

# ***Interactive comment on “Tropical tropospheric ozone columns from nadir retrievals of GOME-1/ERS-2, SCIAMACHY/Envisat, and GOME-2/MetOp-A (1996-2012)” by Elpida Leventidou et al.***

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Referee comment on: Tropical tropospheric ozone columns from nadir retrievals of GOME-1/ERS-2, SCIAMACHY/Envisat, and GOME-2/MetOp-A (1996-2012) by: Elpida Leventidou, Kai-Uwe Eichmann, Mark Weber, and John P. Burrows

## Summary

The paper describes the convective cloud differential algorithm for tropospheric ozone column (TOC) and its application to the WFDOAS level 2 Ozone columns from GOME, SCIAMACHY and GOME-2A. The data are compared to sondes from the SHADOZ

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network and to TOC from SCIAMACHY's limb nadir matching.

General remark

The paper is well written and to large parts well structured it includes a good error discussion of the CCD algorithm. Why do the authors stop the timeseries in 2012- while GOME-2 on MetOp-A is still in operation? A detailed comparison between the data sets would be nice. The authors claim to have a 17 years time period, but how good do the data agree in the overlapping periods? The discussion of Figure 6 focuses on the overall TTOC distribution pattern.

Detailed Discussion

Introduction

L28 The authors explained above that tropospheric ozone has two precursors NO<sub>x</sub> and VOCs, Lightning does not produce VOCs, only NO or O<sub>3</sub> itself.

L30: "The precursors interact with convective systems" I am not sure "interact" is the correct word here, because this implies that the convective system is influenced by the ozone precursors. Replace by "are transported by" or "lifted up by"

L30: the rest of the sentence seems somehow doubled, and confusing

3 The CCD method

In the description of the CCD method a first step is missing. In the level 2 data total columns are stored, how is the ACCO retrieved? The discussion about the different cloud product for SCIAMACHY (SACURA) and GOME/GOME-2 (ROCINN) is a bit unclear and not well structured. Moreover it is partly mixed with detailed studies on the ACCO columns for different CTH or cf. It may partly be shifted to section 2? Separate between the different algorithms (section 2) and the influence on the ACCO (section 3) and reference the respective sections.

L145: "These clouds" refers to those DCCs overshooting the TTL, but this not meant

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here. I assume the authors mean normal large convective clouds with cloud top heights above 7 or 9 km respectively.

L165: “Valks et al. (2014), although it is not documented in detail” I am not sure the authors read the paper by Valks et al. carefully enough: P2517 “To that end, a small correction has been made for the difference between the cloud pressure level and the 200 hPa level (typically 0–2 DU), assuming a constant (small) ozone volume mixing ratio of 5 ppbv (see Sect. 4.2).” Valks et al. (2014) used a constant mixing ratio for the correction and not a climatology as it is used by the authors. Because the correction term is small ( 2 DU) the difference between the 5 ppbv constant profile and the climatology might be negligible. In Figure 4 a) it seems the correction column might be up to 10 DU. This is much higher than the columns mentioned in Valks et al 2014. Is this related to the cloud product, does it influence the TTOC.

L191: “All ACCO resulting in a negative TTOC . . . are screened out” but this depends on the local TCO, So why do screen out the complete latitude band of ACCO if for one TCO a negative TTOC is calculated, instead of removing the local TTOC?

L191 and L194: is “daily binned” correct not “monthly”? According to the following it seems correct.

L193 It is a very good idea to screen out the data with higher deviations. However, calculating the daily averages to check the deviation is time consuming. Why not taking the complete ensemble of all data in a grid cell (independent of the day) and remove the outliers (e.g. more than two or three standard deviations)

## 5 Results

L265 “redistribution of ozone from farther north in Africa around Namibia.” This may be grammatically correct but can be misunderstood easily “Namibia is not farther North in Africa”. Please clarify.

L278: “collocated ozonesonde measurements. . . ( $\pm 5^\circ$  in latitude and longitude)”. What

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does it actually mean? The CCD TTOC are gridded on  $2.5^\circ \times 5^\circ$  grid. The sonde station is in one grid box, then the data are averaged over the surrounding boxes up to  $\pm 5^\circ$ ? In L290 "...from CCD covers a larger area (grid box of  $2.5^\circ$  by  $5^\circ$ )", it seems just the grid box of the sonde station is considered.

L299: How is the "bias" defined? Averaged difference? Difference of the averages? Intercept of the correlation?

Figure 7-9 I am not sure a correlation between two data sets that both show no variation (two flat time series e.g. Kuala Lumpur) makes much sense. It might be useful for stations like Ascencion that show a pronounced annual cycle.

## 5.2 SCIAMACHY limb/nadir matching

L359: Is the tropopause height in the SCIAMACHY data stable enough to subtract 10%, instead of calculating it correctly, under the assumption of a constant mixing ratio?

The big advantage of satellite observation is the global coverage. Here I suggest not focusing on the sonde stations again but using a more global approach. Both datasets have been compared to the sondes independently and the results were satisfying. So for the comparison regional or season averages might be used. Alternatively the differences might be studied and compared to the errors or standard deviations of the two dataset.

## Acknowledgment

Please acknowledge also the work of the SHADOZ network, and your colleagues providing the level2 raw data, unless they are co-authors.

## Tables and Figures

Figure 4a: Compared to the text (L 196 ff) the content of the figure is not clear: The red line is the ACCO used for August 2008. The crosses indicate the means for the first second and last ten days. But why is the difference up to 10 DU? Is it the removal of the

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outliers or correction to 200 hPa, or both? If it is both it might be worth to separate the effects. To include the stations Kuala Lumpur and Hilo is well justified, since they are in the reference region, or close by. But Ascencion Island is far away in the Atlantic Ocean and influenced by the African outflow (figure 4b), how about Fiji? (178°E 18.13°S) or American Samoa?

Figure 5a: The Quasi Biannual Oscillation has a strong influence on the stratospheric column. So for a more detailed study of the stratospheric column (or ACCO) I suggest to split the average according to positive or negative QBO index. How about El Niño? Figure 5b: From my point of view this figure does not add much information, so it might be skipped.

Technical corrections

L86 Later on in chapter 4 (error discussion) the abbreviation for the total ozone column is “TCO” instead of “TOC”. Change in either of the two occurrences.

L53: “usng” -> “using”

L85 “Above Cloud Columnar Ozone” is the correct term for ACCO

L166 vertical column (VC) is usually used in a different context - it often describes the total vertical column, so a more telling name for the correction term might be useful.

L198 remove blank after the bracket “ ( in this case..” -> “(in this case..”

L200 “Kulala Lumpur” -> “Kuala Lumpur”

L205f: “The agreement . . . is less than 2 DU” -> “The difference . . . is less than 2DU”

L275: NO<sub>x</sub> is already explained in the introduction (L27) Skip the part in the brackets, the sentence gets too difficult to read, especially with the full stop inside.

Conclusion

MetopB compare to introduction MetOpA and title MetOp-A

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## References

In some cases a lowercase “a” is written instead of the capital “A”, please recheck the references and correct. I found this error at:

L408 Bracher L439 Ladstätter-Wießenmayer and Rozanov L520-525 Folberth, G. MacKenzie I. Plummer, D. and Strode, S.

L436 Diab et al. Please update to ACP version

L479 PHD thesis, Author is missing

L485 Loschnigg and Webster, remove the \* after Ocean

L487 Loyola et al. From -> from

L496: Rex et al. remove blank in front of the coma between title and journal: ...Composition, Atmospheric ...

L507: Sierk et al. Savigny, C. Von -> Savigny C. von no capital letter

L530: Valks et al. 2003. Mention the Co Authors:

Valks, P. J. M., R. B. A. Koelemeijer, M. van Weele, P. van Velthoven, J. P. F. Fortuin, and H. Kelder, Variability in tropical tropospheric ozone: Analysis with Global Ozone Monitoring Experiment observations and a global model, J. Geophys. Res., 108(D11), 4328, doi:10.1029/2002JD002894, 2003.

The list of figures and list of tables are not necessary

Table 5: This table is quite big and the last line over writes the page number. Therefore the mean TTOC at Fiji for 2008 -2012 is not readable. It might help if you skip the unit for the TTOC for GOME-2 and SCIA? Is the bias the same as mentioned in L299?

Figure 7: c) replace Kuala by Kuala Lumpur

Figure 7 and Figure 11: The CCD data and the sondes in these figures are the same for

Paramibo and Kuala Lumpur. I failed to discover the same features in the two figures, e.g. linear increase in CCD data mid 2007 is shown in figure 7 but not in figure 11.

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