Atmos. Chem. Phys. Discuss., 2, S737–S739, 2002
www.atmos-chem-phys.org/acpd/2/S737/


Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Uncertainties and assessments of chemistry-climate models of the stratosphere" *by* J. Austin et al.

**J. Austin et al.**

Received and published: 13 December 2002

Response to Reviewer 2:

1. Clearly, a full range of ensemble runs changing different model parameters is well beyond our capability in view of the high cost of running the models. However, at no point do we believe that systematic errors can be eliminated by an ensemble of runs of different models, merely reduced to some extent, as becomes clearer as the paper develops. The attribution of model results to specific model differences is often difficult but it is important to try to do so wherever we can, with appropriate caveats. By comparing the two models MAECHEM/CHEM and E39/C the effects of the upper boundary on the residual circulation might in principle be determined, as both models have the same physics and chemistry as stated in section 3.1. In the revised paper, the comparison of the streamfunctions is made slightly more explicit (section 3.3). Comparisons between the two versions of UMETRAC as well as other published work (Manzini et al.,



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1997) show how non-orographic gwd reduce the temperature biases. The connection between heat fluxes and model resolution is indeed partly speculative. In the revised paper, the language is softened to indicate the probable relationship, rather than a demonstrated one. On the other hand, the arguments presented have been strengthened in the revised paper by including the error in the term $\beta$. In the revised paper, the conclusions are also contrasted with the results of the southern hemisphere, which indicate no impact of resolution on the value of $\beta$.

2. The error in $\beta$ has now been included in the table. Its error is a consequence of the natural variability of the atmosphere, and the range of values indicate its high sensitivity.

3. We agree that the water vapour section was incomplete in not showing the model results, but including extra diagnostics from the models would have resulted in considerable additional work. Therefore, the section has been deleted, and, as water vapour trends are important, a summarising paragraph has been placed in the conclusion.

4. The prediction for full recovery is indeed based on only those few models which have been integrated sufficiently far, as now indicated in the revised abstract. While we invite healthy scepticism about future predictions we do not believe that the models generally do badly for the past. For example, while the absolute ozone values in the Arctic are high, the general trends are broadly in agreement with observations, as indicated in Tables 4 and 5. The fact that the models give a large variation is an indication of the variability of the atmosphere, rather than necessarily model errors themselves. Certainly the latter contribute to the results, and by carrying out model comparisons of this kind we have more information at our disposal to improve the models themselves. This is one of the main themes of the paper (the 'uncertainties' indicated in the title, and covering section 3 of the paper). The last sentence of the abstract has been rewritten to convey better the uncertainties of future predictions, particularly for the Arctic.

5. Model diagnostics have now been computed for area averages as well as the local



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minima (Tables 4 and 5) and appropriate comments have been added to the introduction of Section 4 as well as the individual subsections. For polar regions, the essential picture remains unchanged. Therefore, we have not added more figures. The FWHM is now specified in the revised paper. Figure 10 has also been separated in the same style as Figure 9.

6. The phrase 'pattern correlation' has now been defined in the text.

Technical correction: MA-ECHAM has been changed to MAECHAM/CHEM.

Additional changes:

In addition to the above responses to the reviewers, the paper has been improved as follows:

1. There have been minor changes to the text to improve the clarity.

2. The description of the results in Table 3 has been made more concise, with additional results from ULAQ, and with minor corrections for some of the other models.

3. ULAQ results have been added to Figures 5 and 8, and ECHAM/CHEM results have been added to Figure 8, with appropriate additional remarks added to the text.

4. The observations have been added to Figure 6 for the southern hemisphere. Further discussion of the modelled southern hemisphere PSCs has been included and section 4.4 has been expanded in the light of these observations.

5. A discussion of area-averaged results has been included in section 4.5. Table 5 has been added.

6. The error bars for the trends in the timeslice experiments were incorrectly computed in the previous version of the paper, and the corrected values are now included in Table 4.

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Interactive comment on Atmos. Chem. Phys. Discuss., 2, 1035, 2002.