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Measurements of subglacial methane emissions using a low-cost / low-power metal oxide sensor system

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Constraining the various sources and sinks to the global methane (CH4) budget is becoming an increasingly important parameter in mitigating climate change. During a fieldwork campaign in West Greenland in 2016, a new source was identified in which CH4 was emitted from the subglacial domain of the Greenland Ice Sheet (GrIS) to the atmosphere (Christiansen & Jørgensen, 2018). This first report was recently followed up another study showing that the summer discharge of meltwater drives the export of CH4 from the ice-sheet bed (Lamarche-Gagnon et al., 2018). The spatiotemporal understanding of the new cryospheric CH4 source is still limited to two known locations along the entire margin of the GrIS (Christiansen & Jørgensen, 2018; Lamarche-Gagnon et al., 2018), and important knowledge gaps exist concerning i.e. the seasonal variation in CH4 emissions, climatic drivers for the total emissions and spatial extent of the phenomena along the entire margin of the GrIS.

The availability of continuous field measurements of greenhouse gas emissions in Greenland are typically limited by the remoteness of many field sites with following high expedition cost and logistical challenges. The emergence of low-cost/low-power sensor technology in recent years provides an opportunity to overcome many of current restraints on obtaining continuous field measurements and expand the network of unsupervised continuous measurements in remote and hazardous areas without running the risk of losing highly specialized and expensive analytical equipment.

In the current study, we tested the performance of a metal oxide semiconductor (MOS) sensor sensitive to CH4 (Figaro sensor TGS2611) at a subglacial discharge point at the margin of the GrIS in West Greenland. The MOS was powered and controlled by an Arduino Uno microcontroller connected to solar panels and LiFePO4 batteries. The analogue output of the MOS was field calibrated with a high-precision cavity ringdown spectrometer (Ultra Portable Greenhouse gas Analyzer, Los Gatos Research Inc.). The field test showed consistent agreement in the CH4 concentrations measured by the expensive reference analyzer (35.000$) and the low-cost MOS system (approximately 100$) in the concentration range of 2 – 100 ppm CH4 over a period of approximately 8 weeks.

The field test demonstrates a great potential for an improved scientific understanding of subglacial CH4 emissions and the potential climatic feedback mechanisms by enabling an expanded and intensified network of continuously operating MOS-monitoring stations along representative meltwater outlets along the margin of the GrIS at reduced operational costs and at much lower overall risks.

Christiansen, J. R., & Jørgensen, C. J. (2018). First observation of direct methane emission to the atmosphere from the subglacial domain of the Greenland Ice Sheet. Scientific Reports, 8(1), 16623. https://doi.org/10.1038/s41598-018-35054-7

Lamarche-Gagnon, G., Wadham, J. L., Lollar, B. S., Arndt, S., Fietzek, P., Beaton, A. D., … Stibal, M. (2018). Greenland melt drives continuous export of methane from its bed. Nature, In press. https://doi.org/10.1038/s41586-018-0800-0