Supplementary Material for

Contrasting Detection and Attribution of Temperature and Precipitation Changes in the Western Mediterranean from CMIP6 DAMIP Experiments

Diego A. Campos[1,2], M. E. Olmo[1], P. Cos[1], M. Samsó[1],and F. J. Doblas-Reyes[1,3]

[1]Earth Sciences Department, Barcelona Supercomputing Center, Barcelona, Spain
[2]Facultat de Física, Universitat de Barcelona, Barcelona, Spain
[2]Catalan Institution for Research and Advances Studies, ICREA, Barcelona, Spain

Correspondence to: Diego A. Campos (diego.campos@bsc.es)

Table S1: List of ground stations obtained from the ECA&D and GHCH-Daily datasets.

Dataset	Station ID	Latitude	Longitude
ECA&D	33	43.62	1.38
ECA&D	234	43.31	-2.04
ECA&D	263	44.80	20.47
ECA&D	270	41.33	21.57
ECA&D	335	41.42	2.12
ECA&D	420	43.37	-8.42
ECA&D	423	37.42	-5.88
ECA&D	757	43.65	7.21
ECA&D	1406	36.01	-5.60
ECA&D	1681	43.52	16.43
ECA&D	1684	44.55	15.37
ECA&D	2209	41.92	8.79
ECA&D	3921	39.47	-6.34
ECA&D	3971	41.11	-1.41
ECA&D	27368	37.14	-3.63
ECA&D	27518	39.48	-0.37
GHCN-Daily	AGE00147708	36.72	4.05
GHCN-Daily	AGE00147716	35.10	-1.85
GHCN-Daily	IT000016320	40.63	17.93
GHCN-Daily	TS000060725	36.48	8.80

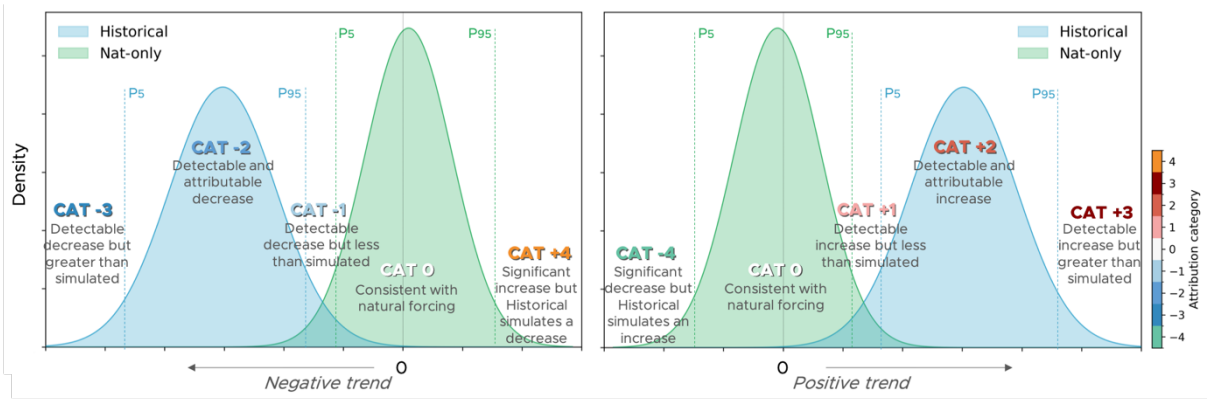

Figure S1: Schematic diagram illustrating the different attribution categories from Knutson & Zeng (2018). The dashed vertical lines are 5th and 95th percentiles of the trend distributions for the Historical (blue) and Natural-only (green) distributions.

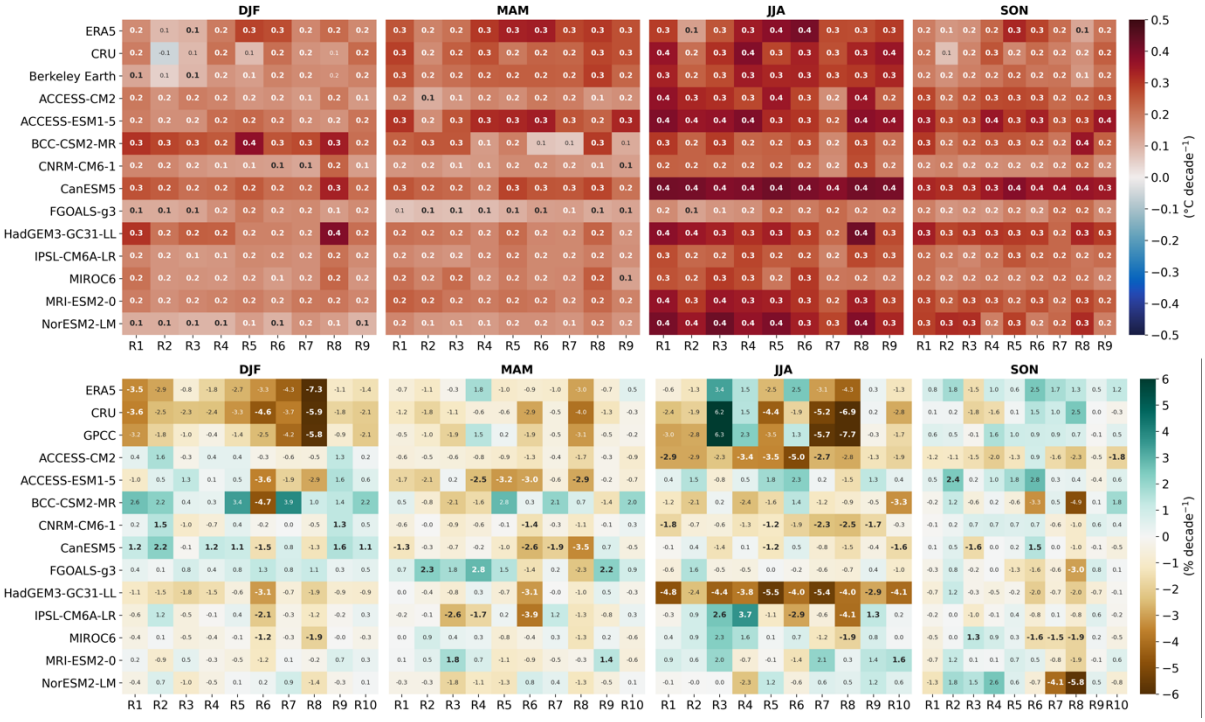

Figure S2: Sub-regional trends in temperature and precipitation across the Western Mediterranean (WM). Columns represent the WM sub-regions defined in Figure 1i, while rows correspond to observational datasets (ERA5, CRU, Berkeley Earth for temperature; ERA5, CRU, GPCC for precipitation) and individual CMIP6 models. Values indicate linear trends over the 1951–2020 period for boreal winter (DJF), spring (MAM), summer (JJA), and autumn (SON). Statistically significant trends are highlighted in bold (see Methods).

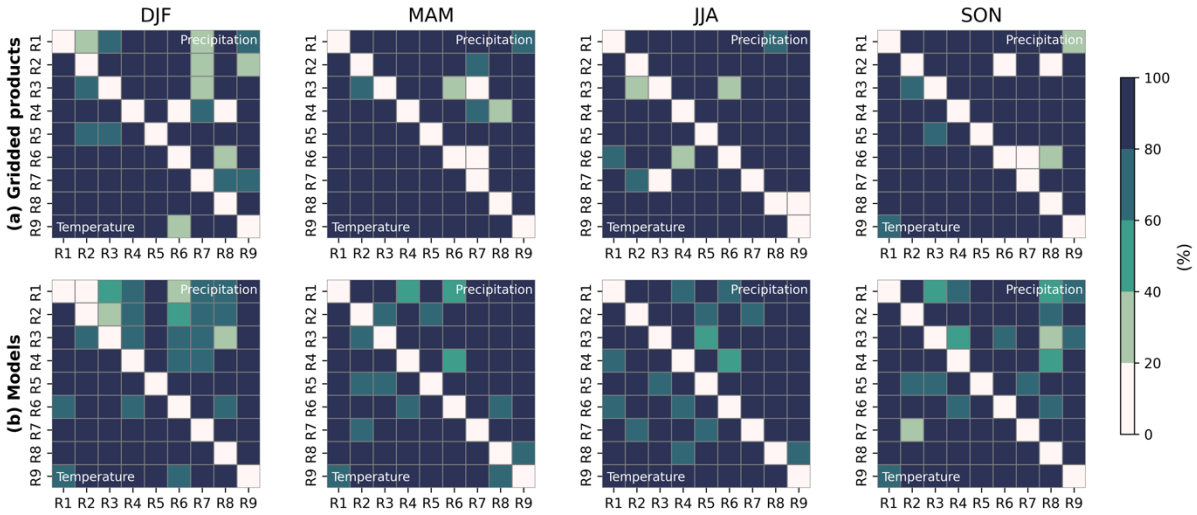

Figure S3: Seasonal rank-sum test for temperature (lower half of each box) and precipitation (upper half of each box). Colours indicate the percentage of observations ((a), upper panels) and model ensemble members ((b), lower panels) that have p-values lower than reference alpha = 0.05.

To assess whether the defined clusters effectively capture distinct regional climatologies, we compared the seasonal Probability Distribution Functions (PDFs) of temperature and precipitation across clusters using the non-parametric Rank-Sum test (Mann & Whitney, 1947). For each variable, the PDFs were constructed using the median values within each cluster. Two clusters were considered significantly different if either temperature or precipitation showed a statistically significant difference at the 5% level.
Supplementary Figure 1 shows, in the upper panel, the percentage of observational datasets (out of three) with p-values below the reference α level, and in the lower panel, the percentage of model ensemble members meeting the same criterion. A higher percentage indicates a stronger ability of the model members (or observational datasets) to distinguish that pair of regions significantly, whether in terms of temperature or precipitation.

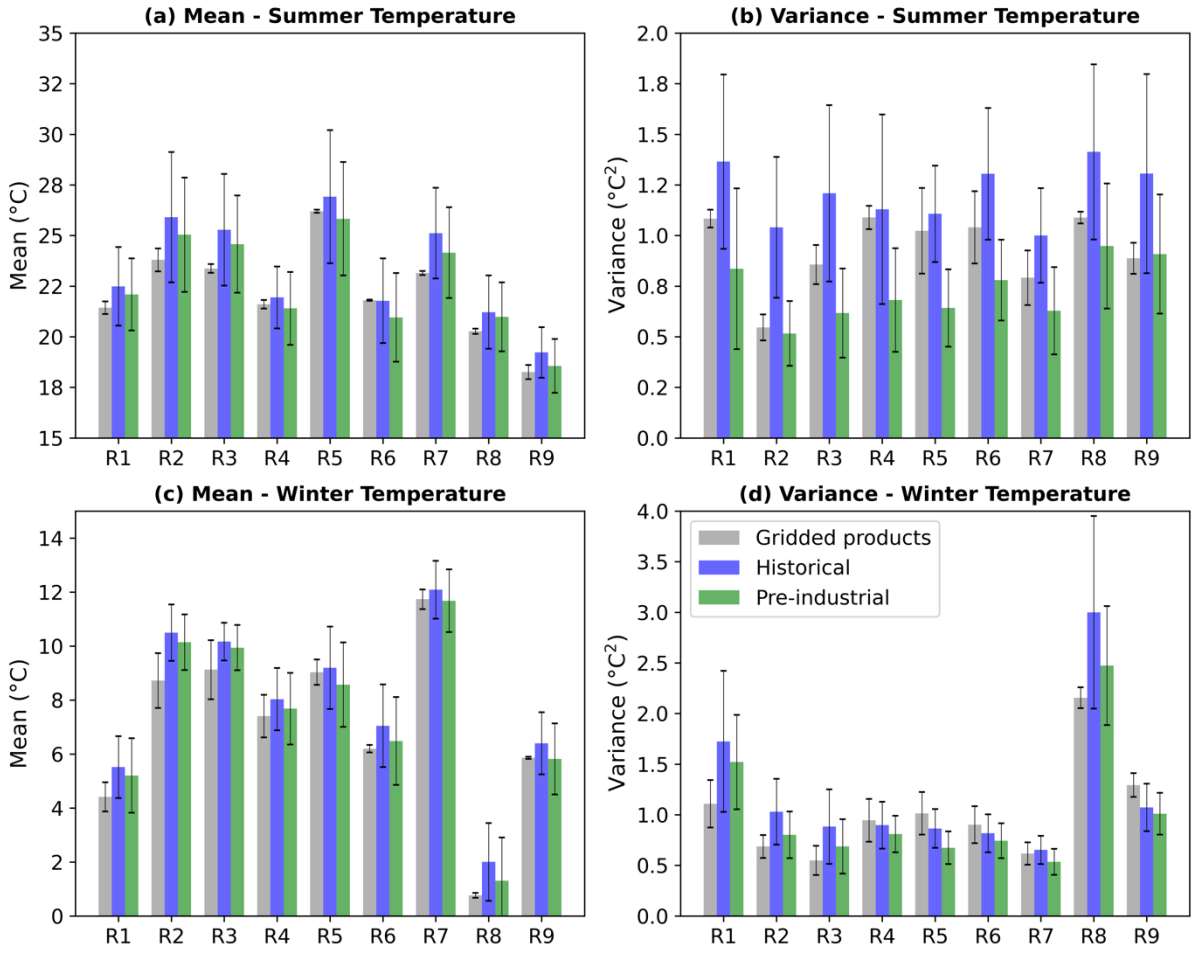

Figure S4: Sub-regional time mean (left panels) and time variance (right panels) of regional median temperature values for summer (top) and winter (bottom). Grey bars represent observations (ERA5, CRU and Berkeley Earth), blue bars correspond to historical simulations (actual climate) for the 1961–1990 period, and green bars show results from 100-year segments of pre-industrial control runs. Vertical lines indicate the standard deviation of mean and variance values from observations and model ensemble members.

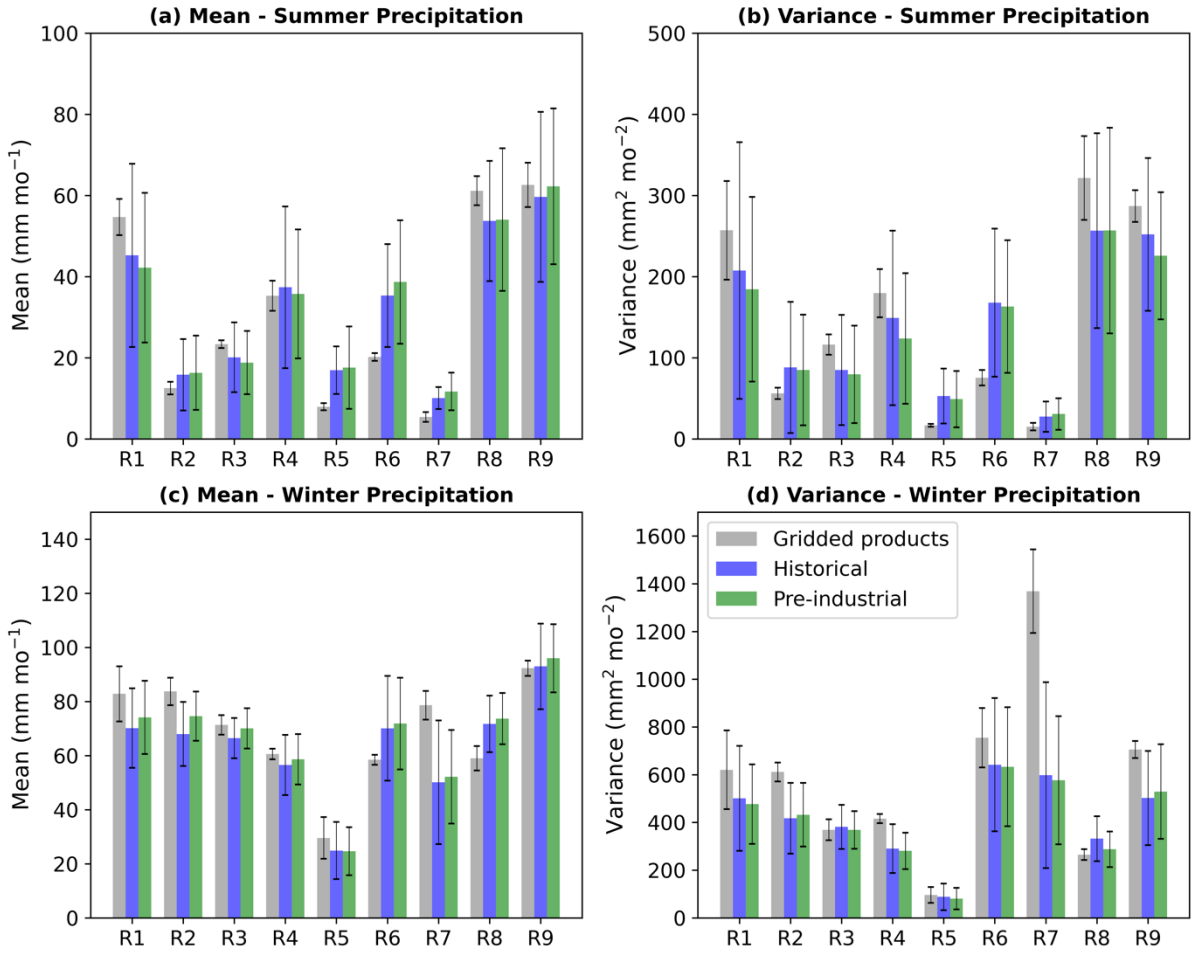

Figure S5: Sub-regional time mean (left panels) and time variance (right panels) of regional median precipitation values for summer (top) and winter (bottom). Grey bars represent observations (ERA5, CRU and GPCC), blue bars correspond to historical simulations (actual climate) for the 1961–1990 period, and green bars show results from 100-year segments of pre-industrial control runs. Vertical lines indicate the standard deviation of mean and variance values from observations and model ensemble members.

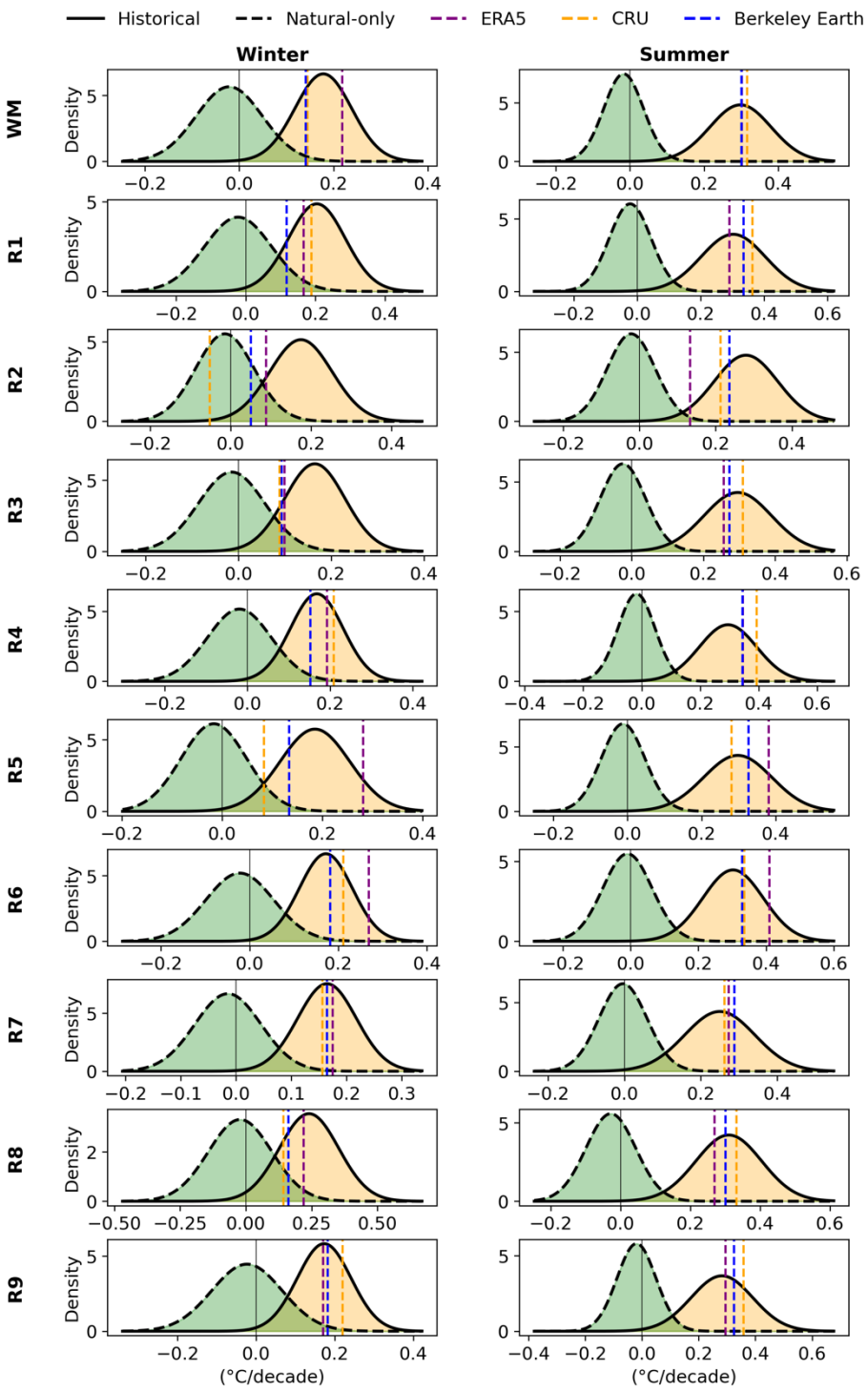

Figure S6: Distribution of simulated 1951-2020 temperature trends for Historical (light blue) and Natural-only (green) experiments for winter (left panels) and summer (right panels). Vertical lines show the observed trends in ERA5 (purple), CRU (yellow) and Berkeley Earth (blue). Distributions are Gaussian and obtained using all the ensemble members of the corresponding model subset.

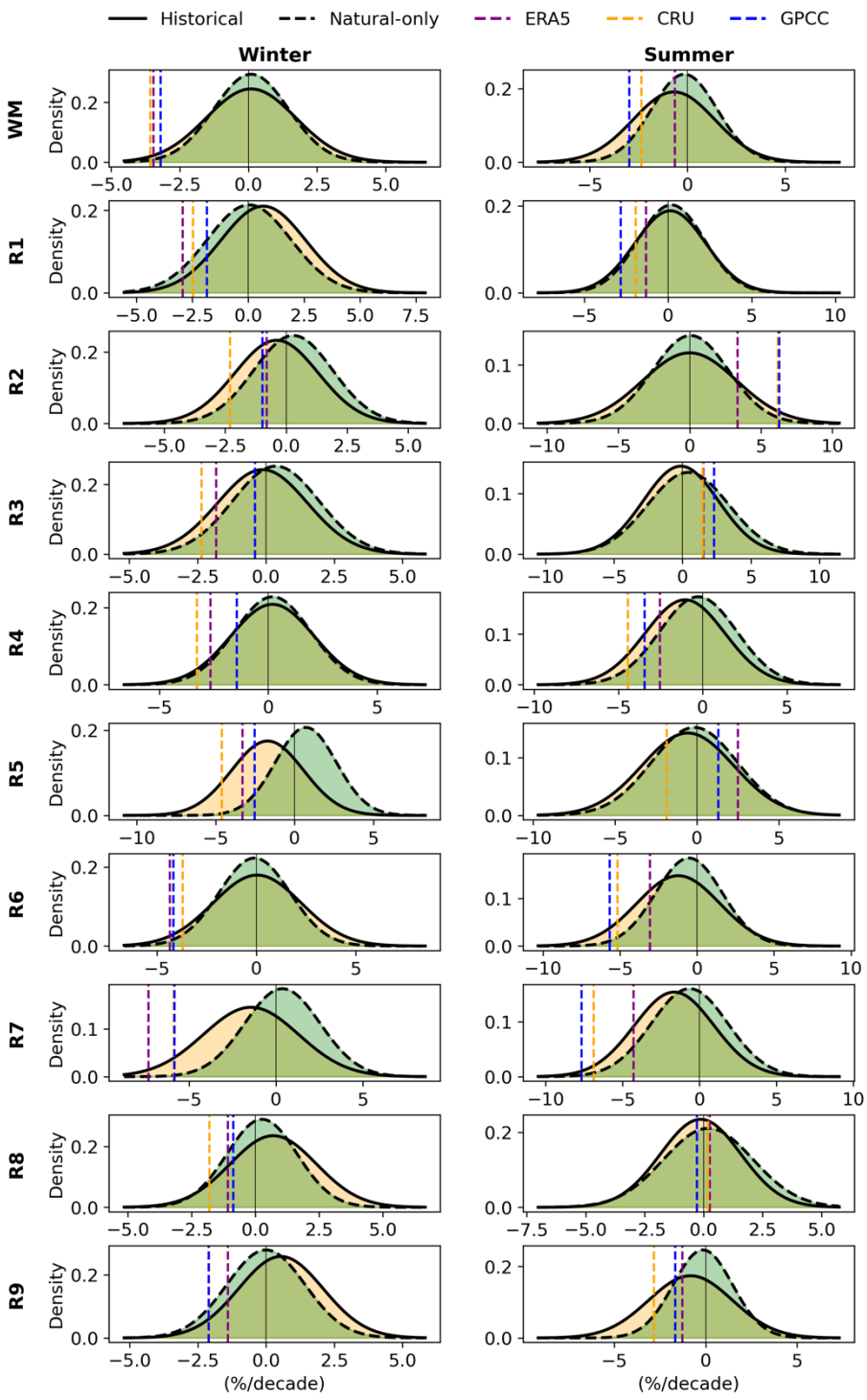

Figure S7: Distribution of simulated 1951-2020 precipitation trends for Historical (light blue) and Natural-only (green) experiments for winter (left panels) and summer (right panels). Vertical lines show the observed trends in ERA5 (purple), CRU (yellow) and Berkeley Earth (blue). Distributions are Gaussian and obtained using all the ensemble members of the corresponding model subset.

Table S2: P-values from the χ^2 consistency test for the optimal fingerprinting statistical models. Values correspond to the two-hypothesis test evaluating the consistency between observed temperature changes and the simulated responses to different forcing combinations: all forcings (ALL), greenhouse gases only (GHG), anthropogenic aerosols only (AAer), natural only (Nat), and internal variability only (IV), as described in the Methods section. Values above 0.05 indicate that the model cannot be rejected at the 5% significance level.

	Winter					Summer				
	ALL	**GHG**	**AAer**	**Nat**	**IV**	**ALL**	**GHG**	**AAer**	**Nat**	**IV**
WM	0.97	0.96	0.16	0.29	0.28	0.66	0.41	0.00	0.00	0.00
R1	0.92	0.64	0.32	0.41	0.31	0.95	0.64	0.01	0.01	0.00
R2	0.87	0.21	0.85	0.91	0.78	0.92	0.16	0.05	0.00	0.00
R3	0.98	0.65	0.54	0.82	0.71	0.83	0.53	0.02	0.00	0.00
R4	0.76	0.81	0.04	0.07	0.07	0.86	0.77	0.00	0.00	0.00
R5	0.88	0.85	0.17	0.44	0.34	0.45	0.41	0.00	0.00	0.00
R6	0.76	0.98	0.01	0.01	0.01	0.42	0.34	0.00	0.00	0.00
R7	0.91	0.98	0.20	0.10	0.12	0.46	0.28	0.00	0.00	0.00
R8	0.90	0.54	0.39	0.51	0.37	0.87	0.21	0.02	0.02	0.00
R9	0.78	0.92	0.06	0.08	0.12	0.85	0.92	0.01	0.04	0.00

Table S3: P-values from the χ^2 consistency test for the optimal fingerprinting statistical models. Values correspond to the two-hypothesis test evaluating the consistency between observed precipitation changes and the simulated responses to different forcing combinations: all forcings (ALL), greenhouse gases only (GHG), anthropogenic aerosols only (AAer), natural only (Nat), and internal variability only (IV), as described in the Methods section. Values above 0.05 indicate that the model cannot be rejected at the 5% significance level.

	Winter					Summer				
	ALL	**GHG**	**AAer**	**Nat**	**IV**	**ALL**	**GHG**	**AAer**	**Nat**	**IV**
WM	0.92	0.81	0.87	0.79	0.75	0.89	0.87	0.79	0.81	0.83
R1	0.84	0.66	0.81	0.81	0.75	0.87	0.73	0.86	0.85	0.52
R2	0.79	0.67	0.75	0.83	0.72	0.85	0.59	0.67	0.75	0.48
R3	0.89	0.86	0.89	0.87	0.86	0.59	0.16	0.79	0.56	0.50
R4	0.82	0.84	0.80	0.79	0.81	0.76	0.73	0.57	0.68	0.63
R5	0.92	0.92	0.71	0.38	0.00	0.86	0.86	0.61	0.85	0.72
R6	0.87	0.86	0.83	0.74	0.47	0.89	0.79	0.73	0.81	0.79
R7	0.85	0.75	0.83	0.76	0.71	0.63	0.69	0.46	0.58	0.57
R8	0.86	0.69	0.74	0.80	0.62	0.69	0.61	0.67	0.66	0.71
R9	0.97	0.83	0.98	0.85	0.91	0.75	0.73	0.39	0.64	0.54