

Interactive comment on “Diagnostics of the Tropical Tropopause Layer from in-situ observations and CCM data” by E. Palazzi et al.

Anonymous Referee #3

Received and published: 7 July 2009

General comments:

This study compares recent aircraft measurements of ozone and water vapour in the tropical tropopause region with data from the chemistry climate model ECHAM/MESy in free running mode using different recently developed diagnostics mainly for use in the extra-tropics. The application of these diagnostics to tropical aircraft data is new and interesting not only from a model-measurement comparison point of view and makes the study certainly worth publishing. The manuscript, however, needs some improvement before I can recommend publication in ACP. In particular, the authors need to be clearer in their conclusions about what the new results are and where their results just confirm already published results. E.g. they should clearly state, what we learned about the model's performance, and if the diagnostics previously applied to the

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extratropics are also valuable for validation in the TTL. In particular I would try to get an answer, if their approach to use the QBO phase instead of a multi-annual mean helps to improve the comparison.

Improvements are needed along the comments stated below along with a list of technical comments, asking for some changes in the language used, but which is far from being complete.

Specific comments:

P11660 L22-26: This sentence to me belongs into the introduction, so to motivate why you perform this analysis. Here in the abstract, on the other hand, you rather need to say based on your results, if the model does represent the TTL structure accurately, or if the application of the new diagnostics can be regarded as useful or not.

P11663 L20-23: I do not think you investigate and show with your evaluations that these couple tracer profiles are representative for the whole TTL mean fine scale structure. Rather your results seem to show that the measurements are influenced by the particular sampling during the aircraft campaigns. You need to either improve your evaluations or take this claim out of the manuscript. (see also comment further below)

P11665 L12: add '...along with their accuracy and precision'

P11666 L22: I did not really follow your approach here. First, 'temporal location' sounds awkward. Rather use something like 'temporal sequence'. However, the campaigns are not marked in their real temporal sequence (TH and TR should be before SC). Is this because of your selection according to the QBO?

P11667: Methodology section: this section might be improved by structuring it a little more. E.g. different subsections for different diagnostics used plus a section on how you handle the data (QBO-classification).

P11670 L16-26: I think this is an interesting approach to sample according to the QBO phase. Has this been done before? If so give references, if not, you should explain

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your motivation for using this approach.

P116672 L6-8: This seems unnecessary/wrong information. The profiles are plotted relative to the tropopause heights, so the dashed-dotted line corresponds to the thermal tropopause of both, the measurements and the models. You did plot the model data also relative to the thermal tropopause, no?

P11672 L10-14: Interesting, and you can see the same feature even in the N₂O profiles, where the N₂O values are higher than expected across the tropopause. A cross-link between this finding and the N₂O section would be helping the reader to tie the conclusions together. Also, rather than just describing what Hector is, the manuscript would improve if you said more directly, that ECHAM Messy just can't resolve this particular feature. In the end the conclusion here tells me that the SCOUT -Darwin measurements are not representative for the mean fine-scale structure of the tropics, so you might want to add or change this in the conclusions.

P11674 L25-30: This is written in an obscured way. It is well-known that there is a seasonal cycle in tropopause/lower stratospheric H₂O due to the seasonal cycle in temperature. Please include some reference.

P11675 L2: The main sink of N₂O (90 percent) is photolysis. Please add a statement.

P11676 L18: I suggest trying to color the data points according to potential temperature bins. This is because 12 hPa at different altitudes may span different widths in km due to differences in the mean height of the tropopause, which may make your comparison worse than it really is.

P11677 L0-4: I think this is also not a new finding, please include some references.

P11677 L2: what do you understand by a 'less pure tracer'? you may want to add at least that 'since H₂O is influenced by microphysical mechanisms'

P11679 L15-22: It would be nice to show the PDFs for all the campaigns.

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P11680 L5-12: this sounds contradictory to the findings of Gettelman and Birner, you need to point out that you refer to the fine scale mean and not the large scale structure, which they found most of the models were capable of resolving.

P11680 L23-26: This comment is just a matter of presentation. As it is written now, one could get the sense that you discovered the TTL (this is a problem found throughout the manuscript to some extent). Since the TTL is already known to exist you may rather write something along these lines: 'indeed the diagnostics used formerly in the extratropics can also be used to capture the TTL'.

P11681 L7-15: This has been shown even using satellite measurements. Refer here to the study by Hegglin et al. (2009).

P11681 L19: This is a new result. Hegglin et al. (2009) did this evaluation only for the extratropics, so you may want to say 'extending the results by Hegglin et al. to the tropics'

P11681 L20-24: I don't think this statement is true. The campaigns with strong convection show clear differences between model and measurements (e.g. Troccinnox N₂O profiles, SCOUT-Darwin/AMMA O₃ profiles). This is likely due to the strong effect of convection as you interpret earlier. This finding has to be clearly stated. It is not pejorative of your results, rather adds an interesting angle to your evaluations, namely that the aircraft measurements may show a sampling bias (since they were designed to look into convection). Along this line, also add a caveat to your last statement 11682 L4-7, namely that the specific focus of the different campaigns may have influenced the outcome of the model-measurement comparison.

Technical comments:

P11660 L3: change 'tracers profiles' to 'tracer profiles' and 'tracers gradients' to 'tracer gradients'. Also put 'using tropopause coordinates' right after 'tracer gradients', since tracer-tracer relationships cannot be used in tropopause coordinates.

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P11660 L7: Suggest to use 'were obtained during four' instead of 'come from the four'.

P11660 L8: what do you mean by 'directly compared'?

P11660 L21: delete 'first'

P11661 L3: Please use a different reference here than Fueglistaler et al. (2005), there were earlier papers on this feature (e.g. Highwood and Hoskins 1998; Folkins et al. 1999; Gettelman et al. 2002).

P11661 L11: write 'transports mass' instead of 'transports the mass'

P11661 L19: do you really mean 'validated' or 'found'?

P11662 L25: suggest to write '... showed that strong gradients in tracer distributions and mixing across the extra-tropical tropopause can be highlighted...'

P11662 L28: correct sentence, use 'In this paper we perform a joint analysis of in-situ high-resolution measurements...' and '...Geophysica during four tropical ...'

P11663 L3: you need to replace the comma before 'and the ECHAM Messy' by a dash.

P11663 L9: write 'The diagnostics are based on the analysis of vertical profiles... and of relative vertical ozone gradients...'

P11663 L11-14: these are awkward sentences, please improve. E.g. use '...chemical species over the whole TTL depth...', replace 'peculiar' by 'different', and start next sentence rather with 'Here we choose O₃, N₂O, H₂O, and CO in order to characterize the TTL'

P11665 L8: write '... can be considered to be the dataset least influenced by convection.'

P11668 L11: change to 'tracer transition'

P11668 L21: change to 'and for process-oriented validation of CCMs'

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P11668 L26: suggest changing 'enhances' to 'emphasizes'

P11669 L6: The Randel et al. (2007) reference seems to be wrongly cited here.

P11671 L21: use 'details' rather than 'specificity'

P11672 L28: delete 'actually'

P11673 L2-5: local effects may not be the only reason for this. You might want to indicate numbers of measurements at each altitude bin in Figures 3-6, this would possibly explain the lack of smoothness in most of the measurement profiles.

P11673 L25: delete 'in the main'

P11676 L8: write 'found in the literature'

P11676 L16: write 'all the points...'

P11679 L23: suggest to write 'of interest because it is the interface...'

P11680 L6: write 'due to the difficulty to understand and correctly...'

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 11659, 2009.

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