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Supplement of

Modeling the smoky troposphere of the southeast Atlantic: a comparison to ORACLES airborne observations from September of 2016

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1 **Table S1. Comparison of flight-day values to the monthly-mean climatology formulated from**
 2 **the same model. Shown are the mean bias (MB), and root-mean-square deviation (RMSD),**
 3 **as well as their ratio (%) to the monthly mean.**

	WRF-CAM5		GEOS-5	
	MB	RMSD	MB	RMSD
<i>Smoke Top Height (m) simulated as observed by HSRL-2 on ER2</i>				
	+125	500	+369	505
	(+3%)	(11%)	(+11%)	(15%)
<i>Smoke Base Height (m) simulated as observed by HSRL-2 on ER2</i>				
	+371	426	+103	292
	(+29%)	(33%)	(+8%)	(23%)
<i>Black Carbon Mass (ng m⁻³)</i>				
3-6 km	-4.5	182.5	-1.8	198.2
	(-1%)	(27%)	(-0%)	(30%)
FT≤ 3km	+161.1	319.3	-98.8	423.6
	(+25%)	(50%)	(-9%)	(38%)
MBL	+40.1	80.3	+82.1	354.2
	(+31%)	(63%)	(+21%)	(93%)
<i>Organic Aerosol Mass (ug m⁻³)</i>				
3-6 km	-0.0	1.5	+0.0	2.9
	(-0%)	(27%)	(+0%)	(32%)
FT≤ 3km	+1.3	2.6	-1.6	6.2
	(+25%)	(50%)	(-10%)	(40%)

MBL	+0.3 (+36%)	0.6 (70%)	+1.0 (+19%)	4.9 (92%)
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Sulfate Aerosol Mass ($\mu\text{g m}^{-3}$)

3-6 km	-0.1 (-4%)	0.2 (19%)	--	--
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FT \leq 3km	+0.2 (+17%)	0.4 (31%)	--	--
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MBL	+0.1 (+13%)	0.3 (44%)	--	--
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Volumetric Mean Diameter (nm)

3-6 km	-7 (-3%)	10 (4%)	--	--
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FT \leq 3km	-6 (-2%)	17 (6%)	--	--
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MBL	-22 (-7%)	37 (12%)	--	--
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Aerosol Optical Depth simulated as observed by HSRL-2 on ER2

Above clouds	+0.018 (+7%)	0.055 (21%)	+0.001 (+1%)	0.036 (16%)
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Aerosol Optical Depth simulated as observed by 4STAR on P3

Above clouds	+0.031 (+12%)	0.048 (18%)	-0.019 (-9%)	0.057 (26%)
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Extinction Coefficient (Mm^{-1}) simulated as observed by HSRL-2 on ER2

3-6 km	+3 (+7%)	12 (23%)	+2 (+5%)	12 (30%)
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*Extinction Coefficient (Mm^{-1}) simulated as observed by
neph+PSAP on P3*

3-6 km	-1 (-3%)	13 (25%)	-1 (-3%)	14 (33%)
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FT \leq 3km	+11 (+22%)	22 (42%)	-8 (-13%)	24 (39%)
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MBL	-2 (-6%)	10 (32%)	+7 (+6%)	67 (62%)
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Scattering Ångström Exponent

3-6 km	+0.1 (+5%)	0.1 (6%)	+0.0 (+0%)	0.0 (2%)
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FT \leq 3k m	+0.0 (+4%)	0.1 (12%)	+0.0 (+2%)	0.1 (6%)
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MBL	+0.1 (+29%)	0.2 (44%)	+0.1 (+10%)	0.2 (30%)
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Absorption Ångström Exponent

3-6 km	+0.0 (+1%)	0.0 (1%)	+0.0 (+0%)	0.0 (0%)
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FT \leq 3k m	+0.0 (+0%)	0.0 (2%)	-0.0 (-0%)	0.0 (1%)
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MBL	+0.0 (+1%)	0.1 (5%)	-0.0 (-0%)	0.0 (2%)
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Single Scattering Albedo

3-6 km	-0.00 (-0%)	0.01 (1%)	-0.00 (-0%)	0.01 (1%)
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FT \leq 3k m	-0.01 (-1%)	0.01 (2%)	-0.00 (-0%)	0.01 (1%)
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MBL	-0.02 (-2%)	0.03 (3%)	-0.01 (-1%)	0.01 (1%)
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Carbon Monoxide (ppbv)

3-6 km	+0 (+0%)	23 (15%)	+0 (+0%)	22 (13%)
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FT≤ 3km	+12 (+10%)	29 (23%)	-2 (-2%)	26 (16%)
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MBL	+3 (+5%)	5 (7%)	+1 (+2%)	12 (15%)
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2 The optical properties are at 500-550 nm. The values are for the P3 flights unless otherwise
 3 noted, in the diagonally and horizontally aligned boxes.

1 **Table S2. The differences of box-average model values from the observations. Shown are**
 2 **the mean bias (MB), and root-mean-square deviation (RMSD), as well as their ratio (%) to**
 3 **the observed mean.**

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		WRF-CAM5		GEOS-5		GEOS-Chem		EAM-E3SM		UM		ALADIN-Climate	
		MB	RMSD	MB	RMSD	MB	RMSD	MB	RMSD	MB	RMSD	MB	RMSD
<i>Smoke Top Height (m) compared to HSRL-2 on ER2</i>													
		-167	415	-456	596	-473	763	-114	460	+6	440	-176	830
		(-3%)	(9%)	(-9%)	(12%)	(-10%)	(16%)	(-2%)	(10%)	(+0%)	(9%)	(-4%)	(17%)
<i>Smoke Base Height (m) compared to HSRL-2 on ER2</i>													
		-422	553	-1401	1424	-877	938	-688	784	-616	709	-299	566
		(-21%)	(27%)	(-69%)	(70%)	(-43%)	(46%)	(-34%)	(38%)	(-31%)	(35%)	(-15%)	(28%)
<i>Black Carbon Mass (ng m⁻³)</i>													
3-6 km		+62.2	172.6	+49.2	206.8	+9.7	282.5	-254.8	285.9	-232.8	277.6	--	--
		(+10%)	(28%)	(+8%)	(34%)	(+2%)	(47%)	(-42%)	(47%)	(-38%)	(46%)	--	--
FT		-11.7	459.3	+171.0	524.6	+7.3	399.6	-515.9	647.3	-131.3	304.6	--	--
≤3km		(-1%)	(57%)	(+20%)	(62%)	(+1%)	(47%)	(-61%)	(76%)	(-16%)	(36%)	--	--
MBL		-5.1	119.9	+291.5	553.7	+82.6	238.0	+4.7	98.6	-45.5	92.6	--	--
		(-3%)	(69%)	(+168%)	(319%)	(+48%)	(137%)	(+2%)	(53%)	(-26%)	(53%)	--	--
<i>Organic Aerosol Mass (ug m⁻³)</i>													
3-6 km		+0.0	2.4	+3.5	5.0	+1.8	4.0	+5.3	5.7	-1.9	2.9	--	--
		(+0%)	(42%)	(+62%)	(89%)	(+32%)	(71%)	(+94%)	(102%)	(-34%)	(52%)	--	--
FT		+0.7	3.1	+7.7	9.2	+3.7	5.4	+2.9	4.1	+0.6	2.9	--	--
≤3km		(+12%)	(53%)	(+119%)	(141%)	(+57%)	(84%)	(+44%)	(63%)	(+9%)	(45%)	--	--
MBL		+0.3	0.8	+5.4	8.9	+2.1	3.9	+3.7	5.1	+0.3	0.9	--	--
		(+26%)	(83%)	(+545%)	(900%)	(+210%)	(392%)	(+352%)	(493%)	(+27%)	(96%)	--	--
<i>Sulfate Aerosol Mass (ug m⁻³)</i>													
3-6 km		+0.5	0.6	--	--	--	--	+0.2	0.3	-0.4	0.6	--	--
		(+66%)	(79%)	--	--	--	--	(+21%)	(43%)	(-56%)	(74%)	--	--
FT		+0.4	0.7	--	--	--	--	+0.1	0.5	-0.7	0.9	--	--
≤3km		(+37%)	(55%)	--	--	--	--	(+6%)	(39%)	(-56%)	(72%)	--	--

MBL	-0.5 (-38%)	0.7 (60%)	--	--	--	--	+1.2 (+93%)	1.5 (121%)	-0.5 (-45%)	0.8 (68%)	--	--
<i>Volumetric Mean Diameter (nm)</i>												
3-6 km	+43 (+21%)	44 (22%)	--	--	--	--	--	--	+28 (+14%)	28 (14%)	--	--
FT ≤3km	+80 (+41%)	83 (42%)	--	--	--	--	--	--	+34 (+17%)	35 (18%)	--	--
MBL	+86 (+41%)	95 (45%)	--	--	--	--	--	--	-5 (-2%)	27 (13%)	--	--

WRF-CAM5 GEOS-5 GEOS-Chem EAM-E3SM UM ALADIN-Climate

MB RMSD MB RMSD MB RMSD MB RMSD MB RMSD MB RMSD

<i>Aerosol Optical Depth compared to HSRL-2 on ER2</i>												
Above clouds	-0.042 (-12%)	0.077 (23%)	-0.101 (-30%)	0.123 (37%)	+0.138 (+42%)	0.189 (57%)	+0.069 (+21%)	0.093 (28%)	0.053 (-16%)	0.087 (26%)	-0.108 (-32%)	0.125 (37%)

<i>Aerosol Optical Depth compared to 4STAR on P3</i>												
Above clouds	-0.068 (-19%)	0.098 (28%)	-0.126 (-38%)	0.183 (56%)	+0.016 (+5%)	0.103 (31%)	+0.063 (+19%)	0.096 (29%)	-0.148 (-45%)	0.181 (55%)	-0.099 (-30%)	0.137 (42%)

<i>Extinction Coefficient (Mm⁻¹) compared to HSRL-2 on ER2</i>												
3-6 km	-16 (-23%)	23 (32%)	-28 (-38%)	32 (44%)	+24 (+33%)	33 (45%)	+1 (+1%)	17 (23%)	-43/-19 (-59/-26%)	49/23 (66/31%)	--	--

<i>Extinction Coefficient (Mm⁻¹) compared to neph+PSAP on P3</i>												
3-6 km	-10 (-17%)	18 (31%)	-20 (-33%)	23 (39%)	+19 (+32%)	40 (67%)	-6 (+11%)	17 (28%)	-42/-33 (-71/-56%)	46/36 (77/61%)	--	--

FT ≤3km	+3 (+4%)	38 (62%)	-12 (-18%)	38 (58%)	+24 (+36%)	39 (59%)	+16 (+24%)	28 (43%)	-30/-16 (-46/-25%)	44/32 (67/49%)	--	--
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MBL	+2 (+6%)	8 (31%)	+88 (+327%)	125 (463%)	+68 (+255%)	83 (310%)	+115 (+406%)	122 (433%)	-3/+70 (-12/+260%)	12/73 (44/272%)	--	--
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Scattering Ångström Exponent

3-6 km	-0.6 (-36%)	0.6 (36%)	-0.1 (-4%)	0.1 (7%)	-0.0 (-0%)	0.1 (3%)	--	--	+0.0/- 0.0 (+2/-2%)	0.1/0.1 (3/8%)	--	--
FT ≤3km	-0.8 (-45%)	0.8 (45%)	-0.0 (-0%)	0.1 (7%)	+0.1 (+3%)	0.1 (6%)	--	--	+0.0/- 0.0 (+2/-1%)	0.1/0.1 (7/6%)	--	--
MBL	-0.5 (-42%)	0.5 (49%)	-0.4 (-40%)	0.6 (51%)	-0.2 (-18%)	0.4 (36%)	--	--	-0.1/-0.3 (-9/- 25%)	0.4/0.4 (33/37%)	--	--

Absorption Ångström Exponent

3-6 km	-0.4 (-27%)	0.4 (27%)	-0.4 (-27%)	0.4 (28%)	-0.4 (-25%)	0.4 (25%)	--	--	-0.1/-0.2 (-5/- 10%)	0.1/0.2 (7/13%)	--	--
FT ≤3km	-0.5 (-29%)	0.5 (29%)	-0.4 (-26%)	0.4 (27%)	-0.4 (-23%)	0.4 (23%)	--	--	-0.1/-0.1 (-7/-9%)	0.1/0.2 (8/11%)	--	--
MBL	-0.4 (-28%)	0.6 (36%)	-0.3 (-21%)	0.5 (33%)	-0.4 (-27%)	0.6 (36%)	--	--	-0.1/-0.4 (-3/- 25%)	0.3/0.7 (20/46%)	--	--

Single Scattering Albedo

3-6 km	-0.03 (-4%)	0.04 (4%)	-0.01 (-2%)	0.02 (3%)	+0.06 (+7%)	0.06 (7%)	+0.02 (+2%)	0.02 (2%)	-0.07/- 0.02 (-8/-3%)	0.08/0.0 3 (9/3%)	--	--
FT ≤3km	-0.00 (-0%)	0.01 (1%)	-0.01 (-1%)	0.02 (2%)	+0.07 (+8%)	0.07 (9%)	+0.06 (+8%)	0.07 (8%)	0.04/+0. 00 (-5/+0%)	0.05/0.0 2 (5/2%)	--	--
MBL	-0.02 (-2%)	0.04 (4%)	+0.03 (+3%)	0.05 (5%)	+0.04 (+5%)	0.06 (6%)	+0.03 (+3%)	0.04 (5%)	+0.01/+ 0.05 (+1/+5%)	0.03/0.0 6 (3/6%)	--	--

Carbon Monoxide (ppbv)

3-6 km	-37 (-20%)	44 (23%)	-19 (-10%)	30 (16%)	-38 (-20%)	45 (24%)	--	--	--	--	--	--
FT ≤3km	-24 (-15%)	43 (27%)	-13 (-7%)	32 (19%)	-8 (-5%)	34 (20%)	--	--	--	--	--	--
MBL	-21 (-22%)	24 (26%)	-11 (-11%)	21 (22%)	-4 (-4%)	19 (20%)	--	--	--	--	--	--

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2 The optical properties are at 500-550 nm. The values are for the P3 flights unless otherwise
3 noted, in the diagonally and horizontally aligned boxes. The hyphens indicate products
4 unavailable. For UM the pair of values, where given, correspond to dry and ambient humidity
5 conditions in this order.

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