

1 **11.SM Chapter 11: Weather and climate extreme events**
2 **in a changing climate - Supplementary Material**

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40 **Date of Draft:**

41 3 May 2021

42
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44 TSU compiled version

45
46 **Acknowledgements:**

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11.SM.1 Mean temperature anomalies for CMIP5 model output

Table 11.SM.1 lists mean annual mean global surface air temperature anomalies for CMIP5 model output for selected time periods and all RCPs, in a similar format as Table 4.2 (Chapter 4). See (Hauser, 2021b) for respective numbers for individual CMIP5 and CMIP6 models.

[START TABLE 11.SM.1 HERE]

Table 11.SM.1: CMIP5 annual mean global surface air temperature anomalies (°C) from the 1850–1900 reference period for selected time periods, regions and all RCPs. Displayed are multi-model averages and 5–95% ranges. Numbers in brackets in the top row indicate the number of models.

	RCP2.6 (21)	RCP4.5 (30)	RCP6.0 (14)	RCP8.5 (32)
near-term (2021-2040)	1.5 (1.1-2.0)	1.6 (1.2-2.0)	1.5 (1.0-1.9)	1.7 (1.2-2.3)
mid-term (2041-2060)	1.7 (1.3-2.2)	2.0 (1.5-2.6)	1.9 (1.4-2.4)	2.5 (1.9-3.2)
long-term (2081-2100)	1.7 (1.1-2.3)	2.5 (1.8-3.2)	2.8 (2.3-3.6)	4.4 (3.2-5.5)
AR5 “near-term” (2016-2035)	1.4 (1.0-1.9)	1.4 (1.1-1.9)	1.4 (0.9-1.8)	1.5 (1.1-2.1)
AR5 “mid-term” (2046-2065)	1.7 (1.2-2.2)	2.1 (1.6-2.7)	2.0 (1.5-2.5)	2.7 (2.1-3.5)
2020 (2011-2030)	1.4 (1.0-1.8)	1.3 (0.9-1.7)	1.3 (0.9-1.7)	1.4 (1.0-1.8)
2030 (2021-2040)	1.5 (1.1-2.0)	1.6 (1.2-2.0)	1.5 (1.0-1.9)	1.7 (1.2-2.3)
2040 (2031-2050)	1.7 (1.2-2.2)	1.8 (1.4-2.3)	1.7 (1.2-2.1)	2.1 (1.6-2.7)
2050 (2041-2060)	1.7 (1.3-2.2)	2.0 (1.5-2.6)	1.9 (1.4-2.4)	2.5 (1.9-3.2)
2060 (2051-2070)	1.7 (1.2-2.3)	2.2 (1.6-2.8)	2.1 (1.6-2.6)	2.9 (2.3-3.8)
2070 (2061-2080)	1.7 (1.2-2.3)	2.3 (1.7-3.0)	2.3 (1.9-2.9)	3.4 (2.6-4.3)
2080 (2071-2090)	1.7 (1.1-2.3)	2.4 (1.8-3.1)	2.6 (2.1-3.3)	3.9 (2.9-4.9)
2090 (2081-2100)	1.7 (1.1-2.3)	2.5 (1.8-3.2)	2.8 (2.3-3.6)	4.4 (3.2-5.5)
2100 (2091-2100)	1.7 (1.0-2.3)	2.5 (1.9-3.2)	2.9 (2.4-3.7)	4.6 (3.4-5.7)

[END TABLE 11.SM.1 HERE]

11.SM.2 Methods used for the figures

11.SM.2.1 Overview

This section provides additional methods used for the figures produced specifically for Chapter 11. These figures are either based on published observational data or data from the sixth phase of the Coupled Model Intercomparison Project (CMIP6) (Eyring et al., 2016). See also Appendix 11.A for additional information on the used data.

11.SM.2.2 Climate indices

Figure 11.11 and Figure 11.17 show trends of observed climate indices. Most of the shown climate indices are defined by the expert group on Climate Change Detection and Indices (ETCCDI) (Karl, Nicholls, &

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1 Ghazi, 1999; Peterson et al., 2001), which were calculated on an annual basis according to the standard
2 procedure. The used ETCCDI indices include hottest daily maximum temperature (TXx), hottest daily
3 minimum temperature (TNn), the annual number of days when daily maximum temperature exceeds its 90th
4 percentile from a base period (TX90p), and consecutive dry days (CDD). Further, trends in the Standardized
5 Precipitation Index (SPI) and the Standardized Precipitation-Evapotranspiration Index (SPEI) at an
6 accumulation scale of 12 months (SPI-12 and SPEI-12) are shown.

7
8 Model data from CMIP6 is shown in Figure 11.2, Figure 11.9, Figure 11.16, Figure 11.18, and Figure 11.19
9 (all other figures showing CMIP6 data are taken from publications). The following indices were computed
10 for the figures: TXx, TNn, annual maximum daily precipitation (Rx1day), and CDD. In addition, total soil
11 moisture (summed over the whole column), a soil-moisture based drought frequency index and a soil-
12 moisture based drought intensity index were analyzed. For soil moisture data from CMIP6 all values are
13 masked over the ocean, land ice, Antarctica, and Greenland.

14 15 16 *11.SM.2.2.1 Soil-moisture based drought indices*

17
18 The soil moisture-based drought indices are displayed in Figure 11.18 and Figure 11.19. Both drought
19 indices are calculated for annual mean and seasonal mean data. First, soil moisture is normalized subtracting
20 the mean over 1850-1900 and dividing it by the standard deviation over the same time period. For the
21 drought frequency the 10th quantile over the period 1850-1900 is calculated and all soil moisture values
22 below this threshold are defined as drought. Finally, the drought frequency for a certain time period is given
23 as fraction of years or season under drought. Time periods are selected for certain global warming levels (see
24 below), where 30-year periods are used. For the drought intensity we calculate the 10th quantile over the
25 period 1850-1900 and for certain global warming levels.

26 27 28 *11.SM.2.3 Observed trends in TXx, TNn, TX90p, and CDD*

29
30 Observed trends in TXx, TNn, TX90p, and CDD are shown in Figure 11.9 and Figure 11.17 (a). The data is
31 obtained from (Dunn et al., 2020) and the calculation of the trends and the selection of valid grid points
32 follows the method outlined in (Dunn et al., 2020). In contrast to (Dunn et al., 2020), however, we show
33 trends for the time period 1960-2018 and the significance was calculated the $p = 0.1$ level.

34 35 36 *11.SM.2.4 Observed trends in SPI and SPEI*

37
38 Trend in SPI and SPEI are shown in Figure 11.17 (b) and (c). The data is obtained from (Spinoni et al.,
39 2019) and trends were calculated by linear regression analysis. Time was the independent variable and the
40 drought severity the dependent variable. The slope of the regression indicates the amount of change. Data
41 was available for 5-year periods. Significance was analyzed by means of the nonparametric Mann–Kendall
42 statistic that measures the degree to which a trend is consistently increasing or decreasing. Autocorrelation
43 was considered in the trend analysis returning the corrected p values after accounting for temporal pseudo
44 replication (Hamed & Ramachandra Rao, 1998).

45 46 47 *11.SM.2.5 CMIP6 data*

48
49 CMIP6 data is specifically analysed for Chapter 11 in Figure 11.3, Figure 11.11, Figure 11.16, Figure 11.18,
50 Figure 11.19, and FAQ 11.1 Figure 1 (all other figures showing CMIP6 data are taken from publications).
51 For these figures historical simulations (1850 to 2015) are combined with the shared socioeconomic
52 pathways (SSPs) projections (O'Neill et al., 2016). The following SSPs were chosen: SSP1-1.9, SSP1-2.6,
53 SSP2-4.5, SSP3-7.0, and SSP5-8.5. This subset of SSPs includes all Tier 1 scenarios (SSP1-2.6, SSP2-4.5,
54 SSP3-7.0, and SSP5-8.5) and additionally the scenario most consistent with a stabilisation at +1.5°C at the
55 end of the 21st century as aimed in the Paris Agreement (SSP1-1.9) (O'Neill et al., 2016).

1 A “ensemble of opportunity” is used, including all available models that pass very basic checks. Only the
2 first ensemble member of each model is used, and all models are weighted equally. In order to be used,
3 models must (i) provide the corresponding variable, (ii) run from 1850 to 2099, (iii) must not have duplicate
4 time steps or missing time steps, and (iv) must not have any obvious data errors (e.g., negative soil moisture,
5 or an inconsistency between historical simulation and projection). The exact model ensemble used for each
6 figure is given in Appendix 11.
7
8

9 **11.SM.2.6 Global warming levels**

10 Global warming levels expressed as changes in global mean surface air temperature (GSAT) relative to the
11 1850-1900 period are used to display changes in climate indices in Chapter 12. See Cross-Chapter Box 11.1
12 for details. Global warming levels are computed as outlined in (Hauser, Engelbrecht, & Fischer, 2021) using
13 20-year periods, except for the soil moisture-based drought indices where 30-year periods are used.
14
15
16

17 **11.SM.2.7 Scaling of regional climate indices**

18 Figure 11.3 shows regional mean changes in TXx as function of GWL. To obtain regional averages of
19 climate indices they are first calculated on the original model grid. Then regional averages are computed,
20 weighting each grid cell with its area (if available, else the grid cells are weighted by the cosine of the
21 latitude). Finally, the mean of the climate index is calculated at GWLs between 0.1°C and 5°C in steps of
22 0.1°C. In Figure 11.3 TXx scaling is shown for individual models (panel a), as multi-model mean for
23 selected SSPs (panel a), or as multi model mean over all used SSPs (see Section 11.SM.1.5; all panels).
24
25
26

27 **11.SM.2.8 Maps at global warming levels**

28 Maps of climate indices at global warming levels are shown in Figure 11.11, Figure 11.16, and Figure 11.19.
29 The response of the climate indices is calculated at three different global warming levels: 1.5°C, 2°C, and
30 4°C. The model data is interpolated on a common 2.5° x 2.5° latitude-longitude grid using a conservative
31 regridding scheme. All models from each of the five used SSPs (see Section 11.SM.1.5) that reaches the
32 warming level is included in the ensemble, thus each model can contribute more than one data point for a
33 given warming level. Finally, the median over all models is calculated.
34
35
36

37 **11.SM.2.9 Warmest three-month season**

38 FAQ 11.1, Figure 1 displays changes in mean precipitation and temperatures for the warmest three
39 consecutive months, which corresponds to summer in mid- to high-latitudes. The warmest months were
40 determined for each model and grid point individually from the period 1850-1900. The warmest-three month
41 season was kept constant over the whole period of the simulation.
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45 **11.SM.3 Multi-model-median regional means at warming levels for selected indices**

46 [START TABLE 11.SM.2 HERE]
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49 **Table 11.SM.2:** Multi model median regional changes in annual hottest daily maximum temperature (TXx) for the
50 globe, global ocean, global land, global land excluding Antarctica, and the AR6 land regions for three
51 global warming levels (GWL) as simulated by CMIP6 models under the forcing scenarios SSP1-1.9,
52 SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5. Regional averages are calculated from the original
53 model grid using the grid cell area as weights if available, else the grid cells where weighted with the
54 cosine of the latitude. See also Hauser (2021).
55

	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	1.40°C	1.90°C	3.93°C
Ocean (ocean)	1.22°C	1.64°C	3.40°C
Land (land)	1.88°C	2.55°C	5.25°C
Land w/o Antarctica (land_wo_antarctica)	1.94°C	2.65°C	5.47°C
Greenland/Iceland (GIC)	1.21°C	1.54°C	2.97°C
N.W.North-America (NWN)	1.93°C	2.55°C	5.23°C
N.E.North-America (NEN)	2.22°C	2.99°C	5.96°C
W.North-America (WNA)	2.24°C	3.01°C	5.95°C
C.North-America (CNA)	2.33°C	3.12°C	5.71°C
E.North-America (ENA)	1.97°C	2.72°C	5.68°C
N.Central-America (NCA)	1.81°C	2.45°C	4.84°C
S.Central-America (SCA)	1.77°C	2.32°C	4.76°C
Caribbean (CAR)	1.59°C	2.11°C	4.33°C
N.W.South-America (NWS)	1.87°C	2.52°C	5.41°C
N.South-America (NSA)	2.24°C	2.98°C	6.35°C
N.E.South-America (NES)	2.04°C	2.69°C	5.39°C
South-American-Monsoon (SAM)	2.58°C	3.44°C	7.33°C
S.W.South-America (SWS)	1.91°C	2.50°C	4.83°C
S.E.South-America (SES)	1.95°C	2.57°C	5.45°C
S.South-America (SSA)	1.91°C	2.41°C	4.52°C
N.Europe (NEU)	1.81°C	2.54°C	4.99°C
West&Central-Europe (WCE)	2.33°C	3.20°C	6.23°C
E.Europe (EEU)	2.20°C	2.97°C	5.76°C
Mediterranean (MED)	2.50°C	3.30°C	6.61°C
Sahara (SAH)	2.39°C	3.09°C	6.03°C
Western-Africa (WAF)	1.62°C	2.19°C	4.53°C
Central-Africa (CAF)	1.56°C	2.12°C	4.67°C
N.Eastern-Africa (NEAF)	1.66°C	2.24°C	4.45°C
S.Eastern-Africa (SEAF)	1.59°C	2.08°C	4.24°C
W.Southern-Africa (WSAF)	2.03°C	2.73°C	5.29°C
E.Southern-Africa (ESAF)	1.93°C	2.66°C	5.45°C
Madagascar (MDG)	1.63°C	2.17°C	4.65°C
Russian-Arctic (RAR)	1.99°C	2.77°C	5.52°C

W.Siberia (WSB)	2.11°C	2.80°C	5.09°C
E.Siberia (ESB)	2.09°C	2.87°C	5.97°C
Russian-Far-East (RFE)	1.93°C	2.69°C	5.45°C
W.C.Asia (WCA)	2.34°C	3.08°C	6.09°C
E.C.Asia (ECA)	2.17°C	2.92°C	5.70°C
Tibetan-Plateau (TIB)	1.65°C	2.32°C	4.55°C
E.Asia (EAS)	1.50°C	2.19°C	4.66°C
Arabian-Peninsula (ARP)	2.29°C	3.06°C	5.99°C
S.Asia (SAS)	1.20°C	1.81°C	4.12°C
S.E.Asia (SEA)	1.40°C	1.85°C	4.23°C
N.Australia (NAU)	1.59°C	2.03°C	3.99°C
C.Australia (CAU)	1.95°C	2.53°C	4.85°C
E.Australia (EAU)	1.60°C	2.13°C	4.25°C
S.Australia (SAU)	1.71°C	2.30°C	4.48°C
New-Zealand (NZ)	1.36°C	1.82°C	3.68°C
E.Antarctica (EAN)	1.18°C	1.65°C	3.22°C
W.Antarctica (WAN)	0.62°C	0.84°C	1.81°C

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[END TABLE 11.SM.2 HERE]

[START TABLE 11.SM.3 HERE]

Table 11.SM.3: As Table 11.SM.2 but for changes in the annual hottest daily minimum temperature (TNn).

	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	1.99°C	2.63°C	5.19°C
Ocean (ocean)	1.74°C	2.28°C	4.53°C
Land (land)	2.64°C	3.48°C	6.80°C
Land w/o Antarctica (land_wo_antarctica)	2.73°C	3.59°C	7.05°C
Greenland/Iceland (GIC)	3.88°C	4.99°C	9.90°C
N.W.North-America (NWN)	4.46°C	6.01°C	12.38°C
N.E.North-America (NEN)	4.85°C	6.37°C	13.22°C
W.North-America (WNA)	2.80°C	3.92°C	7.80°C
C.North-America (CNA)	2.54°C	3.76°C	7.82°C
E.North-America (ENA)	3.67°C	4.99°C	9.72°C
N.Central-America (NCA)	1.79°C	2.36°C	5.03°C

S.Central-America (SCA)	1.59°C	2.08°C	3.87°C
Caribbean (CAR)	1.51°C	2.02°C	3.74°C
N.W.South-America (NWS)	1.87°C	2.43°C	4.89°C
N.South-America (NSA)	1.81°C	2.36°C	4.62°C
N.E.South-America (NES)	1.79°C	2.35°C	4.40°C
South-American-Monsoon (SAM)	1.78°C	2.41°C	4.79°C
S.W.South-America (SWS)	2.04°C	2.66°C	5.90°C
S.E.South-America (SES)	1.42°C	1.80°C	3.75°C
S.South-America (SSA)	2.14°C	2.79°C	6.40°C
N.Europe (NEU)	5.08°C	6.46°C	10.59°C
West&Central-Europe (WCE)	4.80°C	6.06°C	11.04°C
E.Europe (EEU)	4.90°C	6.16°C	11.33°C
Mediterranean (MED)	2.20°C	2.79°C	5.28°C
Sahara (SAH)	2.15°C	2.74°C	5.35°C
Western-Africa (WAF)	2.04°C	2.65°C	4.63°C
Central-Africa (CAF)	1.89°C	2.52°C	4.94°C
N.Eastern-Africa (NEAF)	1.95°C	2.51°C	4.90°C
S.Eastern-Africa (SEAF)	1.83°C	2.36°C	4.54°C
W.Southern-Africa (WSAF)	1.77°C	2.40°C	4.75°C
E.Southern-Africa (ESAF)	1.78°C	2.28°C	4.42°C
Madagascar (MDG)	1.63°C	2.08°C	3.93°C
Russian-Arctic (RAR)	4.81°C	6.44°C	12.78°C
W.Siberia (WSB)	4.05°C	5.52°C	10.26°C
E.Siberia (ESB)	3.42°C	4.55°C	8.62°C
Russian-Far-East (RFE)	4.10°C	5.56°C	11.17°C
W.C.Asia (WCA)	2.75°C	3.56°C	7.32°C
E.C.Asia (ECA)	2.26°C	2.97°C	5.77°C
Tibetan-Plateau (TIB)	2.42°C	2.97°C	5.74°C
E.Asia (EAS)	2.11°C	2.95°C	5.83°C
Arabian-Peninsula (ARP)	2.30°C	2.84°C	5.96°C
S.Asia (SAS)	1.79°C	2.48°C	5.23°C
S.E.Asia (SEA)	1.46°C	1.96°C	4.10°C
N.Australia (NAU)	1.97°C	2.57°C	5.08°C
C.Australia (CAU)	1.62°C	2.06°C	4.22°C
E.Australia (EAU)	1.37°C	1.89°C	3.76°C

S.Australia (SAU)	1.10°C	1.52°C	2.95°C
New-Zealand (NZ)	1.33°C	1.74°C	3.41°C
E.Antarctica (EAN)	1.64°C	2.17°C	4.38°C
W.Antarctica (WAN)	2.26°C	2.95°C	5.58°C

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[END TABLE 11.SM.3 HERE]

[START TABLE 11.SM.4 HERE]

Table 11.SM.4: As Table 11.SM.2 but for changes in annual maximum daily precipitation (Rx1day).

	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	6.96%	9.96%	24.02%
Ocean (ocean)	6.49%	9.12%	22.81%
Land (land)	8.42%	11.42%	26.58%
Land w/o Antarctica (land_wo_antarctica)	8.37%	11.30%	26.56%
Greenland/Iceland (GIC)	11.76%	15.66%	33.77%
N.W.North-America (NWN)	9.06%	12.49%	27.28%
N.E.North-America (NEN)	9.99%	13.29%	26.54%
W.North-America (WNA)	7.09%	8.01%	16.89%
C.North-America (CNA)	7.39%	9.91%	17.93%
E.North-America (ENA)	8.05%	10.67%	22.03%
N.Central-America (NCA)	5.28%	7.29%	15.89%
S.Central-America (SCA)	2.24%	4.55%	8.36%
Caribbean (CAR)	3.38%	2.56%	4.17%
N.W.South-America (NWS)	8.05%	11.05%	26.81%
N.South-America (NSA)	6.26%	8.31%	17.42%
N.E.South-America (NES)	7.26%	9.35%	27.46%
South-American-Monsoon (SAM)	5.73%	9.06%	18.72%
S.W.South-America (SWS)	1.64%	2.50%	3.15%
S.E.South-America (SES)	8.45%	11.91%	24.59%
S.South-America (SSA)	4.87%	7.09%	14.37%
N.Europe (NEU)	9.33%	11.55%	23.21%
West&Central-Europe (WCE)	7.48%	9.51%	18.37%
E.Europe (EEU)	7.28%	8.78%	18.88%
Mediterranean (MED)	3.61%	4.42%	8.88%

Sahara (SAH)	19.43%	24.07%	45.50%
Western-Africa (WAF)	18.26%	19.74%	46.24%
Central-Africa (CAF)	14.36%	18.24%	47.14%
N.Eastern-Africa (NEAF)	13.38%	17.42%	46.12%
S.Eastern-Africa (SEAF)	11.23%	15.66%	41.36%
W.Southern-Africa (WSAF)	4.68%	6.40%	9.36%
E.Southern-Africa (ESAF)	5.95%	9.25%	20.87%
Madagascar (MDG)	6.28%	8.18%	22.26%
Russian-Arctic (RAR)	10.95%	15.89%	31.50%
W.Siberia (WSB)	8.22%	10.53%	19.17%
E.Siberia (ESB)	8.11%	11.36%	24.80%
Russian-Far-East (RFE)	10.54%	15.40%	35.29%
W.C.Asia (WCA)	9.14%	11.48%	24.16%
E.C.Asia (ECA)	9.10%	12.75%	29.93%
Tibetan-Plateau (TIB)	8.80%	12.46%	30.70%
E.Asia (EAS)	7.28%	10.76%	28.69%
Arabian-Peninsula (ARP)	11.07%	17.46%	43.04%
S.Asia (SAS)	10.39%	15.84%	41.56%
S.E.Asia (SEA)	6.77%	10.57%	33.37%
N.Australia (NAU)	6.97%	9.33%	28.35%
C.Australia (CAU)	5.82%	7.06%	15.27%
E.Australia (EAU)	4.01%	5.97%	14.73%
S.Australia (SAU)	5.84%	6.53%	14.18%
New-Zealand (NZ)	8.21%	12.11%	25.55%
E.Antarctica (EAN)	11.68%	15.56%	35.98%
W.Antarctica (WAN)	8.42%	11.47%	23.65%

1 [END TABLE 11.SM.4 HERE]

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4 [START TABLE 11.SM.5 HERE]

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6 **Table 11.SM.5:** As Table 11.SM.2 but for changes in annual maximum five-day precipitation (Rx5day).

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	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	5.24%	7.45%	18.94%
Ocean (ocean)	4.77%	6.74%	17.92%
Land (land)	6.13%	8.54%	20.76%

Land w/o Antarctica (land_wo_antarctica)	6.07%	8.42%	20.52%
Greenland/Iceland (GIC)	11.38%	15.12%	34.24%
N.W.North-America (NWN)	7.87%	11.44%	24.67%
N.E.North-America (NEN)	8.83%	11.51%	22.90%
W.North-America (WNA)	5.08%	6.24%	11.99%
C.North-America (CNA)	5.04%	7.74%	14.33%
E.North-America (ENA)	6.06%	8.47%	18.41%
N.Central-America (NCA)	3.30%	4.34%	10.77%
S.Central-America (SCA)	0.23%	1.02%	1.72%
Caribbean (CAR)	0.21%	-0.18%	-1.94%
N.W.South-America (NWS)	5.65%	7.47%	17.66%
N.South-America (NSA)	3.91%	5.48%	11.10%
N.E.South-America (NES)	6.19%	8.32%	20.24%
South-American-Monsoon (SAM)	4.56%	7.04%	11.26%
S.W.South-America (SWS)	-0.96%	-0.24%	-1.75%
S.E.South-America (SES)	6.75%	9.53%	21.74%
S.South-America (SSA)	2.71%	3.92%	8.37%
N.Europe (NEU)	7.44%	9.42%	18.64%
West&Central-Europe (WCE)	6.26%	8.05%	15.30%
E.Europe (EEU)	6.20%	8.10%	16.22%
Mediterranean (MED)	1.02%	1.36%	2.24%
Sahara (SAH)	17.35%	21.19%	42.94%
Western-Africa (WAF)	13.91%	16.20%	31.56%
Central-Africa (CAF)	11.01%	14.67%	33.88%
N.Eastern-Africa (NEAF)	9.63%	14.11%	35.71%
S.Eastern-Africa (SEAF)	7.35%	9.84%	29.05%
W.Southern-Africa (WSAF)	2.33%	3.13%	4.53%
E.Southern-Africa (ESAF)	4.40%	6.25%	16.42%
Madagascar (MDG)	4.93%	5.46%	15.03%
Russian-Arctic (RAR)	10.02%	14.39%	29.14%
W.Siberia (WSB)	7.18%	9.21%	16.93%
E.Siberia (ESB)	6.32%	9.03%	21.07%
Russian-Far-East (RFE)	8.74%	12.76%	28.94%
W.C.Asia (WCA)	7.42%	9.60%	20.98%
E.C.Asia (ECA)	8.48%	11.50%	26.81%

Tibetan-Plateau (TIB)	5.78%	9.01%	26.12%
E.Asia (EAS)	4.08%	6.38%	22.49%
Arabian-Peninsula (ARP)	10.86%	16.94%	45.56%
S.Asia (SAS)	8.55%	13.32%	34.05%
S.E.Asia (SEA)	4.56%	7.44%	23.12%
N.Australia (NAU)	5.98%	7.14%	21.51%
C.Australia (CAU)	4.55%	5.50%	11.15%
E.Australia (EAU)	2.48%	3.81%	10.23%
S.Australia (SAU)	3.04%	2.80%	8.64%
New-Zealand (NZ)	5.85%	8.08%	18.04%
E.Antarctica (EAN)	10.74%	14.50%	34.17%
W.Antarctica (WAN)	7.75%	10.22%	21.85%

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[END TABLE 11.SM.5 HERE]

[START TABLE 11.SM.6 HERE]

Table 11.SM.6: As Table 11.SM.2 but for changes in annual mean total soil moisture (summed over the whole soil column).

	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	-	-	-
Ocean (ocean)	-	-	-
Land (land)	-	-	-
Land w/o Antarctica (land_wo_antarctica)	-0.93σ	-1.63σ	-3.53σ
Greenland/Iceland (GIC)	-0.54σ	-0.50σ	-2.04σ
N.W.North-America (NWN)	-0.02σ	0.34σ	-2.72σ
N.E.North-America (NEN)	-1.00σ	-0.77σ	-2.21σ
W.North-America (WNA)	-0.53σ	-0.72σ	-1.63σ
C.North-America (CNA)	-1.28σ	-1.14σ	-1.59σ
E.North-America (ENA)	-0.35σ	-0.32σ	-0.76σ
N.Central-America (NCA)	-0.94σ	-1.04σ	-1.52σ
S.Central-America (SCA)	-1.40σ	-1.40σ	-3.42σ
Caribbean (CAR)	-0.54σ	-0.69σ	-1.22σ
N.W.South-America (NWS)	-1.20σ	-1.33σ	-3.50σ
N.South-America (NSA)	-1.21σ	-1.66σ	-3.05σ

N.E.South-America (NES)	-0.38 σ	-0.31 σ	-0.50 σ
South-American-Monsoon (SAM)	-1.34 σ	-1.71 σ	-3.81 σ
S.W.South-America (SWS)	-2.33 σ	-2.91 σ	-4.83 σ
S.E.South-America (SES)	0.16 σ	0.32 σ	-0.11 σ
S.South-America (SSA)	-1.22 σ	-1.58 σ	-2.10 σ
N.Europe (NEU)	0.42 σ	0.16 σ	-0.28 σ
West&Central-Europe (WCE)	0.05 σ	-0.11 σ	-0.72 σ
E.Europe (EEU)	0.55 σ	0.38 σ	0.59 σ
Mediterranean (MED)	-2.03 σ	-2.75 σ	-4.18 σ
Sahara (SAH)	1.31 σ	1.59 σ	3.59 σ
Western-Africa (WAF)	2.14 σ	2.44 σ	2.68 σ
Central-Africa (CAF)	1.76 σ	2.03 σ	2.57 σ
N.Eastern-Africa (NEAF)	1.40 σ	2.27 σ	3.78 σ
S.Eastern-Africa (SEAF)	0.70 σ	1.14 σ	2.08 σ
W.Southern-Africa (WSAF)	-0.93 σ	-1.21 σ	-2.54 σ
E.Southern-Africa (ESAF)	-0.66 σ	-0.82 σ	-1.89 σ
Madagascar (MDG)	-0.09 σ	-0.28 σ	-1.01 σ
Russian-Arctic (RAR)	0.80 σ	0.88 σ	-1.28 σ
W.Siberia (WSB)	1.22 σ	1.24 σ	1.43 σ
E.Siberia (ESB)	0.09 σ	0.11 σ	0.99 σ
Russian-Far-East (RFE)	-0.20 σ	0.00 σ	-0.04 σ
W.C.Asia (WCA)	0.04 σ	0.25 σ	0.15 σ
E.C.Asia (ECA)	0.13 σ	0.29 σ	1.27 σ
Tibetan-Plateau (TIB)	-0.16 σ	-0.48 σ	-1.39 σ
E.Asia (EAS)	-0.30 σ	-0.23 σ	-0.35 σ
Arabian-Peninsula (ARP)	0.47 σ	0.74 σ	3.12 σ
S.Asia (SAS)	1.03 σ	1.33 σ	2.26 σ
S.E.Asia (SEA)	-0.16 σ	-0.07 σ	-0.72 σ
N.Australia (NAU)	-0.03 σ	-0.03 σ	-0.20 σ
C.Australia (CAU)	-0.16 σ	-0.21 σ	-0.46 σ
E.Australia (EAU)	-0.41 σ	-0.46 σ	-0.68 σ
S.Australia (SAU)	-0.61 σ	-0.96 σ	-1.14 σ
New-Zealand (NZ)	-0.23 σ	-0.10 σ	-0.17 σ
E.Antarctica (EAN)	-	-	-
W.Antarctica (WAN)	-	-	-

1 **[END TABLE 11.SM.6 HERE]**

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4 **[START TABLE 11.SM.7 HERE]**

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6 **Table 11.SM.7:** As Table 11.SM.2 but for changes in annual mean soil moisture in the upper 10 cm of the soil column.

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	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	-	-	-
Ocean (ocean)	-	-	-
Land (land)	-	-	-
Land w/o Antarctica (land_wo_antarctica)	-1.40σ	-2.38σ	-6.72σ
Greenland/Iceland (GIC)	-0.92σ	-1.12σ	-3.14σ
N.W.North-America (NWN)	-0.00σ	-0.01σ	-0.93σ
N.E.North-America (NEN)	-0.45σ	-0.63σ	-2.14σ
W.North-America (WNA)	-0.70σ	-0.97σ	-1.66σ
C.North-America (CNA)	-0.59σ	-0.83σ	-1.50σ
E.North-America (ENA)	-0.78σ	-1.14σ	-2.64σ
N.Central-America (NCA)	-0.62σ	-0.76σ	-1.20σ
S.Central-America (SCA)	-1.04σ	-1.36σ	-3.43σ
Caribbean (CAR)	-0.54σ	-0.66σ	-1.44σ
N.W.South-America (NWS)	-0.95σ	-1.23σ	-3.22σ
N.South-America (NSA)	-1.06σ	-1.44σ	-2.92σ
N.E.South-America (NES)	-1.01σ	-1.25σ	-2.59σ
South-American-Monsoon (SAM)	-1.58σ	-1.92σ	-3.36σ
S.W.South-America (SWS)	-1.53σ	-1.87σ	-2.89σ
S.E.South-America (SES)	-0.39σ	-0.37σ	-0.96σ
S.South-America (SSA)	-1.25σ	-1.32σ	-2.46σ
N.Europe (NEU)	-0.88σ	-1.39σ	-3.79σ
West&Central-Europe (WCE)	-0.81σ	-1.23σ	-1.97σ
E.Europe (EEU)	-0.48σ	-0.77σ	-1.59σ
Mediterranean (MED)	-1.45σ	-2.03σ	-3.62σ
Sahara (SAH)	0.70σ	0.69σ	1.35σ
Western-Africa (WAF)	1.33σ	1.24σ	1.54σ
Central-Africa (CAF)	0.92σ	1.11σ	1.52σ
N.Eastern-Africa (NEAF)	0.56σ	0.74σ	2.22σ

S.Eastern-Africa (SEAF)	0.17 σ	0.29 σ	0.62 σ
W.Southern-Africa (WSAF)	-0.93 σ	-1.16 σ	-2.08 σ
E.Southern-Africa (ESAF)	-0.86 σ	-1.11 σ	-2.41 σ
Madagascar (MDG)	-0.51 σ	-0.82 σ	-1.68 σ
Russian-Arctic (RAR)	0.44 σ	0.37 σ	-1.21 σ
W.Siberia (WSB)	0.21 σ	0.08 σ	-0.06 σ
E.Siberia (ESB)	0.62 σ	0.65 σ	1.06 σ
Russian-Far-East (RFE)	-0.07 σ	-0.39 σ	-1.51 σ
W.C.Asia (WCA)	-0.21 σ	-0.38 σ	-0.55 σ
E.C.Asia (ECA)	0.66 σ	0.97 σ	2.38 σ
Tibetan-Plateau (TIB)	0.15 σ	0.25 σ	-0.00 σ
E.Asia (EAS)	-0.43 σ	-0.49 σ	-0.81 σ
Arabian-Peninsula (ARP)	0.20 σ	0.25 σ	0.64 σ
S.Asia (SAS)	0.71 σ	0.80 σ	1.41 σ
S.E.Asia (SEA)	-0.51 σ	-0.34 σ	-1.12 σ
N.Australia (NAU)	-0.14 σ	-0.14 σ	-0.24 σ
C.Australia (CAU)	-0.16 σ	-0.21 σ	-0.54 σ
E.Australia (EAU)	-0.42 σ	-0.41 σ	-0.67 σ
S.Australia (SAU)	-0.57 σ	-0.62 σ	-0.98 σ
New-Zealand (NZ)	-0.37 σ	-0.39 σ	-0.37 σ
E.Antarctica (EAN)	-	-	-
W.Antarctica (WAN)	-	-	-

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[END TABLE 11.SM.7 HERE]

[START TABLE 11.SM.8 HERE]

Table 11.SM.8: As Table 11.SM.2 but for changes in consecutive dry days (CDD).

	Projections		
	+1.5°C GWL	+2.0°C GWL	+4.0°C GWL
Global (global)	0.91day	0.96day	1.48day
Ocean (ocean)	1.65day	1.80day	3.24day
Land (land)	-0.61day	-0.71day	-2.11day
Land w/o Antarctica (land_wo_antarctica)	0.37day	0.46day	0.73day
Greenland/Iceland (GIC)	-3.46day	-4.85day	-8.52day
N.W.North-America (NWN)	-0.91day	-1.47day	-2.51day

N.E.North-America (NEN)	-1.94day	-2.51day	-5.16day
W.North-America (WNA)	0.92day	1.00day	0.25day
C.North-America (CNA)	0.37day	0.32day	1.20day
E.North-America (ENA)	0.19day	0.27day	0.84day
N.Central-America (NCA)	3.46day	4.04day	8.48day
S.Central-America (SCA)	2.63day	4.01day	9.50day
Caribbean (CAR)	1.27day	1.56day	3.29day
N.W.South-America (NWS)	1.48day	1.78day	3.99day
N.South-America (NSA)	6.65day	9.37day	19.56day
N.E.South-America (NES)	15.14day	18.63day	28.44day
South-American-Monsoon (SAM)	8.90day	10.34day	19.05day
S.W.South-America (SWS)	4.11day	5.90day	10.09day
S.E.South-America (SES)	2.54day	2.90day	3.99day
S.South-America (SSA)	0.91day	1.16day	2.09day
N.Europe (NEU)	-0.27day	-0.06day	0.25day
West&Central-Europe (WCE)	1.03day	1.82day	4.09day
E.Europe (EEU)	0.33day	1.08day	1.83day
Mediterranean (MED)	4.96day	7.13day	16.07day
Sahara (SAH)	-8.12day	-7.92day	-15.07day
Western-Africa (WAF)	-1.07day	-0.43day	-0.79day
Central-Africa (CAF)	-1.39day	-1.05day	-1.29day
N.Eastern-Africa (NEAF)	-1.89day	-2.63day	-9.28day
S.Eastern-Africa (SEAF)	2.11day	2.50day	0.89day
W.Southern-Africa (WSAF)	9.81day	14.63day	28.84day
E.Southern-Africa (ESAF)	8.76day	11.29day	23.51day
Madagascar (MDG)	5.98day	8.23day	17.35day
Russian-Arctic (RAR)	-3.73day	-4.75day	-7.41day
W.Siberia (WSB)	-0.83day	-1.02day	-0.16day
E.Siberia (ESB)	-3.46day	-4.73day	-8.75day
Russian-Far-East (RFE)	-2.55day	-3.25day	-5.71day
W.C.Asia (WCA)	-1.07day	-0.42day	-0.55day
E.C.Asia (ECA)	-6.75day	-8.59day	-14.95day
Tibetan-Plateau (TIB)	-1.48day	-1.66day	-5.48day
E.Asia (EAS)	1.42day	0.93day	1.08day
Arabian-Peninsula (ARP)	-6.79day	-8.04day	-19.71day

S.Asia (SAS)	-2.13day	-2.13day	-8.97day
S.E.Asia (SEA)	3.11day	3.29day	7.74day
N.Australia (NAU)	6.61day	5.46day	8.13day
C.Australia (CAU)	3.76day	4.06day	9.81day
E.Australia (EAU)	4.46day	4.37day	9.06day
S.Australia (SAU)	2.93day	3.38day	7.07day
New-Zealand (NZ)	0.11day	0.17day	0.32day
E.Antarctica (EAN)	-12.44day	-16.04day	-34.35day
W.Antarctica (WAN)	-2.09day	-2.79day	-5.22day

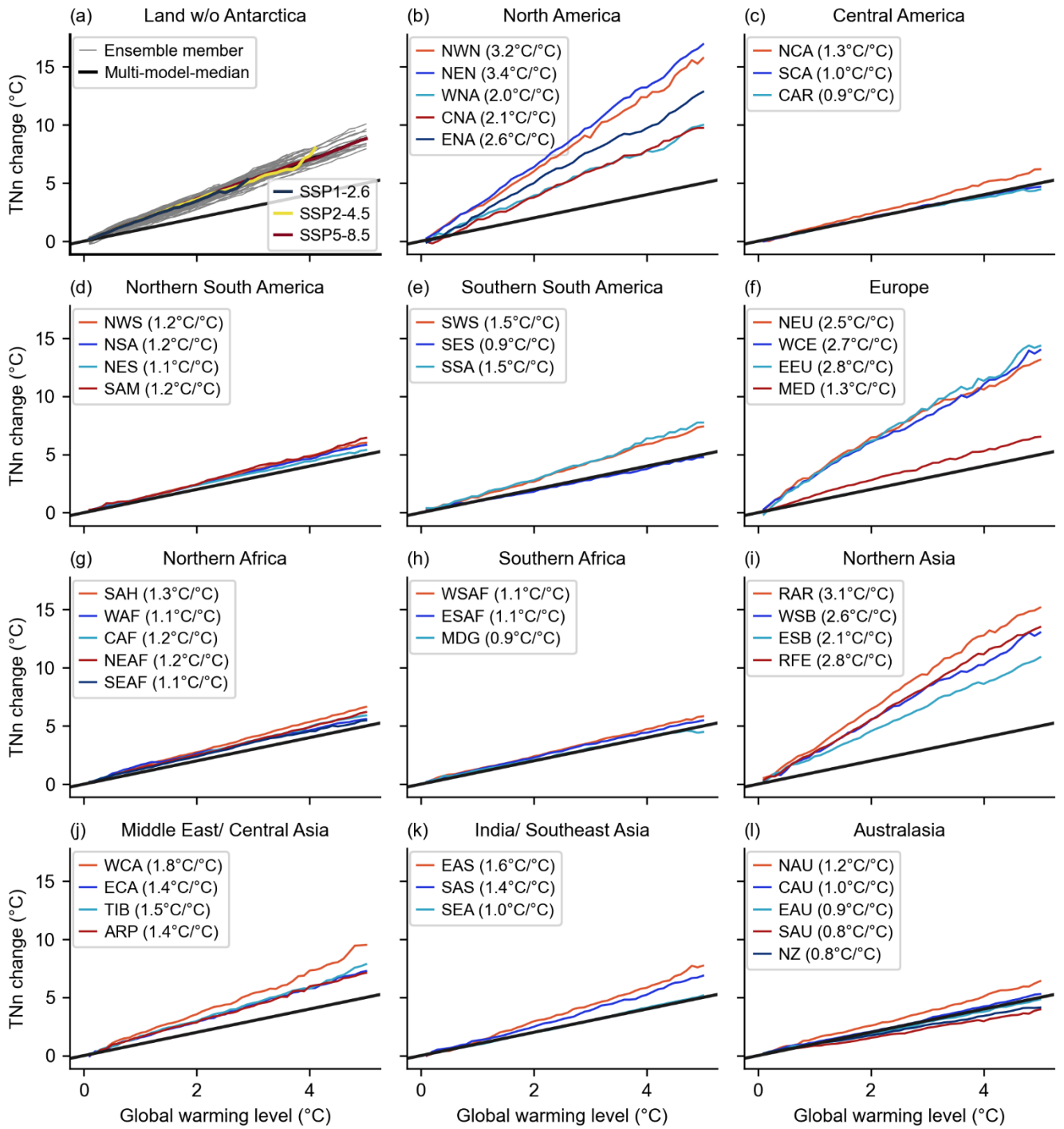
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[END TABLE 11.SM.8 HERE]

1 [START FIGURE 11.SM.1 HERE]

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Scaling of regional annual minimum temperature (TNn)



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6 **Figure 11.SM.1:** As Figure 11.2 but for the annual minimum temperature (TNn).

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8 [END FIGURE 11.SM.1 HERE]

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1 **11.SM.4 Data Table**2
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7**[START TABLE 11.SM.9 HERE]****Table 11.SM.9:** Input Data Table. Input datasets and code used to create chapter figures.

Figure number	Dataset / Code name	Type	Filename / Specificities	License type	Dataset / Code citation	Dataset / Code URL	Related publications / Software used	Notes
Figure 11.2	HadEX3 (v3.0.2) - TXx	Input dataset	HadEX3_TXx_1901-2018_ADW_61-90_1.25x1.875deg.nc	Open Government License http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/		https://www.metoffice.gov.uk/hadobs/hadex3/	(Dunn et	
	HadEX3 (v3.0.2) - TNn	Input dataset	HadEX3_TNn_1901-2018_ADW_61-90_1.25x1.875deg.nc	Open Government License		https://www.metoffice.gov.uk/hadobs/hadex3/	(Dunn et	
	Global average annual mean temperature	Input dataset	glob_temp.csv				Section 2.3.1.1.3	Data provided by from Chapter 2.
	Land average annual mean temperature	Input dataset	land_temp.csv				Section 2.3.1.1.3	Data provided by from Chapter 2.

	Figure 11.2 code	Code	Figure_11.2_obs_ts_plots.ipynb					
Figure 11.3	Figure 11.3 code	Code	Figure_11.3_TXx_scaling.ipynb					
Box 11.1, Figure 1	Changes in annual maximum precipitation	Input dataset	pfahl_2017.nc				(Pfahl,	Data provided by Stephan Pfahl.
	Box 11.1, Figure 1 code	Code	Box_11.1_Figure_1_Pfahl_2017.ipynb					
Figure 11.6	Figure 11.6 input dataset	Input dataset	Changes in txx_baseline0deg.xlsx				(Li et al., 2020)	Figure created by Chao Li.
Figure 11.7	Figure 11.7 input dataset	Input dataset	Changes in rx1day_baseline0deg.xlsx				(Li et al., 2020)	Figure created by Chao Li.
Figure 11.9	HadEX3 (v3.0.2) - TXx	Input dataset	HadEX3_TXx_1901-2018_ADW_61-	Open Government License		https://www.metoffice.gov.uk/hadobs/hadex3/	(Dunn et al., 2020)	

			90_1.25x1.8 75deg.nc					
	HadEX3 (v3.0.2) – TX90p	Input datas et	HadEX3_T X90p_1901- 2018_ADW _61- 90_1.25x1.8 75deg.nc	Open Governm ent License		https://www. metoffice.go v.uk/hadobs/ hadex3/	(Dunn et al., 2020)	Converted from % to days per year.
	HadEX3 (v3.0.2) - TNn	Input datas et	HadEX3_T Nn_1901- 2018_ADW _61- 90_1.25x1.8 75deg.nc	Open Governm ent License		https://www. metoffice.go v.uk/hadobs/ hadex3/	(Dunn et	
	Figure 11.9 code	Code	Figure_11.9 _HadEX3_ maps.ipynb					
Figure 11.10	CMIP6 data	Input datas et	TXx_TNn_ error_CMIP 6.nc				(Wehner, Gleckler, & Lee, 2020)	Data provided by Michael Wehner..
	Figure 11.10	Code	Figure_11.1 0_Wehner_t emperature_ bias.ipynb					
Figure 11.11	Figure 11.11 code for annual maximu m temperat ure (TXx)	Code	Figure_11.1 1_TXx_map .ipynb					
	Figure 11.11 code for annual maximu m temperat ure (TNn)	Code	Figure_11.1 1_TNn_map .ipynb					

Figure 11.12	Figure 11.12 input dataset	Input dataset	Changes in txx_baseline 0deg.xlsx				(Li et al., 2020)	Figure created by Chao Li.
Figure 11.13	Figure 11.13a	Input dataset					(Sun,	Panel a created by Qiaohong Sun
	Figure 11.13 b and c	Input dataset	station_MK_1950_2018.csv				(Sun et al.,	Data provided by Qiaohong Sun.

	Code for Figure 11.13 b and c	Code	Figure_11.13_Rx1day_trend_maps_Sun.ipynb					
Figure 11.14	Bias of CMIP6 w.r.t ERA5	Input dataset	Rx_CMIP6_errors_ERA5.nc				(Wehner et al., 2020)	Data provided by Michael Wehner.
	Bias of CMIP6 w.r.t HadEX3	Input dataset	Rx_CMIP6_errors_HadEx3.nc				(Wehner et al., 2020)	Data provided by Michael Wehner.
	Bias of CMIP6 w.r.t REGEN	Input dataset	Rx_CMIP6_errors_REGEN.nc				(Wehner et al., 2020)	Data provided by Michael Wehner.
	Figure 11.14 code	Code	Figure_11.14_Wehner_precipitation_bias.ipynb					
Figure 11.15	Figure 11.15 input dataset	Input dataset	Changes in rx1day_baseline0deg.xlsx				(Li et al., 2020)	Figure created by Chao Li.
Figure 11.16	Figure 11.16 code	Code	Figure_11.16_Rx1day_map.ipynb					
Figure 11.17	HadEX3 (v3.0.2) - CDD	Input dataset	HadEX3_CDD_1901-2018_ADW_61-90_1.25x1.8_75deg.nc	Open Government License		https://www.metoffice.gov.uk/hadobs/hadex3/	(Dunn et al., 2020)	
	SPI-12 and SPEI-12 trends	Input dataset	results_spinoni_01.nc				(Spinoni et al., 2019)	SPI & SPEI data from (Spinoni et al., 2019) processed by Sergio Vincente Serrano.
	Figure 11.17 code	Code	Figure_11.17_CDD_SPI_SPEI.ipynb					

Figure 11.18	Figure 11.18 code	Code	SMDrought Index.ipynb					
Figure 11.19	code for CDD	Code	Figure_11.19_CDD_map.ipynb					
	code for total soil moisture	Code	Figure_11.19_SM_map.ipynb					
	code for soil moisture based drought frequency	Code	SMDrought Index.ipynb					
Box 11.4, Figure 1	Input dataset Box 11.4 Figure 2	Input dataset	sippel_2015_fig3.txt				(Sippel et al., 2015)	Data provided by Sebastian Sippel..
	Box 11.4, Figure 1 code	Code	Box_11.4_Figure_1_Sippel_2015.ipynb					
Box 11.4 Figure 2	Global ECMWF Reanalysis v5 (ERA5) - temperature	Input dataset	era5_deterministic_recent.t2m.025deg.1m.*.nc	Copernicus License https://cds.climate.copernicus.eu/api/v2/terms/static/license-to-use-copernicus-products.pdf			(Hersbach et al., 2020)	
	Global ECMWF Reanalysis v5 (ERA5) - geopotential	Input dataset	era5_deterministic_recent.z200.025deg.1m.2018.nc	Copernicus License			(Hersbach et al., 2020)	
	Box 11.4, Figure 2 code	Code	Box_11.4_Figure_2_2018.ipynb					

FAQ 11.1, Figure 1	FAQ 11.1 Figure 1	Code	FAQ_11.1_Figure_1_mean_vs_extreme.ipynb					
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[END TABLE 11.SM.9 HERE]

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