**Reviewer 2 comments:**

Sections

Section 1.1 Good initial summary of previous algorithms, but this section can be improved, but the equations from von Fischer et al. (2017) and Weller et al. (2019) are presented without clear explanation of terms (e.g., ppm.metres index). A brief description would help non-specialist readers. Please also read and refer to other relevant studies in which they also derived similar equations, Tettenborn et al.(2025) and Joo et al. (2024). Authors can make an intercomparison emission rate quantifications derived from these equations in a table and discuss the results.

- Greater description will be added to these terms as well as the addition of Tettenborn et al. (2025) and Joo et al., (2024).

Sections 2.1.1 and 2.1.2 Are these efforts made to address instruments drifts? If so, explanations and descriptions can be provided in a better format.

- Section 2.1.1 is designed to understand the response rate of the TILDAS, in order to find the true sampling rate. All other instrumentation used had well defined response rates. However, as the TILDAS had been adapted for use in mobile sampling, its response rate was unknown. The TILDAS is capable of measurements at 10 Hz but this is not a guarantee of true 10 Hz measurements. The response rate found in section 2.1.1 can then be used to inform the time clustering parameter of the algorithm (i.e., the time within which separate enhancements cannot be reliably separated and have to be considered as the same enhancement)
- Section 2.1.2 describes the variation present within the measurements of methane from the MGGA, this section is used to inform the algorithm's enhancement parameter.
- Instrument drift is not addressed as all instruments record to a central computer, instrument lag (between MGGA and TILDAS) is addressed in section 2.4.2.
-We have improved the clarity of these sections.

Section 2.2 It appears that the measurements only took place on the main roads? Why didn't you choose the residential alleys and avenues? In urban surveys those narrower streets have high significance.

- This survey was intended as an initial overview of the efficacy of the updated algorithm and therefore stuck to major roads in order to focus on finding the largest fugitive emissions.
- The aim of this sampling was to get good spatial coverage of the city and maintain as constant a driving speed as possible. By removing the slower, time consuming transects through smaller streets we were able to achieve that.
- Additionally, our previous UK studies in *(Vogel et al., 2024)* focussed on covering the main thoroughfare for each 1 km x 1km grid square but when a street by street approach was undertaken, the majority of emissions detected were from domestic boiler emissions as opposed to pipeline leaks. A smaller survey of intensive driving in York also showed this, the results of which can be added to the SI. However, as losses from gas distribution was our aim with this research, this city-wide route was selected.

Section 2.4.1 This is an important part of your work and should be discussed and described in more details. See comments about the intercomparison with other equations introduced previously.

- More detail will be added to this section. A larger amount of detail will be added in terms of the discussions of different quantification equations. Additionally, another section will be added to the results showing how each quantification equation affects the resulting calculated leak rates.

Section 2.4.2 This section including the graphs can be placed in the supplementary information and main results can be used in the algorithm in the mani manuscript.

- Plots will be moved to the SI while description of the results will be kept in the main manuscript.

Section 2.5 The attribution part using mobile ethane and carbon dioxide is of high relevant. Are the values in X-axis are methane readings (including the background) or the values show methane enhancements? This is important because it is unclear how you classified the values around the 2 ppm into the source specific categories? For further use of ethane and carbon dioxide, I refer you to Fig. S12 (See SI from Maazallahi et al. (2020)) and Sect. S3 and Sect. S5from Maazallahi et al. (2023).

- Values shown in the figure are raw $CH_4$ measurements, sources are not assigned of single point measurements (i.e. a point measuring 2 ppm $CH_4$) rather, they are measured across a 10 second window of the enhancement, a linear regression is used to find the gradient of $C_2$:$C_1$ over this window, which is then used to assign sources. This section will be rewritten in order to provide more clarity. We also intend to include the further use of $CO_2$ and $C_2H_6$ that you recommend from the above references.

Section 3.2 Do you intend to only discuss the pyrogenic sources here? I can see from Fig. 12 that other sources are also shown in the figure.

- The section will be renamed, as Pyrogenic sources are not the only ones discussed in this section.

Section 3.3 Please see comments with regards to the use of other equations. An intercomparison can be made here and discussed in details. This can be a very significant part of your work

- This comparison will be added. It will be especially relevant in the adapted manuscript as we will move to quantification using peak area.

Lines:

L1-3: Title is clear but could be more concise. Consider: “Adapting mobile methane survey algorithms to instrument specifications: a case study in York,UK”.

- Proposed change to: “Fugitive natural gas emissions in York, United Kingdom: Updating existing algorithm parameters based on instrumental limitations.”

L19-20: “This study aims to adapt existing algorithms parameters...”.grammatically awkward. Suggest: “This study adapts existing algorithm parameters by investigating the limitations of the mobile survey platform instrumentation.”

- This change will be made

L21: The claim that old methods may underpredict LIs by 53.5% is striking but should be contextualized: is this due to sensitivity changes or source filtering?

- Context will be added, the change is due to source filtering.

L23: Emission reduction from 185.10 to 60.23 L $min^{-1}$ is very significant.

- This will likely change during corrections as we move towards a peak area quantification and non-specific quantification where LIs are assigned to leak rate bins

L28-30: This sentence reads awkward.

- Changed to: “Signatories of the pledge aim to reduce their 2020 methane emissions by 30 % by 2030. This change was brought about due to increasing concern surrounding methane’s role as a climate forcer.”

L45-61: The transition to UK natural gas network is relevant, but the paragraph could better link to the study's objectives. Better to reduce non-necessary information and provide information about emissions.

- Excess information on the NTS and GDNs will be removed. Instead a focus on the overview of the UKs distribution network, followed by a description on the study's focus on detection of emissions from the GDNs.

L59: The sentence on "many unknowns" is vague. Consider rephrasing to emphasize the need for improved detection methods.

- Change to: "The large distances of natural gas pipework leads to large uncertainties in where a fugitive emission may occur, this highlights the need for mobile measurement surveys, in order to locate these emissions."

L76–85: The introduction of source attribution ($CO_2$, C2H6 and isotopes) is well-placed and sets up the study's contribution.

L86–90: The final paragraph clearly states the paper's aims. Well done.

L91–105: Instrument details are thorough, but the ethane calibration formula is presented without defining "mean response." The calibration procedure can be moved to supplementary information.

- Additional discussion on the TILDAS will be added.

L112–119: The description of TILDAS valve modifications is technical and unclear. However, the rationale for aiming for "true 10Hz" vs. 5Hz is not fully justified. It is also unclear why other parameters are important in terms of emission rate quantifications. These descriptions belong to supplementary information and main findings can be placed in the mani manuscript.

- Why did you the measurements in normalized format?
- Better show the whole measurement graphs.

- More description is required here in order to provide clarity. However, these modifications are not important for quantification of enhancements, but rather for the source attribution of enhancements themselves.

L160-162: Here you point out an important relation between two parameters;driving speed vs sampling frequency. With lower speed and higher measurement frequency, there is higher possibility to capture methane enhancement signals.

- We agree, although the measurement frequency must be due to the response rate and flow rate of the instrument, not the data acquisition speed. This is the key discussion point in 2.1.1

L169-170: do you suggest that a quantification equation should be introduced for each city and instrument used for individual survey? This means that in every urban surveys (city and instrument dependency) a set of control release experiments should be performed.

- We initially wished to present that quantification equations were unique to measurement platforms and that quantification equations based on peak height would never result in a quantification equation that would be applicable to a different platform. However, after comments from the first reviewer and through discussion amongst the authors, we want to move towards a peak area quantification equation, that we believe would be applicable to other platforms regardless of instrumentation.

<u>Equations</u>

Equations are not numbered throughout the manuscript.

- Equation numbers and references to them will be added to the corrected manuscript.

L283 – L208 – L202 – L106 etc.: equations are not numbered.

L283: what are those back boxes in the equation?

- Artifacts appear to have been added during the conversion to a .pdf, this has been corrected.

Figures

Figures are not referenced within the text. Many figures can be moved to the supplementary information and main figures can be kept in the main manuscript.

- References to figures have been added throughout the manuscript, discussion amongst the authors will take place as to which figures should be moved to the SI,

Figure 10 – Use of wind direction and LI assignment are very unclear. It appears that the wind speed values are not corrected and include driving speed as well. The figure is very vague and values are questionable.

- Wind speed is corrected, the figure will be amended to be more clear.

Figure 11: texts are in small fronts. What are the use of those LI numbers? How do you interpret those numbers with regards to e.g. Fig. 10. It is better to discuss specific LIs in details.

- Both figures will be adapted to discuss the LIs in more specific terms

Tables:

Table 1 – Results provided in this table require further, detailed and clear explanation and discussion in the main text. Results from other algorithms can be also included in the table.

- This section will be restructured, providing clearer reference as to which results refer to the algorithm referred to in *(von Fischer et al., 2017; Weller et al., 2019)*, which are from the new method and which are derived from partially updating the old algorithm to the newer algorithm.