

## ***Interactive comment on “Understanding the ability of low-cost MOx sensors to quantify ambient VOCs” by Ashley M. Collier-Oxandale et al.***

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Received and published: 12 January 2019

COMMENT: “Review of Collier-Oxendale et al. “Understanding the ability of low-cost MOx sensors to quantify ambient VOCs” This paper is a welcome addition to the literature on the issue of understanding and utilizing low-cost sensors systems for measuring and monitoring trace gas concentrations in the atmosphere. The focus of the paper is on the co-location of the systems with more accepted independent measurement techniques for the molecules of interest, i.e. VOCs and selected inorganics. The authors describe the statistical methods and techniques in detail and show comprehensive details of the analysis of the uncertainties and effective of their methods in this deployment. More detailed required on the co-located methods.”

C1

RESPONSE: The authors appreciate the overview provided by the reviewer and would like to thank the reviewer for their productive comments, which helped to improve this paper.

COMMENT: “The whole analysis falls or stands of the methods used to compare the sensor data. It is therefore important that the correct details, with references, of the instrumentation used in this study. For example, what type of ptr-ms? ToF/quad? Was the LGR instrument really a cavity ring-down or was it an off-access output spectrometer. This may seem picky, but this is techniques and instrumentation paper and so the details need to be spelled out.”

RESPONSE: The authors agree regarding the importance of precisely describing the reference instrumentation relied upon in this analysis. To address this comment, additional details and expanded descriptions have been added to Section 2.2.

COMMENT: “Discussion on applicability of techniques described and warnings regarding using these type of sensors in isolation with training data in new environments. The study data and methods are well analysed and described. However the sensors are trained using very similar data to the data generated by the methods described and the sensors used. How do we know the accuracy of the sensors in new environments? Techniques used in atmospheric analysis are commonly found to have interferences in “new” environments that result in many years of inferences on “false” data. Low-cost sensors is a new area and it would be good for well-run studies such as this to provide some words of warning for the deployments outside of co-location of well-characterised methods, in a spatial mesh to provide high resolution spatial data to a fixed high quality measurement location or well-understood environments. It is important to note that models only work within the parameters of the training data and so phenomena that are encountered outside of the scope of the training data will probably have unknown uncertainties associated. More in depth discussion of these issues would be of benefit in addition to few lines in the conclusions.”

C2

RESPONSE: This is a significant point raised by the reviewer and the authors agree that it is important to highlight the similarity of the training and testing datasets used in this study as well as discuss potential limitations. To further bring attention to this issue the authors have added a discussion to Section 3.2 on the issue of the transferability of calibrations for low-cost sensors to new environments including referencing existing literature on the topic. The authors also note the potential complexity of this issue for VOC sensors, as in addition to variation in the environmental parameter space and pollutant ranges, the composition of VOCs is likely to vary in new environments.

COMMENT: "Would authors consider adding a "Best practices and procedures" section to the discussion section as mentioned on page 5 section 1.1? This would be a usable summary of their findings."

RESPONSE: The authors agree that best practices and procedures are especially important for low-cost sensors as they are such as accessible technology. While this study is more of a preliminary look at using VOC sensors in the field, several overarching, guiding best practices have been added to the conclusion section. These have been framed as initial best-practices and they provide a foundation for future studies to expand upon.

COMMENT: "Comments, data or discussion of the lifetime of MOx sensors and the sensitivity drift. Do MOx sensors drift? How much do they drift? Is the drift similar across all detected molecules? The training data bookends the measured data and so any sensitivity or selectivity drifts occurring will be implicit in the models produced by the training methods. In my experience there is significant drift and individual sensor-to-sensor variability even within batches. The authors should address the issue of sensor drift somehow within the limits of their study but also more generally how sensor drift issues may impact the application of low-cost sensor systems."

RESPONSE: The authors certainly agree regarding the importance of characterizing and understanding drift for low-cost sensors. In an effort to highlight this issue, a dis-

C3

cussion has been added to Section 3.2 that explores why drift occurs and what other researchers have observed using low-cost sensors. Given the length of the field deployment for this dataset, we were not able to characterize long-term drift. However, we did examine inter-sensor variability at the start and end of the measurement campaign in an effort to understand if any drift might be consistent across sensors of the same type. The results were mixed; we found high and consistent correlation among the two Figaro 2600 sensors at the start and end of the campaign, however, we found low correlation among the two Figaro 2602 sensors at the start and higher correlation at the end. Given the limitations of the dataset, it's difficult to explain what drove the difference in these results, but we believe that including these results illustrates the importance of considering inter-sensor variability, drift, and losses in sensitivity during sensor studies. As to the reviewer's point regarding whether VOC sensors drift consistently across different compounds - this is a very interesting question and the authors have indicated that this would be valuable future work.

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Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-304, 2018.

C4