atmosphere

MDPI

Supplementary Material

Characterization and Source Apportionment of PM in Handan—A Case Study during the COVID-19

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Table S1. The concentrations of $PM_{2.5}$, PM_{10} and $PM_{2.5-10}$ and their t-test results.

Sampling Date	$PM_{2.5}$ (μg/m³)		PM_{10} (μg/m³)		$PM_{2.5–10}$ (μg/m³)	
	Sampling site 1	Sampling site 2	Sampling site 1	Sampling site 2	Sampling site 1	Sampling site 2
05.12	49	53	183	206	134	153
05.13	24	28	84	109	60	81
05.14	69	64	97	123	28	59
05.15	81	88	147	183	66	95
05.16	96	94	179	202	83	108
05.17	26	33	88	131	62	98
05.18	25	25	70	85	45	60
Average value	53	55	121	148	68	93
t	1.23		7.77		9.04	
$t_{0.025,6}$	2.45		2.45		2.45	
P	0.26		0.0002**		0.0001**	

Note:** indicate a significant correlation.

Table S2. The EF of mental elements in two sampling sites.

Date	EF of $PM_{2.5}$ in sampling site 1										
Element	Al	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Pb	Zn
05.12	0.9	1.7	609.1	1.8	2.9	1.2	2.1	1.0	2.7	78.2	78.4
05.13	1.1	4.8	297.5	60.3	2.1	1.5	4.4	2.4	3.9	91.7	86.2
05.14	0.7	1.6	1206.1	3.8	15.7	1.6	7.4	1.0	4.8	271.2	255.6
05.15	0.8	4.2	1095.9	51.0	23.5	1.8	6.6	2.5	5.0	242.5	189.2
05.16	0.8	1.1	502.1	2.5	10.6	1.5	2.9	1.0	3.8	116.9	121.8
05.17	1.0	1.5	220.0	2.3	4.0	1.4	2.3	0.7	3.1	56.4	47.4
05.18	1.1	2.6	354.1	4.0	3.2	2.4	7.9	0.9	6.7	305.0	173.7
EF of $PM_{2.5}$ in sampling site 2											
Date	Al	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Pb	Zn
05.12	0.9	4.5	132.5	1.5	4.9	1.9	2.4	1.0	3.1	77.0	48.8
05.13	0.9	1.5	1376.8	2.6	5.4	1.2	2.2	0.8	2.6	89.2	79.8
05.14	1.1	2.6	613.2	2.5	7.7	1.4	4.8	0.9	3.7	111.1	38.2
05.15	0.7	1.8	1422.8	4.3	14.3	1.4	7.8	1.2	4.1	306.9	186.0
05.16	0.9	2.4	1280.0	6.5	12.7	1.8	6.9	1.4	5.2	264.1	212.0
05.17	0.9	1.4	630.4	2.5	9.9	1.5	3.0	1.0	3.7	125.9	122.9
05.18	1.0	2.1	47.4	2.2	2.3	1.4	2.2	0.8	3.1	52.1	56.5
EF of PM_{10} in sampling site 1											
Date	Al	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Pb	Zn
05.12	1.0	1.5	129.4	0.7	2.8	1.1	1.4	0.6	1.7	14.7	18.0
05.13	1.0	3.6	109.2	9.6	3.0	1.2	1.8	1.1	2.1	23.5	31.5
05.14	0.9	3.9	356.0	1.5	8.1	1.3	2.6	1.0	2.3	73.3	87.4
05.15	0.9	4.3	325.8	11.7	11.0	1.5	2.5	1.2	2.5	64.5	58.2
05.16	1.0	1.7	149.8	1.2	6.2	1.2	1.7	0.8	2.1	29.9	36.8
05.17	1.0	2.6	125.0	8.4	2.9	1.2	1.6	0.9	2.0	14.0	17.3
05.18	1.0	3.8	114.1	1.8	5.1	1.9	2.6	1.1	3.1	71.1	50.1
EF of PM_{10} in sampling site 2											
Date	Al	Ca	Cd	Cr	Cu	Fe	K	Mg	Mn	Pb	Zn
05.12	1.0	2.0	171.2	0.8	3.2	1.1	1.5	0.7	1.8	19.1	21.7
05.13	1.0	5.0	116.3	10.1	2.4	1.1	1.7	1.2	2.2	22.2	12.5

05.14	0.9	4.5	417.4	1.8	8.6	1.2	2.8	1.0	2.5	83.8	60.3
05.15	0.9	4.5	318.1	2.1	8.1	1.3	2.3	1.0	2.5	60.0	55.4
05.16	0.9	2.5	211.8	6.5	6.2	1.2	1.6	0.9	2.1	31.5	39.3
05.17	1.0	3.3	60.0	1.1	2.9	1.2	1.6	0.8	2.2	16.0	21.4

Table S3. Concentration and proportion of PM components.

Grouping	Sampling site 1		Sampling site 2		Grouping	Sampling site 1		Sampling site 2	
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}		$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}
PM (μg/m³)	53	121	55	148	PM (μg/m³)	53	121	55	148
OC (μg/m³)	5.7	9.2	6.5	10.7	Cl^- (μg/m³)	0.7	1.1	0.3	0.7
EC (μg/m³)	1.8	4.0	2.0	4.6	NO_3^- (μg/m³)	9.2	12.2	8.7	12.8
TC (μg/m³)	7.5	13.3	8.5	15.3	SO_4^{2-} (μg/m³)	7.5	8.0	7.5	8.8
OC/EC	3.18	2.29	3.29	2.34	Na^+ (μg/m³)	0.4	0.5	0.3	0.5
OC/TC%	76.1	69.9	76.7	70.0	NH_4^+ (μg/m³)	5.7	5.4	5.4	4.8
EC/TC%	23.9	30.4	23.3	30.0	K^+ (μg/m³)	0.6	0.6	0.8	0.7
OC/PM%	10.8	7.6	11.8	7.2	Mg^{2+} (μg/m³)	0.0	0.2	0.0	0.2
EC/PM%	3.4	3.3	3.6	3.1	Ca^{2+} (μg/m³)	0.6	4.1	0.9	6.3
$OC_{2.5}/OC_{10}$%	62.1		60.7		ϱ(TWSI) (μg/m³)	24.8	32.1	24.0	34.8
$EC_{2.5}/EC_{10}$%	44.8		43.1		ϱ(TWSI)/ϱ(PM) %	46.8	26.5	43.6	23.5
Al (μg/m³)	0.62	3.58	0.69	3.97	ϱ(SNA) (μg/m³)	22.4	25.7	21.6	26.4
Ca (μg/m³)	0.74	4.66	0.71	6.59	ϱ(SNA)/ϱ(TWSI) %	90.3	80.1	90.0	75.9
Fe (μg/m³)	0.58	2.52	0.63	2.73	NO_3^- /SO_4^{2-}	1.2	1.5	1.2	1.5
K (μg/m³)	0.77	1.84	0.86	2.00	SOR	0.3	0.4	0.3	0.4
Mg (μg/m³)	0.24	0.90	0.20	1.03	NOR	0.3	0.3	0.3	0.3
Mn (μg/m³)	0.02	0.07	0.03	0.08	AE	0.32	0.39	0.31	0.41
Pb (μg/m³)	0.02	0.02	0.02	0.03	CE	0.77	1.04	0.67	1.12
Ti (μg/m³)	0.03	0.18	0.04	0.21	AE/CE	0.42	0.38	0.46	0.37
Zn (μg/m³)	0.07	0.11	0.07	0.11					

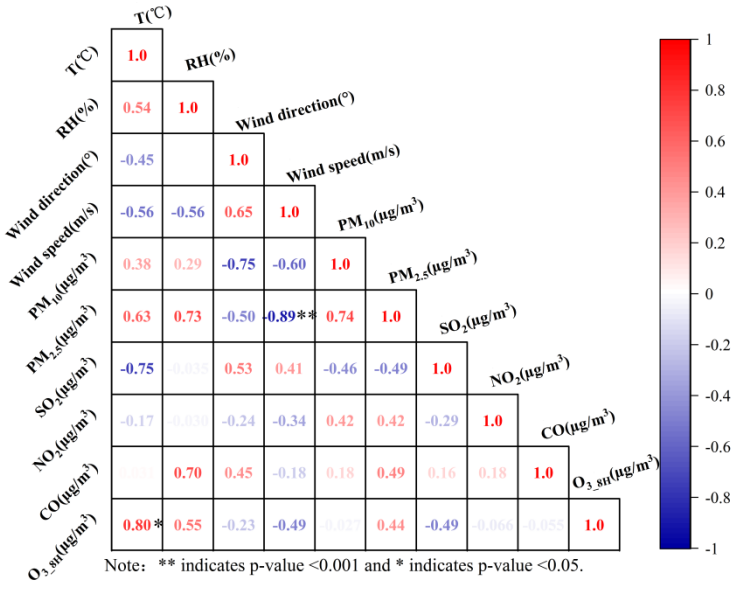

Figure S1. Correlation analysis between pollutants and meteorological factors.

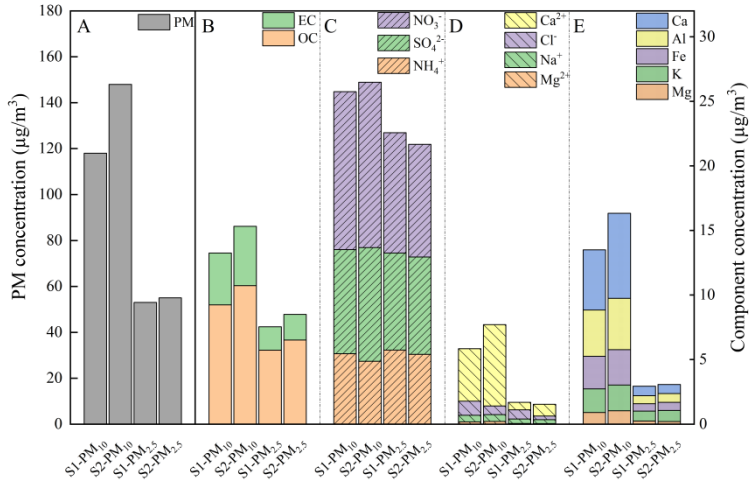

Figure S2. The PM mass concentration (A), OC/EC (B), Sulfate-Nitrate-Ammonium (SNA) (C),Water-Soluble Ion(D), Metal Element (E) concentration in PM (S1-PM_{10} and S2-PM_{10} indicate PM_{10} for sample sites 1 and 2, respectively; S1-$PM_{2.5}$ and S2-PM_{10} indicate $PM_{2.5}$ for sample sites 1 and 2, respectively).

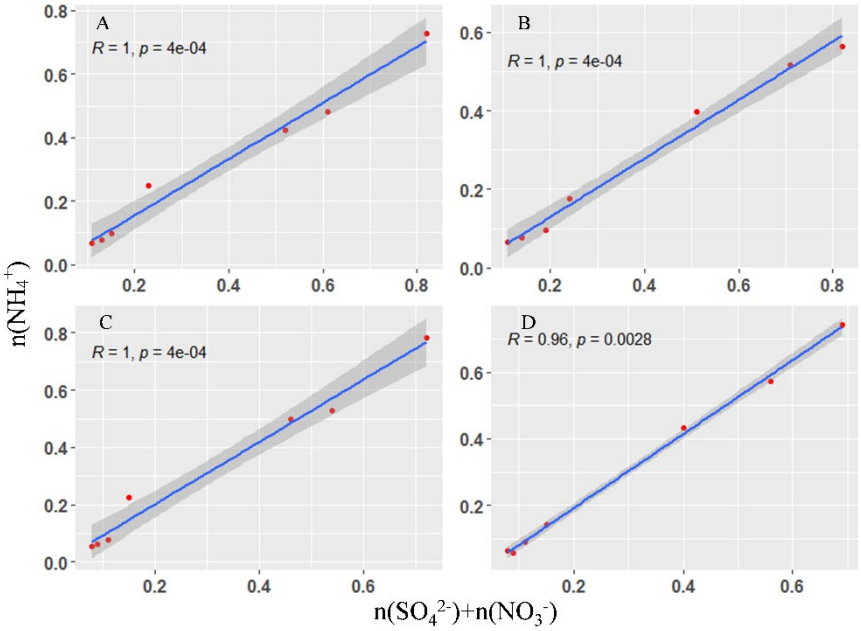

Figure S3. Molar mass relationship between $n(NH_4^+)$ and $n(SO_4^{2-}) + n(NO_3^-)$ in PM.(A: the PM_{10} of sample site 1, B: the PM_{10} of sample site 2, C: the $PM_{2.5}$ of sample site 1, D: the $PM_{2.5}$ of sample site 2).

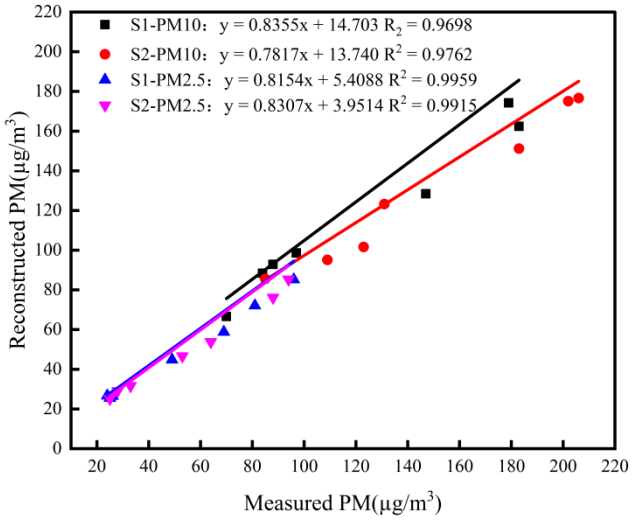

Figure S4. Correlation between the reconstructed and measured PM mass concentration (S1-PM_{10} and S2-PM_{10} indicate PM_{10} for sample sites 1 and 2, respectively; S1-$PM_{2.5}$ and S2-PM_{10} indicate $PM_{2.5}$ for sample sites 1 and 2, respectively).

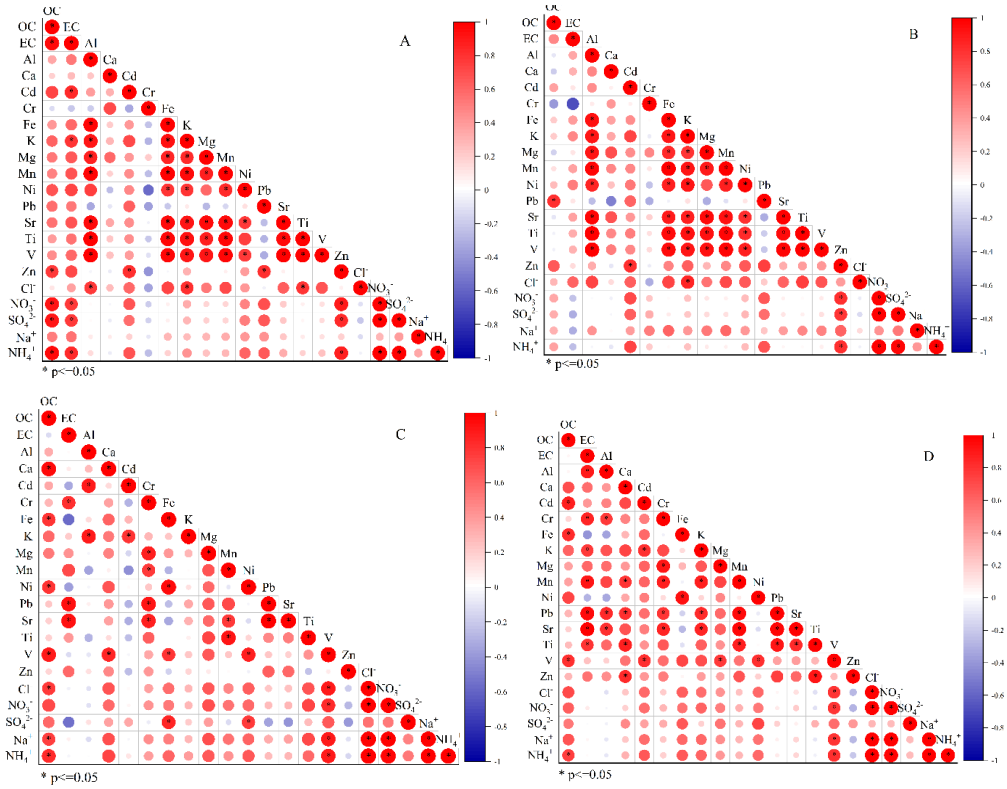

Figure S5. The correlations between the components of $PM_{2.5}$ and PM_{10} (A: the PM_{10} of sample site 1, B: the PM_{10} of sample site 2, C: the $PM_{2.5}$ of sample site 1, D: the $PM_{2.5}$ of sample site 2).

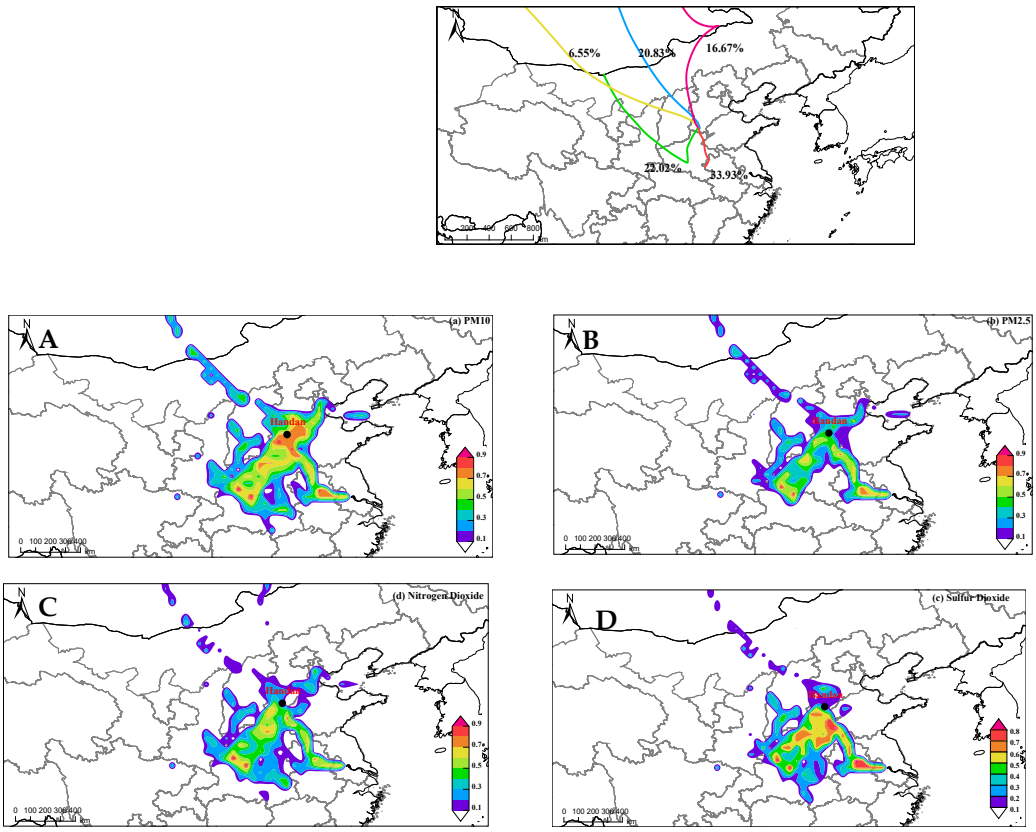

Figure S6. The 48-h backward trajectory and the PSCF analysis based on (A) PM_{10}, (B) $PM_{2.5}$, (C) SO_2, (D) NO_2 concentration.

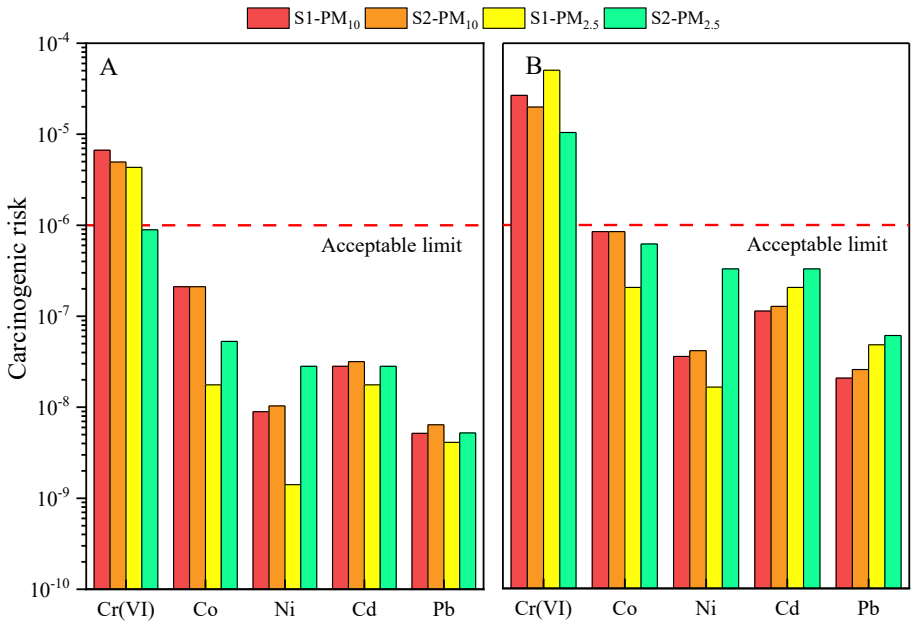

Figure S7. The contribution of different elements to carcinogenic risk (S1-PM_{10} and S2-PM_{10} indicate PM_{10} for sample sites 1 and 2, respectively; S1-$PM_{2.5}$ and S2-PM_{10} indicate $PM_{2.5}$ for sample sites 1 and 2, respectively).