Response to Trude Storelvmo's review

We thank Trude Storelvmo for her comments which we have addressed point by point:

I'd like to congratulate the authors on an important and well written opinion article, and generally agree with the main findings and recommendations. A few things that could be worth adding in a revised manuscript are:

i) While INPs are important, there is a general lack of understanding also of the other (subsequent) processes governing cloud glaciation (secondary ice production, WBF process, riming, seeder-feider, etc). These processes tend to matter way more than INPs when it comes to cloud phase in GCMs. In other words, even with perfect knowledge of INPs, a better cloud phase feedback representation is not guaranteed. This should be stressed more.

A similar point was also raised by Paul DeMott. We have made significant changes to the manuscript to make it clear that other processes are also important. Please see our response to DeMott for details.

ii) The idea that INPs could increase in abundance in future in response to warming is intriguing, but not supported by paleoclimate records in which cold=dusty and warm=dust-free. This should be acknowledged.

This is an interesting point. However, we stress that many INP at the mid-high latitudes may not be dust. In section 6.1 where we discuss this we refer to Wex et al. (2019) who find that that the biological INP active at the warmest temperatures increase in concentration in snow free periods. But, in addition, what will happen to the dust sources of most relevance to CAOs in the future (and their relation to ice and sediment cores) is also not clear. We have added the following brief discussion on what might happen to dust sources in a future world: "In addition to this, it has been argued that high latitude dust sources associated with glaciers will become more active in the future (Bullard et al., 2016) and it was recently shown that mineral dust emissions from the coastal areas of Greenland have increased in the last few decades (Amino et al., 2020). However, in contrast paleo records indicate that warmer periods are generally less dusty than dry periods, although this may reflect a combination of lower latitude sources being more active and increased transport to high latitudes during glacial periods (Lamy et al., 2014; Fischer et al., 2007). Hence, it may be that the glacial-interglacial trends in high latitude dust sources relevant for CAOs are decoupled from low latitude dust sources. More work in identifying the sources of INP in the high latitudes and how these sources will respond to a changing climate is clearly required."

We have added a link to section 6 in section 2 where we introduce the idea of INP changes with climate as our third hypothesis.

We have also adjusted the text to make it clear that it is not only existing sources that are likely to increase in emission strength, but more sources may become available. In section 2 "For example, it has been suggested that less snow and ice cover may lead to more widespread emission sources and higher dust emissions rates at high latitudes " and section 6.1: "…these sources may be active for more of the year and more sources may become available…".

iii) the paper is generally well written, but fixing a few typos towards the end of the paper would make it even better.

We have corrected the replication of section 5 and proof read the manuscript.

References

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