Impact of dust emission on particulate matter in spring of 2018 in China

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Abstract

The Tarim Basin and the Hexi Corridor in western China are two major sources of dust emissions (Dong et al., *ACP*, 2016). Due to the prevailing westerly winds in the winter and spring, the contribution of particulate matter concentration from dust emissions in western China will affect eastern China after regional transmission. This study selected a time period of smog in Beijing in the spring of 2018. Based on the CMAQ model, the contribution of dust emissions to $PM_{2.5}$ and PM_{10} concentrations in typical regions of China was estimated. In the dusty weather, the contribution of sand in western China to particulate matter cannot be ignored.

Method and parameters

- Model: WRF3.9.1, MEGAN2.10, CMAQv5.2.1, NCL6.4.0
- Input data: Tsinghua University anthropogenic emissions list (Emission data). NCEP dataset ds083.2, ds351.0 and ds461.0 (Metrological and observation data).

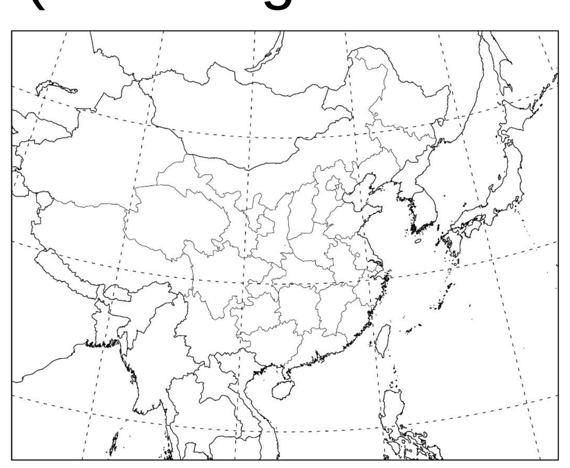

Figure 1. The modeling domain with cells 232 × 182

Model parameters and performance

Parameter	Setting	Parameter	Setting
microphysics	Morrison	land surface	Pleim-Xiu
longwave radiation	rrtmg	cumulus	Kain-Fritsch
shortwave radiation	rrtmg	boundary layer	ACM2
surface layer	Pleim-Xiu	aerosol chemistry	AERO6
gaseous chemistry	CB6	verticle layers	35 → 14

Variable		Unit	Result	Benchmark
Wind Speed	Mean OBS	m/s	2.80	
	Mean PRD	m/s	2.86	
	Bias	m/s	0.06	≤ ±0.5
	Gross Error	m/s	1.16	≤ 2
	RMSE	m/s	1.58	≤ 2
	Sys RMSE	m/s	0.94	
	Unsys RMSE	m/s	1.26	
	IOA		0.81	≥ 0.6
Wind Direction	Mean OBS	deg	218.65	
	Mean PRD	deg	177.37	
	Bias	deg	2.72	≤ ±10

Contribution of dust to PM

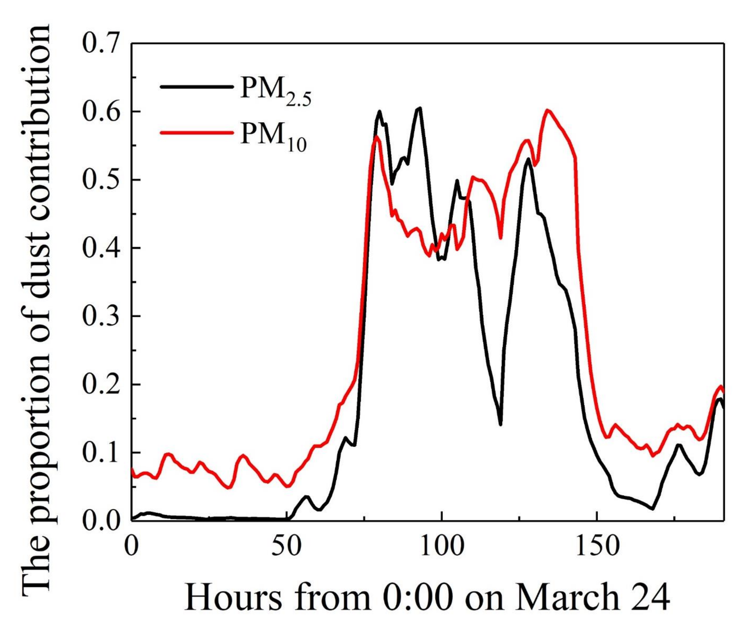

Figure 2. The proportion of dust-contributed PM from 24 to 31 in March 2018

- During the simulation period, the average contribution of dust to $PM_{2.5}$ and PM_{10} was 18.32% and 24.84%, respectively.
- Dust contributes more to coarse particles.
- The maximum contribution can reach 60%.

Comparison of simulation and observation

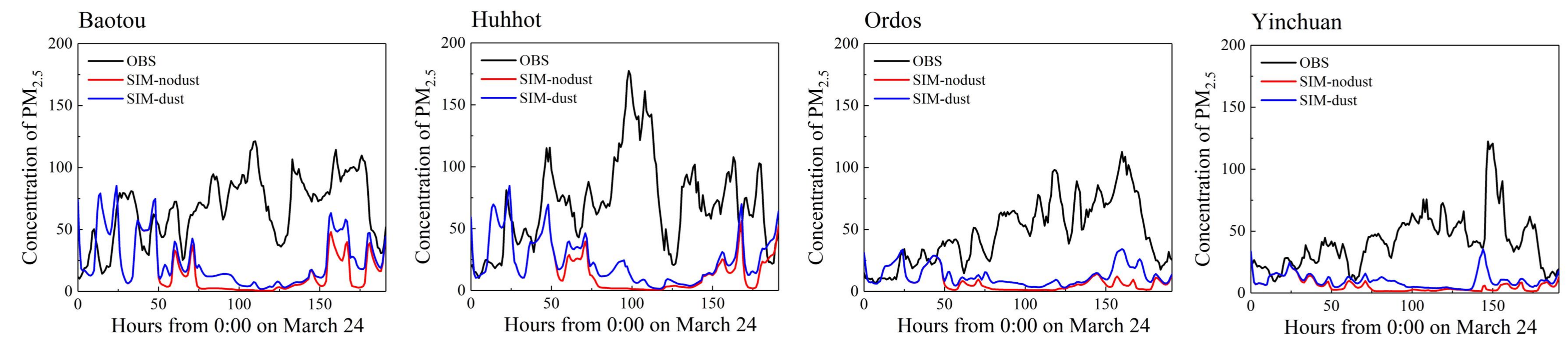

Figure 3. Comparison of simulated and observed concentrations of $PM_{2.5}$

- CMAQ has an underestimation of PM simulation. After considering dust, the underestimation of $PM_{2.5}$ and PM_{10} compared with observations can be reduced by 9.25% and 7.07%, respectively.

Distribution of dust-contributed PM_{10}

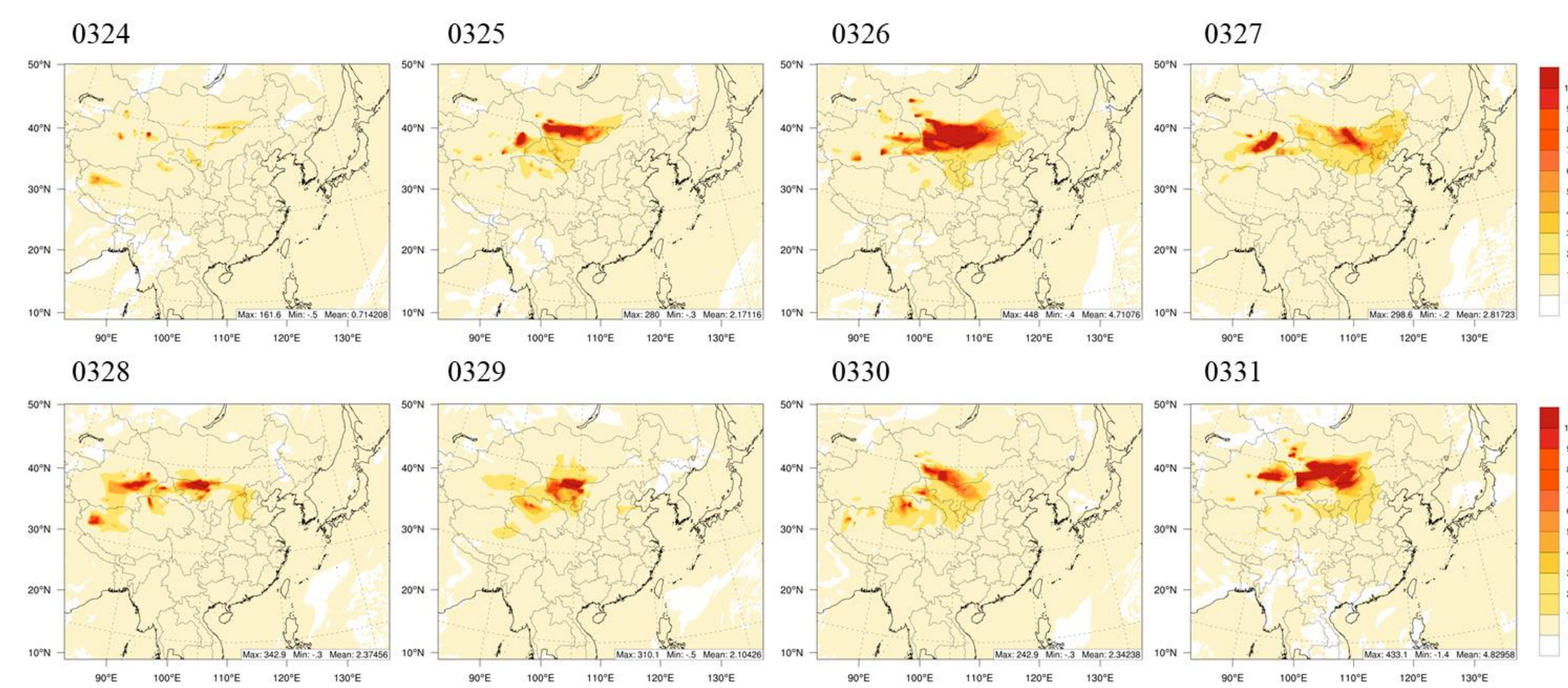

Figure 4. Dust contributed PM_{10} from 24 to 31 in March 2018

Conclusions

- In dusty weather, the contribution of dust to PM cannot be ignored.
- CMAQ can simulate the process of dust contributing to PM including transmission.
- CMAQ has an underestimation of PM simulation. After considering dust, the underestimation of $PM_{2.5}$ and PM_{10} compared with observations can be reduced by 9.25% and 7.07%, respectively.