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*Supplement of*

## **MICS-Asia III: multi-model comparison and evaluation of aerosol over East Asia**

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**Table S1. Basic information on observation stations in each defined sub-region.**

Region	Station Index	Station Name	Latitude	Longitude
Region_1	1	Rishiri	45.12	141.20
	2	Ochiishi	43.17	145.50
	3	Tappi	41.25	140.35
	4	Sadoseki	38.25	138.40
	5	Happo	36.70	137.80
	6	Ijira	35.57	136.68
	7	Oki	36.28	133.18
	8	Banryu	34.68	131.80
	9	Yusuhara	33.38	132.93
	10	Hedo	26.87	128.25
	11	Ogasawara	27.08	142.22
	12	Tokyo	35.68	139.75
	13	Kanghwa	37.70	126.28
	14	Cheju	33.30	126.17
	15	Imsil	35.60	127.18
Region_2	16	Jinyunshan	29.82	106.37
	17	Hongwen	24.47	118.13
	18	Xiangzhou	22.27	113.57
	19	Beijing_Y2010*	39.97	116.37
	20	Beijing_ZWY_Y2010*	39.87	116.43
	21	Beijing_STZ_Y2010*	40.00	116.33
	22	Beijing_NJ_Y2010*	39.80	116.47
	23	Beijing_SDZ_Y2010*	40.65	117.12
	24	Gucheng_Y2010*	39.13	115.80
	25	Beijing_LS_Y2010*	39.97	115.43
	26	Shijiazhuang_Y2010*	38.04	114.50
	27	SACOL_main_Y2010*	35.95	104.14
	28	Langfang_Y2010*	39.55	116.68
	29	Zhangjiakou_Y2010*	40.77	114.92
	30	Zhengzhou_Y2010*	34.78	113.65
	31	Jinan_Y2010*	36.65	116.97
	32	Dongguan_Y2010*	23.02	113.76
	33	Tangshan_Y2010*	39.62	118.15
	34	Shanghai_DT_Y2010*	31.53	121.97
	35	Shanghai_PD_Y2010*	31.23	121.53
	36	Shanghai_QXJ_Y2010*	31.23	121.53
	37	Zhejiang_LA_Y2010*	30.30	119.73

38	Shangdianzi_Y2009to2010*	40.65	117.12
39	Beijing_Y2009to2010*	40.05	116.40
40	Tianjin_Y2009to2010*	39.09	117.31
41	Shijiazhuang_Y2009to2010*	38.04	114.50
42	Chengde_Y2009to2010*	40.96	117.93
43	SCIES_Y2009to2010*	23.12	113.35
44	Beijing_IAP_Y2011to2012*	39.97	116.37
45	Xi'an_Y2010*	34.28	108.84
46	Tianhu_Y2012to2013*	23.65	113.63
47	Beijing_SDZ_Y2010*	40.65	117.12
48	SAES_Y2011to2013*	31.17	121.43
49	Anhui_Y2012to2013*	31.87	117.23
50	YRDNNR_Y2011*	38.03	118.44
51	HBT_BD**	38.82	115.44
52	HBT_BJT**	39.97	116.37
53	HBT_CD**	40.97	117.93
54	HBT_CFD**	39.27	118.44
55	HBT_CZ**	38.29	116.78
56	HBT_DT**	40.09	113.39
57	HBT_GA**	39.15	115.73
58	HBT_HJ**	38.42	116.08
59	HBT_HS**	37.74	115.66
60	HBT_LS**	39.97	115.43
61	HBT_QA**	40.10	118.80
62	HBT_SJZ**	38.03	114.53
63	HBT_TG**	39.04	117.72
64	HBT_TJ**	39.08	117.21
65	HBT_TS**	39.62	118.16
66	HBT_XH**	39.75	116.96
67	HBT_YF**	40.15	116.13
68	HBT_ZJK**	40.77	114.92
69	HBT_ZZ**	39.46	115.99
70	PRD_chengzhong**	23.05	112.47
71	PRD_jinjuzui**	22.82	113.27
72	PRD_huijingcheng**	23.00	113.11
73	PRD_donghu**	22.59	113.08
74	PRD_zimaling**	22.51	113.40
75	PRD_tangjia**	22.35	113.58
76	PRD_haogang**	23.03	113.74
77	PRD_jinguowan**	22.94	114.38

78	PRD_xiapu <sup>**</sup>	23.05	114.42
79	PRD_liyuan <sup>**</sup>	22.55	114.10
80	PRD_luhu <sup>**</sup>	23.16	113.28
81	PRD_wanqingsha <sup>**</sup>	22.71	113.55
82	PRD_tianhu <sup>**</sup>	23.65	113.63
83	UlaanBaatar	47.90	106.82
84	Terelj	47.98	107.48
<b>Region_3</b>	Listvyanka	51.85	104.90
	Irkutsk	52.23	104.25
	Primorskaya	43.70	132.12
88	PhnomPenh	11.55	104.83
89	Jakarta	-6.18	106.83
90	Kototabang	0.20	100.32
91	Bandung	6.90	107.58
92	TanahRata	4.47	101.38
93	PetalingJaya	3.10	101.65
94	DanumValley	4.98	117.85
<b>Region_4</b>	MetroManila	14.63	121.07
	MtStoTomas	16.42	120.60
	Bangkok	13.77	100.53
	Samutprakarn	13.73	100.57
	Patumthani	14.03	100.77
	Khanchanaburi	14.43	98.58
	Chiangmai	18.77	98.93
	NakhonRatchasima	14.45	101.88
	Hanoi	21.02	105.85

\*Observations are collected from published literature (Chen et al., 2012; Li, 2012; Liu, 2012; Meng et al., 2012; Shao, 2012; Wang et al., 2014; Xu, 2012; Xie et al., 2013; Yu, 2013; Tao et al., 2014; Li, 2015; Sun et al., 2015; Wang et al., 2015; Zhang, 2015; Lai et al., 2016; Li et al., 2016; Wang et al., 2016; Deng et al., 2016; Yao et al., 2016). “Y2010” means that date were observed for the year 2010.

\*\*Observations are provided by the China National Environmental Monitoring Center (CNEMC).

**Table S2. Basic information on AERONET stations in each defined sub-region.**

<b>Region</b>	<b>AOD Site Name</b>	<b>Latitude</b>	<b>Longitude</b>
<b>Region_1</b>	Baengnyeong	37.97	124.63
	Gwangju_GIST	35.23	126.84
	Noto	37.33	137.14
	Osaka	34.65	135.59
	Shirahama	33.69	135.36
<b>Region_2</b>	Beijing	39.98	116.38
	Chen-Kung_Univ	23.00	120.22
	Dongsha_Island	20.70	116.73
	EPA-NCU	24.97	121.19
	Hong_Kong_Hok_Tsui	22.21	114.26
	Hong_Kong_PolyU	22.30	114.18
	Lulin	23.47	120.87
	NAM_CO	30.77	90.96
	NCU_Taiwan	24.97	121.19
	SACOL	35.95	104.14
<b>Region_3</b>	Taihu	31.42	120.22
	XiangHe	39.75	116.96
	Xinglong	40.40	117.58
	Dalanzadgad	43.58	104.42
	Ussuriysk	43.70	132.16
<b>Region_4</b>	Bach_Long_Vy	20.13	107.73
	Bac_Lieu	9.28	105.73
	Chiang_Mai_Met_Sta	18.77	98.97
	ND_Marbel_Univ	6.50	124.84
	Silpakorn_Univ	13.82	100.04
	Ubon_Ratchathani	15.25	104.87
	EVK2-CNR	27.96	86.81
<b>Region_5</b>	Jaipur	26.91	75.81
	Kanpur	26.51	80.23
	Kathmandu_Univ	27.60	85.54
	Nainital	29.36	79.46
	Pokhara	28.15	83.97
	Pune	18.54	73.81

**Table S3. Availabilities for aerosol chemical compositions and aerosol optical depth (AOD) simulated by each participating model.**

Model Index	BC	OC	$\text{SO}_4^{2-}$	$\text{NO}_3^-$	$\text{NH}_4^+$	$\text{PM}_{2.5}$	$\text{PM}_{10}$	AOD
M1	Y	Y	Y	Y	Y	Y	Y	Y
M2	Y	Y	Y	Y	Y	Y	Y	Y
M3	Y	Y	Y	Y	Y	Y	Y	Y
M4	Y	Y	Y	Y	Y	Y	Y	Y
M5	Y	Y	Y	Y	Y	Y	Y	—
M6	Y	Y	Y	Y	Y	Y	Y	—
M7	Y	—	Y	Y	Y	Y	Y	Y
M8	Y	Y	Y	Y	Y	Y	Y	—
M9	—	—	Y	Y	Y	Y	Y	Y
M10	—	—	—	—	—	—	—	—
M11	Y	Y	Y	Y	Y	Y	Y	Y
M12	Y	Y	Y	Y	Y	Y	Y	Y
M13	Y	Y	Y	Y	Y	Y	—	Y
M14	Y	Y	Y	Y	Y	Y	Y	Y

“Y” means that the composition is available and analyzed in this manuscript.

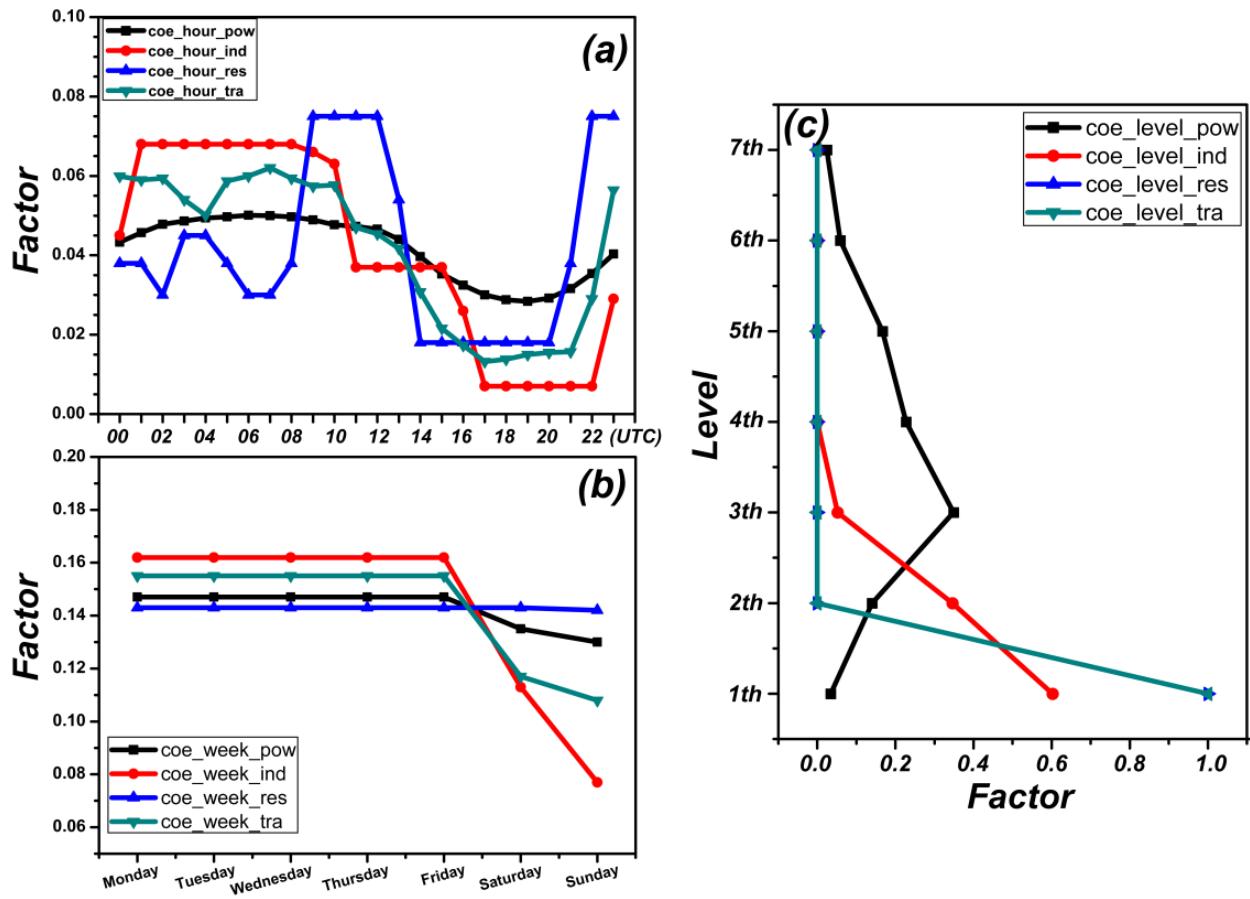


Figure S1. (a) Diurnal and (b) weekly variations in the MIX anthropogenic emission factors for the power, industry, residential, and transportation sectors. (c) The vertical profiles of the emission factors for the first seven levels.

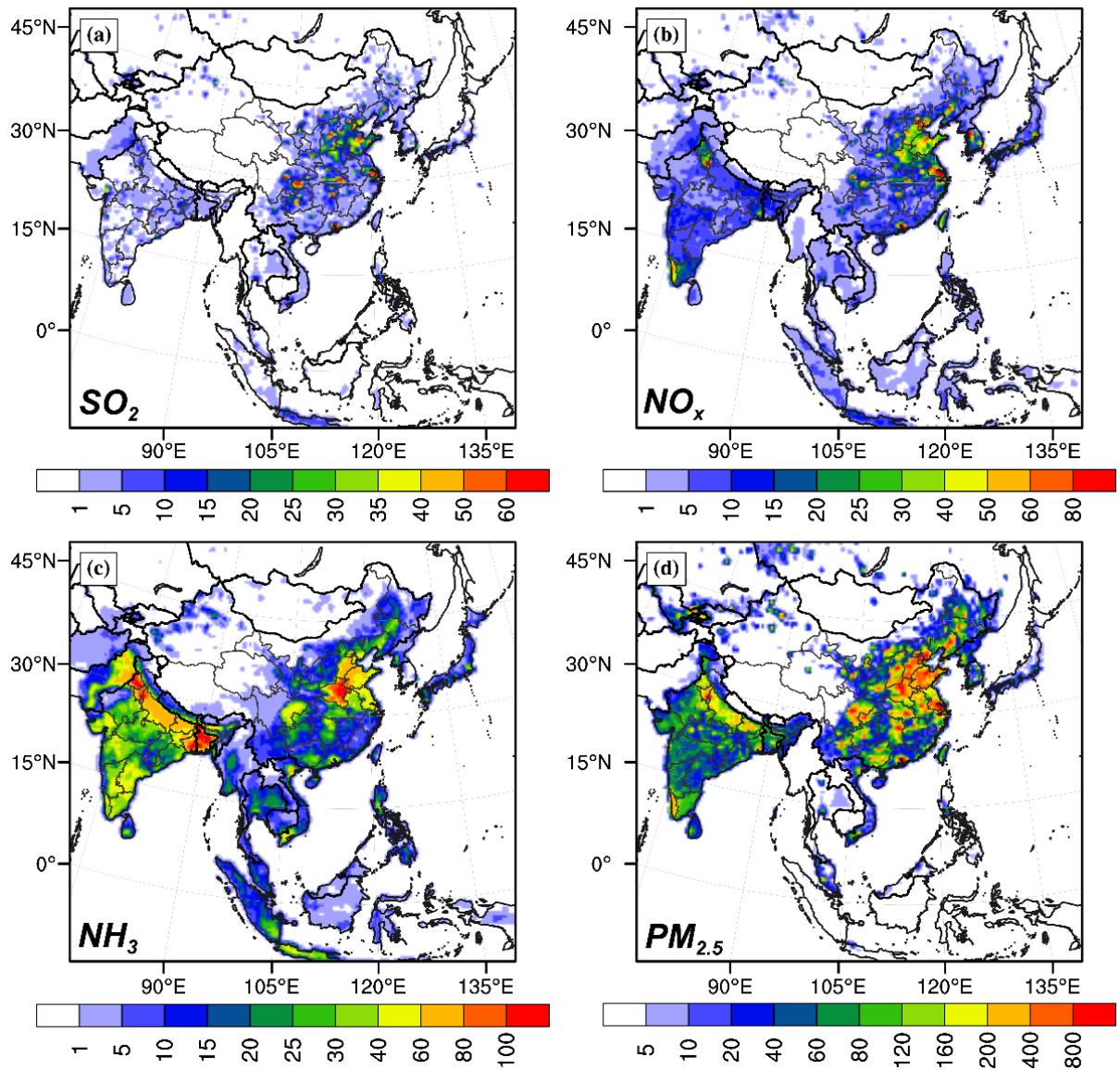
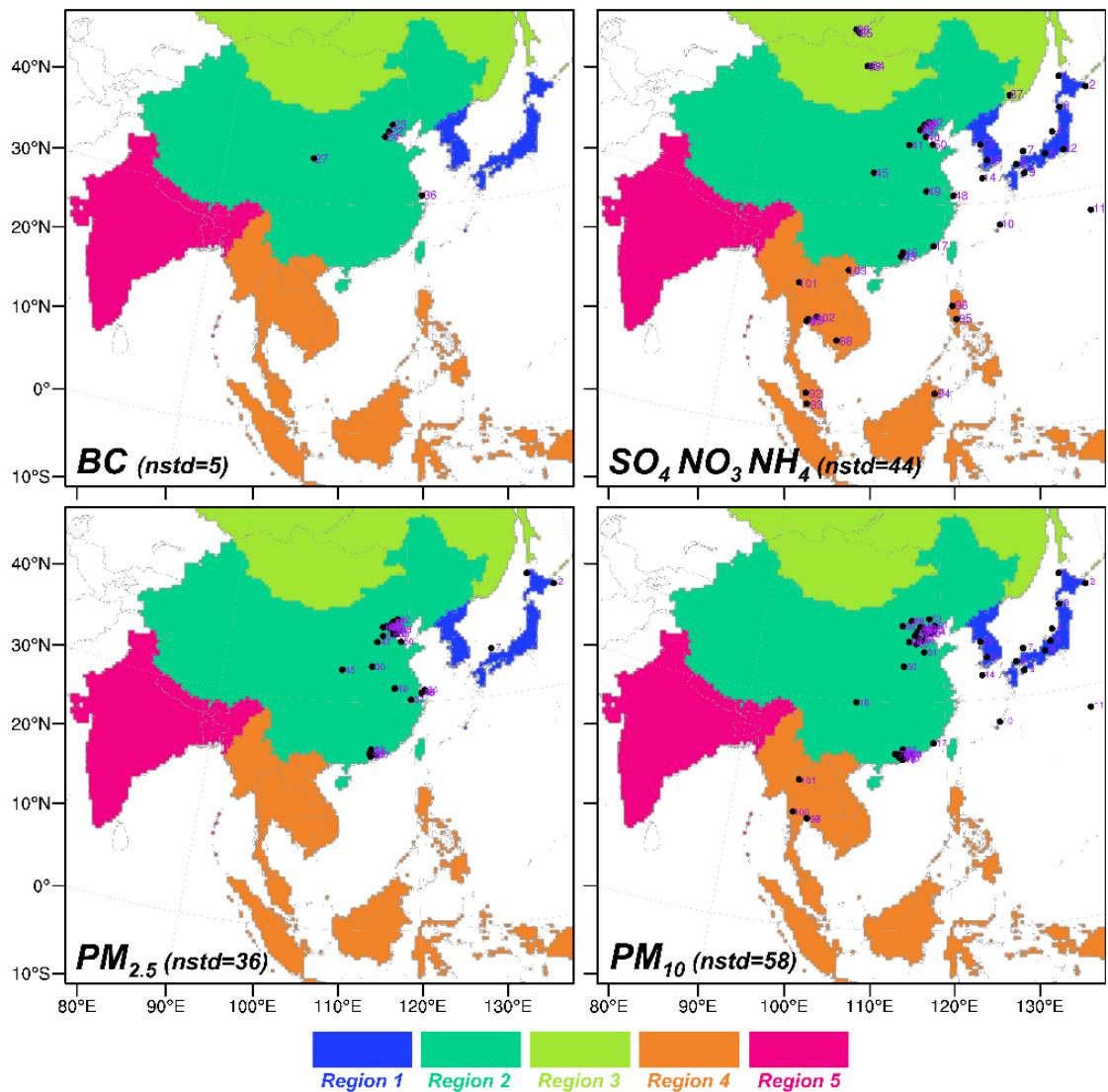


Figure S2. The merged emissions of (a)  $SO_2$ , (b)  $NO_x$ , (c)  $NH_3$  and (d)  $PM_{2.5}$  in 2010 from MIX (anthropogenic emission), MEGAN (biogenic emission), GFED (biomass burning emission), air and ship emission, and volcanic emission. The unit for gas is

5 Mmol/month/grid, and the unit for particulate is Mg/month/grid.



**Figure S3.** Geographical locations of observation sites for each species. The index number of each station, and five defined sub-regions are also shown in each panel.

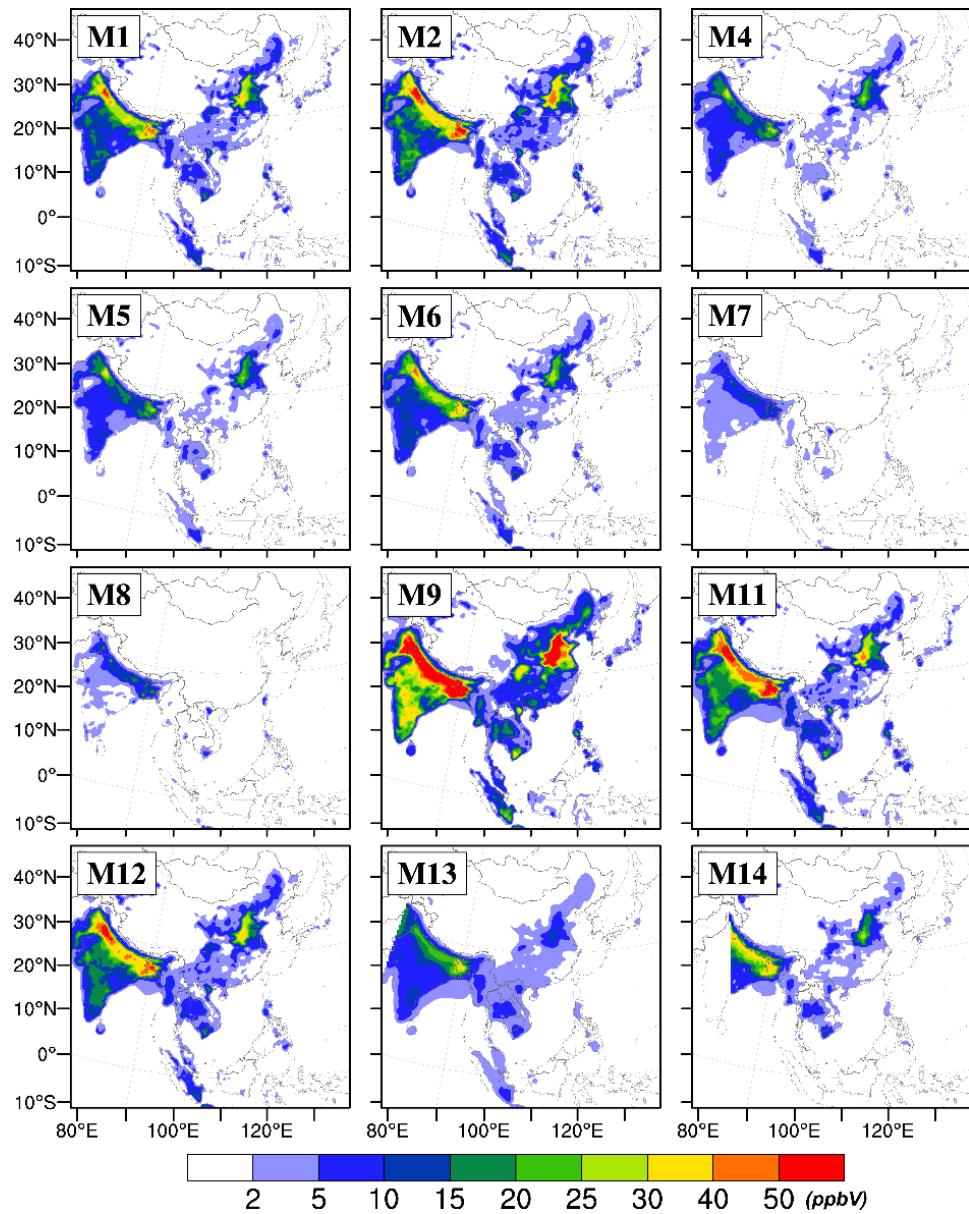
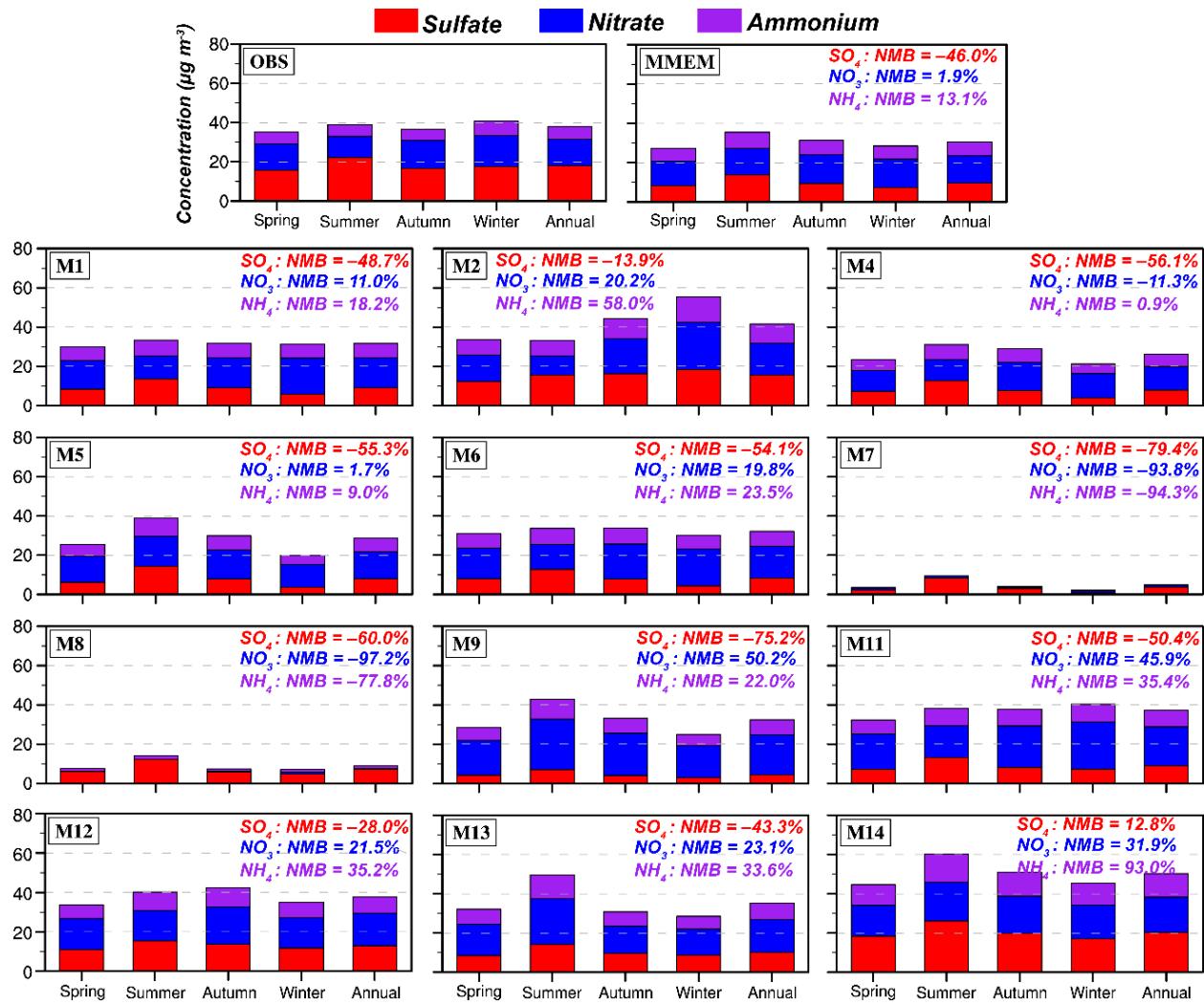


Figure S4. Spatial distributions of simulated  $\text{NH}_3$  concentrations from each participant model.



**Figure S5. Observed and simulated seasonal mean concentrations of  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  for Region\_2. Normalized mean biases (NMBs) of  $\text{SO}_4^{2-}$ ,  $\text{NO}_3^-$ , and  $\text{NH}_4^+$  for the ensemble model and each participant model are also shown. In this figure, the seasonal mean observations are collected from published literatures.**

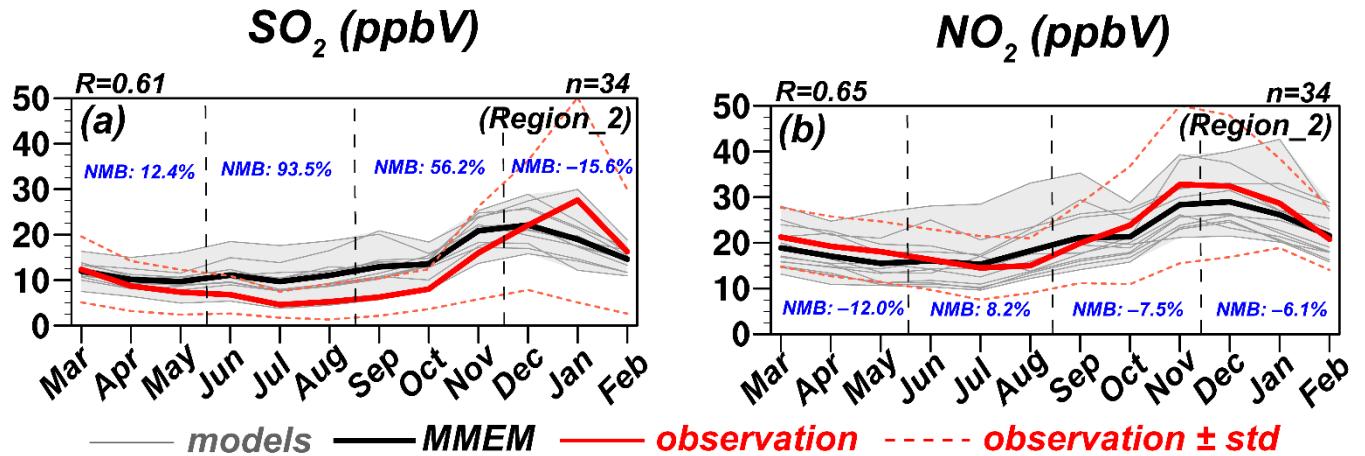


Figure S6. The same as Fig. 4, but for (a)  $SO_2$  and (b)  $NO_2$  for Region\_2. In this picture, the observed monthly mean values are taken from EANET and CNEMC.

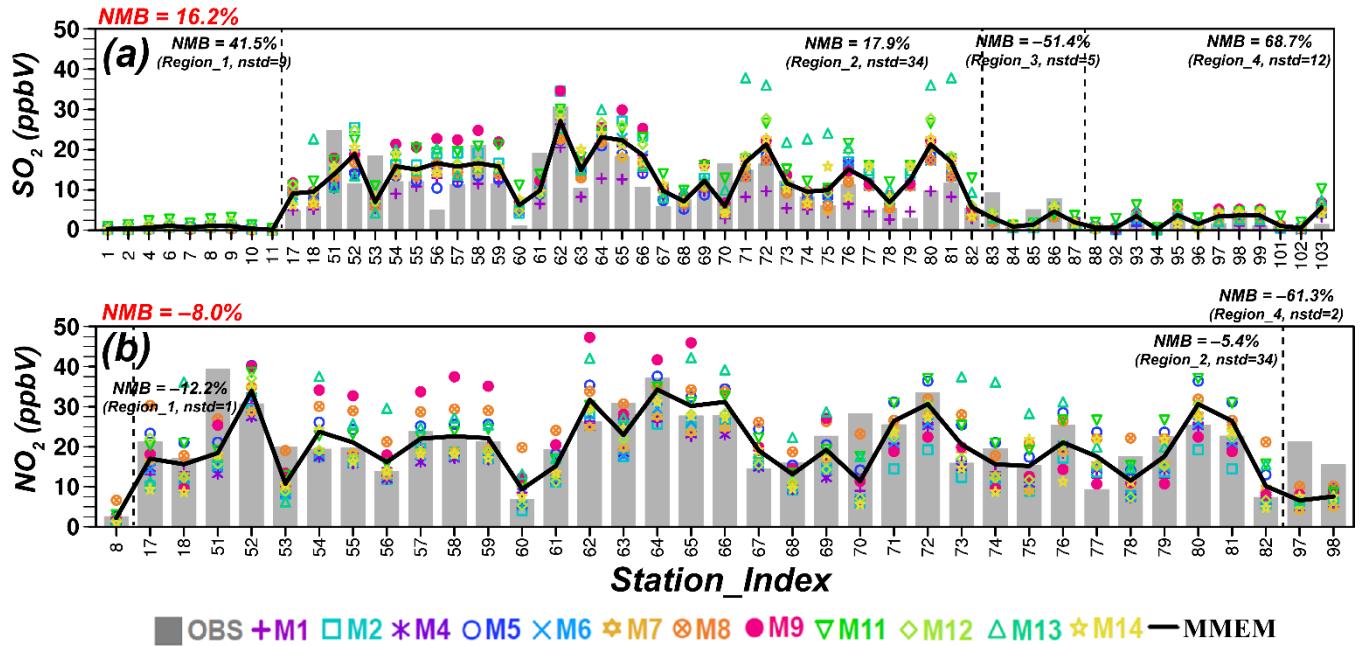
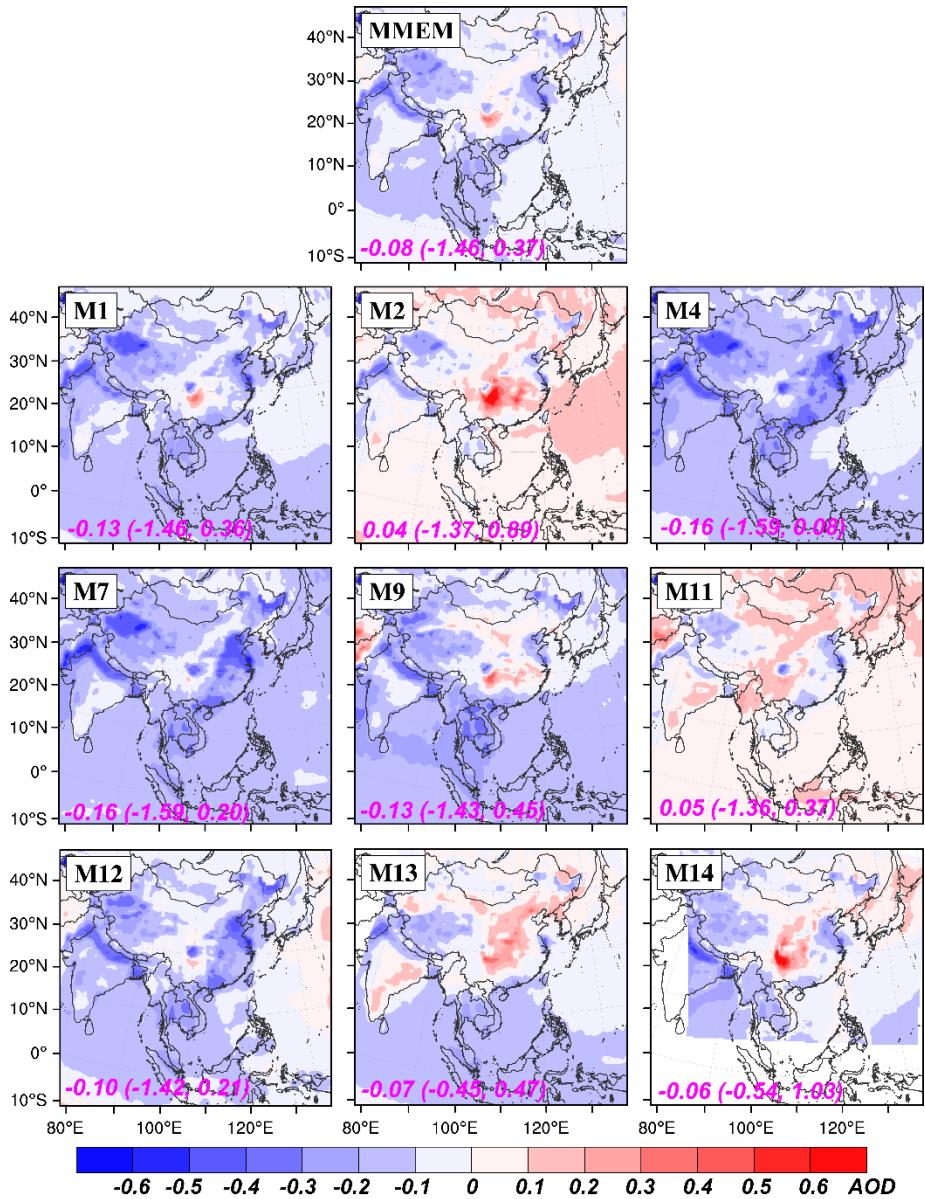
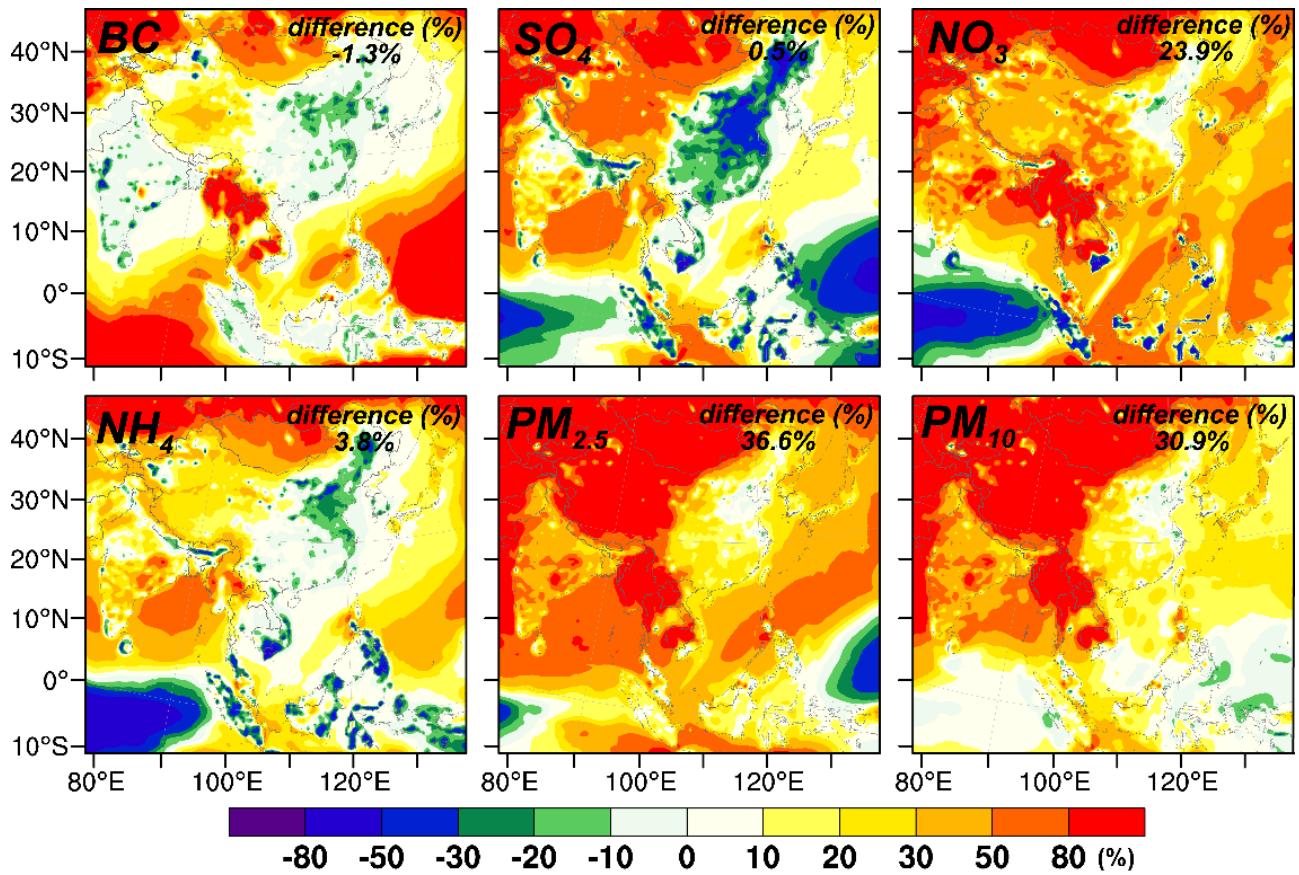


Figure S7. The same as Fig. 3, but for (a)  $\text{SO}_2$  and (b)  $\text{NO}_2$ . In this picture, the observed annual mean values are from EANET and CNEMC.



**Figure S8.** Spatial distributions of the differences between simulated and MODIS aerosol optical depth (AOD) (model minus MODIS). The mean bias (the minimum bias, the maximum bias) are also listed in the bottom left corner of each panel.



**Figure S9.** Spatial distributions of the differences in simulated BC, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, NH<sub>4</sub><sup>+</sup>, PM<sub>2.5</sub> and PM<sub>10</sub> between M1 and M2. The percentage difference is calculated by  $(M1 - M2)/M2 \times 100\%$ .

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