



Supplement of

Study on the impact of three Asian industrial regions on $PM_{2.5}$ in Taiwan and the process analysis during transport

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Supplement S1 WRF and CMAQ model configurations

WRF ersion 3.9.1	Settings
Planetary boundary layer	MRF scheme
Surface and land surface model	Pleim-Xiu
Longwave radiation	RRTM scheme
Shortwave radiation	Goddard short wave scheme
Microphysics	Goddard for domain 1, 2, 3, Lin et al. scheme for domain 4
Cumulus	Kain-Fritsch scheme for domain 1, 2, 3.
CMAQ version 5.2.1	
Gas-phase chemistry	CB05
aerosol mechanism	AE6 (with aqueous chemistry)



Supplement S3. Formulas for statistical evaluation indexes

1. Mean Bias

$$MB = \frac{1}{N} \sum_{1}^{N} (Sim - Obs)$$

 $MAGE = \frac{1}{N} \sum_{1}^{N} |Sim - Obs|$

- 2. Mean Average Gross Error
- 3. Root Mean Square Error

4. Index of agreement, IOA

$$\text{RMSE} = \sqrt{\frac{1}{N} \sum_{1}^{N} (Sim - Obs)^2}$$

$$IOA = 1 - \frac{\sum_{i=1}^{N} (Sim - Obs)^2}{\sum_{i=1}^{N} (|Sim - \overline{Obs}| + |Obs - \overline{Obs}|)^2}$$

WNMB =
$$\frac{\sum_{i=1}^{N} (Sim - Obs)}{N \times 360^{\circ}} \times 100\%$$

WNME =
$$\frac{\sum_{i=1}^{N} |Sim - Obs|}{N \times 360^{\circ}} \times 100\%$$

$$MFB = \frac{2}{N} \sum_{1}^{N} \left(\frac{Sim - Obs}{Sim + Obs} \right)$$

$$MFE = \frac{2}{N} \sum_{1}^{N} \frac{Sim - Obs}{Sim + Obs}$$

$$R = \frac{1}{N} \sum_{i=1}^{N} \left[\frac{(Sim - \overline{Sim})(Obs - \overline{Obs})}{S_p S_o} \right]$$
$$S_P = \left[\frac{1}{N} \sum_{i=1}^{N} (Sim - \overline{Sim})^2 \right]^{\frac{1}{2}}$$
$$S_o = \left[\frac{1}{N} \sum_{i=1}^{N} (Obs - \overline{Obs})^2 \right]^{\frac{1}{2}}$$

- 5. Wind Normalized Mean Bias
- 3. Wind Normalized Mean Error
- 6. Mean Fractional Bias
- 7. Mean Fractional Error
- 8.Correlation coefficient (R)

Supplement S4 Supplementary figures



Date(LST) Figure S4.1: The observed (black dot) and modeled (red line) hourly temperature at eight representative sites for January 2017 (left) and July 2017 (right)



Date(LST) Date(LST) Figure S4.2: The observed (black line) and modeled (red line) hourly wind speed at eight representative sites for January 2017 (left) and July 2017 (right)



Figure S4.3: The observed (black line) and modeled (red line) hourly relative humidity at eight representative sites for January 2017 (left) and July 2017 (right)





Figure S4.4: The observed (upper) and modeled (lower) hourly wind direction at eight representative sites for January 2017 (left) and July 2017 (right)



Figure S4.5: The observed (black line) and simulated (red line) daily average PM_{2.5} at eight representative sites for January 2017 (left) and July 2017 (right)



Figure S4.6: The surface weather map on (a) 08:00 LST Jan 7th, (b) 08:00 LST Jan 8th, (c) 14:00 LST Jan 10th, and (d) 08:00 LST Jan 12th 2017



Figure S4.7: The 72 hour backward trajectory ensemble starts from (1) BQ, (2) ZM, and (3) CY stations and ends at 04:00 UTC (a) January 13, (b) January 9, (c) July 18, and (d) July 30, 2017



Figure S4.8: The daily average impact of PM_{2.5} from BRIR, YRDIR, PRDIR on air quality stations in Taiwan in July 2017. a, b, and c represent influence of BRIR, YRDIR, and PRDIR, respectively ; 1, 2, 3, 4, 5, 6, and 7 represent #1, #2, #3, #4, BQ, ZM, and CY, respectively. The impact was calculated with BFM method, i.e., the difference between the base and zero-out scenarios.



Figure S4.9: The daily contributions of individual processes averaged over the lower 20 layers to the concentrations of PM_{2.5} in July 2017, a, b, c, d, e, f, and g represent #1, #2, #3, #4, BQ, ZM, and CY, respectively ; 1, 2, 3, and 4 represent influence of total emissions, BRIR, YRDIR, and PRDIR, respectively



Figure S4.10: The surface weather map on (a)20:00 LT July 28th, (b) 20:00 LT July 29th, (c) 14:00 LT July 30th, and (d) 02:00 LT July 31st 2017



Figure S4.11: The hourly average contribution of physical process at each layer on July 18th 2017, a, b, c, d, e, f, and g represent #1, #2, #3, #4, BQ, ZM, and CY, respectively ; 1, 2, 3, and 4 represent influence of total emissions, BRIB, YRDIB, and PRDIB, respectively. The values in the brackets on Y-axis of left figures are the model heights of lower 20 layers.



Figure S4.12: The every 3 hour simulated wind vector and PM_{2.5} distribution on the event at (a) 00:00 LST, (b) 03:00 LST, (c) 06:00 LST, (d) 09:00 LST, (e) 12:00 LST, (f) 15:00 LST, (g) 18:00 LST, (h) 21:00 LST, (i) 24:00 LST July 30 2017.



Figure S4.13: The hourly average contribution of physical process at each layer on July 30th 2017, a, b, c, d, e, f, and g represent #1, #2, #3, #4, BQ, ZM, and CY, respectively ; 1, 2, 3, and 4 represent influence of total emissions, BRIB, YRDIB, and PRDIB, respectively. The values in the brackets on Y-axis of left figures are the model heights of lower 20 layers.



Figure S4.14: The comparison of simulation (SIM) and observation (OBS) of PM_{2.5} compositions at #1-#4 and BQ, ZM, and CY on July 18th and 19th 2017