Interactive comment on "Validation of GOME-2/MetOp-A total water vapour column using reference radiosonde data from GRUAN network" by M. Antón et al.

Author's answer to Anonymous Referee #1

The authors greatly acknowledge the anonymous reviewer (Referee #1) for carefully reading the manuscript and providing constructive comments.

Specific comments

Referee Comment: The authors state (pag. 9576) that both data from GDP4.6 and GDP4.7 are used, I think this corresponds to the 1400 cases mentioned in the abstract and in section 3. But then, in the analysis of the geometrical parameters (pag. 9583) it is stated that only GDP4.6 is used, however it seemed to be the same dataset. What is the dataset in this case, how many data points? Please clarify

Author's response: The whole number of satellite-sounding data used in this work was 1400. From this figure, 1204 correspond to satellite data from GDP 4.6 and the remaining (196) from GDP 4.7. In the revised version of the manuscript, the analysis of VZA dependence has been performed using exclusively GOME-2 data from GDP 4.6 for those cases with satellite SZA smaller than 50º in order to minimize the effect of SZA dependence on the relative differences. Hence the number of pairs of data used to analyze the VZA dependence is 617. This information has been added to the manuscript in order to clarify this issue.

Referee Comment: In the beginning of Section 4.2 the authors mention the use of three data sets (all data, CF<5% and CF>50%). But then I could not understand the meaning of the next sentence when it is referred that "The percentage of cases selected is about 39% for cloud-free conditions and 31% for cloudy conditions". Could this be connected with my previous comment on GDP4.6 dataset? Were all 1400 cases considered?

Author's response: The cloud fraction of the satellite scene is measured in percentages with values between 0% (completely cloud-free conditions) and 100% (completely cloudy conditions). For our study, we consider cloud-free cases as those with CF smaller than 5% (0%-5%) and cloudy cases as those with CF higher than 50% (50%-100%). The analysis of SZA dependence (Figure 2) has been performed using all data (1400). Hence, we have 546 (39%) of cloud-free cases and 434 (31%) of cloudy cases. This information has been also included in the revised version of the manuscript.

Referee Comment: Although the authors state that the relative differences between GOME-2 and GRUAN data do not present a significant dependence on CTP for SZA>50(Fig. 6), it is curious to note that, in this case, the relative differences are nearly zero for low CTP (higher clouds). Apparently the shielding effect of clouds is not important for higher SZA or what could be the reason? Do the authors have an explanation for this? In fact, this apparently contrary behavior for higher and lower SZA, respectively, result in an overall decrease of the relative differences (in absolute terms) with decreasing CTP (increasing cloud top height), which would seem to be in disagreement with the explanation given by the authors regarding the shielding effect of clouds.

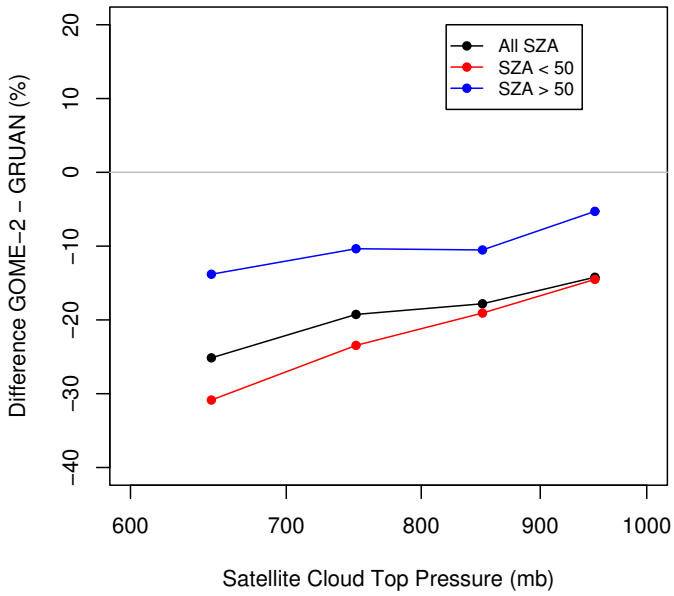
Author's response: The reviewer is right and the results shown in Figure 6 of AMTD paper are apparently in disagreement with the shielding effect associated with clouds. We have analyzed in detail the data used to build this plot in order to clarify this issue. Hence we found the stable behavior shown for SZA>50º is related to the balance between cloudy cases with CF between 5% and 50%, and cloudy cases with CF larger than 50%.

Nevertheless, in the revised version of the manuscript and following the suggestion given by the reviewer #2, we have analyzed all dependences using the weighted mean bias error (MBEw), determined as:

$$\mathrm{MBEw} = \frac{\sum_{i=1}^{N} RD_i \cdot \frac{1}{\sigma^2(RD_i)}}{\sum_{i=1}^{N} \frac{1}{\sigma^2(RD_i)}}$$

where σ (RD) is the combined uncertainty of the sounding-satellite relative differences (RD) which has been obtained from the estimated errors of both satellite and sounding datasets.

Hence the new plot showing the CTP dependence of these differences is:



Therefore, it can be seen that the relative differences increase (in absolute term) with decreasing CTP (increasing cloud top height) for both small and large satellite SZA cases in agreement with the shielding effect.

Referee Comment: GDP 4.6 is affected by a scan angle dependency that introduces a bias between East and West ground pixels, which was corrected in GDP 4.7. In this work, 86% of the data used is from GDP 4.6 (Section 2.1). Is it possible that the results presented regarding the dependence of the relative differences between GOME-2 and GRUAN data on the different cloud quantities are somehow altered due to this East-West bias? Please include a comment on this.

Author's response: We agree with the reviewer that the VZA dependence of the sounding-satellite differences for the outermost west satellite pixels using GDP 4.6 data could affect the results obtained from the analysis of the cloud parameter effects. To avoid this shortcoming, we have decided to remove from the cloud analysis those GDP 4.6 data with VZA higher than +30º. The number of deleted data is small (81 out of 1400) and the new results and plots are very similar to the previous one. We have included in the revised version of the manuscript a brief paragraph explaining this issue.

Technical corrections

Author's response: All technical corrections have been incorporated.