Comments to manuscript AMT-2020-52: Detection of the cloud liquid water path horizontal inhomogeneity in a coastline area by means of ground-based microwave observations: feasibility study by Vladimir S. Kostsov et al.

The paper examines brightness temperatures from a ground-based scanning microwave radiometer to detect the horizontal gradient of LWP between water and land. A few simulations are performed, and the data are interpreted with the help of SEVIRI LWP over land and water. A discussion of possible problems affecting the study outcome is given in the last section of the paper.

General comment

The authors have accomplished a large amount of work on a difficult topic such as the interpretation of off-zenith measurements from a microwave radiometer. Although the concept of using angular measurements to characterize water vapor and liquid water path gradients is feasible, its practical applications are very difficult due to the high variability of the liquid water in the clouds, the inhomogeneity of water vapor, the need to know the cloud location, etc.

In spite of the thorough discussion by the authors, it seems that the only certain result so far is that, under certain very controlled conditions such as those in Fig, 6 and 7, the radiometer contains some qualitative information on the presence of a cloud gradient. However, beyond that, most of the following analysis does not yield any conclusive result. The discussion in section 5 as well does not really provide a definite reason for the figures after Fig. 7.
In addition, the instrument field of view (3 degrees) makes it difficult to interpret the off-zenith measurements if the cloud boundaries are not known. With a 3-degree FOV the radiometer will be sampling a horizontal area of ~ 1 km at 20 km distance when looking up. However, it is not clear if the instrument's field of view was accounted for in the simulations.

I understand that what I am suggesting below is hard because of the effort that was put into this manuscript, however I suggest that the authors rethink the entire methodology used for the analysis and, before they look into the data, they conduct extensive simulations of different scenarios. Detailed suggestions are offered at the end of this review.

Specific comments

Line 196: "The difference between measured and calculated brightness temperatures…" However, in eq. 1 the difference is between calculated and measured. Please rephrase.

Lines 209-215: This could be a good reason not to use the retrieved profiles as input back to the radiative transfer code to calculate the brightness temperatures off-zenith. Actually, I think the methodology to use the retrieved profiles to re-derive brightness temperatures should be entirely avoided.

Fig. 6-11 If I understand this correctly clouds are not simulated in the calculated brightness temperature. If the cloud base and top are not known, then the brightness temperature information off zenith can only give a very qualitative idea on the presence of clouds.

Fig. 6 and 7 and related discussion. It seems to me that, given the difficulty to interpret the signal below 5 degree, and the fact that it could be related to the interaction between the surface and the atmosphere, it is better to limit the scan to angles > 10 degrees altogether.

Line 302: Fig 7: Should it be Fig. 8?

Fig. 11 and related discussion. I am not sure how useful this Figure is as it is hard to conclude anything from it. The behavior of the two quantities is only weakly correlated, if any.

Fig. 12. As stated by the authors the agreement between satellite and radiometer is not improved by passing from the brightness temperature space to the LWP space. The explanations provided in the next section however are hypothetical and it is hard to really understand what is happening.

I wonder if a better approach for this study would be to use the nearby radiosonde database to simulate a large database of scenarios where clouds with different LWP and different cloud base heights and different geometrical thicknesses are simulated at the radiometer's location and at certain distances from the radiometer. The radiometer field of view needs to be simulated as well. This is especially important for off-zenith measurements.

Brightness temperatures at zenith and different angles for each cloud/distance scenario can then be simulated and a mapping can be established between Tbs differences (zenith – scan) + cloud base height + cloud thickness and PWV, LWP (based on the distance of the simulated cloud) + cloud distance. This could be done with some machine learning given the large number of variables and scenarios and could provide information on whether it is even possible to separate the signal. It would also give an idea of the uncertainty associated with the analysis. The coefficients could then be used with real measurements. Cloud boundaries for the real cases could be derived from satellite or perhaps reanalysis data.