Supporting Information for "21st century scenario forcing increases more for CMIP6 than CMIP5 models"

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Introduction

We present tables with an overview of the data included in this study, and estimated parameters from the abrupt 4xCO_2 experiments, in addition to forcing estimates from 2xCO_2 and 0p5xCO_2 experiments.

We show also results from abrupt-4xCO_2 experiments similar to those in Figure 1 in the main manuscript, but where no fixed-SST estimates are available. And similar plots for abrupt-2xCO_2 and abrupt-0p5xCO_2 experiments.

We note also that for many models the branch information found in the metadata contains errors. We have done our best in trying to correct obvious mistakes, but cannot rule out more branch time errors, which could have small impacts on the computed anomalies.

	abrupt-4xCO2	abrupt-2xCO2	abrupt-0p5xCO2
ACCESS-CM2	1	-	-
ACCESS-ESM1-5	2	-	-
AWI-CM-1-1-MR	1	-	-
BCC-CSM2-MR	1	-	-
BCC-ESM1	1	-	-
CAMS-CSM1-0	2	-	-
CESM2	1	1	1
CESM2-FV2	1	-	-
CESM2-WACCM	1	-	-
CESM2-WACCM-FV2	1	-	-
CMCC-CM2-SR5	1	-	-
CMCC-ESM2	1	-	-
CNRM-CM6-1	6	1	1
CNRM-CM6-1-HR	1	-	-
CNRM-ESM2-1	3	-	-
CanESM5	2	1	1
E3SM-1-0	1	-	-
EC-Earth3	2	-	-
EC-Earth3-AerChem	1	-	-
EC-Earth3-CC	1	-	-
EC-Earth3-Veg	1	-	-
FGOALS-f3-L	3	-	-
FGOALS-g3	1	-	-

Table S1. Number of abrupt-4xCO2, abrupt-2xCO2 and abrupt-0p5xCO2 members used in this study, part I.

	abrupt-4xCO2	abrupt-2xCO2	abrupt-0p5xCO2
GFDL-CM4	1	-	-
GFDL-ESM4	1	-	-
GISS-E2-1-G	4	4	1
GISS-E2-1-H	3	2	-
GISS-E2-2-G	1	1	-
GISS-E2-2-H	1	1	-
HadGEM3-GC31-LL	1	1	1
HadGEM3-GC31-MM	1	-	-
ICON-ESM-LR	1	-	-
IITM-ESM	1	-	-
INM-CM4-8	1	-	-
INM-CM5-0	1	-	-
IPSL-CM5A2-INCA	1	-	-
IPSL-CM6A-LR	12	1	1
KIOST-ESM	1	-	-
MIROC-ES2L	1	-	-
MIROC6	1	1	1
MPI-ESM-1-2-HAM	1	-	-
MPI-ESM1-2-HR	1	-	-
MPI-ESM1-2-LR	1	-	-
MRI-ESM2-0	14	1	1
NESM3	1	-	-
NorCPM1	1	-	-
NorESM2-LM	1	-	-
NorESM2-MM	1	-	-
SAM0-UNICON	1	-	-
TaiESM1	1	1	1
UKESM1-0-LL	1	-	-
Number of models	51	12	9

Table S2. Number of abrupt-4xCO2, abrupt-2xCO2 and abrupt-0p5xCO2 members used in this study, part II.

Table S3. Number of members where we have computed transient forcing time series, part I.

	1pctCO2	historical	hist-nat	hist-GHG	hist-aer	ssp119	ssp126	ssp245	ssp370	ssp585
ACCESS-CM2	1	5	3	3	3	-	5	5	5	5
ACCESS-ESM1-5	1	40	3	3	3	-	40	40	40	40
AWI-CM-1-1-MR	1	5	-	-	-	-	1	1	5	1
BCC-CSM2-MR	1	3	3	3	3	-	1	1	1	1
BCC-ESM1	1	3	-	-	-	-	-	-	3	-
CAMS-CSM1-0	2	3	-	-	-	2	2	2	2	2
CESM2	1	11	3	3	2	-	3	3	3	3
CESM2-FV2	1	3	-	-	-	-	-	-	-	-
CESM2-WACCM	1	3	-	-	-	-	1	5	3	5
CESM2-WACCM-FV2	1	3	-	-	-	-	-	-	-	-
CMCC-CM2-SR5	1	7	-	-	-	-	1	1	1	1
CMCC-ESM2	1	1	-	-	-	-	1	1	1	1
CNRM-CM6-1	1	29	10	10	10	-	6	10	6	6
CNRM-CM6-1-HR	1	1	-	-	-	-	1	1	1	1
CNRM-ESM2-1	10	11	-	-	-	5	5	10	5	5
CanESM5	6	65	50	50	30	50	50	50	50	50
E3SM-1-0	1	5	-	-	-	-	-	-	-	-
EC-Earth3	1	72	-	-	-	51	57	71	57	57
EC-Earth3-AerChem	1	2	-	-	-	-	-	-	2	-
EC-Earth3-CC	1	1	-	-	-	-	-	1	-	1
EC-Earth3-Veg	1	9	-	-	-	3	7	8	6	8
FGOALS-f3-L	3	3	-	-	-	-	1	1	1	1
FGOALS-g3	3	6	3	3	3	1	4	4	5	4

Table S4. Number of members where we have computed transient forcing time series, part II.

	1pctCO2	historical	hist-nat	hist-GHG	hist-aer	ssp119	ssp126	ssp245	ssp370	ssp585
GFDL-CM4	1	1	3	-	-	-	-	1	-	1
GFDL-ESM4	1	1	3	1	1	1	1	1	1	1
GISS-E2-1-G	5	46	20	10	15	7	12	31	27	11
GISS-E2-1-H	1	25	-	-	-	2	5	10	6	5
GISS-E2-2-G	1	-	-	-	-	-	-	-	-	-
GISS-E2-2-H	1	5	-	-	-	-	-	-	-	-
HadGEM3-GC31-LL	4	5	10	5	5	-	1	5	-	4
HadGEM3-GC31-MM	1	4	-	-	-	-	1	-	-	4
ICON-ESM-LR	1	5	-	-	-	-	-	-	-	-
IITM-ESM	1	1	-	-	-	-	1	1	1	1
INM-CM4-8	1	1	-	-	-	-	1	1	1	1
INM-CM5-0	1	10	-	-	-	-	1	1	5	1
IPSL-CM5A2-INCA	1	1	-	-	-	-	1	-	1	-
IPSL-CM6A-LR	1	33	10	10	10	6	6	11	11	7
KIOST-ESM	1	1	-	-	-	-	1	1	-	1
MIROC-ES2L	1	26	-	-	-	10	10	25	10	10
MIROC6	1	50	50	3	10	1	50	50	3	50
MPI-ESM-1-2-HAM	1	3	-	-	-	-	-	-	3	-
MPI-ESM1-2-HR	1	10	-	-	-	-	2	2	10	2
MPI-ESM1-2-LR	1	30	-	-	-	30	30	30	30	30
MRI-ESM2-0	2	12	5	5	5	5	5	10	5	6
NESM3	1	5	-	-	-	-	2	2	-	2
NorCPM1	1	30	-	-	-	-	-	-	-	-
NorESM2-LM	1	3	3	3	3	-	1	13	3	1
NorESM2-MM	1	3	-	-	-	-	1	2	1	1
SAM0-UNICON	1	1	-	-	-	-	-	-	-	-
TaiESM1	1	2	-	-	-	-	1	1	1	1
UKESM1-0-LL	4	19	-	-	-	5	16	17	16	5
Number of models	51	50	15	14	14	15	38	38	37	39

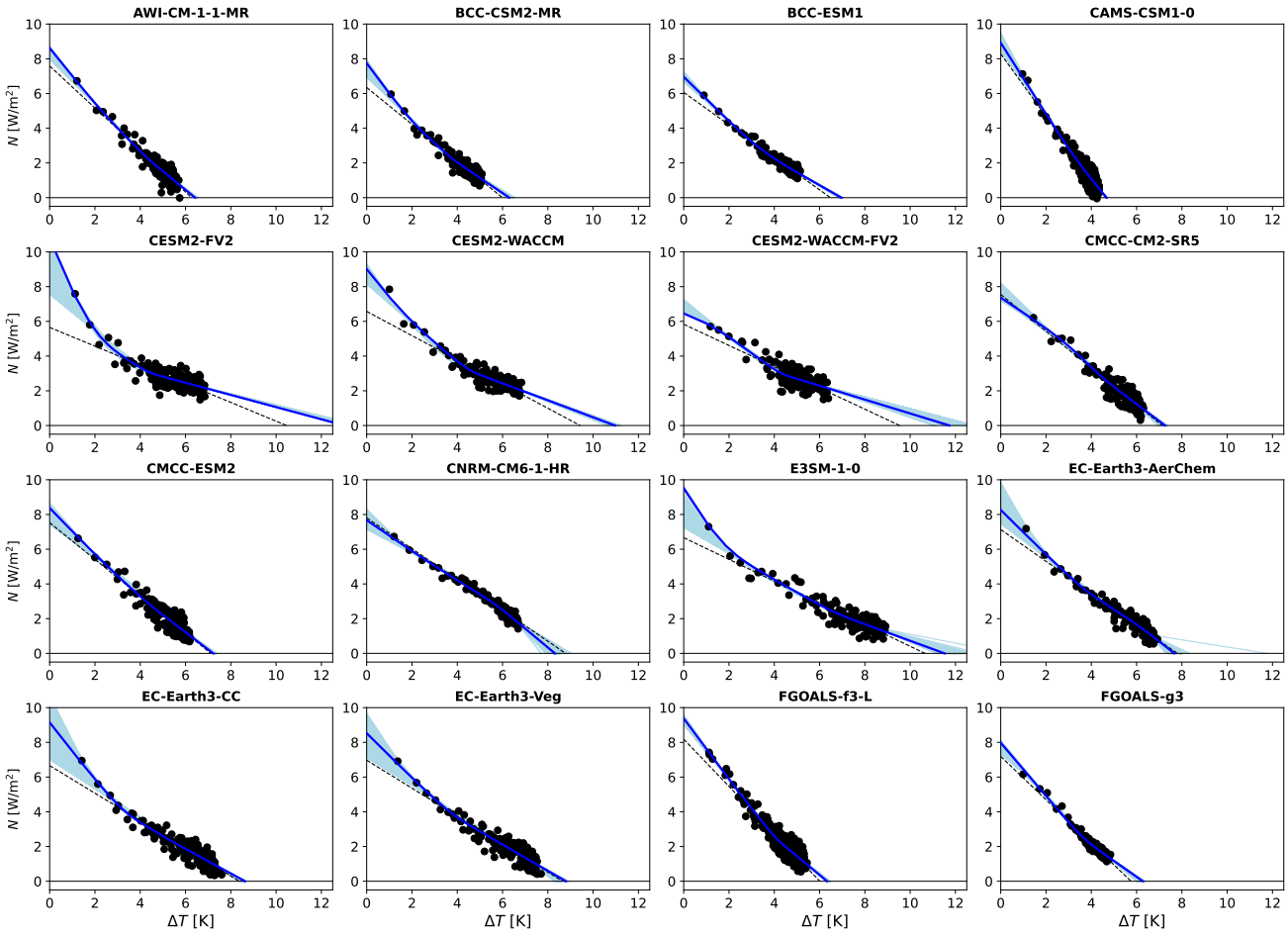

Figure S1. As Figure 1, but for models without fixed-SST forcing. Part I.

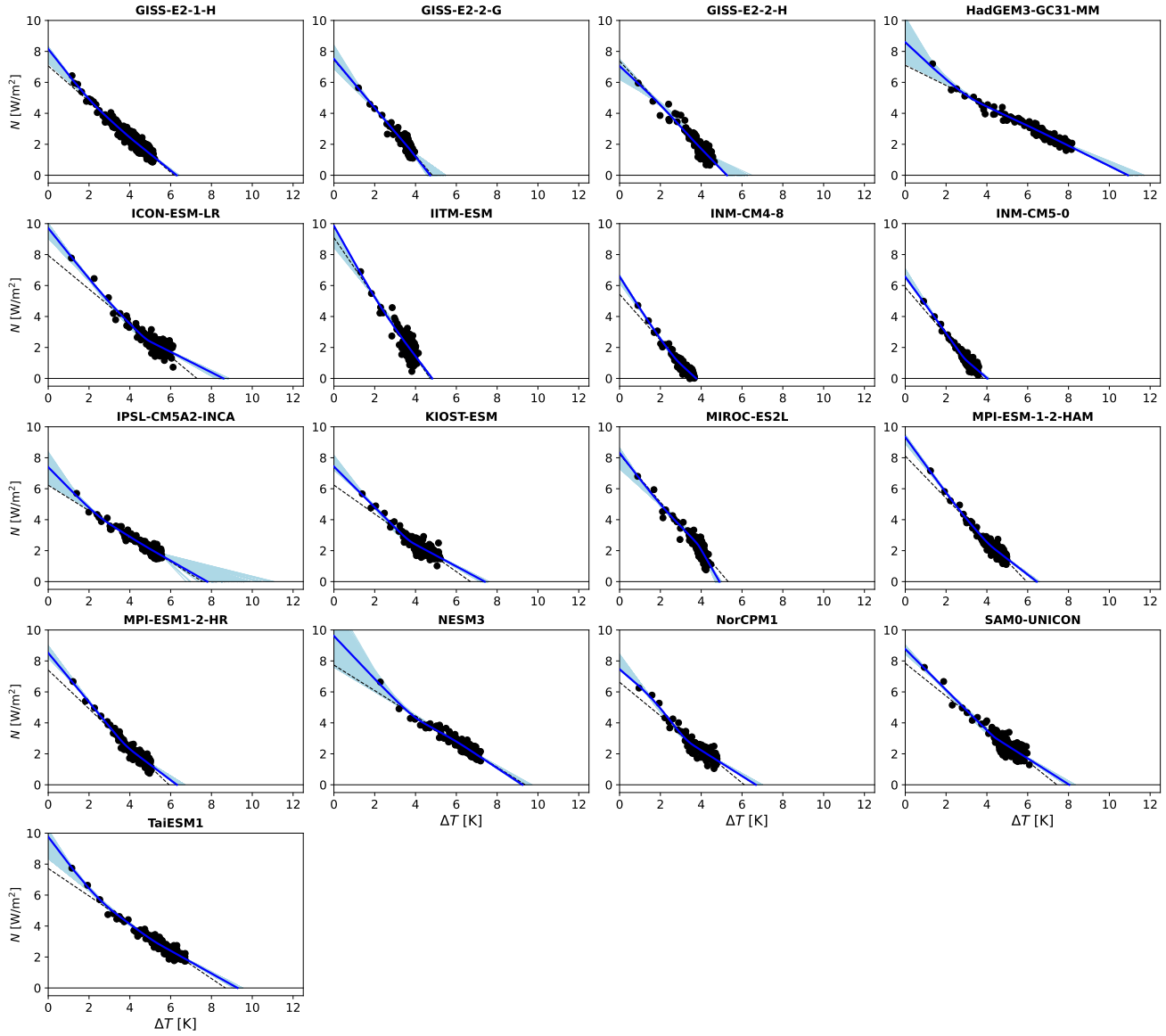

Figure S2. As Figure 1, but for models without fixed-SST forcing. Part II.

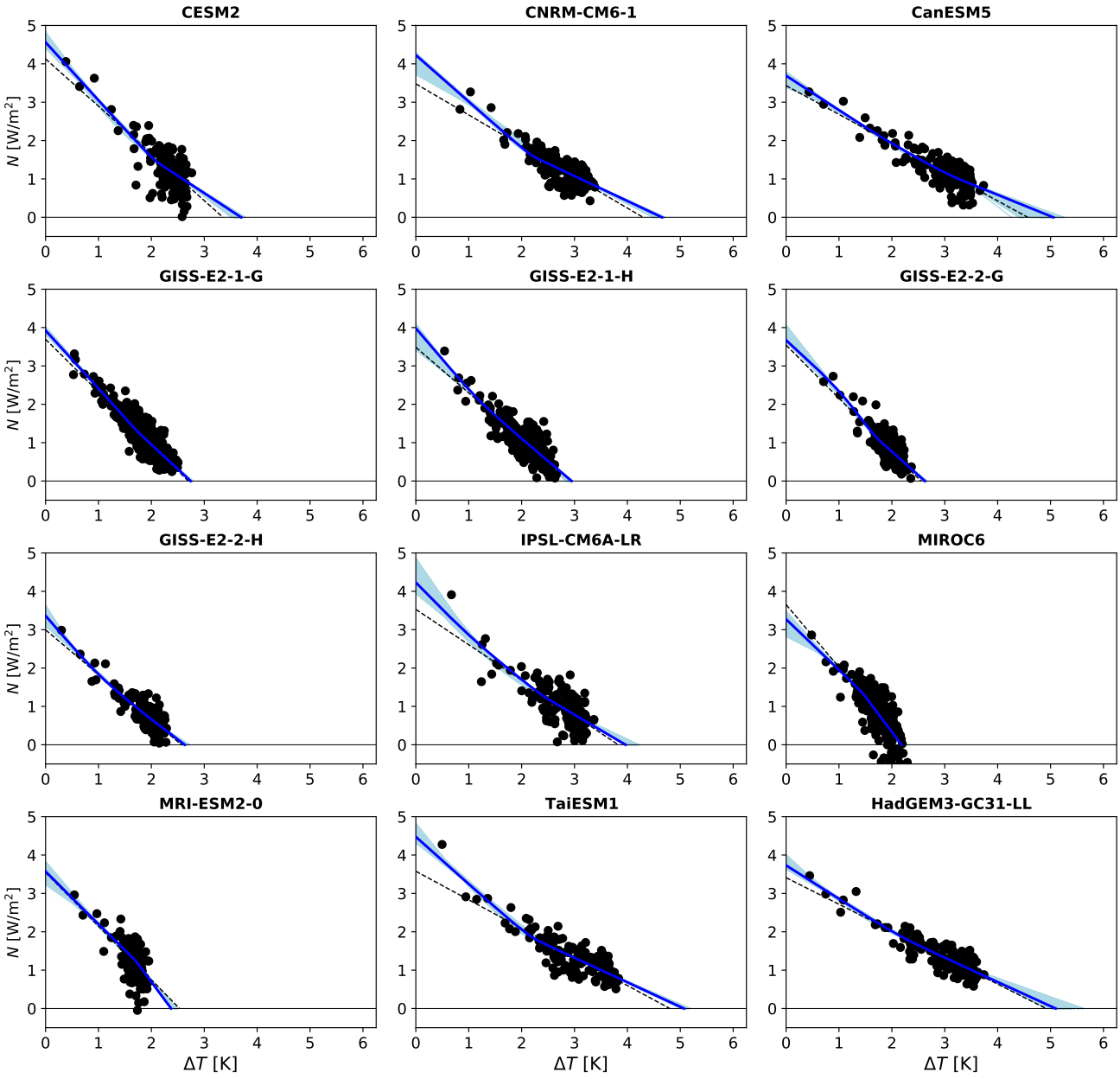

Figure S3. Similar figure as above, but using the abrupt-2xCO2 experiment.

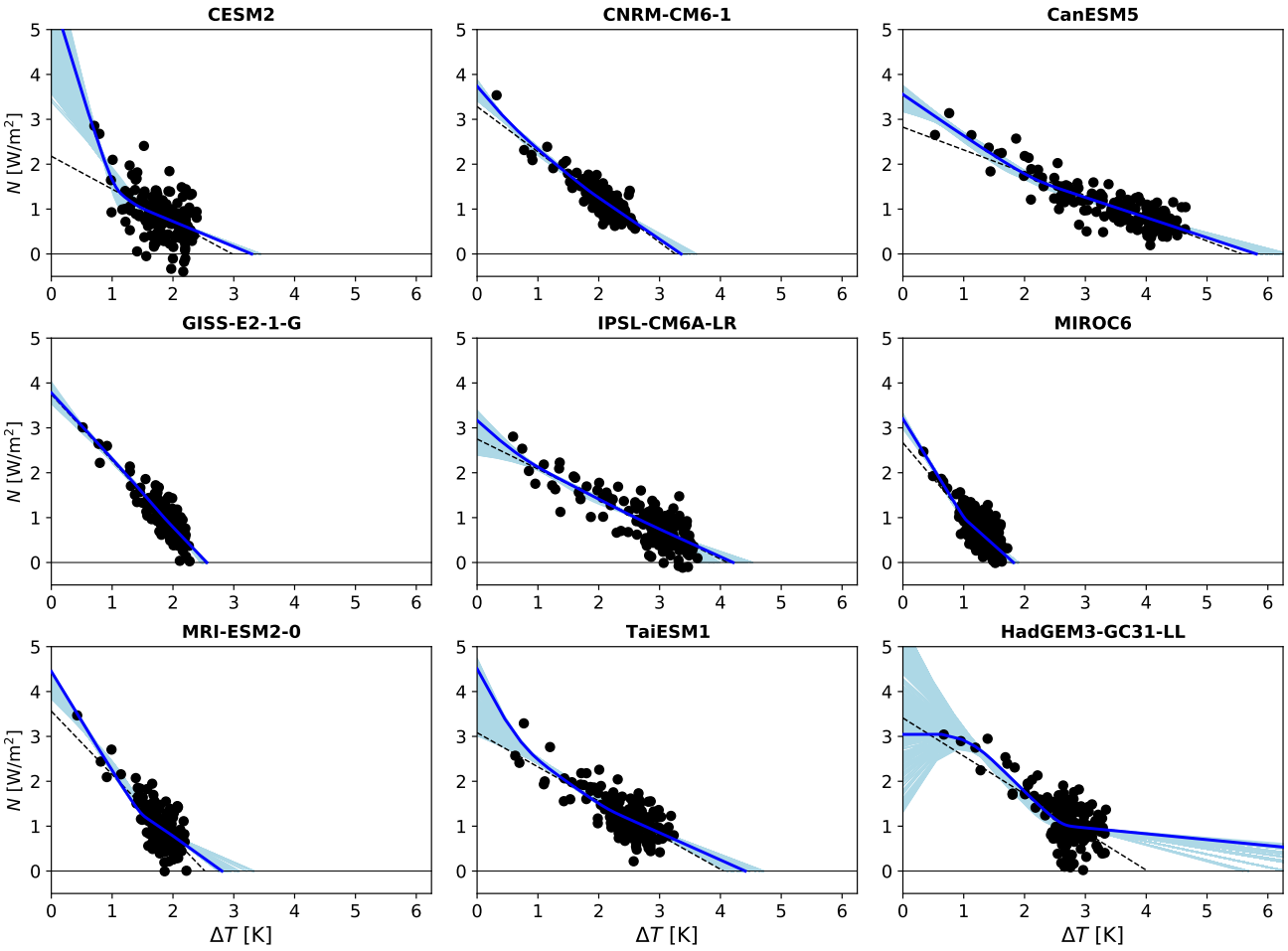

Figure S4. Similar figure as above, but using the abrupt-0p5xCO2 experiment. This experiment has negative responses, but the signs are flipped when performing the estimation and plotting.

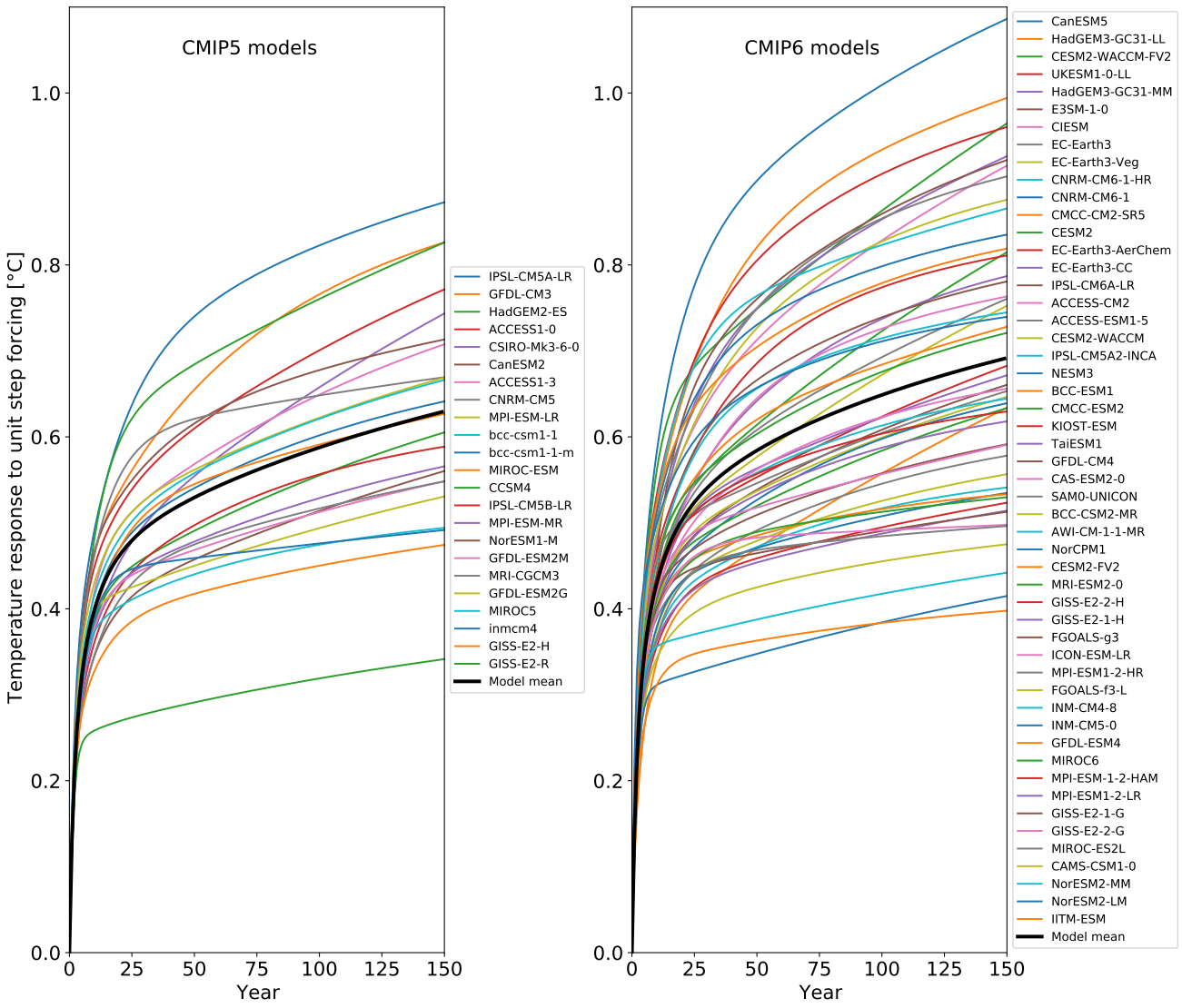

Figure S5. Temperature responses to unit-step forcing. Legend is sorted by the response in year 150. If the temperature responses are strong (weak) it may be because they compensate for weak (strong) forcing estimates.

	piClim-4xCO2	piClim-histall
ACCESS-CM2	1	-
ACCESS-ESM1-5	1	-
CESM2	1	-
CNRM-CM6-1	1	1
CNRM-ESM2-1	1	-
CanESM5	1	3
EC-Earth3	1	1
GFDL-CM4	1	3
GFDL-ESM4	1	-
GISS-E2-1-G	2	3
HadGEM3-GC31-LL	1	3
IPSL-CM6A-LR	5	3
MIROC6	1	3
MPI-ESM1-2-LR	1	1
MRI-ESM2-0	1	-
NorESM2-LM	2	6
NorESM2-MM	1	-
UKESM1-0-LL	1	-
Number of models	18	10

Table S5. Number of members used in this study to compute fixed-SST forcing.

	τ_1	τ_2	τ_3	$-\lambda_1$	$-\lambda_2$	$-\lambda_3$	b_4	$F4x$	$T4x$
ACCESS-CM2	2.57	25.28	139.03	1.58	0.60	0.62	1.63	8.93	9.98
ACCESS-ESM1-5	2.63	14.26	324.14	1.41	1.02	0.46	0.37	7.42	9.40
AWI-CM-1-1-MR	1.17	5.99	87.70	1.72	1.38	1.07	0.58	8.62	6.42
BCC-CSM2-MR	1.11	7.18	184.44	1.93	1.25	0.88	0.11	7.74	6.30
BCC-ESM1	2.72	19.25	337.09	1.32	0.94	0.75	0.02	6.96	6.96
CAMS-CSM1-0	1.87	10.32	131.09	2.07	1.91	1.61	0.09	8.92	4.67
CAS-ESM2-0	1.43	8.93	81.05	2.06	1.07	0.85	0.87	8.81	7.11
CESM2	1.38	6.93	291.55	1.80	1.11	0.44	0.06	9.22	12.15
CESM2-FV2	1.15	6.14	381.16	4.43	0.93	0.35	0.12	10.78	13.02
CESM2-WACCM	1.13	5.75	287.90	2.11	1.17	0.49	0.20	9.01	10.97
CESM2-WACCM-FV2	1.03	5.54	427.24	-0.00	1.00	0.40	0.10	6.45	11.74
CIESM	2.80	16.64	257.81	1.05	0.91	0.51	0.34	9.12	12.63
CMCC-CM2-SR5	1.40	8.28	80.47	0.79	1.33	0.98	0.90	7.37	7.26
CMCC-ESM2	1.25	6.40	105.71	1.39	1.21	1.00	0.59	8.37	7.22
CNRM-CM6-1	1.78	14.26	96.73	1.15	0.66	0.78	1.88	8.29	9.67
CNRM-CM6-1-HR	1.76	12.73	274.71	0.92	0.79	1.09	0.06	7.67	8.31
CNRM-ESM2-1	4.14	40.76	93.08	0.52	0.65	1.04	1.77	5.71	8.09
CanESM5	2.19	13.37	179.44	0.74	0.68	0.60	1.01	7.57	11.62
E3SM-1-0	1.06	9.80	114.58	2.86	0.79	0.48	0.83	9.51	11.52
EC-Earth3	2.66	26.33	107.27	1.24	0.72	0.81	0.52	7.94	8.38
EC-Earth3-AerChem	2.84	28.13	103.24	1.34	0.78	1.03	0.59	8.26	7.67
EC-Earth3-CC	1.71	12.46	80.03	1.78	0.85	0.71	0.67	9.15	8.63
EC-Earth3-Veg	2.27	20.38	88.11	1.35	0.77	0.75	0.63	8.52	8.80
FGOALS-f3-L	1.15	6.13	122.70	1.78	1.71	1.08	0.61	9.38	6.33
FGOALS-g3	2.82	15.44	154.88	1.51	1.50	0.97	0.81	7.92	6.17

Table S6. Parameters estimated from abrupt-4xCO2 experiments, part I.

	τ_1	τ_2	τ_3	$-\lambda_1$	$-\lambda_2$	$-\lambda_3$	b_4	$F4x$	$T4x$
GFDL-CM4	1.96	10.47	175.61	1.72	1.15	0.53	1.02	9.03	9.20
GFDL-ESM4	1.14	5.75	82.88	2.05	1.30	1.36	1.26	8.01	5.32
GISS-E2-1-G	1.16	5.95	341.47	1.45	1.64	1.27	0.44	8.01	5.55
GISS-E2-1-H	1.04	7.26	84.97	1.79	1.23	1.06	1.04	8.16	6.29
GISS-E2-2-G	1.42	10.42	431.60	1.60	1.53	1.68	1.13	7.51	4.72
GISS-E2-2-H	1.33	7.51	83.07	1.16	1.47	1.36	0.85	7.06	5.26
HadGEM3-GC31-LL	2.97	26.13	357.17	1.03	0.57	0.58	0.50	8.03	11.47
HadGEM3-GC31-MM	1.53	15.15	239.48	1.35	0.60	0.65	0.18	8.59	10.92
ICON-ESM-LR	1.31	7.15	397.08	1.73	1.38	0.66	0.29	9.71	8.59
IITM-ESM	1.05	5.37	126.92	2.49	1.92	1.76	1.13	9.85	4.82
INM-CM4-8	1.17	6.53	80.86	2.12	1.89	1.21	0.01	6.58	3.75
INM-CM5-0	1.06	6.38	161.14	1.78	1.92	1.12	0.03	6.56	4.03
IPSL-CM5A2-INCA	1.37	13.05	83.13	1.43	0.84	0.75	1.59	7.39	7.80
IPSL-CM6A-LR	1.08	10.73	93.40	2.07	0.80	0.64	1.17	9.28	9.54
KIOST-ESM	1.05	5.75	285.83	1.30	1.37	0.71	0.02	7.43	7.39
MIROC-ES2L	1.59	9.32	209.35	1.81	1.29	2.29	0.99	8.32	4.89
MIROC6	1.96	13.05	297.24	1.53	1.31	1.77	0.39	7.61	4.94
MPI-ESM-1-2-HAM	1.45	9.67	245.61	1.85	1.59	1.02	0.42	9.33	6.45
MPI-ESM1-2-HR	2.12	10.75	98.71	1.57	1.95	0.99	1.00	8.52	6.31
MPI-ESM1-2-LR	1.87	10.23	257.28	1.92	1.47	1.19	0.10	9.74	6.30
MRI-ESM2-0	1.00	5.26	190.72	1.41	1.41	0.91	0.46	7.71	6.64
NESM3	1.18	11.56	80.78	1.46	0.67	0.87	1.64	9.61	9.24
NorCPM1	1.00	5.02	89.10	0.77	1.83	0.83	1.30	7.46	6.68
NorESM2-LM	1.95	18.67	280.80	2.45	nan	0.94	0.05	9.98	5.76
NorESM2-MM	2.13	12.92	255.69	2.06	nan	1.33	0.03	9.15	5.10
SAM0-UNICON	3.80	26.08	278.66	1.33	nan	0.83	0.12	8.76	8.04
TaiESM1	1.29	8.44	291.73	2.04	0.99	0.73	0.12	9.76	9.28
UKESM1-0-LL	2.03	15.28	96.48	1.04	0.69	0.61	1.64	8.20	11.10
Model mean	1.74	12.20	192.98	1.61	1.17	0.93	0.65	8.36	7.86

Table S7. Parameters estimated from abrupt-4xCO2 experiments, part II.

	F2x	F0p5x	F4x	F4x/F2x	F4x/F0p5x
CESM2	4.56	-5.82	9.22	2.02	-1.58
CNRM-CM6-1	4.23	-3.74	8.29	1.96	-2.22
CanESM5	3.69	-3.55	7.57	2.05	-2.13
GISS-E2-1-G	3.92	-3.78	8.01	2.04	-2.12
GISS-E2-1-H	3.98	nan	8.16	2.05	nan
GISS-E2-2-G	3.67	nan	7.51	2.05	nan
GISS-E2-2-H	3.36	nan	7.06	2.10	nan
HadGEM3-GC31-LL	3.73	-3.04	8.03	2.15	-2.64
IPSL-CM6A-LR	4.23	-3.17	9.28	2.19	-2.93
MIROC6	3.27	-3.20	7.61	2.32	-2.38
MRI-ESM2-0	3.57	-4.45	7.71	2.16	-1.73
TaiESM1	4.48	-4.51	9.76	2.18	-2.17
Model mean	3.89	-3.92	8.18	2.11	-2.21

Table S8. Forcing estimates for 2x, 0.5x, 4x CO_2, and forcing ratios.