Supplementary materials for

El Niño – Southern Oscillation prediction based on the Global Atmospheric Oscillation in CMIP6 models

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Table S1. Main characteristics of the 58 CMIP6 models and cross-correlation of the 1st PCs of the SAT and SLP anomalies with ONI and GAO1 by Historical experiment.

Model developer	Model name	Average model resolution (°lat × °lon)	EOF1 SAT contribution (%)	EOF2 SAT contribution (%)	EOF1 SLP contribution (%)	EOF2 SLP contribution (%)	Max. corr. EOF1 SAT and ONI	Shift at max. corr. EOF1 SAT and ONI (mon.)	Max. corr. EOF1 SLP and GAO1	Shift at max. corr. EOF1 SLP and GAO1 (mon.)
AS-RCEC	TaiESM1	0.938 x 1.250	46.5	19.6	44.5	19.1	0.87	2	0.81	1
AWI	AWI-CM-1-1-MR	0.938 x 0.938	40.5	11.2	36.4	16.8	0.79	3	0.88	0
AWI	AWI-ESM-1-1-LR	1.875 x 1.875	36.4	11.6	29.4	16.8	0.75	3	0.77	0
BCC	BCC-CSM2-MR	1.125 x 1.125	30.2	10.2	31.8	19.2	0.80	2	0.83	0
BCC	BCC-ESM1	2.812 x 2.812	26.4	13.6	31.0	18.1	0.83	1	0.75	0
CAMS	CAMS-CSM1-0	1.125 x 1.125	43.0	12.1	34.8	21.3	0.78	2	0.75	0
CAS	CAS-ESM2-0	1.406 x 1.406	45.4	14.8	37.6	20.4	0.87	2	0.70	0
CAS	FGOALS-f3-L	1.000 x 1.250	50.6	14.2	47.1	15.1	0.89	3	0.79	0
CAS	FGOALS-g3	2.250 x 2.000	44.6	10.8	41.3	17.1	0.82	2	0.84	0
CCCma	CanESM5	2.812 x 2.812	40.1	12.4	40.4	16.7	0.80	3	0.80	0
CCCma	CanESM5-CanOE	2.812 x 2.812	36.8	12.0	36.1	16.4	0.77	3	0.84	0
CCCR-IITM	IITM-ESM	1.915 x 1.875	39.1	15.6	33.9	21.4	0.78	2	0.78	0
CMCC	CMCC-CM2-SR5	0.938 x 1.250	42.2	12.2	42.3	13.6	0.85	3	0.86	0
CMCC	CMCC-ESM2	0.938 x 1.250	47.7	13.1	44.9	13.0	0.88	3	0.86	0
CNRM-CERFACS	CNRM-CM6-1	1.406 x 1.406	39.7	11.7	35.6	20.3	0.84	3	0.85	0
CNRM-CERFACS	CNRM-CM6-1-HR	0.500 x 0.500	33.0	13.7	27.2	22.6	0.70	2	0.42	0
CNRM-CERFACS	CNRM-ESM2-1	1.406 x 1.406	37.5	13.8	34.4	16.4	0.81	3	0.86	0
CSIRO-ARCCSS	ACCESS-CM2	1.250 x 1.875	33.4	14.3	32.6	16.6	0.79	2	0.72	0
CSIRO	ACCESS-ESM1-5	1.241 x 1.875	33.2	10.7	34.5	16.5	0.75	3	0.85	0
E3SM-Project	E3SM-1-0	1.000 x 1.000	37.0	12.1	36.5	14.8	0.86	2	0.86	0
E3SM-Project	E3SM-1-1	1.000 x 1.000	36.0	11.5	35.9	17.8	0.82	2	0.86	0
E3SM-Project	E3SM-1-1-ECA	1.000 x 1.000	38.5	12.1	36.6	19.1	0.79	3	0.81	0
EC-Earth-Consortium	EC-Earth3	0.703 x 0.703	36.9	10.8	33.9	17.9	0.78	2	0.80	0
EC-Earth-Consortium	EC-Earth3-AerChem	0.703 x 0.703	38.7	13.8	35.1	18.7	0.76	2	0.71	0
EC-Earth-Consortium	EC-Earth3-Veg	0.703 x 0.703	41.0	11.7	36.0	19.1	0.82	2	0.82	0
FIO-QLNM	FIO-ESM-2-0	0.938 x 1.250	42.0	15.5	42.2	15.4	0.81	2	0.82	0
HAMMOZ-Consortium	MPI-ESM-1-2-HAM	1.875 x 1.875	38.8	11.9	33.6	16.6	0.83	2	0.79	0
INM	INM-CM4-8	1.500 x 2.000	30.9	12.4	23.6	20.1	0.55	1	0.09	-
INM	INM-CM5-0	1.500 x 2.000	30.2	11.6	25.0	21.4	0.67	1	0.70	0
IPSL	IPSL-CM6A-LR	1.259 x 2.500	45.1	10.0	38.9	20.0	0.81	2	0.83	0

KIOST	KIOST-ESM	1.875 x 1.875	42.3	12.5	39.5	22.9	0.82	3	0.70	0
MIROC	MIROC-ES2L	2.812 x 2.812	56.1	12.8	48.3	17.5	0.92	3	0.85	1
MIROC	MIROC6	1.406 x 1.406	49.0	12.6	45.0	15.3	0.90	3	0.89	0
MOHC	HadGEM3-GC31-LL	1.250 x 1.875	36.8	12.3	37.1	15.2	0.80	2	0.87	0
MOHC	HadGEM3-GC31-MM	0.556 x 0.833	37.0	15.1	36.3	16.8	0.84	3	0.74	0
MOHC	UKESM1-0-LL	1.250 x 1.875	40.9	13.9	40.7	14.0	0.83	3	0.89	0
MOHC	UKESM1-1-LL	1.250 x 1.875	40.3	12.2	40.7	14.1	0.86	3	0.88	0
MPI-M	MPI-ESM1-2-HR	0.938 x 0.938	36.0	10.7	34.3	16.6	0.83	2	0.76	0
MPI-M	MPI-ESM1-2-LR	1.875 x 1.875	44.2	9.2	35.8	19.3	0.87	2	0.90	0
MRI	MRI-ESM2-0	1.125 x 1.125	39.7	14.2	41.0	17.0	0.87	2	0.78	0
NASA-GISS	GISS-E2-1-G	2.000 x 2.500	52.6	16.9	51.2	16.6	0.88	4	0.76	1
NASA-GISS	GISS-E2-1-G-CC	2.000 x 2.500	52.2	16.0	51.3	14.3	0.87	3	0.74	1
NASA-GISS	GISS-E2-1-H	2.000 x 2.500	46.5	15.8	45.8	14.1	0.87	3	0.82	0
NASA-GISS	GISS-E2-2-H	2.000 x 2.500	35.7	11.9	32.2	21.4	0.79	1	0.57	0
NCAR	CESM2	0.938 x 1.250	44.8	14.6	42.5	17.3	0.86	3	0.86	0
NCAR	CESM2-FV2	1.875 x 2.500	49.6	17.7	47.6	16.5	0.89	3	0.88	0
NCAR	CESM2-WACCM	0.938 x 1.250	43.1	13.6	42.6	14.5	0.88	3	0.87	0
NCAR	CESM2-WACCM-FV2	1.875 x 2.500	47.7	17.3	45.5	17.0	0.89	2	0.85	0
NCC	NorCPM1	1.875 x 2.500	41.5	15.3	43.4	15.8	0.82	3	0.78	0
NCC	NorESM2-LM	1.875 x 2.500	42.4	15.5	42.6	14.9	0.82	3	0.85	0
NCC	NorESM2-MM	0.938 x 1.250	44.1	11.1	42.1	13.6	0.83	3	0.86	0
NIMS-KMA	KACE-1-0-G	1.250 x 1.875	31.8	16.6	32.7	16.7	0.81	2	0.76	0
NOAA-GFDL	GFDL-CM4	1.000 x 1.250	38.3	12.8	38.8	14.0	0.83	2	0.88	0
NOAA-GFDL	GFDL-ESM4	1.000 x 1.250	44.6	9.8	44.4	14.8	0.85	2	0.89	0
NUIST	NESM3	1.875 x 1.875	38.3	12.4	34.7	18.1	0.80	1	0.80	0
SNU	SAM0-UNICON	0.938 x 1.250	39.7	15.8	40.4	13.4	0.87	2	0.86	0
THU	CIESM	0.938 x 1.250	45.0	13.4	41.4	14.3	0.84	3	0.87	0
UA	MCM-UA-1-0	2.250 x 3.750	30.7	12.9	29.3	18.1	0.81	1	0.78	0

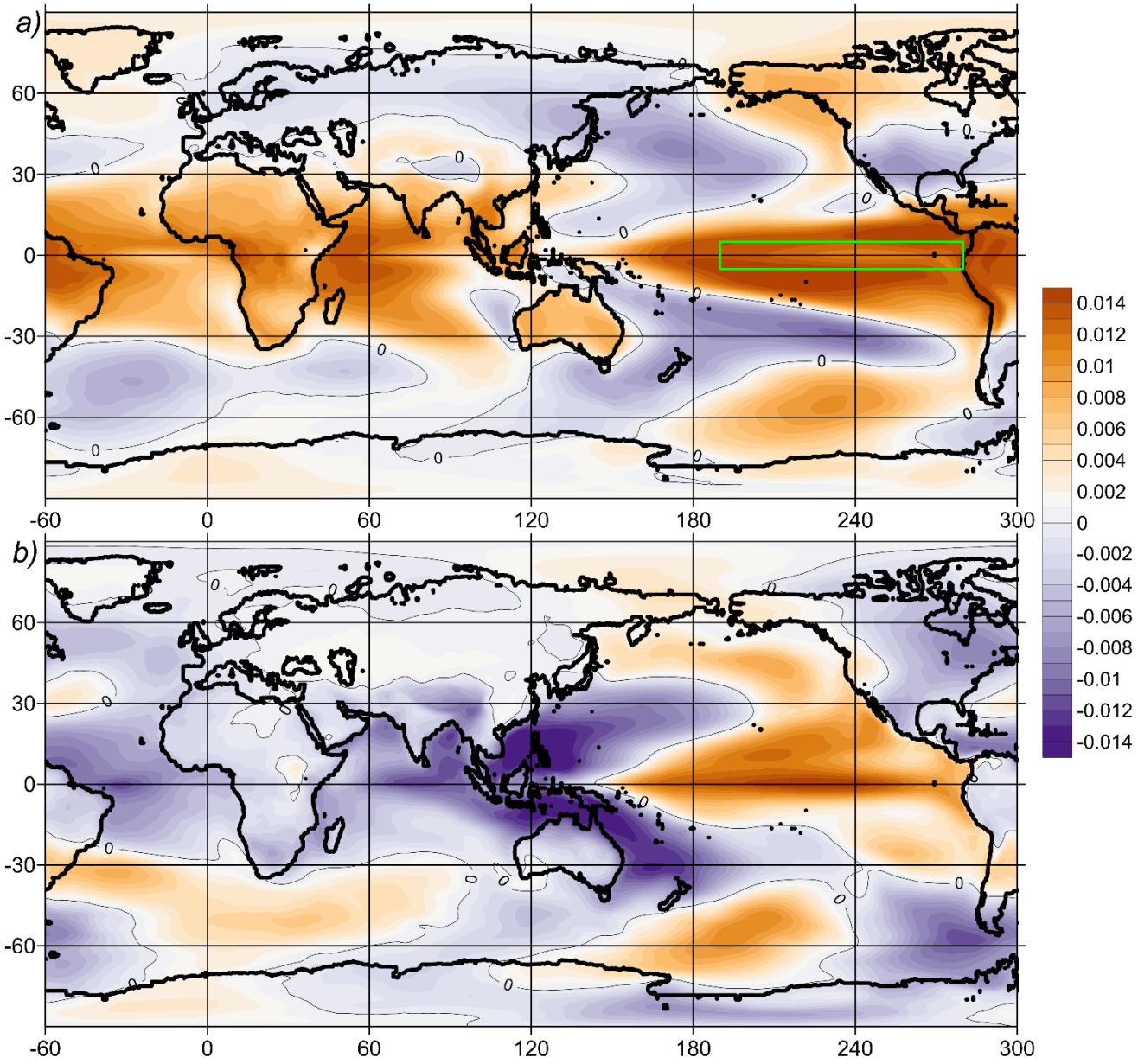


Figure S1. Average 1st (a) and 2nd (b) principal components of interannual variability of surface air temperature (SAT) anomalies for 58 (a) and 23 (b) CMIP6 models (Historical experiment). The green rectangle marks the region for which ONI is calculated.

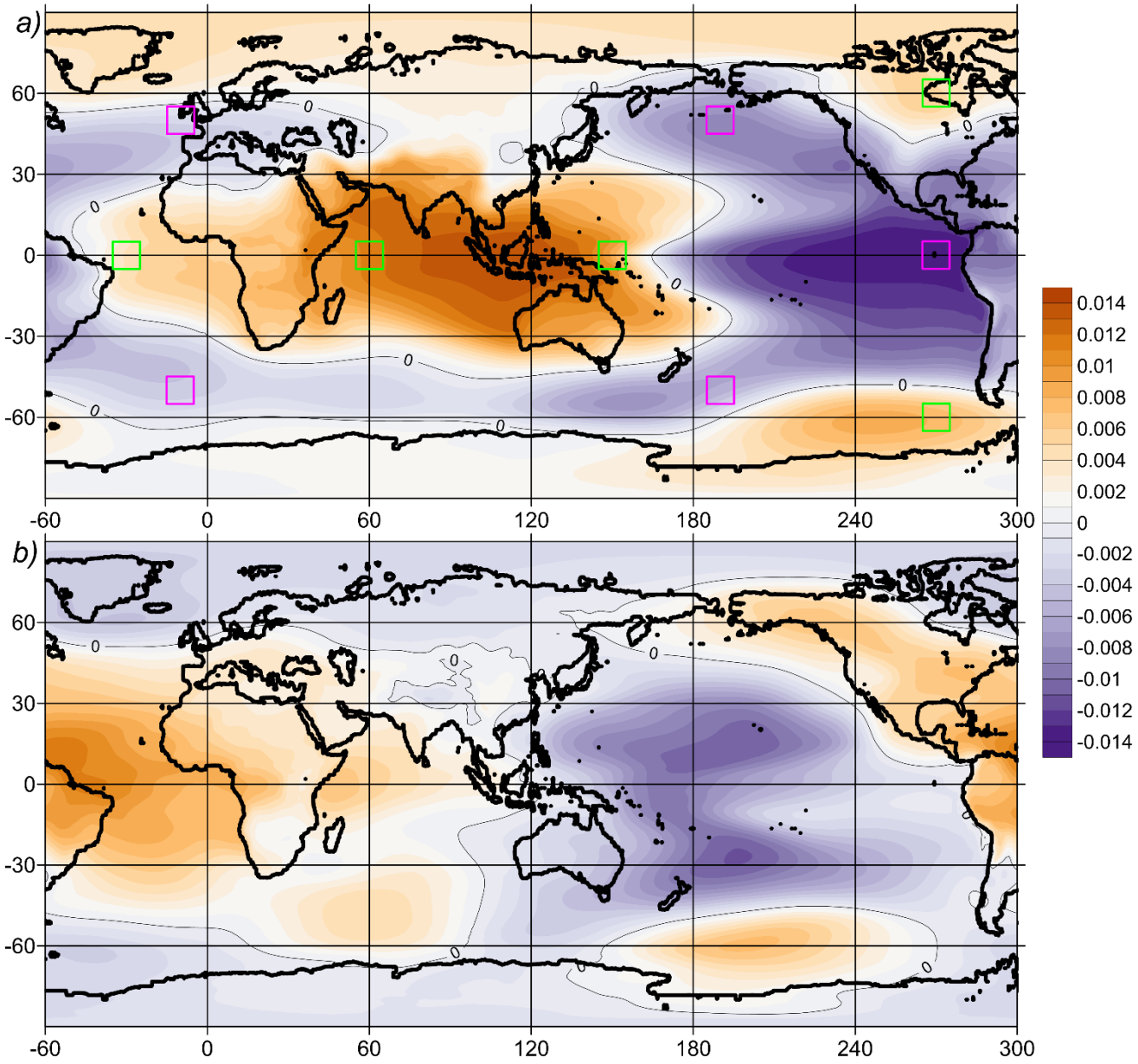


Figure S2. Average 1st (a) and 2nd (b) principal components of interannual variability of sea level pressure (SLP) anomalies for 58 (a) and 23 (b) CMIP6 models (Historical experiment). Green and purple squares highlight the regions for which GAO1 is calculated.

Table S2. Cross-correlations of the 1st and 2nd empirical orthogonal functions of the SAT and SLP anomalies with each other as well as with PGAO (CMIP6 Historical).

Model name	Max. corr. EOF1 SAT and EOF1 SLP	Shift of EOF1 SAT and EOF1 SLP (mon.)	Max. corr. EOF2 SAT and EOF2 SLP	Shift of EOF2 SAT and EOF2 SLP (mon.)	Max. corr. EOF1 SAT and EOF2 SLP	Shift of EOF1 SAT and EOF2 SLP (mon.)	Max. corr. EOF1 SLP and EOF2 SLP	Shift EOF1 SLP and EOF2 SLP (mon.)	Corr. EOF2 SAT and PGAO	Corr. EOF2 SLP and PGAO	Is the model included in the PC2 calculation?
TaiESM1	0.91	1	0.78	1	0.67	8	0.54	7	0.65	0.85	yes
AWI-CM-1-1-MR	0.74	1	0.12	15	0.50	5	0.45	0	0.51	0.02	no
AWI-ESM-1-1-LR	0.57	1	0.25	0	0.45	5	0.59	0	0.36	0.07	no
BCC-CSM2-MR	0.74	1	0.54	0	0.14	-38	0.47	0	0.04	0.05	no
BCC-ESM1	0.71	1	0.49	1	0.20	-8	0.58	0	0.35	0.06	no
CAMS-CSM1-0	0.71	1	0.08	9	0.46	-10	0.37	0	0.14	0.05	no
CAS-ESM2-0	0.72	1	0.21	-1	0.49	6	0.67	0	0.64	0.15	no
FGOALS-f3-L	0.79	1	0.35	0	0.70	7	0.32	0	0.36	0.18	yes
FGOALS-g3	0.81	1	0.12	29	0.59	-11	0.36	0	0.31	0.21	yes
CanESM5	0.62	1	0.42	0	0.38	-15	0.63	0	0.24	0.06	no
CanESM5-CanOE	0.64	3	0.14	2	0.48	-15	0.20	0	0.58	0.10	no
IITM-ESM	0.66	2	0.55	1	0.42	7	0.38	-5	0.49	0.67	yes
CMCC-CM2-SR5	0.84	1	0.17	-10	0.54	11	0.33	0	0.63	0.09	no
CMCC-ESM2	0.85	1	0.53	2	0.56	10	0.36	14	0.43	0.79	yes
CNRM-CM6-1	0.79	2	0.42	0	0.49	-10	0.16	5	0.20	0.06	no
CNRM-CM6-1-HR	0.33	0	0.45	0	0.42	-10	0.74	0	0.30	0.09	no
CNRM-ESM2-1	0.77	1	0.08	-20	0.47	-10	0.35	0	0.37	0.03	no
ACCESS-CM2	0.74	1	0.58	1	0.47	-8	0.47	0	0.42	0.49	yes
ACCESS-ESM1-5	0.76	1	0.37	0	0.57	-12	0.27	0	0.26	0.13	no
E3SM-1-0	0.82	1	0.32	0	0.40	7	0.16	4	0.58	0.34	yes
E3SM-1-1	0.80	1	0.12	-3	0.51	6	0.33	0	0.61	0.19	yes
E3SM-1-1-ECA	0.82	1	0.16	1	0.50	6	0.21	0	0.59	0.04	no
EC-Earth3	0.74	1	0.16	1	0.32	-11	0.26	0	0.47	0.12	no
EC-Earth3-AerChem	0.66	1	0.31	0	0.44	-8	0.13	35	0.44	0.08	no
EC-Earth3-Veg	0.76	1	0.18	1	0.43	-10	0.15	33	0.42	0.13	no
FIO-ESM-2-0	0.80	1	0.60	1	0.52	9	0.35	-1	0.63	0.73	yes
MPI-ESM-1-2-HAM	0.70	1	0.18	0	0.48	9	0.64	0	0.34	0.15	no
INM-CM4-8	0.15	17	0.47	1	0.31	-17	0.47	0	0.56	0.40	yes
INM-CM5-0	0.45	1	0.19	0	0.27	-12	0.25	0	0.47	0.10	no
IPSL-CM6A-LR	0.68	2	0.33	0	0.47	-14	0.20	0	0.21	0.08	no
KIOST-ESM	0.74	2	0.34	0	0.52	-11	0.30	0	0.13	0.02	no
MIROC-ES2L	0.88	3	0.41	3	0.73	11	0.28	16	0.41	0.34	yes
MIROC6	0.85	4	0.19	10	0.64	10	0.15	-13	0.41	0.21	yes
HadGEM3-GC31-LL	0.74	1	0.10	-46	0.37	-12	0.34	0	0.47	0.07	no
HadGEM3-GC31-MM	0.76	1	0.54	1	0.45	7	0.28	7	0.55	0.60	yes
UKESM1-0-LL	0.81	1	0.14	-2	0.50	-11	0.40	0	0.70	0.06	no
UKESM1-1-LL	0.81	1	0.17	-13	0.49	7	0.40	0	0.60	0.02	no
MPI-ESM1-2-HR	0.71	1	0.27	0	0.40	10	0.65	0	0.41	0.12	no
MPI-ESM1-2-LR	0.78	1	0.15	2	0.48	-15	0.11	0	0.25	0.20	yes
MRI-ESM2-0	0.85	1	0.09	10	0.49	7	0.38	0	0.56	0.05	no
GISS-E2-1-G	0.85	2	0.67	1	0.69	9	0.46	8	0.08	0.59	no
GISS-E2-1-G-CC	0.82	2	0.65	1	0.65	-15	0.39	6	0.03	0.51	no
GISS-E2-1-H	0.79	1	0.56	1	0.62	8	0.34	0	0.27	0.41	yes
GISS-E2-2-H	0.56	2	0.15	1	0.48	-11	0.65	0	0.49	0.04	no
CESM2	0.88	1	0.56	1	0.62	7	0.37	10	0.59	0.76	yes
CESM2-FV2	0.90	1	0.77	1	0.72	7	0.55	8	0.56	0.80	yes
CESM2-WACCM	0.88	1	0.22	3	0.46	7	0.22	0	0.47	0.34	yes
CESM2-WACCM-FV2	0.92	1	0.69	1	0.69	7	0.49	8	0.48	0.76	yes
NorCPM1	0.85	1	0.10	1	0.59	8	0.41	0	0.52	0.10	no
NorESM2-LM	0.86	1	0.30	1	0.65	7	0.23	0	0.35	0.42	yes
NorESM2-MM	0.86	1	0.26	14	0.68	6	0.28	17	0.26	0.49	yes
KACE-1-0-G	0.78	1	0.12	4	0.53	6	0.57	0	0.68	0.14	no
GFDL-CM4	0.77	1	0.18	0	0.40	-9	0.17	1	0.64	0.22	yes
GFDL-ESM4	0.82	1	0.29	0	0.40	-15	0.16	1	0.30	0.11	no
NESM3	0.79	1	0.30	1	0.30	-11	0.18	0	0.31	0.14	no
SAM0-UNICON	0.87	1	0.40	1	0.52	8	0.29	12	0.68	0.56	yes
CIESM	0.85	1	0.13	1	0.56	-11	0.21	0	0.54	0.07	no
MCM-UA-1-0	0.77	1	0.07	-53	0.38	-21	0.06	25	0.48	0.11	no

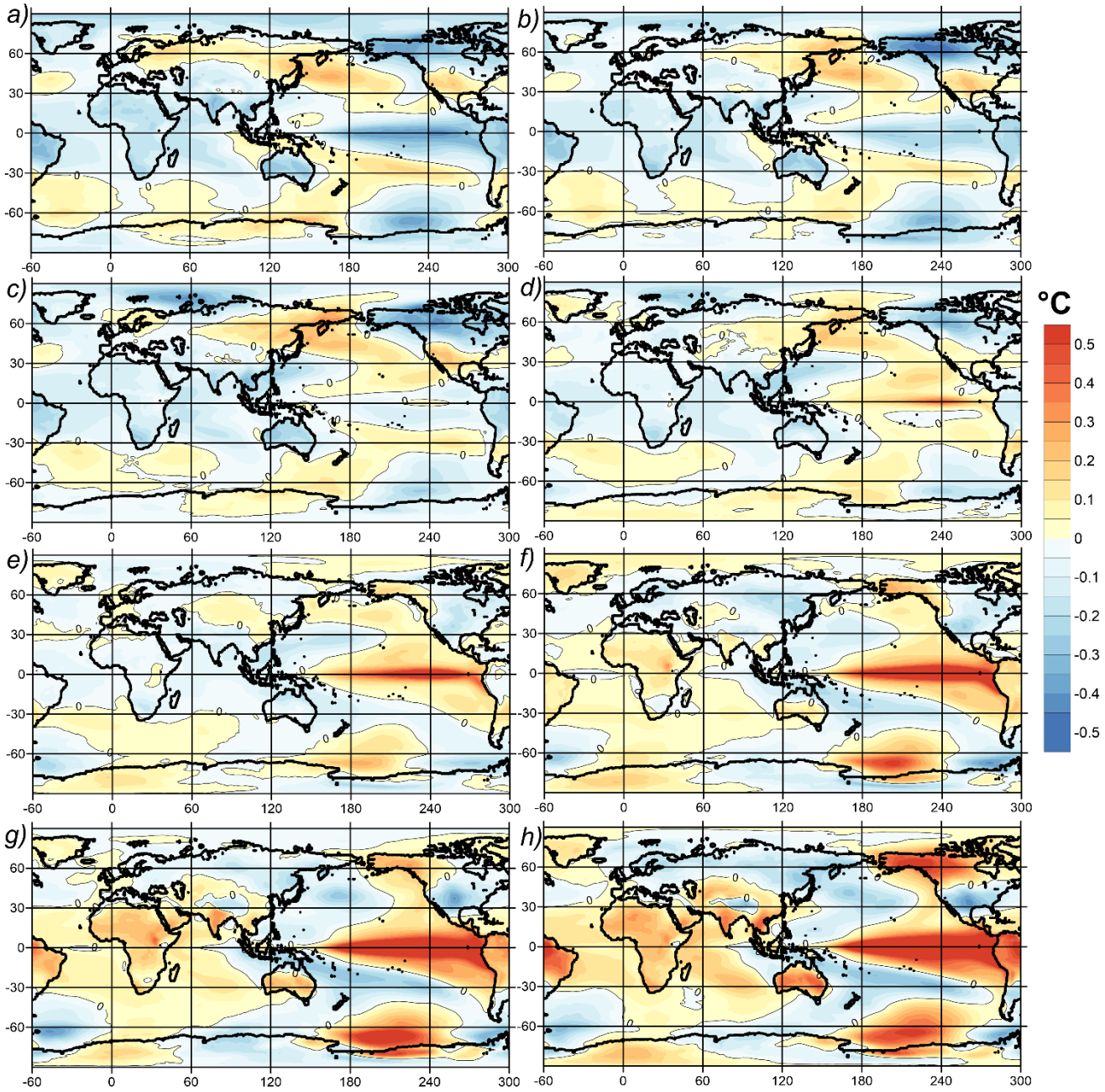


Figure S3. Average compositional fields of SAT anomalies with shifts -14 (a), -12 (b), -10 (c), -8 (d), -6 (e), -4 (f), -2 (g) and 0 (h) months from maximum of El Niño events for 58 CMIP6 models (Historical experiment).

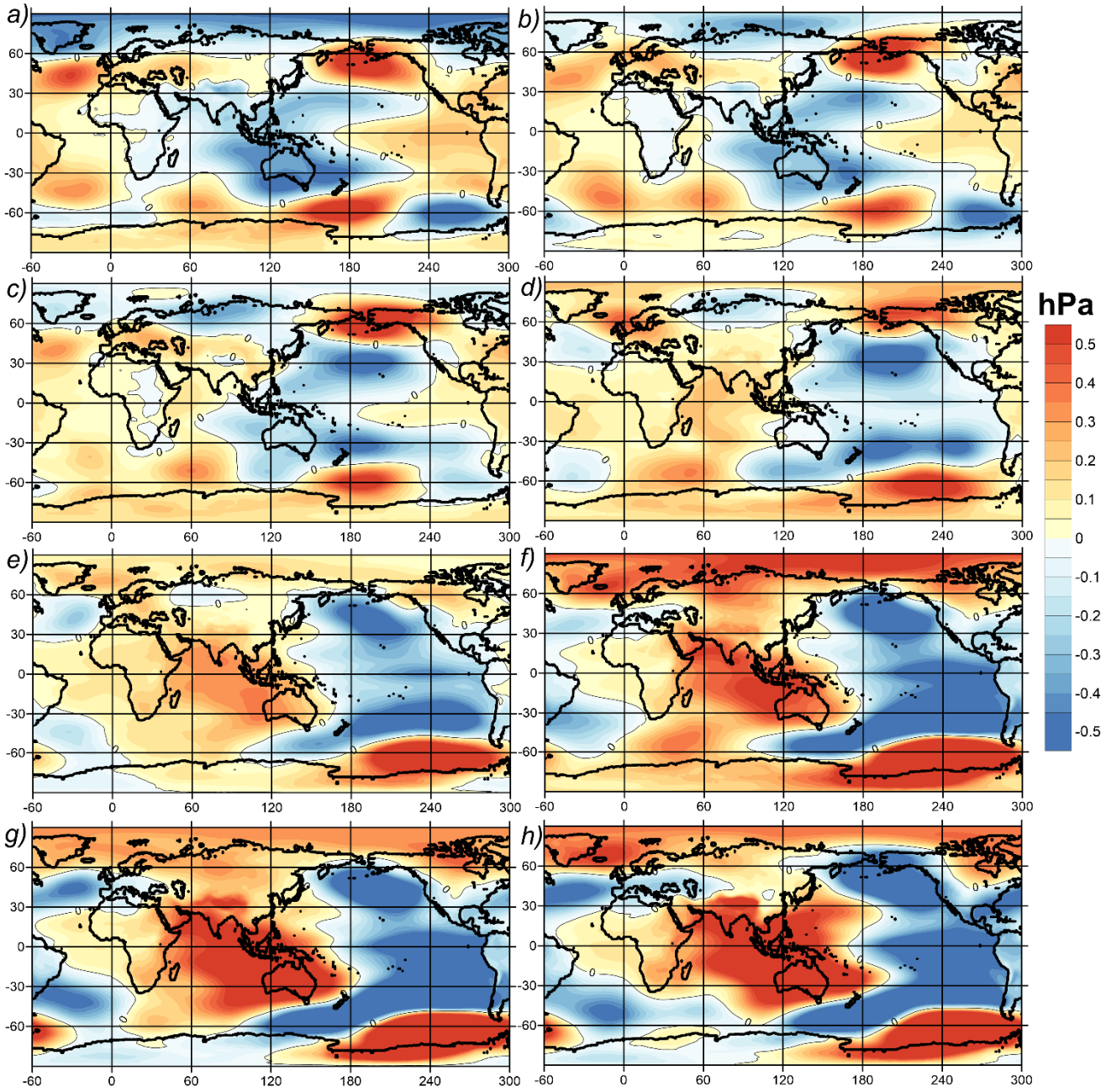


Figure S4. Average compositional fields of SLP anomalies with shifts -14 (a), -12 (b), -10 (c), -8 (d), -6 (e), -4 (f), -2 (g) and 0 (h) months from maximum of El Niño events for 58 CMIP6 models (Historical experiment).

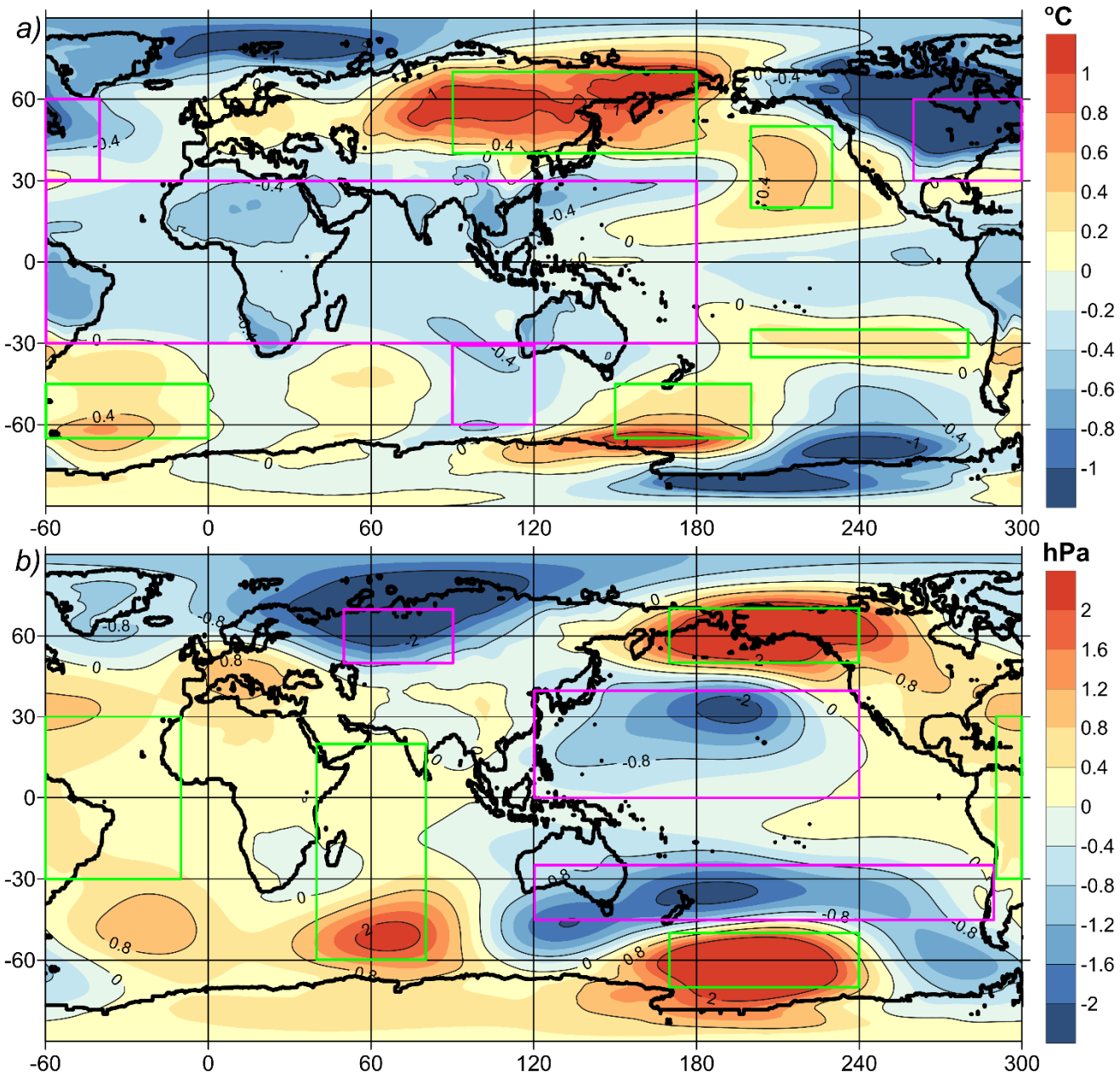


Figure S5. Average compositional fields of SAT (a) and SLP (b) anomalies by PGAO index and leading by approximately 12 months to the maximum of El Niño events according to 58 CMIP6 models (Historical experiment). The regions for which PGAO is calculated are highlighted in green and purple.

Table S3. Cross-spectral and correlation analysis of the ONI. PGAO indices and their EOF1 and EOF2 combined for SAT and SLP (CMIP6 Historical).

Model name	Max. corr. of EOF2 and PGAO	EOF2 and PGAO shift (mon.)	Max. corr. of EOF2 and EOF1	EOF2 and EOF1 shift (mon.)	Max. corr. EOF2 and ONI	EOF2 and ONI shift (mon.)	Max. corr. PGAO and ONI filter from 2 to 7 years	PGAO and ONI shift (mon.)	Coherence of PGAO and ONI periods from 2 to 7 years	Phase relationships of PGAO and ONI (°)
TaiESM1	0.82	1	0.67	-8	0.73	-6	0.84	-11	0.82	-117.3
AWI-CM-1-1-MR	0.35	0	0.37	-6	0.40	-2	0.51	-8	0.72	-29.0
AWI-ESM-1-1-LR	0.36	2	0.66	0	0.52	-2	0.38	-8	0.64	-28.9
BCC-CSM2-MR	-0.11	3	-0.24	0	-0.13	27	0.32	-7	0.73	-33.4
BCC-ESM1	0.30	2	0.42	0	0.20	-3	0.41	-6	0.61	-11.5
CAMS-CSM1-0	0.33	8	0.50	-1	0.49	-1	0.68	-11	0.78	-142.6
CAS-ESM2-0	0.55	1	0.58	-1	0.46	-1	0.71	-8	0.79	-62.6
FGOALS-f3-L	0.48	6	0.57	-7	0.62	-5	0.84	-11	0.79	-139.3
FGOALS-g3	0.20	4	0.48	-1	0.56	-3	0.52	-10	0.73	-33.3
CanESM5	0.25	5	0.50	0	0.43	-2	0.36	-10	0.63	-17.7
CanESM5-CanOE	0.47	1	0.44	-1	0.59	-2	0.58	-9	0.74	-49.8
IITM-ESM	0.67	0	0.46	-7	0.50	-4	-0.61	7	0.78	-139.0
CMCC-CM2-SR5	0.45	2	0.46	-7	0.55	-4	0.70	-12	0.80	-130.4
CMCC-ESM2	0.71	0	0.54	-12	0.61	-8	0.75	-14	0.77	-136.1
CNRM-CM6-1	0.29	7	0.41	-5	0.47	-2	0.59	-10	0.70	-43.6
CNRM-CM6-1-HR	0.27	2	-0.33	12	0.52	-3	-0.58	8	0.74	-128.8
CNRM-ESM2-1	0.28	4	-0.33	11	0.43	-2	0.66	-9	0.78	-47.4
ACCESS-CM2	0.54	1	-0.42	7	0.53	-5	0.68	-9	0.80	-128.1
ACCESS-ESM1-5	0.23	0	-0.33	12	-0.31	15	0.46	-13	0.68	-152.6
E3SM-1-0	0.57	0	0.37	-5	0.43	-4	0.65	-9	0.82	-51.4
E3SM-1-1	0.55	1	0.53	-4	0.52	-3	0.62	-8	0.76	-53.8
E3SM-1-1-ECA	0.37	0	0.30	-7	0.37	-4	0.66	-9	0.80	-41.9
EC-Earth3	0.39	0	-0.19	15	0.19	-6	0.48	-12	0.75	-128.9
EC-Earth3-AerChem	0.32	0	0.31	-6	0.37	-5	0.57	-9	0.76	-42.6
EC-Earth3-Veg	0.36	0	-0.31	11	0.31	-4	0.61	-12	0.75	-125.7
FIO-ESM-2-0	0.77	0	0.49	-10	0.55	-6	0.74	-10	0.82	-54.3
MPI-ESM-1-2-HAM	0.34	1	0.50	-1	0.45	-3	0.48	-12	0.70	-134.5
INM-CM4-8	0.56	0	-0.22	15	0.46	0	0.14	1	0.65	0.8
INM-CM5-0	0.37	0	-0.17	11	0.14	-5	0.31	-9	0.63	-31.5
IPSL-CM6A-LR	0.21	2	0.46	-1	0.48	-2	0.43	-11	0.66	-23.1
KIOST-ESM	0.30	7	0.41	-4	0.44	-3	-0.72	5	0.70	-143.6
MIROC-ES2L	0.49	1	0.63	-10	0.62	-10	0.81	-17	0.85	-137.8
MIROC6	0.44	1	0.51	-11	0.50	-7	0.76	-15	0.85	-126.7
HadGEM3-GC31-LL	0.39	1	0.41	-1	0.41	-2	0.62	-10	0.76	-50.7
HadGEM3-GC31-MM	0.65	1	0.47	-7	0.55	-5	-0.70	7	0.75	-130.6
UKESM1-0-LL	0.54	1	0.43	-5	0.52	-3	0.69	-9	0.78	-54.9
UKESM1-1-LL	0.49	2	0.48	-3	0.55	-2	0.64	-9	0.75	-133.5
MPI-ESM1-2-HR	0.34	1	0.47	-1	0.47	-5	0.54	-14	0.73	-135.1
MPI-ESM1-2-LR	0.32	1	0.41	-4	0.49	-4	0.51	-14	0.76	-148.0
MRI-ESM2-0	0.38	1	0.36	-7	0.43	-6	0.68	-12	0.79	-119.7
GISS-E2-1-G	-0.47	-12	0.65	-9	0.65	-8	-0.86	6	0.87	-150.6
GISS-E2-1-G-CC	0.41	11	0.60	-8	0.61	-8	-0.86	5	0.87	-145.5
GISS-E2-1-H	0.49	5	0.57	-7	0.65	-6	-0.82	7	0.85	-137.1
GISS-E2-2-H	0.36	0	-0.37	11	0.39	-5	-0.52	10	0.72	-143.8
CESM2	0.77	0	0.56	-8	0.58	-5	-0.72	9	0.82	-117.7
CESM2-FV2	0.75	1	0.69	-8	0.70	-6	0.81	-10	0.81	-46.2
CESM2-WACCM	0.54	0	0.44	-7	0.42	-5	0.68	-11	0.77	-125.8
CESM2-WACCM-FV2	0.71	1	0.67	-7	0.66	-5	0.82	-11	0.79	-130.1
NorCPM1	0.45	1	0.43	-7	0.46	-2	0.73	-9	0.81	-51.2
NorESM2-LM	0.48	0	0.51	-7	0.53	-5	0.81	-12	0.84	-124.8
NorESM2-MM	0.50	0	0.63	-6	0.69	-3	0.72	-12	0.82	-121.9
KACE-1-0-G	0.56	1	0.40	-6	0.52	-4	0.69	-8	0.80	-125.4
GFDL-CM4	0.56	0	0.40	-5	0.48	-4	0.64	-9	0.67	-51.6
GFDL-ESM4	0.28	1	0.32	-5	0.38	-4	0.61	-11	0.78	-34.4
NESM3	0.30	1	0.30	-2	0.35	-3	0.60	-11	0.77	-121.1
SAM0-UNICON	0.75	0	0.50	-10	0.55	-7	0.72	-10	0.83	-57.1
CIESM	0.39	6	-0.44	15	0.49	-4	0.74	-13	0.86	-125.4
MCM-UA-1-0	0.41	1	-0.25	24	0.20	-6	0.32	-14	0.61	-148.0

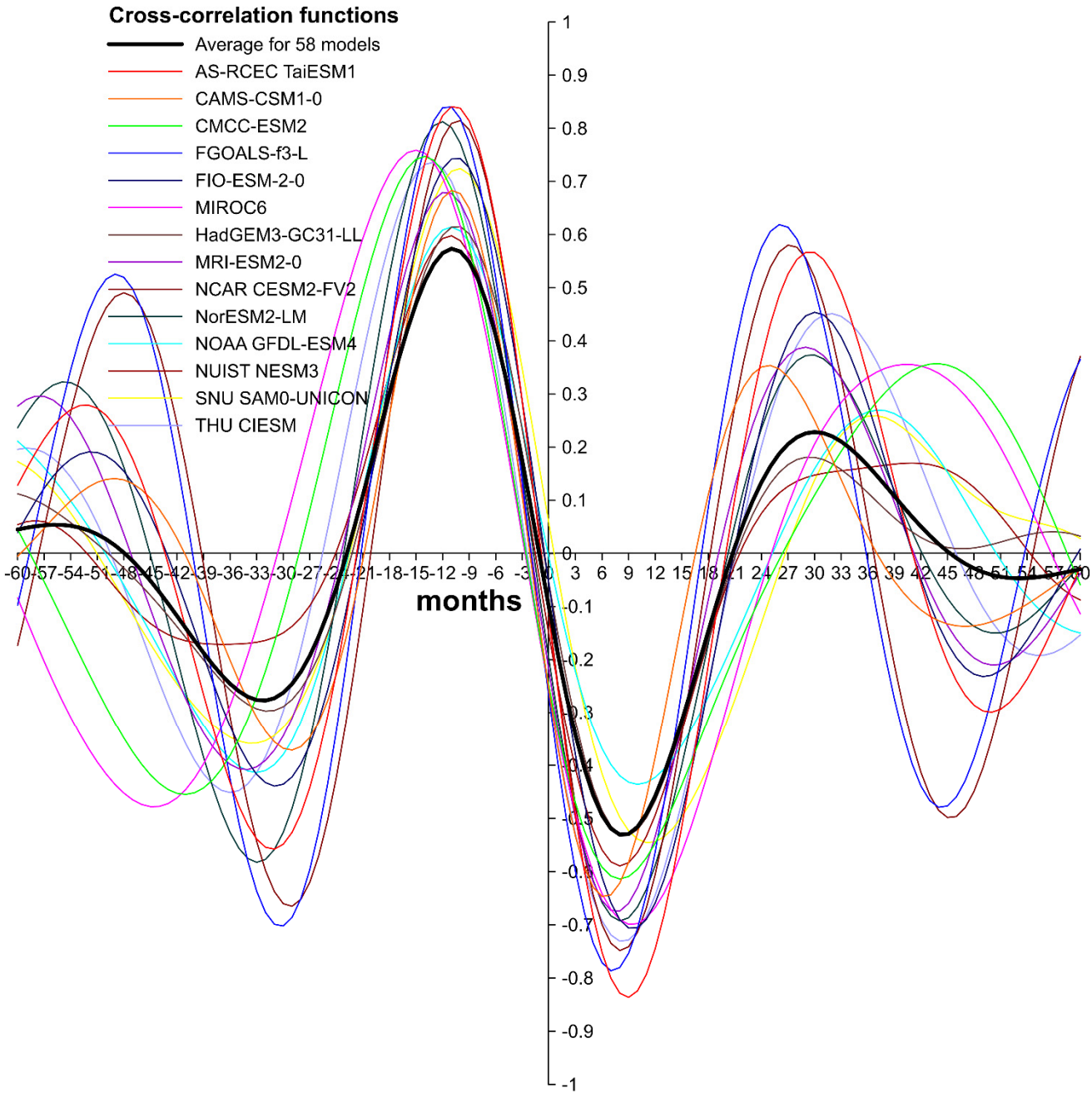


Figure S6. Cross-correlation functions with shifts from -60 to +60 months of the ONI and PGAO indices: average for 58 CMIP6 models (black); separately for models TaiESM1, CAMS-CSM1-0, CMCC-ESM2, FGOALS-f3-L, FIO-ESM-2-0, MIROC6, HadGEM3-GC31-LL, MRI-ESM2-0, CESM2-FV2, NorESM2-LM, GFDL-ESM4, NESM3, SAM0-UNICON and CIESM (Historical experiment). PGAO outperforms ONI at negative shifts.

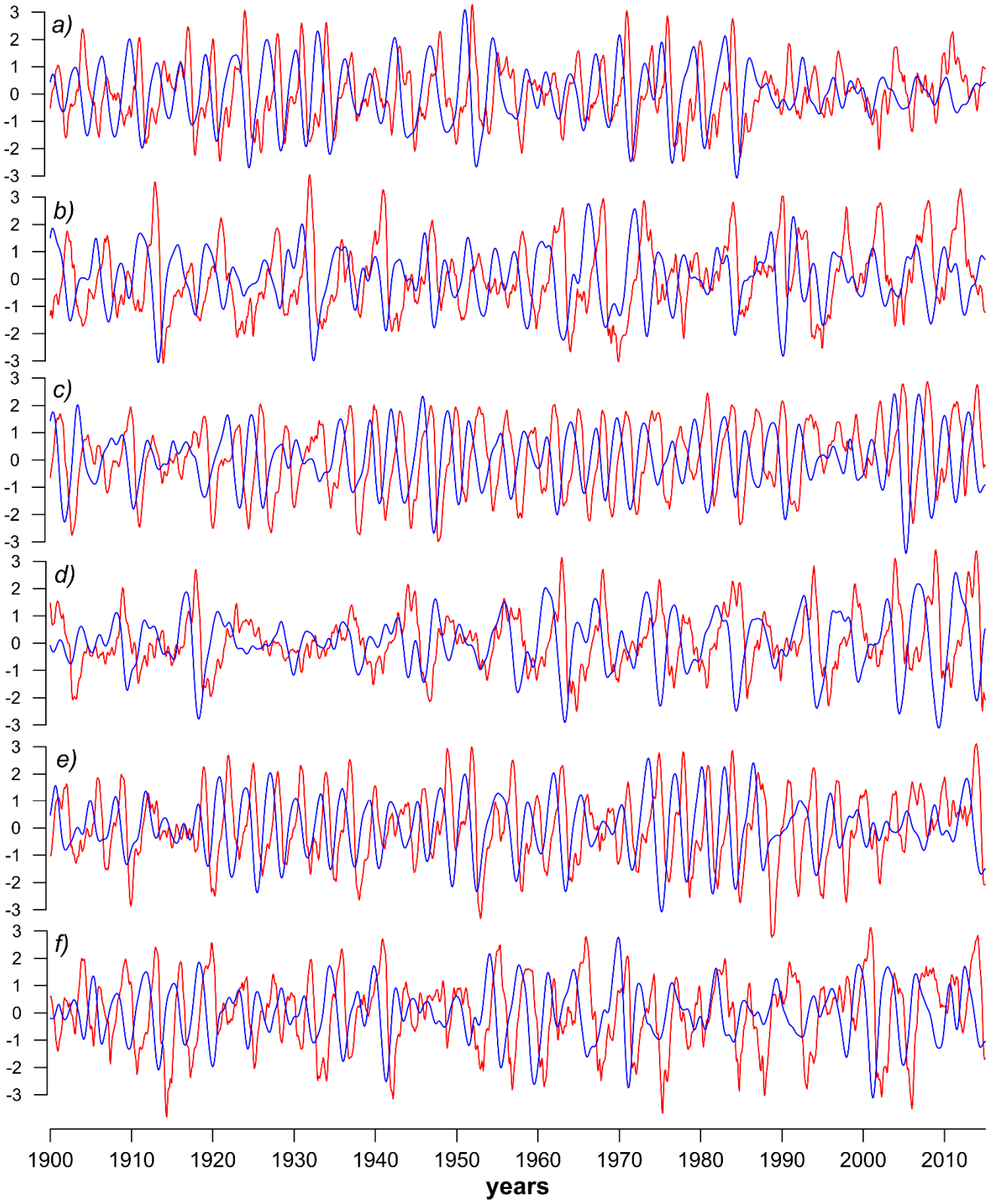


Figure S7. ONI (red) and the ENSO-predictor index (PGAO) (blue) indices for 1900–2014 of the Historical experiment of the CMIP6 models: TaiESM1 (a), CMCC-ESM2 (b), FGOALS-f3-L (c), MIROC6 (d), CESM2-FV2 (e) and NorESM2-LM (f).

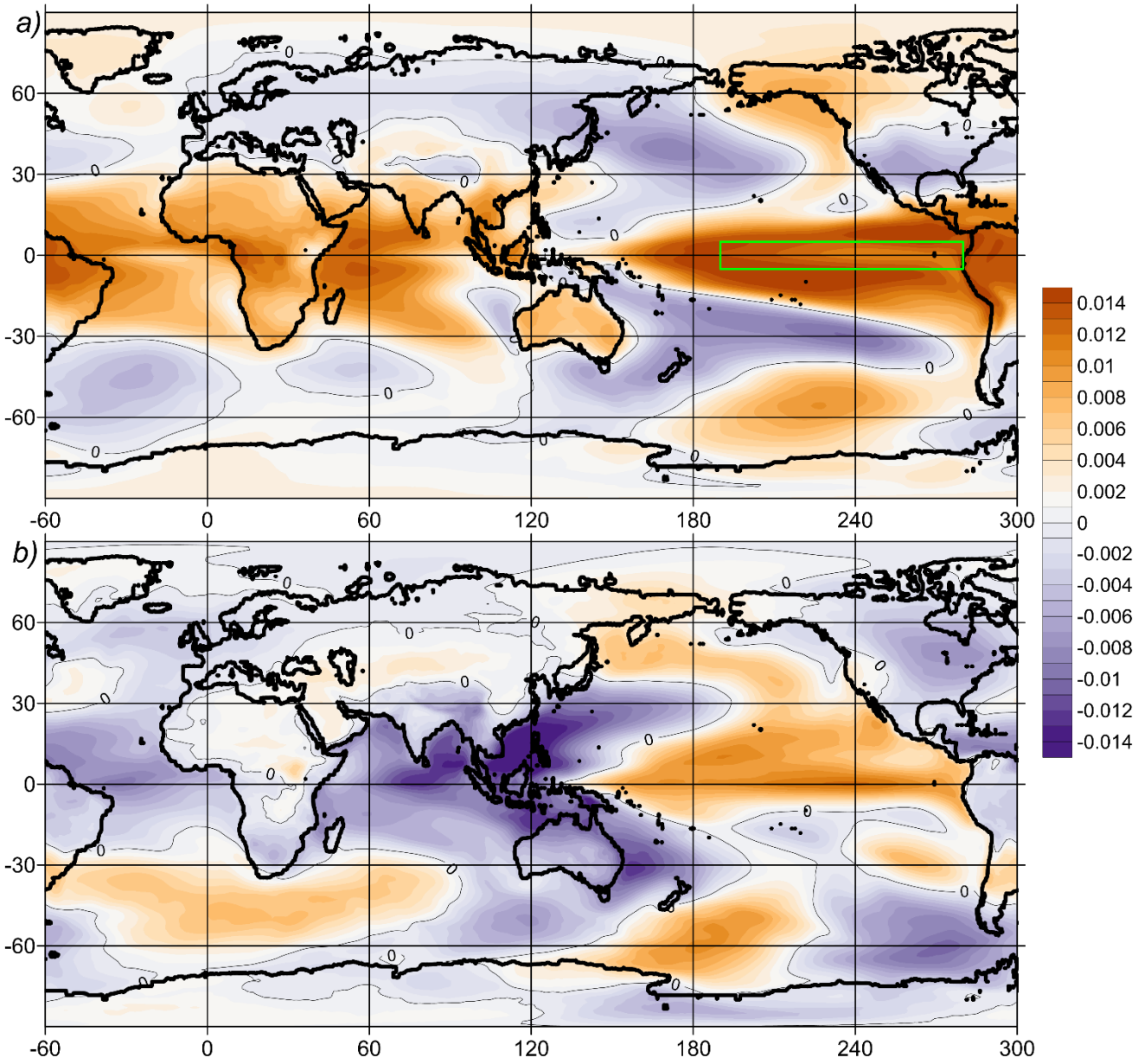


Figure S8. Average 1st (a) and 2nd (b) principal components of interannual variability of surface air temperature (SAT) anomalies for the first 150 years of the piControl experiment.

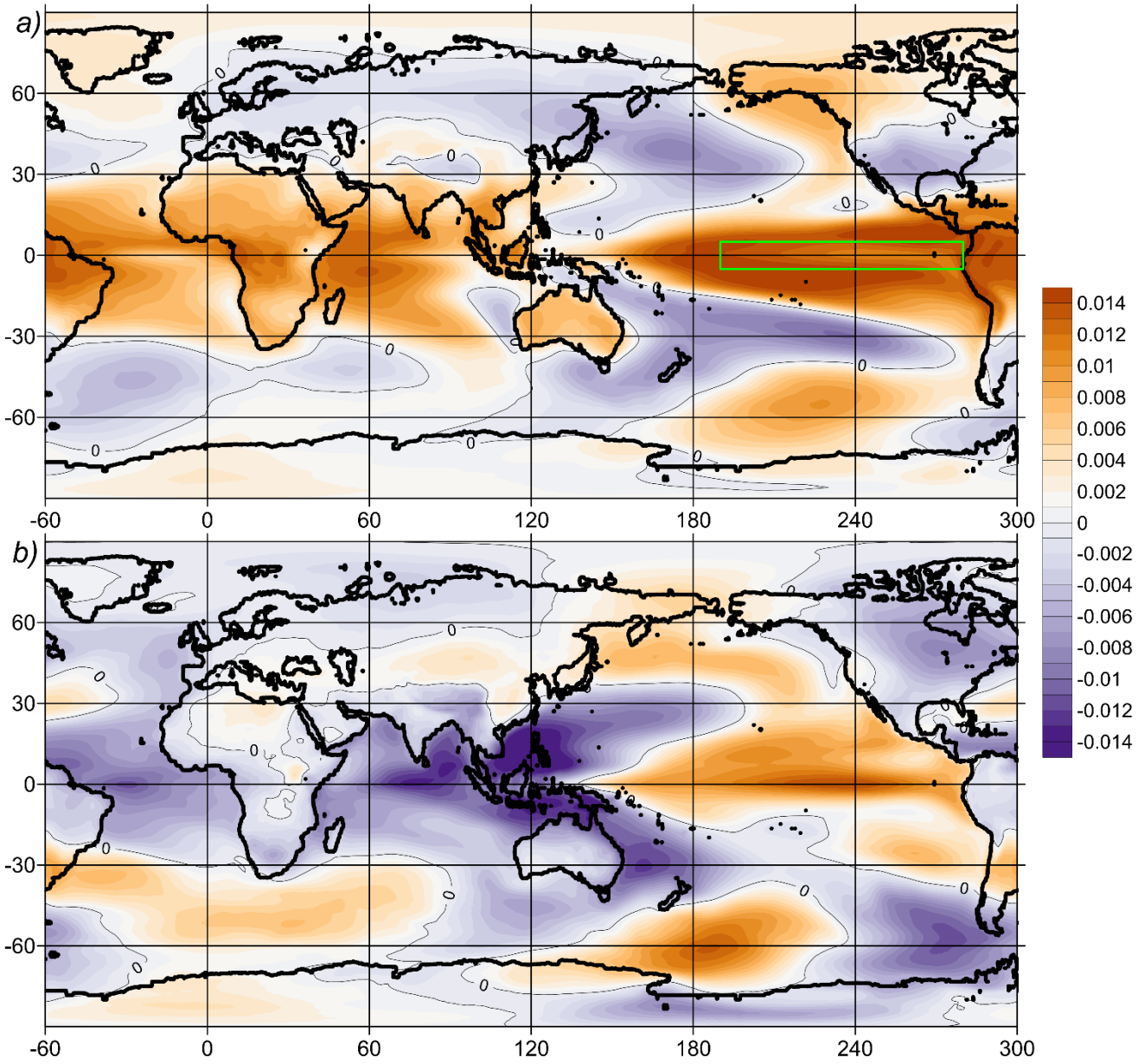


Figure S9. Average 1st (a) and 2nd (b) principal components of interannual variability of surface air temperature (SAT) anomalies for the 2nd 150 years of the piControl experiment.

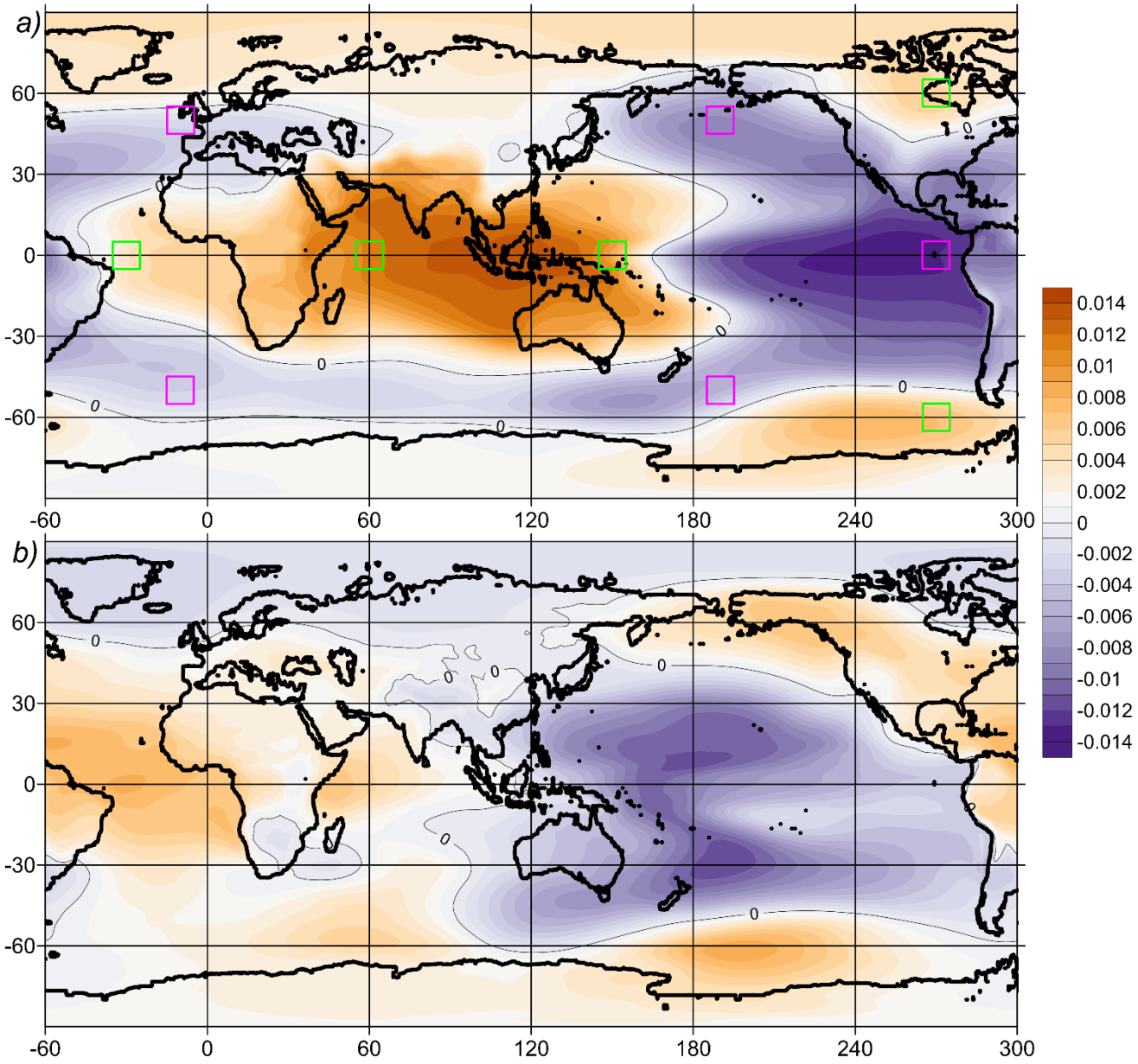


Figure S10. Average 1st (a) and 2nd (b) principal components of interannual variability of sea level pressure (SLP) anomalies for the first 150 years of the piControl experiment.

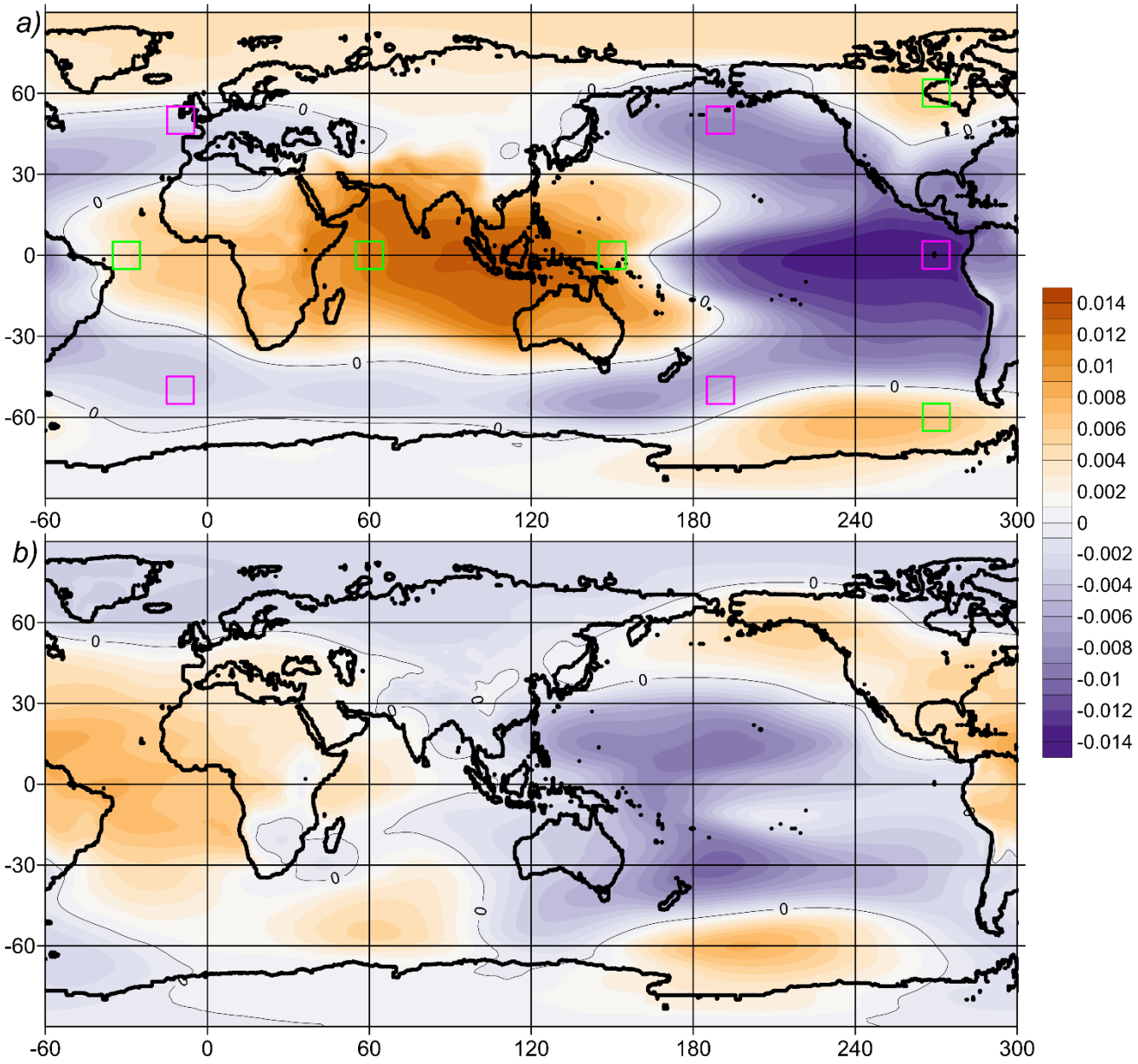


Figure S11. Average 1st (a) and 2nd (b) principal components of interannual variability of sea level pressure (SLP) anomalies for the 2nd 150 years of the piControl experiment.

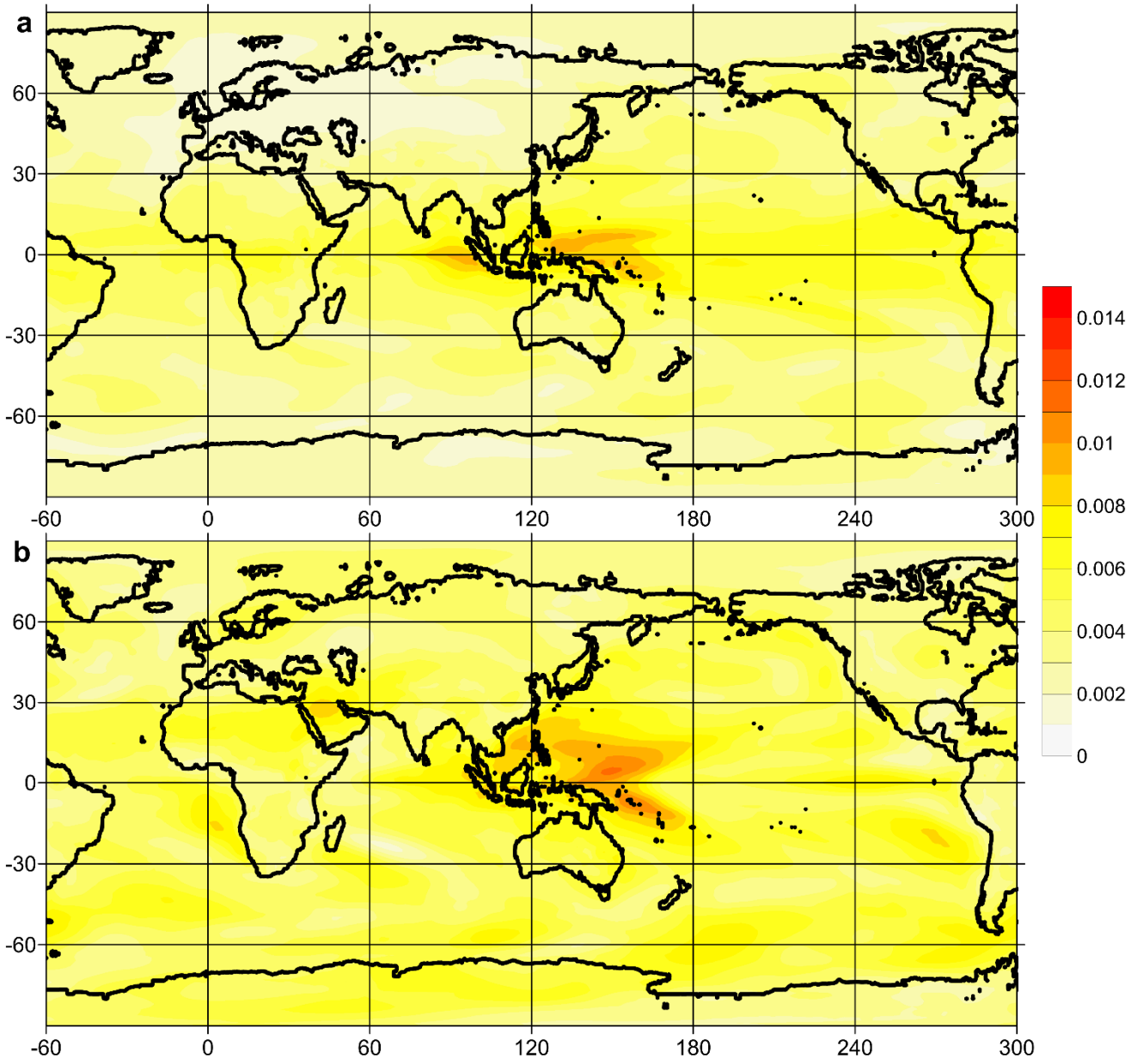


Figure S12. Inter-model standard deviations for 1st (a) and 2nd (b) principal components of interannual variability of surface air temperature (SAT) anomalies for 50 and 28 CMIP6 models.

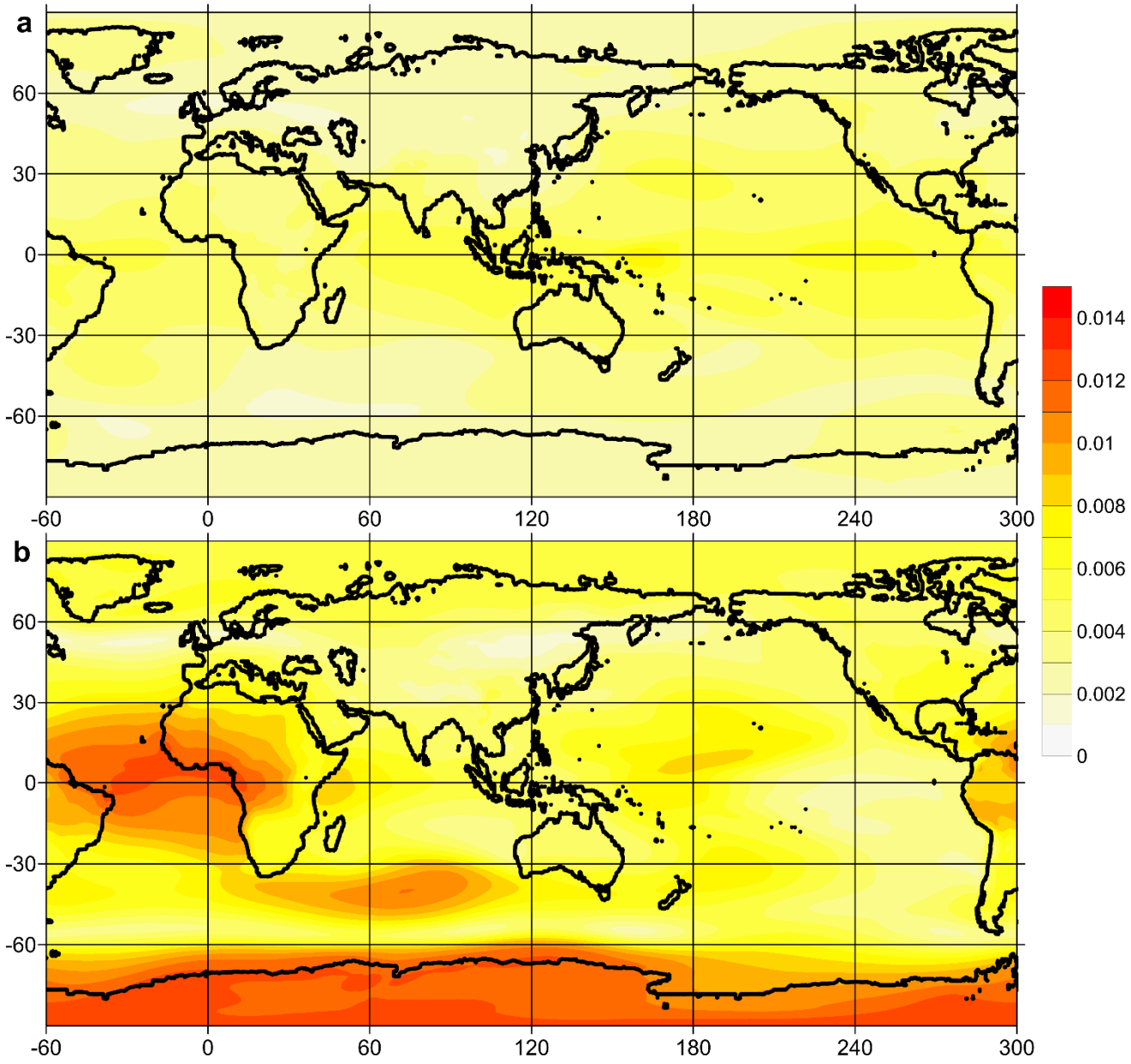


Figure S13. Inter-model standard deviations for 1st (a) and 2nd (b) principal components of interannual variability of sea level pressure (SLP) anomalies for 50 and 28 CMIP6 models.

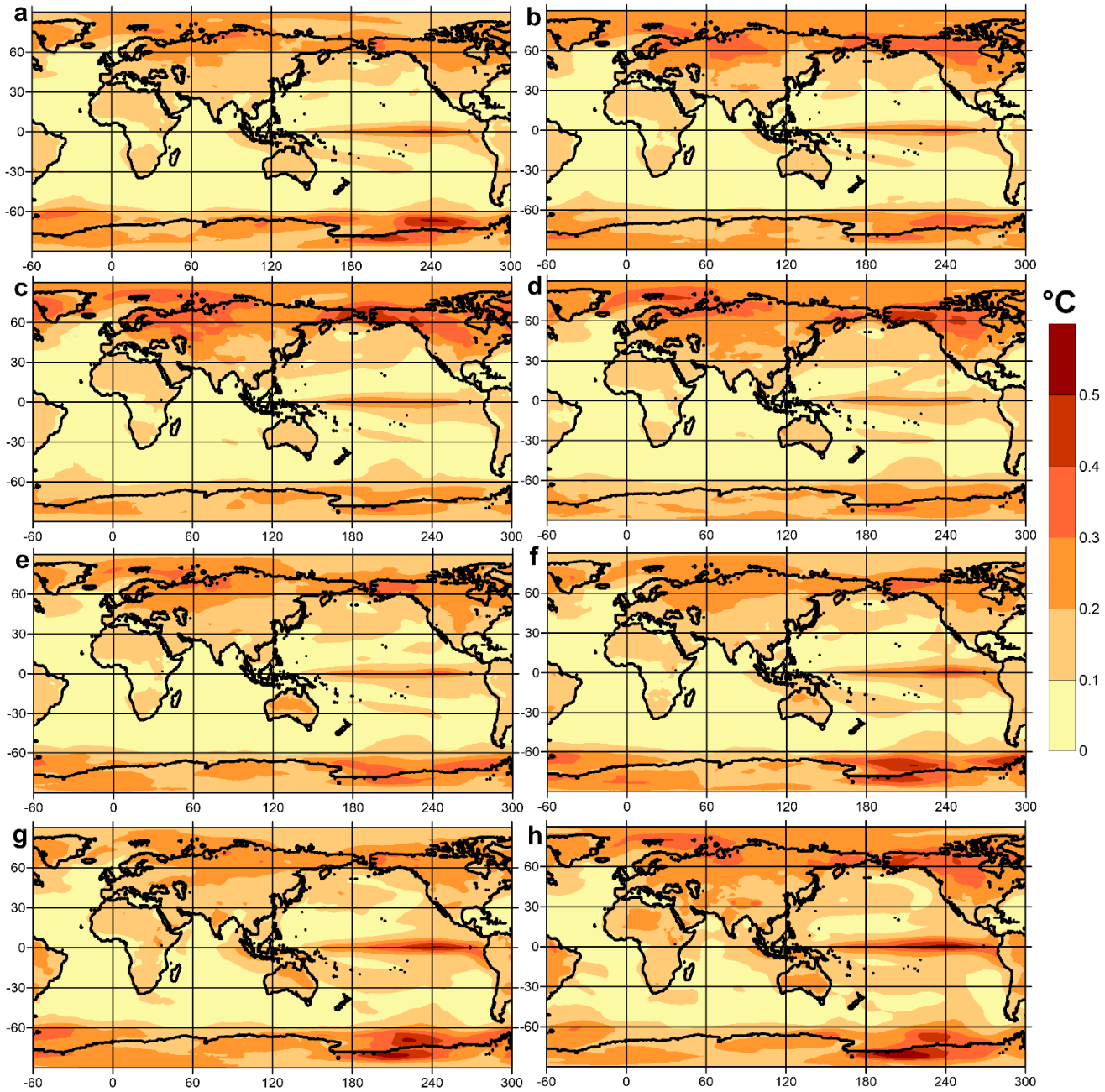


Figure S14. Inter-model standard deviations for compositional fields of SAT anomalies with shifts -14 (a), -12 (b), -10 (c), -8 (d), -6 (e), -4 (f), -2 (g) and 0 (h) months from maximum of El Niño events for 50 CMIP6 models.

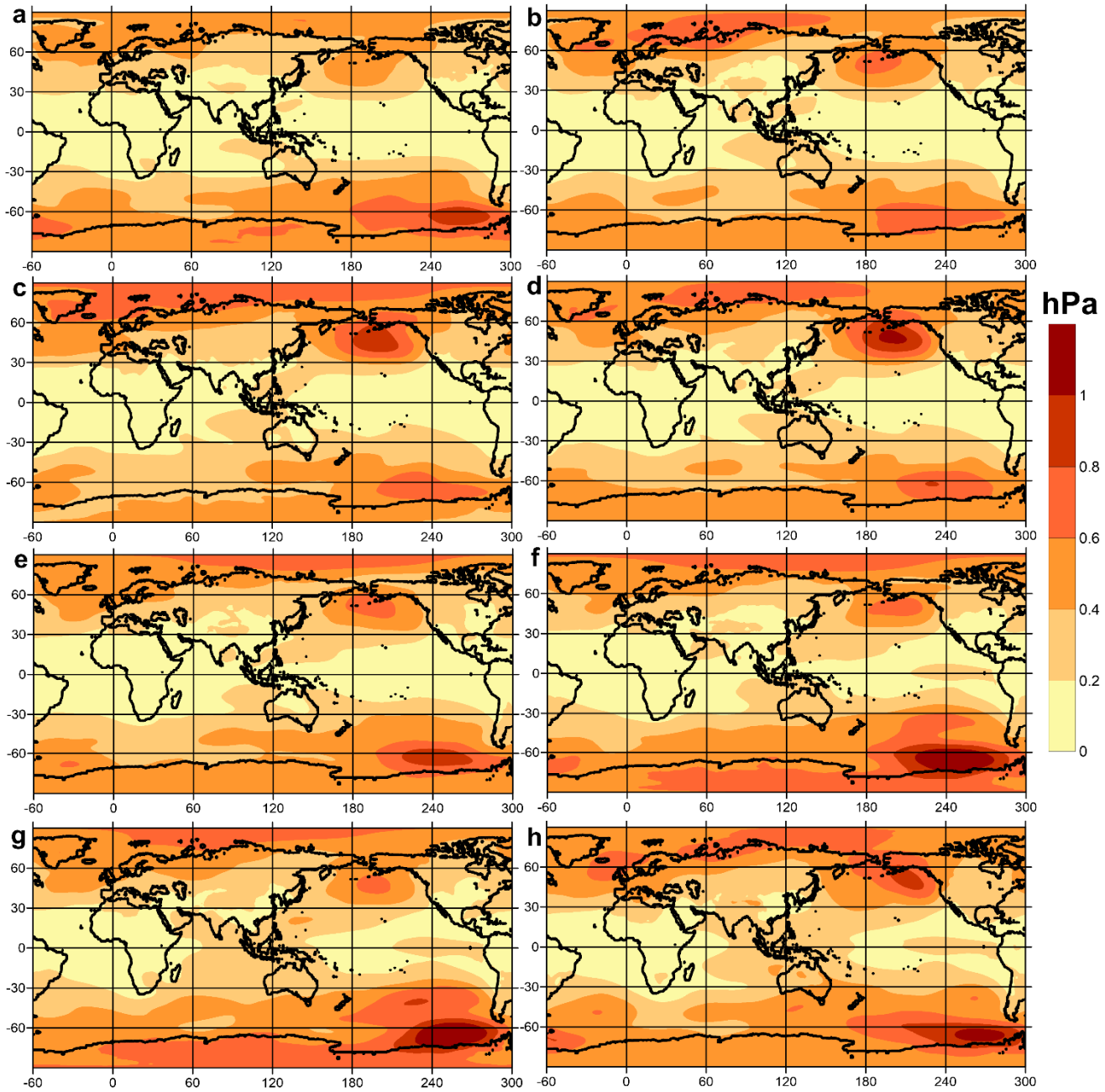


Figure S15. Inter-model standard deviations for compositional fields of SLP anomalies with shifts -14 (a), -12 (b), -10 (c), -8 (d), -6 (e), -4 (f), -2 (g) and 0 (h) months from maximum of El Niño events for 50 CMIP6 models.

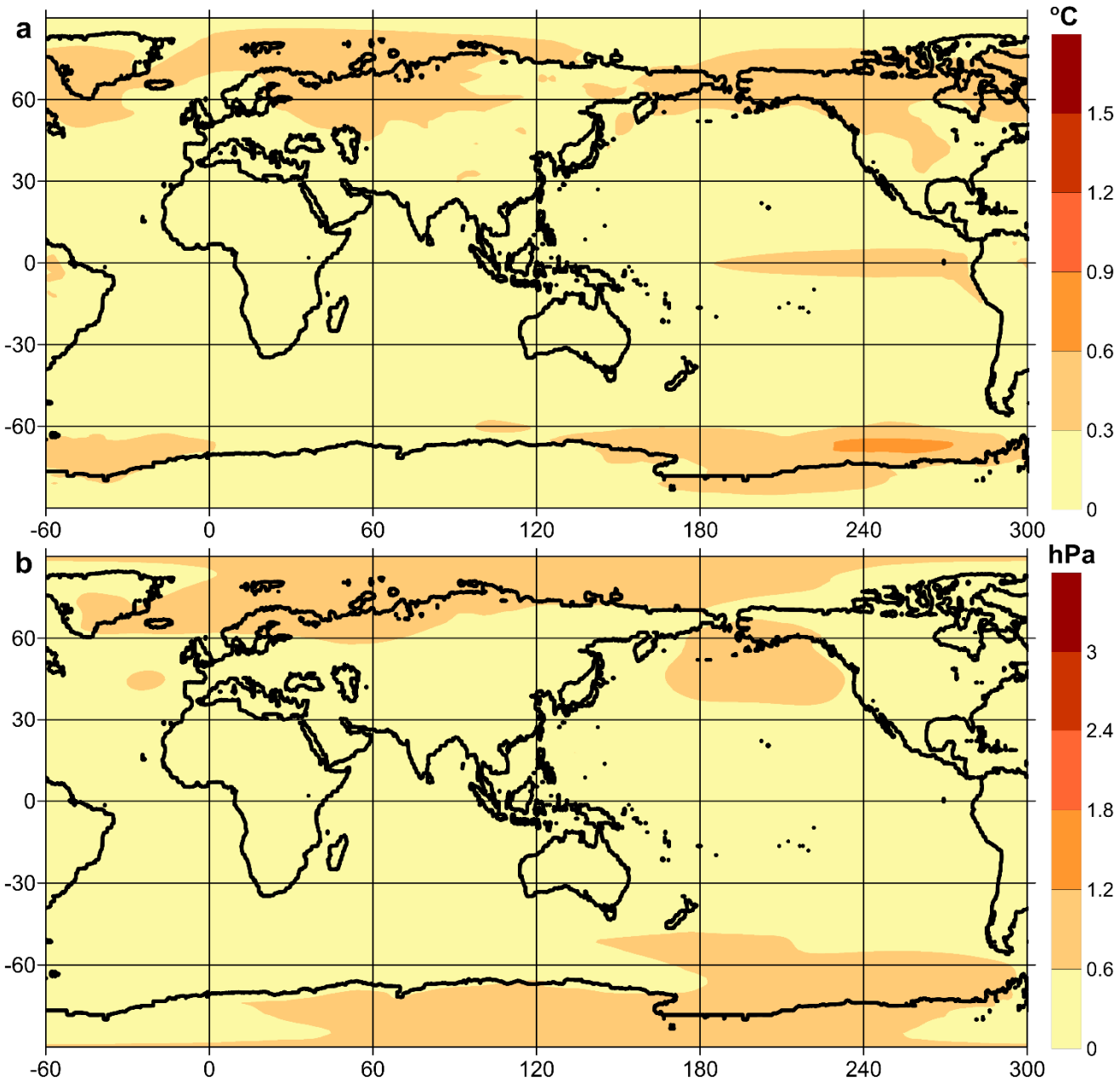


Figure S16. Inter-model standard deviations for compositional fields of SAT (a) and SLP (b) anomalies by PGAO index and leading by approximately 12 months to the maximum of El Niño events according to 50 CMIP6 models.

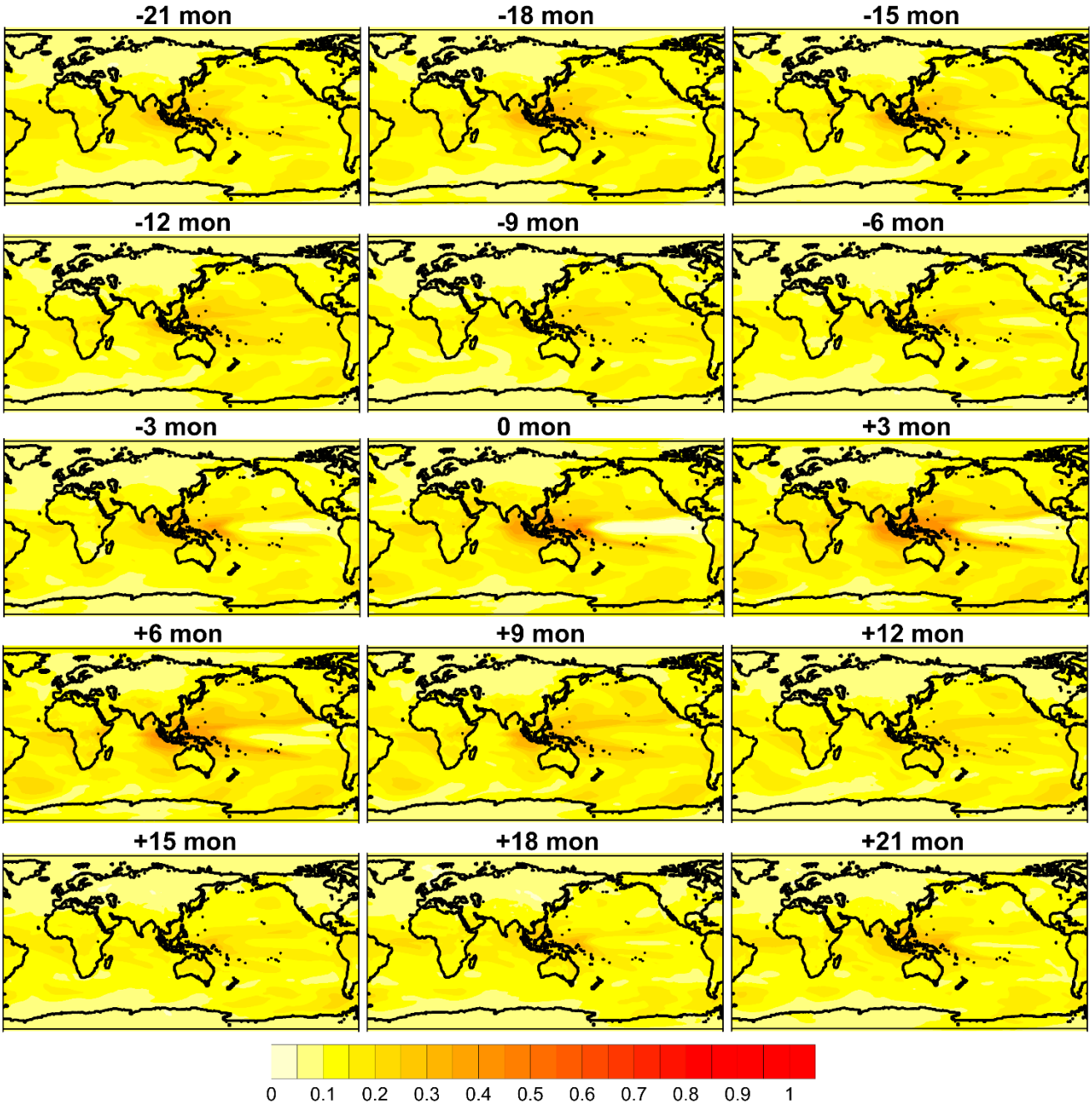


Figure S17. Inter-model standard deviations for the sequence of average grid-point lag cross-correlations fields with the lags from -21 to +21 months (given at intervals of 3 months) between EONI and the SAT anomalies for 50 CMIP6 models.

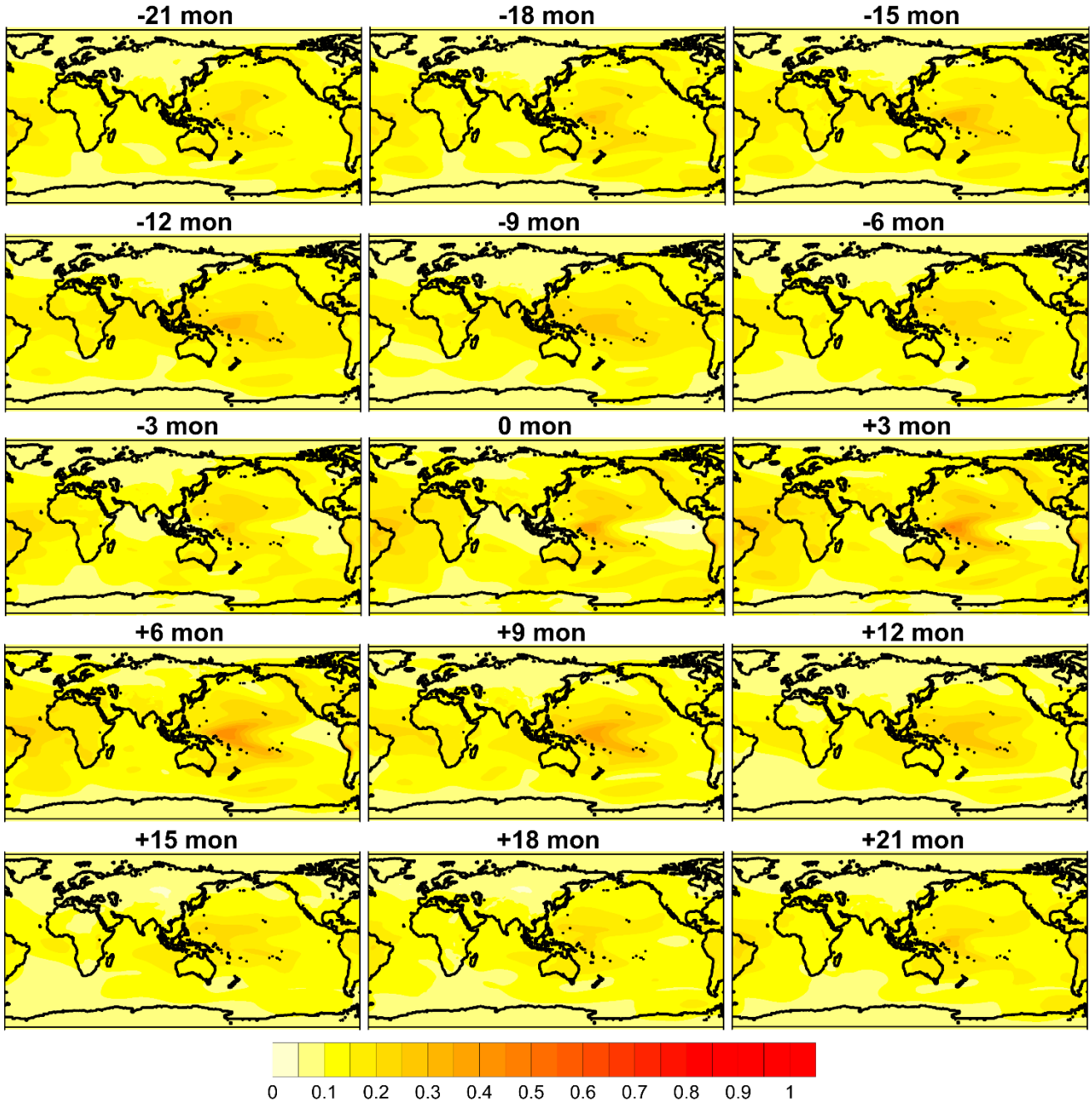


Figure S18. Inter-model standard deviations for the sequence of average grid-point lag cross-correlations fields with the lags from -21 to +21 months (given at intervals of 3 months) between EONI and the SLP anomalies for 50 CMIP6 models.