Authors response on the Anonymous Referee #2 review of "The regional impact of urban emissions on air quality in Europe: the role of the urban canopy effects"

We thank anonymous referee #2 for his positive and constructive comments. We will address each of them and our point-by-point responses follow below. All of the editorial/typographical comments will be addressed in the revision. Reviewer's comments are italicized.

Specific comments/suggestions are listed below.

I. Scientific suggestions on the main text

General:

1. *Regarding the choice of cities, the justification is vague; what is to be highlighted for each city?*

   Authors response: During the selection we followed multiple criteria: a) size should be such that at least a few grid-cells in the 9 km domain cover the city, b) cities are sufficiently far from each other to eliminated inter-city influences (see Huszar et al., 2016a), c) the terrain of the city should have minimal variability to eliminate orographical effects, d) cities should be distant from large water bodies and/or sea to eliminate non-symmetric landuse effects around the city (e.g sea breeze effects).
   We admit that the selection could follow a more objective criteria like number of inhabitants or number of sq km-s, however we assumed (and our results showed) that the differences in results between cities are qualitatively very small and the choice of the list of cities has thus very small effect on the results. This has been mentioned also in the manuscript.

2. *Please provide additional explanations about why the focus was on NOx, PM2.5 and O3.*

   Authors' response: NO2 is an abundant pollutant emitted by cities (mainly by transportation) with harmful effects on health when its concentration surpasses a certain threshold value. According to the EEA 2019 Report (EEA, 2019), still 16 of 27 EU members states recorded concentrations above the annual limit value where the cities we analyzed belong too. The reason for choosing PM2.5 is similar: here, Czechia and Poland reported still very large values making PM2.5 a concern. Lastly, O3 is of interest due to its non-linear response to emission changes and, of course also due to its health treat, while its limit values are still being exceeded in many EU member countries.
   The choice of these pollutants was further motivated by the fact, that our analysis is based on our previous works (Huszar et al., 2020a,b; Huszar et al., 2016a) which focused on these three pollutants too (the motivation was the same).

3. *Please provide details about policy relevance of this work.*

   Authors' response: Chemical Transport Models are known to be an essential tools to evaluate policy related air quality measures to control urban air pollution. As such, it is important that all physical processes driving transport of emitted and secondary formed species from urban emissions are correctly represented. Here we show the error the model can produce if the urban canopy meteorological effects are not included. The policies mitigating the pollution treat of urbanization should thus consider of such effects. Therefor we think this study has very high policy relevance. We added these arguments into the revised text.

4. *Revise the term "fingerprint".*

Authors‘ response: We decided to change this term to „footprint“ which is much more common in studies dealing with urban emissions an in general the environmental impact of human activities.

Specific comments:

Page 4, 118-121, harmonise the info in this paragraph with the info provided in the abstract.

Authors‘ response: we modified the abstract in accordance with the indicated paragraph.

Page 6, 191, please summarise the experimental design e.g. in a table.

Authors‘ response: Table 1 on Page 27 (in the ACPD version of the manuscript, we placed all the tables and figures at the end of the text after References) provides the summary of all experiments including the information weather a) urban canopy effects b) urban emissions were considered.

Page 8, 250, please provide more details about model validation, for ozone in particular.

Authors‘ response: In the corresponding section (“Model validation”) we added more quantitative information on the model biases for all analyzed pollutant to allow the reader to have better idea of the model deficiencies and, in general to make the text more self-consistent.

Page 9, 255, please provide the name of emission model.

Authors‘ response: provided.

Page 13, 399, DJF ozone is missing, please provide an explanation.

Authors‘ response: both NO2 and PM2.5 can be high during all seasons, in particular they can be high in DJF due to limited mixing and stagnant conditions with low PBL. In contrary, O3 is very low in winter due to limited sunshine and high titration by NO, therefor we decided to not consider DJF ozone values in our analysis. Of course, there is an impact on the DJF ozone results, but these have a low relevance due to otherwise very absolute low values.

II. Typing errors

Authors‘ response: all typing errors listed below are corrected in the revised manuscript.

Page 3, 59, replace “ammonia(“ with “ammonia (“ - ok

Page 6, 167, replace “,the” with “, the” - ok

Page 8, 242, replace “models” with “model” - ok

Page 11, 341, replace “therefor” with “therefore” - ok

Page 11, 353, replace “and4” with “and 4” - ok

Page 11, 356, replace “PM” with “PM2.5” - ok

Page 12, 363, replace “and6” with “and 6” - ok

Page 12, 366, replace “maxima” with “maximum” - ok

Page 13, 399, replace Fig/ 7” with “Fig. 7” - ok

Page 14, 455, delete the “.” from “at..” - ok

Page 16, 499, replace “depend” with “depends” - ok

Page 16, 520, replace “and” with “an” - ok

Page 18, 563, “.” is missing - ok

References:
EEA, 2019: European Environment Agency: Air quality in Europe — 2019 report, EEA Report No 10/2019, doi:10.2800/822355, 2019.

Huszar, P., Belda, M., and Halenka, T.: On the long-term impact of emissions from central European cities on regional air quality, Atmos. Chem. Phys., 16, 1331--1352, doi:10.5194/acp-16-1331-2016, 2016a.

Huszar, P., Karlický, J., Ďoubalová, J., Šindelářová, K., Nováková, T., Belda, M., Halenka, T., Žák, M, and Pišoft, P.: Urban canopy meteorological forcing and its impact on ozone and PM2.5: role of vertical turbulent transport, Atmos. Chem. Phys., 20, 1977-2016, https://doi.org/10.5194/acp-20-11977-2020, 2020a.

Huszar, P., Karlický, J., Ďoubalová, J., Nováková, T., Šindelářová, K., Švábik, F., Belda, M., Halenka, T., and Žák, M.: The impact of urban land-surface on extreme air pollution over central Europe, Atmos. Chem. Phys., 20, 11655–11681, https://doi.org/10.5194/acp-20-11655-2020, 2020b