

Interactive comment on “Performance of open-path GasFinder3 devices for CH₄ concentration measurements close to ambient levels” by Christoph Häni et al.

Anonymous Referee #1

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Review of “Performance of open-path GasFinder3 devices for CH₄ concentration measurements close to ambient levels” by Hani et al., submitted to Atmospheric Measurement Techniques (amt-2020-236). This paper describes field tests of Boreal Laser’s open-path CH₄ measurement system, focusing on several performance metrics. Boreal Laser’s GasFinder system has been an important gas sensor for over 20 years. With its relatively low price, extreme robustness, and simplicity of operation, it continues to play an important role in fence-line gas monitoring and emission source rate quantification studies. The subject of this paper is appropriate for the AMT journal, and it will be of interest to a substantial audience. The manuscript is well written and the analysis and conclusions seem sound. I have made mostly minor comments on this

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work. My recommendation is to accept the manuscript for publication.

Major Comment

1. The evidence of poor GasFinder performance (compared to the manufacturer's specifications) is convincing. Two of the analyses in this study are most important. First is the accuracy and precision estimates derived from the QCL comparisons. This gives a good estimate of the performance of an "off-the-shelf" GasFinder. I do suggest a refinement to this analysis. Can the authors cross-calibrate the lasers and the QCL (i.e., force agreement in the long-term average concentration), and then recalculate the precision? This situation would be the best-case scenario for a laser application. The second interesting analysis shows the variability of the laser cross-calibrations with time. This is perhaps the most important practical finding, as in the past users accepted poor agreement between lasers, believing that a cross-calibration can eliminate or reduce that problem. The findings from this study show that is not the case.

2. Can the authors make a case that in some circumstances a GasFinder based IDM measurement (upwind & downwind lasers) can provide a reasonably accurate determination of emissions (e.g., < 20% error)? For example, large cattle feedlots can have a CH₄ concentration rise (above ambient) in the feedlot interior of approximately 1-2 ppm. Based on the errors given in Table 5, are there upwind-downwind laser combinations that might give an emission rate calculation within 20% of the true rate? Such an exercise would be insightful for GasFinder users, and provide for some added perspective.

Minor Comments

3. Line 11: The Boreal Laser company should be identified with the first reference to the GasFinder.

4. Line 12 & 13: Do the authors need to tie this work to agricultural emissions? GasFinders are used more broadly than this (I am aware of their use in CH₄ measurements

at mines, at heavy industries, waste-water treatment plants, etc.). In terms of the entire manuscript, one could delete almost every instance of “agricultural” from the paper.

5. Line 16: “We investigated the uncertainty of six GF3 devices from side by side intercomparison measurements and comparisons to a closed-path quantum cascade laser device”. It is important to add that the comparison was made at near-ambient levels of CH₄ (and indicating the concentration range, e.g., 1.8 – 2.4 ppm).

6. Line 29: “It is in common to many IDM applications that the concentration enhancement related to agricultural CH₄ sources is small, typically between 0.05 and 0.5 ppm.” This “problem” is not unique to agricultural sources, so the “agricultural” qualifier is unneeded.

7. Line 32: “They are based e.g. on the determination of the absorption over a small wavelength range e.g. in the infrared spectrum (tunable diode laser technique for CH₄; DeBruyn et al., 2020).” Awkward and unclear sentence. Rewrite.

8. Line 37: “On the other hand, it is more difficult to assess and control the quality of measurements by open-path gas analyzers in comparison to closed-path instruments.” Very good point.

9. Line 45: “In this paper, we focus on the GasFinder3-OP (GF3) system for CH₄ measurements (Boral Laser Inc, Edmonton Canada) with the ‘Lo-Range’ calibration option.” Some explanation for the “Lo-Range” option is needed. Is this a specific type of laser? Does it use a different fitting curve in the concentration calculation? But I would say this is an unneeded detail in the broad objectives paragraph. Also, correct the company name to “Boreal”.

10. Line 62: “The output data in units of ppm-m was converted to the path-averaged concentration C in units of ppm (i.e. divided by the single path length) and corrected with temperature and pressure . . .” Use “one-way” pathlength rather than “single”.

11. Line 70: “According to the manufacturer, a valid concentration measurement can

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be expected if the 'received power' of the reflected incoming laser beam is in the range of 50 to 3000 μW . . ." Is power a routine output variable from the GasFinder?

12. Line 78: "Two campaigns, P16 and P17, with a focus on the comparison . . . close to an animal housing facility (approx. 100 m north)." Does the sensor proximity to the animal housing mean the CH₄ concentrations were elevated over ambient levels? Other campaigns also took place near gas sources. The authors might want to clarify whether they are looking at true ambient concentrations, or concentrations that ranged from ambient to somewhat above ambient, or near-ambient, etc.

13. Line 220: "However, it remains unclear to what extent a side-by-side intercalibration can be transferred to the actual measurement setup, since relocation of the devices might cause systematic changes, as indicated by the different regression coefficients for different intercomparison campaigns". Excellent and very important point.

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