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

We would like to thank Anonymous Referee #2 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.

The paper discusses total ozone column data retrieved from GOME-2 instruments on board Eumetsat Metop-A and Metop-B satellites with the processor version 4.7.The main new features of the processor v.4.7 are well described. The paper present the intercomparison of GOME-2A and GOME-2B total ozone data and validation them against ground-based measurements. Application of the GOME-2 data in MACC-II assimilation system is discussed as well. The paper is interesting. My specific comments are below.

COMMENTS

1) In Sect. 3.2 (and also in Summary), when discussing the differences in monthly mean data, the authors note that the observed differences can be partially explained by different sampling patterns. From my point of view, it is important to separate the influence of sampling patterns from the instrument-related features. This is easy to check by considering the collocated measurements only. I recommend presenting Figures analogous to Fig. 9 and 10 but based on collocated GOME-2A and GOME-2B data. This would allow a more certain conclusion about the data consistency.

All the data used for calculating the differences of total ozone column densities from GOME-2A and GOME-2B in this manuscript are collocated data. The description of 'different sampling of GOME-2A and GOME-2B over one month' means that in high latitudes there are much less collocated ozone data in one grid due to polar night and large solar zenith angle at winter pole. These low statistics per grid in high latitudes can partly result in the large difference between GOME-2A and GOME-2B in high latitudes. For example, there are only about 13,000 pixels in latitude grid 60N (as shown in the arrow pointing of Figure 1, see below) which is only one tenth of the amount of pixels compared to other grids for December, 2013. This has been clarified in the revised manuscript.

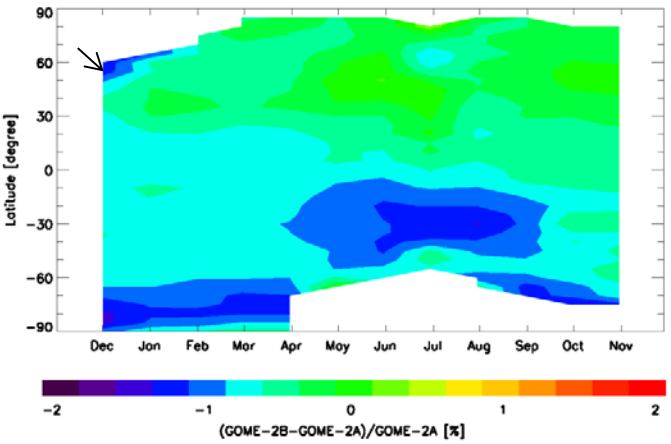


Figure 1. Time series of the zonally mean difference between GOME-2A and GOME-2B total ozone columns from December 2012 to November 2013.

2) I found the presentation of data for 2013 Antarctic ozone hole not logical in the Section 2, which is dedicated to the GDP 4.7 algorithm. The main message from the current Section 2.3 is that GOME-2A and GOME-2B data can be used together without additional corrections. I suggest therefore presenting the geophysical illustration of 2013 Antarctic ozone hole after intercomparison of GOME-2A and GOME-2B data. Furthermore, it would be beneficial to demonstrate the advantages of combined use of data. For such illustration, Figures 5 and 6 might be enhanced with showing data from GOME-2A only, from GOME-2B only, and combined data from GOME-2A&B.

We agree with the reviewer that Section 2.3 should be placed after section 3. Total ozone column retrieved from GOME-2A only and from GOME-2B only have been added to Figure 5. All these changes can be seen in the revised manuscript.

The total ozone column only retrieved from GOME-2A and GOME-2B, and combined data from GOME-2A+2B on 16 October 2013 are shown in Figure 2 (see below). Although GOME-2B has good coverage in the polar region, we still can see that the advantages of combined use of GOME-2A and GOME-2B data. We think it is not necessary to include this figure in the revised manuscript because the updated Figure 5 has already shown the advantages of combined use of GOME-2A &B more clearly.

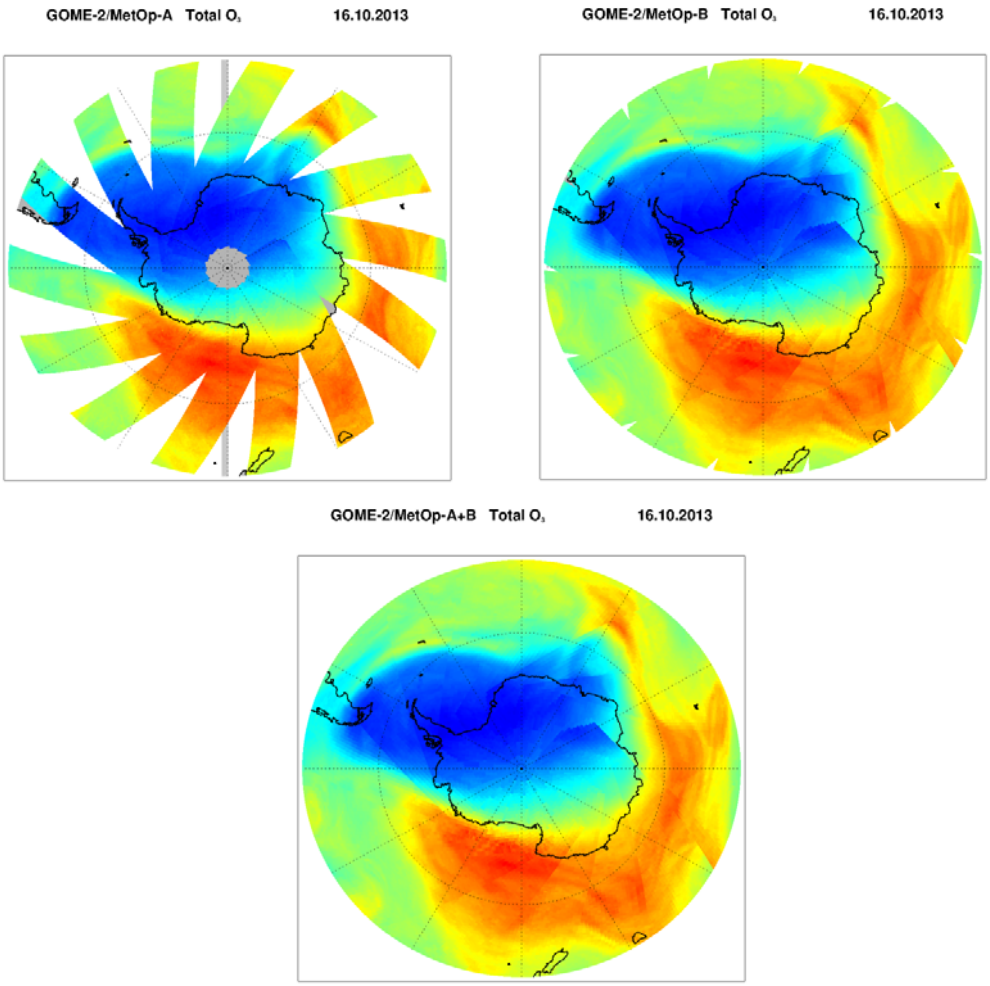


Figure 2. Total ozone maps for 16 October 2013 based on data from GOME-2A only, GOME-2B only and combined data from GOME-2A &2B.

3) P.2260 and P. 2277 "It is concluded that the total ozone columns (TOCs) provided by GOME-2A and GOME-2B are consistent and may be used simultaneously without introducing trends or other systematic effects." This statement requires more quantitative explanation. If you consider trend analysis, the effect induced by a small bias should be compared with the average ozone trend. Regarding the "simultaneous use", the illustration of joint use of the GOME-2A and GOME-2B data for 2013 Antarctic ozone hole can serve as a good example, and it is worth to mention this in the paper.

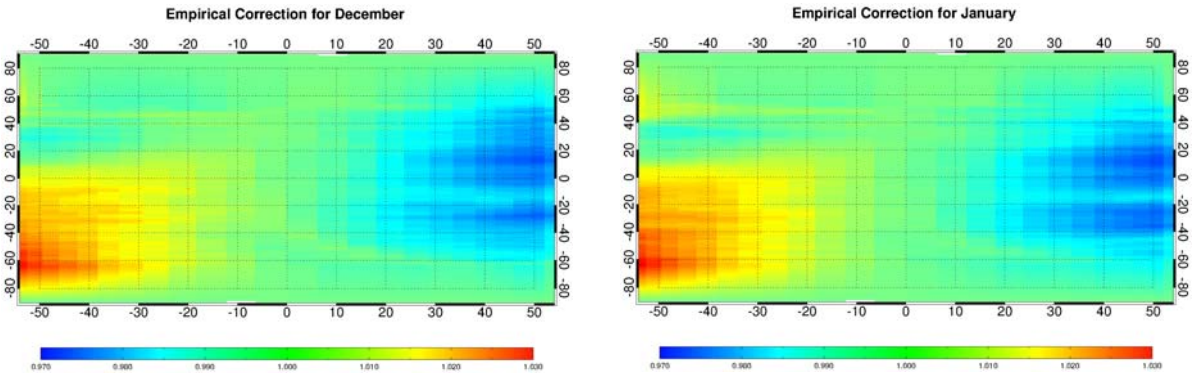
We agree with the reviewer that the total ozone trend analysis is sensitive to a small bias between different instruments. In the meantime, the ozone

trend analysis is not in the range of this paper. To avoid confusing the readers, we will delete ‘without introducing trends’ and change the sentence in P. 2260 to:
It is concluded that the total ozone columns (TOCs) provided by GOME-2A and GOME-2B are consistent and may be used simultaneously without introducing systematic effects. This has been illustrated for the Antarctic ozone hole measurement on 18 October 2013.

In P. 2277, we add one sentence as:
The measurements of the 2013 Antarctic ozone hole illustrated the capacity of the combined use of GOME-2A and GOME-2B instruments to provide homogeneous total ozone data with full daily global coverage.

4) P.2269, the paragraph before section 2.3: How much the empirical correction factors change for successive months? Do you ensure continuity with changing month?

As shown in Figure 3 (see below), the empirical correction factors change slightly for December, January and February (no strong jump). The other successive months show similar patterns. In UPAS, the daily empirical correction factors were calculated by interpolating the monthly empirical correction factors. We do not find any strange jump after implying this interpolation, what also proves the continuity of the correction factor dataset with changing month.



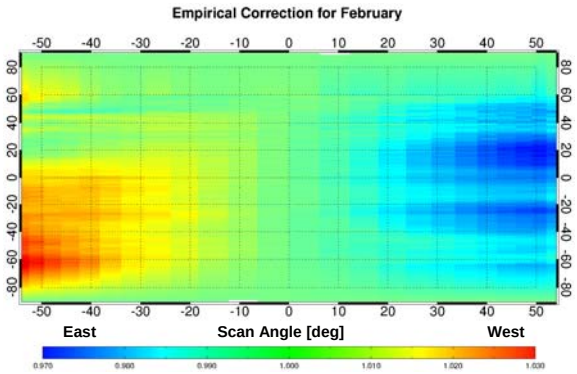


Figure 3. Empirical correction factors as a function of latitude and scan angle (East: scan angle <0°; West: scan angle > 0°) for December, January and February. Correction ratios larger than one (red) are mostly found for the Eastern part of the scan, while correction factors smaller than one (blue) correspond mostly to the Western part of the scan.

5) P.2272, line 18: Please indicate the collocation criteria and/or average spatiotemporal mismatch.

In line 26 of page 2273 we note the collocation criteria, i.e. that we are using a 150km search radius between the satellite centre-of-pixel and the geolocation of the ground-based station and that we are comparing the daily mean TOC values provided by WOUDC to the satellite TOC.

6) P.2272 lines12-16 and Figure 12: What is shown by error bars? Please use the color for error bars consistent with the color of the mean-value curve (red and black).

The error bars show the standard deviation of GOME-2B total ozone column for specified scan angle. The Figure 12 has been changed as the reviewer asked in the revised manuscript.

7) P.2276, line 14: Have OMI and GOME-2 been compared to each other?

Yes, the OMI and GOME-2 data are compared to each other by using the data monitoring statistics of the observations, first-guess and analysis departures that are routinely produced at ECMWF (and in the MACC system). Both datasets show a good agreement, and biases between the different datasets and between the analysis and the datasets are taken care of by using a variational bias correction scheme for both data sets.

TECHNICAL CORRECTIONS

P.2264, l.5 and Eq.(1): Please explain that VCD is denoted by V(n)

Computation of the VCD proceeds iteratively (the superscript n indicates the iteration number) using the formula:

$$V^{(n+1)} = \frac{\frac{E}{M^{(n)}} + \Phi G^{(n)} A_{cloud}^{(n)}}{(1-\Phi)A_{clear}^{(n)} + \Phi A_{cloud}^{(n)}}, \quad (1)$$

where ***V* is VCD**, *E* is the DOAS-retrieved slant column, Φ is the intensity-weighted cloud fraction, and *M* is the molecular Ring correction (Van Roozendael et al., 2006).

P. 2266 l.15: "reference spectra "->"reference cross-sections" ?
Changed.

P.2267, lines 20 and 21: change degree sign into K
Done.

P.2272, paragraph starting in l. 4: Please indicate that collocated data are used here.
The sentence has been changed to:
In Fig. 11 the relative difference between the GOME-2A and GOME-2B total ozone columns ***(collocated ozone data are used here)*** as a function of total ozone columns (left panel) and SZA (right panel) is plotted.

Figure 1: Line notations are different: pluses in panel (a) and diamonds in panels (b, c,d). Are these all for GOME-2A FM?
Yes. The updated figure has been added in the revised manuscript.

Figure 14, left: in the x-axis label, should be "GOME-2A"
Done.

Figure 15: Please add y-axis label (unit) in panels (a) and (b). Figure caption: "from GOME-2 total column " -> "of GOME-2. . ."
The 'Dobson Units' has been added in panels (a) and (b). The caption has been changed.