

## Review AMT-2021-9:

### Improving thermodynamic profile retrievals from microwave radiometers by including Radio Acoustic Sounding System (RASS) Observations

#### General Comment :

The authors have replied to most of my comments and most questionable aspects . The new version where the discussion on NN retrievals is moved to a dedicated Appendix seems to be better suited due to the lack of bias-correction for the NN retrievals but still interesting results to show. I still recommend to answer a few questions about the MWR data bias correction. As biases of the data used in this study are quite large, I think it is important to clearly discuss and clarify the choices made by the author.

After answering these few points, I would recommend the publication of the manuscript to AMT.

Most of the figures are also of poor quality and difficult to read in the pdf version. The authors mention that it is only due to the pdf formatting but original figures are of good quality. I let the editor checks this point in the final version.

1) I am still a bit puzzled by the bias-correction calculation. This is an important aspect of the manuscript as the authors mention the large bias affecting MWR opaque channels of the MWR\_NOAA unit that could make sub-optimal the analysis presented in this paper.

If I understand properly the bias has been computed from differences with the « prior » profiles and thus a climatological monthly mean. Biases in the most opaque channels are significantly affected by the accuracy of the boundary layer temperature profiles used in the simulation by night when low level inversions are present. I am not convinced that a monthly average could correctly infer the bias in the most opaque channels if such cases (low level temperature inversions) are taken into account in the statistics. Similarly K-band and transparent V-band channels are sensitivity to the integrated water vapour which might be poorly represented by a monthly average too.

- Could you explain why clear-sky radiosondes profiles of the campaign cloud not be used to infer this bias correction ?
- Did you investigate the sensitivity of the bias-correction to the database used to derive this correction (prior profiles versus radiosondes) ?
- From figure R2 of your answer : are you convinced that the bias is the same at zenith and oblique scans for this case study (I am sorry but this is very hard for me to read the numbers in the y-axis to check if the values look approximately the same at zenith and oblique scans) ?
- Did you check that the calculated biases were approximately the same through the whole period at zenith and oblique scans as you mention line 420 ?
- Figure5 : in your answer, you show that the oblique scan at  $165^\circ$  is probably affected by a cloud that is probably not yet detected at  $15^\circ$ . Could not that be a problem in the retrieval to mix two TB measurements : one-clear-sky and one cloudy-sky ? How does the PR handle this ? I think resolving elevated temperature inversions often observed during stratus cloud is already challenging for MWRs but probably even more if you mix two scans one in clear-sky and one in cloudy-sky.
- Line 601 : you mention that the bias appears « in this case » : can you just clarify that it is probably affecting the whole time series and not only the case shown in figure2

In figure R3 of your answer you clearly demonstrate that the problem of the MWR retrievals comes from the large bias in the MWR\_CU unit that would be mostly solved with the MWR\_NOAA unit. I would remove channel 57.2884 GHz from the analysis as this channel is likely affected by an

hardware problem. But I think including this result in your manuscript would be very interesting to clearly demonstrate your hypothesis for the reader (like it is clearly demonstrated in your reply)

2) line 318 : The uncertainty in MWR observations is evaluated as the standard deviation of Tb measurements during clear-sky measurements. Firstly could you specify the time window for this uncertainty calculation and secondly could you discuss about forward model uncertainties ? Are these taken into account in the observation error covariance matrix ? I

3) Line 410 : you mention that 5 RS are under rainy conditions. Could you confirm that these data have been discarded from the results in figures 6 to 9 (statistical analysis) ?