

Response to reviewer #1 remarks in the second iteration.

Suggestions for revision or reasons for rejection

(visible to the public if the article is accepted and published)

I would like to thank the authors for their revised version.

My opinion remains that, while the data in itself is valuable, there is insufficient depth of analysis for a Measurement report. This is reinforced by the fact that the valuable piece of analysis (high resolution simulation) cannot be improved since it is anticipated for submission on another paper.

I suggest to constitute a data-only paper and submit elsewhere and keep all the good parts for for the modelling paper.

Taking into account the reviewer suggestion, modelling part has been removed from the text, while the discussion of measurements has been extended.

Response to reviewer #2 remarks in the second iteration.

This report presents a unique and valuable dataset including several measurements of vertical profiles of meteorological variables and CO₂/CH₄ mole fraction in an urban environment. The sampling has good seasonal and diurnal representation, which could be useful for future studies aimed at improved understanding of the urban boundary layer (UBL) and/or CO₂/CH₄ emissions transport.

The authors appreciate underlying the uniqueness and value of the dataset as well as good temporal coverage both in respect to the diurnal and seasonal variability by a reviewer.

This paper in its current state does not follow a logical structure. The authors present the data as useful to improve nocturnal UBL modeling, particularly for complex terrain, but the case studies they present do not align with the objectives presented in the introduction. The case studies demonstrating transitions from CBL to SBL and SBL to CBL do not show new results and the purpose of demonstrating these transitions is not clear (i.e. what new information can be learned from these data?).

The introduction section has been shortened and rearranged according to reviewer suggestions. Selected sections has been modified, some has been removed.

At present, the case studies do not illustrate clear new results warranting a measurement report, but with some reframing this dataset could be presented in a way that highlights its potential applications to contribute to the scientific community in a meaningful way. For example, the text describing the CO₂ and CH₄ case studies could be reframed to show how this dataset shows potential to be used to validate models (in the case of the CO₂) and improve understanding of emissions sources (in the case of CH₄), and the text in the introduction and conclusions could be modified to include this purpose.

Some new aspects related to the influence of the topography as well as a potential of detected high altitude plumes for model benchmarking has been added.

Additionally, the sounding figures are difficult to interpret (or impossible in the case of Figure 3). I sympathise with the authors not wanting to leave out interesting and important information, but I don't think the figures are acceptable in their current state. Less soundings could be included while still illustrating the points the authors intend to make.

Figures 1, 3, 4 and 5 has been simplified (part of profiles removed, UAV and balloon profiles marked with different lines) to make an interpretation easier.

General comments

- The authors should add a more detailed description of the sampling location surroundings and what CO₂ and CH₄ sources are nearby/upwind.

More information about sampling locations surroundings was added to the text.

- The authors are presenting this dataset as useful for investigating the nighttime UBL, but there are plenty of daytime measurements. The authors could present this dataset as something that could be used more broadly.

The introduction and discussion sections has been modified accordingly.

- As previously stated, the case studies do not match the objectives and background presented in the introduction.

The introduction and discussion sections has been modified accordingly.

- The text contains several grammatical errors.

The text was carefully reviewed for linguistic errors.

Specific comments (line numbers refer to tracked changes version of manuscript)

L17-29: This paragraph has more detail than necessary.

Some not relevant aspects has been removed.

L45-47: I would suggest changing the wording because the way this is written implies these lists include all sources of these GHGs when I think the authors are just intending to give examples.

Corrected.

L47-52: I would suggest removing the sentence "In strong wind conditions..." and the following sentence. Variability in GHG mole fractions always depends on both the background and the atmospheric flows in the PBL, among other things like proximity to point sources.

Removed

L52-54: I agree that turbulence plays a major role in diurnal variations but I wouldn't say that's always true for seasonal variations, especially based on the cited article (Li et al. 2014) that only includes summer data. Even for diurnal variations, I would say PBL height changes play the dominant role (although I suppose that is related to turbulence).

Corrected

L74-79: I see where the authors are coming from but I don't agree with this interpretation implying nighttime data are absolutely necessary when plenty of studies have made decent estimates of GHG emissions without including nighttime data. It would make more sense to say nighttime data are often excluded from emissions estimation frameworks because nighttime PBL dynamics are not well understood, and improved understanding could allow us to include the nighttime data that could improve emissions estimates as indicated by Peng et al.'s results.

We are presenting data covering a whole diurnal period however the night time are considered as more difficult to interpret and many emission assessment attempts are focused on day time measurements. Our record is extending this picture also for night time situation giving the opportunity for the developments of methods relying on this period.

Figure 1: This figure would be more informative if it were zoomed in more.

Figure has been modified

L151-153: Authors should explain what analysis they are referring to and a citation should be provided for equation 1.

A simple performance comparison between the altitude reported by GPS system and obtained from the barometric equations pointed to the second method as much more precise for assigning the altitude to the molar fractions measurements. The equation is well known relationship existing in the most of Physics books.

L156 and response to previous reviewer comment: If McKinney et al. 2019 is part of the literature review here, the authors should cite it here as well.

In our opinion the recommendation of specific articles to be cited by reviewer it is not a common practice in the review process.

Section 2.3: Specify how far the location of these observations is from the locations of the campaigns.

Corrected

L266: I think the sentence "The WRF model has been successfully..." could be left out, but if the authors would like to include it, it needs a citation or two.

Modelling part has been removed

Figure 3: (In addition to previous comments) The caption should indicate where these data come from. "Flights" imply these are UAV data but based on the number of flights it seems like the balloon data are also included.

Figure caption has been modified

L309-: Authors should specify earlier in the paragraph which dataset they are referring to (i.e. measurements of profiles from UAV or balloon campaigns or both).

Corrected (different line style on fig.3)

L316: Anthropogenic CO₂ emissions were not mitigated (prevented) by the biogenic sink, I think "counteracted" would be a more accurate word choice.

Modified

L309-328: This paragraph has a lot of speculation presented as truth. For example, I think expecting the decrease in photosynthesis to be a reasonable hypothesis for higher flux at night that would contribute to more CO₂ accumulation at the surface, but the authors have no other data to confirm this. I suggest rewording this section, presenting these statements as hypotheses that could be confirmed by future work. There is also no discussion of variability of anthropogenic emissions here, which probably have a substantial impact given these measurements were conducted in urban areas.

Modified

Figure 4: I agree with the previous reviewer that these figures are too busy to interpret. Yes, data from all hours of the day could be informative, but not all of it is relevant to discussion in the text referring to this figure (section 3.2.1). In their response to the previous review, the authors state that they keep all the data in the figure to highlight a short-time increase in wind speed, but that short-time increase is not discussed in the text.

The figures 1, 3, 4 and 5 has been modified for easier interpretation of presented results.