Response to Reviewer #2

We like to thank the reviewers for providing helpful comments to improve the manuscript. All changes are highlighted in the manuscript file. Added text is wavy-underlined and blue, discarded text is struck out and red.

General Comments from the authors:
We fixed a bug in the source code resulting in a lower amount of reliable Polly^{XT} calibrations from 66 to 53. However, this did not change the results (e.g. bias) significantly. For that reason the following figures were updated: 3, 5, 7, 8 and 9 as well as tables 1 and 2. Furthermore, the figures 2 and 4 were improved with other colors and axis titles. Additionally we removed the coefficient of variation (rel. rmse) from Figure 8. Nevertheless the information is still mentioned in the text (pg 15 line 21).

a) General comments:

The manuscript presents a method to derive water vapour profiles from Raman lidar measurements calibrated by the integrated water vapour (IWV) from a collocated microwave radiometer. The results presented in this study evidence the capability of the synergy of Raman lidar and microwave radiometer measurements to provide water vapour mixing ratio profiles under different atmospheric conditions.

I think that the topic is within the scope of this journal. From my point of view, one important point of this study would be to assess the errors associated to consider a constant calibration factor during the whole campaign, and evidence the advantages of the IWV method again the traditional calibration with radiosondes. The duration of the campaign and the availability of radiosondes would allow this kind of analysis.
We added the investigation considering a constant calibration factor in Figure 8 (blue line). We used the time average from the IWV method (12.4) as constant calibration factor.

In the current state of the paper, only one case has been used to compare the agreement between the different methods (regression, profile and IWV methods).
We added the calibration factors of the other methods to Figure 5 and to the text (pg 13 line 1). Thank you for this remark which is very helpful in underlining the advantage of an automated calibration with MWR.

Moreover, although the advantages of used IWV method could be clear, I consider that should be proven the necessity of this method (continues calibration), since it also implies the necessity of two instruments measuring at the same time (which is not positive aspect) to retrieve water vapour profiles.
We added a new sentence at the end of the conclusion that describes the advantage of IWV method: "Particularly with regard to the increasing amount of ground-based remote sensing supersites that are equipped with Raman lidar and MWR without operational RS launches (e.g. LACROS in Leipzig), water vapour profiles can be retrieved on a routine basis. " (pg 17 line 10)

b) Detailed comments:

- Page 6568, lines 19-20: "Its amount in the atmosphere is controlled mostly by . . ." , please add a reference at the end of this sentence.
  Done as suggested. (Myhre et al., 2013) (pg 2 line 19)

- Page 6570, lines 4-5: Replace " to apply a calibration method which is .." by "to apply a Raman lidar calibration method . . .".
  Done as suggested.

- Page 6571, line 3: I miss a short description about the lidar wavelengths involved in the water

vapour retrievals.
This information is given at the beginning of the methodology section (pg 7 line 10).

- Page 6571, line 20: Which is the time and temporal resolution for the water vapour profiles from BASIL? I guess that the resolution that the authors give is the one for the raw data.
Done as suggested (pg 5 line 23).

- Page 6572, line 5: "The MWR is a passive instrument that measures atmospheric emission at two frequency bands . . .". In the way that you claim that it seems that it is the general definition of MWR, but it is not true, it is just the characteristics of HATPRO radiometer. So please, clarify this point.
We replaced "MWR" by "humidity and temperature profile (HATPRO)" (pg 6 line 9).

- Equation 1: It would be more clarifying to indicate on the right side of the Raman lidar equation for inelastic signals the term correspond to the emitted laser power at wavelength λ0.
We added the emitted laser power term to the equation and we added the index λ_R to the system constant.

- It is not clear how you reach equation 3 from equation 1 and 2 if you don't mention that the water vapour mixing ratio is proportional to the ratio of water vapour and nitrogen molecular number density.
We added a new Eq. (3) and mention the proportionality (pg 8 line 6). Now the derivation is more clear.

- Page 6574: The paragraph where the calculus of the particle extinction coefficient is described should be clarified a little bit. In the way that is now written, it is not very clear if you use the backscatter coefficient to infer the extinction coefficient in the whole range or only in the lowest part.
We clarified this confusion by replacing "to receive more reliable values below 1 km" by "over the full height range" (pg 9 line 8).

- Page 6577, line 11: I guess that both criteria should be fulfilled simultaneously, am I right? Please clarify that in the text.
We replaced "are used" by "have to be fulfilled" (pg 11 line 24).

- Page 6577, line 24: please correct: "The relative difference between these methods amount to . . ."
We correct this sentence as follows: "The relative difference between these methods amounts to…"

- In section 3.1.3 there is not any mention about the assumption in the overlap region with the lidar. There is no any evaluation of the uncertainties of the method due to consider a constant value in the lowest part (400 m for Polly). It would be very interesting this kind of assessment.
We added the according uncertainties: "The associated errors amount to a maximum of 0.6 and 0.1 g kg at the surface for Polly^{XT} and BASIL, respectively. These errors are estimated using the average over nighttime radiosonde profiles during HOPE." (pg 9 line 29)

- Section 3.2: The results shown in Figure 5 are not sufficiently described. There are many vertical gray dashed lines in the plot, however there is a big change in the value of the calibration constant that is indicated by the black and the red line. Please include the discussion and the information that was already indicated in the legend of the Figure. For me it is not clear if all the vertical grey dashed lines (they have different thickness) correspond with changes in the alignment of the system.

We changed the figure and reduced the different lines to one line representing both leaps in time and changes in the setup. Now the figure is more clear. Furthermore we include some informations from the caption to the text (pg 12).

- Section 4.3: I would like to know the number of radiosondes used in the comparisons, since you are comparing several lidar profiles with the same radiosonde.
  We added the number of the radiosondes used for the bias study which are 15 for PollyXT and 6 for BASIL (pg 14 line 25).

- Figure 9: It would be also interesting to show the standard deviation of the bias profiles for the different trajectories.
  We added error bars representing the standard deviation to the plots.