Supporting Information for "Informing future risks of record-level rainfall in the United States"

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1 Supplementary Material

	Region	Town	State	Date	3dayP (mm)	T_r (years)
(a)	Desert Southwest	Three Rivers	CA	05-Feb-1992	231	1200
(b)	Western States	Willows	CA	20-Jan-1997	192	4600
(c)	Southern Rockies	Moab	UT	27-Dec-1992	95	2200
(d)	Chihuahuan Desert	Eunice	NM	31-Jul-2007	122	1600
(e)	Northern Rockies	Cut Bank	MT	28-Apr-2003	135	>5000
(f)	Northern Great Plains	Aberdeen	SD	02-Jul-2006	143	1800
(g)	Southern Great Plains	Olmos Park	TX	15-Sep-1998	248	1700
(h)	Western Great Lakes	Fairmont	MN	28-May-1991	170	2900
(i)	Central Great Lakes	Newark	IL	13-Nov-2005	178	>5000
(j)	Eastern Great Plains	Somerville	TX	14-Jul-1990	289	>5000
(k)	Pacific Northwest	Tanner	WA	23-Jan-1997	256	3300
(l)	Eastern Great Lakes	Walkerton	IN	07-Mar-1994	213	4700
(m)	New England	Biddeford	ME	18-Sep-1989	227	3200
(n)	South Atlantic	Maury	NC	31-Jul-2004	343	2600
(o)	Gulf Coast	Wildwood	TX	14-May-1992	376	1800

Table 1. A table showing the most extreme 3 day precipitation event in each cluster region in the GPCC dataset during the 1988-2013 period. 3dayP is the 3 day total precipitation for the event in mm, T_r is the return period in years estimated from the present analysis

Variable	**Source**	**Time period**	**Season**	**Units**
F^{dry}	GPCC (P<0.4mm)	1988-2013	all	%
P_{50}^{wet}	GPCC (P>0.4mm)	1988-2013	all	mm
P_{99}^{wet}	GPCC (P>0.4mm)	1988-2013	all	mm
D_0	-	-	-	km

Table 2. Variables used to construct inter-point distance metric.

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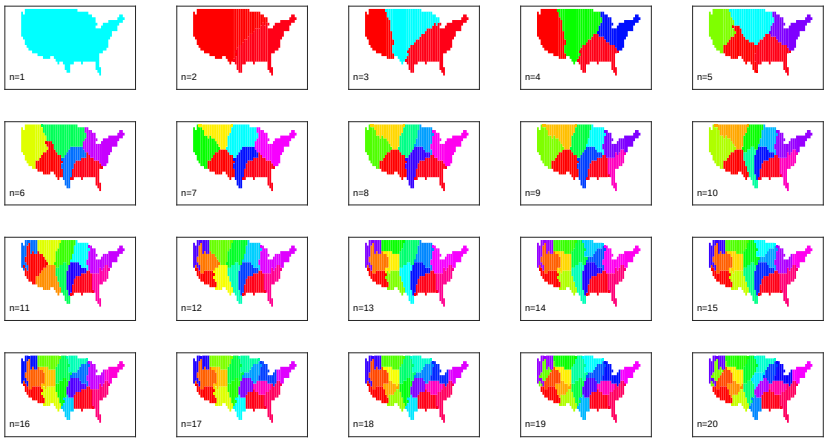

Figure 1. An illustration of how changing the desired number of clusters creates different regional distributions, by varying n_c - the desired number of clusters.

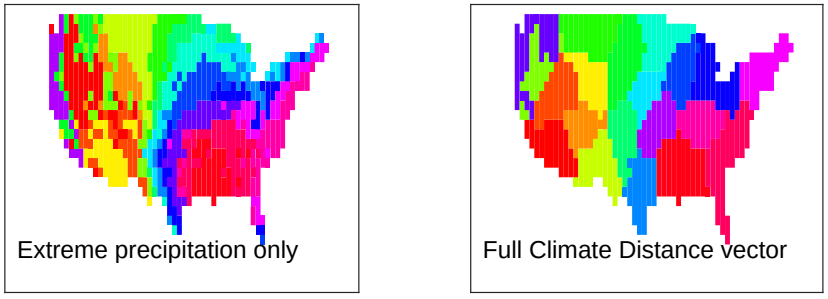

Figure 2. An illustration of how using only extreme precipitation percentiles in the clustering algorithm produces different results to using the full climatological vector (including both mean precipitation and fraction of dry days)

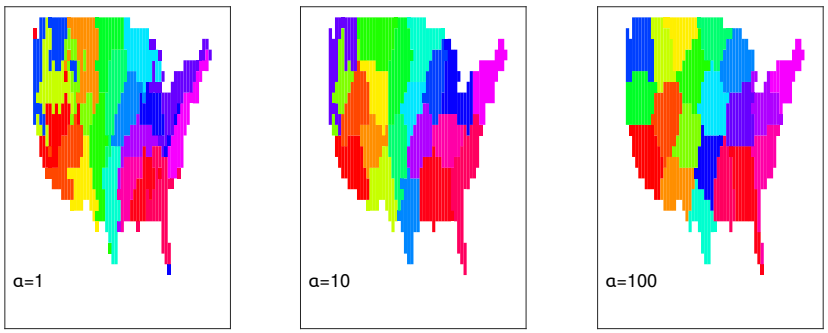

Figure 3. An illustration of how the effect of the α parameter, which tends to make regions more spatially coherent. The central plot with $\alpha = 10$ is equivalent to the main text.

	Region	Present	1.5°C	2.0°C	3.0°C	4.0°C
(a)	Desert Southwest	1000	357	358	350	139
(b)	Western States	1000	283	287	241	159
(c)	Southern Rockies	1000	249	236	159	86
(d)	Chihuahuan Desert	1000	369	248	192	120
(e)	Northern Rockies	1000	1076	1125	248	167
(f)	Northern Great Plains	1000	440	387	379	162
(g)	Southern Great Plains	1000	294	434	276	117
(h)	Western Great Lakes	1000	281	266	186	148
(i)	Central Great Lakes	1000	291	293	146	128
(j)	Eastern Great Plains	1000	305	308	211	139
(k)	Pacific Northwest	1000	411	375	346	139
(l)	Eastern Great Lakes	1000	439	333	287	145
(m)	New England	1000	196	284	214	98
(n)	South Atlantic	1000	240	331	226	96
(o)	Gulf Coast	1000	247	289	234	124

Table 3. A table showing maximum likelihood for return periods of present day 1000 year events at different warming thresholds. Data corresponds to dashed line in Figure 2, representing the mean of the subset of models which reach 4 degrees C warming during the RCP8.5 simulation

	Region	Present	1.5°C	2.0°C	3.0°C	4.0°C
(a)	Desert Southwest	173/277	207/373	219/354	247/344	268/457
(b)	Western States	159/220	193/280	189/291	212/302	232/352
(c)	Southern Rockies	158/202	183/247	184/257	189/318	244/387
(d)	Chihuahuan Desert	165/249	195/373	203/437	205/509	242/808
(e)	Northern Rockies	128/226	179/169	197/198	209/257	240/321
(f)	Northern Great Plains	157/212	189/247	178/258	186/247	218/349
(g)	Southern Great Plains	184/282	211/335	217/313	231/329	268/470
(h)	Western Great Lakes	125/171	149/230	154/258	178/230	209/266
(i)	Central Great Lakes	151/206	180/263	179/282	222/346	227/365
(j)	Eastern Great Plains	185/261	201/310	215/305	225/349	236/427
(k)	Pacific Northwest	143/201	176/255	173/258	202/263	242/356
(l)	Eastern Great Lakes	148/208	186/267	191/283	187/319	243/416
(m)	New England	158/207	195/290	191/279	197/263	224/518
(n)	South Atlantic	177/243	207/376	203/347	228/348	248/607
(o)	Gulf Coast	177/257	200/327	190/301	194/349	238/398

Table 4. A table showing 3 day precipitation levels for 100/500 year events at different warming levels in mm. Values correspond to Figure 4

Model	Baseline	1.5°C	2.0°C	3.0°C	4.0°C
ACCESS1-0	1997-2036	2029-2068	2046-2085	—	—
ACCESS1-3	1998-2037	2029-2068	2045-2084	—	—
CCSM4*	1980-2019	2022-2061	2041-2080	2074-2113	2117-2156
CESM1-BGC	1982-2021	2025-2064	2043-2082	—	—
CMCC-CESM	2006-2045	2034-2073	2051-2090	—	—
CMCC-CM	1996-2035	2029-2068	2043-2082	—	—
CMCC-CMS	1997-2036	2028-2067	2043-2082	—	—
CNRM-CM5	1990-2029	2033-2072	2050-2089	—	—
CSIRO-Mk3-6-0	1994-2033	2030-2069	2045-2084	—	—
CanESM2	1982-2021	2016-2055	2033-2072	2060-2099	—
EC-EARTH	1958-1997	2014-2053	—	—	—
GISS-E2-H	1987-2026	2030-2069	2053-2092	—	—
GISS-E2-R	1995-2034	2043-2082	—	—	—
IPSL-CM5A-LR*	1979-2018	2016-2055	2031-2070	2059-2098	2088-2127
IPSL-CM5A-MR	1983-2022	2019-2058	2033-2072	2060-2099	—
IPSL-CM5B-LR	1985-2024	2028-2067	2046-2085	—	—
MIROC-ESM	1990-2029	2018-2057	2035-2074	2060-2099	—
MIROC-ESM-CHEM	1989-2028	2019-2058	2032-2071	2058-2097	—
MIROC5	1999-2038	2037-2076	2055-2094	—	—
MPI-ESM-LR*	1985-2024	2026-2065	2045-2084	2076-2115	2107-2146
MPI-ESM-MR	1986-2025	2029-2068	2045-2084	—	—
MRI-CGCM3	2008-2047	2040-2079	2060-2099	—	—
NorESM1-M	1999-2038	2039-2078	2058-2097	—	—
bcc-csm1-1*	1979-2018	2025-2064	2042-2081	2077-2116	2121-2160
bcc-csm1-1-m	1975-2014	2018-2057	2040-2079	—	—
inmcm4	2004-2043	2045-2084	—	—	—

Table 5. A table showing the CMIP5 models used in the analysis and the years used to represent each threshold temperature level. Models indicated with * are used to show results for up to 4°C. The baseline period corresponds to 0.67°C of warming.

	Region	Present	1.5°C	2.0°C	3.0°C	4.0°C
(a)	Desert Southwest	798	314	318	315	126
(b)	Western States	2973	474	465	412	247
(c)	Southern Rockies	1405	280	267	174	92
(d)	Chihuahuan Desert	1035	376	251	194	121
(e)	Northern Rockies	>5000	3173	>5000	393	316
(f)	Northern Great Plains	1148	481	417	410	172
(g)	Southern Great Plains	1085	306	462	286	120
(h)	Western Great Lakes	1910	373	345	227	200
(i)	Central Great Lakes	> 5000	536	593	271	221
(j)	Eastern Great Plains	3689	511	484	329	201
(k)	Pacific Northwest	2147	685	600	711	208
(l)	Eastern Great Lakes	3042	809	638	493	246
(m)	New England	2107	250	427	274	117
(n)	South Atlantic	1696	301	447	287	109
(o)	Gulf Coast	1179	261	307	248	129

Table 6. A table showing maximum likelihood for return periods of the observed extreme events in table 1 at different warming thresholds. Data corresponds to dashed green line in Figure 2, representing the mean of the subset of models which reach 4 degrees C warming during the RCP8.5 simulation