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

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Li et al. make a number of important points and illustrate the value of long time series for drawing inferences from chemistry-climate model simulations of the combined effects of climate change and ozone depletion/recovery on stratospheric ozone. I would like to make two comments on their manuscript.

1. The first is a bit awkward, because these are my colleagues, but I can see no way around it. They cite my Atmos-Ocean paper (Shepherd 2008; hereafter S08) for a general review of ozone-climate interactions, but not for the fact that it has already made almost all the same points that they make here, using results from the Canadian Middle Atmosphere Model (CMAM). This would not be a serious issue except that they are presenting these results as the original contribution of this paper. For example, in their Conclusions on p.20232 they say:

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'Previous work has attributed the extratropical ozone "super recovery" to increase in the middle to upper stratospheric ozone due to GHG-induced stratospheric cooling (Eyring et al., 2007). Here we show that, in the GEOSCCM simulations when EESC returns to pre-1980 levels, lower stratospheric ozone increases make significant contribution to the "super recovery" of the extratropical total ozone....Model results also project that the tropical total column ozone will not recover to 1980 values....These results suggest that circulation changes play a larger role in ozone recovery than previously thought.'

Compare the above with the following statements on p.135 from the Summary of S08:

'CMAM also suggests a strengthening Brewer-Dobson circulation due to climate change, which tends to decrease total ozone in the tropics and to increase it in the sub-polar extratropics, especially in the northern hemisphere. These circulation-induced changes in ozone occur mainly in the lowest part of the stratosphere and lead to a long-term "dynamical super-recovery" in total ozone of about 4% above 1960 values in northern mid-latitudes.'

Figure 10 of S08 shows the CMAM total ozone time series together with those of Cly, very similarly to Figure 1 here, and clearly illustrate the "super-recovery" in the sub-polar extratropics, especially in the NH, and the "sub-recovery" in the tropics. (Figure 12 of S08 extends this to polar springtime.) Figure 11 of S08 uses vertical profiles of ozone differences (in DU/km) between past and future in periods of low chlorine loading, very similarly to Figure 2(b) here, to show that the most important changes occur in the lower stratosphere. S08 made the attribution to circulation changes on the basis of the latitudinal fingerprint, the absence of any "super-recovery" in near-global (60°S-60°N) total ozone — this point is discussed further below — the associated temperature changes, and knowledge about the strengthening BDC in CCMs. A detailed analysis of the spatial structure of the changes in the BDC in CMAM was subsequently made (McLandress and Shepherd, J.Clim., in press; available for several months from the AMS web site), which confirms all these inferences as well as providing quantitative details.

Given that no single model result can ever be definitive, it is still important for the GEOSCCM group to publish their results and compare them with those from other models. However their paper needs to acknowledge that S08 already made their main points, and to make a comparison between their results and those of CMAM. With respect to the latter, please note my second point, below.

2. The time period chosen to isolate the effects of climate change (2060-2069 minus 1975-1984) is not ideal, because EESC was far from zero in the 1975-1984 time frame — this is evidently true for GEOSCCM too, based on their Figure 1 — and most models find that ozone depletion had already begun to occur by 1980. (Taking 1975-1984 or 1980 as the baseline is essentially equivalent, since ozone is evolving linearly with time during this period.) Nearly all the models examined by Eyring et al. (2007) have ozone levels well above the 1980 baseline prior to 1980 in both subpolar (Figure 5) and polar (Figure 7) regions. (The fact that the ozone curves in Figure 1 of Li et al. are flat before 1980 may have something to do with the application of their temporal filtering, given the rather odd kinks in the curves at 1980.) Thus, the differences shown here for 2060-2069 minus 1975-1984 include some effects of ozone recovery together with those of climate change. To properly isolate the effects of climate change, it is necessary to go back even earlier. For example, S08 used 1960-1970 as the baseline. (The appropriateness of this choice is evident more generally, not just for CMAM, from Figure 5 of Eyring et al. 2007.) Relative to this baseline, Figure 10(a) of S08 shows that for CMAM, something like 30% of the near-global ozone depletion had already been realized by 1980. On this basis, p.133 of S08 states:

'The fact that CMAM near-global ozone exceeds 1980 values at the end of the twenty-first century is not "super-recovery" but simply a reflection of the fact that in CMAM, 1980 ozone levels were already suffering from ozone depletion.'

Thus, I suspect that a significant part of the column ozone changes attributed by Li et al. to climate change include the effects of ozone recovery. Long-term differences relative to the 1980 baseline simply cannot be attributed to climate change alone. Moreover,

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there is a significant cancellation between upper stratospheric and lower stratospheric changes, as is evident from Figure 11(a) of S08.

When the differences in baseline are taken into account, the GEOSCCM results would seem to be very comparable to those from CMAM shown in S08. The 6% (3%) "super-recovery" in NH (SH) midlatitude total ozone found by Li et al. matches well the CMAM long-term changes relative to the 1975-1984 time period seen in Figure 10 of S08. In terms of vertical structure, Figure 11 of S08 shows "super-recovery" of about 1.8 (0.8) DU/km just below 100 hPa in the NH (SH), values that are very similar to those in Figure 2(b) here. In the tropics, the CMAM ozone decline due to climate change (2% in column ozone, 1.7 DU/km at 70 hPa) is about twice as strong as that found here, but this difference is explained by the fact that a little over one-half the long-term decline in CMAM had been realized by 1980.

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