



Supplement of

Global perspectives on nitrate aerosol dynamics: a comprehensive sensitivity analysis

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Table S1: Seasonal statistical evaluation of EMAC simulated surface concentrations of O₃ as simulated from the Base Case using the CAMS inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	60	38.95	45.01	10.22	6.06	26.23	15.55	13.23
	Spring	60	68.56	72.14	7.38	3.58	10.76	5.22	9.77
	Summer	60	72.27	77.86	9.17	5.58	12.69	7.73	11.49
	Autumn	60	40.71	57.96	17.36	17.25	42.64	42.38	20.19
CASTNET	Winter	639	56.13	54.35	10.16	-1.78	18.11	-3.18	13.88
	Spring	669	75.41	82.34	11.43	6.93	15.15	9.19	14.92
	Summer	653	65.52	94.89	30	29.37	45.79	44.82	35.21
	Autumn	668	56.89	74.78	22.13	17.89	38.9	31.45	26.78
CPCB	Winter	879	33.87	107.51	74.71	73.64	220.57	217.4	80.97
	Spring	810	41.81	134.02	92.28	92.22	220.74	220.59	96.41
	Summer	880	26.77	107.49	81.26	80.72	303.54	301.55	87.77
	Autumn	1021	32.15	122.35	90.43	90.2	281.29	280.58	94.8

Table S2: Seasonal statistical evaluation of EMAC simulated surface concentrations of O₃ as simulated from the Base Case using the CMIP6 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	60	38.95	48.81	12.91	9.85	33.14	25.3	16.51
	Spring	60	68.56	67.35	7.69	-1.2	11.22	-1.76	9.76
	Summer	60	72.27	70.85	8.62	-1.42	11.92	-1.97	10.84
	Autumn	60	40.71	58.66	18.02	17.95	44.26	44.08	20.48
CASTNET	Winter	639	56.13	56.17	10.07	0.04	17.95	0.07	13.62
	Spring	669	75.41	74.61	9.3	-0.8	12.33	-1.06	12.04
	Summer	653	65.52	82.92	20.32	17.4	31.02	26.55	24.96
	Autumn	668	56.89	70.32	17.36	13.43	30.52	23.6	20.83
CPCB	Winter	879	33.87	89.87	58.16	56	171.7	165.33	64.57
	Spring	810	41.81	122.17	80.57	80.37	192.72	192.24	84.77
	Summer	880	26.77	97.2	71.08	70.43	265.52	263.1	76.5
	Autumn	1021	32.15	110.64	79.07	78.49	245.96	244.16	83.33

Table S3: Seasonal statistical evaluation of EMAC simulated surface concentrations of O₃ as simulated from the Base Case using the HTAPv3 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	60	38.95	36.52	11.16	-2.43	28.65	-6.24	13.76
	Spring	60	68.56	63.41	8.48	-5.14	12.37	-7.5	10.32
	Summer	60	72.27	72.36	7.92	0.09	10.96	0.12	10.21
	Autumn	60	40.71	48.46	10.12	7.75	24.85	19.03	13.32
CASTNET	Winter	639	56.13	48.18	12.29	-7.95	21.9	-14.16	15.76
	Spring	669	75.41	78.85	10.84	3.44	14.38	4.56	14.29
	Summer	653	65.52	94.16	29.59	28.64	45.17	43.71	35.42
	Autumn	668	56.89	70.48	20.98	13.59	36.88	23.89	25.96
CPCB	Winter	879	33.87	95.66	63.73	61.79	188.15	182.42	73.25
	Spring	810	41.81	123.13	81.42	81.32	194.76	194.52	86.28
	Summer	880	26.77	99.72	73.49	72.95	274.54	272.5	78.81
	Autumn	1021	32.15	109.08	77.25	76.93	240.29	239.3	82.7

Table S4: Seasonal statistical evaluation of EMAC simulated surface concentrations of NO_x as simulated from the Base Case using the CAMS inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	6.4	10.35	4.06	3.94	63.39	61.62	4.8
	Spring	60	4.54	7.83	3.3	3.3	72.78	72.62	3.69
	Summer	60	3.86	8.11	4.92	4.25	127.44	110.17	5.55
	Autumn	57	5.36	10.03	4.89	4.67	91.25	87.17	5.48
CASTNET	Winter	43	0.97	0.6	0.64	-0.37	66.1	-38.61	0.96
	Spring	42	0.39	0.28	0.28	-0.11	71.81	-26.84	0.42
	Summer	40	0.3	0.28	0.2	-0.02	68.24	-4.84	0.31
	Autumn	45	0.65	0.4	0.42	-0.25	64.52	-38.14	0.78
CPCB	Winter	1034	42.12	12	31.89	-30.12	75.7	-71.51	42.01
	Spring	950	33.65	7.25	26.73	-26.4	79.42	-78.45	36.34
	Summer	1005	23.25	5.93	17.6	-17.32	75.72	-74.5	22.95
	Autumn	1172	37.02	8.26	29.07	-28.75	78.54	-77.68	40.5
NNDMN	Winter	431	24.58	42.28	17.73	17.7	72.15	72.01	21.78
	Spring	426	21.65	39.98	18.33	18.33	84.66	84.64	21.04
	Summer	450	18.94	34.99	16.05	16.05	84.74	84.74	19.5
	Autumn	479	21.55	38.6	17.07	17.05	79.21	79.14	20.93

Table S5: Seasonal statistical evaluation of EMAC simulated surface concentrations of NO_x as simulated from the Base Case using the CMIP6 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	6.4	6.4	3.27	0	51.03	0	4.07
	Spring	60	4.54	3.72	2.47	-0.82	54.37	-18.12	3.49
	Summer	60	3.86	2.02	2.98	-1.84	77.2	-47.76	4.08
	Autumn	57	5.36	4.92	3.2	-0.44	59.65	-8.18	4.37
CASTNET	Winter	43	0.97	0.21	0.76	-0.76	78.3	-78.04	1.25
	Spring	42	0.39	0.12	0.28	-0.26	72.59	-68.07	0.49
	Summer	40	0.3	0.12	0.21	-0.18	70.04	-61.34	0.38
	Autumn	45	0.65	0.12	0.53	-0.53	81.32	-81.14	1.03
CPCB	Winter	1034	42.12	10.93	32.34	-31.19	76.77	-74.05	42.71
	Spring	950	33.65	6.6	27.33	-27.05	81.2	-80.38	36.86
	Summer	1005	23.25	4.92	18.5	-18.33	79.59	-78.85	23.76
	Autumn	1172	37.02	8.11	29.22	-28.9	78.95	-78.08	40.55
NNDMN	Winter	431	24.58	6.11	18.49	-18.47	75.2	-75.15	22.41
	Spring	426	21.65	2.83	18.83	-18.83	86.96	-86.94	21.61
	Summer	450	18.94	2.18	16.76	-16.76	88.48	-88.48	20.21
	Autumn	479	21.55	3.57	17.98	-17.97	83.44	-83.42	21.84

Table S6: Seasonal statistical evaluation of EMAC simulated surface concentrations of NO_x as simulated from the Base Case using the HTAPv3 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	6.4	16.99	10.59	10.59	165.4	165.4	10.99
	Spring	60	4.54	15.54	11.01	11.01	242.56	242.56	11.57
	Summer	60	3.86	14.93	11.22	11.07	290.89	287.03	12.28
	Autumn	57	5.36	17.7	12.34	12.34	230.24	230.24	12.93
CASTNET	Winter	43	0.97	1.42	0.69	0.45	70.92	46.16	0.85
	Spring	42	0.39	0.58	0.34	0.19	89.51	50.29	0.38
	Summer	40	0.3	0.48	0.28	0.18	92.6	56.92	0.32
	Autumn	45	0.65	0.94	0.5	0.3	77.87	45.73	0.79
CPCB	Winter	1034	42.12	61.38	27.73	19.26	65.83	45.73	35.94
	Spring	950	33.65	51.21	21.72	17.56	64.54	52.16	30.57
	Summer	1005	23.25	37.14	14.94	13.89	64.28	59.74	20.31
	Autumn	1172	37.02	54.47	22.52	17.45	60.83	47.15	32.35
NNDMN	Winter	431	24.58	39.68	15.24	15.1	62	61.42	20.01
	Spring	426	21.65	36.75	14.19	14.1	65.52	65.1	17.15
	Summer	450	18.94	31.7	12.82	12.76	67.68	67.34	16.3
	Autumn	479	21.55	34.97	13.59	13.42	63.06	62.29	18.08

Table S7: Seasonal statistical evaluation of EMAC simulated surface concentrations of NH₃ as simulated from the Base Case using the CAMS inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	74	2.36	1.98	1.79	-0.38	75.8	-15.92	3.07
	Spring	75	3.74	9.55	6.98	5.81	186.44	155.13	8.52
	Summer	74	3.85	7.79	4.51	3.94	117.15	102.12	5.11
	Autumn	73	4.52	5.69	5.27	1.17	116.48	25.85	8.55
AMoN	Winter	435	0.94	0.68	0.66	-0.26	70.1	-27.37	1.02
	Spring	491	1.52	2.7	1.65	1.18	108.26	77.19	2.7
	Summer	485	1.81	2.04	1.02	0.23	56.63	12.94	1.35
	Autumn	485	1.37	1.75	0.94	0.38	68.38	27.57	1.22
CPCB	Winter	422	20.91	39.86	27.9	18.95	70	47.54	43.71
	Spring	392	42.03	30.09	25.14	-11.94	83.55	-39.68	33.92
	Summer	439	15.76	26.61	16.64	10.85	62.51	40.78	26.14
	Autumn	545	12.71	29.96	18.54	17.25	61.88	57.57	28.13
NNDMN	Winter	428	5.42	6.46	3.05	1.04	56.23	19.23	5.24
	Spring	426	9.59	10.09	4.91	0.5	51.22	5.24	7.15
	Summer	448	11.25	12.72	5.91	1.47	52.5	13.1	7.72
	Autumn	475	7.56	8.59	3.98	1.03	52.7	13.57	5.49

Table S8: Seasonal statistical evaluation of EMAC simulated surface concentrations of NH₃ as simulated from the Base Case using the CMIP6 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	74	2.36	1.8	2.45	-0.56	103.82	-23.53	3.39
	Spring	75	3.74	2.6	3.33	-1.14	88.92	-30.57	4.75
	Summer	74	3.85	3.54	2.51	-0.31	65.2	-7.98	4.08
	Autumn	73	4.52	3.88	5.18	-0.64	114.65	-14.2	8.83
AMoN	Winter	435	0.94	1.38	0.79	0.44	84.19	47	0.99
	Spring	491	1.52	2.18	1.15	0.65	75.48	42.79	2.24
	Summer	485	1.81	1.89	0.98	0.08	54.45	4.65	1.35
	Autumn	485	1.37	2.37	1.3	1	94.8	72.97	1.64
CPCB	Winter	422	20.91	38.34	22.97	17.43	57.62	43.74	39.83
	Spring	392	42.03	32.35	23.62	-9.68	78.49	-32.18	33.24
	Summer	439	15.76	33.49	18.59	17.73	69.84	66.62	28.82
	Autumn	545	12.71	18.94	17.57	6.23	58.62	20.78	26.44
NNDMN	Winter	428	5.42	3.21	3.31	-2.21	61.11	-40.77	5.73
	Spring	426	9.59	9.43	6.32	-0.16	65.97	-1.68	9.21
	Summer	448	11.25	2.41	8.96	-8.84	79.61	-78.6	11.21
	Autumn	475	7.56	4.29	4.57	-3.26	60.52	-43.19	6.24

Table S9: Seasonal statistical evaluation of EMAC simulated surface concentrations of NH₃ as simulated from the Base Case using the HTAPv3 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	74	2.36	1.42	2.86	-0.94	121.2	-39.72	4.67
	Spring	75	3.74	5.54	5.01	1.79	133.92	47.9	7.18
	Summer	74	3.85	0.65	3.27	-3.2	84.77	-83.06	6.24
	Autumn	73	4.52	0.64	4.21	-3.88	93.18	-85.79	10.35
AMoN	Winter	435	0.94	1.34	0.7	0.4	74.03	42.49	1.04
	Spring	491	1.52	0.97	0.96	-0.56	63.14	-36.58	2.06
	Summer	485	1.81	1.07	1.07	-0.74	58.94	-40.77	1.51
	Autumn	485	1.37	1.65	0.83	0.28	60.56	20.14	1.27
CPCB	Winter	422	20.91	11.24	23.02	-9.67	57.75	-24.25	38.3
	Spring	392	42.03	31.22	16.57	-10.81	55.06	-35.91	26.25
	Summer	439	15.76	11.4	16.68	-4.36	62.68	-53.94	26.66
	Autumn	545	12.71	9.8	16.77	-2.91	55.98	-9.7	26.34
NNDMN	Winter	428	5.42	3.34	5.26	-2.08	96.98	-38.38	7.22
	Spring	426	9.59	12.89	5.13	3.3	53.55	34.39	7.32
	Summer	448	11.25	14.49	6.58	3.24	58.47	28.82	8.63
	Autumn	475	7.56	7.76	4.97	0.2	65.73	2.67	6.54

Table S10: Seasonal statistical evaluation of EMAC simulated surface concentrations of SO₂ as simulated from the Base Case using the CAMS inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	2.35	0.44	2.33	-1.91	293.83	-293.83	2.63
	Spring	60	1.58	0.55	1.31	-1.03	224.33	-224.33	1.46
	Summer	60	1.37	0.46	1.23	-0.91	245.89	-245.89	1.32
	Autumn	59	1.79	0.53	1.84	-1.26	334.32	-334.32	2.03
CASTNET	Winter	26	3.12	0.97	2.15	-2.15	222.54	-222.54	2.24
	Spring	27	1.38	0.81	0.62	-0.57	76.15	-69.72	0.75
	Summer	29	1.61	0.77	0.86	-0.84	111.75	-109.84	1.03
	Autumn	29	2.20	0.84	1.5	-1.36	177.66	-160.91	1.64
CPCB	Winter	941	14.78	20.53	13.54	5.75	91.58	38.88	20.08
	Spring	919	14.55	8.37	9.23	-6.19	63.43	-42.51	17.52
	Summer	973	10.66	6.5	6.89	-4.16	64.58	-39.04	15.13
	Autumn	1095	13.94	13.34	9.28	-0.6	66.56	-4.29	17.92

Table S11: Seasonal statistical evaluation of EMAC simulated surface concentrations of SO₂ as simulated from the Base Case using the CMIP6 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	2.35	0.79	1.57	-1.56	197.58	-196.32	1.81
	Spring	60	1.58	0.58	1	-1	170.73	-170.73	1.1
	Summer	60	1.37	0.5	0.87	-0.87	172.33	-172.33	0.97
	Autumn	59	1.79	0.45	1.24	-1.24	225.68	-225.68	1.4
CASTNET	Winter	26	3.12	2.47	0.7	-0.65	72.63	-66.81	0.82
	Spring	27	1.38	1.44	0.3	0.06	36.88	6.97	0.34
	Summer	29	1.61	1.49	0.39	-0.12	51.48	-16.3	0.46
	Autumn	29	2.20	1.79	0.7	-0.41	83.43	-48.88	0.92
CPCB	Winter	941	14.78	24.8	16.89	10.02	114.3	67.79	23.02
	Spring	919	14.55	10.7	9.35	-3.86	64.23	-26.49	17.23
	Summer	973	10.66	8.6	7.59	-2.06	71.2	-19.33	15.29
	Autumn	1095	13.94	17.43	11.98	3.49	85.93	25.04	19.66

Table S12: Seasonal statistical evaluation of EMAC simulated surface concentrations of SO₂ as simulated from the Base Case using the HTAPv3 inventory, against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EMEP	Winter	59	2.35	0.51	1.04	-1.84	256.67	-256.67	2.28
	Spring	60	1.58	0.53	1.47	-1.05	252.42	-248.73	1.69
	Summer	60	1.37	0.38	1.59	-0.99	317.49	-317.49	1.96
	Autumn	59	1.79	0.5	2.09	-1.29	379.72	-379.72	2.26
CASTNET	Winter	26	3.12	2.23	0.91	-0.89	93.76	-92.4	1.02
	Spring	27	1.38	1.26	0.35	-0.12	43.3	-14.43	0.42
	Summer	29	1.61	0.53	0.41	-0.08	53.89	-9.99	0.49
	Autumn	29	2.20	1.82	0.76	-0.38	89.69	-45.53	0.98
CPCB	Winter	941	14.78	15.69	10.04	0.91	67.93	6.15	17.34
	Spring	919	14.55	7.02	9.35	-7.54	64.27	-51.77	17.85
	Summer	973	10.66	4.9	6.94	-5.77	65.11	-54.07	15.31
	Autumn	1095	13.94	10.04	8.31	-3.9	59.65	-27.97	17.55

Table S13: Seasonal statistical evaluation of EMAC simulated PM_{2.5} NH₄⁺ surface concentrations from the base case against observations during 2010-2018. The used metrics include the Mean Absolute Gross Error (MAGE), Mean Bias (MB), Normalized Mean Error (NME), Normalized Mean Bias (NMB) and Root Mean Square Error (RMSE).

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3400	1.52	0.9	0.77	-0.62	50.39	-40.54	1.14
	Spring	3362	0.98	1.11	0.47	0.13	47.88	13.28	0.6
	Summer	3385	0.82	0.82	0.23	0.0	27.58	-0.4	0.35
	Autumn	3397	0.65	0.75	0.24	0.09	36.47	14.44	0.32
EMEP	Winter	514	2.07	1.43	0.85	-0.64	41.28	-31.09	1.13
	Spring	516	1.24	1.18	0.55	-0.06	44.03	-4.74	0.61
	Summer	522	0.84	0.79	0.26	-0.05	30.97	-5.53	0.31
	Autumn	529	0.83	1.27	0.54	0.44	64.72	53.0	0.73
EANET	Winter	640	1.39	0.73	0.88	-0.66	63.0	-47.36	1.97
	Spring	658	1.07	0.85	0.6	-0.22	56.26	-20.48	1.31
	Summer	651	0.69	1.04	0.49	0.34	70.82	49.44	0.82
	Autumn	654	0.54	0.58	0.34	0.04	61.96	6.83	0.57

Table S14: Seasonal statistical evaluation of EMAC simulated PM_{2.5} SO₄²⁻ surface concentrations from the base case against observations during 2010-2018. The used metrics include the Mean Absolute Gross Error (MAGE), Mean Bias (MB), Normalized Mean Error (NME), Normalized Mean Bias (NMB) and Root Mean Square Error (RMSE).

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3961	2.15	0.76	1.41	-1.39	65.67	-64.8	1.85
	Spring	4040	1.99	1.54	0.59	-0.45	29.79	-22.4	0.77
	Summer	4035	2.64	1.85	0.88	-0.79	33.14	-29.94	1.11
	Autumn	4052	1.87	1.66	0.36	-0.21	19.55	-11.07	0.48
IMPROVE	Winter	2364	0.92	0.52	0.62	-0.41	67.39	-44.13	1.3
	Spring	2993	0.99	0.88	0.27	-0.11	27.14	-11.28	0.37
	Summer	2882	1.35	1.08	0.45	-0.27	33.11	-19.92	0.68
	Autumn	2939	0.94	1.01	0.23	0.07	24.71	7.45	0.31
EMEP	Winter	468	2.82	0.67	2.14	-2.14	76.13	-76.13	2.84
	Spring	465	1.62	1.17	0.75	-0.45	46.43	-27.69	0.87
	Summer	474	2.24	1.5	0.82	-0.74	36.72	-33.05	0.97
	Autumn	481	1.73	1.39	0.74	-0.35	42.82	-19.99	0.89
EANET	Winter	634	3.72	1.09	2.8	-2.63	75.29	-70.83	4.27
	Spring	646	3.79	1.56	2.47	-2.23	65.22	-58.84	3.46
	Summer	655	2.66	1.87	1.42	-0.79	53.45	-29.71	1.89
	Autumn	652	2.28	1.55	1.11	-0.73	48.86	-32.13	1.62

Table S15: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the RES_low sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	2.18	1.16	0.05	54.3	2.25	1.8
	Spring	4027	0.98	1.49	0.81	0.52	83.3	53.2	1.05
	Summer	4029	0.42	0.95	0.7	0.53	167.3	126.6	1.01
	Autumn	4049	0.79	1.32	0.84	0.53	106.8	67.4	1.24
IMPROVE	Winter	2364	0.68	1.13	0.72	0.44	105.6	64.9	1.23
	Spring	2993	0.36	0.73	0.46	0.36	126.2	100	0.67
	Summer	2882	0.19	0.51	0.39	0.32	206.4	168.5	0.62
	Autumn	2939	0.28	0.63	0.46	0.35	163.8	125.6	0.79
EMEP	Winter	525	2.79	2.69	2.3	-0.1	82.5	-3.5	4.47
	Spring	526	2.55	2.65	2.12	0.1	83.3	3.9	4.46
	Summer	528	0.35	1.69	1.42	1.34	409.7	389.3	1.82
	Autumn	542	1.38	3.19	2.24	1.81	162.7	131.1	3.01
EANET	Winter	633	1.64	4.21	3.08	2.57	209.7	188.1	2.97
	Spring	641	1.58	3.07	2.14	1.49	211.2	204.4	3.56
	Summer	643	0.73	1.99	1.46	1.26	241.9	239.2	3.33
	Autumn	638	1.02	1.98	1.23	0.96	90.45	126	2.09

Table S16: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the RES_low sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.8	0.99	-0.32	80.7	-28.55	1.3
	Urban	22	1.46	1.77	1.57	0.31	107.88	21.26	2.13
	Downwind	5	1.24	1.17	1.44	-0.07	116.71	-5.66	1.95
East Asia	Rural	40	6.78	7.64	3.75	0.86	55.33	12.73	4.87
	Urban	78	9.65	8.7	3.99	-0.94	41.39	-9.78	5.27
	Downwind	15	4.86	8.62	4.14	3.75	85.15	77.21	5.03
Europe	Rural	163	1.42	1.58	0.95	0.16	67.01	11.41	1.47
	Urban	28	1.76	1.61	1.07	-0.15	60.63	-8.42	1.6
	Downwind	99	3.18	2.55	1.8	-0.62	56.56	-19.62	2.55
India	Rural	5	0.41	1.97	1.67	1.56	407.92	380.49	2.19
	Urban	14	8.16	3.34	5.16	-4.82	63.21	-59.04	7.87

Table S17: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the RES_high sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	1.93	1.13	-0.21	53	-9.7	1.8
	Spring	4027	0.98	1.12	0.61	0.15	62	15.2	0.85
	Summer	4029	0.42	0.52	0.38	0.1	91	23	0.63
	Autumn	4049	0.79	0.89	0.63	0.1	80	13.3	1.01
IMPROVE	Winter	2364	0.68	0.84	0.6	0.16	87.2	23.1	1.18
	Spring	2993	0.36	0.48	0.31	0.11	85.2	30.9	0.48
	Summer	2882	0.19	0.24	0.2	0.05	104.5	23.8	0.31
	Autumn	2939	0.28	0.37	0.29	0.09	103.7	31.9	0.62
EMEP	Winter	525	2.79	2.33	2.16	-0.45	77.54	-16.26	4.44
	Spring	526	2.55	1.98	1.83	-0.56	71.66	-22.13	4.34
	Summer	528	0.35	0.93	0.73	0.59	212.5	170.4	1.04
	Autumn	542	1.38	2.56	1.72	1.18	124.9	85.32	2.59
EANET	Winter	633	1.64	4.95	3.6	3.31	259	250.3	3.67
	Spring	641	1.58	3.18	2.07	1.6	202.6	199	3.53
	Summer	643	0.73	1.82	1.31	1.09	244.3	232.8	3.18
	Autumn	638	1.02	2.57	1.98	1.55	106.5	163.4	2.81

Table S18: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the RES_high sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.52	0.96	-0.6	85.98	-53.62	1.5
	Urban	22	1.46	1.66	1.49	0.2	102.26	13.65	2
	Downwind	5	1.24	0.66	1.18	-0.57	95.58	-46.28	1.99
East Asia	Rural	40	6.78	7.82	4.31	1.04	63.64	15.28	5.53
	Urban	78	9.65	11.28	4.09	1.63	42.42	16.88	5.46
	Downwind	15	4.86	8.61	4.36	3.75	89.77	77.12	6.45
Europe	Rural	163	1.42	1.16	0.81	-0.26	57.06	-18.1	1.37
	Urban	28	1.76	1.46	1.16	-0.3	65.85	-17.22	1.72
	Downwind	99	3.18	2.23	1.37	-0.94	43.12	-29.69	2.1
India	Rural	5	0.41	2.46	2.07	2.05	504.51	499.75	3.11
	Urban	14	8.16	8.52	2.93	0.36	35.96	4.39	3.7

Table S19: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the CMIP sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	1.51	1.16	-0.63	54.5	-29.35	1.86
	Spring	4027	0.98	0.81	0.52	-0.17	52.9	-17.32	0.81
	Summer	4029	0.42	0.29	0.31	-0.13	73.5	-30.9	0.51
	Autumn	4049	0.79	0.59	0.51	-0.2	65	-25.2	0.86
IMPROVE	Winter	2364	0.68	0.7	0.62	0.02	90.4	2.03	1.21
	Spring	2993	0.36	0.39	0.29	0.03	80.3	7.4	0.46
	Summer	2882	0.19	0.21	0.18	0.02	93.3	9	0.27
	Autumn	2939	0.28	0.3	0.27	0.02	95.8	8.1	0.56
EMEP	Winter	525	2.79	1.92	2.14	-0.87	76.7	-31.2	4.51
	Spring	526	2.55	1.56	1.77	-0.99	69.5	-38.9	4.53
	Summer	528	0.35	0.78	0.64	0.44	183.9	126.1	0.86
	Autumn	542	1.38	1.65	1.18	0.27	85.6	19.8	1.92
EANET	Winter	633	1.64	5.26	3.6	3.62	241.3	225	3.52
	Spring	641	1.58	2.95	1.89	1.37	188.4	167	3.01
	Summer	643	0.73	1.04	0.77	0.31	109.5	98.7	1.89
	Autumn	638	1.02	2.44	1.74	1.42	97.3	144.9	2.51

Table S20: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the CMIP sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.26	0.95	-0.86	85.23	-76.92	1.64
	Urban	22	1.46	0.63	0.91	-0.83	62.1	-56.74	1.79
	Downwind	5	1.24	0.54	0.97	-0.7	78.51	-56.33	1.79
East Asia	Rural	40	6.78	6.51	4.1	-0.27	60.42	-4.04	5.14
	Urban	78	9.65	8.87	3.72	-0.78	38.51	-8.09	4.93
	Downwind	15	4.86	6.7	3.47	1.84	71.43	37.76	4.64
Europe	Rural	163	1.42	0.96	0.76	-0.46	53.4	-32.51	1.35
	Urban	28	1.76	1.02	0.99	-0.75	56.29	-42.34	1.72
	Downwind	99	3.18	1.52	1.81	-1.66	56.96	-52.13	2.61
India	Rural	5	0.41	4.31	4	3.9	974.93	951.53	7.04
	Urban	14	8.16	10.32	4.11	2.16	50.42	26.46	6.96

Table S21: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the HTAP sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	2.53	1.16	0.4	54.2	18.8	1.73
	Spring	4027	0.98	1.3	0.59	0.33	60.8	33.5	0.79
	Summer	4029	0.42	0.48	0.32	0.06	76.9	13.6	0.52
	Autumn	4049	0.79	1.09	0.58	0.3	73.5	38	0.92
IMPROVE	Winter	2364	0.68	1.46	0.97	0.77	141.7	113.2	1.4
	Spring	2993	0.36	0.72	0.44	0.35	120.1	96.5	0.58
	Summer	2882	0.19	0.41	0.3	0.22	159.3	114.7	0.49
	Autumn	2939	0.28	0.64	0.46	0.36	165	129.9	0.74
EMEP	Winter	525	2.79	2.02	2.19	-0.77	78.6	-27.5	4.44
	Spring	526	2.55	3.22	2.3	0.68	90.3	26.5	4.4
	Summer	528	0.35	0.74	0.61	0.39	176.9	114.2	0.87
	Autumn	542	1.38	1.35	1.41	-0.03	102.2	-1.93	2.34
EANET	Winter	633	1.64	6.38	4.09	4.74	313.2	298.6	4.02
	Spring	641	1.58	3.77	2.33	2.19	277.5	245	3.88
	Summer	643	0.73	2.06	1.7	1.33	300.1	268.7	3.57
	Autumn	638	1.02	3.85	2.49	2.83	156.4	194.3	2.99

Table S22: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the HTAP sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.88	0.74	-0.24	66.42	-21.07	1.08
	Urban	22	1.46	1.24	1.11	-0.22	76.13	-14.92	1.76
	Downwind	5	1.24	0.61	0.93	-0.62	74.91	-50.47	1.73
East Asia	Rural	40	6.78	8.92	5.46	2.15	80.5	31.64	7.37
	Urban	78	9.65	11.27	4.49	1.62	46.5	16.76	5.88
	Downwind	15	4.86	8.9	4.24	4.04	87.23	83.1	5.86
Europe	Rural	163	1.42	1.18	0.93	-0.24	65.76	-16.81	1.54
	Urban	28	1.76	1.63	1.05	-0.13	59.86	-7.36	1.54
	Downwind	99	3.18	1.81	1.9	-1.36	59.9	-42.94	2.59
India	Rural	5	0.41	6.86	6.53	6.45	592.81	573.52	11.77
	Urban	14	8.16	16.56	9.3	8.4	114.04	102.96	13.59

Table S23: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the THERM sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	2.11	1.18	-0.02	55.1	-0.96	1.81
	Spring	4027	0.98	1.33	0.7	0.36	72.2	36.4	0.93
	Summer	4029	0.42	0.74	0.52	0.32	123.3	75.7	0.79
	Autumn	4049	0.79	1.17	0.76	0.38	96.2	48.3	1.16
IMPROVE	Winter	2364	0.68	1.01	0.67	0.33	97.7	47.7	1.22
	Spring	2993	0.36	0.63	0.39	0.26	108.2	72.1	0.59
	Summer	2882	0.19	0.42	0.32	0.23	165.6	120.7	0.52
	Autumn	2939	0.28	0.54	0.39	0.26	141.3	92.5	0.74
EMEP	Winter	525	2.79	2.48	2.25	-0.3	80.7	-10.9	4.45
	Spring	526	2.55	2.28	1.96	-0.27	77.1	-10.6	4.38
	Summer	528	0.35	1.33	1.08	0.98	312.6	285.1	1.45
	Autumn	542	1.38	2.95	2.05	1.57	148.8	113.8	2.92
EANET	Winter	633	1.64	4.4	3.4	2.74	234.3	220.8	3.44
	Spring	641	1.58	2.77	1.91	1.21	191.9	177.2	3.27
	Summer	643	0.73	1.68	1.13	1	218.7	216	3.04
	Autumn	638	1.02	2.14	1.66	1.15	93.4	145.9	2.58

Table S24: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the THERM sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.73	0.95	-0.39	85.27	-34.72	1.42
	Urban	22	1.46	1.9	1.66	0.44	113.46	30.35	2.15
	Downwind	5	1.24	0.78	1.09	-0.46	87.89	-36.96	1.76
East Asia	Rural	40	6.78	7.38	4.54	0.6	66.92	8.88	5.82
	Urban	78	9.65	9.75	4	0.1	41.49	1.07	5.19
	Downwind	15	4.86	7.41	2.98	2.55	61.37	52.48	4.55
Europe	Rural	163	1.42	1.44	0.89	0.02	63.11	1.5	1.39
	Urban	28	1.76	1.55	0.99	-0.21	56.43	-12	1.48
	Downwind	99	3.18	2.44	1.53	-0.73	48.02	-23.08	2.18
India	Rural	5	0.41	2.22	1.83	1.81	446.48	441.6	2.7
	Urban	14	8.16	4.66	4.88	-3.5	59.85	-42.84	7.16

Table S25: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the HYDRO sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	1.49	1.13	-0.65	53	-30.3	1.84
	Spring	4027	0.98	0.96	0.55	-0.02	56.3	-1.5	0.81
	Summer	4029	0.42	0.44	0.35	0.02	82.3	4.7	0.55
	Autumn	4049	0.79	0.68	0.55	-0.11	70.2	-13.6	0.91
IMPROVE	Winter	2364	0.68	0.73	0.55	0.05	81.1	7	1.13
	Spring	2993	0.36	0.49	0.32	0.12	87	33.2	0.47
	Summer	2882	0.19	0.31	0.24	0.12	124.9	63.3	0.38
	Autumn	2939	0.28	0.36	0.28	0.08	101.8	29.1	0.57
EMEP	Winter	525	2.79	1.96	2.12	-0.83	76.2	-29.8	4.48
	Spring	526	2.55	1.75	1.87	-0.8	73.4	-31.5	4.5
	Summer	528	0.35	0.88	0.69	0.54	198.5	154.9	0.93
	Autumn	542	1.38	2.08	1.43	0.7	103.6	51	2.21
EANET	Winter	633	1.64	4	2.56	2.36	168.9	132.3	2.33
	Spring	641	1.58	2.46	1.22	0.88	111.4	98.7	1.79
	Summer	643	0.73	1.53	1.02	0.8	167.3	155.4	2.77
	Autumn	638	1.02	1.67	0.86	0.65	73.8	100.5	1.64

Table S26: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the HYDRO sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.42	0.97	-0.7	87.08	-62.49	1.58
	Urban	22	1.46	1.17	1.09	-0.29	74.9	-20.15	1.89
	Downwind	5	1.24	0.53	1.08	-0.71	86.93	-57.26	2.01
East Asia	Rural	40	6.78	6.26	4.17	-0.52	61.58	-7.65	5.35
	Urban	78	9.65	8.08	4.1	-1.57	42.54	-16.27	5.31
	Downwind	15	4.86	6.08	2.31	1.22	47.44	25.1	3.61
Europe	Rural	163	1.42	1.03	0.79	-0.39	55.53	-27.23	1.37
	Urban	28	1.76	1.15	0.93	-0.61	52.97	-34.47	1.63
	Downwind	99	3.18	1.73	1.72	-1.45	54.09	-45.7	2.51
India	Rural	5	0.41	1.61	1.31	1.2	320.44	292.94	1.75
	Urban	14	8.16	4.92	4.74	-3.24	58.04	-39.68	6.57

Table S27: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the SCAV sensitivity against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	1.44	1.18	-0.7	55.4	-32.7	1.87
	Spring	4027	0.98	0.91	0.53	-0.07	54.4	-7.1	0.8
	Summer	4029	0.42	0.57	0.41	0.15	97.1	36.8	0.64
	Autumn	4049	0.79	0.97	0.64	0.18	80.9	23.1	1
IMPROVE	Winter	2364	0.68	0.73	0.53	0.05	78.1	6.2	1.11
	Spring	2993	0.36	0.49	0.3	0.13	81.5	34.4	0.45
	Summer	2882	0.19	0.3	0.21	0.11	112.3	55.6	0.36
	Autumn	2939	0.28	0.44	0.33	0.17	116.8	59.6	0.65
EMEP	Winter	525	2.79	1.5	2.22	-1.29	79.7	-46.2	4.68
	Spring	526	2.55	1.67	1.9	-0.88	74.6	-34.6	4.53
	Summer	528	0.35	0.99	0.78	0.65	227.2	187	1.07
	Autumn	542	1.38	2.09	1.52	0.71	110.2	51.5	2.4
EANET	Winter	633	1.64	3.61	2.04	1.97	144.9	103	2.33
	Spring	641	1.58	1.95	0.95	0.37	88.5	87.7	1.79
	Summer	643	0.73	0.94	0.62	0.21	90.8	79.7	1.4
	Autumn	638	1.02	1.38	0.7	0.36	66.3	88.8	1.64

Table S28: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the SCAV sensitivity against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.59	0.95	-0.53	84.87	-47.24	1.45
	Urban	22	1.46	1.67	1.43	0.21	98.3	14.48	2.01
	Downwind	5	1.24	0.76	1	-0.48	80.65	-38.77	1.68
East Asia	Rural	40	6.78	6.57	4.29	-0.21	63.21	-3.04	5.48
	Urban	78	9.65	8.65	3.68	-1	38.18	-10.32	4.86
	Downwind	15	4.86	6.13	2.63	1.27	54.19	26.12	3.7
Europe	Rural	163	1.42	1.09	0.86	-0.33	60.49	-23.1	1.47
	Urban	28	1.76	1.18	0.95	-0.58	53.79	-32.87	1.65
	Downwind	99	3.18	1.87	1.75	-1.31	55.04	-41.18	2.59
India	Rural	5	0.41	1.96	1.67	1.55	406.77	377.51	2.37
	Urban	14	8.16	7.54	4.08	-0.62	49.96	-7.58	5.17

Table S29: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the COMBO sensitivity (using high grid resolution, reduced N₂O₅ uptake, and the HTAPv3 emission inventory) against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	1.56	1	-0.57	47.1	-26.9	1.74
	Spring	4027	0.98	0.79	0.46	-0.19	46.8	-19.3	0.72
	Summer	4029	0.42	0.21	0.28	-0.21	67.4	-49.5	0.48
	Autumn	4049	0.79	0.47	0.47	-0.32	59.7	-40.4	0.85
IMPROVE	Winter	2364	0.68	0.86	0.63	0.18	91.6	26.1	1.16
	Spring	2993	0.36	0.44	0.28	0.08	77.2	20.3	0.41
	Summer	2882	0.19	0.21	0.18	0.02	95.6	8.4	0.27
	Autumn	2939	0.28	0.3	0.24	0.02	87.7	7.4	0.52
EMEP	Winter	525	2.79	1.59	2.12	-1.2	76	-43.1	4.53
	Spring	526	2.55	2.16	1.82	-0.38	71.4	-15.1	4.27
	Summer	528	0.35	0.38	0.32	0.03	93.2	10.1	0.5
	Autumn	542	1.38	0.88	1.13	-0.5	82.2	-36.1	2.11
EANET	Winter	633	1.64	5.73	3.66	4.09	276.8	250.2	3.45
	Spring	641	1.58	3.51	2.26	1.93	259.6	223.2	3.79
	Summer	643	0.73	2	1.59	1.27	276.7	261.8	3.46
	Autumn	638	1.02	3.13	2.23	2.11	156.4	170.1	2.9

Table S30: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the COMBO sensitivity (using high grid resolution, reduced N₂O₅ uptake, and the HTAPv3 emission inventory) against observations during 2010-2018.

Region	Type of location	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 ($\mu\text{g m}^{-3}$)
North America	Rural	31	1.12	0.38	0.89	-0.73	79.99	-65.69	1.49
	Urban	22	1.46	0.52	1.02	-0.94	70.22	-64.45	1.79
	Downwind	5	1.24	0.34	1.11	-0.89	89.58	-72.26	2.19
East Asia	Rural	40	6.78	7.34	4.54	0.56	66.97	8.27	5.82
	Urban	78	9.65	9.96	4.08	0.32	42.29	3.28	5.47
	Downwind	15	4.86	7.65	3.38	2.79	69.47	57.29	4.88
Europe	Rural	163	1.42	0.75	0.88	-0.66	62.33	-46.94	1.51
	Urban	28	1.76	1.22	1.06	-0.54	60.34	-30.79	1.59
	Downwind	99	3.18	1.27	2.0	-1.9	63.07	-59.88	2.76
India	Rural	5	0.41	5.8	5.42	5.39	1321.43	1314.94	9.6
	Urban	14	8.16	13.97	7.1	5.81	87.02	71.23	10.73

Table S31: Seasonal statistical evaluation of EMAC simulated surface concentrations of PM_{2.5} NO₃⁻ from the initial combined sensitivity (using high grid resolution, reduced N₂O₅ uptake, and the CMIP6 emission inventory) against observations during 2010-2018.

Network	Season	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 ($\mu\text{g m}^{-3}$)
EPA	Winter	3947	2.13	0.18	1.88	-1.95	550.41	-432.06	3.44
	Spring	4027	0.98	0.16	1.23	-0.82	346.6	-291.38	2.04
	Summer	4029	0.42	0.02	0.87	-0.4	367	-349.55	1.97
	Autumn	4049	0.79	0.09	1.04	-0.7	359.18	-340.96	2.65
IMPROVE	Winter	2364	0.68	0.21	1.12	-0.47	215.4	-200.03	2.17
	Spring	2993	0.36	0.19	0.66	-0.17	182.3	-177.4	1.2
	Summer	2882	0.19	0.06	0.57	-0.13	193.17	-217.7	0.99
	Autumn	2939	0.28	0.17	0.48	-0.11	195.08	-198	1.46
EMEP	Winter	525	2.79	0.13	2.88	-2.66	313.7	-283.21	5
	Spring	526	2.55	0.1	2.21	-2.45	330.7	-302.93	5.18
	Summer	528	0.35	0.05	0.98	-0.3	400.6	-201.14	2.77
	Autumn	542	1.38	0.05	1.97	-1.33	374.5	-350.87	3.03
EANET	Winter	633	1.64	0.58	2.83	-1.06	203.2	-212	2.96
	Spring	641	1.58	0.63	1.56	-0.95	133.45	-156.6	2.19
	Summer	643	0.73	0.37	1.89	-0.36	177.32	-144.13	1.84
	Autumn	638	1.02	0.58	1.3	-0.44	143.34	-137.5	2.01

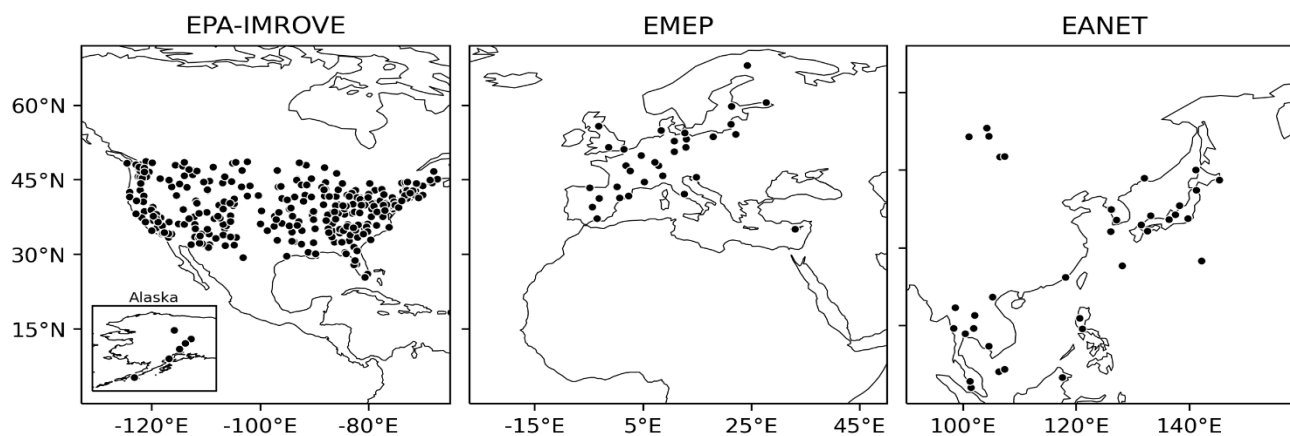
Table S32: Statistical evaluation of EMAC simulated surface concentrations of PM₁ NO₃⁻ from the initial combined sensitivity (using high grid resolution, reduced N₂O₅ uptake, and the CMIP6 emission inventory) against observations during 2010-2018.

Region	Type of location	Number of datasets	Mean Observed (µg m ⁻³)	Mean Predicted (µg m ⁻³)	MAGE (µg m ⁻³)	MB (µg m ⁻³)	NME (%)	NMB (%)	RMSE (µg m ⁻³)
North America	Rural	31	1.12	0.14	0.99	-0.98	88.74	-87.36	1.74
	Urban	22	1.46	0.52	1.05	-0.94	84.36	-77.54	1.65
	Downwind	5	1.24	0.25	1.1	-0.98	89.15	-79.4	2.19
East Asia	Rural	40	6.78	2.44	4.89	-4.34	190.69	-187.5	5.96
	Urban	78	9.65	3.98	4.66	-5.67	192.03	-186.7	5.82
	Downwind	15	4.86	2.83	3.34	-2.03	94.58	-86	4.24
Europe	Rural	163	1.42	0.4	1.19	-1.02	84.58	-87.94	1.81
	Urban	28	1.76	0.56	1.62	-1.2	111.51	-95.65	2.4
	Downwind	99	3.18	0.59	2.47	-2.59	89.61	-88.87	3.23
India	Rural	5	0.41	0.91	1.02	0.5	120.56	112.7	1.43
	Urban	14	8.16	2.64	5.66	-5.52	263.38	-259	8.18

Table S33: Average tropospheric burden of aerosol NO_3^- for the period 2010-2018 for the base case and all sensitivity simulations.

Simulation case	NO_3^- Tropospheric Burden (Tg)
Base Case	0.70
RES_low (T42)	0.89
RES_high (T106)	0.53
CMIP	0.74
HTAP	0.88
THERM	0.69
HYDRO	0.69
SCAV	0.53
COMBO	0.64

(a) Filter Network Measurements Locations



(b) AMS Campaigns Measurements Locations

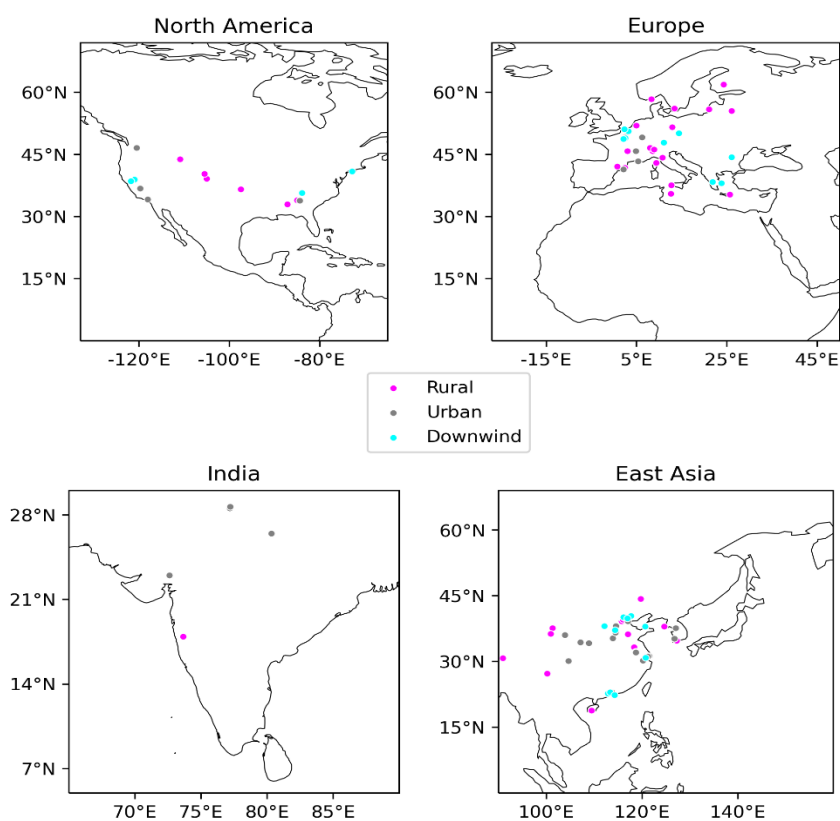


Figure S1: Locations of (a) $\text{PM}_{2.5}$ NO_3^- filter measurements from observation networks and (b) PM_1 NO_3^- AMS measurements from field campaigns in rural (magenta), urban (grey) and urban-downwind (cyan) locations.

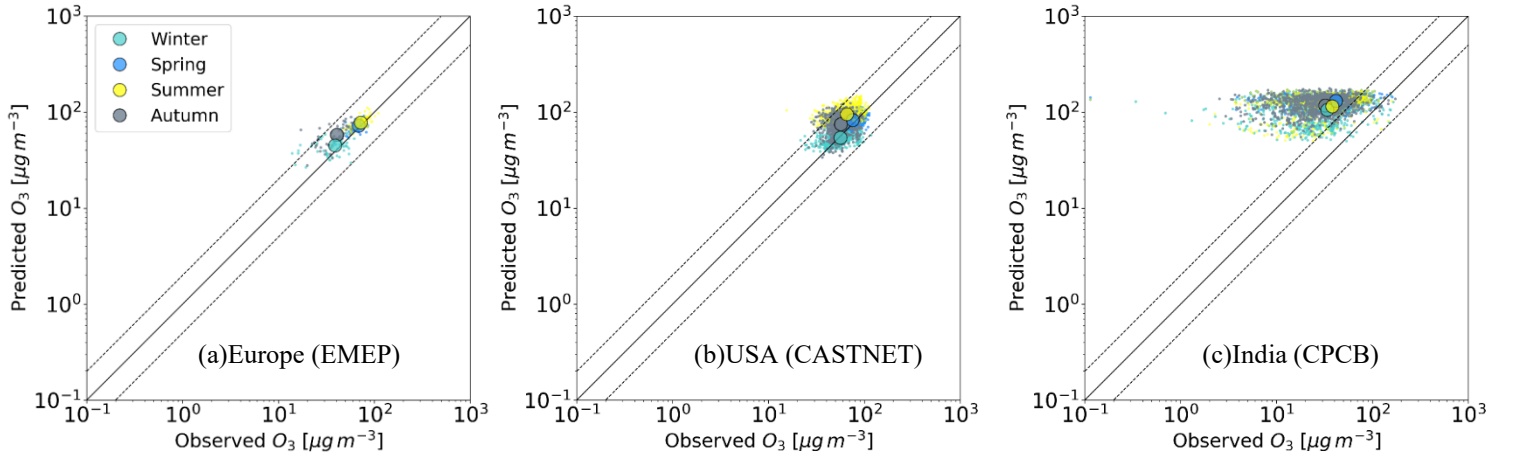


Figure S2: Scatterplots comparing the seasonal mean surface concentrations of O_3 as simulated by EMAC from the Base Case using the CAMS inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

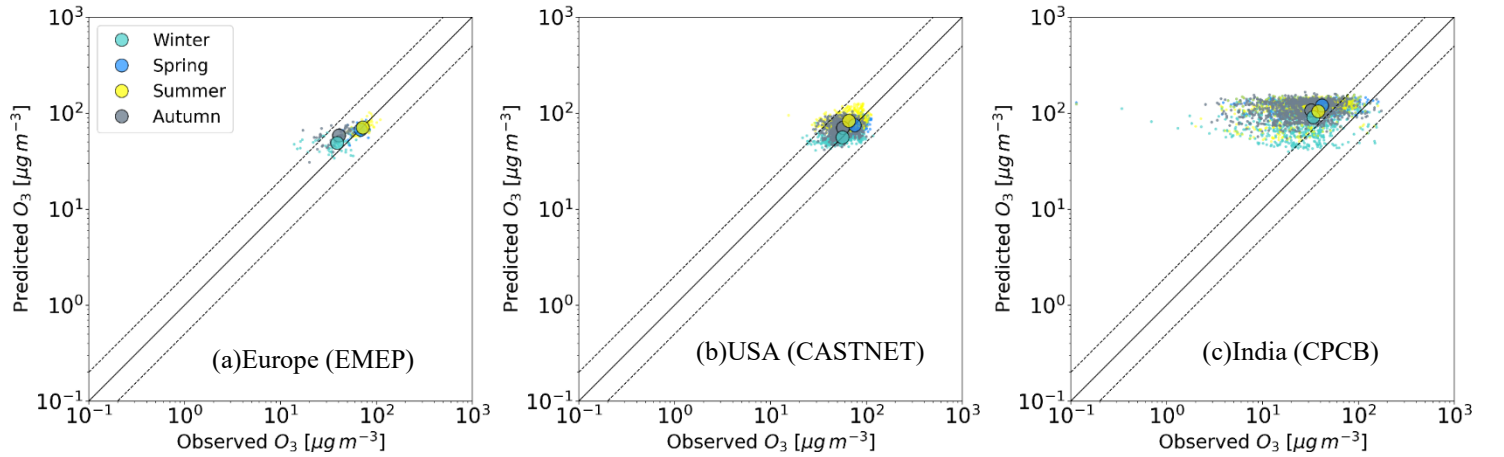


Figure S3: Scatterplots comparing the seasonal mean surface concentrations of O_3 as simulated by EMAC from the Base Case using the CMIP6 inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

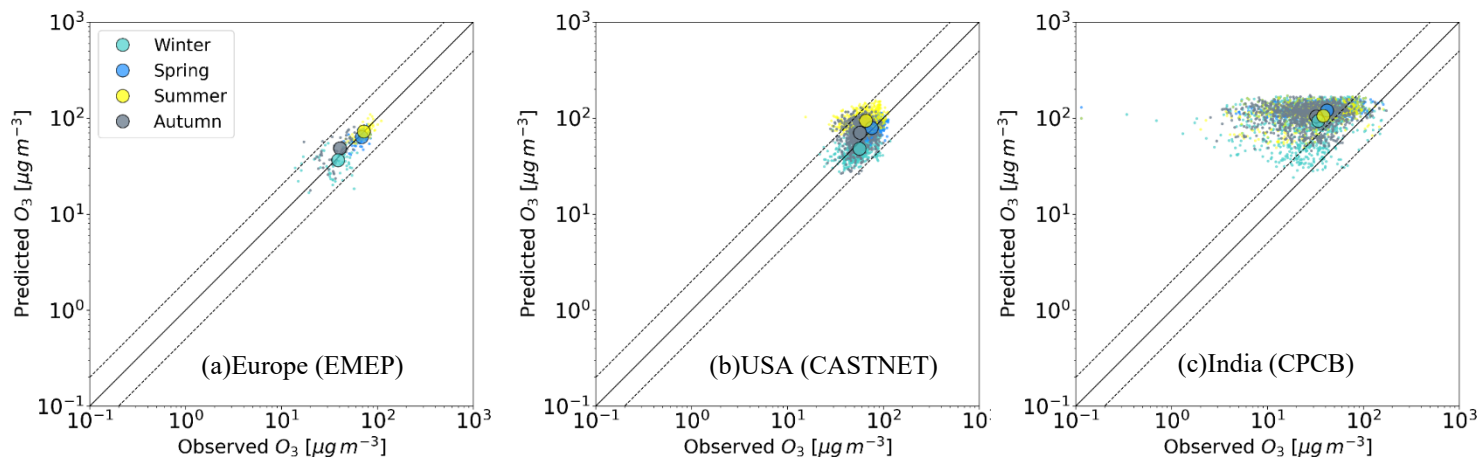


Figure S4: Scatterplots comparing the seasonal mean surface concentrations of O_3 as simulated by EMAC from the Base Case using the HTAPv3 inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

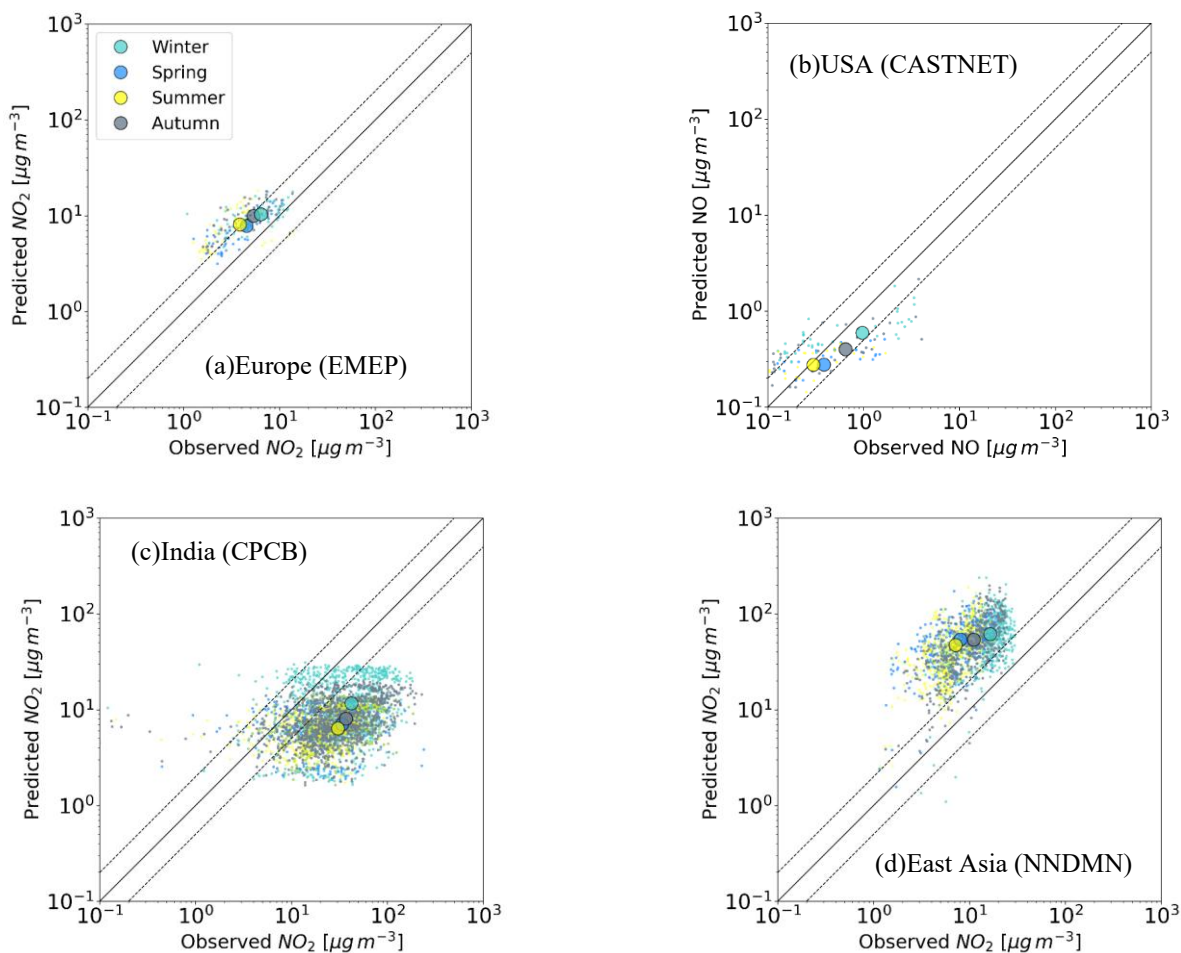


Figure S5: Scatterplots comparing the seasonal mean surface concentrations of NO_x as simulated by EMAC from the Base Case using the CAMS inventory, with observations from the networks of (a) EMEP, (b) CASTNET, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal value.

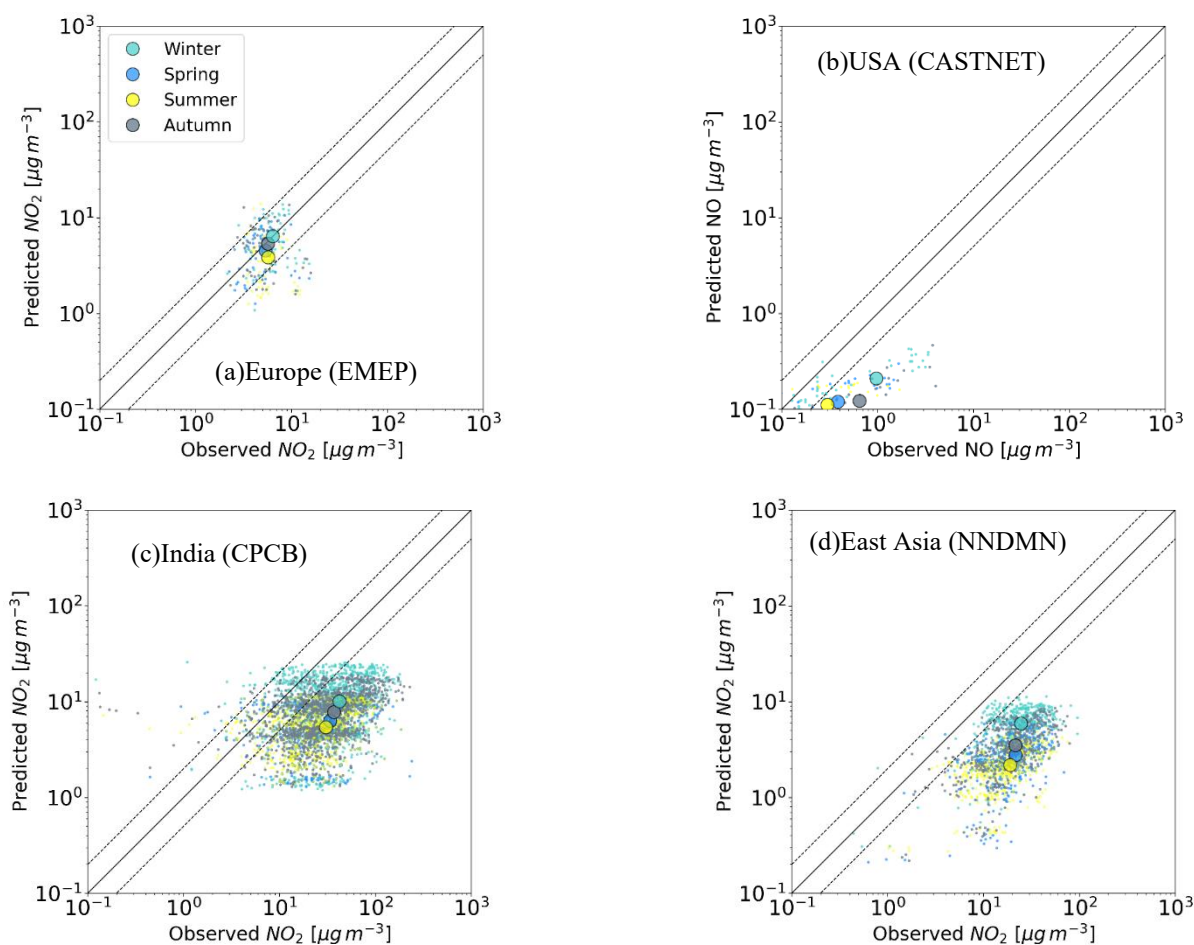


Figure S6: Scatterplots comparing the seasonal mean surface concentrations of NO_x as simulated by EMAC from the Base Case using the CMIP6 inventory, with observations from the networks of (a) EMEP, (b) CASTNET, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

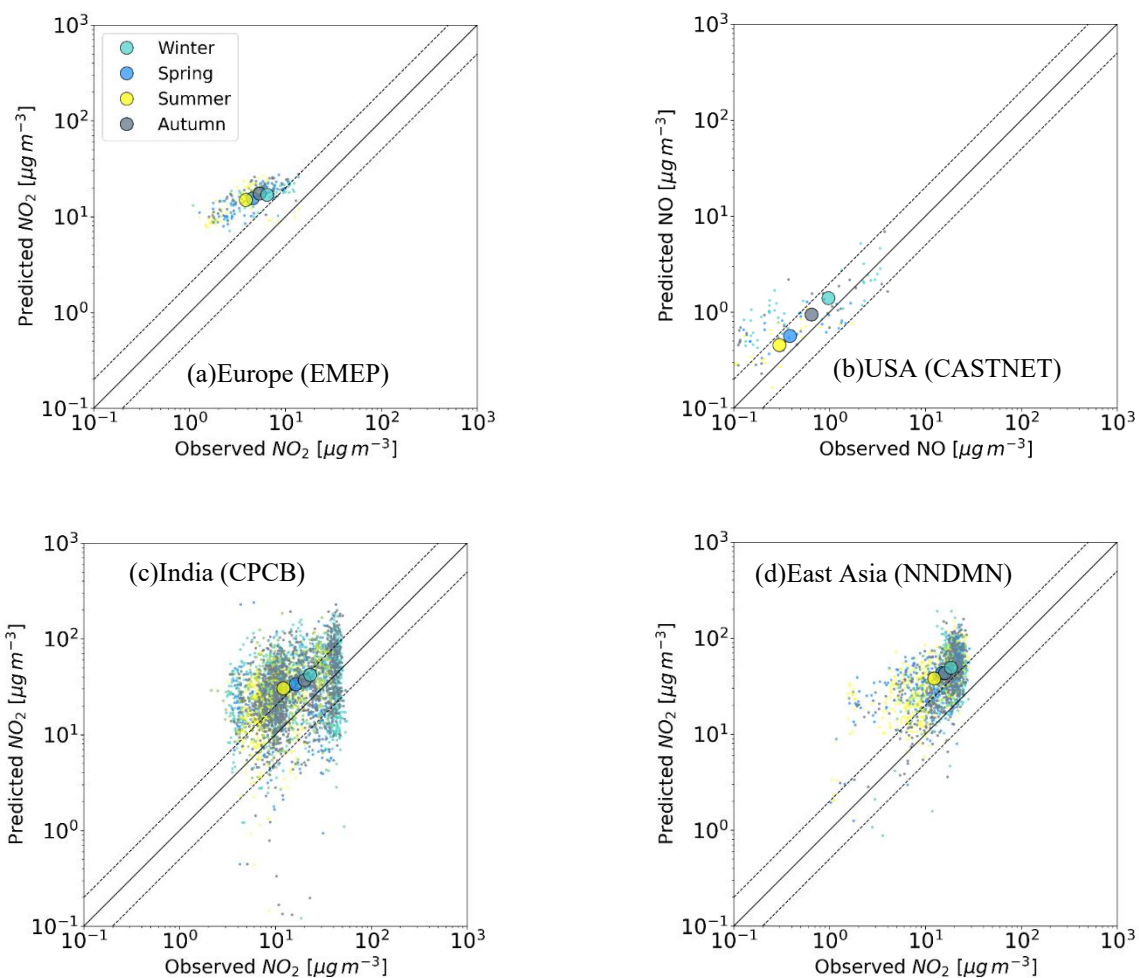


Figure S7: Scatterplots comparing the seasonal mean surface concentrations of NO_x as simulated by EMAC from the Base Case using the HTAPv3 inventory, with observations from the networks of (a) EMEP, (b) CASTNET, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

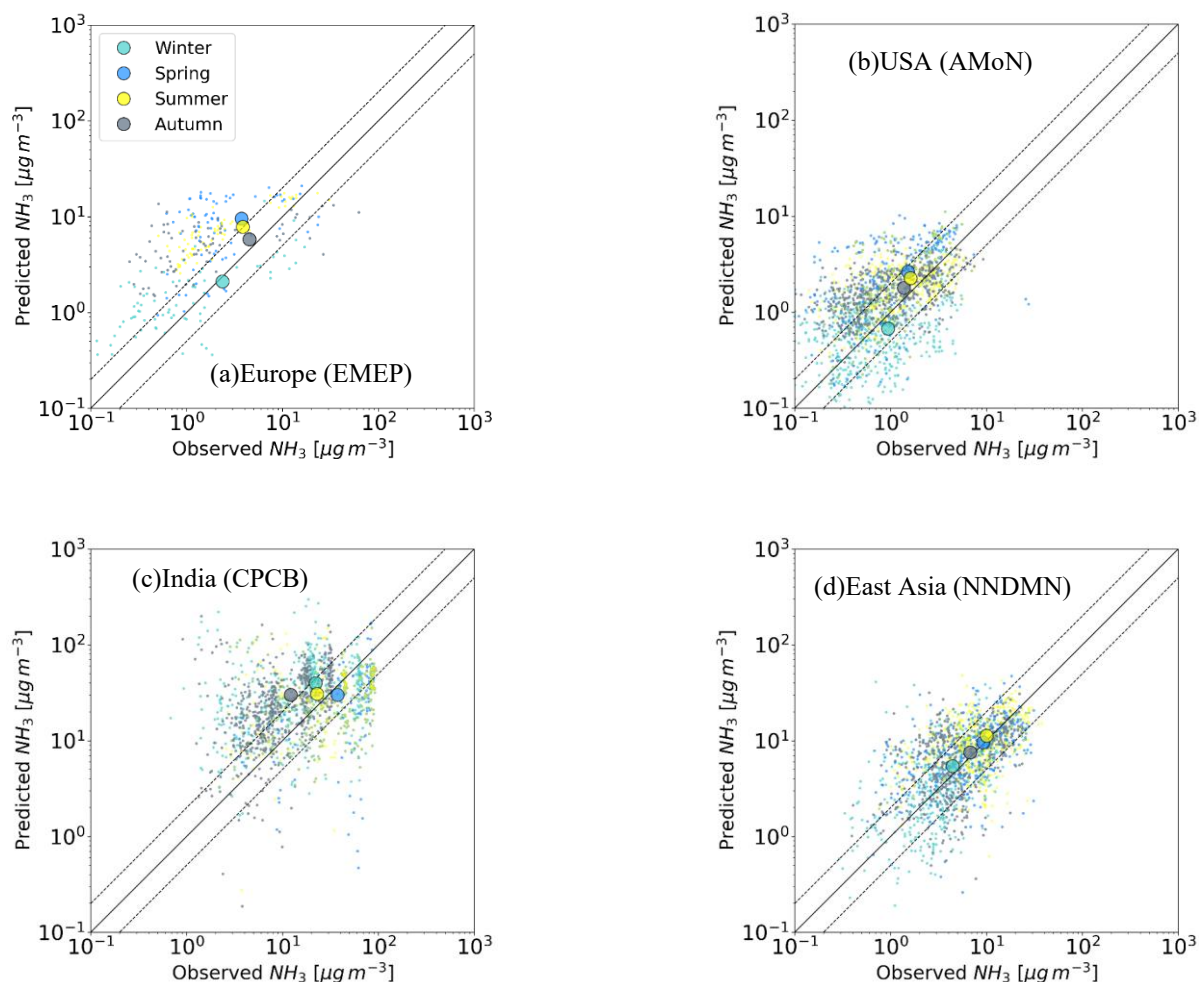


Figure S8: Scatterplots comparing the seasonal mean surface concentrations of NH_3 as simulated by EMAC from the Base Case using the CAMS inventory, with observations from the networks of (a) EMEP, (b) AMoN, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

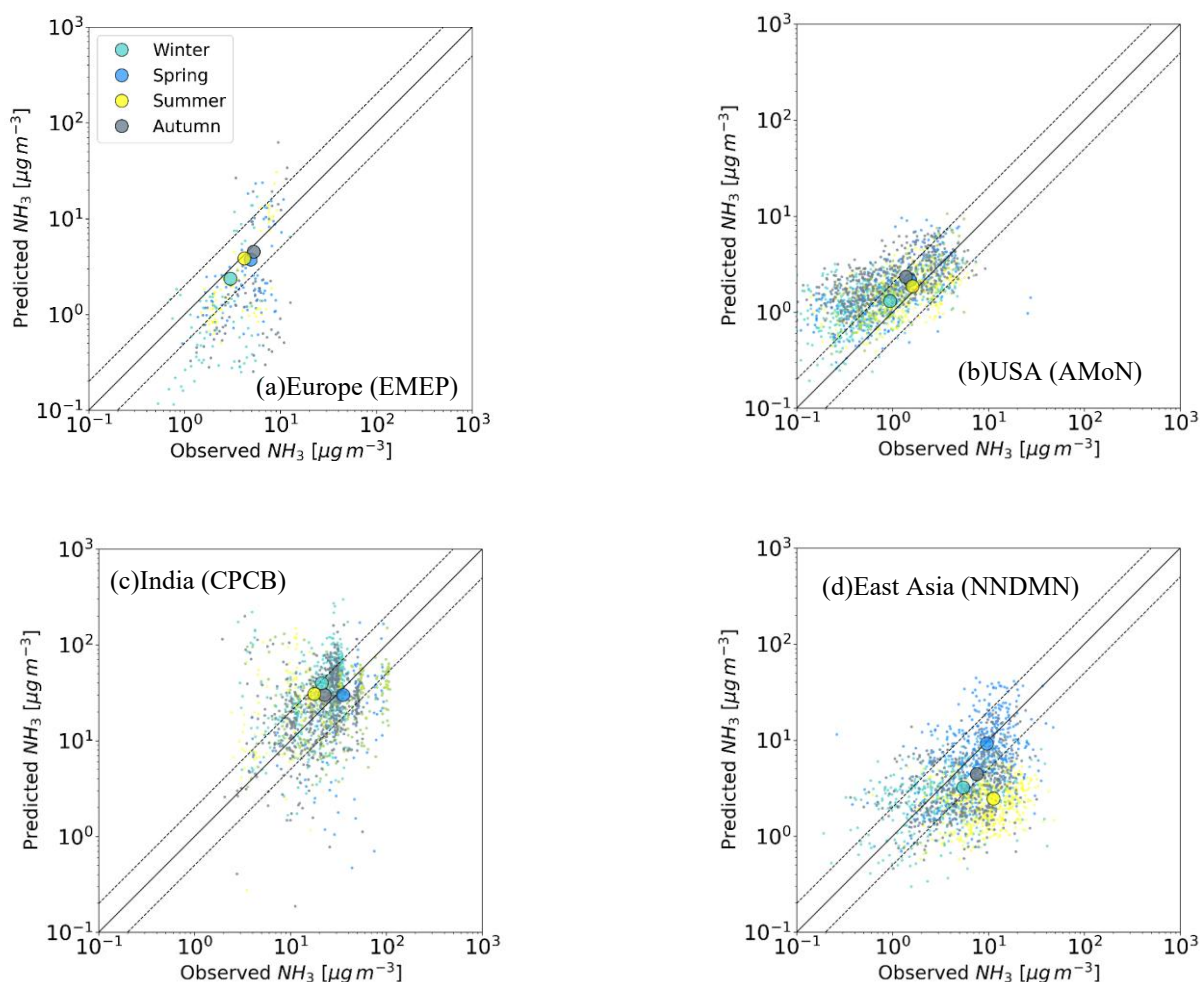


Figure S9: Scatterplots comparing the seasonal mean surface concentrations of NH_3 as simulated by EMAC from the Base Case using the CMIP6 inventory, with observations from the networks of (a) EMEP, (b) AMoN, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

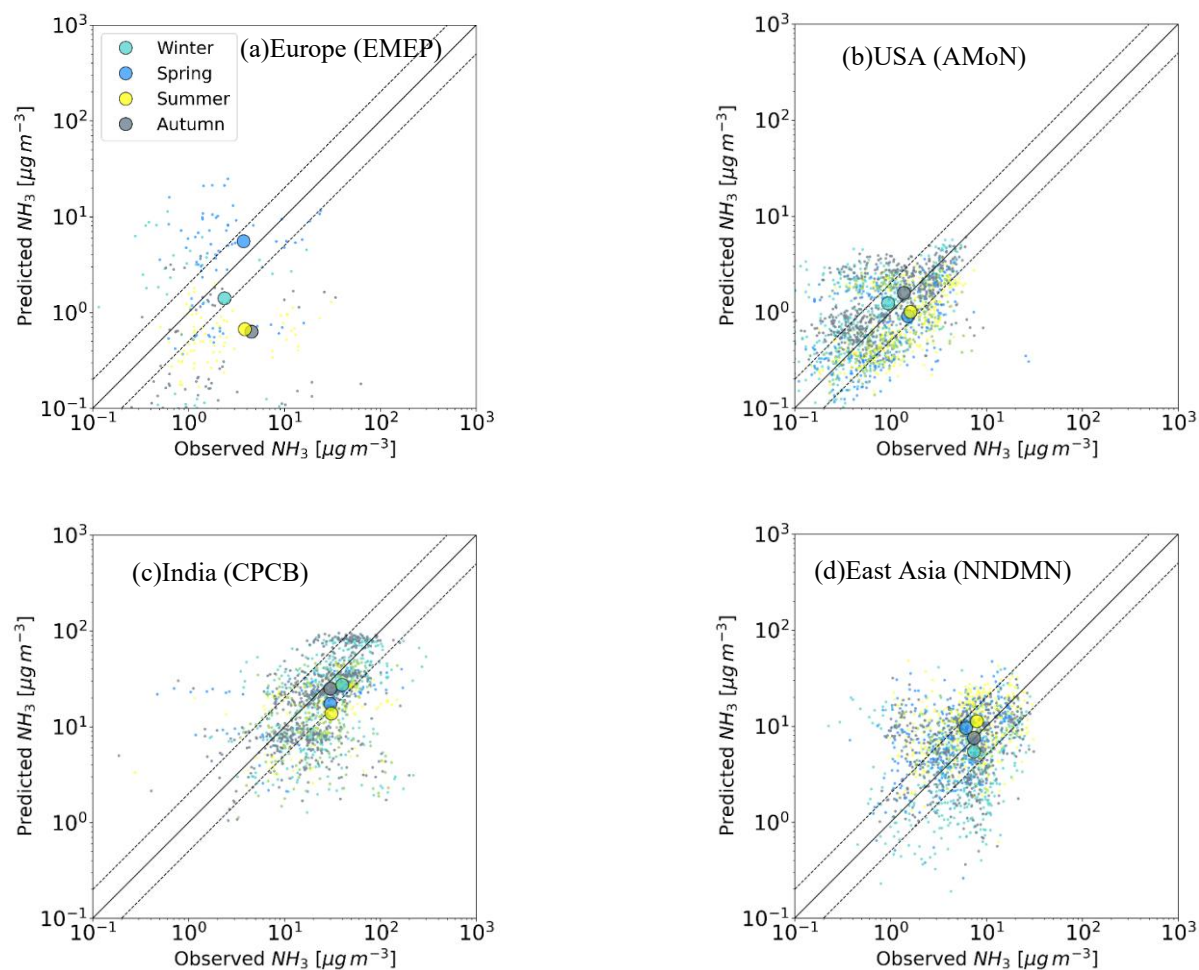


Figure S10: Scatterplots comparing the seasonal mean surface concentrations of NH_3 as simulated by EMAC from the Base Case using the HTAPv3 inventory, with observations from the networks of (a) EMEP, (b) AMoN, (c) CPCB and (d) NNDMN. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

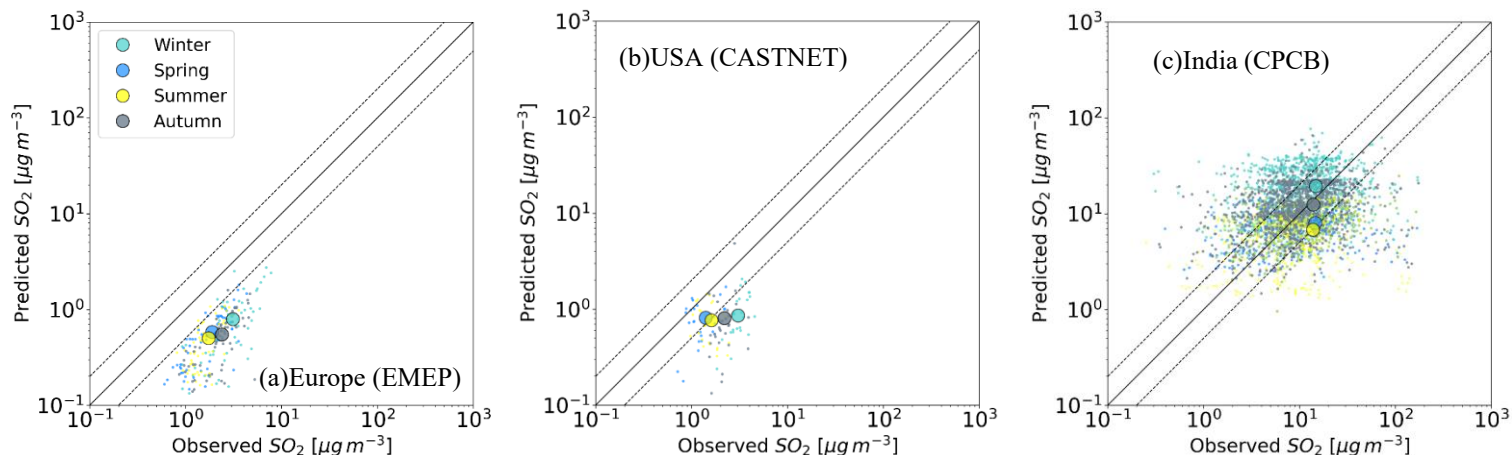


Figure S11: Scatterplots comparing the seasonal mean surface concentrations of SO_2 as simulated by EMAC from the Base Case using the CAMS inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

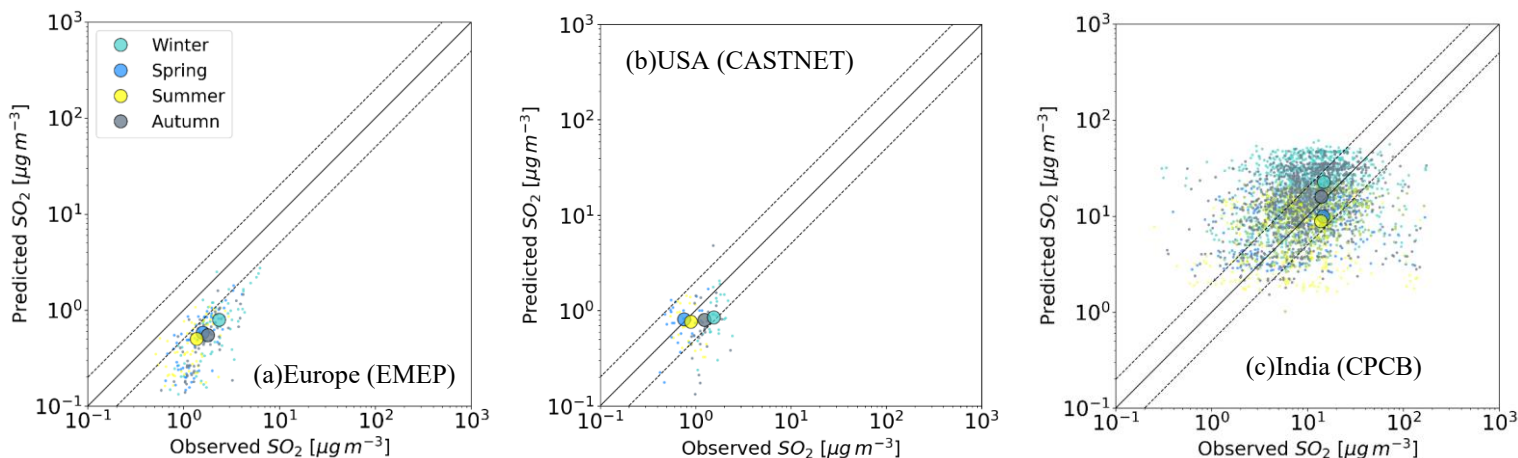


Figure S12: Scatterplots comparing the seasonal mean surface concentrations of SO_2 as simulated by EMAC from the Base Case using the CMIP6 inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

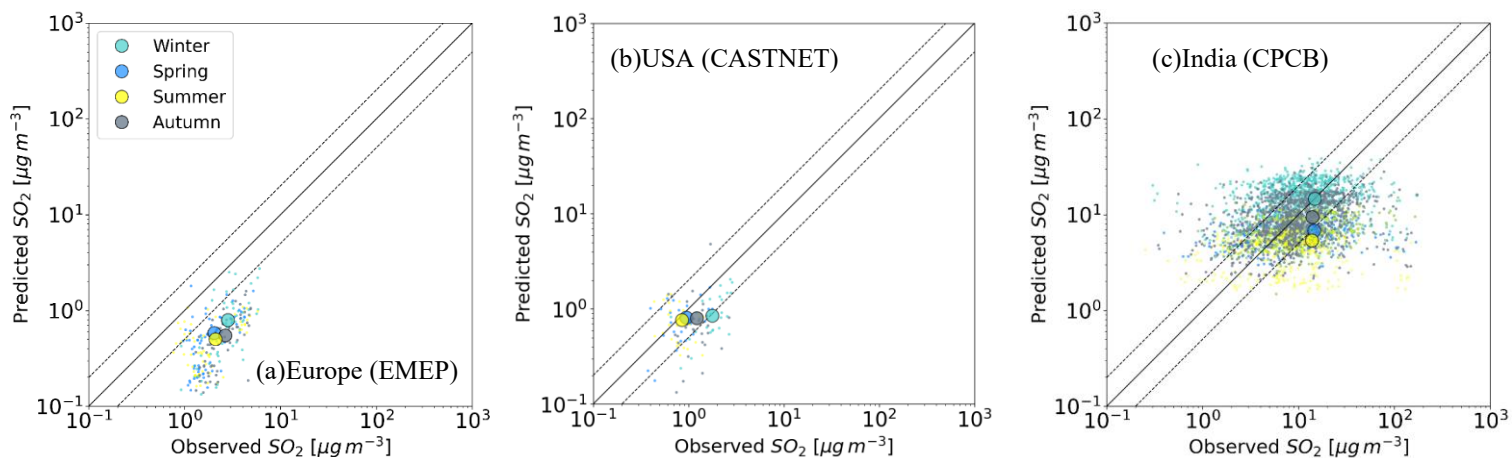
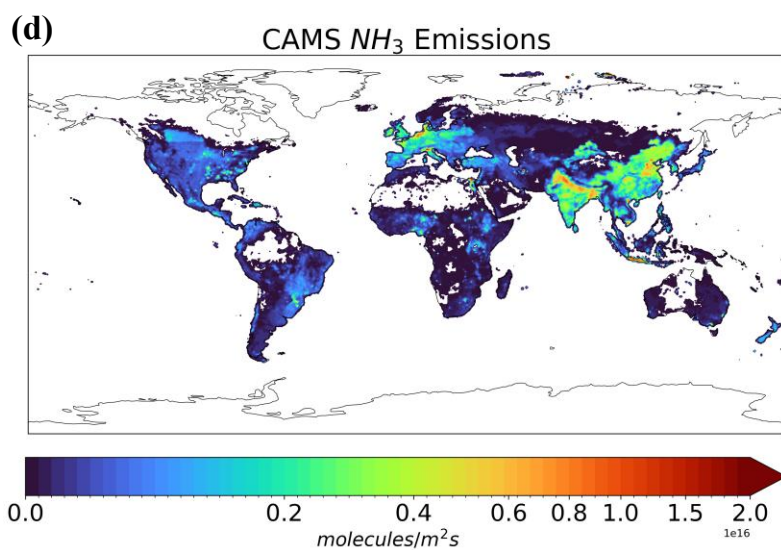
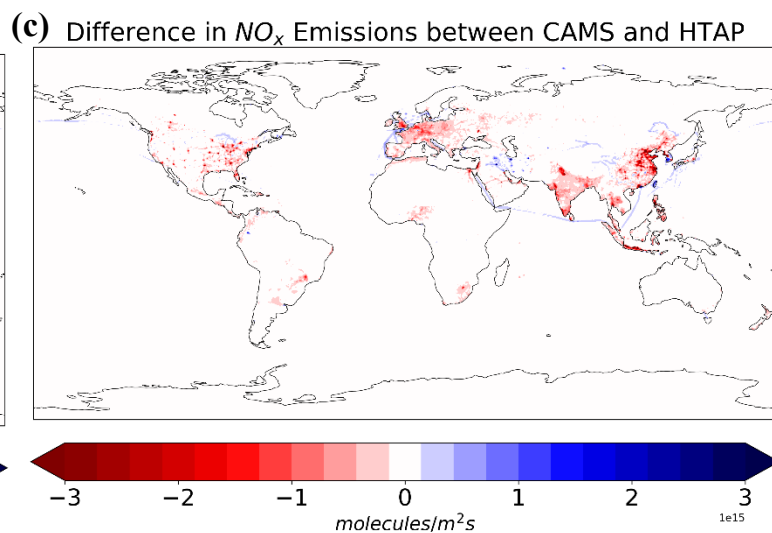
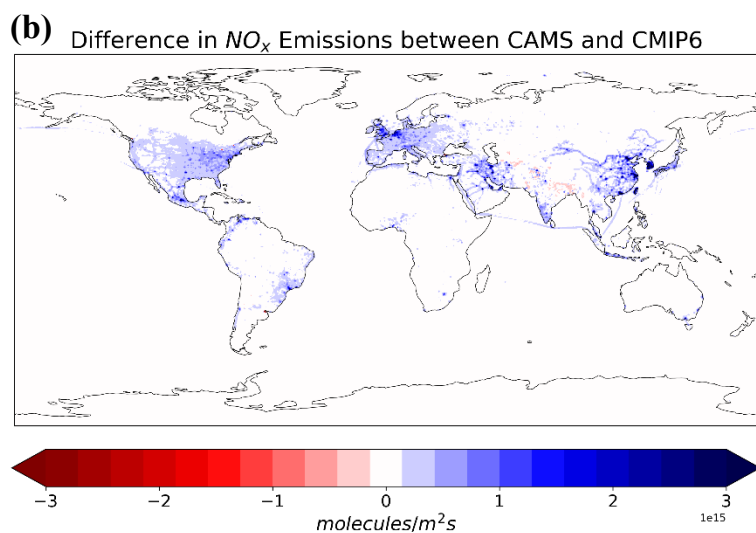
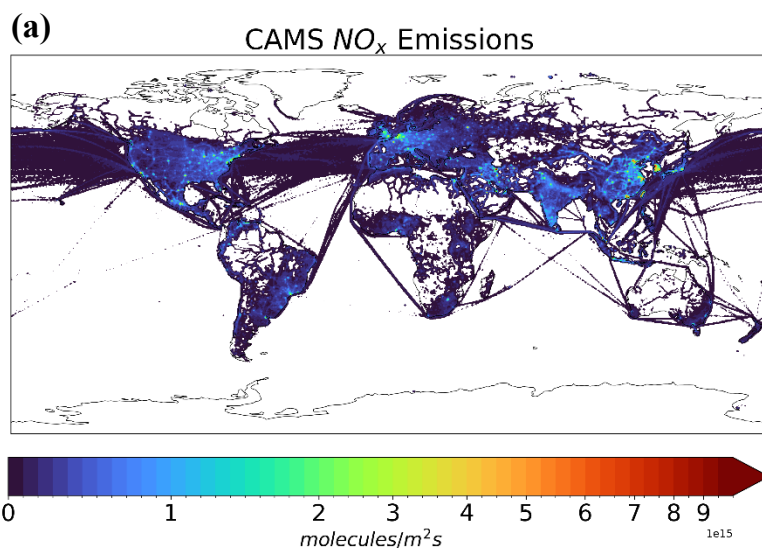
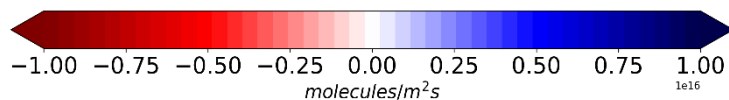
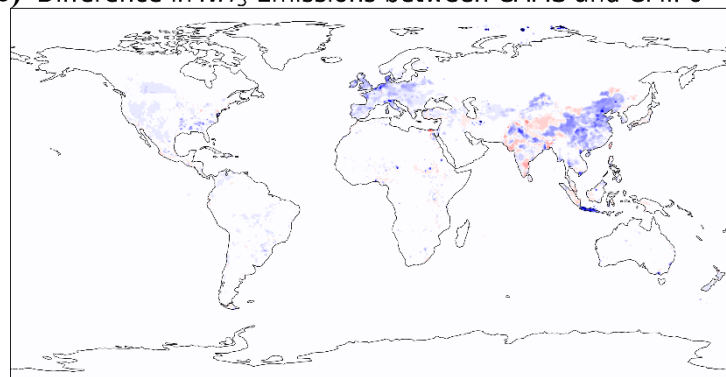


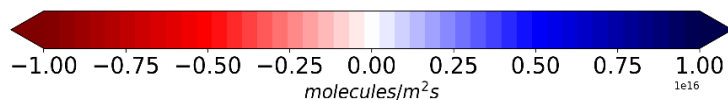
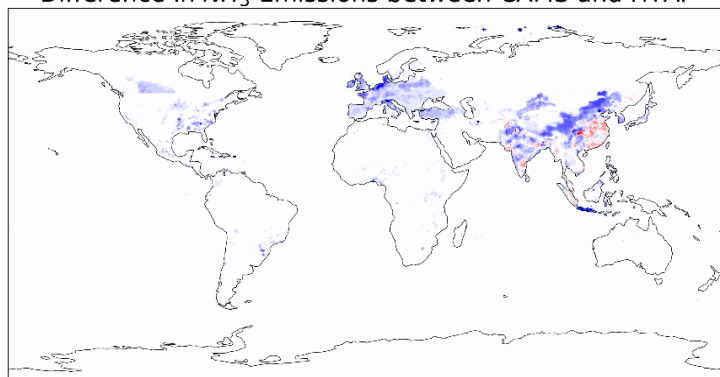
Figure S13: Scatterplots comparing the seasonal mean surface concentrations of SO_2 as simulated by EMAC from the Base Case using the HTAPv3 inventory, with observations from the networks of (a) EMEP, (b) CASTNET and (c) CPCB. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.



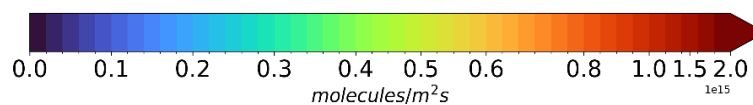
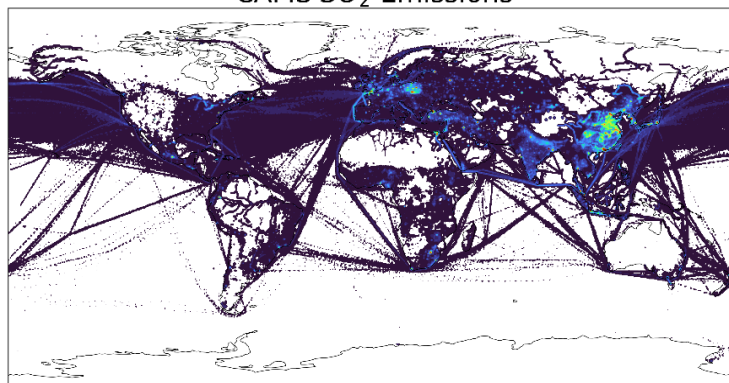
(e) Difference in NH_3 Emissions between CAMS and CMIP6



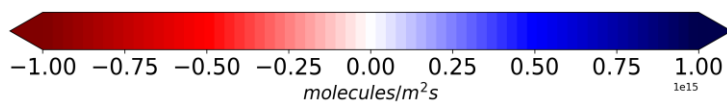
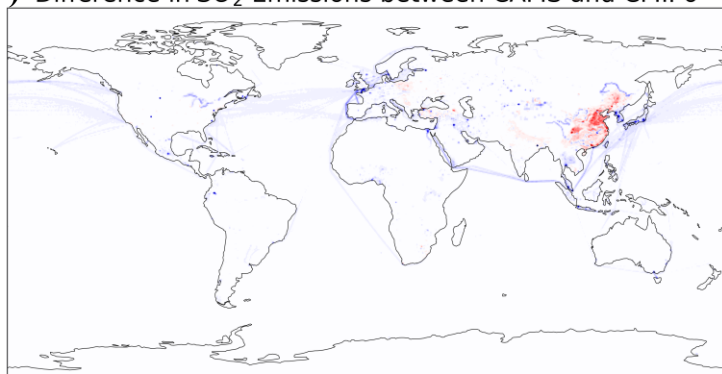
(f) Difference in NH_3 Emissions between CAMS and HTAP



(g) CAMS SO_2 Emissions



(h) Difference in SO_2 Emissions between CAMS and CMIP6



(i) Difference in SO_2 Emissions between CAMS and HTAP

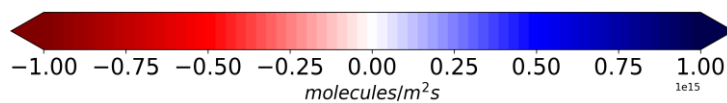
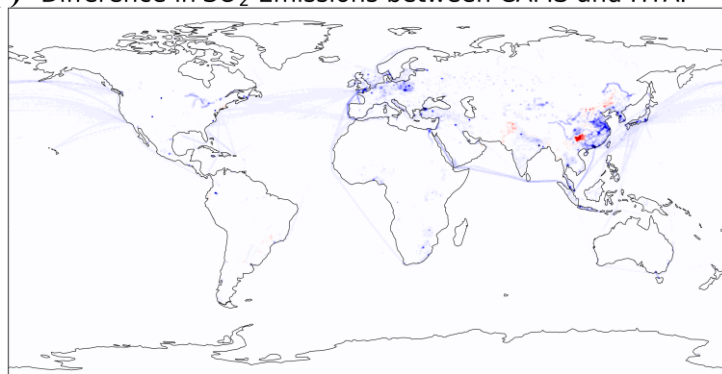


Figure S14: Annual mean surface emission flux of (a) NO_x from the CAMS database. Difference in annual mean surface emission flux of NO_x between the (b) CAMS and CMIP6 databases, (c) between the CAMS and HTAPv3 databases. Annual mean surface emission flux of (d) NH₃ from the CAMS database. Difference in annual mean surface emission flux of NH₃ between the (e) CAMS and CMIP6 databases, (f) between the CAMS and HTAPv3 databases. Annual mean surface emission flux of (g) SO₂ from the CAMS database. Difference in annual mean surface emission flux of SO₂ between the (h) CAMS and CMIP6 databases, (i) between the CAMS and HTAPv3 databases. Blue colors indicate that the respective emission flux from the CAMS database is higher.

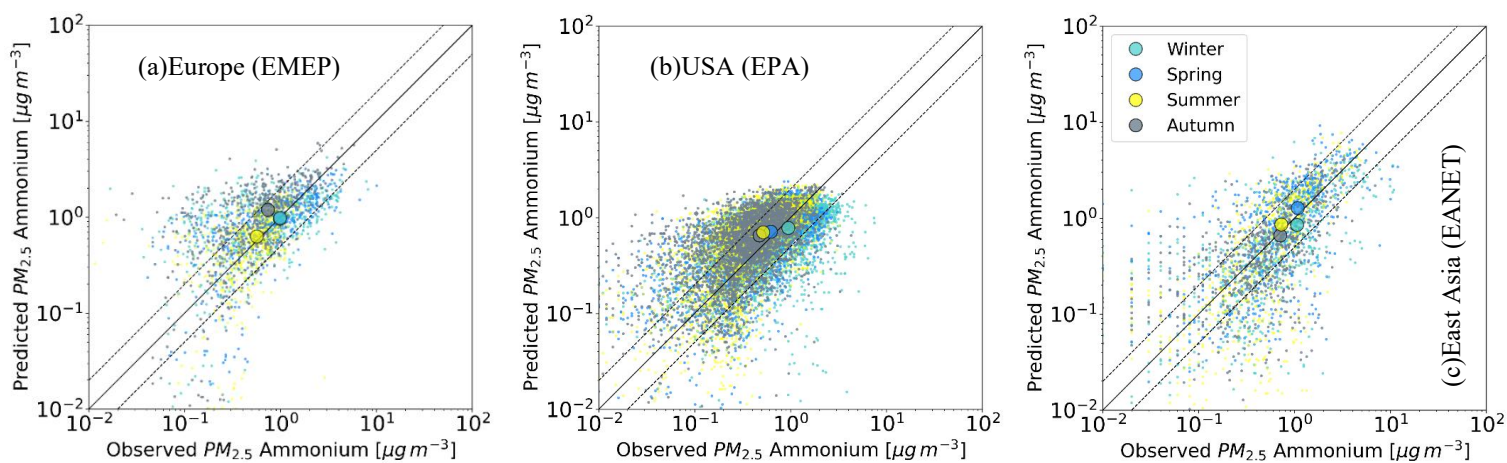


Figure S15: Scatterplots comparing the seasonal mean surface concentrations of $PM_{2.5} NH_4^+$ as simulated by EMAC from the Base Case with observations from the networks of (a) EMEP, (b) EPA and (c) EANET. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

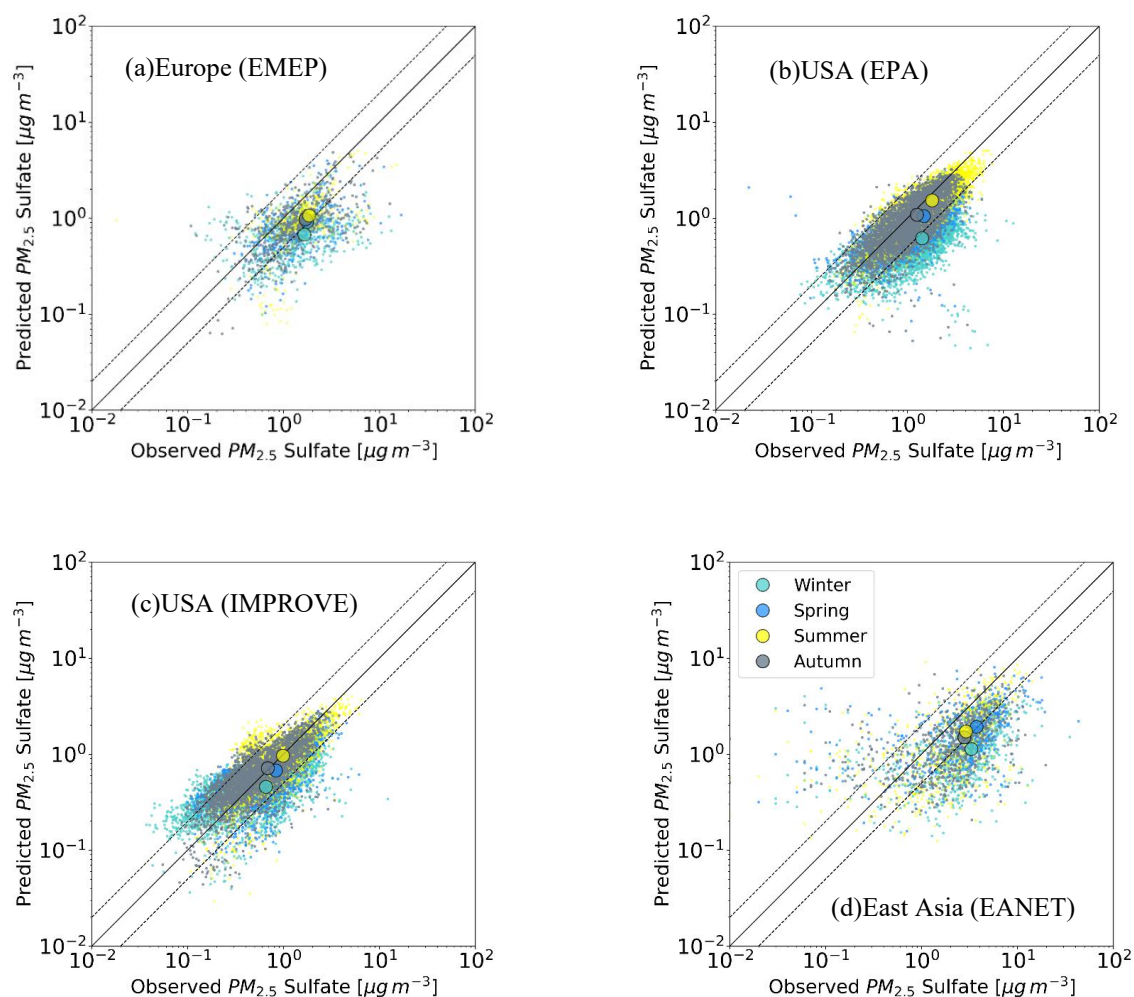


Figure S16: Scatterplots comparing the seasonal mean surface concentrations of $PM_{2.5} SO_4^{2-}$ as simulated by EMAC from the Base Case with observations from the networks of (a) EMEP, (b) EPA, (c) IMPROVE and (d) EANET. Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

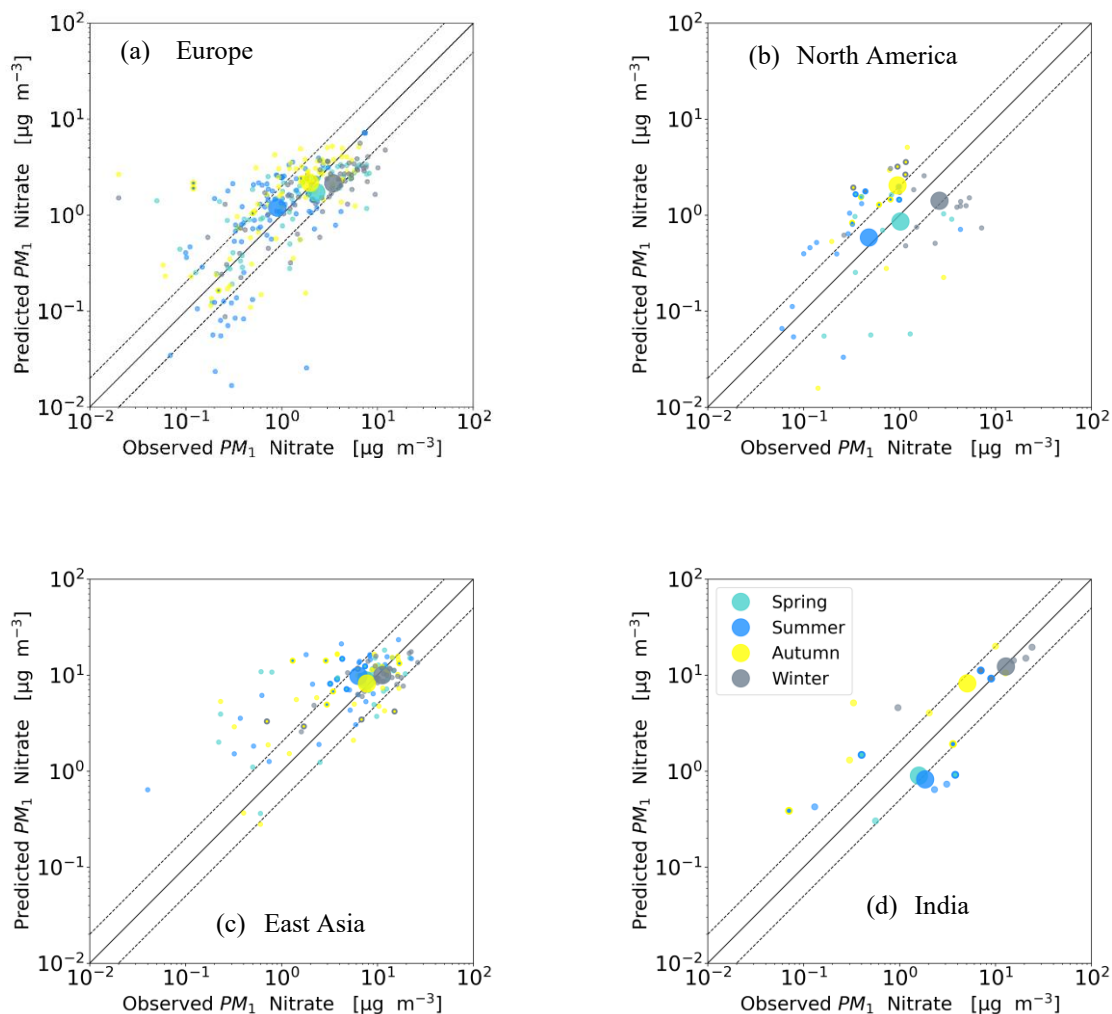


Figure S17: Scatterplots comparing the monthly mean surface concentrations of $PM_1 NO_3^-$ as simulated by EMAC from the Base Case with AMS observations from field campaigns in (a) Europe, (b) North America, (c) East Asia and (d) India in all locations types (urban, rural and downwind). Light blue points indicate values in winter, blue points in spring, yellow points in summer and grey points in autumn. The enlarged dots indicate the mean seasonal values.

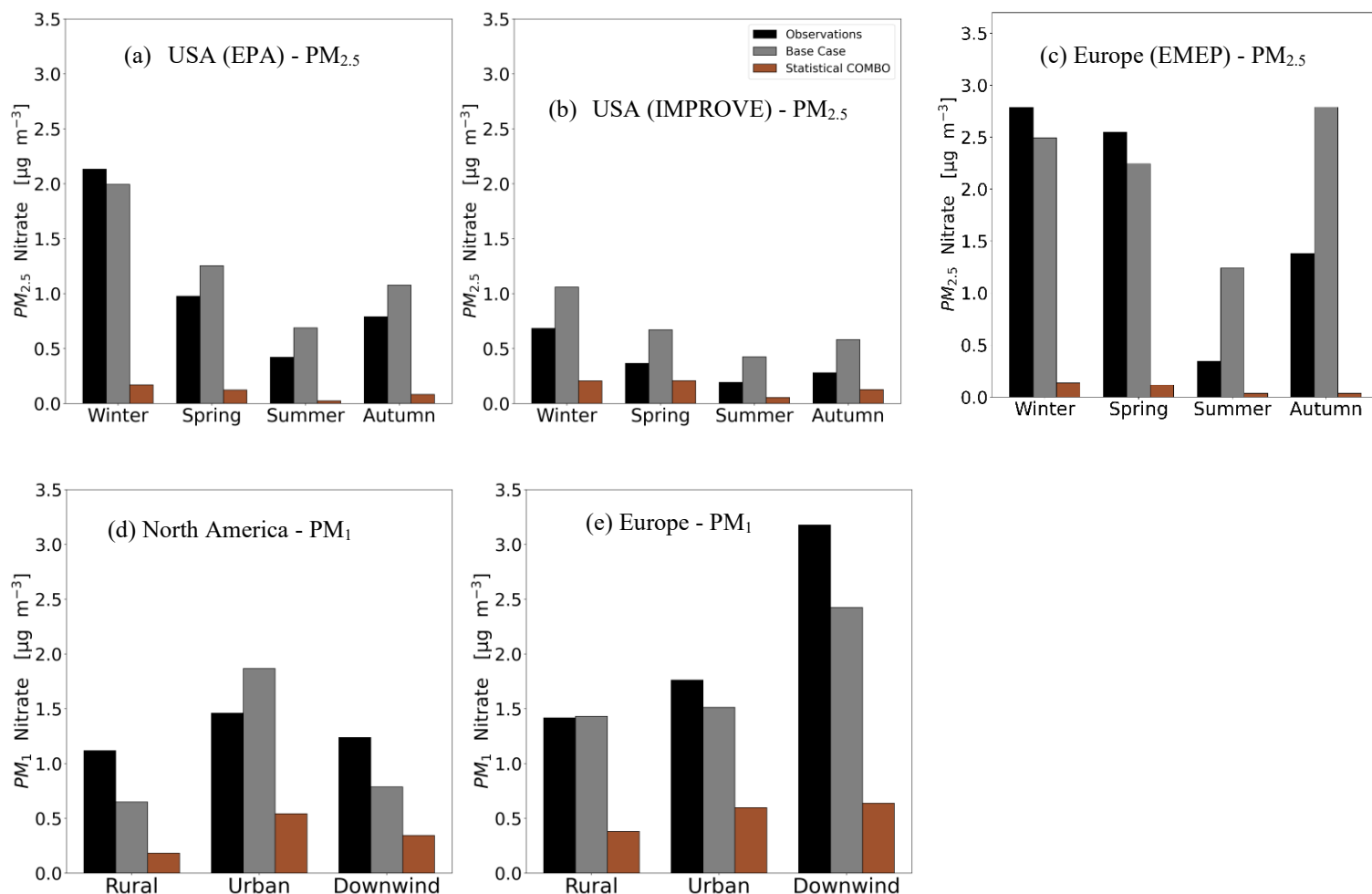


Figure S18: Average seasonal surface concentrations of $PM_{2.5} NO_3^-$ measured (black bars) and predicted from the base case (grey bars) and the initial combined configuration (brown bars), using high grid resolution, reduced N_2O_5 uptake, and the CMIP6 emission inventory, for the networks of (a) EPA, (b) IMPROVE and (c) EMEP during winter, spring, summer and autumn. Average $PM_1 NO_3^-$ surface concentrations measured by AMS instruments in field campaigns (black bars) and predicted by the base case (grey bars) and the initial Combo case (brown bars) for the regions of (d) North America and (e) Europe divided into rural, urban and urban-downwind locations.

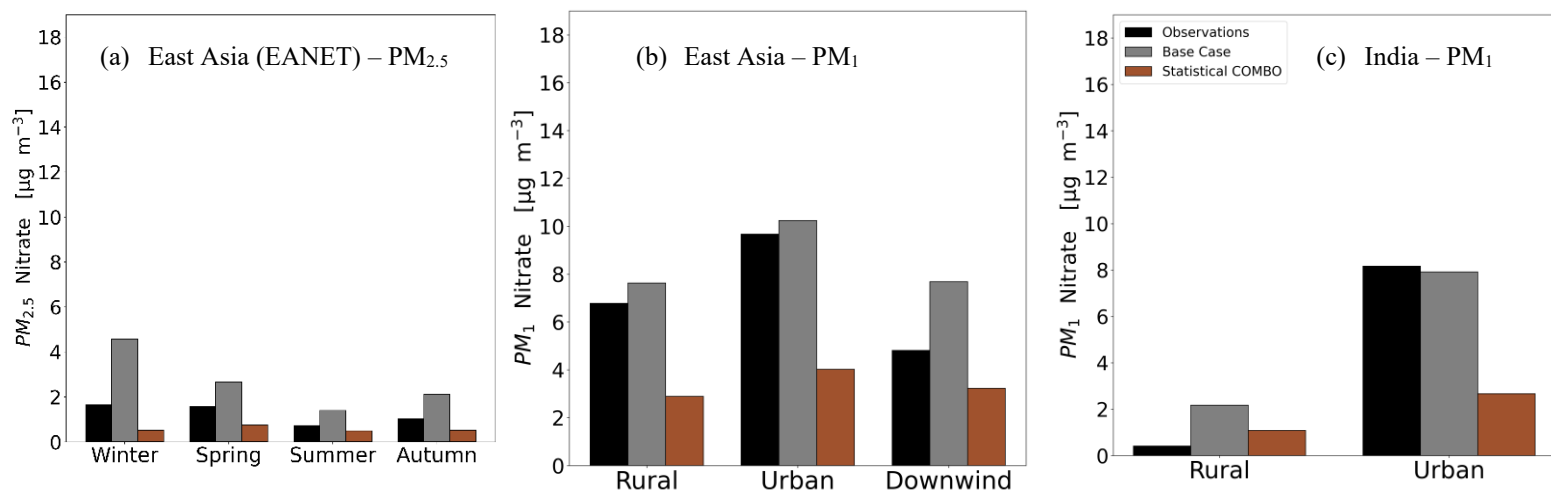


Figure S19: Average seasonal surface concentrations of $\text{PM}_{2.5} \text{NO}_3^-$ measured (black bars) and predicted from the base case (grey bars) and the initial combined configuration (brown bars), using high grid resolution, reduced N_2O_5 uptake, and the CMIP6 emission inventory, for the network of (a) EANET during winter, spring, summer and autumn. Average $\text{PM}_1 \text{NO}_3^-$ surface concentrations measured by AMS instruments in field campaigns (black bars) and predicted by the base case (grey bars) and the initial Combo case (brown bars) for the regions of (a) East Asia and (b) India divided into rural, urban and urban-downwind locations.