Paris Agreement's aim of 1.5°C warming may result in many possible climates – SUPPLEMENTARY INFORMATION

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Supplementary Text 1: Projections of regional changes in climate extremes

The computation of regional climate extreme indices in Table 1 and Figs. 2-3 follows the approach of Seneviratne et al (2016) and Wartenburger et al. (2017). This section provides additional background information compared to Box 1. The considered climate extremes indicators include the warming of the minimum annual night-time temperature (TNn) in the Arctic land [°C], the warming of the maximum annual day-time temperature (TXx) in the contiguous United States [°C], TXx warming in Central Brazil [°C], (soil moisture) drying in the Mediterranean region [in units of standard deviations of pre-industrial climate variability], and increases in heavy precipitation events based on annual maximum consecutive 5-day precipitation (Rx5day) in Southern Asia [%]). The definition of the geographical domains is provided in Seneviratne et al. (2016). The estimates are derived from CMIP5 simulations for 26 climate models and all four Representative Concentration Pathways (RCP) scenarios, i.e. RCP2.6, RCP4.0, RCP6.0 and RCP8.5 (see Suppl. Table S3 for list of analysed simulations).

Supplementary Table S1: Same as Table 1, but for scenarios considered compatible with 1.5°C and 2°C warming in the 5th assessment report of IPCC (Clarke et al. 2014, Rogelj et al. 2015), including projections of changes in regional climate associated with resulting global temperature levels derived following previous studies (Seneviratne et al. 2016, Wartenburger et al. 2017)

		SCEN_1p5C Emissions pathways currently considered in line with keeping warming below 1.5°C in 2100 with 66% chance (allowing for a higher peak in temperature earlier)		SCEN_2C Emissions pathways currently considered in line with keeping warming below 2°C during the entire 21st century with 66% chance	
		"probable" (66th percentile) outcome[a]	"worst-case" 10% (90th percentile) outcome[b]	"probable" (66th percentile) outcome[a]	"worst-case" 10% (90th percentile) outcome[b]
General characteristics of pathway	**Overshoot 1.5°C in 21st century with >50% likelihood[c]**	**Yes (8/8)**	**Yes (8/8)**	**Yes (60/60)**	**Yes (60/60)**
	Overshoot 2°C in 21st century with >50% likelihood	**No (0/8)**	**Yes (4/8)**	**No (0/60)**	**Yes (60/60)**
	Cumulative CO_2 emissions up to peak warming (relative to 2016)[d]	510 (490, 560)	470 (410, 520)	930 (790, 1050)	900 (750, 1040)
	Cumulative CO_2 emissions up to 2100 (relative to 2016)[d] [$GtCO_2$]	-40 (-100, 10)		850 (520, 1000)	
	Global GHG emissions in 2030[d] [$GtCO_2\ y^{-1}$]	19 (17, 21)		28 (23, 32)	
	Years of global net zero CO_2 emissions[d]	2061 (2061, 2063)		2084 (2079, 2086)	
Possible climate range at peak warming (reg+glob)	**Global mean temperature anomaly at peak warming [°C]**	**1.65°C (1.61, 1.68°C)**	**2.01°C (1.95, 2.03°C)**	**1.90°C (1.86, 1.95°C)**	**2.35°C (2.29, 2.48°C)**
	Warming in the Arctic[e] (TNn[f]) [°C]	4.75 °C (4.09, 5.44)	5.90 °C (4.97, 6.85)	5.63 °C (4.68, 6.59)	6.97 °C (6.13, 8.38)
	Warming in the contiguous United States[e] (TXx[f]) [°C]	2.39 °C (1.90, 2.84)	2.97 °C (2.36, 3.40)	2.77 °C (2.20, 3.30)	3.51 °C (3.05, 4.11)
	Warming in Central Brazil[e] (TXx[f]) [°C]	2.55 °C (2.12, 2.97)	3.12 °C (2.66, 3.76)	2.96 °C (2.58, 3.55)	3.66 °C (3.31, 4.21)
	Drying in the Mediterranean region[e] [std[f]] (-1: dry; -2: severely dry; -3: very severely dry)	-1.00 (-2.12, -0.39)	-1.25 (-2.21, -0.51)	-1.11 (-2.18, -0.51)	-1.36 (-2.93, -0.69)
	Increase in heavy precipitation events[f] in Southern Asia[e] [%]	9.78 % (6.52, 13.63)	11.56 % (7.04, 18.50)	10.27 % (6.50, 17.40)	16.74 % (9.60, 23.44)
Possible climate range in 2100 (reg+glob)	**Global mean temperature warming in 2100 [°C]**	**1.41°C (1.39—1.43°C)**	**1.84°C (1.81—1.90°C)**	**1.84°C (1.76—1.89°C)**	**2.30°C (2.21—2.46°C)**
	Warming in the Arctic[g] (TNn[f]) [°C]	4.07 °C (3.53, 4.72)	5.37 °C (4.60, 6.40)	5.37 °C (4.46, 6.38)	6.86 °C (5.83, 8.24)
	Warming in the contiguous United States[g] (TXx[f]) [°C]	2.00 °C (1.60, 2.48)	2.62 °C (2.17, 3.23)	2.62 °C (2.07, 3.24)	3.37 °C (2.88, 4.03)
	Warming in Central Brazil[g] (TXx[f]) [°C]	2.20 °C (1.95, 2.58)	2.88 °C (2.46, 3.48)	2.88 °C (2.43, 3.47)	3.57 °C (3.20, 4.18)
	Drying in the Mediterranean region[g] [std[f]]	-0.96 (-1.89, -0.28)	-1.24 (-2.27, -0.45)	-1.24 (-2.42, -0.46)	-1.38 (-2.79, -0.67)
	Increase in heavy precipitation events[f] in Southern Asia[g] [%]	7.83 % (4.20, 12.00)	10.19 % (6.34, 16.67)	10.19 % (6.46, 16.64)	15.47 % (8.72, 22.98)

[a] 66th percentile estimates for global temperature (i.e. 66% likelihood of being at or below values)
[b] 90th percentile estimates for global temperature (i.e. 10% likelihood of being at or above values)
[c] All 1.5°C scenarios from AR5 include a substantial probability of overshooting above 1.5°C global warming before returning to 1.5°C
[d] The values indicate the median and the interquartile range in parenthesis (25th percentile and 75th percentile)
[e] The regional projections in these rows provide the range [median (q25, q75)] associated with the *median* global temperature outcomes of the considered mitigation scenarios at *peak warming* (see Box 1 and Suppl. Text 1 for details).
[f] TNn: annual minimum night-time temperature; TXx: annual maximum day-time temperature; std: drying of soil moisture expressed in units of standard deviations of pre-industrial climate (1861-1880) variability; Rx5day: annual maximum consecutive 5-day precipitation (see Suppl. Text 1 for details)
[g] Same as footnote e, but for the regional responses associated with the *median* global temperature outcomes of the considered mitigation scenarios *by 2100* (see Box 1 and Suppl. Text 1 for details).

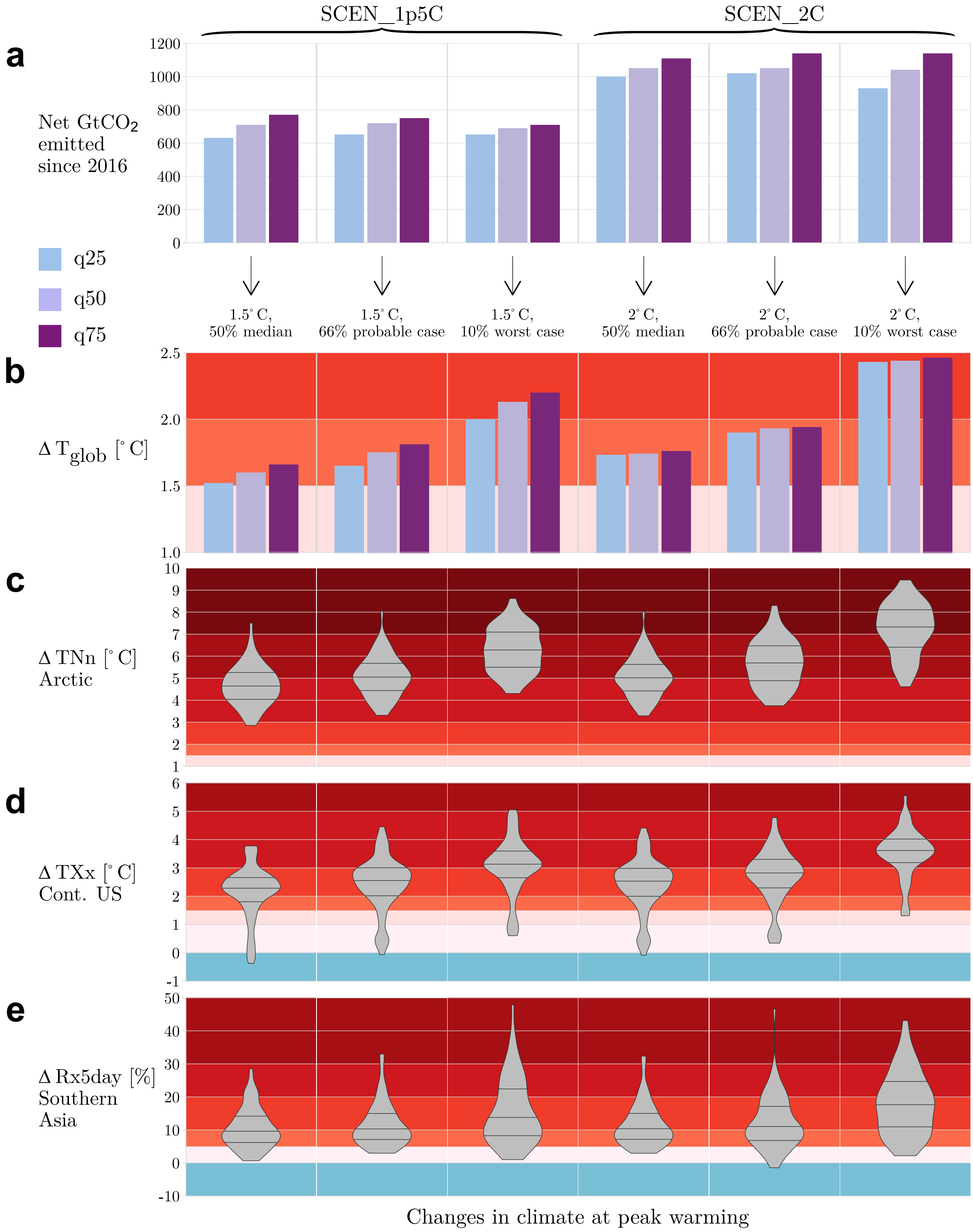
Supplementary Table S2: Same as Table 1, but with inclusion of 50% (median) values for considered emissions scenarios (see Box 1 for details).

		SCEN_1p5C Emissions pathways currently considered in line with keeping warming below 1.5°C in 2100 with 66% chance (allowing for a higher peak in temperature earlier)			SCEN_2C Emissions pathways currently considered in line with keeping warming below 2°C during the entire 21^{st} century with 66% chance		
		"as likely as not" (50^{th} percentile) outcome[a]	"probable" (66^{th} percentile) outcome[b]	"worst-case" 10% (90^{th} percentile) outcome[c]	**"as likely as not" (50^{th} percentile) outcome[a]**	"probable" (66^{th} percentile) outcome[b]	"worst-case" 10% (90^{th} percentile) outcome[c]
General characteristics of pathway	**Overshoot 1.5°C in 21^{st} century with >50% likelihood[d]**	**Yes (13/13)**	**Yes (13/13)**	**Yes (13/13)**	**Yes (10/10)**	**Yes (10/10)**	**Yes (10/10)**
	Overshoot 2°C in 21^{st} century with >50% likelihood	**No (0/13)**	**No (0/13)**	**Yes (10/13)**	**No (0/10)**	**No (0/10)**	**Yes (10/10)**
	Cumulative CO_2 emissions up to peak warming (relative to 2016)[e]	**710 (630,770)**	720 (650, 750)	690 (650, 710)	**1050 (1000, 1110)**	1050(1020, 1140)	1040 (930, 1140)
	Cumulative CO_2 emissions up to 2100 (relative to 2016)[e] [$GtCO_2$]	320 (200, 340)			1030 (910, 1140)		
	Global GHG emissions in 2030[e] [$GtCO_2\ y^{-1}$]	22 (19, 31)			28 (24, 30)		
	Years of global net zero CO_2 emissions[e]	2070 (2067, 2074)			2088 (2085, 2092)		
Possible climate range at peak warming (reg+glob)	**Global mean temperature anomaly at peak warming [°C]**	**1.6°C (1.52-1.66)**	**1.75°C (1.65-1.81)**	**2.13°C (2.0- 2.2)**	**1.74°C (1.73-1.76)**	**1.93°C (1.9-1.94°C)**	**2.44°C (2.43-2.46°C)**
	Warming in the Arctic[f] (TNn[g]) [°C]	**4.66°C (4.05, 5.25)**	4.75 °C (4.09, 5.44)	5.90 °C (4.97, 6.85)	**5.01°C (4.45, 5.58)**	5.63 °C (4.68, 6.59)	6.97 °C (6.13, 8.38)
	Warming in the contiguous United States[f] (TXx[g]) [°C]	**2.28°C (1.91, 2.67)**	2.39 °C (1.90, 2.84)	2.97 °C (2.36, 3.40)	**2.53°C (2.03, 2.95)**	2.77 °C (2.20, 3.30)	3.51 °C (3.05, 4.11)
	Warming in Central Brazil[e] (TXx[f]) [°C]	**2.49°C (2.12, 2.86)**	2.55 °C (2.12, 2.97)	3.12 °C (2.66, 3.76)	**2.72°C (2.33, 3.19)**	2.96 °C (2.58, 3.55)	3.66 °C (3.31, 4.21)
	Drying in the Mediterranean region[f] [std[g]] (-1: dry; -2: severely dry; -3: very severely dry)	**-0.94 (-2.10, -0.38)**	-1.00 (-2.12, -0.39)	-1.25 (-2.21, -0.51)	**-1.26 (-2.35, -0.43)**	-1.11 (-2.18, -0.51)	-1.36 (-2.93, -0.69)
	Increase in heavy precipitation events[g] in Southern Asia[f] [%]	**9.22% (6.26, 13.84)**	9.78 % (6.52, 13.63)	11.56 % (7.04, 18.50)	**9.83% (7.03, 14.87)**	10.27 % (6.50, 17.40)	16.74 % (9.60, 23.44)
Possible climate range in 2100 (reg+glob)	**Global mean temperature warming in 2100 [°C]**	**1.29°C (1.27— 1.31)**	**1.44°C (1.44—1.48)**	**1.88°C (1.85—1.93)**	**1.69°C (1.68—1.7)**	**1.89°C (1.88—1.91°C)**	**2.43°C (2.42—2.46°C)**
	Warming in the Arctic[h] (TNn[g]) [°C]	**3.78°C (3.29, 4.25)**	4.07 °C (3.53, 4.72)	5.37 °C (4.60, 6.40)	**4.90°C (4.30, 5.46)**	5.37 °C (4.46, 6.38)	6.86 °C (5.83, 8.24)
	Warming in the contiguous United States[h] (TXx[g]) [°C]	**1.82°C (1.33, 2.22)**	2.00 °C (1.60, 2.48)	2.62 °C (2.17, 3.23)	**2.45°C (1.98, 2.87)**	2.62 °C (2.07, 3.24)	3.37 °C (2.88, 4.03)
	Warming in Central Brazil[h] (TXx[g]) [°C]	**2.06°C (1.80, 2.40)**	2.20 °C (1.95, 2.58)	2.88 °C (2.46, 3.48)	**2.63°C (2.27, 3.00)**	2.88 °C (2.43, 3.47)	3.57 °C (3.20, 4.18)
	Drying in the Mediterranean region[h] [std[g]]	**-0.72 (-1.84, -0.27)**	-0.96 (-1.89, -0.28)	-1.24 (-2.27, -0.45)	**-1.09 (-2.23, -0.40)**	-1.24 (-2.42, -0.46)	-1.38 (-2.79, -0.67)
	Increase in heavy precipitation events[f] in Southern Asia[h] [%]	**6.48% (3.08, 11.15)**	7.83 % (4.20, 12.00)	10.19 % (6.34, 16.67)	**9.82% (6.69, 13.86)**	10.19 % (6.46, 16.64)	15.47 % (8.72, 22.98)

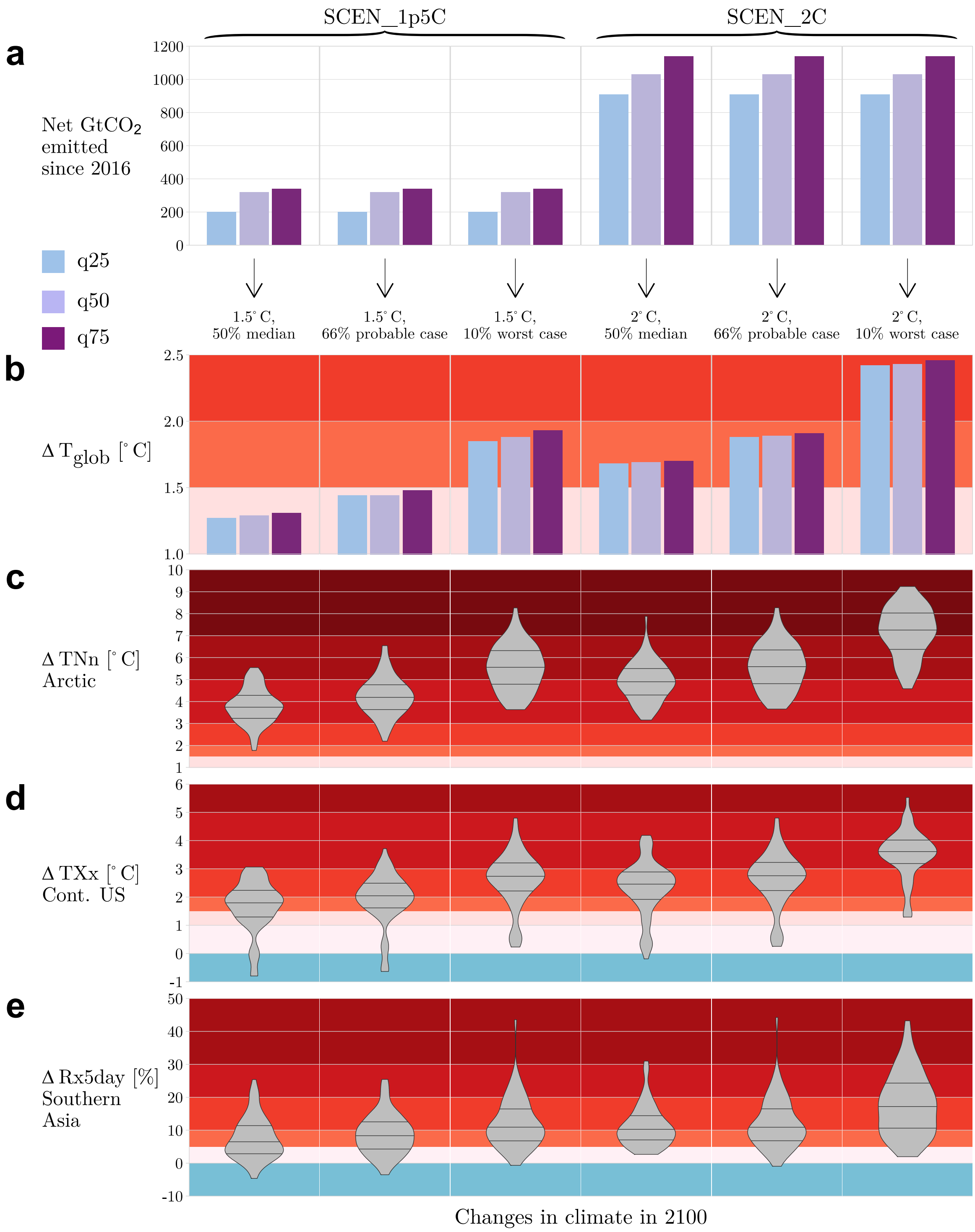
[a] 50^{th} percentile (median) estimates for global temperature (i.e. as likely as not of being below or above values)
[b] 66^{th} percentile estimates for global temperature (i.e. 66% likelihood of being at or below values)
[c] 90^{th} percentile estimates for global temperature (i.e. 10% likelihood of being at or above values)
[d] All 1.5°C scenarios from AR5 include a substantial probability of overshooting above 1.5°C global warming before returning to 1.5°C
[e] The values indicate the median and the interquartile range in parenthesis (25^{th} percentile and 75^{th} percentile)
[f] The regional projections in these rows provide the range [median (q25, q75)] associated with the *median* global temperature outcomes of the considered mitigation scenarios at *peak warming* (see Box 1 and Suppl. Text 1 for details).
[g] TNn: annual minimum night-time temperature; TXx: annual maximum day-time temperature; std: drying of soil moisture expressed in units of standard deviations of pre-industrial climate (1861-1880) variability; Rx5day: annual maximum consecutive 5-day precipitation (see Suppl. Text 1 for details)
[h] Same as footnote f, but for the regional responses associated with the *median* global temperature outcomes of the considered mitigation scenarios *by 2100* (see Box 1 and Suppl. Text 1 for details).

Supplementary Table S3: List of 26 CMIP5 models used in the analysis of climate extremes (see Wartenburger et al. 2017 for more details).

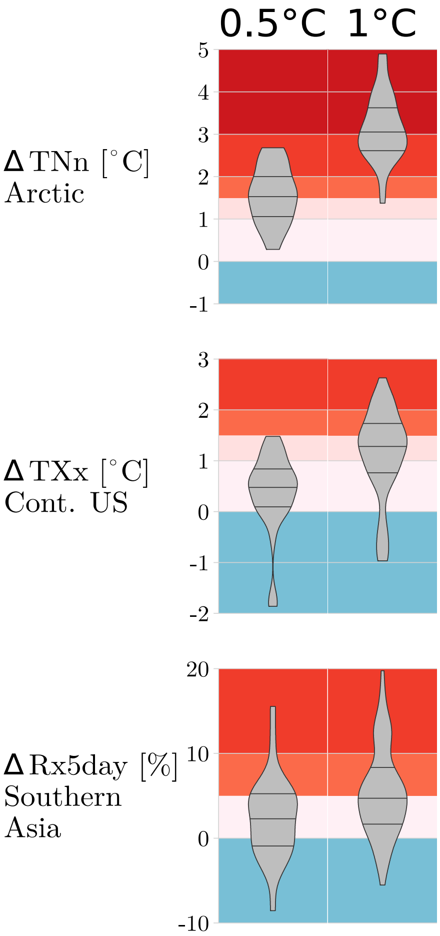
Model	Modelling Centre	Historical	RCP2.6	RCP4.5	RCP6.0	RCP8.5
ACCESS1-0	Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology (BOM), Australia	x		x		x
bcc-csm1-1	Beijing Climate Center, China Meteorological Administration	x	x	x	x	x
bcc-csm1-1-m		x	x	x	x	x
CanESM2	Canadian Centre for Climate Modelling and Analysis	x	x	x		x
CCSM4	National Center for Atmospheric Research, USA	x		x	x	x
CMCC-CM	Centro Euro-Mediterraneo per i Cambiamenti Climatici, Italy	x		x		x
CMCC-CMS		x		x		x
CNRM-CM5	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancées en Calcul Scientifique, France	x	x	x		x
CSIRO-Mk3-6-0	Commonwealth Scientific and Industrial Research Organization / Queensland Climate Change Centre of Excellence, Australia	x	x	x	x	x
FGOALS-s2	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences	x	x	x	x	x
GFDL-CM3		x	x		x	x
GFDL-ESM2G	NOAA Geophysical Fluid Dynamics Laboratory, USA	x	x	x	x	x
GFDL-ESM2M		x	x	x	x	x
HadGEM2-CC	Met Office Hadley Centre, United Kingdom	x		x		x
HadGEM2-ES		x	x		x	x
inmcm4	Institute for Numerical Mathematics, Russia	x		x		x
IPSL-CM5A-LR		x	x	x	x	x
IPSL-CM5A-MR	Institut Pierre-Simon Laplace, France	x	x		x	x
IPSL-CM5B-LR		x		x		x
MIROC-ESM	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies	x	x	x	x	x
MIROC-ESM-CHEM		x	x	x	x	x
MIROC5		x	x	x	x	x
MPI-ESM-LR	Max Planck Institute for Meteorology, Germany	x	x	x		x
MPI-ESM-MR		x	x	x		x
MRI-CGCM3	Meteorological Research Institute, Japan	x	x	x	x	x
NorESM1-M	Norwegian Climate Centre	x	x	x	x	x



Supplementary Figure S1: Same as Fig. 2, but additionally including median estimates (see Suppl. Table S2).



Supplementary Figure S2: Same as Fig. 3, but additionally including median estimates (see Suppl. Table S2).



Supplementary Figure S3: Spread in CMIP5 simulations for recent and present-day climate (0.5°C and 1°C global warming)

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