We thank the reviewer for the careful reading and constructive comments. Below we respond point-by-point (reviewer comments in blue, our responses in black).

1. While the impact of the observation and illumination angular configuration on quantification is analyzed comprehensively, the impact on retrieval is minorly discussed only when reviewing the mathematical expression. I would recommend underlining just the impact on quantification throughout the manuscript. One example would be revising line 4-5.

It is a very good point and needs to clarify that 1) we describe the effect in methane fields and 2) quantify its impact on flux rates.

Abstract: clarified one sentence
This paper describes how observation and illumination angular configuration affects satellite-derived methane enhancement fields and, more critically, the calibration and uncertainty of semi-empirical emission rate estimation models, using simulated datasets.

Introduction: introduced one sentence
The analysis of $\Delta X_{\mathrm{CH}_{4}}$ maps is used to illustrate physical mechanisms, whereas the quantitative assessment focusses on emission flux calibration, the uncertainty, and the probability of detection.

Section 3.1: add a sentence
In this subsection, the impact on $\Delta X_\mathrm{CH_{4}}$ maps is analysed to illustrate changes in plume shape, without attempting a quantitative retrieval performance assessment.

Discussion: add a sentence
Consequently, uncertainties in $\Delta X_\mathrm{CH_{4}}$ are not evaluated independently, but through their propagation to flux quantification.

2. It would be nice to have "(SZA=0)" and "(VZA=0)" in line 93 connecting the term "observation and illumination angle" to SZA and VZA. Furthermore, it would be nice to have SZA and VZA illustrated in Figure 1.

Thanks. All the changes are now included in the manuscript.

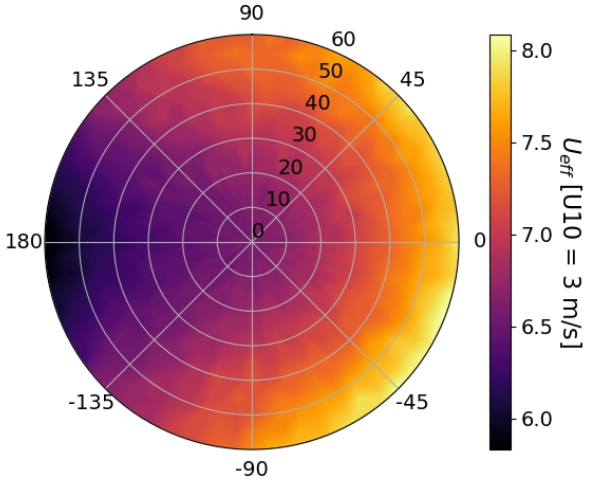
3. How is L the plume length defined? Are you following Varon et al., 2018? Please provide a description. Also, is there a better way to define L? What about calculating the length along the wind direction or the farthest length?

We thank the reviewer for raising this point. In this study, the plume length scale L is explicitly defined as the square root of the plume mask area, following the standard implementation of the IME framework in Section 2.1 when describing Eq. (4).
We have clarified that sentence by rephrasing as:

"L the plume length scale in m, which is typically approximated by the square root of the plume mask area, **following the standard IME formulation of Varon et al. (2018).**"

Alternative definitions of L, such as the plume extent along the wind direction or the maximum plume length, are possible and have been explored in additional sensitivity tests, we have added the following paragrapgh in the discussion section:

"We also tested an alternative definition of the plume length scale L based on the maximum plume extent after noise addition, rather than the square root of the plume mask area used throughout this study. This alternative formulation results in a redistribution of the angular error patterns, with errors tending to concentrate preferentially in the lateral directions of the polar representation rather than symmetrically on either side. This is expected from a plume length definition less affected by plume shape broadening. Nevertheless, the overall magnitude of the errors and their systematic dependence on the observation and illumination geometry remain consistent. These results indicate that, while the specific definition of L influences the spatial expression of the errors, the dominant driver of the uncertainty is the angular configuration itself, reinforcing the main conclusions of this work."
This is a polar plot result of the Ueff:



Because the objective of this study is to highlight the importance of accounting for observation and illumination geometry, rather than to compare alternative plume length definitions, we only briefly mention this sensitivity in the Discussion without expanding into a methodological comparison. We agree that explicitly considering angular effects naturally motivates a broader discussion on quantification methods and training strategies. To facilitate further exploration, both the code and the full simulation framework are made openly available, allowing the community to extend these concepts and apply them to instrument- or application-specific scenarios.

4. I don't see any use of equation 7 and 8. What are you trying to explain with these?

I agree that they are not directly mentioned further in the manuscript, but clarify the conversion of 3D volume mixing ratios in to 2D enhancement maps.

Since we have now published the code, I directly refer to it and make that connection in the manuscript.

5. I believe AA in equation 8 is azimuth angle. Please define AA in the text.

We have now clarified stating "where AA refers to the azimuth of the viewing or solar angles."

6. I think equation 10 should be underlined to highlight that the authors are varying SZA and VZA to analyze how the quantification is affected.

We agree and have clarified the role of Equation (10) by explicitly stating that SZA and VZA are systematically varied in the analysis to assess how angular configuration propagates into emission flux quantification. Explicit sentence:

"Equation \ref{xch4updowncombination} highlights the explicit dependence of the geometric air mass factor on SZA and VZA, which are systematically varied in this study to assess their impact on methane flux quantification."

7. Please explain how Figure 3b and 3c was generated. x and y labeling might help. Is y-axis in figure 3b elevation?

The axis are now included and the caption includes: "A small axis glyph is included in each panel to indicate the along-plume (x), cross-wind (y), and vertical (z) directions."
To better clarify how they are obtained, we have added a short sentence: "The maps are calculated collapsing the across and along the plume directions rather than the vertical one."

8. Figure 6: a detailed description of the polar plot is needed using RAA and SZA.

We have included in the caption of Figures 6, 7 and 8, the following statement:
"The angular axis represents the RAA angles and radial axis refers to the SZA angles."

9. Before explaining Figure 7, please describe that using Ueff simply defined from vertical integration (SZA=0 and VZA=0) of WRF-LES model would cause error, and you are showing the how big that error would be using a ratio.

We have now better explained Fig 7 with the following text:
"Defining the values of Ueff based on ΔXCH4 maps from the vertical integration (SZA=0 and VZA=0) of WRF-LES model270
results in errors. Figure 7 normalises Ueff against the vertical integration scenario (SZA=0 and VZA=0) to show the relative error in the polar coordinates for different U10 winds."

Minor Comments:

- Figure 1: Dx should be Dd to match the text in the manuscript. In the text, downwelling path (before reflection) and upwelling path (after reflection) is described to be green and red respectively, but the figure doesn't match this description.
- Line 162: remove "resulting" before "The resulting"
- Figure 5b: change SZA 0 to SZA 60
- Line 239: change SAA to RAA.
- Figure 7: change SAA to RAA.
- Line 312: remove "in" before "The results"

Thanks for these minor suggestions. We have considered them and made necessary changes in the corrected version