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Atmospheric Measurement Techniques
Discussions

Interactive comment on "Continuous methane concentration measurements at the Greenland Ice Sheet-atmosphere interface using a low-cost low-power metal oxide sensor system" *by* C. J. Jørgensen et al.

Anonymous Referee #1

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General comments

This paper presents laboratory and field calibrations of a low-cost MOS for the measurement of methane concentrations in air. Whilst laser spectroscopy is currently the state-of-the-art solution for high-precision measurements of trace gases such as methane, this technology is expensive and ill-suited to remote, hostile environments such as the Greenland Ice Sheet, which is the study site of this paper. There is a great need to develop low-cost, low-power, rugged sensors capable of operating autonomously in remote locations and this is particularly critical for Arctic ecosystems

where the effects of climate change on greenhouse gas emissions are believed to be much larger than at lower latitudes. This paper compares a low-cost MOS with a state-of-the-art Picarro cavity ringdown spectrometer (CRDS), using the latter as a benchmark, and demonstrates the suitability of the prototype for real-time, in situ measurements. The proof-of-concept study is well-designed and generally adequately documented, and the subject matter is a good match for the scope of the journal. The technology is interesting and I hope that it will be developed further. This manuscript should be considered for publication provided that all the comments listed below are addressed.

Specific comments

The quality of English is acceptable but efforts should be made to shorten sentences throughout the manuscript.

Line 61: the MOS would not directly inform on climatic feedbacks. Please shorten the sentence to "... sensing element for future studies into CH4 emissions from the subglacial domain under the Greenland Ice Sheet."

Line 80: what is an open-ended enclosure?

Lines 85-91: Where/how was the air fed to the MOS sampled from? Through a 50 m tube, independently of the CRDS? If so, the sampling rate, and hence flushing rate of the MOS enclosure, would have been > 3 times that of the CRDS. My interpretation of this is that the autonomous setup would have been different from the calibration one and you would no longer compare like for like (direct comparison?). Please explain.

Line 131: also refers to comment above. "Parallel measurements..."; the setup is still unclear to me. Did you use separate sampling lines for the CRDS and the MOS?

Line 147: I don't understand why 0.042 is more complicated than 0.05. What uncertainty does rounding up (why not round down to 0.04 which is nearest?) add?

Line 165: a graph illustrating the differences in model parameters would be useful.

How significant are the differences between lab and field calibrations? In line 115 (lab calibration) you mentioned that the temperature was kept constant at around 22 °C. Was there a temperature effect in the field calibrations? Please, comment.

Lines 187-189: I do not understand the relevance of discussing the response time of a similar MOS, unless by similar you mean same model, different unit. Furthermore, the response time range (1-30 minutes) is massive compared to the CRDS (< 1 Hz). Considering the large differences in response times, you would have to take into consideration the temporal buffering introduced by the pumping rate, particularly where the Picarro is concerned (∼ 47 seconds to flush the 50 m sampling tube @ 800 mL/min).

Lines 220-222: Re. filtering out the fluctuations attributed to micro-turbulence/ dilution of cavity air by influx of ambient air. If the purpose of the exercise is to study the emissions of CH4 from the cavity, then filtering out such perturbations is justified. However, this paper is concerned with a field assessment of a MOS sensor, and in this context, characterising the response of the 2 sensors to these perturbations is of great interest. This ties in with the comment above (response time and temporal buffering). Looking at Fig. 7a, the outliers in the turbulent period are further from the smoothed line for the CRDS than for the MOS. This might be an effect of the faster response time of the CRDS. It would be interesting to choose a longer averaging time (>= sample line flush rate + sensor response time) and plot the time series of Fig. 7a and b again. I would like to see this analysed and discussed rather than just smooth it out.

Line 284: "very close"; please quantify this statement.

Lines 295-297: Please tone down this statement. Your study evaluates a low-cost sensor for the measurement of CH4 in a hostile environment with the potential to lead to a better understanding and quantification of CH4 emissions from GrIS and similar locations.

Technical comments

Line 57: "... and in sensor network grids." This might require clarification.

Line 57: change "we have in situ tested..." to "we have tested in situ...".

Line 67: "...southern flank..." of what?. Terminus does not seem to be the right term.

Line 74-75: this sentence is clumsy and needs re-structuring. Suggestion "Humidity and temperature of the subglacial air were measured every 10 s using a combined sensor (...) mounted at the tip of the aluminium pole inserted into the cave. The data were recorded using..."

Section 2.2: could you specify whether the MOS setup was built by your lab?

Line 99: "electrical circuit converts" not convert.

Line 100: "were powered" not was.

Line 127: "are inversely" not is.

Lines 132-136: long sentence, difficult to read. Split into 2 parts.

Line 168: "which has been reported to scale linearly..."?

Line 177: "at the margin of the..." not if.

Line 211: "Measurements... show..." not shows.

Line 268: "... while being undetected..."

Line 284: "departs" means leaves. Use a more appropriate verb.

Line 313: "... which could significantly improve..."

Lines 314-317: this sentence is too long. Please divide it into two.

Line 325: Remove "very clean" unless you can substantiate its meaning.

Fig. 7: please indicate the temporal resolution of each plot.

Fig. 8: as in Fig. 7, what is the time step?

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