Review of Egusphere-2023-623

This manuscript presents the investigation of the relationship between sea ice lead fractions and cloud micro- and macro-physics during the MOSAiC field campaign. The study is constructed with an introductory case study followed by statistical analysis. The statistical analyses show that the coupled cases are under the influence of enhanced water vapor transport from the leads area, hence the enhanced moisture supplies contribute to the cloud properties. I found the manuscript to be well constructed and logical in the narrative. Nevertheless, I do have a few comments and suggestions listed below, which should be considered and addressed before potential publication.

General Comment.

The statistical results seem to be based on the available cloudy samples regardless of the cloud types. At least, the cloud type criteria are not clearly stated in the manuscript (i.e., in Fig. 1 and D1, there are already two types of cloud systems: stratiform and convective). I am concerned that the intrinsic differences in the microphysical processes of those different cloud systems would impair or blur the robustness of the results, especially in the interpretation of the comparisons between coupled/decoupled cases and different LF circumstances (i.e., the discussions regarding Fig. 9 to Fig. 11). For instance, the differences in the LWP and IWP between coupling and LF categories could potentially be more influenced by the cloud thicknesses.

I wonder if you have considered enhancing the robustness of the analysis in a more controlled environment, e.g., confining the cloud selection to stratiform or convective clouds only. Please give it some thought.

Minor Comment.

L86. Please define HATPRO.

L109. ‘Advanced Microwave Scanning Radiometer 2 (AMSR2)’

L184. Can you provide the precisions or the estimated errors for the Cloudnet retrievals, preferably, compared with the aircraft in-situ measurements?

L264. According to Appendix A, do you mean 0.05 K^2 here for estimating the sub-cloud mixing layer right?

L377. It seems that the liquid and ice effective radii shown here range from non-precipitating to heavy-precipitating clouds, have you considered the aerosols (e.g., sea salts) advected along the WVT pathway that served as CCN or INP and affect the cloud microphysics, and in turn, bias the results?

L424. If, in the case of LF > 0.02, presumably implied in the aforementioned discussion, it indicates more moisture supply to the cloud layer. How do you interpret the difference in the χ_{ice} dips (~ -20°C) of the decoupled cases, i.e., any ascribable relations between the increased moisture supply and the heterogeneous freezing process? Similar questions can be asked for the dips in ~ -30°C and -40°C.

L442. Since it is mentioned here that the SIC and LF are not equivalent, it would be interesting to show if there is any relationship between SIC and LF, i.e., a scatter plot of conical SIC vs. LF.

L447. '…for IWP vs. LF'

L448. Do you mean 'with only a fairly increase of IWP when SIC change from 100 to 97%'?

L559. 'WVT'

L614. In Table 3 the ratio of coupled to decoupled is ~6:4, while here states that the coupled cases are 10 times more frequent than the decoupled cases when binned by water path. Can you clarify?

Figure 11. The first sentence of the caption conflicts with the subfigures. LWP plots should be (a) and (b), while IWP plots should be (c) and (d). And can you clarify why the bars are sometimes discrete within the same LF bin?