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Atmospheric Chemistry and Physics Discussions

Interactive comment on "What caused extreme ozone concentrations over Cotonou in December 2005?" *by* A. Minga et al.

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Authors are thankful to this reviewer. His/her comments will definitely help to improve the quality of the manuscript. Below are the answer to each specific points.

1) The mix of the extra VOC's needs more explanation than what is summarized in table 8. Does the mix assumed for the calculations fit to the release of hydrocarbon pattern from the petrochemical facility during normal operation or from a release accident with or without an explosion?

In order to sustain the "explosion" hypothesis, the mix of extra VOCs in the "Additional Lagos" run and in the "additional petrochemical explosion" run has been detailed in Table3. In this table, we have also added a column with background concentrations

used for dilution, as asked by reviewer #1. It is rather well known that leaking, with or without fires, often occurs along the pipelines in the region between Lagos and Port Harcourt. The high ozone event in Cotonou cannot be a consequence of this leaking because of its exceptional occurrence, and should rather be a consequence of more powerful emissions, like an explosion. However, as far as the authors know, no publication is available concerning a release accident with explosion. We have therefore made assumptions of such emissions in our "Additional explosion" run.

2) It would also be helpful to know more about the photolysis frequencies of O3 and NO2 as well as the OH concentrations.

The photolysis frequencies of chemical species, including ozone and nitrogen dioxide, are computed from the TUV model (Tropospheric Ultraviolet and Visible radiation model developed at NCAR). The TUV model computes the actinic flux using a two-stream approximation from the geographical location, the altitude and the date for 24 hours every 15 minutes. Then, a database with quantum yields and absorption cross sections of the chemical species is used to compute the photolysis frequencies every 15 minutes. The photolysis frequencies at noon for ozone and NO2 used in our simulation are 4.3 10-4 s-1 for O(3P) pathway, 2.9 10-5 s-1 for O(1D) pathway and 8.7 10-3 s-1 respectively. The hydroxyl radical concentrations at noon the second day in each simulation are: Biomass burning: 0.34 pptv in the 5 days dilution run and 0.3 pptv in the 10 days dilution run. Lagos: 0.25 pptv the 5 days dilution run and 0.23 pptv in the 10 days dilution run. Petrochemical accident: 0.1 pptv in the 5 days dilution run and in the 10 days dilution run. It is now indicated in the text the use of TUV model to compute the photolysis frequencies in the description of the box model (section 4): "The Master Mechanism model consists of a detailed gas phase photochemistry, with nearly 5000 reactions between nearly 2000 species. This model computes the time-dependent chemical evolution of an air parcel initialized with known composition, assuming no additional emissions and no heterogeneous processes. Photolysis frequencies are computed from the TUV model (Madronich and Flocke, 1999) every 15

minutes."

3) Why are the high ozone values only encountered in a layer between 500 m and 1500 m? If release of ozone precursors occurs at the ground, I would expect also high concentrations near the ground. Is dry deposition efficient enough to explain the gradient of ozone?

In the hypothesis of an explosion, precursors are directly emitted in altitude. Then, the production of ozone occurs during the transport and the different stability of atmospheric layers make the plume the way it is between 500 and 1500 m. There is no reason to observe high ozone near the ground, especially over Cotonou. We recall that the ozone enhanced layer is observed over Cotonou, a hundred of km far from the probable explosion over Lagos. To better clarify this point, and because it was also asked by referee#3 we have included a new figure (Fig. 4 in section 3 in the revised manuscript) of the vertical profiles of T and RH along with ozone between the ground and 3 km altitude. It is clear that the plume is lying in the boundary layer, capped by the temperature inversion and the decrease in humidity (the Harmattan layer above is drier than the monsoon layer below), characterizing thus the difference in stability and preventing the vertical mixing. This latter sentence is also included in the revised manuscript.

Minor comments:

a) we now use ppb throughout the revised version of the manuscript.

b) Figures are now numbered in the order they appear in the revised manuscript (1 to 10).

c) Proposed corrections have been made. Mexico city is at 19°N, in the tropics.

The Harmattan layer is now further explained thanks to the new Figure 1. Climatological have been replaced by long-term average. Table 2 has been modified.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 21011, 2009.