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Discussions

Interactive comment on "Total column water vapor retrieval for GOME-2 visible blue observations" *by* Ka Lok Chan et al.

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We thank reviewer #2 for the time to carefully reading the manuscript and providing useful comments. We understand that these comments are positive on the scientific content of the manuscript while appropriate revisions and clarifications are necessary. We have addressed the reviewer's comments on a point to point basis as below for consideration. All page and line numbers refer to the marked-up version of the manuscript.

The paper titled 'Total column water vapor retrieval for GOME-2 visible blue observations' by Chan et al. presents a new method to retrieve total column water vapor(TCWV) from GOME-2 spectra in the blue wavelength band. Slant column water vapor is retrieved using the DOAS spectral fitting technique, and subsequently con-

verted to vertical column using Air Mass Factor (AMF). A dynamic search approach is used to find suitable a priori profile for the AMF calculation. The new algorithm is then applied to retrieve TCWV from GOME-2A and GOME-2B observations. TCWV results from GOME-2A and GOME-2B are also validated against GOME-2 measurements in the red band, sun-photometer and radiosonde measurements. The comparisons show that new blue band retrieval in general shows good agreement with other data sets, and proofed the reliability of the new algorithm. In general, this manuscript presents an interesting results. However, there are still some concerns need to be addressed before publication in AMT.

1) The author introduced the source of a priori water vapor vertical profile in section 3.1.4, which is the statistical result of ERA reanalyzing data for 10 years. In section 2.6, it explained the horizontal and time resolution of ERA data but did not explain the vertical resolution. The vertical resolution and the number of layers should be clearly explained here, because the layer of a priori profile is used to calculate the AMF.

Response: Following the reviewer's suggestion, we have supplemented the number of vertical layer and the resolution of the ERA Interim data set in section 2.6 (page 8, line 3-7).

2) The third line on page 13 of the author indicates that "using a priori profile from model is not optimal for our water vapor retrieval", but the ECMWF ERA data used by the author is also the result of numerical simulation. Here the author only needs to emphasize that the a priori profile used is statistical data, which can reduce the model error.

Response: We followed the reviewer's comment, deleted the sentence and emphasized that the profile information is taken from statistic analysis of historical profiles (page xx, line xx).

3) The author wrote in the third line on page 16 that the profile below cloud is taken from the a priori profile. The water vapor below cloud is close to the atmospheric boundary

layer, where the water vapor concentration is high and the change is large, so this approximation will produce a large error. In addition, should the thickness of the cloud layer also be considered?

Response: The reviewer is right that cloud shield the water vapor column below cloud and hence result in larger error for cloudy scene pixels. The treatment for cloudy pixel follows the independent pixel approximation where the pixel is separated into two independent parts, one with fully cloud cover and the other one is completely cloud free. We have provided a detailed error approximation for cloudy pixel in section 3.1.10. Similar to other tropospheric species, e.g., NO2, we do not recommend user to use data with high cloud fraction. We have also excluded data with intensity weighted cloud fraction larger than 0.5 in our analysis (page 21, line 25). In addition, the thickness of cloud is already considered in the retrieval (see page 16, line 18-21).

4) The authors mentioned the level 1B issue appears at wavelength larger than 460nm, and that is why they avoided including longer wavelength in the spectral analysis. However, we still see a jump of TCWV in 2015 when switching the level 1B data version. The authors should explain why this is still happening even they did not use wavelength longer than 460 nm in their analysis.

Response: The contamination of version 6.0 level 1B data is due to the incomplete removal of Xenon line in the GOME-2 calibration key data. The calibration key data was taken during the preflight on-ground calibration and the calibration key data are used as input for the level 0 to level 1B data processing. The contamination of level 1B data shows negative impact in band 3 while the impact is more significant for wavelength longer 460nm. Therefore, the update of level 1B data also shows an impact on the TCWV product. We have further clarified this point in the manuscript (page 5, line 25-28).

5) The details of the spectral fitting settings are scattered in the text which is quite difficult for the audience to follow. I would suggest the authors to summarize this infor-

mation in a table.

Response: We have now summarized the spectral fitting details in Table 2.

6) The comparison of TCWV to the retrieval in the red band shows a positive bias over vegetations, e.g., South America and Central Africa, which the authors claim that this is related to the uncertainty of the surface albedo data set. The authors also mentioned that they are trying to improve the albedo database to by using new surface albedo retrieval. It would be nice to show some preliminary results (if available) to show the new method can potentially reduce this bias.

Response: Larger differences between TCWV retrieved in the blue and red band can be observed mainly over vegetation, e.g., south America and central Africa. This is mainly related to the large uncertainty of surface albedo over these areas. We are working on improving the albedo by using a new technique (Loyola et al., 2020). However, this technique has not yet been implemented for GOME-2 measurements in the blue band. Therefore, no preliminary result is available.

7) Page 23, line 15-16: When the authors compare big data sets (sample size > 10k), even a small bias is significant, so I think there is no need and uncommon to mention the P value.

Response: We have deleted the sentence.