Review for „**Retrieval of Atmospheric Water Vapor and Temperature Profiles over Antarctica through Iterative Approach**" submitted to *Atmospheric Measurement Techniques* by Zhang et al.

General comments:

The authors provide a study to determine atmospheric profiles of water vapor and temperature from satellite observations over Antarctica with the challenge of correctly assessing surface emissivity.

The study has a great potential in better understanding surface and atmospheric processes over the Antarctic continent by using microwave satellite observations. However, the current version of the manuscript still needs improvements, especially with respect to the description of the algorithms applied to satellite data as well as the use of ground truth, such as radiosondes and ground-based remote sensing observations.

Section 4 (Validation and Discussion) is very repetitive. Please consider only describing one or two regions in detail, whereas only mentioning the particular differences for the other regions. Some figures could be then moved to the annex.

Section 5 (Conclusions) is very short, it needs to clearly summarize the novelties of this study, also discussing the differences between the regions. Furthermore, it is necessary include a thorough discussion and quantification of accuracies, uncertainties and limitations.

Specific comments:

Line 30: Please clarify already here for "atmospheric retrievals" the variables that you are talking about. I guess it's about temperature and humidity, and maybe specify also that you are looking at the microwave range

Line 48: delete "a"

Lines 59 and 62: Do you mean Figure 1 here?

Lines 65-70: Beam width as well as ground-resolutions should be added to table 1

Line 82: You write: "Jacobians of the temperature and water vapor channels peak when the opacity becomes one." This is wrong: Jacobians peak at the maximum of the weighting functions.

Line 98: What is your motivation for Figure 2? Please start with a reasoning here

Figure 2: The plots are too small, please provide larger ones. Y-axis in subplots in 4th column should be limited to 20 km, as one cannot recognize much

Line 124: OE doesn't provide the most "efficient" solution, but the most "probable".

Lines 125-126: It is written "... particularly when retrieving temperature and humidity profiles from Microwave Radiometer (MWR) data". It does not matter which input you use, OE always provides the most probable solution.

Line 136: This section is not only about radiosonde data, you also use ground-based remote sensing data from ARM

Line 140: "albeit at a relatively low time resolution": I don't get what you want to say here. Do you mean that the radiosonde data are coarsely resolved vertically? Or that you have only one sonde per day?

Line 143: "AWARE collected atmospheric profiles every minute…": This are not radiosonde data, but ground-based remote sensing from ARM. It is necessary to describe this dataset in detail, especially also about its differences to radiosonde data (resolution, assumptions, etc.)

Line 148: By "altitude" resolution, do you mean "vertical" resolution?

Line 154: Do you use the radiosonde profile climatology as prior in the OE retrieval? If so, please mention this!

Table 2: How many radiosondes were used from which station? And for which time period? The sounding stations have different altitudes above sea level. Does this have an impact on your dataset?
The second part of table 2 concerning ARM data needs to be treated differently. Please mention which instruments were used here!

Line 174: Equation 1 is not necessary here. As you can't influence NEDT, just describe what components contribute to the noise.

Figure 3: Please refer to the variable names in the figure caption (ε_0, ε_i)

Figure 4: Which data were used to produce this figure? Over which time? Which area? All Antarctica? Is it from Ferraro et al., 2016? Or did you produce this figure?

Line 216: Either present full equation, or leave it out.

Lines 217-218: I don't understand this. What is Q_{j_Ref}? Is it reference water vapor in a certain height? But if so, what is then $Q_{j\_H_2O}$?

Lines 241-248: This section about the radiative transfer equation should come earlier.

Line 252: "solve" instead of "derive"

Line 254 and Figure 5: Do you set the 6th iteration as reference? Otherwise, I don't know why the reference should be matching exactly the red line

Figure 5: "Retrieved using radiosonde derived emissivity" > this is not correct: you don't derive the emissivity from the radiosonde profiles. you just use the radiosonde profile as truth for the atmosphere

Line 281: What are the "optimal profiles"? Do you mean the profiles using surface emissivity from optimal estimation with radiosondes?

Line 287 (and later): "… with only 68% showing a difference within 30% of the actual profile." This is a very complicated way to say that "the standard deviation is 30%". Please simplify throughout the manuscript

Line 300: What is the "true surface emissivity from Radiosonde measurements"? This makes no sense to me.

Technical comments:

Please be consistent throughout the manuscript, how to name different products, such as retrieved profiles with OE, observed radiosonde profiles, etc.

The use of the language also needs to be improved, mostly in terms of using more precise expressions, but also a better use of English language in general.

Please add table captions

Check citation styles