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Atmospheric Measurement Techniques Discussions

Interactive comment on "Determining air pollutant emission rates based on mass balance using airborne measurement data over the Alberta oil sands operations" *by* M. Gordon et al.

Anonymous Referee #1

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General Comments

The authors demonstrate an aircraft mass-balance algorithm based emission quantification technique that accounts for advective and turbulent flux in three dimensions. Two sample flights are analyzed using the proposed technique. The authors present a useful comparison of previous techniques as reported in the literature and the relative strengths and weaknesses of each technique. The subject and novelty of this article is appropriate for this journal.

Overall this manuscript is clearly written and provides a useful framework towards a

consistent and rigorous aircraft emission quantification sampling and calculation routine. The technique provides clear benefits as illustrated by the disaggregation of the flux into 3-D components highlighting flux components that are not usually captured with some current techniques. My concern is that this technique as described is not as directly translatable to other emission quantification operations as may be implied by the paper. The authors analyze relatively ideal case studies to showcase the improvements possible from their technique, which is useful, but do less to identify the specific situations (in terms of both types of emission sources and meteorology) this technique is most suitable for and how this may be adapted to non-ideal situations.

Specific Comments

4772 Line 26: The computation of the contribution of advective transport may, but does not necessarily indicate lower uncertainty compared to other approaches, though it certainly indicates a source of error that is not usually included. Furthermore, author derived uncertainties are not calculated uniformly and do not necessarily include natural limitations of each sampling method. Some of these estimates are purely on the basis of measured variability and do not assess the influence of the assumptions made to complete the calculation. For instance Cambaliza et al. 2014 showed that individual single transect results from transects at different heights collected on the same day could differ by over 100% downwind of a source. Truly lower uncertainty can only be accomplished by improved sampling methods, regardless of how others report uncertainty. Please clarify the uncertainties reported are author derived and do not follow consistent and necessarily comparable protocols.

4774 line 24: Are results from these two flights expected to be representative of all flights? Was meteorology a consideration for the flights chosen for this analysis? Please include a summary of meteorological conditions (wind speed, direction, stability) in the text.

4778 line 22: Interpolation resolution should be determined by the physical resolution

of the instrumentation. Please include the sampling frequency on your instruments and the airspeed of the aircraft. I believe this Picarro model has 5s sampling frequency and the cruising speed of this aircraft is $\sim$125 m/s which, if correct, would mean the best resolution possible for CH4 is 625 m. Variations smaller than this (or whatever the true resolution is) cannot be observed by the aircraft.

4782 Section 3.1: The methods to interpolate near the surface for some of these parameters (wind speed and air density) would theoretically be valid for the entire mixed boundary layer and potentially provide a better estimation than any interpolation method. Did the authors consider using this technique for the entire mixed boundary layer? Were the results different?

4791 Discussion: The authors do not address growth of the boundary layer, or uncertainty in the boundary layer depth, as a source of uncertainty. Please include discussion of how the boundary layer is identified (showing plots of the pertinent variable is the spirals are used would be appropriate) and how it affect the results. It is unclear whether the spirals are conducted before and after the box transect or during the experiment.

4796 Conclusions: This analysis focuses on the relatively ideal case of an isolated point source in flat terrain. Please comment on the applicability of this in other arenas (i.e. isolating point sources from complex emission systems or topography). Physically, many sources of interest are very large and to actually sample a box in a reasonable amount of time an aircraft would likely have to limit the number of transects used. The number of transects available can greatly affect the interpolation output. Furthermore, this analysis provides useful information as to which components carry most of the flux and thus, which would be most appropriate to measure to reduce sampling bias which the authors should comment on.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 4769, 2015.