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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The Tropical Tropopause Layer 1960–2100" *by* A. Gettelman et al.

A. Gettelman et al.

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Replies to Reviewer #4:

We are sorry the reviewer felt that the paper lacked focus. In our revisions we have tried to focus the paper more and highlight key conclusions better, by tightening up the analysis. We think the paper has been improved, and that we are able to address the reviewer’s concerns in the revision. We thank the reviewer for their time and efforts.

Specifically we have brought forward to the introduction the major questions posed in the discussion, and we have removed the edge discussion, while tightening up the analysis of trends. We have added some further discussion of causes of trends with a multiple regression. We think all of these things significantly improve the focus of the paper.

Replies to General Comments:

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1. Demonstration that the models yield credible simulations of the TTL is based on recent work in depth with two models: CMAM and WACCM, published in JGR in 2007, and cited throughout the paper (Gettelman and Birner 2007). We have added further references to this work where appropriate. The reviewer is correct that the TTL in models is a separate paper. We have already tackled “ a full analysis of the quality of the TTL representation in CCMs” and we refer the reviewer to that paper.

1a. In addition, we have added interannual anomalies from a radiosonde archive to better understand trends. We note that GPS Radio Occultation is too new to provide any trend information. We do use it in Gettelman and Birner 2007 to show that the models can reproduce structure and variability.

2. We have tried to avoid grading models in this paper, except where we see there are deficiencies. We obviously have the highest confidence in the models that we know represent the TTL: CMAM and WACCM, and we note that in general their trends are consistent between each other, and with the multi-model trend. We note this in the paper in the conclusions. We do think that consistency is one measure of certainty about trends, particularly if observations and models agree.

3. We have eliminated the discussion of the edge of the tropics in the revision. Despite adding a metric to look at the position of the subtropical jet, we do not see many coherent signals or even significant signals in the analysis, so this is likely to be the subject of a future paper. We think this also improves the focus of the paper.

3a. The zero lapse rate level has been clarified. It is an interpolated version of the cold point, which has a realistic change in level in a coarse resolution model. It behaves similar to the lapse rate tropopause pressure, with a temperature very close to the cold point at a level. We have modified the presentation of this variable to better clarify these points.

4. We have tried to clarify the text and grammar throughout with the help of reviewer

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comments

Specific Comments:

5. Symbols have been changed as suggested

6. Tenses have been changed as suggested

7. The level of main convective outflow is defined in Section 2 based on Gettelman and Forster 2002, and is also discussed in the introduction

8. This has been clarified (“different” sub-grid processes)

9. The paragraphs have been merged

10a. An alternative method is to remove the mean from each timeseries, create a mean ensemble anomaly timeseries, and then take the trend of this timeseries using the bootstrap method which calculates the standard deviation (yielding the uncertainty). This is a more standard formulation based on what we have seen in the recent IPCC report and discussion with an IPCC lead author. The conclusions are not changed by this change.

10b. The “multiple regressions” sentence was confusing and has been removed.

11. This is a formatting error: the footnote should have appeared somewhere in the text and it did not. We will ensure it is in the final version.

12. We meant “midtropospheric vertical gradients”, this has been clarified, along with the other items in the paragraph.

13. Clarified.

14. We have made the time periods more consistent, and quote 1980-2050 trends, with comments on longer trends.

15. Fixed

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16. Clarified: we meant the average ozone, average temperature relationship

17. This is not ‘unexplained’ but is explained following. The phrasing was awkward, and we have changed it.

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 1367, 2008.

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Interactive Comment