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Comment on acp-2020-1174

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Community comment on "The CO₂ integral emission by the megacity of St Petersburg as quantified from ground-based FTIR measurements combined with dispersion modelling" by Dmitry V. Ionov et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-1174-CC1>, 2021

The article describes the new results of the research on the estimation of anthropogenic CO₂ emissions from the territory St.Petersburg megacity (Russia) which has been started in 2019 (see Makarova, M. V., et al., Emission Monitoring Mobile Experiment (EMME): an overview and first results of the St. Petersburg megacity campaign-2019, Atmos. Meas. Tech. Atmos. Meas. Tech., 14, 1047–1073, 2021. <https://doi.org/10.5194/amt-14-1047-2021>). The authors estimated integral CO₂ anthropogenic emissions from the territory of St.Petersburg using different measurements carried out in 2019–2020 and numerical modelling. The problem investigated in the study is important and relevant due to the Earth climate change and the importance of megacities for the variation of the atmospheric gas composition. Therefore, the authors should be welcomed to keep providing studies on the independent assessment of such emissions. This is especially important since it was found in [Y.M. Timofeev et al., Estimates of CO₂ Anthropogenic Emission from the Megacity St. Petersburg. SSN 1028-334X, Doklady Earth Sciences, 2020, Vol. 494, Part 1, pp. 753–756. © Pleiades Publishing, Ltd., 2020.] that the emission estimates according to the report of St.Petersburg administration significantly underpredict actual emissions of the megacity (□in 2 times).

However, the study has several weak points which require additional corrections to be done.

- The different estimates of the St.Petersburg integral emissions which are in range from 44800 to 74800 kt/year are given in the article. The difference between the minimum and maximum of the emissions constitutes approximately 31000 kt/year or □70% relatively to the minimal value.

The variations have to be analyzed, the inaccuracies of the approaches applied and natural variations have to be assessed. What is the reason for such a big spread between emission estimates - the technique of the measurements, lack of the observation data or their quality, the natural emission variation, the influence of the different trajectories, etc? The analysis of the estimated emissions and their uncertainties (random and systematic), the measurement technique and the inversion modelling approach used in the study have to be provided in the article..

- The evaluation of the uncertainties, mentioned in comment 1, have to be provided for both years of the EMME experiment (2019 and 2020) taking into account that the observation data are different for these years (e.g. one and two devices, different trajectories, meteorological conditions, periods of the observations, etc.).

- The significant systematic errors of the integral emission estimation approach used in the study can be related to the trajectories applied in the approach. The analysis of the Fig.6 demonstrates that the trajectories which link the positions of the observations cover the city irregularly. For instance, there are large city`s areas which were not covered by the trajectories completely. By contrast, some of the city's zones were covered by the measurements (which after that were used in the emission estimation) several times.

- Since the quality of a priori information (especially the accuracy of a transport model) is crucial for the quality of inverse modelling, readers can be interested by the comparison of the local measurements of CO₂ mixing ratio in Peterhof and HYSPLIT modelled data. The quantitative analysis (STD, MAE, RMSE) of such comparison before and after the scaling of the a priori emissions have to be provided in the study.

- The authors give insufficient review on the CO₂ and other greenhouse gases emission estimates provided for Moscow and St.Petersburg megacities by other researchers.

- A descriptive table containing details of the 2020 measurement campaign (e.g. atmospheric conditions with its dynamic, etc) has to be added to the article how it was done in the previous study.

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