Review of: "Impact of wildfire smoke on Arctic cirrus formation, part 1: analysis of MOSAiC 2019-2020 observations" by Ansmann et al.

Thank you very much for revising the manuscript and addressing my comments. I think that the manuscript has improved significantly as a result of the revision. In particular, I like the revised model description better. However, I think that some small changes are still needed.

- I disagree with your sentence/argument "Homogeneous freezing needs absolutely smoke-INP-free conditions." (see e.g. line 379, see also my comment for Part 1 of the paper series). Homogeneous nucleation can also occur in parallel with heterogeneous nucleation if the updrafts are strong enough and the supersaturation is large enough to reach the homogeneous freezing threshold (see, for example, Rolf et al. 2012 Fig. 7, Krämer et al. 2016 or Kärcher et al. 2022). The difference between het. and hom. freezing threshold is only S_i_hom - Si_ht = 0.082, so that only a small additional updraft might cause a slight additional supersaturation especially at cold conditions as in your case. This happens in the case when the existing ice surface after heterogeneous freezing is not sufficient to reduce the ice supersaturation via diffusive growth of the ice crystals. For instance Kärcher et al. 2022, a study completely dealing with this topic of the competition between homogeneous and heterogeneous freezing clearly shows that homogeneous freezing can still occur in with INP polluted environment for updrafts of about 50–100 cm/s or higher.

- In particular, when covering the meteorological condition with the simulation, I would still find it better to use a statistic of calculated trajectories based on the meteorological data to show what the mean large scale updraft during that period was. In addition, I would superimpose different wave types from the statistic of Podglajen et al. 2016. But I also think that the main message of the paper can also be shown with idealized trajectories. However, I would also recommend showing to add a case with a stronger gravity wave/updraft. I'm pretty sure that you would see homogeneous freezing in addition to heterogeneous freezing also in your simulation. You are right that shallow gravity waves occur most frequently, but updrafts of up to 0.5 m/s and even higher can also occur from time to time (see Podglajen et al. 2016, Fig. 2). Although these occur with a significantly lower probability, they can also trigger homogeneous nucleation in addition to heterogeneous nucleation. This means that such cases should not be excluded. Since you do not show any measurements of gravity waves, all possible scenarios should be shown. Unfortunately, the occurrence of supersaturation above the homogeneous freezing threshold cannot really be shown with radiosonde data either. This is because the coverage of radiosondes is not sufficient to detect nucleation events and therefore higher ice supersaturation. Such nucleation events with very high supersaturation tend to be very short-lived (see Kärcher et al. 2022). Compared to the first version of the manuscript, you are doing a much better job of showing more realistic scenarios. I also think that there is a lot to be said for heterogeneous nucleation dominating. But I think it can be further improved a bit.

- Another small thing would be to use the term “unlimited INP reservoir". I also believe that the INP reservoir is large, but it is definitely not infinite. I would recommend to change it to something like "large" or "virtually unlimited"... Otherwise, it would exist forever.

References:

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