Validation of OMI Total Column Water Vapor Product

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General comments:

In the manuscript “Validation of OMI Total Column Water Vapor Product” the authors compare the Collection 3 OMI Total Column Water Vapour product with the NCAR's ground based GPS data, the AERONET sun-photometer data and the Remote Sensing System's SSM/I data set. The knowledge of the global distribution of water vapour is fundamental for global atmospheric models aiming to predict weather and monitor climate and is well within the scope of the Atmospheric Chemistry and Physics journal. This is also an important contribution since it exploits the possibility of retrieving water vapour in the blue spectral range and the future Sentinel missions will all lack spectral coverage in the green to red part of the spectrum (above 500 nm)

Substantial conclusions are reached regarding the influence of liquid water on the large low bias observed over ocean and the necessity to reduce the retrieval window to improve the overall consistency of the data set. The 430 - 480 retrieval window used by Wang et al. contains two water vapour bands. By exploiting a smaller (427.7 – 465.0 nm) retrieval window optimized around the 7v band, the authors found a better agreement with the other data sets.
The results and explanations are sufficient to support the interpretation that the large fitting residuals observed over ocean depend on errors in liquid water spectroscopy and water vapour cross sections. Level 2 TCWV data obtained using a new setups are compared with the SSM/I data under different cloud conditions and clearly show an improved agreement. Moreover, the updates discussed in the paper will be considered in the next release of the Smithsonian Astrophysical Observatory OMI water vapour.

The paper is well organized and the validation results are presented in distinct and balanced sections for the different data sets: GPS, AERONET and SSM/I. After a description of the different products and filtering procedures used for the comparisons, the quality of the OMI data is investigated via time series comparisons, spatial distributions and histograms of the mean and median differences. However, the statistical significance of the results hasn't been deeply discussed. More detailed comments are addressed below.

Detailed comments:

Section 3: Comparison results: While discussing the filtering criteria for OMI, the authors empathize the importance of mitigating the cloud influence. It would be useful for the reader to add a more detailed description of the cloud treatment (derivation of cloud fraction and cloud pressure) and to discuss the effect of applying the filtering to the original product (TCWV statistics, global sampling along with other effects).

Section 3.3: OMI and SSM/I: The authors compare the monthly mean SSM/I and OMI data under ‘all’ and ‘clear’ sky conditions and obtain larger negative values in the latter case (for July 2005). However, as suggested by the results of Figure 9, the mean bias between daily gridded SSM/I and OMI data is slightly larger for the ‘all’ sky data (for July 2007). I would suggest to use only daily co-located measurements to perform the monthly comparisons (Figure 8). In fact, a large bias might arise from the different sampling in cloud-free and cloud-contaminated products when comparing Level 3 data sets.

Results concerning the comparison between the SSM/I and OMI old and new products are showed for July. Could you please extend your analysis also to other months or comment on the seasonality (if any) of the outcomes?

Section 4: Algorithm Update: The authors derived the 427.7 – 465.0 nm retrieval window by optimizing around the 7v water vapour band in the OMI spectra. Could you please further motivate this choice and discuss the sensitivity of water vapour to other retrieval window choices?

As shown in Wang et al. (2014), the fitting uncertainty for shorter retrieval window is larger, but the median SCDs decreases as the retrieval window length increases. How these results compare to the current analysis?

The authors state that the differences between the new algorithm and the Version 1.0.0 algorithm mainly come from the change in the retrieval window. Could you please quantify the effects of each modification to the original algorithm?

Although the proposed update to the retrieval algorithm goes in the direction of reducing the bias between the OMI product and the other data sets, residual uncertainties might arise from the AMF calculations, clouds treatment, aerosols, and so on... Could you please give a general comment on the performance of the algorithm (and in particular with respect to the AMF conversion)?

Summary: The new water vapour algorithm can significantly increase the retrieved TCWV over the ocean without affecting those over land much. It might be beneficial to compare the results obtained with the new algorithm with an independent global data set (for example ECMWF reanalysis data, GOME, SSM/I + MERIS...).

Figure 2, 5: The labels of the time series plot could be improved setting regular (yearly) time intervals.

Figure 3, 6 (top): I would suggest to use a discrete scale of coloring to improve readability.