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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Decennial time trends and diurnal patterns of particle number concentrations in a Central European city between 2008 and 2018" *by* Santtu Mikkonen et al.

Anonymous Referee #2

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General comments

The paper presents convincing arguments with statistical methods as why it is likely that decreased traffic emissions have led to decreased particle pollution in Budapeszt. Hence, these results are extremely important from a policy making point of view. In other words, it is neccessary that there are no doubts as to why concentrations have gone down. For this reason, the paper must undergo additional analysis to prove the point that car emissions have indeed led to the decrease of particle concentrations in Budapeszt. If this analysis can not conclusively prove the reason for the decrease, then I must stress the need to be more careful about the conclusion in the abstract

and conclusion section as to the reason for the decrease. And provide a sentence that other reasons for the decrease can not be ruled out.

Hence, I suggest to accept the paper subject to major revision of data analysis as suggested below. In addition there are a few minor remarks that need to be addressed.

Major remarks

Table 2 seems to indicate that there are increasing number of cars and car age as function of time in Budapeszt. How this can lead to decrease in emissions from traffic in chapter 3.1 is not quite convincing despite that Euro regulations are imposing restrictions to emissions from new cars. The total emissions are likely dominated by the ageing cars, and the average age of cars is increasing with time. Is there still a likelihood that the statistical analysis could be wrong for some unknown reason, and the reason for decreasing concentrations is arising as function of varying meteorological conditions between different years as expressed by the MCP parameter and not due to decreased car emissions? After all, the gas concentrations are not decreasing with time as the authors admit. I want the authors to quantify how often MCP weather patterns of type 3, 7, and 12 occur during April, May and August during the earlier years compared to the later years, and see if this can explain why the N6-1000 is higher in the earlier years than the later years (and also for the MCP that do not favor NPF, type 6).

The statistical method of DLM and GLMM are not enough for interpreting the results. A manual analysis of the MCP as described above must be done as well to provide further evidence for decreasing particle trend as being caused by decreasing traffic emissions. I stress also to use an educated guess/calculation of how you expect to see reductions in emissions of particles based on the values of car age and number of vehicles and diesel car share as function of year, and see if your expecations indeed would indicate a decrease in emissions. Just because there is a tendency for decreasing car emissions in Germany, doesn't prove that the same thing is happening for Budapeszt if the traffic fleet composition is different in Budapeszt. Also, I want the authors to look more carefully on meteorological parameters manually as well. Even though for example the average temperature is the same for the different years, doesnt' mean that it is not varying between different days that lead to the particle concentration trends between different years.

Minor remarks

Please denote that the station is an "urban background" station in the abstract, introduction and methodology sections. This is needed for other readers to relate to the expected pollution level, and to know if this is the most polluted place in Budapest, or as you have in this case, a medium population exposure location in the city center, so called urban background. Alternatively, if it is not a typical urban background site, but slightly more polluted (I don't know this), please explain in the introduction and methodology section that the site has a pollution level between a typical heavy trafficked street level site and an urban background site, but closer to typical urban background levels.

Lines 133-134. "the most extensive inter-comparison was realised in summer 2015 (Salma et al., 2016a) and autumn 2019". Please denote which kind of intercomparisons were made.

Chapter 2.1: SO2, CO, NO, NOx, O3, and PM10 measurements: What is the pollution level of the site measuring these paramters: urban background or street level pollution, or something inbetween, or cleaner than an urban background site? Please describe this station as well. Otherwise, we cannot compare the time trends for this site as compared to the BpArt site. For example, the BpArt site might be closer to traffic than the gas measurement site explaining why the BpArt concentrations are decreasing with decreasing traffic emission trends, but not at the gaseous concentration site, which is then relatively more influenced by background long range sources.

Chapter 2.2: The MCP codes are developed for 00:00 UTC time. When you have a time of your particle or gas concentration data or meteorological data, which is the

MPC type that you use? For example, if the measurement time is August 1, 14:00 local time, what is the MCP coding for that time? Is it the MCP coding from August 1, 00:00 UTC, or MCP coding from August 2, 00:00? Or is it denoted as a combination of both MCP codes? It should be clearly stated in the manuscript. The MCP coding from one day to the other might change completely, meaning MCP codes for a measurement time inbetween two MCP coding times can be ambiguous.

Chapter 2.3.1. Would you please explain the autoregressive component?

Equation (4): The MCP is not a continuous variable, but it is discrete. How can you construct a linear output factor from Beta-6 multiplied with MCP-i? Would you mind explaining how Beta-6 and MCP-i and their product are constructed?

Line 274: Q (GRad) calculation is incorrect. The equation is correct only if you have 100 % data coverage. You have between 90 and 100 % data coverage as indicated in the method section. Hence, the calculated value will be systematically underestimated unless you interpolate data for the missing hours of GRad data. This could potentially be the reason why Table 2 Q values are different for different years, and not due to varying total insolation during one year to the other.

Lines 317-318. It is a strong statement to say that "this decoupling confirms that the causes of the decrease in particle number concentrations are not primarily related to meteorological conditions because they would jointly affect the gas concentrations as well". That gas concentrations don't go down and particle number concentrations go down could by accident also be related to a difference in availability of different MCP days during different years and seasons. NPF events could be favored in earlier years due to for example quite high number of certain MCP days with lower particle surface area, which favours NPF, which don't appear as frequent in the later years. This could happen even if the median particle surface area is decreasing every year (as indicated by decreasing N100-N1000). But, this difference in MCP does not automatically mean that the gas concentrations should change in the same way as N6-1000. Hence, I would rephrase the wording from ”confirms” to ”suggests”.

Conclusion: You mention that the accumulation mode particles don’t show a decreasing annual trend. But, according to Table 3 they do.

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