Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-226-RC1, 2020

Atmospheric Measurement Techniques Discussions

Interactive comment on "Mobile atmospheric measurements and local-scale inverse estimation of the location and rates of brief CH_4 and CO_2 releases from point sources" *by* Pramod Kumar et al.

Anonymous Referee #1

Received and published: 3 September 2020

Summary:

The authors take advantage of the TOTAL Anomaly Detection Initiative platform in the south of France to the skill of an inversion framework that uses in-situ measurements from a mobile advice and a Gaussian plume model. The authors attempt to identify the location and magnitudes of sixteen controlled releases of CO2 and CH4 from a platform that is able to reproduce many common release scenarios that one might encounter on operational sites. The authors contest that their inversion system has some skill – especially in terms of estimating the magnitude of the leak. The main source of errors

is attributed to atmospheric turbulence.

The paper covers a topic relevant for AMT. It is well structured. I recommend publication after the comments listed below are considered by the authors.

Although well structured, many details of the paper were hard to follow. The clarity of the paper (e.g. wording, etc.) could be improved and the manuscript would benefit from a good editorial review. I did not include these types of suggestions in this review.

Comments:

(1) Can the authors note on Figure 1 or somewhere else where the "true" releases were from (aka which star)? I notice that one release site is much further than the others. Is there anything about this location that follows through to the results (e.g. harder to pinpoint or quantify?).

(2) Can the authors further clarify why the Gaussian Plume model is a reasonable transport model for their study given some of the inherent drawback the authors note in paragraph 255. I found this discussion difficult to understand. Beyond the points that the authors list, isn't this application based on how field data is collected – given that the study has constant emissions for each release, are the measurement averaging time comparable to the source-to-receptor travel time? It seems like most of their reasons have to do with the fact that the alternatives are just to difficult to implement. How do expect the Gaussian plume model assumption to impact the uncertainties on their results?

(3) Can the authors better explain how the authors used the Gaussian model to simulate mole-fractions (Am) and then use within the inversion to minimize the cost function? Where is xe, ye, and Qe specified in the equations? It seems like the authors varied the release rate (Qs) which I assume goes into the Gaussian model to create an ensemble of modelled concentrations (Am)? Then is ye is just the length of the centroid to the location of the observed mole fraction that with that minimizes the sum

of the squared residuals for the two terms in equation 3? Same with Qe? What type of minimization scheme did the authors use? These sections need a lot more clarify. For example, better nomenclature would help explain how the authors run their inversion with the plume model. A simple flow diagram would help here too.

(4) Similar questions include: How many ensembles do the authors have for each Ao for a given grid locations? Their grid is 2,400 – I assume the authors used all of the Ao one-minute data within the "peaks" (obviously excluding those due to turns, weak winds, other criteria mentioned) or did the authors average in some way? How many Ao measurements did this amount to for each release? Are the number of Ao the same for both gases? All these points should be better clarified in the draft because it is very hard for the reader to follow the method, how it was applied, and thus be able to understand the results and discussions.

(5) It seems like one of the major assumptions of the work is that the authors provide the actual source height of each release to the inversion system. Later, the authors explain that this height might be artificially too low due to turbulence. I would recommend running a sensitivity test varying the source height. For one, it might show if the source height is effectively "higher", then it explains their results. It would also show the sensitivity of the results due to this assumption.

(6) It is unclear how/if the authors estimate uncertainties on their estimated parameters. Can the authors please provide more information? If the authors did not estimate them, I recommend a sensitivity analysis as noted above to help provide some measure of the variability of their estimates to assumptions. The authors must make some attempt at estimating uncertainties.

(7) Can the authors provide a histogram (or something similar) to show how the 5th percentile value compares to the other Ao mole fractions for justification of background? I would expect that the surrounding vegetation that the authors mention doesn't have too much impact given the short duration of their measurement time period but trucks

passing by would. If these are just spikes in the data, I can imagine that the authors could just remove them.

(8) The location error for CH4 is very large especially given the size of the domain and potential release location sites (in general – how far apart are these? Hard to tell from the schematic – I would assume that the average spacing between these would act as a design requirement for the inversion). I suspect that this may have something to do with the fact that the inversion is very underdetermined. Is there any additional information that the authors could provide the system to help reduce the location errors? For example, the authors noted the potential release sites – if these are known a priori, the authors could limit their estimated locations to solely these grid cells. At the very least, the authors could probably make some gross a priori assumptions about where they are not release locations to eliminate part of the solution space.

(9) Following (8) and (1) – can the authors say something about the location of the "potential" release points (some are bunched together while another is much further away and their results?

(10) I am not sure if averaging such a large variation of errors is really a representation of the expected errors – especially for only 7 samples. Can you justify?

(11) Given the range of the release magnitudes – I think it would be nice to see some standard error statistics instead of relative error in the results.

(12) Why aren't there error bars on Figure 5? Having CH4 stacked on CO2 begs for a comparison between the two but they aren't because releases go from 1-16. I would recommend putting these plots side by side instead.

(13) Is one of the main reasons the authors used CO2 and CH4 is because of the background issue? For replication sake, it would have been nice if the authors mimicked their release of CO2 and CH4 (aka same locations, magnitudes, durations, etc.) to be able to compare these. I understand that the authors cannot rerun the experiment but

maybe the authors can group the releases into “similar” types between the two gases to help with the interpretation of results later on?

(14) What can the authors say about the practical application of their results? If the authors need 30 min of sampling – e.g. to improve their estimations – is this typical duration of an intermittent event? How many samples would the authors be able to get in a realistic event? The authors will always have a sampling bias during the day so what does say about their methods? How would the authors extend this for something more useful and practical for operators?

(15) Again, I think presenting the results in relative errors is a bit misleading and I don’t think that the authors demonstrated much skill in actually identifying the location of the leak – which is key for the application of this work. I don’t think this warrants a rejection of the paper but a more realistic description of their results and methods. I think that detecting and quantifying release may just require a better transport model – even if it is just slightly more sophisticated (e.g. AEROMOD).

(16) The authors suggestion of a hybrid approach is intriguing. Is there any other work that explored these ideas?

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