Atmos. Chem. Phys. Discuss., 7, S9733–S9741, 2008
www.atmos-chem-phys-discuss.net/7/S9733/2008/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Tracing biomass burning plumes from the Southern Hemisphere during the AMMA 2006 wet season experiment" *by* C. H. Mari et al.

C. H. Mari et al.

Received and published: 28 March 2008

The authors want to thank M. Lawrence for providing very constructive remarks which helped us to clarify the objectives of the paper.

This manuscript discusses the meteorological situation over central Africa nd its west coast during the AMMA field campaign, and the resulting transport f pollution from biomass burning either out over the Gulf of Guinea in the id-troposphere or north across the equator (accompanied by convective plifting to the upper troposphere). his is studied with a Lagrangian dispersion model using input from satellite bservations of biomass burning fires, along with ozone soundings and atellite CO observations. he approach and the tools in the manuscript are sound, and in principle it hould

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

be possible to make it acceptable for publication in ACP. However, he manuscript is lacking in terms of clearly indicating its scientific ignificance and impact, which needs to be either made clearer, or augmented ith additional analysis before acceptance to ACP.

Major comment:

My only major comment is that the scientific significance of the study is not really clear, and based on what I could put together from the places where it is touched upon in the text, it seems like it is currently insufficient to justify publication. On the one hand, it is certainly somewhat interesting to know that ozone and other by-products of biomass burning sometimes end up over the Gulf of Guinea (in the mid-troposphere) and sometimes over central Africa (in the upper troposphere), and how this relates to the regional meteorology (especially the AEJ-N/S). However, it is not clear whether there is any larger significance to this difference. For instance, is there a substantial difference in the radiative forcing of the ozone depending on which direction it goes? Does it make a difference in terms of OH production and subsequently methane lifetime? Does it have an effect on regions further downwind? Is the net amount of ozone production per unit of burned biomass different for the two directions? Can we make use of the chemistry to learn something previously unknown about the meteorology? Is there an interference to be expected from the accompanying aerosols on marine or continental clouds? Or any other significant implications of this nature? Although a motivation is given in the introduction, in terms of further information beyond the initial observation of Sauvage et al. (2005) of mid-tropospheric ozone maxima, it needs to be made clear why we would be interested in the further details on this interhemispheric transport of biomass burning emissions, especially when the study is somewhat restricted, not including a quantitative analysis for instance of the statistics of this kind of transport (e.g., interannual variability and connection to larger scale climatic conditions and its implications), or of the ozone origins and production (which is noted will be discussed more completely in a future manuscript). In short, these results are interesting on the surface, and seem to be robust, it just needs to be made

ACPD

7, S9733–S9741, 2008

Interactive Comment

really clear in the manuscript what makes them special enough to justify their publication already, separately from the greater detail of the proposed future companion paper.

We would like to answer this criticism with a better explanation of the objective of the paper in the framework of the AMMA program. We recognize that the objective may have not been well introduced in the original version. The aim of this paper is to provide a basic understanding of the predominant pathways for the southern hemispheric biomass burning plumes. Subsequent analysis of ozone production in the biomass burning plumes are currently being carried by several authors: Reeves et al. (2008)[1] for ozone, acetonitrile and CO enhancements as observed on board the UK BAe146 in the middle troposphere; Real et al. (2007) for NOx enhancements in the upper troposphere as seen by the Geophysicae and the DLR F20, and Thouret et al. (2008)[3] for the ozone increase in the middle troposphere measured by the ozonesoundings at Cotonou) Modelling activities will also start on this subject and an intercomparison of global models is currently being conducted to test if global models can reproduce the AEJ-S phases and differentiate the ozone production during these phases.

The following text has been added in the Introduction to clarify the objective of the paper:

A recent study by Sauvage et al. (2005) connected the mid-tropospheric ozone maxima observed in cities near the Gulf of Guinea to biomass burning plumes originating from the opposite dry-season hemisphere. This new finding was the major motivation for the present study in the framework of the AMMA fourth airborne campaign from 25 July to 31 August 2006 (Mari and Prospero, 2005; Redelsperger et al., 2006). During this period, occurences of biomass burning plumes over West Africa were observed on board the aircrafts with elevated concentrations of acetonitrile, ozone and NOx subsequently in the lower and upper troposphere (Real et al., 2007b; Reeves et al., 2007) and by the ozonesounding network in Cotonou (Saunois et al., 2007). These

ACPD

7, S9733–S9741, 2008

occurences showed a large temporal variability (Reeves et al., 2008 [1]; Janicot et al., 2008 [2]). This paper thus aims at providing the basic understanding of the variability of the biomass burning plumes occurence over West Africa and helps the interpretation of the data sampled during the wet season 2006.

Specific Scientific Comments:

1. *AMMA (African Monsoon...) needs to be defined in the abstract*
   Done

2. *Define the acronym GIRAFE*
   Done in the Model description section: "The model around which the GIRAFE-FLEXPART **(reGIonal ReAl time Fire plumes)** tool has been built is the Lagrangian particle dispersion model FLEXPART (Stohl et al., 1998a; Stohl et al., 1998b; Stohl et al., 2005)."

3. *It would be very helpful to have a schematic diagram showing the main transport pathways; in principle, the information is largely available in Figure 2, but it takes a good bit of looking to decipher, and the value of the paper could be increased by a carefully-drawn schematic, with labels for the Gulf of Guinea and the biomass burning regions, and arrows showing the different transport pathways.*

[1]Reeves, C., G., Ancellet, A., Borbon, F., Cairo, K., Law, C., Mari, J., Methven, H., Schlager, V., Thouret, Chemical characterisation of the troposphere over West Africa during the monsoon period as part of AMMA, in preparation, ACPD, 2008.

[2]Janicot, S., Ali, A., Asencio, N., Berry, G., Bock, O., Bourles, B., Caniaux, G., Chauvin, F., Deme, A., Kergoat, L., Lafore, J.-P., Lavaysse, C., Lebel, T., Marticorena, B., Mounier, F., Redelsperger, J.-L., Ravegnani, F., Reeves, C., Roca, R., de Rosnay, P., Sultan, P., Thorncroft, C., Tomasini, M., Ulanovsky, A., and ACMAD forecasters team, Large-scale overview of the summer monsoon over West and Central Africa during the AMMA field experiment in 2006, submitted to Ann. Geophysicae, 2008.

ACPD
7, S9733–S9741, 2008

The new figure 5 (ftp://ftp.aero.obs-mip.fr/pub/MOZAIC/MARI/acpd-2007-0443-fig03-review-only.jpg) shows the predominant pathways of the fire tracers for the three distinct periods identified during the AMMA subperiod.

4. *On Figure 5 it appears that the dashed and dotted lines are reversed (relative to the caption and the text), please check carefully*

   The legend of Figure 5 (now Figure 6 in the updated version) needs to be switched and read as follow: "Ozone mixing ratios measured at Cotonou (6.21N, 2.23E) in ppmv on 25 July (solid line), 3 August (***** dashed line *****) and 17 August (***** dotted line *****)".

   So the picture is now consistent with (1) the AEJ-S break phase corresponding to higher mixing boundary layer on 3 August and (2) ozone maxima at 3 km altitude on 25 July and 17 August during the active phase.

5. *The proposed companion paper needs to be given an in-text reference (author and rough title)*

   Five references of on-going studies have been added to the updated version of the manuscript. The companion paper cited in section 5 has been added: "A complete description of the ozonesoundings and the characterization of the origins of the ozone maxima will be described in a companion paper (Thouret et al., 2008 [3])".

   The other references are:

[3]Thouret, V., Saunois, M., Mari, C., Corre, L., Picart, J., Mariscal, A., Nedelec, P., Minga, A., Solete, A., Agbangla, D., Characterisation of air masses over Cotonou during the wet season: influence of biomass burning and local pollution, in preparation, ACPD, 2008

ACPD

7, S9733–S9741, 2008

Janicot, S., Ali, A., Asencio, N., Berry, G., Bock, O., Bourles, B., Caniaux, G., Chauvin, F., Deme, A., Kergoat, L., Lafore, J.-P., Lavaysse, C., Lebel, T., Marticorena, B., Mounier, F., Redelsperger, J.-L., Ravegnani, F., Reeves, C., Roca, R., de Rosnay, P., Sultan, P., Thorncroft, C., Tomasini, M., Ulanovsky, A., and AMMA forecasters team, Large-scale overview of the summer monsoon over West and Central Africa during the AMMA field experiment in 2006, submitted to Ann. Geophysicae, 2008.

Real, E., Law, K., Borrmann, S., Garnier, A., Cairo, F., Fierli, F., Orlandi, E., Schlager, H., Volk, M. and Minikin, A., Analyses of upper troposphere trace gases and aerosols measurements over West Africa during summer 2006, Proceedings of the 2^{nd} AMMA International Conference, Karlshure, Germany, 26-30 November 2007, 364, 2007.

Reeves, C., G., Ancellet, A., Borbon, F., Cairo, K., Law, C., Mari, J., Methven, H., Schlager, V., Thouret, Chemical characterisation of the troposphere over West Africa during the monsoon period as part of AMMA, in preparation, ACPD, 2008.

Reeves, C., Saunois, M., Mari, C., Murphy, J., Stewart, D., Mills, G., Oram, D., The distribution of tropospheric ozone during the West African Monsoon and its relationship to photochemical relevant tracers, Proceedings of the 2^{nd} AMMA International Conference, Karlshure, Germany, 26-30 November 2007, 367, 2007.

Saunois, M., Thouret, V., Mari, C., Corre, L., Picart, J., Mariscal, A., Nedelec, P., Minga, A., Solete, A., Agbangla, D., Characterisation of air masses over Cotonou during the wet season: influence of biomass burning and local pollution, Proceedings of the 2^{nd} AMMA International Conference, Karlshure, Germany, 26-30 November 2007, 366, 2007.

6. *It is appealing that the ozonesonde profiles coincide well with the break and active periods, though it would be much more convincing to have a statistical analysis, and indication of the mean degree of enhancement, and a discussion*

ACPD

7, S9733–S9741, 2008

of the significance (see above)

An order of magnitude has been added to the text:

"The ozone peaks on 25 July and on 17 August correspond to the active phases of the AEJ-S when the Gulf of Guinea is under the influence of the fire plumes. On the contrary, the low values of ozone observed on 3 August coincide with the AEJ-S break phase, when the Gulf of Guinea is free of biomass burning pollution. **During the actives phases, the ozone mixing ratios are more than doubled (80-90 ppbv) compared to the background values (30-40 ppbv)**.

A more detailed statistical analysis will be provided in Thouret et al. (2008).

7. *"The coincidence of biomass burning and cloud convection was proposed as a key mechanism for the export of biomass burning [emissions] far away from the source regions..." - is there any clear evidence of this in the simulations (they may need to be reanalyzed or run to longer particle residence times before resetting), or in the observations considered here or taken on other platforms during AMMA? This would help with the significance (see above)*

During the time interval of the simulations (10 days), modelled SH biomass burning plumes are exported over West Africa, several thousands of kilometers downwind from the source. Figure ftp://ftp.aero.obs-mip.fr/pub/MOZAIC/MARI/acpd-2007-0443-fig05-review-only.jpg (not shown in the manuscript) clearly shows that the ventilation of biomass burning product in the upper troposphere is more efficient during the break phase when convection and biomass burning coincide. Longer simulations would be necessary to discuss the export over larger distances which is not the scope of this paper focused on the inflows in the west african region. From an experimental point of view, elevated NOx concentration were observed in the upper troposphere above Burkina Faso which could well

ACPD

7, S9733–S9741, 2008

sign biomass burning intrusions (Real et al., 2007).

8. *The end of section 6 is confusing: "...the impact on O3 production over the ocean would be limited...", and in the next sentence, "...provides an additional scenario more favorable to ozone production..." Please clarify what is meant with these two different statements.*

   In the study by Jenkins et al. (1997), the authors stated that in JJA, the conditions are not favorable for the occurence of ozone maximum in the middle and upper troposphere over the ocean because fires are far away from the convective regions and thus have no efficient transport mechanism which could bring ozone precursors over the ocean. On the contrary, this study shows that even during these period, the AEJ-S can transport efficiently biomass burning material out over the ocean. The text has been clarified as follow: "On the contrary, this study shows that the AEJ-S can efficiently transport fresh biomass burning plumes out over the ocean during the wet season, thus providing a scenario favorable to ozone production over the Atlantic ocean."

9. *The forecasting tool is noted several times - it would be interesting to have an indication of the quality of the forecasts versus runs with the analysis meteorology for this particular region and type of meteorological conditions*

   We have not performed an exhaustive quantification of the forecasts scores during the AMMA period studied here. During the campaign, we have checked the consistency of the model outputs with the MOPITT data and the overall agreement in terms of plume extension over the continent and the ocean was good (although we can not provide "numbers").

10. *Conclusions: "...biomass burning plumes are found..." - this is a bit misleading, because they are only simulated (found in the model), and not observed ("found"*

ACPD

7, S9733–S9741, 2008

in the normal sense)

The text has been changed accordingly. "As a consequence, **simulated** biomass burning plumes are found in the upper troposphere over the Gulf of Guinea during the AEJ-S break phase."

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 17339, 2007.