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Atmospheric Measurement Techniques Discussions

Interactive comment on "Evaluating and Improving the Reliability of Gas-Phase Sensor System Calibrations Across New Locations for Ambient Measurements and Personal Exposure Monitoring" *by* Sharad Vikram et al.

Anonymous Referee #1

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This manuscript describes the assessment of several approaches that could be used to improve both the performance and the transferability of low cost gas phase sensor system calibrations. This is a crucial step in the enabling of these technologies for use air pollution monitoring, and this work is a valuable contribution to the growing body of literature on this major remaining challenge for these technologies. Previous work has demonstrated that although successful calibrations can be derived for low cost sensors through co-location with reference grade instruments, these calibrations do not hold if the sensors are moved to a new location, or even at the same location under

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significantly different chemical or meteorological conditions, and are prone to model over-fitting. The lack of a robust and transferrable calibration strategy is most likely due to variations in the multiple environmental parameters, both chemical and physical, that effect sensor signals. The authors of this work propose that by using the data from multiple low cost sensors systems co-located with reference instruments in different locations the resultant calibration will be more generalized. This approach has been suggested previously, however, to this reviewers knowledge this is the most extensive investigation of this approach for gas phase electrochemical sensors to date. The authors also propose a novel two-stage "split-NN" approach to address the challenge of sensor to sensor variability when creating a global calibration.

The analysis presented in this manuscript is thorough and well written, and although the generalized calibration models developed still maintain large sensor errors the methods do show promise. I therefore recommend publication after the following minor comments have been addressed.

Minor comments:

1) Sect. 2.3 pg 9 lines13-15: It would be useful to the reader to know how much data was removed during the preprocessing steps.

2) Sect. 2.5: The split-NN is a novel approach for correcting for sensor-to-sensor variability in sensor signal and response to target compound concentrations. If I am not mistaken however, the environmental variables such as temperature are only used in the second stage of the process. As individual sensors are known to have different responses to their target compound it is more than likely that they will also differ in their responses to interfering compounds and environmental factors (this has been shown previously e.g. Smith et al. 2017). Would the authors not therefore get an improved result if the environmental parameters were included in both stages of the split-NN procedure? The authors should provide further justification of the variables chosen for each step in the split-NN.

3) Fig. 6: Needs units on y-axis.

4) Fig. 7: Needs units on plot axes and the time averaging used for the data points needs to be stated in the fig. caption.

5) Sect. 3.1 pg 15 lines 7-8: The sentence “The increase in bias is more pronounced in the higher capacity models” does not seem to be strongly supported by the data presented in Fig. 7. This statement needs supporting quantitatively or removing.

6) Sect. 3.2: It would be interesting to see the performance improvements from each stage of the split-NN approach. The addition of error plots similar to Fig. 7 for a single sensor after both stages of the process would help visualize the power of the approach.

7) Fig. 9: Needs units on y-axis.

8) Discussion: The authors are open about the limited success of the transferable calibration approaches investigated. It would, however, be beneficial to the field if the authors were to expand further on possible reasons for this and potential ways to improve the methods moving forward.

References: Smith K. R., Edwards P. M., Evans M. J., Lee J. D., Shaw M. D., Squires F., Wilde S. and Lewis A. C.: Clustering approaches to improve the performance of low cost air pollution sensors. Faraday Discuss, 15, 1-15, 2017.

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