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Atmospheric Measurement Techniques Discussions

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Interactive comment on "Field Calibration of Low-Cost Air Pollution Sensors" *by* Andres Gonzalez et al.

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(1) The most significant flaw in the analysis presented is that it seems that the data used to train the calibration models are the same used to evaluate the same models? If so this is not a valid test, and the training and test data need to be independent data sets. (2)

âĂć The field measurements were conducted during two different periods. The period 1 was during September-October 2018 and the period 2 was during March-April 2019. Period 1 includes 154 hours of data for all sensors. Period 2 includes 244 hours for CO, 169 hours for NO, 86 for NO2, and 87 hours for O3. There are no PM2.5. data available for period 2. Calibration 1 is based on data collected during the first half, hours 1 to 76, of period 1. Calibration 2 is based on data collected during the second half of period 1, hours 77 to 154. Calibration 3 is based on the entire 154 hours of data collected during period 1. Calibration 4 is based on all the data available from period 2. âĂć The stability of the calibrations was determined as follows: o Calibration 1, based on the first half of period 1 was tested against data from the second half of period 1. o Calibration 2, based on the second half of period 1 was tested against data from the first half of period 1. o Calibration 3, based on all 154 hours of period 1 was tested against data collected during the first half of period 1, and separately against data collected during the second half of period 1. o Calibration 4 is based on all the data available in period 2. The performance of calibration 3 and calibration 4 was tested against period 2 data.

(3) See Fig2, Fig3, Fig4, and Fig5

(1) Overall the calibration approach is not clear, with no indication of the improvement achieved with the increasing complexity of the calibration equation used. It would be helpful to the reader if the authors could provide a baseline performance of the sensors using a simple linear fit to the raw sensor signals, before including other variables such as temperature. This would enable the impact of sensor interferences, e.g. from temperature, to be understood in both the laboratory and field calibrations. (2). âĂć Charts with the raw signal and explanations are added (3) Line 265. “Before describing the performance of the various calibrations, it is useful to consider the stability of the primary raw signal of the sensors, We. The raw responses of the sensors during three time windows; the first half of period 1, the second half of period 1, and period 2 are plotted against AMS data in Figs.5 (a-d)”

See Fig7 ___

(1) As this is a description of a new instrument the authors should provide an assessment of the measurement uncertainty.

(2) âĂć The uncertainty was measured by the root-mean-square error (RMSE) as shown in table 1.

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(3) See Fig6. Line 315. “Also, adding the temperature and humidity terms only improves R2 and RMSE markedly in four cases, Calibration 1 NO, Calibration 3 NO, Calibration 2 NO2, and Calibration 3 NO2.” Line 320 “Overall the sensor behaved poorly with RMSE values essentially equal to mean measured values.” Line 345 “This relatively poor performance is consistent with the high RMSE and low R2 values reported in Table 1.”

_____ (1) The poor performance seen for the OPC-N2 sensor when compared to reference measurements is not adequately discussed. Early studies using these sensors identified a significant humidity dependence impacting the data under high humidity conditions. A study by Antonio et al. (2018) developed a correction for this instrumental effect on the OPC-N2, resulting in an apparent improvement in data quality. The authors should at the very least acknowledge this earlier work and discuss the implications for the work presented here. (2) âĂć We added humidity as part of independent variables. The p-values of the models for humidity, temperature, and OPC-N2 are in additional material. We also added references. (3)

Line 345. “Another research model achieves R2 =0.75 (Di Antoni et al., 2018) and ranges from 0.8 to 0.93 (Chatzidiakou et al., 2019). A measurement conducted in Memphis, TN presented diverse results range R2 from 0.52 to 0.81 (Feinberg et al., 2019).” ____ (1) Table 1 has no units on values other than the average mixing ratio.

(2) âĂć We added the unit of each value in Table 1. (3) See Fig6

_____ (1) The statement on line 321 that calibrations will last _ 3 months has no supporting evidence and should either be removed or justified. References: Di Antonio A, Popoola OA, Ouyang B, Saffell J, Jones RL. Developing a relative humidity correction for low-cost sensors measuring ambient particulate matter. Sensors (Switzerland) 2018;18:2790. doi: 10.3390/s18092790. (2) âĂć We added the reference.

(3) Line 450. “This supports a re-calibration periodically because of the sensitivity of sensor changes over time, which we anticipate to be ~3 months (Di Antoni et al.,

2018).".

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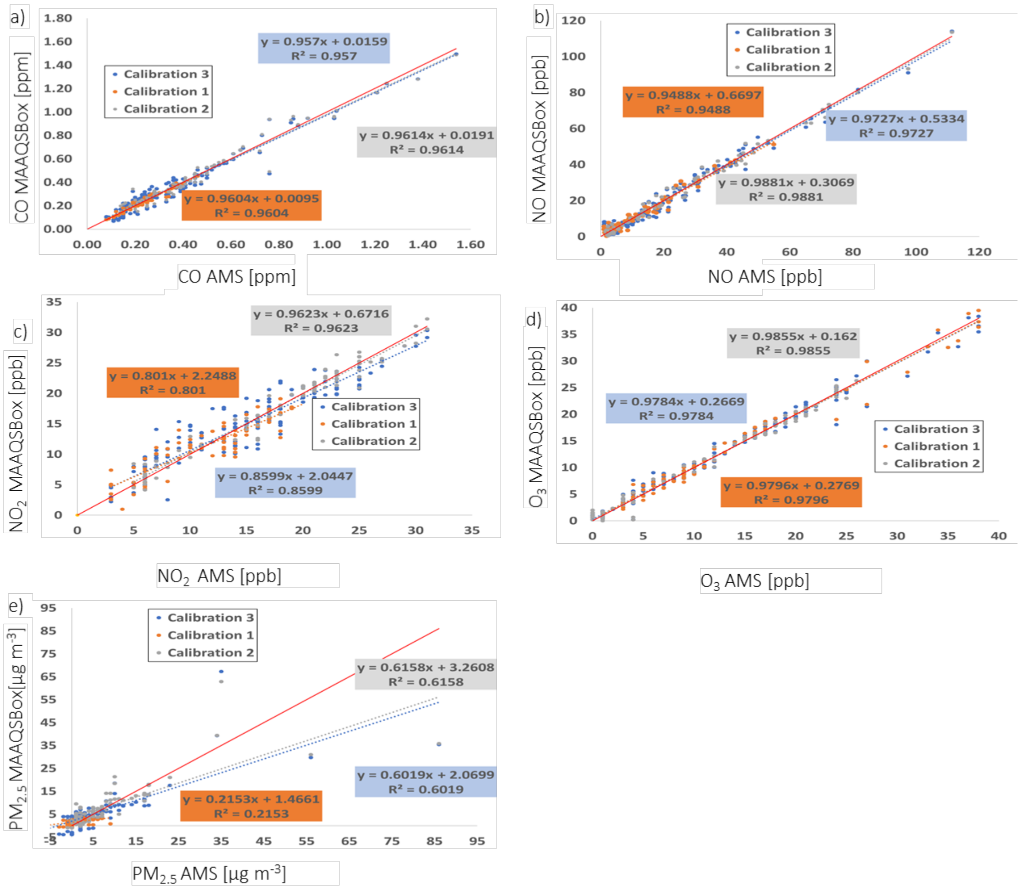

Fig. 1.

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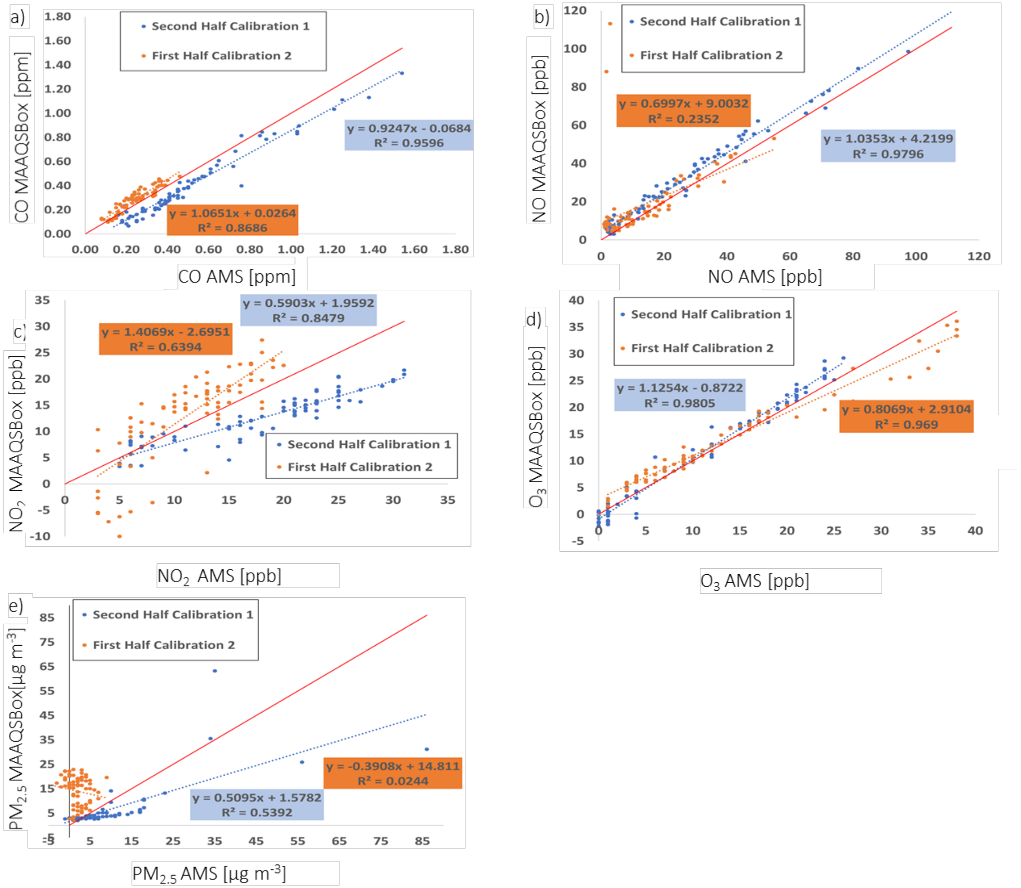

Fig. 2.

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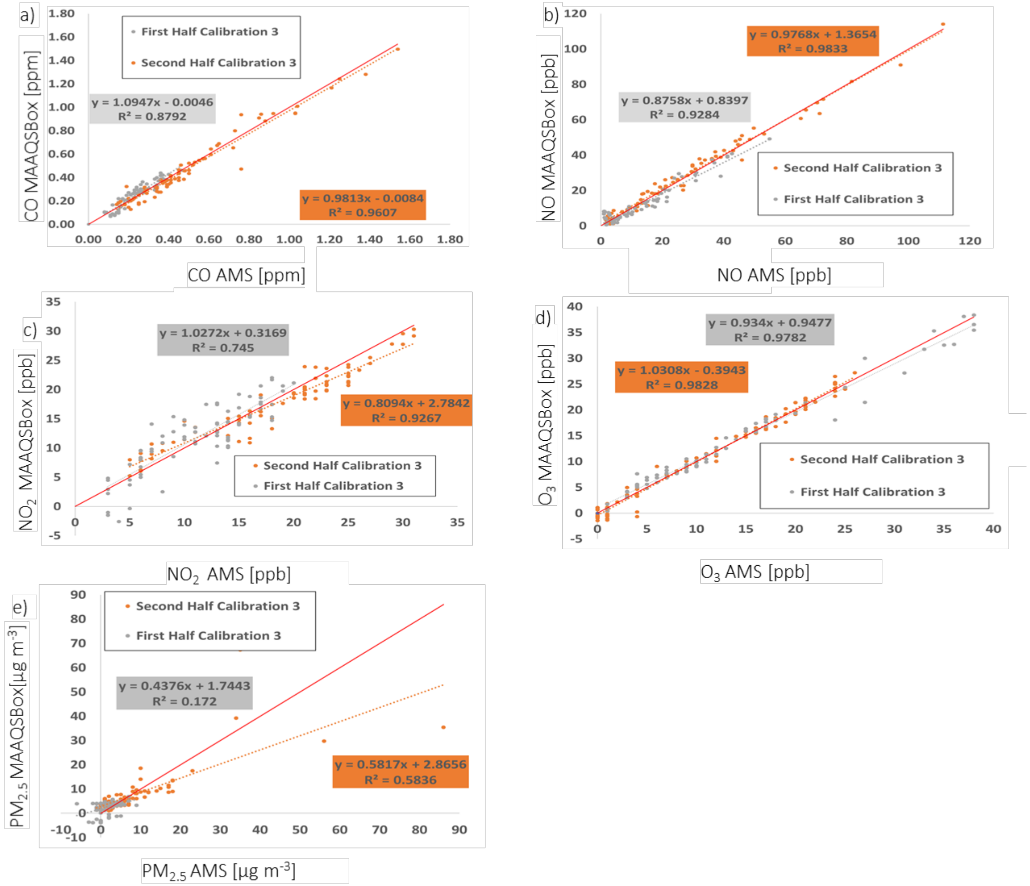

Fig. 3.

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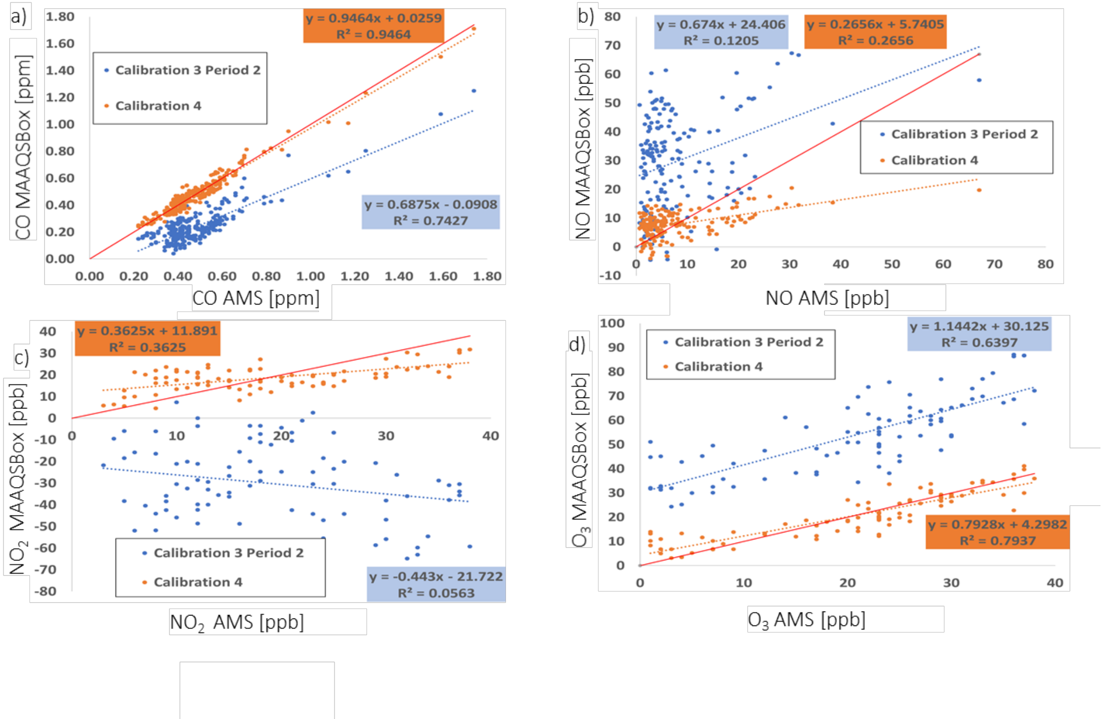

Fig. 4.

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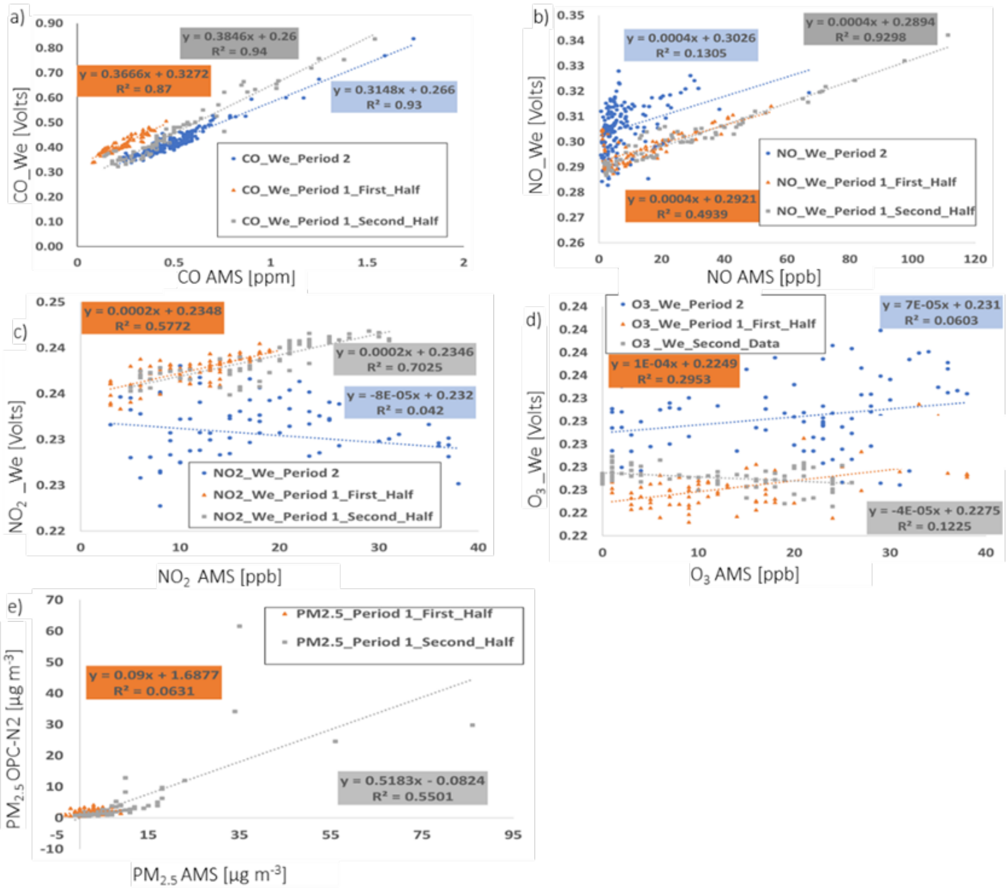

Fig. 5.

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Table S1

Variable	CO	NO	NO_2	O_3	$PM_{2.5}$
Humidity	4.09E-02	6.43E-06	1.63E-	9.44E-06	9.37E-02
Temperature	5.75E-02	6.70E-36	3.50E-	5.97E-02	1.92E-02
*We*_CO	3.18E-49				
*Ae*_CO	9.95E-11				
*We*_NO		2.51E-43			
*Ae*_NO		3.80E-01			
*We*_NO_2			2.99E-	6.92E-35	
*Ae*_NO_2			6.85E-	4.05E-01	
*We*_O_3			2.60E-	1.48E-36	
*Ae*_O_3			4.83E-	2.01E-01	
$PM_{2.5}$					3.02E-02

Fig. 6.

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