

An AI-Driven Reconstruction of Global Surface Temperature with Emphasis on Refining the Antarctic Record

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Table S1: CMIP6 ensemble members for training AI model.

Model	Number	Ensemble
ACCESS-CM2	5	rlilp1fl–r5ilp1fl
ACCESS-ESM1-5	3	rlilp1fl–r3ilp1fl
BCC-CSM2-MR	3	rlilp1fl–r3ilp1fl
BCC-ESM1	3	rlilp1fl–r3ilp1fl
CanESM5	5	rlilp1fl–r5ilp1fl
CESM2	1	rlilp1fl
CESM2-WACCM	1	rlilp1fl
CMCC-ESM2	1	rlilp1fl
CNRM-CM6-1	10	rlilp1f2–r10ilp1f2
EC-Earth3	4	rlilp1fl, r2ilp1fl, r9ilp1fl, r12ilp1fl
FGOALS-g3	4	rlilp1fl, r3ilp1fl, r4ilp1fl, r5ilp1fl
FIO-ESM-2-0	3	rlilp1fl–r3ilp1fl
GISS-E2-1-G	12	rlilp1fl–r6ilp1fl, rlilp3fl–r6ilp3fl
GISS-E2-1-G-CC	1	rlilp1fl
GISS-E2-1-H	11	rlilp1fl–r6ilp1fl, rlilp3fl–r5ilp3fl
GISS-E2-2-G	6	rlilp1fl–r6ilp1fl
GISS-E2-2-H	5	rlilp1fl–r5ilp1fl
INM-CM4-8	1	rlilp1fl
INM-CM5-0	1	rlilp1fl
IPSL-CM6A-LR	6	rlilp1fl–r6ilp1fl
MIROC6	5	rlilp1fl–r5ilp1fl
MPI-ESM1-2-LR	3	rlilp1fl–r3ilp1fl
MRI-ESM2-0	5	rlilp1fl–r5ilp1fl
NorESM2-LM	3	rlilp1fl–r3ilp1fl
NorESM-MM	3	rlilp1fl–r3ilp1fl

Table S2: Antarctic observational stations information.

Used Station	Latitude	Longitude	Elevation(m)	Source	Used Station	Latitude	Longitude	Elevation(m)	Source
Adelaide	-67.80	-68.90	26	2	Mawson Base	-67.60	62.88	14	4
Amundsen-Scott	-90.00	0.00	2830	7	Memurdo Sound Naf	-77.88	166.73	24.1	2
Baldrick AWS	-82.77	-13.05	1968	3	Mirny	-66.55	93.02	40	1, 2
Base Almirante Brown	-64.88	-62.88	1	2	Molodeznaja	-67.67	45.85	50	2
Base Arturo Prat	-62.50	-59.68	5	2	Neumayer	-70.67	-8.25	50	2
Base Baia Terra Nova	-74.70	164.10	92	2	Nico	-89.00	89.67	2935	2
Base Bernardo O'Higgins	-63.32	-56.68	10	2	Novolazarevskaja	-70.77	11.83	119	1, 2
Base Jubany	-62.23	-58.63	11	2	O'Higgins	-63.30	-57.90	10	2
Base Marambio	-64.23	-56.72	198	2	Orcadas	-60.73	-44.73	8	1, 2
Base San Martin	-68.12	-67.13	7	2	Palmer	-64.80	-64.10	8	2
Belgrano II	-77.87	-34.62	256	1, 2	Palmer Station	-64.77	-64.08	8	2
Bellinghausen	-62.18	-58.88	14	2	Pegasus North	-77.95	166.50	10	2
Bonaparte Point	-64.78	-64.07	8	2	Petrel	-63.50	-57.30	18	2
Brianna	-83.89	-134.14	549	2	Possession Is	-71.88	171.20	30	2
Butler Isla	-72.20	-60.17	115	2	Progress	-69.38	76.38	64	2
Byrd Station	-80.01	-119.40	1530	5	Rothera	-67.57	-68.12	33	4
Cape Bird	-77.22	166.43	70	2	Sanae AWS	-71.70	-2.80	817	3
Cape Phillips	-73.52	169.75	568	2	Schwerdtfeger	-79.90	169.98	60	2
Cape Ross	-76.72	162.97	150	2	Scott	-77.80	166.80	16	4
Casey	-66.28	110.52	41	1	Scott Base	-77.84	166.76	16	1, 8
Centro Met Antartico Pdte E	-62.18	-58.98	48	2	Signy Island	-60.71	-45.60	6	2
Centro Metan	-62.42	-58.88	10	2	Siple Dome	-81.65	-148.78	620	2
Concordia	-75.10	123.40	3233	2	Ski Blu	-74.80	-71.48	1589	2
D-47	-67.40	138.73	1560	2	Syowa	-69.00	39.58	21	1, 2
Davis	-68.60	78.00	13	1, 2	Theresa	-84.60	-115.82	1463	2
Dinamet Uruguay	-62.18	-58.85	17	2	Vernadsky	-65.25	-64.27	11	2
Dome C	-74.50	123.00	3280	2	Vostok	-78.45	106.87	3488	1, 2
Dome C II	-75.12	123.37	3250	2	Zhongshan	-69.37	76.38	18	3
Dome Fuji	-77.32	39.70	3810	2	Validation Station				
Dome Plateau Eagle	-76.42	77.02	2830	2	Validation Station	Latitude	Longitude	Elevation(m)	Source
Dumont D'Urville	-66.67	140.02	43	1, 6	Dome A	-80.40	77.40	4084	2
Elaine	-83.13	174.17	60	2	Drescher	-72.87	-19.03	27	2
Elizabeth	-82.62	-137.08	549	2	Ferrell	-77.90	170.80	45	2
Esperanza	-63.20	-56.59	13	1, 2	G3	-70.90	69.90	84	4
Faraday	-65.30	-64.30	11	1, 2	GC41	-71.60	111.30	2763	2
Ferraz	-62.10	-58.40	20	2	General Belgrano	-78.00	-38.80	32	2
Fossil Bluff	-71.32	-68.28	69	2	GF08	-68.50	102.10	2125	4
Gill	-79.98	-178.60	55	2	LG10	-71.30	59.20	2619	3
Great Wall	-62.22	-58.97	10	2	LG35	-76.00	65.00	2345	3
Halvfarryggen Ep11	-71.15	-6.68	694	2	LG59	-73.50	76.90	2565	3
Harry	-83.00	-121.38	945	2	Mount Siple	-73.20	-127.05	230.0	2
Henry	-89.00	-1.02	2755	2	Nordenskiold	-73.05	-13.40	497	4
King Sejong	-62.22	-58.75	11	2	Russkaya	-74.70	-136.90	100	4
Kohnenep9	-75.00	0.00	2892	2	Thurston Island	-72.50	-97.60	225	3
Law Dome Summit	-66.73	112.83	1368	2	Data Source				
Leningradskaya	-69.50	159.38	291	2	1	SCAR READER			
Lettau	-82.52	-174.45	55	2	2	GHCNm			
Limbirt	-75.87	-59.15	40	2	3	AntAWS			
Linda	-78.47	168.38	50	2	4	GSOD			
Maitri	-70.77	11.75	50	2	5	OSU Polar Meteorology Group			
Manuela	-74.95	163.68	80	2	6	Meteo France			
Marilyn	-79.95	165.12	75	2	7	University of Wisconsin-Madison			
Mawson	-67.60	62.90	8	1	8	NIWA			

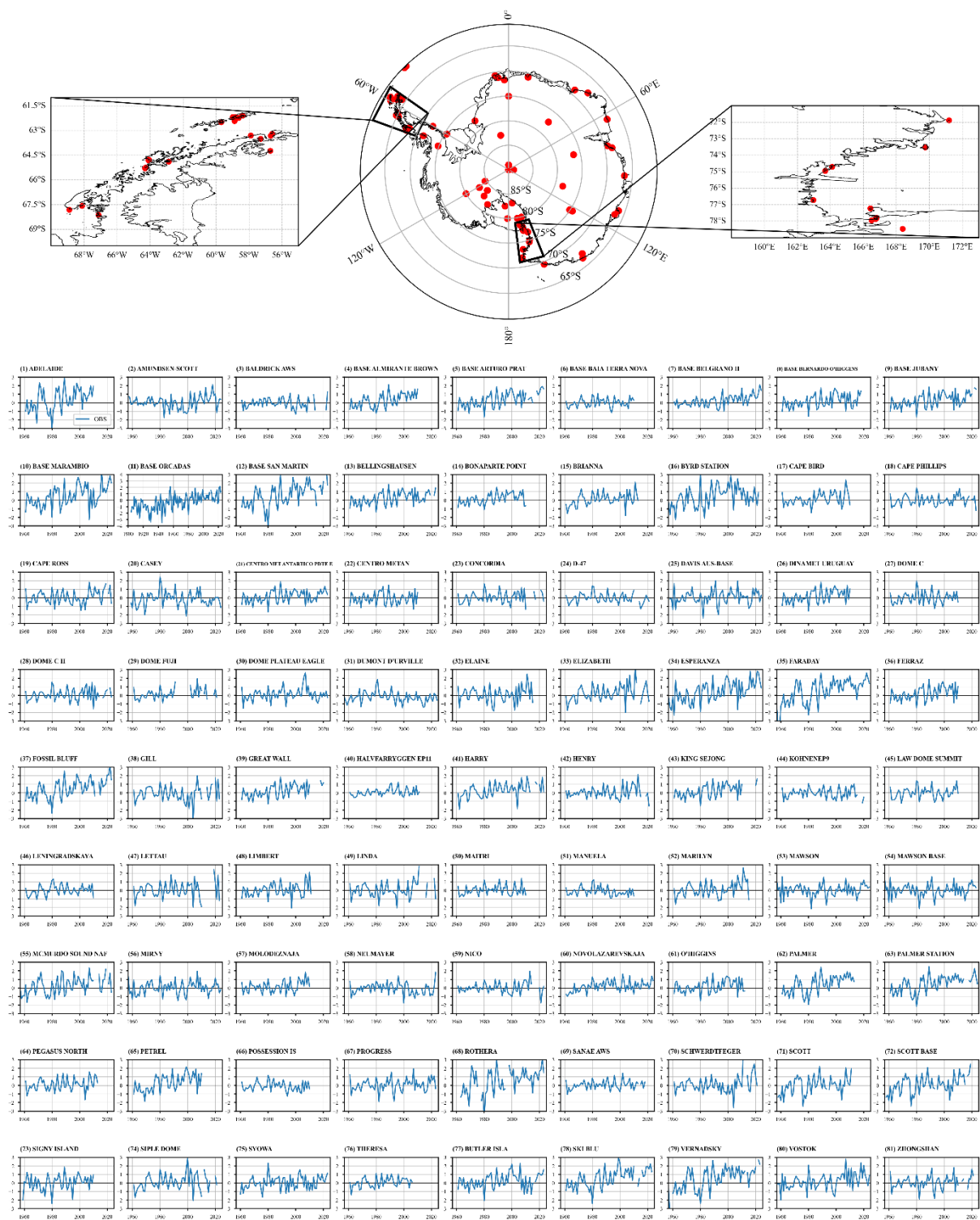
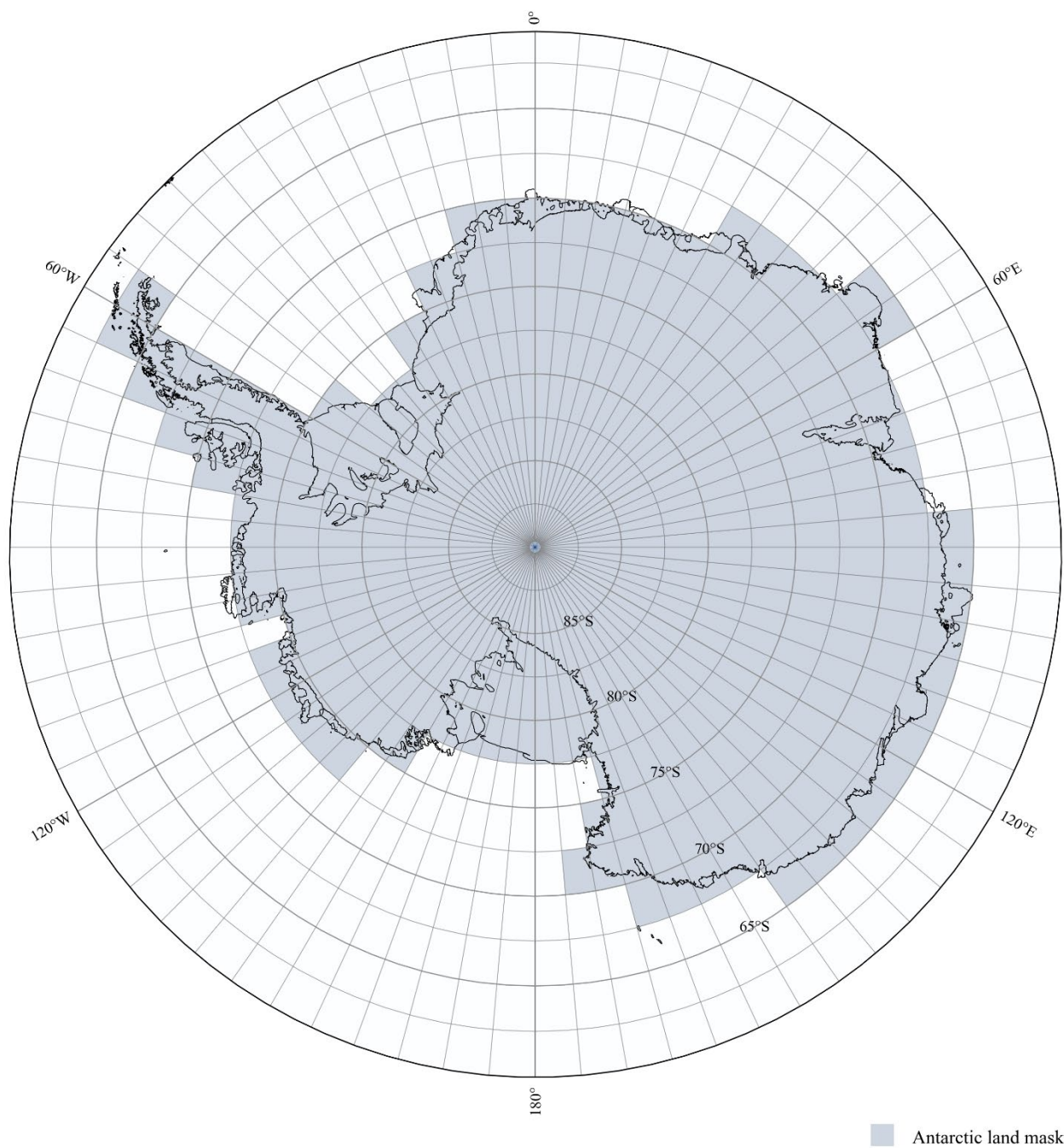


Figure S1: Antarctic stations location and annual mean temperature anomaly time series.



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Figure S2: Antarctic land mask.

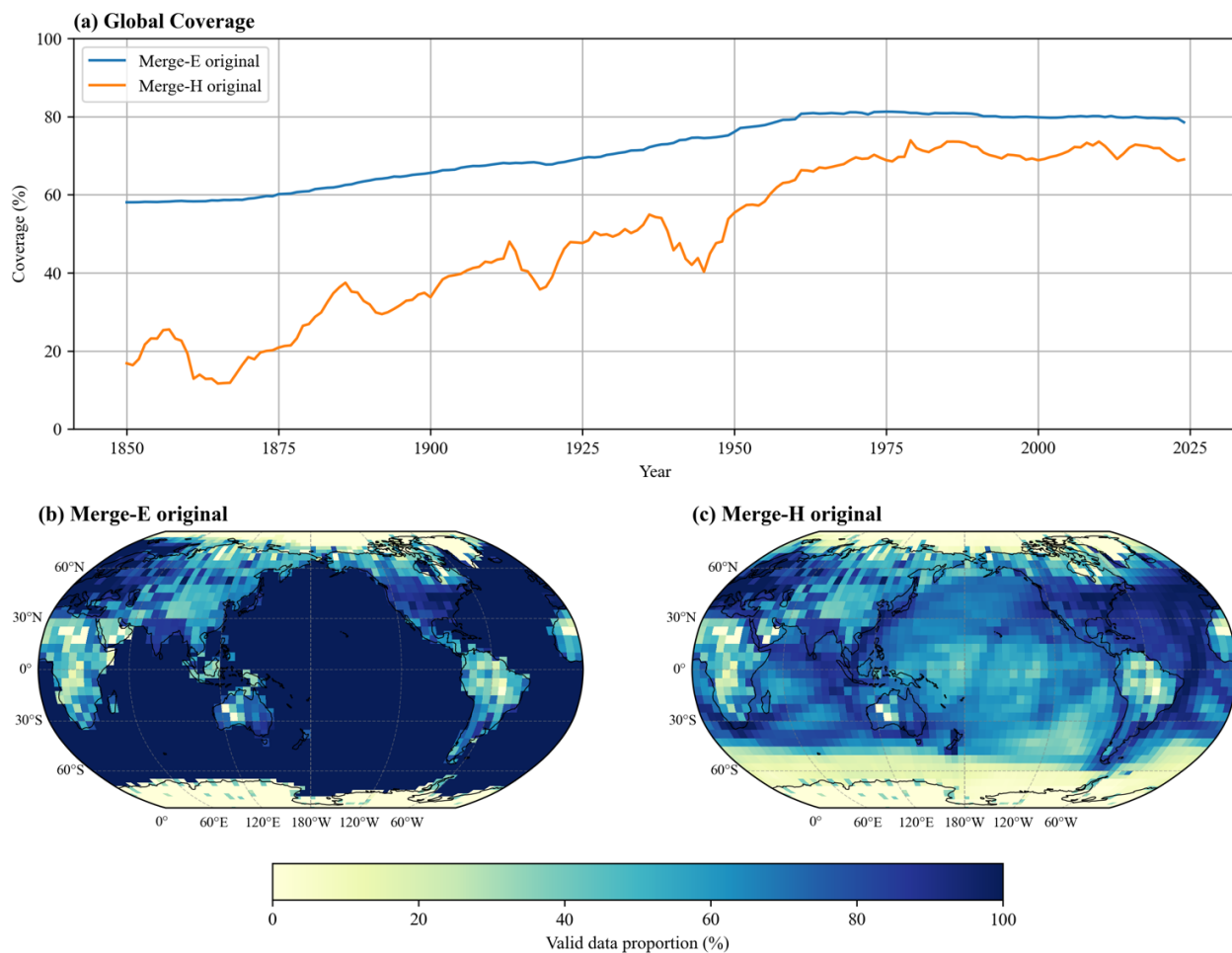


Figure S3: Global annual mean original effective data coverage for Merge-E and Merge-H during 1850–2024 (a). Spatial distribution of grid-level effective data coverage for Merge-E (b). Same as b but for Merge-H (c).

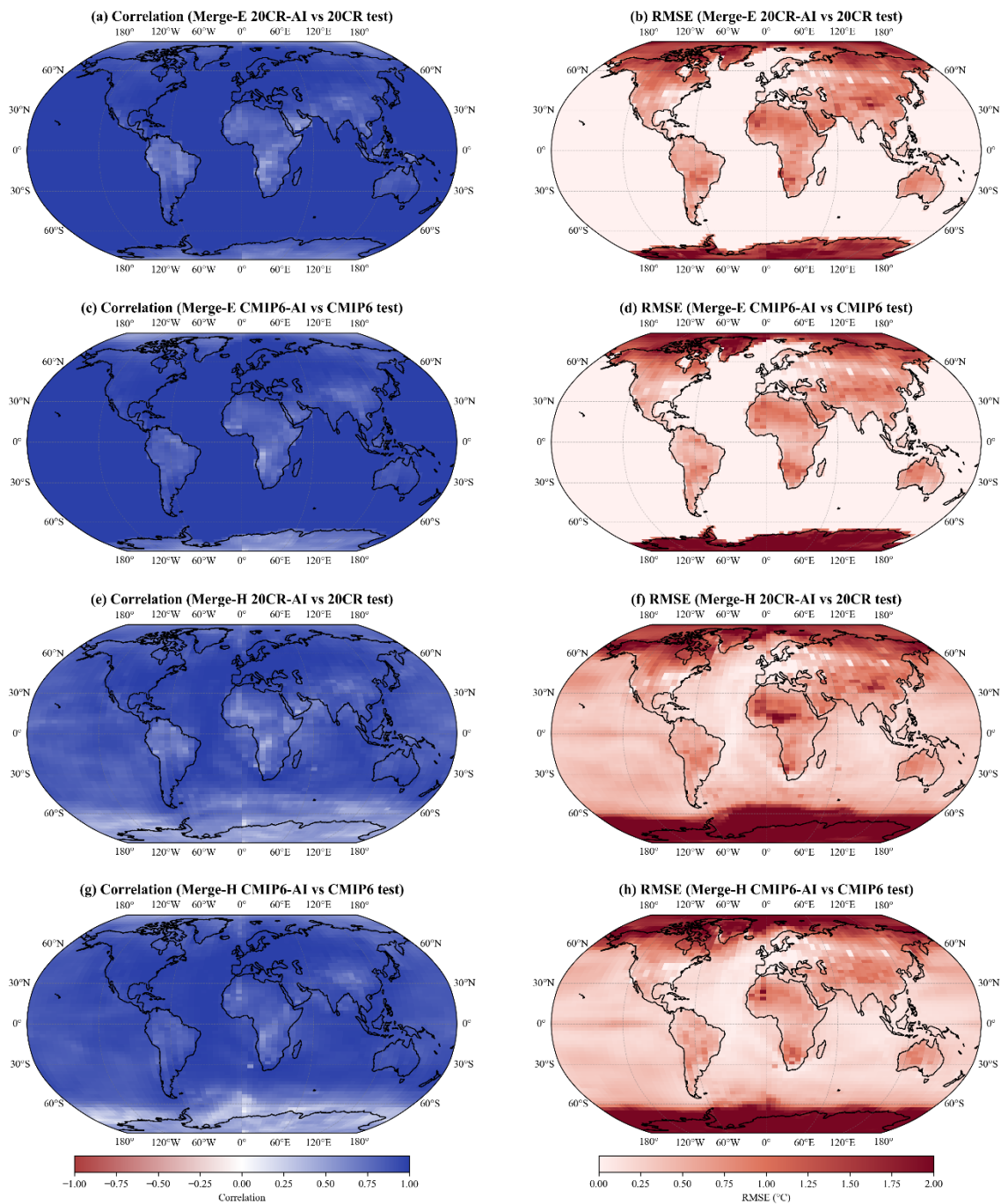


Figure S4: Monthly grid spatial validation results of the AI reconstructions for 1850–2024. Spatial correlation coefficients and RMSE between the 20CR-AI reconstruction and the original 20CR test set under the Merge-E mask (a–b). Same as a–b but for the CMIP6-AI reconstruction of the CMIP6 test set under the Merge-E mask (c–d). Same as a–b but for the 20CR-AI reconstruction of the 20CR test set under the Merge-H mask (e–f). Same as a–b but for the CMIP6-AI reconstruction of the CMIP6 test set under the Merge-H mask (g–h).

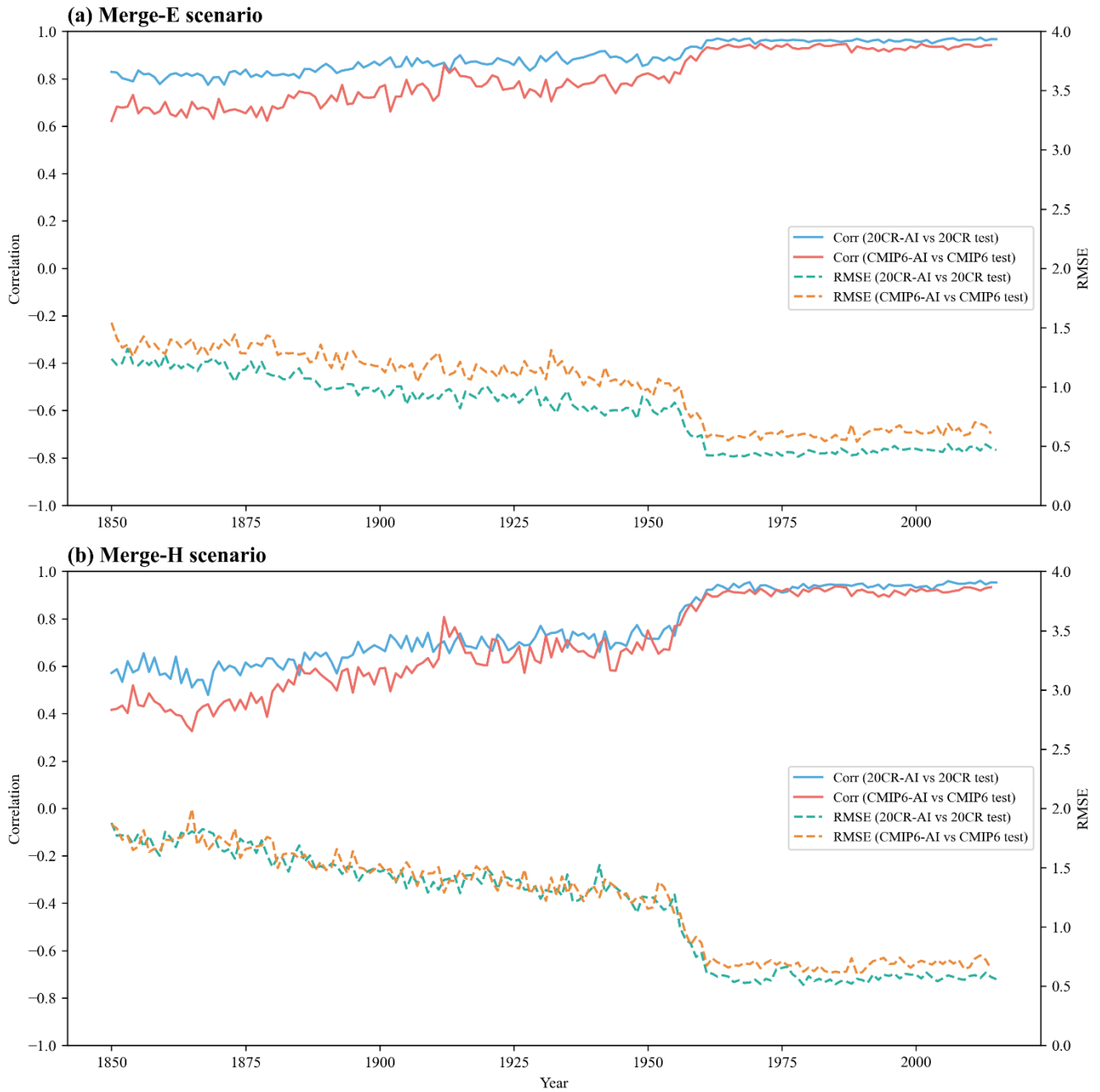


Figure S5: Global annual mean spatial grid correlation coefficients and RMSE of the 20CR and CMIP6 test sets. Annual mean spatial correlation coefficients and RMSE between the 20CR-AI reconstruction and the original 20CR test set, and between the CMIP6-AI reconstruction and the original CMIP6 test set, under the Merge-E mask (a). Same as a but under the Merge-H mask (b).

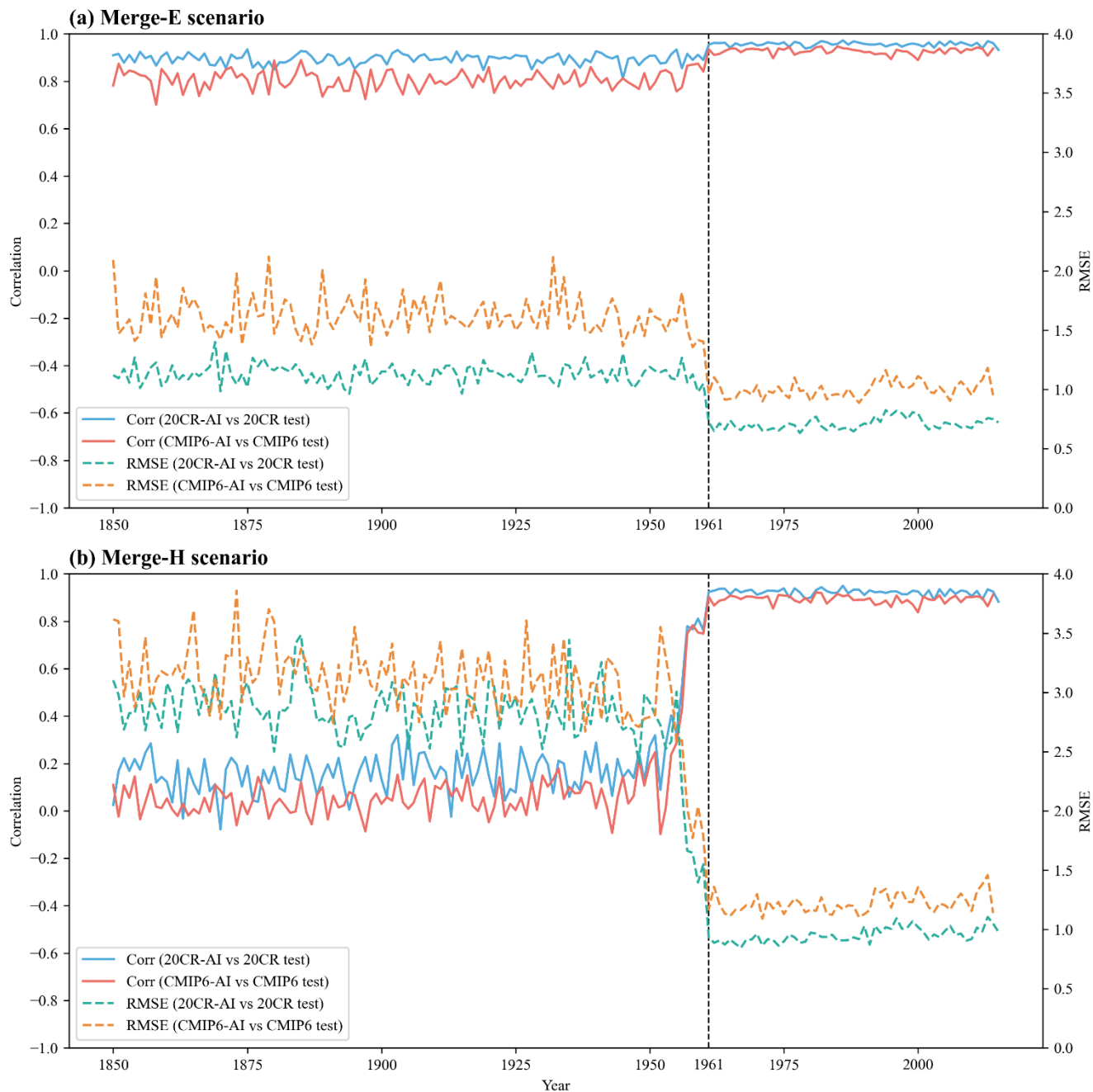


Figure S6: Antarctic annual mean spatial grid correlation coefficients and RMSE time series. Annual mean spatial correlation coefficients and RMSE between the 20CR-AI reconstruction and the original 20CR test set, and between the CMIP6-AI reconstruction and the original CMIP6 test set, under the Merge-E mask (a). Same as a but under the Merge-H mask (b).

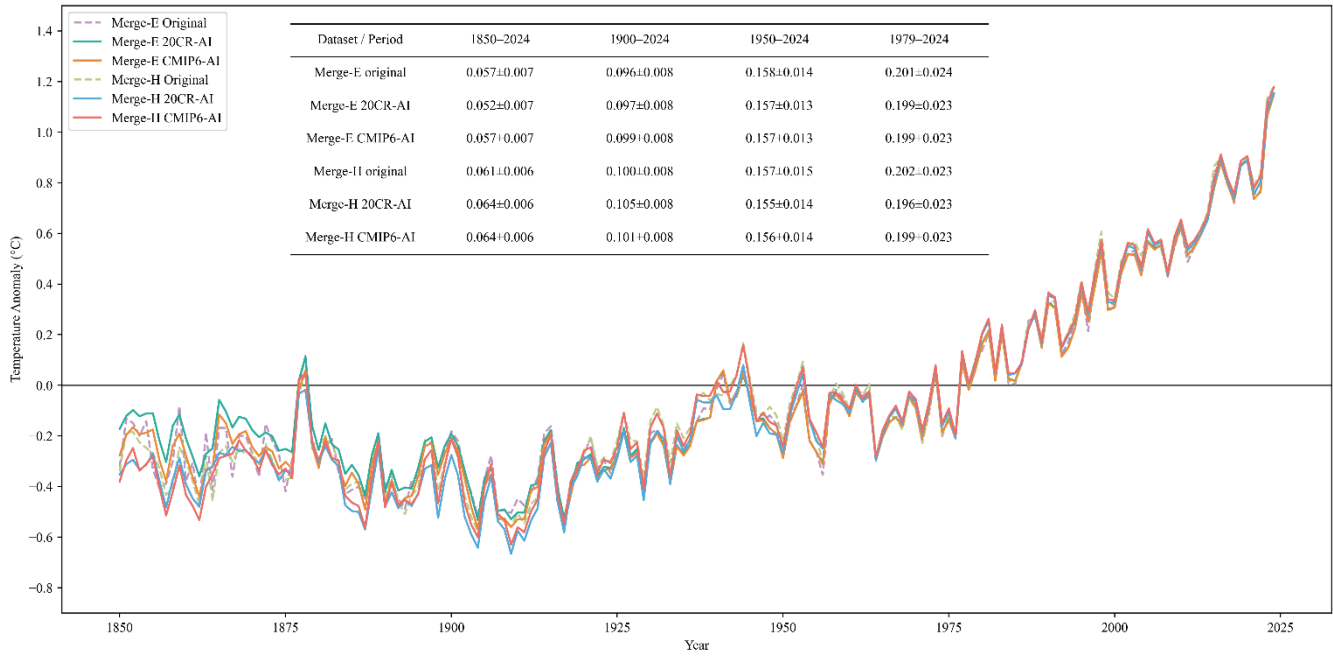


Figure S7: Global annual mean temperature series for 1850–2024 before and after reconstruction under the Merge-E and Merge-H schemes.

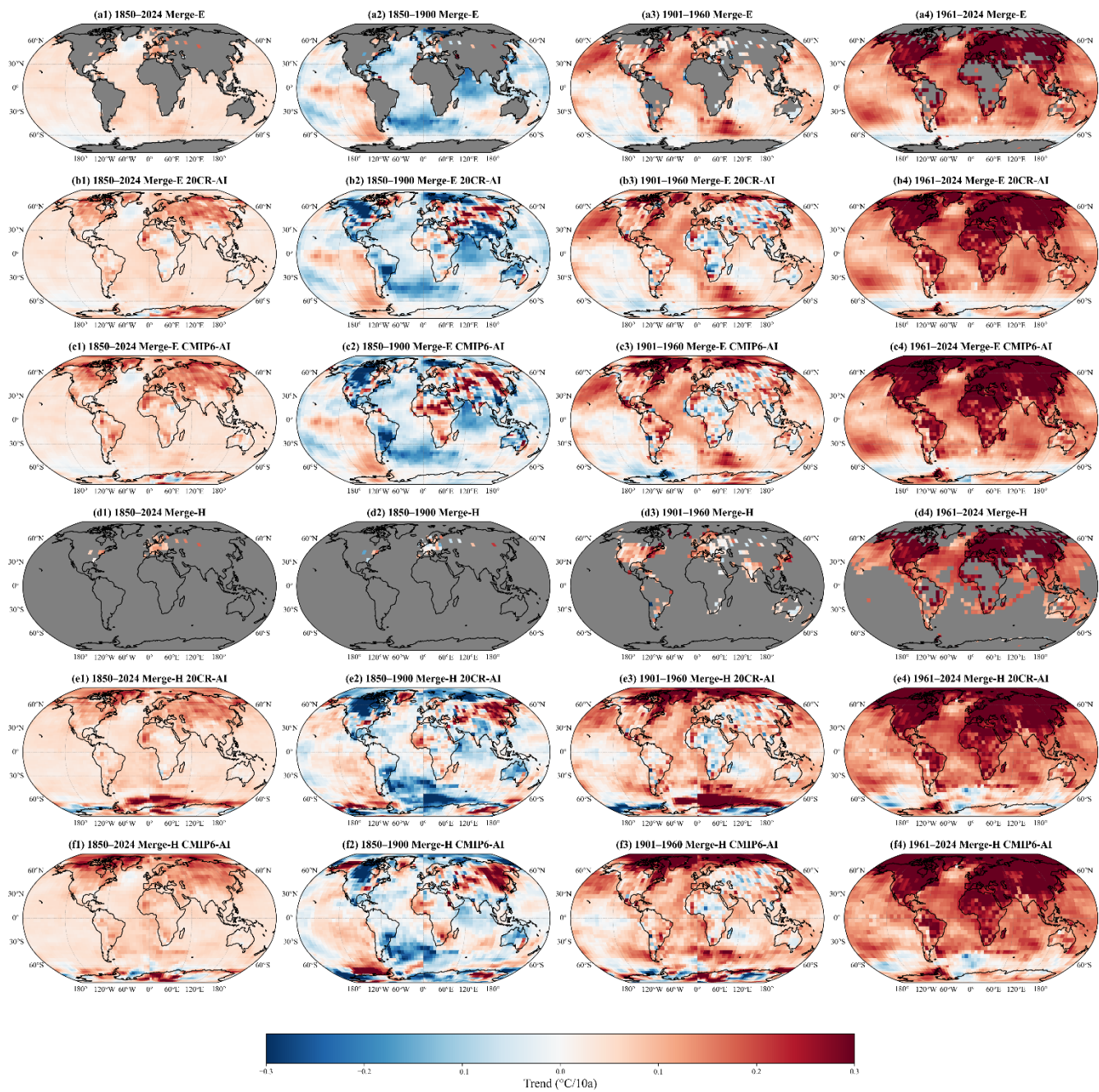


Figure S8: Spatial distribution of global temperature trends.