

## Reply to comments of Referee #1 on the manuscript “GOME-2 total ozone and assimilation in MACC” by N. Hao et al.

We would like to thank Anonymous Referee #1 for his/her helpful comments and suggestions. In the following, we will reply to them point by point, including the reviewer's text in italic and blue.

*This paper does a good job of showing the consistency of the GOME-2 instruments on MetOp-A and MetOp-B satellites. Since the GOME instruments are the source of important global ozone data the details presented in this paper are scientifically important for the users of the GOME data. The paper includes validation against ground based Brewer/Dobson network for the 6 months of overlap of the two instruments. There is also a good discussion of the ozone cross section issue for this processing.*

*comments:*

*Abstract - in line 15 you state that "GDP 4.9 slightly overestimates Dobson observations..." The word "overestimate" contains the implicit assumption that the Dobson or Brewer are correct and that GOME is too high. It is equally likely that the GOME measurement is the more correct and that Dobson is too low. After all, Dobson and Brewer do not agree with each other. I would use a more neutral term and say that "GDP 4.9 ozone is slightly higher than Dobson observations..."*

I agree with the reviewer. The sentence has been changed to:

First global validation results for 6 months of GOME-2B total ozone using ground-based measurements show that on average the GOME-2B total ozone data obtained with GDP 4.7 **are slightly higher than** Dobson observations by about  $2.0\pm 1.0\%$  and Brewer observations by about  $1.0\pm 0.8\%$ .

*p 2268 line 26 - A left/right asymmetry could be caused by even a very small pointing error such that nadir is not actually nadir. This can be caused by inaccurate spacecraft attitude knowledge or by the instrument not being mounted on the spacecraft precisely. Such an error can be accurately corrected, leaving a smaller error for empirical correction. Was this considered? The approach to doing the empirical correction looks good.*

GOME-2 has an upper limit of a potential offset of 0.1 degree in pointing, which amounts to about 2% error in nadir and 5% at the extreme angles. However, the ground resolution for GOME-2 is not good enough to detect offset errors below 0.1 degree in viewing angles. It is difficult for us to

determine and correct the small pointing error as the reviewer suggested. But we tested the effect of the potential offset of 0.1 degree in viewing zenith angle on the AMF calculation and the results show that the effect is very small (less than 0.1%).

*You mention in the introduction that GOME ozone shows very little bias compared to OMI/TOMS data. A plot showing the difference between each GOME instrument and OMI/TOMS (and possibly OMI/DOAS) would be very useful in helping understand the performance of GOME relative to another major satellite ozone monitoring system.*

The wording of this phrase is erroneous indeed. As can be seen in the Figure 1 [see below], there exists a bias between the GOME2 GDP4.7 products and the two OMI algorithms of around 1.5-2%. Apart from this discrepancy, the seasonal variability and interannual features are quite similar in both sets of comparisons, testifying that all three products provide a very similar TOC result. We have corrected this sentence in the revised manuscript.

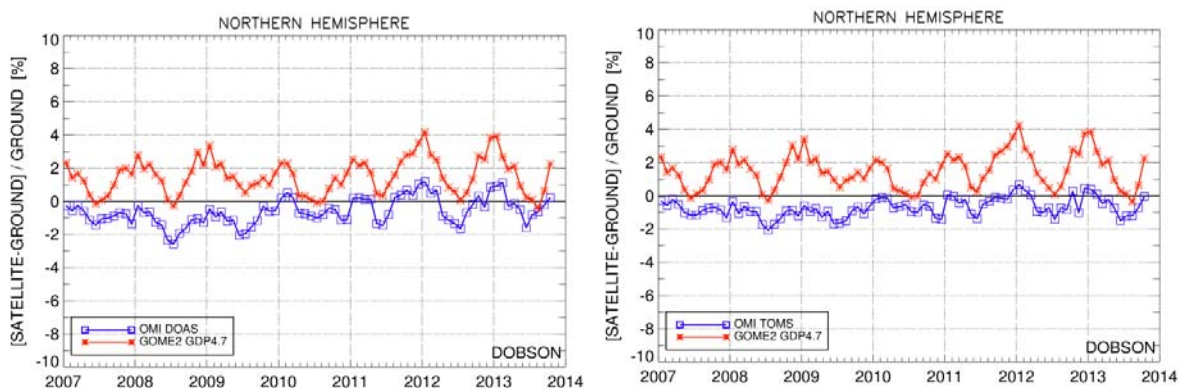


Figure 1. Time series of the monthly mean percentage differences between GOME-2A GDP 4.7 and OMI/DOAS (left panel), OMI/TOMS(right panel) against the Northern Hemisphere Dobson stations.

*Figure 13 - the seasonal difference of GOME relative to northern hemisphere Brewer or Dobson ozone is fairly large, as much as 3% peak to peak. While no two instruments agree on seasonal variation, this is larger than that seen for SBUV/2 or for OMI/TOMS, where the peak to peak variation is more like 1 to 1.5%. Could this be an issue of using only a few selected ground stations in the average? Could this be a characteristic of a*

*DOAS retrieval? This is really not discussed in the text and needs to be explained. The bias is much less of an issue.*

The peak-to-peak variability of around 2-3% observed in Figure 13, which is more pronounced for the Dobson comparisons than the Brewer ones, is due to the different way the two types of algorithms [ground-based and satellite] analyse their observations. This seasonality reflects in effect the seasonal variability of the stratospheric temperature at the peak of the ozone layer thickness. The DOAS algorithm depends on precise knowledge of the ozone absorption coefficients, as discussed previously in the manuscript. These coefficients are not calculated for the range of possible stratospheric temperatures hence introducing a seasonally-affected difference in resulting ozone column compared to the Dobson, and less the Brewer, instruments. Meanwhile, Dobson and Brewer instruments are known to suffer from a temperature dependence of the ozone absorption coefficients used in the algorithm which might also result in this seasonal difference. More detail about the significant temperature dependence of Dobson and Brewer measurements can be found in p2273 of the manuscript.

*Minor edits and comments:*

*p2261 line 2 - say "and should" rather than "which will"*

Done.

*p2261 line 8 - "orbits"*

The sentence has been changed to:

MetOp-A and MetOp-B are flying on **sun-synchronous orbits** with a repeat cycle of 29 days and an equator crossing time of 09:30 local time (descending mode).

*p2261 line 13 - "relatively"*

Changed.

*p2262 line 25 - "freely"*

Changed.

*p2264 line 1 - "an NO2 absorption..."*

Done.

*p2264 line 19 - say "stops when" rather than "stops until"*

The sentence has been changed to:

The iteration stops **when** the relative change in V is less than a prescribed small number (0.1% is used in GDP 4.7).

*p2267 line 9 - "Differences"*

Done

*p2270 line 7 - "similar to those for GOME 2A"*

Done

*Figure 8 - hard to distinguish the symbols for the different dates*

The symbols in Figure 8 have been changed and the updated figure is in the revised manuscript.

*Figure 9 - this figure is not very effective. Could you use a different color scheme such that differences less than 1% versus greater than 1% would be clear?*

The figure with improved color scheme has been changed in the revised manuscript.

*p2271 line 24 - "The relatively larger differences ..."*

Done.

*p2272 line 19 - "activities have been carried out..."*

The sentence has been changed to:

Ever since the first satellite-based total ozone observations became a reality, extensive validation activities **have been carried out** using well-known and dependable ground-based total ozone column (TOC) measurements.