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Atmospheric Chemistry and Physics Discussions

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

F. Li et al.

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Reply to Referee #2

B. SPECIFIC COMMENTS:

Comment: 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.

Reply: The referee is correct. We have revised the text to "Increased greenhouse gases (GHGs) will cool the stratosphere, leading to an increase in the upper strato-

spheric ozone due to the strong temperature dependence of the gas-phase photochemical ozone loss reactions."

Comment: 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 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 arent 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.

Reply: The referee correctly points out that we have not given the whole story on the issue of the cause of the ozone increase due to upper stratospheric cooling. The main point is that cooling slows down the reactions leading to ozone loss and therefore results in an ozone increase. We have changed the text to reflect this point.

Comment: 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

ACPD

8, S11405–S11407, 2009

Interactive Comment

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?

Reply: This paragraph explains why the changes of the ozone advection have opposite signs between the lower stratosphere and upper stratosphere, and between the tropics and extratropics. It should be "larger positive tendency in the upper stratosphere" in the second sentence. We have revised the text to clarify this point.

Comment: 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 significant over the pole?

Reply: The SH peak increase (3%) in the mid-latitude is statistically significant. We have revised the text as "Model results reveal that the extratropical column ozone increases by up to 6% in the NH and 3% in the SH, but the tropical column ozone remains about the same, albeit smaller, after the recovery of EESC".

C. TECHNICAL CORRECTIONS: Comment: 1) Page 20228, lines 27: "Rosenfield" is misspelled.

Reply: This is corrected.

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

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8, S11405–S11407, 2009

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