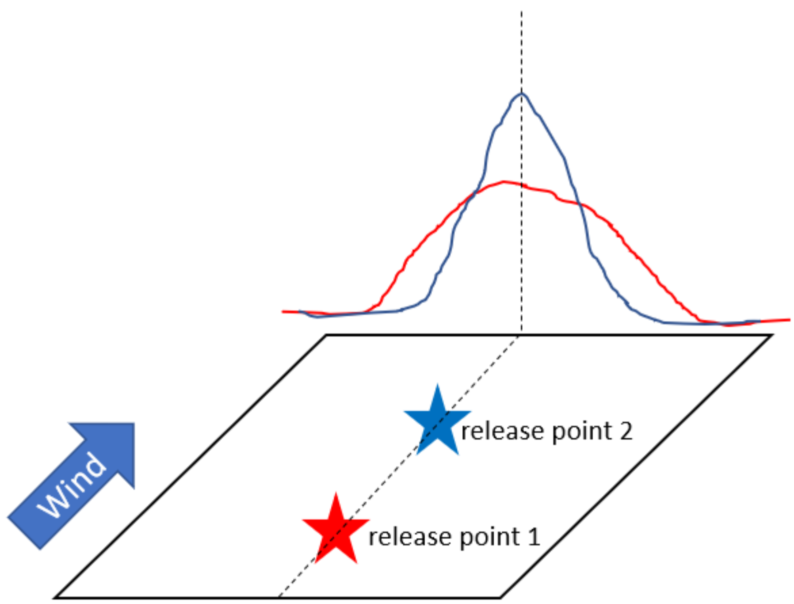
This study presents a new approach to determine the location and rate of point source emissions, and tests the method using a series of controlled releases. Mobile measurements of mole fraction are made on board a car, which performs repeated transects through the plume downwind of the release. A Gaussian plume model (driven by local meteorological measurements) is used to simulate mole fractions at the measurement locations for an ensemble of release locations and emission rates. The offset between modelled and measured locations of the plume centre is calculated, in addition to the difference between the integrated plume enhancement (a.k.a. plume amplitude) for the modelled and measured datasets. Estimates for both release location and emission rate are derived by minimising a cost function that seeks to reduce these two measures of model-measurement mismatch.

The study is well-motivated and the details of the experiment are clearly described. Unfortunately, if I've understood it correctly, I think there is a fundamental problem with the method developed here. As far as I can tell, there is insufficient information content in the plume amplitude and plume-centre location to constrain both the location and rate of emissions. It seems like the plume-centre location can be used to constrain the location of the release to a line along the average wind vector, while the plume amplitude can either constrain the emission rate for a given release location on this line, or the release location for a given emission rate. Take the following example where the wind is perpendicular to the transects:



In this case any release location along the dotted line will result in the same modelled plume-centre location. But a source at release point 2 with a low emission rate will produce the same plume amplitude as a source at release point 1 with a high emission rate. These would produce the same value of J for this transect.

In all but one case presented in this study there are multiple transects of the plume. This adds extra information to the case above. But I don't think it is being used to constrain the location in a useful way. Because the emission rate Q_e does not impact J_W, J is minimised by setting the location of the release to minimise J_W, then setting the release rate to minimise J_p given this location. If the plume centre-location is different for two transects then J_W is minimised by moving the source location further away from the transects. Figure 3 is the perfect example of this in action. J_W alone sets the source location, but the x-value of this source location is purely an artefact of the way the cost function has been constructed.

In section 5.3 it is stated that J_p does not "push far enough for finding a source location". But in most cases it has no impact on the estimated source location at all, I suspect for the reasons outlined above. This is apparent from tables 3 and 5 – the locations are usually the same regardless of whether J or J^{log} is used as the cost function, because in both cases J_W is the same. In cases where there is a difference I guess that it probably arises from some combination of the geometry of the ATEX zone boundary and the discretisation of release locations and emission rates.

It's entirely possible that I've misunderstood what's going on here – if so then I'm sure the authors can put me straight! But until I have faith in the overall approach, I can't recommend that this paper is published. If the authors can convince me that the method is sound then I'm happy to provide more detailed feedback on specific points. Otherwise I think the best option might be to reject this paper in its current form and consider what additional information could be used to better constrain the problem. One obvious candidate would be to use the plume width in some capacity, but I think that to do so would require a more complex model, as one would need to simulate the likely width of the instantaneous plume (rather than the time-averaged plume represented in the Gaussian plume model). Perhaps that is a bad idea… but either way I think some additional constraint is required in order to render this approach useful in determining source location as well as emission rate.