Atmospheric Measurement Techniques Discussions

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Comment on amt-2022-9

Anonymous Referee #1

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-RC1, 2022

The paper provides a useful comparison of methane emission rate methods for rates lower than what has been studied frequently in previous publications. They conduct controlled release testing of four or five different methods. The paper is nicely written and provides interesting data. However, the authors should do more work on providing context for this work and when/where it's applicable. Also, there are edits that are needed throughout the paper.

One concern with this paper is that it's unclear who this work is applicable to. For example, for greenhouse gas emission inventories, there is always the emission factor approach, in contrast to what's shown in Figure 4. The authors mention oil and gas wells but without providing much context into the type of oil and gas wells, which can explain how the flow rates studied were chosen.

Also, the authors caution against doing measurements at sites with hydrogen sulfide and aromatic hydrocarbons, which would bias samples for regional or national inventories. From a policy perspective, wells that emit hydrogen sulfide or aromatic hydrocarbons are often prioritized for mitigation, and it would be unfortunate if we can't quantify the methane emissions being reduced through these efforts.

The methods can give very different uncertainties depending on how the experiment is conducted. For example, there are many ways to implement the Gaussian Plume method, including how and where methane is analyzed and the micrometeorology measured. The same goes for the static and dynamic chambers. Overall, the authors need to add more detail on the methodology and experimental conditions (dates/times, exact equipment and supplies, etc.).

Below are some additional detailed comments:

line 2: what is considered a "small point source"?

line 7: how is a point source defined? At what scale?

line 13: not clear if static chambers are tested in this study.

line 16: why only 200 g/h? confusing because in the text, there are three flow rates mentioned.

line 40: "very small" sounds arbitrary. where does the 0.6 mg/hr come from? Kang et al. (2014) also measured negative emission rates. There also are a wide range of published measurements using this approach for much smaller fluxes found in natural environments.

line 41: replace "place" with "placed"

line 43: The static chamber method does not require a gas chromatograph. In El Hachem and Kang (2022) published in Science of the Total Environment, they do not use a gas chromatograph.

line 50: what is the source of this air? Is it background air?

line 53: what is the background methane concentrations in the air? And what air is the authors referring to?

line 56: how much power is required? What type of power source is needed?

line 62: what is the current commercial HiFlow sampler? I see in the next lines that you mention the Bacharach. But I've heard that it's been discontinued. Are there others that are currently commercially available? In the previous sentence, the authors write "typical rates are 300 l/min" but that implies there are multiple types of samplers. If there is just one, why not just report the on high flow rate?

line 87: the inputs to the bLS model appears to be the same as the GP model? What are the exact meteorology and micrometeorology parameters needed for the bLS model?

line 87: where is this gas concentration taken?

line 94: isn't complex topography and buildings also an issue for the GP model?

line 96: what kind of micrometeorology data is needed?

line 100: for higher emission rates, wouldn't it be easier to do downwind measurements such that site access is less of a concern?

line 100: what are the safety concerns here? just explosion risk due to high methane concentrations? What about H2S (See El Hachem and Kang, 2022)?

line 102: what is meant by "able to approach"? How close to the single point source in meters?

line 103: what are the emission rates considered? In the abstract, it was only for 200 g/h but there are three mentioned later. Need to be consistent throughout.

line 108: why the cut off at 200 g/h? There should be a paragraph on the literature for tests at >200 g/h and describe why those studies are not applicable here.

line 110: the exact dates and times in which each experiment took place needs to be provided.

line 111: it's unclear which exact experiments were done. it would be helpful if the authors could provide a spreadsheet with all the tests that were conducted in the supporting information.

line 115: how were the emission rates set? What is the type of flow controller? What are the gases that are used?

line 115-116: how do you define/determine what is safe or not?

line 116: why not lower than 40 g/hr?

line 125: it's unclear if a static chamber measurement was done?

line 127: what is the location and size of the fan inside the chamber selected? and how was this selected?

line 128: What is meant by "three further air samples? Further to what?

line 132: what where the shapes of the chambers? what is the aspect ratio (height to diameter)?

line 133: how was the quality of the ground seal determined?

line 135: is this experiment a copy of Kang et al (2014), Pihalatie et al (2013), or Collier et al (2014)? Which one took four samples? Kang et al (2014) took 7 to 8 samples.

line 135: there is a "s" missing. it should be "four samples".

line 137: were there duplicates and blanks taken?

line 142: does this imply that emission rates were calculated for test even if only three samples were collected?

line 146: why was this chamber size selected? what is the shape and aspect ratio? How useful is this size for field measurements of oil and gas wells?

line 146: what type of plastic is used?

line 149: what is the detection limit of the HXG-2D? What are the methane concentrations observed inside the chamber?

line 150-151: blanks and duplicates taken?

line 155: how big is the hose end? Was the source enclosed by the Hi-Flow sampler?

line 167: any concerns with topography and large objects (e.g., buildings, trees, and other infrastructure)?

line 177: what is the minimum distance between the sources and the detector?

line 181: how different were the environments in which the experiments were conducted? Importantly, were experiments described in sections 2.1 to 2.5 all conducted on the same day. If they were all conducted on different days, then the uncertainties calculated cannot be directly compared.

line 190-191: The collection of gas vials is not a requirement of the static chamber methodology.

line 193: the static chamber can be used with a methane analyzer (e.g., El Hachem and Kang, 2022), overcoming the first and second shortcoming.

line 196-198: El Hachem and Kang (2022) conducted measurements from H2S-emitting wells using a self-contained breathing apparatus. There are many options available in industry to ensure safe working conditions when toxic gases are present.

line 198: what about for measuring low emitting sources?

line 200: why isn't "cost" italicized like the rest?

Table 1: I'm surprised that the HiFlow sampler is only $5k. Is this correct? The static and dynamic chamber measurements conducted here use a GC, which is around $50k. So it's definitely not free. Even just getting the gas concentrations analyzed elsewhere is not free.

Table 1: why is there no time for measurement and analysis for the static chamber? same for the accuracy.

line 209: there are other ways to reduce the potential of CH4 concentrations in the chamber reaching explosive levels when using static chambers.

line 210: the need for a power source is another important shortcoming of the dynamic chamber method.

line 266-267: what is the dynamic chamber the HiFLow more accurate than?

line 273: who is this decision-making paradigm for?

line 282: what are the conditions in this study? This needs to be better described to assess the applicability of the results.

Figure 4. Many estimates (e.g., the USEPA's GHGI) involve wells with no measurements. It's not possible for all wells to be measured. So if there is no trace gas analyzer, there is always the emission factor approach. But of course, that's not a good predictor of the emissions at a given well but over some large population, it may be representative. So this brings us back to the question of who this figure is for. This figure needs more context in the caption and the text.