Review of “Low-level mixed-phase clouds in a complex Arctic environment” by Gierens et al.

As far as I know this is a second paper reporting results from new 94 GHz cloud radar measurements at AWIPEV in Ny-Alesund after Nomokonova et al. (2019) who reported statistics of liquid, ice and mixed-phase clouds (MPC). This study reveals basic features on MPC using 2.5 year measurements, especially from a viewpoint of influences from the local meteorology. The authors showed that both liquid water path (LWP) and ice water path (IWP) tended to be higher under westerly wind conditions at 850 hPa. They also showed that local wind could affect coupling/decoupling of cloud layer with surface.

Because we still poorly understand behaviors of MPC in the Arctic and corresponding thermal structures of planetary boundary layer under different meteorological conditions, this paper is worth to be published in ACP. However, there are a few points which should be addressed before the publication, as described below.

Major comments:

(1) Moisture

This study describes three items, namely, properties of persistent MPC (P-MPC), local wind directions (surface and 850 hPa), and coupling/decoupling between the cloud layer and surface. Key parameters that connect these three items are temperature and moisture. Although some plots are shown for cloud top temperature, no data is presented for moisture. The authors may show integrated water vapor (IWV) obtained by MWR and atmospheric temperature to describe relationships among the three items.

For example, under the westerly conditions at 850 hPa (from open ocean), did the authors observe higher IWV and temperature as compared with those under easterly conditions (from island)? Did they observe higher IWV for coupled clouds as compared with those for decoupled clouds?

(2) Seasonality

In most of analyses, all data were used irrespective of month when the data was obtained. However, the authors may show the results from viewpoint of seasonality.

For example the authors may show seasonal variations of liquid layer base height, LWP, and IWP. (If they can also show cloud thickness and time duration of clouds (cloud persistence), it would be nice).

The authors may also show wind rose at 850 hPa in four seasons to show how the higher LWP under the westerly conditions at 850 hPa (Fig.8b) reflects the seasonal variations in wind direction.

Minor comments:

L.135: Explain what is “Ze”.

L.135-137: The accuracy in LWP is described as 20-25 gm-2. Uncertainties in IWP is described to be -33 to +50%. Most of the differences in LWP and IWP for different wind directions presented in this study appeared to be within these uncertainties. What are the precision (uncertainties in relative values) in LWP and IWP estimations? Are the results presented in this study statistically significant?

L.194: What is the basis for this criteria? The authors may show some statistical results for vertical profiles of potential temperature in an appendix to show these criteria are reasonable.
Are all data with positive gradient in potential temperature discarded? No threshold value?

Figure 3: This figure is difficult to see. The authors may expand the figure to show the altitude range between 0 and 2km and time period between 03:00-12:00.

L.315 (Fig.8a): The authors may compare the cloud base height with lifting condensation level (LCL) calculated from surface measurements.

L.325: As far as I understood, the results described here are the most important one in this study. The authors may need to explain more on the physics behind. Higher LWP can be due to higher temperature (thermodynamic effect), moisture transport, lower stability (geometrically thicker clouds) and others. The authors may describe how these factors affect LWP under the westerly conditions, using IWV data and from viewpoint of seasonality.

Section 4.3: In my opinion, this section can be moved to appendix or deleted. Figure 9 clearly shows that 850 hPa wind direction is more important than that at surface. The

addition of surface wind analyses did not provide enough insights into the P-MPC.

L.487: What is the “observed differences”?

L. 542: According to Nomoknova et al., (ACP2019), mean value of IWP of MPC was 164 g m-2, while it was 12 gm-2. Why the values are so different?

L.544: Less and higher P-MPC -> Less frequent and higher cloud base height of P-MPC

L.554: The words “weather type” and “wind regime” are used in this study. Describe as “wind direction at 850 hPa” etc, such as in figure captions for Figure 4b.