#### **1** SUPPORTING INFORMATION FOR

A quantitative decoupling analysis (QDA v1.0) method for the assessment of
meteorological, emission and chemical contributions to fine particulate pollution.

#### 5 Text S1 Model Performance Evaluation

To assess the accuracy of the model, simulated meteorological parameters and air pollutant concentrations were compared with observed values. We use several evaluation indicators to quantitatively assess model performance, including Simulated average (MM), Observed average (OM), correlation coefficient (R), mean fractional bias (MFB), mean deviation (MB), standard mean deviation (NMB), standard mean error (NME), root mean square error (RMSE), and index of agreement (IOA), which are defined in Table S1 

## 23 Tables

Metrics	Mathematical Expression	Range		
Correlation coefficient (R)	$R = \frac{\sum_{i=1}^{N} (M_i - MM) (O_i - OM)}{\sqrt{\sum_{i=1}^{N} (M_i - MM)^2} \sqrt{\sum_{i=1}^{N} (O_i - OM)^2}}$	[-1,1]		
Mean Bias (MB)	$MB = \frac{\sum_{i=1}^{N} (M_i - O_i)}{N}$	$[-\infty,+\infty]$		
Mean Error (ME)	$ME = \frac{\sum_{i=1}^{N}  M_i - O_i }{N}$	[0,+∞]		
Normalized Mean Bias (NMB)	$NMB = \frac{\sum_{i=1}^{N} (M_i - O_i)}{\sum_{i=1}^{N} O_i}$	[−1,+∞]		
Normalized Mean Error (NME)	$NME = \frac{\sum_{i=1}^{N}  M_i - O_i }{\sum_{i=1}^{N} O_i}$	[0,+∞]		
Mean Fractional Bias (MFB)	$MFB = \frac{1}{N} \sum \frac{M_i - O_i}{(M_i + O_i)/2} \times 100\%$	[-200%,200%]		
Mean Fractional Error (MFE)	$MFE = \frac{1}{N} \sum \frac{ M_i - O_i }{(M_i + O_i)/2} \times 100\%$	[0,200%]		
Root Mean Square Error (RMSE)	$RMSE = \sqrt{\frac{\sum (M_i - O_i)^2}{N}}$	[0,+∞]		
Index of Agreement (IOA)	$IOA = \begin{cases} 1 - \frac{\sum  M_i - O_i }{2\sum  O_i - OM } &, \sum  M_i - O_i  \le 2\sum  O_i - OM  \\ \frac{2\sum  O_i - OM }{\sum  M_i - O_i } - 1 &, \sum  M_i - O_i  > 2\sum  O_i - OM  \end{cases}$	[-1,1]		

# **Table S1.** Equations of model evaluation metrics

25 N: the number of modeled and observed data pairs;  $M_i$ : modeled concentration at time

<sup>26</sup> i;  $O_i$ : observed concentration at time i;

observations in Beijing										1			
Meteorological Elements	OM	SD OBS	MM	SD MOD	R	MB	NMB	NME	ME	MFB	MFE	RSME	IOA
Ideal value	-	-	-	-	1	0	0	0	0	0	0	0	1
Temp(°C)	0.45	3.86	-0.83	3.88	0.93**	-1.25	-2.86	3.22	1.44	-14.21	8.00	1.81	0.77
WS(m/s)	1.74	0.99	2.39	1.33	0.47**	0.65	0.37	0.62	1.08	26.10	54.97	1.40	0.26
WD(°)	121.84	86.74	170.71	94.17	0.24**	49.12	0.40	0.70	84.73	27.25	64.84	123.93	0.42
RH(%)	65.04	17.54	62.09	15.03	0.85**	-1.10	-0.02	0.11	6.34	-0.08	11.80	8.27	0.78
Pressure(hPa)	1025	3.59	1025	3.05	0.93**	-0.07	-7e-05	0.001	1.07	-0.01	0.10	1.30	0.81
Precursor Gases													
$NO_2(\mu g/m^3)$	81.66	30.96	74.56	30.85	0.75**	-9.33	-0.11	0.22	17.76	-14.88	26.26	23.73	0.63
$SO_2(\mu g/m^3)$	68.55	42.19	63.30	28.20	0.74**	-6.80	-0.10	0.31	20.99	-4.79	32.50	29.21	0.70
PM <sub>2.5</sub> and its Chemical Component													
$PM_{2.5}(\mu g/m^3)$	168.93	105.96	168.23	84.88	0.83**	-13.70	-0.08	0.25	42.12	-0.41	27.63	61.36	0.78
$NH_4^+(\mu g/m^3)$	32.15	17.13	41.69	27.42	0.95**	9.54	0.30	0.37	11.97	18.76	27.05	16.14	0.58
$SO_4^{2-}(\mu g/m^3)$	43.19	24.00	22.54	12.90	0.81**	-20.65	-0.48	0.48	20.65	-54.65	54.65	24.90	0.47
$NO_{3}(\mu g/m^{3})$	54.65	32.31	57.24	38.94	0.90**	2.59	0.05	0.20	10.89	3.50	22.06	14.36	0.80
$OC(\mu g/m^3)$	36.83	17.69	37.62	17.57	0.79**	0.79	0.02	0.17	6.28	3.58	17.49	7.43	0.76

 Table S2. Evaluation results for simulated meteorological elements, precursor gas concentration and chemical components against

 observations in Beijing

Note: *MM*: averaged model results; *OM*: averaged observations; SD: standard deviation; R is the Spearman correlation coefficient, \*\* denotes significant correlation at the 0.01 level, \* denotes
 significant correlation at the 0.05 level

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## 41 Figures



Figure S1. Evaluation of simulated PM<sub>2.5</sub> concentrations against ground-based
observations over Beijing-Tianjin-Hebei Region during (a) precontamination, (b)
accumulation, (c) maintenance and (d) removal stages.

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Figure S2. Surface weather chart at different stages of pollution (February 18<sup>th</sup> 03:00
UTC stands for the stage 1, February 20<sup>th</sup> 12:00 UTC stands for the stage 2, February
25<sup>th</sup> 00:00 UTC stands for the stage 3, and February 26<sup>th</sup> 18:00 UTC stands for the stage

4.)





