

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

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Received and published: 14 September 2004

Anonymous Referee#2 :

We sincerely thank Referee #2 for his/her work on this paper and the helpful comments provided in this review. They will definitely help to improve the paper, to make it clearer in the objectives and easier to read. We answer below to the second review made by Referee#2 and posted on the 30 July 2004.

Major Comments:

A): Referee#2 suggests to begin by Figure 4 (seasonal cycle) In the revised version of the paper, not so many detailed will be written, as asked by referee#2. We will discuss the most interesting results in great detail, and mentioned briefly the other ones. Concerning Figure 4, we would not like to present it first. In the context of such a “climatological” paper, giving the readers a first assessment of the ozone vertical

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distribution for the entire year, Figure 4 is already a kind of summary of the Figs 3a and 3b. We can see the monthly vertical profiles as raw data and Fig 4 as an elaborated product to highlight the absence of any strong seasonal cycle over the region called Gulf of Guinea compared to the other regions. The analyses of monthly profiles lead us to consider the proper different altitude ranges for building Fig 4.

B): Referee#2 has noticed some errors between the text p 3299 (line18) and the Fig. 5g and h. Referee#2 is right. Backtrajectories (Figs. 5g and 5h) show an easterly and south easterly origin, i.e. the region of fires over Zambia and Tanzania. Although the pressure levels never exceed 500 hPa, we assumed that convective events may have lifted up some air masses laden with ozone, from the lower troposphere of the region of fires. As suggested by Referee#1, all the figures concerning the mid troposphere transport pathways will be omitted in the revised version and replaced by analyses of streamlines at constant pressure level associated with references from previous studies (in the frame of TRACE-A and SAFARI for example).

C): Figure 9 We apologize once again for the mistake in the submitted version. There was a mismatch between the Fig. 9 (p. 3329) and the text p. 3297-3298. References of the figures in the text do not correspond with the Fig. 9, and the caption is not appropriate. We should have replaced wrong sentences in the text: -p. 3297 (line 22) "Figure 9a" by: "Figure 9c" -p. 3298 (line17) "Fig. 9c" by: "Fig. 9b" -p. 3298 (line 25) "Figure 9b" by: "Figure 9a". In the next version, these 3 different figures will be correctly labeled to avoid any confusion, in three different Figures 11, 12 and 13, with the appropriate caption.

D): Referee#2 is surprised that the trajectories calculated with monthly mean wind fields provide valuable information to interpret the MOZAIC data. We emphasize that our goal is to present climatological analyses of ozone, at monthly and seasonal scales. Then we aimed to explain the monthly characteristics of ozone with the most persistent transport pathways acting at monthly scale. That monthly mean wind fields provide variable transport pathways to interpret MOZAIC data is now demonstrated by a com-

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parison with a set of daily back trajectories. The document is posted on the MOZAIC website ((<http://www.aero.obs-mip.fr/mozaic/sauvage/papier.pdf>). Some results of this comparison will be shown in the revised draft, to justify the use of monthly wind fields (two figures showing comparison with back trajectories computed with monthly and daily analyses, and the Table 1 as a summarized. This last one is available on the MOZAIC website).

E): Referee#2 thinks that English must be improved. We will make the revised version check and correct once again by a native English speaker.

F): Referee#2 thinks that Section 4 is not a comparison with TOMS. Referee#2 is right. We should have used a title like “Calculation of the MOZAIC Tropical Tropospheric Ozone Columns (TTOCs)” instead of “Comparison of MOZAIC and TOMS TTOCs” to make it clearer. The TOMS data and analyses have been only referenced in the introduction -p 3289 (lines 15-27). The goal of this section was just to present TTOCs calculations from the first regular in-situ measurements in the region. The scope of the paper was not to make a detailed comparison with the satellite data set. In this paragraph we only aimed to summarize the ozone climatology seen with the MOZAIC program in terms of tropospheric column because that is a commonly used quantity for tropical areas. However, this section will be removed from the revised version will be the topic of another paper in preparation.

Minor Comments:

1): trajectory calculation. The starting points of the trajectories are a square of 2° latitude by 2° longitude centered over the airport. We can precise this point in the caption of Fig 5. Concerning the starting point of the trajectories in Fig. 5c, we did not choose a square over Abidjan only to make the bundles of the trajectories clearer. We did not show trajectories over East Africa because we thought that the description of the airflows p. 3302 found a justification with the given reference (Findlater, 1974).

2): Refree#2 asks if the Figures showing biomass burning fires in Jan. and July 1999

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are representative for the entire time period of the MOZAIC data. With these Figures, we only wanted to plot an example exhibiting the burning geographical areas during two specific months characteristic of the biomass burning season in each hemisphere. As showed in previous studies giving seasonal fire counts averaged over 5 years (Jenkins and Ryu, 2004; Duncan et al., 2003), the geographical areas of fires during the boreal winter (DJF), and during the boreal summer (JJA) are the same as in our figure. Only the intensity of the fires may change on an interannual variability point of view. This is beyond the scope of this paper. We just wanted to highlight the localization of fires during the two opposite seasons. To make the text and the analysis clearer we agree to include a new figure in the next version. This one will show the fire spots for the entire seasons (DJF and JJA) averaged over the entire MOZAIC period (1998-2002). This figure has been posted on the MOZAIC web site.

3): Figures 3a and 3b We will definitely change that. See below the outline of the next version and the list of figures.

4): “ozone background” on a monthly mean time scale. The term of background had not been properly defined in the previous ACPD version. It will be done in the revised version. The background is considered as being the ozone monthly mean during the less polluted season (here MAM). In this study it appears to be quite constant at about 40-50 ppbv throughout the troposphere. To further argue the use of this formulation, please note that such a term is also used for seasonal CO studies by Cooper et al. (2002, in JGR vol 107 no D7, 10.1029/2001JD000902).

5): ozone vertical gradient in Fig. 8 (p. 3297 line 17) As said previously, we admit we made an abusive use of the term “deposition”. In that specific case, the strong positive ozone vertical gradient between 1000 and 800 hPa is obviously linked to the different regimes: monsoon flow at the bottom and Trades on the top.

6): discussion with deposition and mixing processes seems to be speculative. We would like to replace the sentence p. 3297 (line 4-6) “During the regional transport

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Ë to reduce ozone concentration” by: “During the regional transport in the southeast-
erlies, deposition, convective or turbulent mixing processes may explain the reduced
ozone concentrations between Brazzaville and Lagos” to make it less affirmative and
speculative. This hypothesis is not proved with the MOZAIC data, only with literature.

7): Budget analysis in section 5. As said previously this section will be the topic of a
future paper.

8): “ozone paradox” Concerning the “ ozone paradox ”, this one is defined in introduc-
tion p. 3289 (line 22-27) in order to give an exhaustive overview of the problems in
understanding the ozone distribution over this region. Papers concerning lot of stud-
ies dealing with this subject (Thompson et al., 2000; Martin et al., 2002; Edwards et
al., 2003; Jenkins and Ryu, 2004) are referenced in the article. For a better under-
standing the sentence p. 3289 (line 25-27) “This lower tropospheric insensitivity Ë in
December-February (DJF)”, should be replaced by “This lower tropospheric insensitiv-
ity increases the “tropical Atlantic paradox” (Thompson et al., 2000). This term is used
to name the measurements of higher tropospheric ozone columns over the south At-
lantic than over the north, when northern tropical Africa is at its biomass burning peak,
during December-February (DJF) season”. In the current version of the paper, we
just mentioned this “paradox” in section 4 with the calculation of the MOZAIC TTOCs,
showing different values than the satellite columns. The goal of this paper was not to
further study this “ozone paradox”. Indeed section 4 will be removed because the other
paper in preparation is more appropriate to focus on this subject.

Editorial Comments:

All the remarks made by Referee#2 will be taken into account in the final version.
Concerning specific questions:

d) -p. 3289 line 13: 2 ± 2 Tg/yr is the exact value given in the Swap et al. (2003) paper
(page 7 of the PDF online version on JGR) f) -p 3290 line 20 “2 ppbv + 2%” means that
the precision is 2 ppbv in the case of ozone concentrations lower than 100 ppb or 2%

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in the opposite case, as explained in Thouret et al., (1998b). j) -p. 3298= line 27 There is a mistake. “Lagos” is the good word, and not “Abidjan”. k) -p. 3299 line 5: “DM” is for “Dry Matter”. o)-p. 3310 The exact reference for Edwards et al. is “JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 108, NO. D8, 4237, doi:10.1029/2002JD002927, 2003 ” p) -p. 3311 “V. W. J. H. Kirchhoff” is the correct name r) Table 1: “HS” and “HN” will be changed in “SH” and “NH”, and it will be noticed in the caption the exact signification “Southern Hemisphere” and “Northern Hemisphere”. 1993 is the correct year for the (Weller at al. 1996) Polastern cruises.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 3285, 2004.

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