Review of the manuscript titled: “Measurement Report: Differences in cloud optical and microphysical properties in the Arctic and Antarctic derived using thermal infrared spectroscopy”, by Joseph Hung, Penny M. Rowe, Christopher J. Cox, Emily M. McCullough, Liam Kroll, Raia Ottenheimer, Matthew D. Shupe, Von P. Walden, and Kimberly Strong

General Comments:

The Measurement Report compares cloud properties from two ground sites, one in the Arctic and one in Antarctica using AERI instrumentation. The authors constructed a robust retrieval of cloud optical depth, thermodynamic phase and effective radius of liquid and ice particles. This retrieval allowed for the investigation of a long-term record of these cloud properties in Eureka, Canada. In addition, the study provided detailed measurements and analysis of polar cloud properties at two locations, exploring the similarities and differences at these high latitude sites. Ultimately, this study serves as a valuable contribution to the characterization and understanding of mixed-phase and supercooled liquid clouds, which have strong implications for the Earth’s radiation budget.

Novel insights between the differences of the results at Eureka and that of McMurdo were explored in detail, framing the new results within the context of well-referenced past studies. In addition, the study considered and described data caveats well, including differences in cloud boundary methodology and discrepancies in the span of the measurements. The writing was clearly presented, and I recommend the manuscript for publication after the following items are addressed.

Specific Comments:

Does the CLARRA retrieval report uncertainties? There is little discussion of the retrieved uncertainties and how that factors into the validity of the comparisons throughout the paper.

Figure 1: Adding the latitude and longitude of each location in the caption would add clarity to the Figure.

Table 1: Add the radiosonde types to the table for completeness. Also listing the surface meteorology data used would be useful to know (i.e. 2m temperature, 2m RH, . . .).

Line 162: Is section 2.1 the correct section to reference? I am not finding the description there in the instrumentation section.

Table 2: Were there any sensitivity studies done on the channel selection? Or what is done completely by inspection of microwindows and based on the previous studies referenced?

Figure 3: Make sure the input to the left side of the figure is complete (list all inputs to the model). For example, does the box of "profiles of temperature, pressure trace gases" also use surface meteorology as data input to account for reflected upwelling LW? What remote sensing is used as data input?

Line 183: Is this considered "radiative closure" or "radiative consistency"? This quality control check is a good one.

Line 240: Figure 5 does not indicate the mean ice fraction.

Last line of the caption in figure 4: suggest changing "monthly mean" to "weighted monthly mean" or change the legend in the bottom panel.

Line 277: Clarify what "this bias" is referring to.

Line 297: The previous sentence says there is no seasonality at McMurdo, in contrast to this sentence on line 297. Perhaps reword as "the small seasonal differences".

Lines 363-364: I don't see how the variability of optical depth is similar at both locations. The variability at these two locations looks different in Figure 9.

Line 378: What is meant by "an annual cycle around 10 um"? Is that the same things as "an annual mean value of 10 um"?

Figure B1 caption: Change "of the CBH error" to "of the CBH difference".

Technical Corrections:

Line 29: Remove extra semicolon after "hydrometer".

Line 105: Suggest changing "Earth's emission spectrum" to "downwelling atmospheric emission spectrum."

Line 124: Suggest changing "quick-looks of" to "example".

Line152: Change to "radiative transfer output".

Line 185: remove the word "sky"

Line277: Change "solar" to "shortwave" as the sun emit wavelengths into the infrared.

Line 318: Suggesting changing "to note the extent" to "to note that the extent"

Line 378: space between "10" and "um"