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Comment on acp-2021-1072

Anonymous Referee #3

Referee comment on "Observations of cold-cloud properties in the Norwegian Arctic using ground-based and spaceborne lidar" by Britta Schäfer et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1072-RC2>, 2022

Review of: "Observations of cold cloud properties in the Norwegian Arctic using ground-based and spaceborne lidar"

by Britta Schäfer, Tim Carlsen, Ingrid Hanssen, Michael Gausa, and Trude Storelvmo

Comments:

The authors present ground-based lidar observations of cold clouds in Andenes (Norway), covering a period of seven years. They explored two case studies to assess 1) the agreement between a co-located cirrus observation from ground-based lidar and CALIPSO, and 2) the ground-based lidar's capability of determining cloud phase in mixed-phase clouds from depolarization measurements. Also, they presented statistics of cold clouds macrophysical properties for the period 2011-2017.

I find the manuscript interesting and well-organized. I have the following comments that require clarifications before publication of the manuscript.

Clarification needed:

- The authors mentioned that they used 137 ERA5 pressure levels. What is known is that ERA5 are available at 137 model levels (not pressure level) and 37 pressure levels (coarse). Please clarify if some conversion procedures have been used or correction is needed?
- Based on Figure 1, in average ERA5 can overestimates (underestimates) cloud top temperature with a difference that can reach ~ 10 K. Please, elaborate on the effect of this differences on your results and conclusion, especially for the period before 2014 ?
- In addition to the spatial difference, what is the average time lag between the radiosonde and ERA5 (for cloud top temperature) ?
- Also, the vertical resolution of ERA5 at pressure levels is still coarse (not the case for model level, especially at the cirrus cloud levels). Using the interpolation can omit some important details, especially for thin cirrus. Please elaborate?
- Line195: Which method is used to estimate the tropopause? Please clarify?
- Please clarify further about phase discrimination between cirrus, mixed-phase and liquid clouds, during maintenance break from April 2013 to July 2015 ?
- The authors mentioned that "... Thus, the cirrus cloud is extending well into the tropopause, dehumidifying the upper troposphere and lower stratosphere region through ice crystal growth and sedimentation."
- Can you provide evidence (quantification) on dehumidifying the lower stratosphere caused by cirrus? Also, on cirrus reaching lower stratosphere causing dehydration.
- I would like to see figures and discussion about the corresponding relative humidity with respect to ice (in-cloud and clear-sky) associated with cirrus cloud. Also, its impact on cirrus cloud, dehydration, and your conclusion.

Minor comments:

Correct "occurence" --> occurrence. (lines 8, 22, 57, 64,66, 291 and y-axis of Fig.5b)