

Interactive comment on “Evaluation of CESM1 (WACCM) free-running and specified-dynamics atmospheric composition simulations using global multi-species satellite data records” by Lucien Froidevaux et al.

Anonymous Referee #1

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This paper evaluates two versions of the WACCM model using satellite observations, mainly from AURA MLS, but also using multi-instrument compilations. The paper contains some interesting results, but it is also very long (70 pages in the submitted format and 32 figures, plus supplement) and focussed on one specific model.

The paper contains an evaluation of the model (SD and FR) for 5 species compared to satellite observations. The paper points out general agreement and areas of disagreement, but the reasons for any disagreement are not really looked into (except for HNO₃ and the lack of ion chemistry). The comparison of the performance of the SD and FR

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models is a main focus of the paper. There are differences but overall conclusions on the accuracy of SD models, for example, seem to be missing.

The paper also uses both the models and data to look at trends. Reading the abstract paragraph which summarises the trend work does not give me a clear view of the main scientific points that have come out of the trend work. Is there something new about the observed known recent upper stratospheric ozone increase (i.e. recovery)? Or are the main points related to whether SD or FR simulations are better for studying past trends of different types of species (and I realise there are potential issues with both approaches). The paper also discusses metrics which can be used to evaluate CCM runs using observations. There is a lot of information here but again the main messages and recommendations are not clear to me.

For me as a reviewer the questions about this paper are (i) what are new scientific results related to CCMs (including diagnostics) or trends in general and (ii) why does the evaluation of the two WACCM versions belong in an ACP paper, rather than the sister journal Geophysical Model Development (GMD). At the moment, and using the abstract as a basis, I really don't get the main scientific advances which would justify ACP versus GMD.

My recommendation is that the work needs to be presented with clearer scientific messages coming through in the abstract and conclusions. Work which does not directly contribute to the ACP-level results could be put in a GMD paper, or an expanded supplement.

Minor comments

Page 1. Line 20. Can you be quantitative when discussing model over/underestimates?

Page 1. Lines 26-27. In what way are the detailed interactions not as well represented?

Page 2. Line 12. 'differences' rather than 'variability'?

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Page 2. Line 14. 'driven' – not the correct word for what is inside the model. Usual used for the external forcings like winds or emissions etc.

Page 2. Line 17-18. I think you should say a lot more about other SD work and cite papers, as SD v FR is a main focus of this paper. This would help to think about whether the WACCM SD results may be applicable to other SD models?

Page 2. Line 27. Explain 'high quality'.

Page 2. Line 36-39. Can you give examples of trend studies that have had these problems? Again, for the trend results presented here to be of scientific interest to the community, we need to know about issues of what has been done before.

Page 3. Line 34. After reading these sections it is not clear to me if ACE data (and which version) is included in either of the GOZCARDS versions. Please clarify.

Page 4. Line 39. Clarify that 'organic halogens' are the source gases.

Page 5. Line 2. So the FR WACCM is relaxed to the observed tropical winds (QBO). What is the implications of that for the comparison? Does that constrain some of the comparisons? What would happen without this relaxation? (Why is it done?).

Page 5. Line 11. New paragraph before 'Both'.

Page 6. Line 28. The model comparisons don't use the satellite averaging kernels (or temporal sampling I suppose?). Can you add more details on why you see no reason to apply the AKs?

Page 7. Line 13. Any idea why there are larger differences for SD WACCM? What are the implications for SD studies?

Page 7. Line 16. Explain 'good dynamical tracer' for non experts.

Page 12. Line 36. 'do not have the right chemistry'. I would suggest rephrasing this.

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