Supplemental Material

Application of an Online-Coupled Regional Climate Model, WRF-CAM5, over East Asia for Examination of Ice Nucleation Schemes: Part I. Comprehensive Model Evaluation and Trend Analysis for 2006 and 2011

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Table S1. Performance statistics for meteorological predictions for 2011 WRF-CAM5 baseline simulation with M92.

Variable	Data Source	Number	Mean Obs.	Sim.	Mean Sim.	*R*	NMB (%)	NME (%)	MB	MAGE	RMSE	FB	FGE	IOA
P (mb)	NCDC	7296	942.0	M92	928.6	0.96	−1.5	2.5	−13.4	21.8	35.3	−0.02	0.03	1.0
T2 (℃)	NCDC	11193	13.5	M92	12.4	0.98	−8.0	14.9	−1.1	2.0	2.7	0.4	−0.2	1.0
Q2 (g kg^{-1})	NCDC	7293	8.0	M92	8.0	0.98	0.7	9.6	0.1	0.8	1.1	0.03	0.1	1.0
WS10 (m s^{-1})	NCDC	8229	3.0	M92	3.4	0.54	12.3	32.7	0.4	1.0	1.3	0.1	0.3	0.7
Precip	NCDC	10815	2.6	M92	2.9	0.69	11.1	61.5	0.3	1.6	3.2	−	−	0.8
(mm day^{-1})	GPCP	13398	3.1	M92	3.2	0.76	2.5	34.2	0.1	1.1	1.5	−0.03	0.4	0.9
CCN (cm^{-2})		4917	0.8	M92	0.5	0.72	−32.2	48.5	−0.2	0.4	0.8	−0.1	0.4	
CDNC (cm^{-3})		9111	140.3	M92	97.6	0.64	−30.4	36.6	−42.6	51.3	63.5	−0.5	0.5	
CF		13398	0.6	M92	0.6	0.83	−5.7	14.1	0.0	0.1	0.1	−0.1	0.2	
PWV (cm)	MODIS	13398	2.1	M92	2.2	0.99	2.2	7.3	0.1	0.2	0.2	0.1	0.1	
CWP (g m^{-2})		13398	101.1	M92	50.7	0.83	−49.8	50.0	−50.4	50.6	55.2	−0.9	0.9	
IWP (g m^{-2})		13398	222.9	M92	9.6	−0.08	−95.7	95.7	−213.6	213.6	219.6	−1.8	1.8	
AOD		13070	0.3	M92	0.2	0.68	−45.2	47.8	−0.1	0.1	0.2	−0.6	0.7	
COT		13398	15.2	M92	8.5	0.84	−44.0	44.5	−6.7	6.7	7.4	−0.7	0.7	
GLW (W m^{-2})		13398	324.4	M92	315.2	0.99	−2.8	3.1	−9.2	9.9	12.7	−0.03	0.03	
SWD (W m^{-2})	CERES	13398	179.7	M92	202.6	0.90	12.7	12.9	22.9	23.2	26.1	0.1	0.1	
SWCF (W m^{-2})		13398	−54.0	M92	−45.6	0.90	−15.5	18.1	−8.4	9.8	12.4	−0.2	0.2	
LWCF (W m^{-2})		13398	28.8	M92	19.9	0.70	−30.9	31.1	−8.9	8.9	10.0	−0.4	0.4	

Number: number of observations; Sim: simulation; Obs: observation; NMB: normalized mean bias; NME: normalized mean error; MB: mean bias; MAGE: mean error; RMSE: root mean square error; FB: fractional bias; FGE: fractional gross error; IOA: index of agreement.

Table S2. Performance statistics for surface chemical concentrations and column mass abundance of gaseous species for 2011.

Variable	Data Source	Number	Mean Obs	Mean Mod	Corr	NMB	NME	MB	MAGE	RMSE	FB	FGE
CO ($\mu g\ m^{-3}$)	HK	8760	785.9	574.5	0.4	−26.9	36.0	−211.5	283.0	370.7	−0.3	0.4
CO (ppm)	TW	324	0.4	0.2	0.5	−41.1	43.3	−0.2	0.2	0.2	−0.5	0.5
	JP	1265	0.4	0.2	0.2	−55.4	56.0	−0.2	0.2	0.3	−0.7	0.7
	SK	792	0.4	0.2	0.3	−51.9	55.9	−0.2	0.2	0.3	−0.6	0.7
Col. CO (10^{18} molec. cm^{-2})	MOPPIT	13398	2.0	2.0	0.9	−1.8	7.7	0.0	0.2	0.2	0.0	0.1
NO ($\mu g\ m^{-3}$)	HK	8758	82.2	12.9	0.25	−82.1	83.5	−68.2	68.6	84.6	−1.49	1.50
NO (ppb)	TW	324	4.0	0.8	0.15	−79.6	81.9	−3.2	3.3	4.2	−1.3	1.3
	JP	2658	4.9	0.5	0.0	−89.0	91.8	−4.3	4.5	6.4	−1.4	1.5
NO_2 ($\mu g\ m^{-3}$)	CH	30	117.3	61.1	−0.4	−48.0	50.2	−56.3	58.9	69.0	−0.6	0.7
	HK	8759	67.8	58.7	0.4	−13.3	42.1	−9.0	28.5	37.0	−0.2	0.5
NO_2 (ppb)	TW	324	12.9	8.2	0.1	−36.4	51.4	−4.7	6.6	8.5	−0.4	0.6
	JP	2658	9.3	5.0	−0.1	−46.1	69.0	−4.3	6.4	8.0	−0.6	0.9
	SK	792	15.9	10.0	0.2	−37.2	59.3	−5.9	9.4	11.6	−0.4	0.8
Col. NO_2 (10^{15} molec. cm^{-2})	SCIAMACHY	13398	3.3	3.3	0.9	0.4	34.6	0.0	1.1	2.6	0.0	0.4
SO_2 ($\mu g\ m^{-3}$)	CH	2356	94.7	77.5	0.0	−18.2	63.3	−17.2	59.9	79.6	−0.4	0.7
	HK	8759	13.0	75.2	0.1	478.1	480.2	62.2	62.5	82.8	1.2	1.3
SO_2 (ppb)	TW	324	3.7	1.4	0.0	−62.2	74.0	−2.3	2.7	3.2	−1.0	1.1
	JP	2539	2.0	1.2	−0.1	−41.4	74.0	−0.8	1.5	2.0	−0.3	0.9
	SK	792	4.3	3.4	0.3	−21.6	50.4	−0.9	2.2	2.9	−0.2	0.6
Col. SO_2 (DU)	SCIAMACHY	13398	0.4	0.3	0.5	−14.5	78.1	−0.1	0.3	0.4	−0.6	0.9
Col. HCHO (10^{15} molec. cm^{-2})	SCIAMACHY	13398	6.1	6.0	0.83	−0.3	24.4	0.1	1.5	1.9	−0.1	0.29
O_3 ($\mu g\ m^{-3}$)	HK	8759	35.4	47.4	0.5	33.9	95.9	12.0	33.9	49.5	-0.2	1.0

Table S2. *Cont.*

Variable	Data Source	Number	Mean Obs	Mean Mod	Corr	NMB	NME	MB	MAGE	RMSE	FB	FGE
O_3 (ppb)	TW	324	31.3	36.5	0.6	16.6	25.3	5.2	7.9	9.6	0.2	0.2
	JP	2437	30.6	35.1	0.5	14.9	25.1	4.5	7.7	9.5	0.2	0.2
	SK	792	26.0	34.0	0.4	31.1	43.9	8.0	11.4	14.3	0.3	0.4
TOR (DU)	OMI	13398	31.1	33.5	0.9	7.9	8.7	2.5	2.7	3.3	0.1	0.1
$PM_{2.5}$ ($\mu g\ m^{-3}$)	HK	8759	35.2	65.3	0.2	85.5	109.8	30.1	38.6	63.4	0.4	0.6
	TW	324	30.4	15.4	0.4	−49.5	51.8	−15.1	15.8	20.1	−0.6	0.6
	CH	1032	89.5	86.2	0.2	−3.7	52.6	−3.3	47.1	60.2	−0.2	0.6
PM_{10} ($\mu g\ m^{-3}$)	HK	8759	51.0	67.0	0.2	31.3	72.9	16.0	37.2	59.2	0.1	0.6
	TW	324	52.2	19.5	0.4	−62.7	63.0	−32.7	32.9	39.3	−0.9	0.9
	JP	2676	18.8	12.2	0.1	−35.0	48.8	−6.6	9.2	11.2	−0.4	0.6
	SK	792	41.5	28.4	0.3	−31.7	45.0	−13.1	18.7	21.8	−0.4	0.6

Number: number of observations; Sim: simulation; Obs: observation; NMB: normalized mean bias; NME: normalized mean error; MB: mean bias; MAGE: mean error; RMSE: root mean square error; FB: fractional bias; FGE: fractional gross error; IOA: index of agreement.

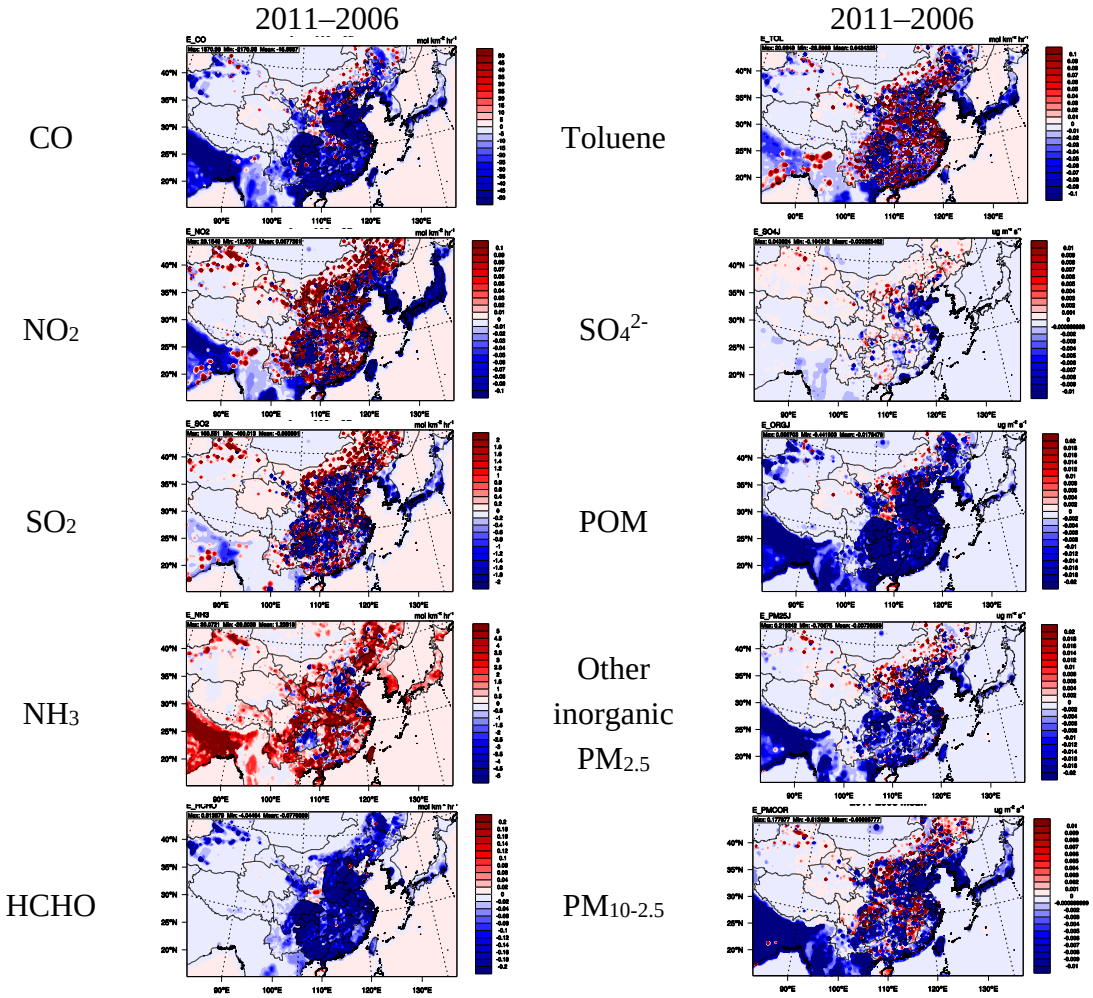

Figure S1. Spatial distributions of the differences in the emissions of gaseous and PM species between 2011 and 2006.