

COVID-19 higher morbidity and mortality in Chinese regions with lower air quality

Supplementary information

	unit	count	mean	std	min	25%	median	75%	max	range	iqr
CO sat	μmol/m2	347	40721	8751	15826	36202	42348	47034	60605	44778	10833
NO ₂ sat	μmol/m2	347	57.58	42.62	5.00	26.00	42.70	83.85	185.39	180.42	57.85
O ₃ sat	μmol/m2	347	130602	14073	115053	118774	126147	138924	170378	55325	20150
SO ₂ sat	μmol/m2	347	58.61	65.11	-60.00	10.43	42.10	102.70	316.53	376.43	92.27
Aerosol sat	index	347	-0.97	0.17	-1.30	-1.06	-1.00	-0.92	-0.02	1.28	0.14
HCHO sat	μmol/m2	347	142.04	42.65	50.00	107.63	150.06	178.36	219.85	169.55	70.74
PM 2.5 ground	AQI	308	110.78	27.79	38.20	92.63	111.55	128.51	186.96	148.76	35.88
PM 10 ground	AQI	308	63.61	22.98	19.96	46.26	60.90	75.67	170.27	150.31	29.40
CO ground	AQI	308	9.71	3.97	2.39	7.11	8.74	11.85	27.01	24.63	4.74
NO ₂ ground	AQI	308	13.72	5.40	3.17	9.63	13.40	17.41	28.57	25.40	7.78
O ₃ ground	AQI	308	25.83	5.87	14.22	21.70	25.17	28.98	50.54	36.31	7.28
SO ₂ ground	AQI	308	13.24	7.96	1.14	7.88	10.97	16.46	40.58	39.44	8.58

Table 1 S.I. Descriptive statistics for the different satellite- and ground-based air quality measurements. AQI = Air Quality Index, iqr = interquartile range. Negative values for the UV Aerosol Index (Aerosol sat) indicate that the amount of UV-absorbing aerosol detected by the sensor is inferior to a theoretical amount (see <https://earth.esa.int/web/sentinel/technical-guides/sentinel-5p/level-2/aerosol-index>, accessed on 31 October 2020). Negative values of SO₂ detected by satellite are due to noise in the data and are observed in particular over clean regions with low emissions (see https://developers.google.com/earth-engine/datasets/catalog/COPERNICUS_S5P_OFFL_L3_SO2, accessed on 31 October 2020).

	Population density		
	df (n-2)	tau	p-value
CO sat	345	56	<.001
NO ₂ sat	345	.65	<.001
O ₃ sat	345	-.08	.019
SO ₂ sat	345	.04	.246
Aerosol sat	345	-.11	.003
HCHO sat	345	.61	<.001
PM 2.5 ground	306	.34	<.001
PM 10 ground	306	.21	<.001
CO ground	306	.09	.022
NO ₂ ground	306	.37	<.001
O ₃ ground	306	.13	.001
SO ₂ ground	306	.15	<.001

Table 2 S.I. Correlation between satellite- and ground-based air quality variables and population density in China.

<u>China without Wuhan</u>	<u>Infections</u> (/100k pop)			<u>Fatalities</u> (/100k pop)			<u>Mortality</u> (fatalities/infections)		
	df (n-2)	tau	p-value	df (n-2)	tau	p-value	df (n-2)	tau	p-value
CO sat	336	.28	<.001	336	.18	<.001	312	.16	<.001
NO ₂ sat	336	.22	<.001	336	.14	.001	312	.12	.008
O ₃ sat	336	-.08	.031	336	.00	.943	312	.02	.617
SO ₂ sat	336	-.10	.006	336	-.02	.690	312	.00	.975
Aerosol sat	336	-.12	.001	336	-.03	.537	312	.00	.992
HCHO sat	336	.34	<.001	336	.19	<.001	312	.16	<.001
PM 2.5 ground	301	.15	<.001	301	.18	<.001	284	.17	<.001
PM 10 ground	301	.04	.361	301	.12	.008	284	.13	.006
CO ground	301	-.01	.798	301	.11	.013	284	.12	.008
NO ₂ ground	301	.11	.003	301	.12	.009	284	.11	.012
O ₃ ground	301	-.03	.512	301	-.02	.637	284	-.03	.528
SO ₂ ground	301	-.01	.851	301	.04	.396	284	.06	.171
population	336	.22	<.001	336	.16	<.001	312	.14	.002
pop density	336	.32	<.001	336	.15	<.001	312	.12	.007

Table 3 S.I. Correlation between satellite- and ground-based air quality variables and cumulated COVID-19 infections per 100,000 inhabitants, fatalities per 100,000 inhabitants, and mortality rate in China (without the administrative unit of Wuhan), until 23 May 2020.

<u>China without Hubei prov.</u>	<u>Infections</u> (/100k pop)			<u>Fatalities</u> (/100k pop)			<u>Mortality</u> (fatalities/infections)		
	df (n-2)	tau	p-value	df (n-2)	tau	p-value	df (n-2)	tau	p-value
CO sat	320	.26	<.001	320	.13	.002	296	.11	.011
NO ₂ sat	320	.26	<.001	320	.15	.001	296	.13	.005
O ₃ sat	320	-.07	.054	320	.03	.551	296	.04	.417
SO ₂ sat	320	-.08	.044	320	.04	.386	296	.05	.275
Aerosol sat	320	-.10	.008	320	.03	.539	296	.05	.299
HCHO sat	320	.32	<.001	320	.14	.002	296	.11	.016
PM 2.5 ground	286	.10	.011	286	.11	.018	269	.11	.022
PM 10 ground	286	.00	.992	286	.07	.108	269	.08	.087
CO ground	286	-.03	.395	286	.09	.052	269	.10	.032
NO ₂ ground	286	.13	.001	286	.15	.002	269	.14	.003
O ₃ ground	286	-.02	.668	286	-.01	.858	269	-.02	.697
SO ₂ ground	286	-.01	.876	286	.04	.338	269	.06	.179
population	320	.26	<.001	320	.21	<.001	296	.19	<.001
pop density	320	.35	<.001	320	.19	<.001	296	.15	<.001

Table 4 S.I. Correlation between satellite- and ground-based air quality variables and cumulated COVID-19 infections per 100,000 inhabitants, fatalities per 100,000 inhabitants, and mortality rate in China (without Hubei province), until 23 May 2020.