Atmos. Meas. Tech. Discuss., 5, C3556–C3560, 2013
www.atmos-meas-tech-discuss.net/5/C3556/2013/

Atmospheric Measurement Techniques Discussions

Interactive comment on "Biases caused by the instrument bandwidth and beam width on simulated brightness temperature measurements from scanning microwave radiometers" *by* V. Meunier et al.

Anonymous Referee #2

Received and published: 14 January 2013

This manuscript provides a theoretical error analysis of the effect of the beam and band width on ground-based microwave brightness temperature measurements.

While there is a potential scientific significance in this topic, especially in view of upcoming combined radar and radiometric measurements, the manuscript as it is substantially lacks scientific quality. The error analyis is very coarse and does not consider a sufficiently large data set of atmospheric conditions. There is an unsufficient description of the used radiative transfer model. The RT model itself, as it is described in the

text, is not adequate from my point of view. And although the authors claim that their study will be useful for combined radar and radiometric retrievals, they use clear-sky atmospheres most of the time (or all the time?).

Please find a detailed justification of the above statement in the following:

- Radiative transfer model: There are some minor problems in the mathematical formulation of the radiative transfer equation (see detailed comments below), but there are also some more fundamental things that are incomprehensible to me. (1) You use the model of Rosenkrantz to model the absorption coefficients that are later on used in your RT model. You should justify your choice of Rosenkrantz and also discuss the errors that are inherent in this model (Hewison et al., MetZ 2006). You also mention that you only model the absorption coefficients of the dry atmosphere (page 8088, line 25) but later on in the text you somehow retrieve the liquid water path? There is also no explanation given how your RT model works, i.e., how you numerically solve the RT equation and how you discretize your model atmosphere (how many layers, thickness of these layers). There should be at least a sketch of your model geometry, where it could be seen how the atmospheric layers and the earth curvature are discretized. What in particular remains a mystery to me is your choice for a model for the vertical gradient of the refractive index. You use a very coarse model from 1966, while at the same time you have the state-of-the-art model of Rosenkrantz for the calculation of the absorption coefficients. Why not using this model also for the calculation of the refractive index? Then, once you have the refractive indices, how do you calculate the propagation path? I assume you somehow apply the Snell-Descartes law at the discretization boundaries of your atmospheric profile, but nothing is explained. In addition it is also a very strong assumption to choose a ground emmissivity of 1. In the frequency range you consider, the emmissivity is somewhere at 0.9. Imagine you look at a cold sky with a BT of 10 K and the temperature of the ground is 300 K. This means that the ground emmits 0.9*300+0.1*10 = 271 K, which is considerably different to the 300 K that one would have if the emmissivity were 1. Hence this choice needs to be rethought or better justified.

- Error statistics: You use only two different atmospheric profiles (midlatitude winter, midlatitude summer) which I consider as insufficient for an in-depth analysis. A proper statistical analysis should also contain some information about the expected fluctuation of the overall bias. Such an analysis should be based on an ensemble of radiosonde profiles. If you use only one climatological profile, your analysis lacks the effects that small scale atmospheric fluctuations have on the incoming brightness temperature (such as temperature inversion layers etc). One of my main points is the fact that you do not consider a contribution from clouds and rain for your analysis. One one hand, this makes me wonder how you can simulate the effect of LWP retrievals (where did I miss something here?), and on the other hand this dramatically hampers the applicability of your study. Since you state that this study is useful for potential radar / radiometer retrievals, I don't see how this should be useful if you only consider dry atmospheres since cloud and weather radars measure only meaningful things if hydrometeors are present. I have also difficulties to understand why you did not map the off-zenith simulated brightness temperatures to the zenith direction. The lower the zenith angle, the higher is the BT simply due to the increased atmospheric path. It is therefore difficult to compare the errors that stem from simulations at low elevation angles with those simulated in zenith direction. I have also not understood how you can model the impact of beamwidth and bandwidth effects on the retrieved temperature profile. You use a rather primitive temperature retrieval (Eq 11), but from this equation I don't see how you can get a temperature profile. If you want to calculate the effect of your forward model errors on the radiometer's temperature retrieval capability, you should use some more sophisticated retrieval algorithms (neuronal networks, optimal estimation ...).

- Generally I must say that the manuscript is a bit dissapointing and I would have appreciated if the senior collegues of the first author would have invested some more time in editing the manuscript.

Specific comments: Page 8086:

line 11: "The impact of the antenna beam width is higher than the receiver band width". That's a strange sentence since antenna beam width and receiver band width are two completely different things. line 17: Ground-based radiometers have been used for a lot of other things and not necessarily in zenith-looking mode.

Page 8087:

line 11: An explanation should be given why the beam width for a radiometer is wider for the same frequency than for a radar. line 20: Explain "TB". line 24: 90° elevation. line 27: "width" -> "beam width"? line 27: Define "air mass" line 29: Write either "air mass" or "airmass".

Page 8088:

line 1: Use either "beam width" or "beamwidth" Equation 1: tau is usually used for the opacity. line 14: The unit of radiance is usually W mˆ(-2) srˆ(-1) fˆ(-1) line 21: A(f,0,s) is the opacity i.e., the integral over the absorption coefficients line 20: Why you define the absorption coefficients in Np kmˆ-1? Does not make sense in your formulation of the RT equation. Explain Np. line 23: Why do you choose Rosenkrantz 1998? line 25: Why only the dry atmosphere? What about LWP if you only consider the dry atmosphere?

Page 8089:

line 6: Why don't you use the Rayleigh-Jeans approximation? line 6: Define c as the speed of light. Give somewhere a sketch or a drawing that explains your geometry.

Page 8090: Eq. (8) I don't understand the choice of this model (see general comments above). line 20: Give some references for this statement.

Page 8091: Line 4: This is a very strong assumption (see general comments above). Line 7: Emmissivity depends also on polarization. Line 19: The water vapor absorption line gives no information on the amount of liquid water. Line 22: These channels provide only information about the temperature in the lower tropospere.

Page 8092: line 3: Define your beamwidth: Is your beamwidth value the point where your fitted Gaussian dropped to 1/e? Why didn't you include the W-band frequency? Eq. (10) Please reconsider the notation of this equation. The index 'i' is not the frequency (line 24). line 27: If these values are not mapped to zenith, then the statistics are not going to be satisfying (see general comments above).

Page 8093: Line 1: Why this separation? Due to the opaqueness of some of the channels? Equation (11): I do not see a temperature profile here. What's this temperature T and at which height can it be found? It's a rather primitive retrieval which I doubt is going to work. Line 13: Why don't you include cloud liquid water?

Proper statistics should also give an idea about the standard deviation, not only the bias. Why is only one atmospheric profile used?

Page 8096: line 12: "minimums" -> minima

Page 8097: Eq 13: Why not "="

Line 22: "B" was used for the Planck radiation beforeand is here now used for the bandwidth. Page

Page 8098: Line 7: I do not understand this sentence at all.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 8085, 2012.