

## Referee report

The report is well written, extensive and covers a topic that is relevant to the scientific community. I recommend it for publication with some revisions.

### Major points

- I would like to see more relevance for MethaneAIR w.r.t. MethaneSAT. Is the method presented here is only briefly revisited in the last few paragraphs of the conclusions. More and/or an expanded discussion on this point likely improves the quality of the paper.
- Section 2: Although less important than the ISRF, the PSF size should be mentioned.
- Section 3: I am missing information on source (i.e. laser) stability for the measurements as well as expected noise levels.
- Figures: Some figures are relatively small, with important details being referenced at times difficult to discern. Enlarging some figures (notably Fig. 4, 5, 6, 7, 12, 13, 14) greatly enhances their effect.
- Figure 6: Straylight kernels are often four times bigger than the detector itself to account for far-field. See e.g. Fig. 11a in Tol et al., 2018. This is not given here. Even if these far-field straylight are within the noise, this is a key part of the kernel. Please give the full kernel.
- Figure 14: For the total 'smoothed' ISRF there are discrete transitions. It appears there is no truly smooth ISRF. Why was this done? Please explain.
- Section 7: Only the ISRF was validated in flight. Although in that derivation a straylight correction was done, this is not presented. Was there some activity on straylight validation?

### Minor points

- Line 2: ...anthropogenic CH<sub>4</sub> point sources...
- Line 2 (as well as later): Define scale of 'basin'
- Line 22 : minor, but GOSAT is a satellite, while TROPOMI is an instrument. They are treated equally here. Sentinel-5P is the satellite carrying TROPOMI.
- Line 30/31: Define 'intermediate' scales
- Line 32/33: I assume the swath is 200 km, not 200 km<sup>2</sup>?
- Line 36: Please motivate the choice for the 1.27 O<sub>2</sub> band more (e.g. explain recent advances, why proximity is better)
- Line 64: Remove 'only'
- Line 64 - 69 : Only TROPOMI is mentioned here. Are there other stray light treatments, e.g. GOSAT, GOSAT2, that are worth mentioning?
- Line 71 or 80: similar(ity) – At times it must be guessed how similar or dissimilar MethaneSAT is from MethaneAIR (see major point). Please quantify as much as possible.
- Line 81: quantify swath width in text. One important part is the swath \*angle\* difference between MethaneSAT and MethaneAIR.
- Line 86: sub-pixel \*spectral\* smile
- Line 83: Figure 5 referenced before Figures 2,3 and 4.
- Line 118: I do not understand the motivation to force the intercept to be zero.

- Line 136-139: What is the relevance of these statements?
- Line 149: Quantify the decrease in QE
- Figure 5 : Please mark which laser responses were done with different power to account for the decrease in QE
- Line 186 : Is the 2 % for both? Please quantify for either spectrometer.
- Figure 10: Are these normalized? Please give Y-axis.
- Line 242: Please give ISRF beyond 7.5 pixels in nm as well.
- Line 246: Confusing. These are individual pixels within the full spatial illumination of a laser? And are these not correlated with the bad pixels mentioned earlier?
- Section 7 : Please give dates and lengths of flight. Date of flight can only be read from caption of Fig. 17.
- Line 303: Why was only a single across track position done? This could be repeated for similar across track positions at other points during the flight. Are results similar?
- Line 308 : Difference is attributed to temperature changes due to environment. Could the temperature difference be quantified?