

Supplement of Atmos. Chem. Phys., 18, 2725–2747, 2018
<https://doi.org/10.5194/acp-18-2725-2018-supplement>
© Author(s) 2018. This work is distributed under
the Creative Commons Attribution 3.0 License.



Atmospheric
Chemistry
and Physics
Open Access
EGU

Supplement of

Integrated emission inventory and modeling to assess distribution of particulate matter mass and black carbon composition in Southeast Asia

Didin Agustian Permadi et al.

Correspondence to: Nguyen Thi Kim Oanh (kimoanh@ait.ac.th)

The copyright of individual parts of the supplement might differ from the CC BY 3.0 License.

Supplementary Information (SI)

Table S1. Definition of statistical measures used for WRF/CHIMERE output evaluation.

Parameters	Formula	Suggested criteria
Mean bias (MB) ¹	$MB = \frac{1}{N} \sum_{i=1}^N (M_i - O_i)$	WS : $\leq \pm 0.5 \text{ m s}^{-1}$ WD : $\leq \pm 10 \text{ deg}$ T : $\leq \pm 0.5 \text{ }^{\circ}\text{C}$ H : $\leq \pm 1 \text{ g kg}^{-1}$
Mean absolute gross error (MAGE) ¹	$MAGE = \frac{1}{N} \sum_{i=1}^N M_i - O_i $	WD : $\leq +30 \text{ deg}$ T : $\leq +2 \text{ }^{\circ}\text{C}$ H : $\leq +2 \text{ g kg}^{-1}$
Root mean squared error (RMSE) ¹	$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (M_i - O_i)^2}$	WS : $\leq +2 \text{ m s}^{-1}$
Mean fractional bias(MFB) ²	$MFB = \frac{2}{N} \sum_{i=1}^N \left[\frac{(M_i - O_i)}{(M_i + O_i)} \right] \cdot 100$	PM criteria : $\leq \pm 60 \text{ \%}$
Mean fractional error (MFE) ²	$MFE = \frac{2}{N} \sum_{i=1}^N \left[\frac{ M_i - O_i }{(M_i + O_i)} \right] \cdot 100$	PM criteria : $\leq +75 \text{ \%}$

Notes: Adapted from the compilation by Kim Oanh et al. (2012)

M-modeled value (model outputs for the first layer in different grids); O-observations; N-number of observations; WS-Wind Speed; WD-Wind Direction; T-Temperature; H- Relative Humidity.

Sources: ¹Emery et al. (2001), ²Boylan and Russell (2006).

Table S2. Summary of ground observations used for model evaluation.

No	Data sources	Data type	Information		
			Name	longitude	latitude
Meteorological parameters					
1	Olongapo-Philippines	TMP, RH, DIR, SPD	RPLB-98426	14.8	120.3
2	Davao-Philippines	TMP, RH, DIR, SPD	RPMD-98753	7.1	125.6
3	Don Muang-Thailand	TMP, RH, DIR, SPD	VTBD-48456	13.9	100.6
4	Trat-Thailand	TMP, RH, DIR, SPD	VTBO-48500	12.3	102.3
5	Pnom Penh-Cambodia	TMP, RH, DIR, SPD	VDPP-48991	11.5	104.8
6	Jakarta-Indonesia	TMP, RH, DIR, SPD	WIII-96749	6.1	106.7
7	Kuala Lumpur-Malaysia	TMP, RH, DIR, SPD	WMKK-48647	3.1	101.5
8	Sarawak-Malaysia	TMP, RH, DIR, SPD	WBKK-96471	5.9	116.0
Ground measurement of aerosols					
1	AIRPET project	Daily (24h) average of PM ₁₀ , PM _{2.5} , BC, and OC ambient concentrations	<ul style="list-style-type: none"> AIT, Thailand (sub-urban) Tegallega (TL), Indonesia (mix urban) Manila (MO), Philippines observatory (mix urban) Thuong Dinh (TD), Vietnam (mix urban) 	100.6 107.6 121.1 105.8	14.1 -6.9 14.6 20.9
2	APN project	Hourly EC/BC and OC	AIT, Thailand (sub-urban)	100.6	14.1
4	Urban air quality monitoring network in Bangkok, Thailand	Hourly PM ₁₀	Klongjun (10T), Thailand (mix urban) Huaykwang (11T), Thailand (mix urban)	100.5 100.6	13.8 13.9
5	Urban air quality monitoring network in Kuala Lumpur, Malaysia	Hourly PM ₁₀	<ul style="list-style-type: none"> Petaling Jaya, Malaysia (Urban) Jerantut, Malaysia(remote) 	101.6 101.7	3.1 3.1
6	City air quality monitoring network in Surabaya, Indonesia	Hourly PM ₁₀	Taman Prestasi (SUF1) Indonesia (mix urban)	112.7	-7.3
Ground measurement of AOD					
1	AERONET Thailand	AOD level 2	Phimai	102.6	15.2
2	AERONET Singapore	AOD level 2	Singapore	103.8	1.3
3	AERONET Vietnam	AOD level 2	Bac Giang	106.2	21.3
4	AERONET Vietnam	AOD level 2	Bac Lieu	105.7	9.3
5	AERONET Taiwan	AOD level 2	Chen Kung	120.2	23.0
6	AERONET Hong Kong	AOD level 2	Hok Sui	114.3	22.2
7	AERONET Thailand	AOD level 2	Mukdahan	104.7	16.6
8	AERONET Indonesia	AOD level 2	Puspitek Serpong	106.6	6.3
9	AERONET Thailand	AOD level 2	Silpakorn University	100.0	13.8
10	AERONET Thailand	AOD level 2	Songkhla Met Station	100.6	7.2

Table S3. Summary of simulated domain maximum ground-level concentrations PM₁₀, PM_{2.5} and BC for different periods.

Pollutants	Averaging period ^a	Month, 2007											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
PM ₁₀ ($\mu\text{g m}^{-3}$)	Max hourly	325	267	157	327	242	253	261	245	240	259	164	162
	Max monthly avg	69	89	65	127	62	48	72	58	69	86	44	30
	Max annual avg								50				
PM _{2.5} ($\mu\text{g m}^{-3}$)	Max hourly	188	154	157	189	143	147	147	150	139	150	99	98
	Max annual avg	40	55	49	82	47	27	44	37	45	53	27	19
	Annual average								32				
BC ($\mu\text{g m}^{-3}$)	Max hourly	39	31	28	38	30	31	33	32	30	32	23	20
	Max monthly avg	8.2	10.1	21.1	15.8	7.1	6.1	9.3	7.8	8.7	10.9	5.9	2.1
	Max annual avg								6				

Note: ^a One maximum value simulated in the whole modeling domain for the considered period.



Figure S1. Modeling domains of WRF and CHIMERE.

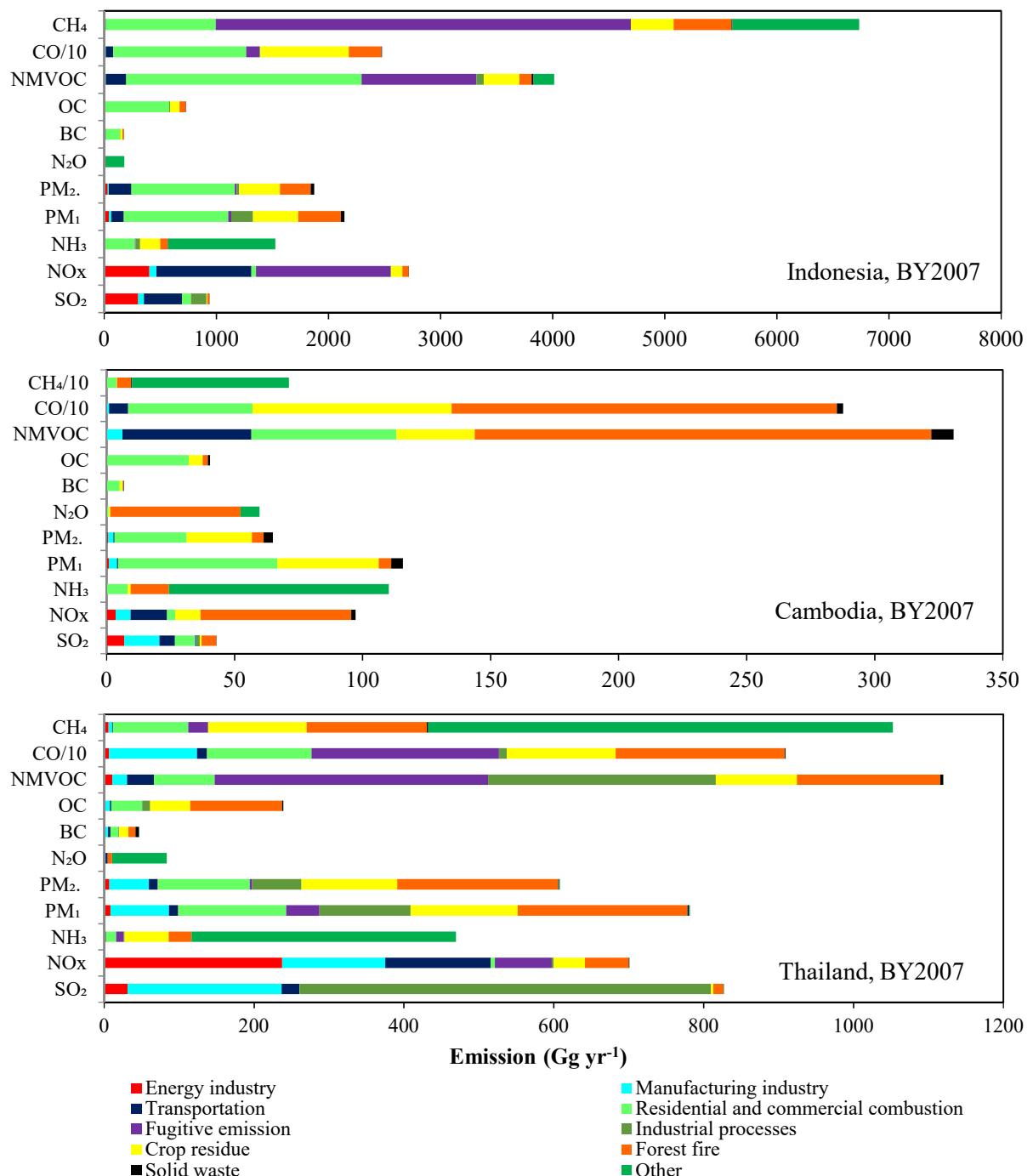


Figure S2. Total emission and shares for Indonesia, Cambodia and Thailand for base year of 2007.

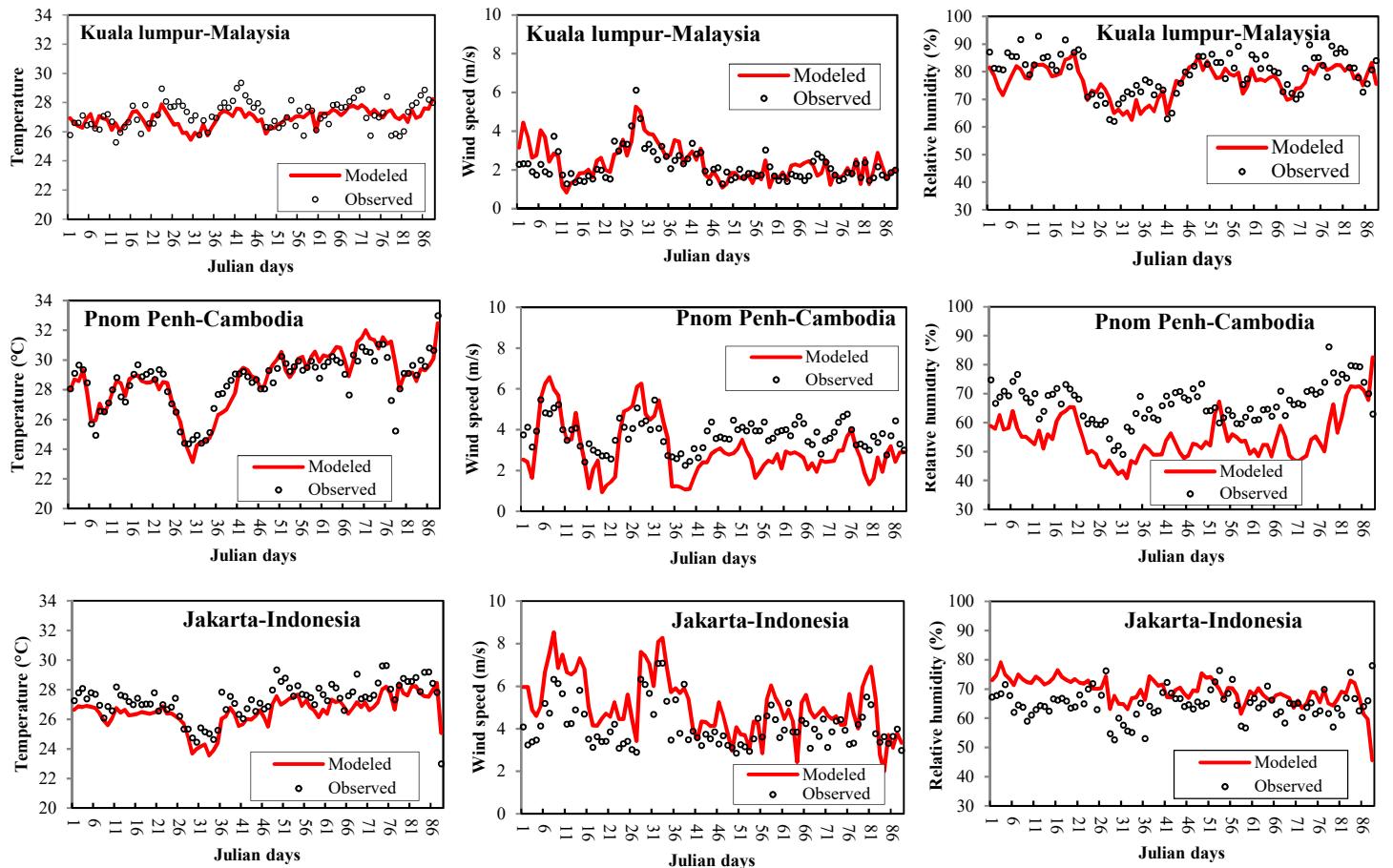


Figure S3a. Time series of daily average modeled (WRF) vs. observed relative humidity, temperature and wind speed at three WMO stations in Kuala Lumpur (Malaysia), Phnom Penh (Cambodia), and Jakarta (Indonesia) for period of January – March 2007.

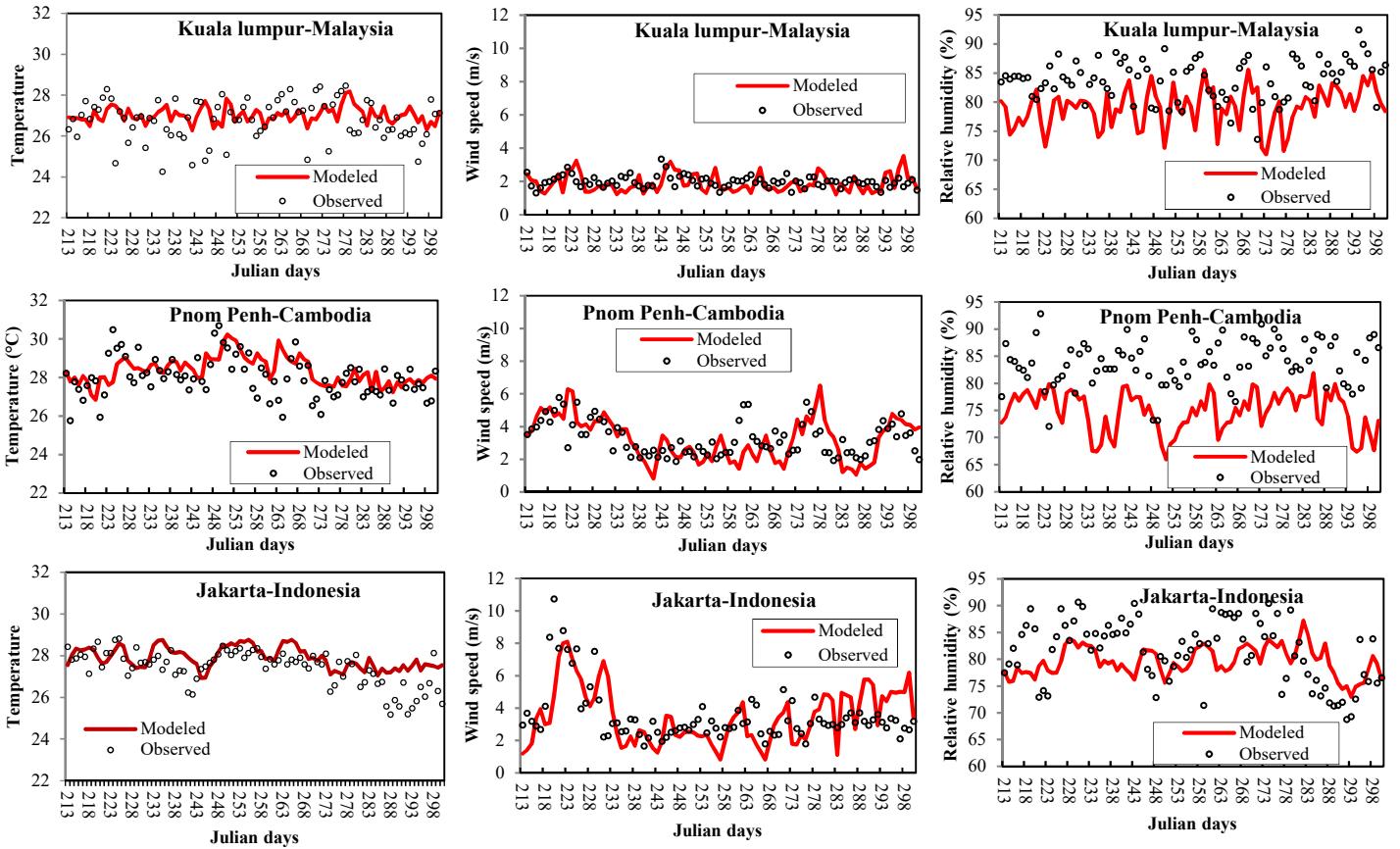


Figure S3b. Time series of daily average modeled (WRF) vs. observed relative humidity, temperature and wind speed at three WMO stations in Kuala Lumpur (Malaysia), Phnom Penh (Cambodia), and Jakarta (Indonesia) for period of August – October 2007.

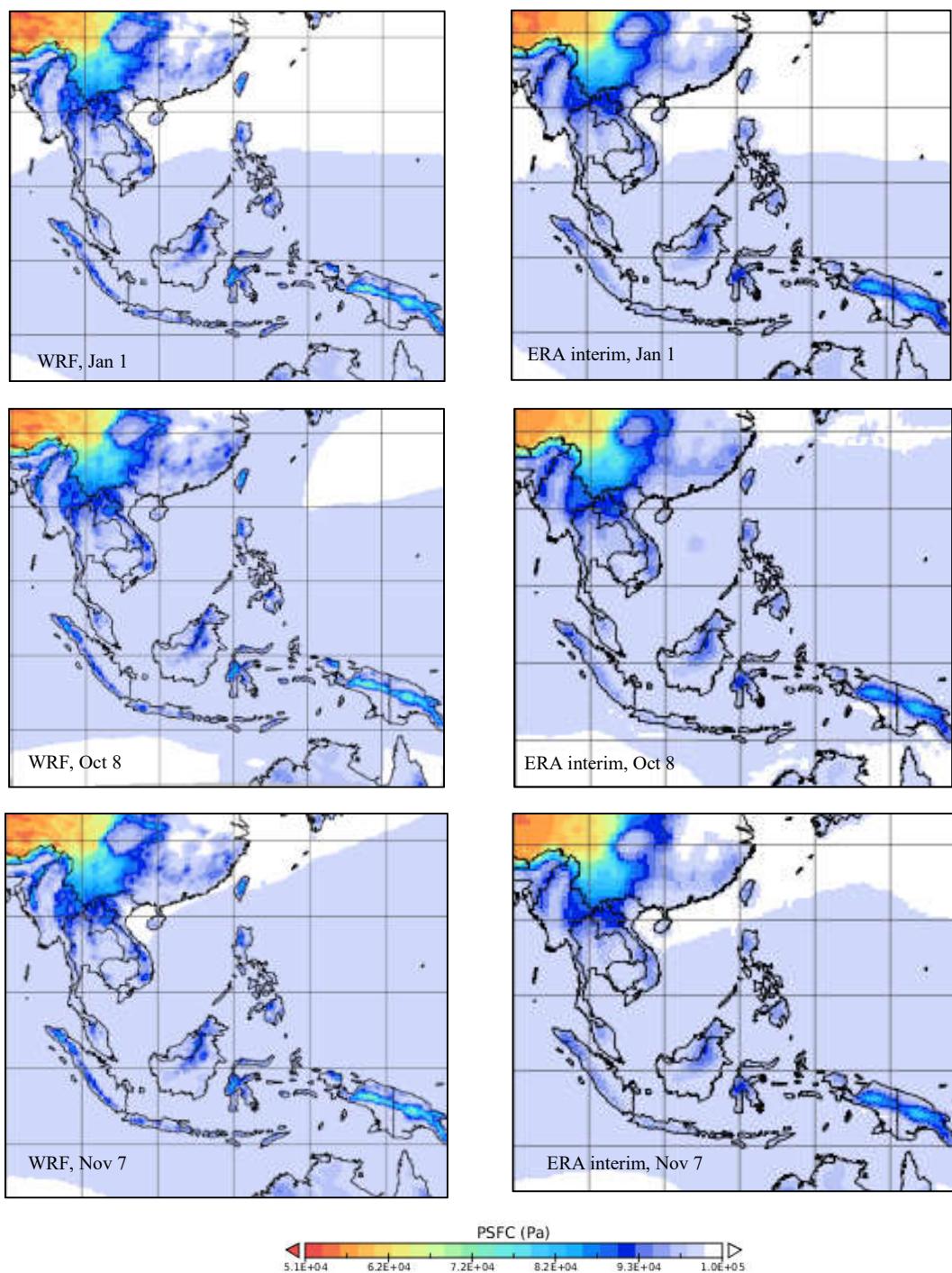


Figure S4. Comparison of modeled surface pressure and ERA interim reanalysis data for the selected days in 2007 at 00:00 UTC.

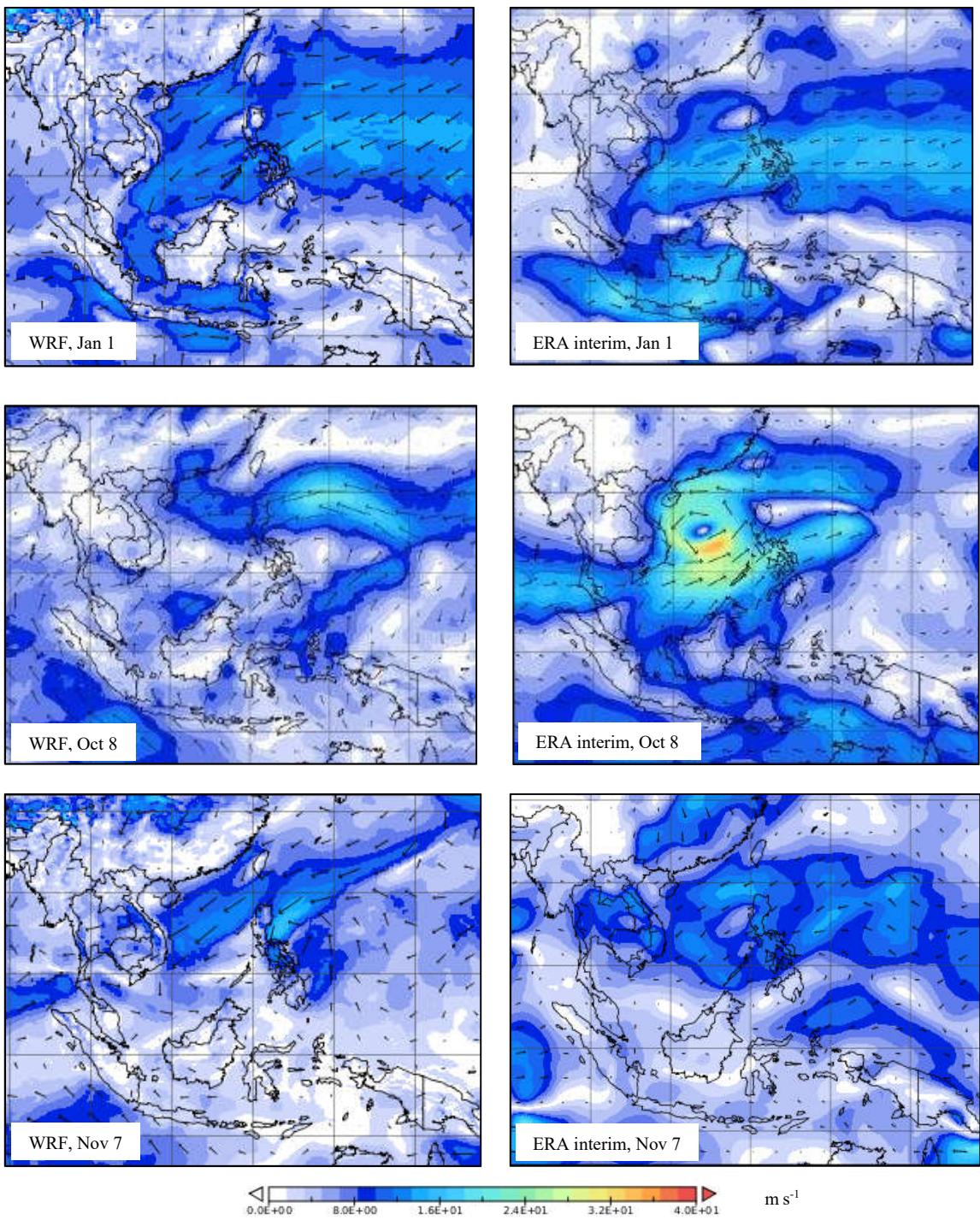


Figure S5. Comparison of modeled and ERA upper wind fields at 850 hPa on the selected days in 2007 at 00:00 UTC.

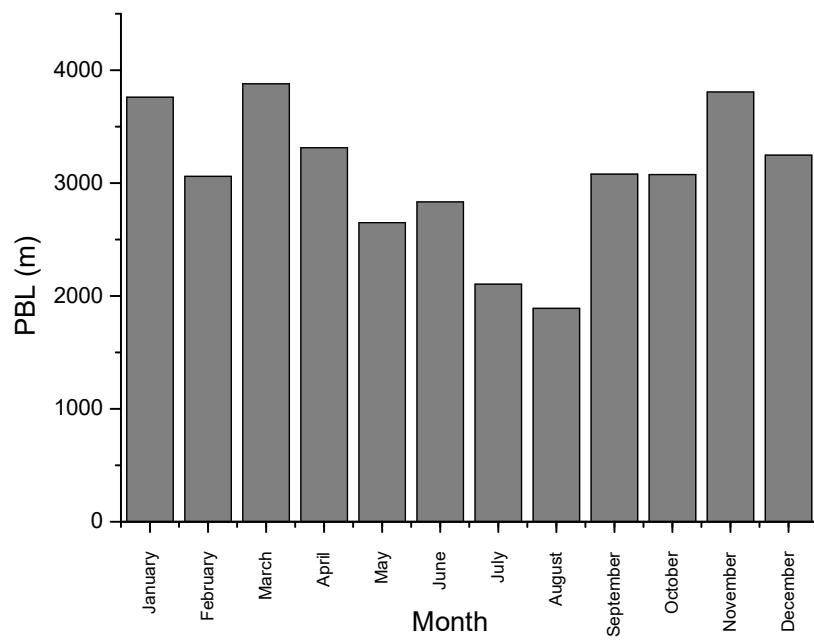


Figure S6. Domain maximum hourly values of simulated PBL for the different months.

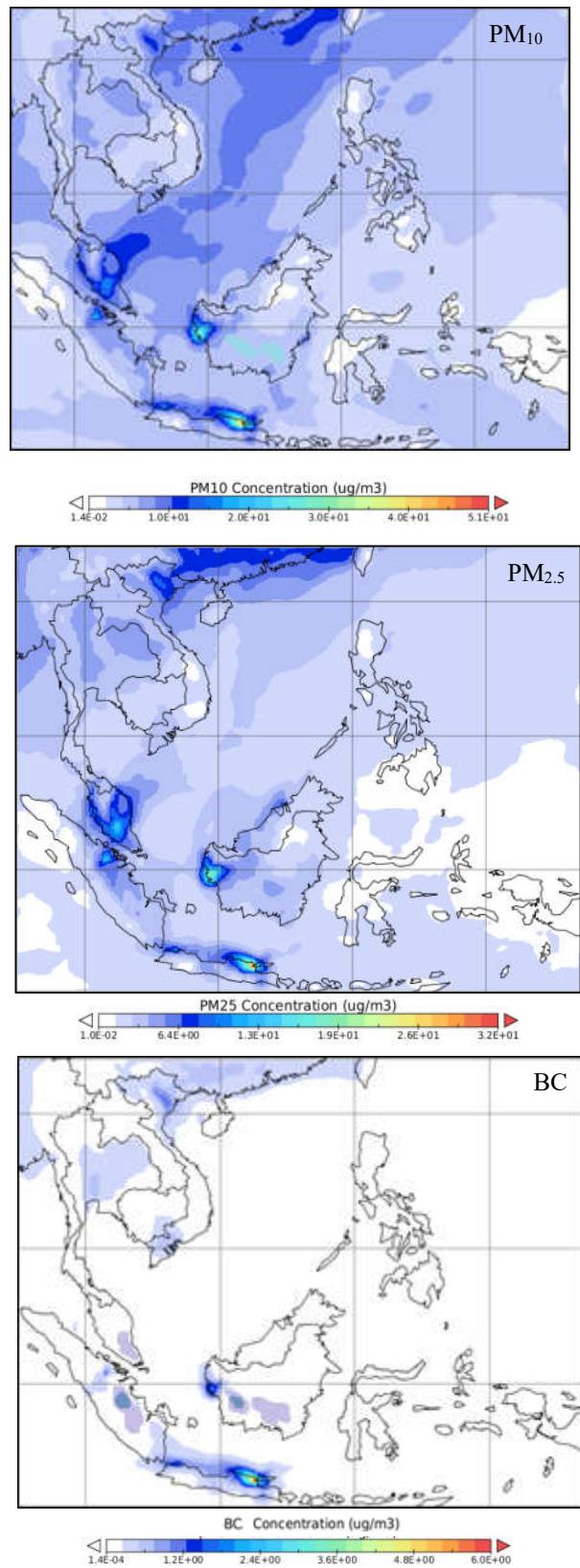


Figure S7. Simulated annual average of PM₁₀, PM_{2.5} and BC concentrations of 2007 over the domain.

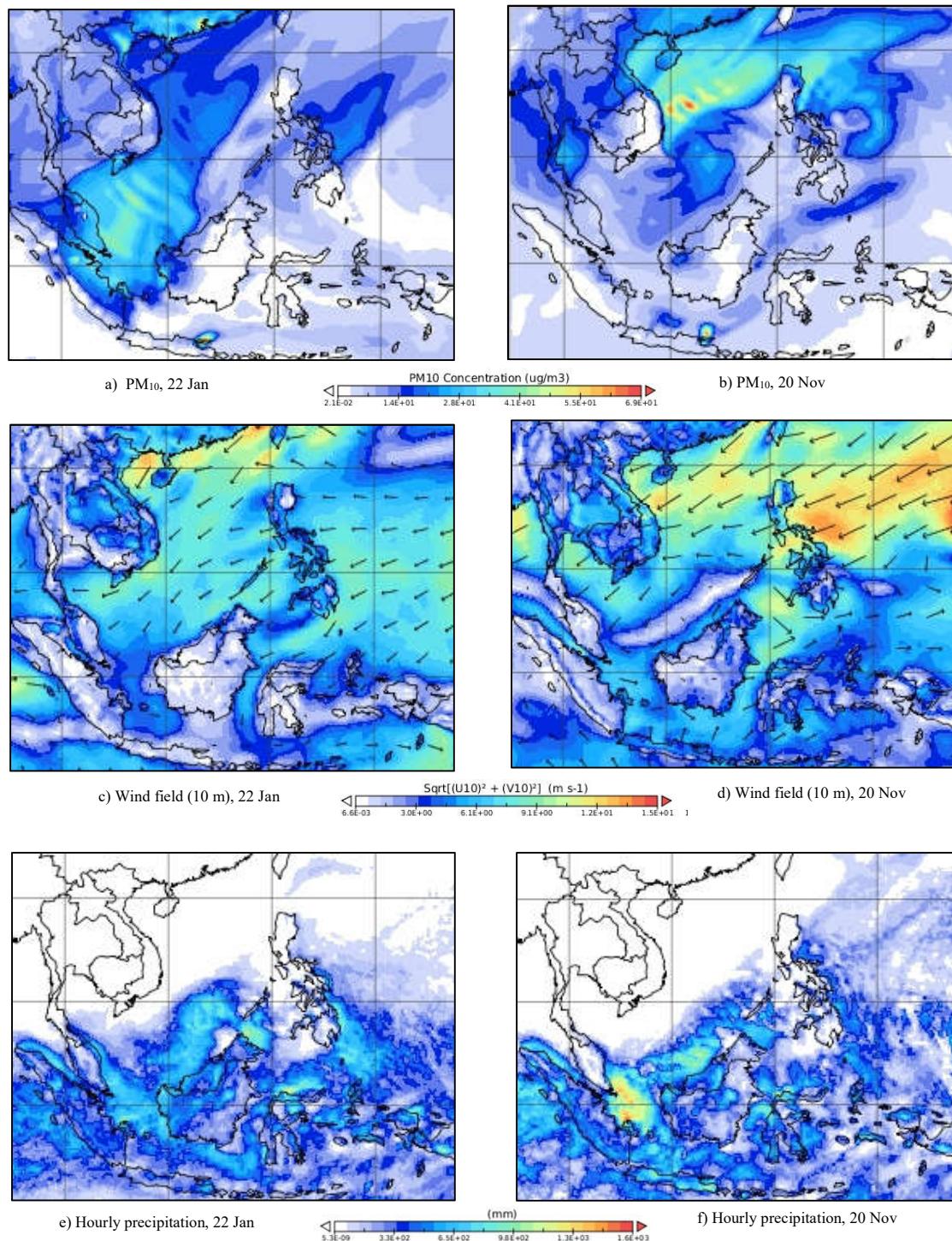


Figure S8. Typical simulated maximum hourly PM₁₀ concentration and wind field at 10 m in 22 January and 20 November, 00:00 UTC.

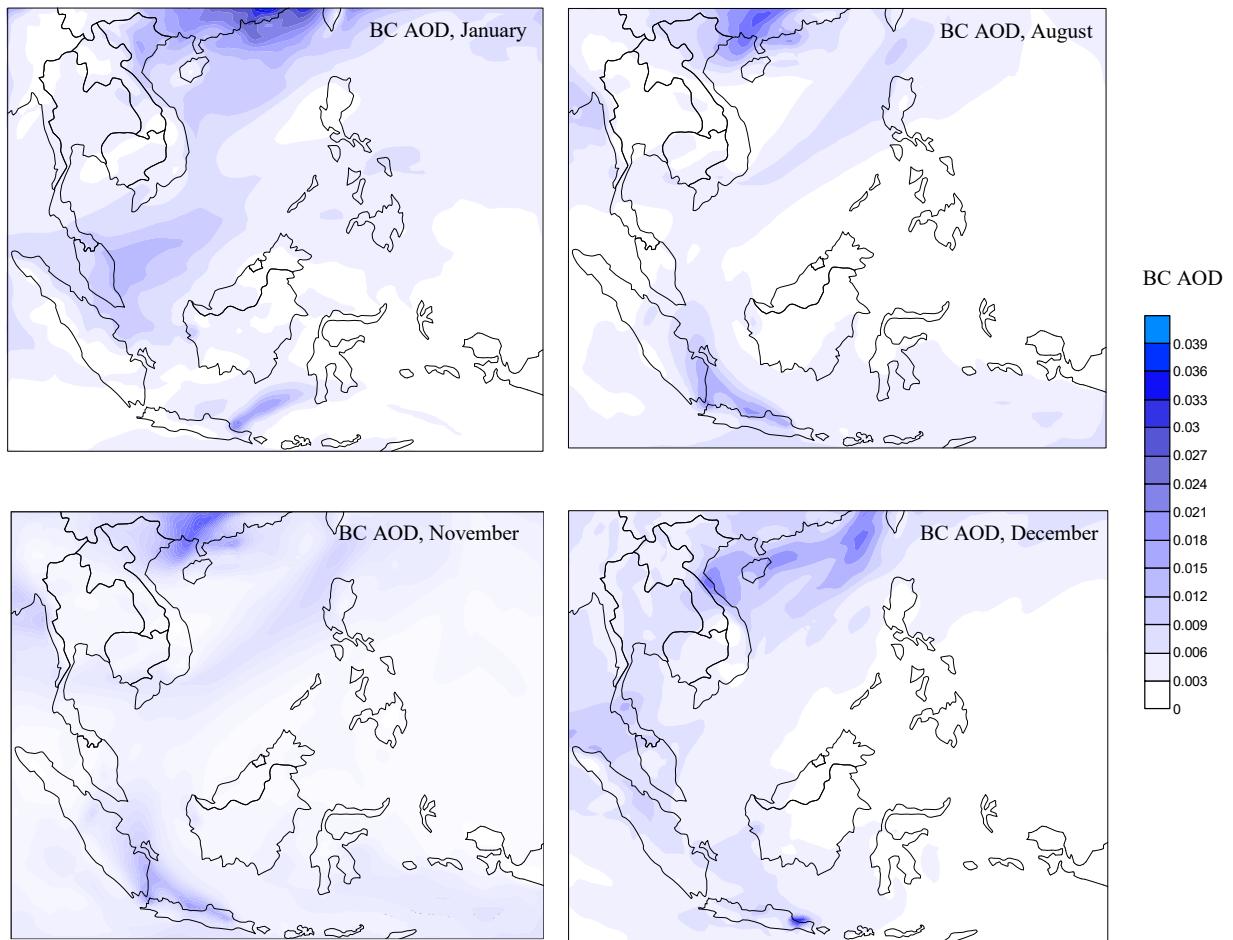


Figure S9. Monthly average of simulated BC AOD for the selected months.