

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-225

Anonymous Referee #1

Referee comment on "Comparison of particle number size distribution trends in ground measurements and climate models" by Ville Leinonen et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-225-RC1>, 2022

The authors perform a trend analysis using measured aerosol distributions modes (nucleation, Aitken and accumulation modes) over several long-term measurement sites across Europe and the Arctic. Trends are analyzed both seasonally and long-term (interannually). In addition, the trends derived from measurements are compared to those derived from models. While the trend analysis is thorough, the way in which results are presented are difficult to process as the authors rely on conveying the trends in several large tables. The coloring of the tables does help readability of the, but some of the discussed results would be better presented in more traditional direct comparison plots. Based on my comments shown below, I recommend publication after major revisions.

General comments:

The manuscript is currently difficult to read. In general, the manuscript would benefit from some heavy editing. Additionally, the analysis uses measurements from 21 sites and a lot of site specific results are discussed and are somewhat meaningless without context or detailed site information. General results on measurement trends based on site class, latitude (north vs south) and agreement (or lack of agreement) with the models would provide a much clearer story.

Many of these "figures", are actually large tables that are difficult to digest. Figures 4 and 5, for example, have a lot of information, but are very difficult to extract trends in the... trends. While some cases have large trends, they are not necessarily significant which also makes it difficult to pick out consistent trends between sites that are also significant. I believe the site order is based on latitude, but I feel in some analysis it is more appropriate to group by site classification. The latitude doesn't really matter if pollution is the major influence on the site. Also the results would be much more informative if the trends were plotted against each other. For example, the authors discuss how N and Dp and other variables correlate. I suggest plotting these trends against each other and stick these tables in the supplement. Such comparisons might require having the site location being unknown, but you can at least color the points by site class. Another idea is, a bar graph showing N for one mode at each site would also make it easier to identify consistent trends and their magnitude. At the very least, I suggest removing sigma from these tables as there is little discussion on trends in sigma and trends in sigma are low in magnitude all around.

Similarly for later figures 6-8 a direct comparison of measurements and model values would be easier to gauge than a large table of numbers. The tables have useful information for those that want site specific information and would be great in the supplement.

I wonder if the site classifications are appropriate. I am not familiar with many of the measurement sites and I am sure each has unique features; however, Mace Head is a well-known coastal site, that is greatly influenced by the Atlantic, but here it has been grouped together with rural sites despite this significant difference in aerosol source influence.

The authors need to clearly indicate which figure is being discussing more often. Currently the authors have inserted the figures in the manuscript themselves in spots that make it relatively easy to identify the figure being discussed, but the figures are likely to be moved to different locations if accepted for publication.

Specific comments:

Line 38-39 – check sentence wording "in total of for".

Line 44-45 – reconsider the use of the word "stronger"

Line 51 – I do not understand the use of the word "harmonized " in this context.

Line 57 – "ACI altogether their ability to activate cloud droplets". This does not make sense.

Line 83 – incomplete sentence

Line 88 – While not ideal, it is straightforward on how to compare point measurements with models despite their differing temporal and spatial scale. You simply pick the grid box containing the measurement location and overlapping time range. There is no other reasonable way.

Line 96 –do you mean co-locating?

Line 103 – section 2.0 (before section 2.1) is sort of an unnecessary summary of the rest of section 2. I suggest removing this text, but if you keep it at least references the relevant subsections in section 2 so that it is clear that you will go into more detail later.

Line 142-146 unclear. What is the "whole time period"? Why was the data interpolated?

Line 131- in line 110 you said 7 years of data.

159-161 repetitive

174 – what is "this size"?

205 - "There were differences in nucleation mode representation during a day and during a year, nucleation mode most often being fitted after midday." What are the differences in representation?

208 - how would taking the mean affect the modes?

209 – why are nucleation mode number concentrations more uncertain?

214 – a minimum of 5 days is quite a low limit for a monthly average.

251 – table 3?

327-329 "We used the Dynamic linear model (DLM)" is stated twice in the same sentence.

363 – what is "seasonal data of monthly averages"?

439 - You do not label any sites as "mountain" or "continental" so it's not totally clear how you can make this comparison. It's also not clear what makes a site "continental" vs urban or rural.

450 – As you mentioned, you are limited by your measurement lowest diameter. Also, the nucleation mode starts small and grows via condensation, so the measurements likely simply occurred after some growth of the nucleation mode.

484 – Hold off on mentioning the sen-theil estimator until discussing it with Figure 4.

506-507 how do you know this? Source?

518 why does the mace head site data end in 2012? I thought this site was still making measurements.

520 this sentence is redundant with the next sentence and somewhat contradicts the sentence starting on 522.

579-580 only 1 model shows a statistically significant trend for the Pallas nucleation

mode.

605 "When the trends in the models are investigated" this is unnecessary text...

Line 608-609 Plotting measurement vs model trend would really help gauge your argument. Furthermore, is it even meaningful that only the statistically significant values agree?

626- A major contributor to accumulation mode particles is cloud processing.

644- reference the figure before discussing the results in the figure.

683 "When the modelled pattern of seasonality of observations and models are investigated, interesting differences and variations in the patterns were observed." Only when being investigated? Unnecessary text.

750 – I do not understand what is being stated here. Of course sites have distinct locations. Local particle properties at a larger area? What larger area?

The introduction is a little hard to follow. Better transition words/sentences would greatly help the flow of the text.

Section 2 – Please provide definitions of the different site types, particularly those that are not commonly used (rural vs rural regional background)

Section 2.1.2 is vague. You should provide all ways in which the data was quality checked for reproducibility, not a single example.

Figure 6-8 I suggest coloring the text in the map using your site class as well.