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Comment on acp-2022-246

Anonymous Referee #2

Referee comment on "Quantifying methane emissions from the global scale down to point sources using satellite observations of atmospheric methane" by Daniel J. Jacob et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-246-RC2, 2022

This paper is a nice review of the current and future satellite observing systems that focus on measuring atmospheric methane in the short-wave infrared region of the spectrum and inverting those measurements into emissions on various spatial scales. This paper will be helpful to the community, I enjoyed reading it, and I recommend publication after these comments are addressed.

General comments:

One trend in Earth observation satellites is the growth of for-profit companies that claim to estimate emissions but do not release their data to the public free of charge (e.g., GHGSat). This goes against the grain of space agency data policies, and the lack of transparency, validation, and reproducibility is concerning. This issue should be addressed in this paper, and the impacts of the lack of open data access should be considered. (For example, do space agencies need to step up to fill the gap in small spatial scale targeting capabilities of these satellites to ensure open, fair, and equitable access?) In addition, the cost of working with the data from each of these instruments should be listed in Table 1.

The Plant et al. (2022) tracer correlation method is briefly mentioned in the concluding remarks (Line 850) but has significant ground- and aircraft-based heritage and could warrant a bit more discussion in terms of the potential advantages and disadvantages of the method. This method should have reduced sensitivity to wind speed and direction but requires simultaneous measurements of several tracers and reasonably accurate bottom-up inventories. Might this method help improve the emissions from, say, GeoCarb, given that it will measure methane, CO, and CO_2?

Minor comments:

GOSAT-2 is first mentioned on P8, but GOSAT is mentioned in several places earlier. Perhaps call it the "GOSAT suite" (or something similar) to ensure that it is clear to the reader that there is more than one GOSAT instrument. Also, in Table 1, JAXA is listed as the GOSAT Agency, but I believe it is JAXA, MOE, and NIES that have contributed equally to the GOSAT suite of instruments.

Section 2.3 – Random error is indeed reducible by temporal averaging, but this is only effective if there is sufficient spatial sampling. If data are sparse over the time period and location of interest, random error can cause a significant loss of accuracy. I would expect that for TROPOMI CH_4, for example, with its current sparsity, random error could play a significant role if the goal is to measure periodic emission events over a small region or point source.

I agree that surface reflectivity (albedo) is an important source of spatial variability bias, and I think airmass could be similarly pernicious, as it aliases into latitudinal and seasonal effects, and can impact regional emissions at higher latitudes that have seasonal sampling biases.

Line 215 – traded against coarse*r* (0.1-10 km) spatial resolution (add the final "r" to "coarse")

Please define terms related to measurement types: hyperspectral, multispectral, etc.

Line 592: please fix the brackets around the definition of alpha: alpha = $(M_a/M_{CH4})(g/(pU))$