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Atmospheric Measurement Techniques
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Discussions

Interactive comment on "Use of electrochemical sensors for measurement of air pollution: correcting interference response and validating measurements" *by* Eben S. Cross et al.

Anonymous Referee #1

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This is a rigorous attempt to illustrate the challenges and utility of deploying 'low cost' air quality sensors in a community. This is a field of growing interest – likely to become more crowded – with important implications across most spheres of atmospheric research. A particularly strength of this work is stressed by the authors in warranting caution in interpretation of data from these types of sensors.

Specific comments: P1, Line 14: perhaps this is better phrased as '. . .address environmental justice issues related to air quality.' P1, Line 22: 'Protecting the air environment. . .' isn't really one of the most important PH challenges. Rather, it is protecting populations from degraded air quality exposure that is important. P1, Line 29: to presume the authors mean US dollars? P8, Line 18: extra word 'in'

General Comments: One issue that is not discussed is the potential for lot variability in sensor performance within a single manufacturer. Whilst the authors provide adequate detail on which make/model has been chosen (P2, L33-40), do these EC sensors exhibit differences within a manufacturer production lot? Or are there differences across different lots?

The paper begins with a discussion on environmental justice (abstract), and includes very specific references to asthma rates in the sampled community (P4, lines 1-4). Context is, of course, important, but these facts seem out of place in this manuscript which is mainly a focus on the technical details of using and interpreting EC sensors.

It was surprising to see a reported temperature range of 5-45 degrees in a northern US city, but the authors later state that this was internal box temperature to assess electrode function under actual operating conditions. When comparing these data, was a correction to ambient temp and RH taken into account (e.g. temp/RH measured by a nearby met station)? For example, if ambient temp and RH were 25 deg and 50%, but the internal temp where 35 deg and 15% because of strong sunlight, one would expect a significant effect, given the apparent sensitivity.

Why was there no data included or discussed for particulate matter or CO2?

In a number of cases, the authors refer to this sensor package as a 'low-cost' replacement for measuring air quality, which could play a key role towards empowering environmental justice (P9, Line 34). The authors are correct in asserting that lower cost sensors likely have a role in improving granularity in air quality monitoring networks, especially in locations with disproportionate air quality burdens, like the relatively low income communities in which this study takes place. But the idea of 'low cost' is a fairly subjective statement that seems meant to broaden the appeal of these products to communities in need. The development of low or lower cost sensor units with an eye towards reducing injustices is a noble and important direction for air quality scientists, but it might provide value to compare this instrument against the few other existing low/lower cost sensing units that are found in the literature – both in terms of sensor performance and relative cost.

The largest issue seems to be in interpretation and setup of the HDMR model to adjust sensor data to real values. Specifically, the authors state that the model can 'capture the intricate interdependencies of the variables…' in order to correct the data and provide guidance to researchers which variables are most impactful (P6, Line 1). These statements presume that the researchers enter in all possible variables that are likely to play a role in sensor performance. Given the relative few number of variables measured, and presumably computed, how can a researcher have confidence that they are accounting for all – or at least most – of the likely variants that may affect their results? The concern here is that there may be other plausible covariates that affect sensor performance. For example, one might imagine a measure of CO2 by NDIR could be affected by water vapor (which is imputed by this sensor package), but also by other ambient IR-absorbing components (that are not measured)?

The authors also note (P 6, Line 8-9) that in the first step of modeling, a user can choose how many variables are selected to interact with one another. How does one quantitatively make this determination?

It is very difficult to discern useful results from Figure 3. Further, we must presume that these data have been validated by the investigators. If so, it is surprising to see spikes of ozone exceeding 1000ppb with some regularity in this location, as observed by the reference monitor.

Figure 5 is a fairly useful illustrative figure that clearly identifies sensor limitations. But it is troubling to see divergence between the EC sensor and the reference sensor in periods of relative stability in temperature. This seems to need further explanation – how does your data compare for this specific time series after it has been modeled?

The authors included a number of variables to consider in adjusting or training the model, but specifically excluded sensor age, noting that the sensors were approxi-

mately 6-7 months old at the end of the study and, therefore, should have limited effect on model performance. Firstly, wouldn't it be more appropriate to compare sensor age to manufacturing date, rather than when a package is opened? And second, it is unsatisfying to ignore sensor age as a relevant variable, given the relatively short lifetimes of these sensors. For example, the NDIR lamp and electrode has a lifetime of 2000-6000 hours (according to the manufacturer), depending on lamp light time and the presence of heavy contaminating pollution. This is 80- 250 days, which is not much longer than the study length presented here, and suggests that long term drive is something that should not be ignored.

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