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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The CO_2 inhibition of terrestrial isoprene emission significantly affects future ozone projections" *by* P. J. Young et al.

Anonymous Referee #1

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General Comments:

This paper describes a modeling study where the direct influence of CO2 inhibition on biogenic isoprene emissions, and further, on global atmospheric chemistry in a future climate scenario is investigated. Another study has used the model to show the impacts of CO2 inhibition on future global isoprene emissions (Arneth et al., 2007), and this manuscript takes a further step to evaluate that impact on ozone and hydroxyl radical concentrations. Other studies that have investigated the impact of changes in natural vegetation and climate on future biogenic emissions and chemistry have predicted increases in emissions. Those that have also included anthropogenic changes in land use have show reductions in emissions.

The study results are interesting and the method of the study is sound. Although the chemical mechanism used by the authors is uncertain, the authors describe their assumptions well and do a good job comparing to other published modeling studies. Based on my knowledge of the literature, the authors cite the appropriate articles published on the subject. I recommend minor revisions before this paper be published by Atmospheric Chemistry and Physics.

The authors cite a paper by Wilkinson et al. (2008) who developed an isoprene emission response to increased CO2 concentrations. How different is the empirical algorithm applied in the LPJ-GUESS model here to the response function of Wilkinson et al.? I understand that the data produced by Wilkenson et al. are included in the empirical fit applied for this study (shown on Figure 1). However, if the authors used the results from Wilkinson et al., would the results of this study be significantly different? (Also, is it possible to use different symbols on Figure 1 to represent the various datasets shown? E.g. triangles for data from Wilkinson et al. [2008], circles for Sharkey et al. [1991], etc.)

There are many changes in vegetation and climate that may impact future biogenic emissions of isoprene. For this study, the authors take into account changes in natural vegetation, temperature, light (I am assuming), and NPP (increased from increased CO2 fertilization in the future). Anthropogenic land use change is mentioned, but not included in this study. How about changes in future NPP due to increased O3 concentrations (Sitch et al., Nature, 2007) and changes in the Nitrogen-Carbon cycle (Thornton et al., Global Biogechemical Cycles, 2007)? I understand that this is beyond the scope of this paper, but perhaps could be mentioned as yet more uncertainties in the system that should be addressed. The authors could more strongly argue the value of this particular study and its results. The paper highlights the incredible uncertainty associated with the isoprene chemistry in the atmosphere; this is just one component of the system that has yet to be resolved.

Specific comments:

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Pg 19897: what is the rate constant of ISO2+NO reaction? (only yield is given); but for the other reaction, rate constant is given? could more information be provided here?

Page 19898: How long were the simulations? 1 year? 10 years? This is not clear. If one year, how is it possible to use a current climate? Is this truly representative of the time period? Perhaps a bit more detail could be provided about the model simulations.

Young et al. 2008 is cited several times, yet- it is not a published paper. I think that the authors need to either cite a published paper or include more detailed justification in this manuscript (e.g., pager 19900, line 15-16)

Is it possible to attribute the change in O3 concentrations/burden to climate versus chemistry? Based on the wide variety of chemistry options and climate forcing, what does this tell us?

Page 19903, line 8: 13 percent increase in tropical tropopause OH? I don't read this from the figure.

Page 19903, lines 14-15: the authors may want to reword to state that it's caused by reduced reactions of isoprene and OH.

Page 19903: "Globally, the average tropospheric OH concentration was 7.2 percent higher in wCO2 which extended the tropospheric chemical lifetime of methane by 7 months (Table 1), illustrating the indirect radiative forcing attributable to isoprene (Collins et al., 2002)."

If OH concentrations are higher, then wouldn't that mean that there is more OH to react with methane, and the methane lifetime would be reduced? It looks like in Table 1, the sentence should read that the CH4 lifetime was reduced by 7 months? (and from which simulation?) Also, this would reduce the indirect radiative forcing of isoprene, wouldn't it?

Page 19904: so it's a wash between the climate influence on OH and the isoprene emission change on OH? The authors state that the climate influence on OH is the

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same magnitude (but opposite direction) of the change in OH from the wCO2-noCO2 simulations. However, don't those two also take into account the climate? I find it difficult to pull out the significance of this evaluation explanation, and suggest a rewrite of this section would be helpful.

Page 19904: The first sentence of the Conclusions section could be reworded.

The impact on future O3 concentrations is important not only for climate forcing, but also for future air quality impacts. The authors may want to consider mentioning this, too.

Technical Corrections:

Pg 19895, line 27-28: Sentence could use some commas: "but when included, based on our current knowledge, the CO2-inhibition of isoprene emission"

Pg 19898, line 6: do you mean "emissions from biomass burning and biogenic emissions other than isoprene"?

Page 19904, line 2: extra period needs to be removed.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 19891, 2008.