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Atmospheric Measurement Techniques Discussions

Interactive comment on "Determination of NO_x emissions from Frankfurt Airport by optical spectroscopy (DOAS) — A feasibility study" *by* Erna Frins et al.

Anonymous Referee #3

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In their manuscript, the authors report on car DOAS measurements of NO2 around Frankfurt airport. Using the vertical columns derived from their observations in combination with wind data they estimate the NOx emissions of the airport during three rounds. With additional assumptions on aircraft movements and vertical distribution, they then derive rough estimates of emissions per take-off.

The topic of the paper is interesting as aircraft emissions of NOx are poorly constrained and car DOAS measurements could be a simple way of adding information on this topic, in particular as they integrate vertically. The manuscript is clearly written and fits into the scope of AMT. However, the paper has a number of limitations and shortcomings which are in part difficult to fix and I'm therefore reluctant to recommend it for

publication. If the authors decide to submit a revised version, they should consider my concerns in detail and address them in their revisions.

My first comment to the measurements is that it is unfortunate that there are so few of them and that they were taken at 20° elevation angle. In my opinion, for flux measurements, a large number of zenith-sky observations taken with short integration times would be more useful as this reduces uncertainties in the integration of the flux and also in the light path. The three rounds around the airport have all relatively large gaps and I think that a statistically much more meaningful data set could be measured by the authors in a relatively short time when using one of their more modern instruments.

My second comment on the measurements is that the authors need to discuss the possibility of contamination of their measurements by car emissions on the highways they are driving on. The high NO2 signal close to the airport is suggesting that this NO2 was emitted from the airport but at least part of the NO2 could also be from road traffic, in particular as the instrument was integrating at 20° elevation along the road.

My third comment on the measurements is that the fundamental problem of estimating variable emissions using the flux approach needs to be discussed in more detail. As the authors will agree, the computation of emissions from measurements of the flux through an envelope around the source will only be straight forward if everything is in stationary state. If emissions change over time, they can only be estimated taking the distance between measurement and emission and wind speed and direction into account. This is then more a plume transect than a flux method, and for accurate results, plume dispersion and also NOx plume chemistry need to be considered. In the case of the airport this is further complicated by the presence of several moving sources at different distances from the measurement. While the manuscript tries to address parts of this issue, I think a much more detailed discussion is needed here.

My fourth comment on the measurements is that in the introduction, the problem of separation between aircraft and other emissions on the airport area is discussed in

some detail, suggesting that the current study will improve in this respect on previous ones. However, I do not see how the car-DOAS measurements can solve this problem. While integrating vertically through the atmosphere helps to include aircraft emissions during the first part of the ascent in the measurements, all ground-level emissions will still contribute to the emission estimate, independent of their source.

The main argument the authors make for their ability to estimate aircraft emissions during take-off is the correlation of NO2 flux with the number of aircraft take-offs. While I would expect to see such a correlation, the small number of three rounds in combination with the difficulty to quantify the number of take-offs and the other uncertainties makes this analysis pointless in my eyes. As stated above, I think that with limited effort, the authors could make this a much more meaningful study by adding a few more data points.

Although the manuscript is clearly written, it lacks some relevant information: The location, time and geometry of the background spectrum needs to be given, the method of computing the tropospheric columns should briefly be repeated and a figure showing the tropospheric vertical columns from the three rounds as a function of position along the track would be helpful to read the absolute numbers and to see their variability in time. Adding the wind arrow in Figures 3a-c would also be useful.

As a last comment I missed a discussion of the numbers the authors derive in the context of existing NOx emission estimates for aircrafts and airports. I'm sure that Frankfurt airport has to report NOx emissions to the environmental agencies and it would be appropriate to compare the values obtained from this study with those from the operators and also with numbers published in earlier work.

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