

Interactive comment on “Projected global tropospheric ozone impacts on vegetation under different emission and climate scenarios” by Pierre Sicard et al.

Pierre Sicard et al.

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Dear Reviewer,

Thank you for giving us the opportunity of a reply. We hope that we have satisfactorily addressed all concerns.

Best regards

Pierre Sicard

Anonymous Referee #3

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L142 "when the stomatal conductance is greater than 0": what do you mean? Do you mean the "leafy season"? Please rephrase it.

The reviewer is right. We realize that it was not clear that we computed the AOT40 for a model grid for hours between 8am and 8pm (local time) for all days of the year. We will state it clearly in the text and we have removed this sentence.

L147 "the overestimation of AOT40 does not affect our results": it is not clear why. Please rephrase it.

The aim of this study is to assess how O₃ stress to vegetation changes between historical period and future. By calculating AOT40 year-round, an overestimation can be observed over polluted region. Even if the AOT40 is misestimated at a given model grid point, as we compared the mean change between present and future at the same model grid point, thus the change is consistent. We rephrased to stress that an over-estimation of AOT40 does not affect our main conclusions (instead of "results") about the percentage of change in the potential O₃ impact on photosynthetic assimilation.

L170 not "per unit of ozone-uptake" but "per unit of AOT40"

The reviewer is right. Alpha is an empirically derived ozone response coefficient.

L172 Again you did not use "ozone-uptake" in Eq. (2). You can describe it as "regressions of the photosynthesis response to ozone (Reich, 1987)".

The reviewer is right. Data from the literature demonstrate strong relationships between cumulative ozone exposure and reductions in both net photosynthesis and plant growth. Figures from Reich (1987) show the percentage of change of photosynthesis in relation to ozone exposure, so we reworded as suggested.

L173 What are the "other vegetation types"? And please justify why the photosynthetic responses to AOT40 are same between deciduous trees and "other vegetation types".

We would like to thank the reviewer for this comment. The photosynthetic responses

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to AOT40 are not the same between deciduous trees and “other vegetation types”. We now clearly explained in the text that the relationships between cumulative ozone exposure and reductions in both net photosynthesis and plant growth vary among and even within species (Reich, 1987; Ollinger et al., 1997; Anav et al., 2011). Differences in response per unit uptake tend to be greater in magnitude between functional groups (e.g., hardwoods vs. conifers) where leaf structure and plant growth strategy differ most widely (Reich, 1987).

From the Global Land Cover Facility (GLCF) data at 1degree of spatial resolution, we grouped the vegetation in 3 categories and then we used the following factors: conifers, crops and deciduous trees. Ollinger et al., 1997 derived a leaf-level ozone response equation for broadleaved deciduous species (2.6×10^{-6}) and we used 0.7×10^{-6} for coniferous and 3.9×10^{-6} for crops (Reich, 1987).

L464-465 Nemani et al. (2003) and Zhu et al. (2016) did not show the ozone impacts. Please revise it.

The reviewer is right. These analyses (Nemani et al., 2003; Zhu et al., 2016) focused on impacts of global environmental changes (e.g. climate, land-cover, nitrogen deposition, CO2 fertilization) on vegetation. We have reworded as suggested.

L480-481 “In these areas, the increasing effect of a warming: : ”: where can we refer for this result? Please specify it.

We compared the GPP reduction (from - 10 to - 20%) due to O3 (Sitch et al., 2007) and the strong increase in NPP and LAI due to climate change (Nemani et al., 2003; Zhu et al., 2016) over Amazon forest. We have reformulated as “In these areas, we observed an increasing effect of a warming climate on forests (e.g. increase in greening, NPP, LAI) as compared to a reduction in GPP due to O3 (Sitch et al., 2007)”.

L491-496 “mainly due to the lack of empirical data about the response of different species to O3”: We have to say that this is a weak rationale. In fact, Sitch et al.

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(2007) considered five plant types (broad-leaved tree, needle-leaved tree, C3 crops, C4 crops and shrubs; please see the Table S1 of their paper). But we can find a marked difference in estimated ozone concentration in 2100 between this study (Fig. 1) and Sitch et al. (2007). A major advantage of this study is a comparison between the models and scenarios. The authors should reconsider the sentence and should emphasize what is the need to explore future potential impacts of ozone.

The reviewer is right. The ozone concentrations over Amazon forest are lower in Sitch et al., (2007), i.e. 75-90 ppb in summer (present) and more than 90 ppb by 2100. In our study, the annual O₃ mean is around 15-20 ppb by 2100. In this section, we added in the text explanations about the overestimation in GPP reductions simulated by Sitch et al. (2007) in summer such as the estimated O₃ concentration in 2100, the lack of empirical data about the response of different species to O₃ the non-inclusion of the nitrogen limitation of growth.

L553-560: I agree with the statement. However, if so, readers are wondering why AOT40 was targeted in this paper. The authors can put more “take-home messages” for readers. For example, what is a climatic condition (arid/humid) in high AOT40 regions? How about the need for a parameterization of the ozone dose-response relationships in tropical plants? ...etc. The reviewer is right and we decided to add a few more information about the AOT40 limitations at global scale (e.g. factors affecting stomata e.g. water availability).

L578”the lower risk areas include evergreen broadleaf forests ”: we cannot find the description about the parameters in evergreen broadleaf forests (lines 170-174). Did you target this plant type? We did not focus on evergreen, as now clearly explained in the text. By using the land-cover data (GLCF), we can observe that the lower O₃ risk areas (Figure 3) correspond to areas with evergreen broadleaf forests.

Figure 3 legend: “the potential ozone impact on vegetation“: of what? Maybe photosynthetic assimilation. But please specify it. Indeed, we added “the potential O₃ impact

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on photosynthetic assimilation”.

L551 “..South Asia they may..”: you had better put “, and” before “they may”. Done

L552 not “were” but “was” Done

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