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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 #1

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This is a descriptive paper that examines data collected during a Summer and Autumn cruise along the Siberian Shelf in 2014. The purpose of the study is to document the statistics of the clouds that were observed with a focus on their geometric properties and bulk microphysical characteristics. There was emphasis on how those properties changed from Summer to Autumn. It is difficult to find a unifying theme to this paper aside from the fact that clouds change between summer and fall. Some of my difficulty stems from an insufficient description of the measurements and the algorithms and why the authors chose to focus on some data streams but not others.

This paper would be much helped by demonstrating a couple of illustrative case studies

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Discussion paper

that show typical events and that illuminate the main points of the paper. For instance, I would like to know what the change in microwave brightness temperature at 31 GHz looks like for a cloud with liquid water path of 10 g m-2, how such a cloud appears on the w-band radar and whether the lidar is penetrating through the cloud. Another useful case study would illustrate a cloud system that extends through the inversion and that is precipitating ice versus liquid.

Precipitation is not addressed at all yet the boundary layer clouds at issue here must precipitate quite often.

1. While the occurrence of semitransparent liquid clouds in the Arctic have been known for some time, these are normally diagnosed with an infrared spectrometer and ceilometer. Is there something special about the microwave radiometer used in this study and the algorithm used in the inversions that allow it to have precision below the 20 or 30 g m-2 that is typical of such instruments? This seems to be the level of precision cited in the referenced papers. The authors describe an "offset correction" for the LWP based on clear sky periods. What does this mean and how is determined and justified?

2. The authors use an algorithm to categorize profiles that was published in 2007 as part of the Cloudnet program. I am skeptical that this algorithm could be used reliably without modification from one data set to another since such algorithms always rely on various tunable thresholds to make decisions. I wonder if the authors could describe the thresholds used by this algorithm to classify profiles between liquid, mixed, and ice and whether they found it necessary to adjust the thresholds in the algorithm.

3. The Hogan et al (2006) IWC algorithm uses airborne data collected over the UK in mostly frontal clouds as I recall using a Mass-Size relationship developed by Brown and Francis in such clouds. Is there a reason to suspect that the ice precipitation produced in the Arctic boundary layer is similar to frontal ice precipitation over the UK so that the same regression algorithm could be used here?

4. Perhaps I missed it but how often were radiosondes launched during this voyage?

5. A binary classification of warm air advection based on the temperature at 1 km seems problematic to me. Warm air advection implies large scale transport with the wind perpendicular to a thermal gradient. True warm air advection would have real implications for clouds because it is typically accompanied by deep large-scale ascent, etc. Perhaps the authors could show statistics of the strength of the advection in units of temperature per unit time and how the cloud distributions respond to this?

6. The vertical structure of mixed phase clouds is important. In these Arctic clouds typically ice precipitation sediments from a thin liquid water layer. Is that what is seen here? Is the radar able to detect the water layers? If so, how often? Is the MWR capable of retrieving the water path from such layers? If so, what is the typical increase in microwave brightness temperature? A case study would be interesting and useful to establish confidence in the analysis methodology.

7. There is no mention of drizzle, light rain or snow. I'm not sure how a study of clouds in the Arctic could be complete without considering the properties of the precipitation that certainly occurs much of the time.