

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-1072

Anonymous Referee #1

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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-RC1>, 2022

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This manuscript compares cloud macrophysical properties from ground-based and spaceborne lidar observations. For two case studies and a 7-year long data set, the cloud base and top heights, and the phase of the clouds observed over Andenes in the Norwegian Arctic were derived. By means of thermodynamic profiles, the temperature at cloud top was estimated. For the ground-based lidar, the closest radiosonde or ERA-5 was applied, while for the spaceborne system the ECMWF-AUX data product was used. Additionally, the phase separation capability of a polarization lidar is highlighted. The manuscript is well structured and it provides a valuable contribution to the study of Arctic clouds. The paper is of interest to the community, especially the comparison between the ground-based and spaceborne lidar systems is of importance and it should be published after some major revisions were made.

The reason to apply different methods for the estimation of the cloud top temperature is not clear to me. If the goal was to assess the ECMWF-AUX data product, this should be made more clear in the manuscript. However, if the objective was to compare the observations of the two lidar systems, the same approach to derive the cloud top temperature should be applied. In this case, I do not see a reason, to not also not apply the radiosonde/ERA-5 approach to derive the cloud top temperature for the spaceborne observations.

In addition, I doubt that indeed the cloud top temperature can be derived as accurately as it is suggested by Figure 7 a+b. Here the histogram bins have been set to 1K, which seems rather accurate when considering, e.g., that only two radiosondes were launched per day and the radiosonde may have drifted up 20-50km (e.g., according to Seidel, JGR, 2011, <https://doi.org/10.1029/2010JD014891>) until it reaches the upper troposphere / lower stratosphere.

Besides these comments, I have some minor comments:

A general comment: Consider reducing connector words, like "however, nevertheless, ...". Especially however is used rather often (e.g., 3 times between lines 37 and 45).

Page 2, line 55: Mention the difficulties of satellites to detect lower clouds due to ground clutter

Page 3, line 72: Define "cold cloud"

Page 3, line 86: Add "profiling" before "the middle and upper atmosphere"

Page 4, line 112: Better reword: "The cloud optical depth is another..."

Page 5, line 123: Explain how you get the molecular backscatter.

Page 5, line 132: How many false classifications were manually detected? What could cause such a false classification?

Page 5, line 136: How far is Bodø from Andenes?

Page 6, line 165: Remove "This increases the number of satellite overpasses"

Page 9, line 209: Add "cirrus" before "category" and change "found" to "observed"

Page 9, line 223: I suggest rewording this paragraph and stating the information, that the radiosonde did not penetrate the observed layer already at the beginning.

Page 9, line 230: What is meant by "the center of the cloud"? I guess the base of the liquid dominated layer. Later the virga is described as "below cloud", which sounds like, the base of the liquid-dominated layer is the cloud base. Please be more specific.

Page 11, line 166: "This is less ...". What does "this" refer to?

Page 13, Figure 6: I suggest combining Figure 6 a+b into one plot. The same holds for Fig. 7 c+d (I am not sure about Fig. 7 a+b).

Page 13, line 290/291: remove "as well"

Page 13, line 302/303: please change Barrow to UtqiaĀivik

Page 14, line 308: Remove "In terms of geometrical properties"

Page 16, line 329/330: "ice nucleating particle concentrations are often sufficient to completely glaciare single-layer clouds at the given temperatures". This statement is too strong, as some of the observed clouds may have formed via homogeneous ice formation.