

# ***Interactive comment on “Optimal Estimation of Water Vapour Profiles using a Combination of Raman Lidar and Microwave Radiometer” by Andreas Foth and Bernhard Pospichal***

## **Anonymous Referee #1**

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The paper by Foth et al. presents a retrieval of water vapor from ground based microwave radiometer using an apriori computed from the previous state and collocated lidar measurements. This paper is appropriate for AMT as no science is discussed. Before publication, the paper needs to add a discussion on how the error in the filtered profile changes as the previous state is farther in time. Also, it needs to have a section/examples showing the impact of using the saturation constrain versus not using one.

Comments: P1L17: This sentence implies that the water vapor is some how being dictated by the IPCC, please rewrite. P1L19: Its amount is controlled mostly by the air temperature, rather by emissions. → In the stratosphere, the water vapor is controlled

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by the tropopause coldest temperature, do you mean in the boundary layer is controlled by sea surface temperature. Please specify and provide a reference.

P1L24: About the H<sub>2</sub>O lifetime, is that in the troposphere/boundary layer? Are you sure about this number? Figure 5.23 of “Aeronomy of the Middle Atmosphere: Chemistry and Physics of the Stratosphere (Guy Brasseur and Susan Solomon)” shows a lifetime varying from hundred of years at around 20km to 1 day at around 120km.

P3L6 Please describe what is the difference between this study and Han et al. 1997? Is it just that in here it is used optimal estimation?

P5L6 Weighting functions and jacobians are not the same. Please double check what are you showing.

P6L9: You are not projecting in time the last analysed state, you are just advancing this state without any modification because H is and M are the unity matrix. Please change

Figure 3: please delete the blue part of the color bar in the correlation coefficient.

Equation 7, why is  $St,k$  here, when you just said P8L12 than  $St,k$  can be skipped. I would assume that using RS climatology is an extreme case, if you are using the previous state from 5 min ago, the correlation and covariance matrices are going to be completely different to the ones if the previous state were from 6 hours ago (I presume that these ones will look more like the RS climatology) Please clarify.

P10L10. In this work, it has be shown . . . This implies that in a previous section of Foth et al 2017 it has been shown that such a method is more robust, which is not the case. Change to: The cloud base of a liquid . . . (Baars, et al) which has been shown to be a more robust method for the automatic . . .

P12L6: In Rodgers there is no mention of supersaturation cost function. Further, have you try not using such constraint. You are apriori is so tight I do not expect that it is needed.

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Equation 18 has an extra bracket. Figure 6 and 10: You could show the OEMMWR to showcase the impact of the lidar apriori.

Figure 8 Could you add the lidar measurement to see if the bias is bigger or smaller than the OEM. Also, is this for 23:02 as in figure 7 or this are for a previous estimate. Further, when you do these comparisons do you apply the averaging kernels, all the MWR will look poorly if you do not include them. Also MWRstat never has an error bar, please add. (also in Figure 11)

Figure 11: What time?

P19L6: For the most part, the RS profile is also within the OEM MWR uncertainty

P21L5: add shown in red after “as introduced in Fig.9”

P21L15-20: Are you implying that the lidar retrieval have a bias for altitude higher than 6km. Could you relax your apriori at those heights so that the information arises from the MWR. This needs to be fixed because in the clear sky the bias should be less than in the rest of the scenarios.

Is the accuracy error shown in Figure 14 taken into account in the error characteristics shown in the previous figures. Also, what are the main differences between L93 and R98, do they use different absorption cross sections, if so, which ones. Speaking of accuracy, what is the impact of the temperature error upon your water vapor retrievals. Would it be better to use a profile derive from RS than from MWR due to the low vertical resolution of the later.

P23L15: enormously is a strong word change to marginally improves.

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