Met Office

Supplementary material for:

"Future Changes to high impact weather in the UK"

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CONTENTS

1 BIAS ADJUSTMENT

The output from climate models typically exhibit systematic differences between model results and observations which arise primarily from our incomplete understanding and representation of the climate system. While the fidelity of model output has improved steadily over the recent decades, impact-based studies routinely apply statistical correction methodologies to calibrate model output against observations. As the metrics assessed in this work are all impacts based, we too apply some bias adjustment of model output.

Throughout this study the bias adjustment approach used is Scaled Distribution Mapping (SDM), full details can be found in Switanek et al 2017.This bias adjustment is applied to daily UKCP18 RCM data and has been shown to be significantly better than other bias adjustment methods at preserving modelled climate change trends as well as the mean, standard deviation and skewness of the distributions of the daily data. Switanek et al 2017 show the performance advantages of SDM against quantile mapping (Wood et al., 2004; Piani et al., 2010; Themeßl et al., 2011; Gudmundsson et al., 2012; Teutschbein and Seibert, 2013), detrended quantile mapping (Hempel et al. 2013; Bürger et al. 2013) and quantile delta mapping (Cannon et al. 2015).

The processes for precipitation and temperature differ slightly to account for the different characteristics of these variable distributions, but each works on the time series of data from one calendar month (over many years) at a time.

1.1 Bias adjustment of precipitation

First the number of rainy days is examined. As climate model systematically produce too many days of very low rain amounts (drizzle), SDM explicitly accounts for this in its approach by setting a low daily rainfall total as a cut off (0.1mm in practice) and calculating the number of rain days in the observations and the modelled historical and future periods of interest. The number of rain days in the bias adjusted data is then estimated by scaling the number of rain days in the observations by the ratio of the fraction of rain days in the observations to the fraction of rain days in the modelled historical period.

Rain days in each of the three data sets are sorted into three lists and used to fit parameters of an assumed functional form of the probability distribution of daily precipitation. In line with many other studies we fit a gamma distribution to each data set.

Cumulative distribution functions (CDF) of the fitted functions are then used to produce a scaling factor relating the modelled historical values to the modelled future values by taking the ratio of the inverse CDF of the modelled future data to the inverse CDF of the modelling historical data.

CDFs of the fitted functions are then converted to return periods (1 / 1 – CDF), each of which is then interpolated onto the number of rains days in the modelled future data. The return period functions are then combined by scaling the modelled future data by the ratio of the observational to the modelled historical data. This stage is scaling the likelihood of a given return period which is then limited to a minimum value to 1 (as any lower than this would imply the CDF is below 0 which is not possible).

Bias adjusted precipitation data is then obtained by first converting the scaled return periods into a scaled CDF (1 – 1 / return period). The inverse CDF of the observed data is then calculated for the scaled CDF data to produce the precipitation values for each quartile. This is then multiplied by the scaling between modelled and future precipitation calculated previously. This ordered distribution of precipitation values is then interpolated onto the number of rain days in the bias adjusted data, which was calculated at the start of the process, giving the final bias adjusted distribution of rainfall.

Finally, for precipitation, the bias adjusted data is put back into the time series. This is done by replacing the highest modelled future values with the highest bias adjusted values, then the next highest pairs, and so on. As the number of rain days in the model is expected to be larger than in the observations, we expect the number of rain days in modelled future data to be higher than in the bias adjusted data. Therefore, not all the rain days in the modelled future data will have been replaced when the end of the bias adjusted data has been used. All the additional days of rain with lower rainfall that the bias adjusted data are all set to zero thereby preserving the bias adjusted number of rain days.

1.2 Bias adjustment of temperature

The bias adjustment process is slightly different in the case of temperature. Temperature data is first detrended in both the observed and modelled data. This trend will be added back in after the bias adjustment procedure is applied to the extracted variability. A normal distribution is used to produce a CDF for the detrended temperature distributions of each of the observations, modelled historical and modelled future data separately.

A scaling factor is then determined between the modelled future and modelled historical data, but unlike precipitation where the ratio of the inverse CDFs is used, here the absolute differences between the inverse CDF of the modelled future and modelled historical is used as multiplied by the ratio of the standard deviations of the observations to the modelled historical data.

Return periods of each data set are then calculated, allowing for the temperature distribution being a two tailed distribution. This is calculated as: 1 / (0.5 - |CDF - 0.5|).

The scaled return periods are then calculated as before, from the ratio of that for the modelled future being multiplied by the ratio of the observational values to the modelled historical values and limited to 1. The scaled return periods are then converted back to a scaled CDF.

The bias adjusted data is then calculated from the inverse CDF of the observational data being applied to the scaled CDF and then being added to the scaling factor from earlier (this differs from the methodology for precipitation in which the scaling factor is a multiplier).

Then the modelled future data is replaced with the bias adjusted data and the trend for the modelled future data added back in.

Figures 1 to 4 show results with (on right) and without (on left) SDM performed on the underlying data. These figures show a comparison of the index results computed before and after this bias adjustment is performed. In all cases, this has removed most of the difference in the area average index values calculated with observed and modelled data for the calibration period (1981-2000). Also, the differences in the other observed periods calculated with the mean modelled trend are minimal. For these reasons this bias adjustment method is considered effective for these results.

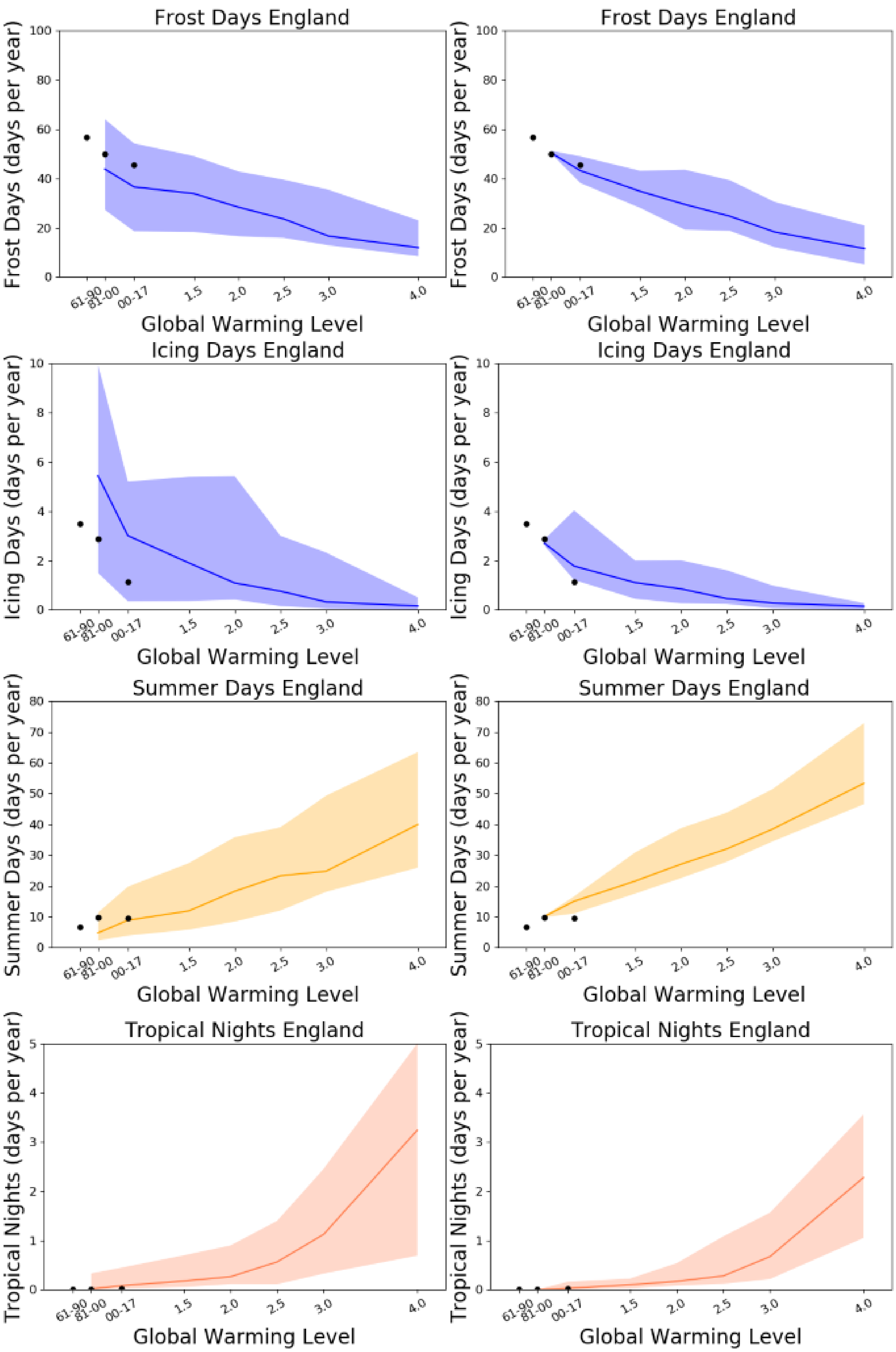

Figure 1: Temperature based indices computed with (right-hand panels) and without (left-hand panels) the bias adjustment. Similar features are seen for all regions, here results are shown for England as an example to show the how the bias adjustment affects the results.

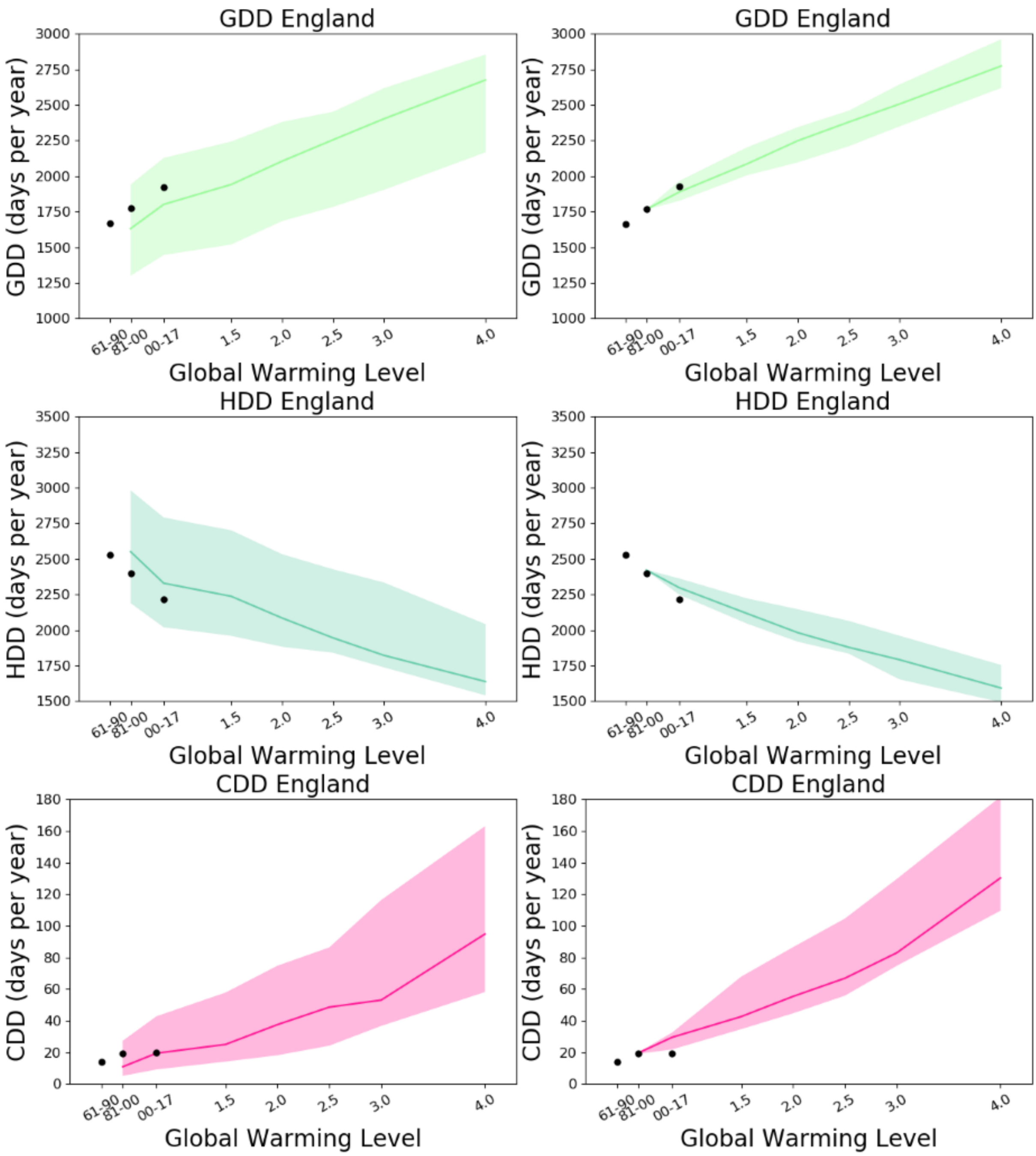

Figure 2: Degree Days indices computed with (right-hand panels) and without (left-hand panels) the bias adjustment. Similar features are seen for all regions, here results are shown for England as an example to show how the bias adjustment affects the results.

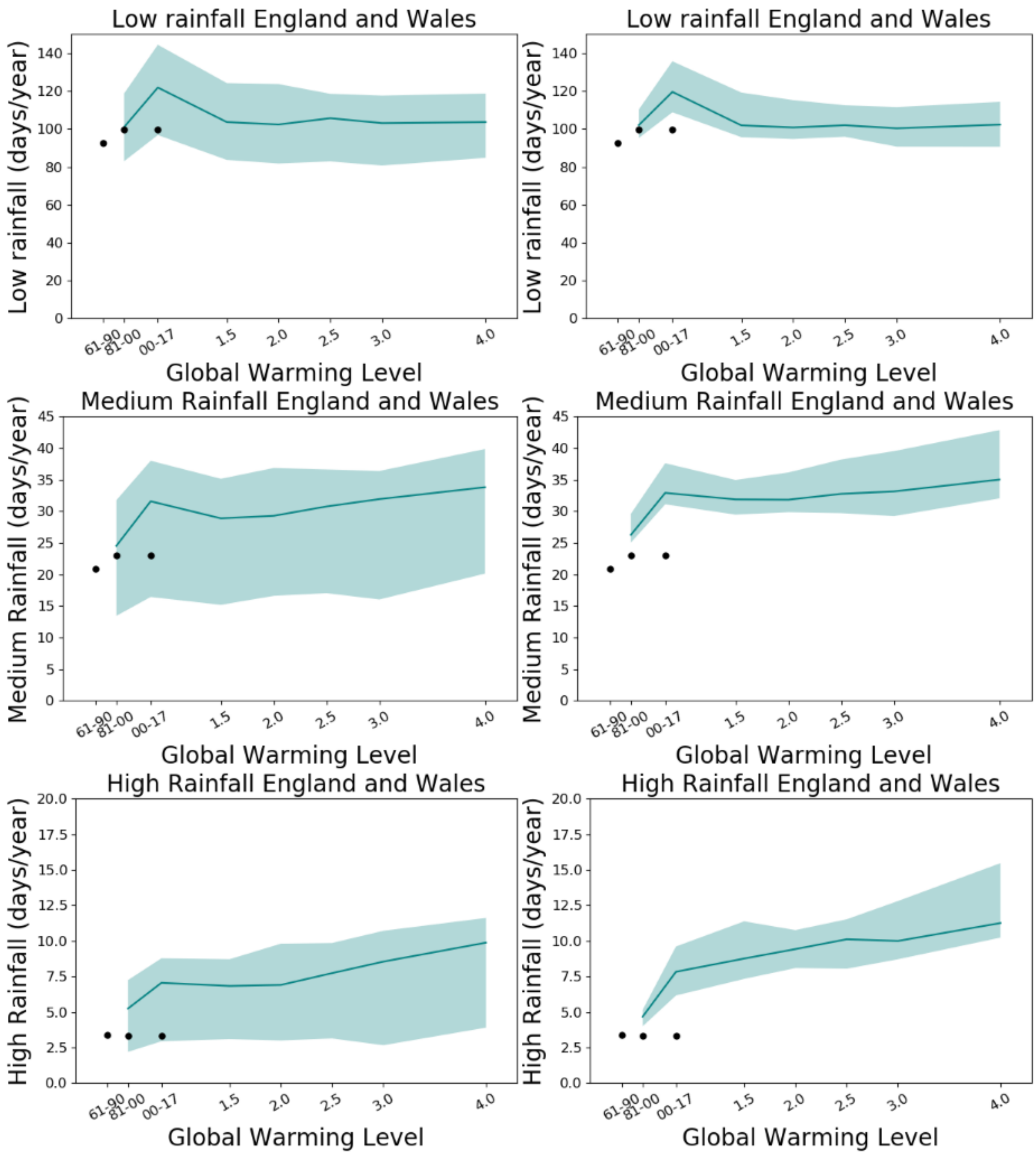

Figure 3: Rainfall indices computed with (right-hand panels) and without (left-hand panels) the bias adjustment. Similar features are seen for all regions, here results are shown for England as an example to show how the bias adjustment affects the results.

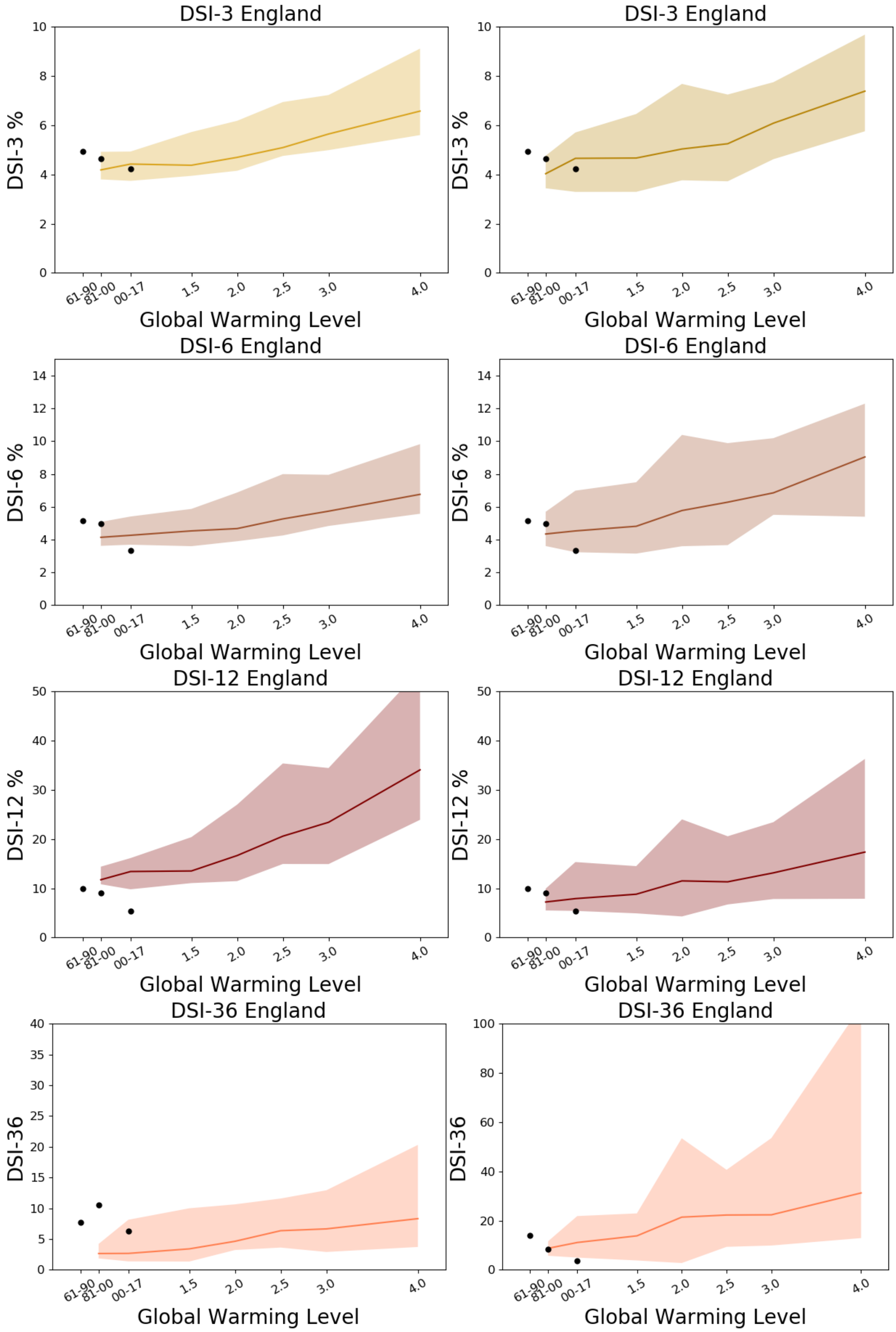

Figure 4: Drought indices computed with (right-hand panels) and without (left-hand panels) the bias adjustment. Similar features are seen for all regions, here results are shown for England as an example to show how the bias adjustment affects the results.

2 RAINFALL THRESHOLD REGIONAL DEFINITIONS

Table 1: regional definitions used for the National Severe Weather Warning thresholds

England and Wales	Northern Ireland	NW Scotland	SW Scotland	SW Scotland	South and East Scotland
All England and Wales	All Northern Ireland	Highlands Western Isles Shetland Argyll and Bute	Dumfries and Galloway	Angus Dundee East Ayrshire East Dunbartonshire East Lothian East Renfrewshire Edinburgh Falkirk Fife Glasgow Inverclyde Midlothian North Ayrshire North Lanarkshire Renfrewshire Scottish Borders South Ayrshire South Lanarkshire West Dunbartonshire West Lothian	Aberdeen Aberdeenshire Clackmannanshire Moray Orkney Perth & Kinross Stirling

3 REGIONAL AVERAGE PROJECTIONS

3.1 Temperature

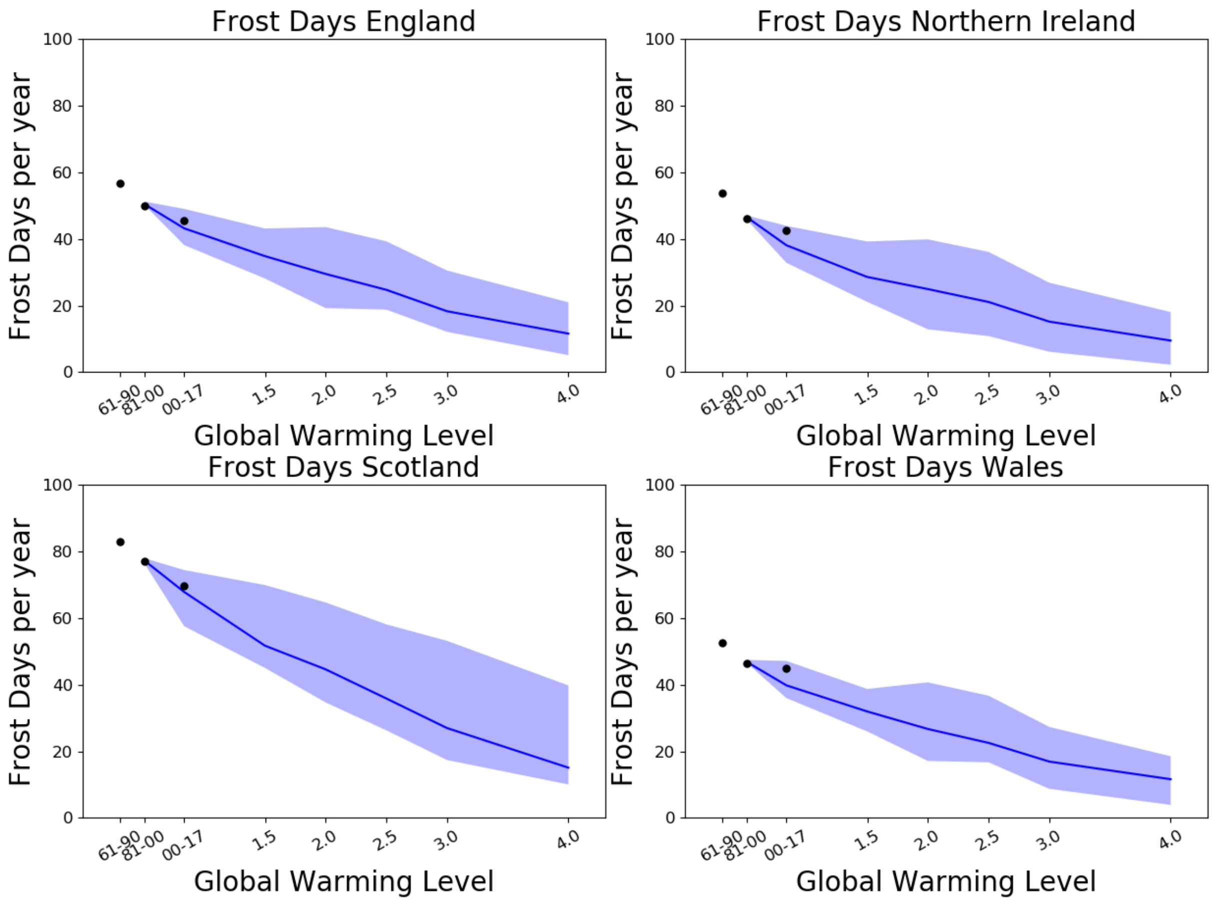

Figure 5 Evolution of frost days index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

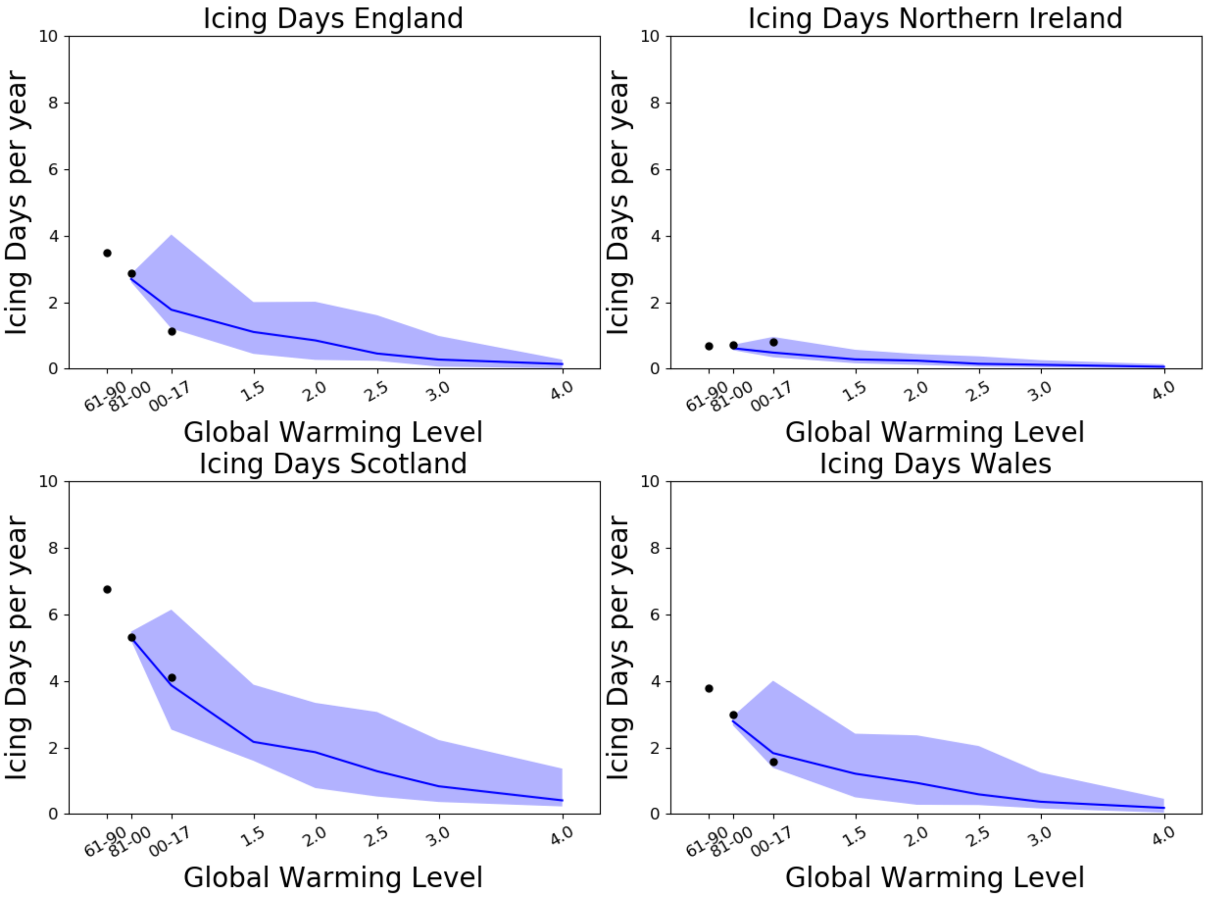

Figure 6 Evolution of icing days index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

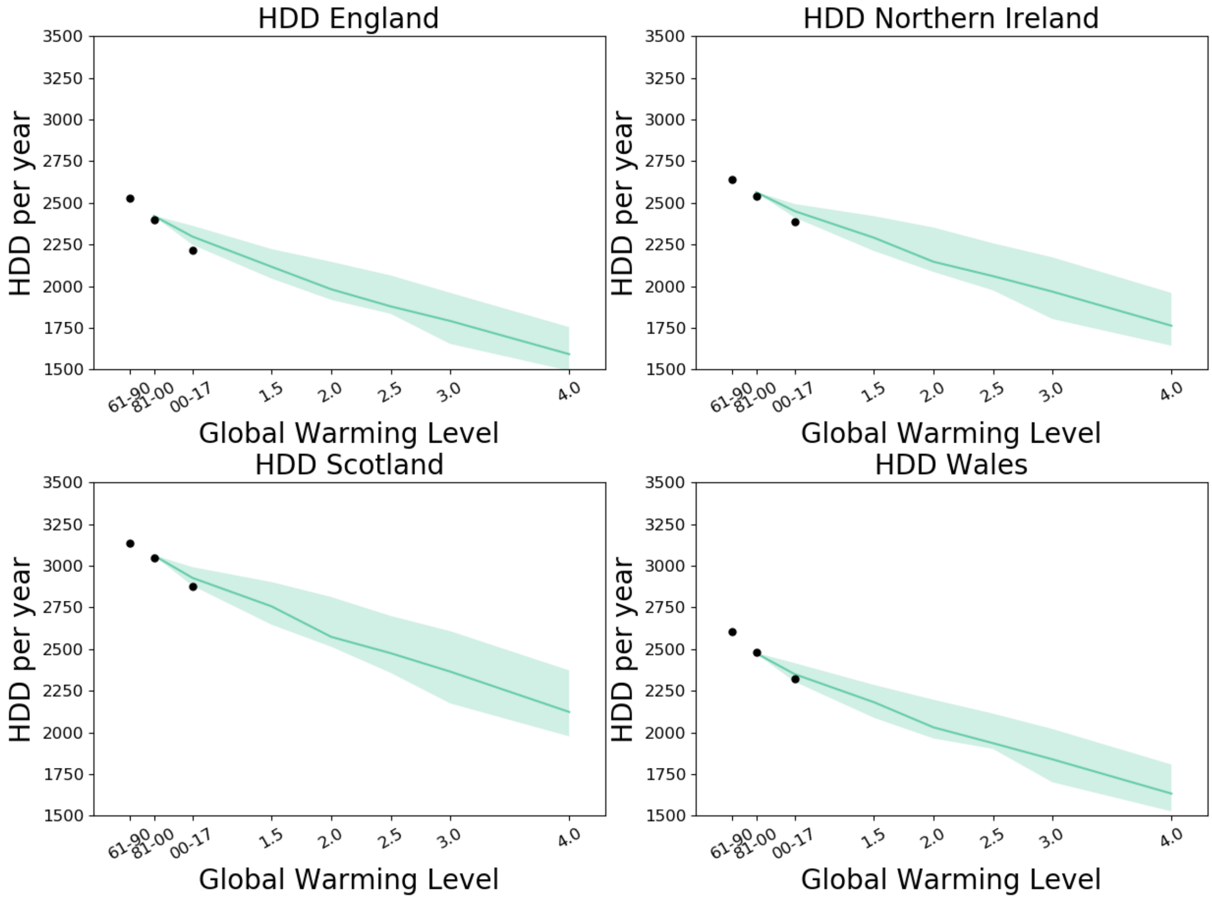

Figure 7 Evolution of heating degree days with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

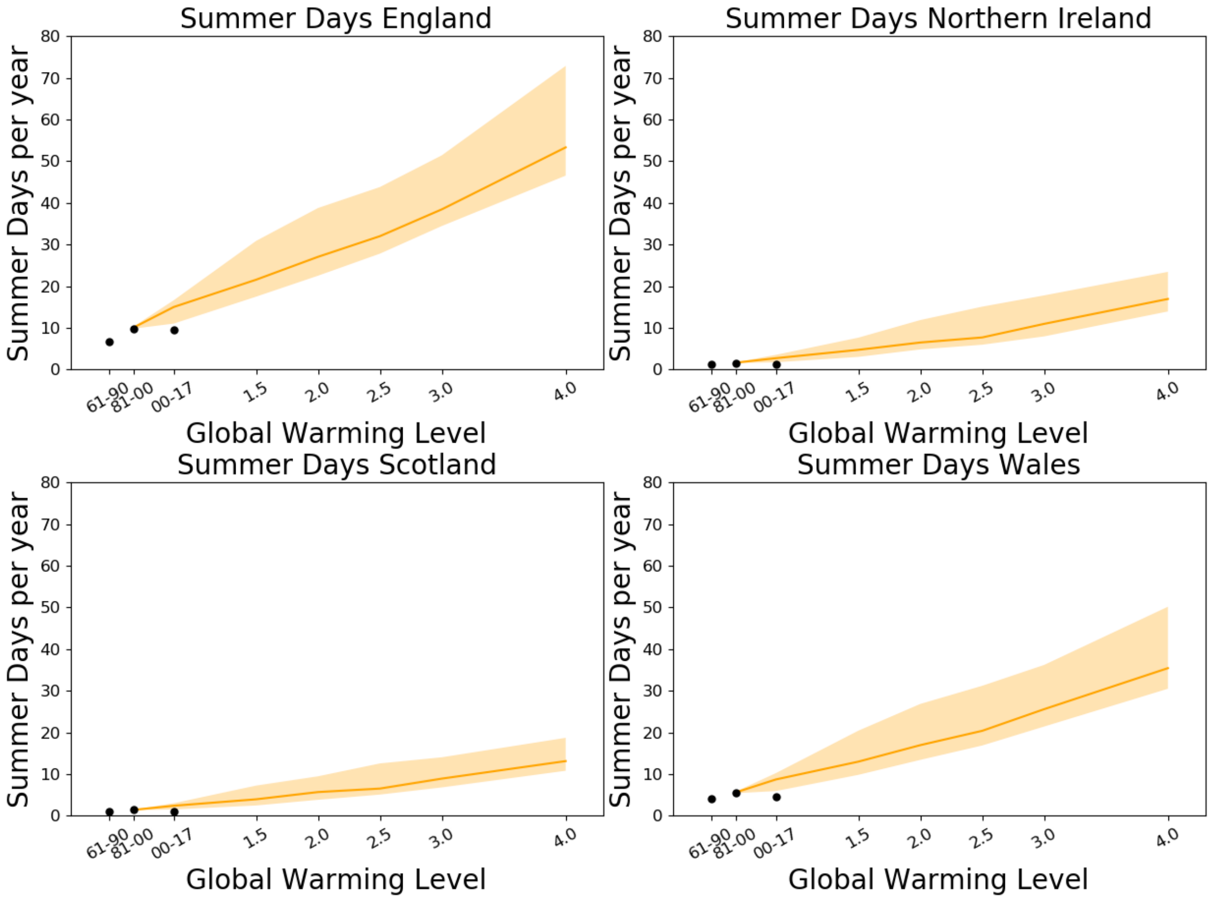

Figure 8 Evolution of Summer days index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

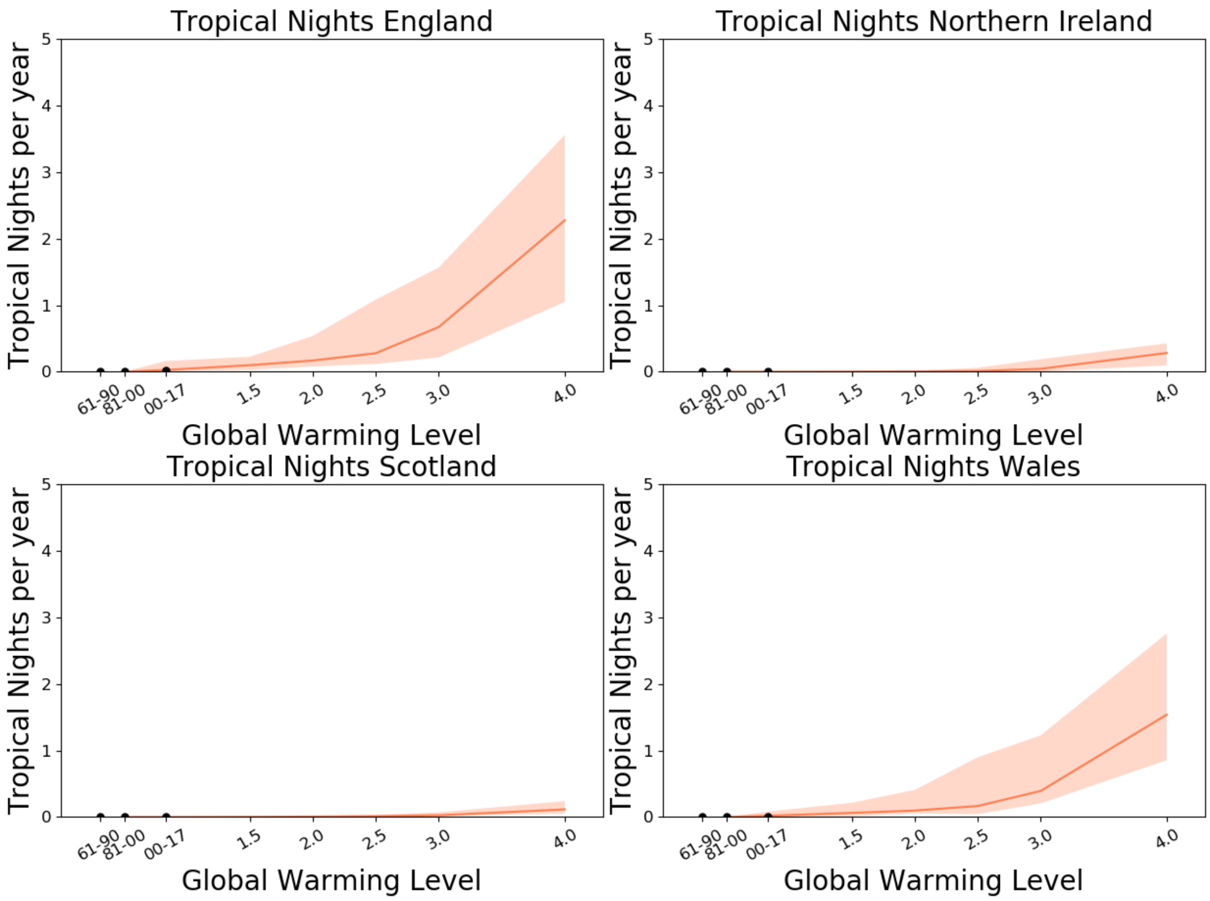

Figure 9 Evolution of tropical nights index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

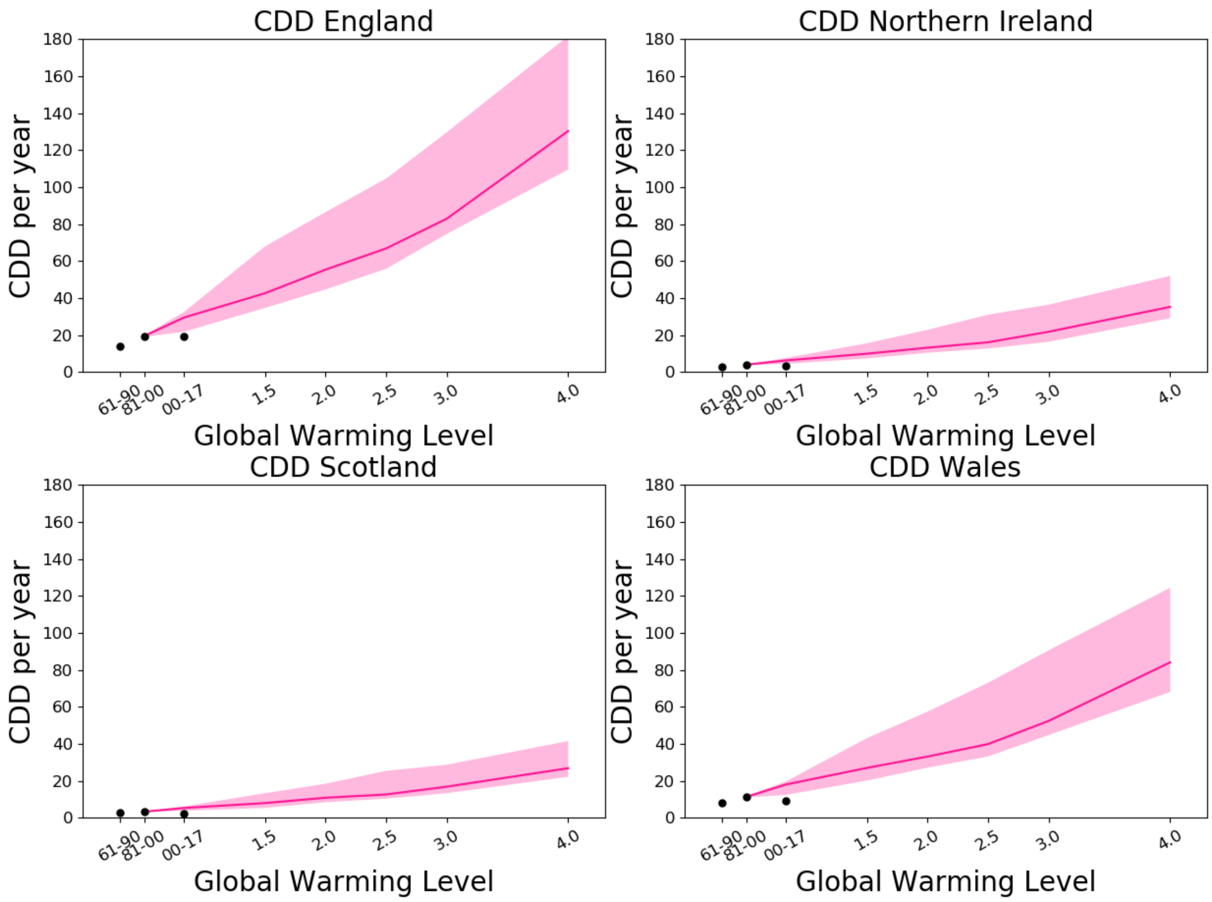

Figure 10 Evolution of cooling degree days index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

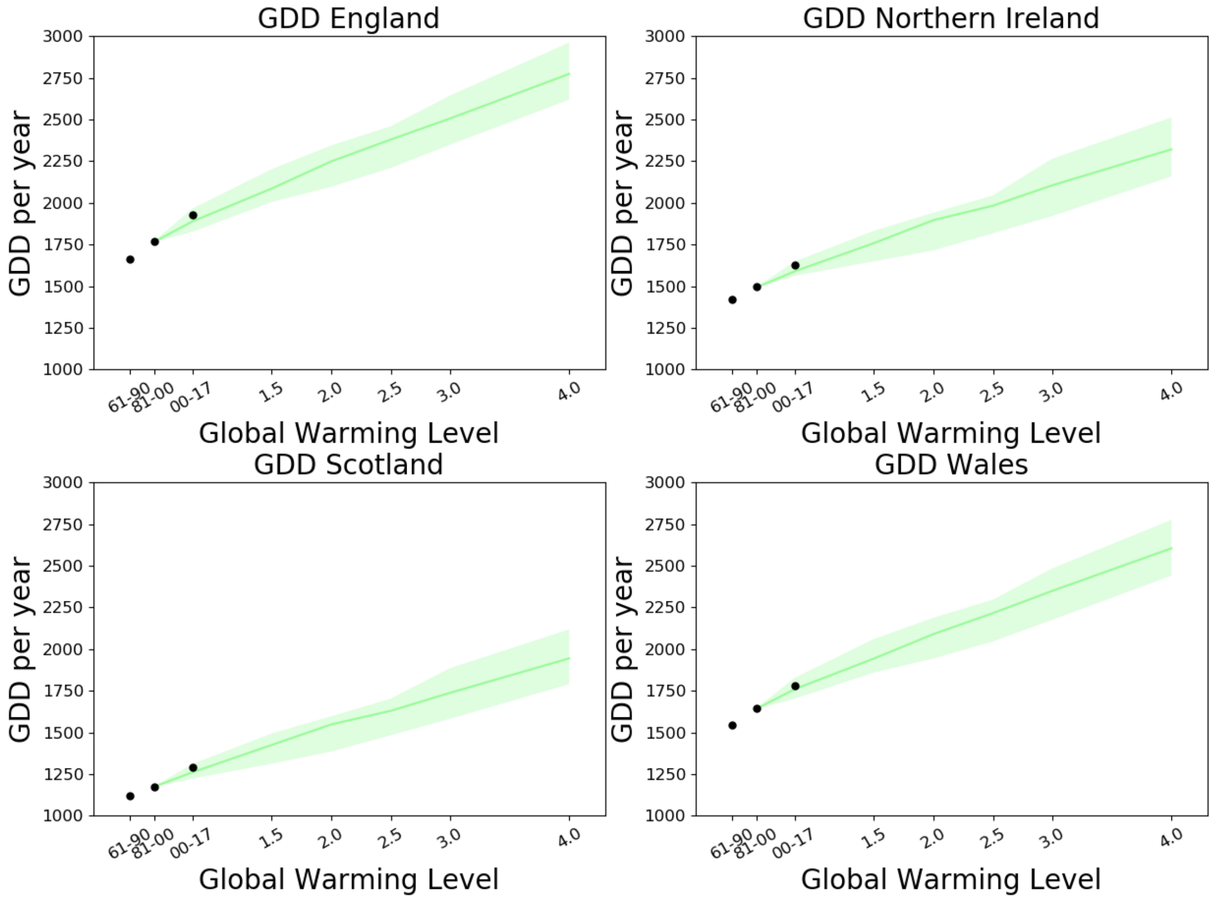

Figure 11 Evolution of growing degree days index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

3.2 Drought

It should be noted the natural variability in the observed DSI is quite significant and that is why the 1961-90 climatological average value is higher than the later baselines, mainly as it includes the 1970s during which the UK experienced several prolonged dry periods.

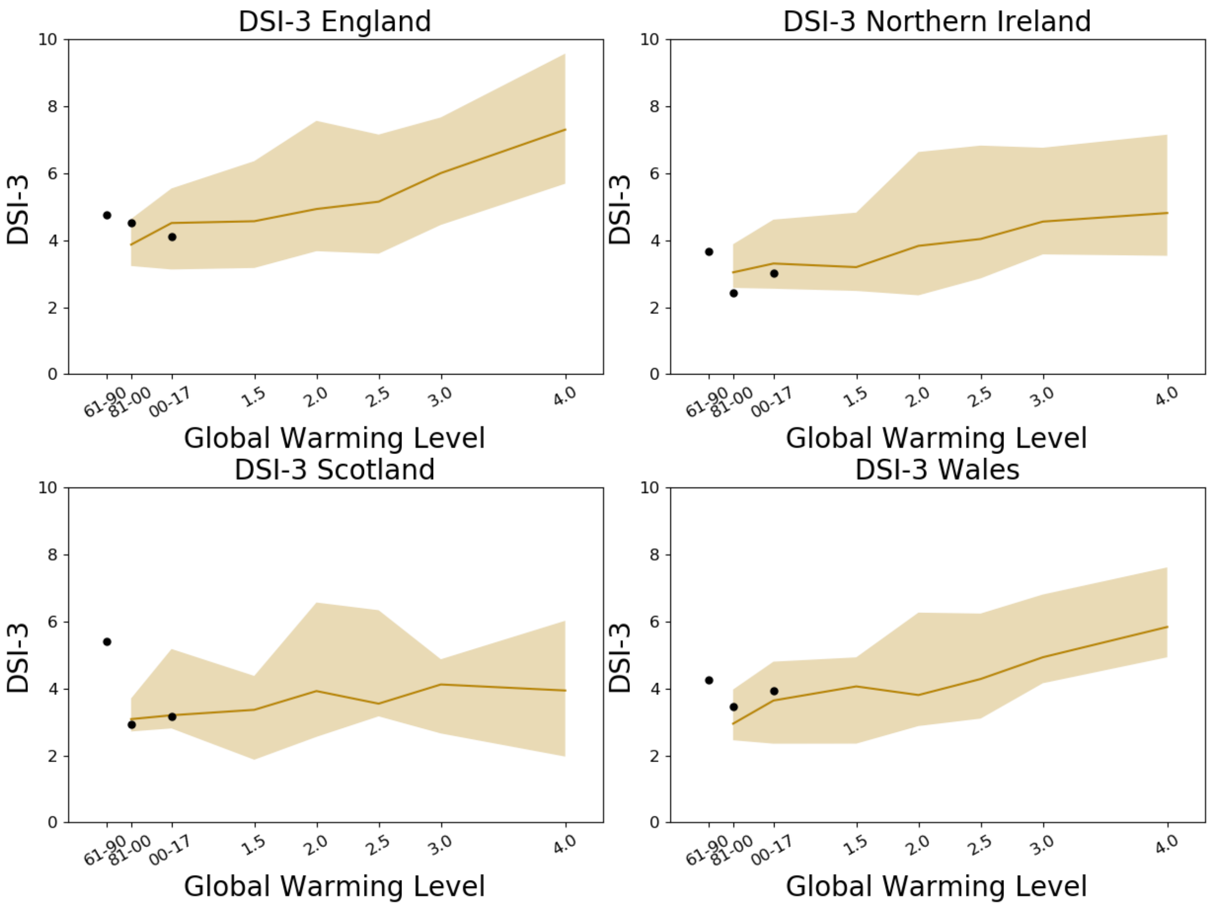

Figure 12 Evolution of 3-month drought severity index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

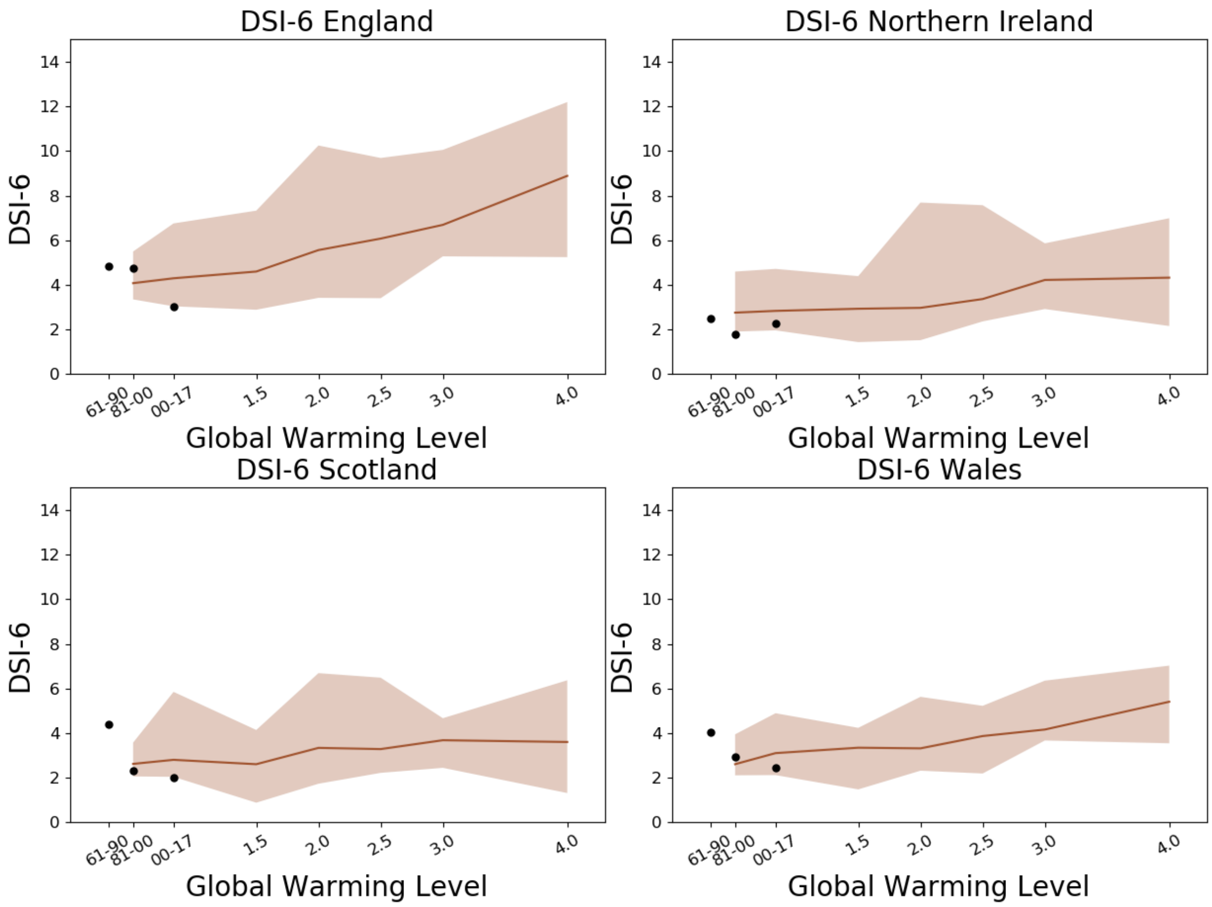

Figure 13 Evolution of 6-month drought severity index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

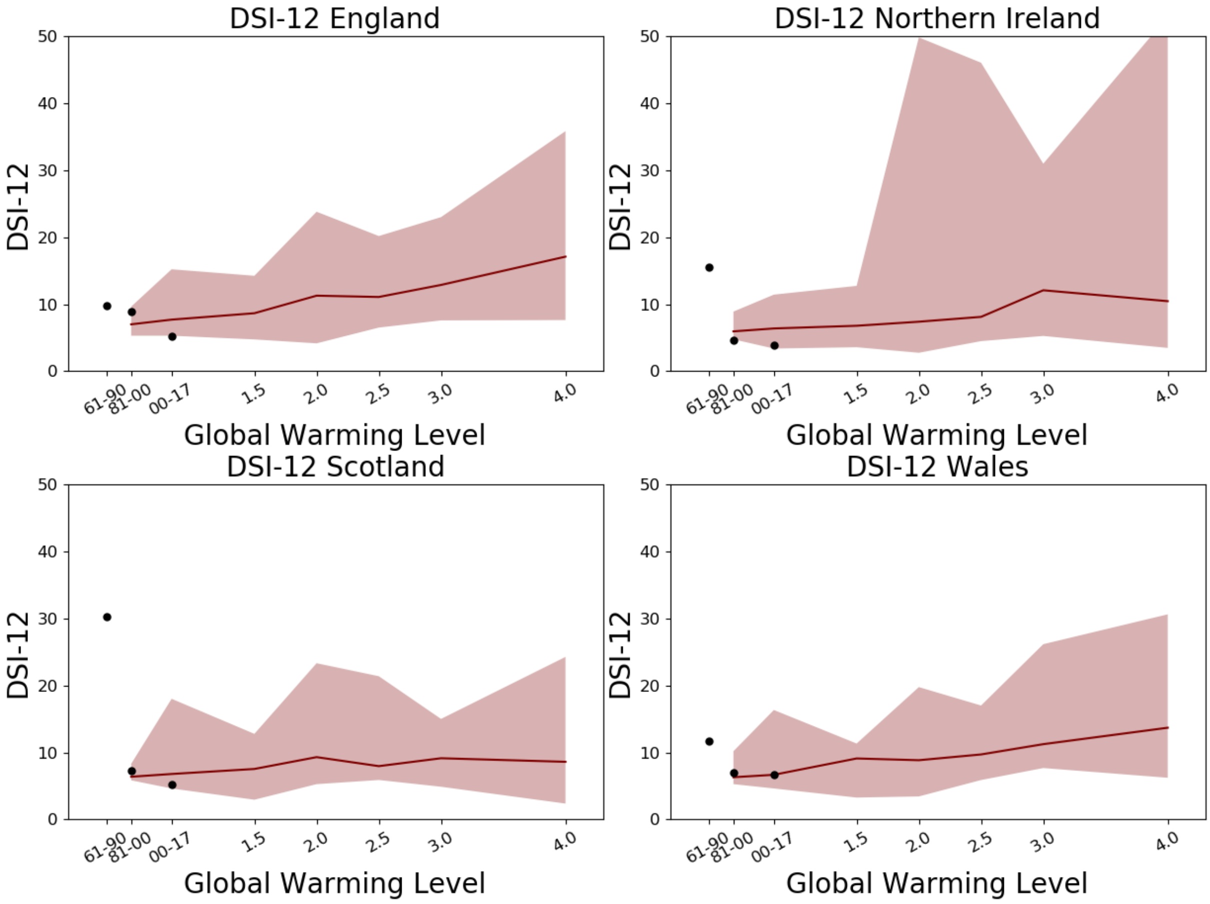

Figure 14 Evolution of 12-month drought severity index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

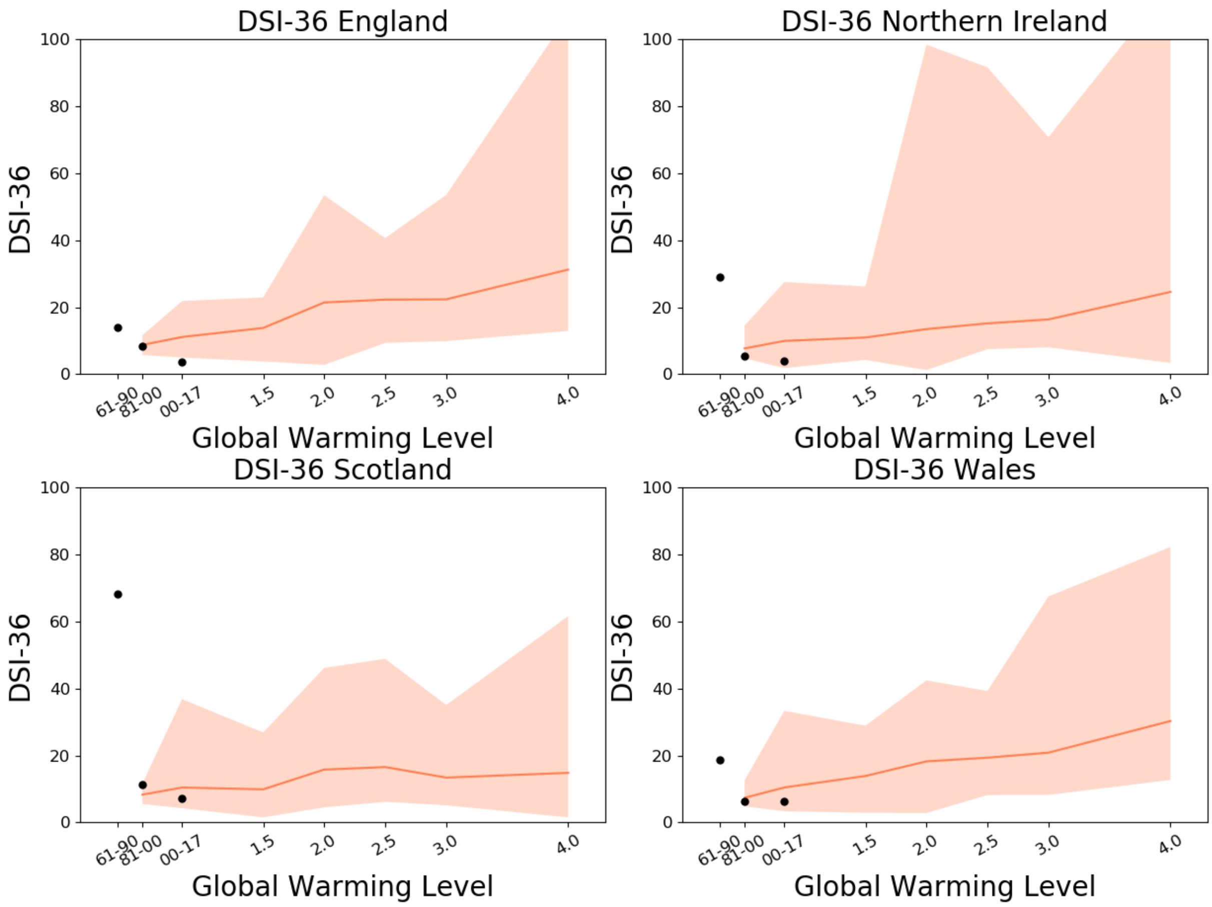

Figure 15 Evolution of 3-year drought severity index with increasing global mean temperature for each administrative area of the UK. This is the 21 year mean average index centred on the year each warming level is predicted to be reached. The ensemble range is shown as a plume with the ensemble median average as the solid line. The mean average index is computed with observations for baseline periods 1961-1990, 1981-2000 and 2000-2017 and is shown by black dots.

4 CHANGES AT DIFFERENT WARMING LEVELS

Table 2 The year each ensemble member passed the global warming threshold.

Ensemble Member	Global Warming Level				
	1.5°C	2.0°C	2.5°C	3.0°C	4.0°C
1	2019	2029	2041	2048	2063
4	2016	2026	2036	2045	2059
5	2019	2032	2041	2051	2065
6	2019	2029	2038	2047	2063
7	2016	2031	2041	2050	2063
8	2018	2033	2043	2052	2069
9	2014	2028	2036	2043	2056
10	2020	2032	2041	2049	2066
11	2017	2028	2038	2048	2062
12	2022	2035	2044	2052	2065
13	2017	2029	2039	2048	2063
15	2019	2032	2043	2052	2067

Table 3 Change in index per global warming level in England. Ensemble median with the ensemble range provided in brackets.

	Changes in England compared to 1981-2000 mean at Global Warming Levels relative to 1850-1900				
Index	1.5°C	2°C	2.5°C	3°C	4°C
Frost Days (days)	-16 (-22 : -9)	-20 (-26 : -14)	-25 (-31 : -18)	-31 (-36 : -23)	-39 (-43 : -31)
Icing Days (days)	-2 (-2 : -1)	-2 (-2 : -1)	-2 (-2 : -2)	-2 (-3 : -2)	-3 (-3 : -2)
Summer Days (days)	+12 (+8 : +18)	+17 (+13 : +24)	+22 (+18 : +30)	+29 (+25 : +38)	+45 (+37 : +55)
Tropical Nights (days)	0 (0 : 0)	0 (0 : 0)	0 (0 : 0)	+1 (0 : +1)	+2 (+1 : +3)
HDD (degree days)	-347 (-409 : -297)	-517 (-557 : -360)	-630 (-660 : -469)	-737 (-813 : -649)	-969 (-1074 : -845)
CDD (degree days)	+23 (+16 : +40)	+37 (+27 : +50)	+48 (+38 : +64)	+67 (+56 : +88)	+114 (+90 : +156)
GDD (degree days)	+329 (+256 : +397)	+479 (+398 : +563)	+613 (+496 : +662)	+744 (+676 : +836)	+1012 (+899 : +1168)
DSI-3 (%)	+0.76 (-0.45 : +1.73)	+0.92 (-0.03 : +3.2)	+1.3 (+0.42 : +3.13)	+2.27 (+0.79 : +3.28)	+3.39 (+1.9 : +4.95)
DSI-6 (%)	+0.83 (-1.03 : +2.68)	+1.12 (-0.36 : +5.43)	+1.67 (+0.05 : +4.58)	+2.73 (+0.91 : +5.39)	+4.42 (+1.37 : +7.04)
DSI-12 (%)	+2.06 (-3.37 : +6.14)	+4.96 (+0.6 : +14.17)	+3.53 (+0.67 : +10.38)	+4.68 (+1.22 : +14.59)	+10.29 (+1.98 : +17.19)
DSI-36 (%)	+4.78 (-3.93 : +11.44)	+12.42 (+2.43 : +31.34)	+15.06 (+6.02 : +27.27)	+15.57 (+5.16 : +40.75)	+25.07 (+9.43 : +59.47)

Table 4 Change in index per global warming level in Wales. Ensemble median with the ensemble range provided in brackets

	Changes in Wales compared to 1981-2000 mean at Global Warming Levels relative to 1850-1900				
Index	1.5°C	2°C	2.5°C	3°C	4°C
Frost Days (days)	**-15** (-20 : -9)	**-19** (-24 : -13)	**-23** (-29 : -17)	**-30** (-33 : -22)	**-35** (-39 : -30)
Icing Days (days)	**-2** (-2 : -1)	**-2** (-2 : -1)	**-2** (-2 : -1)	**-2** (-3 : -2)	**-3** (-3 : -2)
Summer Days (days)	**+8** (+5 : +13)	**+12** (+9 : +16)	**+15** (+12 : +20)	**+20** (+17 : +25)	**+31** (+26 : +41)
Tropical Nights (days)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : +1)	**+2** (+1 : +2)
HDD (degree days)	**-340** (-415 : -292)	**-505** (-556 : -363)	**-626** (-648 : -472)	**-738** (-808 : -658)	**-972** (-1080 : -852)
CDD (degree days)	**+16** (+10 : +26)	**+23** (+18 : +31)	**+29** (+23 : +40)	**+41** (+34 : +58)	**+73** (+61 : +108)
GDD (degree days)	**+308** (+242 : +379)	**+450** (+383 : +539)	**+570** (+474 : +634)	**+705** (+627 : +786)	**+972** (+853 : +1123)
DSI-3 (%)	**+0.87** (-0.38 : +1.4)	**+0.73** (-0.26 : +2.7)	**+1.38** (+0.14 : +2.94)	**+2.12** (+0.97 : +2.99)	**+2.67** (+2.16 : +4.3)
DSI-6 (%)	**+0.58** (-0.87 : +1.71)	**+0.63** (-0.63 : +2.58)	**+1.25** (-0.28 : +2.69)	**+1.77** (+0.42 : +3.28)	**+2.67** (+1.68 : +4.26)
DSI-12 (%)	**+2.59** (-2.64 : +5.52)	**+3.32** (-2.51 : +12.12)	**+3.7** (+0.18 : +9.13)	**+5.58** (+0.78 : +11.08)	**+9.07** (+1.08 : +22.43)
DSI-36 (%)	**+5.33** (-0.98 : +12.84)	**+10.68** (-1.34 : +29.74)	**+14.32** (+6.06 : +23.92)	**+19.32** (+5.67 : +40.42)	**+26.5** (+8.36 : +60.71)

Table 5 Change in index per global warming level in Northern Ireland. Ensemble median with the ensemble range provided in brackets

	Changes in Northern Ireland compared to 1981-2000 mean at Global Warming Levels relative to 1850-1900				
Index	1.5°C	2°C	2.5°C	3°C	4°C
Frost Days (days)	**-18** (-24 : -11)	**-21** (-30 : -12)	**-25** (-34 : -16)	**-31** (-38 : -21)	**-37** (-42 : -30)
Icing Days (days)	**0** (0 : 0)	**0** (0 : 0)	**0** (-1 : 0)	**-1** (-1 : 0)	**-1** (-1 : -1)
Summer Days (days)	**+3** (+2 : + 6)	**+5** (+3 : +6)	**+6** (+5 : +7)	**+10** (+7 : +12)	**+16** (+13 : +21)
Tropical Nights (days)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)
HDD (degree days)	**-301** (-391 : -256)	**-467** (-512 : -344)	**-561** (-613 : -432)	**-683** (-769 : -609)	**-902** (-1002 : -763)
CDD (degree days)	**+6** (+4 : +10)	**+9** (+7 : +12)	**+12** (+10 : +15)	**+19** (+15 : +26)	**+32** (+26 : +46)
GDD (degree days)	**+266** (+206 : +332)	**+398** (+334 : +443)	**+490** (+408 : +550)	**+610** (+538 : +668)	**+842** (+721 : +948)
DSI-3 (%)	**+0.32** (-0.74 : +1.07)	**+0.71** (-0.83 : +2.83)	**+0.94** (-0.38 : +3.5)	**+1.43** (+0.4 : +3.35)	**+1.88** (+0.76 : +3.83)
DSI-6 (%)	**+0.17** (-1.42 : +1.25)	**+0.56** (-1.58 : +2.26)	**+0.79** (-0.9 : +2.61)	**+1.47** (+0.61 : +2.87)	**+1.54** (-0.19 : +3.32)
DSI-12 (%)	**+1.14** (-1.15 : +4.64)	**+1.69** (-1.54 : +9.84)	**+2.45** (-0.47 : +16.79)	**+5.83** (-0.22 : +18.22)	**+4.45** (-1.56 : +32.79)
DSI-36 (%)	**+3.41** (-3.16 : +10.3)	**+3.69** (-2.28 : +28.19)	**+11.59** (+1.8 : +41.65)	**+9.11** (+1.47 : +50.33)	**+17.74** (-2.06 : +86.34)

Table 6 Change in index per global warming level in Scotland. Ensemble median with the ensemble range provided in brackets.

	Changes in Scotland compared to 1981-2000 mean at Global Warming Levels relative to 1850-1900				
Index	1.5°C	2°C	2.5°C	3°C	4°C
Frost Days (days)	**-24** (-30 : -12)	**-32** (-42 : -18)	**-40** (-49 : -25)	**-48** (-58 : -41)	**-62** (-67 : -53)
Icing Days (days)	**-3** (-4 : -2)	**-4** (-4 : -2)	**-4** (-5 : -3)	**-5** (-5 : -4)	**-5** (-5 : -5)
Summer Days (days)	**+3** (+1 : +5)	**+4** (+3 : +5)	**+5** (+4 : +7)	**+8** (+6 : +10)	**+12** (+10 : +17)
Tropical Nights (days)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)
HDD (degree days)	**-334** (-434 : -294)	**-528** (-574 : -388)	**-642** (-682 : -491)	**-766** (-874 : -701)	**-1011** (-1113 : -891)
CDD (degree days)	**+5** (+3 : +9)	**+8** (+6 : +10)	**+9** (+8 : +13)	**+14** (+11 : +21)	**+24** (+19 : +37)
GDD (degree days)	**+251** (+178 : +302)	**+368** (+311 : +410)	**+452** (+376 : +504)	**+566** (+487 : +630)	**+776** (+691 : +876)
DSI-3 (%)	**+0.25** (-0.83 : +0.73)	**+0.64** (-0.38 : +2.24)	**+0.62** (-0.22 : +2.03)	**+0.83** (-0.29 : +1.79)	**+0.7** (-0.17 : +1.78)
DSI-6 (%)	**+0.06** (-1.07 : +0.67)	**+0.66** (-0.77 : +1.93)	**+0.57** (-0.11 : +2.21)	**+1.08** (+0.19 : +1.73)	**+1.03** (-0.07 : +2.38)
DSI-12 (%)	**+1.06** (-2.5 : +4.65)	**+3.29** (-0.92 : +7.15)	**+1.22** (+0.07 : +12.89)	**+2.83** (-1.1 : +7.12)	**+2.36** (-1.85 : +8.39)
DSI-36 (%)	**+2.48** (-2.25 : +13.12)	**+8.76** (-0.24 : +15.56)	**+9.87** (+1.27 : +32.52)	**+6.49** (-2.06 : +22.8)	**+8.68** (-3.46 : +19.26)

Table 7: Change in index per global warming level averaged over whole UK. Ensemble median with the ensemble range provided in brackets.

	Changes in UK compared to 1981-2000 mean at Global Warming Levels relative to 1850-1900				
Index	**1.5°C**	**2°C**	**2.5°C**	**3°C**	**4°C**
Frost Days (days)	**-18** (-24 : -10)	**-24** (-31 : -14)	**-29** (-37 : -20)	**-36** (-42 : -27)	**-46** (-49 : -37)
Icing Days (days)	**-2** (-2 : -1)	**-2** (-3 : -1)	**-3** (-3 : -2)	**-3** (-3 : -3)	**-3** (-3 : -3)
Summer Days (days)	**+8** (+5 : +13)	**+12** (+9 : +16)	**+15** (+12 : +20)	**+20** (+17 : +26)	**+31** (+26 : +39)
Tropical Nights (days)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**0** (0 : 0)	**+1** (+1 : +2)
HDD (degree days)	**-338** (-412 : -295)	**-524** (-548 : -368)	**-622** (-662 : -473)	**-742** (-822 : -665)	**-979** (-1082 : -855)
CDD (degree days)	**+16** (+10 : +27)	**+25** (+18 : +33)	**+31** (+25 : +42)	**+45** (+38 : +59)	**+77** (+61 : +107)
GDD (degree days)	**+294** (+228 : +357)	**+437** (+366 : +506)	**+554** (+450 : +600)	**+676** (+604 : +753)	**+934** (+817 : +1066)
DSI-3 (%)	**+0.66** **(-0.53 : +1.08)**	**+0.8** (-0.06 : +2.8)	**+1.13** (+0.14 : +2.65)	**+1.67** (+0.52 : +2.61)	**+2.24** (+1.21 : +3.64)
DSI-6 (%)	**+0.47** (-1.04 : +1.58)	**+0.73** (-0.25 : +4.18)	**+1.36** (+0.08 : +3.29)	**+2.0** (+0.67 : +3.63)	**+2.87** (+0.86 : +4.57)
DSI-12 (%)	**+1.43** (-2.54 : +4.21)	**+3.14** (+0.33 : +9.01)	**+3.34** (+0.48 : +8.02)	**+4.85** (+0.5 : +10.88)	**+6.59** (-0.17 : +18.66)
DSI-36 (%)	**+5.7** (-1.87 : +10.81)	**+10.62** (+3.54 : +26.38)	**+11.59** (+5.71 : +22.32)	**+15.89** (+2.51 : +31.49)	**+24.79** (+4.02 : +54.84)

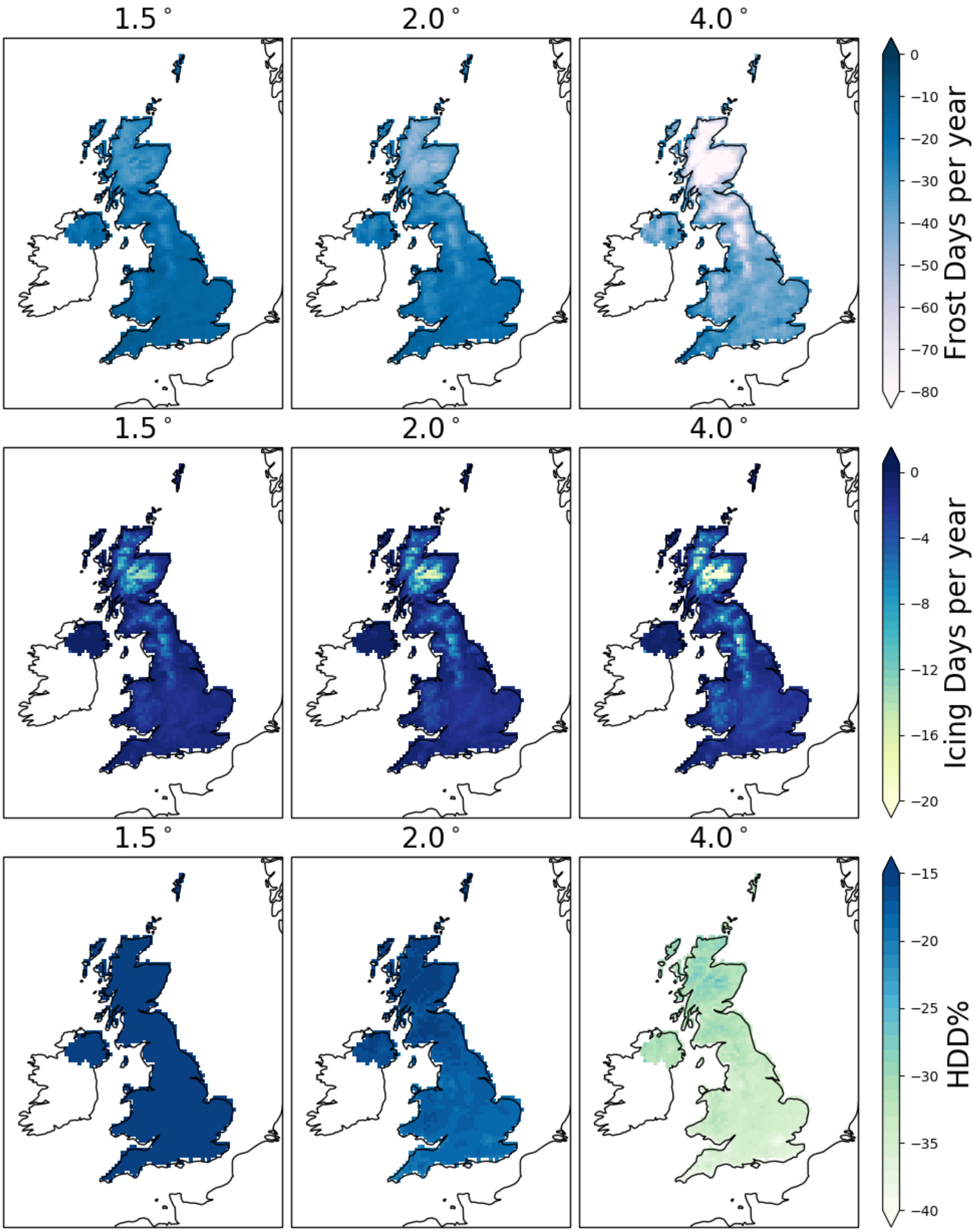

Figure 16 Change in cold weather impact metrics from 1981-2000 mean to 1.5°C, 2°C and 4°C degrees global warming relative to 1850-1900

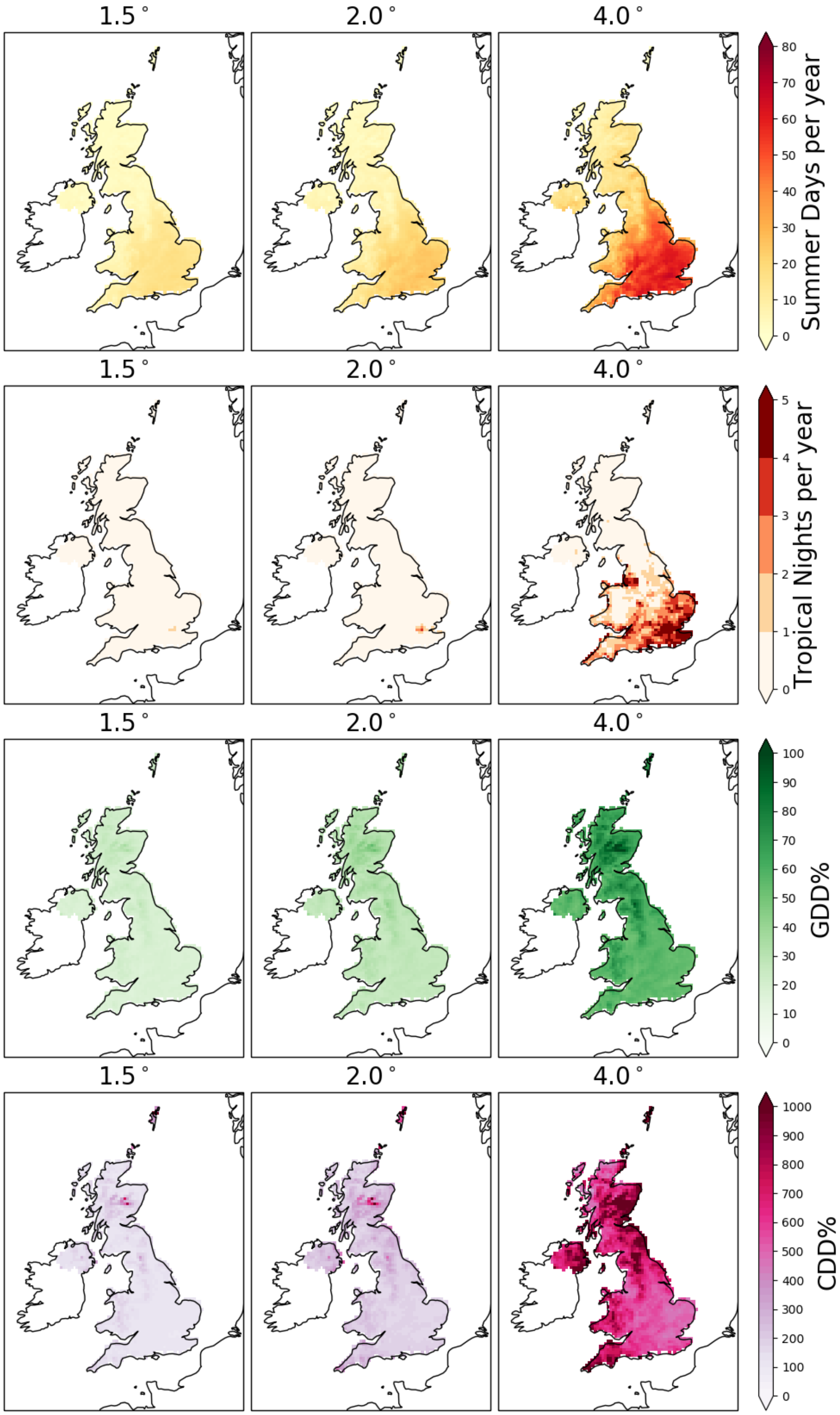

Figure 17 Change in hot weather impact metrics from 1981-2000 mean to 1.5°C, 2°C and 4°C degree global warming relative to 1850-1900

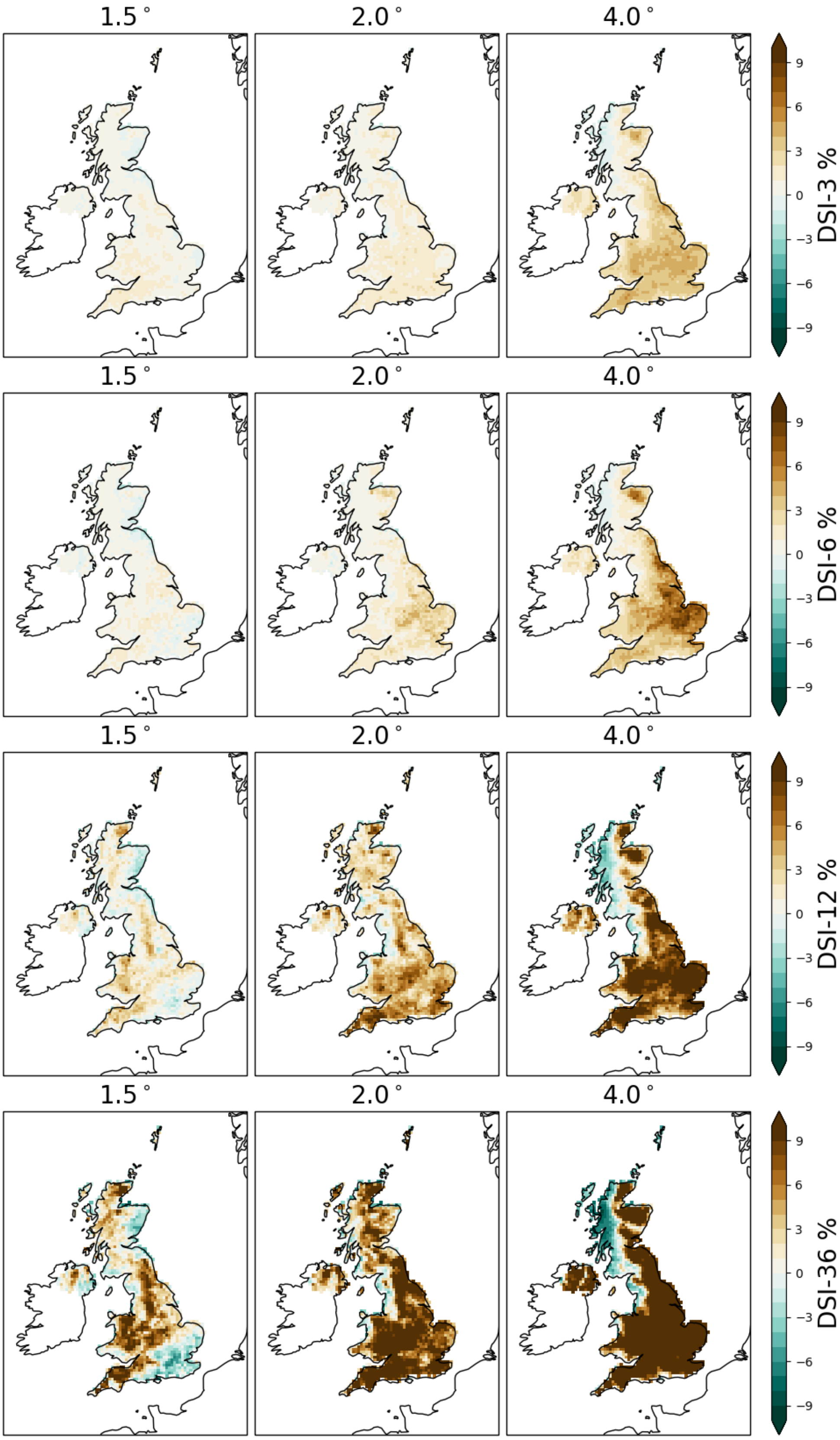

Figure 18 Change in drought metrics from 1981-2000 mean to 1.5°C, 2°C and 4°C degree global warming relative to 1850-1900

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