General Comments

This manuscript presents IASI water vapour VMR profiles retrieved using the MUSICA algorithm and evaluates them against coincident GRUAN radiosonde profiles measured at three stations representing tropical, mid-latitude, and high-latitude conditions. The MUSICA MetOp/IASI water vapour retrieval method is described, averaging kernels and DOFS are presented, and the error budget terms are thoroughly evaluated. Vertical profiles of the errors are used to identify the dominant sources of uncertainty as a function of altitude. A total of 100 coincident GRUAN profiles are used for validation. These are regridded to the IASI altitude grid and smoothed with the averaging kernels prior to the comparisons. Correlation plots at three altitudes and vertical profiles of the mean relative difference and its standard deviation are used to quantify the agreement between the two datasets. Overall, IASI and GRUAN differ by less than 25% between 1.5 and 10 km altitude, and are within the errors for the two data products. The authors conclude that the MUSICA MetOp/IASI retrieval processor provides water vapour VMR profiles with good accuracy and captures variations between 1.5 km above ground up to the tropopause with a precision that is consistent with the theoretical error assessment. The manuscript is clearly and concisely written and I recommend publication after the minor comments below are addressed.

We thank anonymous referee #1 for the very useful comments with respect to content, but also for the careful technical corrections.

Specific Comments

Page 4, lines 9-15 – Se is used to denote the error covariance matrix in both Eqs. 8 and 9, implying that these are the same. However, the former is due to parameter uncertainties and the latter is due to measurement uncertainty. Rename one of them to clearly differentiate?

We will make the notations in line with the recommendations that are currently elaborated by the TUNER team.
The error covariance matrix due to parameter uncertainties will be called: $\mathbf{S}_{x,b}$
The error covariance matrix due to noise in the measured spectra will be called $\mathbf{S}_{x,noise}$
Furthermore, we will use *b* as the variable for parameters. The errors in *b* will be described by *Δb.*
Errors in the retrieval state vector will be described as *Δx*. Equations (7) – (9) will be written as:

$$\Delta x = -\mathbf{G}\mathbf{K}_b \Delta b \quad (7)$$

$$\mathbf{S}_{x,b} = -\mathbf{G}\mathbf{K}_b \mathbf{S}_b \mathbf{K}_b^T \mathbf{G}^T \quad (8)$$

$$\mathbf{S}_{x,noise} = \mathbf{G}\mathbf{S}_{y,noise}\mathbf{G}^T \quad (9)$$

Equations (1), (2), (3) and (4) will be changed accordingly.

Page 6, line 12 – 100 coincident IASI-GRUAN profiles is not a large number for a validation study, particularly for such a highly variable species as water vapour, even though they do cover three representative sites. Some discussion to justify that this number sufficient for good statistics should be added, perhaps citing other water vapour validation studies.

We agree that it would be desirable to have more profiles that can be compared. However, at the moment the here used 100 profiles are the only radiosonde profile data that have been processed with the GRUAN recommendations and that have been measured in coincidence with IASI observations. We will remark this in the manuscript and also discuss the use IASI-GRUAN collocation criteria in the context to other water vapour profile comparison studies.

Page 7, line 5 – Provide the collocation criteria for the Manus Island comparisons, as done for Lindenberg (lines 14-15). Similarly, provide them for Sodanklya at line 22.

Yes, we will better describe the collocation criteria for all three sites.

Page 7, lines 17-19 – Shouldn’t this information about the Manus Island IASI data version be included in Section 3.2? Comment on whether there are differences between v4 and v5. Also in Section 3.4, state which version is used for Sodankyla.

Yes, for all sites and comparison periods we will describe the used IASI L2 PPF versions.

Page 10, line 12 – The text says that “The right panel of Fig. 5 illustrates that . . . a cirrus cloud has a weaker dependency on wavenumber than a dust layer.” However, in this figure, the line for cirrus cloud (green) decreases more with wavenumber than does the line for dust (blue), suggesting that cirrus has a stronger dependency on wavenumber. Clarify.

We have used the term “weaker”, because the cirrus cloud has almost no signal at 1400 cm^{-1}, but a signal of -1.0 $mWm^2sr^{-1}(cm^{-1})^{-1}$ at 1190 cm^{-1}. The dust cloud has a signal at 1400 cm^{-1} of about -0.5 $mWm^2sr^{-1}(cm^{-1})^{-1}$ at 1400 cm^{-1}. In order to avoid confusion we suggest using “another”, instead of “a weaker”.

Page 11, line 4 – Here and elsewhere, why use “error pattern profile” rather than “error profile”? The xe in Eq. 7 and plotted in Figs. 7, 8, and 9, is just defined as the error. Delete “pattern” throughout, or define it.

Ok, we agree. We will use error profile and delete “pattern”.

Page 11, lines 15-20 – This paragraph doesn’t comment on the oscillations seen in the lower panels of Fig. 7. Add some discussion.

The error in the atmospheric temperature has the strongest impact on the retrieved state vector x at the altitudes where the temperature error is located. This explains why the black, red, green and blue lines peak at different altitudes. The oscillation of a single error profile can be understood by Eq. (7), which is used for calculating the error profiles. Errors in the temperature propagate to the spectra according to $\mathbf{K}_b$ and are then interpreted according to **G**, which in turn depends on the constraint (second part of the Cost function 2).

Page 14, Section 5.1 and Figure 11 – In the text or the figure, provide the slopes in linear space and the correlation coefficient R2 for each of the panels.

We will provide a Table with the R^2 values and the 95% confidence interval of the linear regression line slopes.

Page 14, line 18-19 – Explain why the two terms in Eq. 15 are approximately equivalent.

Because $\Delta \ln(x) = {}^{\Delta x}/_{x}$ we interpret the logarithmic scale difference between IASI and GRUAN as the relative difference (and use GRUAN data in the denominator).

Technical Corrections

We will consider all the technical corrections listed below.

Page 1, line 8 – degreeS

Page 1, line 13 – coincidENT

Page 1, line 15 – but never exceeds 30%

Page 1, line 17 – in accordance WITH the

Page 2, line 10 – aircraft AND satellites

Page 2, line 16 – delete respective

Page 2, line 34 – outcomeS

Page 3, line 3 – introduction to the

Page 3, line 8 – THE forward model F), which relates the

Page 3, line 9 – add period after equation

Page 3, line 18 – delete level

Page 3, line 20 – whereby THE kind

Page 4, line 21-22 – reorder cited references

Page 4, line 22 – delete ranging

Page 4, line 27 – HITRAN 2016? could state this explicitly

Page 5, line 3 – a priori PROFILE

Page 5, line 11 – by THE US Geological Survey

Page 5, line 17 – differences COMPARED to the

Page 6, line 11 – observationS

Page 6, line 16 – could change “mid-latitudinal” to “mid-latitude” throughout

Page 6, line 20 – FOR more details

Page 7, line 5 and 13– coincidences WITH

Page 7, line 13 – representative OF all

Page 7, line 16 – As for Manus

Page 8, line 14 – Fig. 4 (not 5)

Page 9, line 7 – delete hypothetically

Page 9, line 13 – coverage BY opaque

Page 10, line 24 – The error profiles shown are

Page 11, line 32 – maximUM errors

Page 12, line 2 – in Fig. 8.

Page 12, line 4 – Strictly, Fig. 9 shows the influence of cloud type on the errors, rather than the retrieval.

Page 12, line 5 – Now using “humidity” as equivalent to water vapour VMR – is that correct?

Page 12, line 10 – Fig. 9 middle row shows results for clouds at 4.9 km, not 3.0 km, at Manus Island and Lindenberg. Clarify this in the discussion.

Page 12, line 10 – Elsewhere, altitude above ground is referenced, rather than altitude above mean sea level. Check that terminology is correct.

Page 12, line 13-14 – errors are more than 10%.

Page 12, line 18 – (FOR details

Page 12, line 21 – This differs from the

Page 12, line 22 – for THESE different

Page 12, line 25 – “So we have to” – rather colloquial

Page 12, line 31 – put ON the . . .

Page 13, line 1 – thereby preventing the correction from producing strongly oscillating profiles

Page 13, line 32 – and in situ data identify well

Page 14, line 8 – delete if

Page 14, line 9 – VMRs (rather than concentrations – two references)

Page 15, line 5 – agreement WITH the

Page 15, line 14 – representative OF three

Page 15, line 28 – giving the study presented here a good

Page 16, line 2 – The MUSICA MetOp/IASI data presented here are

Page 17, line 7 – radiosonde CAN be

Page 17, line 14 – depicts the correlated

Page 17, line 26 – ground to 5-20%

Page 22, Figure 1 – spectrUM

Page 25, Figure 4 – degreeS; spelling of Lindenberg is incorrect in the figure

Page 26, Figure 5 – Since (4-6km) altitude range is given for Dust in the legend, could add (13-14km) for Cirrus.

Page 27, Figure 6 – error profiles derived from instrument noise

Page 28, Figure 7 – delete different

Page 29, Figure 8 – Font size for site names is different from Figures 7 and 9. Also smaller in Figure A.2.

Page 31, Figure 10 – x-axis label is Water vapour, but H2O used in other figures. In caption: MetOp/IASI retrieval OF H2O profiles.

Page 32, Figure 11 – Add linear slopes and correlation coefficient R2 to each panel. In caption: Red and black colourS