

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2022-200

Anonymous Referee #1

Referee comment on "Secondary aerosol formation in marine Arctic environments: a model measurement comparison at Ny-Ålesund" by Carlton Xavier et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-200-RC1>, 2022

The paper named Secondary aerosol formation in marine Arctic environments: A model measurement comparison at Ny-Ålesund

made for an interesting read including a detailed size resolved aerosol model and a good dataset. My impression is however that sometimes the authors have a tendency to explain everything based on the novelty of the approach compared to more traditional works.

The most serious concern to me possibly undermining some of the conclusions is that although the aerosol model is very complex with respect to MSA formation and aqueous formation as well as NH₃ related new particle formation (NPF) it seems to lack a number of other basic reactions. It is possible that this information can be found in the referenced material, but if so I think this information can be included easily without.

This includes: Aqueous phase production of SO₄ from SO₂, e.g. Seinfeld and Pandis (1997) (H₂O₂ and O₃). E.g. The last lines of the abstract point to MSA only for the particle growth.

Gas phase production of SO₂ from DMS (Possibly unclear description in the text)

NPF from other mechanisms, binary or in combinations with organic low volatile compounds, e.g. Vehkamäki et al. (2002), Paasonen et al. (2010). Are these processes found or assumed to be unimportant.

As these are the "traditional" explanations for the reaction pathways and growth I think it is needed to show the relative fraction of these processes compared to new. SO I would like to see the fraction of DMS going to as opposed to SO₂, and aqueous phase SO₂-SO₄ as opposed to DMS-MSA(aq)

I have also a general question about the supersaturation experiments.

"Increasing S to 0.8% increases

accumulation mode particles, since more particles with $S_c < S$ are activated to cloud droplets

(Aitken mode concentration decreases with respect to BaseCase simulations, since more smaller particles are activated into cloud droplets)."

Even for S of 0.8 % the critical diameter is more than 50 nm, actually I think the observed local number minimum may work as a proxy for activation size.

Figure 8 however show an impact already at 20-30 nm. Is it possible that the reason for the reduction is not from direct activation of the particles but rather an increased cloud droplet surface area, i.e the inverse of the explanation given for cloudoff.

Figure S8 shows as far as I can see the same lines for NPFOff and no dissolution. Does NPF in the model depend on cloud processes?

One last question with respect to assumptions about the relatively high number of 3-12 nm shown in observations figure S8, compared to the apparently? lower number found in figure 8. It is hard to compare visually with log-normal distributions, but still figure 8 does seem to give a much lower number of for the 3-12 nm size.

General comment:

It is easy for the reader to mix up PM and PN. I think it is common to use only N for the number but that is more of a suggestion and I leave that to the authors.

Last section of abstract, as discussed above. Are all processes included?

Details:

--"size < 12nm" Please define size as radius or diameter the first time you define it. Later on size is fine as long as it retains the same definition.

--Measurement period. Did you experiment with classifying the trajectories when discussing the results. Eg. a western airflow is expected to have both marine and more clouds than a easterly flow so the trajectories with marine characteristics may have experienced lower emissions than continental pathways so the size distribution may also be caused by different emissions, not only the cloud processing.

Section 2.2 Sea surface temperature above 0. --> No trajectories from areas with sea-ice so no negative SST?

Table 1: Please make the table smaller and more readable. Also I think it is useful for the reader if you also refer to the table in the results section.

Table 3. For readability please consider using the same order of species in the text as in the table

line 678. Sea-spray aerosols are not scavenged --> Why?

721: Typo tin-cloud --> in-cloud