Atmospheric Measurement Techniques Discussions

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Comment on amt-2022-308

Daniel Furuta (Referee)

Referee comment on "Characterising the methane gas and environmental response of the Figaro Taguchi Gas Sensor (TGS) 2611-E00" by Adil Shah et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-308-RC1, 2022

General comments: The paper is a useful addition to the growing body of literature around these low-cost sensors. In particular, the discussion of ambient vs. synthetic air for calibration and the power-law model presented in section 3 are interesting contributions. I found the paper's narrative somewhat difficult to follow, and had difficulty keeping track of the different systems and variables (e.g. System A vs. System B; the various resistance values). Possibly some minor restructuring to center the novel findings and more explicit terminology/notation throughout would help with readability.

Specific comments by line number:
110-130: While these previous studies report usable results with TGS2600, they used different models and system designs, and it is unclear whether the results are generalizable or tied to specific characteristics of the research sites or experiments. In our previous study (https://amt.copernicus.org/articles/15/5117/2022/) we did not find TGS2600 to respond to low levels of methane in a laboratory setting. This section would be improved by mention of some of the papers' caveats; for example, Eugster and Kling (2012) note in section 3.5 an R^2 of less than 0.20; Collier-Oxandale et al. found different models necessary for their different sites and note that some overfitting was observed, and so on.

172 & 184: The 5k resistor choice needs justification. As you note at line 165, the reference resistor should be close in value to the expected sensor resistance. Around background methane levels one would expect a sensor resistance an order of magnitude larger than your 5k choice, as can be seen in your supplemental information (which is consistent with our observations).

169-179: More detail about the logging system would be useful, particularly the ADC resolution, noise floor, and so on, as these can be expected to determine sensitivity in combination with the reference resistor choice. I would be interested in a brief sensitivity calculation using the ADC resolution/noise floor and the 5k reference resistor to show the

ability to detect small changes in the sensor resistance. The logger's power supply stability is also a critical detail for your system's performance.

194: For the application 35mV is possibly not good enough; is this value referring to the accuracy of the setting, ripple, drift, or a combination of all of them? 35mV ripple would swamp any sensor response to small methane changes, for example. You have some discussion of supply voltage sensitivity in your supplemental information, but a short quantitative discussion of what this supply voltage tolerance means in terms of sensor response/detection capability would be illuminating, as it's not immediately obvious to me how big of a concern the supply voltage accuracy is for your experiment.

311-318: The H2O fluctuations within each period are substantial (from the chart, up to 0.5%) and appear to continue over the whole of each sampling period. If the sensors require hours to stabilize at a given humidity level, will they stabilize at all given this large fluctuation?

316 and throughout: Could you remind the reader what R2 indicates or use a more descriptive subscript? I had difficulty remembering the resistance notation, much of which is similar - R2, Rb, Rl, etc.

337: As the sensors are much more responsive to humidity than to methane, is 3% uncertainty good enough?

355: Fig 10 shows some fluctuation in sensor response in the last two minutes, and it looks like the sensors stabilize at the new methane levels quite quickly. Why is it better to select the last two minutes of each methane level rather than the last 10 minutes, which appear to already be stable?

361: Why is Eq. 3 only valid for system A?

Table 4: The variation in the alpha values for the sensors is surprising to me - our previous work found TGS2611-E00 to be quite consistent, at least within the same production batch. Were your sensors taken from the same batch, or is there some other component in the system that might be causing this variation? You mention this at line 641, but it would be good to also indicate whether your sensors have the same or different batch codes (printed on the side of the component).

421: Again, why the last five minutes? It looks like the sensors stabilize more quickly than that, as far as I can see from Fig. 12.

Section 5.1: Your field and lab tests presumably used different power arrangements. Could you add some discussion of the steps taken to ensure consistent electrical operating conditions between the field and lab tests (particularly 5V supply stability)? In the supplemental information you show that different supply voltages cause different sensor responses; is this possibly involved in the differences?

Section 6: This section is difficult to read to me, and doesn't highlight the major contributions of the paper. It would be more clear to me if broken into multiple paragraphs, and with stronger emphasis on the findings you believe to be particularly important.