

Response to editor and reviewer's comments

Sorry for missing revisions and responses to referees' comments. Our responses to the comments are presented below in dark green. Minor revisions associated with the comments are marked with same color in the manuscript.

Comments to the Author from referee #1:

I thank the authors for their effort in revising the manuscript. I am particularly pleased that discussions of the results are now more precise, backed with references and straight to the point. The title now also fits the paper much better.

One point that could still be argued about is that of mixed-phase clouds, but I'll agree with the authors in these are difficult to quantify and deal with from a remote sensing point of view. Mentioning them (as done in section 2.2) should be sufficient for this paper. However, I would like to see that discussion highlighted again in the conclusion so that the current limitation due to ignoring mixed-phase clouds or supercooled layers in current results is properly reminded to the reader. Provided the abovementioned addition to the conclusion in a revised manuscript, I am happy to suggest for accepting the paper to ACP.

Thank referee. A sentence about current limitation in the results has been added in last paragraph with dark green.

Comments to the Author from referee #2:

General: The paper has again improved, but my assessment remains that the data set is very interesting, the scientific evaluation and the writing style could still be upgraded. Nevertheless, I'll now recommend the paper for publication with 'minor revisions'. However, I would like to recommend the authors to please submit more mature papers in future to avoid such lengthy review processes with several revision cycles.

Thank the editors and reviewers very much for the patience. We are very grateful to you for your comments on this article, based on which research results and quality of the article are improved. In addition, we have also benefited a lot from them. Our knowledge of the radar detection ability of cirrus and cirrus clouds related microphysics gets more accurate. Thanks again.

1) Lines 19-21: ,Our analysis indicates that most cirrus clouds are of the in situ-origin type in winter and autumn; the in situ-origin type cirrus clouds are more common than liquid-origin cirrus clouds in spring, while summer features more liquid-origin cirrus clouds.‘

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, Our analysis indicates that in spring, in situ-origin cirrus are more common than liquid origin cirrus, while in summer liquid-origin cirrus are more frequent; in autumn and winter, most cirrus clouds are of in situ-origin.‘

Revisions have been made according to referee's suggestion.

2) Line 27: ,Cirrus clouds are dominated by ice crystals. Studies show that the occurrence frequency of the cirrus clouds exhibits latitudinal variability ...‘

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, Cirrus clouds consist solely of ice crystals. Their occurrence frequency exhibits latitudinal variability ...‘

Revisions have been made according to referee's suggestion.

3) Lines 71-79: *For comparison, the 94 GHz cloud profiling radar (CPR) on CloudSat has a sensitivity of approximately -30 dBZ. As shown by in situ measurements, the number density of ice particles often peaks at particle sizes between 100 and 1000 μm in effective diameter in effective diameter (Heymsfield et al., 2013).* This sentence is neither needed nor correct.

Calculations or measurements of radar reflectivity in previous studies reveal that the reflectivity of ice clouds over mid-latitude regions are mostly larger than -30 dBZ (Deng et al., 2010; Pokharel and Vali, 2011; Matrosov and Heymsfield, 2017). Therefore, KPDR is capable of detecting most ice clouds over Beijing. However, the Ka-band radar is more sensitive to larger particles in a cloud target since the reflectivity is proportional to the D^6 (D is particle size). For the CPR, thin ice clouds with ice water content (IWC) lower than approximately 0.4 mg/m^3 are invisible (Wu et al., 2009). It is possible that KPDR may miss some thin ice clouds when they only consist of very small ice crystals (i.e., D less than 20 μm in effective diameter) or the IWC is smaller than 0.4 mg/m^3 .

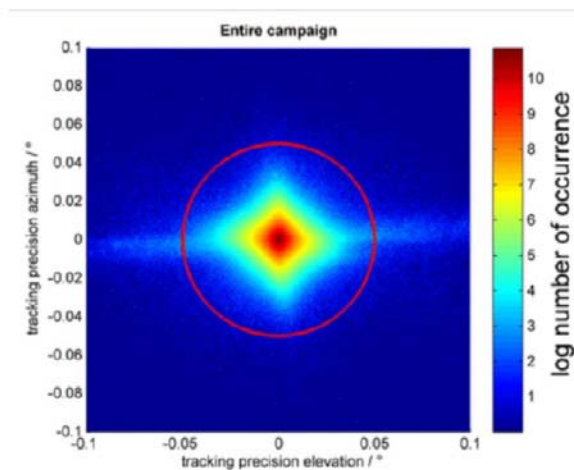
Revisions have been made according to referee's suggestion.

4) Line 88: *Ice clouds ~~is~~ are composed of various types of ice crystals and ~~is~~ are usually thin.*

Revisions have been made according to referee's suggestion.

5) point 12) of the last review:

A logarithmic color code is usually used for a wide range of values to be displayed. Below is an example from the Internet - please redo Figures 5 and 6 in this way:



https://www.researchgate.net/figure/Both-figures-showoccurrence-of-tracking-errors-in-logarithmic-color-code-Theleft_fig2_281982255

We modify Figures 5 and 6 using the log number way.

6) point 15) of the last review, new lines 334-339:

, In the four seasons, the 'n' at -45°C is the biggest among all temperatures, indicating that cirrus cloud appears more frequently at -45°C than at other temperatures. This is the result of the combination of temperature, water vapor and upward movement. For example, the lower the temperature, the more conducive it is to the formation of ice particles (this is not correct). On the other hand, limited upward movements determine the maximum height (lowest temperature) where water vapor or cloud particles can reach (this is not correct). Spring has the biggest 'n' at each

temperature, indicating that cirrus clouds in spring are the most frequent, which has also been shown in Fig. 2.'

The finding that cirrus clouds appear most frequent at -45°C is consistent with the findings of Krämer et al. (2020) from 10 years of satellite observations (what is great!). The reason is that at these altitudes both in situ origin and liquid origin cirrus appear, whereas at colder temperatures only in situ origin cirrus exist. Please change the explanation accordingly.

Krämer, M., Rolf, C., Spelten, N., Afchine, A., Fahey, D., Jensen, E., Khaykin, S., Kuhn, T., Lawson, P., Lykov, A., Pan, L. L., Riese, M., Rollins, A., Stroh, F., Thornberry, T., Wolf, V., Woods, S., Spichtinger, P., Quaas, J., and Sourdeval, O.: A Microphysics Guide to Cirrus – Part II: Climatologies of Clouds and Humidity from Observations, Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2020-40>, in review, 2020.

Yes. The reason suggested by referee revealed the essences. Revisions have been made according to referee's suggestion.