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Atmospheric Measurement Techniques Discussions

Interactive comment on "Total Column Water Vapour Retrieval from S-5P/TROPOMI in the Visible Blue Spectral Range" *by* C. Borger et al.

Anonymous Referee #1

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Review of Total Column Water Vapour Retrieval from S-5P/TROPOMI in the Visible Blue Spectral Range by Christian Borger et al.

This paper presents a study where the authors have developed an algorithm to retrieve total column water vapour (TCWV) from 'blue' portion of the visible spectrum band on Sentinel 5-P/TROPOMI, and make comparisons with some validation sources.

This is an interesting study, and is a good example of exploiting the potential satellite data beyond that which was intended by the developers of TROPOMI. It is certainly of interest to the AMT community, and I recommend publication, if the following points and concerns are addressed.

General Comments

In general, the paper lacks context to the wider TROPOMI picture, and only very briefly states the justification for why the authors attempt TCWV retrieval in the blue part of the visible spectrum. Even here, this discussion is in relation to the 'red' portion of the visible spectrum (where the authors have experience), and not products from other spectral regions (e.g. the SWIR). Especially since the errors can get quite high with these retrievals (up to 50%), I think the authors need to discuss the added benefit of retrievals from the 'blue' band to TROPOMI. The authors very briefly give some discussion to this in the conclusions (processing time, etc), this needs to be expanded upon.

The authors identify TCWV products from other spectral regions on other instruments (e.g. TIR from AIRS), but there is no discussion on how TCWV from the 'blue' band compare to the TCWV products from these other instruments and spectral regions. This discussion needs to be included into the paper.

Section 1 – The Introduction.

Context is lacking in this section, it is unclear as to the advantages of retrieving TCWV from this particular spectral region. Given the other spectral bands and satellites that the authors mention, and not just the 'red portion' of the spectrum.

Indeed, the authors have not referenced the study covering water vapour retrieval from the 2305-2385 nm TROPOMI spectral band (Schneider et al., 2020), which would have been in the AMT discussion forum at time of submission. They have also missed water vapour retrieval studies from the Shortwave Infrared (SWIR) in general, this is very strange since the SWIR gives good sensitivity to the surface e.g. (Trent et al., 2018), and surface sensitivity is clearly one of the key selling points for the 'blue' region.

Section 3 – A priori water vapour

While the aim of this section is clear, the story of how the methods that are used are a little unclear, and the general message gets a little lost in the details. Here in

section 3, I think a few sentences that summarises the processes that are undertaken in sections 3.1 and 3.2 would be useful. Readers may well be unfamiliar with COSMIC and ROMSAF, and some background would be beneficial here. Given the importance of the a priori profile on the results, some discussion on the biases associated with using COSMIC as a base would be welcome.

Section 6 – Validation study.

More detail about the SSMIS and SuomiNet data are needed here, fundamentally why did the authors choose these measurements for their validation, and why are they appropriate for TROPOMI inter-comparisons?

In the introduction the authors identify some specific advantages of retrieving TCWV from the blue part of the spectrum as opposed to the red, which has been done previously. To me, the validation section would have been a good opportunity to compare against TCWV data from the red part of the spectrum, not necessarily from TROPOMI, but from other satellites. Indeed comparisons from other 'blue' TCWV measurements from OMI as identified by the authors would have been useful, to identify any potential differences between the spectral regions. Or, please justify their exclusion from the study. Validation is largely done using TCWV retrieved from microwave instruments, are there any particular biases associated with TCWV retrievals, when compared against the visible band?

Other

With regards to the English, the paper could be improved given a review by a native English speaker. I will not go into detailed specifics in this review, but this paper would benefit from a greater use of punctuation (i.e. commas).

There are a large number of figures in this paper, and while I applaud the efforts of the authors for the detail they have gone into, 26 figures + 14 in the appendices is unneeded for a journal paper, which should only be showing the key highlights. I

suggest to the authors to place some of these figures in supplementary materials.

In addition, on some of the Figures the axis labels and legends are quite small (e.g. Figure 5), I recommend that the authors increase the font size.

Additional thoughts

I note that the authors have stated that their dataset is available on request, I would strongly encourage them to place their dataset into an online repository.

Specific comments.

On p3, line 75. The authors state that the absorption is weak in the fit window, and hence the line lists vary. I am not convinced by this argument, to me just because absorption is weak the uncertainty of the spectral lines shouldn't necessarily be higher, does HITRAN state this? What exactly is different between the databases, is it the position of the lines, the number of lines?

P4, line 91. Why are the data shown from Figures 1 and 2 based on different orbits? It'd be more consistent to show the same orbit results.

P5, Equation (4) – The calculation of atmospheric refractivity is highly dependent of air pressure and air temperature. Therefore the scale height for the water vapour profiles is highly dependent on knowledge of these factors. How accurate is this knowledge, and how sensitive is the calculation of scale height to errors in the knowledge of air pressure and air temperature?

P5, line 143. Why 63% (assuming this is total water vapour up to 150 hPa)? Is this because there is not much water vapour above this point? If so, this should be stated.

P5, line 147. Why 7%?

P6, I think Figures 5 and 6 could be moved to the appendices or supplementary material. For Figure 5, it is very unclear to me exactly what causes the 'bad' profiles, as opposed to the good profiles, this needs to be expanded upon.

P7, line 187. How are ocean and land differentiated? What about heterogeneous scenes or lakes?

Figure 14. The authors claim that there is a distinct separation of the H2O VCD between land and ocean, which vary between albedo versions. I did see it eventually, but it is quite subtle, this might be represented better if focused upon? Also, I don't feel that the inclusion of this Figure is particular beneficial to the paper, and can be placed in supplementary material.

P10, section 5. There is no discussion on instrumentation errors such as ILSF biases and radiometric errors. Can you comment on the impact of these?

P11, line 316. Is the spectroscopic uncertainty not as significant as any of these other factors? It would be useful to state the impact of this uncertainty in relation to the others. These are mentioned in the summary, but would be useful in the main text as well.

P15, summary and conclusion. Can you comment on the uncertainty of the retrievals (you say up to 50%) in comparison to TCWV retrievals from other spectral bands.

P15, lines 469-471. Here the authors state that the retrieval allows for a fast execution of large datasets. This to me is one of the key benefits of the retrievals in this waveband, however this is the first time that it has been mentioned in the manuscript. A brief discussion on processing times, and comparisons with other TCWV products would be beneficial.

Technical P2, line 45 – A reference should be added for the increase in TROPOMI spatial resolution to 3.5x5.6.

P3, line 83 – Band 4 is mentioned for the first time, please identify what TROPOMI Band 4 is.

A number of the equations appear to be missing equation numbers, e.g. the AMD calculations p4, lines 106, 111.

P5, line 120 – Could you provide an explicit statement for what is meant by scale height please.

P5, line 130 – Please define ROMSAF.

P5, line 135 – GPS RO allows to retrieve profile information -> GPS RO allows for the retrieval of profile information

P15, line 468 – and Sentinel 5

P19, line 534 – greak -> great

References

Schneider, A. et al. (2020) 'First data set of H2O/HDO columns from the Tropospheric Monitoring Instrument (TROPOMI)', Atmospheric Measurement Techniques, 13(1), pp. 85–100. doi: 10.5194/amt-13-85-2020.

Trent, T. et al. (2018) 'Observing Water Vapour in the Planetary Boundary Layer from the Short-Wave Infrared', Remote Sensing, 10(9), p. 1469. doi: 10.3390/rs10091469.

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