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Atmospheric Measurement Techniques Discussions

Interactive comment on "Detection and Quantification of CH_4 Plumes using the WFM-DOAS retrieval on AVIRIS-NG hyperspectral data" *by* Jakob Borchardt et al.

Anonymous Referee #2

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General comments

Borchardt et al. present an application of the weighting function modified differential optical absorption spectroscopy (WFM-DOAS) trace gas retrieval algorithm to AVIRIS-NG aircraft remote sensing observations. They evaluate the ability of the algorithm to retrieve methane and carbon dioxide column concentrations from the aircraft data, and demonstrate its effectiveness for detecting and quantifying individual methane point sources. The authors present comprehensive error analyses for both the column retrieval and their emission rate estimates, and discuss ways in which the uncertainties could be reduced in the future. The paper is a good fit for *AMT*. I would recommend

publication subject to minor revisions as outlined below.

Specific comments

- Please define the WFM-DOAS acronym early on in the text.
- The abstract is very long. Much of the content there seems better suited for the introduction. I would recommend shortening the abstract to one or two paragraphs so the reader can quickly get a sense of the paper's main findings/results.
- P4, L11: Hamlin et al. (2011) cite 10 nm spectral sampling for AVIRIS and 5 nm spectral resolution for the next-generation instrument. I can't find a statement of 5 nm spectral sampling in their paper. If I'm not mistaken, can you add a reference for the 5 nm spectral sampling number?
- P5, L2: What kind of interpolation is used?
- P5, L3: Any motivation for using the 50-m average? Is it just a convenient choice or is there an argument for this being the most relevant wind speed?
- P5, L4: I couldn't find a description in the text of how the wind direction was assessed from the plume shape. Can you elaborate?
- Table 1: Can you explain why the PSF-CH4-proxy uncertainty is (slightly) higher than the PSF-CH4 uncertainty? Error stacking from the uncorrelated errors in PSF-CH4 and PSF-CO2?
- I'm familiar with the CO2 proxy method being applied in the 1650 nm window where there is also strong CO2 absorption, but not in the 2300 nm window. Can you comment on the effectiveness of the method at 2300 nm compared to 1650 nm?

- Can you explain more clearly the pros/cons of WFM-DOAS compared to IMAP-DOAS and Matched Filter? How much faster is WFM than IMAP? When/why is it better than Matched Filter? You say in the abstract that WFM "fills a gap" between the other two retrieval algorithms, and mention some of the differences between them in section 1 and section 5, but I didn't get a clear picture of the motivation behind WFM, except that it's computationally cheaper than IMAP. What are the trade-offs? A concise explanation in the introduction of when/why we should use WFM instead of IMAP or MF would be very helpful.
- P18, L1-10: The double plume structure is intriguing. Could you briefly elaborate on the height of the source, solar zenith angle, and distance between the two plume images in this case? Also, how did you determine wind direction and do the cross-sectional method for this plume?
- P18, L28: How do you define inside/outside the plume? I think previous AVIRIS studies used a threshold, did you do that too?
- P21, L1: Is the wind speed calculation referred to here the 50-m average from ERA5, or something else?
- Section 4.3: Are these 1-sigma or 2-sigma errors? Or confidence intervals?
- P21, L26: I don't understand why the higher wind would cause you to underestimate the emission rate. Shouldn't the cross-sectional method be able to deal with this? Each plume transect gives you an emission estimate, and the higher wind speed will result in higher estimates. I can see how the precision would be lower for a weaker plume, since you might have fewer transects to analyze. But a negative bias would imply that you are missing part of each transect. In that case, couldn't you extend the transects further from the plume axis? This goes back to my question about defining inside/outside the plume. . .

Technical corrections

- P10, L33: Sentence unclear, please rephrase.
- Figure 5: Typo in "forest."
- Figure 8: Panel labels are wrong in the caption.

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