Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2020-56-RC2, 2020

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Properties of Arctic liquid and mixed phase clouds from ship-borne Cloudnet observations during ACSE 2014" *by* Peggy Achtert et al.

Anonymous Referee #2

Received and published: 1 March 2020

This is a useful manuscript that documents observations of liquid and ice in Arctic clouds that were made during the ACSE 2014 field experiment. Liquid and ice properties were retrieved from radar, radiosonde, and other observations using the Cloudnet algorithm.

There were no in-situ observations of these clouds, and so further discussion of measurement uncertainties or else comparison to in-situ aircraft observations of similar clouds in the Arctic or mid latitudes would be welcome.

The authors also might consider adding more speculations about the physical mechanisms behind the observations. For instance, why are the clouds mixed-phase at such

Printer-friendly version

Discussion paper

warm temperatures (Fig. 10)? More physical explanation might help better tie together the observations into a more coherent understanding.

Specific comments:

Lines 116–118: “Liquid water content (LWC) is calculated from microwave radiometer-derived LWP (with an offset correction based on clear-sky periods) and liquid layer cloud boundaries by distributing the liquid using the scaled-linear adiabatic assumption, i.e. LWC increasing linearly with height from zero at cloud base.” So LWC is assumed to increase linearly with height, but then in Fig. 8, the LWC is plotted and the authors conclude “Liquid clouds show maximum LWC between 0.03 and 2.00 gm−3 within the upper quarter of the cloud”. Is this a conclusion about nature or merely an artifact of the authors’ assumption of linearly increasing LWC with height?

Lines 143–146: “We further separate the large-scale circulation between warm-air advection events (WAA, Tjernström et al. (2015) and conditions during which no warm-air advection took place (non-WAA). WAA was identified from the ACSE soundings as when the temperature at 1.0 km height exceeded a threshold of 5 C, empirically derived from Figure 2a of Sotiropoulou et al.(2016).” Is this simple temperature criterion sufficient to accurately diagnose warm-air advection? Can it be corroborated by, e.g., wind observations showing wind from southern, warmer regions?

Lines 247–248: “Figure 8 provides a profile view of the LWC and the IWC of the clouds considered in Figure 7. The scaled altitude ranges from the base of the clouds (zero) to the cloud top (unity).” In this figure, is the cloud base defined as liquid cloud base, ice cloud base, or the lower of the two? In the leftmost (liquid) panel, some clouds exhibit non-zero liquid at cloud base, which seems contradictory. Shouldn’t cloud base in a liquid-only cloud be defined as the altitude at which liquid goes to zero? If so, how can the liquid remain non-zero at cloud base? In the middle and right-hand (mixed-phase) panels, all but two of the cloud layers have liquid extending all the way to cloud base, and ice approaching zero at cloud base. Why weren’t there more clouds with ice falling

out of liquid cloud base? Is this an observational artifact?

Line 329–330: “While they find that about 50% of all clouds are mixed-phase at a temperature of about -10 C, the ACSE observations reveal that in the Arctic a mixed-phase cloud fraction of 50% is reached already at -2 C.” Can the authors speculate about why this difference is observed in these datasets for Arctic and mid-latitude clouds? E.g., do more of the Arctic clouds have cold regions above that nucleate ice, which then sediments down to warmer temperatures (e.g., Fleishauer et al. 2002)?

Lines 350–351: “The ACSE data set reveals a strong reduction in the occurrence rate of liquid clouds and an increase for both mixed-phase clouds and ice clouds at low levels during autumn compared tosummer.” To me, a striking difference between summer and autumn is that there is more drizzle/rain during summer (see Fig. 2). I encourage the authors to comment on this if they have a hypothesis why this is observed.

Fig. 1: Is it possible to display more clearly the area covered by sea ice using, e.g., light-blue shading?

Fig. 2: The red-green-blue (liquid-mixed-ice) colour convention of Figures 3 and 4 is not followed in Fig. 2, which uses yellow to denote ice, e.g.. Would it be clearer to make the colour convention of Fig. 2 match that of Figures 3 and 4?

Fig. 2 seems to suggest that ice clouds are geometrically thicker than mixed-phase clouds, whereas Fig. 4 seems to suggest that it’s the other way around. Which is it? Are these two figures consistent with each other?

Reference:

Fleishauer, R. P., Larson, V. E., & Vonder Haar, T. H. (2002). Observed microphysical structure of midlevel, mixed-phase clouds. Journal of the atmospheric sciences, 59(11), 1779-1804.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-56,

2020.