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Atmospheric Measurement Techniques Discussions

Interactive comment on "Long-term reliability of the Figaro TGS 2600 solid-state methane sensor under low Arctic conditions at Toolik lake, Alaska" *by* Werner Eugster et al.

Werner Eugster et al.

werner.eugster@usys.ethz.ch

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Response to Reviewer #2

Reviewer feedback in copied in with black text, our response, how we plan to revise our manuscript, is given in indented blue text.

This manuscript presents the results from a field deployment of a pair of low-cost metaloxide sensors. The sensors were co-located with a reference instrument, allowing the researchers to train various calibration models to predict methane concentrations. These calibration models relied on the signals from the low-cost sensors as well as other sensors (i.e., temperature and humidity). Researchers then assessed the performance of and potential for these sensors using the predicted signals.

This manuscript is especially relevant to the field of low-cost sensor research and readers of Atmospheric Measurement Techniques for two reasons: (1) it provides an example of a long-term (multi-year) field deployment of low-cost metal-oxide sensors, and (2) it provides an example of VOC sensors deployed to predict ambient methane levels - two areas that would benefit from further study. Furthermore, the deployment of the sensors in a remote area with little potential for the presence of confounding pollutants provides useful information on the potential ability of this sensor to be used for methane detection. Though a few revisions (listed below) are recommended prior to publication.

Thank you for your very supportive assessment. Your comments are very valuable for us to improve clarity and add an interesting aspect about the sensitivity of the TGS 2600 to CO from wildfires.

1. Please clarify throughout whether the results for the linear model being discussed in the text are based on the model that was fitted to the complete data set or the model which was fitted to the shorter training data set.

This will be done.

Additionally, the training and testing periods defined for the linear model (in Table 1) and for the ANN (in the end of Section 2.4) appear to be different. Could the authors comment on the rationale for this choice and whether the use of these different periods might affect the comparability of the results for these two models presented in Table 1?

We will recalculate the ANN to match the same data selection as we used for the linear model.

2. In Section 2.3, please provide information on any additional processing of the sensor data that may have occurred (e.g., filtering outliers, or removing sensor “warm-up” periods), or state that the data did not undergo additional filtering or processing.

This will be done.

3. Suggest moving the description of the motivation and development of the model for heat loss to an earlier point in the manuscript (e.g., after the description of the linear model in Section 3.0). This would assist the reader in their interpretation of the results in Table 1. Though the discussion of how this approach could be improved should remain in Section 3.5.

This can be done.

4. Could the authors provide additional information or discuss how the parameters of the model were selected (Eq. 2), for example, did this model yield substantial improvements over a simpler linear model?

We used the stepAIC function of the MASS package in R. We will add the details to the text.

5. Suggest expanding on the point made in Section 3.5 (Lines 253-254) to explain in what ways laboratory conditions over-simplify real-world conditions. This observation has been demonstrated in other studies [1, 2] and it could be valuable to highlight the challenges that may be associated with laboratory calibrations of sensors for this particular application.

This aspect also caught the attention of Reviewer #1. We will thus revise the text, in part with advice from Dr. Nick Martin, National Physics Laboratories, London on this topic. In addition we will emphasize that testing in the temperature and moisture conditions in the range from –40 °C to 0 °C is not easy in a laboratory environment.

6. Could the authors provide additional detail on the potential or likelihood for confounding pollutants, in particular carbon monoxide (Section 2.2)? For example, are there any towns nearby where emissions from wintertime heating may be a concern, or did any major wildfires occur in the area throughout the deployment period?

We will add to the text that the study site is in such a remote site that winter time heating negligible, certainly not what one would expect from an urbanized area. However, wildfire influences in summer time (from fires in forests far to the south of our site and in the south side of the Brooks Range) may produce high CO levels that would lead to apparent high CH4 mole fractions. We will add an extra analysis of an episode where smoke from a wild fire south of the Brooks Range mountains was present at Toolik Field Station according to our own records, and compare that period with the period immediately before when the smoke arrived. We can also compare from similar weeks in the year before and year after when the fire occurred.

7. Is there any concern that the temperature/humidity sensor described in Section 2.2 might itself experience any issues with drift or aging over such a long field deployment?

Any sensor might be subject to drifting and aging. What we can do in our revisions is to compare our dedicated temperature and relative humidity sensor with the reference sensor of the long-term weather station at the same site.

8. Line 38: add an ‘s’, “assessment of low-cost sensor[s]” 9. Line 66: delete ‘e.g.,’, “in an area like e.g., the arctic” 10. Line 246-247: change the color of the red text to black 11. Line 254: delete ‘it’, “as it would be required”

These minor changes will be applied as suggested.

References

[1] Castell, N., Dauge, F., Schneider, P., Vogt, M., Lerner, U., Fishbain, B., . . . Bartonova, A. (2017). Can commercial low-cost sensor platforms contribute to air quality monitoring and exposure estimates? Environment International, 99, 293-302.
[2] Piedrahita, R., Xiang, Y., Masson, N., Ortega, J., Collier, A., Jiang, Y., . . . Shang, L. (2014). The next generation of low-cost personal air quality sensors for quantitative exposure monitoring. Atmospheric Measurement Techniques Discussions, 7(2), 2425-2457.

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