

Supplementary Materials

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Table S1. Stations with locations.

Station Name	City	Log	Lat
1811A	Luoyang	112.3628	34.6692
1812A	Luoyang	112.3931	34.6516
1813A	Luoyang	112.4333	34.67
1814A	Luoyang	112.4657	34.6871
1815A	Luoyang	112.494	34.6886
1816A	Luoyang	112.3844	34.623
1817A	Luoyang	112.4267	34.6258
1818A	Anyang	114.4839	36.0621
1819A	Anyang	114.3551	36.1017
1820A	Anyang	114.361	36.0681
1821A	Anyang	114.3931	36.0883
1822A	Anyang	114.286	36.11
1823A	Kaifeng	114.3406	34.8022
1824A	Kaifeng	114.3389	34.7781
1825A	Kaifeng	114.3733	34.7975
1826A	Kaifeng	114.2885	34.7965
1827A	Jiaozuo	113.261	35.235
1828A	Jiaozuo	113.2269	35.2127
1829A	Jiaozuo	113.2467	35.176
1830A	Jiaozuo	113.1987	35.2703
1831A	Pingdingshan	113.3064	33.7214
1832A	Pingdingshan	113.3257	33.742
1833A	Pingdingshan	113.2919	33.737
1834A	Pingdingshan	113.182	33.774
1835A	Sanmenxia	111.1922	34.7752
1836A	Sanmenxia	111.1587	34.7942
1837A	Sanmenxia	111.1858	34.7917
1838A	Sanmenxia	111.143	34.7955
2054A	Xinyang	114.1099	32.1059
2064A	Xinyang	113.9956	32.1271
2065A	Xinyang	114.0775	32.1195
2066A	Xinyang	114.0609	32.1399
2067A	Zhoukou	114.6613	33.6128
2068A	Zhoukou	114.6758	33.6347
2069A	Zhoukou	114.6546	33.5979
2070A	Zhoukou	114.6369	33.6406
2385A	Hebi	114.17	35.9019
2386A	Hebi	114.2956	35.7511
2387A	Hebi	114.2878	35.7306
2388A	Xinxiang	113.926	35.279
2389A	Xinxiang	113.836	35.31
2390A	Xinxiang	113.884	35.272
2391A	Xinxiang	113.883	35.303
2392A	Puyang	115.0312	35.7636
2393A	Puyang	114.9906	35.767
2394A	Puyang	115.0574	35.7609

2395A	Puyang	115.0866	35.7754
2396A	Xuchang	113.8276	34.0159
2397A	Xuchang	113.8208	34.0314
2398A	Xuchang	113.7906	33.9953
2399A	Luohe	114.051	33.5699
2400A	Luohe	114.0055	33.5698
2401A	Luohe	114.0138	33.5828
2402A	Luohe	114.0261	33.5698
2403A	Nanyang	112.5192	32.9917
2404A	Nanyang	112.5339	33.0086
2405A	Nanyang	112.5003	32.9735
2406A	Nanyang	112.5779	33.0144
2407A	Nanyang	112.548	32.9692
2408A	Shangqiu	115.6702	34.4285
2409A	Shangqiu	115.6458	34.4045
2410A	Shangqiu	115.6293	34.3948
2411A	Shangqiu	115.6578	34.402
2420A	ZhuMaDian	114.0189	32.9656
2421A	ZhuMaDian	114.0114	33.015
2422A	ZhuMaDian	113.9976	32.9771

Table S2. City-wise change of air quality pattern.

Cities	Year	AQI	CO	NO2	O3	PM10	PM2.5	SO2	AQI	CO	NO2	O3	PM10	PM2.5	SO2
Anyang	2017	118.24	1.82	46.90	65.98	140.63	81.21	28.67							
	2018	110.09	1.56	41.17	69.11	123.59	73.56	21.17	-7%	-14%	-12%	5%	-12%	-9%	-26%
	2019	108.38	1.25	38.26	69.19	117.71	70.88	15.42	-2%	-20%	-7%	0%	-5%	-4%	-27%
	2020	103.30	1.13	36.47	64.30	110.31	67.10	12.80	-5%	-10%	-5%	-7%	-6%	-5%	-17%
	2021	67.58	0.67	18.38	104.56	75.79	29.78	6.44	-35%	-40%	-50%	63%	-31%	-56%	-50%
Hebi	2017	95.67	1.65	44.56	65.79	116.22	62.29	27.46							
	2018	91.52	1.35	42.57	73.12	112.81	55.22	18.59	-4%	-18%	-4%	11%	-3%	-11%	-32%
	2019	93.61	0.82	36.89	65.03	100.77	60.56	12.70	2%	-39%	-13%	-11%	-11%	10%	-32%
	2020	91.18	0.97	37.18	61.43	95.25	59.47	11.62	-3%	18%	1%	-6%	-5%	-2%	-9%
	2021	68.50	0.60	19.81	102.81	76.36	32.88	8.68	-25%	-38%	-47%	67%	-20%	-45%	-25%
Jiaozuo	2017	109.07	1.46	40.92	70.67	129.25	74.91	23.94							
	2018	102.32	1.17	34.73	78.31	122.01	67.04	16.18	-6%	-20%	-15%	11%	-6%	-11%	-32%
	2019	95.87	0.93	33.08	75.45	109.46	60.69	12.44	-6%	-21%	-5%	-4%	-10%	-9%	-23%
	2020	86.36	0.89	29.35	73.89	94.36	55.52	11.17	-10%	-4%	-11%	-2%	-14%	-9%	-10%
	2021	63.37	0.59	13.85	112.36	64.03	28.55	8.16	-27%	-34%	-53%	52%	-32%	-49%	-27%
Kaifeng	2017	105.10	1.31	39.55	68.83	119.96	68.77	22.12							
	2018	103.90	1.08	34.39	73.63	115.80	65.59	15.77	-1%	-18%	-13%	7%	-3%	-5%	-29%
	2019	102.87	1.04	34.21	71.76	108.64	67.03	11.05	-1%	-4%	-1%	-3%	-6%	2%	-30%
	2020	81.44	1.20	29.22	57.51	81.13	53.87	11.46	-21%	15%	-15%	-20%	-25%	-20%	4%
	2021	61.58	0.64	15.00	104.60	69.34	27.48	5.41	-24%	-47%	-49%	82%	-15%	-49%	-53%
Luohe	2017	98.17	1.03	37.67	64.59	117.30	64.61	16.27							
	2018	97.88	0.83	33.88	71.50	113.56	62.18	12.26	0%	-20%	-10%	11%	-3%	-4%	-25%
	2019	93.51	0.73	29.66	71.80	99.55	60.10	9.85	-4%	-12%	-12%	0%	-12%	-3%	-20%
	2020	83.30	0.77	25.17	68.38	84.91	54.41	9.25	-11%	6%	-15%	-5%	-15%	-9%	-6%
	2021	53.89	0.59	12.55	94.41	57.08	26.51	7.73	-35%	-23%	-50%	38%	-33%	-51%	-16%
Luoyang	2017	105.88	1.49	39.77	70.55	122.54	71.02	24.82							
	2018	95.80	1.25	41.04	65.69	113.45	60.68	18.33	-10%	-16%	3%	-7%	-7%	-15%	-26%
	2019	97.20	0.78	38.67	64.95	110.81	61.39	10.06	1%	-38%	-6%	-1%	-2%	1%	-45%
	2020	82.51	0.77	33.06	62.63	90.58	51.00	8.21	-15%	-1%	-14%	-4%	-18%	-17%	-18%
	2021	58.47	0.63	17.46	103.16	61.16	24.99	5.93	-29%	-18%	-47%	65%	-32%	-51%	-28%
Nanyang	2017	92.20	1.32	31.57	74.53	109.65	57.80	14.56							

	2018	92.15	1.04	34.22	73.66	102.97	59.81	7.70	0%	-21%	8%	-1%	-6%	3%	-47%
	2019	90.99	0.95	28.86	74.23	95.99	59.99	7.42	-1%	-9%	-16%	1%	-7%	0%	-4%
	2020	80.58	0.91	24.69	70.58	85.49	51.81	7.94	-11%	-5%	-14%	-5%	-11%	-14%	7%
	2021	49.87	0.77	13.93	91.84	51.28	24.98	7.37	-38%	-15%	-44%	30%	-40%	-52%	-7%
	2017	101.80	1.23	38.52	73.01	119.34	68.44	23.65							
Pingdingshan	2018	97.77	0.97	36.41	73.48	111.09	64.88	17.30	-4%	-21%	-5%	1%	-7%	-5%	-27%
	2019	99.51	0.96	34.80	71.45	104.64	64.56	12.38	2%	-1%	-4%	-3%	-6%	-1%	-28%
	2020	76.85	0.86	30.62	71.43	83.51	49.12	11.26	-23%	-11%	-12%	0%	-20%	-24%	-9%
	2021	54.50	0.61	18.91	93.77	56.52	27.66	6.46	-29%	-29%	-38%	31%	-32%	-44%	-43%
	2017	104.57	1.47	41.10	69.60	120.08	69.32	22.70							
Puyang	2018	98.85	1.09	34.49	78.35	108.99	63.46	16.19	-5%	-25%	-16%	13%	-9%	-8%	-29%
	2019	84.59	0.67	29.04	72.31	95.72	53.41	13.04	-14%	-39%	-16%	-8%	-12%	-16%	-19%
	2020	91.55	0.81	31.31	67.30	92.04	59.37	10.03	8%	21%	8%	-7%	-4%	11%	-23%
	2021	64.34	0.57	15.98	101.96	72.69	30.83	6.12	-30%	-30%	-49%	52%	-21%	-48%	-39%
	2017	99.32	1.19	38.81	66.73	111.06	64.85	22.60							
Sanmenxia	2018	94.82	0.95	34.53	71.34	109.07	57.12	13.66	-5%	-20%	-11%	7%	-2%	-12%	-40%
	2019	89.96	0.88	31.42	65.27	93.54	56.60	9.87	-5%	-7%	-9%	-9%	-14%	-1%	-28%
	2020	76.40	0.81	28.17	62.71	74.45	46.81	7.35	-15%	-8%	-10%	-4%	-20%	-17%	-25%
	2021	58.81	0.62	17.66	102.53	63.30	25.95	5.53	-23%	-24%	-37%	63%	-15%	-45%	-25%
	2017	97.37	0.88	35.37	70.69	117.06	62.92	13.68							
Shangqiu	2018	97.19	0.92	32.55	72.93	110.37	61.80	9.70	0%	5%	-8%	3%	-6%	-2%	-29%
	2019	89.48	0.77	29.68	73.58	94.33	56.12	9.80	-8%	-17%	-9%	1%	-15%	-9%	1%
	2020	82.12	0.72	26.70	69.33	79.79	52.62	7.16	-8%	-7%	-10%	-6%	-15%	-6%	-27%
	2021	57.66	0.58	12.14	98.51	62.57	26.36	5.39	-30%	-19%	-55%	42%	-22%	-50%	-25%
	2017	102.77	1.49	49.14	64.85	122.05	68.78	28.33							
Xinxiang	2018	96.72	1.22	46.41	72.73	112.17	62.27	18.63	-6%	-18%	-6%	12%	-8%	-9%	-34%
	2019	90.64	1.04	42.87	63.00	104.10	56.45	16.12	-6%	-15%	-8%	-13%	-7%	-9%	-13%
	2020	82.81	0.92	33.77	64.30	93.03	51.97	12.70	-9%	-12%	-21%	2%	-11%	-8%	-21%
	2021	65.15	0.70	19.49	104.82	71.39	30.45	9.36	-21%	-24%	-42%	63%	-23%	-41%	-26%
	2017	79.40	0.82	27.32	66.40	89.95	51.81	12.63							
Xinyang	2018	82.61	0.77	26.02	78.50	93.14	53.13	8.52	4%	-6%	-5%	18%	4%	3%	-33%
	2019	74.61	0.61	24.33	73.63	77.47	48.26	6.60	-10%	-20%	-6%	-6%	-17%	-9%	-22%
	2020	65.10	0.69	20.90	72.64	67.13	40.68	6.44	-13%	13%	-14%	-1%	-13%	-16%	-3%
	2021	41.75	0.43	10.23	83.61	38.63	21.23	6.99	-36%	-38%	-51%	15%	-42%	-48%	9%
	2017	99.01	1.31	41.82	68.32	109.97	65.92	22.54							
Xuchang	2018	100.24	1.12	36.82	70.49	113.53	63.33	13.31	1%	-14%	-12%	3%	3%	-4%	-41%
	2019	93.33	1.00	33.68	69.11	93.18	60.79	11.84	-7%	-11%	-9%	-2%	-18%	-4%	-11%
	2020	77.98	0.87	28.31	68.43	74.84	49.80	10.62	-16%	-12%	-16%	-1%	-20%	-18%	-10%
	2021	53.89	0.72	16.03	91.48	56.05	25.82	6.26	-31%	-18%	-43%	34%	-25%	-48%	-41%
	2017	93.05	1.20	33.24	72.89	107.79	61.07	16.66							
Zhoukou	2018	96.54	0.95	28.98	78.29	112.60	59.02	12.40	4%	-21%	-13%	7%	4%	-3%	-26%
	2019	90.37	0.81	27.51	75.16	98.41	56.85	9.94	-6%	-15%	-5%	-4%	-13%	-4%	-20%
	2020	85.44	0.82	26.30	66.33	82.88	55.35	9.02	-5%	1%	-4%	-12%	-16%	-3%	-9%
	2021	52.58	0.62	11.93	89.78	57.57	23.21	6.65	-38%	-25%	-55%	35%	-31%	-58%	-26%
	2017	92.46	0.96	35.99	72.54	107.95	59.20	15.27							
ZhuMaDian	2018	92.89	0.82	33.89	75.05	108.39	59.66	12.90	0%	-15%	-6%	3%	0%	1%	-16%
	2019	84.28	0.67	27.49	71.44	92.58	54.31	7.29	-9%	-18%	-19%	-5%	-15%	-9%	-44%
	2020	70.76	0.74	23.95	67.50	73.68	45.23	7.72	-16%	11%	-13%	-6%	-20%	-17%	6%
	2021	47.33	0.46	13.22	89.15	44.10	24.52	7.57	-33%	-38%	-45%	32%	-40%	-46%	-2%
	2017	89.69	0.93	34.91	70.37	104.71	57.42	14.81							
Zhengzhou	2018	90.10	0.79	32.87	72.79	105.13	57.87	12.52	0%	-15%	-6%	3%	0%	1%	-16%
	2019	81.76	0.65	26.66	69.29	89.80	52.69	7.07	-9%	-18%	-19%	-5%	-15%	-9%	-44%
	2020	68.64	0.72	23.23	65.47	71.47	43.87	7.49	-16%	11%	-13%	-6%	-20%	-17%	6%
	2021	45.91	0.45	12.82	86.48	42.78	23.78	7.34	-33%	-38%	-45%	32%	-40%	-46%	-2%

Jiyuan	2017	90.26	1.17	32.24	70.71	104.55	59.24	16.16							
	2018	93.64	0.93	28.11	75.94	109.22	57.25	12.03	4%	-21%	-13%	7%	4%	-3%	-26%
	2019	87.66	0.79	26.68	72.91	95.46	55.14	9.64	-6%	-15%	-5%	-4%	-13%	-4%	-20%
	2020	82.87	0.80	25.51	64.34	80.39	53.69	8.75	-5%	1%	-4%	-12%	-16%	-3%	-9%
	2021	51.01	0.60	11.57	87.08	55.84	22.51	6.45	-38%	-25%	-55%	35%	-31%	-58%	-26%