6 September 2025

Subject: response to referee report

We thank both referees for their helpful comments. We have implemented most of the recommended edits. To address concerns about the manuscript's length and readability, we have reduced the scope of the paper to a first assessment of Tanager-1 performance and moved some detailed supporting text and figures to a Supplemental Information appendix. The sections on observing system completeness and predicted spatio-temporal coverage of the Tanager constellation were removed and will be covered in greater depth in a subsequent manuscript.

Additional specific responses are summarized below.

Best regards,

Riley Duren on behalf of the co-authors

Referee 2

Here is a list of the parts of the manuscript where I think improvements are needed:

- Abstract: it is very long, and reads more as an executive summary of an internal mission report than as an abstract of a scientific pubilication. I would propose to shorten it substantially, especially in the parts not directly related to findings of this study.

We have revised the abstract as suggested.

- Sec. 1.1: these paragraphs provide a review of past and current missions with sensitivity to methane and CO2. However, the part of this section referring to "point source images" is strongly biased towards the instruments and work by the authors. It is striking (and a bit annoying) not to find a single reference to the GHGSat program, which is very similar to Carbon Mapper in terms of observational requirements and capabilities (with a superior performance for GHGSat currently because of their higher number of operating satellites). It is also surprising not to find references to the retrieval and analysis work that has been done (mostly by groups in Europe and China) with other space-based imaging spectrometers, including EnMAP, PRISMA and the AHSI onboard the GF and ZY1 satellites, which are also very similar to the Tanager instruments. I would strongly request the authors to better reflect the international context in their study.

We have added a new section 1.2 that summarizes the state of the art in point source imaging satellites that includes GHGSat, EnMAP, PRISMA, AHSI and EMIT to provide better context for the contributions of Carbon Mapper/Tanager to the growing ecosystem.

- Sec. 2: it is also very lengthy: In my opinion, the first two paragraphs read as a new introduction section, sec 2.1.2 does not add meaningful content, L388-397 are redundant with previous contents, and L399-419, L470-480 and L620-655 provide much more detail on the instrument design than what is actually needed to understand Tanager's potential for GHG retrievals. I believe that the whole section would benefit from shortening and focusing on the mission and instrument parameters directly affect

We have significantly reduced the length of section 2 by moving some material to SI section and removing other material to be covered in a future manuscript.

- Sec. 2.5.3: please explain how uncertainties in emission rates are estimated

We have added a section on uncertainty quantification in the SI section

- Sec. 4.1, MDL: does this MDL analysis only refer to one pixel standing out from the background XCH4 values, as I seem to interpret from Eq. 7? I don't think that you would claim a plume detection if this is only based on a 1-pixel enhancement, but you would need several connected pixels with an enhancement n-times higher than the noise level. Is this correct? If so, I don't this metric can be used as an absolute measure of detection limit, as I think you are doing within this section.

Equation 7 (now equation 4) provides a first order method for estimating MDL based on 1-2 pixels as outlined in Jacob et al. However, this is not equivalent to saying that we would report a plume detection based solely on a 1-2 pixel enhancement. We explain at multiple places throughout the manuscript that a more robust method for determining detection limit is empirical testing to establish a Probability Of Detection (POD). As discussed, empirical testing to determine POD can take upwards of a year for most satellites so we're not yet able to report that. Instead, as explained we summarize what we think is a robust initial assessment of single measurement precision as a check of whether the instrument and retrieval algorithms are performing as designed and on track to meet sensitivity targets. We do not rely solely on MDL as an absolute measure of detection limit as explained in the text. However, to address this concern we have added the following text and a new figure: "As an additional check on the single pixel MDLs presented in Tables 4 and 5, we compare Tanager detections to independent metered rates and AVIRIS-3 quantified rates near the predicted Tanager MDL. Figure 18A shows a multi-pixel plume detected by Tanager-1, acquired in Maximum Sensitivity mode, for the lowest unblinded controlled release test with a reported release rate of 99 $\pm$4 kg/h on December 21, 2024 at 18:24 UTC. Figure 18B shows another plume detected by Tanager-1 in Standard Sensitivity mode in the Permian Basin on October 4, 2024 at 17:48 UTC that was also detected by AVIRIS-3 and quantified by AVIRIS-3 as 179 $\pm$ 106 kg/h. In both cases a clear plume, extending well beyond a single pixel is readily visible, suggesting that our MDL predictions are in line with mass-balance noise estimates derived from Equation"

Other minor comments:

- L151 “of CH4”

Corrected.

- L343 “types. And”

Corrected.

- Table 1, I miss the GSD parameter

Added.

- Figs.3 and 4: they should have a more similar format. Also, axis labels are missing in Fig.4.

Moved to SI section and corrected.

- L656 FPA has been defined ealier in the text

Corrected.

- L778 and L785: two consecutive definitions of QC

Corrected.

- L895 TOA has been defined ealier in the text

Corrected.

- L978 “Condo”?

We have vacated our Condo in the Congo. Seriously, thanks for the catch.

- L1010-1016: As the authors know, super-emissions in the Permian basin are typically short-lived. I don’t think that the 7 t/h source would have been active 15 days after the initial Tanager detection even if it had not been notified.

The observational evidence suggests that this source persisted for at least 10 days, perhaps longer. This is consistent with analysis of previous observations of super emitters in the Permian. We added the following text regarding this example: “Analysis of contemporaneous AVIRIS-3 aerial surveys of the Permian on October 1, 9 and 10 reveal high emissions at the same location in all 7 observations (in addition to the Tanager detection), indicating a persistent source with an average emission rate of 4200 $\pm$ 500 kgCH_4/h over at least that 10 day interval.”

- Fig. 20, 21: ppm·m units should be used for consistency with the other figures and XCH4 maps

Our experience is that when it comes to representing single measurement precision and noise relative to background concentrations, the convention is to use mmol m-2 and % rather than ppm-m. We feel this offers a more consistent comparison with precision and noise reported elsewhere in the literature.

- L1210: “for an isolated of interest”

This section was removed in the interest of reducing the manuscript length.

- Fig. 25, 26: they should have the same y-axis label; also, please, discuss the TTA peaks in the text.

This section was removed in the interest of reducing the manuscript length.