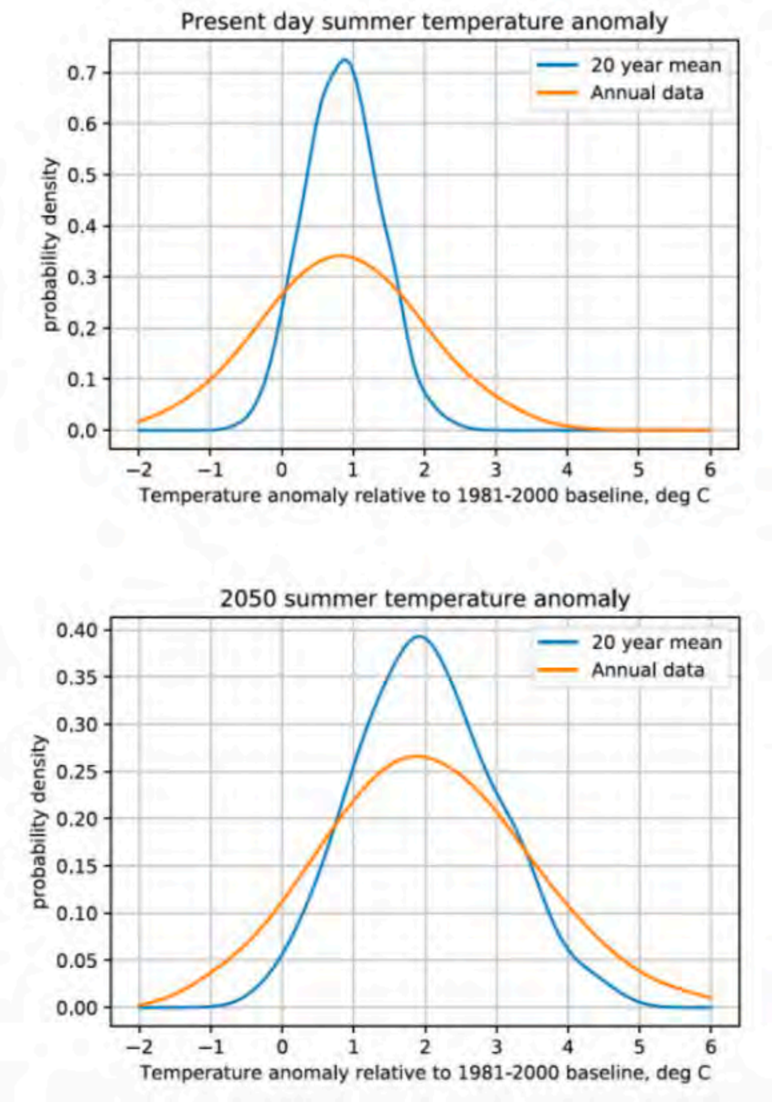


Figure 11. Distributions of annual and 20-year mean UK summer temperature anomalies at present and by 2050 compared to 1980 to 2000 based on RCP8.5; there is an approximate 1ºC shift in the median towards warmer temperatures by 2050

- Greatest temperature rises are expected in the south of the UK, but perhaps a little less so in Cornwall than in areas further east

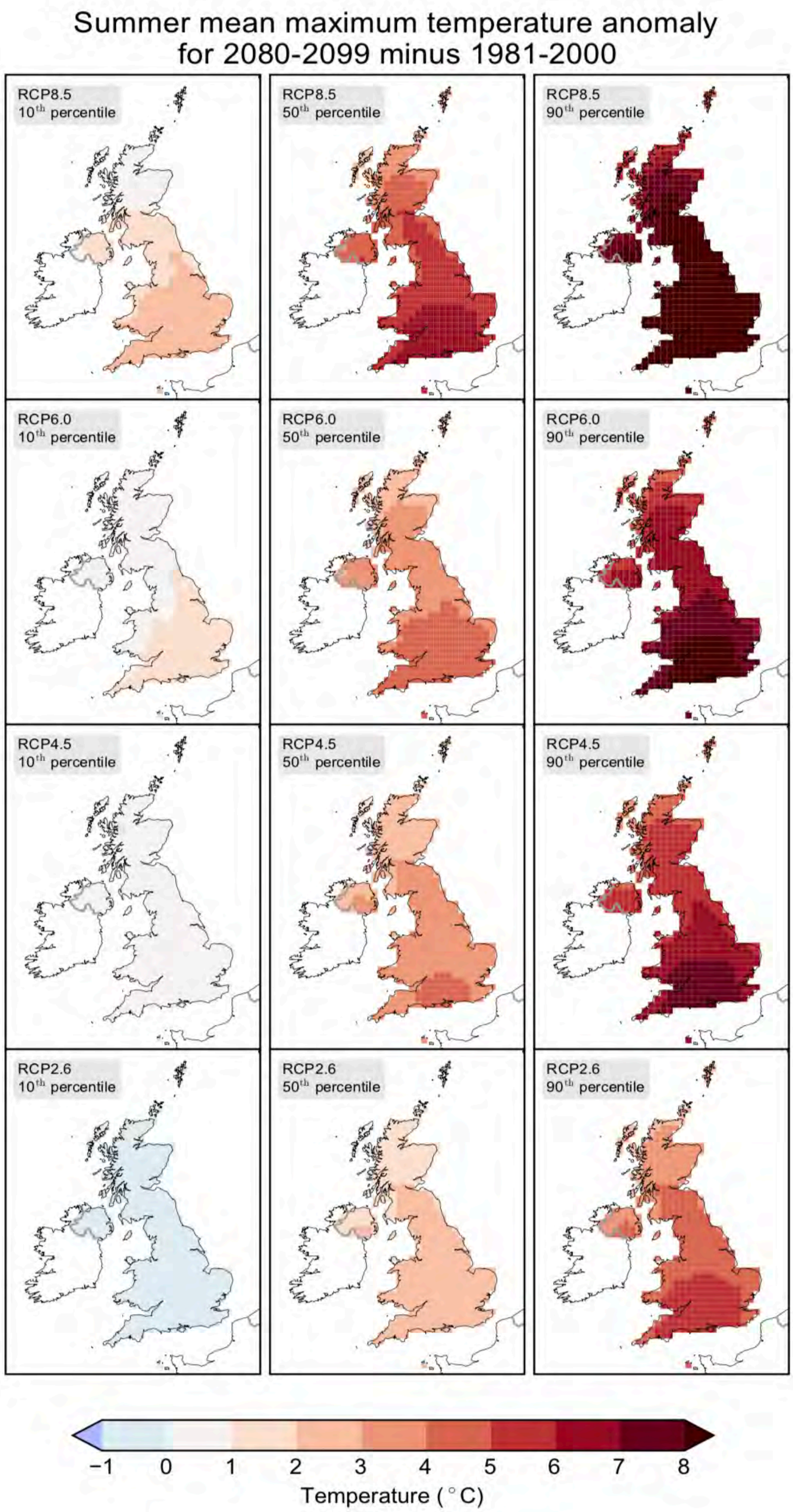


Figure 12. Projected changes in UK summer temperatures 2080 to 2099 as compared to 1981 to 2000 under various emissions scenarios (from CCRA3)

- The numbers of summer days, tropical nights, growing degree days and cooling degree days are all expected to increase, the more so with higher emissions

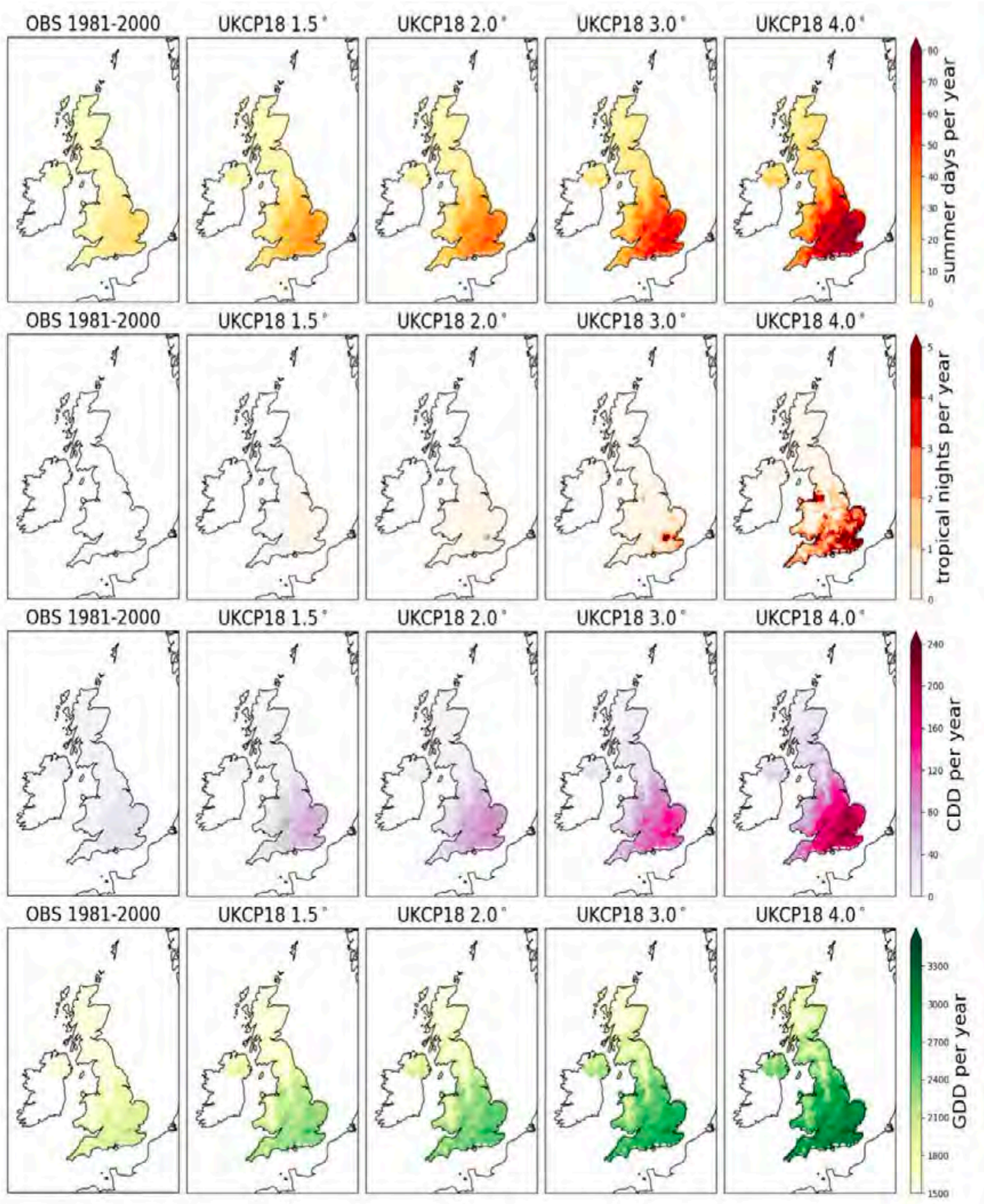


Figure 13. Numbers of summer days (top row), tropical nights (second row), cooling degree days (third row) and growing degree days (bottom) row as observed for 1981 to 2000 and as projected for different levels of global warming (columns).

CID Grouping – Heat and Cold

Extreme Heat - Episodic high surface temperature events potentially exacerbated by humidity

High confidence impacts (dark shading in Table 1) on: *temperate and boreal forests; grasslands and savannah; crop systems; livestock and pasture systems; forestry systems; cities; labour productivity; morbidity; mortality;* ***livestock mortality*****.**

Low/moderate confidence impacts (light shading in Table 1) on: *lakes, rivers and wetlands; coastal land and inertial zones;* ***fisheries and aquaculture systems;*** *land and water transportation; energy infrastructure; recreations and tourism***.**

Overall Summary for Extreme Heat

Trends:

- Alongside increases in mean temperatures, maximum temperatures have also been rising faster than the former except in summer, together with an increase in the frequency of heatwaves at least for urban areas but likely across the country

Projections:

- Maximum temperatures are set to increase throughout the century, the more so with higher emissions, resulting in increases in heat loads
- Differences in temperature increases according to the various emissions scenarios become more substantial later in the century
- As a direct example, the likelihood of a summer with temperatures exceeding those of 1976 increases later in the century and with higher emissions, becoming almost certain by 2100 under RCP8.5
- Individual daily maximum temperatures may increase, with temperatures in the upper 30s or even lower 40s ºC becoming plausible later in the century under higher emissions

Examples of impacts based on CIPs:

- On many aspects of the land environment and ecology, on agricultural production, on the fabric and utilisation of cities and the built environment, on health including morbidity and mortality (HC)
- On aquatic and coastal systems, on energy infrastructure, on transportation and recreation (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: forestry, building and energy infrastructures, industrial and environmental production, water quality, health
- Areas carrying risks and opportunities include: carbon stores, coastal habitats, building fabric, energy demand, changes to landscape character
- Areas carrying opportunities include: new species colonisation, new cropping and aquaculture opportunities, new business demands for goods and services

More Detail on Trends for Extreme Heat

Main points from IPCC WGI AR6 for Globe and NEU for Extreme Heat

- Temperatures have increased already over NEU (HC) and with it the frequencies of heatwaves (VL)
- Increase in the intensity and frequency of hot extremes (VL)
- Heat stress based on the wet bulb global temperature appears to have increased (MC but LE)
- Changes in relative humidity may be towards a decrease associated with the higher temperatures

Main points from MONCIC for South-West England and South Wales for Extreme Heat

- All temperature trends examined from MONCIC are statistically significant at the 1% level *except* the 1979 to 2020 trend in summer maximum temperatures (below 5%); note that equivalent trend in average summer temperatures was statistically significant
- The trend in mean annual maximum temperatures is similar to that in the mean annual temperature since the 1880s, including a period of relative stability during the 1920s to 1950s and of reduced maxima during the 1960s and 1970s
- Annual and seasonal trends of maximum temperatures across 1979 to 2020 are:
    - Annual: 0.337ºC/decade
    - Winter: 0.367ºC/decade
    - Spring: 0.421ºC/decade
    - Summer: 0.235ºC/decade
    - Autumn: 0.322ºC/decade
- By comparison with trends over 1979 to 2020 in mean temperatures, those in maximum temperatures are higher annually and seasonally except during summer (note: no statistical significance tests of these differences have been made)
- The trend is strongest overall in Spring, whereas in mean temperatures it was weakest in Spring

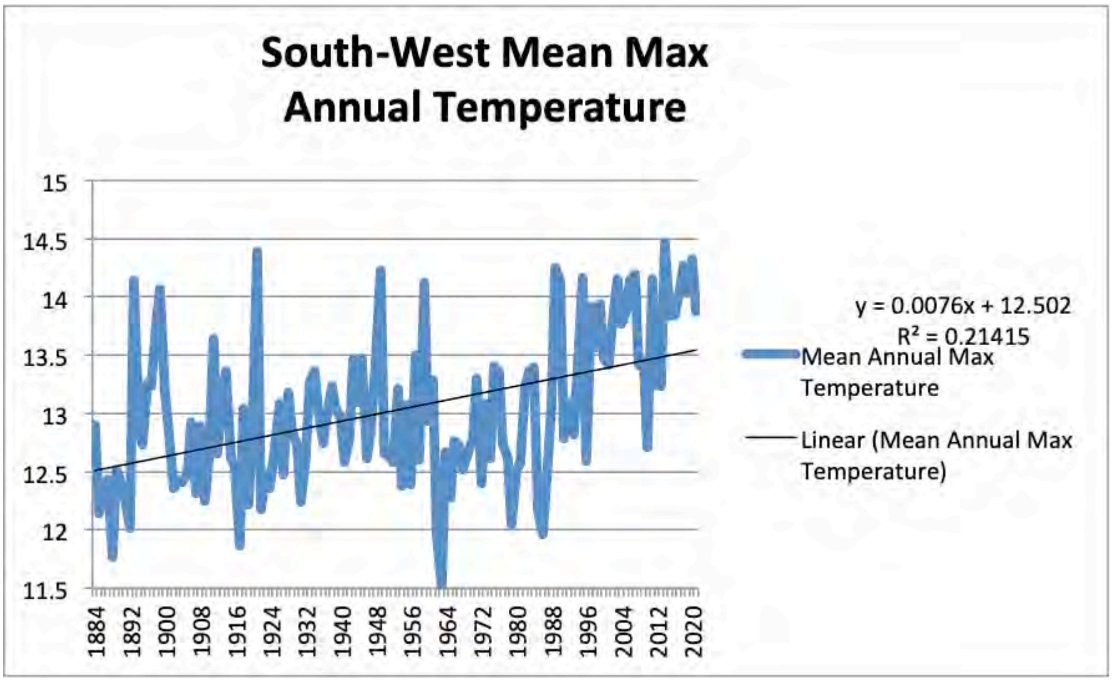


Figure 14. Annual mean maximum temperature trend 1884 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.076ºC/decade, significant at the 1% level.

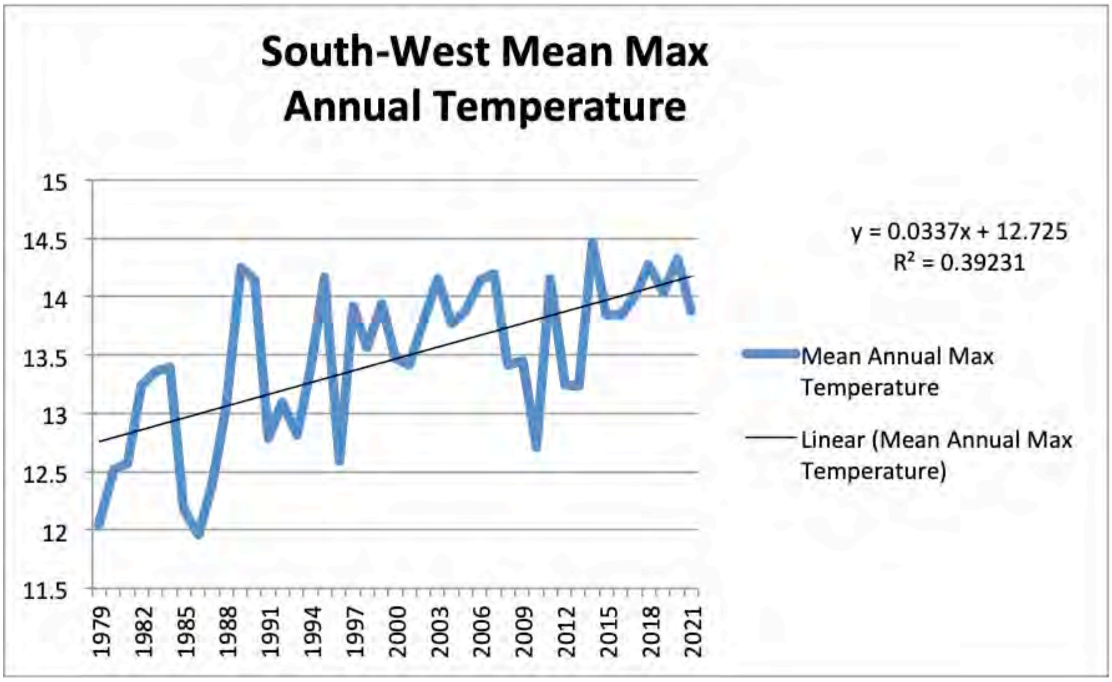


Figure 15. Annual mean maximum temperature trend 1979 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.337ºC/decade, significant at the 1% level.

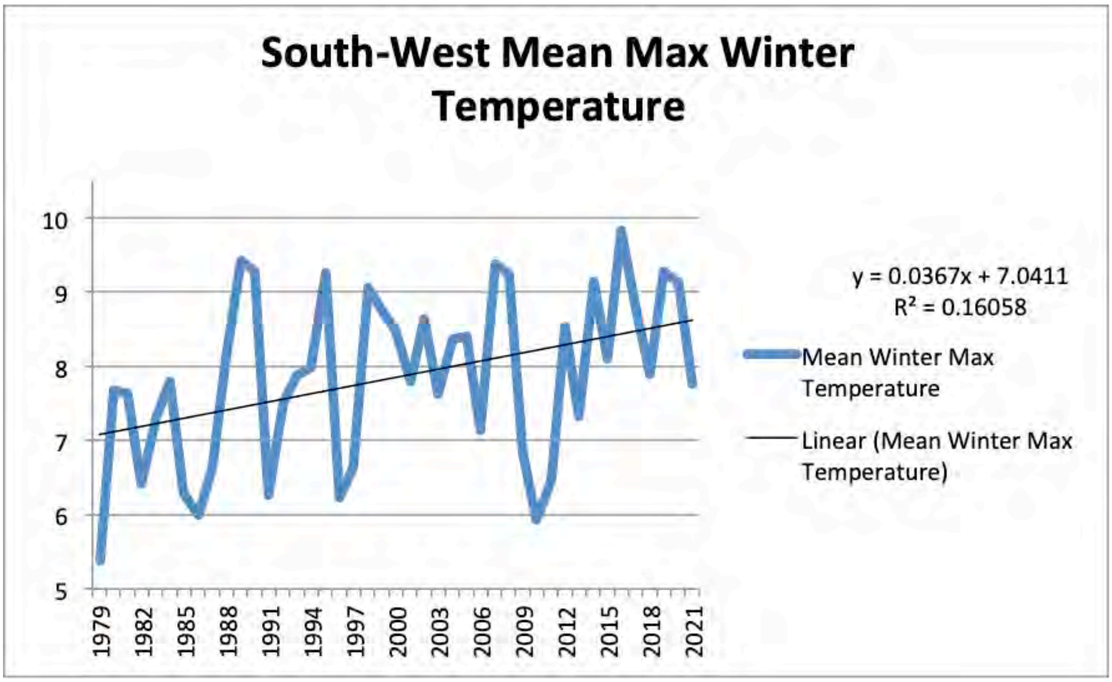


Figure 16. Winter mean maximum temperature trend 1979 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.367ºC/decade, significant at the 1% level.

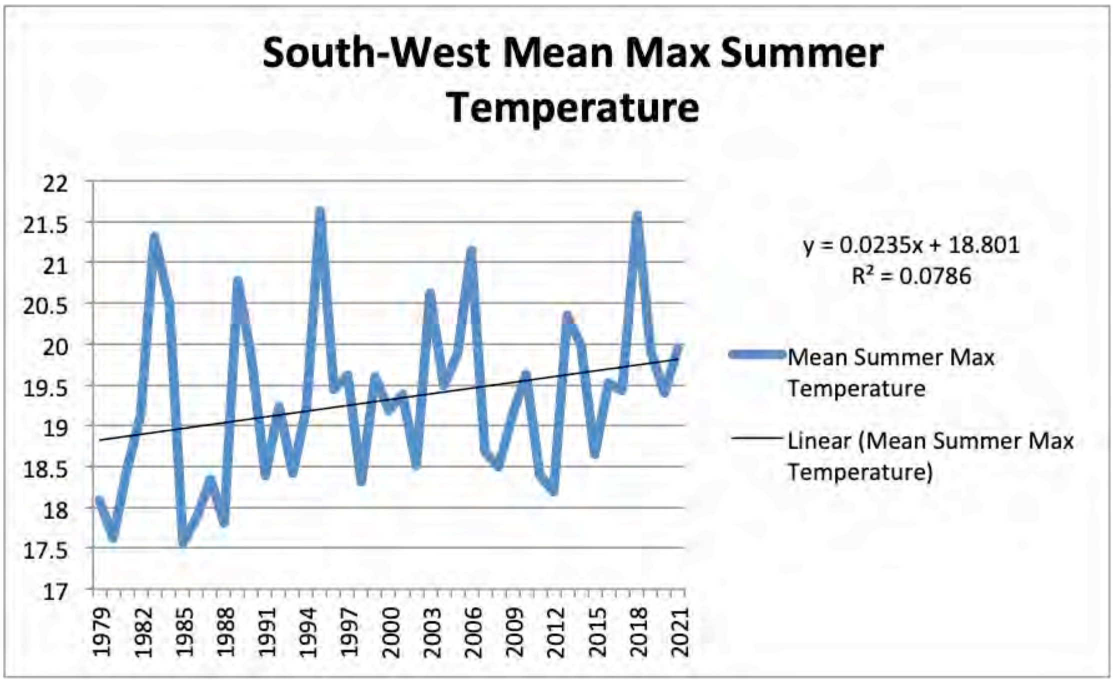


Figure 17. Summer mean maximum temperature trend 1979 to 2020 in ºC for South-West England and South Wales from the MONCIC fitted with a linear trend line. The overall trend is 0.235ºC/decade, significant at the 10% level.

Main points from CCRA3 for Extreme Heat

- New weather and climate records are being set more frequently, with the UK experiencing unprecedented high temperatures

- UK temperature extremes (>95th percentile) are increasing 15-48% faster than the UK mean temperature and >50% faster than the global mean
- For the UK as a whole the frequency of creating new monthly mean temperature records appears to have increased

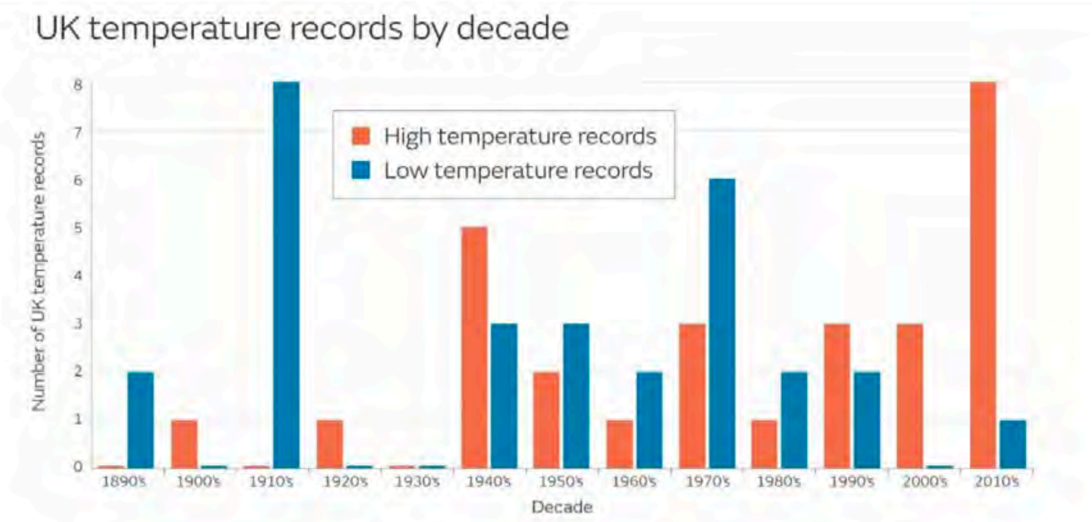


Figure 18. Decadal frequencies of new monthly mean temperature records across the UK.

- Cornwall is less frequently visited by heatwaves (three or more consecutive days with maximum temperatures at or above a county-specific threshold in the range 25ºC to 28ºC) than much of the rest of England, but there is evidence, at least for metropolitan areas, that the frequency of these events is increasing

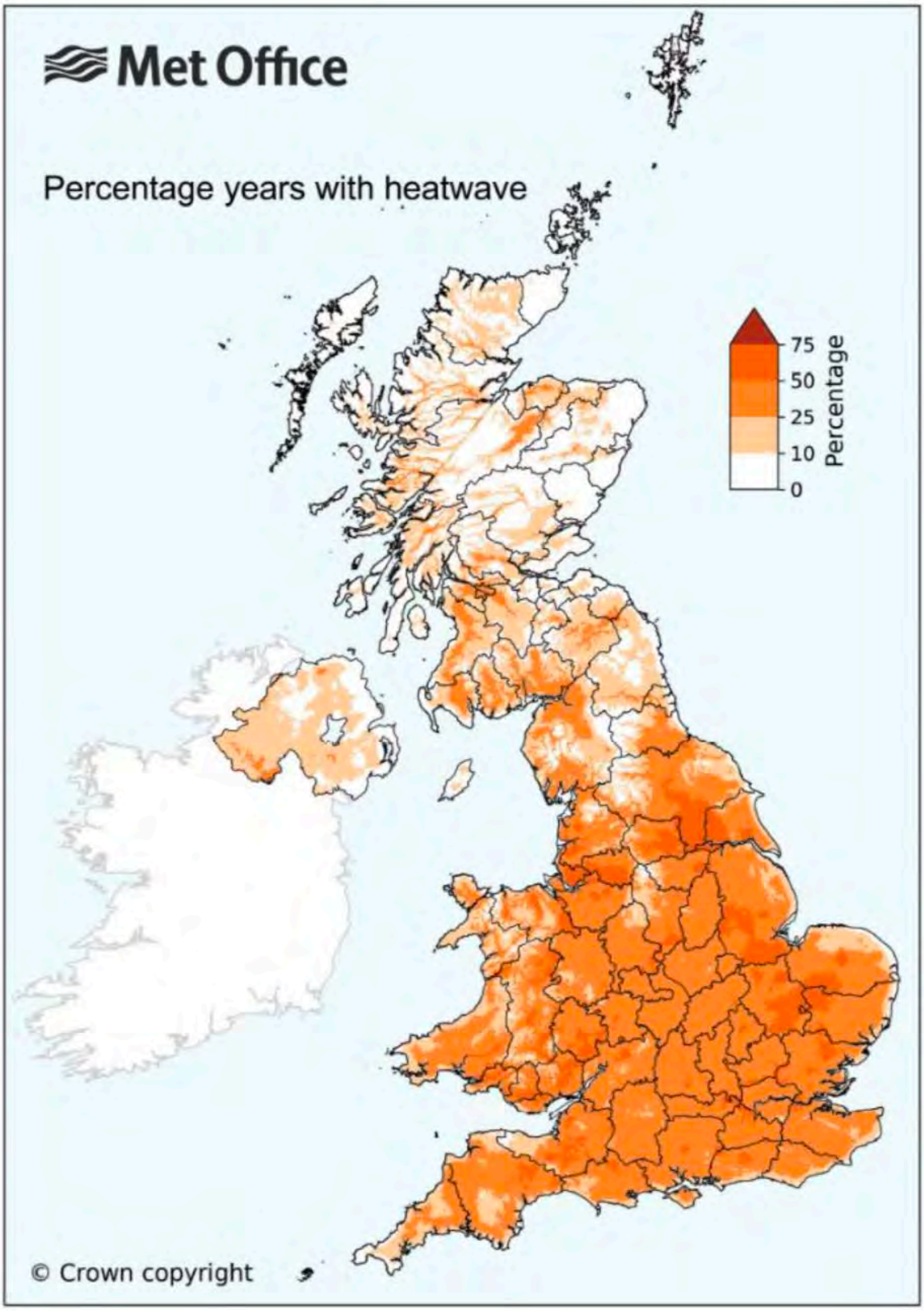


Figure 19. The percentage of years over 1961 to 2018 in which at least one heatwave as defined in the previous bullet occurred

More Detail on Projections for Extreme Heat

Main Points from IPCC WG1 AR6 for the Globe and NEU for Extreme Heat

- CMIP6 projections are robust in projecting increases in the intensities and frequencies of hot extremes, with higher increases related to higher emissions
- VL that heatwaves will increase in frequency and duration, with impacts on morbidity, mortality and labour capacity

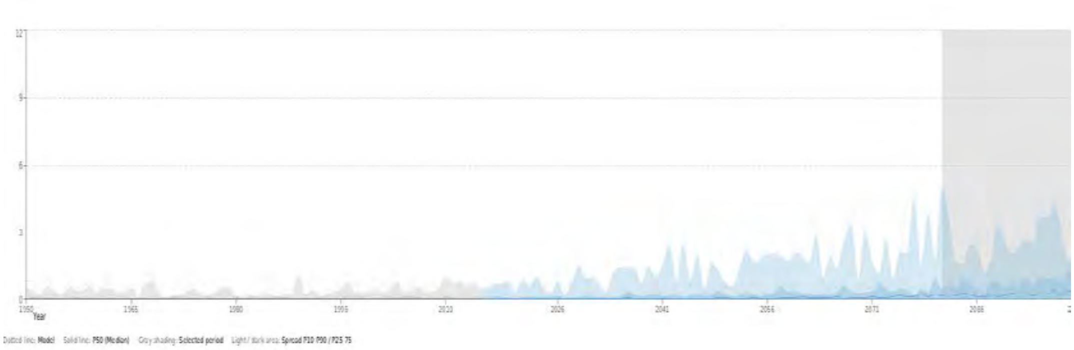


Figure 20. Changes in the frequency of the annual number of days with temperature maxima above 35ºC over NEU from CMIP6 under SSP3-7.0

Main Points from UKCP18 for Extreme Heat

- In the following table temperature increases that are projected over South Cornwall for the annual (illustrated in the Mean Temperature section) and summer season changes under RCP8.5 are contrasted; there are minimal differences on the cool sides of the plumes but the likelihoods of higher temperatures in summer compared to the year as a whole increase markedly for the higher percentiles:

Percentiles	5th	10th	25th	50th	75th	90th	95th
Annual	1.8ºC	2.4ºC	3.4ºC	4.5ºC	5.7ºC	6.8ºC	7.4ºC
Summer	1.9ºC	2.4ºC	4.2ºC	6.2ºC	8.1ºC	9.8ºC	11.0ºC

- The possibilities that high daily temperatures will occur will increase under all emissions scenarios, but more so under the higher scenarios. Under RCP2.6 the highest daily temperature with a 20-year return period with a 50% likelihood is about 31.2ºC or more, under RCP8.5 this value increases to 36ºC. Naturally, even higher values may occur with longer return periods.

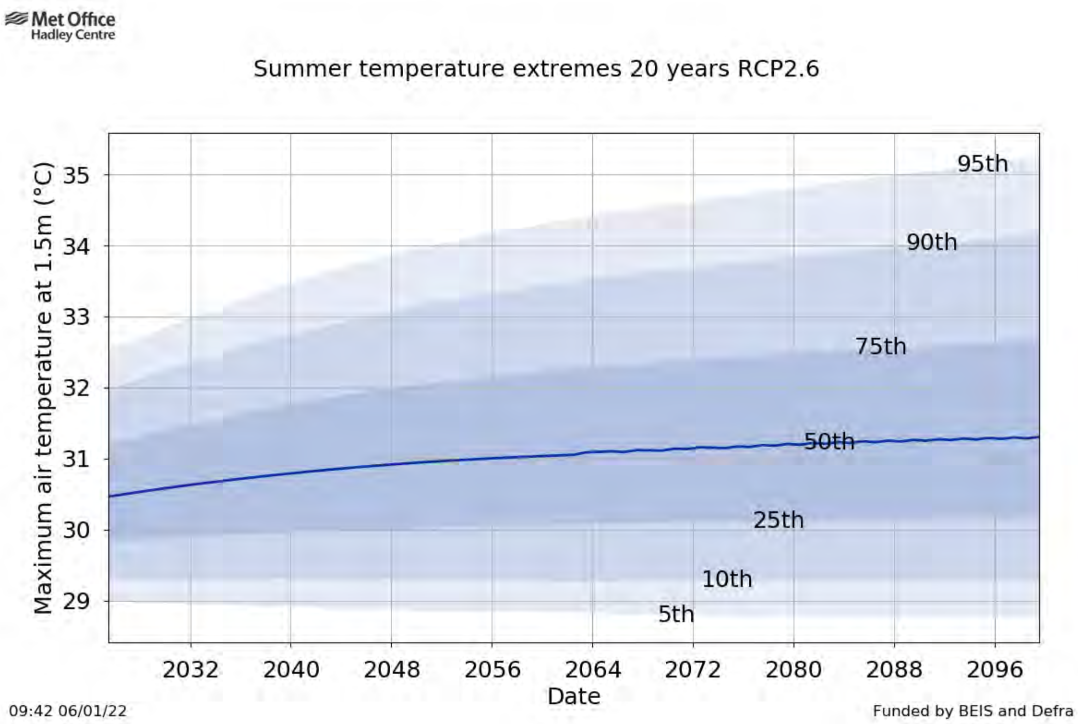


Figure 21. Return values (absolute figures) for temperature extremes with return periods of 20 years under RCP2.6.

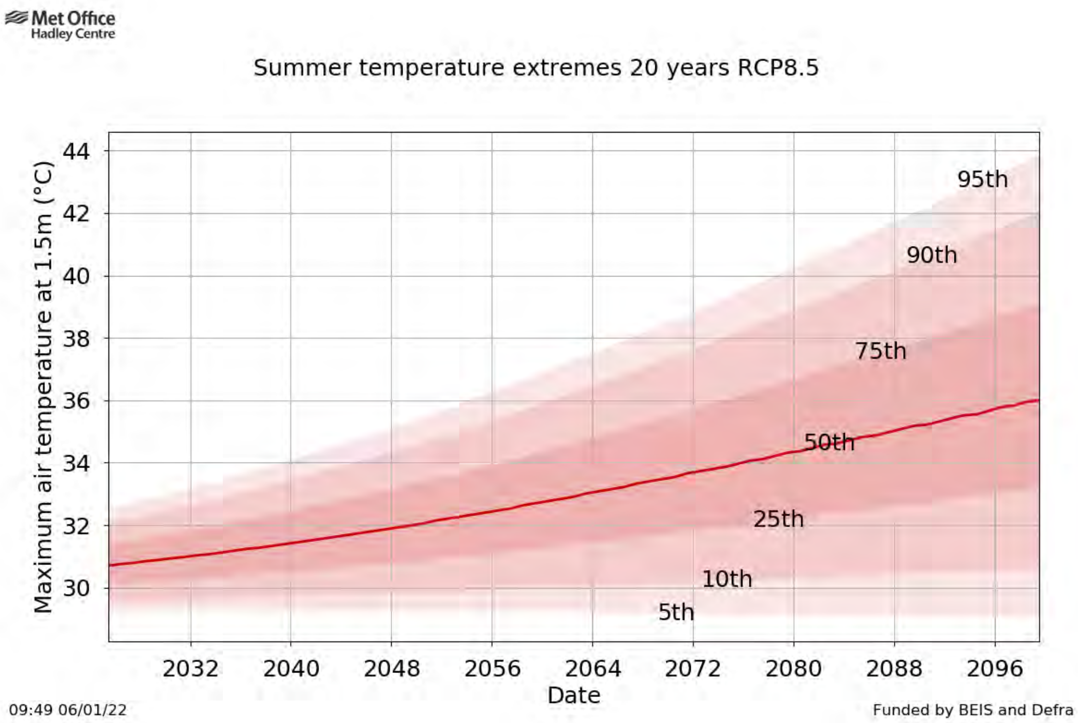


Figure 22. Return values (absolute figures) for temperature extremes with return periods of 20 years under RCP8.5.

- Selected distributions for future maximum summer temperature increases over South Cornwall for all emissions scenarios are shown in the following diagram;

for all emissions scenarios the pdfs indicate mainly positive changes, changes that increase with emissions and in time, and thus the likelihoods of increased frequencies of future hot spells:

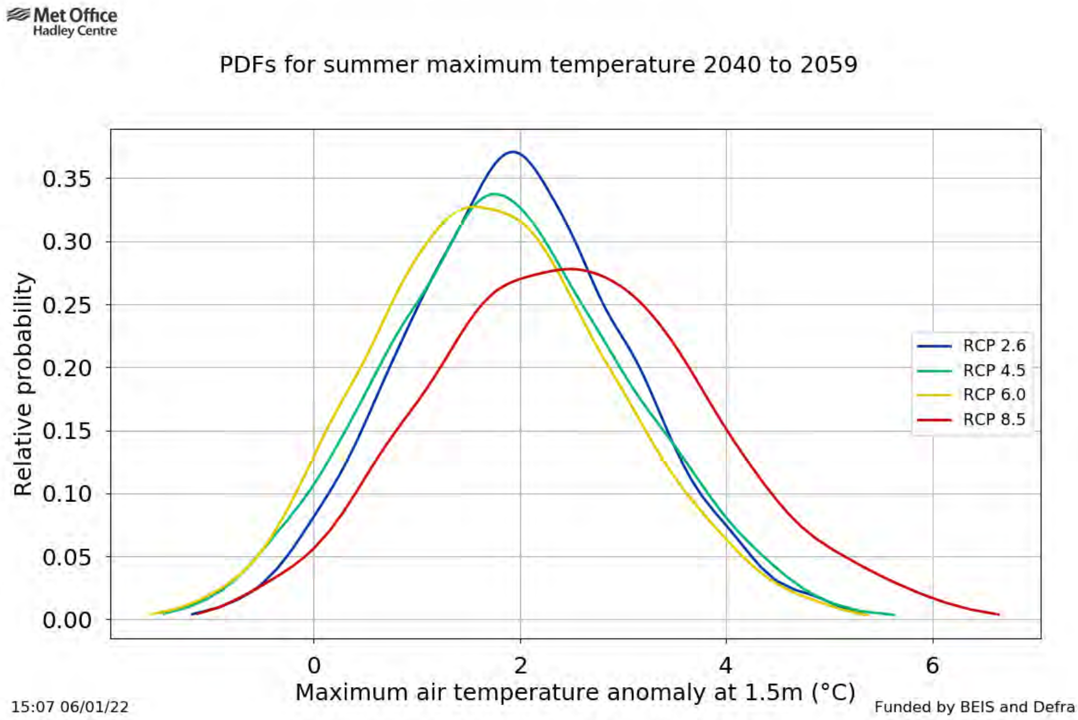


Figure 23. Future summer season average maximum temperature change distributions compared to 1981 to 2000 by 2040 to 2059 under all four RCPs.

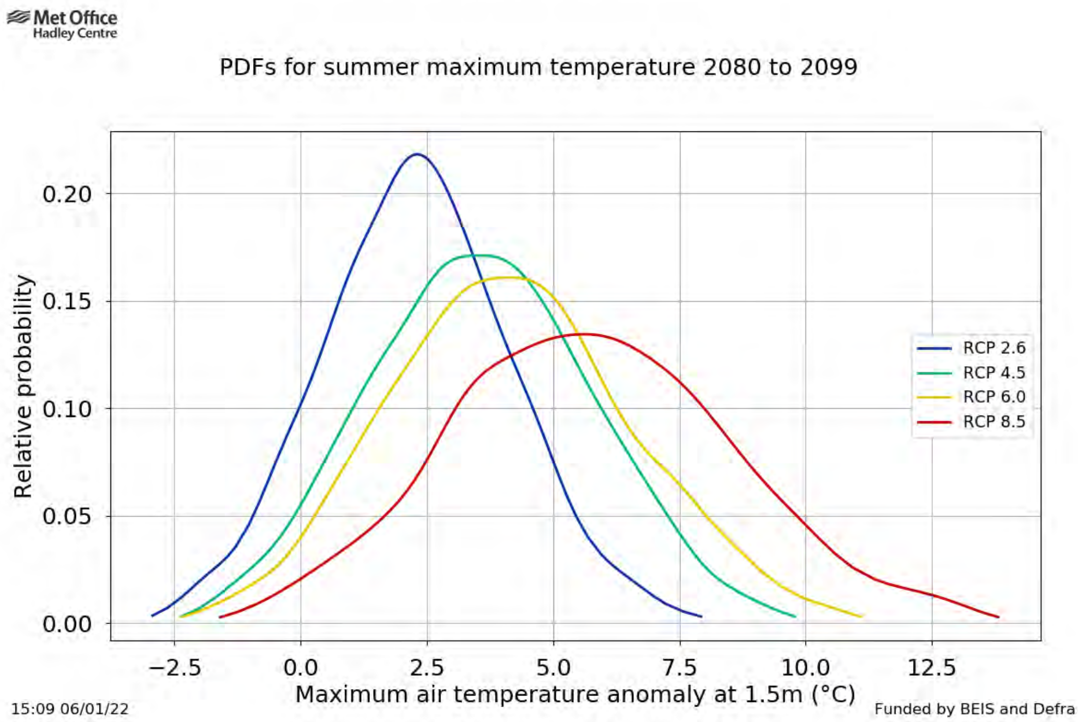


Figure 24. Future summer season average maximum temperature change distributions compared to 1981 to 2000 by 2080 to 2099 under all four RCPs.

Main Points from CCRA3 for Extreme Heat

- Future summers are likely to be warmer than projected in the CCRA2
- There are likely to be more frequent daily events of high temperatures, with an exacerbation of heat islands in cities resulting in uncomfortable conditions both day and night
- Likelihoods of hot summers will increase in the future, based on RCP8.5, as summer temperatures themselves increase

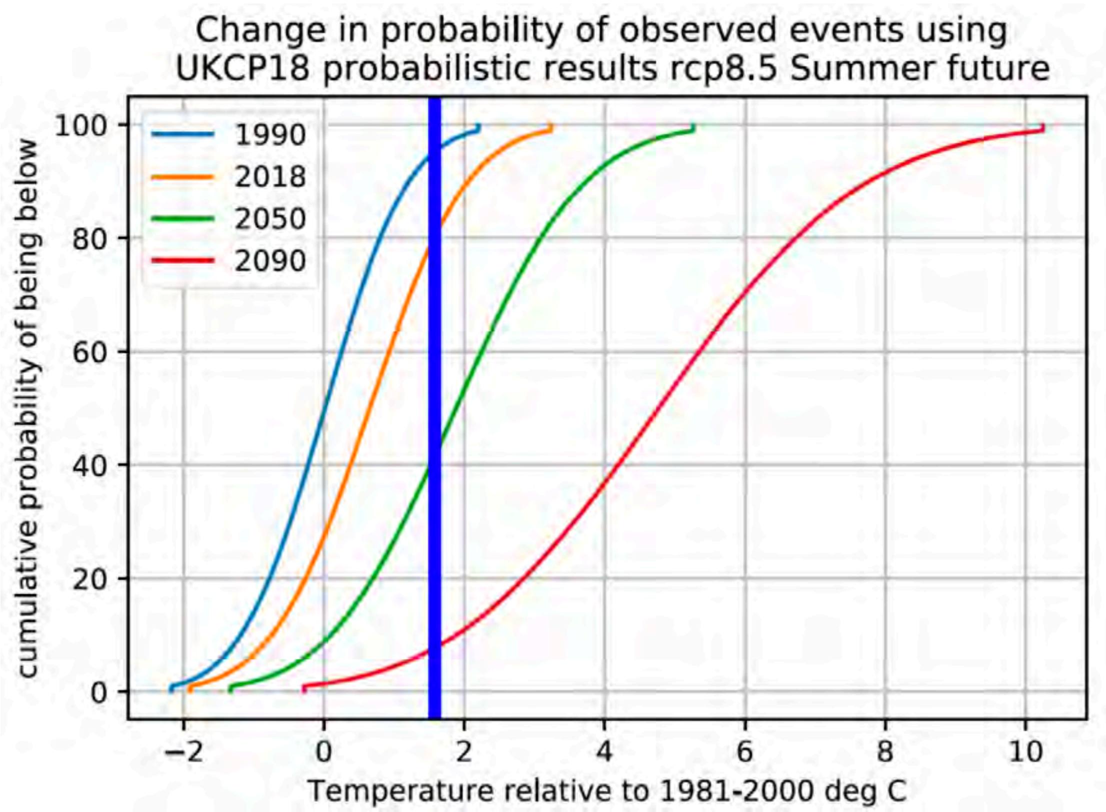


Figure 25. Likelihoods of changes in UK summer temperatures from RCP8.5 projections from 1981 to 2000 for projections for four year. The blue bar represents the famous hot summer of 1976. Thus, e.g., in 1990 there was a 40% chance of being slightly above the 1981 to 2000 summer mean, but by 2018 that had become about 70%, by 2050 it may be about 90%, and by 2090 summer temperatures will almost certainly be above that mean.

- The likelihoods of specific high temperatures being exceeded more regularly across the UK will rise, with one projection under RCP8.5 suggesting that by 2080 the frequency of exceeding 40ºC at some UK location will be similar to the frequency for 32ºC in present climate; Cornwall's maritime location will help moderate the extremes, but high temperatures remain possible especially for inland parts of the county (see the UKCP18 section above)
- According to estimates under RCP4.5 and RCP8.5 the return period for daily maximum temperatures exceeding 30ºC in the interior eastern part of the county by late century may change from the current (10-50) years to (5-10) years or (up to 5) years respectively (the brackets indicate the range of return periods

available in the report), and 35ºC from (more than 1000) years to (500-1000) or (10-50) years respectively; there is no material change in the return period for 40ºC. In other words, high temperatures may be expected more frequently the more the atmosphere warms, although maximum values are moderated in western and coastal parts of the county. The urban heat island might amplify warming in Truro and in any other larger settlements.

- See also the diagram for Summer Days and Tropical Nights in the Mean Temperature section

CID Grouping – Heat and Cold

Cold Spell - Episodic cold surface air temperature events potentially exacerbated by wind

High confidence impacts (dark shading in Table 1) on: *livestock and pasture systems; livestock mortality*.

Low/moderate confidence impacts (light shading in Table 1) on: *temperate and boreal forests; lakes, rivers and wetlands; grassland and savannah; crop systems; forestry systems; land and water transportation; energy infrastructure; built environment; labour productivity; morbidity; mortality; recreations and tourism*.

Overall Summary for Cold Spell

Trends:

- Cold spells have decreased in frequency and severity
- The rate of increase in minimum temperatures is, on average and in general, slower than the rate in average and maximum temperatures

Projections:

- The decrease in the frequencies and intensities of cold spells is expected to continue
- Accompanying the decrease in cold spells will be a decrease in energy demands

Examples of impacts based on CIDs:

- On forests, on livestock and pasture systems
- On livestock mortality

Examples of impacts based on CCRA3:

- Areas carrying risks include: to food safety, to agriculture from pathogens
- Areas carrying risks and opportunities include: to carbon stores, to landscape character
- Areas carrying opportunities include: new species colonisation, agricultural and forestry production, new cropping and aquaculture opportunities, food availability

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More Detail on Trends for Cold Spell

Main Points from IPCC WGI AR6 for the Globe and NEU for Cold Spell

- Cold events over NEU have already decreased in frequency (HC)
- CMIP6 projections are robust in projecting decreases in the intensities and frequencies of cold extremes, with greater decreases related to higher emissions

Main Points from MONCIC for Cold Spell

- Most minimum temperature trends examined from MONCIC are statistically significant at the 1% level. The exceptions are winter and spring, although both are significant at the 5% level. The likely reason for the relatively weak trends in these latter two seasons is the presence of unusually cold periods in the record, such as the 1979 and 2010 winters and the 2013 spring.

- The record for annual mean minimum temperatures from 1884 to 2020 contains the plateau during the 1920s to 1950s and the cooling in the 1960s and 1970s found also in the mean and maximum records.
- Annual and seasonal trends of minimum temperatures across 1979 to 2020 are:
  - Annual: 0.269ºC/decade
  - Winter: 0.337ºC/decade
  - Spring: 0.204ºC/decade
  - Summer: 0.259ºC/decade
  - Autumn: 0.253ºC/decade
- In general these trends are lower than those in the mean and the mean maximum temperatures, indicating that, while the evidence suggests that all temperatures are increasing, maximum temperatures are increasing faster than minima, that the former are the more significant re mean trends, and that the diurnal range of temperatures is tending to increase.

Main Points from CCRA3 for Cold Spell

- The frequency of creation of new record low monthly mean temperatures appears to be decreasing

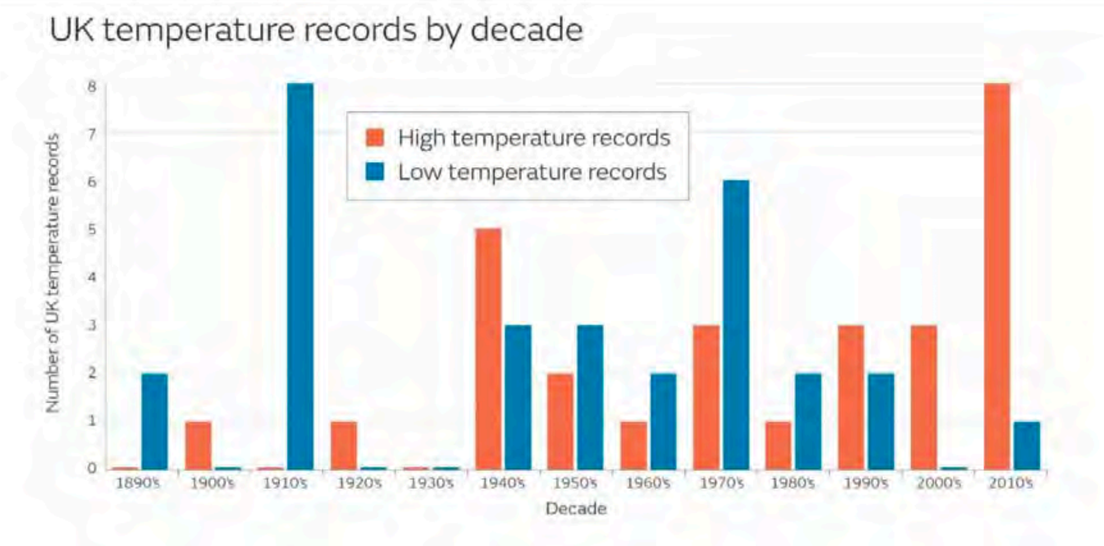


Figure 26. Decadal frequencies of new monthly mean temperature records across the UK.

More Detail on Projections for Cold Spell

Main Points from IPCC WGI AR6 for Cold Spell

- The decrease in winter cold spells is expected to continue (HC)
- Alongside the decrease in cold spell frequency will come reductions in winter energy demands

Main Points from UKCP18 for Cold Spell

- Selected distributions for future winter minimum temperature changes over South Cornwall for all emissions scenarios and shown in the following diagram; for all emissions scenarios the pdfs indicate mainly positive changes, changes that increase with emissions and in time, and thus the likelihoods of reduced frequencies of future cold spells:

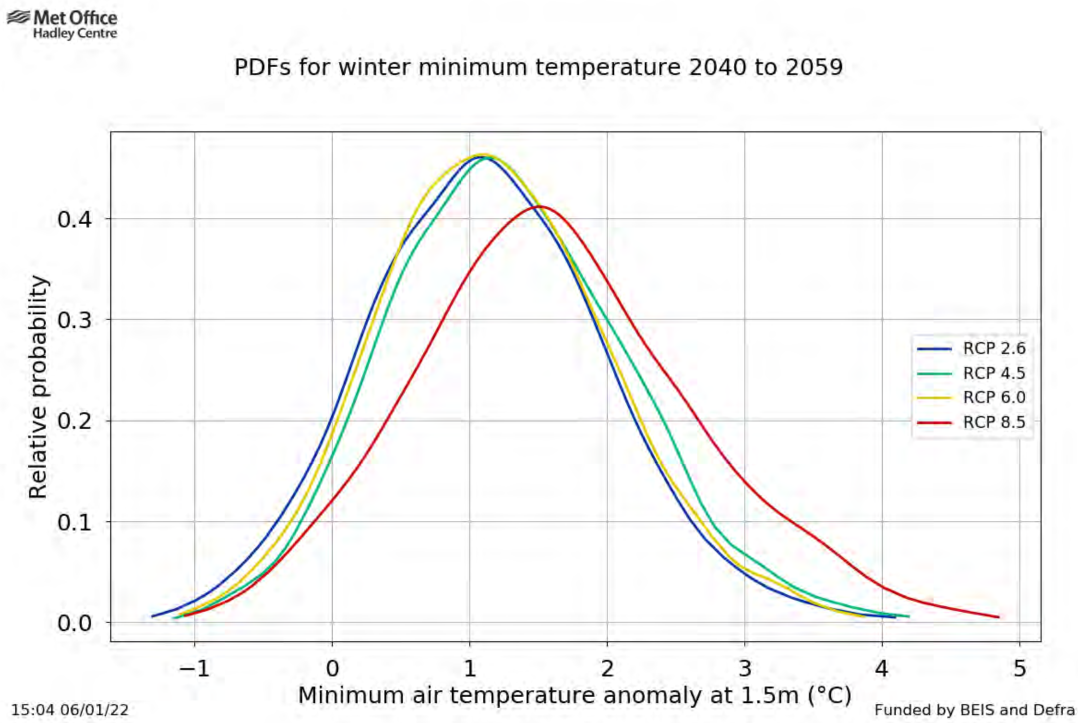


Figure 27. Future winter season average minimum temperature change distributions compared to 1981 to 2000 by 2040 to 2059 under all four RCPs.

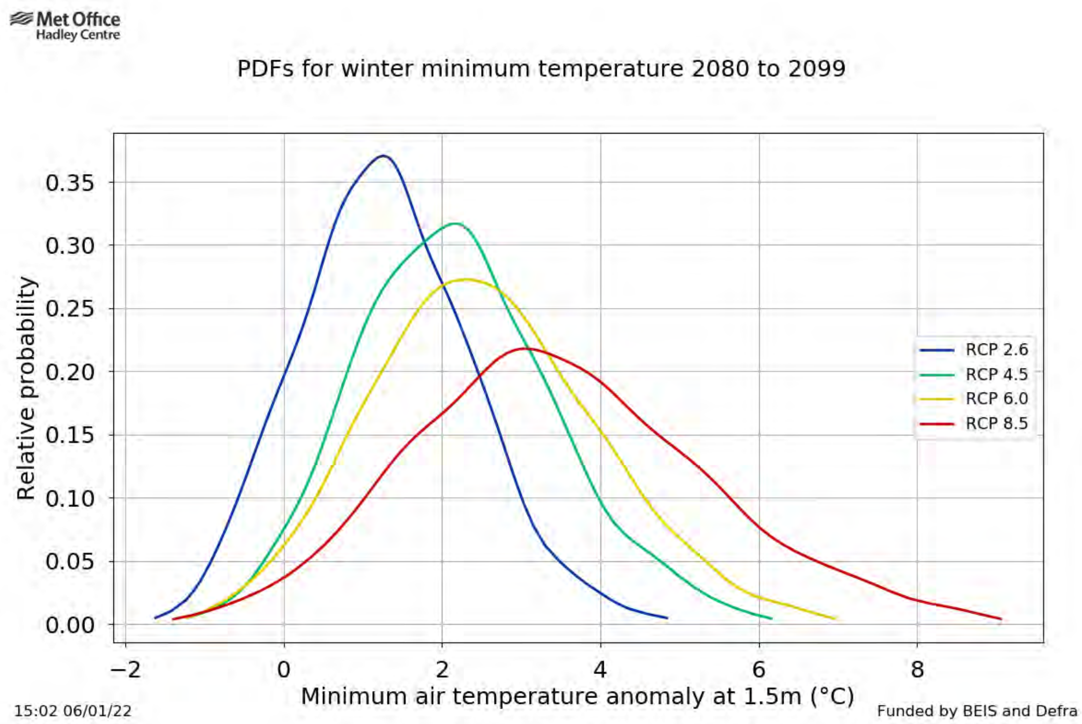


Figure 28. Future winter season average minimum temperature change distributions compared to 1981 to 2000 by 2080 to 2099 under all four RCPs.

- Nevertheless cold and dry winters will still occur in the future

CID Grouping – Heat and Cold

Frost - Freeze and thaw events near the land surface and their seasonality

High confidence impacts (dark shading in Table 1) on: *temperate and boreal forests; crop systems*.

Low/moderate confidence impacts (light shading in Table 1) on: *lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; forestry systems; land and water transportation; recreations and tourism*

Overall summary for Frost

Trends:

- Frosts have decreased in frequency and severity

Projections:

- The observed reductions in the frequencies of frosts is expected to continue into the future, with the greatest reductions under higher emissions

Examples of impacts based on CIDs:

- On forests, on grasslands and cropping systems

Examples of impacts based on CCRA3:

- Areas carrying risks include: to forestry, to public health
- Areas carrying risks and opportunities include: to landscape character
- Areas carrying opportunities include: new species colonisation, new cropping and aquaculture opportunities, food availability

More Detail on Trends for Frost

Main Points from IPCC WGI AR6 for the Globe and NEU for Frost

- Frost and freeze events have decreased in frequency over NEU (HC)

Main Points from UKCP18 for Frost

- Across the UK 2008 to 2017 has experienced a reduction of 5% in days with air frosts and 9% with ground frost compared to the average over 1981-2010, and 15%/14% respectively in comparison to 1961 to 1990
- The annual number of days with air frosts has declined over the period 1960 to 2021, significant at the 1% level
- The annual and seasonal (summer excluded) numbers of days with air frosts also appears to have declined across 1979 to 2021 but statistical significance is marginal at best

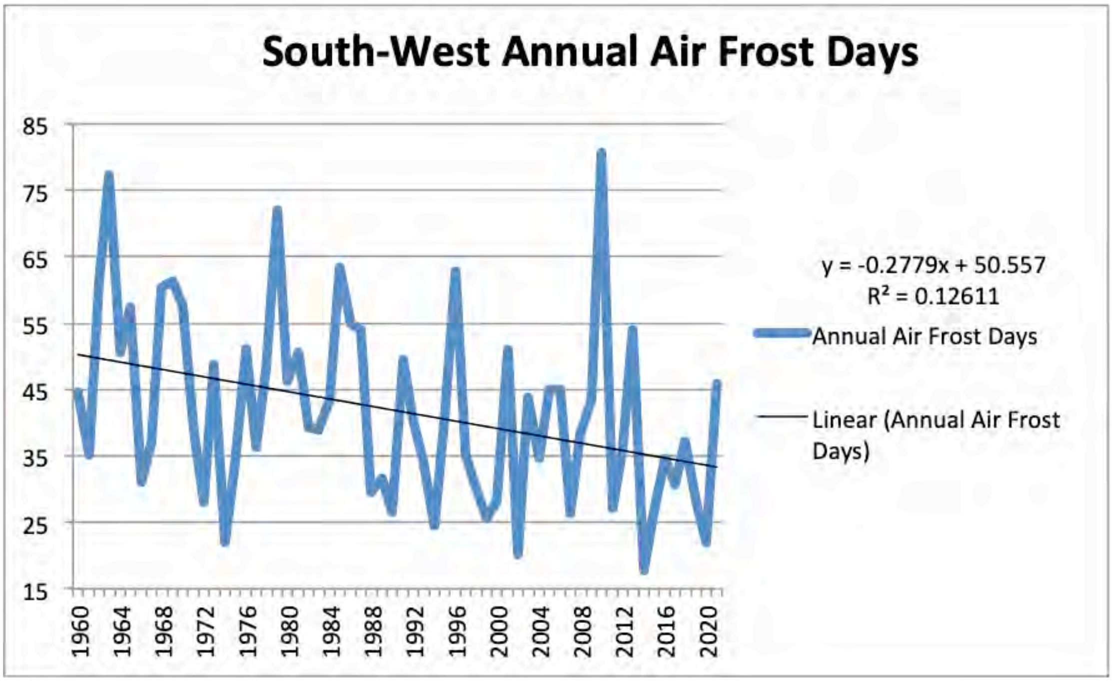


Figure 29. Time series of the annual number of days with air frosts over SWESW 1960 to 2021

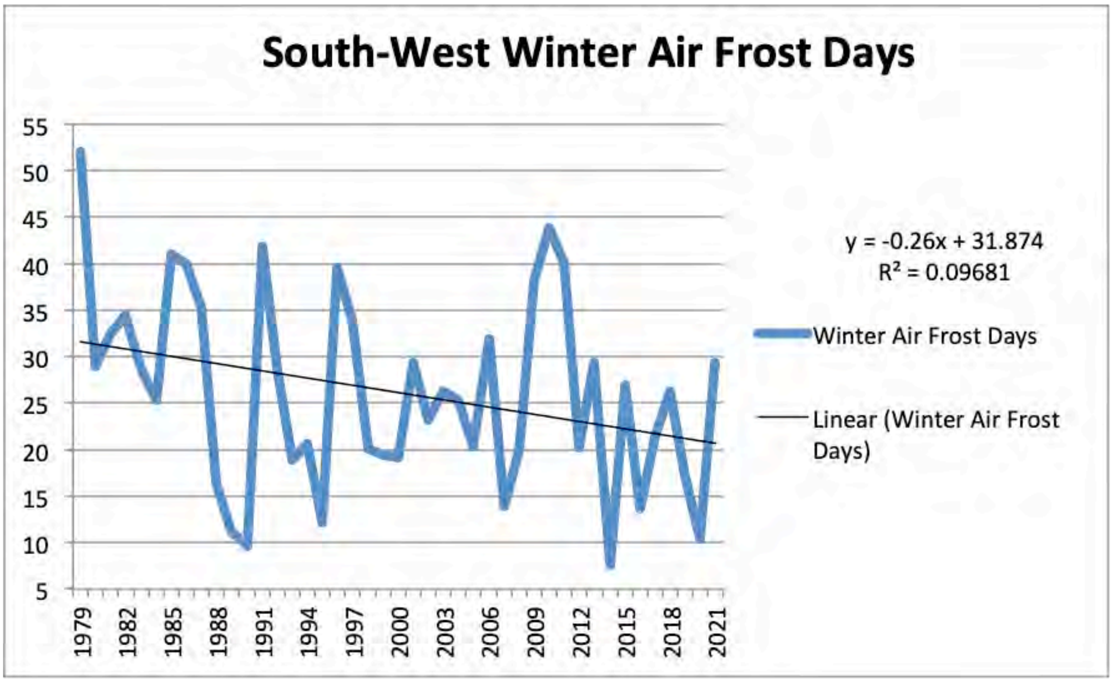


Figure 30. Time series of the winter number of days with air frosts over SWESW 1979 to 2021

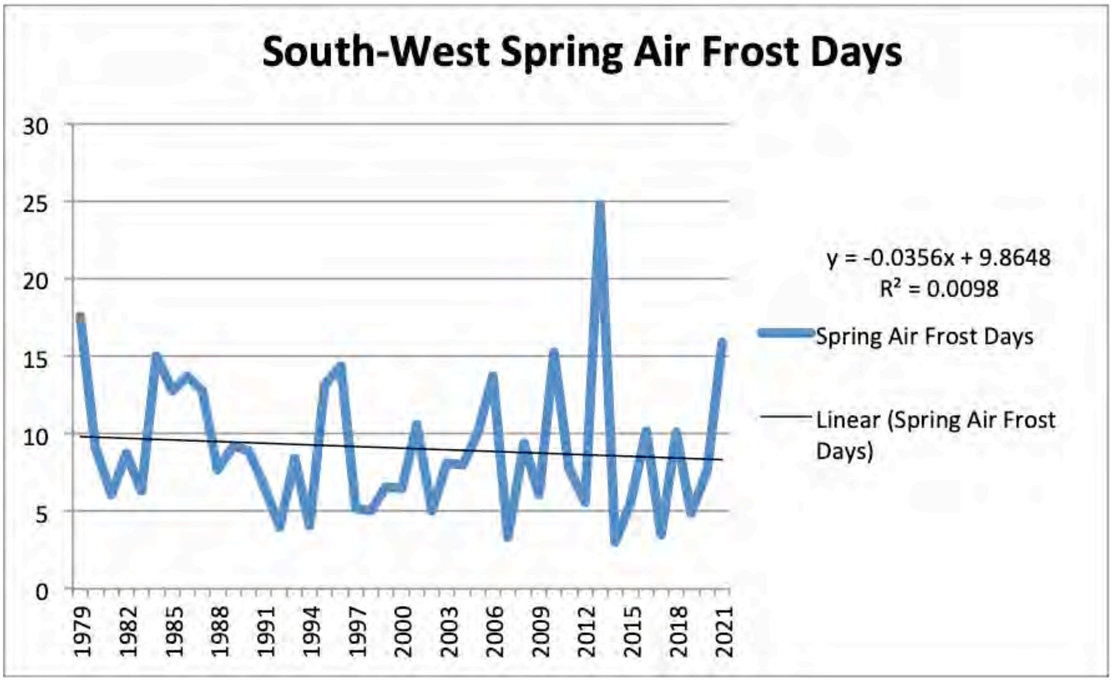


Figure 31. Time series of the spring number of days with air frosts over SWESW 1979 to 2021

Main Points from CCRA3 for Frost

- There has been a reduction in the number of frost days across the UK

More Detail on Projections for Frost

Main Points from IPCC WGI AR6 for the Globe and NEU for Frost

- VL that reductions in the frequencies of frosts over NEU will continue

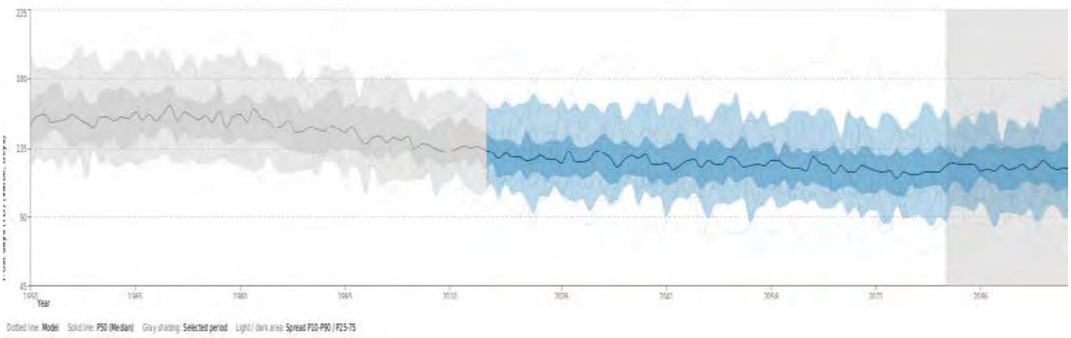


Figure 32. Projections for the number of days with frost over NEU from CMIP6 under SSP1-2.6

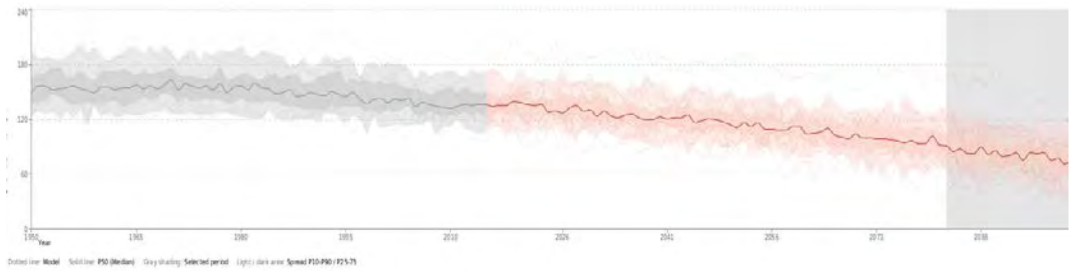


Figure 33. **Projections for the number of days with frost over NEU from CMIP6 under SSP5-8.5**

Main Points from CCRA3 for Frost

- The number of frost days, of days with icing, and the number of HHDs, will decrease over Cornwall, progressively so with higher global temperature increases.

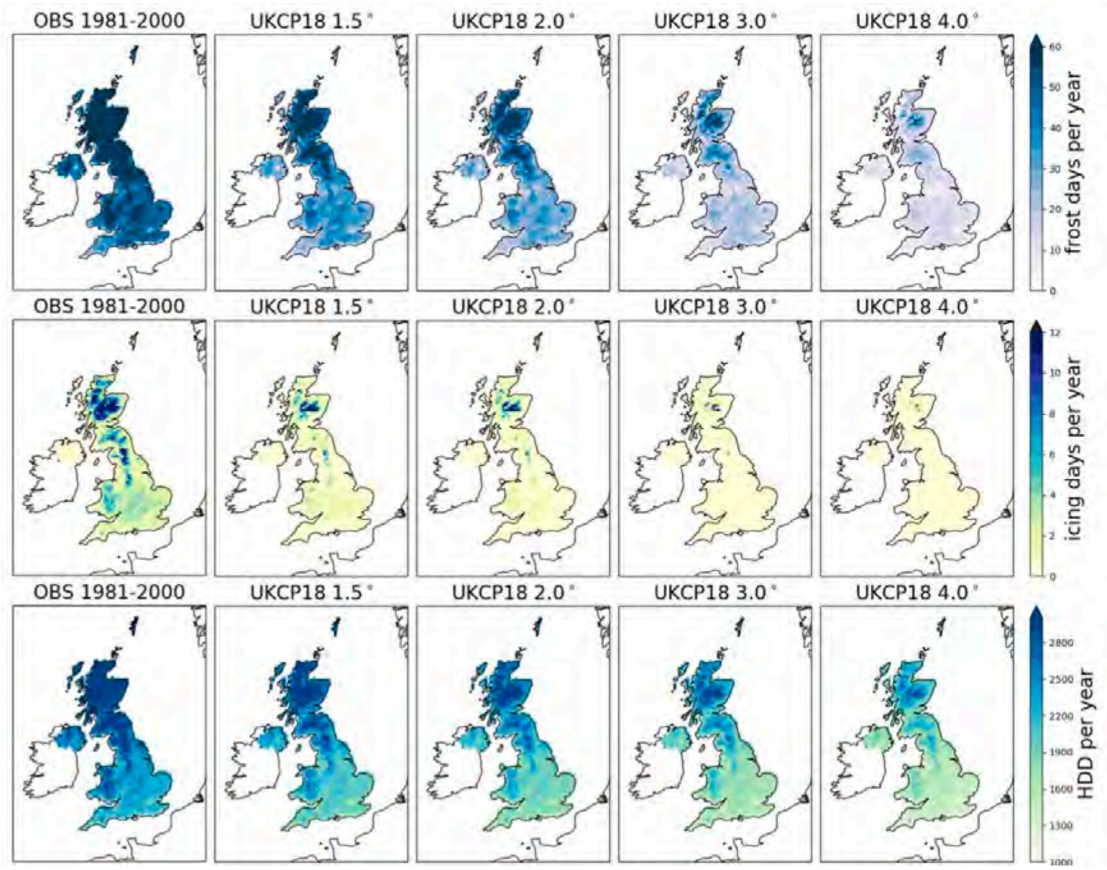


Figure 34. The number of frost days per year (top row), icing days per year (middle row), and heating degree days (HDDs) per year (bottom) row for 1981 to 2000 observations for various levels of global warming (columns).

- Nevertheless some years will still see similar numbers of frost events as in recent years

CID Grouping – Wet and Dry

Mean Precipitation - Mean precipitation, its diurnal and seasonal cycles, and associated soil moisture and humidity conditions

High confidence impacts (dark shading in Table 1) on: *lakes, rivers and wetlands; grasslands and savannah; aquifers and groundwater; streamflow and surface water; crop systems*.

Low/moderate confidence impacts (light shading in Table 1) on*: temperate and boreal forests; coastal land and inertial zones; coastal seas; water quality; livestock and pasture systems; forestry systems; energy infrastructure; morbidity; mortality; recreations and tourism*.

Overall Summary for Mean Precipitation

Trends:

- Trends in rainfall may vary, even in direction, when assessed over different periods, perhaps through data issues or perhaps through the complexities of those atmospheric changes that control rainfall totals
- No evidence for any trends in rainfall totals has emerged here for the period 1979 to 2021, the period thought to contain maximum anthropogenic impacts on the climate
- Statistically significant positive trends appear to be present in in both annual and winter totals over 1862 to 2021, both of which are intensified in the 1979 to 2021 period but without statistical significance
- As far as can be determined without further investigation, recent annual and seasonal trends over both NEU and SWESW are similar
- No evidence has been found for a negative trend in summer rainfall
- **However**, in a separate paper focussed on Cornwall, Kosanic *et al.* (2014) noted that station data up to about 2010 (from various starting dates) differed from those at the national scale indicating negative annual trends.

Projections:

- A general picture of increased DJF rainfall and decreased JJA rainfall, both in the latter parts of the century, with greater changes under higher emissions, and thus leading to increased rainfall seasonality
- Limited changes in spring and autumn rainfall
- Given the above two points, both based on central values across the ensembles, the spread of projections can be wide, more so under high emissions, reaching perhaps ±80%; hence care must be taken in planning to accommodate changes other than those represented by ensemble mean values

Examples of impacts based on CIDs:

- On all aspects of the surface water systems and on crops (HC)
- On several other environmental and ecological aspects, as well as non-cropping production, health and tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: agriculture, forests, water supply and quality, food safety, property and infrastructure, etc.

- Areas carrying risks and opportunities include: agricultural and forestry productivity, landscape character, etc.
- Areas carrying opportunities include: new species colonisation on land and in water, new agricultural and forestry production, etc.

More Detail on Trends for Mean Precipitation

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Mean Precipitation

- Warmer global atmosphere translates to increased *global* precipitation (HC) in the VL range of 1% to 3% per ºC; increases are focussed likely into the wetter seasons, but warming also increases evaporation and the severity of droughts
- Global land precipitation has increased since 1950s, and faster since 1980s (MC)
- Interannual rainfall variability and extremes will increase faster than average changes (HC)
- Trends from various data sets for 1980 to 2015 are non-significant (with one exception) as indicated in the table below (units are mm per day per decade/mm per year per decade; bold if significant at least at the 5% level; italics if negative; other data sets provide equivalent results)

Data Set	Trend Period	Annual	DJF	MAM	JJA	SON
ERA5	1980-2015	0.014/5.11	0.022/8.0	0.006/2.19	**0.071/25.9**	*−0.043/−15.7*
W5E5	1980-2015	0.012/4.38	0.014/5.11	0.010/3.65	0.065/23.7	*−0.047/−17.2*
GPCP	1980-2015	*−0.008/−2.92*	*−0.024/−8.76*	0.003/1.10	0.036/13.14	*−0.048/17.52*
CRU TS	1980-2015	0.026/9.49	0.029/10.59	0.014/5.11	0.076/27.74	*−0.027/−9.86*

- The trend from 1901 to 2019 illustrated in the Figure below, from CRU TS, appears to suggest an increasing trend through the recent 120 years or so over NEU

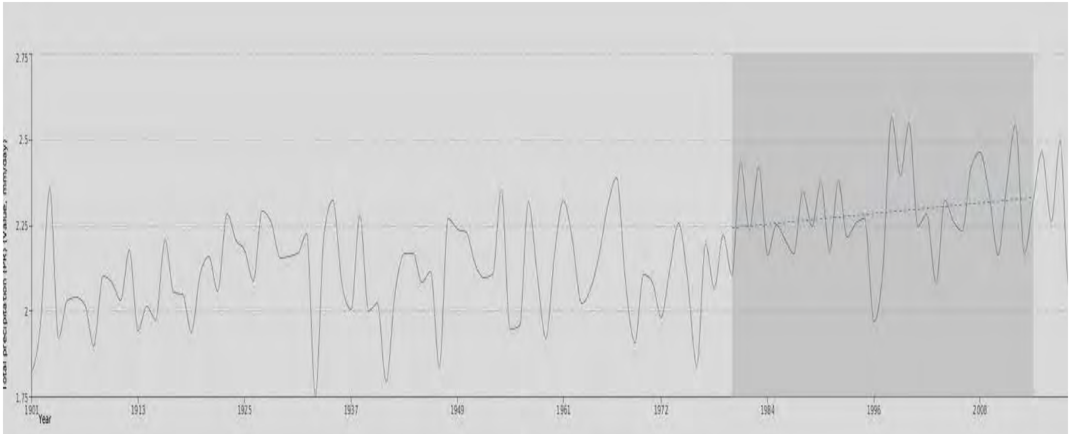


Figure 35. Time series for annual precipitation over NEU 1901 to 2019 from CRU TS from the AR6 Atlas (precipitation values are mm/day); the heavy shading indicates 1980-2015 as summarised in the table above.

Main Points from MONCIC for South-West England and South Wales for Mean Precipitation

- Trends in total annual and seasonal rainfalls are not, in general, significant at the 5% level over two periods, 1862 to 2020 and 1979 to 2020, except for positive trends for 1862 to 2020 in annual and in winter totals (see table below – bold if significant at the 5% level, italics if negative)
- In the table values are presented as mm per year/mm per decade; thus the overall trend in annual values from 1862 to 2021 represents roughly a 65mm increase, apparently with a contribution of perhaps 44mm in winter
- Limited consistency appears to be present other than as above for any season, with different direction of trends over the two periods in MAM, JJA and SON
- For annual totals, and for all seasonal totals, the results suggest that trends have become stronger (if still not significant at the 5% levels) in 1979 to 2020

Trend period	Annual	DJF	MAM	JJA	SON
1862 to 2021	**0.593/5.93**	**0.400/4.00**	0.164/1.64	*0.063/0.63*	0.078/0.78
1979 to 2021	1.01/10.1	0.922/9.22	*1.152/11.52*	1.489/14.89	*0.412/4.12*

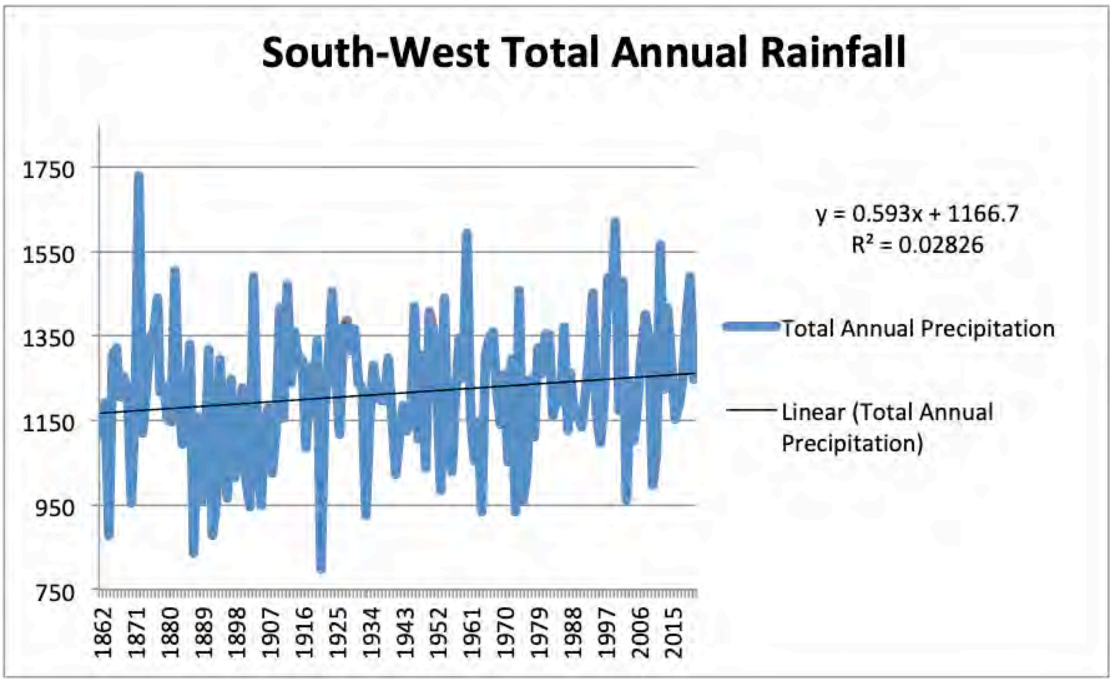


Figure 36. Time series for annual precipitation totals over SWESW from 1862 to 2021 from MONCIC (values are annual totals in mm).

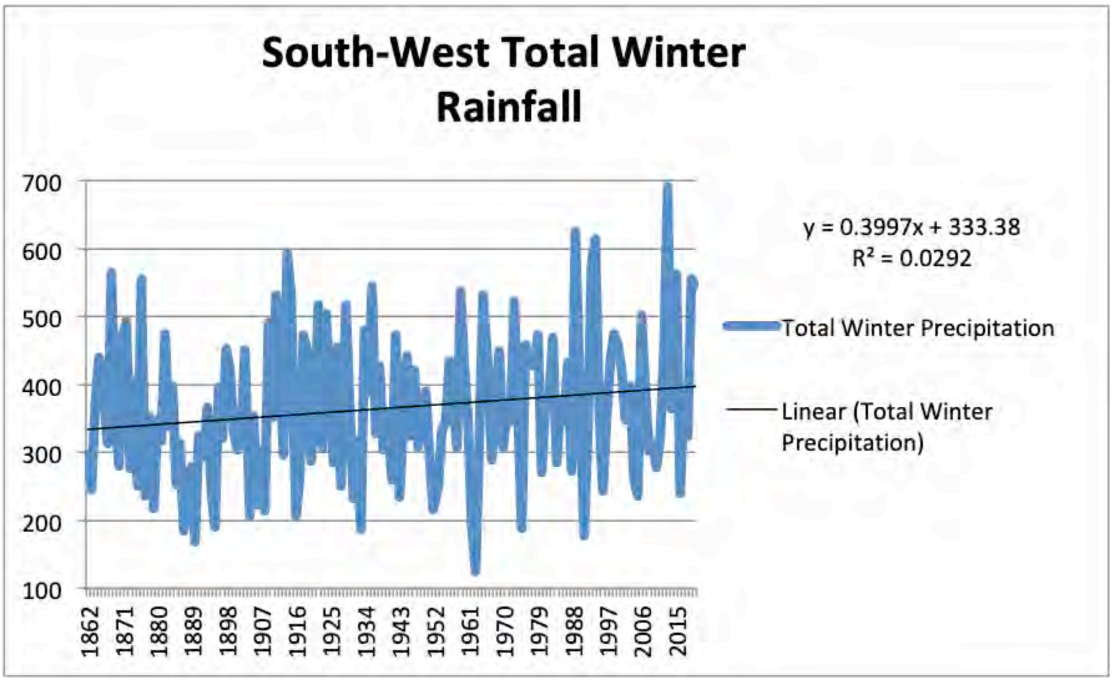


Figure 37. Time series for winter precipitation totals over SWESW from 1862 to 2021 from MONCIC (values are annual totals in mm).

Main Points from CCRA3 for Mean Precipitation

- For all of the UK as a whole, and for the four nations independently, data since 1860 suggest an increasing trend since about 1980
- Noting that seasonal rainfall trends tend to be biased by interannual and decadal variability, for the UK as a whole there are signs of increasing winter rainfall but of limited, if any, change in other seasons, including no summer decrease in recent years

More Detail on Projections for Mean Precipitation

Main Points from IPCC WGI AR6 for the globe and for NEU for Mean Precipitation

- Global land precipitation increases more with higher emissions, and results become more robust with higher emissions
- For NEU: increases in annual mean precipitation will emerge by about 2050 (HC)
- Over Cornwall rainfall will most likely increase in winter and decrease in summer, but substantial uncertainty over mid-term trends; results in increased rainfall seasonality, more so with higher emissions
- Specific estimates for robust (only) changes 2081 to 2200 from 1995 to 2014 for Cornwall include:
    - Up to 10% increase in DJF under SSP2-4.5
    - 10% to 20% increase in DJF under SSP3-7.0
    - 10% to 20% decrease in JJA under SSP3-7.0
    - Up to 10% decrease in JJA under SSP2-4.5
    - Up to 10% increase in SON under SSP2-4.5

Main Points from UKCP18 for Mean Precipitation

- Tested data for several 25km^2 areas over Cornwall to check for orographic differences simulated by the downscaling, but no substantive differences noted; hence results are only for one representative area in the south central part of the county (that includes Truro)
- Ignoring decadal fluctuations (which have minimal predictability) there are limited differences in the annual projections, with no trends apparent

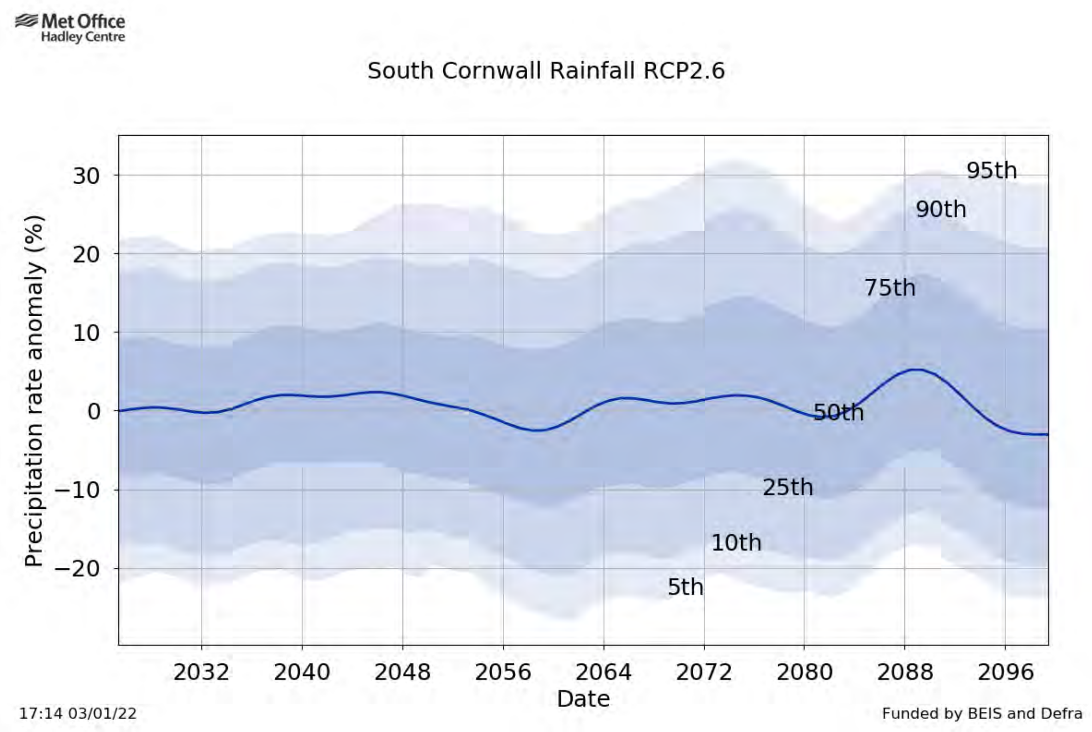


Figure 38. UKCP18 annual rainfall projections 2025 to 2100 for south-central Cornwall under RCP2.6 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

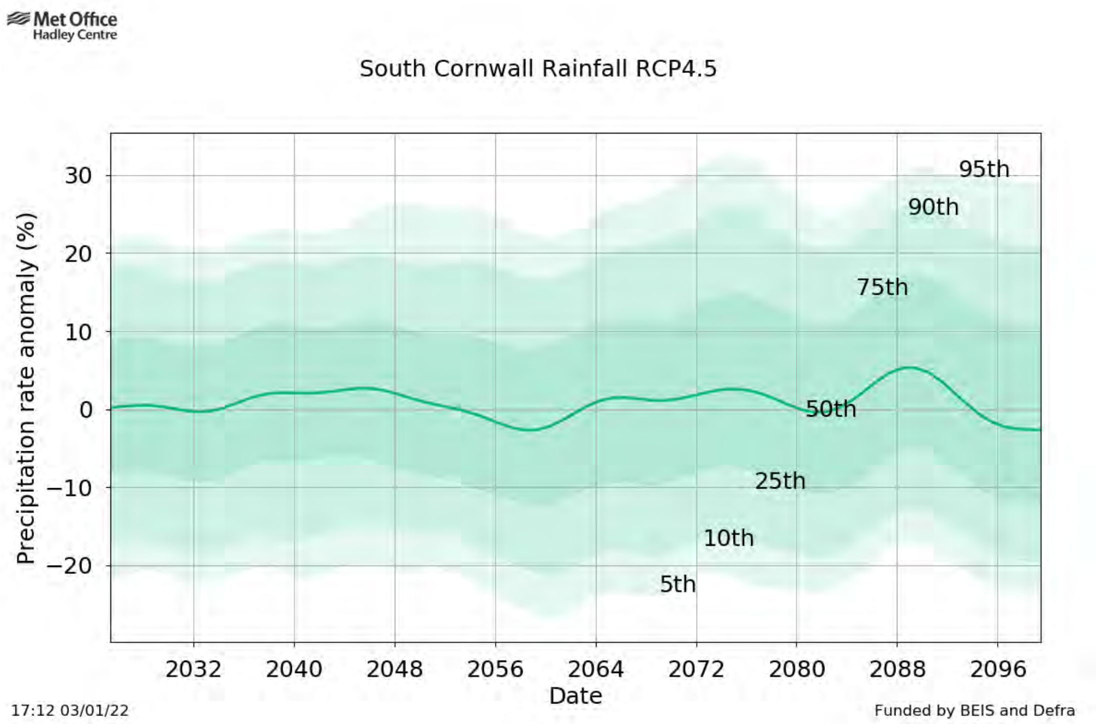


Figure 39. UKCP18 annual rainfall projections 2025 to 2100 for south-central Cornwall under RCP4.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

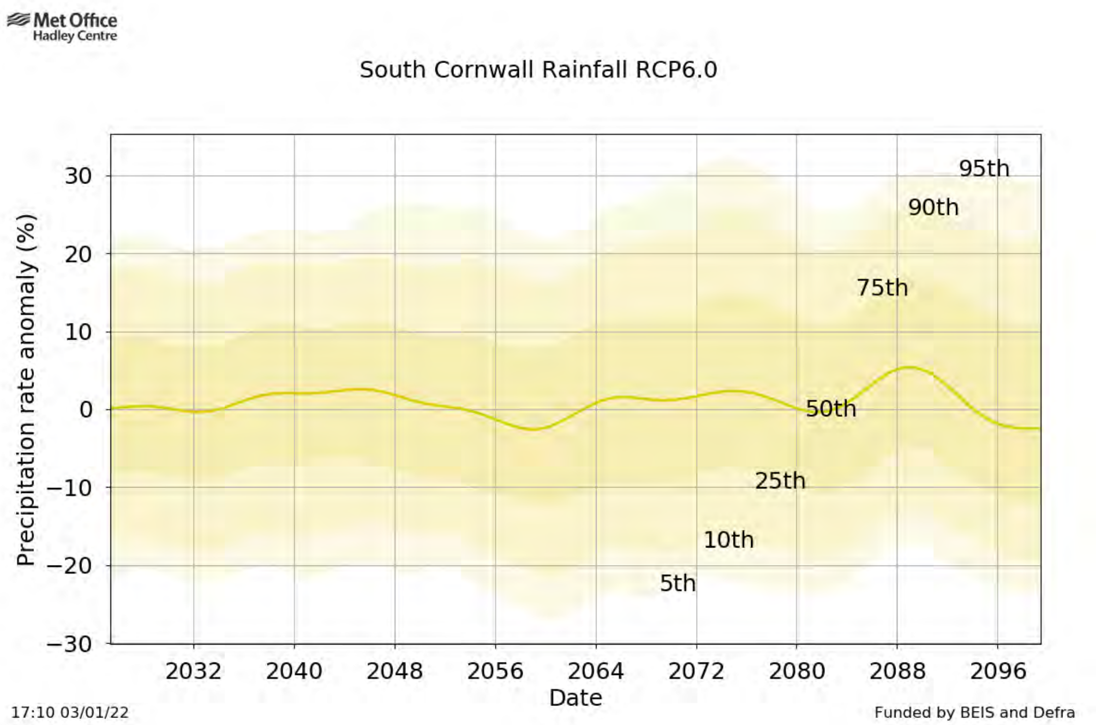


Figure 40. UKCP18 annual rainfall projections 2025 to 2100 for south-central Cornwall under RCP6.0 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

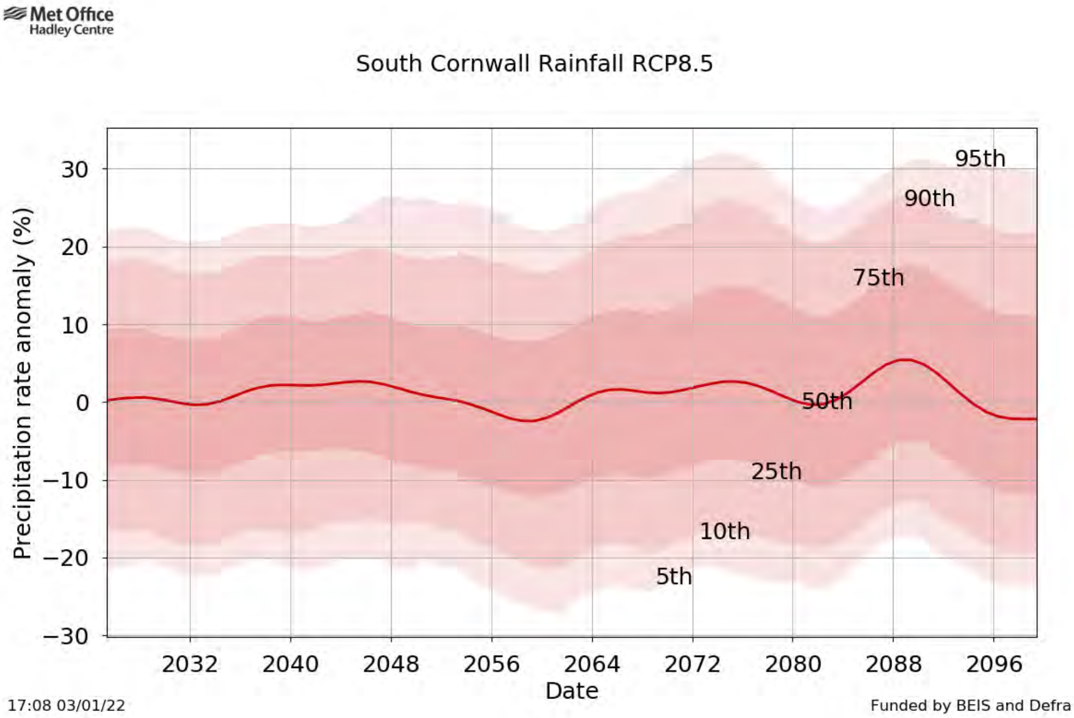


Figure 41. UKCP18 annual rainfall projections 2025 to 2100 for south-central Cornwall under RCP8.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

- For Spring/Autumn the RCP8.5 projections suggest a long-term reduction/increase according to the medians (noting that these do *not* represent predictions) but otherwise no trends

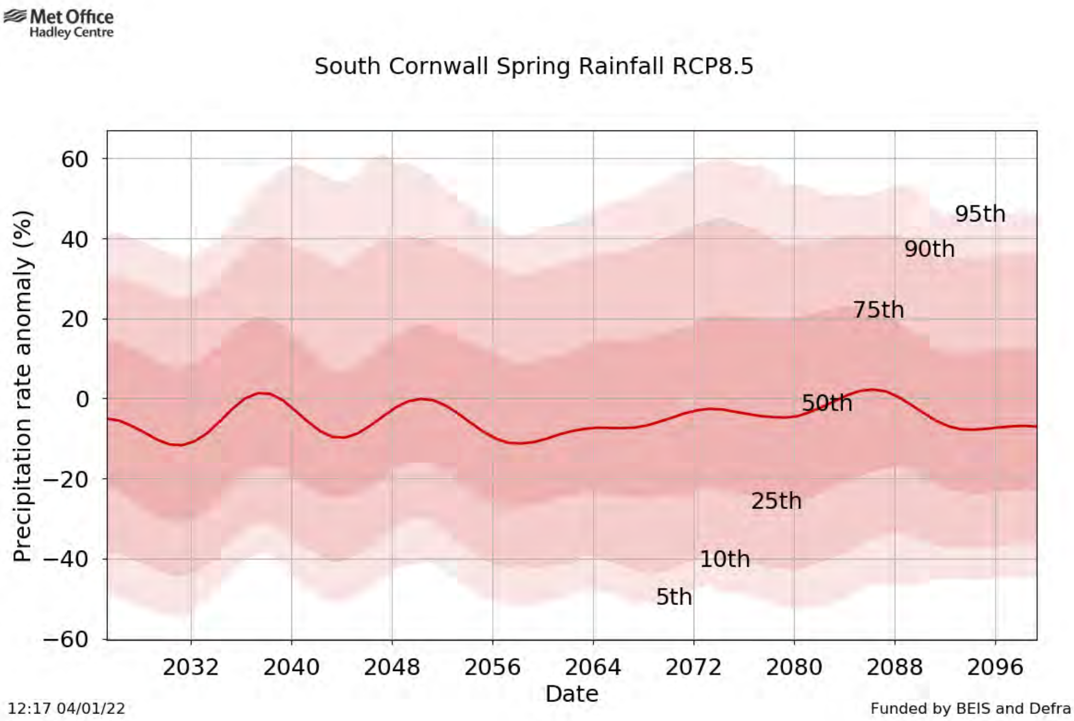


Figure 42. UKCP18 spring rainfall projections 2025 to 2100 for south-central Cornwall under RCP8.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

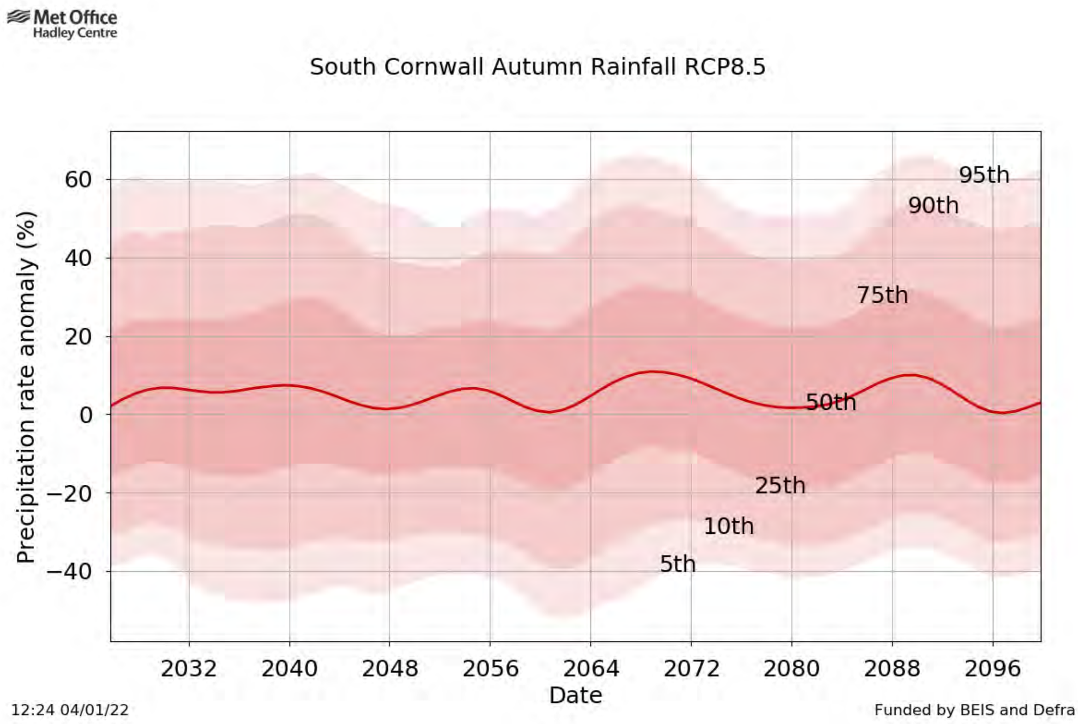


Figure 43. UKCP18 autumn rainfall projections 2025 to 2100 for south-central Cornwall under RCP8.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

- For Winter/Summer the RCP8.5 projections suggest, based on the medians (*not* predictions), possible immediate increases/decreases in totals, with an upward trend in winter rainfall from around 2070 and a downward trend in summer rainfall from around 2050

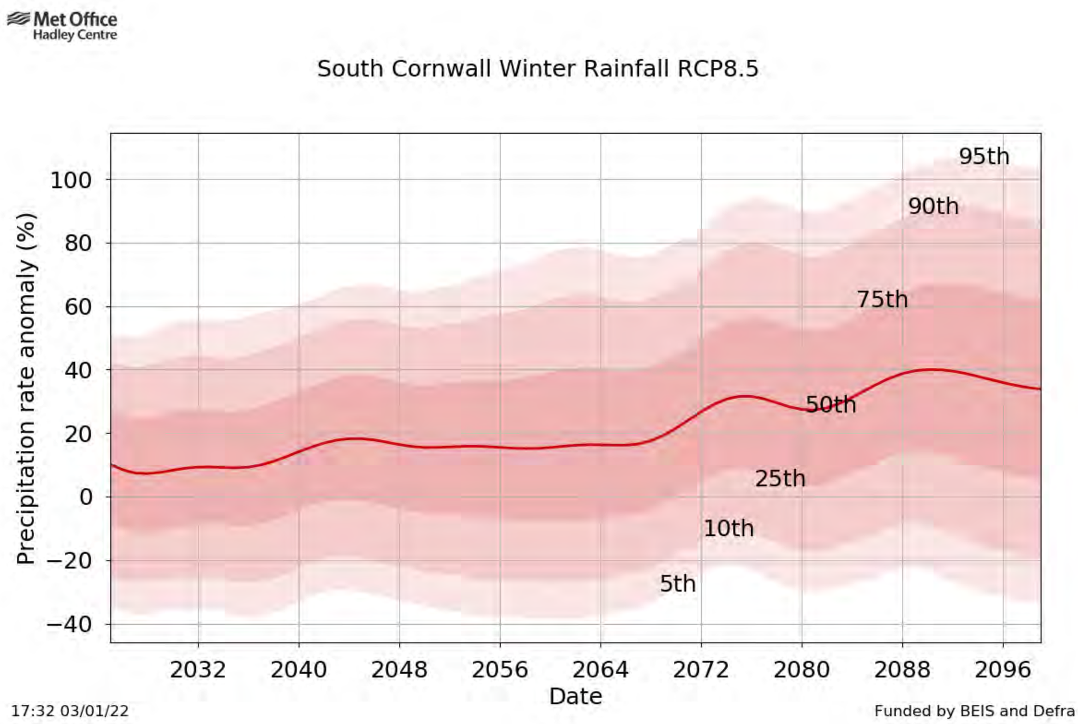


Figure 44. UKCP18 winter rainfall projections 2025 to 2100 for south-central Cornwall under RCP8.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

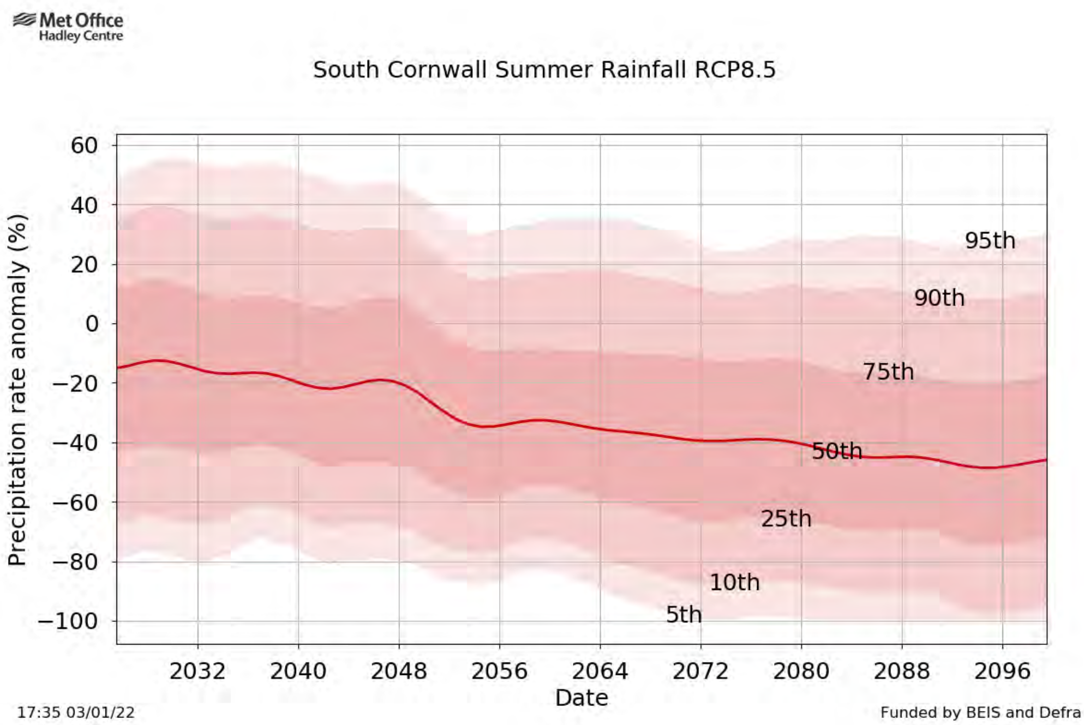
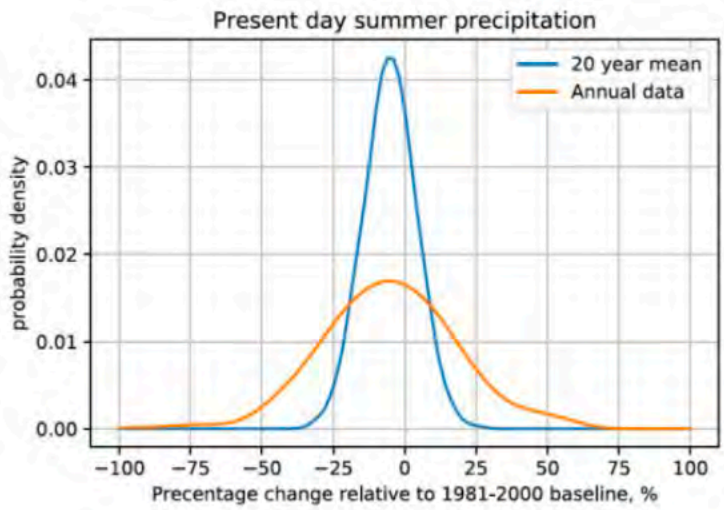


Figure 45. UKCP18 summer rainfall projections 2025 to 2100 for south-central Cornwall under RCP8.5 as anomalies from 1981 to 2000; the heavy line indicates the median with selected percentiles marked and shaded

- The downward trend in summer rainfall according to the medians (i.e. not all projections are consistent in giving a decrease) is evident under all RCPs, marginal for RCP2.6 but strengthening as emissions increase; in all cases the median lies close to or below -20% by 2100.
- Similarly the upward trend in winter rainfall is evident post about 2070 for all RCPs, marginally for RCP2.6 but increasing with emissions; there is minimal change in the increase according to the median up to 2070 for all emissions
- UKCP18 Summary Statements:
    - At 2ºC of global warming: Percentage precipitation changes vary seasonally with some indication of drier summers and slightly wetter winters.
    - At 4ºC of global warming: Precipitation changes indicate wetter winters and drier summers, with summer drying largest in the south with median reductions of 40 to 60% possible across England and Wales

Main Points from CCRA3 for Mean Precipitation

- Winters will become wetter overall and summers drier; nevertheless wetter summers are also possible



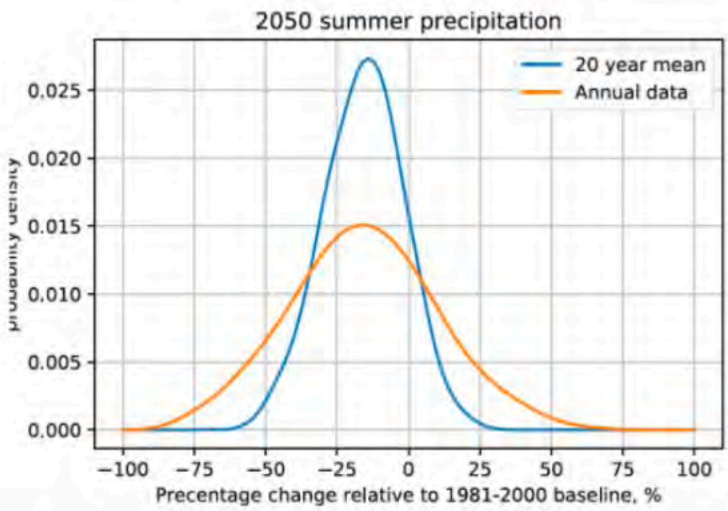


Figure 46. Distributions of annual and 20-year mean UK summer rainfall totals anomalies at present and by 2050 compared to 1980 to 2000 based on RCP8.5; there is an approximate 10% shift in the median towards drier totals by 2050

- For summer, regardless of projection set or of emissions, in relative terms across the UK, Cornwall will see some of the greatest decreases in seasonal rainfall totals

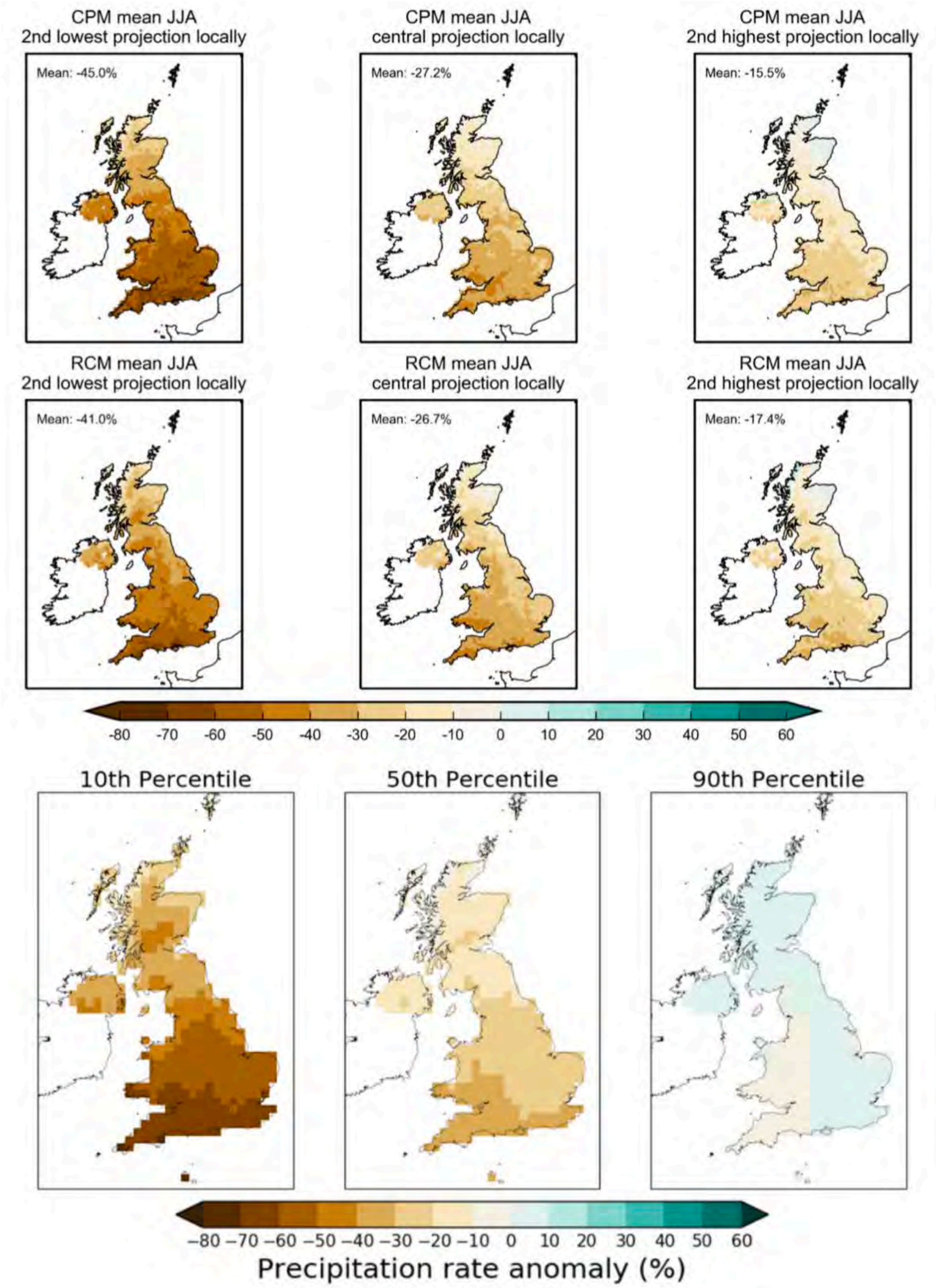


Figure 47. Summer mean projections for 2061 to 2080 from 1981 to 2000 for three different UKCP18 projections sets, 2.2km along top row, 12km along second row, and 25km (as used in the UKCP18 section above) along the bottom row.

- Equivalently, in winter, regardless of projection set or of emissions, in relative terms across the UK, Cornwall will see some of the greatest increases in seasonal rainfall totals alongside many other coastal regions.

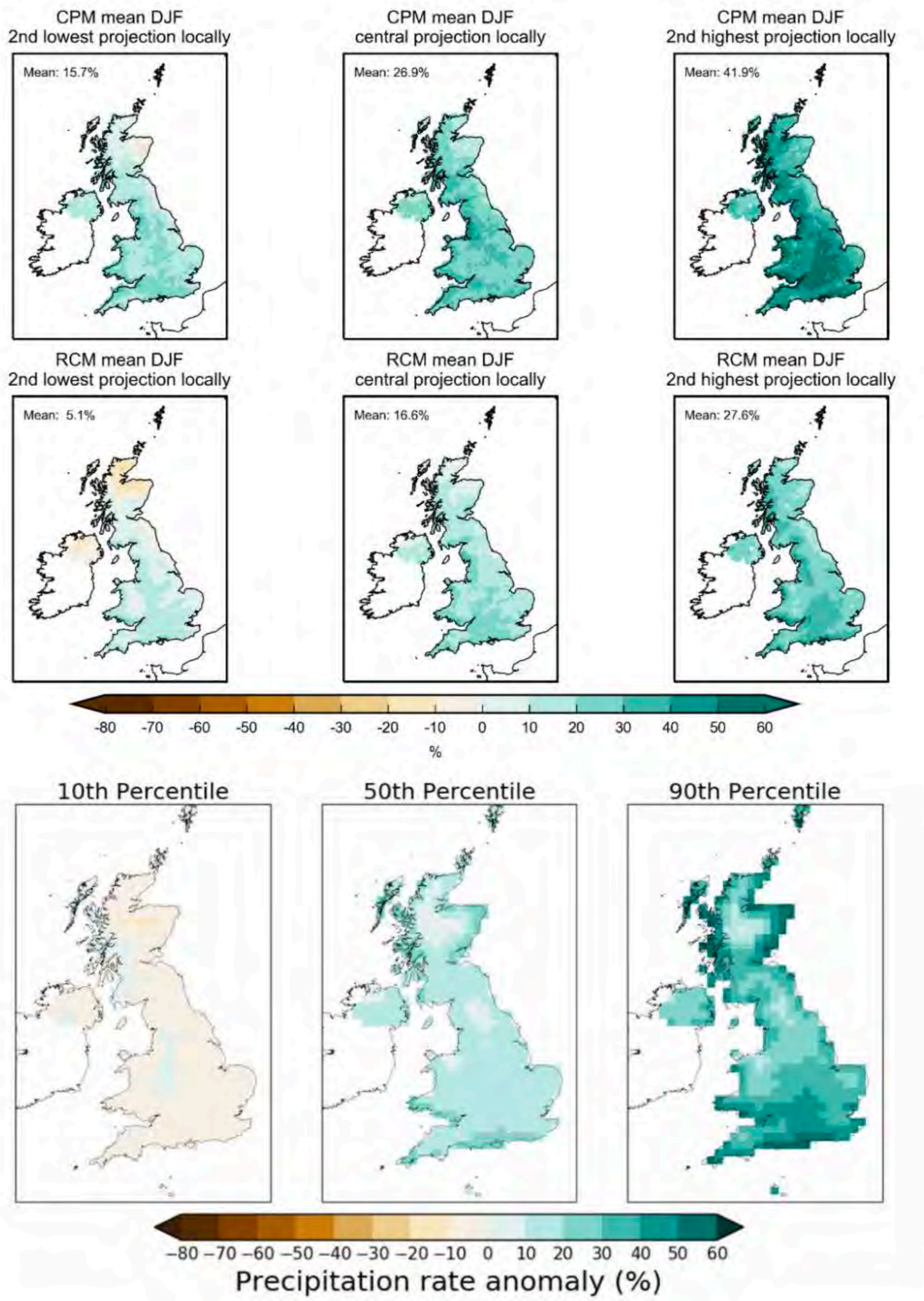


Figure 48. Winter mean projections for 2061 to 2080 from 1981 to 2000 for three different UKCP18 projections sets, 2.2km along top row, 12km along second row, and 25km (as used in the UKCP18 section above) along the bottom row.

- The signal of increasing rainfall with global temperature increase is strongest in the west, including much of Cornwall; tests of strength indicate signals are strongest over Scotland but that significant signals are present over east Cornwall.

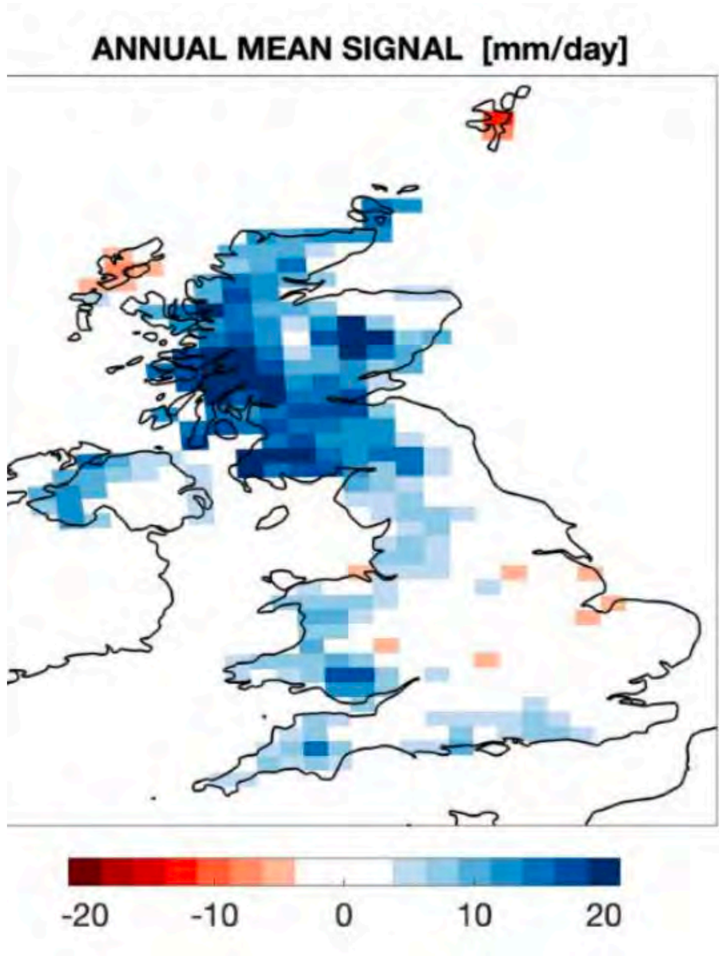


Figure 49. Change in rainfall per ºC of rise in the global mean temperature, from the CCRA3.

CID Grouping – Wet and Dry

River flood - Episodic high water levels in streams and rivers driven by basin runoff and the expected seasonal cycle of flooding

High confidence impacts (dark shading in Table 1) on: ***lakes, rivers and wetlands; streamflow and surface water; crop systems; livestock and pasture systems; cities; land and water transportation; built environment; mortality; housing stock; farmland; livestock mortality.***

Low/moderate confidence impacts (light shading in Table 1) on: ***temperate and boreal forests; grasslands and savannah; coastal land and inertial zones; coastal seas; aquifers and groundwater; water quality; forestry systems; fisheries and aquaculture systems; energy infrastructure.***

Overall Summary for River Flood

Trends:

- Detection of trends in river flooding is complex and dependent upon the time period examined
- There is some evidence that while flooding over NEU has decreased that over southern UK specifically has increased

Projections:

- Difficult to provide details specific to Cornwall as each flooding event is dependent upon a variety of climate plus other factors
- Nevertheless there is an indication of the potential for a future increase in the number of flooding events especially in, but not necessarily limited to, winter
- Given projections of higher rainfall intensities at times it is reasonable to suggest that events such as the 1952 Lynmouth and 2004 Boscastle floods will occur into the future, perhaps with increased intensity; note that both of these were summer rather than winter events

Examples of impacts based on CIDs:

- On businesses and infrastructure in general, on transport, on cities, on crop systems (HC)
- On water quality and water delivery, on forestry, on energy systems (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: businesses, soils, freshwater species, water safety, property and infrastructure, etc.
- Areas carrying risks and opportunities include: landscape character
- Areas carrying opportunities include: none immediately apparent

More Detail on Trends for River Flood

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for River Flood

- Decreasing trend in flooding over NEU (MC), but the report specifically *excludes* southern England

- From SR1.5 an increasing number of reported UK floods 1884-2013

More Detail on Projections for River Flood

Main Points from IPCC WGI AR6 for the globe and for NEU for River Flood

- Increases in heavy precipitation under a warmer atmosphere increase the potential severity of flood hazards (HC)
- Increases in precipitation variability in a warmer climate increase the likelihood both of flooding and of drought
- Exposure to flooding hazard increases as atmosphere gets warmer (MC)
- In a paper published subsequent to the AR6 it was established that tropical cyclone tracks have shifted a little polewards (without evidence for changes in frequency or severity); this possibly implies more frequent passage of ex-tropical cyclones across the North Atlantic towards the UK

Main Points from UKCP18 for River Flood

- UKCP18 appears to provide no specific details on future river flooding (as the focus is on climate changes rather than on complex impacts)

Main Points from CCRA3 for River Flood

- A projected shift towards relatively mobile cyclonic weather systems, particularly in winter, may increase the threat of flooding particularly over western UK
- Sub-daily precipitation intensity is related to increases in local flash flooding

CID Grouping – Wet and Dry

Heavy precipitation and fluvial flood - High rates of precipitation and resulting episodic, localised flooding of streams and flat lands

High confidence impacts (dark shading in Table 1) on: *streamflow and surface water; crop systems; cities; land and water transportation; built environment;* ***mortality.***

Low/moderate confidence impacts (light shading in Table 1) on: *temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; aquifers and groundwater; water quality; livestock and pasture systems; housing stock; farmland; livestock mortality.*

Overall Summary for Heavy Precipitation and Fluvial Flood

Trends:

- As with trends in mean rainfall, trends in heavy rainfall may vary, even in direction, when assessed over different periods, perhaps through data issues, including the handling of the relative rarity of such events, or perhaps through the complexities of those atmospheric changes that control rainfall totals
- Nevertheless while the IPCC has presented evidence for increasing heavy precipitation over NEU as a whole the evidence is not as compelling over SWESW, although CCRA3 states that the UK has experienced unprecedented heavy rainfall events
- There appears to be no evidence for any possible trends in fluvial flooding

Projections:

- Most evidence points to increases in heavy rainfall events, both in terms of frequency and in terms of intensity
- Increases are expected to occur through the year, even in summer when mean rainfall is likely to decrease
- Increases are likely also to be greater with higher emissions/exacerbated global warming
- Any increases in frequency or intensity of heavy rainfall events are likely to lead to increases in fluvial flooding

Examples of impacts based on CIDs:

- On all aspects of the surface water systems and on crops, on cities and on transportation, and perhaps on mortality (HC)
- On several other environmental and ecological aspects, on aquifers and groundwater, on water quality, as well as non-cropping production (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: business and general infrastructure, agriculture, forests, freshwater species and habitats, water supply and quality, food safety and security, etc.
- Areas carrying risks and opportunities include: agricultural and forestry productivity, landscape character, business for new goods and services, landscape character, etc.
- Areas carrying opportunities include: new species colonisation on land and in water, new agricultural and forestry production, etc.

More Detail on Trends for Heavy Precipitation and Fluvial Flood

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Heavy Precipitation and Fluvial Flood

- Heavy precipitation has intensified over NEU and that there are changes in flood seasonality associated with snow melt (HC)

Main Points from MONCIC for South-West England and South Wales Heavy Precipitation and Fluvial Flood

- Data for the number of days with more than 1mm of rainfall across the SWESW region illustrate the difficulties of assessing trends given dependencies on the periods analysed; the annual time series from 1891 to 2021 suggests that there was a peak in heavy rainfall events (as indicated by days with at least 1mm) early in the 20th Century, followed by a decline to relatively lower frequencies of days in the 1950s and 1960s, with a possible recovery since
- The overall negative trend in heavy rain days is marginally significant over 1891 to 2021 while the increasing trend from 1979 to 2021 is not significant

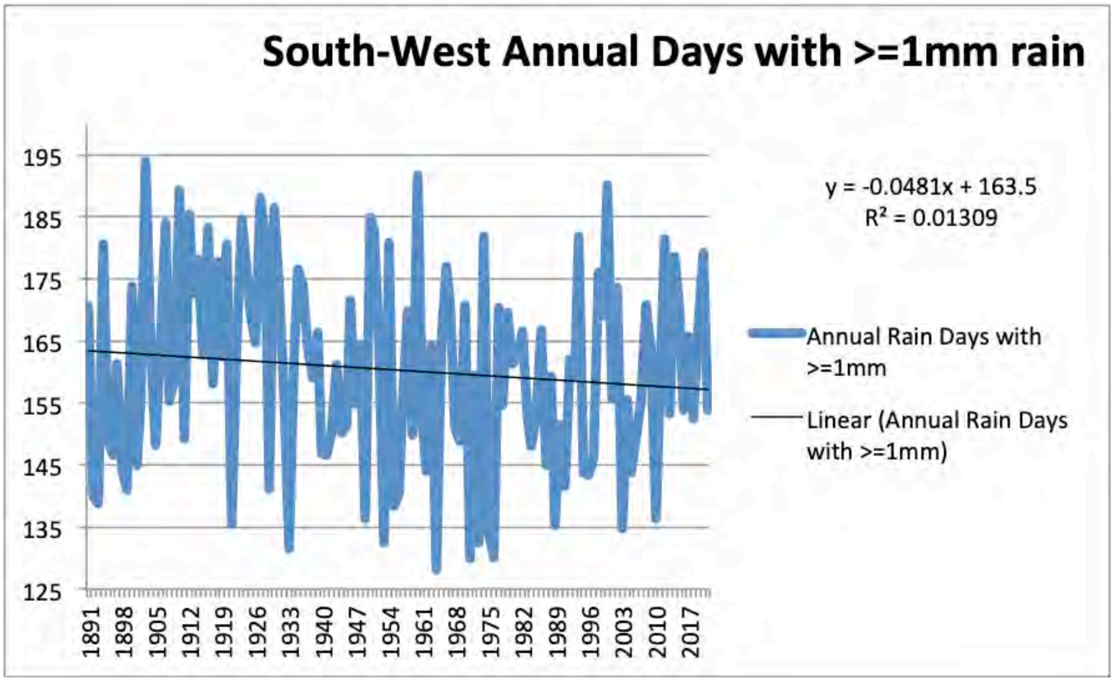


Figure 50. Time series of the annual number of days with heavy rainfall (i.e. at least 1mm) over SWESW from 1881 to 2021

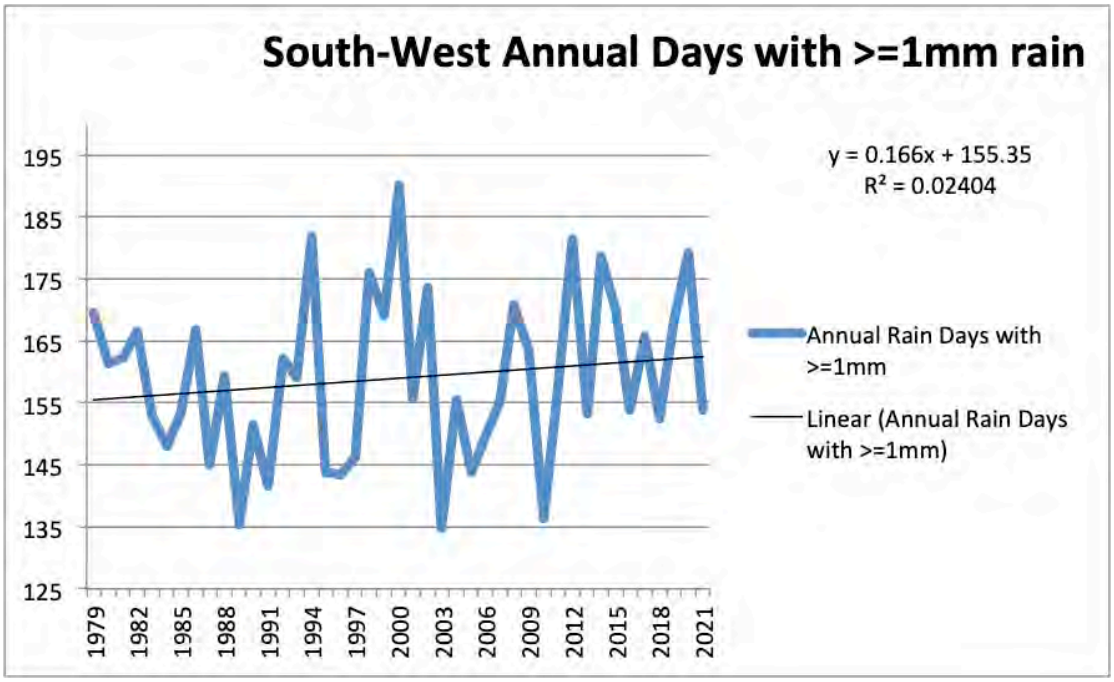


Figure 51. Time series of the annual number of days with heavy rainfall (i.e. at least 1mm) over SWESW from 1979 to 2021

- Seasonal trends for numbers of rain days with at least 1mm over 1979 to 2021 vary in sign but none are statistically significant (positive in winter and summer; negative in spring; no trend in autumn)

Main Points from CCRA3 for Heavy Precipitation and Fluvial Flood

- The UK has experienced unprecedented heavy rainfall
- Heavy rainfall extremes are intensifying with global warming at rate consistent with the increase in atmospheric moisture (7% per ºC)

More Detail on Projections for Heavy Precipitation and Fluvial

Main Points from IPCC WGI AR6 for the globe and for NEU for Heavy Precipitation and Fluvial Flood

- The severity of heavy precipitation events increases in a warmer climate (HC)
- The intensification of heavy rainfall will continue into the future, and will be exacerbated with higher degrees of warming (compared to 1995-2014 MC to VL as warming increases; compared to pre-industry HC to EL as warming increases)
- Projections from CMIP6 for the annual numbers of days with rainfall of at least 1mm and at least 5mm suggest that neither increases except perhaps marginally under SSP1-2.6 but that there are definite positive trends under SSP5-8.5
- Confidence in the conclusion that heavy precipitation will intensify increases with higher emissions

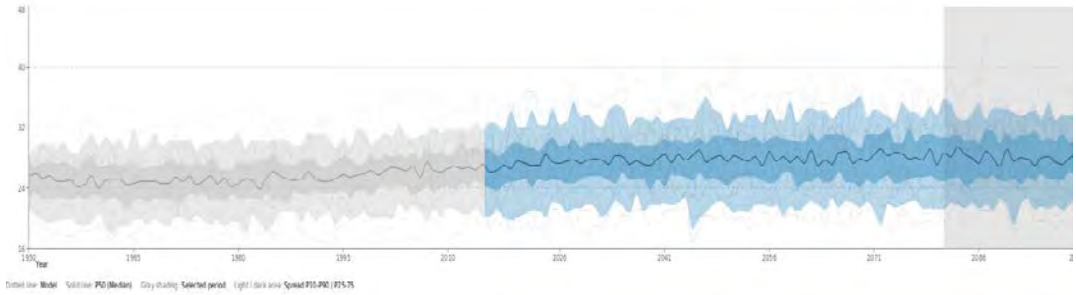


Figure 52. Projected annual number of days with rainfall of at least 1mm over NEU from CMIP6 under SSP1-2.6

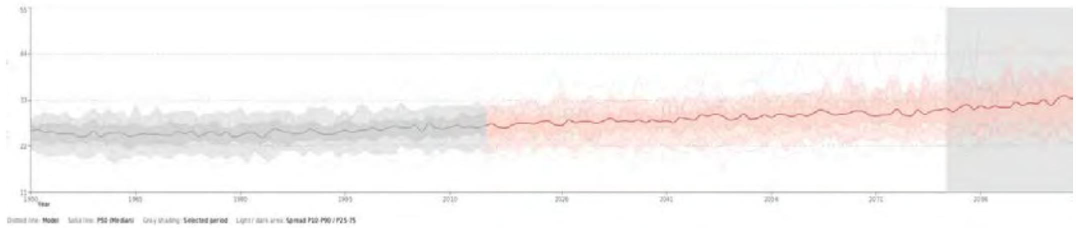


Figure 53. Projected annual number of days with rainfall of at least 1mm over NEU from CMIP6 under SSP5-8.5

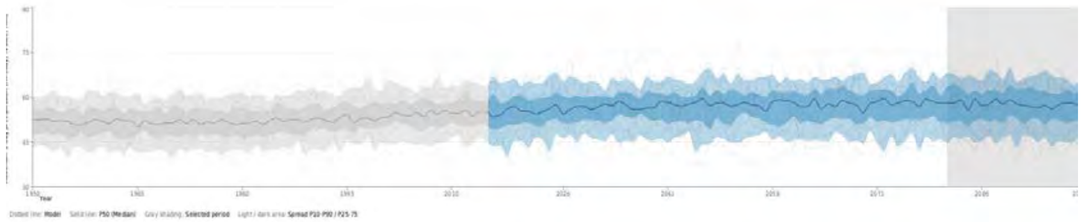


Figure 54. Projected annual number of days with rainfall of at least 5mm over NEU from CMIP6 under SSP1-2.6

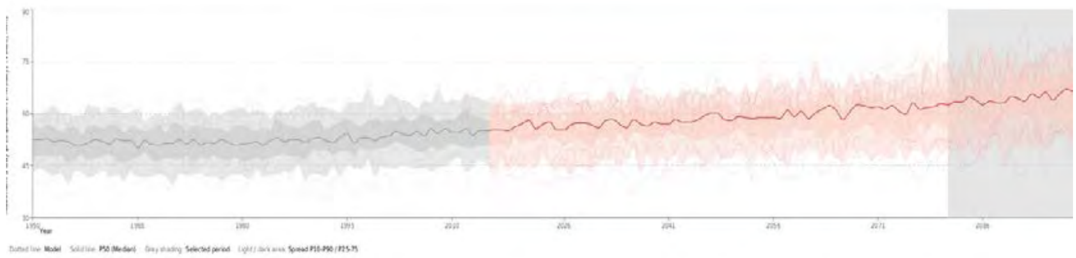


Figure 55. Projected annual number of days with rainfall of at least 5mm over NEU from CMIP6 under SSP5-8.5

Main Points from UKCP18 for Heavy Precipitation and Fluvial Flood

- UKCP18 projections for South Cornwall suggest that heavy rainfall events, as represented by the rainfall totals over 1 day and over 5 days of rainfall, are likely to increase, perhaps only marginally under RCP2.6 but more distinctly under RCP8.5; the figures following illustrate the projections for winter

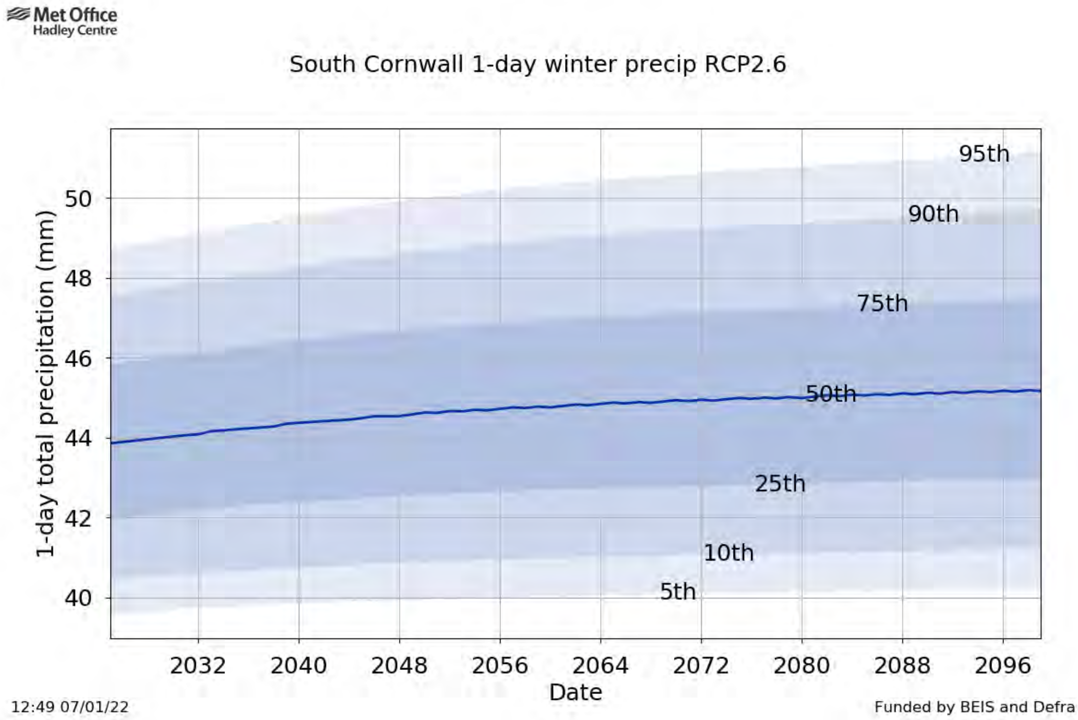


Figure 56. Projected winter 1-day rainfall totals over South Cornwall under RCP2.6

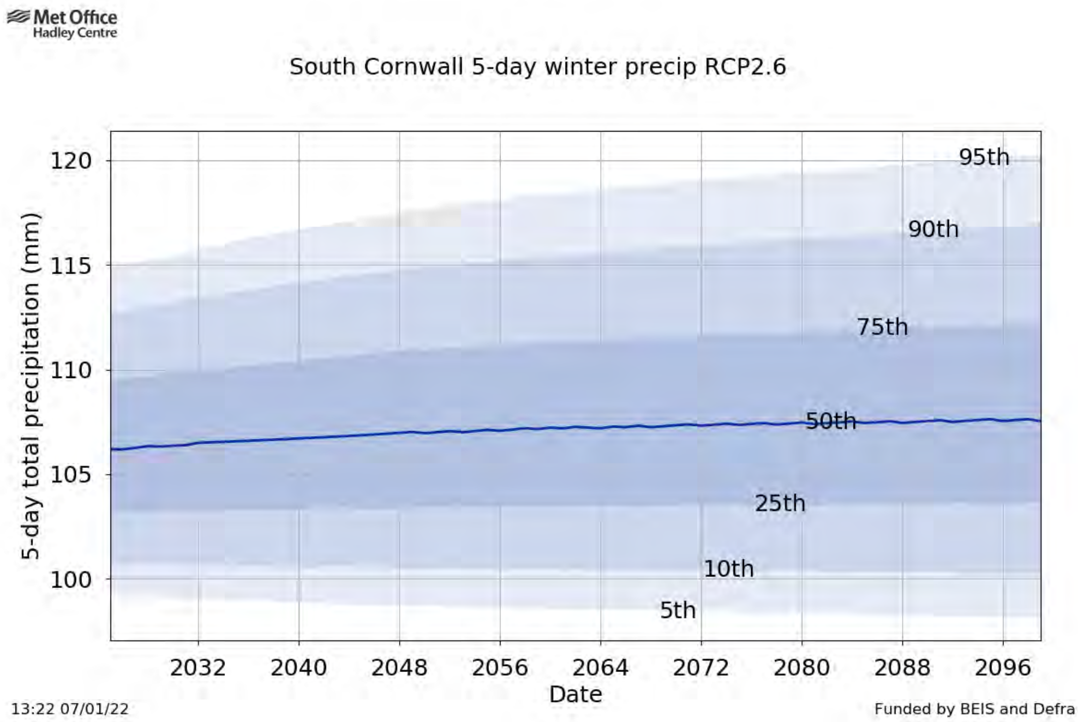


Figure 57. Projected winter 5-day rainfall totals over South Cornwall under RCP2.6

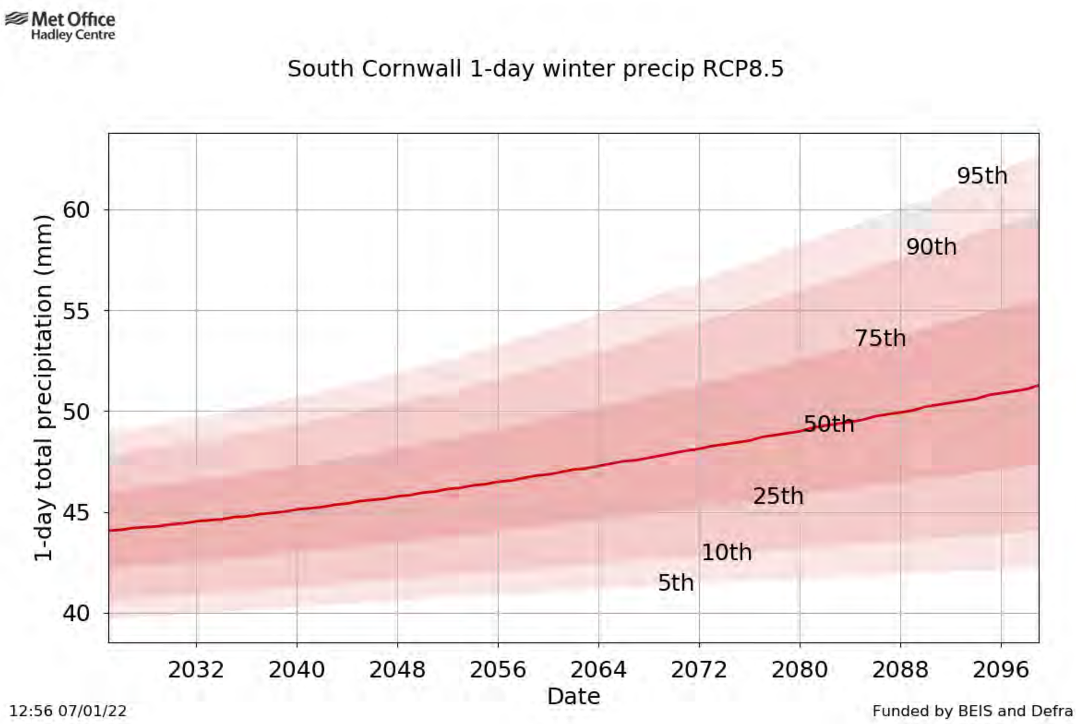


Figure 58. Projected winter 1-day rainfall totals over South Cornwall under RCP8.5

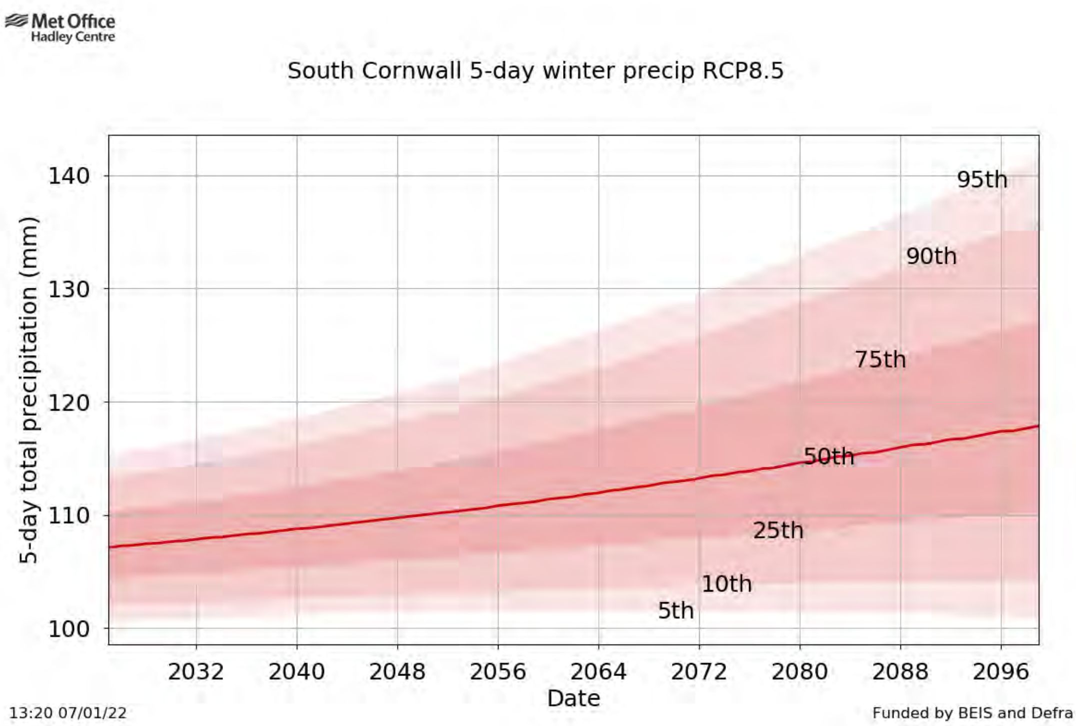


Figure 59. Projected winter 5-day rainfall totals over South Cornwall under RCP8.5

Main Points from CCRA3 for Heavy Precipitation and Fluvial Flood

- Estimates using an advanced model indicate that both the frequency of wet days and the intensity of rainfall on wet days is likely to increase in winter, including over Cornwall

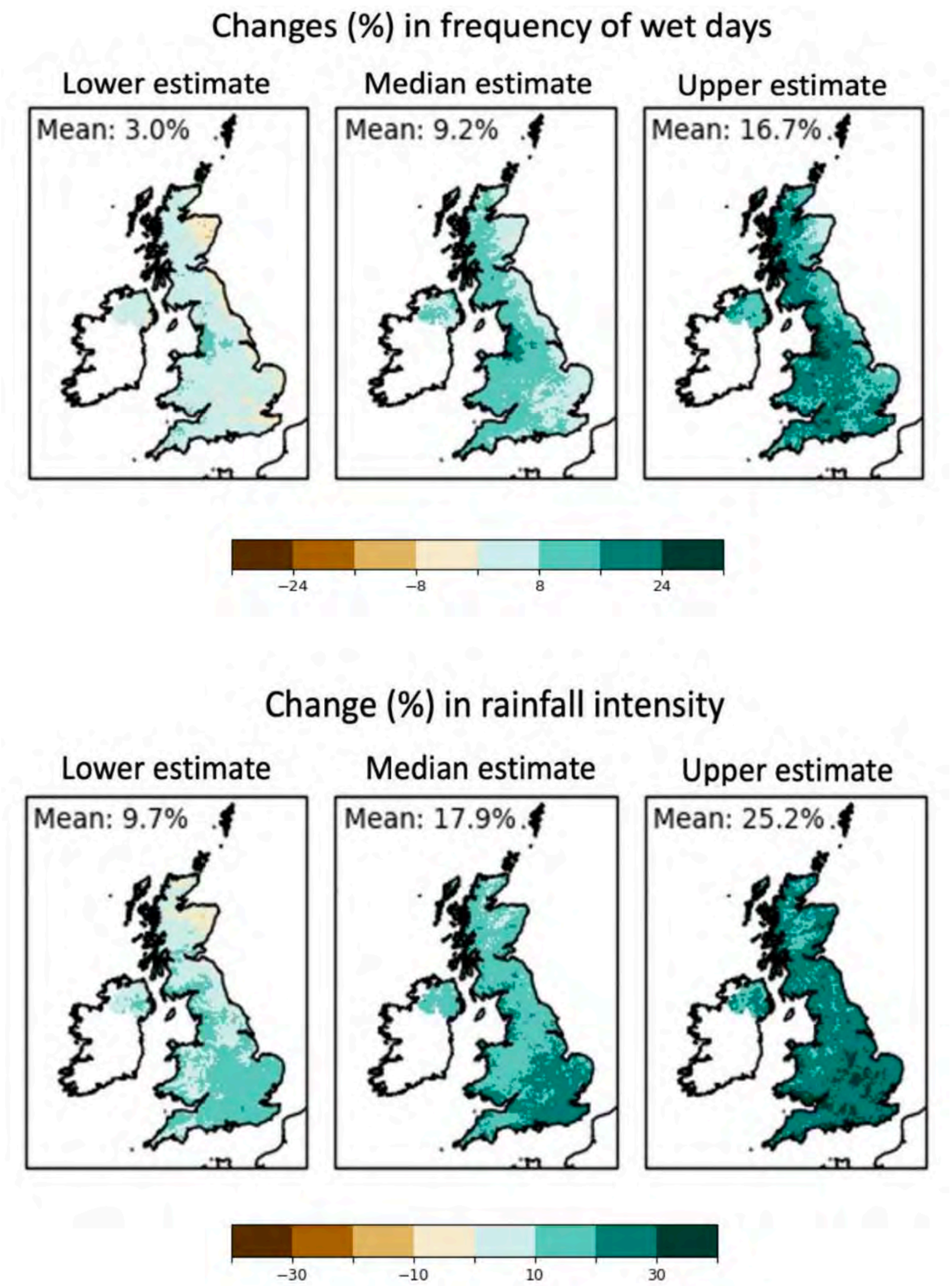


Figure 60. Ranges of projections of the frequencies of wet days and of the change in rainfall intensity on wet days under RCP8.5 for winters in 2061 to 2080 as against 1981 to 2000.

- Equivalently, in summer the frequency of wet days is likely to decrease over Cornwall but with an increase in rainfall intensity on wet days

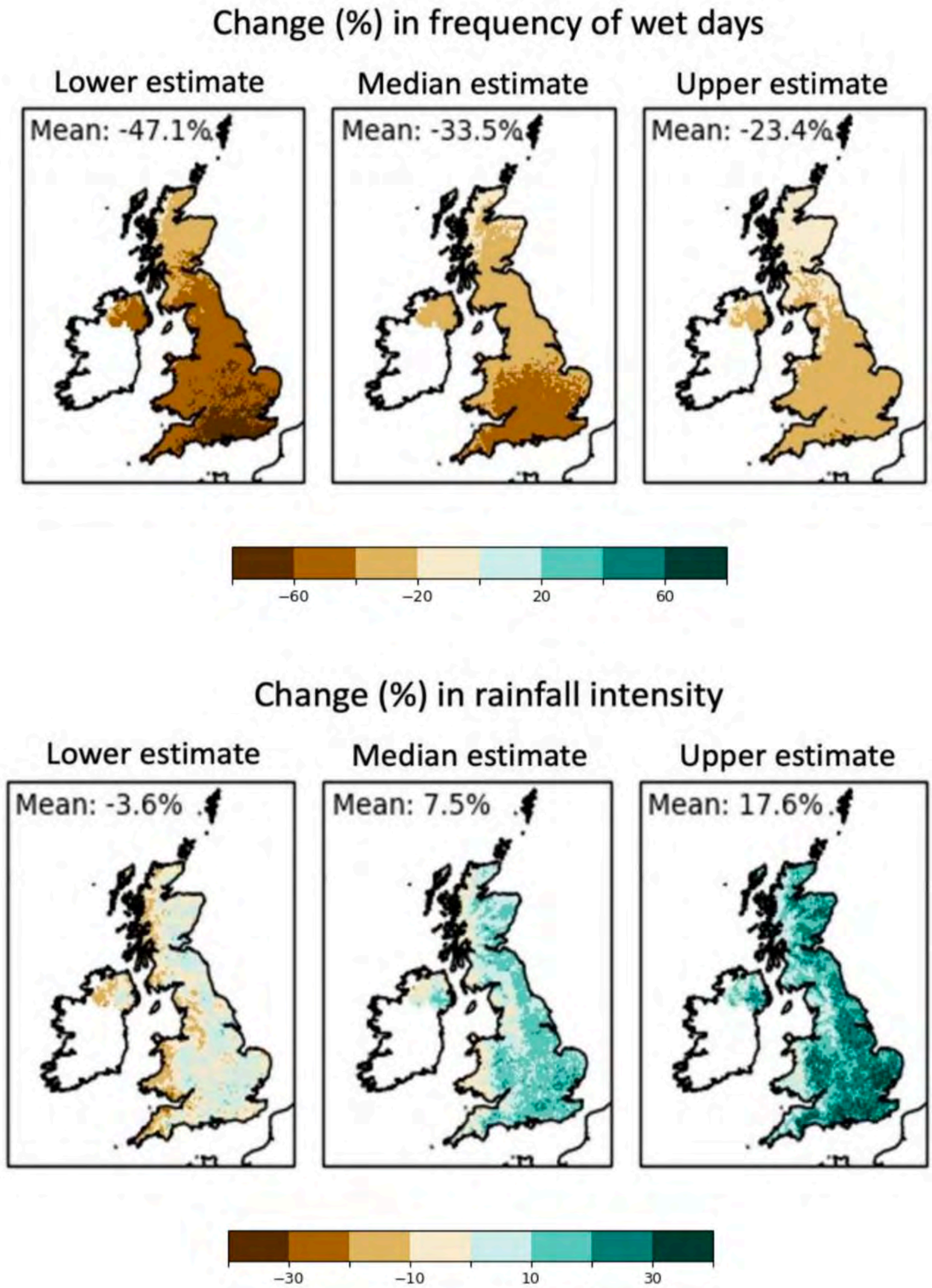


Figure 61. Ranges of projections of the frequencies of wet days and of the change in rainfall intensity on wet days under RCP8.5 for summers in 2061 to 2080 as against 1981 to 2000.

- Increases in rainfall frequency and intensity will contribute towards increases in severe flooding

CID Grouping – Wet and Dry

Landslide - Ground and water atmospheric conditions that lead to geological mass movements, including landslide, mudslide, and rockfall

High confidence impacts (dark shading in Table 1) on: mortality.

Low/moderate confidence impacts (light shading in Table 1) on: coastal land and inertial zones; cities; land and water transportation; built environment; housing stock; farmland.

Overall Summary for Landslide

Trends:

- There appears to be limited information on any trends in landslides, either in NEU or in SWESW

Projections:

- Given that multiple factors in addition to weather/climate drive landslides, there are only indirect assessments of what might happen in future; given the possibility of heavier rainfall events in winter (in particular, but other seasons also) it is surmised that the risk of landslides will increase

Examples of impacts based on CIDs:

- On mortality (HC)
- On coastal land and inertial zones, and on other infrastructure of any form, on farmland (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: food and water supply and quality, etc.
- Areas carrying risks and opportunities include: none identified
- Areas carrying opportunities include: none identified

More Detail on Trends for Landslide

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU Landslide

- No trends in landslide frequencies or severities detected (LC)

Main Points from CCRA3 for Landslide

- Not mentioned

More Detail on Projections for Landslide

Main Points from IPCC WGI AR6 for the globe and for NEU for Landslide

- No details provided for NEU, but do provide comments suggesting likely increases for other parts of Europe

Main Points from UKCP18 for Landslide

- None made

Main Points from CCRA3 for Landslide

- With the possibility of heavier future rainfall, particularly in, but not necessarily limited to, winter, the risk of landslides will increase
- A further possible risk from abrupt thaws leading to landslides

CID Grouping – Wet and Dry

Aridity - Mean conditions of precipitation and evapotranspiration compared to potential atmospheric and surface water demand, resulting in low mean surface water, low soil moisture and/or low relative humidity

High confidence impacts (dark shading in Table 1) on*: grasslands and savannah; aquifers and groundwater; streamflow and surface water; crop systems; livestock and pasture systems; forestry systems; farmland.*

Low/moderate confidence impacts (light shading in Table 1) on: *temperate and boreal forests; lakes, rivers and wetlands; coastal land and inertial zones; water quality; cities; land and water transportation; energy infrastructure; morbidity; recreations and tourism; indigenous traditions.*

Overall Summary for Aridity

Overview note:

- The term 'aridity' is treated here as synonymous with 'meteorological drought', i.e. a deficit of rainfall over a long period as compared with the long-term mean, despite the official IPCC definition given above. This approach permits ready differentiation in treatment with the two following sections on 'Hydrological Drought' and 'Agricultural and Ecological Drought'.

Trends:

- See the section on Mean Precipitation also
- There is no evidence for any change in drought frequency or severity over Cornwall in recent history, notwithstanding any recent drought occurrences
- Summer is the season most at risk from aridity, but the trend since 1979 over SWESW is positive without statistical significance
- **However**, in a separate paper focussed on Cornwall, Kosanic *et al.* (2014) noted that station data up to about 2010 (from various starting dates) differed from those at the national scale indicating negative *annual* trends.
- Trends in rainfall may vary, even in direction, when assessed over different periods, perhaps through data issues or perhaps through the complexities of those atmospheric changes that control rainfall totals

Projections:

- Projections point in general to a decrease in rainfall and an increase in aridity (exacerbated by higher temperatures) particularly in summer later in the century
- Changes in aridity, and in seasonality with projected increases in winter rainfall, will be more severe under higher emissions
- The projections as noted above do not eliminate the possibility of future aridity in some years in any season, nor of high rainfall in some summer seasons

Examples of impacts based on CIDs:

- On surface ecology, on all aspects of surface and sub-surface water systems and on agricultural production in all forms (HC)
- On rivers, lakes and forest, on several other environmental and ecological aspects including coastal ecology, as well as non-cropping production, on energy and other infrastructure, morbidity and tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: agriculture, forests, terrestrial and aquatic species and habitats/soil, water supply and quality, food safety, property and infrastructure, etc.
- Areas carrying risks and opportunities include: agricultural and forestry productivity, landscape character, etc.
- Areas carrying opportunities include: carbon stores, new agricultural and forestry production, etc.

More Detail on Trends for Aridity

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Aridity

- For NEU a decrease in aridity (HC)
- Meteorological drought may have decreased in intensity and frequency over NEU but results are dependent upon measurement index, time frame and region

Main Points from MONCIC for South-West England and South Wales for Aridity

- Details of the rainfall trend analysis for SWESW were presented in the section on Mean Precipitation
- In summary: only annual rainfall and DJF rainfall over 1982 to 2020 contained statistically significant positive trends. Trends (non-significant) in the season with greatest risk of aridity, summer, were negative over 1862 to 2021 but positive over 1979 to 2021

Main Points from CCRA3 for Aridity

- Details for SWESW were presented in the section on Mean Precipitation
- In summary: CCRA3 is consistent with the MONCIC analysis above suggesting no detectable decrease in summer rainfall

More Detail on Projections for Aridity

Main Points from IPCC WGI AR6 for the globe and for NEU for Aridity

- Drought frequency and severity will decrease over NEU (MC)
- HC that decreasing trends in JJA rainfall will develop later in the century over Cornwall (see also section on Mean Precipitation)
- With projected winter rainfall increases and summer decreases later in the century a change in rainfall seasonality is expected, the more likely under higher emissions

Main Points from UKCP18 for Aridity

- Details for South Cornwall were presented in the section on Mean Precipitation

- In summary: there is a likely downwards trend in summer rainfall under all RCPs, marginal for RCP2.6 but strengthening with higher emissions
- Changes in seasonality become more prominent under higher emissions

Main Points from CCRA3 for Aridity

- Meteorological droughts are expected to become more severe, partly resulting from summers (and perhaps other seasons) with decreased rainfall and partly from increased temperatures
- There are some inconsistencies (not detailed here – see p53 of CCRA3) between circulation changes and rainfall changes in UKMO projections
- See also the DSI chart in the 'Agricultural and Ecological Drought' section

CID Grouping – Wet and Dry

Hydrological drought - Episodic combination of runoff deficit and evaporative demand that lead to dry soil

High confidence impacts (dark shading in Table 1) on: *lakes, rivers and wetlands; streamflow and surface water; crop systems; land and water transportation; livestock mortality*.

Low/moderate confidence impacts (light shading in Table 1) on: *grasslands and savannah; coastal land and inertial zones; aquifers and groundwater; water quality; livestock and pasture systems; fisheries and aquaculture systems; cities; energy infrastructure; morbidity; mortality; recreations and tourism*.

Overall Summary for Hydrological Drought

Overview note:

- From a climate perspective there is minimal difference between 'aridity' as treated in the previous section and 'hydrological drought' but noting that additional non-climate factors are involved in the latter; thus meteorological drought and hydrological drought do not occur necessarily simultaneously

Trends:

- No trends in hydrological droughts have been detected, but the same issues as treated under the 'Mean Precipitation' and 'Aridity' sections apply

Projections:

- The consensus position, based on IPCC WGI AR6 and CCRA3 is that the severity of hydrological droughts will increase in future, particularly later in the century; the season with highest risk is summer, but the risk cannot be neglected in the other seasons

Examples of impacts based on CIDs:

- On all aspects of the surface water systems and on crops and livestock mortality, on land and water transportation (HC)
- On several other environmental and ecological aspects including coastal and aquifers, as well as non-cropping production, water quality, energy infrastructure, health and tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: soils, agriculture, forests, water supply and quality, food safety, property and infrastructure, etc.
- Areas carrying risks and opportunities include: agricultural and forestry productivity, landscape character, etc.
- Areas carrying opportunities include: new species colonisation on land and in water, new agricultural and forestry production, etc.

More Detail on Trends for Hydrological Drought

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Hydrological Drought

- Trends in hydrological drought not detected over NEU (LC)

Main Points from MONCIC for South-West England and South Wales for Hydrological Drought

- As in the 'Mean Precipitation' and 'Aridity' sections, there are no statistically significant negative trends in rainfall in any season over SWESW

Main Points from CCRA3 for Hydrological Drought

- CCRA3 is consistent with the MONCIC analysis above suggesting no detectable decrease in summer rainfall

More Detail on Projections for Hydrological Drought

Main Points from IPCC WGI AR6 for the globe and for NEU for Hydrological Drought

- Limited trends over the UK (LC) but perhaps an increase in drought in summer under 4ºC of global warming
- Drought frequency and severity will decrease over NEU (MC)
- HC that decreasing trends in JJA rainfall will develop later in the century over Cornwall (see also section on Mean Precipitation)
- With projected winter rainfall increases and summer decreases later in the century a change in rainfall seasonality is expected, most likely under higher emissions

Main Points from UKCP18 for Hydrological Drought

- Details for South Cornwall were presented in the section on Mean Precipitation

Main Points from CCRA3 for Hydrological Drought

- Hydrological droughts are expected to become more severe in future, with some drier seasons and exacerbating higher temperatures
- Severity increases with the degree of warming, of particular consequence to hydrological droughts
- See also the DSI diagram in the 'Agricultural and Ecological Drought' section

CID Grouping – Wet and Dry

Agricultural and ecological drought - Episodic combination of soil moisture supply deficit and atmospheric demand requirements that challenge the vegetation's ability to meet its water needs for transpiration and growth [Note: 'agricultural' vs. 'ecological' term depends on affected biome]

High confidence impacts (dark shading in Table 1) on: temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; crop systems; livestock and pasture systems; forestry systems; livestock mortality.

Low/moderate confidence impacts (light shading in Table 1) on: coastal land and inertial zones; built environment.

Overall Summary for Agricultural and Ecological Drought

Overview note:

- From a climate perspective there is minimal difference between 'aridity' as treated in the earlier section and either 'hydrological drought' or 'agricultural and ecological drought' but noting that additional non-climate factors are involved in both latter; thus the different types of drought do not occur necessarily simultaneously

Trends:

- No trends in agricultural and ecological droughts have been detected, but the same issues as treated under the 'Mean Precipitation' and 'Aridity' sections apply

Projections:

- The consensus position, based on IPCC WGI AR6 and CCRA3, is that the severity of agricultural and ecological droughts will increase in future, particularly later in the century; the season with highest risk is summer, but the risk cannot be neglected in the other seasons
- Drought intensity over Cornwall may approach levels experienced elsewhere in the UK

Examples of impacts based on CIDs:

- On forests, grasslands, all aspects of the surface water systems and on crops and all types of agricultural production, on livestock mortality (HC)
- On several other environmental and ecological aspects, including coastal zones, on the built environment in general (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: agriculture, forests, water supply and quality, food safety, property and infrastructure, etc.
- Areas carrying risks and opportunities include: carbon stores, agricultural and forestry productivity, landscape character, etc.
- Areas carrying opportunities include: new species colonisation on land and in water, new agricultural and forestry production, etc.

More Detail on Trends for Agricultural and Ecological Drought

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Agricultural and Ecological Drought

- LC in any direction of any trend for agricultural and ecological drought over NEU

Main Points from MONCIC for South-West England and South Wales for Agricultural and Ecological Drought

- As in the 'Mean Precipitation', 'Aridity' and 'Hydrological Drought' sections, there are no statistically significant negative trends in rainfall in any season over SWESW

Main Points from CCRA3 for Agricultural and Ecological Drought

- CCRA3 is consistent with the MONCIC analysis above suggesting no detectable decrease in summer rainfall

More Detail on Projections for Agricultural and Ecological Drought

Main Points from IPCC WGI AR6 for the globe and for NEU for Agricultural and Ecological Drought

- LC on the future direction of any trends in agricultural and ecological droughts over NEU but winter droughts may reduce in frequency

Main Points from UKCP18 for Agricultural and Ecological Drought

- Details are summarised in the 'Aridity' section

Main Points from CCRA3 for Agricultural and Ecological Drought

- Agricultural droughts are expected to become more severe in the future
- The following diagrams summarise the Drought Severity Index (DSI) for observations and various global warming levels based on UKMO projections; potential drought severity for Cornwall might not be as critical as for some areas further east but remains an issue

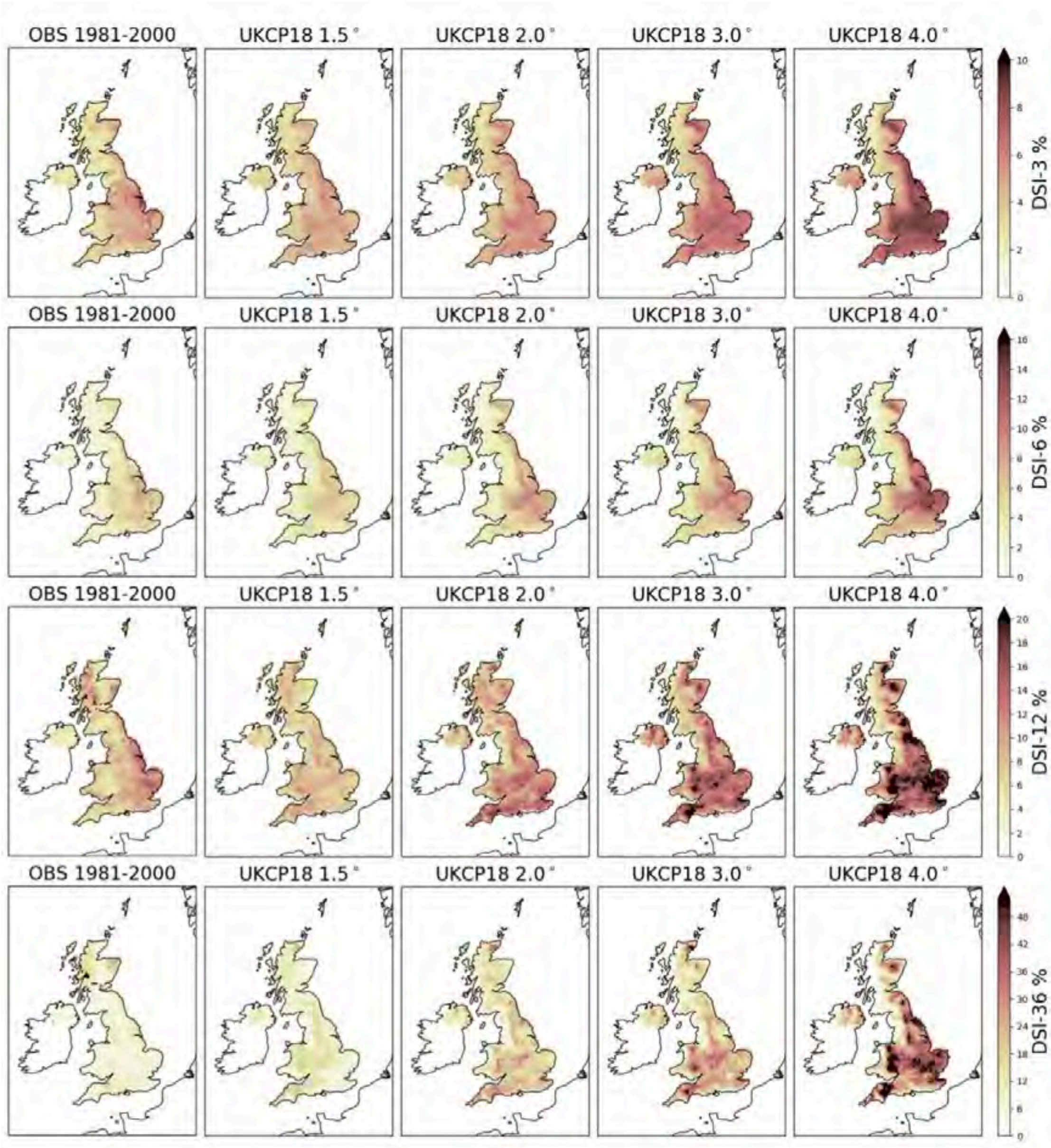


Figure 62. DSI over 3, 6, 12 and 36 months estimated from 1981 to 2000 and at various levels of global warming

CID Grouping – Wet and Dry

Fire Weather – weather conditions conducive to triggering and sustaining wildfires, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity, and wind. Fire weather does not include the presence or absence of fuel load. [Note: distinct from wildfire occurrence and area burned]

High confidence impacts (dark shading in Table 1) on: *temperate and boreal forests; forestry systems; mortality;* ***housing stock*****.**

Low/moderate confidence impacts (light shading in Table 1) on*: lakes, rivers and wetlands; grasslands and savannah; streamflow and surface water; water quality; crop systems; livestock and pasture systems; cities; built environment; labour productivity; morbidity; recreations and tourism;* ***livestock mortality; indigenous traditions.***

Overall Summary for Fire Weather

Overview note:

- From a climate perspective there are several factors included under the 'Fire Weather' banner, including the rainfall and drought issues covered in previous sections, plus humidity and winds; fires may be triggered by a number of factors, from the meteorological perspective most generally lightning or focusing of sunshine through water droplets

Trends:

- No trends in fire weather have been detected

Projections:

- There is minimal information on the future of fire weather other than a position in CCRA3 based on a recent analysis of the threat that fires will become more likely and more severe given suitable surrounding conditions

Examples of impacts based on CIDs:

- On forests and mortality (HC)
- On several other environmental and ecological aspects, including coastal zones, on surface water and water quality, on agricultural systems, on the built environment in general (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: agriculture, forests, habitats, water supply and quality, food safety, property and infrastructure, etc.
- Areas carrying risks and opportunities include: carbon stores, agricultural and forestry productivity, landscape character, etc.
- Areas carrying opportunities include: new species colonisation on land and in water, new agricultural and forestry production, etc.

More Detail on Trends for Fire Weather

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Fire Weather

- LC in any direction of any trend in fire weather over NEU

Main Points from MONCIC for SWESW for Fire Weather

- As in the 'Mean Precipitation', 'Aridity' and 'Hydrological Drought' sections, there are no statistically significant negative trends in rainfall in any season over SWESW
- There are indications that sunshine has increased over SWESW – see 'Radiation at Surface' section

Main Points from CCRA3 for Fire Weather

- Does not cover trends in fire weather

More Detail on Projections for Agricultural and Ecological Drought

Main Points from IPCC WGI AR6 for the globe and for NEU for Fire Weather

- IPCC WGI AR6 does not appear to cover projections of fire weather

Main Points from UKCP18 for Fire Weather

- UKCP18 does not cover fire weather

Main Points from CCRA3 for Fire Weather

- Wildfires become increasingly likely and potential more severe in future

CID Grouping – Wind

Mean wind speed - Mean wind speeds and transport patterns and their diurnal and seasonal cycles

High confidence impacts (dark shading in Table 1) on: *energy infrastructure*.

Low/moderate confidence impacts (light shading in Table 1) on: *lakes, rivers and wetlands; grasslands and savannah; coastal seas; shelf seas and upwelling zones; crop systems; forestry systems; fisheries and aquaculture systems*.

Overall Summary for Mean Wind Speed

Trends:

- The picture with regards to trends is a little mixed, and might be analysis period dependent
- In general most evidence for trends is in winter, perhaps increasing in association with stronger storminess, but limited evidence in other seasons
- Strong interannual variability in wind speeds tends to cover trends

Projections:

- There is the possibility that winter wind speeds may increase overall, but subject to interannual variability, whereas in other seasons the trend may be downwards

Examples of impacts based on CIDs:

- On energy infrastructure (HC)
- On several environmental and ecological aspects, including lakes, grasslands and coastal seas, on agricultural and aquiculture systems, on the built environment in general (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: water, energy, transport and coastal infrastructure, etc.
- Areas carrying risks and opportunities include: landscape character, etc.
- Areas carrying opportunities include: new habitats, new business opportunities etc.

More Detail on Trends for Mean Wind Speed

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Mean Wind Speed

- Wind speeds have been decreasing over NEU in recent decades (MC), but with a possible increase in the last decade (LC); also large interannual variability

Main Points from UKCP18 for SWESW for Mean Wind Speed

- Increase in wind speeds in winter over the UK during second half of 21st Century

Main Points from CCRA3 for Mean Wind Speed

- “Significant” decrease in winds in summer but no trend in winter

More Detail on Projections for Mean Wind Speed

Main Points from IPCC WGI AR6 for the globe and for NEU for Mean Wind Speed

- Decreases in wind speed will emerge (MC)
- Under RCP8.5 daily and interannual variability in wind speeds will increase (LC)

Main Points from UKCP18 for Mean Wind Speed

- Attempts were made to access wind projections near Truro (2.5km^2 scale as wind data not provided at the 5km^2 scale), but the server detected no data for these requests
- In two sets of projections for mean winter UK-average wind speeds one indicates a possible increase, but modest compared to the inter-annual variability, while the second indicates no trend

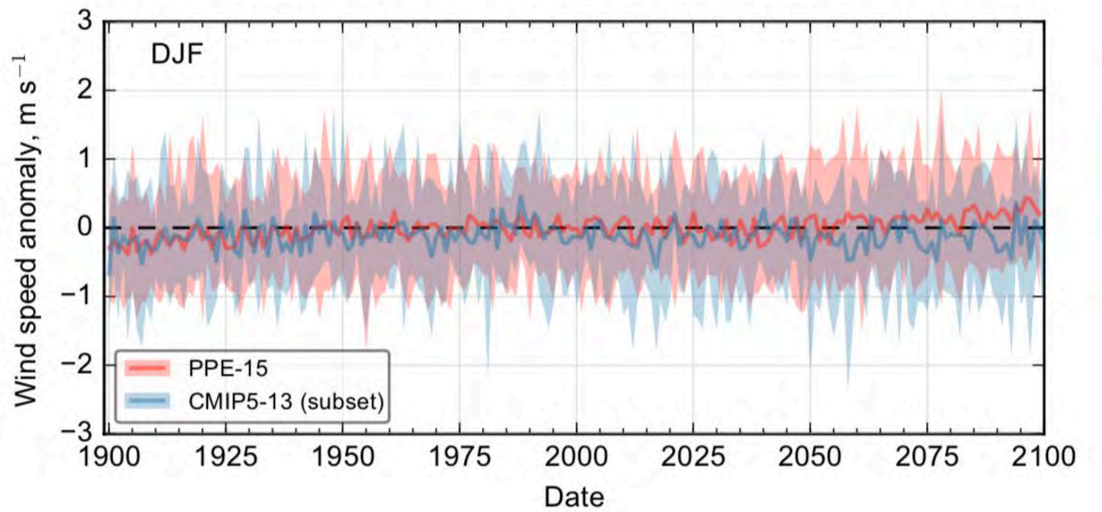


Figure 63. Two UKMO projections for DJF wind speeds over the UK as a whole.

Main Points from CCRA3 for Mean Wind Speed

- In an assessment of projections of wind speeds over England from UKCP09, UKCP18 and a recent set of downscaled projections, there is limited evidence of negative trends in winter, but more so in the other seasons, especially summer

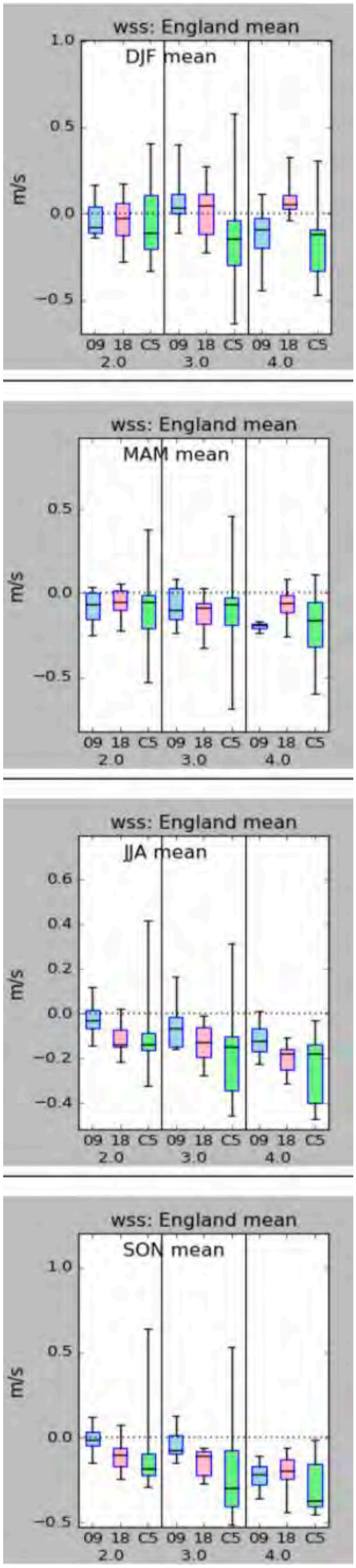


Figure 64. Seasonal mean wind speed projections over England based on three sets of projections at three levels of global temperature rise, 2ºC, 3ºC and 4ºC.

Severe wind storm - Severe storms including thunderstorms, wind gusts, derechos, and tornados

High confidence impacts (dark shading in Table 1) on: ***cities; energy infrastructure; built environment; mortality; housing stock.***

Low/moderate confidence impacts (light shading in Table 1) on: ***temperate and boreal forests; crop systems; livestock and pasture systems; forestry systems; fisheries and aquaculture systems; land and water transportation; recreations and tourism***

Overall Summary for Severe Wind Storm

Trends:
- No clear picture emerges on any trends in severe wind storms, although there is natural variability that results in both increases and decreases over multi-year periods
- Insufficient data to examine small-scale storms such as tornadoes

Projections:
- Again there is no clear picture, although the IPCC WGI AR6 indicates that clustering of storms may increase in future

Examples of impacts based on CIDs:
- On all types of infrastructure, on mortality (HC)
- On several environmental and ecological aspects, including forests, on agricultural and aquiculture systems, on transport systems, on tourism (LC/MC)

Examples of impacts based on CCRA3:
- Areas carrying risks include: water, energy, transport and coastal infrastructure, etc.
- Areas carrying risks and opportunities include: landscape character, etc.
- Areas carrying opportunities include: new business opportunities etc.

More Detail on Trends for Severe Wind Storm

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Severe Wind Storm

- MC that severe wind storms have increased in frequency over NEU
- Large uncertainties but some evidence for decreases in the strongest winds
- Insufficient information on tornadoes

Main Points from UKCP18 for SWESW for Severe Wind Storm

- No trends in storminess as measured by wind gusts over the recent 4 decades

Main Points from CCRA3 for Severe Wind Storm

- Three studies indicate that there have been no definable trends in storminess, although there are periodic increases and decreases associated with natural climate variability
- Natural variability is illustrated by the number of days each year with gusts of 40+, 50+ and 60+ knots at at least 20 low-level UK stations:

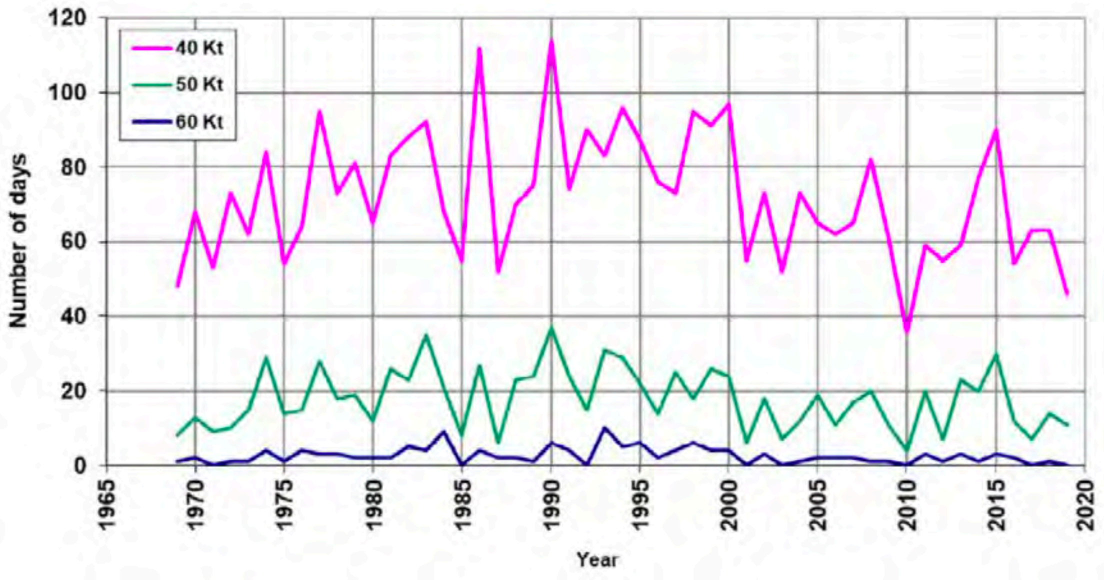


Figure 65. UK wind gust events – number of days each year

More Detail on Projections for Severe Wind Storm

Main Points from IPCC WGI AR6 for the globe and for NEU for Severe Wind Storm

- Serial clustering of storms will increase over Europe (MC), with the possibility of increases in frequency and depth of storms

Main Points from UKCP18 for Severe Wind Storm

- Not covered

Main Points from CCRA3 for Severe Wind Storm

- No clear indication of any trends in storminess over the rest of the century

CID Grouping – Wind

Tropical cyclone - Strong, rotating storm originating over tropical oceans accompanied by high winds, rainfall, and storm surge

High confidence impacts (dark shading in Table 1) on: ***cities; energy infrastructure; built environment; mortality; housing stock.***

Low/moderate confidence impacts (light shading in Table 1) on: ***coastal land and inertial zones; coastal seas; crop systems; fisheries and aquaculture systems; land and water transportation; recreations and tourism; livestock mortality.***

Overview note:

- The UK is not directly impacted by tropical cyclones, and thus the detail provided in most other sections is not given here
- Nevertheless ex-tropical cyclones re-curve over the North Atlantic Ocean in autumn and can pass over or close to the UK as relatively intense extra-tropical cyclones that can bring strong winds and heavy rainfall
- For the tropical North Atlantic, as well as for other tropical basins, the IPCC WGI AR6 projections suggest future reductions in the numbers of tropical cyclones but increases in their average intensities
- Further, both the IPCC WGI AR6 and a recent paper point to polewards shifts in cyclones tracks associated with the warming
- There exists the possibility, therefore, that future ex-tropical cyclones reaching the UK might arrive with heavier rainfall and stronger winds than typical in past such events

CID Grouping – Wind

Sand and dust storms - Storms causing the transport of soil and fine dust particles

***High confidence impacts (dark shading in Table 1) on**: grasslands and savannah; cities; land and water transportation; farmland.*

***Low/moderate confidence impacts (light shading in Table 1) on:** temperate and boreal forests; lakes, rivers and wetlands; coastal land and inertial zones; coastal seas; streamflow and surface water; water quality; crop systems; livestock and pasture systems; energy infrastructure; built environment; labour productivity; morbidity; recreations and tourism.*

Overview note:

- The UK is not directly impacted by sand and dust storms, except perhaps on rare local scales, and thus the detail provided in most other sections is not given here
- The issue is included simply to note that a possibly drier future climate over southern Europe (the projections for the south of the continent point to more substantial future reduced rainfall, especially in summer, than for the north) might induce occasional sand and dust storms over the UK
- The UK already experiences falls of dust lifted from the Sahara Desert from time to time, and it is possible the source of these events might expand with increased aridity over southern Europe

CID Grouping – Snow and Ice

Snow, glacier and ice sheet - Snowpack seasonality and characteristics of glaciers and ice sheets including calving events and meltwater [only snow relevant for Cornwall]

High confidence impacts (dark shading in Table 1) on: ***streamflow and surface water; recreations and tourism.***

Low/moderate confidence impacts (light shading in Table 1) on: ***temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; aquifers and groundwater; water quality; crop systems; livestock and pasture systems; forestry systems; fisheries and aquaculture systems; cities; land and water transportation; housing stock; indigenous traditions.***

Overall Summary for Snow[, Glacier and Ice Sheet]

Trends:

- There have been decreases in snow cover both over NEU and the UK in recent decades

Projections:

- With temperatures rising the expectation is that the number of snow falls and the amounts of lying snow will decrease through the century

Examples of impacts based on CIDs:

- On all types of streamflow and surface water, on recreation and tourism (HC)
- On several environmental and ecological aspects, including forests and coastal zones, on agricultural and aquiculture systems, on water quality, on agricultural production, on built environment and transport systems (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: infrastructure of all types, water, energy, transport, etc.
- Areas carrying risks and opportunities include: new species colonisation, landscape character, etc.
- Areas carrying opportunities include: agricultural production, new freshwater species etc.

More Detail on Trends for Snow[, Glacier and Ice Sheet]

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Snow

- Spring snow cover over the NH has been decreasing, at least since 1978 (VHC)

Main Points from UKCP18 for SWESW for Snow

- Despite heavy snow falls in 2009, 2010, 2013 and 2018 the number and severity of falls has in general been decreasing since the 1960s

Main Points from CCRA3 for Snow

- The CCRA3 does not appear to provide details on trends in snow

More Detail on Projections for Snow[, Glacier and Ice Sheet]

Main Points from IPCC WGI AR6 for the globe and for NEU for Snow

- Further decreases of NH snow cover will emerge after 2050

Main Points from UKCP18 for Snow

- UKCP18 projections indicate a reduction in both winter mean snowfall and lying snow by 2061 to 2080 as compared to 1981 to 2000

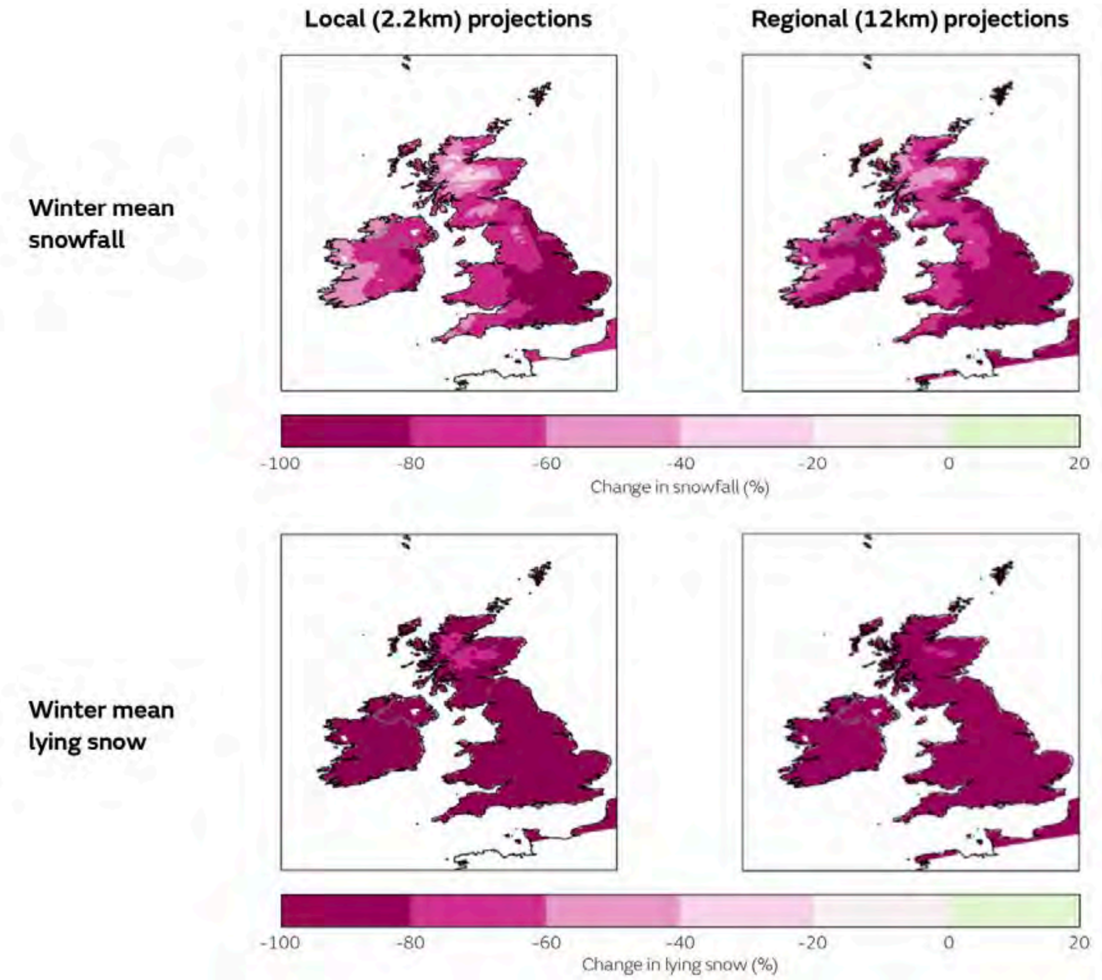


Figure 66. UKCP projections of winter snowfall and amount lying in 2061 to 2080 as compared to 1981 to 2000

Main Points from CCRA3 for Snow

- Future projections of snow are covered only in terms of their relationships to the frequencies of frost days (see the Frost section). As, in general, the UKCP18 frost days projections point to future decreases it is assumed also that snowfall will decrease as temperatures rise

CID Grouping – Snow and Ice

Permafrost - Permanently frozen deep soil layers, their ice characteristics, and the characteristics of seasonally frozen soils above [not relevant for Cornwall]

Impacts and other details not included as Permafrost is not directly relevant to Cornwall

CID Grouping – Snow and Ice

Lake, river and sea ice - The seasonality and characteristics of ice formations on the ocean and freshwater bodies of water [not relevant for Cornwall]

Impacts and other details not included as Lake, River and Sea Ice is not directly relevant to Cornwall

CID Grouping – Snow and Ice

Heavy snowfall and ice storm - High snowfall and ice storm events including freezing rain and rain-on-snow conditions [only heavy snow relevant for Cornwall]

High confidence impacts (dark shading in Table 1) on: ***cities; land water transportation; energy infrastructure.***

Low/moderate confidence impacts (light shading in Table 1) on: ***temperate and boreal forests; lakes, rivers and wetlands; crop systems; livestock and pasture systems; forestry systems; built environment; labour productivity; mortality; recreations and tourism; livestock mortality; indigenous traditions.***

Overall summary for Heavy Snowfall and Ice Storm

Overview note:

- See the Section on Snow, Glacier and Ice Sheet for general information about past and future snowfall and snow coverage over the UK; none of the reports add useful further detail for heavy snow while ice storms are rare over the UK – both may be assumed to decrease in frequency, but not necessarily to disappear, in warmer climates

CID Grouping – Snow and Ice

Hail - Storms producing solid hailstones

High confidence impacts (dark shading in Table 1) on: *crop systems*.

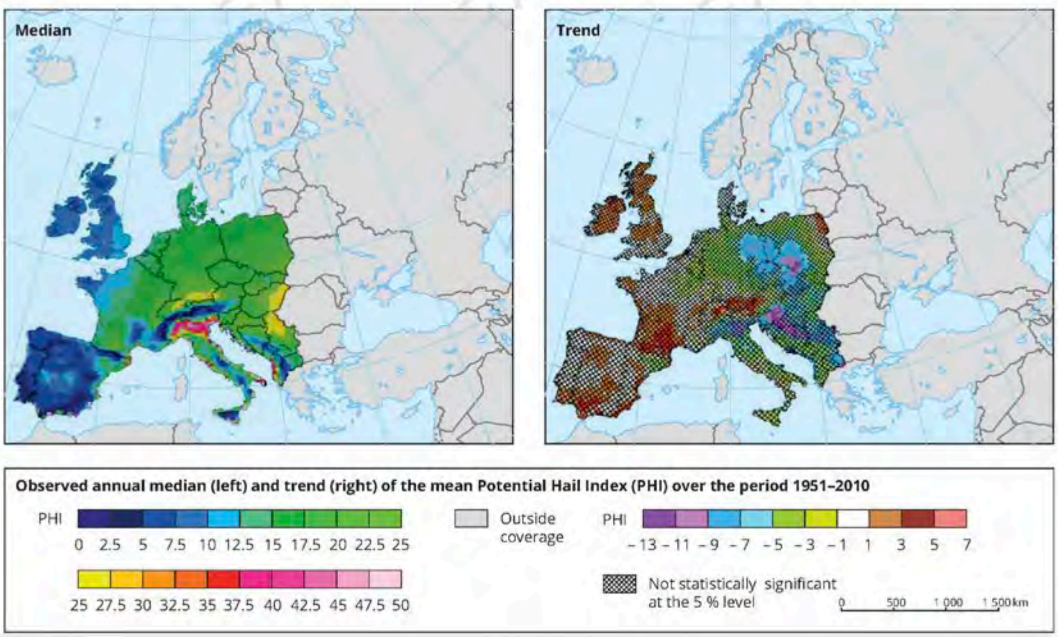
Low/moderate confidence impacts (light shading in Table 1) on: *livestock and pasture systems; forestry systems; land and water transportation; energy infrastructure; built environment; morbidity*.

Overall summary for Hail

Overview Note:

- There is minimal information re hail in the IPCC WGI AR6, UKCP18 or CCRA3 other than an indication that projections suggest that the environment might become more conducive for the formation of hail storms as the atmosphere warms
- Hail is most common in western UK, most frequently in winter. Elsewhere it us most frequent in spring. Storms producing damaging hail are rare and occur mostly in summer in eastern and northern parts.
- The European Environment Agency has produced the diagram below indicating the relatively low threat of hail in the west (low values of PHI) and a lack of detected trend 1951 to 2010.

Fig. 1: Observed annual median and trend of the Mean Potential Hail Index (PHI) over the period 1951-2010



CID Grouping – Snow and Ice

Snow avalanche - Cryospheric mass movements and the conditions of collapsing snowpack [not relevant for Cornwall]

Impacts and other details not included as not directly relevant to Cornwall

CID Grouping – Coastal

Relative sea level - The local mean sea surface height relative to the local solid surface

***High confidence impacts (dark shading in Table 1) on**: coastal land and inertial zones; coastal seas; aquifers and groundwater; water quality; cities; land and water transportation; built environment; housing stock; farmland.*

***Low/moderate confidence impacts (light shading in Table 1) on:** fisheries and aquaculture systems; recreations and tourism; indigenous traditions.*

Overall Summary for Relative Sea Level

Trends:

- Note that Relative Sea Level includes any changes in the sea itself combined with any changes in land elevation (rises or subsidence)
- The evidence is incontrovertible that sea level has been rising around the UK for at least the past 100 years, to a total of in excess of 150mm

Projections:

- Projections all point to continued increases in sea levels, with Cornwall seeing some of the highest rises around the UK
- The amount of rise will depend on emissions, with an estimated overall future range of about 0.2m up to a little over 1m
- The majority of projections presented here do not include impacts from such as collapse of either the Greenland or the West Antarctic ice sheets; the latter is the more threatening across this century, while the former is already steadily adding to sea level rise

Examples of impacts based on CIDs:

- On all aspects of the coastal zone, including any infrastructure, aquifers and groundwater plus related water quality, on coastal seas and their ecosystems (HC)
- On fisheries and aquaculture, and on tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: all coastal business, habitation and transport infrastructure, coastal sub-surface infrastructure, aquifers, water supply and quality, marine species etc.
- Areas carrying risks and opportunities include: landscape character, etc.
- Areas carrying opportunities include: new species colonisation etc.

More Detail on Trends for Relative Sea Level

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Relative Sea Level

- Mean value of RSL rise across the sub-polar North Atlantic 1.08[0.79 to 1.38]mm/year over 1900 to 2018, as compared to 1.7mm/year in GMSL rise
- For 1993 to 2018 the rate of RSL rise has increased to 2.17[1.66 to 2.66]mm/year, compared to that in GMSL of 3.25mm/year

Main Points from UKCP18 for SWESW for Relative Sea Level

- RSL has increased around the UK by about 1.4mm/year over the 20th Century

Main Points from CCRA3 for Relative Sea Level

- SLR has been increasing constantly through the 20th Century around the UK, not considering changes in land elevation (average, but local variations not shown):

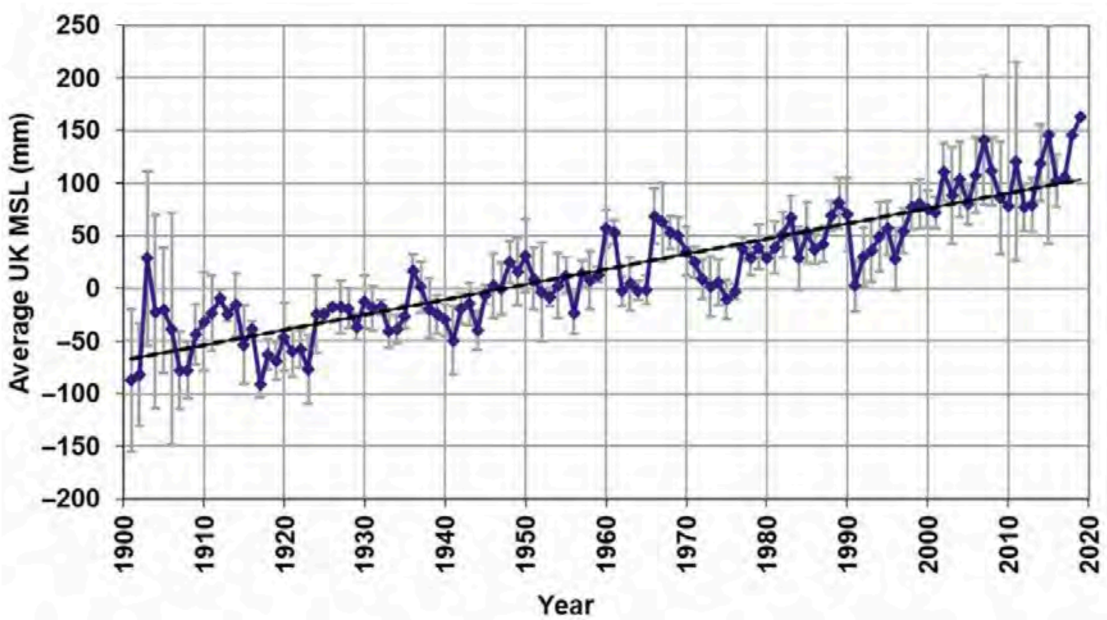


Figure 67. The UK Sea Level Index based on 5 stations

More Detail on Projections for Relative Sea Level

Main Points from IPCC WGI AR6 for the globe and for NEU for Relative Sea Level

- Relative Sea Level Rise will continue with effects emerging by 2050 (HC)
- RSL rise will continue around Europe (EL); regional mean rises projected for 2080 to 2100 compared to 1995 to 2014 cover 0.4 to 0.5 m under SSP1-RCP2.6 to 0.7 to 0.8m under SSP5-RCP8.5, although these may be under-estimates given incomplete inclusion of land subsidence
- Atlantic coasts are amongst the areas with strongest projected rises
- It is likely that a 0.5m rise in GMSL will occur this century, with near-certainty under SSP5-RCP8.5
- There could be significant local departures from the regional mean projections

Main Points from UKCP18 for Relative Sea Level

- At Cardiff (the closest location given to Cornwall) projected SLR rises by 2100 compared to 1971 to 2000 are 0.27 to 0.69m under RCP2.6, 0.35 to 0.81m under RCP4.5, and 0.51 to 1.13m under RCP8.5
- For the UK RSL rise is a little lower than global SLR

- Projections using an average calibrated on data for 49 UK ports suggest that rises around Cornwall will be amongst the highest at any UK location:

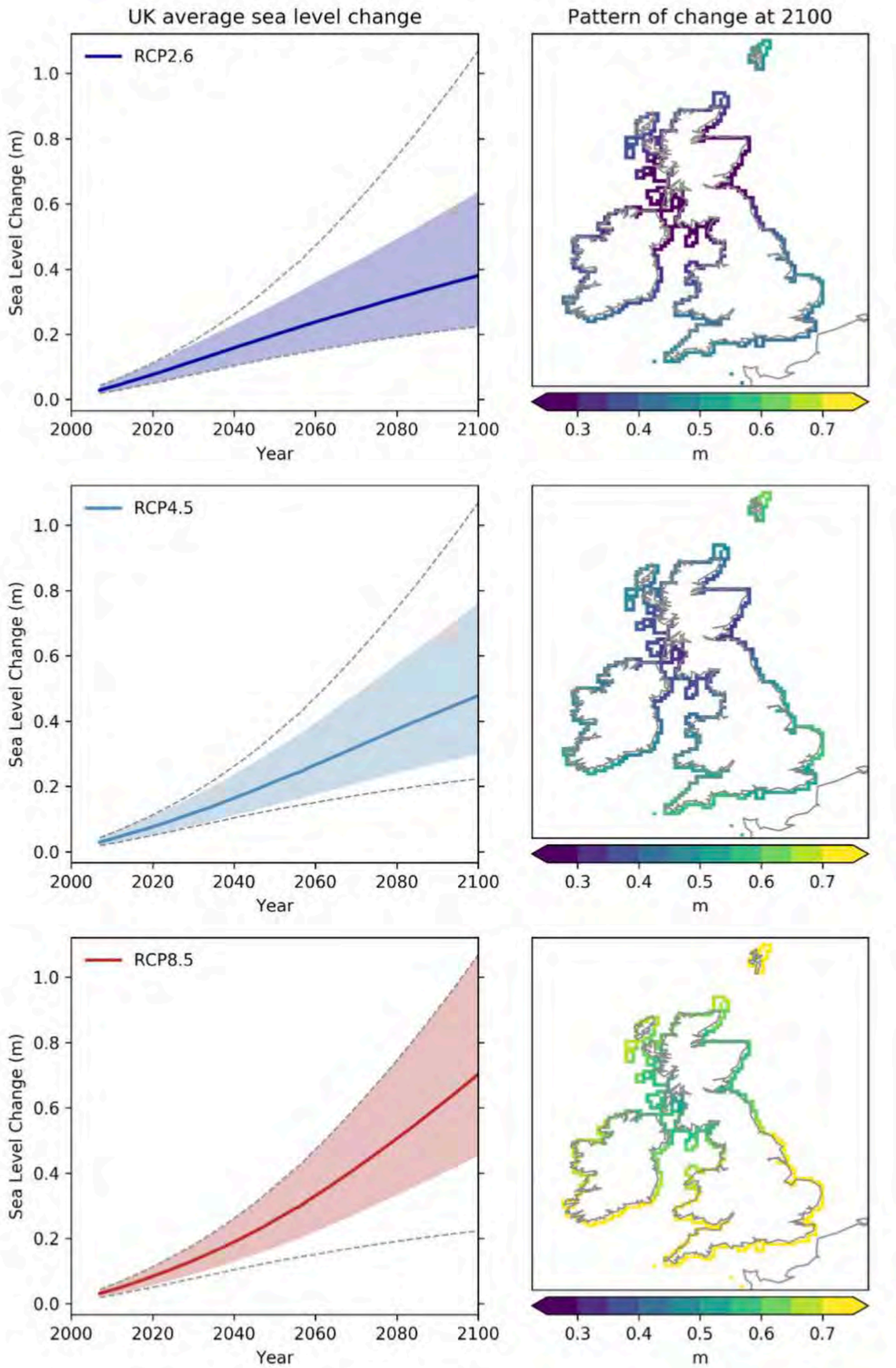


Figure 68. Time series of RSL rise under three RCPs in left column and spatial distribution of rises in right column.

- Projected ranges for Cardiff, the closest to Cornwall, illustrate the dependency of SLR on emissions:

	London			Cardiff		
YEAR	R2.6	R4.5	R8.5	R2.6	R4.5	R8.5
2020	0.07 – 0.13	0.07 – 0.13	0.07 – 0.13	0.06 – 0.12	0.06 – 0.12	0.07 – 0.13
2040	0.13 – 0.26	0.14 – 0.27	0.16 – 0.29	0.12 – 0.25	0.13 – 0.26	0.15 – 0.28
2060	0.19 – 0.40	0.22 – 0.44	0.26 – 0.52	0.18 – 0.39	0.21 – 0.43	0.25 – 0.51
2080	0.24 – 0.55	0.30 – 0.63	0.39 – 0.80	0.23 – 0.53	0.28 – 0.62	0.38 – 0.79
2100	0.29 – 0.70	0.37 – 0.83	0.53 – 1.15	0.27 – 0.69	0.35 – 0.81	0.51 – 1.13

Figure 69. Ranges of SLR under various emissions compared to 1981 to 2000.

Main Points from CCRA3 for Relative Sea Level

- Basic results presented in CCRA3 are the same as those in UKCP18 above, but there is further consideration of the possibilities of abrupt increases in sea levels arising from collapses of the Greenland Ice Sheet or the West Antarctic Ice Sheet:
  - According to SROCC Greenland Ice Sheet melt is not likely to lead to abrupt changes, will contribute a few 10s of cm to rise during this century, but would contribute 7m with a total collapse

- More threatening is the West Antarctic Ice Sheet, possibly already collapsing, with estimates of possible 1m or more rises later in the century:

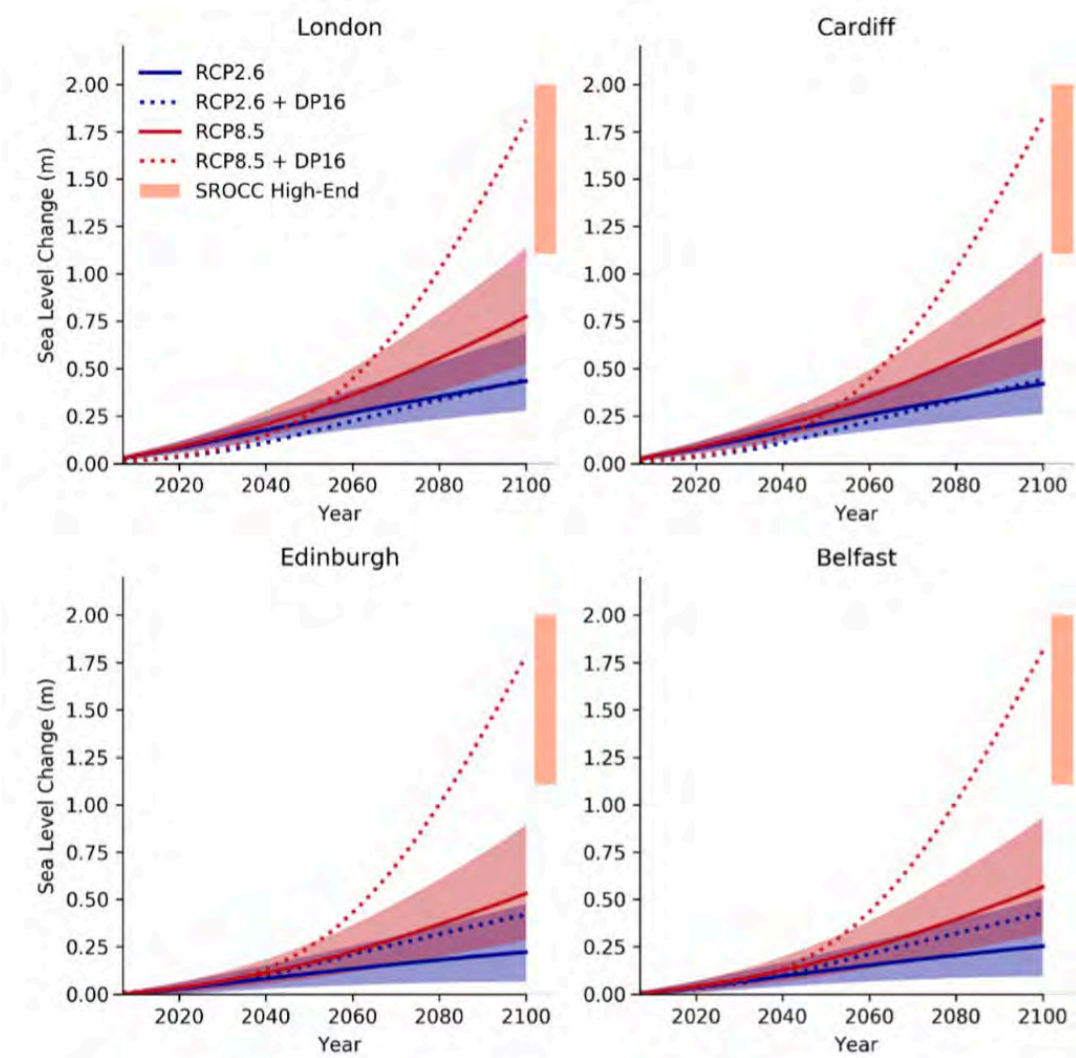


Figure 70. Some estimates of increases in sea levels given collapse of the West Antarctic Ice Sheet alongside projected changes without any collapse (DP16 refers to the method employed)

CID Grouping – Coastal

Coastal flood - Flooding driven by episodic high coastal water levels that result from a combination of relative sea level rise, tides, storm surge, and wave setup

High confidence impacts (dark shading in Table 1) on: ***coastal land and inertial zones; fisheries and aquaculture systems; cities; land and water transportation; built environment; mortality; housing stock.***

Low/moderate confidence impacts (light shading in Table 1) on: ***water quality; crop systems; livestock and pasture systems; forestry systems; energy infrastructure; farmland; livestock mortality.***

Overall Summary for Coastal Flood

Overview Note:

- Coastal flooding is perhaps more directly significant for the coastal zone and communities than is SLR; ETWLs (extreme total water levels) may already episodically exceed levels projected for mean SLR; ETWL is the sum of RSL, tides, storm surge and wave setup, the latter not strictly a climate variable

Trends:

- Trends are difficult to establish, and may be locally dependent, but available information indicates a clear increase in coastal flooding events over recent decades

Projections:

- All projections point to an increase in coastal flooding, with factors involved including SLR, stronger winds and higher waves associated with some storms, particularly in winter, as well as tidal locking resulting from higher sea levels

Examples of impacts based on CIDs:

- On all types of coastal infrastructure, on fisheries and aquaculture, on transportation, on mortality (HC)
- On several environmental and ecological aspects, including water quality, on agricultural and aquiculture systems in the coastal zones, on tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: business and social activities, infrastructure networks and services, people, cultural heritage, transport, etc.
- Areas carrying risks and opportunities include: agricultural productivity, carbon stores, coastal habitats, landscape character, etc.
- Areas carrying opportunities include: new species colonisation, new agricultural opportunities etc.

More Detail on Trends for Coastal Flood

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Coastal Flood

- Does not detail trends but notes that the current 1 in a 100 year ETWL around the UK is about 2.5 to 5.0m, but is non-specific about Cornwall

- High tide flooding events that occurred 5 times/year during 1961 to 1980 increased in frequency to over 8 times/year during 1995 to 2014 (HC)

Main Points from UKCP18 for SWESW for Coastal Flood

- No discussion of trends

Main Points from CCRA3 for Coastal Flood

- No discussion of trends

More Detail on Projections for Coastal Flood

Main Points from IPCC WGI AR6 for the globe and for NEU for Coastal Flood

- Coastal flooding will increase (HC)
- Extreme sea levels that recently occurred once/century will occur at least annually at 19-31% of gauge sites by 2050 and at ~60% (SSP1-2.6) to ~82% (SSP5-8.5) of sites by 2100 (MC)
- Compared to the recent past ETWL events will be 20 to 30 times more frequent by 2050 and 160 to 530 times more frequent by 2100 dependent upon emissions (MC)
- Note that the above includes no allowances for abrupt changes such as ice sheet collapses

Main Points from UKCP18 for Coastal Flood

- UK coastal flooding will increase over the century regardless of emissions, resulting in increases in both the frequency and magnitude of flooding events
- There may be changes in tidal characteristics
- No evidence for significant changes from present in future storm surges

Main Points from CCRA3 for Coastal Flood

- No clear indication of any trends in storminess over the rest of the century but the possibility that western UK, particularly in winter, may experience increased rainfall, stronger winds and higher waves raises the risks of coastal flooding
- Tidal locking will increase as sea levels rise, impeding flow of water into the sea and raising the likelihoods of both interior and coastal flooding

CID Grouping – Coastal

Coastal erosion - Long term or episodic change in shoreline position caused by relative sea level rise, nearshore currents, waves, and storm surges

***High confidence impacts (dark shading in Table 1) on**: coastal land and inertial zones; coastal seas; built environment; recreations and tourism; **housing stock**.*

***Low/moderate confidence impacts (light shading in Table 1) on:** cities; land and water transportation; **farmland; indigenous traditions**.*

Overall Summary for Coastal Erosion

Trends:

- No clear picture emerges on any trends in coastal erosion

Projections:

- Again there is no clear picture, although the only indications available, from UKCP18, point to future decreases in mean SWH but perhaps an increase in Annual Maximum SWH around the Cornish coastline
- Otherwise coastal erosion is expected to increase in general, and perhaps to amplify, with additional land lost to the ocean

Examples of impacts based on CIDs:

- On all types of coastal infrastructure and the surrounding seas, on recreation and tourism (HC)
- On transport systems (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: coastal infrastructure and services in all forms, marine species, etc.
- Areas carrying risks and opportunities include: landscape character, etc.
- Areas carrying opportunities include: new business opportunities, marine species etc.

More Detail on Trends for Coastal Erosion

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Coastal Erosion

- There are reports of shoreline retreats over the Atlantic coastline in NEU

Main Points from UKCP18 for SWESW for Coastal Erosion

- No information on trends

Main Points from CCRA3 for Coastal Erosion

- Few details provided

More Detail on Projections for Coastal Erosion

Main Points from IPCC WGI AR6 for the globe and for NEU for Coastal Erosion

- Increases in coastal erosion will emerge, particularly along sandy coasts and in areas with no additional sediment sink/sources or physical barriers to shoreline retreat (HC)
- Shoreline retreat could reach 80m in places under the highest emissions

Main Points from UKCP18 for Coastal Erosion

- An attempt was made to simulate changes in coastal storm surges and extreme water levels but results from the models used were so diverse as to prohibit any overarching conclusions
- Wave height is an important component of coastal erosion, and under UKCP18 some RCP8.5 modelling simulations have been carried out, as illustrated in the following figure
- The top row in the figure illustrates the simulated 1971 to 2000 mean SWH (dotted) and annual maximum SWH (solid) around the UK; the plot proceeds counter-clockwise from the Bristol Channel but the approximate location of Cornwall is indicated by the 'Land's End' arrow (about the 500km marker); according to this simulation set SWH around Cornwall is amongst the highest in the UK, and thus also so is the potential for coastal erosion
- The lower two rows indicate the simulated changes in mean and Annual maximum SWH at 2041 to 2060 and 2081 to 2100 under RCP4.5 and RCP8.5; for Cornwall the simulations indicate that mean SWH will decrease but that there may be an increase in the annual maximum SWH

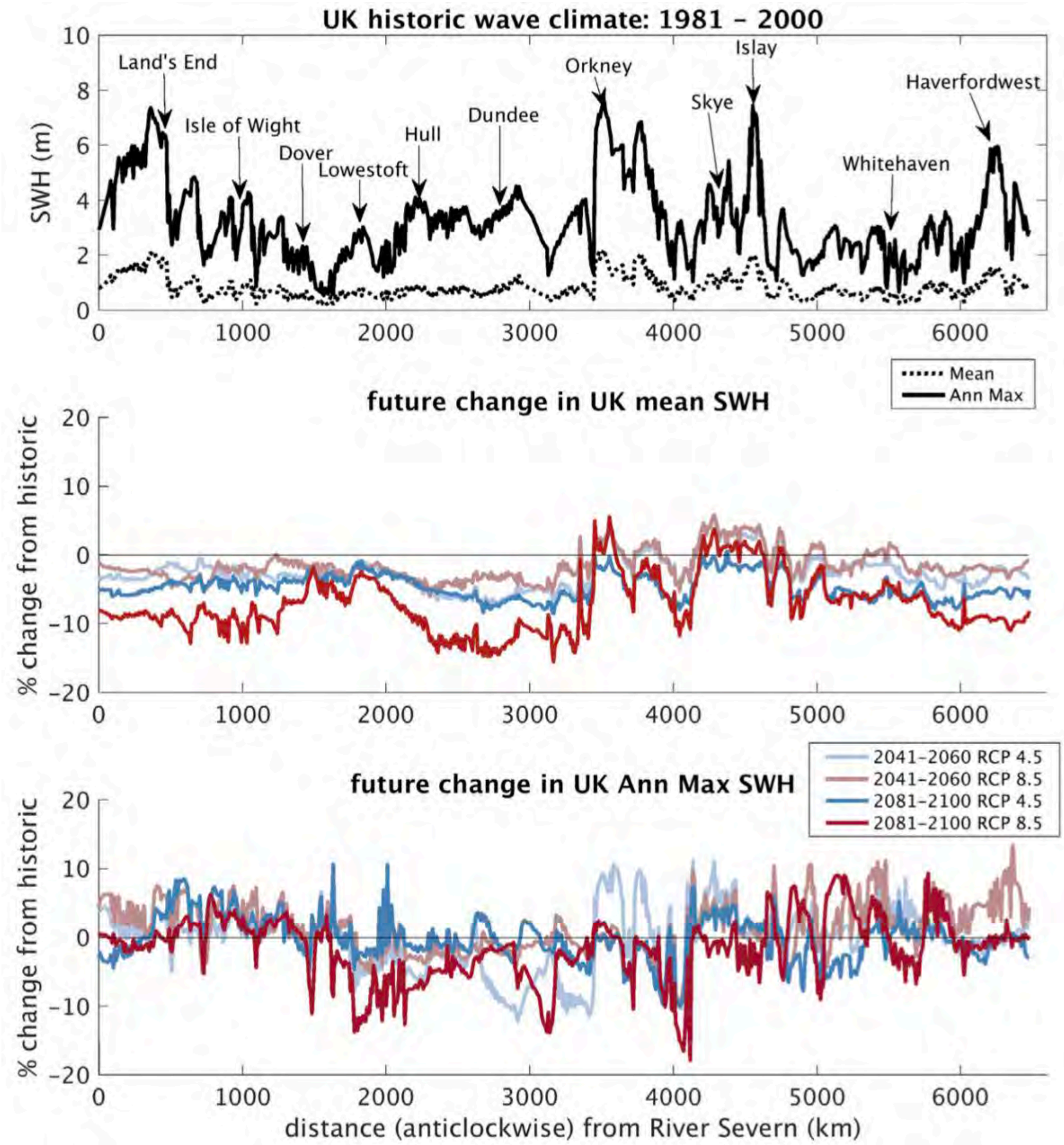


Figure 71. See text for details

Main Points from CCRA3 for Coastal Erosion

- No additional details other than as provided by UKCP18 above

CID Grouping – Oceanic

Mean ocean temperature - Mean temperature profile of ocean through the seasons, including heat content at different depths and associated stratification

High confidence impacts (dark shading in Table 1) on: *coastal land and inertial zones; coastal seas; shelf seas and upwelling zones; fisheries and aquaculture systems.*

Low/moderate confidence impacts (light shading in Table 1) on: none.

Overall Summary for Mean Ocean Temperature

Trends:

- Ocean surface temperatures (and overall heat content) have been rising steadily

Projections:

- There are no projections directly for UK coastal waters but global temperatures will continue to rise at rates determined by emissions through this century and beyond

Examples of impacts based on CIDs:

- On all types of coastal infrastructure and the surrounding seas, on shelf seas, on fisheries and aquaculture (HC)
- None (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: coastal infrastructure and services in all forms, marine species, etc.
- Areas carrying risks and opportunities include: new maritime species, carbon stores, etc.
- Areas carrying opportunities include: new business opportunities, marine species etc.

More Detail on Trends for Mean Ocean Temperature

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Mean Ocean Temperature

- Warming trends have emerged already in the North Atlantic (HC) but the picture for the coastal regions surround NEU is less clear
- Global mean SST has increased by 0.88ºC by 2011 to 2020 as compared to 1850 to 1900, with 0.6ºC of that rise since 1980

Main Points from UKCP18 for SWESW for Mean Ocean Temperature

- No information on trends

Main Points from CCRA3 for Mean Ocean Temperature

- Temperatures of UK coastal waters have rising at similar rates to land temperatures, with waters on average over 2010 to 2020 0.3ºC warmer than during 1981 to 2010 and 0.6ºC warmer than 1961 to 1990

More Detail on Projections for Mean Ocean Temperature

Main Points from IPCC WGI AR6 for the globe and for NEU for Mean Ocean Temperature

- Increases in SSTs over the Atlantic Ocean have already emerged (HC)
- Further increases in SST will occur (VC) and will likely continue until at least 2300
- Estimated global average increases based on 1995 to 2014 to 2081 to 2200 range in the means from 0.86ºC under SSP1-2.6 to 2.89ºC under SSP5-8.5

Main Points from UKCP18 for Mean Ocean Temperature

- No details provided

Main Points from CCRA3 for Mean Ocean Temperature

- No details provided but the expectation that UK coastal waters will continue become warmer, perhaps at a similar rate to land surface temperatures

CID Grouping – Oceanic

Marine heatwave - Episodic extreme ocean temperatures

High confidence impacts (dark shading in Table 1) on: *coastal land and inertial zones; coastal seas; shelf seas and upwelling zones;* ***fisheries and aquaculture systems*****.**

Low/moderate confidence impacts (light shading in Table 1) on: *recreations and tourism***.**

Overall Summary for Marine Heatwave

Trends:

- Strong evidence that, at least globally, but by extension locally to the UK, the frequency, severity and lengths of marine heatwaves (periods of high SSTs with a damaging effect on the ecology) has increased in recent decades

Projections:

- As for trends above, no local details have been found but expectations that events will continue to increase in frequency, severity and length and that these will affect the UK

Examples of impacts based on CIDs:

- On many aspects of the coastal ecology and economy, in fisheries and aquaculture, on housing stock (HC)
- On recreation and tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: marine species, marine habitats, fisheries etc.
- Areas carrying risks and opportunities include: coastal species, etc.
- Areas carrying opportunities include: new business opportunities, new marine species etc.

More Detail on Trends for Marine Heatwave

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Marine Heatwave

- Marine heatwaves have become more frequent (HC)
- Since the 1980s event frequencies have roughly doubled (HC) and events have become more intense and longer lasting (MC)
- Events can occur in all basins

Main Points from UKCP18 for SWESW for Marine Heatwave

- No information on trends

Main Points from CCRA3 for Marine Heatwave

- No information on trends

More Detail on Projections for Marine Heatwave

Main Points from IPCC WGI AR6 for the globe and for NEU for Marine Heatwave

- Further increases in the frequencies of events are expected, more so under higher emissions, with the greatest changes in the tropics and the Arctic, with relatively moderate increases at mid latitudes (MC)
- Oceanic areas west of the UK will experience more events but perhaps at a lesser level than the global average, but HC that these will emerge

Main Points from UKCP18 for Marine Heatwave

- No information on projections

Main Points from CCRA3 for Marine Heatwave

- No information on projections

CID Grouping – Oceanic

Ocean acidity - Profile of ocean water pH and accompanying concentrations of carbonate and bicarbonate ions

High confidence impacts (dark shading in Table 1) on: *coastal land and inertial zones; coastal seas; shelf seas and upwelling zones; fisheries and aquaculture systems*.

Low/moderate confidence impacts (light shading in Table 1) on: *morbidity*.

Overall Summary for Ocean Acidity

Trends:

- Almost certain that at the global level ocean acidity is increasing

Projections:

- Acidity will continue to increase but trends may start reversing direction by mid century under the lowest emission scenarios

Examples of impacts based on CIDs:

- On all types of coastal seas and shelf seas, on fisheries and aquaculture (HC)
- On morbidity (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: aquifers, marine species and habitats, etc.
- Areas carrying risks and opportunities include: marine species, etc.
- Areas carrying opportunities include: new business opportunities, new marine species etc.

More Detail on Trends for Ocean Acidity

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Ocean Acidity

- Ocean acidity has increased (VC)

Main Points from UKCP18 for SWESW for Ocean Acidity

- No information on trends

Main Points from CCRA3 for Ocean Acidity

- No information on trends

More Detail on Projections for Ocean Acidity

Main Points from IPCC WGI AR6 for the globe and for NEU for Ocean Acidity

- Ocean acidity will increase with trends emerging mainly after 2050 (HC)

- In general acidity at the global level is projected to increase although there may be some recovery under lowest emissions scenarios

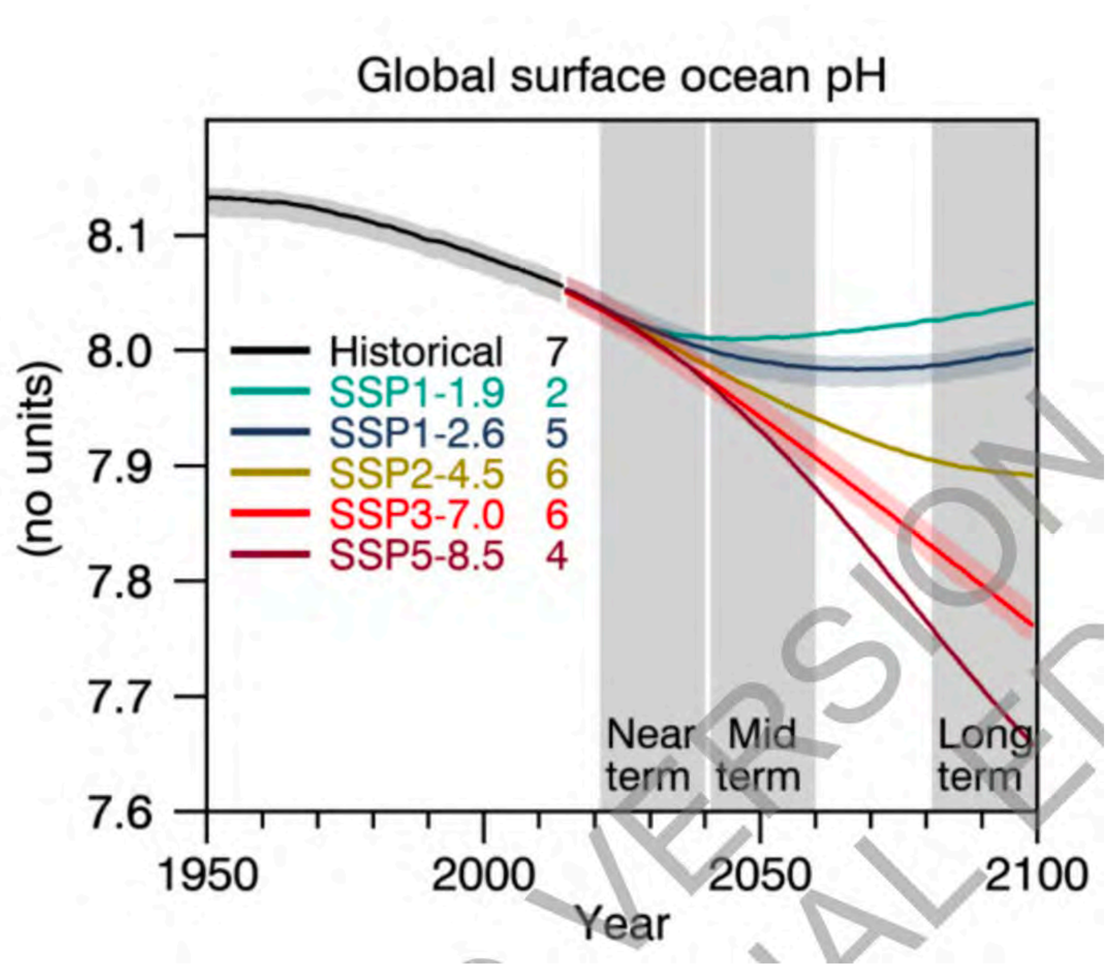


Figure 72. Projections of ocean acidity under 5 emissions scenarios

Main Points from UKCP18 for Ocean Acidity

- No information on projections

Main Points from CCRA3 for Ocean Acidity

- No information on projections

CID Grouping – Oceanic

Ocean salinity - Profile of ocean salinity and associated seasonal stratification [Note: distinct from salinisation of freshwater resources]

High confidence impacts (dark shading in Table 1) on: none.

Low/moderate confidence impacts (light shading in Table 1) on: *coastal land and inertial zones; coastal seas; shelf seas and upwelling zones;* ***aquifers and groundwater; water quality; crop systems; fisheries and aquaculture systems***.

Overall Summary for Ocean Salinity

Overview Note:

- In addition to direct impacts on coastal and marine ecology, changes in salinity in the North Atlantic can have a major impact on the Atlantic Meridional Overturning Circulation (AMOC), a key component in the global oceanic circulation and one that, if changed, can lead to adjustments in the global circulation lasting centuries. The AMOC has been relatively stable over the past 8000 years (MC) but has declined over the 20th Century (LC). Projections under all emissions scenarios suggest that the decline will most likely continue but that the circulation will not switch off fully this century, although the possibility exists that it might later. All projections discussed in this document have incorporated the decline over the next few decades, but a major adjustment in climate will occur at the time of any switch-off, should that occur. With switch-off ice age conditions are likely to recur, moving Northern Europe into a cooler (moderated by earlier warming) and probably drier climate.

Trends:

- A global trend of increasing salinity, although in the North Atlantic salinity has decreased

Projections:

- Salinity is expected to increase

Examples of impacts based on CIDs:

- No HC impacts
- On coastal land and seas and on shelf sea, on aquifers and water quality, on coastal agriculture ands aquaculture (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: coastal and oceanic species and habitats, cultural heritage, etc.
- Areas carrying risks and opportunities include: marine species, etc.
- Areas carrying opportunities include: new business opportunities, marine species etc.

More Detail on Trends for Ocean Salinity

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Ocean Salinity

- Salinity trends in the North Atlantic are location-dependent and have increased salinity gradients in some areas

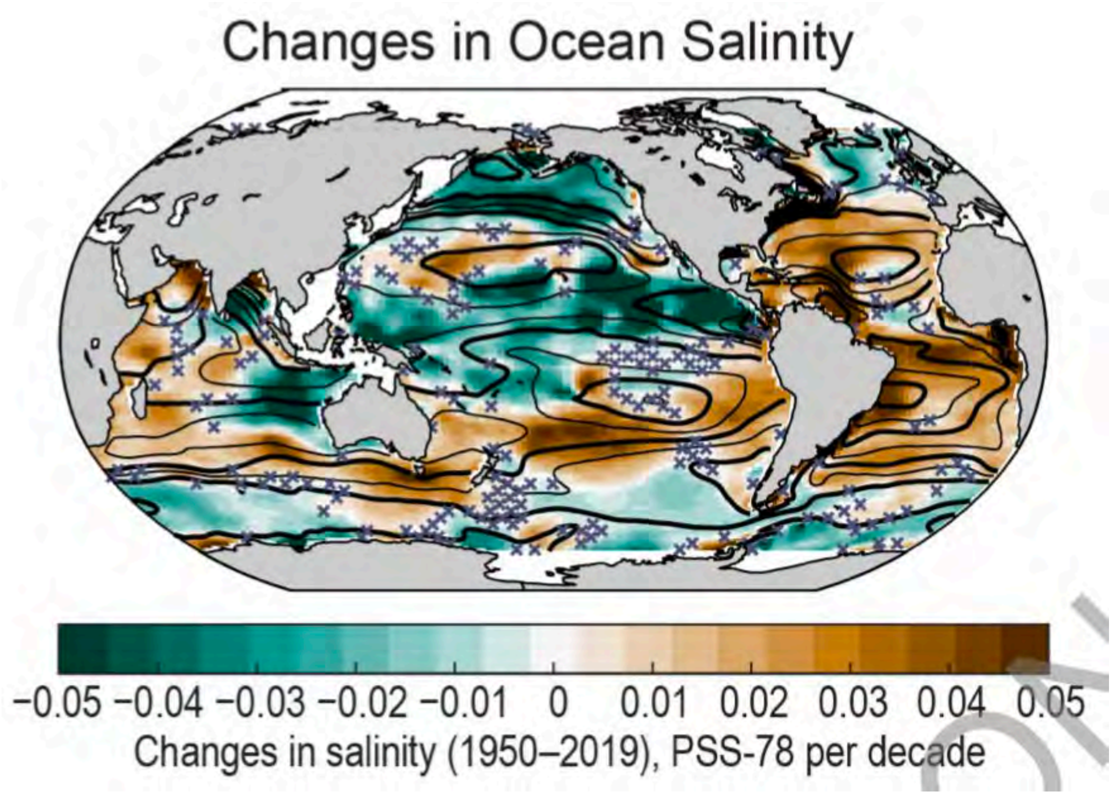


Figure 73. Changes in salinity 1950 to 2019

Main Points from UKCP18 for SWESW for Ocean Salinity

- No information on trends

Main Points from CCRA3 for Ocean Salinity

- No information on trends

More Detail on Projections for Ocean Salinity

Main Points from IPCC WGI AR6 for the globe and for NEU for Ocean Salinity

- Increases in ocean salinity will emerge later in the century at least under highest emissions (MC)

Main Points from UKCP18 for Ocean Salinity

- No information on projections

Main Points from CCRA3 for Ocean Salinity

- No information on projections

CID Grouping – Oceanic

Dissolved oxygen - Profile of ocean water dissolved oxygen and episodic low oxygen events

High confidence impacts (dark shading in Table 1) on: *coastal seas.*

Low/moderate confidence impacts (light shading in Table 1) on*: coastal land and inertial zones; shelf seas and upwelling zones; fisheries and aquaculture systems*.

Overall Summary for Dissolved Oxygen

Trends:

- Limited information but oxygen levels have been decreasing in general

Projections:

- Again limited information but deoxygenation expected to continue

Examples of impacts based on CIDs:

- On all types of coastal seas and marine species (HC)
- On coastal land, shelf seas, fisheries and aquaculture (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: aquifers, marine species, etc.
- Areas carrying risks and opportunities include: coastal species, etc.
- Areas carrying opportunities include: new business opportunities, marine species etc.

More Detail on Trends for Dissolved Oxygen

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Dissolved Oxygen

- Dissolved oxygen has decreased over many areas of the global ocean, with expanding zones of minima (HC) but there appear to be no details specific to the North Atlantic

Main Points from UKCP18 for SWESW for Dissolved Oxygen

- No information on trends

Main Points from CCRA3 for Dissolved Oxygen

- No information on trends

More Detail on Projections for Dissolved Oxygen

Main Points from IPCC WGI AR6 for the globe and for NEU for Dissolved Oxygen

- Deoxygenation to continue and to emerge in the North Atlantic by 2050 (MC)

Main Points from UKCP18 for Dissolved Oxygen

- No information on projections

Main Points from CCRA3 for Dissolved Oxygen

- No information on projections

CID Grouping – Other

Air pollution weather - Atmospheric conditions that increase the likelihood of high particulate matter or ozone concentrations or chemical processes generating air pollutants [Note: distinct from aerosol emissions or air pollution concentrations themselves]

High confidence impacts (dark shading in Table 1) on: none.

Low/moderate confidence impacts (light shading in Table 1) on: *temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; coastal seas;* ***crop systems; livestock and pasture systems; forestry systems;*** *cities; energy infrastructure; labour productivity; morbidity; mortality; recreations and tourism*.

Overall Summary for Air Pollution Weather

Overview note:

- This note replaces the Trends and Projections summaries as the issue is complex and dependent upon many local, non-climatic factors; the projections available point to all possibilities of reduced and increased pollution, with many local dependencies

Examples of impacts based on CIDs:

- No HC impacts
- On numerous aspects of the ecology, on agricultural and aquaculture production, on cities, on energy infrastructure, on labour productivity, on morbidity and mortality, on recreation and tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: health and wellbeing, terrestrial species, cultural heritage etc.
- Areas carrying risks and opportunities include: not apparent that there are any unless pollution is reduced
- Areas carrying opportunities include: not apparent that there are any unless pollution is reduced

More Detail on Trends for Air Pollution Weather

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Air Pollution Weather

- Complex and mainly dependent on non-climatic factors

Main Points from UKCP18 for SWESW for Air Pollution Weather

- No information on trends

Main Points from CCRA3 for Air Pollution Weather

- No information on trends

More Detail on Projections for Air Pollution Weather

Main Points from IPCC WGI AR6 for the globe and for NEU for Air Pollution Weather

- Any changes primarily driven by non-climatic factors (HC)

Main Points from UKCP18 for Air Pollution Weather

- Poor air quality is exacerbated by higher temperatures

Main Points from CCRA3 for Air Pollution Weather

- No information on projections

CID Grouping – Other

Atmospheric CO_2 at surface - Concentration of atmospheric carbon dioxide (CO2) at the surface [Note: distinct from overall radiative effect of CO2 as greenhouse gas]

High confidence impacts (dark shading in Table 1) on*: temperate forests and boreal zones; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; coastal seas; crop systems; forestry systems.*

Low/moderate confidence impacts (light shading in Table 1) on: *livestock and pasture systems; morbidity.*

Overall Summary for Atmospheric CO_2 At Surface

Trends:

- Limited information but surface CO_2 concentrations have been increasing in general

Projections:

- Again limited information but further increases are expected, not least because of a warming atmosphere

Examples of impacts based on CIDs:

- On forests, lakes, rivers, grasslands, coastal land seas, crop systems (HC)
- On livestock, morbidity (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: terrestrial species, pests, health, cultural heritage etc.
- Areas carrying risks and opportunities include: carbon stores, agricultural productivity, etc.
- Areas carrying opportunities include: new species, agricultural productivity etc.

More Detail on Trends for Atmospheric CO_2 At Surface

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Atmospheric CO_2 At Surface

- Concentrations of surface CO_2 have increased (HC)

Main Points from UKCP18 for SWESW for Atmospheric CO_2 At Surface

- No information on trends

Main Points from CCRA3 for Atmospheric CO_2 At Surface

- No information on trends

More Detail on Projections for Atmospheric CO_2 At Surface

Main Points from IPCC WGI AR6 for the globe and for NEU for Atmospheric CO_2 At Surface

- No projections have been found other than an indication of HC that surface concentrations will continue to increase

Main Points from UKCP18 for Atmospheric CO_2 At Surface

- No information on projections

Main Points from CCRA3 for Atmospheric CO_2 At Surface

- A warmer atmosphere will contribute towards increasing surface CO_2 concentrations through encouraging microbial breakdown of organic carbon

CID Grouping – Other

Radiation at surface - Balance of net shortwave, long wave and ultraviolet radiation at the earth's surface and their diurnal and seasonal patterns

High confidence impacts (dark shading in Table 1) on: energy infrastructure.

Low/moderate confidence impacts (light shading in Table 1) on: temperate and boreal forests; lakes, rivers and wetlands; grasslands and savannah; coastal land and inertial zones; coastal seas; shelf seas and upwelling zones; crop systems; livestock and pasture systems; forestry systems; built environment; labour productivity; morbidity; mortality; recreations and tourism.

Overall Summary for Radiation at Surface

Overview note:

- Changes in radiation at the surface are the combined effect of several drivers. The source of radiation is the sun, and it can be assumed that that basic input does not change. Factors that do affect surface radiation include the amounts, thicknesses and types of cloud, as well as atmospheric turbidity. In this section the amount of clouds and the total net simulated shortwave flux are the only factors considered.

Trends:

- For Cornwall, sunshine appears to have increased over 1979 to 2021, although most changes, annual and seasonal, do not reach statistical significance and there appears to have been minimal, if any, change in summer; increase in sunshine point to equivalent decreases in cloudiness

Projections:

- For Cornwall there are two related factors: cloudiness is projected to continue to decrease, particularly in summer, while the shortwave radiation flux is equivalently projected to increase

Examples of impacts based on CIDs:

- On energy infrastructure (HC)
- On oceanic and coastal ecosystems and equivalently on agricultural production systems, on labour productivity, on the built environment, on morbidity and mortality, and on tourism (LC/MC)

Examples of impacts based on CCRA3:

- Areas carrying risks include: health, cultural heritage, etc.
- Areas carrying risks and opportunities include: energy demand, landscape character, etc.
- Areas carrying opportunities include: health, energy infrastructure etc.

More Detail on Trends for Radiation at Surface

Main Points from IPCC WGI AR6 for NEU for the Globe and NEU for Radiation at Surface

- Surface radiation over NEU has decreased (MC)

Main Points from MONCIC for SWESW for Radiation at Surface

- Trends on sunshine 1979 to 2021 over SWESW tend to be positive, the likely exception being in summer
- All trends in sunshine are not significant at the 1% level apart from those for annual and spring

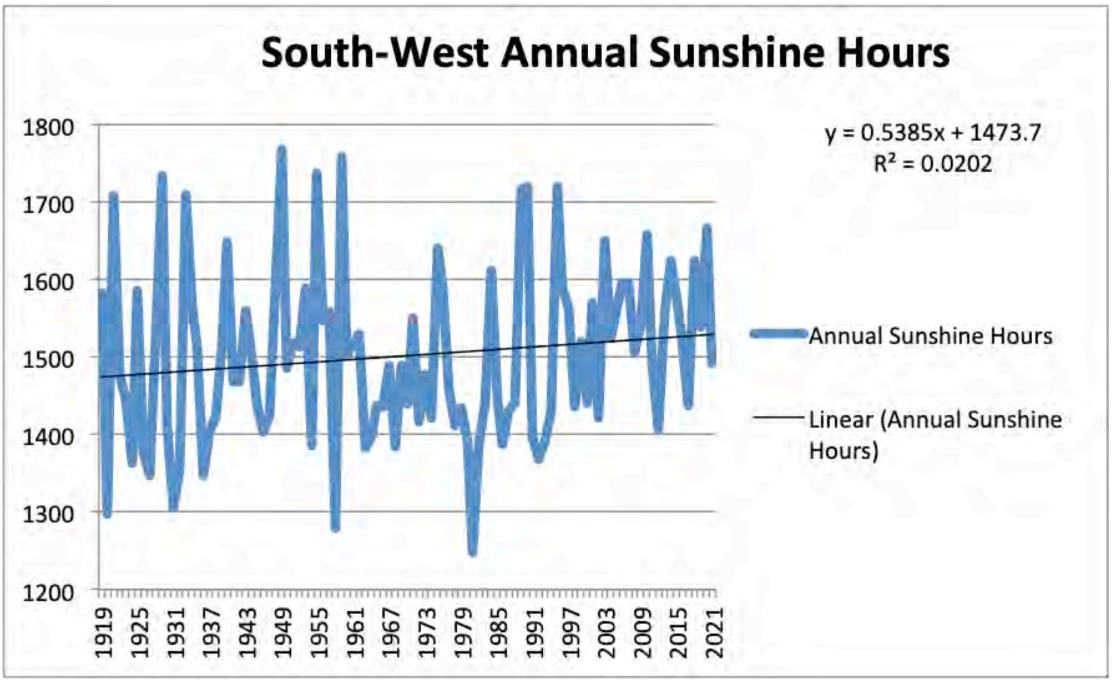


Figure 74. Annual sunshine totals over SWESW 1919 to 2021

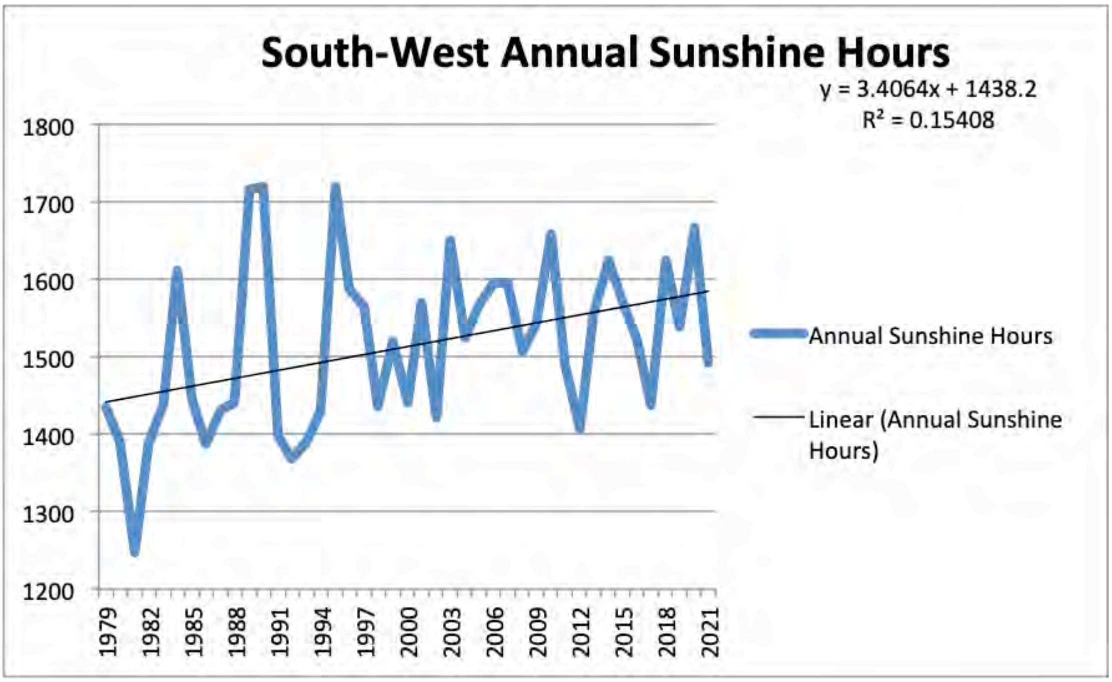


Figure 75. Annual sunshine totals over SWESW 1979 to 2021

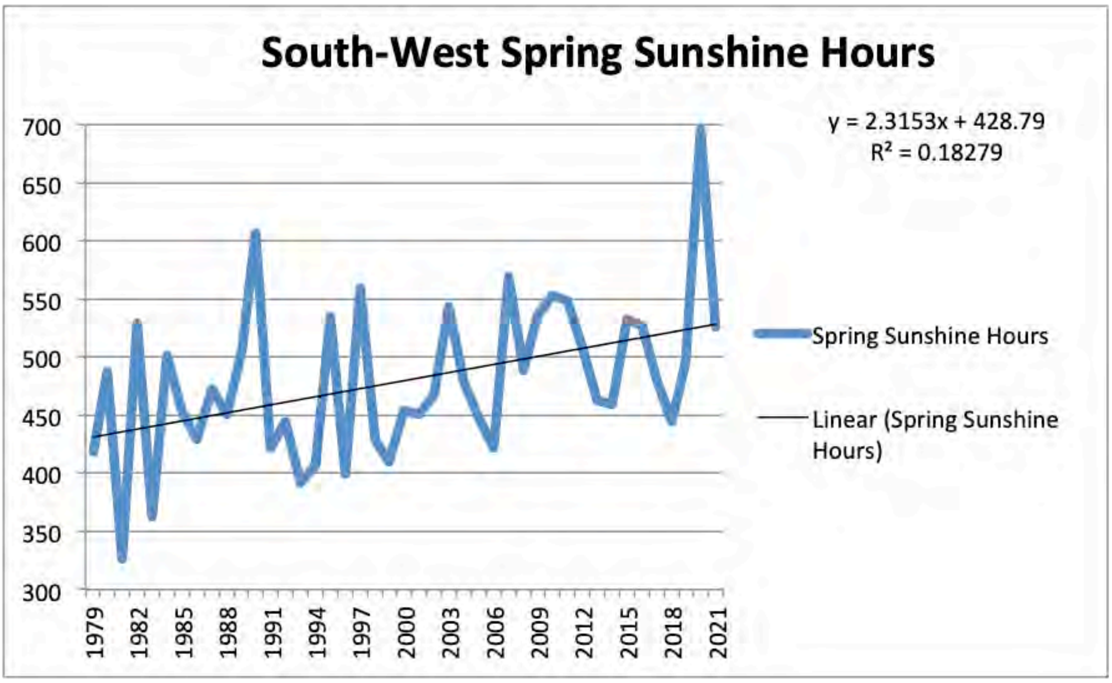


Figure 76. Sunshine totals in spring over SWESW 1979 to 2021

Main Points from CCRA3 for Radiation at Surface

- No information on trends

More Detail on Projections for Radiation at Surface

Main Points from IPCC WGI AR6 for the globe and for NEU for Radiation at Surface

- Decreases in global cloudiness are expected to continue

Main Points from UKCP18 for Radiation at Surface

- Cloudiness over Cornwall is projected most likely to decrease, particularly in summer, while the shortwave radiation flux is projected most likely to increase

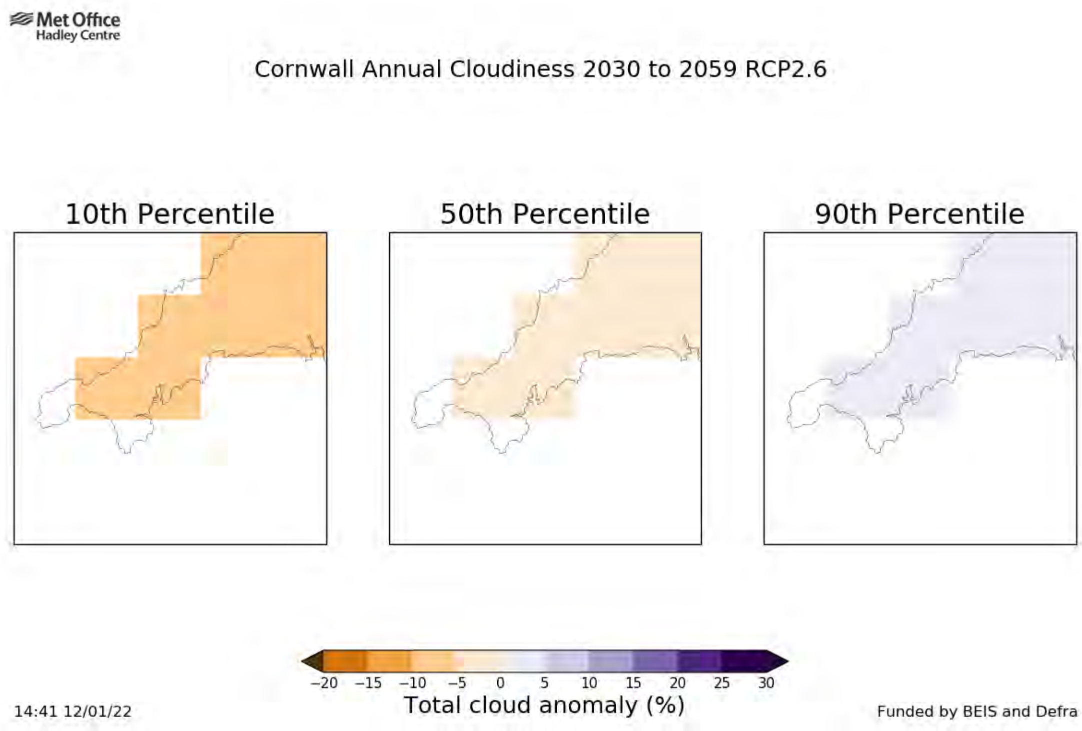


Figure 77. Annual cloudiness change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are similar for RCP8.5

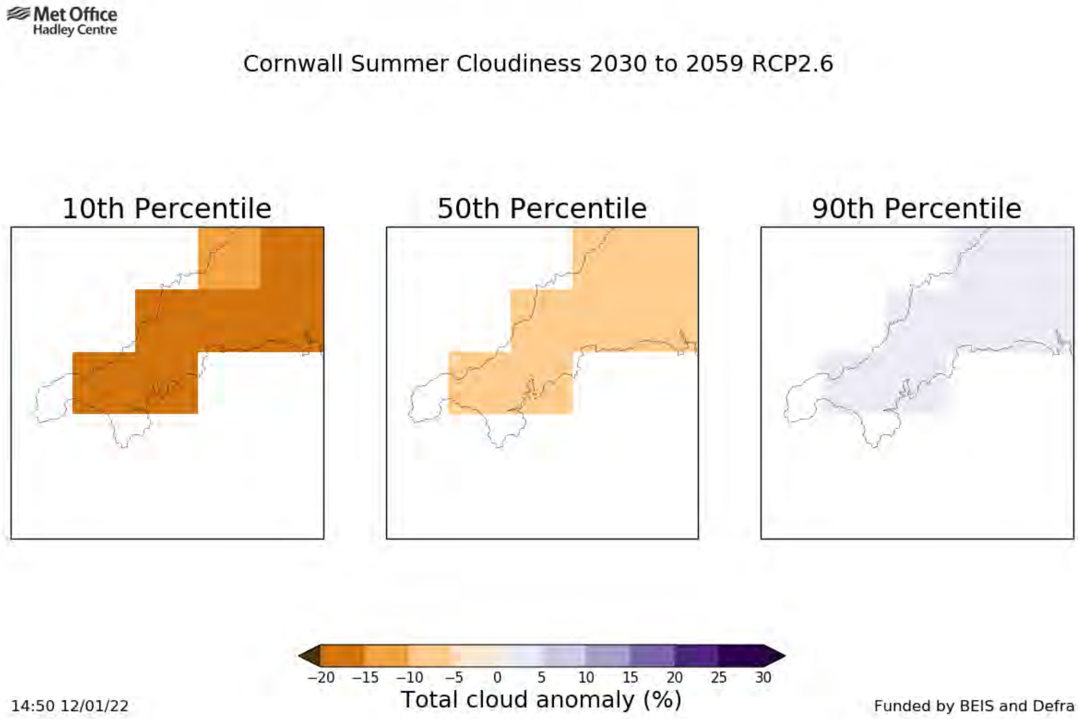


Figure 78. Summer cloudiness change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are similar for RCP8.5

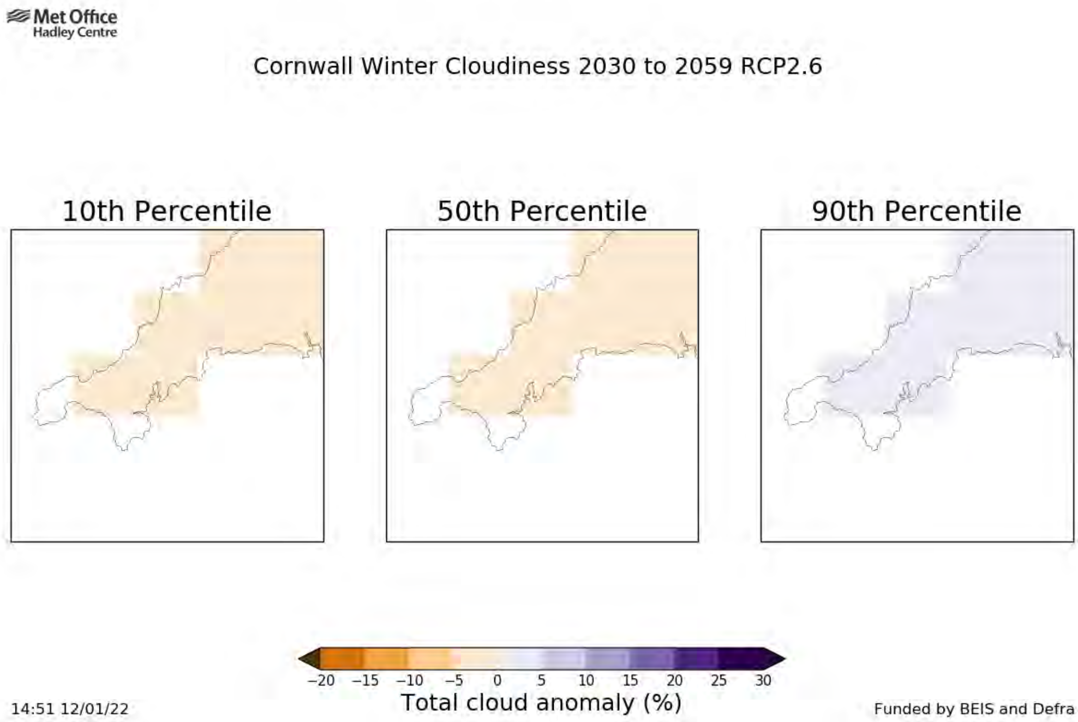


Figure 79. Winter cloudiness change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are similar for RCP8.5

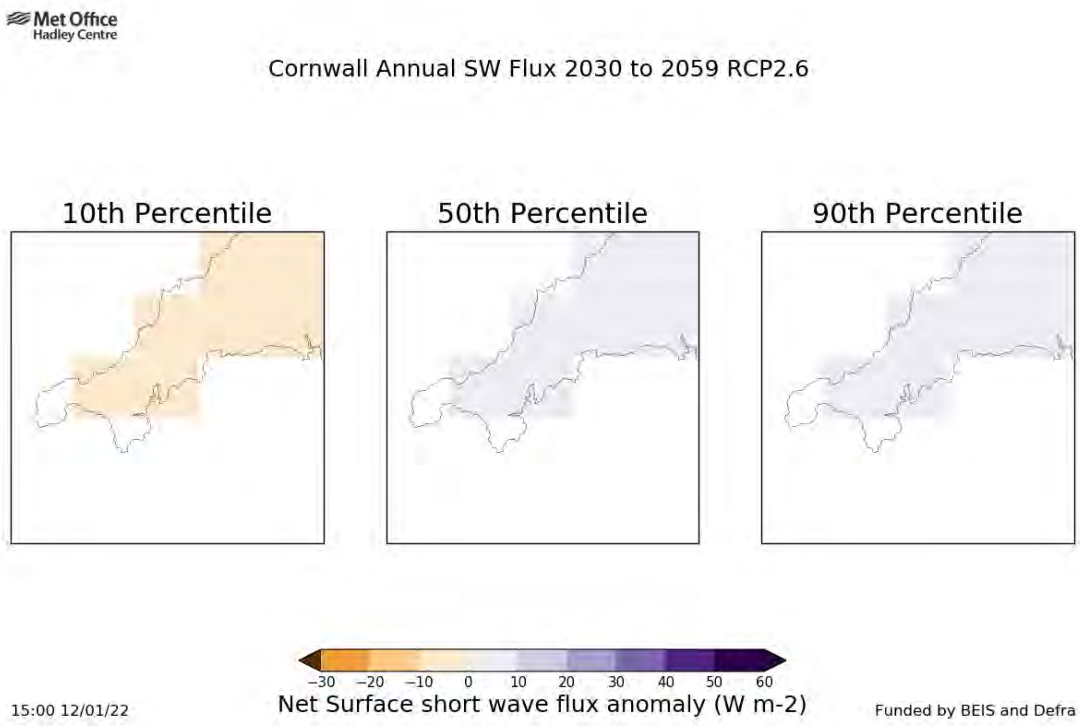


Figure 80. Annual shortwave flux change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are similar for RCP8.5

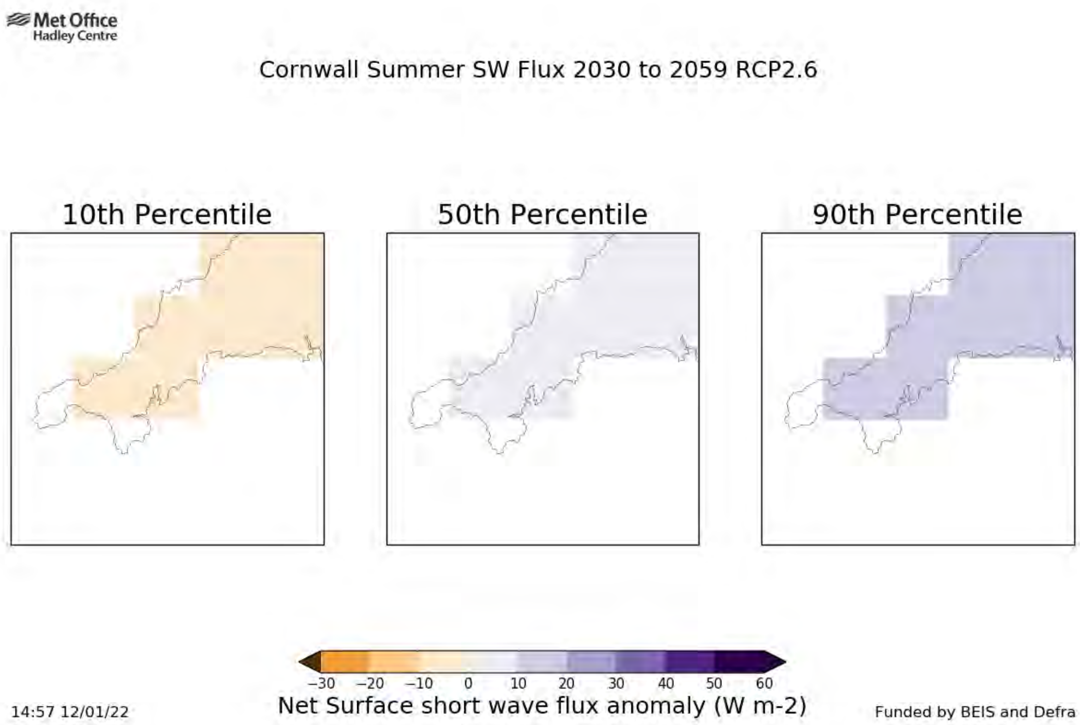


Figure 81. Summer shortwave flux change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are roughly similar for RCP8.5

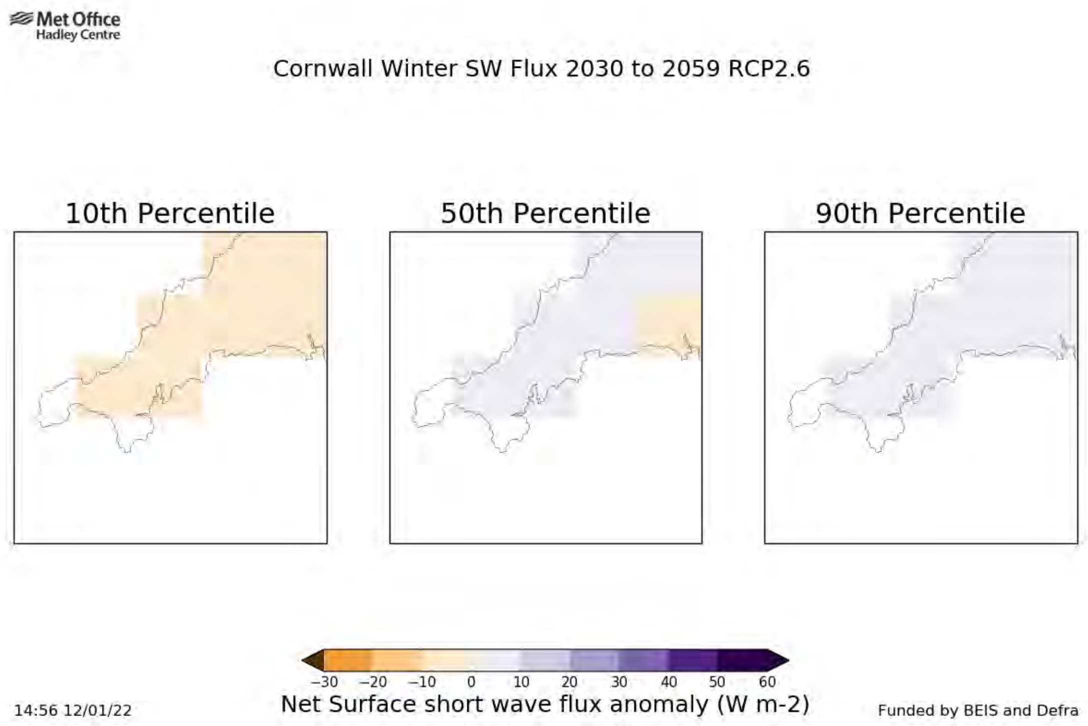


Figure 82. Winter shortwave flux change over Cornwall 2030 to 2059 compared to 1981 to 2000 under RCP2.6; results are similar for RCP8.5

Main Points from CCRA3 for Radiation at Surface

- Cloudiness is projected to decrease in summer and surface radiation to increase (no results are provided for other seasons)

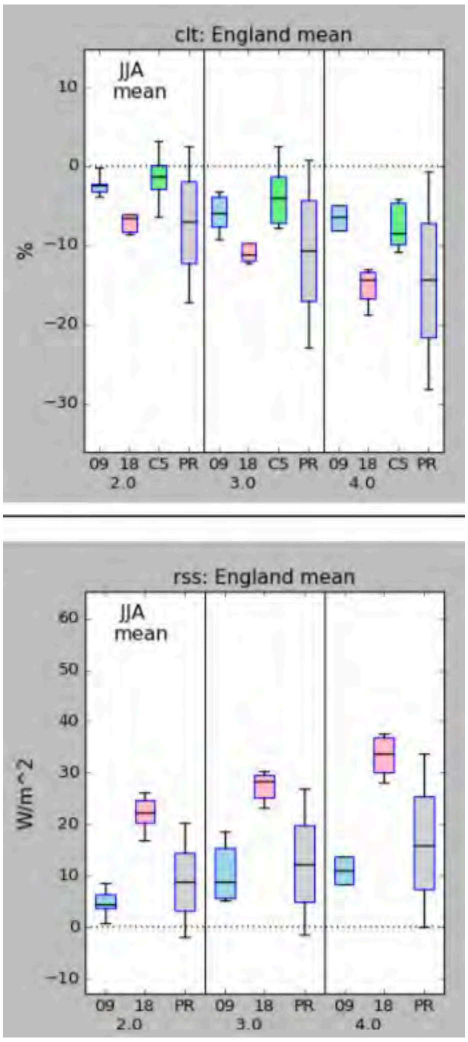


Figure 83. Projected changes in summer cloudiness (top) and surface radiation (bottom) using three projection approaches compared to 1981 to 2000 over England at three levels of global warming

Annex 1. Summary of the information and documents used to develop the assessment

The documents and information sources collated to provide this assessment of climate change over Cornwall include:

- The UK Climate Change Risk Assessment No. 3, CCRA3, 2021
- The UK Climate Projections 2018, UKCP18
- The Working Group I Report to the Intergovernmental Panel on Climate Change Assessment Report No. 6, WGI IPCC AR6, 2021

Major features of the above are summarised in the table below; each feature is discussed in following sections, in which the acronyms are explained.

Source	Climate Change Models	Emissions scenarios	Base period	Temporal scales	Spatial scales
CCRA3	Uses mainly those from UKCP09 and UKCP18	RCP2.6 RCP4.5 RCP6.0 RCP8.5	Depends on source being accessed, e.g. 1850-1900	Various	Global, UK, regional in UK
UKCP18 (and MONCIC)	All UKMO	RCP2.6 RCP4.5 RCP6.0 RCP8.5 SRES A1B	1961-1990 1981-2000 1981-2010	Months; Seasons; Annual; Various future periods selectable	60km; 25km, 12km; 2.2km; for MONCIC regional
IPCC WGI AR6	CMIP6 in the main report; selectable in the Atlas including CMIP6, CMIP5, all CORDEX, plus observations)	SSP1-2.6 SSP2-4.5 SSP3-7.0 SSP5-8.5	1995-2014 in the main report; selectable in the Atlas (1995-2014; 1986-2005; 1850-1900; 1961-1990; 1981-2010)	Mainly to 2100 (some extension beyond); main details in fixed 20-year periods (2021-2040; 2041-2060; 2081-2100)	In the region of 100 to 200km for CMIP6 (global maps are published on a small scale that gives interpretation difficulties); details only to regional scale with CMIP5/CORDEX. Details provided down to regional scale, the area that includes Cornwall being NEU

The Sources

These sources carry a vast amount of information that has been collated and summarised into details pertinent to Cornwall. Cornwall-specific information is not always available and so the information has been selected to be representative as far as possible. This process comes with the caution that frequently, when treating climate issues, it is optimal to use larger spatial and temporal scales than might be available in order to remove noise. The scales used in general are summarised in the table above, with more details following.

The IPCC WGI AR6 report has been agreed at intergovernmental level; the draft version has been used as the finalised text is yet to be published. As a result I the reproductions of some figures in the Main report parts of the background watermark included in the draft necessarily have been included.

The WGI report consists of 12 main chapters, most of which have contributed to this report, as have a number of the Annexes and Fact Sheets. New in the AR6 is the interactive IPCC Atlas, from which a number of diagrams used have been extracted. This covers both observations and projections, but during the work an issue with the observations side was found that prohibited further analyses (this was reported and is in the process of being resolved).

The WGI component will be joined during 2022 by equivalent reports from WGII and WGIII, plus an overall synthesis, but these are not available at the time of preparation of this report.

UKCP18 is the latest in a line of increasingly comprehensive climate analyses, focussed on the UK, from UKMO mainly using in-house climate models and data (including data available at MONCIC which, for the sake of simplicity, is assumed here as part of UKCP18). In addition to on-line access to a large number of statistics, that have provided many of the diagrams, there are a large number of reports under the UKCP18 banner. The main ones used have been the "Science Overview Report" and the "Marine Report", but several others have been referenced.

The UK Climate Risks Indicators project (part of the UK Climate Resilience project) has a web site, https://uk-cri.org/, built out of UKCP18 that is easier for general use than UKCP18 itself, although as far as can be seen it contains the same information. Details are available for projections jointly over Devon and Cornwall as well as for the two counties independently. The details provided in the Main report are taken only from UKCP18.

CCRA3 is the latest assessment by the Climate Change Committee, produced under UK Law once every 5 years. While it takes much of its information from UKCP18 other sources are used to build a comprehensive picture. There are a number of individual reports, fact sheets, briefings, etc., many of which have been used, but the main focus has been on the "Technical Report" and on the "England Annex" that includes estimates of national risks and opportunities.

Spatial Scales

There is no standardised spatial scale for producing projections, although it is possible to interpolate results from the different models to the same scales. In general the global models (GCMs) submitted to CMIP have spatial scales of around 200km, although this scale is reducing as computing power increases. For Regional Models (RCMs) a typical scale is 20km, although a model used in UKCP18 has a scale of 2.2km.

The IPCC WGI AR6 report largely covers the global scale, with maps that can be interpreted with care down to the Cornish region, plus a series of interpretations for regions throughout the world. The entire UK in included in the North Europe, NEU, region, and information for this is included as far as it is relevant to Cornwall.

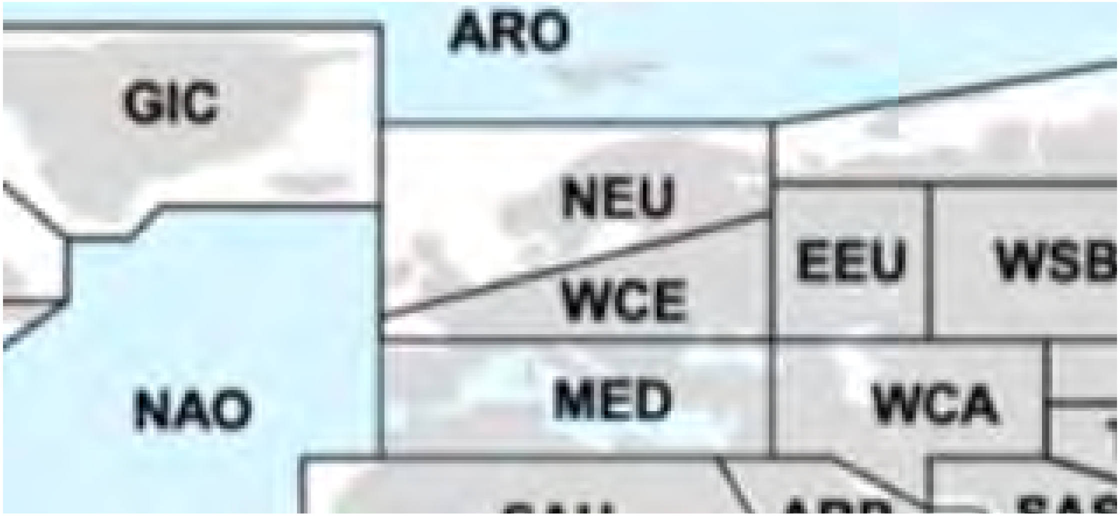


Figure 1. Regions used as standard throughout the IPCC WGI AR6 report. Data have been extracted from the Region covering Cornwall, North Europe – NEU

UKCP18 covers various scales from 60km, used for global calculations, down to 2.2km; the models used at the various scales are not necessarily the same and therefore there may be technical dependencies amongst the results. For most of the projections used in this Cornwall report the 25km scale has been used, as this is the only scale at which a comprehensive set of emissions scenarios is available. Checks have been made to examine representativity by contrasting results from other 25km blocks with those from the one used; the block used is acceptably representative.

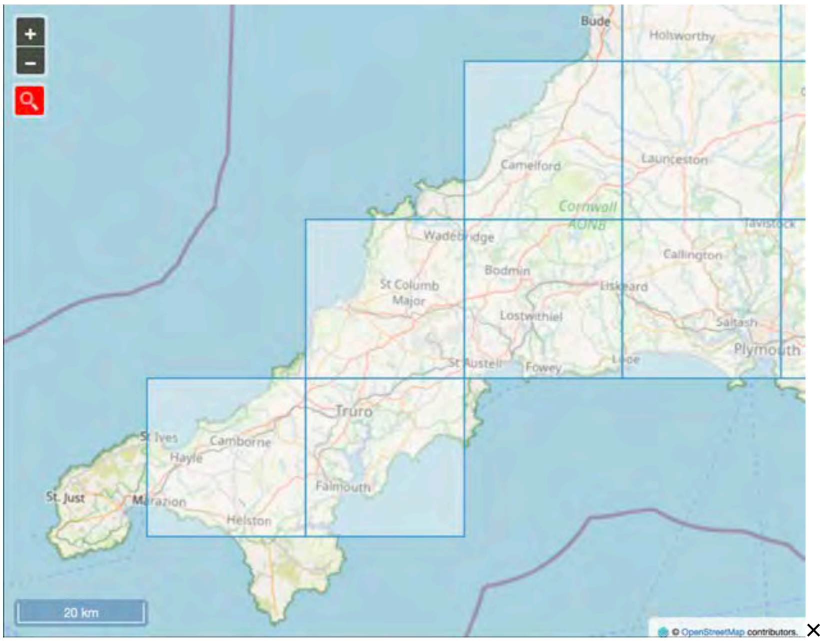


Figure 2. The UKCP18 25km grid over southwest England. The block that includes Truro has been used for most projections representative for the county.

In certain analyses in which likelihood thresholds are presented, data have been extracted from a region covering the entire county of Cornwall.

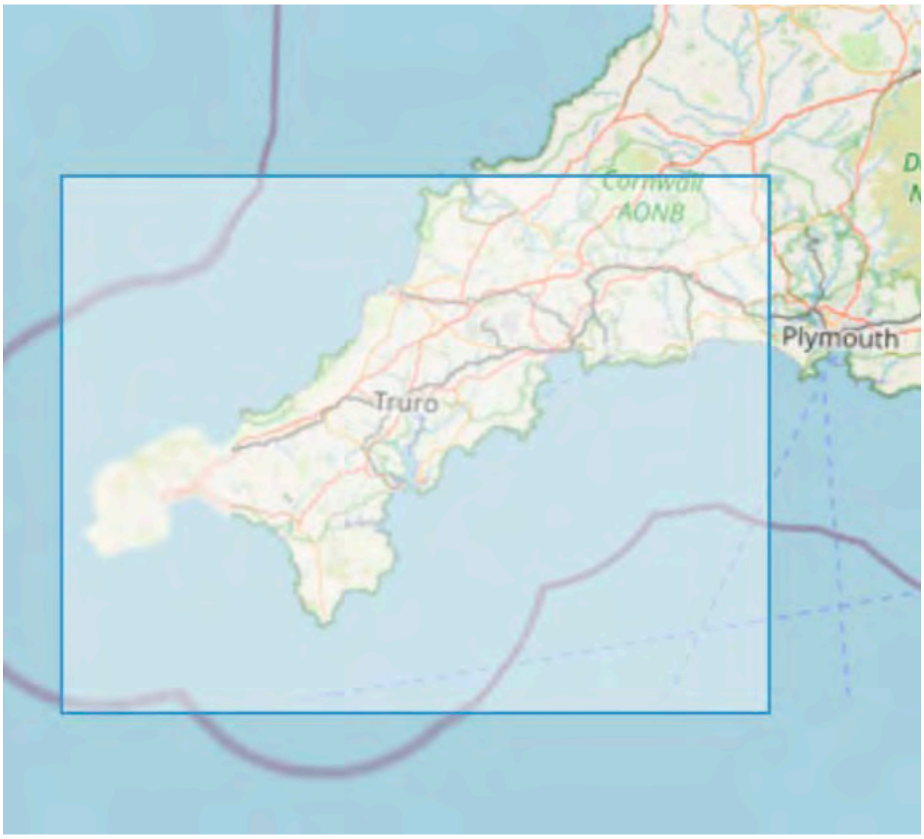


Figure 3. The area covering Cornwall used for projections analyses that produce likelihoods thresholds.

In addition, observational data from MONCIC for the South West England and South Wales (SWESW) region has been included.

Figure 4. The regions available from MONCIC, with the S Wales and England SW referred to throughout as SWESW.

Spatial scales used in CCRA3 are dependent upon available information but are often focussed on the four individual countries within the UK. Some of the time series extracted from MONCIC begin well back into the 1800s.

Temporal Scales

Some observational data are available on a daily scale, but the focus in the report has been to seasonal and annual scales.

Projections are normally averaged over 20-year or, perhaps the better option, 30-year periods. Shorter periods are not often used as they may contain greater degrees of noise, plus the objective is to extract the signal related to climate change that may appear only progressively in time. A variety of temporal scales have been used in the report to build a comprehensive picture.

Base Periods

None of the climate models used in CMIP simulate climate perfectly. For example, simulated temperatures might be higher/lower than those observed, and similarly for rainfall. Perhaps the greatest skill the models possess is in simulating the average global temperature. Biases emerge more strongly as the focus is placed on increasingly smaller areas and on reduced time scales. As a straightforward approach to reducing the major biases, climate change projections are calculated not in absolute terms but as adjustments from runs with each model during a historical period, the base period. These historical runs over the base period are made usually independently of the projections themselves but are then used to adjust values produced by the projections, an approach that permits intercomparison of results from the galaxy of models.

Base periods have changed with each succeeding AR/CMIP; thus projected changes have also modified a little as later base periods tend to include higher temperatures (the position with rainfall may be more complex). As noted in the table above, various base periods are available in UKCP18. The main base period in CMIP6/AR6 is 1995 to 2014 (in CMIP5/AR5 it was 1986 to 2005), but some results refer to other periods. For UKCP18 the period 1981 to 2000 has been used when possible, as this is the most consistent period available. Hence various base periods are employed in the analyses. In general, however, given that this is not a precise science, the differences in the base periods should have no practical impacts on the results.

Base periods used have been noted in the report, and in principle it is possible to adjust values to provide consistency between all results to a single base period. Adjustment is most straightforward for temperatures, less so for variables such as rainfall. However this does not in general adjust the tone of the results, not least given the uncertainties involved.

As an final note, the year 1979 is often used as the start of a base period, and does appear in some of the analyses in this report. This year is favoured because a major international project that ran through the year improved substantially the quantity and quality of atmospheric and oceanic observations on the global scale.

Climate Change Models

There are a growing number of centres developing climate change models that are contributed to a central data archive called CMIPn under the auspices of the WCRP. The most recent such set, CMIP6, has been used in the development of the WGI IPCC AR6 (for the AR5 it was CMIP5). CMIP6 is the most complex of the series to date, and is divided into a number of separate MIPs that provide the basis for model assessment within various contexts. For most of the projections used here results have been taken from the ScenarioMIP, focussed on projections using the models to 2100 and beyond.

No individual model is perfect in its projections, and there is no way in which a "best" model can be selected. Thus CMIP is developed from a number of individual projections all created under similar bounding conditions (including the emissions scenarios), an ensemble. Results presented in this assessment use a variety of approaches for interpreting results from the ensembles, including probabilities, the approach most consistent with theory. Deterministic predictions have not been included.

Emissions Scenarios - Introduction

Emissions scenarios used in CMIP6/AR6 are summarised in the table following, with details of previous scenarios provided subsequently:

SSP Scenario	Basis of storyline	Tier 1	Tier 2
SSP 1	Sustainability (Taking the Green Road): Low challenges for mitigation (resource efficiency) and for adaptation (rapid development)	SSP1-2.6	SSP1-1.9
SSP 2	Middle of the Road: with intermediate changes for both mitigation and adaptation	SSP2-4.5	-
SSP 3	Regional Rivalry (A Rocky Road): High challenges for mitigation (regionalised energy/land policies) and for adaptation (slow development)	SSP3-7.0	-
SSP 4	Inequality (A Road Divided): Low challenges for mitigation (global high tech economy) but high challenges for adaptation (regional low tech economies)	-	SSP4-3.4; SSP4-6.0
SSP 5	Fossil-Fuelled Development (Taking the Highway): High challenges for mitigation (resource/fossil fuel intensive) but low challenges for adaptation (rapid development)	SSP5-8.5	SSP5-3.4

The SSPs are defined using the storylines summarised in the second column. These storylines do not incorporate any climate details but all can be combined with the climate forcings described in the earlier RCPs (as used in the AR5 and discussed below). Thus SSP1-2.6 is a combination of SSP1 with RCP2.6. The figure given with 'RCP' is an indicator of the radiative forcing of the atmosphere by 2100, the larger the value the greater the cumulative emissions and the concentration of CO_2 in the atmosphere. Given the large potential number of combinations between SSPs and RCPs, not all consistent between storyline and radiative forcing, the combinations listed under Tier 1 have been given priority in developing CMIP6 and are the only ones assessed.

There is no simple selection of a "best" emissions scenario. Those with '8.5' were based on a "business-as-usual" approach during the earlier development of scenarios; there is a growing view that these are now too high given the current climate-relevant political and economic conditions. Nevertheless many published projections still use '8.5'.

In CMIP5 RCP6.0 was used by only a relatively few projections submitted. In the SSPs '7.0', often viewed now as the more realistic high scenario as against '8.5', has replaced '6.0'. '7.0' has a similar number of projections in CMIP6 as the other Tier 1 combinations.

In the CMIP5 projections RCP2.6 was the only one that offered a reasonable chance of meeting the Paris Agreement target of 2.0ºC (a small chance with the middle-of-the-road '4.5'), and the only chance of reaching the 1.5ºC target that formed the basis of the CoP26 negotiations in Glasgow, November 2021. '2.6' has been joined by a lower-emissions scenario, '1.9', although the latter is used only in the lower-priority Tier 2. Results from '2.6' only are assessed here.

In summary:

- '8.5' is the highest emissions scenario, certainly producing the largest temperature changes, and *perhaps* those in rainfall; now viewed as probably too high in terms of emissions; often used to develop "worst case" climate change scenarios on which to base "no regrets" adaptation planning
- '7.0' is perhaps a better option for "worst case" planning

- '4.5' is a middle-of-the road option, more consistent perhaps with expectations following immediate outcomes from CoP26
- '2.6' is the option that provides the smallest changes in temperatures and rainfall; it would be an appropriate planning choice should onward discussions in future CoPs succeed in reducing emissions to meet the Paris Agreement target.

Emissions Scenarios - Details

To date the emissions scenarios employed to provide the details necessary to enable GCM projections to be made to the end of the century (and beyond in some cases) cover greenhouse gas concentrations in the atmosphere only. Just as it is not possible to identify a "best" projection it is equally not possible to identify a "best" emissions scenario from those available, with the scenarios covering a range of reasonable futures, a range growing as knowledge develops. Note that although large numbers of scenarios have been developed (both under the IPCC banner and elsewhere – for instance, for SRES, discussed below, 40 scenarios were created) resource limitations restrict capabilities to create projections for all, and thus in the CMIP projects the focus has been on a limited few scenarios, and only those are discussed below. Timelines of the development of the various main greenhouse gas scenarios used by the IPCC in their Assessments to date are listed in Table below.

Approaches taken sequentially in generating climate scenarios using Global Climate Models

CO_2 Doubling (steady state simulations)	Early research work and used in all Assessments
1% increase in CO_2 per annum (transient simulations)	Early research work and used in all Assessments
SA90 – Scenario A of 1990 (Business as Usual) (there was also SB, SC and SD)	First Assessment Report and its Supplement
IS92 – IPCC 1992 Scenario (there was IS92a to IS92f)	First Supplement, Second and Third Assessment Reports
SRES – Special Report on Emissions Scenarios (to 2100) (see Table 2 below)	Third, Fourth and Fifth Assessment Reports
RCPs – Representative Concentration Pathways (to 2100, but have been extended to 2300)	Fourth and Fifth Assessment Reports
SSPs – Shared Socio-Economic Pathways (see Table 3 below)	Fifth and Sixth Assessment Reports[1]

The earliest GCM projections, including most before the IPCC commenced work, simply used two model runs, one with GHG concentrations set at historical, pre-industrial, values, the second with a doubling of that value. Models were then run over sufficiently long periods to achieve climatic steady state and differences between the two runs assessed. A slightly more sophisticated approach was to increase GHG concentrations by 1% per year, typically as far as doubling. Both approaches were required in order that projections might be made in lieu of any information at that time on possible future GHG

[1] For practical reasons much of the work of IPCC WGII (Impacts, Adaptation, and Vulnerability) cannot take place using the latest emissions scenarios until the work of WGI (The Physical Science Basis) has been completed; thus the reports of WGII tend to lag by one assessment cycle behind those of WGI in terms of emissions scenarios used.

concentrations, but both are still in use as straightforward methods to inter-compare models and to assess the impacts of changes in model formulations[2].

The first attempts at a more realistic view of future GHG concentrations were prepared for the First IPCC Assessment Report of 1990 – SA90 (Scenario A 1990), SB90, SC90 and SD90, the latter three being modifications around the Business-As-Usual estimates of SA90 on which most modelling research at that time was focused. An improved set was developed for the 1992 Supplement to the First Assessment Report – IS92a, IS92b, ..., IS92f (IPCC Scenario 1992a, etc.,) and used further in the Second Assessment Report of 1995, but it was in preparation for the Third Assessment Report of 2001 that a major step forward was made through developing storylines quantified through the use of EMICs, published in 2000 in the IPCC Special Report on Emissions Scenarios (SRES). The main SRES Scenarios are shown in the Table below, which includes a brief summary of the related storylines. In principle highest emissions are to be expected under A2, in which the background is to maximise economic growth within a competitive environment (regional decision making), as opposed to B1, lowest emissions, with globally-coordinated decision making focussed on environmental protection. In practice emissions as assessed were greater under A1FI than under A2 through most of the 21st Century. Again for reasons of limited computer time, most projections provided to CMIP3 and reviewed in the IPCC Third Assessment Report focused on A1B, A2 and B1.

Summary of the storylines used in the SRES Scenarios

SRES Scenario	Basis of storyline
A1FI (fossil fuel intensive) A1T (technology-based generation) A1B (balanced between fossil fuels and technology)	Global decision making; economic growth priority
A2	Regional decision making; economic growth priority
B1	Global decision making; environmental protection priority
B2	Regional decision making; environmental protection priority

A new approach was taken in the Fifth Assessment Report, in which Relative Concentration Pathways (RCPs) were used; RCPs are based on future radiative properties of the atmosphere under various GHG concentrations but without any underlying socioeconomic storylines. Four RCPs have been used for CMIP5, RCP2.6, RCP4.5, RCP6.0 and RCP8.5, progressively higher numbers indicating greater GHG emissions and concentrations. In straightforward terms:

- RCP8.5 is roughly equivalent to A1FI
- RCP6.0 is roughly midway between A2 and B1
- RCP4.5 is roughly equivalent to B1
- RCP2.6 introduces lower emissions than in any SRES Scenario, with net anthropogenic emissions ceasing by about 2070.

[2] One use of the doubled CO_2 concentrations is to make a straightforward assessment of "climate sensitivity", i.e. the increase in average global temperature should GHG concentrations double from pre-industrial levels. Models exhibit a range of values for climate sensitivity, those with higher values projecting larger increases by the end of the century as well as nearer dates by which increases at the levels that form the Paris Agreement would be reached.

According to calculations based on CMIP5, net emissions must cease (or become net zero) at some stage during the 21st Century if the 2°C target set by the UNFCCC (notwithstanding the 1.5ºC aspirational target) in the Paris Agreement as defining dangerous anthropogenic interference in the climate system is not to be breached. Some views indicate that cessation should be achieved by 2050, somewhat earlier than under RCP2.6. According to the IPCC AR5 it is only a pathway similar to RCP2.6 that provides a reasonable likelihood of achieving the Paris Agreement.

Of course much has changed since the Paris Agreement was concluded, and at Cop26 in Glasgow, 2021, the main focus was on a target increase of 1.5ºC rather than 2ºC, an option left open in the Agreement. Clearly tighter emissions targets are required to meet this lower threshold.

List of the Climate Impacts Drivers (CIDs) considered in Chapter 12 of the IPCC WGI AR6

The right-hand column refers to the locations of detailed discussion in the IPCC WGI AR6.

CID Type	CID Category	Brief Description	Physical Description of Phenomena
Heat and Cold	Mean air temperature	Mean surface air temperature and its diurnal and seasonal cycles.	CH2, CH3, CH4, Atlas
	Extreme heat	Episodic high surface air temperature events potentially exacerbated by humidity.	CH11
	Cold spell	Episodic cold surface air temperature events potentially exacerbated by wind.	CH11
	Frost	Freeze and thaw events near the land surface and their seasonality.	CH12
Wet and Dry	Mean precipitation	Mean precipitation, its diurnal and seasonal cycles, and associated soil moisture and humidity conditions.	CH2, CH8, Atlas
	River flood	Episodic high water levels in streams and rivers driven by basin runoff and the expected seasonal cycle of flooding.	CH8, CH11
	Heavy precipitation and pluvial flood	High rates of precipitation and resulting episodic, localized flooding of streams and flat lands.	CH11
	Landslide	Ground and atmospheric conditions that lead to geological mass movements, including landslide, mudslide, and rockfall.	CH12
	Aridity	Mean conditions of precipitation and evapotranspiration compared to potential atmospheric and surface water demand, resulting in low mean surface water, low soil moisture and/or low relative humidity.	CH8, CH11, Atlas
	Hydrological drought	Episodic combination of runoff deficit and evaporative demand that lead to dry soil.	CH8, CH11
	Agricultural and ecological drought	Episodic combination of soil moisture supply deficit and atmospheric demand requirements that challenge the vegetation's ability to meet its water needs for transpiration and growth. *Note: 'agricultural' vs. 'ecological' term depends on affected biome.*	CH8, CH11
	Fire weather	Weather conditions conducive to triggering and sustaining wildfires, usually based on a set of indicators and combinations of indicators including temperature, soil moisture, humidity, and wind. Fire weather does not include the presence or absence of fuel load. *Note: distinct from wildfire occurrence and area burned.*	CH11, CH12
Wind	Mean wind speed	Mean wind speeds and transport patterns and their diurnal and seasonal cycles.	CH2, CH12
	Severe wind storm	Severe storms including thunderstorms, wind gusts, derechos, and tornados.	CH11, CH12
	Tropical cyclone	Strong, rotating storm originating over tropical oceans accompanied by high winds, rainfall, and storm surge.	CH11
	Sand and dust storm	Storms causing the transport of soil and fine dust particles.	CH8, CH12
Snow and Ice	Snow, glacier and ice sheet	Snowpack seasonality and characteristics of glaciers and ice sheets including calving events and meltwater.	CH2, CH9, Atlas
	Permafrost	Permanently frozen deep soil layers, their ice characteristics, and the characteristics of seasonally frozen soils above.	CH2, CH9
	Lake, river and sea ice	The seasonality and characteristics of ice formations on the ocean and freshwater bodies of water.	CH2, CH9
	Heavy snowfall and ice storm	High snowfall and ice storm events including freezing rain and rain-on-snow conditions.	CH11, CH12
	Hail	Storms producing solid hailstones.	CH11, CH12

	Snow avalanche	Cryospheric mass movements and the conditions of collapsing snowpack.	CH12
Coastal	**Relative sea level**	The local mean sea surface height relative to the local solid surface.	CH9
	Coastal flood	Flooding driven by episodic high coastal water levels that result from a combination of relative sea level rise, tides, storm surge, and wave setup.	CH9, CH12
	Coastal erosion	Long term or episodic change in shoreline position caused by relative sea level rise, nearshore currents, waves, and storm surges.	CH12
Open Ocean	**Mean ocean temperature**	Mean temperature profile of ocean through the seasons, including heat content at different depths and associated stratification.	CH2, CH9
	Marine heatwave	Episodic extreme ocean temperatures.	CH9, CH12
	Ocean acidity	Profile of ocean water pH and accompanying concentrations of carbonate and bicarbonate ions.	CH5
	Ocean salinity	Profile of ocean salinity and associated seasonal stratification. *Note: distinct from salinization of freshwater resources.*	CH2, CH5
	Dissolved oxygen	Profile of ocean water dissolved oxygen and episodic low oxygen events.	CH5
Other	**Air pollution weather**	Atmospheric conditions that increase the likelihood of high particulate matter or ozone concentrations or chemical processes generating air pollutants. *Note: distinct from aerosol emissions or air pollution concentrations themselves.*	CH6
	Atmospheric CO_2 at surface	Concentration of atmospheric carbon dioxide [CO_2] at the surface. *Note: distinct from overall radiative effect of CO_2 as greenhouse gas.*	CH5
	Radiation at surface	Balance of net shortwave, longwave and ultraviolet radiation at the earth's surface and their diurnal and seasonal patterns.	CH7

Risks and Opportunities considered in CCRA3

The 61 Risks and Opportunities considered in the CCRA3 (from p11-12 of the Complete Report).

Table 2 Risks and opportunities assessed in the CCRA3 Technical Report

	Natural Environment and Assets
N1	Risks to terrestrial species and habitats from changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding and saline intrusion).
N2	Risks to terrestrial species and habitats from pests, pathogens and invasive species
N3	Opportunities from new species colonisations in terrestrial habitats
N4	Risk to soils from changing climatic conditions, including seasonal aridity and wetness.
N5	Risks and opportunities for natural carbon stores, carbon sequestration from changing climatic conditions, including temperature change and water scarcity
N6	Risks to and opportunities for agricultural and forestry productivity from extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind and saline intrustion).
N7	Risks to agriculture from pests, pathogens and invasive species
N8	Risks to forestry from pests, pathogens and invasive species
N9	Opportunities for agricultural and forestry productivity from new/alternative species becoming suitable.
N10	Risks to aquifers and agricultural land from sea level rise, saltwater intrusion
N11	Risks to freshwater species and habitats from changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts.
N12	Risks to freshwater species and habitats from pests, pathogens and invasive species
N13	Opportunities to freshwater species and habitats from new species colonisations
N14	Risks to marine species, habitats and fisheries from changing climatic conditions, including ocean acidification and higher water temperatures.
N15	Opportunities to marine species, habitats and fisheries from changing climatic conditions
N16	Risks to marine species and habitats from pests, pathogens and invasive species
N17	Risks and opportunities to coastal species and habitats due to coastal flooding, erosion and climate factors.
N18	Risks and opportunities from climate change to landscape character
	Infrastructure
I1	Risks to infrastructure networks (water, energy, transport, ICT) from cascading failures

I2	Risks to infrastructure services from river, surface water and groundwater flooding
I3	Risks to infrastructure services from coastal flooding and erosion
I4	Risks to bridges and pipelines from flooding and erosion
I5	Risks to transport networks from slope and embankment failure
I6	Risks to hydroelectric generation from low or high river flows
I7	Risks to subterranean and surface infrastructure from subsidence
I8	Risks to public water supplies from reduced water availability
I9	Risks to energy generation from reduced water availability
I10	Risks to energy from high and low temperatures, high winds, lightning
I11	Risks to offshore infrastructure from storms and high waves
I12	Risks to transport from high and low temperatures, high winds, lightning
I13	Risks to digital from high and low temperatures, high winds, lightning
	Health, Communities and the Built Environment
H1	Risks to health and wellbeing from high temperatures
H2	Opportunities for health and wellbeing from higher temperatures
H3	Risks to people, communities and buildings from flooding
H4	Risks to the viability of coastal communities from sea level rise
H5	Risks to building fabric
H6	Risks and opportunities from summer and winter household energy demand
H7	Risks to health and wellbeing from changes in air quality
H8	Risks to health from vector-borne disease
H9	Risks to food safety and food security
H10	Risks to water quality and household water supplies
H11	Risks to cultural heritage
H12	Risks to health and social care delivery
H13	Risks to education and prison services
	Business and industry
B1	Risks to businesses from flooding
B2	Risks to businesses and infrastructure from coastal change from erosion, flooding and extreme weather events
B3	Risks to business from water scarcity
B4	Risks to finance, investment and insurance including access to capital for businesses
B5	Risks to business from reduced employee productivity due to infrastructure disruption and higher temperatures in working environments
B6	Risks to business from disruption to supply chains and distribution networks
B7	Opportunities for business from changes in demand for goods and services
	International Dimensions
ID1	Risks to UK food availability, safety, and quality from climate change overseas
ID2	Opportunities for UK food availability and exports from climate impacts overseas
ID3	Risks and opportunities to the UK from climate-related international human mobility
ID4	Risks to the UK from international violent conflict resulting from climate change overseas
ID5	Risks to international law and governance from climate change that will impact the UK
ID6	Opportunities from climate change (including Arctic ice melt) on international trade routes
ID7	Risks associated with international trade routes
ID8	Risk to the UK finance sector from climate change overseas
ID9	Risk to UK public health from climate change overseas
ID10	Systemic risk arising from the amplification of named risks cascading across sectors and borders

The summary of risks and opportunities as assessed within the England Annex of the CCRA3

Natural Environment and Assets Natural Environment and Assets			
Risk or Opportunity	**Risk number and Receptor**	**Nature of risk/opportunity**	**Urgency Score**
RISKS	N1. Terrestrial species and habitats	Changing climatic conditions and extreme events, including temperature change, water scarcity, wildfire, flooding, wind, and altered hydrology (including water scarcity, flooding and saline intrusion)	More action needed
RISKS	N2. Terrestrial species and habitats	Pests, pathogens and invasive species	More action needed
RISKS	N4. Soils	Changing climatic conditions, including seasonal aridity and wetness	More action needed
RISKS	N7. Agriculture	Pests, pathogens and invasive species	More action needed
RISKS	N8. Forestry	Pests, pathogens and invasive species	More action needed
RISKS	N10. Aquifers and agricultural land	Sea level rise, saltwater intrusion	Further investigation
RISKS	N11. Freshwater species and habitats	Changing climatic conditions and extreme events, including higher water temperatures, flooding, water scarcity and phenological shifts	More action needed
RISKS	N12. Freshwater species and habitats	Pests, pathogens and invasive species	More action needed
RISKS	N14. Marine species, habitats and fisheries	Changing climatic conditions, including ocean acidification and higher water temperatures	More action needed
RISKS	N16. Marine species and habitats	Pests, pathogens and invasive species	More action needed
RISKS & OPPORTUNITIES	N5. Natural carbon stores, carbon sequestration and GHG emissions	Changing climatic conditions, including temperature change and water scarcity	More action needed
RISKS & OPPORTUNITIES	N6. Agricultural and forestry productivity	Extreme events and changing climatic conditions (including temperature change, water scarcity, wildfire, flooding, coastal erosion, wind)	More action needed
RISKS & OPPORTUNITIES	N17. Coastal species and habitats	Coastal flooding, erosion and climate factors	More action needed
RISKS & OPPORTUNITIES	N18. Landscape character	Climate change	Further investigation
OPPORTUNITIES	N3. Terrestrial species and habitats	New species colonisations	Further investigation
OPPORTUNITIES	N9. Agricultural and forestry productivity	New/alternative species becoming suitable	Further investigation
OPPORTUNITIES	N13. Freshwater species and habitats	New species colonisations	Sustain current action
OPPORTUNITIES	N15. Marine species, habitats and fisheries	Changing climatic conditions	Further investigation

Infrastructure

Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	I1. Infrastructure networks (water, energy, transport, ICT)	Cascading failures	More action needed
RISKS	I2. Infrastructure services	River, surface water and groundwater flooding	More action needed
RISKS	I3. Infrastructure services	Coastal flooding and erosion	Further investigation
RISKS	I4. Bridges and pipelines	Flooding and erosion	Further investigation
RISKS	I5. Transport networks	Slope and embankment failure	More action needed
RISKS	I6. Hydroelectric generation	Low or high river flows	Further investigation
RISKS	I7. Subterranean and surface infrastructure	Subsidence	Further investigation
RISKS	I8. Public water supplies	Reduced water availability	More action needed
RISKS	I9. Energy generation	Reduced water availability	Further investigation
RISKS	I10. Energy	High and low temperatures, high winds, lightning	Further investigation
RISKS	I11. Offshore infrastructure	Storms and high waves	Sustain current action
RISKS	I12. Transport	High and low temperatures, high winds, lightning	More action needed
RISKS	I13. Digital	High and low temperatures, high winds, lightning	Further investigation

Health, Communities and the Built Environment

Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	H1. Health and wellbeing	High temperatures	More action needed
RISKS	H3. People, communities and buildings	Flooding	More action needed
RISKS	H4. Viability of coastal communities	Sea level rise	More action needed
RISKS	H5. Building fabric	Moisture, wind and driving rain	Further investigation
RISKS	H7. Health and wellbeing	Changes in indoor and outdoor air quality	Further investigation
RISKS	H8. Health	Vector-borne disease	More action needed
RISKS	H9. Food safety and food security	Higher temperatures (food safety) and extreme weather (food security)	Further investigation
RISKS	H10. Health	Poor water quality and household water supply interruptions	Further investigation
RISKS	H11. Cultural heritage	Changes in temperature, precipitation, groundwater, land, ocean and coastal change	More action needed
RISKS	H12. Health and social care delivery	Extreme weather	More action needed
RISKS	H13. Delivery of Education and prison services	Extreme weather	More action needed
RISKS & OPPORTUNITIES	H6. Household energy demand	Summer and winter temperature changes	More action needed
OPPORTUNITIES	H2. Health and wellbeing	High temperatures	Further investigation

Business and Industry

Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	B1. Flooding of business sites	Increase in flood risk	More action needed
RISKS	B2. Coastal business locations and infrastructure	Coastal flooding, extreme weather, erosion and sea level rise	More action needed
RISKS	B3. Business production processes	Water scarcity	Further investigation
RISKS	B4. Business access to finance, investment and insurance	Extreme weather	Sustain current action
RISKS	B5. Reduced employee productivity in businesses	Infrastructure disruption and higher temperatures in working environments	Further investigation
RISKS	B6. Disruption to business supply chains and distribution networks	Extreme weather	More action needed
OPPORTUNITIES	B7. Changes in demand for goods and services	Long-term climate change	Further investigation

International Dimensions

Risk or Opportunity	Risk number and Receptor	Nature of risk/opportunity	Urgency Score
RISKS	ID1. Food availability, safety, and quality	Decreasing yields from rising temperatures, water scarcity and ocean changes globally	More action needed
RISKS & OPPORTUNITIES	ID3. Migration to the UK and effects on the UK's interests overseas	Climate-related international human mobility	Watching brief
RISKS	ID4. The UK's international interests and responsibilities	International violent conflict resulting from climate change overseas	More action needed
RISKS	ID5. Changes to international governance affecting the UK	Reduced international collective governance due to climate change and responses to it	More action needed
RISKS	ID7. International trade routes	Climate hazards affecting supply chains	More action needed
RISKS	ID8. Economic loss to the UK	Climate driven resource governance pressures and financial exposure	Sustain current action
RISKS	ID9. UK public health	Increase in vector borne diseases due to climate change	More action needed
RISKS	ID10. Risk multiplication to the UK	Interactions and cascades of named risks across systems and geographies	More action needed
OPPORTUNITIES	ID2. UK food availability and exports	Increases in productivity and areas suitable for agriculture overseas	Watching brief
OPPORTUNITIES	ID6. Increased trade for the UK	Arctic ice melt opening up new trading routes	Watching brief

Glossary

AMOC	Atlantic Meridional Overturning Circulation
ARn	Assessment Report n (1…6) of the IPCC
Bn	Business and Industry (1…7) (CCRA3 risk/opportunities assessment)
CCRA2	UK Climate Change Risk Assessment No. 2, 2016
CCRA3	UK Climate Change Risk Assessment No. 3, 2021
CDD	Colling Degree Days (Daily mean temperature above 22ºC)
CID	Climate Impact Driver
CMIPn	Climate Model Intercomparison Project n (1…6)
CoP	UNFCCC Conference of the Parties
CORDEX	Coordinated Downscaling Experiment
CRU TS	Climate Research Unit Time Series (University of East Anglia and UKMO)
DJF	December, January, February (Northern Winter)
DSI-n	Drought Severity Index (n-month shortfall as % of average)
ECMWF	European Centre for Medium-Range Weather Forecasts
EL	Extremely Likely (IPCC WGI AR6 assessment)
E-OBS	European and North African Observations
ERA5	ECMWF Re-Analysis v5
ETWL	Extreme Total Water Levels
FD	Frost Day (Daily minimum temperature below 0ºC)
FI	Further Investigation (CCRA3 risk/opportunities assessment)
GCM	Global Climate Model
GDD	Growing Degree Days (Daily mean temperature above 5.5ºC)
GHG	Greenhouse Gas
GMSL	Global Mean Sea Level
GoUK	Government of the United Kingdom
GPCP	Global Precipitation Climatology Project
HC	High Confidence (IPCC WGI AR6 assessment)
HDD	Heating Degree Days (Daily mean temperature below 15.5ºC)
Hn	Health, Communities and the Built Environment (1…13) (CCRA3 risk/opportunities assessment)
In	Infrastructure (1…13) (CCRA3 risk/opportunities assessment)
IDn	International Dimensions (1…10) (CCRA3 risk/opportunities assessment)
ID	Icing Day (Daily maximum temperature below 0ºC)
IPCC	Intergovernmental Panel on Climate Change
JJA	June, July, August (Northern Summer)
LC	Low Confidence (IPCC WGI AR6 assessment)
LE	Limited Evidence (IPCC WGI AR6 assessment)
MAM	March, April, May (Northern Spring)
MAN	More Action Needed (CCRA3 risk/opportunities assessment)
MC	Medium Confidence (IPCC WGI AR6 assessment)
MIP	Model Intercomparison Project
MONCIC	Met Office National Climate Information Centre
NH	Northern Hemisphere
Nn	Natural Environment and Assets (1…17) (CCRA3 risk/opportunities assessment)
NEU	North Europe – the region covering Cornwall used in the AR6
PHI	Potential Hail Index

RCM	Regional Climate Model
RCP	Relative Concentration Pathway
RSL	Relative Sea Level
SCA	Sustain Current Action (CCRA3 risk/opportunities assessment)
SD	Summer Day (Daily maximum temperature above 25ºC)
SLR	Sea Level Rise
SON	September, October, November (Northern Autumn)
SRES	IPCC Special Report on missions Scenarios 2000
SROCC	IPCC Special Report on The Ocean and Cryosphere in a Changing Climate
SR1.5	IPCC Special Report on Global Warming of 1.5°C. The impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty 2018
SSP	Shared Socioeconomic Pathway
SST	Sea Surface Temperature
SWESW	South West England and South Wales (the area used by MONCIC)
SWH	Significant Wave Height
TN	Tropical Night (Daily minimum temperature above 20ºC)
UKCP09/UKCP18	UK Climate Projections (2009 or 2018)
UKCRP	UK Climate Resilience Programme
UKMO	United Kingdom Meteorological Office
UNFCCC	United Nations Framework Convention on Climate Change
VC	Virtually Certain (IPCC WGI AR6 assessment)
VHC	Very High Confidence (IPCC WGI AR6 assessment)
VL	Very Likely (IPCC WGI AR6 assessment)
WB	Watching Brief (CCRA3 risk/opportunities assessment)
WCRP	World Climate Research Programme
WFDE5	Bias corrected ERA5
WGI	Working Group I of the IPCC on “The Physical Science Basis”
WGII	Working Group II of the IPCC on “Impacts, Adaptation, and Vulnerability”
WGIII	Working Group III of the IPCC on “Mitigation of Climate Change”
W5E5	WFDE5 over land merged with ERA5 over the ocean

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Cornwall recycles
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