Supplementary Materials:

Low- and Medium-Cost Sensors for Tropospheric Ozone Monitoring – Results of an Evaluation Study in Wrocław, Poland

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Table S1. Characteristics of ozone concentrations and meteorological conditions in Wroclaw during the period analysed.

		Ozone concentration				Meteorological parameters		
Year	**Month**	**AVG (μg/m³)**	**MAX (μg/m³)**	**Exceedance days**	No data (hr/%)	K (MJ/m²)	T (°C)	RH (%)
2019	VI	76.3	135.8	5	40 (5.6%)	210.6	22.3	57.3
	VII	70.2	144.9	3	18 (2.4%)	170.4	19.9	58.3
	VIII	65.8	121.8	0	168 (23%)	150.0	20.7	64.8
	IX	53.8*	111.8*	0*	421 (58%)	102.7	14.8	71.0
	X	47.9	110.8	0	90 (12%)	63.2	10.7	79.4
	XI	35.3	88.0	0	61 (8.4%)	29.1	7.1	79.5
	XII	41.3	85.9	0	83 (11%)	19.3	3.5	77.2
2020	IX	35.3	70.2	0	110 (15%)	28.2	2.4	75.8
	II	52.1	80.6	0	3 (0.4%)	40.4	5.4	65.1
	III	51.9	114.5	0	12 (1.6%)	98.3	5.4	56.3
	IV	62.1	119.0	0	29 (4.0%)	162.1	10.0	46.3
	V	62.0	136.2	1	21 (2.8%)	154.0	11.9	59.9
	VI	60.2	117.7	0	1 (0.1%)	139.4	17.9	67.7
	VII	62.1*	90.1*	0*	711 (96%)	178.0	18.9	60.3
	VIII	59.0*	121.1*	0*	303 (41%)	148.6	20.5	65.8
	IX	43.7	104.6	0	80 (11%)	107.5	15.2	71.1
	X	32.2	78.1	0	20 (2.7%)	45.1	10.8	77.5
	XI	25.0	57.1	0	138 (19%)	26.7	6.0	78.3
	XII	24.2*	68.6*	0*	272 (37%)	20.7	2.3	78.7

AVG – average value, MAX – hourly maximum value, exceedance days – number of days with a maximum 8-hour concentration above 120 μg/m³, K↓ - the sum of incoming solar radiation, T – mean monthly air temperature, RH – mean monthly relative humidity. *The light grey signature with asterisk indicates missing data at a level above 25%.

All data from the Meteorological Observatory of the Department of Climatology and Atmosphere Protection of the University of Wrocław are publicly available via https://opendata.meteo.uni.wroc.pl/. (accessed on 25 February 2022)

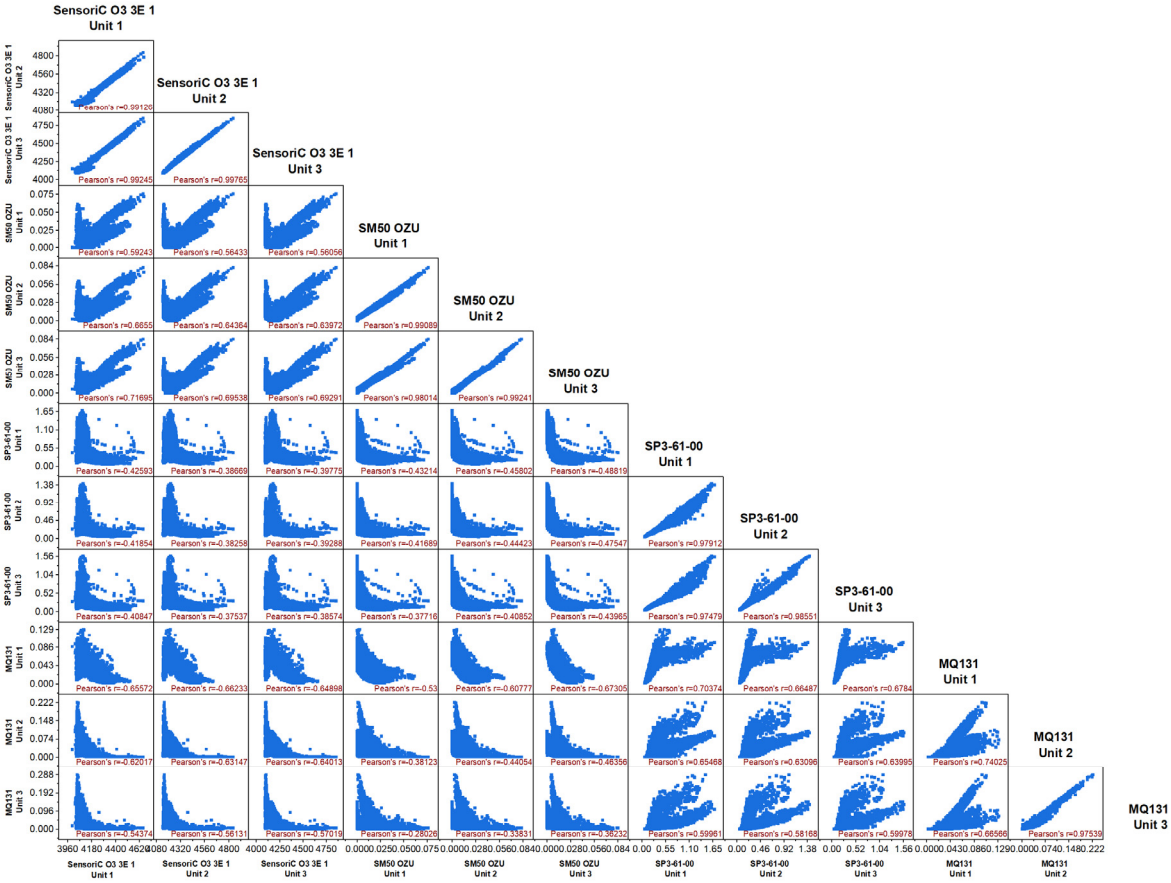
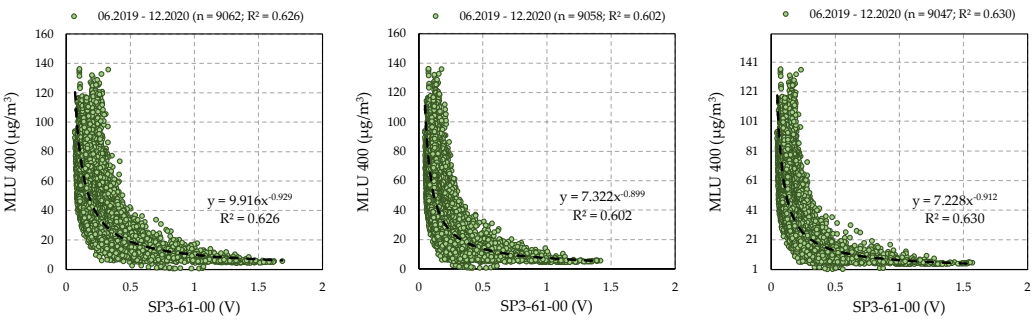
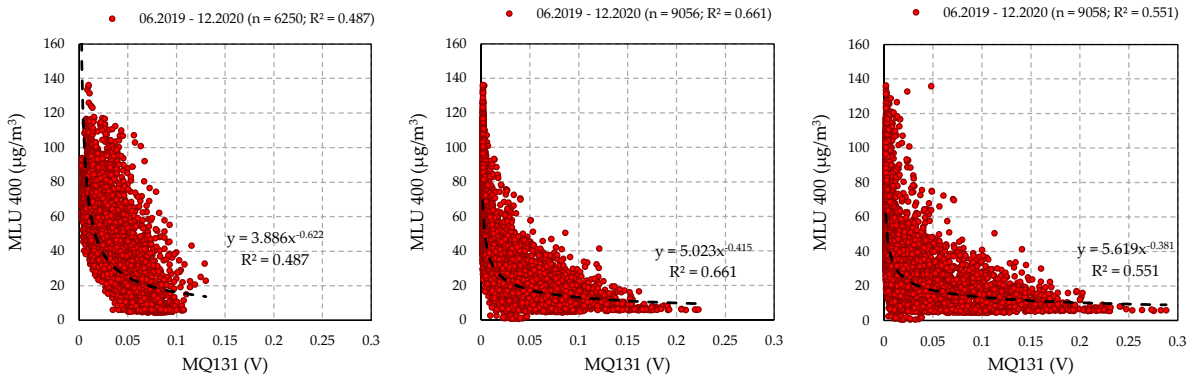


Figure S1. Scatterplots and Pearson's correlation coefficients between all units of the tested ozone sensors.



(a) (b) (c)

Figure S2. Power-law fitting results for 1-hour averaged data from the entire study period for SP3-61-00: (a) unit No. 1, (b) unit No. 2, (c) unit No. 3. Dashed lines denote the fitted curves. n – number of samples used for the fitting, R^2 – coefficient of determination.



(a) (b) (c)

Figure S3. Power-law fitting results for 1-hour averaged data from the entire study period for MQ131: (a) unit No. 1, (b) unit No. 2, (c) unit No. 3. Dashed lines denote the fitted curves. n – number of samples used for the fitting, R^2 – coefficient of determination.

Table S2. Coefficients of determination for SensoriC O3 3E 1 (City Technology) calibration models. C_{O_3} – ozone concentration from reference instrument (µg/m³), S – raw sensor output (µg/m³), T – temperature (°C), RH – relative humidity (%), $a_0 \ldots a_3$ - regression coefficients.

Calibration model	Test period	Coefficient of determination		
		Unit 1	Unit 2	Unit 3
$C_{O_3} = a_0 + a_1 \cdot S$	1) 06.2019 – 03.2020	0.913	0.933	0.924
	2) 03.2020 – 07.2020	0.674	0.613	0.665
	1) + 2) 06.2019 – 07.2020	0.836	0.817	0.837
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot T$	1) 06.2019 – 03.2020	0.917	0.936	0.928
	2) 03.2020 – 07.2020	0.823	0.826	0.828
	1) + 2) 06.2019 – 07.2020	0.876	0.874	0.880
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot RH$	1) 06.2019 – 03.2020	0.913	0.934	0.924
	2) 03.2020 – 07.2020	0.687	0.639	0.682
	1) + 2) 06.2019 – 07.2020	0.837	0.822	0.840
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot T + a_3 \cdot RH$	1) 06.2019 – 03.2020	0.917	0.936	0.928
	2) 03.2020 – 07.2020	0.837	0.839	0.843
	1) + 2) 06.2019 – 07.2020	0.876	0.875	0.882

Table S3. Coefficients of determination for SM50 OZU (Aeroqual) calibration models. C_{O_3} – ozone concentration from reference instrument (μg/m³), S – raw sensor output (ppm), T – temperature (°C), RH – relative humidity (%), $a_0 \dots a_3$ - regression coefficients.

Calibration model	Test period	Coefficient of determination		
		Unit 1	Unit 2	Unit 3
$C_{O_3} = a_0 + a_1 \cdot S$	1) 06.2019 – 10.2019	0.973	0.973	0.974
	2) 10.2019 – 08.2020	0.942	0.949	0.952
	3) 08.2020 – 12.2020	0.962	0.975	0.970
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot T$	1) 06.2019 – 10.2019	0.973	0.973	0.974
	2) 10.2019 – 08.2020	0.950	0.958	0.968
	3) 08.2020 – 12.2020	0.975	0.978	0.980
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot RH$	1) 06.2019 – 10.2019	0.973	0.973	0.974
	2) 10.2019 – 08.2020	0.945	0.952	0.953
	3) 08.2020 – 12.2020	0.964	0.976	0.970
$C_{O_3} = a_0 + a_1 \cdot S + a_2 \cdot T + a_3 \cdot RH$	1) 06.2019 – 03.2020	0.973	0.974	0.974
	2) 03.2020 – 07.2020	0.952	0.961	0.968
	1) + 2) 06.2019 – 07.2020	0.976	0.979	0.980

Table S4. Coefficients of determination for SP3-61-00 (FIS) calibration models. C_{O_3} – ozone concentration from reference instrument (μg/m³), S – raw sensor output (V), T – temperature (°C), RH – relative humidity (%), $a_0 \dots a_4$ - regression coefficients. Parameters of non-linear models calculated using robust fitting functions in a Matlab environment.

Calibration model	Test period	Coefficient of determination		
		Unit 1	Unit 2	Unit 3
$C_{O_3} = a_0 + a_1 \cdot S^{a_2}$	1) 06.2019 – 10.2019	0.787	0.664	0.759
	2) 10.2019 – 08.2020	0.745	0.689	0.738
	3) 08.2020 – 12.2020	0.762	0.729	0.767
	Full period: 06.2019 –12.2020	0.626	0.602	0.630
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot T$	1) 06.2019 – 10.2019	0.873	0.810	0.896
	2) 10.2019 – 08.2020	0.825	0.801	0.844
	3) 08.2020 – 12.2020	0.844	0.826	0.855
	Full period: 06.2019 –12.2020	0.769	0.769	0.808
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot RH$	1) 06.2019 – 10.2019	0.891	0.863	0.897
	2) 10.2019 – 08.2020	0.757	0.725	0.742
	3) 08.2020 – 12.2020	0.764	0.751	0.765
	Full period: 06.2019 –12.2020	0.648	0.728	0.734
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot T + a_4 \cdot RH$	1) 06.2019 – 10.2019	0.909	0.849	0.900
	2) 10.2019 – 08.2020	0.817	0.827	0.845
	3) 08.2020 – 12.2020	0.845	0.831	0.849
	Full period: 06.2019 –12.2020	0.831	0.828	0.844

Table S5. Coefficients of determination for MQ131 (Winsen) calibration models. C_{O_3} – ozone concentration from reference instrument (μg/m³), S – raw sensor output (V), T – temperature (°C), RH – relative humidity (%), $a_0 \dots a_4$ - regression coefficients. Parameters of non-linear models calculated using robust fitting functions in a Matlab environment.

Calibration model	Test period	Coefficient of determination		
		Unit 1	Unit 2	Unit 3
$C_{O_3} = a_0 + a_1 \cdot S^{a_2}$	1) 06.2019 – 10.2019	no data	0.708	0.516
	2) 10.2019 – 08.2020	0.394	0.710	0.631
	3) 08.2020 – 12.2020	0.596	0.635	0.578
	Full period: 06.2019 –12.2020	0.487	0.661	0.551
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot T$	1) 06.2019 – 10.2019	no data	0.816	0.832
	2) 10.2019 – 08.2020	0.893	0.866	0.806
	3) 08.2020 – 12.2020	0.873	0.867	0.843
	Full period: 06.2019 –12.2020	0.894	0.871	0.817
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot RH$	1) 06.2019 – 10.2019	no data	0.871	0.827
	2) 10.2019 – 08.2020	0.613	0.790	0.742
	3) 08.2020 – 12.2020	0.601	0.785	0.751
	Full period: 06.2019 –12.2020	0.720	0.786	0.739
$C_{O_3} = a_0 + a_1 \cdot S^{a_2} + a_3 \cdot T + a_4 \cdot RH$	1) 06.2019 – 10.2019	no data	0.886	0.879
	2) 10.2019 – 08.2020	0.897	0.889	0.857
	3) 08.2020 – 12.2020	0.689	0.689	0.862
	Full period: 06.2019 –12.2020	0.884	0.896	0.868