Supporting Information for

Causes of Reduced Climate Sensitivity in E3SM from Version 1 to Version 2

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Introduction

In this Supporting Information, we provide additional tables and figures that support the results in the main text (Table S1-S4; Figure S1-S6).
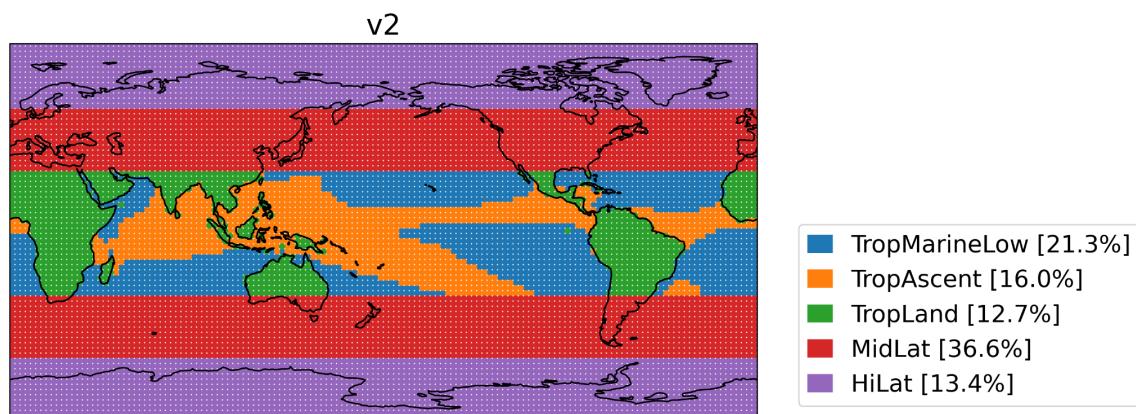
Figure S1. Partitioned global cloud regimes using latitude bands, land and ocean mask, and ensemble-mean vertical velocity at 700 hPa. Percentages indicate the area of the planet covered by each regime. Details are in the text.
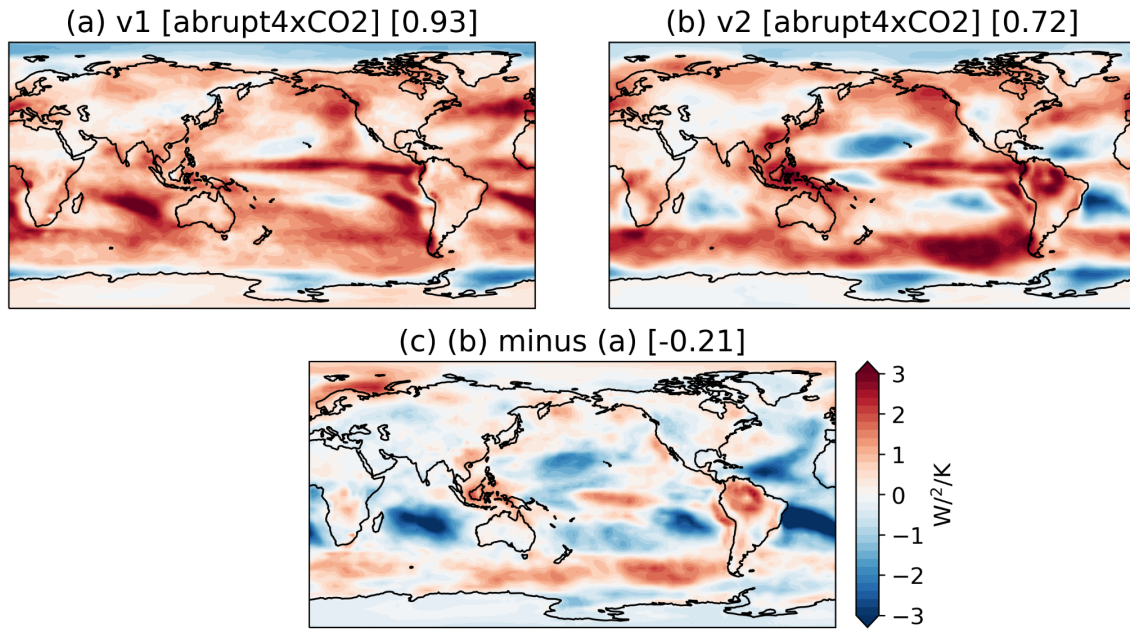
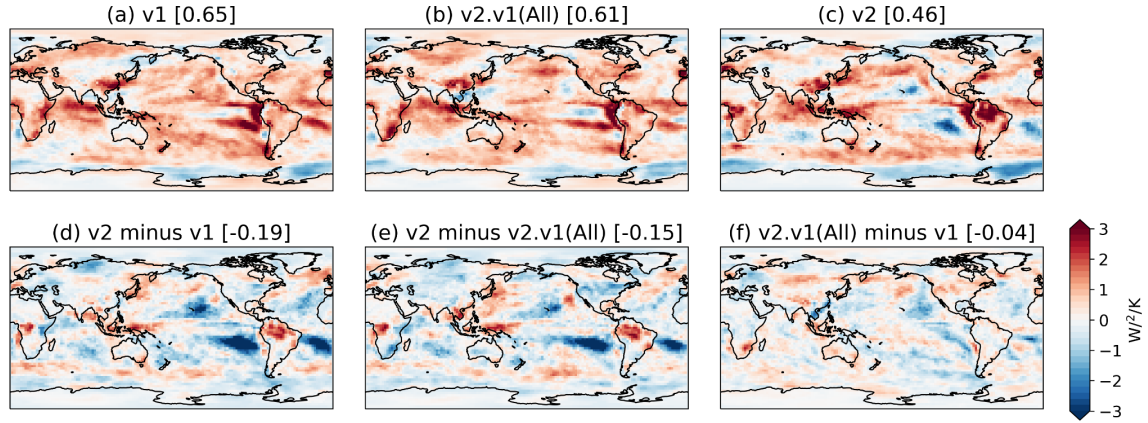**Figure S2.** Same as Figure 2, but for coupled experiments of v1 and v2.

Figure S3. Spatial distribution of total cloud feedback from (a) v1, (b) v2.v1(All), (c) v2 and the difference between (d) v2 and v1, (e) v2 and v2.v1(All) and (f) v2.v1(All) and v1. The global mean values are labeled in brackets.
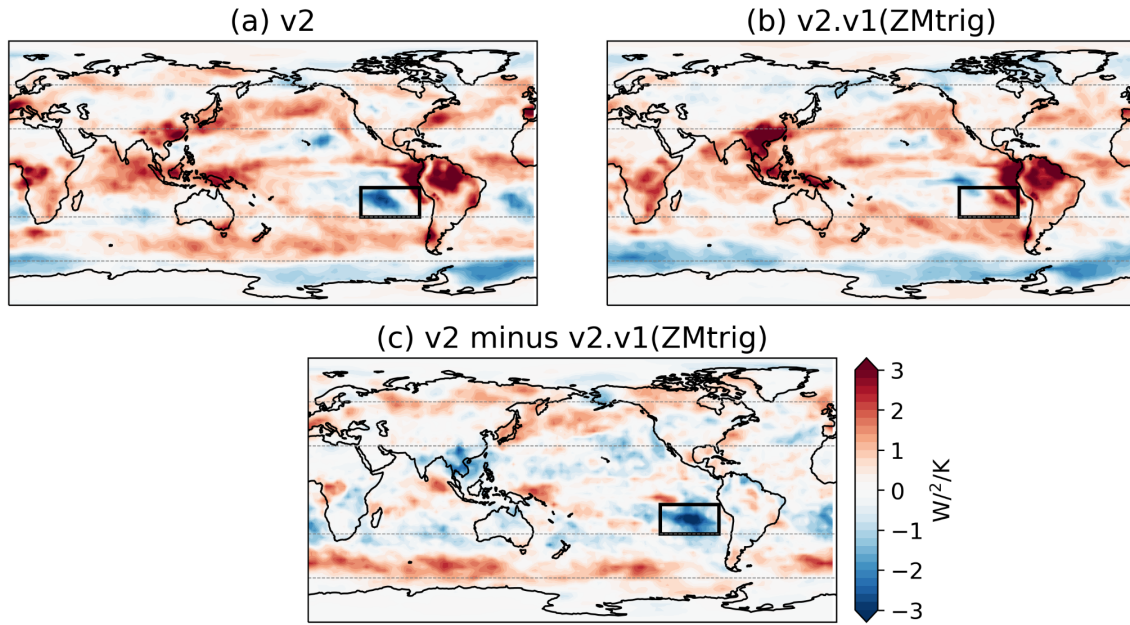
Figure S4. Same as Figure 2, but for v2 and v2.v1(ZMtrig). The black boxes in panels (a) - (c) denote the region for investigating the impact of trigger function, ranging from 10°S to 30°S, 80°W to 120°W.
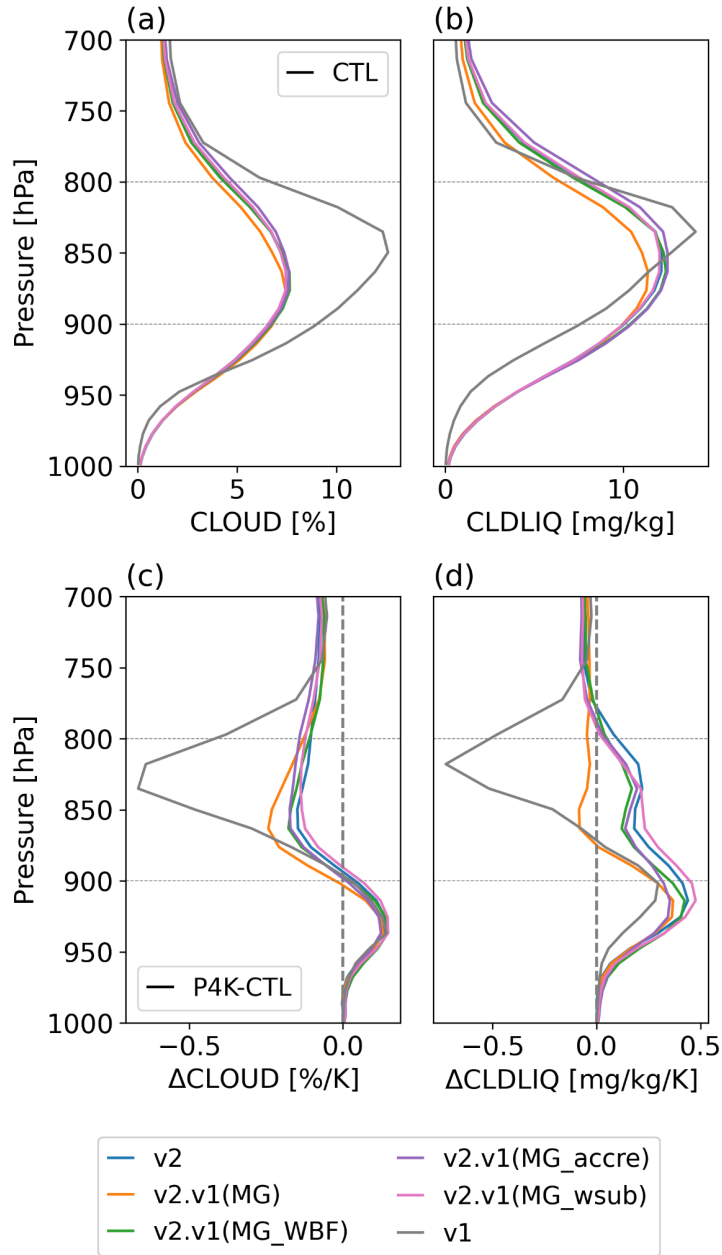
Figure S5. Same as Figure 8 but for v2.v1(MG_WBF), v2.v1(MG_accre) and v2.v1(MG_wsub).
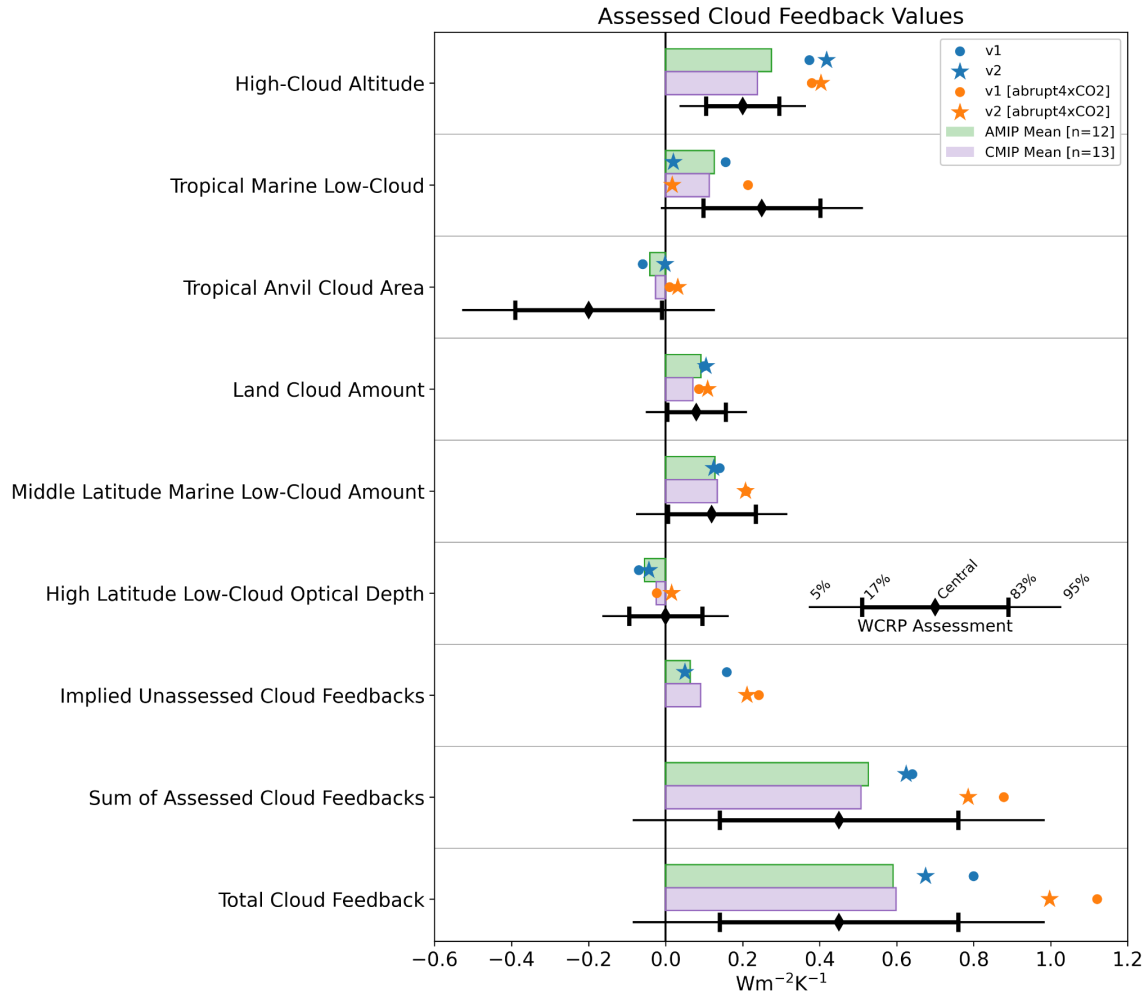
Figure S6. Cloud feedback components estimated from E3SM atmosphere-only v1 (blue dot), atmosphere-only v2 (blue asterisk), 150 yr coupled v1 (v1 [abrupt4xCO2]) (orange dot), and 150 yr coupled v2 (v2 [abrupt4xCO2]) (orange asterisk) simulations, from ensemble mean of CMIP5 and CMIP6 models (bars), and from Sherwood et al. (2020) (black error bars). The multi-model means are indicated with green and purple bars for AMIP and CMIP experiments, respectively. The expert-assessed likely and very likely confidence intervals are indicated with black error bars. For more details about the cloud feedback decomposition and the code see Zelinka et al. (2022) and Zelinka et al. (2021a).

Table S1. ERF for 2xCO2 and feedback in v1 and v2 experiments. The different experiments for ERF and feedback are denoted in the bracket ['ERF'/'feedback'].

	ERF [W/m^2]	Feedback [$W/m^2/K$]
v1 [150yr abrupt-4xCO2/ 150yr abrupt-4xCO2]	3.34	-0.63
v2 [150yr abrupt-4xCO2/ 150yr abrupt-4xCO2]	2.95	-0.74
v1 [amip-4xCO2/ amip-p4K]	4.24	-1.34
v2 [amip-4xCO2/ amip-p4K]	4.04	-1.53

Table S2. Number of samples in four categories based on CAPE and dCAPE values from hourly output of 1 yr simulations over the defined marine low cloud region (30°S-10°S, 120°W-80°W) in v2. Their ratio to the total samples (=3188640) are denoted in the bracket.

	CAPE>0,dCAPE>0 (ZM is active)	CAPE<=0,dCAPE>0	CAPE<=0,dCAPE<=0	CAPE>0,dCAPE<=0
CTL	520907 [0.16]	127 [0.0]	1362006 [0.43]	1305600 [0.41]
P4K	727535 [0.23]	49 [0.0]	901749 [0.28]	1559307 [0.49]

Table S3. Number of samples in three categories based on CAPE values from hourly output of 1 yr simulations over the defined marine low cloud region (30°S-10°S, 120°W-80°W) in v2.v1(ZMtrig). Their ratio to the total samples (=3188640) are denoted in the bracket.

	CAPE<=0	0<CAPE<=70	CAPE>70 (ZM is active)
CTL	20822 [0.01]	933739 [0.29]	2234079 [0.70]
P4K	58519 [0.02]	1272604 [0.40]	1857517 [0.58]

Table S4. Cloud feedbacks (W/m^2/K) in each regime from all simulations in Table 2 and Table 3.

	Short name	Marine Low	Trop Ascent	Trop Land	MidLat	HiLat	Global
	v1	0.19	0.15	0.10	0.21	0.01	0.65
	v2.v1(All)	0.14	0.14	0.10	0.22	0.01	0.61
Progressively reverted simulations	**v2.v1(clubb.MG.ZMother.gust.ZMtrig.gw)**	0.11	0.14	0.11	0.18	0.01	0.55
	v2.v1(clubb.MG.ZMother.gust.ZMtrig)	0.11	0.14	0.10	0.21	0.00	0.56
	v2.v1(clubb.MG.ZMother.gust)	0.08	0.13	0.11	0.31	0.02	0.65
	v2.v1(clubb.MG.ZMother)	0.10	0.13	0.13	0.28	0.01	0.65
	v2.v1(clubb.MG)	0.07	0.18	0.16	0.26	0.00	0.68
Singly reverted simulations	**v2.v1(clubb)**	0.03	0.17	0.15	0.18	-0.03	0.50
	v2.v1(ZMtrig)	0.08	0.13	0.15	0.11	-0.04	0.43
	v2.v1(ZMtrig_ULL)	0.01	0.15	0.12	0.20	-0.02	0.46
	v2.v1(MG)	0.07	0.18	0.15	0.29	0.01	0.69
	v2.v1(ZMother)	0.05	0.09	0.12	0.21	-0.03	0.43
	v2.v1(clubb)	0.03	0.17	0.15	0.18	-0.03	0.50
	v2	0.01	0.15	0.12	0.20	-0.02	0.46