

## **Supporting information**

# **Pollution characteristics and sources of environmentally persistent free radicals and oxidation potential in fine particulate matter related to city lockdown (CLD) in Xi'an, China**

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### **Contents:**

Number of pages: 22

S1: Acronym definitions (S2)

Figures: 12

Tables: 4

**S1: Acronym definitions:**

PM: particulate matter

CLD: city lockdown

EPR: electron paramagnetic resonance

EPFRs: environmentally persistent free radicals

ROS: reactive oxygen species

OP: oxidative potential

DTT: dithiothreitol

Abs: absorbance

WSIs: water-soluble ions

OC: organic carbon

EC: elemental carbon

PMF: positive matrix factorization

**Table S1.** Concentration of air pollutants before and during the CLD, compared to 2019.

<b>Date</b>	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>2</sub></b>	<b>O<sub>3</sub></b>	<b>SO<sub>2</sub></b>	<b>CO</b>
2019.01.14	273	230	93	17	18	2.16
2019.01.15	93	40	42	37	11	0.77
2019.01.16	77	33	51	17	16	0.94
2019.01.17	121	73	69	19	17	1.21
2019.01.18	161	111	82	10	18	1.53
2019.01.19	133	81	66	19	16	1.21
2019.01.20	106	57	60	22	17	1.03
2019.01.21	76	36	50	30	12	0.78
2019.01.22	111	67	82	18	16	1.20
2019.01.23	141	92	82	25	22	1.54
2019.01.24	211	153	96	7	29	2.00
2019.01.25	139	74	57	23	19	1.11
2019.01.26	146	104	58	22	21	1.30
2019.01.27	179	140	63	14	21	1.47
2019.01.28	156	120	63	22	19	1.42
2019.01.29	150	111	66	34	20	1.33
2019.01.30	125	99	60	21	13	1.25
2019.01.31	65	37	26	36	4	0.76
2019.02.01	88	54	36	35	8	1.02
2019.02.02	168	82	36	41	9	1.03
2019.02.03	130	33	23	53	7	0.53
2020.01.14	113	90	49	22	14	1.22
2020.01.15	154	152	55	10	11	1.47
2020.01.16	165	169	55	9	11	1.82
2020.01.17	211	195	68	7	10	2.00
2020.01.18	209	191	68	15	8	1.68
2020.01.19	87	48	47	33	10	0.79
2020.01.20	99	57	49	31	16	1.00
2020.01.21	118	91	50	31	18	1.37
2020.01.22	158	145	51	29	14	1.50
2020.01.23	229	223	58	26	14	1.90
2020.01.24	225	217	34	41	14	1.81
2020.01.25	226	225	24	46	12	1.75
2020.01.26	159	158	21	49	9	1.41
2020.01.27	70	71	16	62	8	1.00
2020.01.28	57	56	21	51	8	1.07
2020.01.29	67	64	23	52	10	1.03
2020.01.30	75	70	29	61	12	1.02

**Table S1.** Continued

2020.01.31	118	117	33	62	14	1.28
2020.02.01	135	138	31	63	17	1.49
2020.02.02	71	64	15	73	10	0.83
2020.02.03	54	44	22	58	13	0.83

**Table S2.** Concentration of 9 water-soluble ions before and during the CLD, compared to 2019.

Date	Na <sup>+</sup>	K <sup>+</sup>	Mg <sup>2+</sup>	Ca <sup>2+</sup>	NH <sub>4</sub> <sup>+</sup>	NO <sub>3</sub> <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	F <sup>-</sup>	Cl <sup>-</sup>
2019.01.14	0.48	1.81	0.16	4.31	21.09	32.18	20.57	0.31	4.64
2019.01.15	0.94	0.53	0.21	5.93	2.94	4.1	5.9	0.22	1.51
2019.01.16	0.79	0.99	0.21	5.89	5.44	6.52	6.65	0.25	3.88
2019.01.17	0.65	1.42	0.22	5.66	9.62	13.75	8.94	0.31	4.93
2019.01.18	0.66	1.51	0.22	5.38	11.99	17.56	10.31	0.32	5.67
2019.01.19	0.73	1	0.25	6.82	7.39	10.12	8.01	0.32	3.64
2019.01.20	0.78	0.53	0.29	8.19	4.85	6.39	7.68	0.3	2.32
2019.01.21	0.84	0.8	0.28	7.16	5.42	7.42	7.94	0.26	3.26
2019.01.22	0.38	1.11	0.17	4.84	8.17	11.96	6.51	0.22	3.93
2019.01.23	0.78	1.95	0.24	6.24	11.56	15.65	10.44	0.34	6.44
2019.01.24	0.98	2.26	0.38	7.94	16.27	23.32	14.24	0.5	8.18
2019.01.25	0.97	1	0.29	7.37	9.08	14.56	9.63	0.39	3.13
2019.01.26	0.53	1.32	0.28	5.44	14.52	24.11	11.14	0.59	4.12
2019.01.27	0.51	2.22	0.31	6.1	23.33	38.8	21.31	0.45	6.12
2019.01.28	0.62	2.2	0.31	6.46	17.53	25.05	15.2	0.44	7.33
2019.01.29	0.44	1.61	0.22	5.29	14.42	21.74	12.32	0.31	5.39
2019.01.30	0.03	0.46	0.04	0.63	7.85	10.95	10.01	0.11	2.35
2019.01.31	0.31	0.53	0.11	2.58	4.49	4.71	8.1	0.14	1.32
2019.02.01	0.35	1.39	0.12	2.17	11.13	11.3	15.09	0.23	3.58
2019.02.02	3.27	0.77	0.62	12.21	5.14	6.69	15.6	0.37	3.6
2019.02.03	1.46	0.71	0.36	7.43	2.66	3.46	6.6	0.2	2.74
2020.01.14	0.38	0.91	0.26	4.62	13.5	2.42	2.36	0.09	0.31
2020.01.15	0.02	0.69	0	0	18.1	22.55	20.18	0.12	2.08
2020.01.16	0.03	1.09	0.01	0.29	20.59	26.14	22.44	0.14	2.92
2020.01.17	0.09	1.45	0.03	0.38	31.36	4.46	4.09	0.09	0.53
2020.01.18	0.25	1.07	0.11	2.02	22.93	29.8	26.58	0.19	3.74
2020.01.19	1.06	0.56	0.18	4.55	3.18	3.89	6.26	0.14	2.61
2020.01.20	0.65	0.96	0.17	3.96	7.13	9.79	8.22	0.23	2.96
2020.01.21	0.35	1.42	0.16	2.36	10.35	15.82	10.08	0.23	4.06
2020.01.22	0.16	2.42	0.17	1.62	20.37	29.6	20.19	0.27	5.17
2020.01.23	0.3	2.65	0.12	1.13	27.69	38.68	27.92	0.21	6.33
2020.01.24	0.1	3.08	0.19	0.2	21.35	24.1	29.44	0.22	4.34
2020.01.25	0.1	6.16	0.44	0.11	22.03	23.09	35.4	0.25	5.15
2020.01.26	0	0.77	0.03	0.15	11.4	10.26	17.32	0.1	1.43
2020.01.27	0	0.74	0.04	0.12	9.87	8.91	14.94	0.13	1.46
2020.01.28	0.02	0.83	0.05	0.36	7.23	6.81	11.24	0.13	1.49
2020.01.29	0.02	0.69	0.06	0.54	6.74	6.02	11.18	0.15	1.11

**Table S2.** Continued

2020.01.30	0.13	1.61	0.07	0.55	10.53	10.74	14.83	0.21	2.83
2020.01.31	0.11	1.41	0.11	0.94	14.25	17.27	16.64	0.21	3.74
2020.02.01	0.18	1.15	0.04	0.4	12.17	13.15	15	0.15	3.73
2020.02.02	0.24	0.34	0.06	1.07	3.05	3.48	5.01	0.13	0.82
2020.02.03	0.24	1.02	0.08	0.96	6.2	8.31	6.53	0.16	2.5

**Table S3.** The concentrations of organic carbon (OC) and elemental carbon (EC), OC/EC ratio before and during the CLD, compared to 2019.

<b>Date</b>	<b>OC ug/m<sup>3</sup></b>	<b>EC ug/m<sup>3</sup></b>	<b>OC/EC ratio</b>
2019.01.14	47.42	2.18	21.71
2019.01.15	23.72	2.19	10.84
2019.01.16	27.61	2.49	11.09
2019.01.17	49.88	5.22	9.55
2019.01.18	39.26	8.20	4.78
2019.01.19	33.73	3.72	9.06
2019.01.20	20.51	7.87	2.61
2019.01.21	30.40	3.99	7.62
2019.01.22	40.70	3.34	12.20
2019.01.23	43.95	2.03	21.62
2019.01.24	51.57	7.36	7.00
2019.01.25	25.95	5.72	4.54
2019.01.26	37.85	3.33	11.38
2019.01.27	47.27	2.91	16.26
2019.01.28	43.60	3.12	13.96
2019.01.29	38.74	2.13	18.17
2019.01.30	18.86	1.07	17.58
2019.01.31	16.72	3.54	4.73
2019.02.01	28.03	2.36	11.89
2019.02.02	27.51	8.52	3.23
2019.02.03	14.97	7.67	1.95
2020.01.14	21.93	2.52	8.71
2020.01.15	17.58	1.76	10.00
2020.01.16	20.97	0.84	24.97
2020.01.17	26.90	1.50	17.89
2020.01.18	28.61	1.50	19.09
2020.01.19	21.56	1.09	19.76
2020.01.20	22.21	3.87	5.74
2020.01.21	29.97	2.32	12.92
2020.01.22	38.35	2.13	18.01
2020.01.23	42.12	1.69	24.94
2020.01.24	34.70	1.66	20.85
2020.01.25	25.15	1.52	16.49
2020.01.26	12.04	0.83	14.43
2020.01.27	10.01	5.74	1.74
2020.01.28	17.00	0.93	18.32

**Table S3.** Continued

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2020.01.29	19.61	0.97	20.12
2020.01.30	26.87	1.35	19.92
2020.01.31	29.61	1.48	20.01
2020.02.01	25.11	0.28	90.20
2020.02.02	14.83	0.47	31.63
2020.02.03	23.49	0.55	43.07

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**Table S4.** Signal characteristics and EPFR concentrations in atmospheric PM<sub>2.5</sub> samples before and during the CLD, same as in 2019.

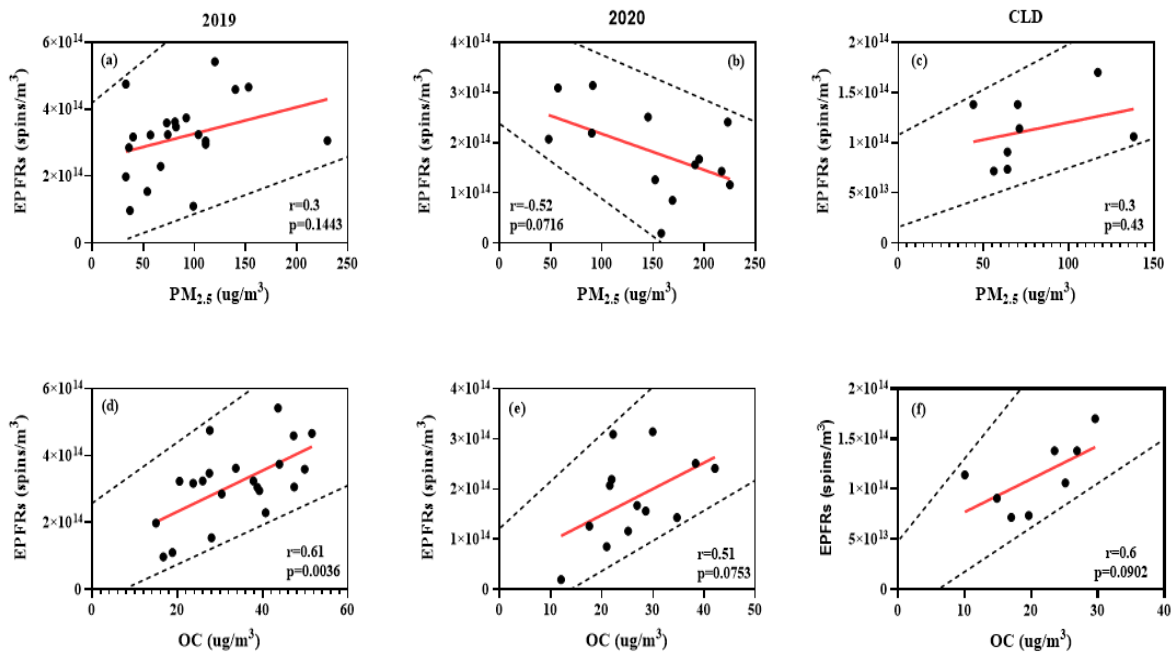
Sampling date	PM <sub>2.5</sub> concentration (µg/m <sup>3</sup> )	<i>g</i> factor	$\Delta H_{p-p}$	Spin concentration in PM <sub>2.5</sub> (×10 <sup>18</sup> spins/g)	Atmospheric concentration (×10 <sup>14</sup> spins/m <sup>3</sup> )
2019.01.14	230	2.0028	5.5106	1.33E+18	3.06E+14
2019.01.15	40	2.0029	4.9514	7.92E+18	3.17E+14
2019.01.16	33	2.0028	5.5946	1.44E+19	4.75E+14
2019.01.17	73	2.0028	5.8028	4.92E+18	3.59E+14
2019.01.18	111	2.0025	5.8456	2.66E+18	2.95E+14
2019.01.19	81	2.0027	5.707	4.46E+18	3.62E+14
2019.01.20	57	2.0028	5.4675	5.67E+18	3.23E+14
2019.01.21	36	2.0028	5.6146	7.92E+18	2.85E+14
2019.01.22	67	2.0028	5.7204	3.42E+18	2.29E+14
2019.01.23	92	2.0028	5.7482	4.07E+18	3.74E+14
2019.01.24	153	2.0026	5.7459	3.05E+18	4.66E+14
2019.01.25	74	2.0027	5.2702	4.37E+18	3.24E+14
2019.01.26	104	2.0028	5.2884	3.12E+18	3.24E+14
2019.01.27	140	2.0028	6.2825	3.28E+18	4.59E+14
2019.01.28	120	2.0029	5.5364	4.52E+18	5.42E+14
2019.01.29	111	2.0028	5.1267	2.75E+18	3.05E+14
2019.01.30	99	2.0031	4.9503	1.11E+18	1.10E+14
2019.01.31	37	2.0031	4.8426	2.63E+18	9.74E+13
2019.02.01	54	2.0029	4.8177	2.86E+18	1.54E+14
2019.02.02	82	2.003	5.1103	4.23E+18	3.47E+14
2019.02.03	33	2.0031	5.6611	6.01E+18	1.98E+14
2020.01.14	90	2.0032	5.1307	2.43E+18	2.19E+14
2020.01.15	152	2.0029	5.9517	8.30E+17	1.26E+14
2020.01.16	169	2.0029	4.6332	5.05E+17	8.53E+13
2020.01.17	195	2.0028	6.1481	8.54E+17	1.67E+14
2020.01.18	191	2.0033	5.0538	8.16E+17	1.56E+14
2020.01.19	48	2.003	5.7787	4.31E+18	2.07E+14
2020.01.20	57	2.003	5.6396	5.42E+18	3.09E+14
2020.01.21	91	2.0031	5.4585	3.45E+18	3.14E+14
2020.01.22	145	2.003	5.0656	1.73E+18	2.51E+14
2020.01.23	223	2.0031	4.9591	1.08E+18	2.41E+14
2020.01.24	217	2.003	4.6044	6.57E+17	1.43E+14
2020.01.25	225	2.0031	4.4476	5.15E+17	1.16E+14
2020.01.26	158	2.0031	3.1282	1.24E+17	1.95E+13

**Table S4.** Continued

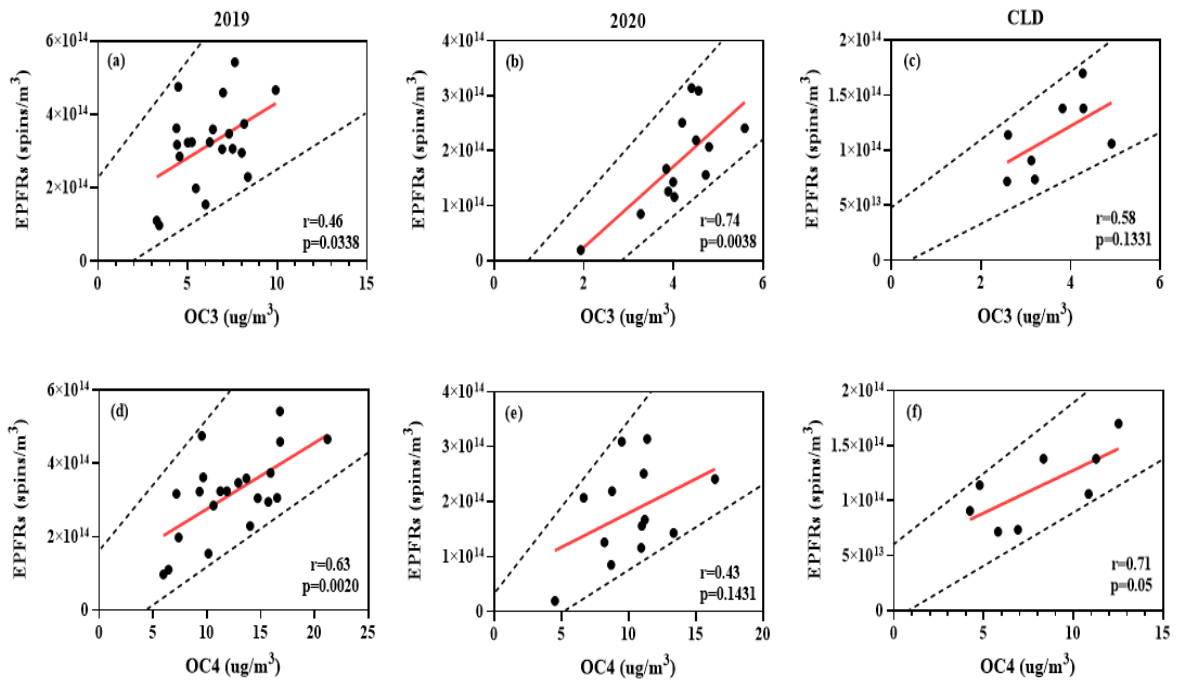
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2020.01.27	71	2.003	6.2308	1.61E+18	1.14E+14
2020.01.28	56	2.0031	4.4229	1.28E+18	7.17E+13
2020.01.29	64	2.0029	4.492	1.15E+18	7.36E+13
2020.01.30	70	2.0031	4.6518	1.97E+18	1.38E+14
2020.01.31	117	2.0032	4.958	1.45E+18	1.70E+14
2020.02.01	138	2.0031	4.5375	7.66E+17	1.06E+14
2020.02.02	64	2.0031	5.042	1.42E+18	9.07E+13
2020.02.03	44	2.0031	4.8571	3.14E+18	1.38E+14

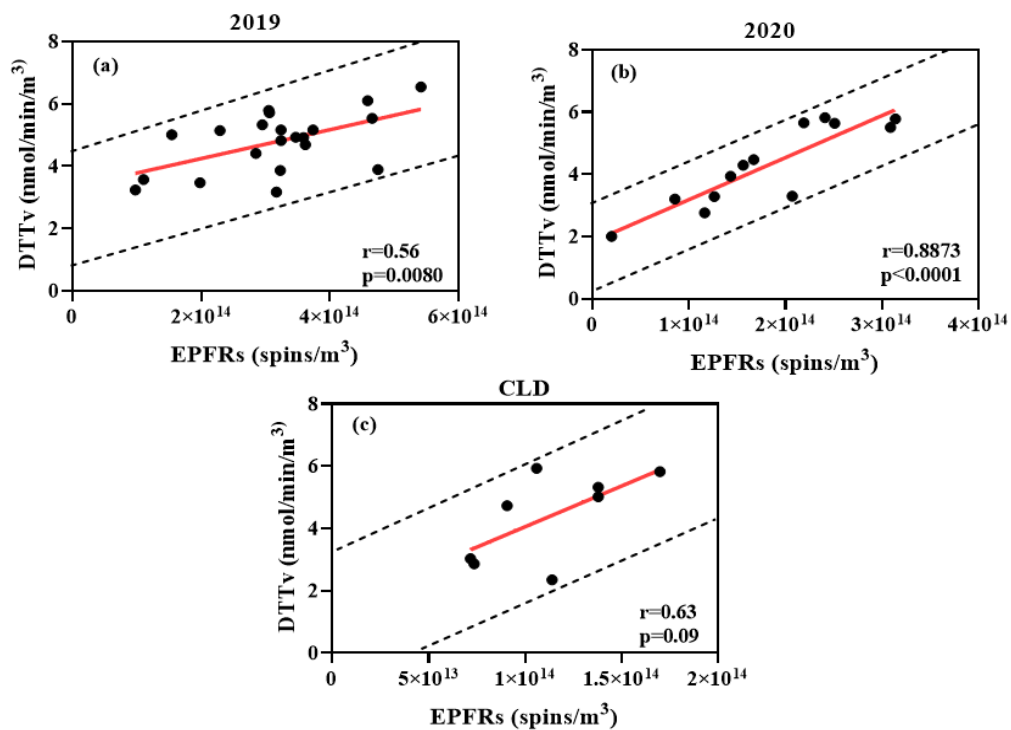
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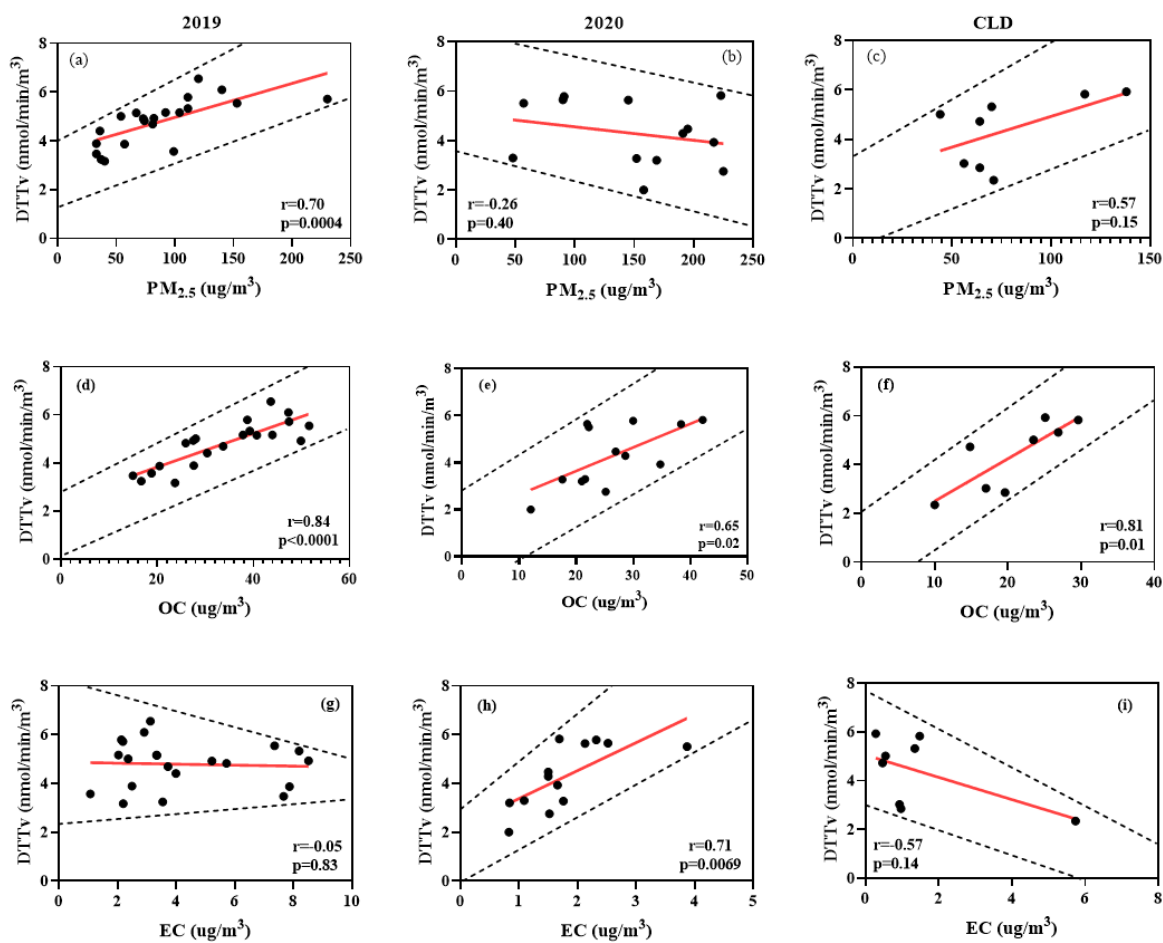
**Fig.S1.** The correlation analysis between EPFRs and PM<sub>2.5</sub> (a, b, c); OC (d, e, f) before and during CLD.



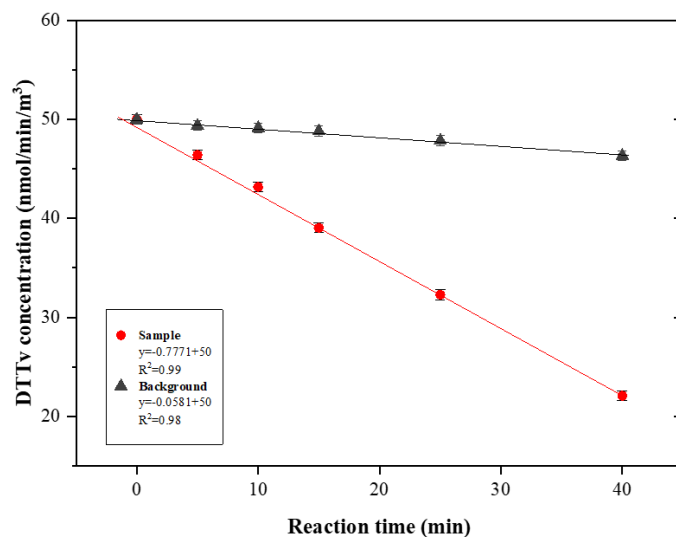
**Fig.S2.** The correlation analysis between EPRs and OC3 (a, b, c); OC4 (d, e, f) before and during CLD.



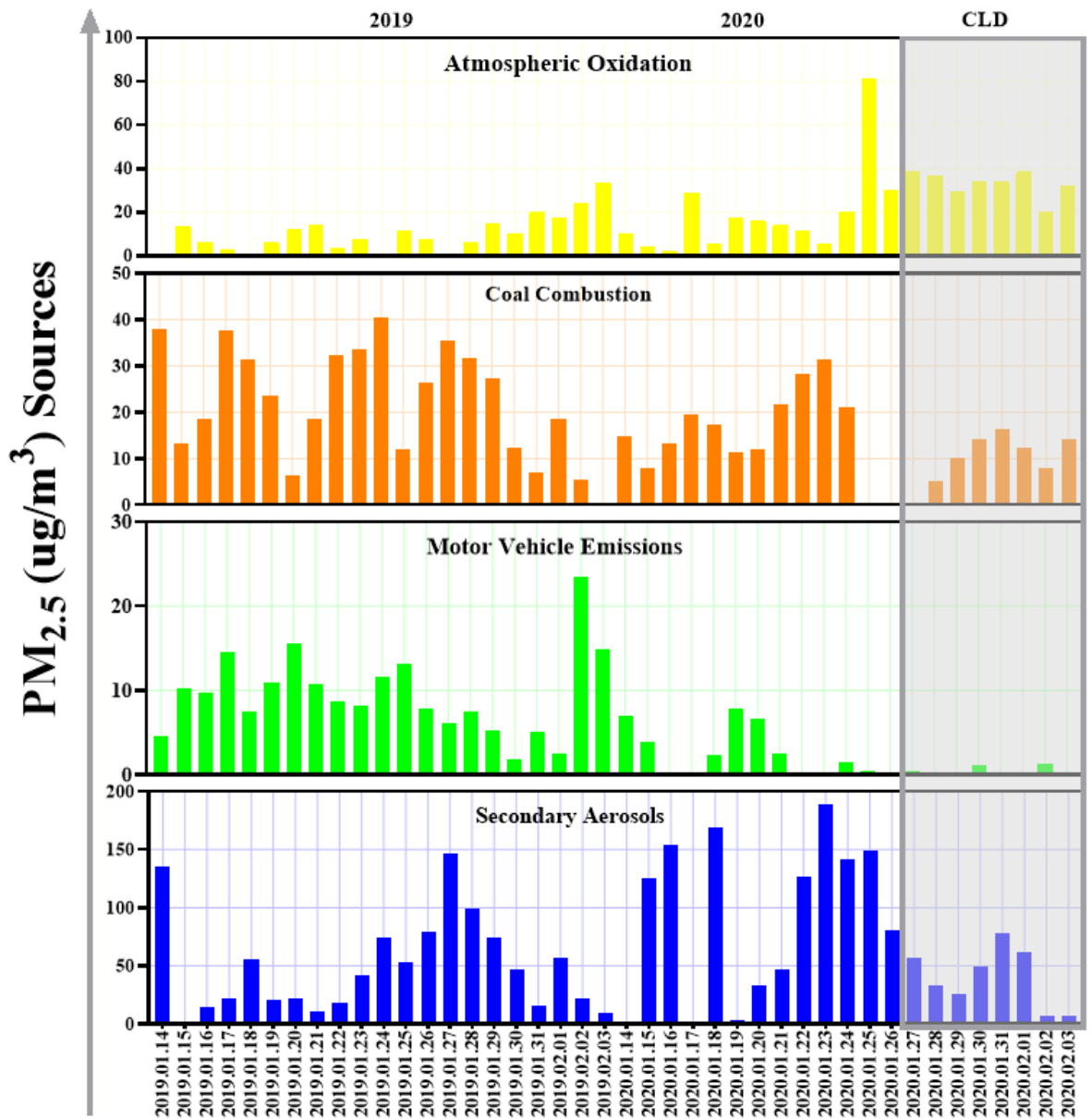
**Fig.S3.** The correlation analysis between DTTv and EPFRs (a, b, c) before and during CLD.



**Fig.S4.** The correlation analysis between DTTv and PM<sub>2.5</sub> (a, b, c); OC (d, e, f), and EC (g, h, i) before and during CLD.

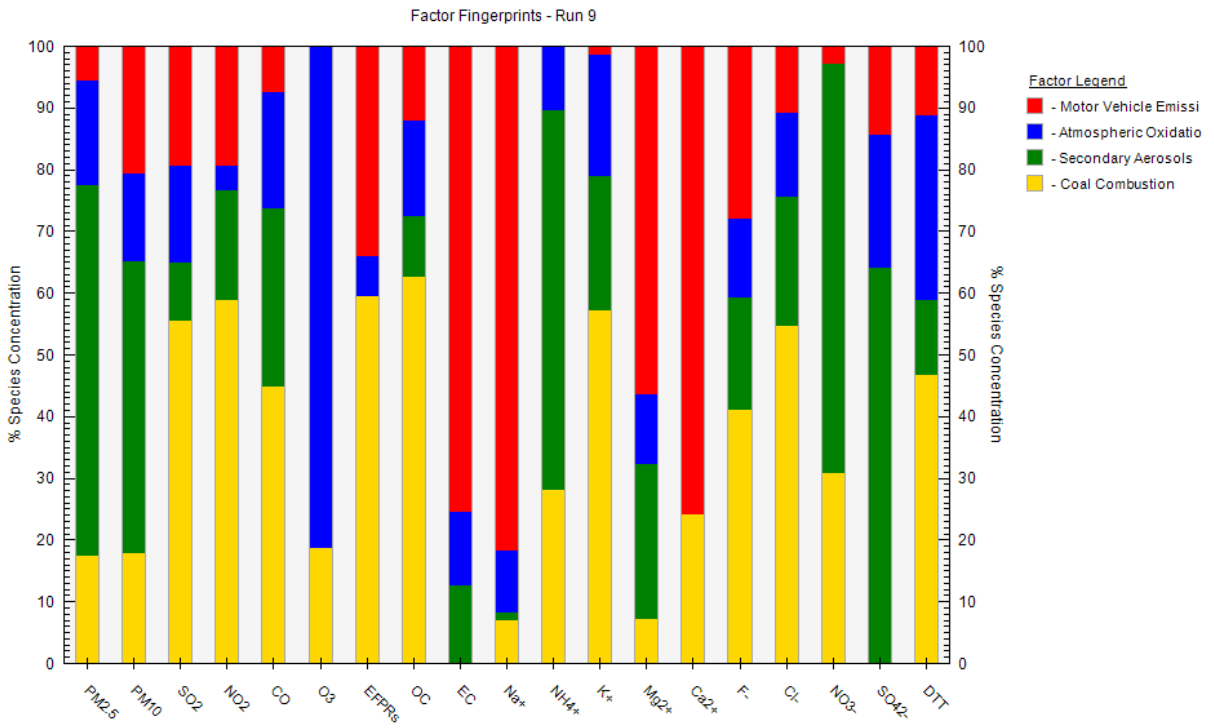


**Fig.S5.** Parallelism of random samples ( $n=3$ ) and background ( $n=3$ ) during the city lockdown in Xi'an, 2020. The error bars indicate the standard deviation.

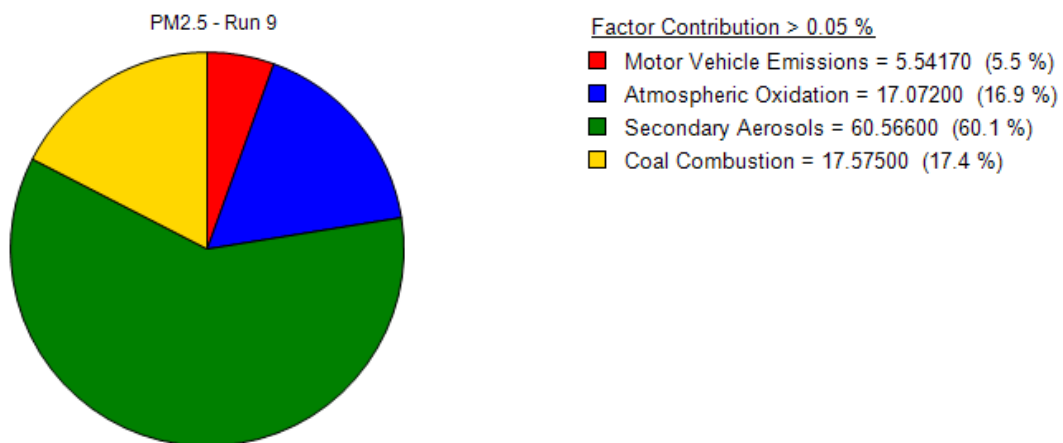


**Fig.S6.** Analysis of PM<sub>2.5</sub> source contributions by PMF model before and during the CLD. The bars represent the concentrations of various species to the factors.

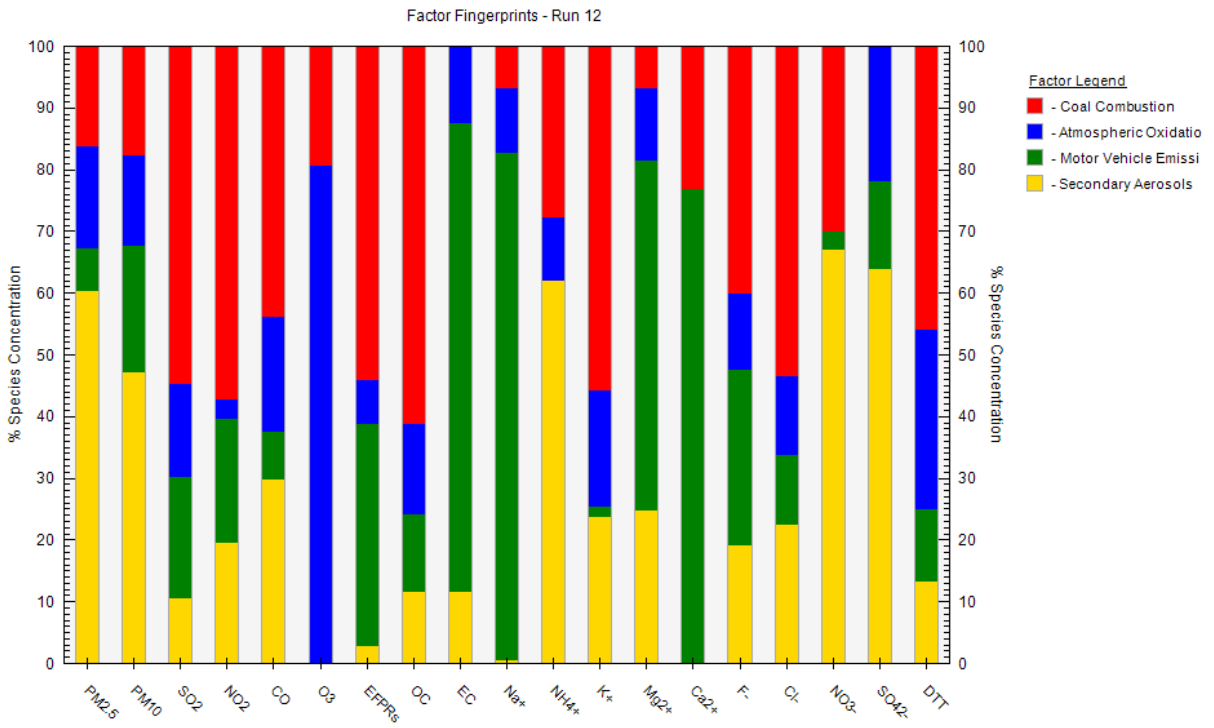




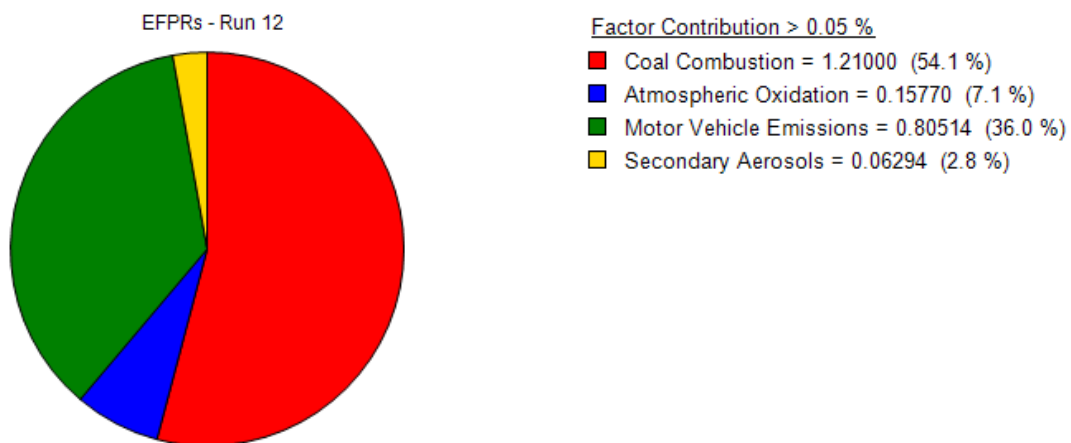
**Fig.S7.** Source apportionment of PM<sub>2.5</sub> based on PMF model analysis before and during the city lockdown (CLD)



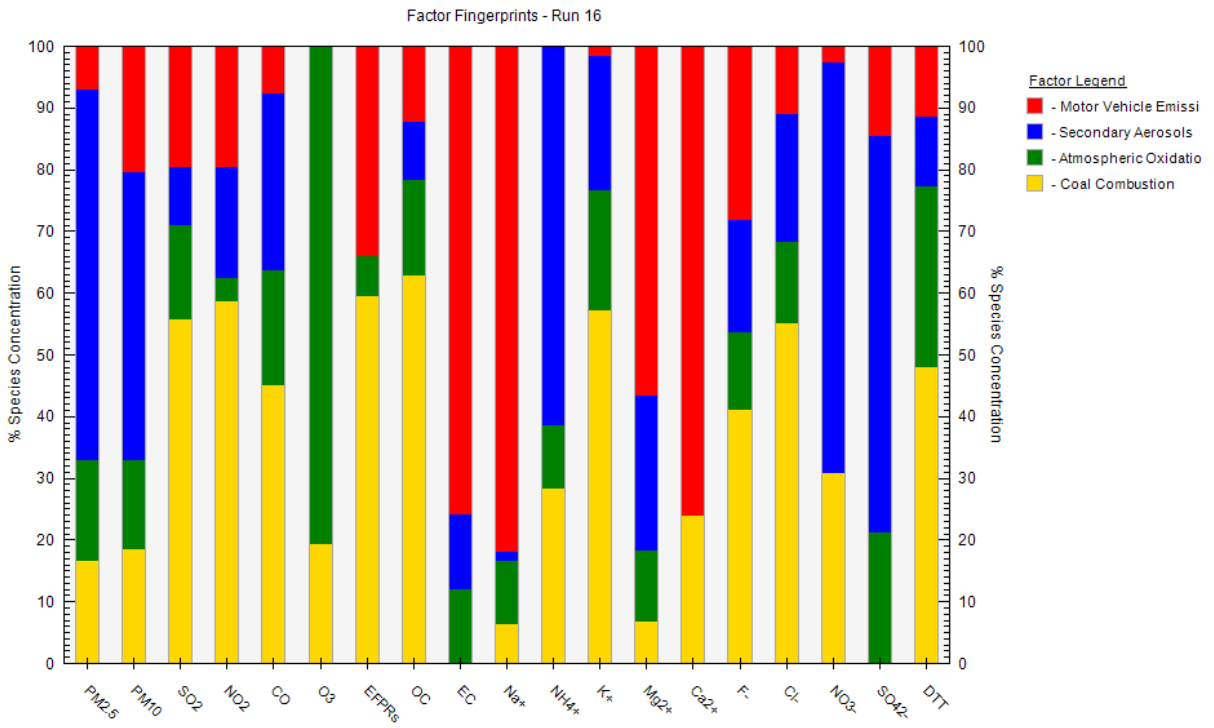
**Fig.S8.** Percentages of the different source contributions to PM<sub>2.5</sub> based on PMF model analysis before and during the city lockdown (CLD)



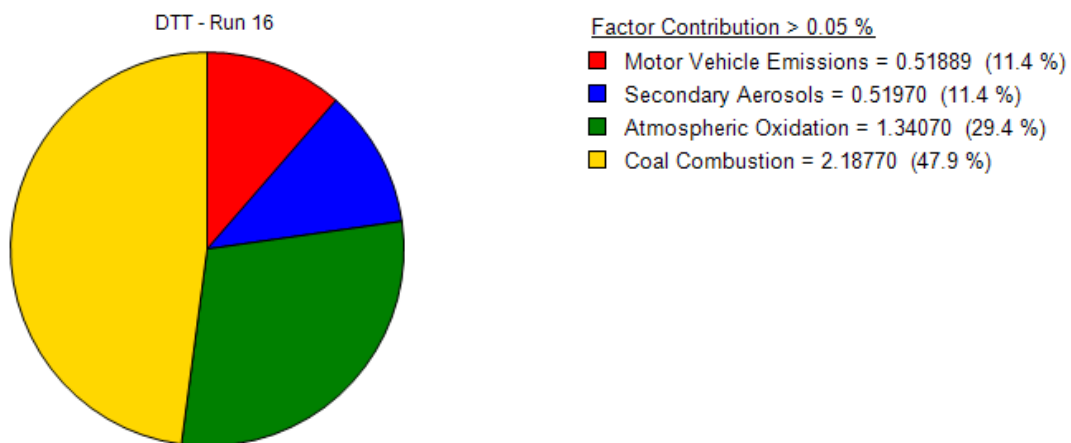
**Fig.S9.** Source apportionment of EPFRs based on PMF model analysis before and during the city lockdown (CLD)



**Fig.S10.** Percentages of the different source contributions to EPFRs based on PMF model analysis before and during the city lockdown (CLD)



**Fig.S11.** Source apportionment of DTTv based on PMF model analysis before and during the city lockdown (CLD)



**Fig.S12.** Percentages of the different source contributions to DTTv based on PMF model analysis before and during the city lockdown (CLD)