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Interactive comment on "Emission Monitoring Mobile Experiment (EMME): an overview and first results of the St. Petersburg megacity campaign-2019" *by* Maria V. Makarova et al.

Anonymous Referee #2

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This paper describes a new top down approach of estimating the total emissions of several climate gases and air pollutants from a megacity. A similar approach has only been applied a few times in other cities and here the emissions for the full city of Sankt Petersburg are presented.

General comments

The paper is well written, with good language and nice, instructive graphs in most cases. It is claimed that the objective of the paper is to provide emission numbers for Sankt Petersburg. However a significant, and in my mind, to big part of the paper describes the general methodology with complementary data. The abstract is rather

long and detailed, and it should be made more concise with focus on the results. The main body is too detailed for a scientific paper: a) The Modis data is not relevant since it is not actively used, b) Remove nice photos of StPetersburg, c) In the introduction, there is a lot of explanation about different variants of obtaining windspeed and effective path, but this is not used in any significant extent in the results; this should dbe shortened

If I understand right, the methodology is the same as used in other campaigns (Berlin). In the introduction or elsewhere an overview about the other studies should be added with discussion on how comparable this study is to the other ones in terms of methodology and results . E.g. was effective path used by other studies. In Eq 1 you calculate the flux using total column (needed to get the right unit. You also introduce Xgas (I assume against total pressure). When do you use Xgas in the calculation? Is it only to show thing quantitatively? I assume in most cases te pressure is the same for up and downwind site ? Add in the text a definition of Xgas (not know for everyone) and describe what is your purpose here for showing it ?

For the wind used in the final results the authors rely on the Hysplit model, which in turn is based on a global model (NCEP) for the wind. The authors argue that the use of data from this model provides less variability in the final results. I argue that the wind variability is less for the Hysplit data than for real measurements, since it is large domain model, and Hysplit will therefore artificially smooth the wind data. This should be beter discussed by the authors. The authors present their flux estimation based on modelled effective path. Such an excercise provides useful data but it is hard for the reader to understand how the data was produced and its errors, since the data represents a combination of measurements and model. I suggest presenting also the purely measured data based on a constant path. For the effective path the authors claim they made a land use analysis and they refer to a public web site but there little information given in the paper and it is hard for the reader to understand the assumptions made here. Forinstance, I am missing an explanation about what are the

hypothesis about the detailed emission source categories and differentiation between species (CO_2, CH_4, NO_2). The species above orginate from different emission source categories; e.g CH_4 could partly come from the waterways (sewers and water canals) and pipelines rather than mobile and fixed combustion sources which are relevant for CO_2 and NO_2. This will make the effective path species dependent. The emissions from water ways could also be impacted by windspeed. I suggest adding a graph for the landuse model and include the model as complementary material for this paper. The NO_2 DOAS data are explained very briefly wrt to methodology and results. Did you use the same methodology as for the other species, even though you measure in a full circle around town. I suggesting describing the methodology in a better way and results. Did you use the NO_2 data to correct the FTIR measured data, if so clarify.

The treatment of uncertainties is all based on the obtained/measured variability of the parameters used to calculate the flux (total column, effective path and wind). In my mind this is an assessment of the random uncertainty. However there is no mentioning of systematic errors of any of these parameters. Please add a discussion about this and change absolute uncertainties to random uncertainty. In the CO_2 and CO data there is a factor of two difference between the column measured data and the one measured by in situ data. This is explained by the fact that the CO_2 and CO emissions are released from high chimneys (200m). However the mixing layer should be several hundred meters (at minimum) at solar conditions and the pollutants should therefore well mixed at some distances from the chimney (>1 km). This was also supported by kite measurements. In addition a considerable portion of the CO_2 should come from transport sector. The discussion should be improved on this topic. , All in all, I believe the paper should be published, with some minor improvements, based on my general and specific comments.

Specific comments

(Note that some of the comments below will be the same as in the general comments)

P3: Row 83: When making refence to other studies it would be relevant to add similar large scale measurements by mobile FTIR (Solar Occultation Flux technique) and mobile DOAS which has been applied fo large scale flux measurements for at least decade by now : e.g. 1. de Foy, et al., (2007) Modelling constraints on the emission inventory and on vertical dispersion for CO and SO2 in the Mexico City Metropolitan Area using Solar FTIR and zenith sky UV spectroscopy. Atmospheric Chemistry And Physics 7, pp. 781-801. DOI: 10.5194/acp-7-781-2007. 2. Mellqvist, et al., (2010) Measurements of industrial emissions of alkenes in Texas using the solar occultation flux method. Journal of Geophysical Research - Atmospheres 115. DOI: 10.1029/2008JD011682. 3. Johansson, J., et al. (2014) Emission measurements of alkenes, alkanes, SO2, and NO2 from stationary sources in Southeast Texas over a 5 year period using SOF and mobile DOAS. Journal of Geophysical Research-Atmospheres 119, no. 4, pp. 1973-1991. DOI: 10.1002/2013jd020485. 4. Johansson, et al. (2014) Quantitative measurements and modeling of industrial formaldehyde emissions in the Greater Houston area during campaigns in 2009 and 2011. Journal of Geophysical Research-Atmospheres 119, no. 7, pp. 4303-4322. DOI: 10.1002/2013JD020159. 5. Kille N, et al, The CU Mobile Solar Occultation Fluxinstrument, AMT, 10, 373-392, 2017

P 5, row 121: You claim that the DOAS measures tropospheric columns. Please elaborate in a few sentences what is actually measured, even though you refer to previous studies. Are you using multiaxis measurements to derive absolute columns or is it differential columns assuming that the upwind measurements is free from troposheric NO2, and hence that the differential measurements corresponds to the tropospheric absolute column

P5, row 132. Add references from other places on mobile DOAS, e.g. Johansson, M et al., Mobile mini-DOAS measurement of the outflow of NO2 and HCHO from Mexico city, ACP, 9(15):5647-5653, 2009. Rivera, C. et al., (2010) Quantification of NO2 and SO2 emissions from the Houston Ship Channel and Texas City industrial areas during the 2006 Texas Air Quality Study. Journal of Geophysical Research - Atmospheres

115. DOI: 10.1029/2009JD012675.

P6, row 171: This sentence is unclear rewrite it. Forinstance Table 1 presents daily information ...

P8, row 128: Define Xgas (is it against pressure?) and motivate why you introduce this. Would it not be more appropiate to compare total columns instead of Xgas since TC is the ones used for the flux.

P8, row 232: The comparions between the two spectrometers is very convincing. Nevertheless, it only shows how the spectral properties of two spectrometers influences the statistical error of the measurements. Please comment how this information was used.

P 9, 244: I think this section should be more detailed wrt the spectroscopy. At least a couple of general sentences for how te retrieval is done and if there are interfering species etc could be helpful,

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