Review "Statistics on clouds and their relation to thermodynamic conditions at Ny-Ålesund using ground-based sensor synergy" by T. Nomokonova, K. Ebell, U. Löhnert, M. Maturilli, C. Ritter and E. O'Connor

The manuscript presents a 13 months analysis of vertical cloud information and the corresponding thermodynamic conditions from ground-based instruments and radiosoundings at a research station in Ny-Ålesund, Spitsbergen. The dataset was analysed in terms of cloud occurrence, cloud structure (single layer vs. multi-layer clouds) and cloud phase (liquid, mixed-phase, ice). Additionally the liquid water path and ice water path was estimated. Single-layer clouds were also related to in-cloud temperature and relative humidity. Some of the results were compared to ICON model output. The presented dataset is of great interest and the analysis provides new insights in the structure of Arctic clouds. Some of the analysis could be discussed a bit more thoroughly, therefore I recommend to accept this paper after major revisions.

1 Major comments:

- The cloudnet algorithm seams to use thermodynamic profiles of a NWP model. Please explain what that exactly means and how that influences the analysis? If the thermodynamic profiles deviate a lot from real conditions (as measured by radiosounding for example) what are the consequences? And could that probably lead to inconsistency when using in a further analysis later on radiosoundings as additional information?
- Discuss more the uncertainties of the measurements and their role in terms of interpretation of the results, e.g. the uncertainty range of IWC (which seems to be quite large). This could be of importance especially when it comes to comparisons. Include this discussion also in the conclusions when discussing the comparison of observations with ICON model output.
- In section 5 cloudnet products are used in combination with radiosoundings in comparison to ICON model output. I am missing one essential discussion here: How different are the temperature and humidity profiles from ICON compared to the radiosoundings? If the thermodynamic profiles from ICON deviate considerably from the data from radiosoundings the analysis could be limited by that independent of the cloud information derived by cloudnet or from ICON.

- Discuss more what the thermodynamic conditions mean when related to cloud properties. What can be derived from this information and what is still missing? Does not for cloud formation also the stability or layer of the atmosphere (boundary layer, inversion etc.) play a huge role? Could that be analysed with the used dataset as well?

2 Specific comments:

- Add the vertical range of each instrument (lowest detection, maximum profilig range). Especially the lowest detection could be interesting to know.
- Page 6, line 27: What is the IWC uncertainty range between -40 and -20°? Please add that information as well.
- Page 7, line 5: Is it not a 6 hour dataset if the data is generated at 00, 06 ... ? Please correct or explain.
- Page 7, line 19: Why was the ICON output not used consistent for the whole time period of analysis? What is the difference introduced by using ICON compared to GDAS1? Which uncertainty results from using one or the other? Explain more what the influence is of the model data used on the cloudnet products and thus on your analysis.
- Page 7, line 24: Why was a forecast product used and not nudged simulations using reanalysis data? Would it not be more correct to use nudged simulations or are there technical limitations? Is the vertical profile data the same as used for Cloudnet?
- Page 9, line 4: How was the monthly mean IWV estimated? From radiosonde profiles?
- Section 3: What is the conclusion from your analysis about the thermodynamic conditions? How much can the results be generalized or what does it mean for the findings of the paper that the year 2017 was different from previous years?
- Page 11, line 29: Please explain how the Cloudnet IWC product is estimated.
- Page 11, line 33/Section 4.3: How does not taking into account cases with liquid precipitation influence the results due to bias for specific cloud types? Or is there no cloud type bias for liquid precipitation?
- Page 12, line 8: How is the geometrical thickness of the single-layer clouds estimated?
- Page 12, line 27: Specify the model domain/region of the 6 regional models.
- Page 13, line 1: Which region/domain was the comparison focused on?
- Page 13, line 22: How would correcting for the drift influence the results or how much uncertainty is introduced by not doing so?

- Page 14, line 20: Explain how the ice nuclei information has to be specified in ICON.
- Page 14, line 21: Why is the IN concentration increasing? Explain your argumentation here better.
- Section 5: Discuss how the model resolution of ICON could influence the results and your interpretation.
- Page 17, line 9: You write that single-layer ice clouds are thicker than mixed-phase clouds. Why is that? Do cloud droplets not increase the cloud thickness?
- Figure 6: It would be interesting to add another subplot of the subfigures b and c showing the profiles for the lower 2 km.
- Figure 8: Why does the liquid precipitation only occur in mixed-phase clouds? Are there no liquid clouds with liquid precipitation?
- Figure 11: How are single-layer clouds defined in ICON? As one model level cloud free in between model level containing clouds? Please specify.
- Figure 11: What is the time resolution of the ICON output used for the analysis compared to the observations? How would the observations look like if not the time period of one hour around the radiosounding would be used but instead the time period of the ICON output? How does the model resolution thus influence the results?
- Figure 11 and 12: You mention here that the global ICON model is used- how different is the resolution compared to the single-column version mentioned earlier? Which domain size/how many grid cells were analysed?
- Figure 12: There is considerably less profiles analysed from the ICON model compared to the observations- how does that influence the analysis? Is the statistics sufficient for general statements about the clouds?

3 Small remarks,typos:

- Write out abbreviations in the abstract (AWIPEV, LWP, IWP, ICON).
- The numbering of the subsections is not always correct, e.g. p. 5, l. 12 and p. 5, l. 27 subsection 2.2.5 has to be replaced by subsection 2.5, p. 12 l. 20 Sect. 22.2 does not exist, p. 13 l. 19 Sec. 4.4.2 does not exist.
- The analysed period is not mentioned consistent throughout the manuscript. From the plots etc. it looks like as the analysed period is from middle of June to July 2017. However in the manuscript it is often stated that 14 months are analysed. Also at some place the period is mentioned with different start/end dates, e.g. p. 6 l. 29: August, p. 7 l. 9: 31 January 2017.
- Leave away the article in front of ICON or add model (in ICON ... or in the ICON modell...).

- Some figures (e.g. Fig. 5) seam not to be vectorized and thus have not such a good resolution when zooming in- change if possible.
- Page 1, line 10: delete the (to ICON model output).
- Page 1, line 11-13: Rewrite the sentence/split it into two (Distinct ... evident.).
- Page 1, line 15: Add "budget" (in the energy budget).
- Page 4, line 6: Add model data, which is also included in Table 2.
- Page 4, line 9: Why 21st of May? The analysis starts in June 2006.
- Page 4, line 10: Which radiosonde type was used after 2 May 2017?
- Page 5, line 25: There is a "." too much in front of the citation.
- Page 6, line 27 and page 15, line 13: Add unit after temperature (C).
- Page 7, line 23: Replace compared with compare.
- Page 8, line 5: Do you mean less variable instead of milder?
- Page 8, line 33: Replace K with °C to be consistent.
- Page 11, line 26: Change header to "Single-layer clouds and their relation to thermodynamic consitions".
- Page 11, line 31f: Add percentages for all numbers.
- Page 14, line 1: Replace Figure11d with Fig. 11d.
- Page 16, line 3: Replace "the different time period" with "a different time period".
- Page 17, line 12: Replace "cloud models" with NWP or climate models (depending on what you want to say here).
- Page 17, line 20 and 22: One time you write the liquid phase in ICON is in the temperature range from -10°C and one time from -15°C. Explain the difference between the two statements or be consistent.
- Figure 1: Increase size of Figure and or labels.
- Figure 2: Add in the figure caption that white space means no data availability.
- Figure 5: There is not dotted line in the figure (the ice line is dashed instead of dotted).
- Figure 7: The plot shows the period from June to July 2017- correct the caption accordingly.
- Figure 7: Use only one color for each category (now every color has another colorline at the top of the bar).
- Figure 9: Explain the Δ information in the x-axis labels in the caption.

- Figure 9: Is it not July 2017 instead of August 2017?
- Figure 9: Replace “Frequency” with “The frequency of occurence” in the caption.
- Figure 10: The x-axis labels are not formatted the right way (..=?)?
- Figure 10: What does the number mean on top of each column?
- Figure 11: Remove profiles in the figure labels for c and g (or add it in all other figures to be consistent).
- Table 1 and 2: Reformat the text to make the columns better readable.
- Table 1, 4th column, line 3: Add commas in between the different vertical resolutions.
- Table 2: Write each column capitalized at the beginning.
- Table 2: Add the temporal resolution, vertical resolution and retrieved parameters for radar, ceilometer and ICON.