

Supplement to:

ORACLE-lite (v3.0): a reduced-complexity module for simulating organic aerosol formation and evolution in long-term chemistry–climate models

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Table S1: Statistical evaluation of EMAC-simulated PM₁ SOA-sv concentrations against AMS and ACSM observations of L-OOA over 2000–2020. Results are shown for Europe, North America, and Eastern Asia. These regions are further divided into rural, downwind, and urban sites.

Continent	Region	Number of datasets	Mean observed ($\mu\text{g m}^{-3}$)	Mean predicted ($\mu\text{g m}^{-3}$)	MAGE ($\mu\text{g m}^{-3}$)	MB ($\mu\text{g m}^{-3}$)	NME (%)	NMB (%)	RMSE ($\mu\text{g m}^{-3}$)
Europe	all	82	1.18	1.08	0.63	-0.10	53.54	-8.63	0.82
	rural	58	1.02	1.04	0.61	0.02	60.11	2.24	0.82
	downwind	13	1.49	0.93	0.81	-0.56	54.14	-37.54	0.95
	urban	11	1.65	1.43	0.52	-0.22	31.44	-13.11	0.68
North America	all	51	1.89	2.19	1.22	0.30	64.80	15.79	1.69
	rural	28	1.59	1.94	0.96	0.34	60.36	21.62	1.27
	downwind	3	4.33	1.98	2.47	-2.35	57.14	-54.34	2.96
	urban	20	1.93	2.56	1.40	0.63	72.50	32.62	1.93
Eastern Asia	all	100	4.69	2.68	2.39	-2.01	50.91	-42.91	3.35
	rural	22	4.03	2.23	2.20	-1.80	54.69	-44.61	2.76
	downwind	11	3.84	2.77	1.20	-1.08	31.19	-28.07	1.61
	urban	67	5.05	2.81	2.65	-2.24	52.39	-44.32	3.72

Table S2: Statistical evaluation of EMAC-simulated PM₁ SOA-iv concentrations against AMS and ACSM M-OOA observations over 2000–2020. Results are shown for Europe, North America, and Eastern Asia. These regions are further divided into rural, downwind, and urban sites.

Continent	Region	Number of datasets	Mean observed ($\mu\text{g m}^{-3}$)	Mean predicted ($\mu\text{g m}^{-3}$)	MAGE ($\mu\text{g m}^{-3}$)	MB ($\mu\text{g m}^{-3}$)	NME (%)	NMB (%)	RMSE ($\mu\text{g m}^{-3}$)
Europe	all	92	1.61	0.70	1.04	-0.91	64.31	-56.57	1.45
	rural	66	1.53	0.67	0.98	-0.86	63.54	-56.24	1.48
	downwind	14	1.84	0.59	1.42	-1.25	77.11	-68.15	1.54
	urban	12	1.78	0.99	0.93	-0.78	52.54	-44.13	1.13
North America	all	60	2.13	1.61	1.21	-0.52	57.04	-24.32	1.48
	rural	33	1.90	1.44	1.12	-0.46	58.77	-24.04	1.36
	downwind	4	2.21	1.58	0.67	-0.64	30.34	-28.74	0.88
Eastern Asia	urban	23	2.44	1.85	1.45	-0.58	59.33	-23.93	1.70
	all	109	6.42	0.96	5.46	-5.46	85.06	-85.03	6.81
	rural	27	4.59	0.87	3.72	-3.72	81.19	-81.03	4.61
	downwind	11	4.92	1.09	3.83	-3.83	77.87	-77.87	5.11
	urban	71	7.36	0.98	6.38	-6.38	86.72	-86.72	7.69

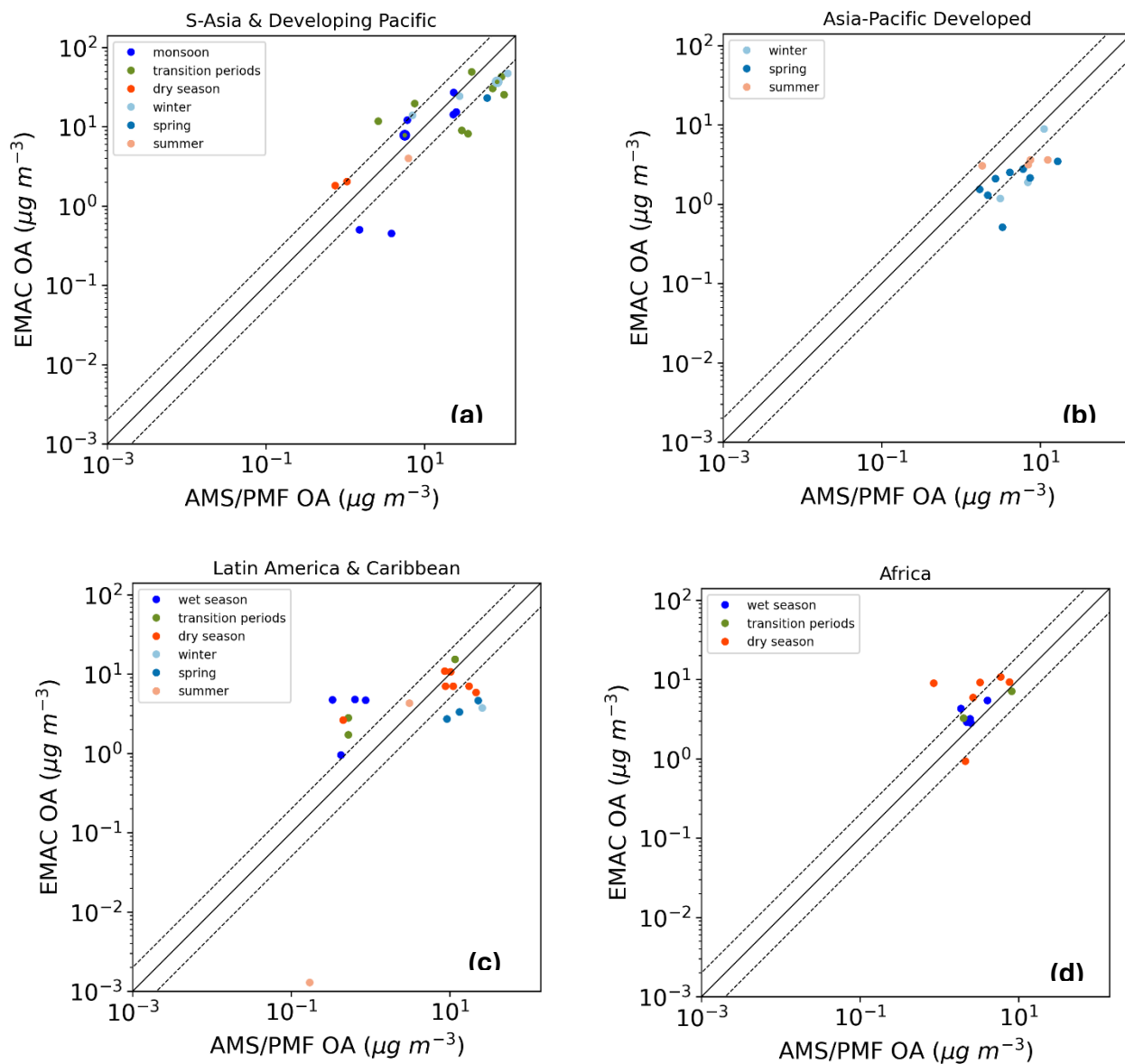


Figure S1: Scatter plots comparing EMAC simulated PM_1 OA concentrations ($\mu\text{g m}^{-3}$) with AMS/ACSM observations over (a) South Asia and Developing Pacific, (b) Asia-Pacific Developed, (c) Latin America and the Caribbean, and (d) Africa regions. Each point represents the mean OA concentration of an individual dataset and is colored by season of the field campaign. Solid and dashed lines indicate the 1:1, 2:1, and 1:2 relationships.