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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Stratospheric ozone in the post-CFC era" *by* F. Li et al.

Anonymous Referee #2

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A. GENERAL COMMENTS:

To start off, this is a very well written paper – concise and to the point. Its conclusions are of immediate interest to the community and should be published with very few correction.

The paper discusses stratospheric ozone recovery in the 21st century and its sensitivity to climate change using model simulations from a couple chemistry-climate model. Previously such studies have generally been limited to analysis of the vertically integrated column amount. Here the full vertical and latitudinal structure of ozone changes between 1980 and the 2060s (when the chlorine loading is projected to return to 1980 levels) are analyzed.

The authors look at changes in ozone above and below 15 hPa, and show that ozone changes in the upper region is due to CO2 induced temperature effects and due to

transport changes in the lower region.

Several interesting conclusions are made. For example, it is shown that lower stratospheric ozone changes average out in a global sense (ozone decreases in the tropics and increases in the extra-tropics), and thus the global mean column ozone increase from 1980 to the 2060s is due mainly to upper stratospheric ozone recovery. However, it is also shown that locally lower stratospheric ozone increases are significant and can even exceed upper stratospheric increases (this is the case in the NH extra-tropics). And thus, the author stresses, circulation changes play a larger role than previously thought.

Below follows a few specific comments and a technical correction that I hope will help to improve that paper.

B. SPECIFIC COMMENTS:

1) Page 20224, lines 24-26: "Increased greenhouse gases (GHG) will cool the stratosphere, which will lead to an increase in ozone due to the temperature dependence of the chemical reactions involved in ozone loss (Barnett et al., 1975)".

This is true only for the part of the stratosphere where ozone is under gas-phase photochemical control, i.e. mainly the upper part of the stratosphere). In the polar lower stratosphere winter and spring regions, where heterogeneous chemistry takes place, the relationship between temperature and ozone is expected to be reverse to that in the upper stratosphere. The quoted statement is too general.

2) Page 20228, lines 24-27: "A reverse relationship between ozone and temperature in the upper stratosphere has long been known, which is mostly due to the strong temperature dependence of the chemical ozone loss rate in the Chapman reactions O+O3->2O2 (k=exp[-2060/T]) (Rosenfiled et al., 2002)".

The Chapman cycle is indeed responsible for the most of the ozone response to temperature changes in the upper stratosphere, however Jonsson et al. (2004) have shown

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that most of the effect comes not from the temperature dependency of the rate coefficient of the O+O3 reaction (the k-value quoted above) but from the temperature dependency of the odd oxygen partitioning reaction O+O2+M->O3+M, which controls the atomic oxygen concentration. (Rosenfield et al. also acknowledge the importance of this effect.) However, details like this aren't perhaps relevant to this paper, but the quoted statement is perhaps a bit misleading.

Reference: Jonsson, A. I., J. De Grandpre, V. F., Fomichev, J. C. McConnell and S. R. Beagley, "Doubled CO2-induced Cooling in the Middle Atmosphere: Photochemical Analysis of the Ozone Radiative Feedback", J. Geophys. Res., Vol. 109, D24103, 2004.

3) Page 20229, lines 19-26: "Note that the actual changes of ozone advection depend on both the strength of the Brewer-Dobson circulation and the gradient of ozone. In the tropics, enhanced upwelling produces larger negative ozone tendency in the lower stratosphere and positive tendency in the upper stratosphere, because the vertical ozone gradient changes sign around 10 hPa (ozone concentrations peak around 10 hPa). In the middle and high latitudes, accelerated downwelling results in stronger negative ozone tendency in the upper stratosphere, and larger positive ozone tendency in the extratropical lower stratosphere except in a band near 60S and the Arctic lower stratosphere".

I found this paragraph a little hard to follow. I don't think there is anything really wrong with it, I just had to read it several times to get it. Should it not be "...and LARGER positive tendency in the upper stratosphere" in the second sentence?

4) Page 20232, lines 5-7: "Model results reveal that the extratropical column ozone increases by up to 6% in the NH, but the tropical column ozone remains about the same, albeit smaller, after the recovery of EESC".

Why is the extratropical behaviour mentioned only for the NH. Why not mention the SH too (for completeness)? Is it because the SH ozone increase is not statistically

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significant over the pole?

C. TECHNICAL CORRECTIONS:

1) Page 20228, lines 27: "Rosenfield" is misspelled.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 20223, 2008.

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