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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of climate change on tropospheric ozone and its global budgets" *by* G. Zeng et al.

Anonymous Referee #1

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===== General comments:

This manuscript describes future projection of global tropospheric ozone, particularly focusing on the impacts of climate change in their numerical experiments including simple sensitivity simulations to check the impacts of subsequent changes such as isoprene and soil NOx emission increases. The manuscript seems to function as an introduction of the updated version of their model as well. The authors interpret and discuss their model results very carefully well mentioning both chemical and physical aspects.

The experimental scenario and setup are straightforward, and are clearly described in the manuscript.

The authors use the first half of this paper for evaluating their new model version with isoprene chemistry. Since this paper discusses the impacts of isoprene emissions change, this may appear reasonable. However, I think, the authors could better present the model evaluation in Section 4 by reducing the tedious descriptions.

The overall text is competently written, and reference to related previous studies is appropriate and adequate, several sentences seem to be tediously written, though.

The subject of this paper appears to be appropriate to the ACP. Changing process of tropospheric ozone is complex, and there are only a limited number of studies on future ozone projection including climate change impacts. And, given the large importance of ozone for understanding climate change, this study can be regarded as a significant addition to the current knowledge. However, I would like the authors to consider my questions and revise the manuscript before I recommend the publication of this paper. Details of my comments will be found in the following.

===== Major comments:

Block-11146:

*** L22: What does "the climate resolution" mean ? May be a relatively coarse horizontal resolution in a general climate model ?

Block-11148:

*** L14-: "The baseline run A covers the years 1996-2000 using emissions for year 2000 and is used to verify the model performance against observations."

Did the authors nudge the meteorology in the UM model to the reanalysis data for 1996-2000 ? or , just prescribe SSTs ?

*** L17-: "Run C calculates future changes due to changes in both anthropogenic emissions and the climate using 2100 emissions (same as run B) and a double CO2 climate forcing with appropriate SSTs."

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I am a little concerned about the consistency between the "appropriate SSTs" and the atmospheric forcing with doubled CO2. Were the SSTs calculated under the double CO2 condition ?

Block-11150 & 11151:

Section 4.1 describes general features in tropospheric ozone distribution related to Fig.1 and 2. But, since those have been shown already in many of the previous studies, I recommend that the authors should describe their results more briefly.

Block-11151

*** Fig.1 In January, you calculated a relatively large ozone peak in the equatorial Atlantic (west of Africa) which seems to be associated with the north African biomass burning in this season. But, there appear no ozone enhancements over the land in North Africa. Is that due to strong dry deposition over the land surface ?

*** Fig.4 I recommend that the authors should replace the vertical axis by height in kilometer or by the log(P) pressure coordinate. In the simple pressure coordinate, vertical gradient of ozone in the upper troposphere can not be appropriately displayed. So please change the vertical axis.

Block-11153

In the paragraph describing the global ozone budget: The authors should mention the ozone budget in the previous version of the model without isoprene chemistry to show how the budget is modified by adding isoprene oxidation. That information could be helpful for interpreting results of the isoprene sensitivity run in this study (section 5).

Block-11156

*** L2-: "The O3 increase in the stratosphere results from transport of O3 precursors from the troposphere"

Doesn't transport of O3 itself from the troposphere contribute to it as well ?

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*** Fig.8: What is the reason for the significant NOx reduction in the stratosphere?

Block-11157

*** 1st paragraph: Please describe the annual and global mean increase in surface temperature here.

*** L15-: "the enhanced Brewer-Dobson circulation more rapidly lifts O3-poor air upwards in the tropics and transports O3-rich air into high latitudes"

I would like to know the vertical resolution of the model in the lower stratosphere. Is that sufficient to represent the BD circulation ?

Block-11158

*** L21-: "our calculations show that increases of HOx correlate closely to the increase in O3, "

The increased HOx may not be a reason for the increased ozone production. Increase in HOx can be just a result of increased ozone instead.

Block-11161

Is it possible to include a figure to display the increased PAN abundances ? : zonal mean distribution or vertical profiles as in Fig.6.

Block-11162

section 5.3.2: Fig.13(b): Why did lower stratospheric ozone decrease responding to the increased soil NOx emissions ?

6 conclusions: "We calculate a net stratospheric to tropospheric ozone flux of 452 Tg/year, a gross O3 chemical production of 3620 Tg(O3)/year, and a gross O3 chemical destruction of 3108 Tg/year. However, the gross chemical production of O3 is relatively low compared to a recent multimodel study."

I guess that relatively small ozone production and destruction can be related to lower

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water vapor abundances in a climate model. Is there any such evidence in your model?

===== Minor comments:

Block-11149 L24: "Oliver and Berdowski" –>"Olivier and ..."

Block-11162 L10: The sentence does not make sense. Something is wrong.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 11141, 2007.