
Supplementary Information

Stratospheric water vapor: an important climate feedback

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Table 1 SWV-driven radiative perturbations (Wm^{-2}) at the ToA and the associated climate feedbacks ($\text{Wm}^{-2}\text{K}^{-1}$). The stratosphere and troposphere are separated using the PORT piControl tropopause definition. For the kernel calculation, model specific piControl tropopause heights are used to enable direct comparison with Huang et al. (2016). If using the PORT tropopause, we calculate a multi-model mean feedback of $0.03 \pm 0.01 \text{ Wm}^{-2}\text{K}^{-1}$. The final column shows the surface temperature change (K) due to $4\times\text{CO}_2$.

Model	Instantaneous, ToA					Adjusted, ToA				ΔT_s
	LW	SW	Net	Feedback	Feedback (kernel)	LW	SW	Net	Feedback	
ACCESS1-0	0.12	0.00	0.12	0.02	0.02	1.01	0.00	1.02	0.18	5.56
ACCESS1-3	0.09	0.00	0.09	0.02	0.02	0.71	0.00	0.71	0.15	4.86
bcc-csm1-1-m	0.11	0.00	0.11	0.02	0.02	0.81	0.00	0.81	0.16	5.03
bcc-csm1-1	0.09	0.00	0.09	0.02	0.02	0.62	0.00	0.62	0.13	4.81
BNU-ESM	0.11	0.00	0.11	0.02	0.01	0.90	0.00	0.90	0.14	6.21
CanESM2	0.18	0.00	0.19	0.03	0.03	0.82	0.00	0.82	0.14	5.83
CCSM4	0.08	0.00	0.08	0.02	0.01	0.62	0.00	0.62	0.13	4.78
CNRM-CM5	0.10	0.00	0.10	0.02	0.02	0.98	0.00	0.99	0.19	5.23
CNRM-CM5-2	0.10	0.00	0.10	0.02	0.02	1.01	0.00	1.01	0.19	5.20
CSIRO-Mk3-6-0	0.19	0.00	0.19	0.03	0.02	1.53	0.00	1.53	0.28	5.55
FGOALS-g2	0.10	0.00	0.10	0.02	0.01	0.58	0.00	0.58	0.12	4.96
FGOALS-s2	0.13	0.00	0.13	0.02	0.03	0.79	0.00	0.79	0.14	5.77
GFDL-CM3	0.17	0.00	0.17	0.03	0.03	1.04	0.00	1.04	0.18	5.79
GFDL-ESM2G	0.11	0.00	0.11	0.03	0.03	0.92	0.00	0.93	0.25	3.71
GFDL-ESM2M	0.12	0.00	0.12	0.03	0.03	0.98	0.00	0.99	0.26	3.83
GISS-E2-H	0.08	0.00	0.08	0.02	0.02	0.49	0.00	0.50	0.12	4.05
GISS-E2-R	0.08	0.00	0.08	0.02	0.02	0.46	0.00	0.46	0.14	3.39
HadGEM2-ES	0.14	0.00	0.14	0.02	0.02	0.97	0.00	0.97	0.16	6.24
IPSL-CM5A-MR	0.23	0.00	0.23	0.04	0.03	1.47	0.00	1.47	0.25	5.77
IPSL-CM5B-LR	0.10	0.00	0.10	0.02	0.03	0.72	0.00	0.72	0.17	4.35
MIROC5	0.08	0.00	0.08	0.02	0.02	0.56	0.00	0.57	0.14	4.18
MIROC-ESM	0.18	0.00	0.19	0.03	0.02	1.04	0.00	1.04	0.16	6.62
MPI-ESM-LR	0.19	0.00	0.19	0.03	0.03	1.10	0.00	1.10	0.19	5.89
MPI-ESM-MR	0.17	0.00	0.18	0.03	0.03	0.99	0.00	1.00	0.18	5.64
MPI-ESM-P	0.19	0.00	0.19	0.03	0.03	1.08	0.00	1.08	0.19	5.70
MRI-CGCM3	0.12	0.00	0.12	0.03	0.03	0.90	0.00	0.90	0.21	4.35
NorESM1-M	0.07	0.00	0.07	0.02	0.01	0.47	0.00	0.47	0.11	4.14
Mean	0.13	0.00	0.13	0.03	0.02	0.87	0.00	0.87	0.17	5.09
Std. Dev.	0.04	0.00	0.04	0.01	0.01	0.27	0.00	0.27	0.05	0.86
Min.	0.07	0.00	0.07	0.02	0.01	0.46	0.00	0.46	0.11	3.39
Max.	0.23	0.00	0.23	0.04	0.03	1.53	0.00	1.53	0.28	6.62

Table 2 SWV-driven radiative perturbations (Wm^{-2}) (stratosphere-adjusted only) at the tropopause and the associated climate feedbacks ($\text{Wm}^{-2}\text{K}^{-1}$). The stratosphere and troposphere are separated using the abrupt4xCO2 tropopause definition. The final column shows the surface temperature change (K) due to 4xCO₂.

Model	Adjusted, tropopause				ΔT_s
	LW	SW	Net	Feedback	
ACCESS1-0	1.12	-0.23	0.88	0.16	5.56
ACCESS1-3	0.79	-0.17	0.62	0.13	4.86
bcc-csm1-1-m	0.91	-0.19	0.72	0.14	5.03
bcc-csm1-1	0.71	-0.15	0.56	0.12	4.81
BNU-ESM	1.06	-0.22	0.83	0.13	6.21
CanESM2	0.86	-0.17	0.68	0.12	5.83
CCSM4	0.65	-0.13	0.52	0.11	4.78
CNRM-CM5	1.19	-0.24	0.94	0.18	5.23
CNRM-CM5-2	1.22	-0.25	0.97	0.19	5.20
CSIRO-Mk3-6-0	1.86	-0.40	1.46	0.26	5.55
FGOALS-g2	0.66	-0.14	0.52	0.11	4.96
FGOALS-s2	0.89	-0.17	0.71	0.12	5.77
GFDL-CM3	1.15	-0.24	0.91	0.16	5.79
GFDL-ESM2G	1.08	-0.22	0.86	0.23	3.71
GFDL-ESM2M	1.15	-0.24	0.91	0.24	3.83
GISS-E2-H	0.53	-0.10	0.43	0.11	4.05
GISS-E2-R	0.50	-0.10	0.40	0.12	3.39
HadGEM2-ES	1.08	-0.22	0.86	0.14	6.24
IPSL-CM5A-MR	1.67	-0.36	1.31	0.23	5.77
IPSL-CM5B-LR	0.82	-0.16	0.66	0.15	4.35
MIROC5	0.63	-0.12	0.50	0.12	4.18
MIROC-ESM	1.19	-0.25	0.94	0.14	6.62
MPI-ESM-LR	1.26	-0.27	0.99	0.17	5.89
MPI-ESM-MR	1.12	-0.23	0.89	0.16	5.64
MPI-ESM-P	1.25	-0.27	0.98	0.17	5.70
MRI-CGCM3	1.05	-0.22	0.83	0.19	4.35
NorESM1-M	0.53	-0.11	0.42	0.10	4.14
Mean	1.00	-0.21	0.79	0.15	5.09
Std. dev.	0.33	0.07	0.26	0.04	0.86
Min.	0.50	-0.40	0.40	0.10	3.39
Max.	1.86	-0.10	1.46	0.26	6.62

Table 3 SWV-driven radiative perturbations (Wm^{-2}) (stratosphere-adjusted only) at the ToA and the associated climate feedbacks ($\text{Wm}^{-2}\text{K}^{-1}$). The stratosphere and troposphere are separated using the abrupt4xCO₂ tropopause definition. The final column shows the surface temperature change (K) due to 4xCO₂.

Model	Adjusted, ToA				ΔT_s
	LW	SW	Net	Feedback	
ACCESS1-0	0.87	0.00	0.87	0.16	5.56
ACCESS1-3	0.61	0.00	0.61	0.12	4.86
bcc-csm1-1-m	0.70	0.00	0.70	0.14	5.03
bcc-csm1-1	0.55	0.00	0.55	0.11	4.81
BNU-ESM	0.82	0.00	0.82	0.13	6.21
CanESM2	0.67	0.00	0.67	0.12	5.83
CCSM4	0.50	0.00	0.50	0.11	4.78
CNRM-CM5	0.93	0.00	0.93	0.18	5.23
CNRM-CM5-2	0.95	0.00	0.96	0.18	5.20
CSIRO-Mk3-6-0	1.44	0.00	1.45	0.26	5.55
FGOALS-g2	0.51	0.00	0.51	0.10	4.96
FGOALS-s2	0.69	0.00	0.70	0.12	5.77
GFDL-CM3	0.90	0.00	0.90	0.15	5.79
GFDL-ESM2G	0.84	0.00	0.84	0.23	3.71
GFDL-ESM2M	0.90	0.00	0.90	0.23	3.83
GISS-E2-H	0.41	0.00	0.41	0.10	4.05
GISS-E2-R	0.39	0.00	0.39	0.11	3.39
HadGEM2-ES	0.84	0.00	0.84	0.13	6.24
IPSL-CM5A-MR	1.29	0.00	1.29	0.22	5.77
IPSL-CM5B-LR	0.64	0.00	0.65	0.15	4.35
MIROC5	0.49	0.00	0.49	0.12	4.18
MIROC-ESM	0.92	0.00	0.92	0.14	6.62
MPI-ESM-LR	0.98	0.00	0.98	0.17	5.89
MPI-ESM-MR	0.87	0.00	0.87	0.16	5.64
MPI-ESM-P	0.96	0.00	0.96	0.17	5.70
MRI-CGCM3	0.81	0.00	0.81	0.19	4.35
NorESM1-M	0.41	0.00	0.41	0.10	4.14
Mean	0.77	0.00	0.78	0.15	5.09
Std. dev.	0.25	0.00	0.25	0.04	0.86
Min.	0.39	0.00	0.39	0.10	3.39
Max.	1.44	0.00	1.45	0.26	6.62

Table 4 SWV-driven radiative perturbations (Wm^{-2}) (stratosphere-adjusted only) at the tropopause for perturbations to SWV in the LMS only. The stratosphere and troposphere are separated using the piControl tropopause definition. The final column shows the net radiative perturbation from LMS changes relative to that from the whole stratosphere (Table 1 in main text).

Model	Adjusted, tropopause			% of total
	LW	SW	Net	
ACCESS1-0	0.84	-0.16	0.68	66
ACCESS1-3	0.69	-0.14	0.56	77
bcc-csm1-1-m	0.80	-0.16	0.64	78
bcc-csm1-1	0.63	-0.13	0.50	80
BNU-ESM	0.87	-0.18	0.69	76
CanESM2	0.98	-0.20	0.78	94
CCSM4	0.62	-0.12	0.49	80
CNRM-CM5	0.76	-0.15	0.62	62
CNRM-CM5-2	0.77	-0.15	0.63	62
CSIRO-Mk3-6-0	1.30	-0.26	1.04	67
FGOALS-g2	0.58	-0.11	0.46	78
FGOALS-s2	0.84	-0.17	0.67	84
GFDL-CM3	1.08	-0.22	0.86	81
GFDL-ESM2G	0.77	-0.14	0.63	67
GFDL-ESM2M	0.81	-0.15	0.66	66
GISS-E2-H	0.49	-0.09	0.40	78
GISS-E2-R	0.45	-0.08	0.37	78
HadGEM2-ES	0.89	-0.16	0.72	73
IPSL-CM5A-MR	1.45	-0.29	1.16	78
IPSL-CM5B-LR	0.71	-0.13	0.58	79
MIROC5	0.63	-0.13	0.50	87
MIROC-ESM	1.13	-0.24	0.89	84
MPI-ESM-LR	1.12	-0.23	0.89	79
MPI-ESM-MR	1.03	-0.21	0.82	81
MPI-ESM-P	1.10	-0.23	0.88	79
MRI-CGCM3	0.83	-0.17	0.66	73
NorESM1-M	0.51	-0.10	0.41	85
Mean	0.84	-0.17	0.67	77
Std. Dev.	0.25	0.05	0.19	8
Min.	0.45	-0.29	0.37	62
Max.	1.45	-0.08	1.16	94