Reviewer Report on amt-2021-387

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General Comments:

I appreciate the idea of developing a lower-cost CO_2-flux measurement system and find the paper to be well written and of appropriate length and depth

The methods are well documented, as are the results, although I wish some more details on the calibration were shown. On the one side, I find the lack of reference/calibration data for the CO_2 flux measurement part a bit disappointing. I wish the authors could provide a comparison with a commercially available flux measurement system, but I understand that organizing such an experiment is not easy. On the other side, I have doubts regarding the CO_2 measurement calibration model and the necessity of a relatively complex calibration setup for the particular application. I will discuss these points in more details in the following section.

Specific Comments

1) L17: You wrote that the results were corrected for illumination. This does not appear anywhere in the main body of the article. Please either remove this or edit section 2.2 and the results section to reflect this. Do you think illumination would have an impact on the CO_2 calibration? I could only imagine an indirect effect through heating of the sensor, which is already captured by the temperature calibration.

2) L88: In my experience employing very similar sensors (SenseAir LP8), air humidity has a large effect on the data quality, particularly for RH> 80, causing an highly nonlinear saturation in the measured concentration. Could you please report the RH range used for calibration? As you measure directly above soil, I would expect the RH in the chamber to routinely reach these values. Did you experience this? This could have an impact on data quality, particularly if you experience a sharp increase in RH within the chamber during the measurement time. Could you show the graph of RH for the linear accumulation experiment of Figure 6?

3) I appreciate the effort spent to develop a high-quality calibration model. However, in the case of NSS-NTF flux measurements, calibrated data is not strictly necessary as long as the sensor's calibration does not change *during* the measurement timespan as the flux is determined "differentially" by considering the rate of growth of the CO_2 concentration within the chamber. Could you briefly comment on this in your paper? This could save significant resources for researchers that intend to reproduce your system but do not have the means to perform a comprehensive calibration.

4) In contrast to the above point, in the case of SS-TF chambers, the effect of calibration is not negligible here. For example, if the sensor in the mixing chamber shows a large bias in its response compared to the sensor in the flux chamber (or vice versa), the bias will induce a similar bias in the estimated flux. Therefore, it is clear that uncalibrated sensors cannot be used in this configuration. Could you comment on this? Could you suggest a simplified calibration procedure for those who do not have access to calibration facilities? Would a field calibration with a known gas sample be sufficient?

5) L167 could you provide a summary of the environmental parameters the sensors were exposed to during the calibration cycle? Did you systematically sweep a space of T/RH configurations?

6) L175 could you also show the response of the sensors as a timeseries of relative deviation from the reference provided by the CRDS? Showing this timeseries alongside T and RH would provide some insights regarding their effect on data quality as mentioned in question 3.

7) L183 you report that pressure has the largest effect of the sensor response and that pressure compensation provides the largest reduction in RMSE. Why did you choose to use a linear model for pressure compensation instead of using the quadratic formula suggested by SenseAir in their application note? (see http://www.co2meters.com/Documentation/AppNotes/AN149-Senseair-Pressure-Dependence.pdf)

8) L185 While your statement is true in our experience with the CarboSense network; I think such frequent calibrations could be replaced by in-field calibration for intercept/sensitivity using one respectively two references gases. In the case of NSS-NTF measurements, calibration is not *strictly* necessary to obtain corrected flux measurements as I pointed out above.

9) L202 For the SS-TF measurements you employed multiple sensors on each chamber. Do you think this redundancy could be exploited to improve data quality, for example by averaging the signals or to determine biases?