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The role of meteorological conditions and pollution control strategies in reducing air pollution in Beijing during APEC 2014 and Victory Parade 2015

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S1. Temperature steps and duration of NOISH thermal-optical method protocol.

Table S1. Temperature steps and duration of NOISH thermal-optical method protocol.

Carrier gas	Duration (sec)	Temperature (°C)
He-1	10	Ambient
He-2	95	600
He-3	90	840
He-4	30	No heat
O_2-1	35	550
O_2-2	45	650
O_2-3	115	870
CalGas	125	No heat

S2. The relationship between $PM_{2.5}$ concentrations and meteorological parameters.

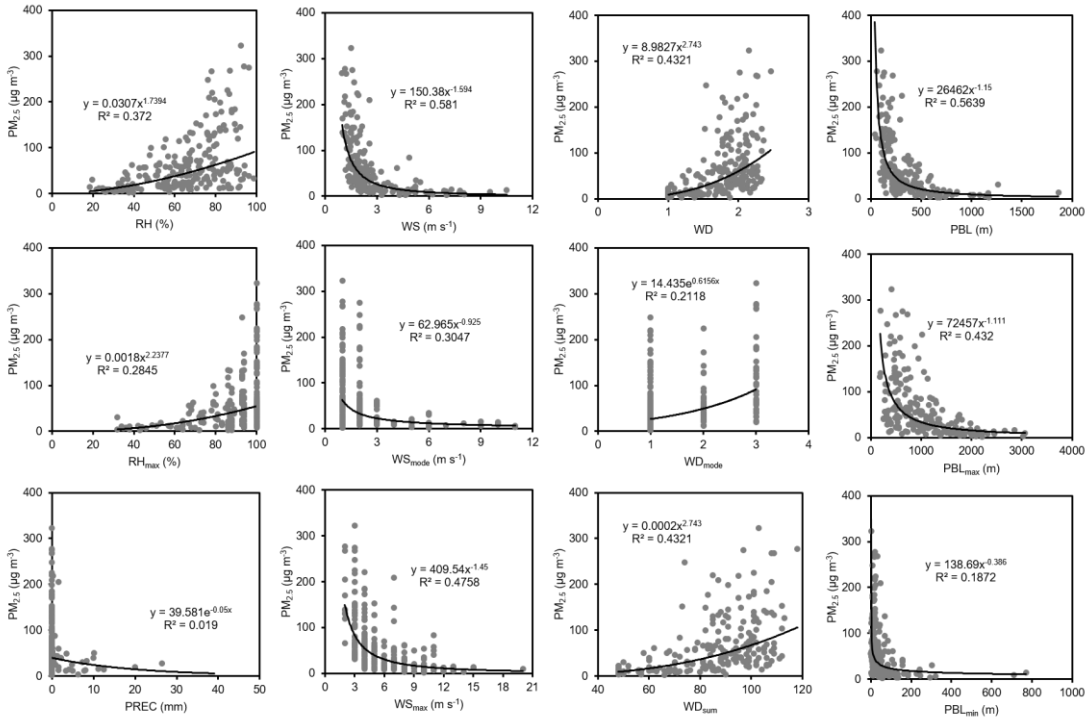

Fig S2. Scatter plot and correlation between $PM_{2.5}$ concentrations (*y* axis) and meteorological parameters (*x* axis) during the APEC and Parade sampling periods.

S3. The prevalence of WD during the APEC and Parade campaigns.

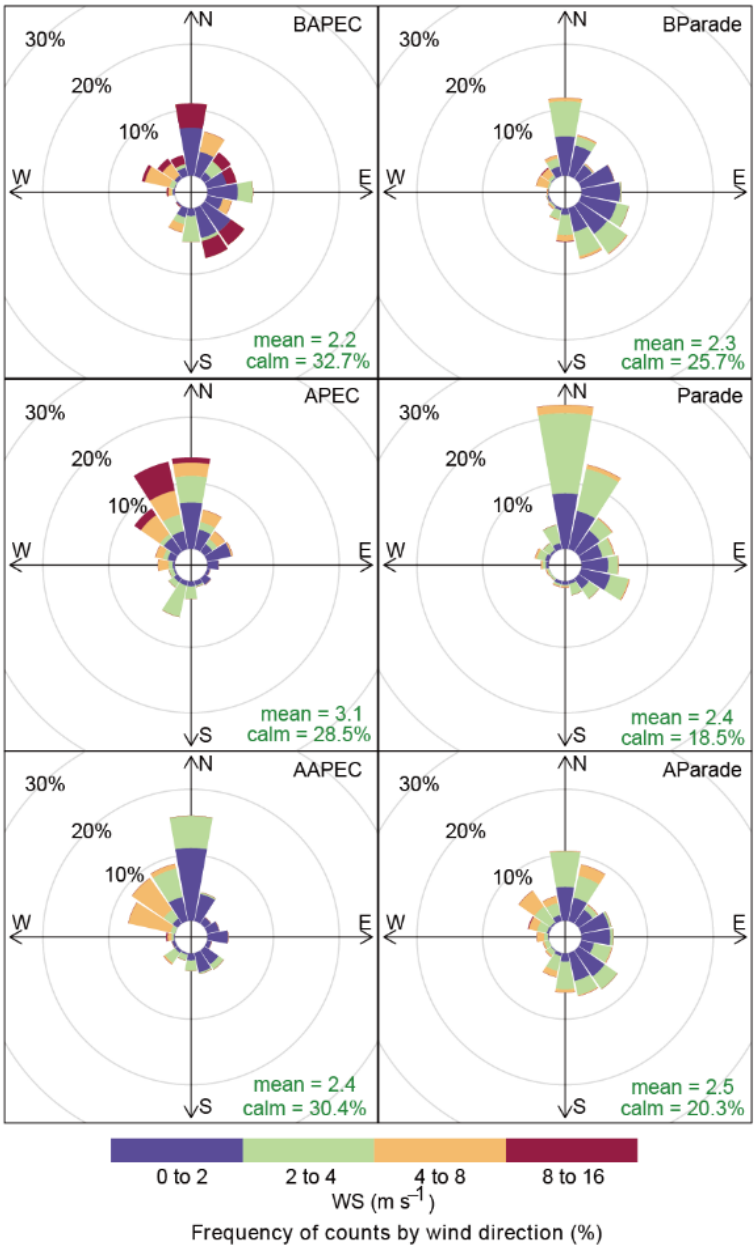

Figure S3. Wind rose plots based on frequencies of half-hourly data before APEC (BAPEC), during APEC, and after APEC (AAPEC) on the left, and before Parade (BParade), during Parade, and after Parade (AParade) on the right.

Figure S3 shows the prevalence of WD during the APEC and Parade campaigns. During APEC, the prevailing WD was from the north and northwest, and accounted for

30–40% of the wind frequency. The mean WS during APEC was 3.1 m s^{-1}, higher than before APEC (2.2 m s^{-1}) and after APEC (2.4 m s^{-1}). The "calm and variable" proportion of APEC was 28.5%, which was lowest during the APEC campaign. During Parade, a northern and northeastern WD accounted for more than 30% of the wind frequency, and the "calm and variable" proportion was 18.5%, much lower than before Parade (25.7%) and after Parade (20.3%).

S4. Time series of daily average $PM_{2.5}$ concentrations and PBL heights during the APEC and Parade campaigns.

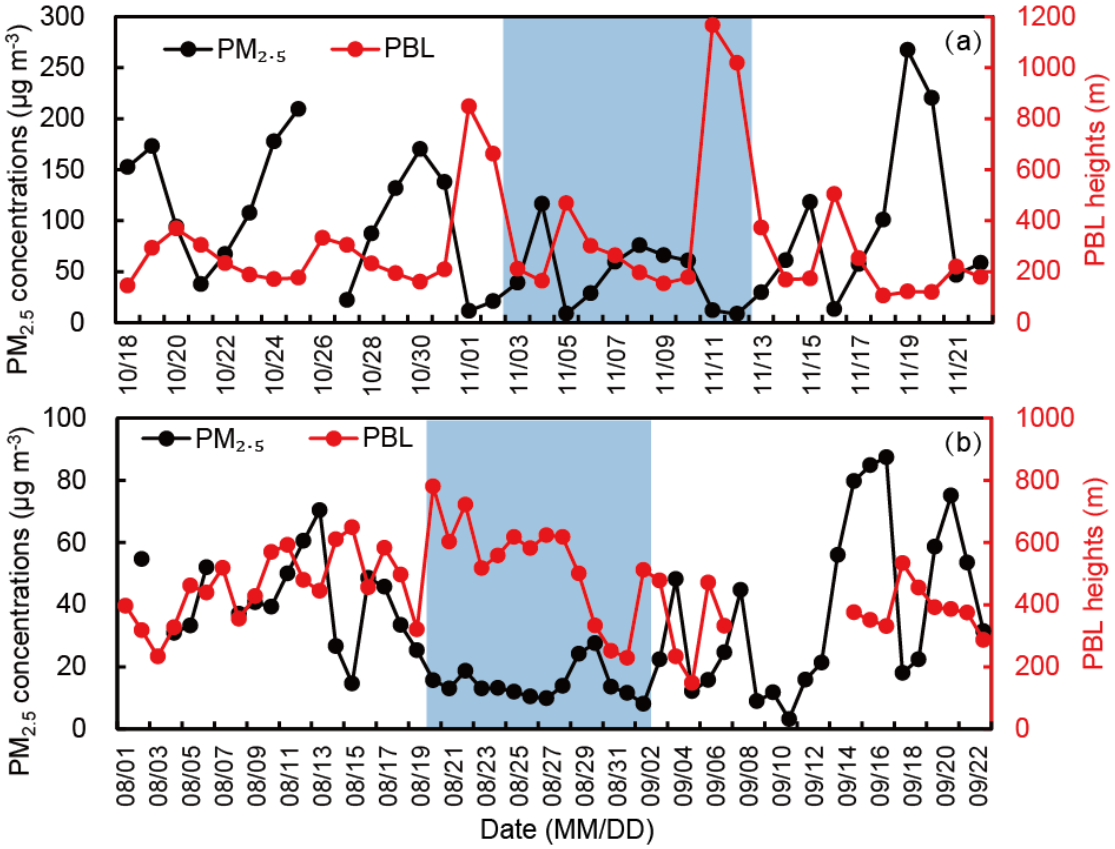

Figure S4. Time series of daily $PM_{2.5}$ concentrations and planetary boundary layer (PBL) heights during the (a) APEC and (b) Parade campaigns. The black line represents $PM_{2.5}$ concentrations and the red line represents PBL heights. The blue-shaded areas highlight the pollution control periods of APEC 2014 (3 November to 12 November 2014) and Parade 2015 (20 August to 3 September 2015).

Figure S4 shows a time series of daily average $PM_{2.5}$ concentrations and PBL heights during the APEC and Parade campaigns, indicating that they have an anti-correlation. In both periods of before and after APEC, the PBL heights were mostly less than 400 m. Compared with during APEC and during Parade, the PBL heights increased on 5, 11, and 12 November during APEC and were mostly higher than 400 m during Parade, which was much more favourable for the diffusion of air pollutants during the

control period.

S5. Statistical summary showing the meteorological conditions and the concentrations of pollutants on the days with stable meteorological conditions.

Table S5. Statistical summary showing the meteorological conditions (WS and PBL height), and the concentrations of pollutants on the days with stable meteorological conditions during the APEC campaign. BAPEC/BParade: before APEC/Parade, AAPEC/AParade: after APEC/Parade.

		WS	PBL	$PM_{2.5}$	OC	EC	SO_4^{2-}	NO_3^-	NH_4^+	SO_2	NO	NO_x	O_3
		($m\ s^{-1}$)	(m)	($\mu g\ m^{-3}$)									
BAPEC	10/18	1.27	145	153	-	-	14.3	43.0	19.4	-	73	240	45.2
	10/22	1.46	233	67	10.9	3.6	7.4	14.0	9.3	12.1	59	153	4.4
	10/23	1.46	188	108	18.0	2.6	11.3	23.7	13.2	11.5	91	200	6.6
	10/24	1.52	171	177	20.5	3.0	24.6	54.2	28.3	12.0	73	205	20.4
	10/28	1.71	232	87	15.9	3.8	7.0	17.8	7.9	13.0	69	165	14.2
	10/29	1.10	193	132	23.6	5.3	10.6	35.2	14.0	15.6	99	229	10.0
	10/30	1.00	160	170	26.0	4.0	18.5	56.0	25.7	18.4	77	195	7.5
	10/31	1.50	209	138	17.0	3.9	13.5	29.3	16.1	8.1	79	183	4.6
	Mean	**1.38**	**191**	**129**	**18.8**	**3.7**	**13.4**	**34.2**	**16.7**	**12.9**	**77**	**196**	**14.1**
APEC	11/3	1.98	211	39	11.1	1.8	1.8	4.9	2.6	5.8	19	84	36.5
	11/4	1.85	163	116	22.7	2.9	9.6	33.1	13.2	26.0	31	144	20.5
	11/7	1.63	264	59	12.5	2.8	4.3	10.9	6.1	13.6	30	101	15.0
	11/8	2.00	196	76	17.3	2.4	7.3	21.1	8.8	11.8	26	101	33.6
	11/9	1.79	154	66	17.6	2.5	4.9	14.0	6.3	9.2	44	125	27.7
	11/10	2.13	177	61	14.3	1.8	5.6	17.9	7.5	10.2	31	115	29.2
	Mean	**1.90**	**194**	**70**	**15.9**	**2.4**	**5.6**	**17.0**	**7.4**	**12.7**	**30**	**112**	**27.1**
AAPEC	11/14	1.58	169	61	15.2	4.5	3.4	6.4	4.1	30.3	87	171	14.7
	11/15	1.38	173	118	24.2	6.6	7.2	19.6	10.6	52.0	148	276	5.0
	11/17	2.48	252	57	14.5	3.8	2.8	4.0	3.7	30.4	125	206	25.0
	11/18	1.44	106	101	27.1	3.8	6.3	14.3	8.3	54.5	162	285	6.2
	11/19	1.23	121	267	53.2	5.0	38.2	55.6	35.2	54.6	190	369	1.0
	11/20	1.94	120	220	41.6	3.7	26.2	46.9	28.8	38.8	200	383	2.9
	11/22	1.96	178	58	14.0	3.3	3.3	5.4	4.5	32.2	89	183	26.7
	Mean	**1.72**	**160**	**126**	**27.1**	**4.4**	**12.5**	**21.7**	**13.6**	**41.8**	**143**	**268**	**11.6**

The days with stable meteorological conditions were determined with the method introduced in Section 3.2.1. As a result, eight days before APEC (18, 22, 23, 24, 28, 29, 30, and 31 October 2014), six days during APEC (3, 4, 7, 8, 9, and 10 November 2014), and seven days after APEC (14, 15, 17, 18, 19, 20, and 22 November 2014) were

defined as having stable meteorological conditions. Table S5 lists the meteorological conditions (WSs and PBL heights), and the concentrations of pollutants on the days with stable meteorological conditions during the APEC campaign. For the Parade campaign, only one day in each of the BParade, Parade, and AParade periods was defined as having stable meteorological conditions. This was considered to not be well representative of the Parade campaign. Thus, we only assessed the variation of air pollutant concentrations during stable meteorological periods of the APEC campaign.

For days with stable meteorological conditions during the APEC campaign, the average WS was 1.4, 1.9, and 1.7 m s^{-1} before, during, and after APEC, respectively; and the average PBL height was 191, 194, and 160 m in the same three periods, respectively. This clearly shows that the meteorological conditions of days considered to be stable throughout the APEC campaign were very similar.

S6. Error transfer formula

$$N = f(x_1, x_2, x_3) \quad (1)$$

$$\overline{N} = f(\overline{x_1}, \overline{x_2}, \overline{x_3}) \quad (2)$$

$$S_N = \sqrt{\left(\frac{\partial f}{\partial x_1}\right)^2 {S_{x_1}}^2 + \left(\frac{\partial f}{\partial x_2}\right)^2 {S_{x_2}}^2 + \left(\frac{\partial f}{\partial x_3}\right)^2 {S_{x_3}}^2} \quad (3)$$

In this study, *N* represents the percentage reduction calculated by comparing the decreased average pollutant concentration during APEC to that before APEC, and *x* represents the pollutant concentrations during and before APEC.

S7. The percentage differences for the $PM_{2.5}$ concentrations of four periods that were randomly selected from within the non-control stable days of the APEC 2014 and Parade 2015 campaigns.

Table S7. The percentage differences (PD) for the $PM_{2.5}$ concentrations of four periods (P1, P2, P3, and P4) that were randomly selected from within the non-control stable days of the APEC 2014 and Parade 2015 campaigns.

Periods	Mean values ($\mu g\ m^{-3}$)	SD ($\mu g\ m^{-3}$)	Total SD ($\mu g\ m^{-3}$)	Percentage differences (PD)*				Mean PD	RMSE of PD
				P1	P2	P3	P4		
P1	120	97	59	-	-	-	-	-16%	18%
P2	101	58		-16%	-	-	-		
P3	96	40		-20%	-5%	-	-		
P4	87	23		-28%	-14%	-9%	-		

* Percentage difference (PD) = (Mean value of P_{n+1} - Mean value of P_n)/Mean value of $P_n \times 100\%$.

Table S7 lists the percentage differences among the mean $PM_{2.5}$ concentrations of four periods that were randomly selected from within the non-control days of the APEC and Parade campaigns. Based on the assumptions that days with stable meteorological conditions were representative of the corresponding periods during the APEC campaign, and the emission intensities were constant, the percentage differences in the mean $PM_{2.5}$ concentrations between these four random periods should be close to zero. The mean concentrations during P1, P2, P3, and P4 were 120, 101, 96, and 87 $\mu g\ m^{-3}$, respectively. The standard deviation (SD) during P1, P2, P3, and P4 were 97, 58, 40, and 23 $\mu g\ m^{-3}$, respectively, with the average SD being 59 $\mu g\ m^{-3}$. The mean value of the percentage differences of the mean $PM_{2.5}$ concentrations between P1, P2, P3, and P4 was −16%, with a root mean square error (RMSE) of 18%.

S8. Changes of pollutant concentrations on days with stable meteorological conditions during the APEC campaign.

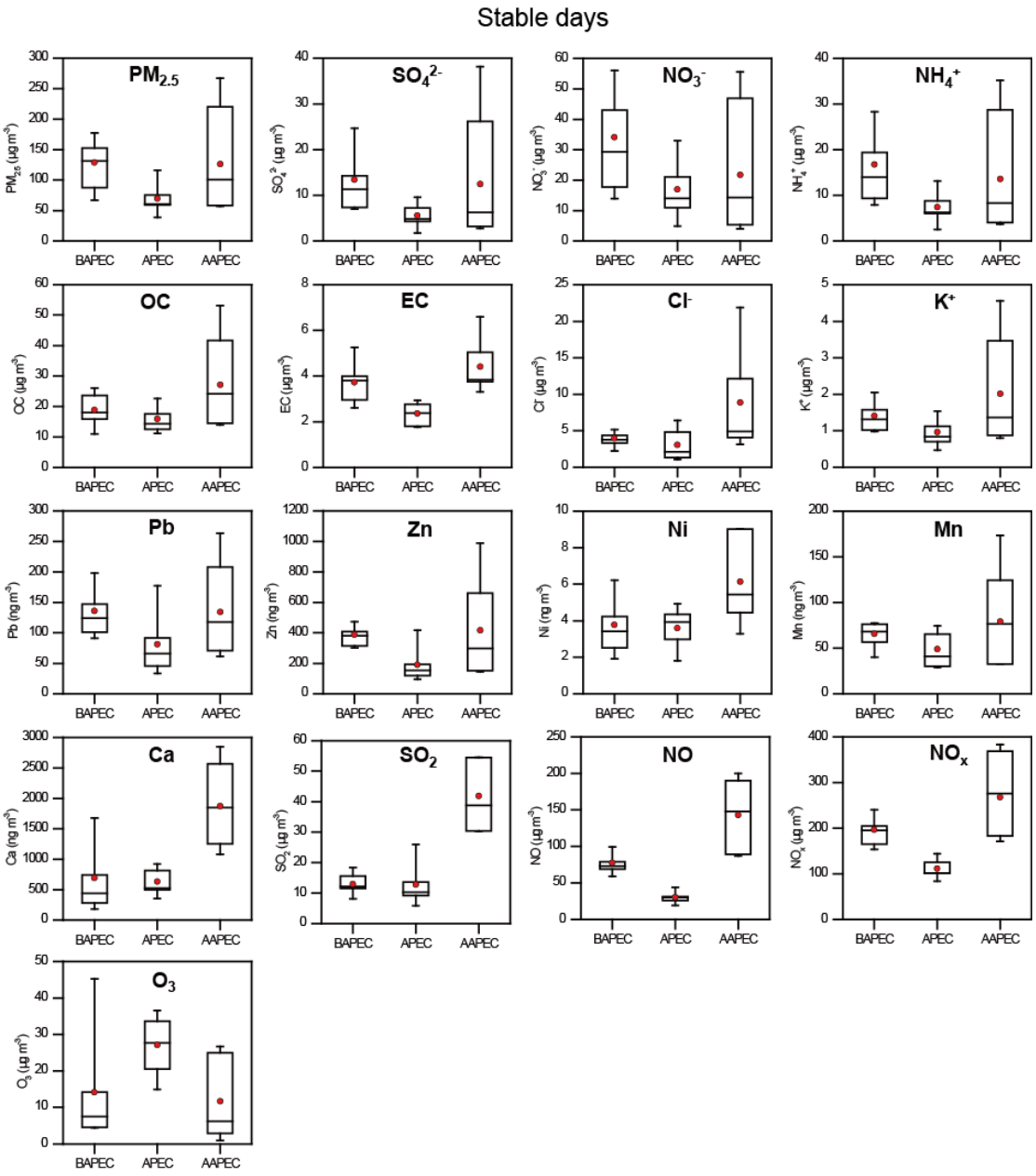

Figure S8. Variations of air pollutant concentrations during days with stable meteorological conditions during the APEC 2014 campaign, including $PM_{2.5}$, SNA (sulphate + nitrate + ammonium), organic carbon (OC), elemental carbon (EC), Cl^-, K^+, elements (Pb, Zn, Ni, Mn, and Ca), and gaseous pollutants (SO_2, NO, NO_x, and O_3). The red points represent mean values. The black cross bars are median values. The black box denotes the 25th and 75th percentiles. The whiskers represent the maximum and minimum, respectively. BAPEC/BParade: before APEC/Parade, AAPEC/AParade: after APEC/Parade.

S9. Residual analysis of GLM.

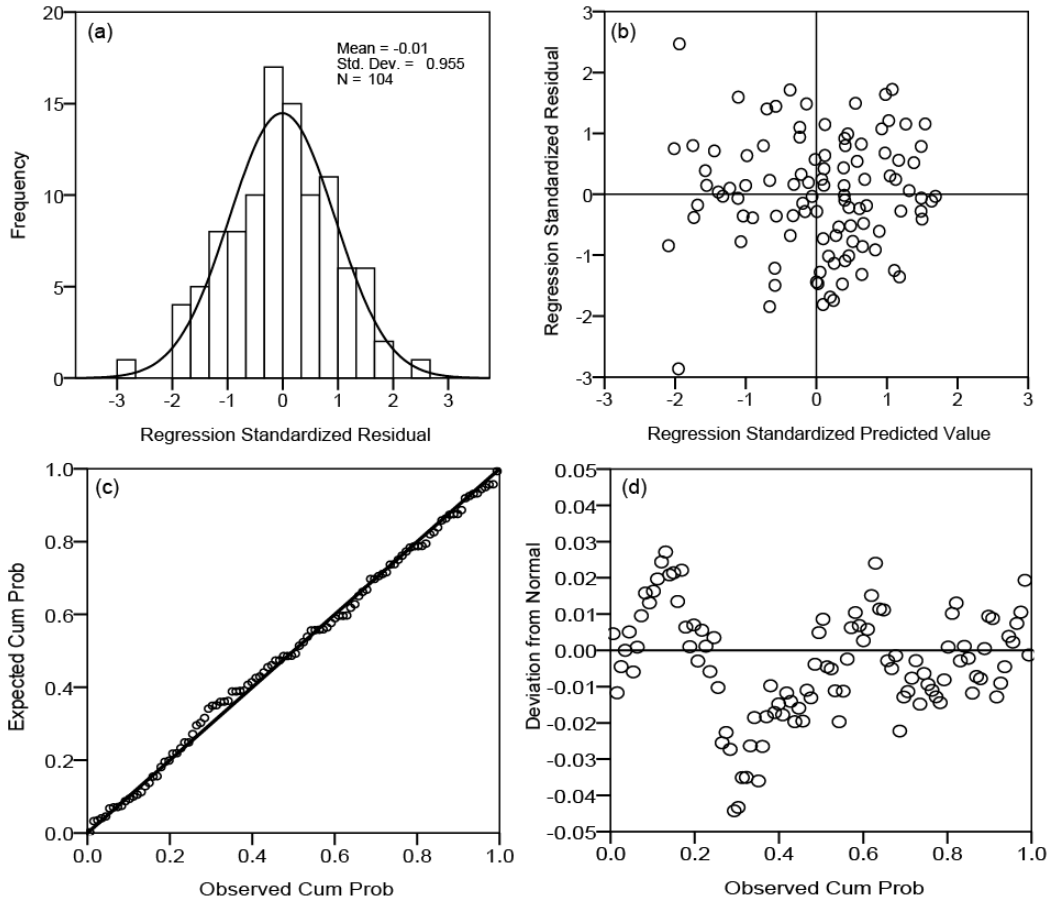

Figure S9. Residual analysis of the model. (a) Histogram of the regression standardized residual. (b) Scatter plot between the regression standardized predicted value and regression standardized residual. (c) Normal P-P plot of the regression standardized residual between the observed cumulative probability and expected cumulative probability. (d) De-trended normal P-P plot of the standardized residual of observed cumulative probability.

We used the $PM_{2.5}$ model as an example. Figure S9 shows a residual analysis of the model. According to the residual histogram (a), the mean value of the regression standardized residual was −0.01, with a standard deviation of 0.955. According to the P-P graph (c), the distribution of the observed and expected cumulative probability spread along the diagonal of $y = x$. According to the de-trended P-P graph (d), the deviations from a normal distribution were within ±0.05. These results indicate that the

model residuals followed a normal distribution. The scatter diagram of residuals and simulated values (b) could be applied to test the homoscedasticity, i.e. the distribution of the regression residual did not change over the range of values predicted by the regression.

S10. Hypothesis K-S test summary of the unstandardized/standardized residual.

Table S10. Hypothesis K-S test summary of the unstandardized/standardized residual.

	Null Hypothesis	Test	Sig.*	Decision
1	The distribution of Unstandardized Residual is normal with mean -0.00 and standard deviation 0.40.	One-Sample Kolmogorov-Smirnov Test	0.96	Retain the null hypothesis.
2	The distribution of Standardized Residual is normal with mean -0.01 and standard deviation 0.96.		0.96	Retain the null hypothesis.

*The significance level is 0.05.

Hypothesis K-S test is often applied to test the normal distribution of a series of values. In this case, the test retains the null hypothesis that the distribution of unstandardized and standardized residual is normal, indicating that the residual follows the normal distribution.