Review of the revised manuscript

"Methane retrieval from MethaneAIR using the CO2 Proxy Approach: A demonstration for the upcoming MethaneSAT mission" by Chan Miller et al.

General comments

The authors have added references and clarified methodologies as requested and expanded sections in the supplement to address the feedback on detailing the mathematical bases and assumptions of their model, which I previously considered insufficient in some parts. They made significant updates where needed, while also justifying their original approaches when they disagreed with the comments.

Overall, their response improves the manuscript's clarity and demonstrates a commitment to addressing the reviewer's concerns. Therefore, the manuscript should be published after minor revisions are made.

Specific comments

Note that my line numbers refer to the version of the document that includes red and blue differences.

Consider revising the order of the conclusions in Section 8 to present the most important aspects first, followed by the less critical ones. In my opinion the temperature-induced shifts, for instance, should not be the first aspect discussed in the conclusions.

Add clarification to distinguish between the terms "quantification" and "detection", noting the term "quantification" is italicized at line 589 and that the detection limit of 121 kg/h and the quantification limit of 200 kg/h are considered consistent.

It would be beneficial to include a table comparing the specifications of MethaneAIR and MethaneSAT, as numerous figures are mentioned throughout the manuscript.

15: Please ensure that the number 2.5 ppb for the latitude gradient bias is clearly referenced in the main text, as it currently appears to be missing from Section 5.2.

26: Consider to clarify what is meant by "fine spatial resolution" and "large swaths" in the context of MethaneAIR, and provide specific information similar to the details given for MethaneSAT in the following sentence.

42: Including a table comparing the specifications of MethaneAIR to MethaneSAT at this point would be helpful.

61: Consider to mention that scattering effects are more pronounced at shorter wavelengths, thus the 1.6 µm band is more affected than the 2.3 µm band in TROPOMI.

64: You mention data from aircraft but also refer to satellite platforms.

65: Does this relate even more to the precision requirement?

94: How do MethaneSAT's 20-30 revisits per year impact its claim or capability for monitoring?

104: Am I right that strictly speaking, it is the primary retrieval method used to infer concentration enhancements (which are then used in the emission inversion).

109: Review the phrase "sensor rate spatial coverage."

Fig. 2: Consider specifying what constitutes a “typical measurement” in terms of photon radiance or another metric.

165: Clarify what is meant by "an additional set of weaker lines overlap with the C."

231: Does the initial estimation of surface albedo consider only a single pixel?

Sec. 4.1: I suggest making the section more concise.

Fig. 5: Label the squeeze factor next to the colorbar in (c1), similar to how ppb is labeled in (c2). What cross-track index is displayed in (c2)?

274-279: This passage could be rewritten for better clarity.

393: The reference in Fig 11 to XCH4 being constant within 50 km is not entirely convincing (though it remains reasonable).

394: Consider the potential issues of relying on data from a single pixel, even if it's only for an a priori estimate.

395, Fig. 12: Would using the median be a more robust measure than the mean?

Fig. 12: Consider adding a colorbar.

395: Ensure consistency; the text mentions computing the mean from a 0.02 width bin, but the figure caption refers to ±0.1 width, while the gray lines represent 0.02 binned averages.

Fig. 13: Please describe the units of the colorbars.

426: Given the importance of the 35 ppb finding, consider adding a statement relating this to Section 2.1 of the attachment. Also, think about moving the precision finding of 35 ppb to Section 5.3, as it is based on data presented in that section.

430: How is the smoothed image 'g' calculated?

Fig. 15: Consider to ensure that the colorbars have specified lower and upper bounds. Also, consider specifying time in hh:mm:ss format as done in Fig. 17.

514-515: Clarify why the detection limit of 121 kg/h and the quantification limit of 200 kg/h are considered consistent.

496: This point suggests a broader issue regarding the estimation of average emission rates from irregular revisits. Consider adding a brief discussion on this topic in the discussion section.

500: Provide at least one argument or reference to support this statement.

Fig. 19: Discuss any implications for the IME method if the swath cuts the plumes. Adjust the axis labels and colorbar font sizes for better readability.

Fig. 20: Increase the colorbar font size.

S1.2: Briefly explain why the a priori profile pressure and temperature levels are dependent on the a priori surface and tropopause pressure, and how these coefficients are determined.

Eq. (S9): Describe how the optical depths are adjusted for an adjusted temperature.

Eq. (S8): Shouldn't the ratio yield a sigma coordinate on the left-hand side?

S2.3.2: Clarify whether the RR method is only feasible for aggregated pixels since single pixels cannot be divided into upper and lower halves. Explain the rationale for choosing upper/lower division over left/right.

S2.3.2, Fig. S10: Consider using colorbar annotations instead of titles for consistency.

Fig. S12: Confirm whether "Pixel Mean XCH4 Enhancement" is the correct label for the colorbar. Should it instead indicate enhancement in the plume, affecting the error depending on the plume's prominence?