

Interactive comment on “Retrieval of tropospheric water vapour by using spectra of a 22 GHz radiometer” by R. Bleisch et al.

Anonymous Referee #1

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General comments:

This manuscript describes an approach of validating water vapour profiles up to 7 km with a vertical resolution from 3 km - 5 km from a 22 GHz microwave radiometer at the meteorological station at Zimmerwald (Switzerland). For the validation the results are compared with profiles from radiosonde ascents, a microwave radiometer (RPG-HATPRO) and a Raman lidar at Payerne (distance ≈ 40 km) and an FTIR instrument at Jungfrauoch (distance ≈ 50 km). From the comparison results the authors deduce a good agreement (correlation with radiosonde profiles 0.7) with a wet bias of 10 to 20%. In principle the intercomparison results merit publication, but due to basic deficits major revisions will be necessary.

As known from the analysis of radiosonde launches with short time differences or from
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adjacent sites, water vapour is highly variable on short time scales and small spatial scales. Thus, for me it seems to be rather questionable if a validation with instruments with a horizontal distance of at least 40 km makes sense at all. The observed differences presumably reflect more the natural variability of water vapour than the measurement errors of the instruments. The outcome of this comparison study is rather weak because we do not learn anything but the fact, that the instruments precision is within the region of values one would expect from this high variability. Doing the same intercomparison with two high-accuracy water-vapour sounders like radiosondes would presumably yield very similar results. I would not call this a validation.

For performing a reasonable validation the authors should acknowledge the principle difference between a) comparing individual profiles from two sounding systems and b) deriving conclusions from a large ensemble of intercomparisons.

As to a) a comparison with an accurate and validated instrument at the same location within short time intervals is required to make sure that the same airmass is probed. For this reason the comparison with the FTIR instrument at Jungfrauoch tells nothing of scientific significance about the accuracy and precision of the MIAWARA. Therefore Fig. 13 and the related discussion should be erased from the manuscript. For the same reason Fig. 10 and its related discussion should be removed from the manuscript.

As to b) the only reasonable way to use measurement results from a distant station (such as Payerne) within this comparison work will be to calculate the mean differences on a statistical basis, because only such approach potentially blurs the effect of the high variability.

Additionally, I would like to request the authors to compare the MIAWARA results with water-vapour profiles from NCEP. NCEP profiles presumably reflect the reality at Zimmerwald much more reliable than radiosonde ascents at Payerne. As a first step I suggest to compare integrated water-vapour columns between ground and an altitude of 5 km. The high error region of the MIAWARA instrument is clipped off then while

usually more than 90% of the total water vapour column will be counted. Not before this yields well corresponding results one should analyze the details of water-vapour profiles.

Furthermore, I suggest to discuss the quality of the HATPRO data in more detail before using it for a comparison with MIAWARA. Results of a direct comparison of HATPRO with lidar and radiosonde should be shown then.

Specific comments:

1. P1428 L9-12: This listing of results is somewhat poor for a paper abstract. A retrieval is sensitive up to 7 km (which is only about 6 km above the ground at Zimmerwald) and a resolution is something between 3 and 5 km means that the resolution is only marginal different from the entire measurement range. I suggest to discuss about domains (e.g., boundary layer and free troposphere). A correlation of 0.7 does definitely not prove a good agreement! This correlation more or less reflects the ability of both measurement techniques to measure water vapour. Due to the high variability of water vapour the correlation tells probably nothing about the quality of the instruments.
2. P1428: The location and altitude of the radiometer instrument is missing in the abstract.
3. P1428 L18: Schneider et al. (2010) is not an adequate citation for the topic of global warming in the context with water vapour. There was a lot of work about this topic done by others before and this should be cited correctly (e.g., Harries (1996, 1997), Lindzen, Hansen and many others).
4. P1428 L23: Delete sentence "For this, there exist several measuring techniques." This is obvious if comparing different methods.
5. P1428 L23-25: The altitude range up to 7 km is not "large" compared to other techniques (e.g., GPS, lidar, radio sounding, aircraft, FTIR,...).
6. P1430 L1: Altitude of Zimmerwald is missing.

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P1431 L6: An averaging time of 2 - 4h is rather long and limiting the significance of the comparison study. This should be discussed here.

P1432 L2: Define Bayes' probability theorem!

P1433 L16-21: At first, I do not understand that the FWHM of the AVK is a direct measure for the vertical resolution. This needs a more detailed explanation.

P1434 L9: Explain the Curtis-Godson approach or at least insert a citation.

P1434 L11-L16: I would not call this a good reproduction! A correlation of the order of 0.7 is rather poor for a measure that varies more than one order of magnitude! To me, this does not automatically mean that the measurement quality is bad, but other impacts as small-scale and short term-variability blur out any information about the quality of the measurements.

P1434 L17-26: Why not comparing column integrated water vapour between ground and 7 km or even only 5 km as suggested above? This would eliminate problems with different resolutions and work also as smoothing filter to small-scale variability.

P1435 L4-13: This proves, that the intercomparison is probably more a measure of atmospheric "noise" than a validation.

P1435 L18: techn. corr. "Institute".

P1436 L12-14: It is better to write that the HATPRO has a wet bias compared to the lidar, because presumably the lidar is much more accurate.

P1436 L24 - P 1437 L16: I suggest to erase the MIAWARA – FTIR comparison from this validation study. It is known from radion-sonde launches that water vapour is too variable to learn anything about the quality of single measures from two instruments having a distance of 50 km from each other, in particular within complex terrain!

P1436 L28: There was former work done by others, this should be cited correctly.

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P1441 Conclusion: It should be stated that a better spatial matching (with the radio sondes) leads to significant better intercomparison results.

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