Trajectory mapping of middle atmospheric water vapor by a mini network of NDACC instruments

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Response to comments from Referee #1 on ACPD paper acpd-15-12777-2015:

Dear Referee #1,

Thank you for reviewing our paper "Trajectory mapping of middle atmospheric water vapor by a mini network of NDACC instruments". We highly esteem your comments and try to answer your four posed issues (i) to (iv). Your Referee comments are colored in blue and our answers remain in black. Since this response is submitted during phase 1 (open discussion) of the interactive discussion, the author's changes (beyond typos) to the manuscript are not included yet, but will follow in phase 2 (final response).

(i)
The verification of the TM data using Aura MLS data (Sect. 3.5) – I understand that the latter is used as the a priori for the NDACC data. This suggests that this validation may not be sufficiently independent. The authors should discuss this.The other referee remarked on this;

Concerning your comment/issue (i), we mostly refer to the response to the first comment of Referee #2. An independent source of validation could be ECMWF. But then the question arises, if it is still appropriate to use the MLS as traveling standard to correct for the biases, as this might imply a new bias if the data is compared afterwards to ECMWF model data. Consequently we would have to correct for the instrument biases by the use of ECMWF data alone. The advantage of subsequent validation (difference plot) to ECMWF would be that all TM domains go into the statistics due to the high resolution and global coverage of the model data. Finally, we decided to not include an additional validation towards ECMWF, as the paper/manuscript size would increase too much and we think that with the applied strategy the validation towards MLS is sufficiently independent to a priori data (s. our response to Referee #2 comment 1).

(ii)
Sect. 3.4 does not seem to me to add much to the discussion. Is it needed?

As the wind field is important in any TM study and we know that large differences between ground-based measurements and ECMWF model analysis have been observed (Rüfenacht et al., 2014), we think it is worthwhile to include this side study as part of the result section. Although the assumptions of constant to high wind velocities within the ECMWF operational model is idealized, a downscaling ECMWF winds by 30 % dur-

ing LAGRANTO calculations improved the result of the TM domain comparison versus MLS ($\sim 4\%$ more domains within $\pm 10\%$ deviation to MLS). We want to keep Sect. 3.4 as small part of our paper.

The authors could improve the figures – for example, the value of n is difficult to read in Figs. 1-2. Similarly, other text above the plots is difficult to see (e.g., Fig. 3);

For the revised paper we will make new Figs. 1-2 to increase the fontsize of the titles (n = ...) corresponding to the subplots. We think that the titles in Fig. 3 will be better readable in the final version (Figs. 3, 4, 5 and 7 will have the same size). With the ACPD format and the large caption of Fig. 3, we agree that it is a little bit difficult to see here. Another point is, that the information of the titles for Figs. 3-5 and 7 is given also in the caption of Fig. 3.

Another way of filling in gaps in the satellite observational record would be to use analyses/reanalyses of the middle atmosphere, e.g., from ECMWF. Could the authors mention this alternative, and discuss the relative advantages/disadvantages of each approach?

In the revised manuscript version we will mention that alternatives exist to fill in occurring data gaps. Data from ECMWF operational analysis or reanalysis has a good spatial global coverage on the one hand, while MLS measurements are confined to orbits around the earth. On the other hand the accuracy of moisture fields in ECMWF data could be problematic in the upper atmosphere. Some studies (e.g., Feist et al., 2007) found that the ECMWF model produces an unrealistically moist mesosphere, which is not present in the MLS observations. Since there is no stratospheric H_2O data being assimilated in the ECMWF model, we think that using the model data above the troposphere is really not an alternative. So both, ECMWF and Aura MLS, have advantages as well as disadvantages in regard of filling in data gaps for validation with our TM method.

Style points/typos

The text: There is a slight mixing of UK and US English spelling. The authors should stick to one or the other. I suggest US English, as this is more prevalent in the text.

We appreciate this hint and screened the text for UK English words. The reference list is not touched, but for the rest we will try to avoid UK English. The following has been found:

- Word expressions with "centre" (Br.) are changed to "center" (Am.)

- Word expressions with "analyse" (Br.) are changed to "analyze" (Am.)

- Word expressions with "travelling" (Br.) are changed to "traveling" (Am.)

- Word expressions with "vapour" (Br.) are changed to "vapor" (Am.)

- Word expressions with "behaviour" (Br.) are changed to "behavior" (Am.)

- Word expressions with "neighbour" (Br.) are changed to "neighbor" (Am.)

P. 12784
L. 11: Finland. L. 23: I suggest you do not start a sentence with an acronym.

- Page 12784, line 11: We changed "Finnland" to "Finland"

- Page 12784, line 23: We changed the beginning of the sentence "SWARA..." to "The microwave radiometer SWARA..."

P. 12789
L. 8: Do you need "obviously"?

- Page 12789, line 8: "Obviously" is now discarded.

P. 12793
L. 22-23: Perhaps use "challenging" instead of "interesting".

- Page 12793, line 22-23: We adopt your suggestion to use "challenging" instead of "interesting", as it is more suitable to the sentence

P. 12795
L. 19: I suggest replacing "probably" with "likely".

- Page 12795, line 19: You are right, "likely" is more convenient than "probably"

P. 12799
L. 14: Do you need "indeed"?

- Page 12799, line 14: No, we do not need "indeed" implicitly, so we omit it

P. 12800
L. 5: Good results of what?

- Page 12800, line 5: Now more precise: "Table 2 underlines the good results of the TM approach with respect to Aura MLS observations."

P. 12803
L. 11: Do you need "seems to be able"? Would "is able" be more succinct?
L. 20: The sentence including "unveiled weak points" is not clear to me. Please rewrite.
L. 22: Do you need "apparently"?

- Page 12803, line 11: "seems to be able" is replaced by "is able", as the expression is more distinct

- Page 12803, line 20: Here we suggest to split up the sentence into two in order to clarify: "Within our investigation only one out of five ground-based radiometers was located north of 60° N (MIAWARA-C), but the instrument retrievals in the lower stratosphere were affected by high a priori contributions (measurement response $< 60\,\%$), leading to H_2O profile data omissions. Thus TM data inside the stratospheric vortex in case study A, B and D is missing or reduced."

- Page 12803, line 22: Now "apparently" is omitted

References

Feist, D. G., Geer, A. J., Müller, S., and Kämpfer, N. (2007). Middle atmosphere water vapour and dynamical features in aircraft measurements and ecmwf analyses. *Atmospheric Chemistry and Physics*, 7(20):5291–5307.

Rüfenacht, R., Murk, A., Kämpfer, N., Eriksson, P., and Buehler, S. A. (2014). Middle-atmospheric zonal and meridional wind profiles from polar, tropical and midlatitudes with the ground-based microwave doppler wind radiometer wira. *Atmospheric Measurement Techniques*, 7(12):4491–4505.