A1 in Northumberland: Morpeth to Ellingham

Scheme Number: TR010041

6.8 Environmental Statement – Appendix 14.1 Vulnerability to Climate Change Baseline

Part B

APFP Regulation 5(2)(a)

Planning Act 2008

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

June 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

The A1 in Northumberland: Morpeth to Ellingham

Development Consent Order 20[xx]

Environmental Statement - Appendix

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FIGURES

14 VULNERABILITY TO CLIMATE CHANGE

14.1.1. This appendix provides a description of the climate baseline for the Study Area, as referred to in the **Chapter 14: Climate, Volume 3** of this ES (**Application Document Reference: TR010041/APP/6.3**) assessment of the vulnerability of the Scheme to climate change.

CURRENT CLIMATE

RAINFALL

14.1.2. A1 in Northumberland: Alnwick to Ellingham (Part B) of the Scheme is located in the North East of England which has a temperate climate. Information on long term average observed climate variables over the period 1980 – 2010 is presented below.

14.1.3. Over much of the North East region, the number of days with rainfall totals of 1 mm or more ('wet days') tends to follow a pattern similar to the monthly rainfall totals. In the higher parts in winter (December-February), 45-50 days is the norm but this decreases to about 35 days in summer (June-August). In the drier areas closer to the coast, about 30 days in winter and about 25 days in summer are typical (**Ref. 14.1.1**). Periods of prolonged rainfall are often associated with east or north east winds on the northern flank of depressions passing to the south of the area.

14.1.4. **Figure 14-1-1** shows the long-term average monthly rainfall for the North East region between 1981 and 2010 (**Ref. 14.1.1**). It shows that the region is considerably drier than most parts of the UK, with the lowest monthly rainfall in May and the highest in November.

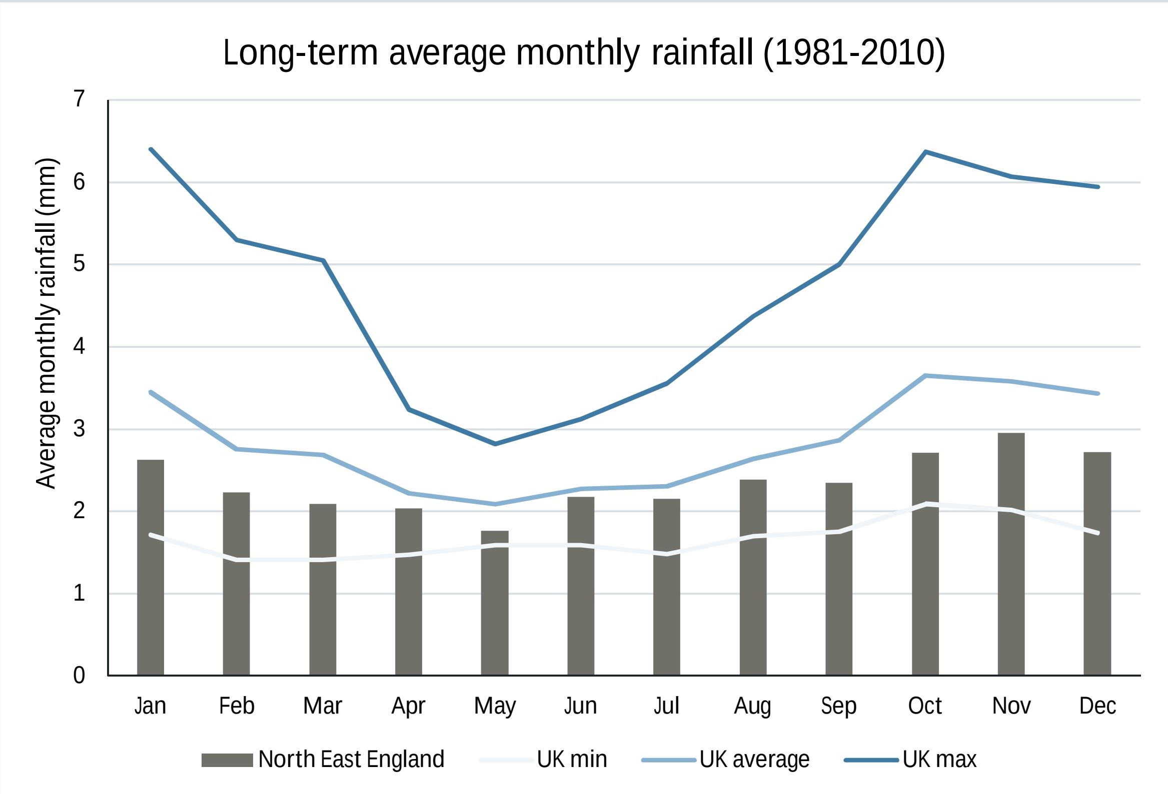


Figure 14-1-1 - Long term average mean monthly rainfall

14.1.5. Average summer (June, July and August) and winter (December, January and February) rainfall at Boulmer weather station (20 km east of Alnwick) for the period 1981-2010 is summarised in **Table 14-1-1**.

Table 14-1-1 – Long term average of mean rainfall (mm) 1981-2010 at Boulmer weather station

Period	Mean Rainfall (mm)
Summer (JJA)	59.6
Winter (DJF)	54.7

14.1.6. **Figure 14-1-2** shows annual average days of heavy rainfall (>= 10 mm). In summary, the study area experiences a higher number of 'wet days' in winter than in summer.

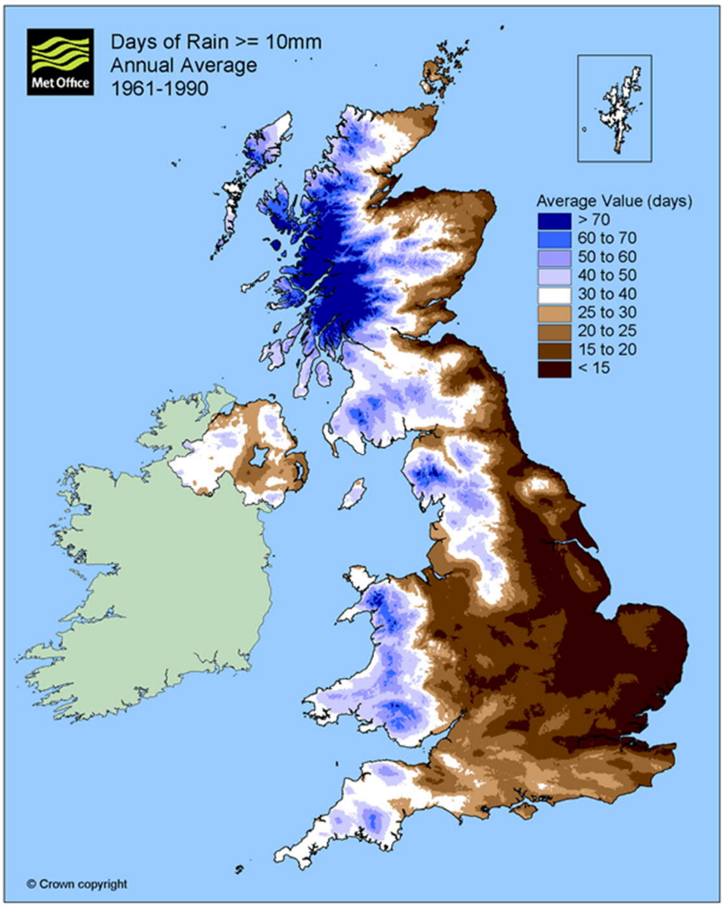


Figure 14-1-2 – Days of rain >= 10 mm (1961-1990)

TEMPERATURE

14.1.7. **Figure 14-1-3** shows the long-term average mean monthly temperature for the North East region between 1981 and 2010 (**Ref. 14.1.1**). It shows that the region is less warm than the UK average, with July being the warmest month and January being the coldest month.

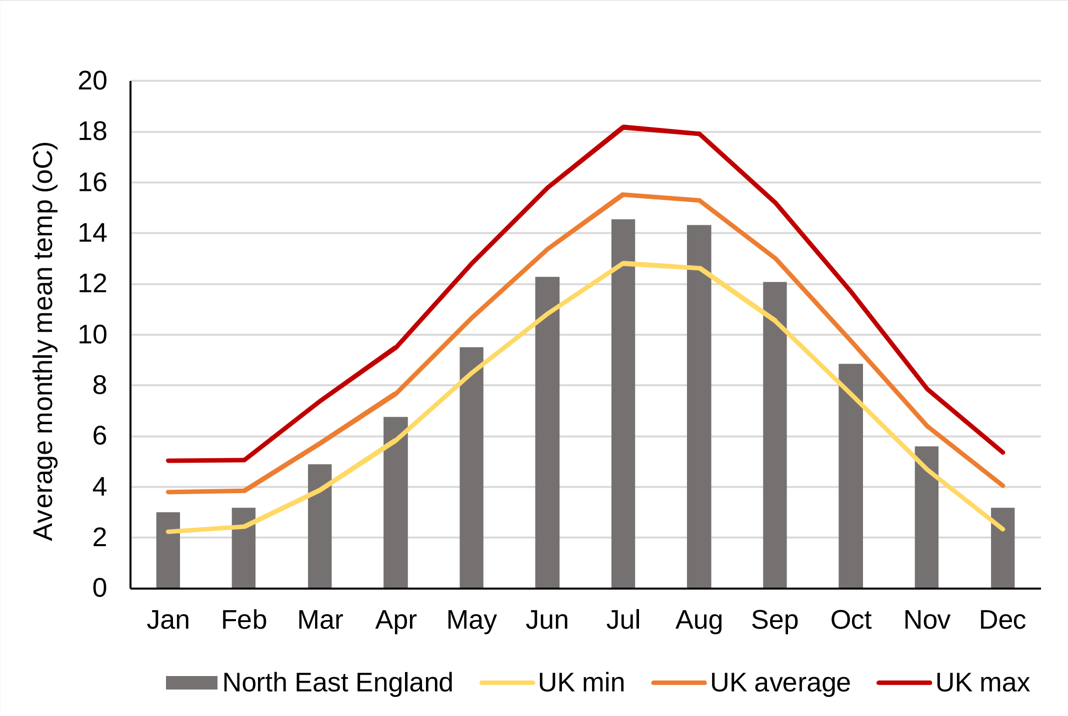


Figure 14-1-3 - Long term average mean monthly temperature 1981 – 2010

14.1.8. The long-term average of maximum mean summer temperature for the North East region for the 1981-2010 period is given in **Table 14-1-2** below (**Ref. 14.1.1**).

Table 14-1-2 – Long-term average of maximum mean summer temperature (ºC) for the period 1981-2010

Variable	Temperature (ºC)
Maximum Mean Summer Temperature (ºC) (1981-2010)	17.6

WIND

14.1.9. **Figure 14-1-4** shows the long-term average monthly mean wind speed in the north east region between 1981 and 2010 (**Ref. 14.1.1**). It shows that the region closely matches the UK average, with highest wind speeds occurring in January and lowest wind speeds occurring in July.

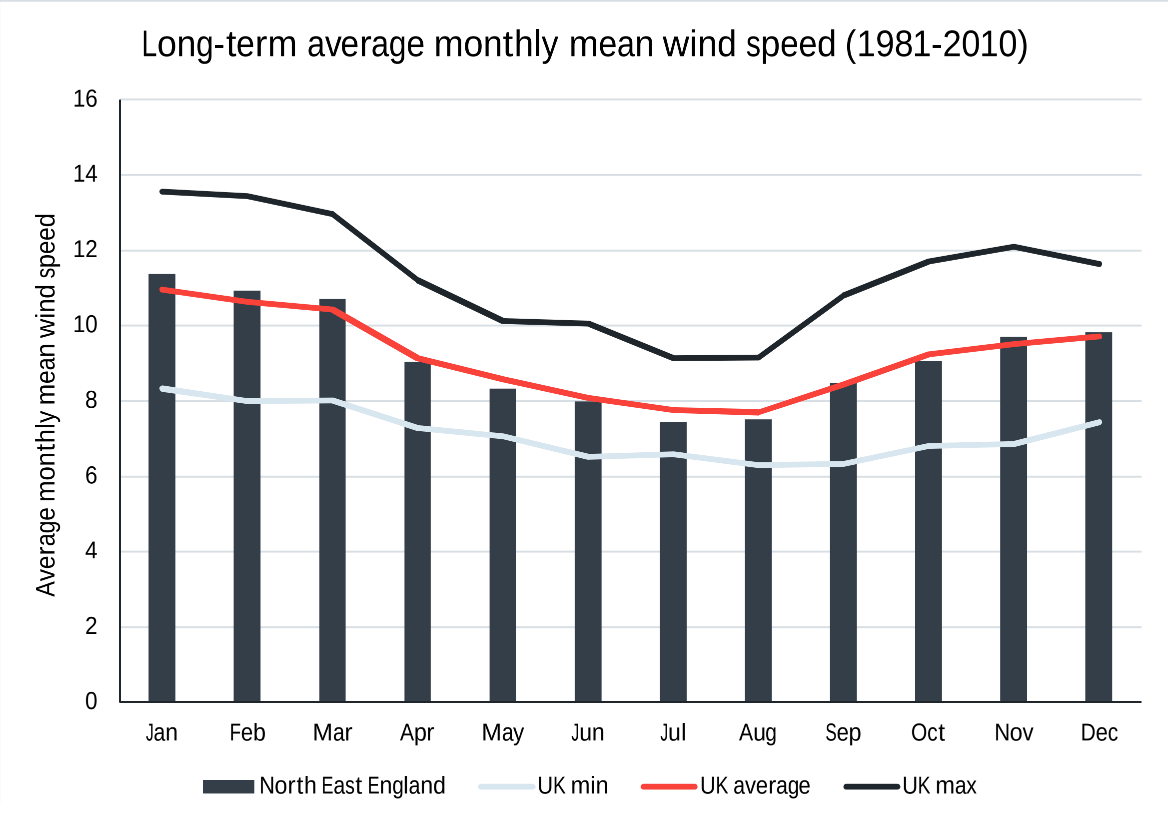


Figure 14-1-4 – Long term average monthly mean speed (1981-2010)

PROJECTED CLIMATE

14.1.10. Information on projected climate is taken from the UK Climate Projections 2018 (**Ref. 14.1.2**) where available. The UKCP18 projections are the most up-to-date projections of climate change for the UK. UKCP18 includes probabilistic projections of a range of climate variables for different emissions scenarios, Representative Concentration Pathways (RCP)[1], and for a range of time slices to the end of the 21st Century. In this baseline section, the central estimate (50th percentile) projections for the 2080s RCP8.5 are presented.

[1] The RCPs provide a range of possible trajectories of how global land use and emissions of GHGs and air pollutants may change through the 21st century. They are named according to their radiative forcing values in the year 2100 (2.6, 4.5, 6.0 and 8.5 Wm-2).

14.1.11. At the time of writing this ES, not all UKCP18 data was available. Where UKCP18 data is not available, information has been taken from UKCP09.

RAINFALL

14.1.12. Over land, UKCP18 project that general trends of climate changes in the 21st century would move towards warmer, wetter winters and hotter, drier summers. However, natural variations mean that some cold winters, some dry winters, some cool summers and some wet summers would still occur.

14.1.13. The projected changes to average summer and winter rainfall for the 2050s and 2080s for the North East are summarised in **Table 14-1-3** below.

Table 14-1-3 – Projected change in mean summer and winter precipitation (%) for the 2050s and 2080s for the North East

Season / time slice		PERCENTILE CHANGE		
		10th	50th	90th
Summer	2050s	-29%	-14%	1%
	2080s	-42%	-23%	-5%
Winter	2050s	-4%	11%	27%
	2080s	1%	22%	46%

14.1.14. **Table 14-1-3** presents the percentile changes for the range of precipitation predicted. The 10th and 90th percentile provide the lower and upper estimates of precipitation change. For example, for the summer in the 2050s, precipitation is very unlikely to decrease by 29% or increase by 1%.

14.1.15. UKCP18 suggests that by the 2050s in the North East region, mean winter precipitation is projected to increase by up to 11% (50th percentile) under RCP8.5. For the summer, by the 2050s in the North East region, mean summer precipitation is projected to decrease by up 14% (50th percentile) under RCP8.5.

14.1.16. UKCP18 suggests that by the 2080s in the North East region, mean winter precipitation is projected to increase by up to 22% (50th percentile) under RCP8.5. Mean summer precipitation is projected to decrease by up 23% (50th percentile) under RCP8.5.

14.1.17. **Figure 14-1-5** and **Figure 14-1-6** summarise projected changes in mean winter precipitation for the 2050s and 2080s under RCP 8.5. **Figure 14-1-7** and **Figure 14-1-8** summarise projected changes in mean summer precipitation for the 2050s and 2080s under RCP 8.5.

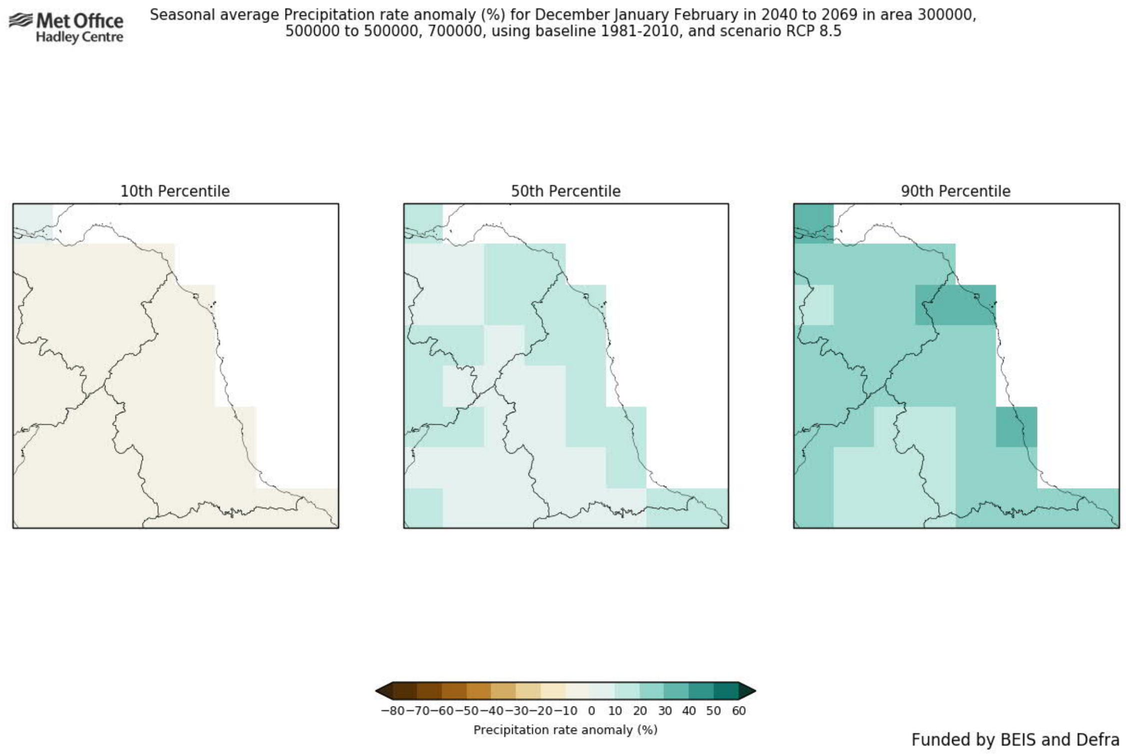


Figure 14-1-5 - UKCP18 projections for changes in mean winter precipitation for the 2050s under RCP8.5

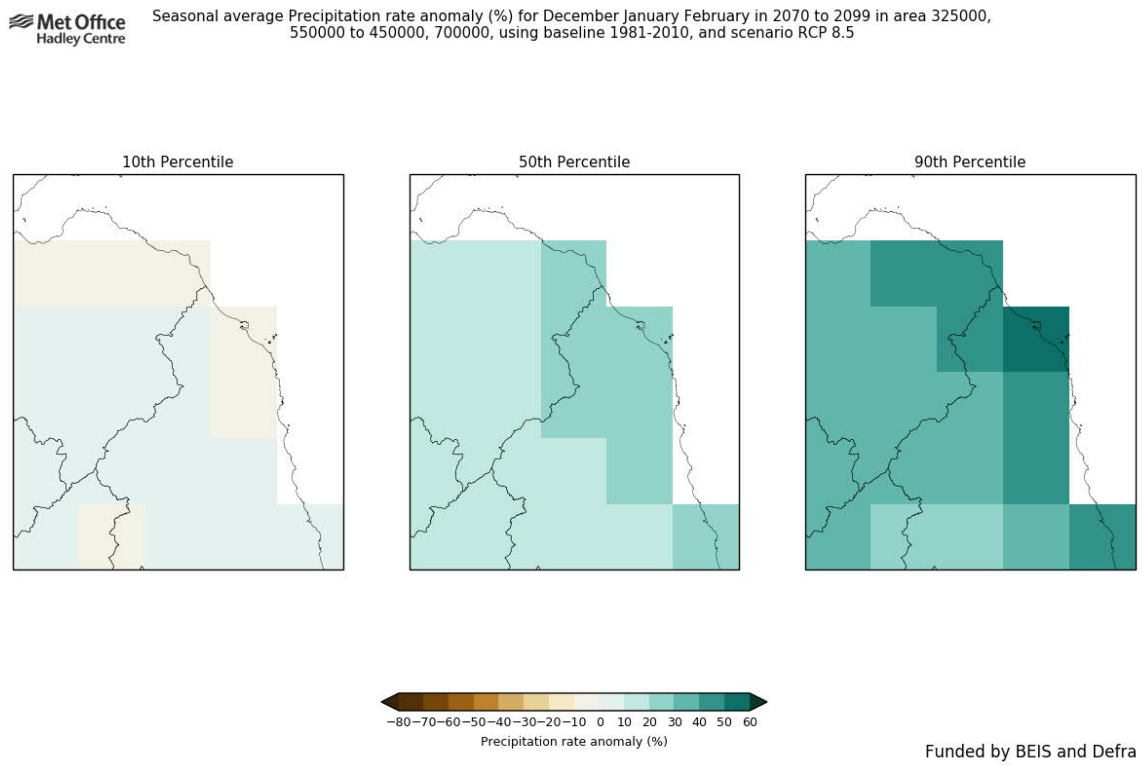


Figure 14-1-6- UKCP18 projections for changes in mean winter precipitation for the 2080s under RCP8.5

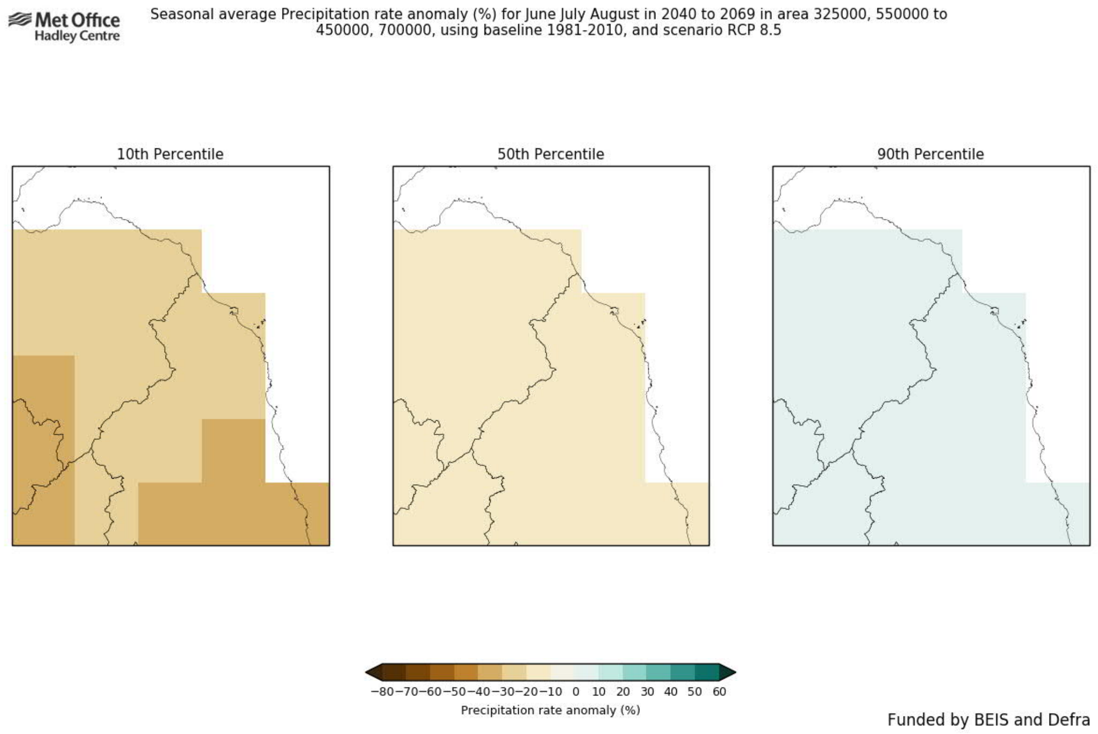


Figure 14-1-7 - UKCP18 projections for changes in mean summer precipitation for the 2050s under RCP8.5

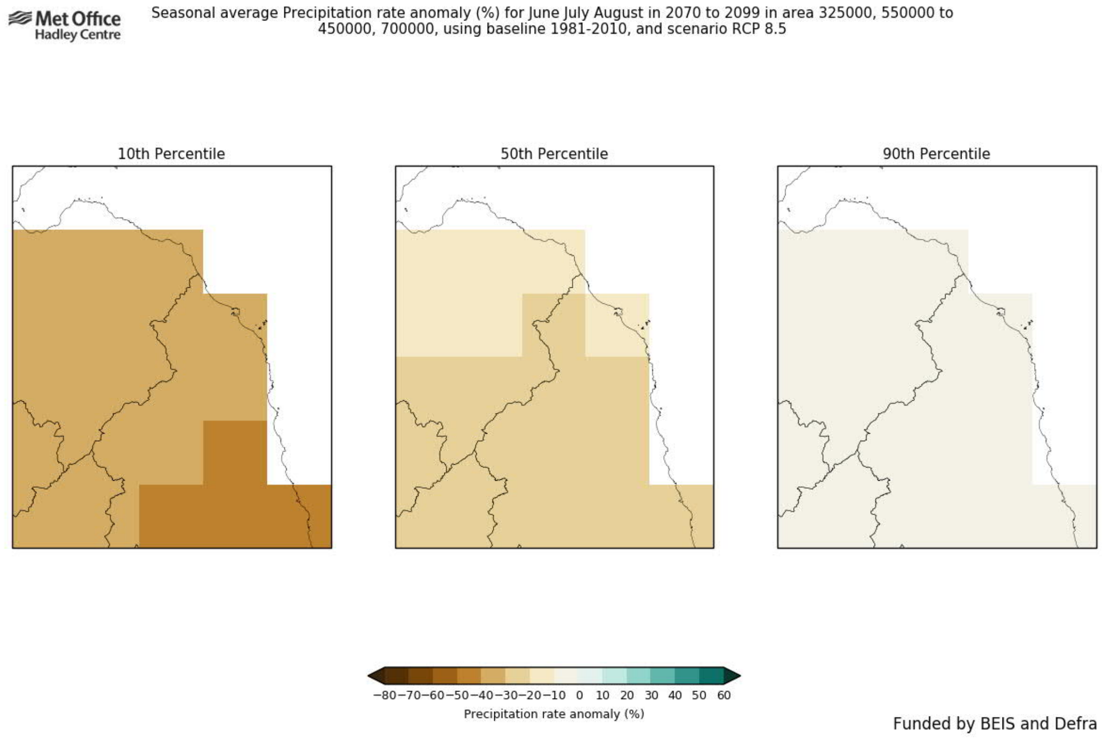


Figure 14-1-8 - UKCP18 projections for changes in mean summer precipitation for the 2080s under RCP8.5

14.1.18. Snowfall is closely linked with temperature, with falls rarely occurring if the temperature is higher than 4°C. For snow to lie for any length of time, the temperature normally must be lower than this. With regards to future changes, rising winter temperatures are likely to reduce the amount of precipitation that falls as snow in winter. UKCP18 does not provide data on snowfall. UKCP09 projects a reduction of mean snowfall, the number of days when snow falls and heavy snow events by the end of the 21st century.

TEMPERATURE

14.1.19. Climate change is projected to lead to hotter summers and warmer winters. The UKCP18 probabilistic projections over land show that there is more warming in the summer than in the winter. Additionally, in summer there is a pronounced north south contrast at the scale of the UK, with greater increases in maximum summer temperatures over the southern UK compared to northern Scotland.

14.1.20. **Table 14-1-4** summarises the UKCP18 projections for changes in mean temperature from the baseline in the North East in the 2050s and 2080s under RCP 8.5.

Table 14-1-4 – UKCP18 Projections for changes in mean temperature in the 2050s and 2080s

Season / time slice		PERCENTILE CHANGE (°C)		
		10th	50th	90th
Summer	2050s	0.8	2.0	3.3
	2080s	1.8	4.1	6.4
Winter	2050s	0.5	1.6	2.9
	2080s	1.2	3.0	5.0

14.1.21. **Table 14-1-4** presents the percentile changes for the range of warming predicted. The 50th percentile (central estimate) is considered the level for which as much evidence points to a lower outcome as a higher one and is therefore taken as the median value of predicted change. The 10th and 90th percentile provide the lower and upper estimates of warming. For example, for summer in the 2050s, temperature increase is very unlikely to be less than a 0.8°C increase, or more than a 3.3°C increase.

14.1.22. UKCP18 suggests that by the 2050s, mean winter temperature in the North East region is expected to increase by 1.6ºC (50th percentile) under RCP8.5. And that by the 2080s, mean winter temperature in the North East region is expected to increase by 3.0ºC (50th percentile) under RCP8.5.

14.1.23. For the summer, by the 2050s, mean summer temperature in the North East region is expected to increase by 2.0ºC (50th percentile) under RCP8.5. And by the 2080s, mean summer temperature in the North East region is expected to increase by 4.1ºC (50th percentile) under RCP8.5

14.1.24. **Figure 14-1-9** and **Figure 14-1-10** summarises changes in mean winter temperature for the 2050s and 2080s under RCP8.5. **Figure 14-1-11** and **Figure 14-1-12** summarises changes in mean summer temperature for the 2050s and 2080s under RCP8.5.

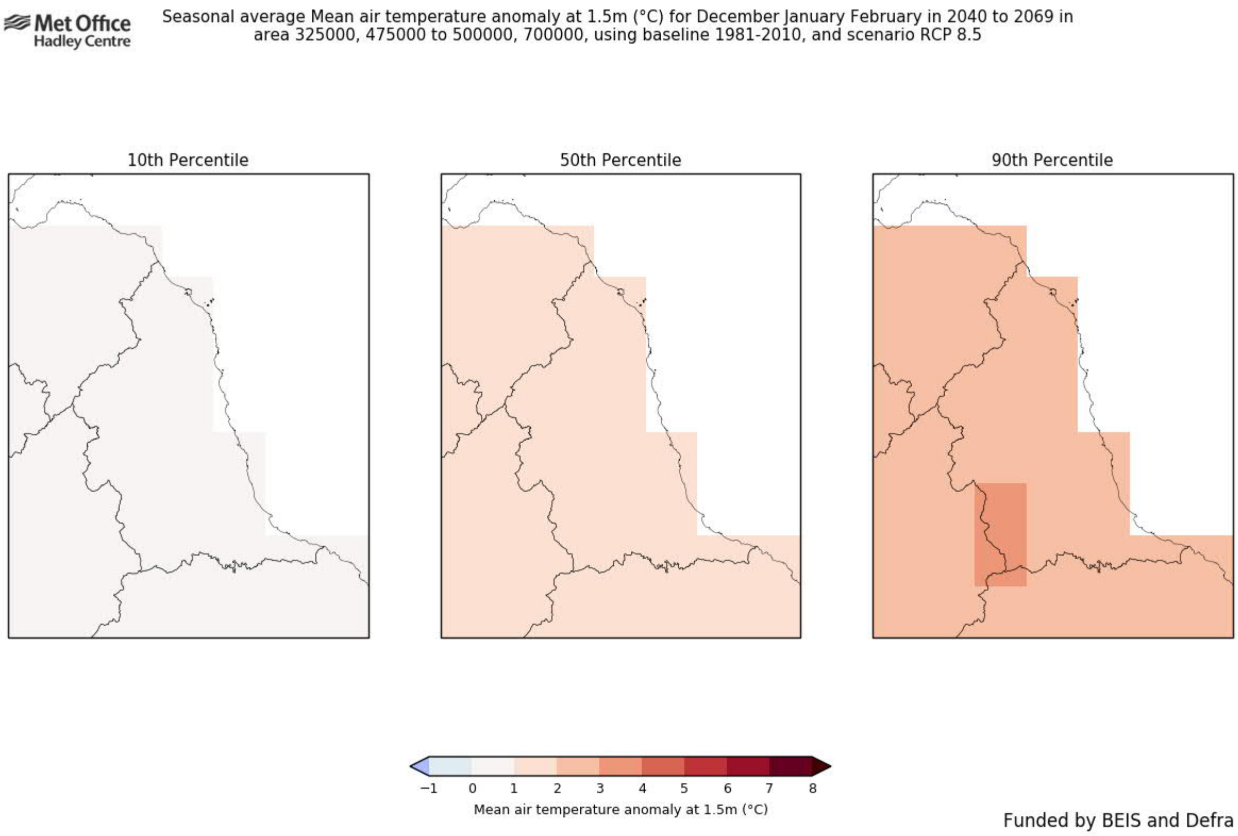


Figure 14-1-9 - UKCP18 projections for changes in mean winter temperature for the 2050s under RCP8.5

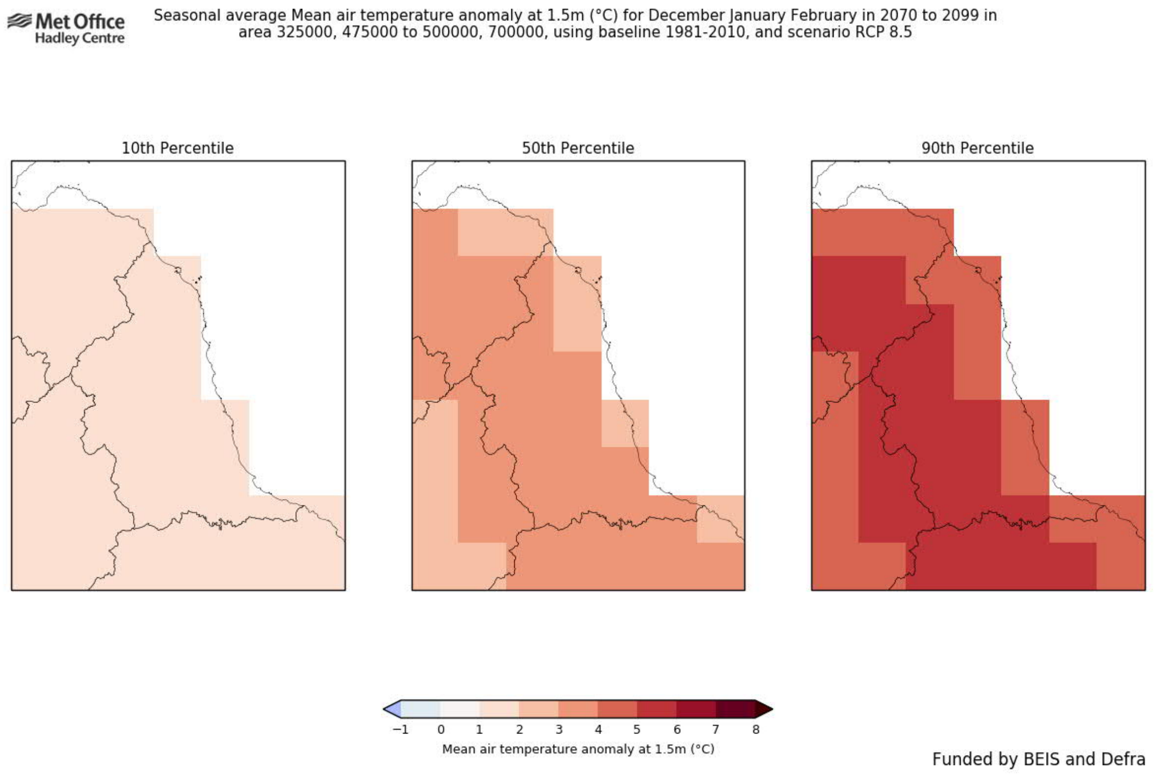


Figure 14-1-10 - UKCP18 projections for changes in mean winter temperature for the 2080s under RCP8.5

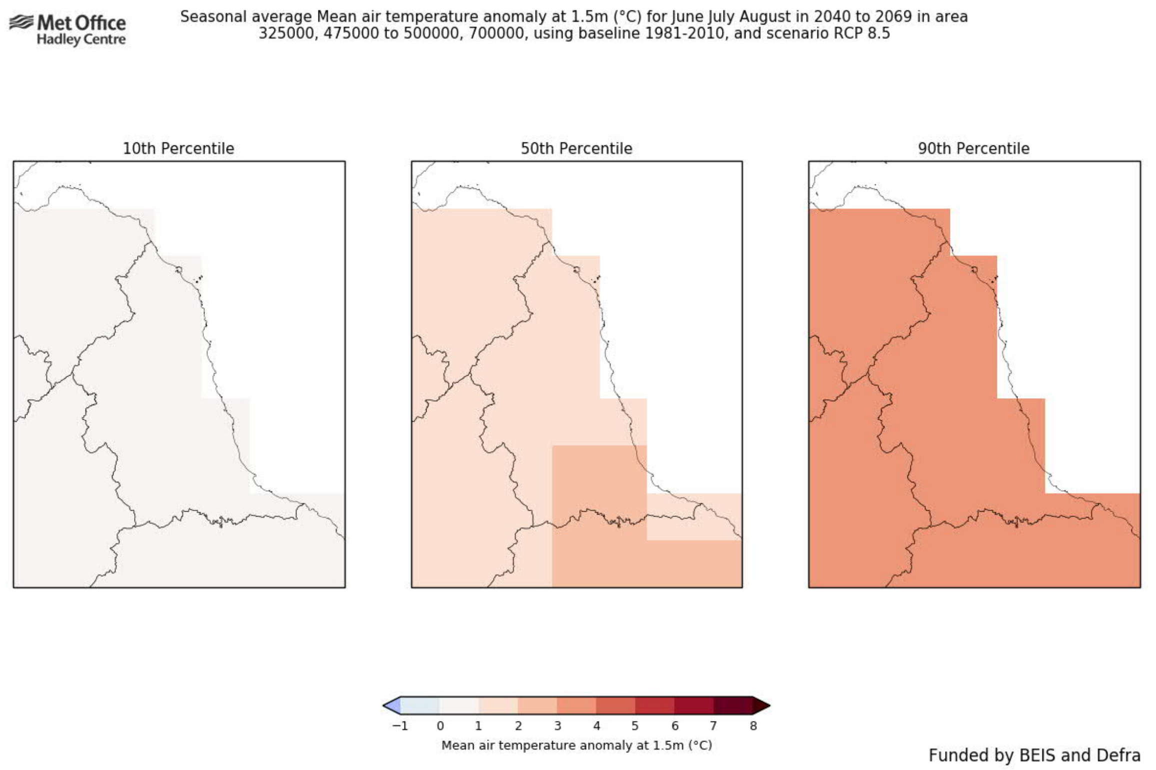


Figure 14-1-11 - UKCP18 projections for changes in mean summer temperature for the 2050s under RCP8.5

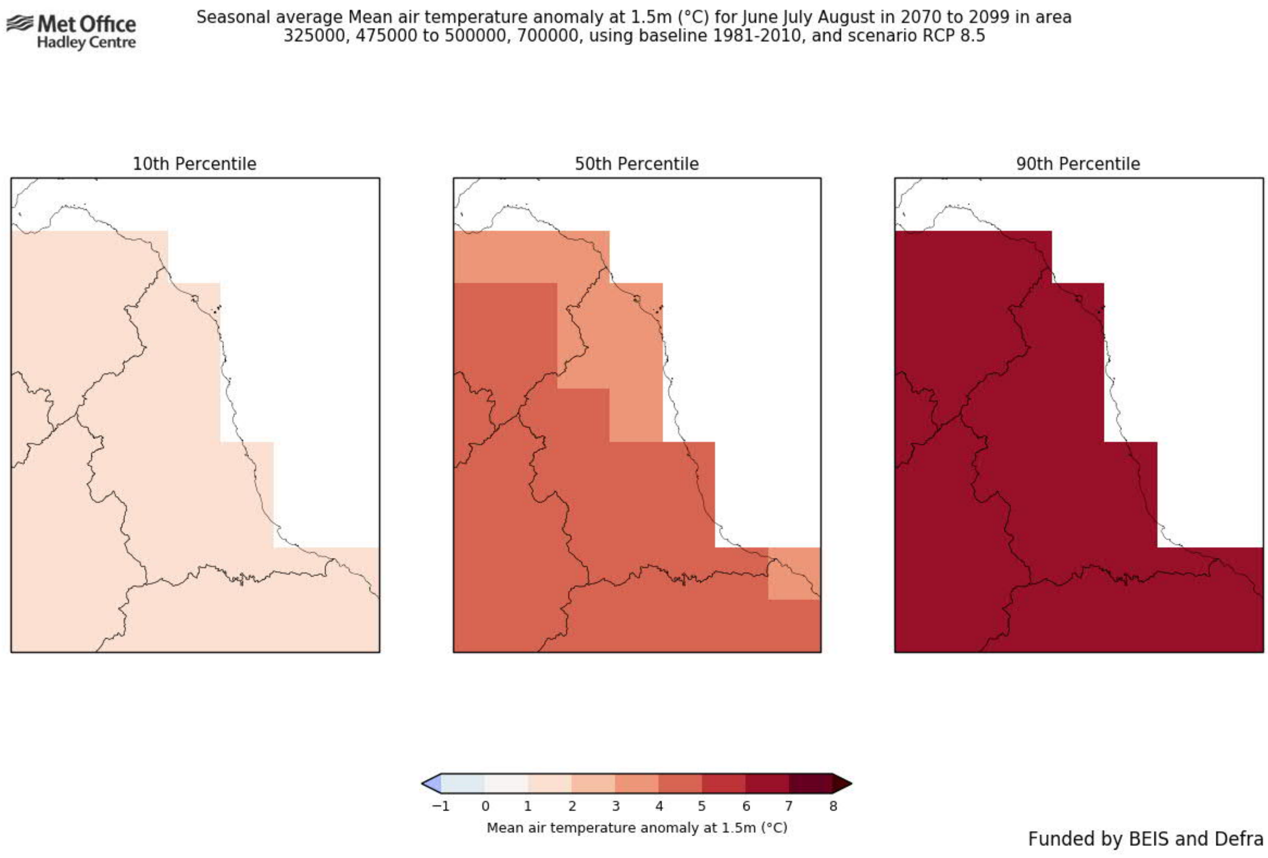


Figure 14-1-12 - UKCP18 projections for changes in mean summer temperature for the 2080s under RCP8.5

14.1.25. In addition to changes in seasonal average temperatures, it is likely that there would be more extreme temperature events. By the 2080s, projections for daily maximum summer temperature for the North East region suggest increases of around 4.5ºC, (50th percentile). By the 2080s, projections for daily minimum summer temperature suggests an increase of 3.3ºC (50th percentile).

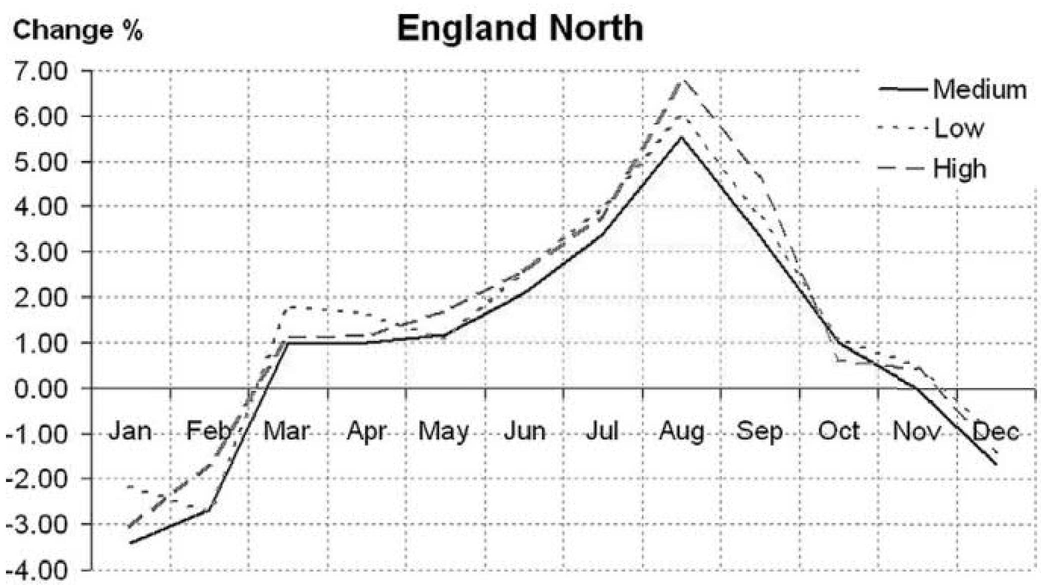
SOLAR RADIATION

14.1.26. A recent (regional) study (**Ref. 14.1.3**) suggests that the North of the UK, including the North East region and the study area, is likely to see an increase in annual solar radiation by the 2050s of 3.8 watts per square meter (W m-2) and by the 2080s of 4.6 Wm-2 under the central (50th percentile) estimate, under the High emissions scenario. **Table 14-1-5** outlines the changes in annual solar radiation for the 2050s and 2080s under the UKCP09 emissions scenarios.

Table 14-1-5 - Changes in annual solar radiation (Wm^{-2})

Period	High		
	10th	50th	90th
2050s	-0.6	3.8	8.5
2080s	-1.5	4.6	11.3

14.1.27. All regions of the UK are likely to have increased cloud cover (although there is large uncertainty around future projections of cloud cover) and therefore slightly less solar radiation during the winter. **Figure 14-1-11** describes the change (%) in solar radiation from the baseline for the 2050s for the North of England, which includes the study area. The results suggest that increases in solar radiation are more likely in the spring and summer than in autumn and winter.



Source: Burnett *et al.*, (2014) **Ref. 14.1.3**

Figure 14-1-11 - Projected regional average change (%) of solar radiation (2050s)

WIND

14.1.28. The UKCP18 projections show an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season when more significant impacts of wind are experienced. This is accompanied by an increase in frequency of winter storms over the UK.

14.1.29. There is large uncertainty in projected changes in circulation over the UK and natural climate variability contributes much of this uncertainty (**Ref. 14.1.4**). It is therefore difficult to represent regional wind extreme winds and gusts within regional climate models (**Ref. 14.1.5**).

RELATIVE HUMIDITY

14.1.30. Relative humidity measures how close the air is to being saturated. UKCP18 projections have been used to determine relative humidity future projections.

14.1.31. By the 2050s, projections for winter mean relative humidity in the North East region suggest an increase of up to 10% under RCP 8.5 (central estimate). By the 2080s, winter mean relative humidity could increase by up to 22% (RCP 8.5, central estimate). The projection for summer mean humidity in the 2050s under the high emissions scenario is an increase of up to 10% (central estimate). By the 2080s the increase could be as much as 20% (RCP8.5, central estimate).

REFERENCES

- **Ref. 14.1.1** Jenkins, G.J., Perry, M.C., and Prior, M.J. (2008). The climate of the United Kingdom and recent trends. Met Office Hadley Centre, Exeter, UK.
- **Ref. 14.1.2** Met Office (2019) Met Office UK Climate Projections. Available at: https://www.metoffice.gov.uk/research/collaboration/ukcp (accessed 22 Feb 2019).
- **Ref. 14.1.3** Burnett, D., Barbour, E. and Harrison, G.P. (2014) The UK solar energy resource and the impact of climate change. Renewable Energy, 71, 333-343.
- **Ref. 14.1.4** Brown, S., Boorman, P., McDonald, R., and Murphy. J. (2012) Interpretation for use of surface wind speed projections from the 11-member Met Office Regional Climate Model ensemble. Post-launch technical documentation for UKCP09. Met Office Hadley Centre, Exeter, UK.
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