

## ***Interactive comment on “VESPA-22: a ground-based microwave spectrometer for long-term measurements of Polar stratospheric water vapor” by Gabriele Mevi et al.***

### **Anonymous Referee #2**

Received and published: 18 September 2017

The discussion paper gives an extensive introduction to the VESPA-22 instrument, its calibration and data analysis, as well as a comparison of measurement results with MLS observations. It fits well in the AMTD journal, but it would benefit from a few clarifications and corrections.

In general, the introduction in section 3 to 5 repeats the basics of radiative transfer, balancing instruments and optimal estimation, which are already described in detail in the cited literature. In my opinion, these sections could be easily shortened without loss of information.

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## Technical Comments:

The abstract (p.1 line 13) and section 3 describe the VESPA-22 back-end as an FFTS with 500 MHz bandwidth and 31kHz resolution. However, the schematic in Fig. 1(b) shows a system with 1GHz bandwidth. Is this the actual schematic of the instrument? Also P4 line 1 states a 2GS/s sampling rate, which results in a 1 GHz Nyquist bandwidth.

P. 3 line 13: The sentence "the waveguide used by VESPA-22 polarizes the incoming radiation with a gain difference between the two polarization modes of 45 dB" is both incorrect and irrelevant. The rectangular waveguide supports only a single polarization by definition. The stated 45dB may refer to the feed horn, but the actual cross-polar with the offset reflector will be much worse. Bertagnolio 2012 states for the same instrument 35dB and 24dB, respectively. This should not affect the observations, so the sentence could be easily removed.

P. 6 line 28 states that the opacity in Fig 3 was calculated for water vapor profiles measured by AURA/MLS. However, the dominant effect in this figure is due to tropospheric water vapor which is not measured by MLS.

P. 9 line 24 states that a 6 MHz wide interval around the line center is kept at 31kHz resolution, while all other channels are binned with 50 channels. In Fig 6(b) the interval without binning looks much smaller than 6MHz. According to p. 14 line 1 the matrix with the measurement error  $S_e$  was assumed with constant diagonal elements which are calculated from the residuals after an initial run of the retrieval. However, the central channels without binning will have a higher measurement error as the ones without binning. Please provide also the range of measurement errors which were used in  $S_e$  for the daily retrievals. The retrieval errors in Fig 11 seem to be very small. Could this be an artifact of an underestimation of the measurement errors in  $S_e$  due to the binning at the line wings?

Where do the values for the apriori covariance in Fig. 5 come from?

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P. 14 line 7: "A second-order polynomial is also added to the retrieval ...". At which stage is it taken into account in the retrieval, and how does it affect the measurement response at the lower altitudes? Is it really a second order polynomial, or just a straight line?

P. 10 line 7 "The noise diode produces a signal that can be considered constant in frequency within 1.5%.". Where does this number come from, and can it be demonstrated in the VESPA22 measurements? Over which bandwidth is it valid? Presumably only 40MHz are used for the retrieval, but according to Eq. 20 the mean  $T_{ND}$  is calculated for a much wider frequency range.

Also the opacity of the Delrin sheet is assumed to be frequency independent. Is this really the case, or does e.g. the polynomial baseline fit change after changing the thickness of the Delrin sheet?

P. 12 line 6 claims that the noise diode temperatures measured with LN2 and tipping curve agree within 0.4%. However, the fluctuations of the tipping curve results in Fig. 4 seem to be in the order of several Kelvin, which should result in a higher discrepancy. Are these fluctuations measurement errors caused e.g. by an inhomogeneous atmosphere, or do they represent a real fluctuation of the noise diode ENR caused e.g. by changes of the laboratory temperature? Which value was used in the actual retrievals?

P 11 line 3: " $T_{atm}$  is the average temperature obtained from radiosonde data by weighting the tropospheric temperature vertical profile with the water vapor concentration profile." Is this weighting done with the water vapor vmr or with  $vmr \cdot p$  ?

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Minor comments on language and typos:

Several occasions: replace "depending from" with "depending on"

The abstract (p.1 line 3) mentions an integration time in the order of hours, but the paper discusses only the results of daily mean values.

P. 2 line 17: The statement "Positive trends were observed during the last two decades" is followed by citations from 1999-2001. This sentence should be reworded or backed by more recent citations.

P. 3 line 10: instead of "full beam at half power" the term "full width at half maximum" (FWHM) would be more common and is also used in the cited Bertagnoli 2012 paper

P. 3 line 19: "Two noise diodes are inserted in the IF chain" should read "RF chain". Preferably "IF" and "RF" should be explained at first instance.

P. 4 line 19 mentions the brand name "eccofoam", but earlier the window was identified as LD-15 which is a different material.

P. 9 line 3: The statement "The 'zero' signal is measured and subtracted to every acquired spectrum..." is misleading and could be understood that  $V_0$  is measured with every spectrum. Please clarify when and how often  $V_0$  is measured and whether it has a significant effect. Presumably it does not contribute at all to the result since the calibration with Eq. 13 and 16 uses always differences between two raw spectra.

P. 9 line 5: "..and subtracts the counts number from these two sources" should probably read "...numbers...".

P. 13 line 16 states that the central 400MHz are used in the retrieval. Since the Fig 68a) shows only 40 MHz this is most likely a typo.

P. 17 line 6+8: There seems to be a copy and paste error in the sentences "... integrated for second-degree polynomial 24 hours ..." and "The cyan line is the retrieved by the inversion..."

P. 22 line 20 and following: These paragraphs repeat the principles of the Delrin balancing, Eq 42 is very similar to Eq.8. Also the details of the sheets and how their opacity is determined are presented. In my opinion this would fit better to section 4.1 where the instrument and calibration are discussed, than into this section 6 "retrieval uncertainty".

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P23 line 30: "...of the datasets obtained with the different models [...] respect to the reference model dataset..." Apparently a missing "with" in [...], otherwise the sentence does not make sense to me.

Fig. 10: The labels (c) and (d) are missing in the lower two subplots. Fig. 17: The labels (a) and (b) are missing in the two subplots.

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[Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2017-264, 2017.](#)

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