

Interactive comment on “The sensitivity of stratospheric ozone changes through the 21st century to N₂O and CH₄” by L. E. Revell et al.

Anonymous Referee #1

Received and published: 26 September 2012

General Comments. Overall this is a very straightforward study that addresses the impact that future CH₄ and N₂O increases will have on ozone. The simulations are clearly defined and the results are clearly shown. This paper is a useful addition to understanding the role that CH₄ and N₂O independently play in affecting stratospheric ozone. I have a few specific comments that I would like addressed (see below).

Specific Comments:

Page 1, Abstract:

You should state, “Overall however, increasing the CH₄ concentrations lead to an increase in global-mean total column ozone.” You should follow this sentence up with why this happens. (You did state “why” for the N₂O increases).

C7464

Page 2, discussion 16-20. Please summarize the mechanism where “. . . its effectiveness as an ODS is mitigated by increases in CH₄ and CO₂”. I believe you are talking about the temperature dependence of N+O₂? E.g., Rosenfield et al. 2002, describes the mechanism in the following manner: “A reduction in NO_y with cooling has been shown [Rosenfield and Douglass, 1998] to arise from the very large temperature dependence of the reaction N + O₂ => NO + O (k ~exp[-3600/T]). The abundance of N is increased with cooling, leading to an increase in the loss of NO_y which is controlled by the reaction N + NO => N₂ + O. This decrease in NO_y contributes to the reduction of the ozone loss frequency due to the NO_x cycle.”

Page 2, line 22, 23. List catalytic cycle. E.g.,

H + O₃ => OH + O₂, followed by OH + O => H + O₂.

Page 3, lines 6 through 9. The authors state that “Furthermore, in the troposphere and lower stratosphere, where the concentrations of CO is sufficiently large (Lanzendorf et al., 2001), increase HO_x causes an increase in the rates of reactions (R2) – (R5), therefore leading to ozone production.” In Lanzendorf et al., the CO abundance was coming from observations. In the CCM simulations, in this paper, I don’t believe the tropospheric mechanism includes oxidation of NMHCs to form CO, therefore, the abundance of CO will be significantly less than what observations would suggest (in the troposphere and lower stratosphere). Therefore, based on this discussion, the ozone production process would be underestimated. This “apparent” lack of detailed tropospheric chemistry should be commented on if you are going to discuss photochemical smog processes in the lower stratosphere.

Page 4, lines 1 through 3. Please define here if you only include CH₄ and its oxidation products (i.e., no representation of NMHCs).

Page 6 discussion of Figure 4. It would be very interesting to also see a figure that showed the change in reactive odd nitrogen (NO_x) consistent with the “N₂O-8.5 minus N₂O-2.6” case, both in absolute change and percentage. Since the main production

C7465

region for NO_x (O₁D + N₂O) is in the tropics, near 5-10hPa, this would show where the peak loading of NO_y is occurring. It would also show that there is significant loading in the lower stratosphere causing the ozone change depicted in figure 4a. This is just a suggestion.

Page 6, lines 11-20. You could make a similar figure showing the change in reactive odd hydrogen (HO_x) to complement figure 5. Again, this is just a suggestion to add more quantitative details on how the ozone precursors are changing.

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 17583, 2012.

C7466