

Review report for “OMI Total Column Water Vapour Version 4: Validation and Applications”

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General comments

In this manuscript, the version 4 TCWV retrieval from OMI is validated against ground-based GPS TCWV retrievals over land and SSMIS satellite microwave retrievals over land. Differences of the version 4 retrieval with previous versions have been described, although a detailed analysis of the improvement with respect to the previous version is still lacking. I will point out some specific examples where such an additional comparison might be included in the manuscript. Also the interpretation of some of the findings for the OMI TCWV differences with TCWV from GPS or SSMIS is lacking, see again below in my specific comments.

Thereafter, 3 well-chosen examples show the importance of having a global TCWV dataset, here from OMI. These are nice demonstrations of the TCWV product, but the authors might argue more what the added value of in particular OMI TCWV (and version 4) is for those applications, compared to other satellite retrievals or reanalyses.

Specific comments

- Page 1, line 10: I would write out “OMI” already in the abstract, as well as WRF (on line 28).
- Page 2-3, lines 58 –60: to me, it is strange to already mention a result of the analysis in the introduction of the manuscript. I would drop this sentence.
- Page 3, lines 72-73: here again, you already mention a result of this study in the introduction. Reformulate please.
- Page 3, line 80: data filtering criteria are recommended
- Page 4, lines 96-100: rather strange formulation. I would start the sentence with “In the non-linear least square fitting, we consider...” And also, please reformulate “In addition to water vapour” to a more specific formulation as e.g. “the use of spectroscopic water vapour dataset”.
- Page 4, lines 100-108: to a reader that is not entirely in the satellite data retrieval field, it might seem ought that you start the discussion here with what version 4 is not using (common mode) in the fitting. Perhaps describe first how the fitting is done with version 4 and then describe the disadvantages of the common mode.
- Page 4, lines 109-110: as it turned out that the choice of the water vapour reference spectrum really matters for the comparison between the version 3 and 4 TCWV retrievals (later in the manuscript), you might comment on why you use an “older” water vapour reference spectrum in version 4 than in version 3.
- Page 6, lines 134-139: is the compromise for the wavelength interval as retrieval window for version 4, chosen for a particular orbit number and geographical area, also tested/valid for other orbits and other areas? Please comment.

- Page 6, lines 140-145 and Fig 2.: I really do not understand what is represented in Fig 2. Is this the overall median SCD of the entire dataset or also for the same orbit and geographical area as in Fig. 1? Please specify.
- Page 8, lines 184-185: from which dataset do you obtain the “mean elevation within the corresponding $0.25^\circ \times 0.25^\circ$ grid square”?
- Page 9, lines 203-204: “because the fitting includes many other interference molecules whose reference spectra may also contain errors within the retrieval window” → are version 3 and version 4 not using the same reference spectra for those molecules? So the errors in those reference spectra should then give the same effect in both version 3 and 4, no?
- Page 9, lines 211-212: “This indicates a positive bias of OMI against GPS for small TCWV and a negative bias for large TCWV”
- Page 11, lines 235-236: what might be the reason for the rapid increase of r from $f=0.05$ to $f=0.15$? The other parameters are changing more smoothly between the different f ranges (as well as the r for the other f ranges).
- Page 13, lines 267-268: “suggesting that OMI cloudy TCWV is larger than OMI clear TCWV in general”. Come up with an explanation here.
- Page 13, lines 273-274: “In most cases, higher cloud fraction thresholds correspond to larger σ values.” Give an explanation here.
- In Section 3.2, you do not compare the version 3 OMI –SSM TCWV retrievals with the version 4 OMI – SSM TCWV retrievals. As you did it for GPS (over land), we lack the information of the version 4 behaviour w.r.t. version 3 over the oceans.
- Page 16, lines 348-351: this part belongs to the section describing the sensitivity of the OMI-GPS TCWV differences, and not here.
- In contrast, I would add a paragraph at the end of section 3 in which you mention the overall conclusions of the OMI TCWV validation with both GPS and SSMIS (e.g. best agreement in the 10-20/30 mm range, worse for smaller & higher TCWV ranges + reasons) and some conclusions on the improvement of version 4 over version 3.
- Page 17, Fig 7a: indicate the July 2010 and July 2015 epochs on the time series of the ENSO index.
- Page 17, lines 368-373: mentioning Level 3 and Level 2 for creating the different climatologies is confusing to me. Basically, you first construct the long-term (2005-2015) July TCWV monthly mean map (climatology). Then you create the July 2010 monthly mean map, and the July 2015 monthly mean map and you calculate the differences of those monthly means with the long-term July climatology, right? Shouldn't you use exactly the same dataset (Level 2 or Level 3) for those monthly mean maps?
- Page 17, lines 374-377: personally, I would prefer not to use the verbs “increases” and “decreases” when comparing a monthly mean of a specific month with the long-term monthly mean (=anomalies), but rather reserve those verbs in describing trends in time series. I would rather use “is elevated/higher w.r.t. “
- Page 18, line 381: if you give a possible reason for the differences in details, then you should also specify what those “differences in details” are.

- Page 20, line 412: write out NARR.
- Page 20, line 418-419: Describing Figure 9, you write that “TCWV is generally lower in the run without evapotranspiration”. This is true, except in the lower boundaries of the box. Where does it come from?
- Page 21, lines 439-448: You use a very detailed description of the AR event of 6-7 Nov 2006, based on datasets that are not used/shown here. Could you not describe the event shorter – process-wise – and refer to the frequently cited Neiman et al. 2008 paper for more details?
- Page 22, lines 465-466: “is consistent with the dark stripe in the upper tropospheric water vapor image obtained by GOES-11” → show similarities to the formation processes, not to datasets or observations not shown here.
- Page 24, Figure 11: please add in the figure caption that the grey color coding means no data available.
- Page 25, line 523-524: specify the “error” in the simulated AR structure (i.e. too strong southern filament of TCWV).