Thank you to RC2 for putting time and effort to read and review our manuscript. The reviews were helpful and insightful and have made the paper stronger. Below are the comments from RC2 and the responses by the authors are in blue.

RC2: 'Comment on egusphere-2023-1420', Anonymous Referee #2

The manuscript by Ayasse et al. departs from the significant difference obtained in the methane emission estimation results during two controlled emission experiments in order to understand the cause of the flux underestimation obtained in the first campaign, compare the results obtained by processing the data with two different algorithms (CMF and IMAP-DOAS) and, therefore, better understand the behavior of both algorithms and give a guide to which algorithm is more appropriate for each case. In addition, it suggests a solution to avoid obtaining underestimates from flight campaigns if the Matched Filter approach is to be used to process the data. The study has been done with data collected with the GAO sensor in the controlled release experiments organized by Standford University in 2021 and 2022 and also in previous campaigns performed in other areas of the United States, which adds robustness to the study.

I consider the methodology used in this work appropriate and the analysis of the results rigorous and valuable to the scientific community. In addition, the manuscript reads well and is easy to follow. However, I would like to see a little more elaboration on some of the points I list below and some issues need to be addressed. I recommend the publication of this article once the following points are corrected or taken into consideration:

Major comments:

The abstract mentions that the column-wise retrieval algorithm is sensitive to the flight line length so that it can have a systematic low bias on short flight lines but does not have to be on long enough flights and that this bias is not present in the per-pixel retrieval. Reading this in the abstract, one might first think, why not always use per-pixel retrieval and avoid bias? I suggest including a line clarifying that, on the other hand, per-pixel retrieval has a much higher computational cost, so for large amounts of data processing, it is more optimal to use column retrieval.

The abstract has been edited to include the following sentence “However, the pixel-wise retrieval is computationally expensive and the column-wise retrieval algorithms can produce good results when the flight line length is sufficiently long.”

In the same way, in the text, it is mentioned that CMF is computationally more efficient than IMAP-DOAS, but I miss a more quantitative comparison of this difference to help readers better understand the difference. I think it would be helpful to add a sentence, for example, in the methodology section, with an indicative example of "for an image of x length/ xx number of pixels, processing with CMF would take about x minutes, while with IMAP-DOAS xx hours" or similar.

P5 L192 has been edited to read “However, the current processing time of IMAP-DOAS makes its operational use limited. At best it takes 1 second per pixel to run, therefore 5,700 pixels (which typically is a 300 by 300 m area) can take 2-3 hours to run. In contrast it takes about 7 minutes to run an entire 3.3 million pixel scene with the CMF. Future processing improvements may significantly reduce the computation cost, but it is unlikely IMAP-DOAS will ever be as computationally efficient as the CMF.”

Lines 169-176: here, I understand that for the CMF, you first remove the background and then obtain the mask of the plume with the values that have remained above the removed background, and in IMEP-DOAS, you first have the mask and then with the values that are not included in the mask you determine the concentration of the background. If correct, how do you calculate the initial mask with the IMAP-DOAS method? Do you do it manually? Taking first an indicative background value? I would appreciate a clarification on this in the text.

The CMF produces a methane enhancement above background as its output. P4 L125 and line P7 L215 have both been edited to make this clearer. P7 L215 now reads “…the CMF (which retrieves an enhancement above background and therefore does not have background methane incorporated in the pixel values)…”.

Given the noise in the image it is still necessary to threshold the pixels in order to identify pixels associated with the plume, however there is no additional adjustment (such as subtracting off background values) needed to the data. For IMAP-DOAS, the algorithm retrieves a total column concentration, which means that included in the per-pixel value is the background concentration. We ultimately want the enhancement above background, so we need to subtract off the background concentration. To do that we first identify the plume using the methods described in P6 L215-217 (“we calculated thresholds using the 80-98th percentile of 1 km area around the plume origin. The thresholds were then used to filter out low values, we then calculated connected components starting at the plume origin, then used a dilation to fill in gaps.”)

Line 305: regarding the sentence "In practice, we anticipate the POD performance to vary across observing regions and seasons.", this was already shown in Gorroño et al., 2023 https://amt.copernicus.org/articles/16/89/2023/amt-16-89-2023.html with Sentinel 2, which it would be worth mentioning.

A citation to Gorrono et al 2023 has been added here.

Lines 324-325: the first sentence of the paragraph sounds a bit out of place. Satellites typically have a specific and invariable swath and do not take longer or shorter images. However, it may happen to get a very variable image with, for example, a large presence of water or a higher methane content than normal, preventing an appropriate formation of the covariance matrix and leading to under- or over-estimates. This is a discussion that I missed in the manuscript and could fit here to make sense of the sentence.

The purpose here is to stress how important it is to use controlled releases to test, evaluate, and understand how accurately we can quantify point source methane emission. In referencing satellites, the point is to show that this type of analysis will become more critical once routine

global measurements are used for applications beyond science. I have edited the final paragraph to be less focused on satellites are more focused on global and routine measurements with remote sensing in general.

Line 326: about the sentence "As a larger constellation of instruments, and specifically satellites such as EMIT and Planet/Carbon Mapper's Tanager, are used to map methane, ...", first, EMIT is not a satellite and second, why "specifically" EMIT and Planet/Carbon Mapper? If the reason is the common use of the Matched Filter to process the data, generally in studies with PRISMA, EnMAP, or Gaofen5, the CMF is also used to optimize the computational cost (e.g. Irakulis-Loitxate et al. 2021 https://www.science.org/doi/epdf/10.1126/sciadv.abf4507, Guanter et al. 2021 https://www.sciencedirect.com/science/article/abs/pii/S0034425721003916, Roger et al. 2023 https://eartharxiv.org/repository/view/5235/, Nesme et al. 2021 https://doi.org/10.3390/rs13244992). I suggest changing the sentence by removing the "and specifically satellites such as EMIT and Planet/Carbon Mapper's Tanager," and adding the reference of Jacob et al., 2022 after "... constellation of instruments", or simply removing "specifically satellites" and name the other satellites as well.

I removed mention to specific satellites. The final sentence read " As a larger constellation of instruments are used to map CH4 (Jacob et al., 2022) , more controlled release tests will be needed to fully validate emissions."

References section: the references Ayasse et al., Foote et al., Maasakkers et al., and Ocko et al. are not mentioned in the text.

The references have been edited.

Minor corrections:

Line 21 and 22: in addition to the references you cite there, nowadays, there are quite a lot of studies confirming that a significant component of the anthropogenic methane budget comes from a relatively small population of high emission point sources (e.g. Frenkenberg et al., 2016 PNAS, Irakulis-Loitxate et al., 2022 ES&T and ES&TL, Ehret et al., 2022 ES&T), so, for correctness, I suggest you put an "e.g." at the beginning of the list.

The edit has been made as suggested.

Line 24: at the end of the sentence " ... effects in the next few decades.", I miss a reference that affirms the sentence. Reference to Ocko et al., 2021 would be appropriate here, which is listed in the references but not mentioned in the manuscript. Otherwise, reference to IPCC, 2023: Summary for Policymakers. doi: 10.59327/IPCC/AR6-9789291691647.001would also be appropriate.

The edit has been made as suggested.

Line 26: I think it is not totally fair to say that airborne imaging spectrometers can repeatedly map large areas. A satellite does have the ability to map large areas every few days over long periods of time (e.g., Irakulis-Loitxate et al., 2022 https://pubs.acs.org/doi/full/10.1021/acs.est.1c04873), but airborne mapping is limited to campaign periods. It is true that in the same campaign, the same locations can be mapped several times, but then there will not be a revisit, in the best cases, before ~one year. I suggest changing the sentence to "In particular, airborne imaging spectrometers with shortwave infrared (SWIR) sensitivity have emerged as useful tools for point source quantification due to their high spatial resolution, low detection limit, and ability to map large areas for point sources" or similar.

The edit has been made as suggested.

Line 29: at the end of the sentence "... environmental variables including surface illumination and atmospheric transport.", a reference is missing. An appropriate reference would be Gorroño et al., 2023 https://amt.copernicus.org/articles/16/89/2023/amt-16-89-2023.html

The reference has been added as suggested.

Line 31: for the sentence "... and complexity.", please add a reference, e.g., Jacob et al., 2022 https://acp.copernicus.org/articles/22/9617/2022/acp-22-9617-2022.html

The reference has been added as suggested.

Line 62: I think here you are referring to this other paper by Sherwin et al. https://www.nature.com/articles/s41598-023-30761-2 not listed in the references.

The references have been edited.

Lines 74 and 79: add space between 3 and km.

The edit has been made as suggested.

Line 96: Please add a reference at the end of the sentence "... CH4 has known absorption properties.”. The reference of your paper, Ayasse et al., 2018, listed in the bibliography (but not mentioned in the text) would work great.

The references have been edited.

Line 97, 176, 260: for consistency, matched filter => CMF. It also looks like there is a formatting error on this line.

The edits have been made as suggested.

Line 98, 101, 196: for consistency, methane => CH4

The edits have been made as suggested.

Line 112, 147, 244, 303: for consistency with the rest of the citations, Thorpe et al., 2017 (without the name/acronyms).

The edit has been made as suggested.

Line 144: add Where before So to make it easier to read.

The edit has been made as suggested.

Line 155: again, for consistency with other citations, Frankenberg et al. 2016 (without the name)

The edit has been made as suggested.

Line 213: for clarity, add "CMF results" or "left panel" after Figure 1.

The edit has been made as suggested.

Lines 232-234 and 273/Figure 4: add a) and b) in the panels of the figure, or change the test to Figure 4 left and right.

Right and left panel have been added.

Line 250: section S2 => Section 2 or Methodology section

This is a reference to the supplemental section and this has been changed in the text for clarity.

Line 259, 285, 287: the F in capital letter in "figure 5" and "figure 7"

The edits have been made as suggested.

Line 293: POD should also be defined in the test

The edit has been made as suggested.

Line 304: Solar Zenit Angle (SZA)

The edit has been made as suggested.

Figure 2: for completeness, I think it is worth including in this figure the flight line length of the second controlled release experiment in 2022.

Figure 2 has been edited to include the 2022 controlled release.

Figure 2: in the figure caption, it should be explained what the gray bar and black circles are.

For figure 2 the caption has been edited to include " The data is displayed as a box plot with the blue box representing the inter quartile range, the gray bar is the median, the dashed lines are the min and max, and the black circles are outliers"

Figure 4: in the title of the plots, what does CM mean? If it refers to Comparison of Methods, I suggest removing it.

CM has been removed from the figure titles.