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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Biomass burning related ozone damage on vegetation over the Amazon forest" *by* F. Pacifico et al.

F. Pacifico et al.

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Response to F. Dentener (Referee) (acpd-14-C6433-2014)

Detailed comments p. 19956 l. 7 bias 5-15 ppb. The abstract should guide the reader to explain what that could mean for the calculated impacts.

R: At page 19956, line 7, we have added: '. The simulated impact of ozone damage from present-day biomass burning on vegetation productivity is about 230 TgC yr−1. Taking into account that uncertainty in these estimates is substantial, this ozone damage impact over the Amazon forest is of the same order of magnitude as the release of carbon dioxide due to fire in South America; in effect to potentially double the impact of biomass burning on the carbon cycle.' And we have removed: 'When biomass burning

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emissions are increased by 100%, our model simulates a maximum impact of 10% reduction in monthly mean net plant productivity averaged over the Amazon forest, with local peaks of 50-60% reduction for the months of intense fire activity.' We have also replaced the title with: 'Biomass burning related ozone damage on vegetation over the Amazon forest: a model sensitivity study'.

p. 19956 l. 12 reduces ozone by how much?

R: At page 19956, line 12 we have added : (by about 15ppb during the biomass burning season)

p. 19956 l. 10-17 Something needs to be said about the time period of evaluation, and what emissions are considered (there are issues).

R: At page 19956, line 3 we have added: ', under present-day climate conditions'. At page 19956, line 5 we have added: 'for years 2010 to 2012'. At page 19956, line 3 we have added : Here we consider biomass burning emissions from wildfires, deforestation fires, agricultural forest burning, residential and commercial combustion. '.

p. 19956 l. 10-17 Something on the type of biomass burning deforestation fires.

R: Please see page 19962, line 27: 'We define biomass burning emissions as those from . . .' We are not able to distinguish between anthropogenic and wildfire.

p. 19956 l. 10-17 More on implications in the abstract ('could be as large as the direct impact on the carbon cycle' but that is an upper limit). Would it be possible to present a more realistic range?

R: See above for modification of abstract text. In the absence of data on ozone damage to tropical forest species, it is not possible to present a more realistic range; therefore we purposely chose to study an upper limit to show whether ozone effects due to biomass burning could be important or not on the carbon cycle.

p. 19957 l. 9 40 ppb is kind of an arbitrary threshold- and it is not clear if it also holds

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for tropical vegetation- with different genotypes. It is picked up in the discussion, but could be alluded here.

R: At page 19957, line 13 we have added: ', e.g. tropical rainforest vegetation may be particularly sensitive to surface O3, even at concentrations below 40ppb (a threshold associated with extra-tropical vegetation), due to high stomatal conductances.'

p. 19957 Is Le Quere reference for 'current' budgets or missing processes?

R: Le Queré is reference for current budgets. At page 19957, line 28 we have replaced: 'current estimates of the effects of biomass burning on the carbon cycle may be underestimated (Le Quéré et al., 2009).' With 'current estimates of the effects of biomass burning on the carbon cycle (Le Quéré et al., 2009) may be underestimated.'

p. 19958 l. 8 derived from ; where=>were

R: At page 19958, line 8 we have replaced 'where' with 'were'.

p. 19958 l. 19 describe shortly what this scheme is including (or refer to p. 19961).

R: At page 19958, line 9 we have added: 'flux-gradient'. At page 19958, line 11 we have added: (see model description).

p. 19959 l. 20 Is the possible bias of these emission discussed later?

R: This is discussed at page 19967 starting from line 1.

p. 19960 Where is ExtTC scheme evaluated, was it part of an chemistry intercomparison for example ? Does it include state-of-the-art radical cycling and what does that mean for ozone?

R: The model used in this study does not include state-of-science OH recycling from BVOC chemistry. We use MIM (Mainz isoprene mechanism) for this study. OH recycling would increase oxidation capacity of the atmosphere to some extend and thus maybe increase ozone production. But that depends on other factors and would require

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further investigation.

p. 19960 l. 10 What are the uncertainties of the VOC emissions (see discussion)?

R: Please see page 19968 line 2.

p. 19961 l 19 The use of the 'high' sensitivity mode seems quite critical and should at least be mentioned in the abstract and conclusions.

R: This is mentioned in the conclusion, please see page 19969, line 27. At page 19956, line 11 we have added: 'We used the ozone damage scheme in the "high" sensitivity mode to give an upper limit for this effect.'

p. 19961 l. 25 see earlier remark on 40 ppb as a threshold; indeed we know little about how ozone-vegetation interactions work in the tropics.

R: See response to earlier comment.

p. 19962 l. 27 Can you evaluate which fraction of the emissions are deforestation?

R: At page 19963 line 2 we have added: 'The dominant fire types in South America are from deforestation and degradation fires in an arc around Amazonia, with some regional hotspots of agricultural burning (see Figure 13 in Van der Werf et al., 2010). Between 2001 and 2009 the percentage contribution to annual fire emissions from fire types (deforestation and degradation, grassland and savanna, woodland, forest, agriculture) are (59%, 22%, 10%, 8%, 2%) over Southern Hemisphere South America (Figure 13 van der Werf et al., 2010), with minor differences between this dataset (GFedv3) and the earlier Gfedv2 in this region (see Fig. 16 in Van der Werf et al., 2010).'

p. 19962 To what extent was the landcover data adjusted to represent the recent conditions?

R: At page 19962 line 27 we have added: 'The vegetation distribution was not adjusted for loss of vegetation due to fire'.

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p. 19962 l understand that the model evaluates 9 years of ecosystem response. Can something be said about response on longer-time scales?

R: In this study we focus on the short-term ecosystem-effects. Further study and longer simulations would be necessary to investigate to the longer-term effects, however prolonged reduced productivity will influence the carbon cycle for some years to come, and affect vegetation composition.

p. 19963 The availabity of ca. 1-2 years of ozone data is limiting the comparison. What is known about interannual variability? E.g. from Shadoz sonde networkhttp://croc.gsfc.nasa.gov/shadoz/Paramaribo.html

R: To our knowledge there are no longer surface ozone measurement records that are representative of the Amazon forest, apart those included in this study.

p. 19963 Figure 1/Figure 2 The figures are quite hard to read (font size of legenda, spaghetti of lines); if I understand it well the full dots are the monthly average measurements, and the individual lines are the single measurement days? It is not clear why the authors want to present these single days- since as expected the model standard deviation is much lower (monthly av. Emissions, coarse resolution). Perhaps the plots can be simplified and include an monthly average (or monthly daytime comparison of data in one additional panel, which would highlight the magnitude of seasonal bias.

R: We have improved figure 1 and 2.

p. 19964 l. 23 higher than other months? Higher than measurements?

R: We have replaced the sentence at page 19964, line 23 with: 'Surface O3 mixing ratios simulated with HadGEM2 are higher during the months of August, September and October over the Amazon forest, and in particular over our region of analysis, because of the higher biomass burning emissions in the model during these months.'

p. 19965 l.5 l. 22 I am missing an evaluation of NPP. It would be good to know if 'current'

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NPP is of the right order of magnitude. Is there any field evidence that vegetation was damaged by ozone in plumes?

R: We have added an evaluation of NPP in the supplementary material. To our knowledge there are no published data of field experiments of ozone damage on plants for the Amazon forest. We added the following text in the supplementary material: 'Simulated HadGEM2 NPP are compared against a meta-analysis of field data from the Ecosystem Model Data Model Intercomparison project (EMDI). Measurements from the 81 'class A' ("well documented and intensively studied") sites, representative of all major global biomes, are compared against our simulations. Traditionally, global vegetation models underestimate NPP in tropical ecosystems, and tend towards an asymptote of ∼1000 g C m–2 (Prentice et al., 2007). HadGEM2 is able to reproduce the main geographical variations of NPP globally (Figure 3), especially in the Northern Hemisphere, where more observations are available. In addition HadGEM2 is able to better simulate higher tropical NPP, although it appears to overestimate NPP over the Amazon region.'

p. 19966 l. 6 which variability is discussed? Interannual or daily variability?

R: At page 19966, line 6 we have added : 'inter-annual'.

p. 19666 l. 10 Why is this low productivity threshold chosen. Do the authors mean, i.e. the analysis focuses on high productivity regions?

R: At page 19666, line 10 we have replaced : '(i.e. forest, high productivity regions).' With '(i.e. we focus on high productivity regions, e.g. forests)'

p. 19666 l. 17 It would be good to include in Figure 1 and Figure 2 a panel that shows this increase more clearly; it is hard to read the numbers.

R: We have improved figure 1 and 2.

p. 19666 l. 23 : : :not impossible: : :=> redundant sentence.

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R: At page 19666, line 23 we have removed ‘however, it is not altogether impossible.’

p. 19967 resolutions=>resolution.

R: At page 19967 we have replaced ‘resolutions’ with ‘resolution’.

p. 19967 There has been no evaluation of the isoprene/terpenes/OVoc in this paper. What are tentatively the uncertainties (specifically for this region) and how could it contribute to the O3 overestimate.

R: For the evaluation of modelled isoprene emission we refer to Pacifico et al., (2011), please see page 19960 line 10. For the evaluation of modelled terpenes, methanol, and acetone emission we refer to Guenther et al., (1995), please see page 19960 line 11.

p. 19969 A recurring science is issue the re-cycling of HOx. How was this included in the chemistry scheme and how could it influence ozone?

R: Our chemistry scheme does not include state-of-science OH recycling from BVOC chemistry. We use MIM (Mainz isoprene mechanism) for this study. OH recycling would increase oxidation capacity of the atmosphere to some extend and thus may increase ozone production. But that depends on many other factors and would require a separate study.

p. 19969 l. 10 this is an interesting perspective, and could already be alluded to in the introduction motivating this study.

R: At page 19957, line 13 we have added: ‘Moreover, tropical vegetation evolved in low background O3 concentrations and could be more sensitive to O3.’

p. 19969 l. 16 mention that this is for the ‘high’ sensitivity case, and for the Amazonian (whole or only the ‘box’?).

R: At page 19969, line 17 we have added: ‘over our area of analysis’. At page 19969, line 18 we have added: ‘using the “high” sensitivity mode in the O3 damage scheme’.

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p. 19969 l. 27 It is not clear why the authors can use the +100 % case to estimate an 'maximum' effect, while earlier it was stated that even the 'current' emissions are probably overestimate since deforestation fires have declined. In my opinion these numbers, which also figure in the abstract are somewhat handwaving, the authors have the means to do better; e.g. explore the low sensitivity case, a range between -50 and 50 % of emissions.

R: We think that the high-sensitivity -100% (i.e. no biomass burning) compared with the present-day biomass burning case establishes an upper limit for the expected effect. Referring to smaller perturbation scenarios (e.g. +/-50%) for the low-sensitivity ozone damage scheme would give a lower-perturbation response and is thus already included in our range. Sensitivity is only one factor, chemistry, and above all process understanding is at least as important. We are establishing a first assessment not a final definitive answer. It is more a qualitative than quantitative assessment and just points out that more research is needed. We also explored both increases and decreases in biomass burning to investigate possible non-linearities in response.

Please also note the supplement to this comment:
http://www.atmos-chem-phys-discuss.net/14/C10042/2014/acpd-14-C10042-2014-supplement.zip

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Interactive comment on Atmos. Chem. Phys. Discuss., 14, 19955, 2014.

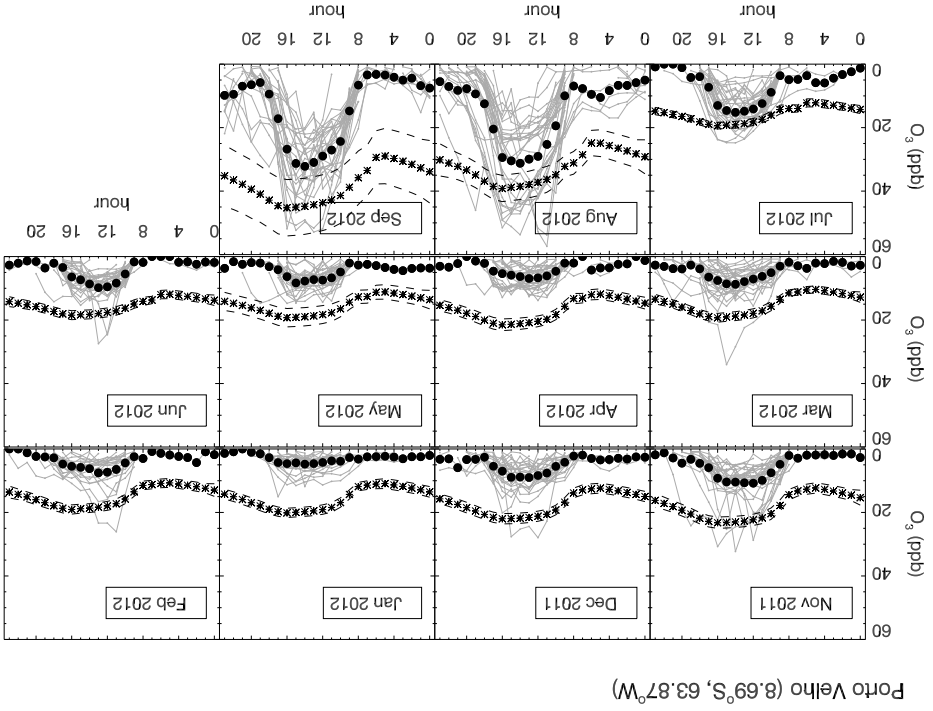

Fig. 1.

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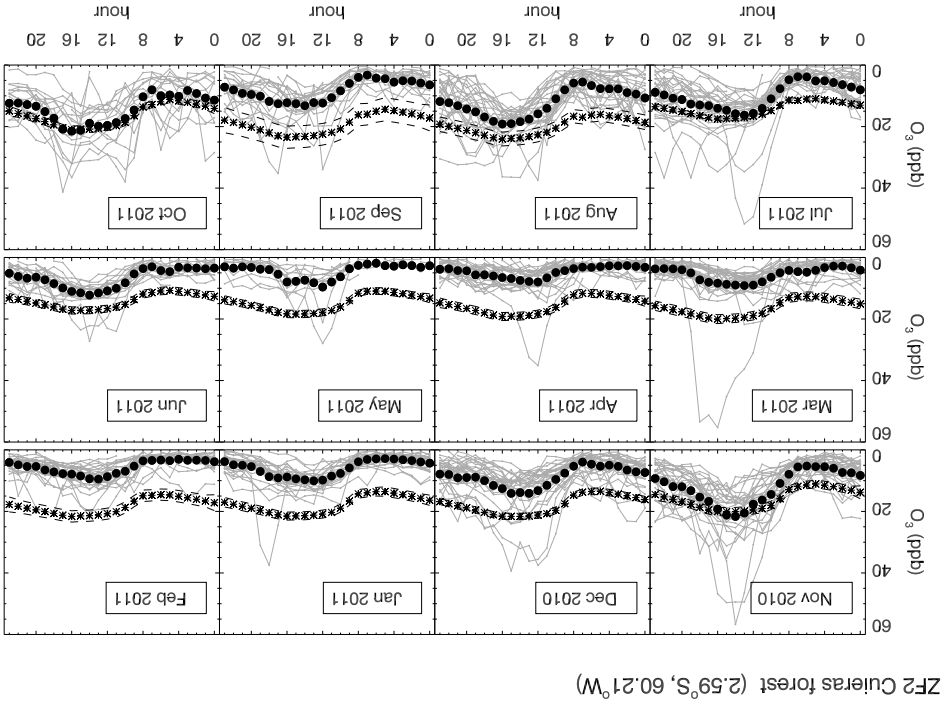

Fig. 2.

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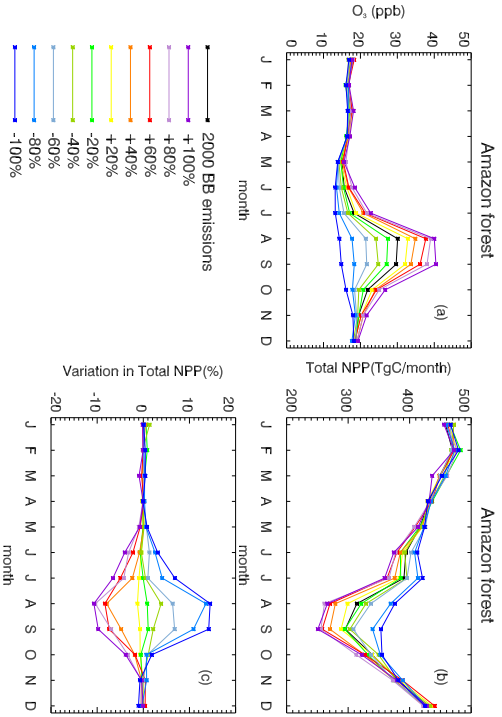

Fig. 3.

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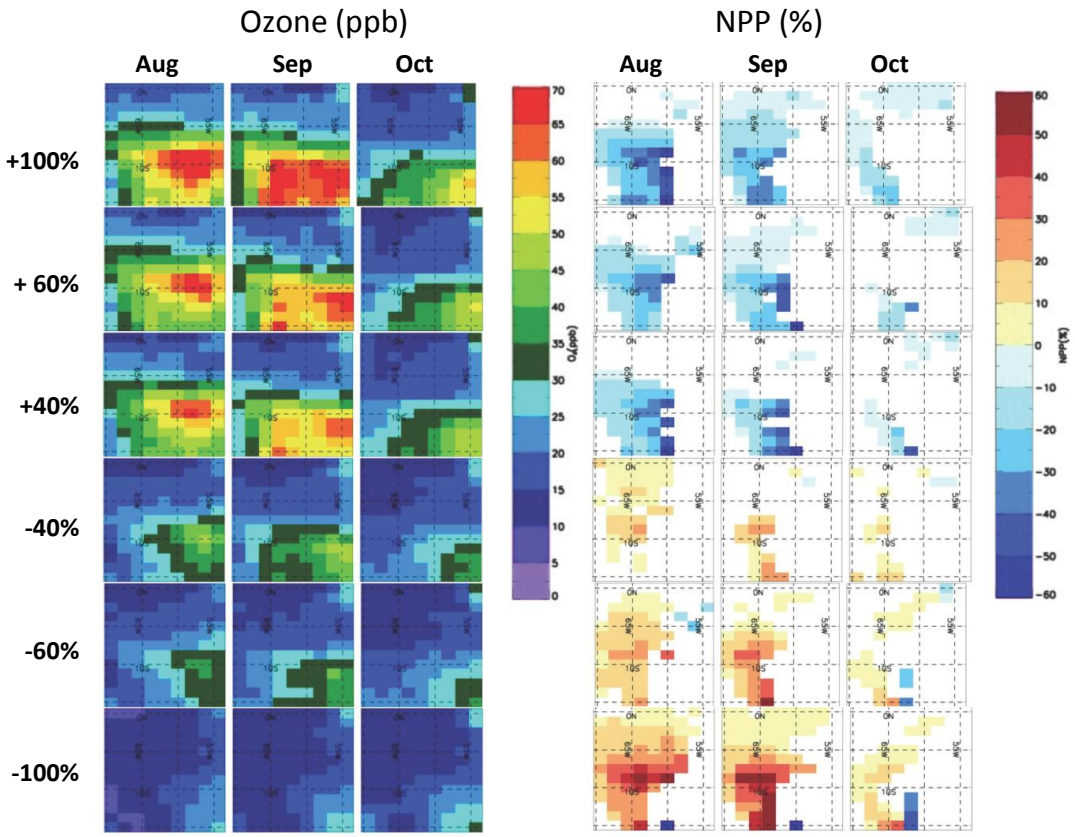

Fig. 4.

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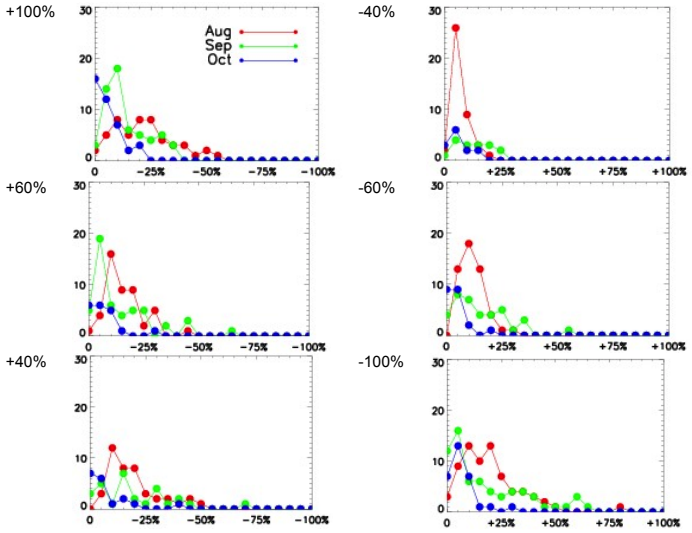

Fig. 5.

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