

## ***Interactive comment on “Tropospheric ozone over Equatorial Africa: regional aspects from the MOZAIC data” by B. Sauvage et al.***

### **Anonymous Referee #2**

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I did my original review with the manuscript I downloaded the first day it was online. Obviously this pdf-file had errors and some Figures were missing. I therefore looked at the paper again, using this time the updated version of the pdf-file. Now Fig. 3 is complete and it is easier to follow the discussion of this Figure. However, with Fig. 9 there is still confusion and parts of the interpretation can't be correct (see below). So I can only slightly modify my original review and still think that the text must be significantly improved. For me the paper was really difficult to read and so it might be for others. It now follows a slightly modified version of my original review.

This study presents ozone data from the MOZAIC program over equatorial Africa. This is a very valuable data set and the climatology over 6 years provides interesting results that are very important for our understanding of tropospheric ozone and transport processes in this area. But the paper is not yet well written. The presentation of the results

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is not structured very well and it is difficult for the reader to follow the too detailed presentation. Although the results are very valuable, the paper should not be published in ACP in its present form. I suggest a a major rewriting of the text with a clear focus on the main points before the paper can be reconsidered for publication in ACP.

Major Comments:

A) The paper contains too many details. I don't think that it is necessary to describe in equal detail the three layers (cf. Fig. 4) for the 3 African regions in all seasons. Reading the abstract and summary it is clear that the authors regard some results as particularly important. They should be discussed in great detail - others should only be mentioned briefly. It is also confusing that the discussion jumps a lot between regions, levels and seasons. Some Figures (e.g. Fig. 4) are reconsidered several times but they are never discussed as a whole. However, a Figure like Fig. 4 would be ideal to discuss at the beginning of the presentation of the results and to provide an overview of the important aspects of the measurements. They could then be analysed in more detail in the following sections.

B) There are errors in the interpretation of some of the trajectory figures: Fig. 5g and h both show a flow in the middle troposphere (Fig. 5g:  $p < 600$  hPa, Fig. 5h:  $p < 500$  hPa). However, on p. 3299 (line 18) it is written that "... bring lower tropospheric air laden with ozone ...". Clearly, this is not in agreement with the trajectories shown. This is an important point, because if the trajectories are representative for the flow the question arises how the high ozone values get to altitudes with  $p < 500$  hPa.

C) For Fig. 9 there is still an important mismatch between the description in the text and the Figure caption/labels. If I estimate seasonal mean profiles "by eye" from Fig. 3 it seems to me that the Figure caption is correct, so (a) is for the respective burning season, (b) for DJF and (c) for JJA. But in the text, Fig. 9(c) is regarded as the DJF Figure (p. 3300 line 26: "The strong ozone enhanced layer appearing in DJF over Brazzaville (Fig. 9c) (which has higher concentrations than those observed over Lagos

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at the same time) could be explained ..."). However, because really Fig. 9b is for DJF it seems to me that Lagos has higher concentrations than Brazzaville at this time of the year. So the interpretation on p. 3300 regarding lightning is based on the wrong Figure. The same is true for the interpretation of the JJA profiles. Here it is written that "Figure 9a shows the vertical ozone profile over Lagos and Brazzaville in JJA. Up to 500 hPa the vertical profile over Lagos is similar in shape to that over Brazzaville ..." (p. 3297 line 22). However, the two profiles for JJA are shown in Fig. 9c and are rather different for the two stations. So also here the description of the Figure and the interpretation must be changed.

D) A scientific point: it is surprising to me, that trajectories calculated with monthly mean wind fields provide valuable information to interpret the MOZAIC observations. On p. 3292 (line 28) it is mentioned that backward trajectories calculated with 6-hourly analyses led to the same interpretation. I think that (some results of) this comparison should be shown to justify the use of monthly mean wind fields.

E) The English must be improved. Some sentences/formulations are very hard to understand in the present version. For instance - p. 3286 sentence "The boreal summer ozone maximum ..." - p. 3288 sentence "The East African low-level jet ..." - p. 3301 formulation "bringing clear air on contrary of Angola" - p. 3303 sentence "The lower tropospheric enhancement ..."

F) Section 4 is not really a comparison with TOMS, because no TOMS data are shown nor mentioned nor referenced! However, it is important to include all possible comparisons with existing data sets.

Minor comments: \_\_\_\_\_

1) The trajectory calculation is unclear and not systematic. What are the starting points leading to the bundles of trajectories shown in Fig. 5? Quite often it looks like trajectories were started from a square region around the airports. But in Fig. 5c it does not look like a square region. Why? And why are no trajectories shown for eastern Africa?

On p. 3302 there is a description of airflows but this is not confirmed with trajectories.

2) The geographical distribution of biomass burning plays an important role in this study. However, only two Figures are shown for Jan and July 1999. Are they representative for the entire time period of MOZAIC observations? What about the other seasons? If possible, provide a more complete illustration of biomass burning in Central Africa for the years 1997-2003.

3) Why are the multi-panel Figures labeled 3a and 3b? I suggest that giving them separate numbers would be easier for the reader.

4) I don't understand the use of the term "ozone background" in this paper (e.g. p. 3296 line 25): clearly, if one looks at high resolution ozone data, then it is natural to distinguish between background and episodic events. However, here we look at monthly or even seasonal mean values. What is the "background" on this time scale?

5) Why is the vertical gradient in Fig. 8 a sign of ozone deposition (p. 3298 line 17)? Is it not simply two different flows at different altitudes with different ozone concentrations?

6) The discussion with deposition and mixing processes (p. 3298 line 5) seems to be highly speculative and not based directly on MOZAIC observations. I suggest to eliminate the more speculative parts of the discussion - there are enough clear facts from your data set!

7) I have problems with the budget analysis in section 5. How can you justify to use the Brazzaville O<sub>3</sub> profile for the entire southern wall of your box? I expect very different O<sub>3</sub> profiles over the Atlantic ocean for instance. I expect, that the term F\_SHAR is overestimated due to this overemphasize of the Brazzaville profile. Clearly, this could have important implications for the resulting ozone production value. Also, Figs. 12b,c are totally unsuitable, mainly because the wind vectors can't be seen. What should be shown instead are vertical cross-sections of the flow perpendicular to the box boundaries.

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8) I can not understand your discussion of the ozone paradox. This issue is mentioned several times but never clearly explained. What is the paradox? What is your explanation for it that contrasts with previous explanations?

Editorial comments: \_\_\_\_\_

- a) p. 3286 line 2: "... give the first tropospheric ozone climatology"
- b) p. 3287 line 22: "emissions factor" should read "emission factors"
- c) p. 3288 line 26: Start the sentence with "In terms of atmospheric chemistry, Africa remains ..."
- d) p. 3289 line 13: is the value  $2 \pm 2$  Tg/yr correct?
- e) p. 3290 line 17: "... ozone and water vapour"
- f) p. 3290 line 20: what means "2 ppbv +2%" ??
- g) p. 3291 line 24: "... standard error OF the ozone monthly mean"
- h) p. 3292 line 12: "... for 1 SE < 5%. This clearly ..."
- i) p. 3292 line 24: the ECMWF has 60 vertical levels
- j) p. 3298 line 27: Abidjan?? I think the Figure is for Lagos?!
- k) p. 3299 line 5: what is "DM"?
- l) p. 3301 line 5: there is no Staudt et al. 2002b, so "2002a" should read "2002"
- m) p. 3306 line 10: Hauglustaine et al. 2004 is not in list of references
- n) p. 3310 Diab et al.: "1996b" should read "1996"
- o) p. 3310 Edwards et al. 2002: missing volume number
- p) p. 3311 is "Kirchhoffn, V. W. J. H." correct?

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q) p. 3313 Ref. Rotman et al. is incomplete

r) Table 1: what is "HS" and "HN"? What are "1987, 1988" referring to in the publication list of the Polarstern cruises?

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