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Atmospheric Measurement Techniques
Discussions

Interactive comment on "An Examination of Enhanced Atmospheric Methane Detection Methods for Predicting Performance of a Novel Multiband Uncooled Radiometer Imager" *by* Cody M. Webber and John P. Kerekes

Anonymous Referee #1

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General comments: The manuscript uses three methods to evaluate the performance of a multiband uncooled radiometer imager, which would be cost-effective compared to a cooled hyperspectral instrument. The reasoning is sound, with interesting results for the community. There are however several clarifications that needs to be made regarding the aim of the study and for the evaluation of the instrument using the different methods to be more clear for the reader.

Specific comments: 1a. Is the goal of the study to be able to quantify CH4 concentrations (column densities) or to only detect areas of enhanced CH4 without quantification? This should be made more clear. E.g. comparisons are made between MURI and HyTES, applying similar methods, but some studies using HyTES data have been able to quantify CH4 average concentrations using radiative transfer modeling (e.g. Kuai et al. 2016). If quantificaion is the aim, then e.g. for the Single Pixel NEdT Comparison: how would the method be able to differenciate between a change in temperature contrast and an actual increase in methane for the two cases (background and plume case). The brightness temperature would be affected by the background temperature, the CH4 temperature, and the CH4 column density. How can these three parameters be found from one brightness temperature? It is also likely that the background temperature (and thus the background vs CH4 temperature contrast) would be different between the two cases (no plume and plume).

1b. One of the aims of the study seems to be providing a novel, cost-efficient system for satellites, utilizing low cost microbolometers and not requiring an expensive cooling system. Is the developed system (MURI) mainly to be used for satellites (which are expensive anyway with many other high costs) or is the idea to use the system for ground-based (possibly airborne) measurements as well? (where reducing the cost could have a higher impact). This should be made more clear.

2. Section 2.3 (Normalized Differential Methane Index). The method does not account for varying ground emissivity, the background vs gas temperature contrast, or the H2O and N2O column densities (are there strong absorption lines from these in the the SB1 and SB2 bands?). These would effect the efficiency to detect CH4 (and for sure retrieval of column densities if this is a goal). If only detection, there could be false alarms from e.g. high H2O concentrations (which has lines overlapping the 7.7 micron CH4 band). Emissivities could also be different between different background materials.

3a. Section 4.1. There are three relevant temperatures for this test: background, ambient, and plume. The efficacy to detect a plume would be very dependent on the background - plume temperature contrast, and if this contrast is 0 deg the plume could not be detected regardless of the sensitivity of a sensor as all the CH4 absorption lines in the plume emits as much light as is removed (resulting in no absorption and no detectable difference in brightness temperature). In Figure 5, the 0 K curve (plume - ambient contrast is 0) would be a horizontal line if Tambient = Tbackground. It should thus be made more clear what temperarure difference has been assumed between the ambient and background. Also, caption to Fig. 5 should explain that the curves are different contrast of ambient and plume temperature. In winter it could very well be emissions features, with the plume increasing the brightness temperature with e.g. a background of ice on a lake. The sentence (P11, first row) "The results here indicate that a plume with a temperature difference as high as +10 K to ambient temperature is absorbing energy" - this again depends on the ambient - background temperature (which is not given as the ambient temperature is not given). This should be made more clear.

3b. Similarly, in the conclusions (P12) it is stated "The single band investigation confirmed that methane plumes with large concentrations and temperature differences compared to ambient atmospheric conditions lead to detectable contrasts". I agree with sufficiently large concentrations, but the important temperature difference is not the ambient and plume temperatures, it is the background and plume temperatures. This should be made more clear/rewritten. One could easily have the case of a very large plume-ambient temperature difference (say 10 K) but also a 10 K background-ambient temperature difference, leading to no absorption lines and no difference in brightness temperature.

Technical corrections: - Wrong table number. Page 9, 4.1. states "Table 3 contains...", this should be Table 2? (there is no Table 3) - Abstract: 7.68 um -> 7.68 μm. Also in other parts of the text (e.g. Table 1) using u instead of μ - Table 1: Write μm in the headers instead of every row - Introduction: Use CH4 instead of methane after first having introduced "methane (CH4)". This is also the case for many other parts of the text. - P5L17. "from pair" - > "from pairs"

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