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Interactive comment on “Optimal estimation of tropospheric H₂O and δ D with IASI/METOP” by M. Schneider and F. Hase

Anonymous Referee #1

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General Comments:

This paper shows comparisons between satellite-based estimates of delta-d and H₂O and those from an up-looking FTS. The H₂O estimates are further compared against nearby sonde measurements. The paper can be greatly improved with some modifications to the presentation but as far as I can tell no further change to the analysis is needed. In general I recommend adding some additional text on how the IASI retrievals from PROFITT differ from those in Herbin et al. 2009. I think the main difference is that the constraints used by Herbin are much looser than those used in the PROFITT code and consequently the uncertainties are much larger. In addition, as noted in the manuscript, it is critical that the comparison shows that the actual and calculated errors are consistent in order for the data users to be confident in these estimates. While

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these comparisons are effectively shown in the paper, they are shown in a roundabout manner; the paper could be improved if the authors explicitly state these comparisons in the abstract, text, and conclusions. E.g., add a statement along the lines of “The calculated error in the comparison between the IASI based delta-d estimates and the uplooking FTS based delta-d estimates is approximately XXX per mil. The actual errors (RMS between IASI and ground-based FTS) are YYY per mil.” A similar statement for the water estimates would also be useful.

Abstract: Line 1: Awkward grammar. Maybe instead say: “We present estimates of H₂O and delta-d derived from radiances measured by IASI.

Line12: Replace ‘quasi’ with ‘near’

Line 15: replace ‘confirms’ with ‘is consistent with’

Page 16109 Line 6: Change ‘the large potential of water isotopologues’ with ‘the potential of water isotopologues for assessing the distribution of hydrological processes’

Page 16109 Line 26: The word ‘quasi’ means ‘virtual’ or ‘resembling’. I think you mean ‘approximate’ or ‘near’ instead.

Page 16110 Line 11: Replace ‘validate them. Therefore we compare’ with ‘validate these calculated errors with comparison between’

Page 16110 Line 16: Define PROFFIT and PRFFFWD acronyms.

Page 16113 Line 9: State whether the radiosondes are launched near Tenerife or are used to construct a gridded climatology globally. I am assuming Tenerife since you are comparing to the local FTS measurements but it would be useful for the reader to know as well.

Page 16113 Line 23: The reader might be confused by use of per mil in this description. Adding a statement that 80 per mil is approximately .08 near the surface would be helpful.

Page 16116: Add equation for gain matrix as the calculation of the derivative of x with respect to the radiance is not obvious to those not familiar with optimal estimation.

Page 16116: Equation 7 is useful for examining the different error sources and how to add them together as well as examine their cross terms but does not describe the statistics of the uncertainties in “ x ” since it assumes that the parameter ε is some bias term. Perhaps this is why some of the values in Figures 4 and 5 are negative? That would imply that you could add these terms up and they might offset each other since they are bias terms. However, a biased form for the errors is highly unlikely for temperature, emissivity, and interfering species because these uncertainties are derived from a noisy spectra, but a biased form is likely with the spectroscopy uncertainties. I would include the covariance form for this equation to Equation 7 and then plot the square root of the diagonal of this term; this is essentially what you already plotted except that this term will always be positive.

Page 16116: Are these land or ocean scenes? For ocean, the emissivity uncertainty should be much smaller than 5%. Also, are you correlating the uncertainties (off diagonals of S_a) for emissivity? If the emissivity parameters are un-correlated this could introduce significant propagated error into your retrieval. (e.g., If the satellite sees land at one frequency one would expect it to see land in another).

Page 16118: Reference Worden et al. and Schneider et al. at the end of line 8.

Page 16118 Line 23: Pun intended? Add a comma after ‘Naturally’.

Page 16119: This error description is confusing. As mentioned earlier I would calculate the expectation of equation 7 to obtain the expected covariance of these errors. Also, there is no smoothing error term in Figure 6 which could lead the reader to conclude that the errors near the surface are dominated by random error whereas in fact the primary error in the estimate near the surface is essentially due to lack of sensitivity.

Section 4.3 and 4.4. This is in general a very nice comparison between the IASI H₂O,

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sondes, and uplooking FTS. However, the way the section is written is somewhat confusing. For example, the comparisons between PROFFIT H2O and Sonde H2O as well as IASI delta-d and FTS delta-d will, in the absence of systematic errors, agree to within the uncertainties described in the previous section and any residual “smoothing error” (Equation 9) due to the limited vertical sensitivity of the measurements. (1) For the water comparisons it would be useful to see the calculated random uncertainties in Figure 9 to see if they agree with the actual random uncertainties (since smoothing error is removed in this comparison). (2) For the delta-d / FTS comparisons it would be useful to see the residual smoothing (Equation 9) PLUS the random errors along with the correlation plots or stated in a table. In principal these actual and calculated uncertainties should approximately agree (although the calculated should be less than the actual due to remaining systematic and “non-linearity” errors).

Figure 1: this figure will be more meaningful if the radiance residuals are in a separate figure (e.g. multi-panel figure) with the estimated noise over-plotted with the radiance residual. A key aspect of optimal estimation is error characterization and this characterization only applies if the retrieval converges to the noise level or you can account for any remaining radiance residuals between model and data.

Figure 2 and 3 and corresponding text: The discussion on the averaging kernels is somewhat subtle and may be lost on most readers. . . . The main point from Figure 2 (and 3) is to show where the estimate has peak sensitivity. I would just show either the columns or rows (my preference is row) of the averaging kernel as either one will effectively suffice to make your argument. However, if the purpose of showing both column and row is that you are also trying to show that there is significant cross-correlations in the estimate that must be taken into account then you might want to emphasize this point in the text.

Figure 3: The delta-d estimates described by Herbin et al. have much greater sensitivity (and error) to delta-d than you calculate. I think this is because they use a much looser constraint. You might want to point this out in the text.

Figure 4-5: Captions within plots are small, can you make bigger?

Figure 13-14: As noted earlier, add the calculated uncertainties (residual smoothing + random) in these figures or in a table.

References: You should consider adding the Rodgers and Connor Inter-comparison paper as a reference

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 16107, 2011.

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