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Interactive comment on "Significant decline of mesospheric water vapor at the NDACC site Bern in the period 2007 to 2018" *by* Martin Lainer et al.

Anonymous Referee #3

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The work presents 11 years and 1 month of water volume mixing ratio data gathered by a ground-based long-wave instrument operating in Switzerland. The authors fit their retrieved water vapor profiles to a modeled time series so that they can extract a decadal trend of how the water volume mixing ratio has changed.

1 General point

I am not convinced that the fitted time model of Equation 2 is good. The figure on this topic, Figure 3, has a yearly variation from 4 ppmv to 8 ppmv in the altitude range the authors selected to show. The residual is about 1 ppmv, up and down to 0.5 ppmv,

or 12-25% of the total volume mixing ratio. This is a lot, especially as the authors find a decadal trend that is of equal or smaller magnitude than the residuals. The authors need to justify these residuals, identify where they are from, and clearly limit the error range of the time model.

2 Specific points

2.1 About Equation 2, the time series

In Figure 3, the fit seems much more regular over the years than the gathered data. This might be because there are large uncertainties allowed in the fitting mechanism, or because the fit is simply not good. What are the computed uncertainties? Please give error bars in Figure 3.

How are you sure that $F_{10.7}$, the multivariate ENSO index, and the quasi-biennial oscillation phase shift, all only have linear influence on water vapor volume mixing ratios?

What happens to the fit if you switch from monthly to weekly, daily, or a by-the-measurements time series?

Using c_n/d_n and already having defined c_1 and d_1 is confusing. Also, by your own definitions on page 6 line 24, you never fit semi-annual or annual changes. This does not seem as intended. Can you define m, and which l_n you use more precisely? And why limit yourself to just annual and semi-annual trends immediately without decomposing these frequencies from the data first? It is perfectly reasonable to have weather trends that are not exactly annual during such short times as 11 years. And because of the QBO, even lower frequencies seems reasonable to find as well.

Please confirm that the added extra month that makes the time series 11 years and 1 month long has no impact on your results. Its a minor thing, but with such a poor fit, and with the sharp increase of water vapor there is in Figure 3 around April/May, a single outlier like this can be bothersome.

2.2 About a priori and retrieval model constraints

Why the large area for the a priori? You point north, so the southern tip of said area is at your instrument site? Are the coincidences evenly distributed in said area?

You have a 10% difference between your own measurements and those of Aura/MLS. Are these differences constant over the years?

There was a recent conference proceedings paper by Rosenkranz et al [10.1109/MICRORAD.2018.8430729] about model errors in the microwave range due to both errors in spectroscopic parameters and the correlation between these errors due to how they are derived in the lab. You never explicitly say so, but I presume you are using his model for the molecular oxygen absorption and possibly even for water in said range, so it seems relevant. If so, the recent paper's findings are important, and they are that there is potential brightness temperature errors of between 0.5 and 1 K in and around the water line you are measuring. What would taking this into account do for your retrievals? Also, please give and cite the spectroscopic model you are using, since this is a user option in ARTS/Qpack.

2.3 About the water measurements

Please give specific examples of the fits of Figure 1 for the change that happens around 2011 and explain why you don't believe changing your setup affects the quality of the retrievals from these figures. I can guess you have some sort of standing wave that you can remove in post via periodograms or whatever your favorite deconvolution method might be. I do not think I should be guessing these things though, since it makes the

study less repeatable. So a couple of plots with the measured and fitted line in the center, and an explanation why it is clear that the results are the same both pre- and post-2011 in terms of water vapor would help.

3 Technical notes

The entire discussion about ozone in the introduction is irrelevant for the rest of the paper. Please remove it.

Equation 3 should not use y since it is already used in Equation 2. Please change either one of these equations.

Please give all the fitted parameters for Equation 2 in a table or in a figure for different altitudes.

All paper May as such and not Mai.

Page 1 line 15. Please reformulate the first sentence to clarify what is characterizing what and how it is characterizing it. I can guess what you mean but it is unclear.

Page 1 line 21. Please tell for what year the 0.05 W/m^2 is from.

Page 3 line 3-4. Please cite and give the full name of each instrument.

Page 7 line 25: according.

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