Supporting Information for *Absorbing aerosol choices influence precipitation changes across future scenarios*

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0094-8276/22/$5.00

Table S1. Individual CMIP6 Models used in ScenarioMIP Ensemble

Model	Member
CanESM5	r1i1p1f1
CESM2-WACCM	r1i1p1f1
CMCC-CM2-SR5	r1i1p1f1
CMCC-ESM2	r1i1p1f1
CNRM-CM6-1	r1i1p1f2
CNRM-CM6-1-HR	r1i1p1f2
CNRM-ESM2-1	r1i1p1f2
GFDL-ESM4	r1i1p1f1
INM-CM4-8	r1i1p1f1
INM-CM5-0	r1i1p1f1
IPSL-CM6A-LR	r1i1p1f1
MIROC6	r1i1p1f1
MIROC-ES2L	r1i1p1f2
MPI-ESM1-2-HR	r1i1p1f1
MPI-ESM1-2-LR	r1i1p1f1
MRI-ESM2-0	r1i1p1f1
NorESM2-LM	r1i1p1f1
UKESM1-0-LL	r1i1p1f2

Table S2. ScenarioMIP Global Ensemble Mean, SE Changes and Quantities

Variable	Units	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
ΔT	K	0.78±0.04	1.83±0.09	3.00±0.15	3.92±0.20
ΔWVP	kgm^{-2}	1.30±0.07	3.29±0.17	5.74±0.29	7.75±0.39
$\Delta AAOD$	$\cdot 10^{-3}$	-1.67±0.08	-1.76±0.09	0.15±0.02	-1.19±0.05
ΔCO_2*	ppm	37.8	187.9	416.7	660.0
ΔCH_4	ppb	-795±7	-203±12	1386±22	576±17
ΔSW	Wm^{-2}	-0.03±0.02	1.18±0.06	3.51±0.17	3.83±0.20
ΔLW	Wm^{-2}	-2.00±0.11	-3.98±0.20	-6.24±0.31	-8.08±0.41
ΔSH	Wm^{-2}	0.095±0.006	-0.34±0.02	-0.98±0.05	-0.97±0.05
ΔLH	Wm^{-2}	2.01±0.10	3.27±0.17	3.86±0.19	5.41±0.27
η	$Wm^{-2}K^{-1}$	2.21±0.22	2.06±0.26	1.86±0.25	1.84±0.28
$\overline{\eta_{SSP}}$	1.99 ± 0.25	-	-	-	-
η_a	$Wm^{-2}K^{-1}$	2.54±0.16	1.76±0.07	1.30±0.07	1.39±0.07
ΔP	Wm^{-2}	2.00±0.10	3.23±0.17	3.90±0.20	5.44±0.27
ΔP_{fast}	Wm^{-2}	0.43±0.27	-0.42±0.48	-2.07±0.80	-2.35±1.04
$\Delta P_{fastCO2}$	Wm^{-2}	-0.28±0.02	-1.19±0.10	-2.21±0.19	-3.02±0.26
$\Delta P_{fastCH4}$	Wm^{-2}	0.25±0.05	0.05±0.01	-0.25±0.05	-0.12±0.02
$\Delta P_{fastAAOD}$	Wm^{-2}	0.46±0.27	0.72±0.49	0.39±0.83	0.79±1.07
$\Delta P_{fastAAOD}P20$	Wm^{-2}	0.33±0.26	0.41±0.50	-0.12±0.84	0.13±1.08
ΔP_{AAOD}	Wm^{-2}	0.62±0.25	0.65±0.27	-0.05±0.34	0.45±0.28
ΔSW_{AAOD}	Wm^{-2}	-0.87±0.04	-0.91±0.05	0.08±0.01	-0.62±0.03

* CO_2 is prescribed in ScenarioMIP simulations thus no SE is reported.

Table S3. Mean, SE for Global Energy Budget Changes from Figure 2

Variable	Units	SSP2-4.5	SSP3-7.0
ΔSW	$Wm^{-2}K^{-1}$	0.64±0.09	1.2±0.2
ΔSW_{AAOD}	$Wm^{-2}K^{-1}$	-0.50±0.07	0.026±0.007
ΔSW_{WVP}	$Wm^{-2}K^{-1}$	1.1±0.2	1.1±0.2
ΔLW	$Wm^{-2}K^{-1}$	-2.2±0.3	-2.1±0.3
ΔSH	$Wm^{-2}K^{-1}$	-0.19±0.03	-0.33±0.05
$\Delta LH = L_v \Delta P$	$Wm^{-2}K^{-1}$	1.8±0.3	1.3±0.2

Table S4. ScenarioMIP Regional Ensemble Mean, SE for $\Delta AAOD$

Region	Units	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
Global	$\cdot 10^{-3}$	-1.67±0.08	-1.76±0.09	0.15±0.02	-1.19±0.05
Southeast Asia	$\cdot 10^{-3}$	-8.28±0.40	-9.12±0.49	-1.74±0.18	-8.85±0.42
Equatorial Africa	$\cdot 10^{-3}$	-2.95±0.13	-4.98±0.29	2.97±0.15	1.11±0.25

Table S5. Mean, SE for Regional Budget Changes from Figures 3 and 4

Variable	Units	SSP2-4.5	SSP3-7.0
Southeast Asia (0-45°N, 60-130°E)			
$L_v\Delta P$	$Wm^{-2}K^{-1}$	4.0±0.6	2.6±0.4
$L_v\Delta P_{thermo}$	$Wm^{-2}K^{-1}$	4.8±0.8	3.6±0.5
$L_v\Delta P_{circ}$	$Wm^{-2}K^{-1}$	-0.8±0.8	-1.0±0.5
ΔSW	$Wm^{-2}K^{-1}$	-0.7±0.1	1.1±0.2
ΔSW_{AAOD}	$Wm^{-2}K^{-1}$	-2.6±0.4	-0.30±0.07
ΔSW_{WVP}	$Wm^{-2}K^{-1}$	1.5±0.4	1.5±0.4
ΔLW	$Wm^{-2}K^{-1}$	-2.4±0.3	-2.6±0.4
ΔSH	$Wm^{-2}K^{-1}$	0.58±0.09	-0.11±0.02
$\Delta div(s)$	$Wm^{-2}K^{-1}$	1.5±0.6	1.0±0.4
$\Delta div(q_v)$	$Wm^{-2}K^{-1}$	-1.1±0.6	-0.9±0.4
$\Delta div(q_v)_{thermo}$	$Wm^{-2}K^{-1}$	-1.9±1.0	-1.9±0.8
$\Delta div(q_v)_{circ}$	$Wm^{-2}K^{-1}$	0.8±1.1	1.0±0.9
ΔLH	$Wm^{-2}K^{-1}$	2.8±0.4	1.7±0.2
Equatorial Africa (15°S-15°N, 30°W-30°E)			
$L_v\Delta P$	$Wm^{-2}K^{-1}$	1.6±0.3	1.3±0.3
$L_v\Delta P_{thermo}$	$Wm^{-2}K^{-1}$	2.1±0.5	1.0±0.3
$L_v\Delta P_{circ}$	$Wm^{-2}K^{-1}$	-0.6±0.6	0.3±0.4
ΔSW	$Wm^{-2}K^{-1}$	0.10±0.07	1.7±0.2
ΔSW_{AAOD}	$Wm^{-2}K^{-1}$	-1.4±0.2	0.51±0.07
ΔSW_{WVP}	$Wm^{-2}K^{-1}$	1.7±0.5	1.6±0.5
ΔLW	$Wm^{-2}K^{-1}$	-2.7±0.4	-2.5±0.4
ΔSH	$Wm^{-2}K^{-1}$	0.47±0.08	-0.14±0.03
$\Delta div(s)$	$Wm^{-2}K^{-1}$	-0.6±0.4	0.3±0.4
$\Delta div(q_v)$	$Wm^{-2}K^{-1}$	1.2±0.4	0.3±0.3
$\Delta div(q_v)_{thermo}$	$Wm^{-2}K^{-1}$	0.6±0.2	0.6±0.5
$\Delta div(q_v)_{circ}$	$Wm^{-2}K^{-1}$	0.6±0.5	-0.3±0.6
ΔLH	$Wm^{-2}K^{-1}$	2.7±0.4	1.6±0.2

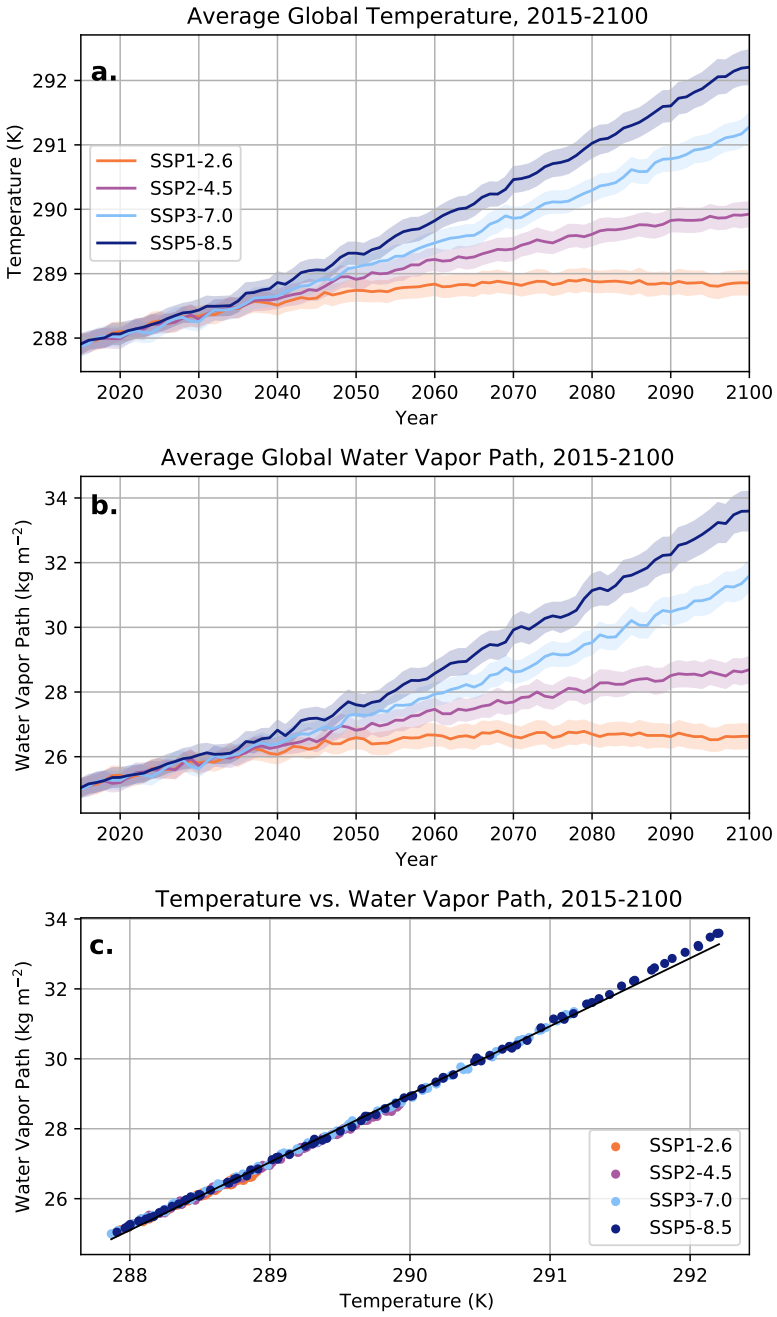

Figure S1. Global multi-model ensemble mean (line) and corresponding standard error (shading) by scenario across period of interest (2015-2100) for (a) temperature and (b) water vapor path. (c) The global multi-model ensemble mean temperature is correlated with water vapor path at R^2= 0.997 at 95% confidence and has a slope of m= 1.94 kg m^{-2} K^{-1}.

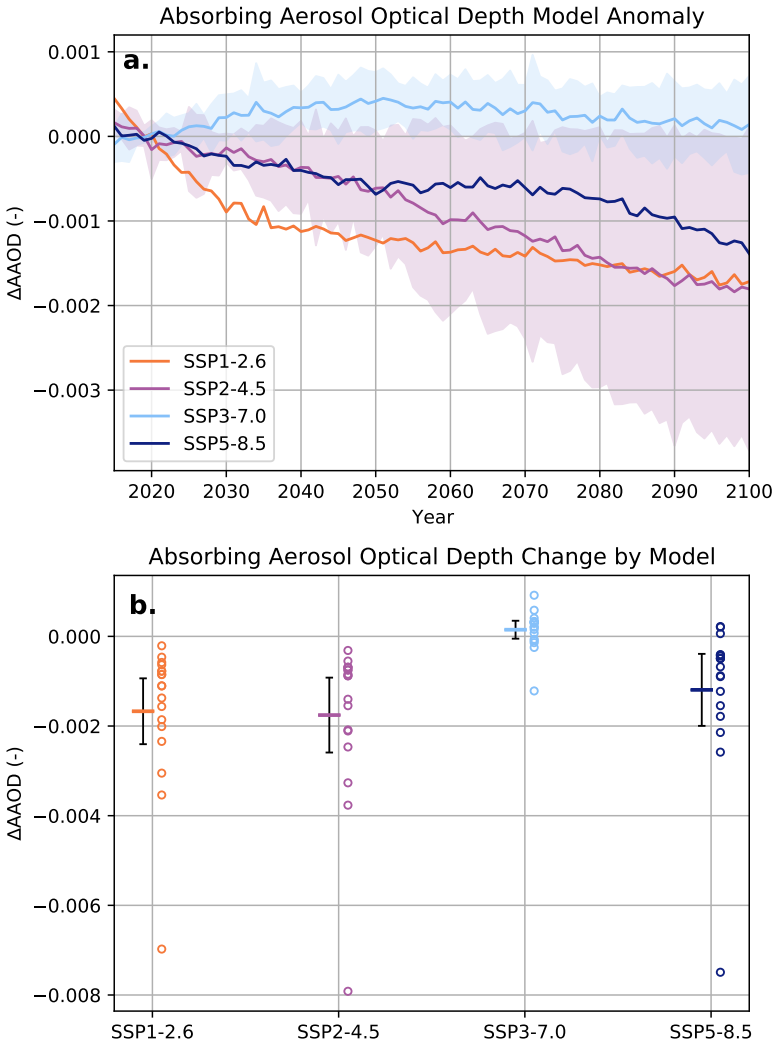

Figure S2. (a) SSP multi-model mean of trends in the anomaly of $AAOD$ from the 2015-2025 period. Standard deviations are included for SSP2-4.5 and SSP3-7.0. (b) Global mean $\Delta AAOD$ for individual CMIP6 models (circles) with mean (horizontal bar) and 2SE (error bars) for all scenarios.

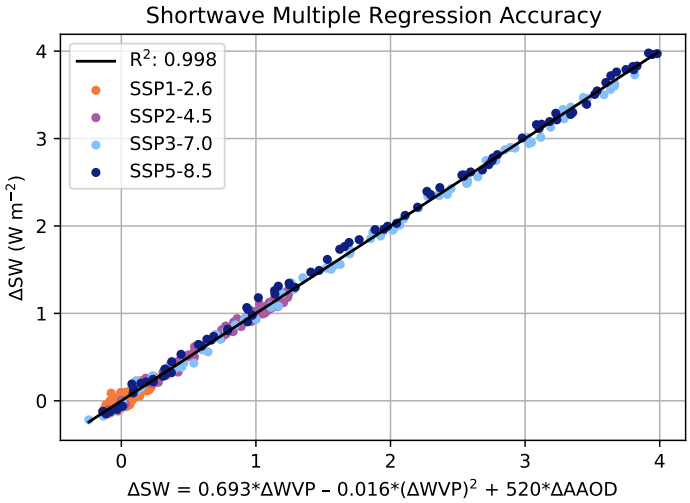

Figure S3. CMIP6 SSP change in SW vs. predicted change in SW based on changes in WVP and AAOD from Eq. 2. Each scatter point represents a year from 2015-2100.

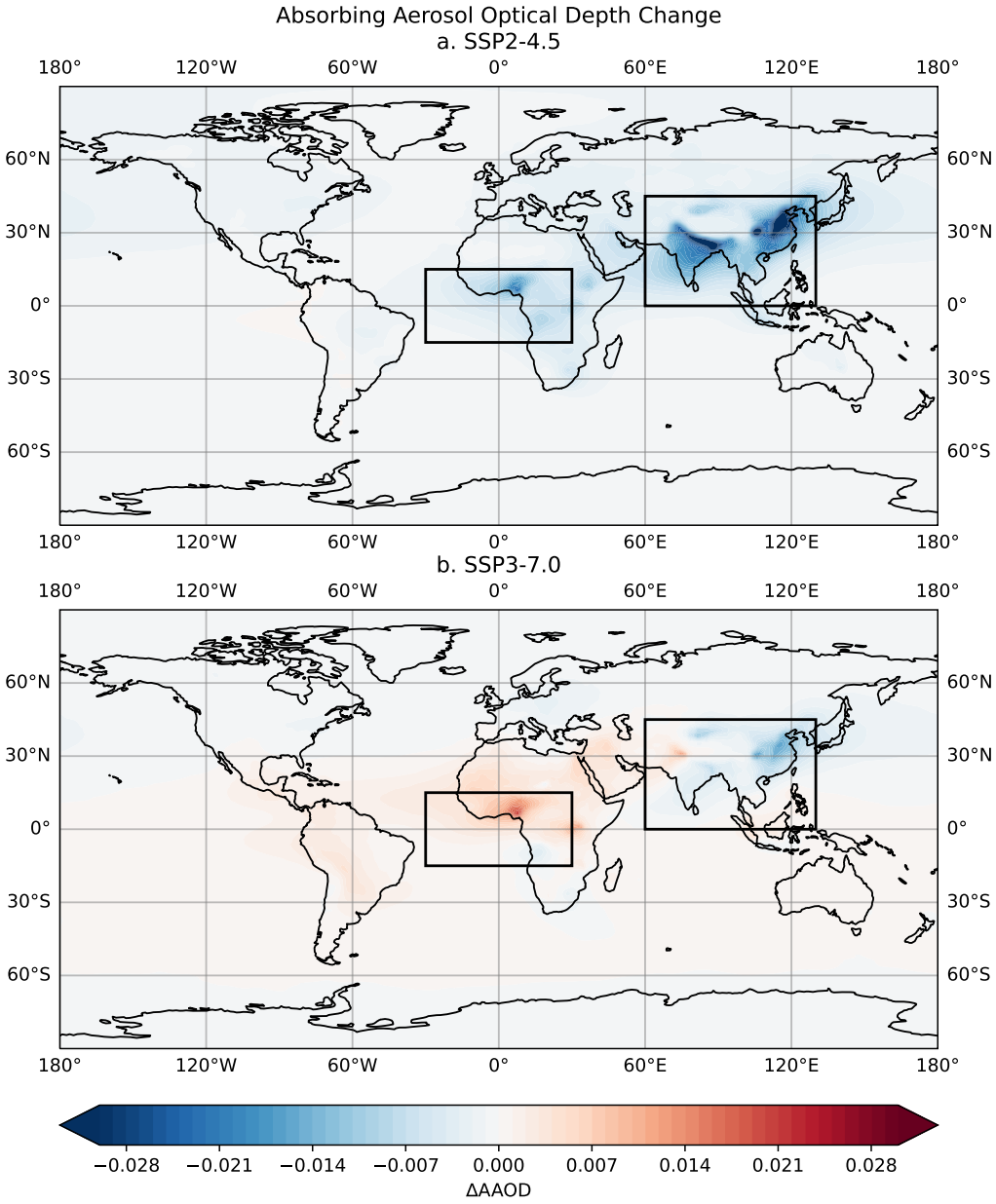

Figure S4. Global changes in AAOD between 2015-2025 and 2090-2100 for two CMIP6 SSP simulations with contrasting aerosol choices: (a) SSP2-4.5 (*Middle of the road*) and (b) SSP3-7.0 (*Regional Rivalry*). Two regions of interest are highlighted: Southeast Asia (0-45°N, 60-130°E) which experiences decreases in AAOD in both (a, b) and Equatorial Africa (15°S-15°N, 30°W-30°E) which experiences decreases in AAOD in (a) but increases in (b). See Table S4 for values.

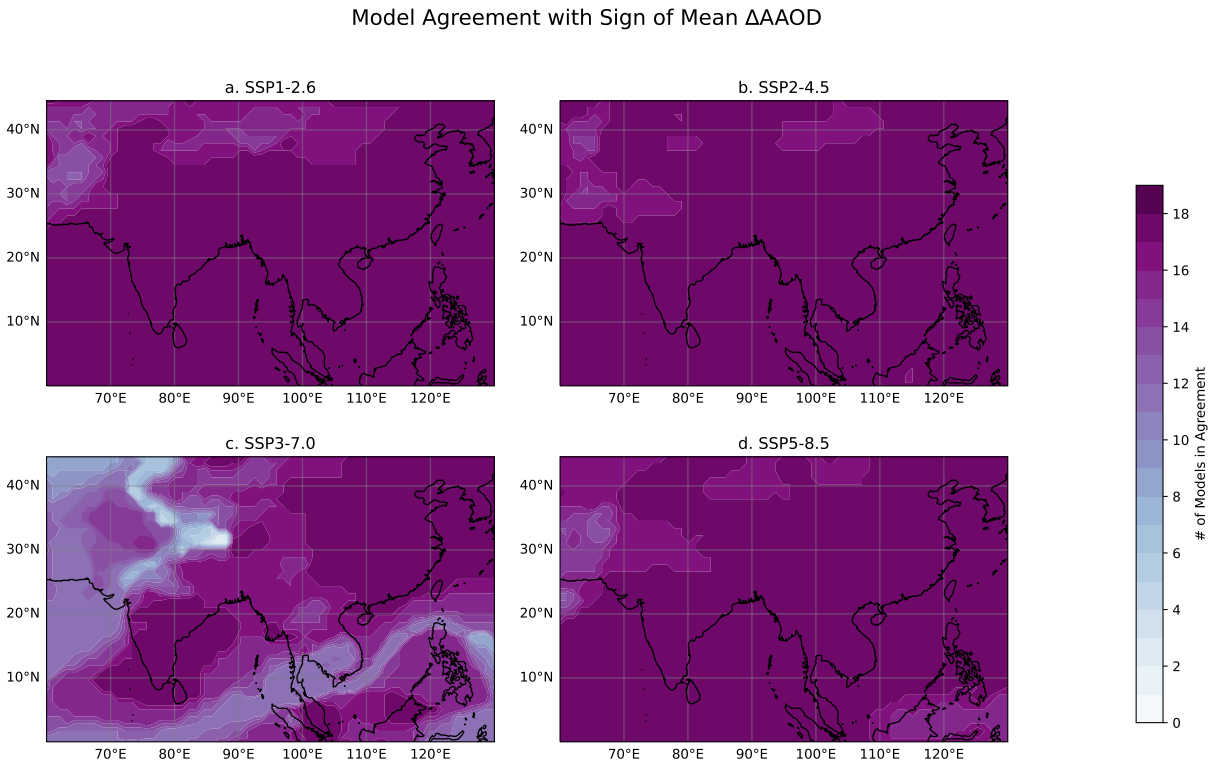

Figure S5. Number of CMIP6 models that agree in the sign of the regional $\Delta AAOD$ in Southeast Asia (0-45°N, 60-130°E) between 2015-2025 and 2090-2100 for four ScenarioMIP simulations: (a) SSP1-2.6, (b) SSP2-4.5, (c) SSP3-7.0, and (d) SSP5-8.5.

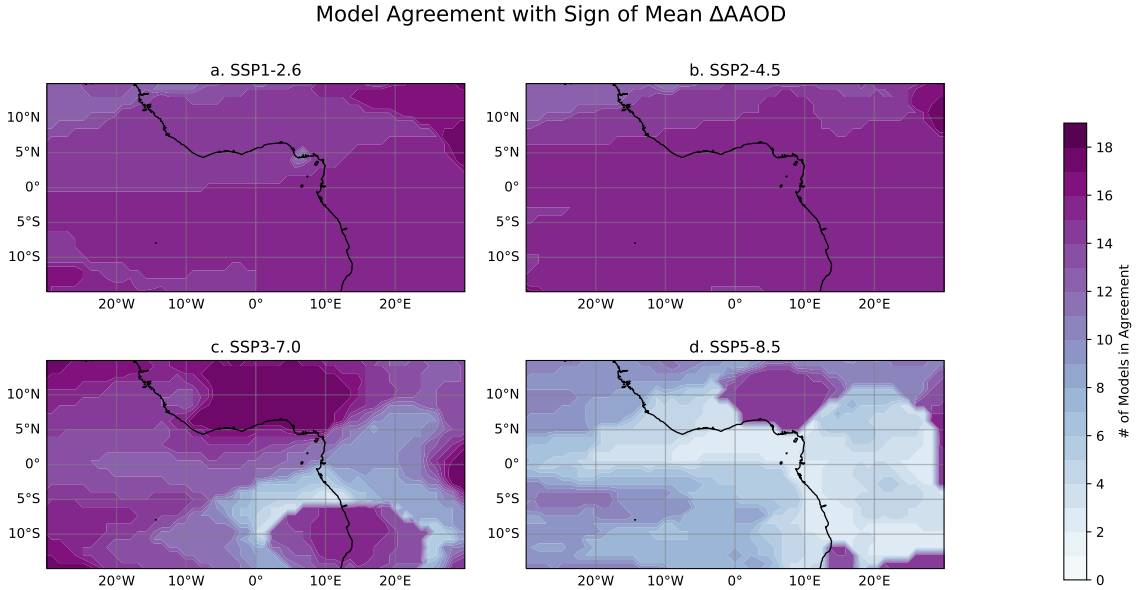

Figure S6. Number of CMIP6 models that agree in the sign of the regional $\Delta AAOD$ in Equatorial Africa (15°S-15°N, 30°W-30°E) between 2015-2025 and 2090-2100 for four ScenarioMIP simulations: (a) SSP1-2.6, (b) SSP2-4.5, (c) SSP3-7.0, and (d) SSP5-8.5.