

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on **acp-2021-1100**

Anonymous Referee #1

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Referee comment on "Black carbon aerosol reductions during COVID-19 confinement quantified by aircraft measurements over Europe" by Ovid O. Krüger et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1100-RC1>, 2022

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This manuscript is a straightforward and relatively brief analysis of vertical profiles of airborne black carbon (BC) measurements made over western Europe in July 2017 prior to the COVID-19 pandemic and in May and June 2020 during the "lockdown", or "confinements", of much personal and industrial activity. The intent is to show that lower BC mass concentrations (Mbc) in 2020 relative to 2017 can be attributed to differences in emissions due to the lockdown, which varied between countries in western Europe. To account for varying meteorology, the ECHAM/MESSy model is used to simulate the Mbc for each of the sampling periods. The HALO aircraft was "flown" through model space to calculate median profiles that can be directly compared to those measured by the aircraft. Median vertical profiles measured in 2020 were about 47% lower than in 2017 (when integrated vertically to get a columnar loading value). According to the model, only about 7% of this difference was attributable to meteorological/transport differences, while 40% of the difference was attributable to reduced emissions during the shutdown period in 2020 (and a slight, long-term decreasing trend in BC emissions).

The manuscript is well written and, as I said, rather straightforward. It will be of interest to the general public and policymakers, but is likely not to be much of a surprise to atmospheric scientists. Emissions went down, so the atmospheric loading went down roughly proportionally. But documenting this is worthwhile, and I find the paper appropriate for publication in ACP with relatively minor revisions.

Major comments:

The structure of the manuscript is unusual for ACP, and appears more like a Nature or Science format. There is a quite short main text body that discusses the findings and leaves many questions unanswered, followed by a very extensive Appendix that provides

the experimental details, modeling parameters, etc. I don't have a particular problem with this format, but initially I was wondering where all the details had gone to. I suggest that the authors add a brief paragraph near the front stating the structure of the paper, and that details of the measurements, modeling, and results will be found in the Appendix, perhaps even outlining the Appendix. As detailed below, there are some spots where more information needs to be given in a single sentence, with the appropriate section of the Appendix pointed out.

I would very much like to see the equivalent of Fig. 3, but for the model results, in either the main section or in the Appendix. A lot can be learned by looking at how well the model simulates the spatial pattern of in situ data. I'd be especially curious to see if the very large Mbc values found between 2 and 4 km in the data during 2017, from biomass burning transport, is simulated by the model.

The authors need to discuss in the main text difference between free tropospheric measurements vs. the planetary boundary layer. This topic is brought up in Appendix A1, but I believe this needs to be emphasized more. The altitudes in Fig. 2 and 3 are not clearly defined; is the altitude above mean sea level, or is it above local terrain? It might make more sense to plot everything against altitude above ground level, which can be obtained using a digital elevation model database; there are several readily available. The average PBL height could also be shown, to help differentiate between locally/regionally emitted BC and that transported from long distance.

Line 111: Can you define the "lockdown period"? Is May 2020 not in the lockdown? I see that this is well documented in the Appendix, but I think it would be helpful to show one of these graphs in the main text and clearly define what is meant by the lockdown period since it is used frequently in the main text.

Minor Comments:

Figure 2: Is the y-axis altitude above sea level, or above the local surface?

Figure 2: You say solid lines represent "average" values. "Average" is not mathematically defined. Is this the geometric mean, the arithmetic mean, or some other type of average? I assume the arithmetic mean. In that case, it's interesting that the mean and median values are so different for the 2017 Mbc data, suggesting some strong transport events between 1500 and 3500 m that are driving the mean to much larger values than the median. (This ends up being discussed in the Appendix; a reference here to that section of the Appendix would be helpful.)

Figure 2: The caption says that Mbc is shown in panels A, B, C, and F, but it's shown in A, B, C, and D. Panel F shows the BC core diameter. The caption also says that panel E

shows the measured "Mbc"; it should be "Nbc".

Lines 110-115: How much BC is emitted from heavy goods vehicles vs light duty vehicles? Did the lockdown affect them both the same? (Again, this appears later in the Appendix but should be discussed briefly here.)

Line 119: what are "motor spirits"? Gasoline (petrol)? Or Diesel? Is kerosene different than Diesel? Or is this aviation (jet) fuel? Please clearly define your fuel terms, since there are substantial differences in usage of these terms across different countries.

Line 124: Please define what is meant by "solid fuels". Coal, biomass, anything else?

Line 138: By "general emission reductions" do you mean "reductions associated with long-term trends"?

Line 144: The sentence beginning "In particular. . ." is not a complete sentence.

Figure A8: What are the units on the x-axis? This graph has a gray background that is different from all the others.

Figure A9: If panels A and B were placed on the same scale we could more clearly see the reduction in Mbc during BlueSky as opposed to EMeRGe.