Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2022-9

Anonymous Referee #2

Referee comment on "A quantitative comparison of methods used to measure smaller methane emissions typically observed from superannuated oil and gas infrastructure" by Stuart N. Riddick et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-9-RC2, 2022

General comments

The research presented in this paper reproduced and implemented in a controlled release experiment a portfolio of techniques dedicated to quantifying methane emissions from a point source. Through the source typology and chosen emission rate, the emphasis is on potential applications to fugitive 'small' (<=200 g/hr) emissions in the oil and gas sector. The research encompasses well established and already published methods including flux chambers and atmospheric downwind measurements.

The paper discusses the respective merits of each method, implemented from a very practical perspective, including an assessment of precision and accuracy.

The novelty of the paper lies in the joint implementation of all these methods in a single experiment focusing on low emission rates. The methods are already published elsewhere.

The paper presents several weaknesses in my opinion:

- The state of the art in the introduction doesn't acknowledge other available techniques. The selection of methods reproduced in the study is not explicit, and the reasons for ignoring/discarding other techniques is not clarified.
- There is a lack of context elaborating on the specific needs of the industry (e.g. buried sources are ignored or implicitly included as the paper seem to focus on aerial point sources), and possibly introducing some sort of statistical distribution of leak size would be useful.

- Finding that accuracy calculated from 3 estimates (Ar) improves compared to the discrepancy of a first, single estimate (A) is trivial but nevertheless occupies a significant part of the results (sect 3.1) and discussion: Sect. 4.1 is dedicated to this, even discussing a particular occurrence where 3-point accuracy is lower than the single point discrepancy. In general, if Ar is available, there is little statistical sense to discuss A at all.
- The "decision making paradigm" (Sect 4.2) is limited in scope by ignoring other techniques and situations that may representative of the industry, and it seems to operates in its own limited rationality, letting the reader ignore other works.

Specific comments

L16: not only for 200 g/h.

L29: why is this 200g/h threshold important? Is there a scientific rationale? Is it specifically representative of situations or technical challenges in the industry?

L31-38: A number of techniques and approaches (FLIR, mass balance, tracer release, remote sensing…) are ignored in this study. Their existence and their absence here should be acknowledged and thoroughly commented. They may not be included in this study for some (presumably good) reasons?

L37: "despite the interest in developing methods": unclear

L78: what is "total reflection of CH4 at the surface"?

L79: I would argue that mass balance is the simplest method, rather than GP.

L81: perfect "gaussian" plumes are indeed seldom met in nature. But also it is rare to have lonely 'weak' plumes in an industrial setting, so the GP approach needs to account somehow for multiple sources.

L98: is it the same 38% uncertainty applicable for 4ug/h and 3kg/h?

L102: if the 200g/h limit is for safety/practical reason, is it still useful in real life?

L108: can you please then comment on what was done at leak rates higher than 200 g/h? What are the limitations to transfer these conclusions to smaller leak rates? Why should we care about leak rates below 200g/h?

L110: it seems that the section 2 repeat the method description from the introduction, or at least lists again each method. The text would be more fluid and logical if all method description (including Eqs 1-5) are into the Method section and the introduction then focuses more strongly on state of the art, context and research questions.

L117: what are the uncertainties associated to the release rate (for example from the mass flow controllers)? How long does the releases last? What is the shape of the injection exhaust/outlet? Is there any attempt to reproduce a 'diffusive' exhaust? Or to control the gas exhaust velocity?

L122: how long is the calibration? How precise is the gas standard?

L127: how well do we expect the air inside the chamber to be mixed with the fan?

L128 how is the air sample drawn?

L134: why zero wind condition and not "wind speed below X m/s"? can you elaborate on this serious limitation?

L165: at what height is the gas scooter measurement made? Was any attempt made to measure CH4 across the plume (cross wind) to confirm the gaussian shape of the plume? If not, why?

L178: What is the impact of very small distance (5m) on the accuracy – does the model have a lower limit? Also measurements at 5m downwind suggest that relatively close access (and at the same height AGL) is possible, this should be acknowledged (also in Table 1).

L195 and following: why not automate chamber opening to avoid explosive limit? This should be easily done in a commercial context, and acknowledged in the discussion.

L227: the accuracy of the single "snapshot" becomes irrelevant once 3 repeat measurements are available for the release. Accuracy and precision derived from 3 points supersede the single measurement discrepancy as informative numbers.

L232: abs(A) "decreases": this is not confirmed in Fig 2b. can you please explain where this comes from?

L242: please quantify "generally"

L245: Ar>A : to me this is meaningless. It just means that there was some luck in the first value, and therefore it carries little sense to report A once you have Ar.

L251: This is expected and may be seen as trivial. On the opposite, what is surprising is when it is not the case. Why does SD for some techniques increase with increasing emission rate?

Fig.3 in my opinion would deserve further comments and discussion.

L265: Which technique has the lowest A is relatively unimportant when Ar is available. Ar>A is also fairly trivial from a very general perspective.

L280-283: These sentences are vague, complicated. There seems to be a confusion between the site scale uncertainty and the single GP uncertainty. Could you please clarify in terms of separating biases and random errors? (and all methods here seem to have consistent biases). Did you make any attempt to look at uncertainty budget in the different methods, the GP in particular, including the choice of stability class? Does it match with the 3-point accuracy?

L293-294: Can you please explain the "meaning and balance" and provide examples of studies that "present unexpected findings"?

Fig. 4: other parameters/selectors would be useful but are ignored in this study: is the source buried? What is the source intensity? Did you perform a source detection prior to

quantification? Some techniques are missing; as such, the value of this diagram is very poor for decision making, although the idea is good.

Editorial comments

L21: GP: expand acronym

L103: “copy” I suggest “reproduce”

L177-178: the cited papers are not listed in the References section

Fig 3: what is y axis unit?