Review for paper „ Observations of water vapor within a mid-tropospheric smoke plume using ground-based microwave radiometry"

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submitted to Atmospheric Measurement Techniques

General vote: Major revision

General comments:

The manuscript presents measurements from a microwave radiometer in the vicinity of forest fires in order to detect water vapor increases due to combustion reactions. The approach is interesting, however the number of cases and the lack of a statistical analysis makes the hypothesis that signals in the measurements are related to the smoke plume fairly vague.

Thank you for your comments and I appreciate the time you've spent to help improve this manuscript. My responses to your comments are given in bold directly below the individual bullet points.

I consider the paper to be published only after some major changes, such as:

- Checking whether the increase in water vapor on the case study days is significantly higher than on other days. A good way for that would be also checking the diurnal variation of PWV and WV profiles or typical diurnal cycles of water vapor and compare smoke-free with smoke days.

I did not compare the case studies to other smoke-free days as we were somewhat limited in the number of overall radiometer observations. Additionally, the intra-day variation could be quite substantial and is out of the primary scope of the present paper. However, knowledge of the day-to-day variation in water vapor in that layer would make for an interesting study on its own.

- Using backward trajectories to verify if the airmass considered stems in fact from the smoke region. This would also allow to answer the speculation of the smoke plume height for 2 of 3 case studies. You could use HYSPLIT for that.

I did utilize HYSPLIT in an attempt to determine smoke plume height over the radiometer. However, the HYSPLIT trajectories are very sensitive to plume injection height over the smoke source and those heights are unknown. I could not verify an injection height for the smoke therefore was not confident in the smoke height provided by the trajectory analysis.

- State more clearly that the vertical resolution of water vapor profiles by microwave radiometers is very coarse and that only 2 independent layers can be derived over the whole profile. Especially inversions in mid and high troposphere cannot be determined by MWR. Using the integrated water vapor might give more robust results, as the PWV retrieval has much less uncertainties than WV profiles retrieved from MWR.

This has been addressed in Section 2 with the inclusion of additional references. The integrated water vapor was not used because it would be heavily weighted towards the lowest layer of the atmosphere where most of the water vapor is contained.

- What did you do in case of rainy periods? Did you filter out these data? The measurements are not meaningful at all during rain due to scattering by (large) raindrops. Please mention that in section 2 or 3. See also Figure 1 for that!

This has been addressed in Section 3. Additionally, there was no rain observed during the periods of study.

- Consider to reduce the amount of figures, as some information is redundant.

I did remove MODIS imagery for two of the case studies to lessen the number of figures.

Specific comments, Technical corrections:

- page 2, line 10: What causes the differences between 0.05 and 3 g kg-1 ? Please specify what causes this differences!

This is outside the scope of the present paper. The referenced paper describes the involved calculations that gave the differences.

- page 2, line 22: What is “small percentage”? Do you have a number for that? Check if there is a number in the reference paper!

This has been addressed.

- page 3, line 9: The effective resolution is much coarser. There are only 2 independent vertical layers which can be detected. For more details check e.g. Caddedu, 2013 or Löhnert and Maier, 2012 or Güldner and Spänkuch, 2001. Note that the weighting functions for WV profiles do strongly overlap. Please state the uncertainty level for the profiles!

This has been addressed with the addition of several more references in Section 2.

- page 3, line 12-13: “integrated precipitable water vapor profiles” > this expression is nonsense. For the integrated value write either “integrated water vapor” or “precipitable water”. “water vapor profiles” would correspond to vertically resolved retrievals.

This has been addressed.

- page 3, line 16: Please keep in mind that the vertical resolution is very coarse and that only 2 independent layers can be detected. The vertical information comes only due to the pressure broadening of the water vapor line, this signal is relatively small. Water vapor profiles from MWR are generally unable to capture inversions.

This has been addressed.

- page 3, line 18: write “brightness temperature” instead of “blackbody temperature”

This has been addressed.

- page 4, line 30: reference for CALIPSO! e.g. Winker et al., 2010 or Omar et al., 2009 for products

This has been addressed.

- page 5, line 16-18 / Figure 7: Did you look into the aerosol classification product from CALIPSO? This is also available online!

This has been addressed.

- page 5, line 19: SD means South Dakota?

This has been addressed.

- page 5, line 22: better "approximately 1830". 1831 is too specific to be approximately…

This has been addressed.

- page 6, line 9: is that result significant? 7 % less water vapor with an uncertainty which is in my knowledge much higher than that

This has been addressed with the inclusion of a Student's T Test.

- page 6, line 28: what is the increase in PWV (integrated water vapor)? is there any large scale water vapor transport? check trajectories and weather charts for that!

This is an important point. However, I did include wording that it was assumed there was no large scale water vapor transport during the periods of study. Spatial resolution on the "weather charts" is insufficient to determine transport of moisture at the levels I am studying.

- page 7, line 29: how do you know background levels? the increase of 250 % might also be caused by synoptic scale water vapor advection

Admittedly, it could be. I am assuming that it wasn't.

- page 8, lines 20-23: for that, a thorough check of trajectories could give an answer

See above responses.

- page 8, line 25: MWR water vapor profiles are not really a "novel technique", it's just the first time to derive changes in

This has been addressed.

Comments to figures:

- Figure 1: What are the outliers on 8/9 and 8/13? Are the data filtered for rain?

This has been addressed.

- Figures 2, 3, and 4 could be put into one plot (maybe with subplots).

This is an interesting idea but I did not change the plots. There is no impact to the final paper.

- Fig. 7: mention figure reference (CALIPSO website)

This has been addressed.

- In my opinion, it would be enough to show either 1 line per km (3,4,5,6 km) or PWV in the time series plots (Fig. 10, 13, 16). There is no additional information in the other lines!

As noted, the vertical resolution is very course above the boundary layer. I do think that the inclusion of all of the lines in the figures between 3-6 km does illustrate that each line may not provide additional information. I think that is an important piece of the figures.

- Fig. 11 does not show so much – you could skip that since you have Fig. 12 for the same day

Figure 12 was removed and Figure 11 was enhanced to better show the smoke plume.