

Dear authors, dear Mikko,

Thanks for the revised manuscript. One of the reviewers had a another look at the revised manuscript and has some last technical comments (see comments be referee #1).

In addition, I also found some more minor/technical issues. I would encourage one of the native speakers to read the manuscript one more time, there are still some English grammar issues.

**Thank you for the positive comments. Below our responses to the comments by you and referee 1 are marked in bold. Besides addressing these comments, we carefully checked out the grammar of the text once again.**

Here are some examples plus some further comments:

- Title: "sub-arctic" -> "subarctic", **Corrected**

- Line 47-50: Please re-phrase this long and hard-to-understand sentence

**We rewrote the text on these lines into the following form: “ Most of the atmospheric sulfate is formed from SO<sub>2</sub> in a liquid phase in cloud droplets, and these droplets either evaporate leading to sulfate aerosol production or precipitate as acid rain. However, with very high concentrations of SO<sub>2</sub> downwind the Kola Peninsula area, high production rates of gas-phase sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) due to photochemical oxidation of SO<sub>2</sub> is expected.”**

- Line 100: Add "the" before "Russian". **Corrected**

- Line 110-111: "The other DMPS" ... is this part of the Twin-DMPS or another DMPS? What is the diameter range of the first DMPS?

**Yes, this is part of the Twin-DMPS. We modified the sentence into the following form: “The DMPS measuring 3-10 nm particles malfunctioned during 9-10 and 14-27 January, resulting in the loss of data from this size range on those days.”**

- Line 116: Add "of" after "concentrations" and remove the comma. **Corrected**

- Line 120: Maybe better: "THE same calibration coefficient was used for THE reported MSA and HIO<sub>3</sub> CONCENTRATIONS". **Corrected, as suggested.**

- Line 149: Is this equation now from Stolzenburg et al, Jokinen et al, or Beck et al? or a combination of al?

**To clarify this, we re-wrote the text into the following form: “GR<sub>2</sub> was approximated by assuming irreversible sulphuric acid condensation as the sole mechanism of growth similar to Jokinen et al. (2018) and Beck et al. (2021), and it was calculated according to the formula given by Stolzenburg et al., (2020):”**

- Line 154: Add "A" before "more" and "the" before "GR". **Added.**

- Line 164: Add "A" or "One" before "drawback" and "the" before "concentration". **Added.**

- Line 165: It should probably be "GFs". We re-wrote it as "Furthermore, the temporal variability of GR ..."

- Line 169: Probably better: "The effect of the different approaches to determine GF is visualized in ..."

**We agree. Corrected as suggested.**

- Data availability: Please add the DOI/link.

**Done:** <https://zenodo.org/record/5524857#.YUyVoGYzbwc>

- Figure 3 and 4: The period 01/05 and 03/01 in the first panel should probably be white (now it is interpolated)

**Corrected**

- Figure 6: Panel-labels are missing. I also assume that they can be made smaller/places above each other. What is the reason to show both arrival heights? This is not addressed in the text so far.

**Corrected.**

**Showing 2 arrival heights reveals, for example, how sensitive the calculated trajectories are to the exact arrival height.**

- Figure 7: Units of the colorbar are missing

**Corrected**

- Figure 8: Quite long figure caption and I would suggest to move the discussion within the caption to the main text.

**We removed that last 2 sentences from the figure caption, as roughly the same issues are already discussed in the main text. We think that the rest of the text in this caption is essential for understanding the contents of the figure.**

- Figure 10: Panel-labels are missing.

**Corrected.**

- Supplement: Maybe add the paper title to the top.

- Figure S2: Add a proper figure caption before starting the discussion.

**Done**

- Figure S3, S6, S7, S9: Panel labels are missing.

**Corrected**

- Figure S5 and S8 and S11: Panel labels are missing (in figure and caption).

**Corrected**

Referee #1 comments

I congratulate the authors for the nice job, the quality of the manuscript improved significantly from the first version. The manuscript is now ready for publication after addressing the following minor corrections.

**We thank the referee for the new comments, which further improve the quality of this work. Our responses to each comment are written in bold.**

Line 84: Include also reference to Brean et al 2021 for SA-DMA nucleation (<https://doi.org/10.1038/s41561-021-00751-y>)

**We added the suggested reference and another recent reference relevant to this statement. The revised text reads now: “Amines, especially dimethyl amine, were found to contribute to the initiation of nucleation in polluted urban air (Yao et al., 2018; Brean et al., 2021; Cai et al., 2021).”**

Line 237: quantify the “several orders of magnitude”, how much was the increase?

**Increase is ca. X100. We rewrote “ca. 2 orders of magnitude”**

Line 404: a good reference here would be Kivekäs et al. 2016 <https://doi.org/10.3402/tellusb.v68.29706>

**We agree. We added this reference.**

Line 479: zenodo link is missing

**Fixed: <https://zenodo.org/record/5524857#.YUyVoGYzbwc>**

Figure 1: mention in the label that Varrío is the measurement site.

**We added “Our measurement site is located in Värriö.” to the figure caption.**

Figure 2: colorscale and subplot labels are missing.

**Corrected.**

Figure 3c and 4c consider using a log scale for sulfuric acid

**We prefer keeping a linear scale to see more clearly the sulphuric acid concentration spikes typically associated with new particle formation events. In a logarithmic scale, low-**

concentration data points with large uncertainties and not relevant for new particle formation would become the dominant feature of these plots.

Figure 5 and 7: "examination period" sounds weird, replace with something like "examined NPF events"

**We agree. We rewrote it to the following form: "... during the period 28-29 January 2020."**

Figure 6: subplot labels are missing.

**Corrected**

figure 7f: in the legend you are mixing acronyms (SA) with chemical formula (NH<sub>3</sub>), consider using a more consistent notation. Additionally, in the caption you should mention that the subscript number after SA indicates the number of SA molecules in each cluster.

**Corrected (SA, IA and MSA substituted by their chemical formulae)**

Figure 8: consider rephrasing the final sentence to mention that the discrepancy is within the expected variability when comparing atmospheric nucleation rate measurements with models based on chamber data.

**We actually removed this sentence from the figure caption, because i) the editors requested moving such text from the figure caption to the main text, and ii) because almost identical text already existed in the main text.**

Figure 9: I would mention that the size of the circles is proportional to the concentration. Replace "an anion" with "the anion".

**Corrected as suggested.**

Figure 11: remove the sentence "New particle formation in the eastern air mass significantly increases the concentrations of particles in every size class." This single sentence is not needed because this figure is discussed in the main text and it is also a bit misleading because it does not mention the role of primary emissions (which is properly discussed in the main text).

**We fully agree on this. We removed the sentence.**