Dear Tom,

Thank you for your response. Please find our additional comments below.

MOSAiC Lidar profiles

In Figure 1 (below) we are showing vertical profiles of aerosol extinction coefficient retrieved from lidar during MOSAiC and from model output. The retrievals of lidar extinction coefficient – the only in-situ measurement of aerosols aloft that is available from MOSAiC for this case study – are limited in time to only two individual profiles, approximately one day after the occurrence of the peak of aerosol mass at the location of the RV Polarstern. The simulated profiles show extinction coefficient for 600 nm wavelength. The simulation using Thompson microphysics, as presented in the manuscript, is shown in red, and the sensitivity test with no production of aerosols from blowing snow (mentioned in our Author Comment 1, https://doi.org/10.5194/egusphere-2026-2369-AC1) is shown in purple. Lidar measurements are in black.

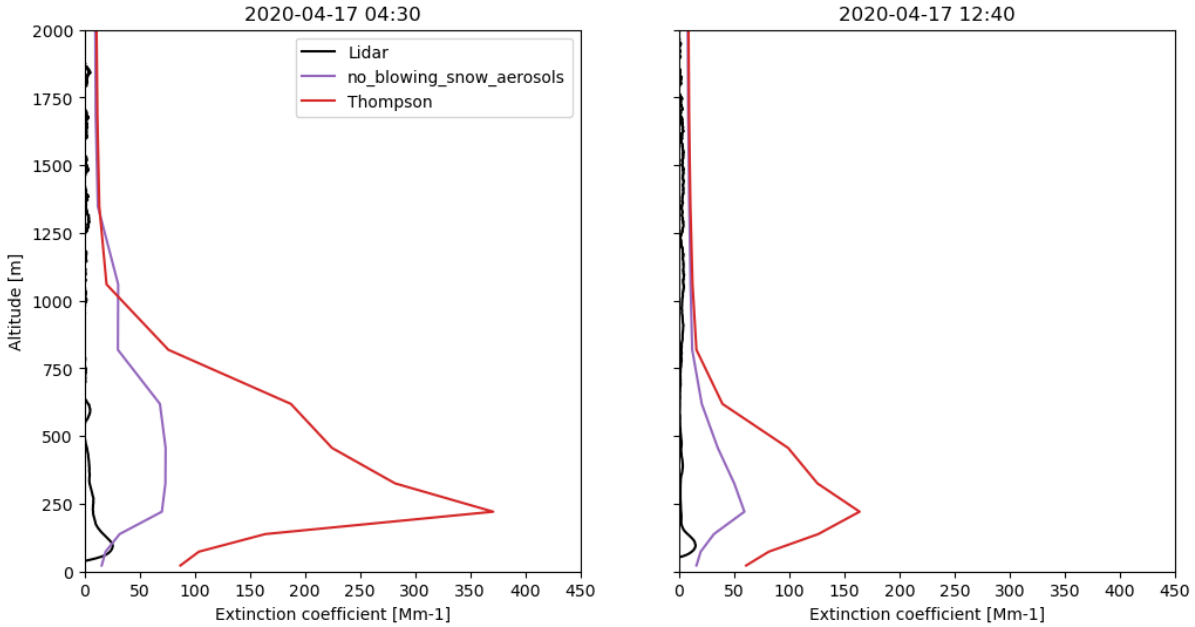


Figure 1: profiles of extinction coefficient from lidar (black lines), default model configuration as presented in the manuscript (red lines) and sensitivity test with no blowing snow (purple lines).

The default simulation overestimates the measured extinction profiles, showing an overestimation at surface as well as a peak in extinction around 250 m altitude which is not present in the lidar measurements. The sensitivity test *no_blowing_snow_aerosols* performs somewhat better, achieving a better agreement with measurements at the surface while still exhibiting higher extinction coefficients aloft.

There are several points to make about this figure in the context of this study. Firstly, this figure tells us that the burden of sea salt aerosol from blowing snow is likely too high in the model, likely because of assumptions made about some of the uncertain parameters in the scheme, such as the size distribution of the emitted aerosols. This is an interesting topic to consider for future work, but further improvements on this scheme are not in the scope of this paper.

Secondly, the profiles in the figure suggest that the burden of aerosol aloft (up to about 1000 m, i.e. of relevance to clouds) is higher in the model than that suggested by the lidar measurements. However, there are several caveats to this. Extinction coefficient is not only sensitive to aerosol burden but also to other parameters which are notably uncertain in models in the high Arctic,

namely the different optical properties of different aerosol species / composition, and the size distribution of the aerosols. Moreover, since the lidar signal undergoes attenuation as it travels through the atmosphere, it is not clear to what extent this biases the comparison of extinction coefficient at altitudes of around 250 m and more. Therefore, it is not possible to make a robust evaluation of the aerosol burden at cloud level from these results.

Sulphate mass at Zeppelin

In an attempt to perform further evaluation of the model, we have compared sulphate aerosol mass from model output and from measurements at Zeppelin observatory. The measurements were taken from the EBAS database and are available both from aerosol mass spectrometer (AMS) at 1 hour resolution and from filter sampling at daily resolution. The maximum cutoff for the AMS air inlet is quoted in the EBAS metadata as 10 μm. Platt et al., (2022) state that the filters have an effective cutoff of approximately 10 μm. In the figure below we sum the total sulphate mass from the model, which has an upper limit of 10 μm in the largest aerosol size bin.

Since Zeppelin is a mountain site at ~400 m altitude, it frequently samples air from above the boundary layer and can thus be considered somewhat representative of cloud-level air. The time series of sulphate aerosol mass is shown below.

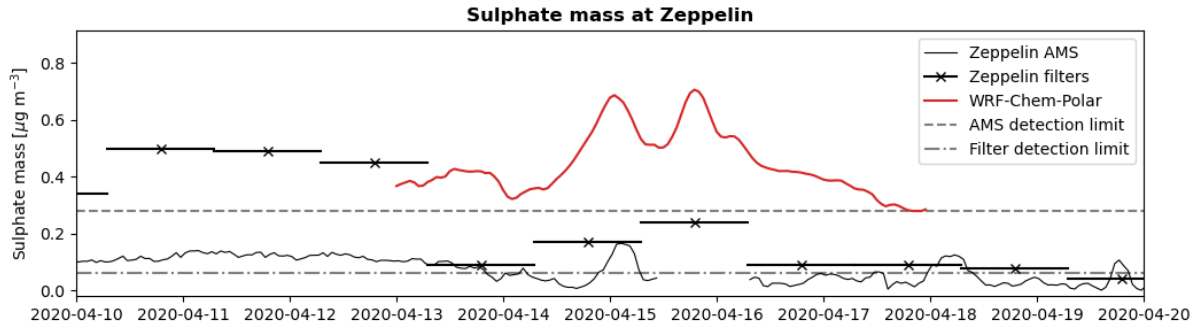


Figure 2: time series of sulphate aerosol mass from AMS at Zeppelin observatory (black line), filters at Zeppelin (black horizontal bars with crosses), and WRF-Chem-Polar (red line). WRF-Chem-Polar output is from the model grid cell closest to Zeppelin and has been interpolated vertically to the altitude of the station. Grey dashed lines shows the detection limits of the measurements as quoted in the EBAS metadata. Horizontal bars indicate integration time period of filter measurements, crosses show the midpoint in time.

Up to the 13th April (background conditions before the WAI), the AMS and the filters do not agree well on the sulphate mass. The AMS is below detection limit while the filters show values of between 0.3 and 0.5 μg m^{-3}. The simulated sulphate mass in the background is between the AMS and the filters, i.e. it sits within this uncertainty from the measurements. During the WAI (15-16th April), the AMS remains below detection limit and has missing data. The filters show values of approximately 0.2-0.3 μg m^{-3}. The model simulates a peak of approximately 0.7 μg m^{-3}, about a factor of 2-3 greater than the filters.

Additional text in manuscript

This lack of ability to perform a detailed evaluation of aerosols at cloud level represents a key limitation of the study. To highlight this fact in the paper, we have made the following changes to the manuscript.

We have added the following text at line 246 (first paragraph of conclusions):
"Moreover, although we performed model evaluation at the surface for the central Arctic, there is a lack of detailed aerosol microphysical measurements available at cloud level. It is therefore a

limitation of the current study that we cannot further constrain the model representation of aerosol at the cloud level, where it is most relevant for the impacts we investigate."

We also added this discussion at line 259:
"A limitation of this study is the lack of an evaluation of aerosol properties at cloud level, due to a lack of aerosol microphysical measurements aloft. However, we note that the WAI promoted strong vertical mixing in the lower atmosphere during the event (Dada et al., 2022; Angot et al., 2026), increasing our confidence that the evaluation of aerosols at the surface can provide some constraint on the aerosols aloft."

We hope that the figures presented in this document provide greater confidence in our use of the model. We do not consider that they add a lot to the original manuscript outside of these discussions, therefore we have not added them. We ultimately leave it to your discretion whether this is necessary.

Conclusion

Despite these general limitations regarding the evaluation of aerosols aloft, we remain confident in the main conclusions of the study. We note that we originally chose to use surface aerosol mass measurements to evaluate the model due to the well-mixed nature of the lower atmosphere during this event (Angot et al., 2026; Dada et al., 2022). Such conditions imply that the evaluations of the model at the surface (i.e. Figure 4 of the manuscript) can also improve confidence in the performance of the model at cloud level for this event. Overall, we believe that the main conclusions of the study are robust to any potential overestimation of aerosol burden at cloud level that is suggested by the figures above. An overestimation of aerosol burden by the model would most likely actually amplify the effects of the aerosols on cloud and surface radiative budget in the simulations. This suggests that our main conclusion is robust, which is that the aerosol-cloud interactions do not produce a strong surface radiative effect over sea ice.

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