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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Mobile measurement of methane emissions from natural gas developments in Northeastern British Columbia, Canada" *by* Emmaline Atherton et al.

Anonymous Referee #2

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General Comments

* The manuscript is extremely well written. * This paper addresses an important need in the community with a practical and well-described method for estimating emissions rapidly and on a broad scale. * While I understand that there was not an opportunity to benchmark the estimates against other methods of emissions estimation, the lack of validation remains a significant weakness. I nevertheless recommend publication, but this caveat should be recognized at key steps in the analysis. * The largest omission from the paper is the lack of any uncertainty estimate for the emissions from the region. Some effort should be made to rectify this in the final paper. * I don't understant the use of linear regressions (with variable slope and offset) for the detection rate estimates.

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Discussion paper

Justification of why this analysis should be used over the simple calculation of rate = emitting sources / total sources should be provided, or the authors should revert to the simpler analysis.

Specific Comments: - P1 L17: emissions estimates for the Montney development does not have an uncertainty estimate. It is difficult to interpret the emission results without an uncertainty associated with it.

- P5 L1 - 10: The authors state that they are using excursions in the eCO2:eCH4 ratio (<150) as indications of natural gas emissions. However, I would imagine that other sources of CO2 could add noise to this ratio (especially since there are other vehicles that contribute to excess CO2). Figure 3 further indicates this issue. A fairly obvious alternative would be to use the same RMRI algorithm and use eCH4 > threshold as a criterion for when emissions are detected. It would be helpful if the authors could provide some more justification why the ratio eCO2:eCH4 is a better metric than simply eCH4.

- P5 L10-12: "Our optimal RMRI was taken to be the point at which anomalies were maximized, but also where we avoided the rapid noise-associated increase associated with extremely short RMRIs": in practice, how was this optimization performed? It appears to be a subjective choice. Is this true? It would be preferable if the choice was made objectively using quantitative criteria; it would also be preferable to have the same algorithm be used for all surveys.

- P5 L 18-19: "Combustion values were also recorded along the routes when eCO2:eCH4 exceeded 1000, and were related to vehicle tail-pipe emissions and industry". What does 'combustion values' mean?

- P5 L24-25: "because ratios are more conservative than concentrations in valleys and other areas where pooling of 25 gases is common, and fewer false positives are likely" - doesn't the RMRI algorithm take care of slowly varying concentrations of CH4? It would be good to demonstrate clearly why eCO2:eCH4 is an advantage; if one were to

reproduce this method at a larger scale, it would be good to provide clear understanding of why the CO2 concentration is required.

- P5 L28-30: why was the value 150 selected? What is the effect of this selection on, for example, the emissions estimate, the number of emitters detected, the detection limit, etc. Similarly, what is the effective limit on detection of the system, in units of eCO2:eCH4?

- P6 L7: are there any estimates of cattle emission in this region that could be included?

- P7 L10: how is this probability defined? Per mile? Per second? For the whole route? This isn't clear.

- P7 L1-5: The kernel density plots do not have a clear knee below 215. Where is 150 on this plot? why was 150 selelected, and not 125 or 175, for example?

P7 L16-20 and Fig 4. Was wind direction used to evaluate whether a plume should have been detected from the green well pads? Are the databases of well locations up to date? Was there an effort to corroborate locations with on-ground survey or satellite imagery?

P7 L32: "it had to have > 50% emission persistence." Similarly, did persistence include wind direction? In other words, did persistence include whether the potential source was upwind of the vehicle at the moments the vehicle passed by?

P11 L8: "concentrations will decrease exponentially away from a release source": the dependence on distance is not exponential. Gaussian plume models predict something like $\sim$1/d to 1/dˆ2, for example.

P11 L11-18: Wouldn't nearby plumes (with faster time signatures) be diluted more than more distant plumes? And wouldn't the peak area (in time) be conserved for short pulses? This is a very big adjustment of the concentrations and therefore the emissions. Did you use peak height or peak area to estimate emissions?

P12 L9: Rather than using the MDL as the average estimate of emissions, wouldn't it be possible to actually craft an estimate of emissions given the plume dispersion model and estimated distances?

p12 L28: It is important to include some uncertainty estimates for the emissions estimate. Even a simple low and high estimate of error is better than nothing. For example, the estimates of errors on the slope of the active wells could be used to bound the estimate.

p14 L9: It's not clear how this method identifies super emitters, since the authors do not present a clear method for quantifying emissions and identifying the largest emitters. How does this method help identify the largest emitters?

Fig 5: In some panels (e.g., the top panels), the regression lines do not pass through zero. This doesn't make any physical sense. Why should there be a threshold for number of wells surveyed below which no emissions should occur? Why would there be no emissions for surveys with fewer than 60 wells surveyed? I don't understand the rationale for a linear regression. Why not simply ratio the total number of sites with emissions / total number of sites surveyed across all surveys for each category? This would make more intuitive sense. Alternatively, the linear regressions could be forced through zero, which would be similar.

Fig 6 and 7: similar comments to above for Fig. 5.

Fig 8: Is the occurrance structure due to the fact that some areas were surveyed only three times, which did not allow for a 50% persistence point, for example? This set of plots is a bit confusing.

Fig 9: what do negative mean eCH4 excursions mean (gray bars of lower panels)?

Fig 10: could you add in the survey paths on this plot for reference?

Typographical error and other small comments P1 L13-15: "older infrastructure tended to emit more often (per unit) with comparable severity in terms of measured excess

concentrations on-road." - unclear; per unit? what is a unit? reword for clarity, please

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