

Supplementary Materials

Seasonal Variation Characteristics of Bacteria and Fungi in PM_{2.5} in Typical Basin Cities of Xi'an and Linfen, China

Sen Wang ^{1,2,*}, Wanyu Liu ^{1,2}, Jun Li ^{1,2}, Haotian Sun ^{1,2}, Yali Qian ^{1,2}, Liuyi Ding ^{1,2}, Hao Ma ^{1,2} and Jiao Li ^{1,2}

¹ Shaanxi Key Laboratory of Earth Surface System and Environmental Carrying Capacity, College of Urban and Environmental Science, Northwest University, Xi'an 710127, China; liuwanyu@stumail.nwu.edu.cn (W.L.); 201931878@stumail.nwu.edu.cn (J.L.); sunhaotian@nwu.edu.cn (H.S.); 201631652@stumail.nwu.edu.cn (Y.Q.); 201620794@stumail.nwu.edu.cn (L.D.); 201820837@stumail.nwu.edu.cn (H.M.); lijiao2@stumail.nwu.edu.cn (J.L.)

² Shannxi Xi'an Urban Forest Ecosystem Research Station, Xi'an 710127, China;

* Correspondence: wangsen@nwu.edu.cn

Five table (Table S1-S5) and three figure (Figure S1-S3), 17 pages.

Lists of tables:

Table S1 Pollution and meteorological data in sampling period of Xi'an and Linfen.

Table S2 Functional groups related to the carbon cycling.

Table S3 Functional groups related to the nitrogen cycling.

Table S4 Functional groups related to the human pathogens.

Table S5 Functional groups related to the sulfur cycling.

Tables

Table S1 Pollution and meteorological data in sampling period of Xi'an and Linfen.

Sample	Group	Year	Date	PM _{2.5} (ug/m ³)	PM ₁₀ (ug/m ³)	CO (mg/m ³)	NO ₂ (ug/m ³)	SO ₂ (ug/m ³)	O ₃ (ug/m ³)	AQI	Temperature (°C)	Relative humidity (%)	Wind scale
XA1	WXA	2017	December 24	43	150	1.4	57	22	88	100	4	34	1
XA2	WXA		December 25	93	197	1.9	74	32	39	129	1	49	1
XA3	WXA		December 26	139	217	2.7	107	45	21	183	2	53	1
XA4	WXA		December 27	236	308	3.1	121	45	26	281	1	67	0
XA5	WXA		December 28	288	350	3	99	35	62	337	1	73	0
XA6	WXA	2018	January 1	160	310	2.4	83	30	60	215	1	65	0
XA7	WXA		January 2	225	368	2.9	91	57	10	278	0	78	0
XA8	WXA		January 3	163	274	2.5	71	21	13	207	0	91	1
XA9	WXA		January 4	91	102	1.2	42	14	38	120	-3	92	0
XA10	WXA		January 5	124	136	1.5	43	26	37	163	-3	87	1
XA11	WXA		January 6	128	150	1.8	29	22	69	168	-2	96	0
XA12	WXA		January 7	95	116	1.6	28	27	98	125	0	84	1
XA13	WXA		January 8	38	84	0.9	33	24	107	68	-1	55	1
XA14	WXA		January 9	88	147	1.5	59	34	98	124	0	60	0
XA15	SPXA		April 19	38	148	1.3	62	10	138	102	23	58	1
XA16	SPXA		April 20	46	112	1.3	29	11	126	83	21	71	1
XA17	SPXA		April 21	38	57	1.3	30	9	133	62	20	81	1
XA18	SPXA		April 22	83	92	1.3	54	8	104	113	19	88	1
XA19	SPXA		April 24	25	51	1.2	21	8	58	50	14	87	1
XA20	SPXA		April 25	15	28	1.1	21	8	89	30	14	87	1
XA21	SPXA		April 26	20	45	1	40	8	155	45	17	75	0
XA22	SUXA		July 30	21	39	0.8	28	5	163	47	29	74	1
XA23	SUXA		July 31	22	39	0.9	27	4	177	42	27	80	0

XA24	SUXA	August 1	21	41	0.7	21	5	202	45	28	80	1
XA25	SUXA	August 2	12	25	0.6	37	6	107	30	30	64	0
XA26	SUXA	August 3	33	54	0.7	37	6	247	67	30	67	1
XA27	SUXA	August 4	36	67	0.8	36	6	249	79	30	63	1
XA28	SUXA	August 5	40	70	0.8	51	6	276	78	30	64	0
XA29	AXA	October 27	49	77	0.8	59	9	91	72	10	64	0
XA30	AXA	October 28	30	70	0.8	55	9	102	60	13	51	1
XA31	AXA	October 29	27	59	0.7	53	9	103	54	13	47	0
XA32	AXA	October 30	26	64	0.7	54	8	102	56	14	43	0
XA33	AXA	November 5	30	46	0.8	41	7	28	45	6	94	1
XA34	AXA	November 6	19	24	0.7	28	7	54	29	5	93	1
XA35	AXA	November 7	25	31	0.8	38	7	81	40	5	92	0
LF1	WLF	January 16	312	416	5.4	94	179	81	354	0	64	1
LF2	WLF	January 17	172	239	3.1	58	143	73	219	1	49	1
LF3	WLF	January 18	117	180	2.3	69	173	30	151	0	49	0
LF4	WLF	January 19	232	298	4.3	89	209	57	279	0	58	1
LF5	WLF	January 22	274	392	4.8	93	248	81	314	2	56	1
LF6	WLF	January 23	21	55	1	31	47	64	51	0	27	1
LF7	WLF	January 24	74	124	1.8	54	126	49	108	-1	32	1
LF8	SPLF	April 18	65	161	1.6	46	34	207	106	21	47	1
LF9	SPLF	April 19	59	143	1.3	24	22	238	100	23	44	1
LF10	SPLF	April 20	48	106	1.2	25	14	181	83	22	47	1
LF11	SPLF	April 21	89	121	2.1	32	15	95	118	19	88	1
LF12	SPLF	April 22	49	71	1.5	21	22	78	71	16	65	2
LF13	SPLF	April 24	57	94	2.1	33	23	80	81	16	67	2
LF14	SPLF	April 25	82	111	2	27	15	103	110	15	74	1
LF15	SPLF	April 26	83	127	1.9	37	16	174	111	17	68	1

LF16	SPLF	April 27	79	138	1.7	30	19	203	110	21	51	1
LF17	SULF	July 30	51	77	1.1	18	20	173	74	28	66	1
LF18	SULF	July 31	40	65	1	24	11	152	61	25	87	1
LF19	SULF	August 1	34	53	0.8	16	9	125	53	27	76	1
LF20	SULF	August 2	42	64	0.9	19	7	147	62	28	69	1
LF21	SULF	August 3	70	102	1.1	20	8	214	96	29	62	1
LF22	SULF	August 4	89	129	1.2	25	18	301	126	30	56	1
LF23	SULF	August 5	49	78	1	18	15	187	71	30	52	1
LF24	ALF	October 27	28	86	1.3	47	23	124	69	9	38	1
LF25	ALF	October 28	30	81	1.6	46	25	90	61	12	32	1
LF26	ALF	October 29	24	75	1.2	43	20	94	56	13	33	1
LF27	ALF	October 30	29	87	1.3	50	26	104	67	11	39	1
LF28	ALF	October 31	29	94	1.1	52	29	84	72	11	37	1
LF29	ALF	November 1	70	137	1.5	70	58	162	105	13	33	1
LF30	ALF	November 2	54	103	1.1	39	14	177	81	13	45	1

Table S2 Functional groups related to the carbon cycling.

Groups	WXA	SPXA	SUXA	AXA	WLF	SPLF	SULF	ALF
aerobic chemoheterotrophy	22.16%	20.31%	19.55%	16.39%	4.34%	22.13%	18.75%	18.39%
chemoheterotrophy	24.07%	20.20%	9.40%	27.34%	11.92%	26.82%	19.08%	15.07%
phototrophy	1.27%	2.12%	0.45%	1.57%	0.28%	0.29%	0.92%	0.51%
photoautotrophy	0.92%	0.66%	0.32%	0.25%	0.21%	0.11%	0.60%	0.36%
photoheterotrophy	0.76%	1.42%	0.12%	0.61%	0.18%	0.14%	0.33%	1.02%
anoxygenic photoautotrophy S oxidizing	0.02%	0.01%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%
anoxygenic photoautotrophy	0.02%	0.01%	0.00%	0.00%	0.01%	0.01%	0.00%	0.01%
oxygenic photoautotrophy	0.76%	0.65%	0.32%	0.25%	0.20%	0.10%	0.60%	0.35%
cellulolysis	0.09%	0.04%	0.02%	0.07%	0.09%	0.05%	0.02%	0.10%
methyлотrophy	1.17%	1.29%	1.43%	1.82%	1.84%	0.88%	1.66%	4.00%
methanol oxidation	1.14%	1.12%	1.43%	1.80%	1.83%	1.02%	1.22%	2.86%
hydrocarbon degradation	10.14%	4.67%	3.62%	1.07%	10.86%	6.00%	4.67%	1.81%
methanotrophy	0.04%	0.03%	0.00%	0.02%	0.01%	0.04%	0.03%	0.03%
methanogenesis	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
cyanobacteria	0.76%	0.65%	0.32%	0.25%	0.20%	0.10%	0.60%	0.35%
animal parasites or symbionts	2.84%	8.16%	17.62%	7.41%	4.99%	6.30%	8.81%	6.06%
human gut	0.39%	0.75%	1.76%	0.47%	1.60%	0.94%	0.60%	0.86%
mammal gut	0.57%	0.66%	1.76%	0.79%	1.69%	0.94%	0.60%	1.33%
chloroplasts	1.75%	1.51%	0.37%	1.09%	1.16%	5.91%	0.75%	2.61%
methanogenesis by CO ₂ reduction with H ₂	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
hydrogenotrophic methanogenesis	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
aromatic hydrocarbon degradation	0.19%	0.13%	0.15%	0.29%	3.35%	0.07%	0.24%	0.11%
aromatic compound degradation	1.83%	3.24%	4.27%	3.17%	3.20%	4.56%	5.25%	4.06%
aliphatic non methane hydrocarbon degradation	0.17%	0.10%	0.08%	0.10%	2.98%	0.06%	0.07%	0.16%
fumarate respiration	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

reductive acetogenesis	0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.01%
fermentation	4.98%	11.99%	17.74%	7.81%	18.99%	8.99%	12.71%	5.73%

Table S3 Functional groups related to the nitrogen cycling.

Groups	WXA	SPXA	SUXA	AXA	WLF	SPLF	SULF	ALF
aerobic ammonia oxidation	0.10%	0.23%	0.01%	0.08%	0.02%	0.07%	0.01%	0.13%
aerobic nitrite oxidation	0.17%	0.12%	0.07%	0.05%	0.06%	0.02%	0.06%	0.08%
nitrification	0.25%	0.36%	0.08%	0.11%	0.08%	0.06%	0.07%	0.24%
nitrate denitrification	0.58%	0.74%	0.45%	1.59%	0.38%	0.46%	0.82%	1.71%
nitrite denitrification	0.58%	0.74%	0.45%	1.59%	0.38%	0.46%	0.82%	1.71%
nitrous oxide denitrification	0.58%	0.74%	0.45%	1.59%	0.38%	0.46%	0.82%	1.71%
denitrification	0.58%	0.74%	0.45%	1.59%	0.38%	0.46%	0.82%	1.71%
nitrate ammonification	0.90%	0.06%	0.03%	0.05%	0.40%	0.10%	0.09%	0.16%
nitrite ammonification	0.78%	0.11%	0.28%	0.26%	0.62%	0.15%	0.24%	0.49%
nitrite respiration	1.75%	1.21%	0.80%	1.91%	0.70%	0.71%	0.70%	2.45%
nitrate respiration	2.52%	1.10%	1.00%	0.65%	1.63%	0.74%	1.54%	2.35%
nitrate reduction	4.30%	6.34%	5.68%	3.56%	8.51%	3.57%	3.75%	4.03%
nitrogen respiration	2.26%	0.91%	1.25%	1.92%	1.91%	0.71%	1.55%	2.00%
nitrogen fixation	0.22%	0.23%	0.29%	0.24%	0.03%	0.09%	0.25%	0.37%
ureolysis	1.72%	1.19%	1.45%	3.39%	5.54%	1.37%	1.19%	3.49%

Table S4 Functional groups related to the human pathogens.

Groups	WXA	SPXA	SUXA	AXA	WLF	SPLF	SULF	ALF
human pathogens septicemia	0.25%	0.14%	0.10%	0.36%	0.04%	0.09%	0.07%	0.96%
human pathogens pneumonia	0.00%	0.02%	0.05%	0.03%	0.01%	0.01%	0.04%	0.02%
human pathogens nosocomia	0.03%	0.02%	0.05%	0.04%	0.01%	0.01%	0.16%	0.02%
human pathogens meningitis	0.25%	0.12%	0.06%	0.39%	0.02%	0.08%	0.04%	1.12%
human pathogens diarrhea	0.03%	0.06%	0.45%	0.01%	0.13%	0.08%	0.10%	0.02%
human pathogens all	2.33%	2.38%	3.63%	3.87%	1.66%	2.71%	6.32%	4.33%
plant pathogen	0.94%	0.13%	0.12%	0.05%	0.48%	0.14%	0.18%	0.25%

Table S5 Functional groups related to the sulfur cycling.

Groups	WXA	SPXA	SUXA	AXA	WLF	SPLF	SULF	ALF
sulfate respiration	0.06%	0.04%	0.04%	0.04%	0.39%	0.09%	0.00%	0.02%
sulfur respiration	0.02%	0.05%	0.17%	0.03%	0.00%	0.10%	0.07%	0.10%
sulfite respiration	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
thiosulfate respiration	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%	0.01%
respiration of sulfur compounds	0.08%	0.12%	0.13%	0.07%	0.39%	0.25%	0.08%	0.13%
dark sulfide oxidation	0.03%	0.01%	0.00%	0.04%	0.00%	0.00%	0.00%	0.01%
dark oxidation of sulfur compounds	0.05%	0.02%	0.02%	0.06%	0.01%	0.03%	0.04%	0.03%

List of figure:

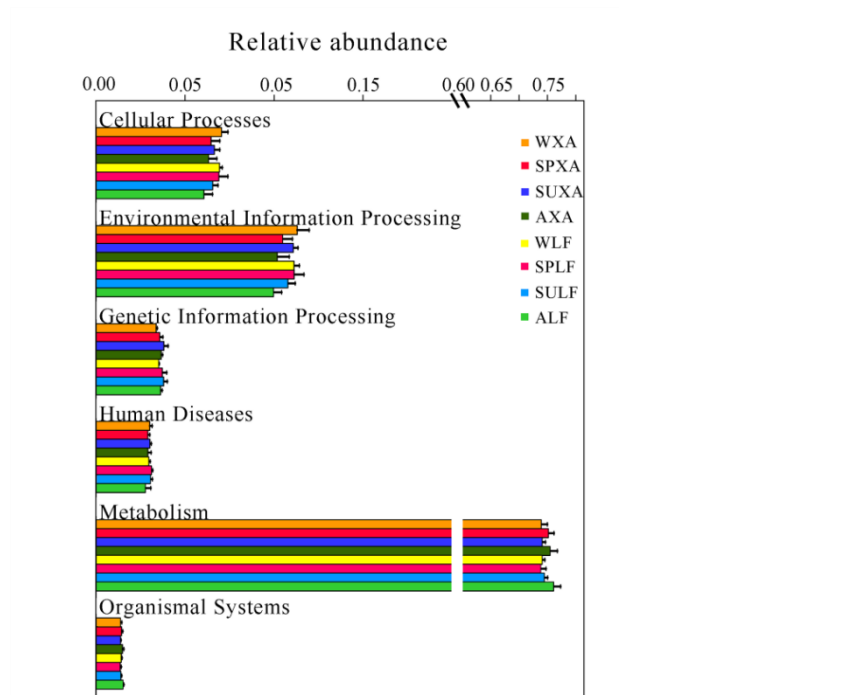
Fig. S1. Bacterial community functions were predicted using Tax4Fun2 algorithm during different seasons. (a) At level 1. (b) Top 20 KEGG subsystems at level 2.

Fig. S2. The relative abundance of carbon cycling, nitrogen cycling, sulfur cycling, and human pathogens in Xi'an and Linfen.

Fig. S3. Heatmap based on relative abundance (%) of pathogenic fungi in all PM_{2.5} samples.

Figures

a



b

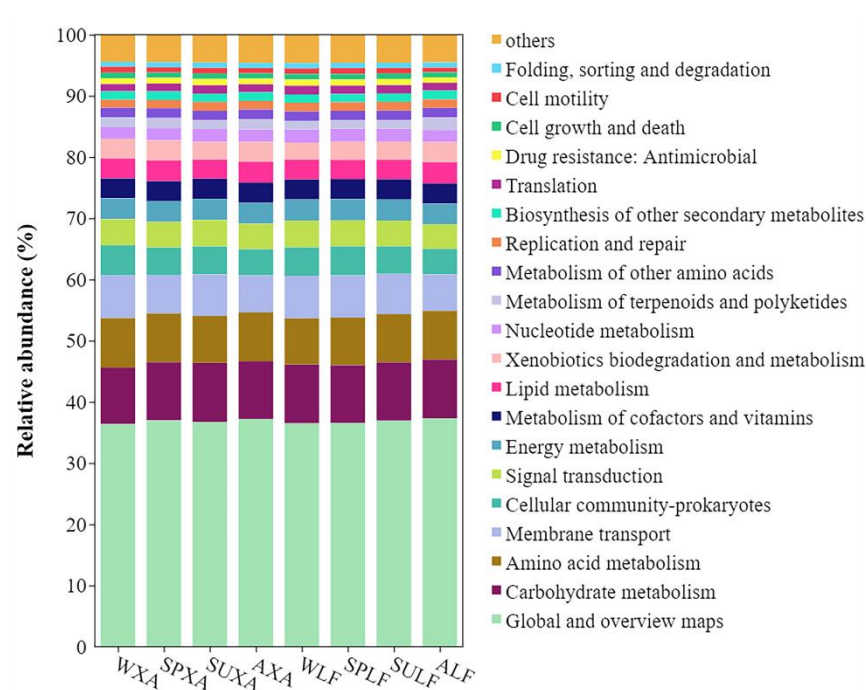
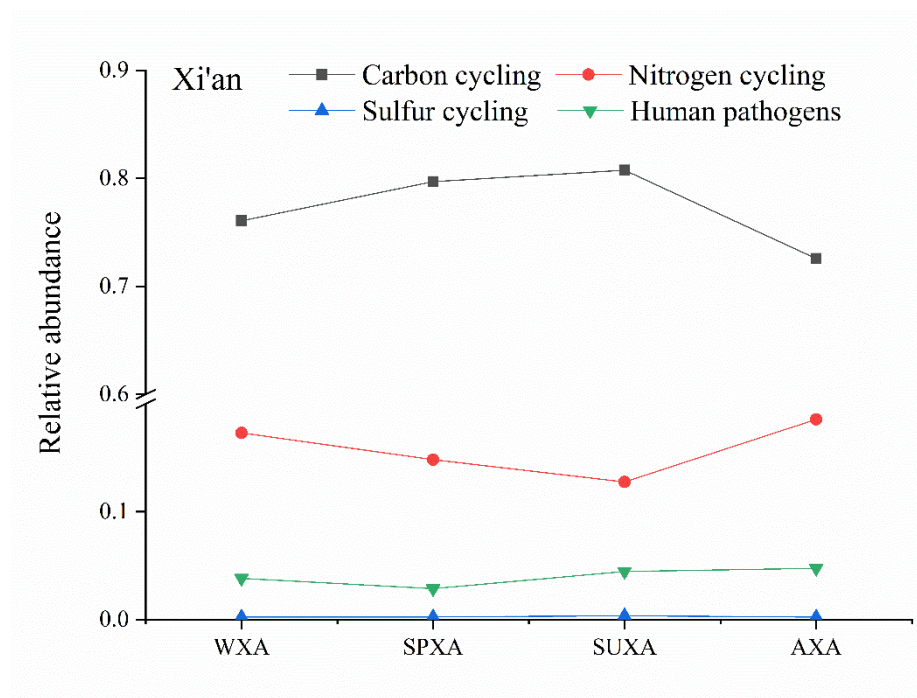


Fig. S1. Bacterial community functions were predicted using Tax4Fun2 algorithm during different seasons. (a) At level 1. (b) Top 20 KEGG subsystems at level 2.

a



b

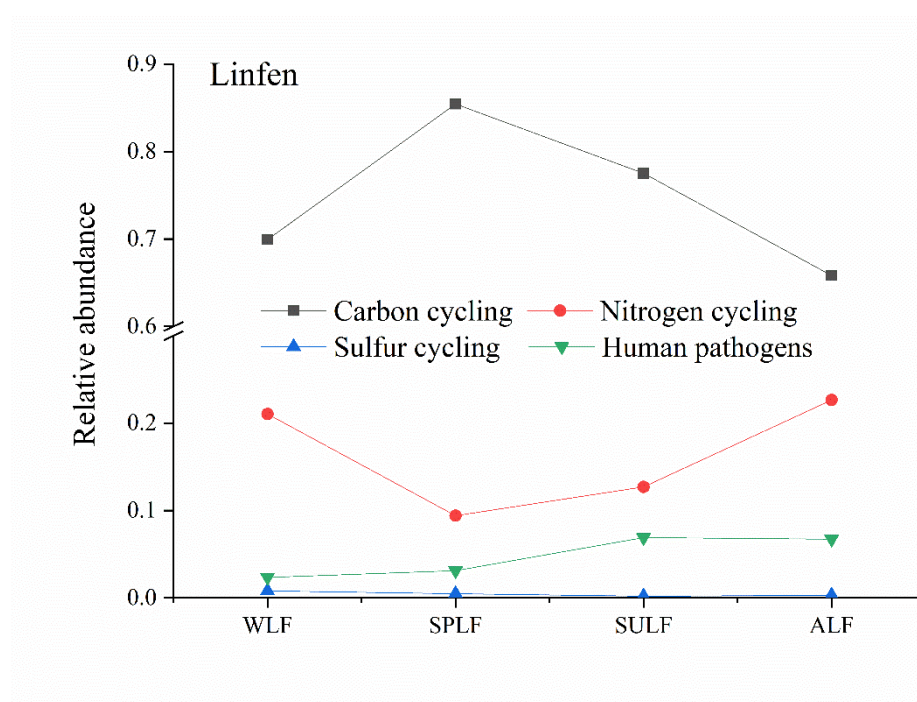


Fig. S2. The relative abundance of carbon cycling, nitrogen cycling, sulfur cycling, and human pathogens in Xi'an and Linfen.

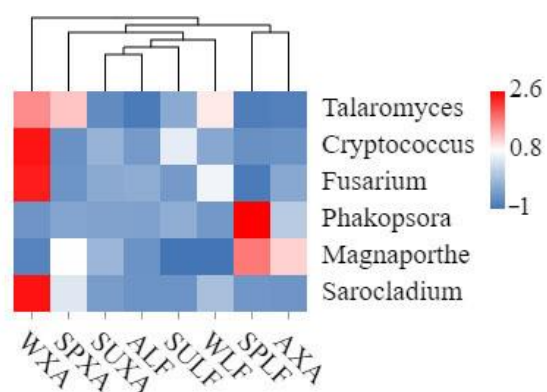


Fig. S3. Heatmap based on relative abundance (%) of pathogenic fungi in all PM_{2.5} samples.