

## ***Interactive comment on “Quantifying uncertainty in projections of stratospheric ozone over the 21st century” by A. J. Charlton-Perez et al.***

**Anonymous Referee #1**

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This paper separates the uncertainty in simulated values of column ozone into model and scenario uncertainty and internal variability. Comparing the relative sizes of these terms, the paper shows that it should be possible to reduce uncertainty in ozone projections throughout the 21st century by reducing model uncertainty, especially up to the date of ozone return to 1980 values. This is an important point.

I would recommend this paper for publication subject to the substantial number of minor revisions noted below.

C2461

### **MINOR CORRECTIONS**

Page 5, line 25: Since it is stratospheric ozone that is being studied in this paper, I think it is most honest to mention that CAM3.5 is actually a low top model, with model lid height around 3hPa. If you feel this will have no impact on the results, I think you should still state this.

Page 13, lines 15-18: Surely it is not just the smaller averaging area and shorter averaging period that leads to increased internal variability being seen in the polar regions? I thought the winter poles were far more variable than other parts of the atmosphere in any case. Also, please explain WHY a peak in internal variability is seen near to the period of maximum ozone depletion.

Page 14, lines 9-10: Again, it would be good to add a qualifier here, stating that the differences may also be due to different models being used (in particular, a low top model in the RCP case).

Page 15, line 10: Somewhere in this text you should clarify that it is the STANDARD DEVIATION shown by all lines in Figure 3, and that the black line shows the total VARIANCE (i.e. it is the sqrt of the sum of the squares of all the coloured lines).

Page 15, lines 12-15: I think it should be stated that there is not particularly good agreement between the SRES and RCP estimates after around 2050. This is a potentially important point that is already made elsewhere in the paper. The sentence here currently contradicts that statement.

Page 16: On line 4 you refer to the "tropical upper stratosphere". Therefore, on line 8, should "upper stratosphere" be "extra-tropical upper stratosphere" ?

C2462

Page 16, line 8: Could you be a bit more specific than "factors other than GHG induced cooling" ? For example, does transport play a role?

Page 16, lines 11-19: See also Ray et al., submitted to JGR, which shows the observations suggest a slightly weaker than predicted increase in the Brewer-Dobson circulation, and the importance also of horizontal mixing across the tropopause.

Page 16, line 25: Model uncertainty does NOT reduce over the course of the 21st century – it reduces until around 2050 and then increases again. Therefore I don't see how an argument relating this to reducing ODS concentrations can be correct.

Page 17, lines 16-20: If Arctic ozone is close to the multi-model mean for CAM3.5 and WACCM, above it for GEOSCCM, and below it for CCSRNIES, then how is this consistent with there being a difference between the SRES simulations (WACCM, GEOSCCM, CCSRNIES) and the RCP simulations (CAM3.5) ?

Page 18: A "robust change in ozone", "detectable change from 2000 values", and "statistically robust change in column ozone" are discussed. Statistically robust in what sense? I understand the signal to noise argument, but are the changes significant at the 95

Page 19, line 6: "total uncertainty in all three components". Are you re-defining "total" here? I thought "total" was the SUM of the uncertainty of the three components whereas here it seems to be applied to each in turn.

Page 20: How do the fractional uncertainties shown in Figure 5 relate to those that can be obtained simply by reading the fractional contributions straight from Figure 2?

Page 22: If you agree, it might be nice to add that future work computing a

C2463

process-based breakdown of model uncertainty would also be useful.

## **TYPOGRAPHICAL ERRORS**

Page 5, lines 11-12: "[Chapter 9 of SPARC CCMVal, 2010; Waugh and Eyring, (2008)]" should be "(Chapter 9 of SPARC CCMVal, 2010; Waugh and Eyring, 2008)"

Page 9, line 19: "These estimate" should be "This estimate"

Figure 1 caption: Should "GHG scenario runs and adding this shift to" read "GHG scenario runs for 4 of the 6 specific models to" ?

Table 1: In column 3 you have listed MRI twice (once for each reference). Consistent with what is done for other models, this should only be listed once.

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C2464