We would like to thank the reviewer for the comments and suggestions to our manuscript. In the following, we answer to the reviewer's comments and indicate the changes in the manuscript that were implemented according to the recommendations. The comments are in black. Our answers are in blue.

Referee #2:

Summary

Lian et al. present a study investigating long-term changes in CO_2 emissions in the Greater Paris Area using different emission data products in combination with atmospheric observations. The inventories provided by origin.earth, AirParif and TNO can be the basis for policy decisions and they are validated using a bayesian inversion system which relies on assimilating morning and afternoon observations from a ground-based network. This emission monitoring framework performs well, is able to detect trends and short-term changes in emissions, here due to COVID-lockdowns. Overall, the paper is well-written and clearly structured. The description of the components is concise and a lot of information and illustrations of the actual performance are given in the appendix. The scope of the paper aligns very well with ACP and I can fully recommend publication after some minor changes have been considered.

Response:

We thank the referee for the positive comments on our manuscript.

General comments

1.) Unfortunately, the description of the modelling framework and its performance is very short. A lot of instructive and convincing information (plots) are only found in the supplemental materials. It could be worthwhile considering moving at least one into the main text.

Response:

This suggestion is well taken. We have added <Section 2.4 Inversion configuration> together with Figure S4 and Table S1 in the revised manuscript to better describe key points of the atmospheric inverse modeling system used in this study. In addition, we have also moved the figure <Monthly average daytime (8-17 UTC) observed CO_2 concentrations at seven in situ stations> into the main text as Figure 2.

2.) The manuscript does not discuss any other greenhouse gasses. In recent years several mobile surveys have been conducted highlighting significant CH_4 emissions in the region. It would be more balanced to mention CH_4, N_2O as other gases that need to be mitigated (or why they can be ignored for the Plan Climat de Paris).

Response:

As given in the manuscript, the emission reduction targets in the Paris climate action plan refer to greenhouse gas (GHG) emissions, including not only CO_2 but also CH_4 and N_2O. It is worth noting that the emissions of CH_4 and N_2O in the Paris region are much lower compared to those of CO_2 even when considering the global warming potential of these gases. According to the AirParif (official air quality agency of the Paris region, https://www.airparif.asso.fr/en/) inventory, the contribution of each GHG in CO_2 equivalent is 94% for CO_2, 4% for N_2O and 2% for CH_4 in 2010 (AirParif, 2013). Defratyka et al. (2021) also reported that the natural gas network in Paris exhibited a leak rate of 0.11 leak indications per unique driven kilometer, which were classified as small leaks. Therefore, Paris is in the middle to low range compared to U.S cities, according to von Fischer et al. (2017) leak size categories. To highlight the emphasis of this study on CO_2 emissions while also addressing CH_4 and N_2O, we have added

the following sentence in the manuscript:

"According to the AirParif (official air quality agency of the Paris region, https://www.airparif.asso.fr/en/) inventory, the contribution of each of the main GHG (in term of CO_2 equivalent emission) is 94% for CO_2, 4% for N_2O and 2% for CH_4 in 2010 (AirParif, 2013)."

Specific comments

P3L17: please provide a quantitative measure of the instrument performance, what does 'high precision' mean here?

Response:

According to previous studies in Paris (Xueref-Remy et al., 2018), when properly calibrated, the cavity ring-down spectroscopy (CRDS) instruments could have a high precision that is better than 0.1 ppm on hourly average CO_2 data. We have added the following sentence in the revised manuscript:

"The precision of the one-hour average CO_2 concentration is better than 0.1 ppm (Xueref-Remy et al., 2018)."

P4L33: formatting issue with "ru le"

Response:

Corrected.

P4L36: consider changing "imposed" to "required to be"

Response:

Text changed as suggested.

P15 L10: The blue boxplots should be added to the legend or the description of the other symbols to the captions. Splitting up the information seems unnecessary.

Response:

The blue boxplots have been added to the legend.

Reference:

AIRPARIF: Bilan des émissions de polluants atmosphériques et de gaz à effet de serre en Île-de-France pour l'année 2010 et historique 2000/2005, 2013.

Defratyka, S. M., Paris, J. D., Yver-Kwok, C., Fernandez, J. M., Korben, P., & Bousquet, P.: Mapping urban methane sources in Paris, France. Environmental science & technology, 55(13), 8583-8591, https://doi.org/10.1021/acs.est.1c00859, 2021.

von Fischer, J. C., Cooley, D., Chamberlain, S., Gaylord, A., Griebenow, C. J., Hamburg, S. P., ... & Ham, J.: Rapid, vehicle-based identification of location and magnitude of urban natural gas pipeline leaks. Environmental Science & Technology, 51(7), 4091-4099, https://doi.org/10.1021/acs.est.6b06095, 2017.

Xueref-Remy, I., Dieudonné, E., Vuillemin, C., Lopez, M., Lac, C., Schmidt, M., Delmotte, M., Chevallier, F., Ravetta, F., Perrussel, O., Ciais, P., Bréon, F.-M., Broquet, G., Ramonet, M., Spain, T. G., and Ampe, C.: Diurnal, synoptic and seasonal variability of atmospheric CO_2 in the Paris megacity area, Atmos. Chem. Phys., 18, 3335–3362, https://doi.org/10.5194/acp-18-3335-2018, 2018.