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Atmospheric Measurement Techniques Discussions
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Interactive comment on "Facility level measurement of off-shore oil gas installations from a small airborne platform: Method development for quantification and source identification of methane emissions" *by* James France et al.

Anonymous Referee #1

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The Authors describe the development of an airborne measurement platform for the quantification and source attribution of methane from offshore oil and gas operations. The instruments, their airborne deployment and the techniques for data analysis are not really new, but the manuscript would provide a useful reference in future publications that use the data from this platform. I agree that is a worthwhile objective. Overall, the paper is very straightforward and can be published after accounting for the following comments.

Line 56: Suggest “used” instead of “trialled”. The latter suggests that previous work should be regarded as somewhat preliminary, but I believe that airborne determination of methane fluxes is quite a mature method by now.

Line 105: A 5-second delay between air entering the inlet and reaching the instruments seems quite long. What is the volume of the sampling manifold and what is the pump speed?

Lines 125-135: I suggest adding a table with the different instruments, parameters measured, measurement precisions and time responses.

Lines 153-154: What mixing ratio would be required for in-flight calibrations and what was available?

Lines 160-165: Is ethane reported as mixing ratios in dry air (as you presumably do for methane)?

Lines 166-174: I re-read papers from two other groups that have used the same TILDAS instrument for airborne measurements of ethane and they seem to have overcome this issue (Smith et al. 2015; Peischl et al. 2018). For example, Smith et al. say that “in-flight drift varied within the instrument precision during a typical research flight” and Peischl et al. gave a “variability of in-flight standard retrieval, $\pm$0.7%”. These papers should be cited and discussed in this context. How is the airborne deployment of the TILDAS instrument different between the present study and Smith et al. and Peischl et al.? Note that even in a pressurized aircraft, the cabin pressure can still show considerable variability after take-off.

Section 2.5.1 and 2.5.2: When collecting whole air or bag samples in narrow plumes near sources, the exact timing of the sample delay, and open and close times is important to get the best correlation with the in-situ measurements. How well are these known for the instrumentation described here? Fill times are typically a function of altitude.

Lines 220-223: It is not clear if these limitations pertain to the study by Gorchov Negron or to the present manuscript.

Lines 226-238: How far from point sources were the downwind transects typically?

Figures 4 and 5: Perhaps you can add the flight tracks or general location of the flights to the map.

Lines 262-264: Part of the reason that methane shows so little structure in Figure 5 is that it is near the global background. If there are no nearby sources, methane will be perfectly constant regardless of how stable or well-mixed the boundary layer is. Do you have a better example where methane is enhanced more and mixed evenly across the boundary layer?

Section 4.2: Showing that the slow-response instrument is insufficient to separate plumes and determine plume shape is not particularly new or surprising. Does this instrument provide other strengths to justify being part of the payload? For example, is the slow-response instrument more stable and accurate, and allow for important cross calibration opportunities with the fast-response instruments?

Figure 6: Please provide a clearer legend. I found it difficult to decide what is what from the caption and the axis labels.

Equation (1): I found this confusing. Why do you use an average methane enhancement in a plume when you have the time response that allow you to integrate fluxes across a plume (with fluxes in every bin calculated by Eq. 1)? The approach described here relies on a normal distribution of methane in the plumes. Is that true? In addition, this equation yields the flux in units of moles per seconds per meter altitude. This still needs to be integrated across altitude for a meaningful flux number (in moles per second) that can be compared with emissions estimates, but that last step is not included in Equation (1).

Line 323: “vertical extent of the plume” instead of “vertical resolution”?

Lines 340-341: Have you tried to calculate cross correlations between the CH4 and C2H6 measurements to determine the difference in delay times between the two measurements?

Section 5.3: Why not simply show a Keeling plot? The discussion of why such plots are challenging for this application is hard to fully understand without having an example with actual data to look at. Instead, the results are presented in Figure 8 in a very indirect way. The point of this analysis appears to be that with fewer data points (when downwind sampling is less extensive) the deterioration of precision for the 13CH4 delta value is not too severe. But what are the delta values you are trying to distinguish? It might be helpful to add those as horizontal lines in Figure 8 and discuss the loss in precision in terms of those delta values. Overall, the discussion left it unclear to me whether or not the 13CH4 measurements gave useful information. This measurement is one of the more novel aspects of this work and it would be good to see the potential of the method demonstrated in more detail.

Figure 8: What are the differently colored symbols? Also, the caption repeats "source signature data" twice.

Table A1 seems a little out of place as none of these data are used in the manuscript.

References

Peischl, J., Eilerman, S. J., Neuman, J. A., Aikin, K. C., de Gouw, J. A., Gilman, J. B., Herndon, S. C., Nadkarni, R., Trainer, M., Warneke, C. and Ryerson, T. B.: Quantifying methane and ethane emissions to the atmosphere from Central and Western U.S. oil and natural gas production regions, J. Geophys. Res.-Atmos., 123, 7725–7740, doi:10.1029/2018JD028622, 2018.

Smith, M. L., Kort, E. A., Karion, A., Sweeney, C., Herndon, S. C. and Yacovitch, T. I.: Airborne Ethane Observations in the Barnett Shale: Quantification of Ethane Flux and Attribution of Methane Emissions, Environ. Sci. Technol., 49, 8158–8166, doi:10.1021/acs.est.5b00219, 2015.

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