Comment on acp-2021-180

Anonymous Referee #1

Referee comment on "Spatially and temporally resolved measurements of NO$_x$ fluxes by airborne eddy covariance over Greater London" by Adam R. Vaughan et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-180-RC2, 2021

General Comments

Vaughan et al. presented a powerful aircraft NOx flux measurements using an comprehensive eddy-covariance (EC) approach for the Greater London region. The EC approach is a well-developed method to determine the fluxes for the long live greenhouse gas emissions. Nevertheless, the use of EC remains quite challenge for the reactive gases such as NOx. In this study, the authors successfully implemented EC with a low flying aircraft. They had calculated high spatial resolution NOx fluxes and generated real-time emission grids over complex urban terrain. Significant differences were found between the measured fluxes and those estimated from national atmospheric emission inventory (NAEI), with measured values up to two times higher in Central London than those predicted by NAEI. As said by the authors, the new method demonstrated in this study for London will be a valuable tool for other urban areas worldwide. Nevertheless, there are still some more explanations needed to be added for clarity. The paper can be published after addressing my comments in the followings.

Specific Comments

Introduction: it will be more valuable to summary more about the significance and the current progress of NOx flux measurement in complex terrain and then the advantage of airborne eddy-covariance approach should be emphasized.

Methods: the general description on the AQD instrumentation and the methodology of eddy covariance with environmental response functions (ERF) can be shortened as it is well established instruments and software packages. In contrast, more information on the use of AQD and the specific improvement on the ERF as well as the aircraft cruises (flight time, heights, speed, etc.) shall be added.

Methods: the specification of 9 Hz for the AQD instrument as the data frequency (time resolution) is not appropriate. The 9 Hz is the data acquisition rate but the input values of edd4R requires the time resolution. Sum up all the residence time of the air samples in the AQD shall be roughly the response time and the time resolution will be even longer than that.

Results: the authors may show and analyze their original observations of NO and NO2 before the results of EC deduced NOx flux. There are plenty of information from the directly observed values of both NO and NO2. For example, the NO2/NO ratio will give you some estimates of the observed air mass ages. To show the directly observed values are also a check of the data quality for the subsequent EC analysis. The flight legs may cross different terrains. The observed NO and NO2 may be different for traffic (surface) and industrial (point) emissions.

Results: Are there nighttime flights or twilight flights? The stated minimum flight height is around 300-400 meter which is limited in the range of nocturnal residual layer and the NOx emissions may not be measured precisely. The needs additional explanations.

Results: The solar azimuth angle seems to be a dominant factor for the NOx emission rates which means a strong diurnal pattern of the varied emissions sources. Some in-depth discussions on this feature may be added in the paper.

Results: in previous publications by the same group, tower platform has also been used by the same group in GLR to deliver the NOx emission flux. Will there be a better idea to pin point the key environment factors of NOx emissions?

Technical Comments

On line 17, "the Greater London region" is mentioned here for the first time, the abbreviation "GLR" should follow.

On line 35 the second page, extra spaces appear in brackets.

On line 80 Table 1, the first and last line of the table needs to be upper/underlined. Besides, all the other tables in the main text should be modified to an identical format.

On line 113, please add more detailed descriptions on how the 3.3 % correction was calculated.

On line 122, please unify the tense of the sentences of the experiments. This sentence uses the present tense, while the previous sentence uses the past tense.

On line 128, please provide specifications about the UV pen ray lamp.

On line 235, shall be table 2.