Supplementary Material

Long-term trends of global marine primary and secondary aerosol production during the recent global warming hiatus (2000-2015)

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Supplementary Table 1. Summary of Mann–Kendall (MK) statistics of annual trends in dimethyl sulfide (DMS) fluxes (μmol m^{-2} yr^{-1}) for each latitude band (10° interval between 0° and 60°) over the global ocean during the study period (2000–2015).

Latitude	All				MAM			JJA			SON			DJF		
	Q[a]	p[b]	Avg[c]	Std[d]	Q	p	Avg	Q	p	Avg	Q	p	Avg	Q	p	Avg
Northern Hemisphere																
50°-60°	-0.365	-0.16	239.4	210.6	-0.365	-0.04	100.7	-1.825	-0.13	169.4	-13.14	-1.76	619.8	**-2.920**	-0.91	695.3
40°-50°	**-4.745**[*]	-1.65	245.6	150.7	**-3.650**	-0.36	140.5	**-8.760**	-0.62	233.6	-11.68	-1.57	421.2	-4.745	-1.48	256.2
30°-40°	**-10.22**	-3.19	273.0	145.3	**-4.380**	-0.44	162.8	**-13.51**	-0.95	412.1	**-14.97**	-2.01	308.1	**-10.95**	-3.42	293.5
20°-30°	**-8.760**	-1.18	740.2	266.8	-3.285	-0.33	616.9	**-23.36**	-1.64	1021.6	**-10.59**	-1.42	231.0	-6.935	-2.16	277.8
10°-20°	**-6.935**	-0.49	1349.0	278.9	**-10.22**	-1.02	1309.6	**-20.81**	-1.46	1347.9	**-12.78**	-1.72	804.8	10.95	3.42	523.4
0°-10°	**-13.14**	-1.31	953.7	234.7	**-16.06**	-1.60	832.9	**-21.90**	-1.54	1016.2	**-15.33**	-2.06	1163.6	2.190	0.68	1595.4
Southern Hemisphere																
0°-10°	**-15.70**	-1.45	1094.3	265.0	-5.840	-0.58	933.3	-0.365	-0.03	1428.2	**-9.855**	-1.32	581.4	-5.840	-1.82	908.9
10°-20°	-4.015	-0.32	1246.5	203.7	**-8.760**	-0.87	1247.2	8.030	0.56	1400.5	-2.190	-0.29	1084.4	-9.125	-2.85	1082.6
20°-30°	-5.840	-0.83	630.7	304.4	**-12.41**	-1.24	720.9	0.000	0.00	337.3	-6.935	-0.93	1259.3	**-10.22**	-3.19	927.8
30°-40°	**-9.490**	-4.17	189.4	117.5	**-5.110**	-0.51	174.1	**-6.570**	-0.46	161.3	**-5.840**	-0.78	520.1	**-8.760**	-2.73	287.6
40°-50°	**-5.840**	-1.06	390.9	207.0	**-17.16**	-1.71	471.6	-7.665	-0.54	239.4	**-5.110**	-0.69	132.1	**-27.01**	-8.43	598.2
50°-60°	**-18.62**	-3.00	415.0	244.2	**-19.71**	-1.96	545.7	**-9.125**	-0.64	155.1	**-11.32**	-1.52	261.0	**-21.17**	-6.61	539.5

[a] Q is a slope of long-term trend calculated using the non-parametric Sen's method.
[b] %/yr.
[c] Average.
[d] Standard deviation.
[*] Values in bold are statistically significant with 90% confidence level.

Supplementary Table 2. Summary of MK statistics of MODIS aerosol optical depth (AOD) for each latitude band (10° interval between 0° and 60°) over the global ocean during 2003–2015.

Latitude	All				MAM			JJA			SON			DJF		
	Q[a]	p[b]	Avg[c]	Std[d]	Q	p	Avg	Q	p	Avg	Q	p	Avg	Q	p	Avg
Northern Hemisphere																
50°-60°	0.0007	0.48	0.122	0.015	-0.0040	-2.18	0.137	**0.0030**	1.74	0.144	-0.0009	-1.00	0.079	0.0009	1.59	0.067
40°-50°	-0.0003	-0.20	0.130	0.011	-0.0023	-1.11	0.168	0.0013	0.70	0.152	-0.0003	-0.34	0.094	0.0003	0.36	0.097
30°-40°	**-0.0013**[*]	-0.80	0.164	0.009	**-0.0014**	-0.61	0.215	**-0.0025**	-1.24	0.183	-0.0010	-0.84	0.125	-0.0001	-0.09	0.127
20°-30°	0.0000	-0.01	0.191	0.006	0.0001	0.03	0.219	-0.0007	-0.30	0.235	**-0.0009**	-0.61	0.159	0.0010	0.65	0.149
10°-20°	0.0008	0.40	0.215	0.007	-0.0003	-0.12	0.249	0.0010	0.38	0.279	-0.0001	-0.07	0.172	0.0013	0.84	0.164
0°-10°	0.0005	0.29	0.178	0.007	-0.0007	-0.36	0.194	**0.0009**	0.60	0.165	0.0002	0.13	0.139	0.0006	0.32	0.192
Southern Hemisphere																
0°-10°	-0.0004	-0.25	0.154	0.010	-0.0001	-0.07	0.121	0.0001	0.04	0.164	-0.0014	-0.89	0.166	0.0011	0.80	0.141
10°-20°	-0.0003	-0.28	0.104	0.006	0.0006	0.78	0.078	0.0005	0.54	0.089	-0.0007	-0.50	0.146	0.0001	0.07	0.098
20°-30°	0.0001	0.18	0.072	0.003	**0.0004**	0.70	0.060	0.0001	0.23	0.058	0.0003	0.31	0.092	0.0000	0.01	0.076
30°-40°	0.0002	0.32	0.073	0.004	**0.0003**	0.51	0.059	0.0006	1.11	0.062	0.0004	0.49	0.090	0.0003	0.37	0.080
40°-50°	**0.0005**	0.59	0.080	0.005	0.0001	0.09	0.066	**0.0006**	1.08	0.063	**0.0007**	0.87	0.093	0.0003	0.30	0.099
50°-60°	**0.0008**	1.05	0.080	0.006	0.0000	0.04	0.068	**0.0005**	0.87	0.057	**0.0014**	1.73	0.088	0.0004	0.49	0.095

[a] Q is a slope of long-term trend calculated using the non-parametric Sen's method.
[b] %/yr.
[c] Average.
[d] Standard deviation.
[*] Values in bold are statistically significant with 90% confidence level.

Supplementary Table 3. Seasonal variations in AOD derived from sea spray aerosol (SSA) emissions (AOD_{SSA}) for each latitude band over the global ocean during the study period (2000–2015).

	MAM	JJA	SON	DJF	Average
Northern Hemisphere					
50°-60°	0.0227	0.0205	0.0247	0.0294	0.0240
40°-50°	0.0227	0.0213	0.0235	0.0281	0.0239
30°-40°	0.0220	0.0225	0.0216	0.0268	0.0232
20°-30°	0.0260	0.0278	0.0268	0.0265	0.0268
10°-20°	0.0332	0.0330	0.0289	0.0345	0.0324
0°-10°	0.0282	0.0291	0.0264	0.0304	0.0285
Average	0.0258	0.0257	0.0253	0.0293	0.0265
Southern Hemisphere					
0°-10°	0.0269	0.0333	0.0304	0.0280	0.0296
10°-20°	0.0311	0.0377	0.0352	0.0292	0.0333
20°-30°	0.0273	0.0254	0.0271	0.0290	0.0272
30°-40°	0.0219	0.0240	0.0226	0.0227	0.0228
40°-50°	0.0304	0.0317	0.0321	0.0307	0.0312
50°-60°	0.0368	0.0344	0.0371	0.0342	0.0355
Average	0.0291	0.0311	0.0307	0.0290	0.0299

Supplementary Table 4. Seasonal variations in AOD derived from SSA and DMS ($AOD_{SSA+DMS}$) for each latitude band over the global ocean during the study period (2000–2015).

	MAM	JJA	SON	DJF	Average
Northern Hemisphere					
50°-60°	0.0449	0.0456	0.0572	0.0562	0.0497
40°-50°	0.0459	0.0471	0.0526	0.0569	0.0510
30°-40°	0.0458	0.0553	0.0482	0.0569	0.0519
20°-30°	0.0679	0.0843	0.0758	0.0660	0.0737
10°-20°	0.1023	0.1035	0.0902	0.1123	0.1008
0°-10°	0.0821	0.0873	0.0760	0.0953	0.0854
Average	0.0648	0.0705	0.0667	0.0739	0.0688
Southern Hemisphere					
0°-10°	0.0791	0.1063	0.0893	0.0795	0.0895
10°-20°	0.0953	0.1102	0.1015	0.0872	0.0987
20°-30°	0.0731	0.0569	0.0654	0.0837	0.0695
30°-40°	0.0465	0.0476	0.0455	0.0525	0.0480
40°-50°	0.0662	0.0567	0.0591	0.0711	0.0640
50°-60°	0.0771	0.0569	0.0631	0.0714	0.0683
Average	0.0729	0.0724	0.0706	0.0742	0.0730

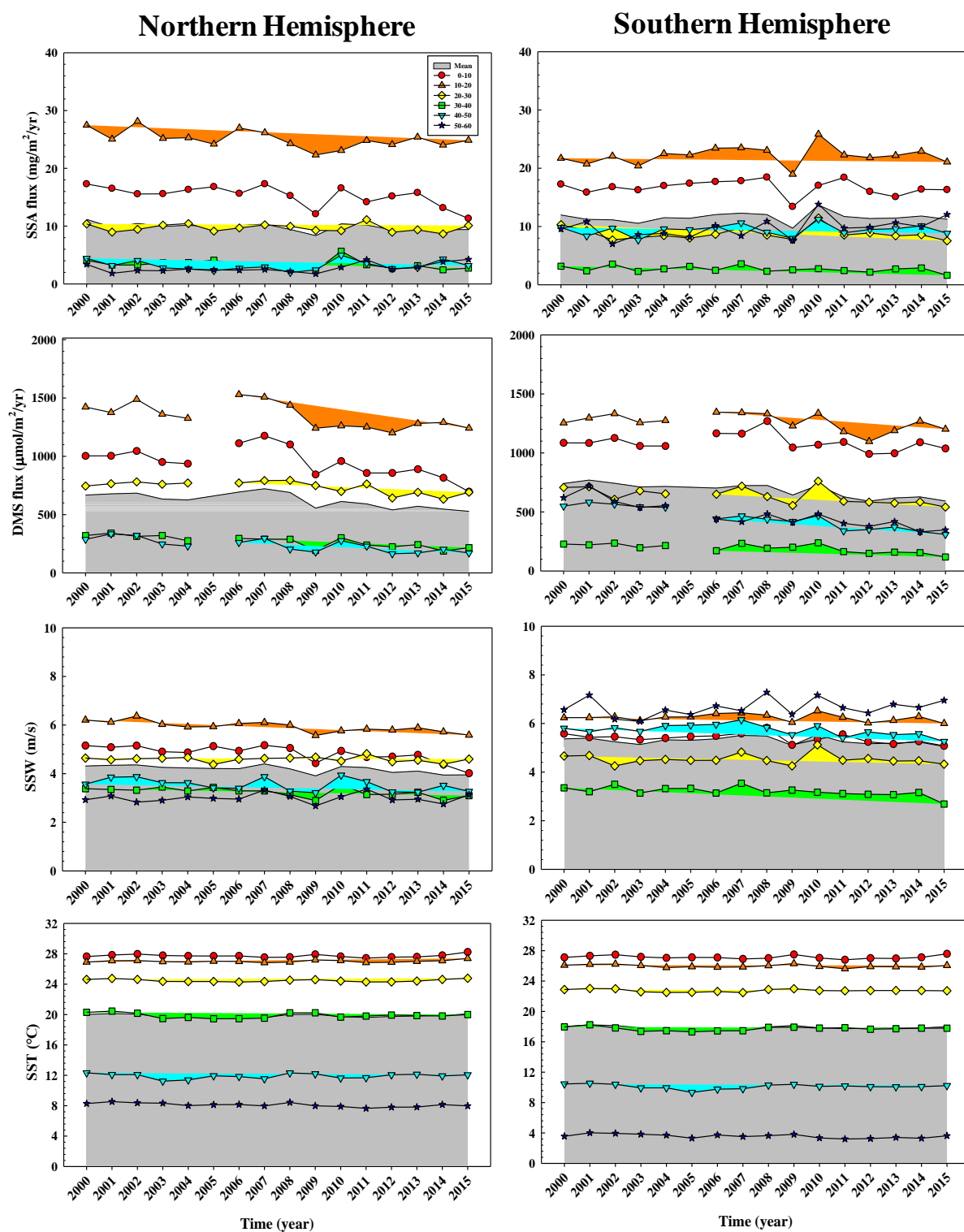
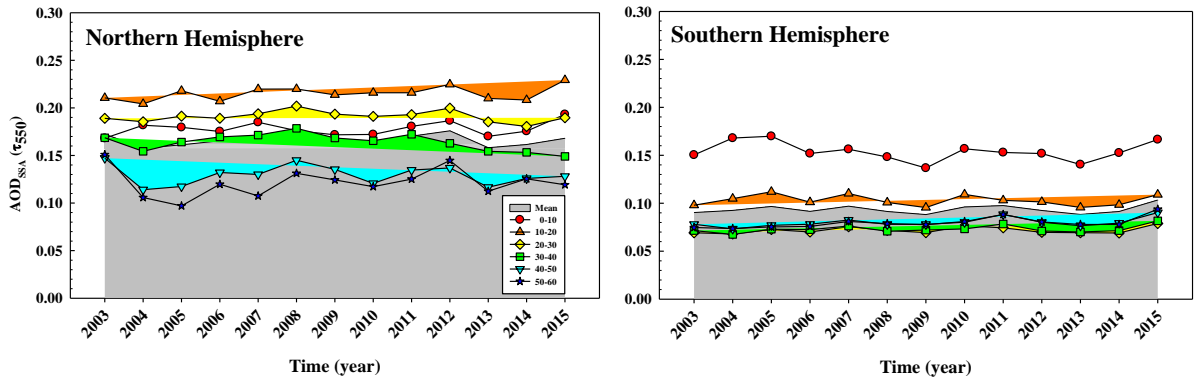
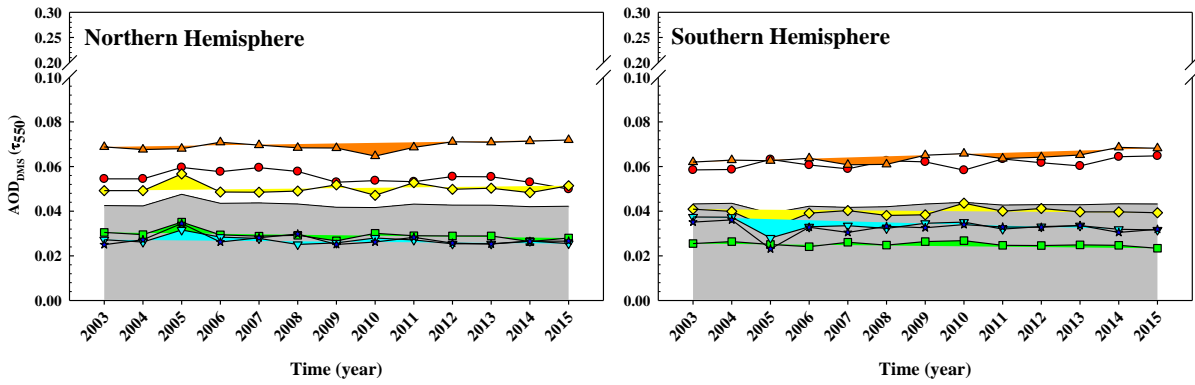
Supplementary Table 5. Seasonal variations in MODIS AOD for each latitude band over the global ocean during 2003–2015.

	MAM	JJA	SON	DJF	Average
Northern Hemisphere					
50°-60°	0.139	0.146	0.086	0.067	0.110
40°-50°	0.169	0.153	0.095	0.097	0.129
30°-40°	0.217	0.185	0.126	0.127	0.164
20°-30°	0.220	0.236	0.159	0.149	0.191
10°-20°	0.246	0.278	0.172	0.164	0.215
0°-10°	0.193	0.165	0.137	0.192	0.172
Average	0.197	0.194	0.129	0.133	0.164
Southern Hemisphere					
0°-10°	0.121	0.164	0.164	0.141	0.148
10°-20°	0.077	0.089	0.145	0.098	0.102
20°-30°	0.059	0.058	0.091	0.076	0.071
30°-40°	0.058	0.062	0.090	0.080	0.073
40°-50°	0.065	0.061	0.092	0.099	0.079
50°-60°	0.068	0.055	0.085	0.095	0.076
Average	0.075	0.082	0.111	0.098	0.092

Supplementary Table 6. Seasonal contributions of AOD_{SSA} to MODIS AOD for each latitude band over the global ocean during 2003–2015.

	MAM	JJA	SON	DJF	Average
Northern Hemisphere					
50°-60°	19.9	23.6	43.2	64.5	35.4
40°-50°	17.7	20.9	30.2	39.8	27.2
30°-40°	15.1	21.3	25.2	32.5	23.4
20°-30°	20.0	25.5	31.4	32.2	27.3
10°-20°	22.8	21.9	26.8	33.8	26.4
0°-10°	21.5	25.3	26.2	23.7	24.0
Average	19.5	23.1	30.5	37.8	27.3
Southern Hemisphere					
0°-10°	27.5	30.3	27.4	25.2	27.8
10°-20°	39.4	50.7	34.4	31.7	39.3
20°-30°	43.7	45.1	32.0	38.3	39.8
30°-40°	41.4	44.0	28.5	32.8	36.8
40°-50°	56.7	65.1	40.0	36.0	49.5
50°-60°	74.2	93.3	51.8	42.5	62.2
Average	47.1	54.7	35.7	34.4	42.6

Supplementary Table 7. Seasonal contributions of $AOD_{SSA+DMS}$ to MODIS AOD for each latitude band over the global ocean during 2003–2015.

	MAM	JJA	SON	DJF	Average
Northern Hemisphere					
50°-60°	32.1	43.1	74.4	68.9	52.0
40°-50°	30.8	38.2	61.7	66.5	49.9
30°-40°	30.1	50.2	53.3	61.7	48.5
20°-30°	49.7	71.6	82.6	74.9	69.7
10°-20°	66.3	64.3	78.2	98.8	77.4
0°-10°	55.5	63.7	62.6	67.0	62.1
Average	44.1	55.2	68.8	73.0	59.9
Southern Hemisphere					
0°-10°	72.4	85.7	71.3	63.7	73.4
10°-20°	100.0	100.0	92.6	89.7	100.0
20°-30°	99.8	95.5	74.7	99.3	95.3
30°-40°	82.6	81.7	54.4	71.7	70.2
40°-50°	100.0	94.5	70.1	78.9	88.3
50°-60°	100.0	95.3	78.6	81.3	89.4
Average	92.5	92.1	73.6	80.8	86.1

Supplementary Fig. 1. Yearly variations in sea spray aerosol (SSA) emissions, dimethyl sulfide (DMS) fluxes, sea surface wind (SSW), and sea surface temperature (SST) for each latitude band (10° interval) during the entire study period (2000–2015). DMS fluxes in 2005 were excluded due to the unavailability of mixed layer depth (MLD) data from January to June 2005.

Supplementary Fig. 2. Yearly variations in (a) AOD (τ_{550}) derived from SSA emissions (AOD_{SSA}) and (b) DMS fluxes (AOD_{DMS}) zonally averaged over the latitude bands (10° interval between 0° and 60°) during 2003–2015.