

Interactive comment on “Uncertainties of ground-based microwave radiometer retrievals in zenith and off-zenith methods under snow conditions” by Wengang Zhang et al.

Anonymous Referee #2

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The manuscript AMT-2016-253 by Zhang et al. is within the scope of the journal and it meets the scientific quality for AMT.

However, before the manuscript gets accepted for publication on AMT, I encourage the authors to address the following comments that should help improving the overall quality of the manuscript.

Major Comment:

The manuscript it's not totally convincing unless the authors also show zenith and off-zenith retrievals under non-precipitating conditions, so to demonstrate that there's no systematic issue with zenith retrievals. Figures 4-9 seem to qualitatively suggest that

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zenith and off-zenith retrievals are closer during non-precipitating conditions, but a statistical analysis, similar to Figures 1-3 but in non-precipitating conditions, would demonstrate that quantitatively. I strongly suggest the authors to add this analysis. It could be condensed in one figure with 3 panels showing RMSE for temperature (panel 1), relative humidity (panel 2), and vapour density (panel 3), each with zenith and off-zenith method in non-precipitating conditions.

Minor Comments:

- Several typos are present: e.g. page 2 (line 5), page 3 (line 12), page 5 (line 12 retrieved -> retrieval), ... Many times “clear” and “clearly” are misused: e.g. page 9 (lines 1, 5, and 9) But I stop here and leave these to the technical editor.

- page 4, line 18: “The distances between them are all less than 30 m.” Please rephrase to clarify that the distances between MWR, RAOB launching station, and meteorological sensors are all less than 30 m. Observations may be much more distant due to radiosonde drifting, among other reasons.

- page 5, line 3: “up to 10 km” Please remove “up to 10 km” as it is incorrect and does not add anything here. 10 km is just the upper boundary of the vertical range for which the MWR software compute retrievals. Technically speaking the penetration depth depends upon absorption, i.e. it's different for each MWR channel.

- page 5, line 15: “radiative transfer equations” Please rephrase to clarify that radiative transfer model is used in the training phase of the retrieval algorithm, not in the real-time retrieval computation.

- page 6, line 6: “the RAOB profiles are interpolated to the height levels of the MWR” Interpolation does not account for the inherent MWR smoothing error. Ideally one should smooth the RAOB profiles at the original resolution considering the MWR averaging kernels and then interpolate on the MWR levels. E.g. see: <http://www.atmos-meas-tech.net/5/1121/2012/> <http://www.atmos-meas-tech.net/7/3023/2014/> The au-

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thors shall at least mention this issue.

- page 7, lines 18-19: "where the correlation coefficient rapidly increases from 0.01 to 0.92" The above sentence is misleading; it seems to hint that the correlation coefficient increases in a continuous way from 0.01 to 0.92, while it's either 0.01 (zenith) or 0.92 (off-zenith). I suggest to remove it.
- page 9, lines 7-8: "yet it is generally smaller than" I believe this refers to off-zenith, but this information is missing.
- page 9, lines 13-14: "are not reasonable as those" I believe the authors mean "are not as reasonable as those". Please check.
- page 9, line 19: "great" I suggest replacing this word with "some", as otherwise the authors should say with respect to what (similarly on page 11, line 8).
- page 10, lines 2-6: "the off-zenith observations are more representative of the conditions in which radiosonde observations are also taken" It's not clear whether the paper Xu et al. 2014 analyses data from the same site and synoptical conditions. If so, please state that clearly. Otherwise I believe their results cannot be generalised to the site/conditions presented in the manuscript. (similarly on page 14, lines 21-22)
- page 10, lines 17-18: "the greater temperature is well accordant with the snowfall time" In Figure 4 I see the warming of zenith retrievals during the snowfall. But I also see a warmer spot before the snowfall (around 12 UTC of 4 Feb). This is also evident in relative humidity and vapour density retrievals (Fig. 6 and 8, respectively). The authors completely ignore this feature, while I believe it must be discussed. Maybe there was liquid precipitation? A time series of precipitation rate and type would be very useful.
- page 11, lines 1-3: It seems to me obvious that the less snow, the less impact; so it is reasonable that heavy snow causes 10 K contrast, while light snow causes 3 K contrast. I don't see why the authors say that "light snow on the radome is blown away immediately"? The effect is there, 3 K it's far from being negligible.

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- page 11, lines 10-12: The authors shall dwell more on the reason why snow causes larger temperature and humidity retrievals. I think Kneifel et al. 2010 provide some qualitative explanation.
- page 11, line 14: "temperature in zenith method is more reasonable" I believe the author mean in off-zenith
- page 12, lines 1-5: Not clear, please check grammar and possibly rephrase.
- page 13, lines 1-2: Please check grammar and possibly remove. I think it is obvious that larger impact is associated to heavier snowfall.

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