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Comment on acp-2021-10

Anonymous Referee #3

Referee comment on "Ice nucleation on surrogates of boreal forest SOA particles: effect of water content and oxidative age" by Ana A. Piedehierro et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-10-RC2, 2021

Review of "Ice nucleation on surrogates of boreal forest SOA particles: effect of water content and oxidative age" by Piedehierro et al.

General comment:

SOA particles have been shown to be important for the climate system, and therefore, if they are able to facilitate ice formation is of high importance. The present study reports the ice nucleation (IN) abilities of 100 nm SOA particles at temperatures between 210 and 240K using the SPIN. The role of oxidative age and water content on the IN abilities of the SOA particles was evaluated. The authors found that SOA particles are inefficient INPs and that the oxidative age has little effect on their IN abilities. On the other hand, the "water content" was reported to be a key driver in determining if SOA particles can nucleate ice particles via homogeneous freezing. The manuscript is well written, the experiments were carefully designed, and it nicely fits with the ACP scope. The manuscript can be accepted after the following points are considered.

Major comment:

- The authors argued that the "water content" was of high importance when determining if SOA particles can facilitate ice formation via homogeneous freezing or not. However, the "water content" was not measured/reported as it was simply inferred from the RH (>1%, >10% and 40%). It is of high importance if the authors can quantify the water content on the SOA particles at the three RHs.
- The role of particle size on the ice nucleating abilities of SOA was not discussed at all. Ignatius et al. (2016) showed that there is particle size dependence on the SOA IN abilities. Why were 100 nm SOA particles selected for the present study? Also, the authors mentioned that the 100 nm SOA particles were quasi-monodisperse; however,

particle size distributions were not provided.

Minor comments:

- In the introduction it is neither mentioned nor discussed why is it important to study SOA particles and what are the atmospheric implications if they act as INPs?
- Recent and important studies relevant to SOA and ice nucleation such as Knopf et al. (2018); Wolf et al. (2020); Paramonov et al. (2020); Mahilang et al. (2021); Kilchhofer et al. (2021) and Bertozzi et al. (2021) are not discussed.
- Along the text the authors mentioned that three different RH conditions were evaluated; however, it is unclear if the second RH was "<10%" or "=10%".
- Add Cziczo et al. (2013) in Line 5 page 2 in addition to DeMott et al. (2003).
- Add Knopt et al. (2018) and Mahilang et al. (2021) after "ice nucleation mechanisms" in Line 15 page 2.
- What were the typical OH and O3 concentrations during the SOA generation.
- The author mentioned that "low levels of background SOA (< 1 μgm−3)" were obtained between experiments. However, I am wondering how stable were the background particle concentration and particle size distributions?
- Lines 23-26 page 6. Please clearly state that these results are from Schill and Tolbert (2012). As written it is not very obvious.
- "Humidity conditions" and "humidity needed" sound a bit awkward.
- Lines 17-19 page 9. How about particle size?
- "This is the first study reporting the IN ability of SOA from real pine emissions representative of boreal forest environments." How about Paramonov et al. (2020)?

Technical comments:

- I am not sure if "soots" is appropriate.
- Add more details about "purified air".
- "silica gel dryer". What was the length of the dryer, how often was it dried, and what was the RH at the end of the dryer?
- "diffusion sources". What does it mean?
- Add the model and brand of the used OPC.
- Figure 3 caption. "AS data from Welti et al. (2020)". It seems to be out of place.
- Figure 5 caption. "viscosity 4e5 to 6e6". Fix it.