Supplement of

Changes in source contributions of particulate matter during COVID-19 pandemic in the Yangtze River Delta, China

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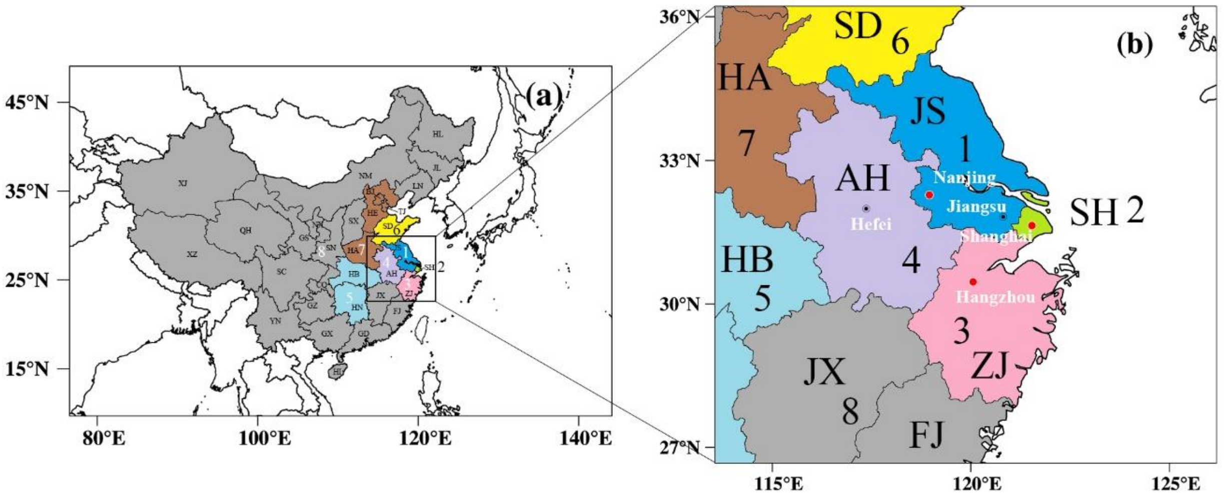


Figure S1. (a) Modelling domain covers whole China and (b) the Yangtze River Delta (YRD) with designation of source regions. Location of three selected cities also marked with red dots.

Table S1. Province names and their abbreviations

Province	Abbreviation	Province	Abbreviation
Beijing	BJ	Henan	HA
Tianjin	TJ	Hubei	HB
Hebei	HE	Hunan	HN
Shanxi	SX	Guangdong	GD
Inner Mongolia	NM	Guangxi	GX
Liaoning	LN	Hainan	HI
Jilin	JL	Chongqing	CQ
Heilongjiang	HL	Sichuan	SC
Shanghai	SH	Guizhou	GZ
Jiangsu	JS	Yunnan	YN
Zhejiang	ZJ	Xizang	XZ
Anhui	AH	Shaanxi	SN
Fujian	FJ	Gansu	GS
Jiangxi	JX	Qinghai	QH
Shandong	SD	Ningxia	NX
Henan	HA	Xinjiang	XJ
Hubei	HB		

Table S2. Model performance of meteorological parameters temperature at 2 m above the ground surface (T2), wind speed (WSPD), wind direction (WD) and relative humidity (RH) before and during the lockdown. (PRE is mean prediction; OBS is mean observation; MB is mean bias; GE is gross error; and RMSE is root mean square error). The values that do not meet the criteria were denoted in bold.

	Statistics	Before the lockdown	During the lockdown	Benchmarks*
T2 (K)	OBS	279.8	278.9	
	PRE	281.4	280.5	
	MB	**1.6**	**1.6**	≤±0.5
	GE	**2.2**	2.0	≤2.0
	RMSE	2.7	2.6	
WSPD (ms^{-1})	OBS	3.0	3.3	
	PRE	3.5	4.3	
	MB	0.5	**0.9**	≤±0.5
	GE	1.3	1.6	≤2.0
	RMSE	1.7	2.0	≤2.0
WD (°)	OBS	159,6	185.1	
	PRE	143.0	181.7	
	MB	-6.0	1.8	≤±10
	GE	**36.5**	29.2	≤±30
	RMSE	52.6	43.8	
RH (%)	OBS	82.9	85.7	
	PRE	80.6	80.1	
	MB	-2.4	-5.6	
	GE	9.1	8.6	
	RMSE	11.7	11.3	

Note: * were benchmarks limits suggested by Emery and Tai (2001).

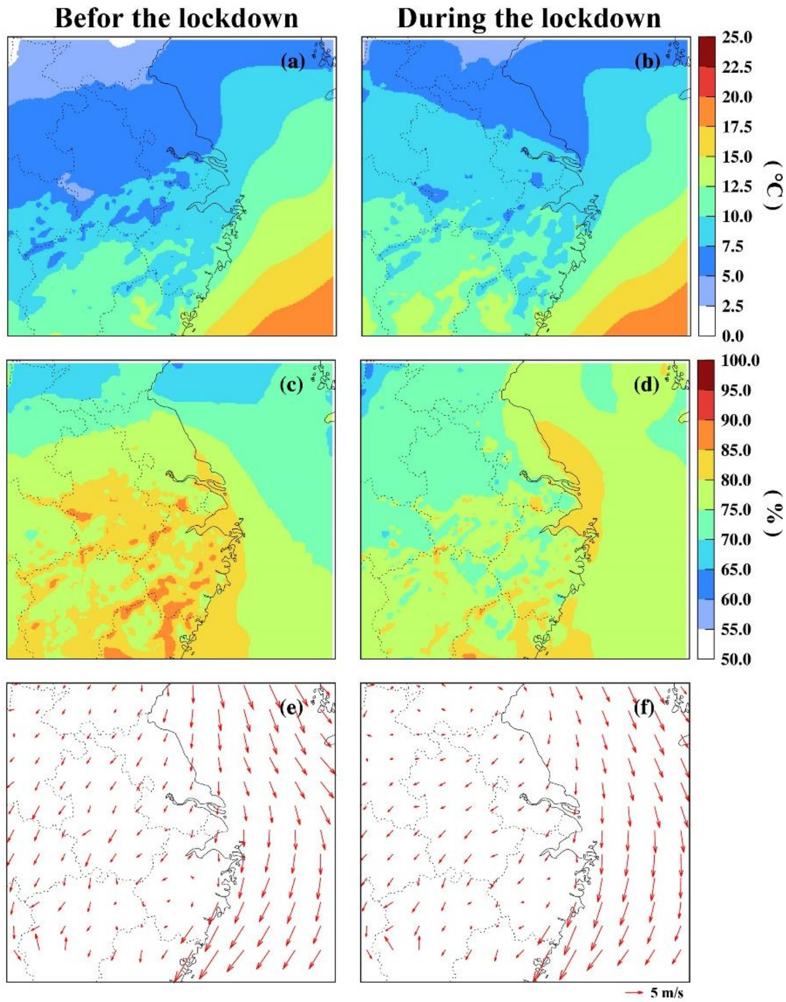
Table S3. Model performance of $PM_{2.5}$ and its components in the YRD before and during the lockdown period. The observations of sulfate (SO_4^{2-}), nitrate (NO_3^-) and ammonium (NH_4^+) from January 08 to February 10 were based on Chen et al. (2020). (OBS is mean observation; PRE is mean prediction; MFB is mean fractional bias; MFE is mean fractional error; MNB is mean normalized bias; MNE is mean normalized error). The performance criteria were suggested by Boylan and Russell (2006).

	Statistics	Before the lockdown	During the lockdown	Criteria
$PM_{2.5}$	OBS	69.32	43.38	
(μg m^{-3})	PRE	84.89	51.83	
	MNB	0.72	0.61	
	MNE	0.99	0.9	
	MFB	0.2	0.15	≤±0.6
	MFE	0.57	0.55	≤0.75
SO_4^{2-}	OBS	7.49	5.20	
(μg m^{-3})	PRE	14.28	8.06	
	MNB	1.07	0.85	
	MNE	1.14	0.98	
	MFB	0.52	0.40	
	MFE	0.59	0.55	
NO_3^-	OBS	14.77	6.68	
(μg m^{-3})	PRE	23.28	10.07	
	MNB	0.79	0.48	
	MNE	1.02	0.63	
	MFB	0.30	0.21	
	MFE	0.62	0.42	
NH_4^+	OBS	7.71	4.28	
(μg m^{-3})	PRE	11.38	5.63	
	MNB	0.56	0.36	
	MNE	0.72	0.51	
	MFB	0.24	0.21	
	MFE	0.42	0.39	

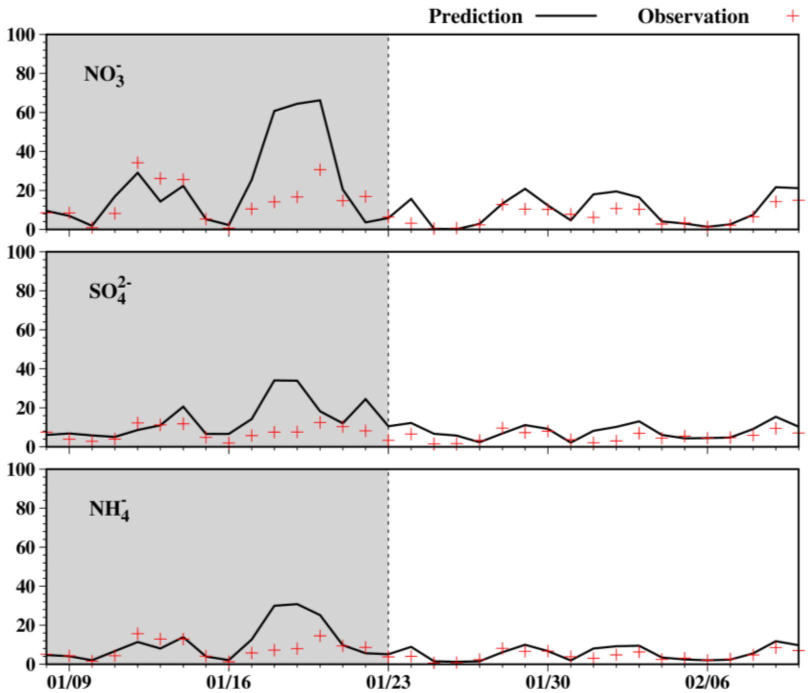
Table S4. Indices used to evaluate model performance.

Index	Definition*	Remarks
Mean bias (MB)	$\frac{1}{N}\sum_{i=1}^{N}(M_i - O_i)$	
Root mean square error (RMSE)	$\sqrt{\frac{1}{N}\sum_{i=1}^{N}(M_i - O_i)^2}$	Reported as %
Gross Error (GE)	$\frac{1}{N}\sum_{i=1}^{N}\frac{\lvert M_i - O_i\rvert}{O_i}$	Reported as %
Mean normalized bias (MNB)	$\frac{1}{N}\sum_{i=1}^{N}\frac{M_i - O_i}{O_i}$	Reported as %
Mean normalized error (MNE)	$\frac{1}{N}\sum_{i=1}^{N}\frac{\lvert M_i - O_i\rvert}{O_i}$	Reported as %
Mean fractional bias (MFB)	$\frac{2}{N}\sum_{i=1}^{N}\frac{(M_i - O_i)}{(M_i + O_i)}$	Reported as %
Mean fractional error (MFE)	$\frac{2}{N}\sum_{i=1}^{N}\frac{\lvert M_i - O_i\rvert}{(M_i + O_i)}$	Reported as %

Note: * i represents the pairing of N observations O and predictions M by site and time.



35 **Figure S2.** Regional variations of meteorological parameters including (a-b) Temperature, (c-d) Relative humidity, and (e-f) Wind fields in the YRD before and during the lockdown period.



40 **Figure S3.** Comparison of modelled and observed sulfate, nitrate and ammonium at the Jiangwan Campus of Fudan University (31.338° N, 121.511° E) Shanghai from January 08 to February 10 based on Chen et al. (2020). The shaded area represents the period before the lockdown. Units are μg m^{-3}.

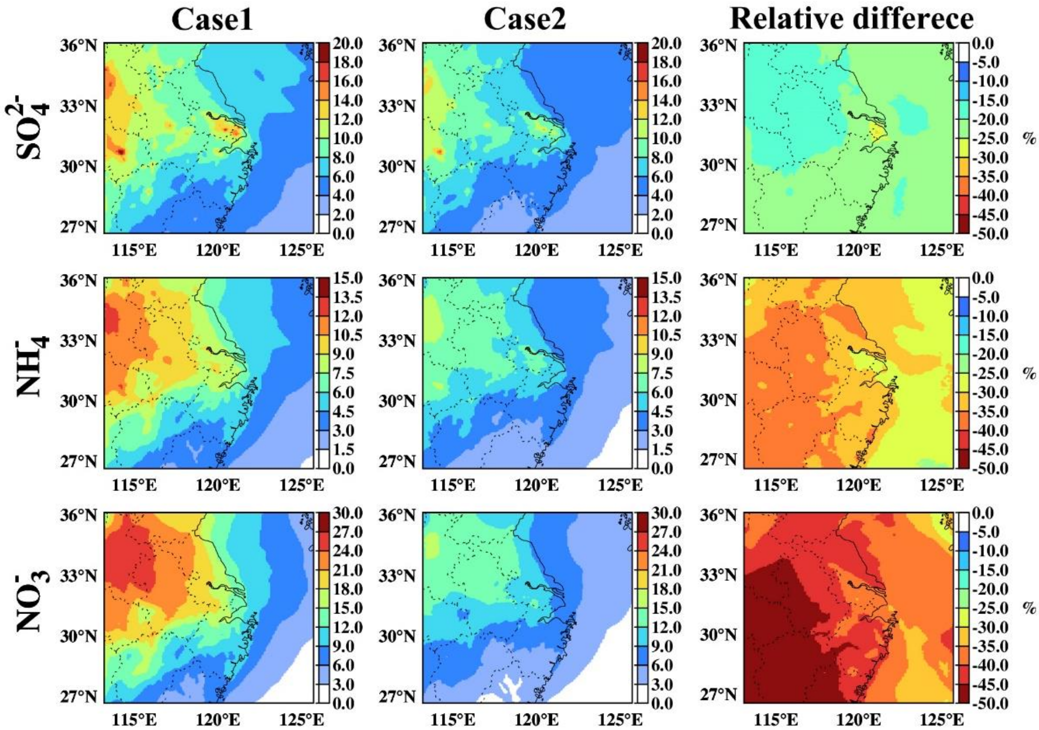


Figure S4. Spatial distributions of predicted sulfate, ammonium, and nitrate and their changes caused by lockdown measures in the YRD from January 23 to February 28, 2020. Relative difference is calculated by (Case 2 – Case 1) / Case 1. Note color ranges are different among panels.

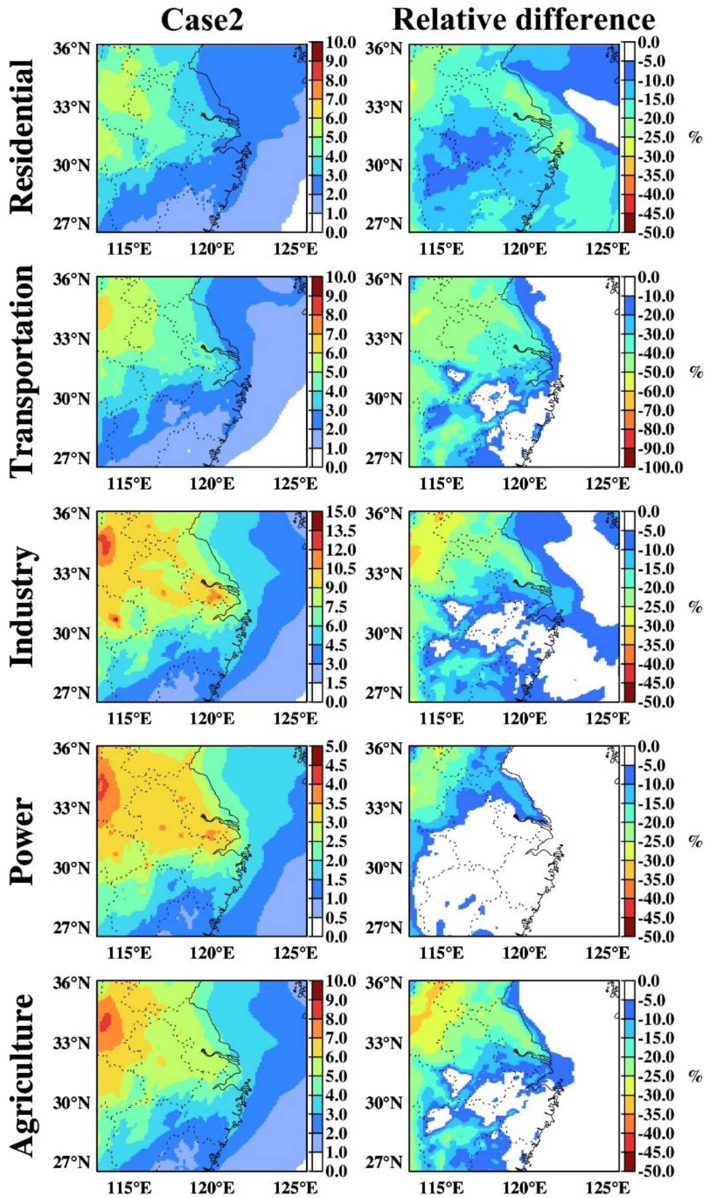


Figure S5. Predicted secondary inorganic aerosols (SIA) from different emission sectors of Case 2 and change ratios caused by the lockdown in the YRD from January 23 to February 28, 2020. Note color ranges are different among panels.

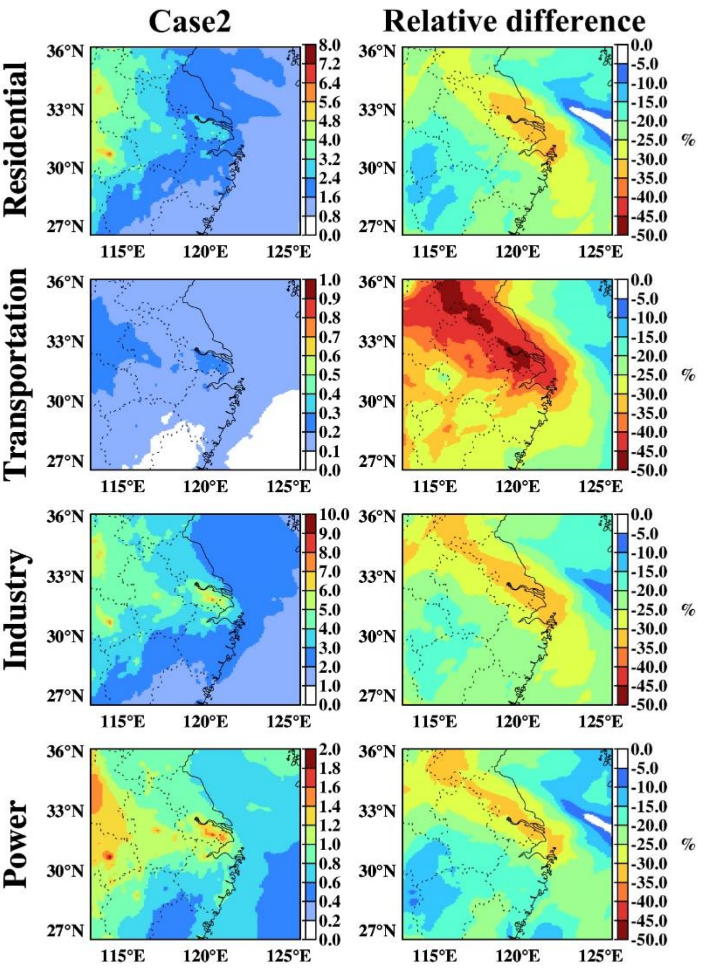


Figure S6. Same as Fig. S5, but for sulfate. Note color ranges are different among panels.

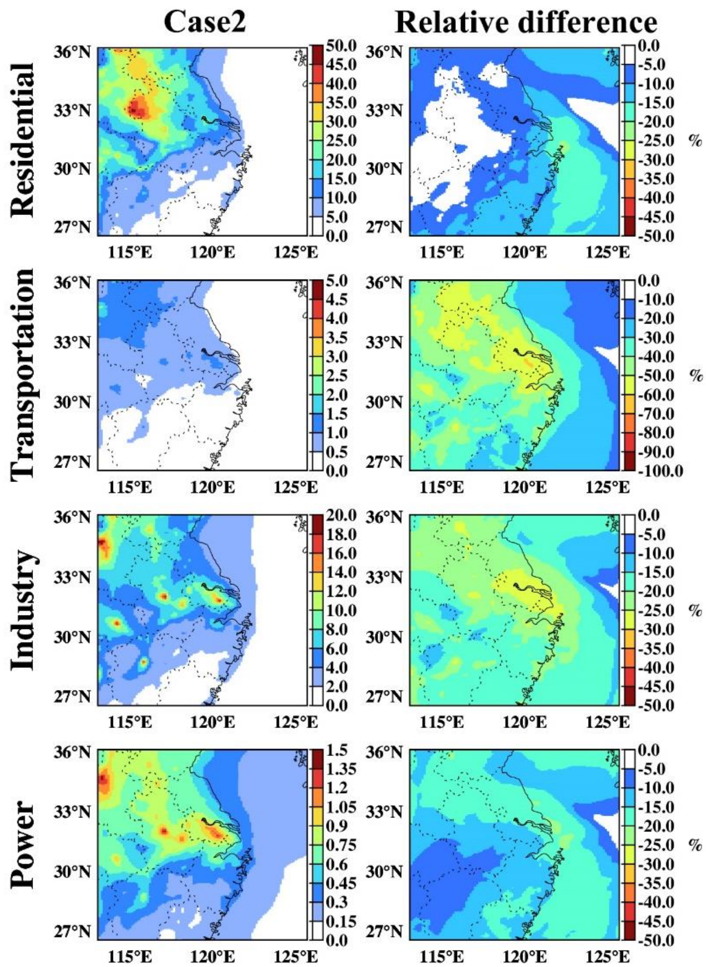


Figure S7. Same as Fig. S5, but for primary particulate matter (PPM). Note color ranges are different among panels.

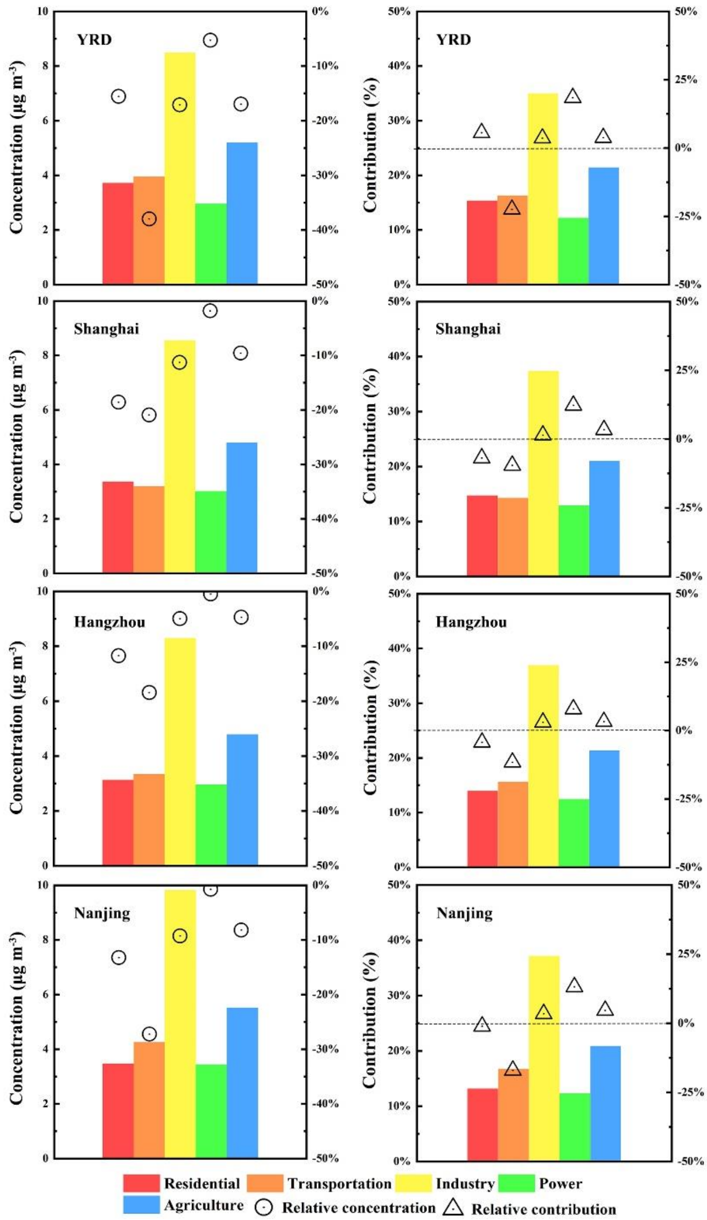


Figure S8. Concentrations and contributions of different emission sectors to SIA in the YRD and three major cities of Case 2 (histogram corresponding to left black Y-axis) and changes corresponding to right Y-axis from January 23 to February 28, 2020.

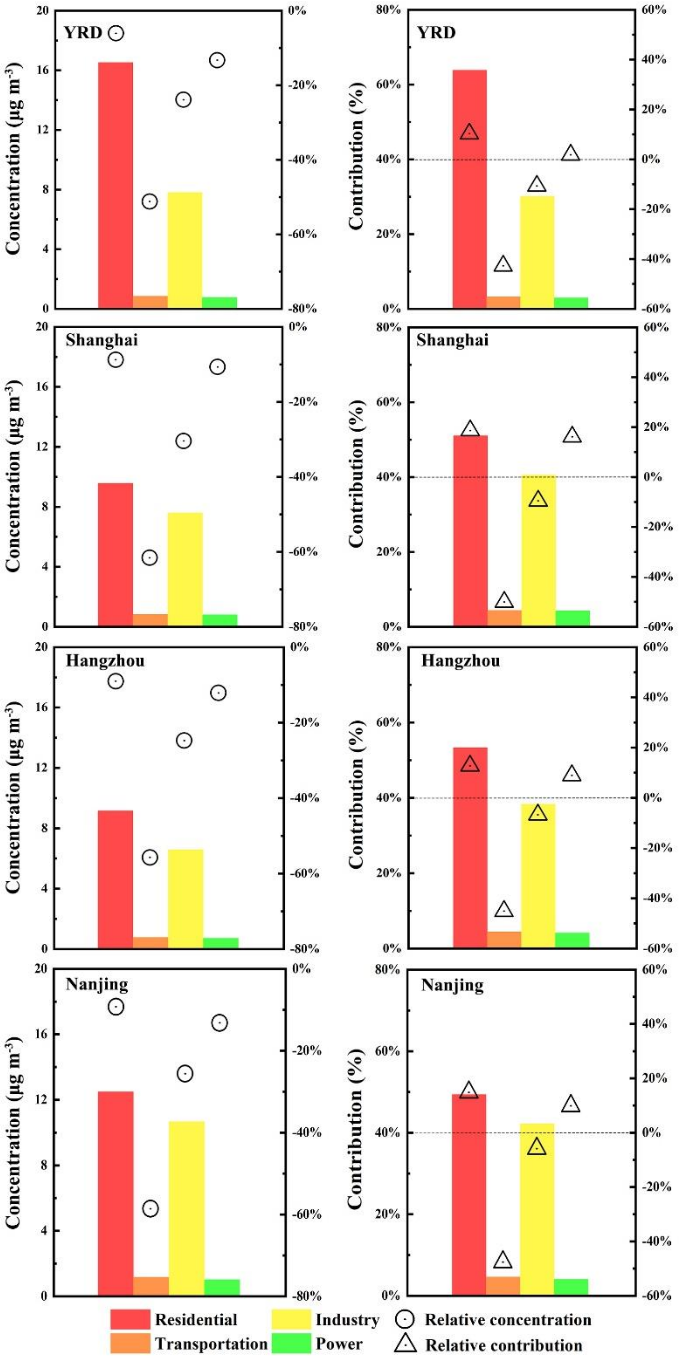


Figure S9. Same as Fig.S8 but for PPM.

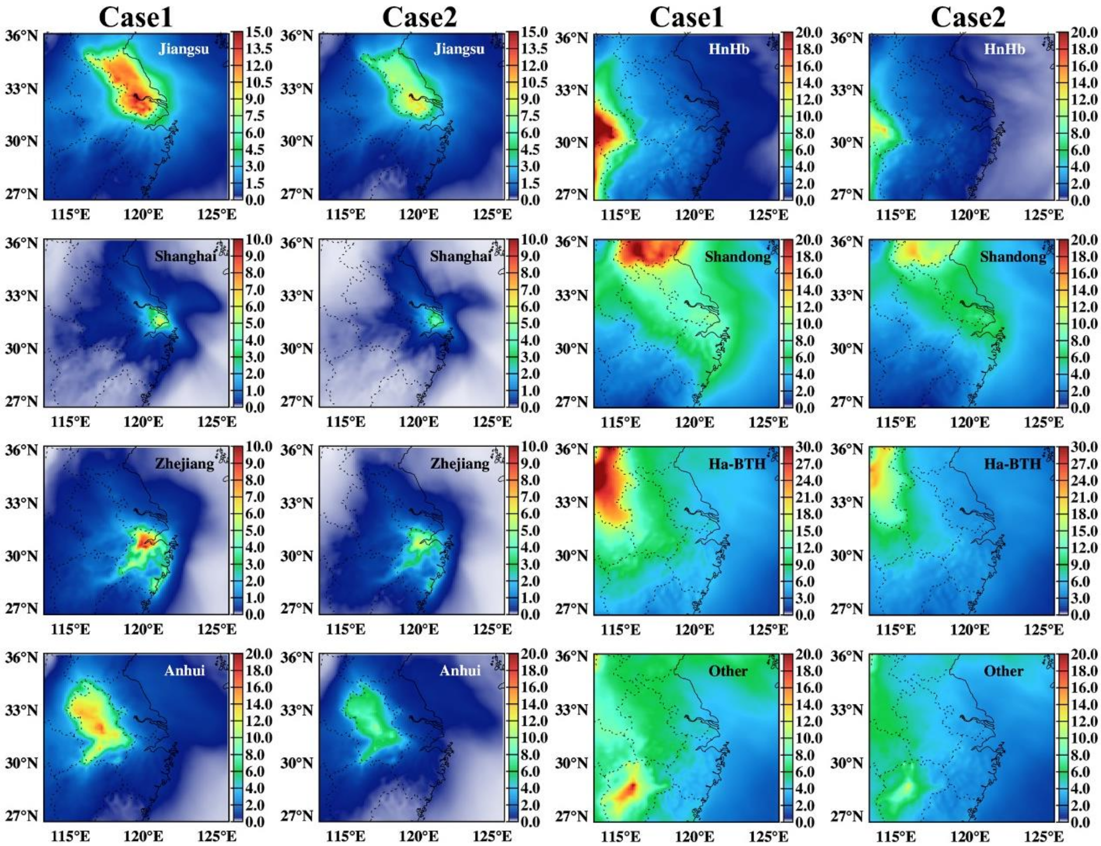


Figure S10. Averaged regional contributions of predicted SIA in the YRD from 23 to February 28, 2020. Note color ranges are different among panels.

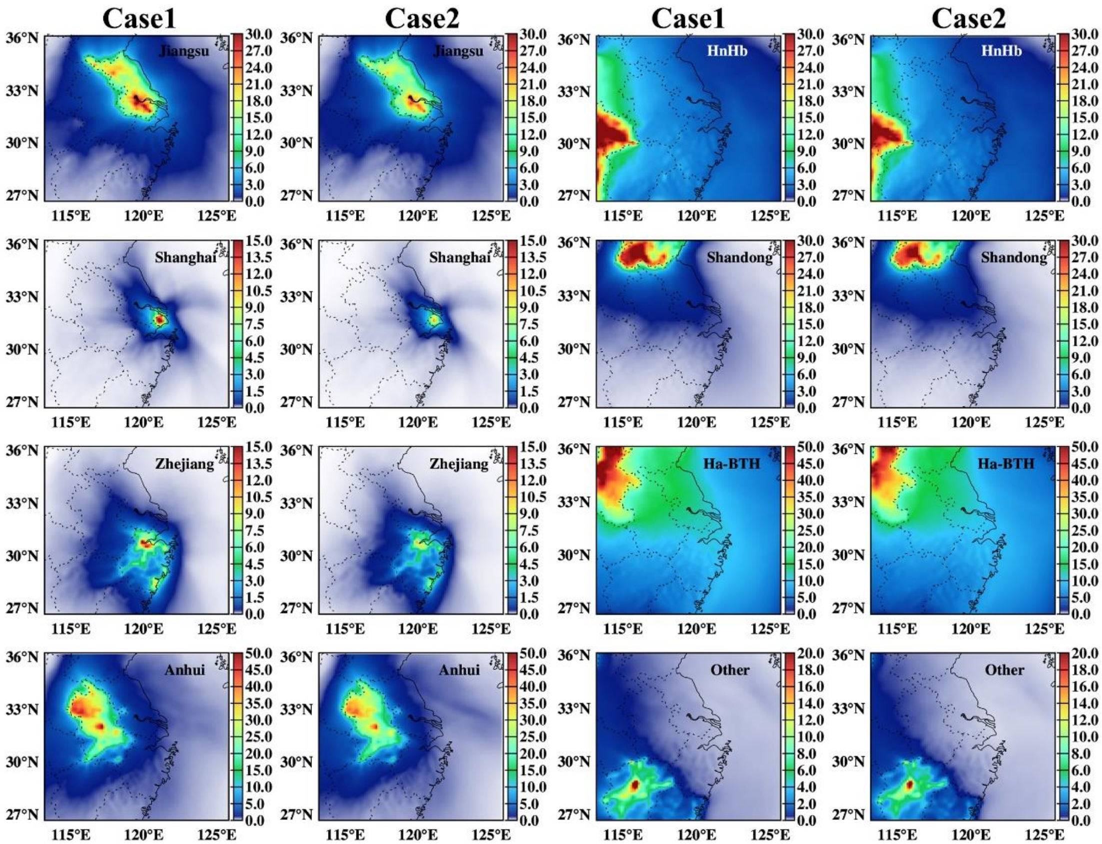


Figure S11. Same as Fig. S10, but for PPM. Note color ranges are different among panels.

Reference

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Chen, H., Huo, J., Fu, Q., Duan, Y., Xiao, H., and Chen, J.: Impact of quarantine measures on chemical compositions of PM2.5 during the COVID-19 epidemic in Shanghai, China, Sci Total Environ, 743, 140758, 10.1016/j.scitotenv.2020.140758, 2020.

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