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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.

G. Zeng et al.

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We are grateful to the reviewer for his/her encouraging comments and detailed suggestions. We have addressed each of the points/questions raised and have altered the text and figures accordingly. Modifications are highlighted in the revised text. We believe that the manuscript has been improved andis ready for publication in ACP.

Response to specific comments:

Block-11146: ###### *** L22: What does "the climate resolution" mean ? May be a relatively coarse horizontal resolution in a general climate model ?

— The climate resolution does mean a relatively coarse horizontal resolution in a GCM. We have altered the text to make the statement clear.

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 for1996-2000 ? or , just prescribe SSTs ?

— We didn't nudge the meteorology but use the prescribed SSTs from observations. We have reorganized this section to describe the experiment setup more clearly.

*** 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." 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 ?

— Yes, the SSTs used in runC are calculated using the Hadly Centre coupled ocean-atmosphere GCM under the double CO2 condition. We have reorganized this section.

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.

— We have taken out Fig2 and have modified the text accordingly.

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 inNorth Africa. Is that due to strong dry deposition over the land surface?

— It is due to the strong dry deposition of ozone over the land. Note that we have reduced the discussion on figure 1 in accordance with the referee's recommendations.

*** 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,

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vertical gradient of ozone in the upper troposphere can not be appropriately displayed. So please change the vertical axis.

— We have changed vertical axis, and have also reduced the number of stations on the figure. The related text has been modified.

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).

— We have added a paragraph to address this question.

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 ?

— We believe that the ozone increase in the stratosphere results mainly from transport of ozone precursors from the troposphere. We have added "mainly" in the sentence.

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

— NOx to HNO3 ratio has decreased in this case.

Block-11157 ###### *** 1st paragraph: Please describe the annual and global mean increase in surface temperature here.

— There is a 4K increase of annual and global mean surface temperature here. The text has been modified.

*** 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 ?

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— The model's vertical levels above 200 hPa are: 199.6, 149.5, 99.2, 56.9, 29.6, 14.8 and 4.6 hPa. We think that it is sufficient to represent the BD circulation , although increased resolution would be preferred. Nevertheless our model results are consistent with those from study by Butchart et al.; they calculated increased mass flux with the increased BD circulation in the future climate.

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.

— We agree that the increase in HOx can be a result of increased ozone. It can be both cause and effect. We have adjusted the text.

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.

— We have added a figure here to display zonal and annual mean changes in PAN due to the increase of isoprene emissions.

Block-11162 ###### section 5.3.2: Fig.13(b): Why did lower stratospheric ozone decrease responding to the increased soil NOx emissions ?

— NOx acts as a chemical sink of ozone in the stratosphere.

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

— We found no such evidence by comparing our modeled water vapour fields to the ERA 40 H2O fields; they are very similar. We need to examine other factors to find

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explanations (e.g. differences in chemical mechanism, lightning, etc.).

===== Minor comments:

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

— Corrected.

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

— We have modified the text here.

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