

## Author response to referee comments on

### “Shift in cold-point tropopause trends derived from radiosonde, satellite, and reanalysis data

by Zolghadrshojaee et al.

#### Anonymous Referee #2

In this study temperature trends are derived from radiosonde, satellite and reanalysis data with special focus on the cold point tropopause. Thereby, the period for which the trend is estimated is extended compared to previous study and covers the time period from 1980-2023, thus more than 40 years. Although this study does not present any significant new results it merits in my opinion publication. The extension of the data considered and the according update in trend estimates justifies a publication since if I understand the summary of previous studies correctly the time periods previously considered were much shorter. Thus, analyzing here about 40 years of data is quite valuable for deriving reliable trend estimates. However, the writing of the manuscript should be improved to better point out what the highlights and major results of this study are.

We thank the referee for their valuable comments. We have changed the manuscript according to the comments listed below. Most importantly, we have rewritten the abstract, shortened some of the data sections and streamlined the discussion of the different potential mechanisms and implications of the shift in temperature trends in the TTL. We have also added information on the explained temperature variability and a sensitivity study analyzing sampling density and choice of regression model. As a result of these and other changes, the manuscript has clearly improved now better highlighting the major results of the study. Comments are reproduced below, followed by our responses in blue font.

#### Specific comments:

Abstract: The abstract needs to be improved. For example, the second paragraph is providing too many details on the results without making clear what the main result is and what the implications of this study are.

Thanks for pointing this out. We have completely rewritten the second paragraph of the abstract, which is now more focused on the main results as well as potential mechanisms and implications.

P3, L79: You consider here a time period of 40 years! This could be more clearly be pointed out. Especially since it seems that earlier studies considered significantly shorter time periods which were considering max ~ 20 years.

We have added this fact here and in other places.

P3, L84: The authors published last year a paper on this topic. It would be worth to also clearly point out what the differences between your previous study and this study are.

We have added one sentence here highlighting the differences between the two studies.

P3, L86: Section 2, especially the sections about the radiosonde data could be improved. I had trouble to understand what the differences between the adjusted and unadjusted data is. I had the feeling that you here also got lost a bit in the details. I would suggest to put 2.1 and 2.2 in one subsection (thus 2.1 and called “Radiosonde data”) and then start with an introductory sentence and then have two subsubsection headers (with or without section numbering) on the adjusted and unadjusted radiosonde data.

Thanks for the suggestion, we have restructured sections 2.1 and 2.2 accordingly and have added short summary of the differences between the two data types.

P4, L116ff: Does this paragraph really belong to this subsection? I had rather the feeling this is part of the result section.

Given that the very good agreement of the residuals from adjusted and unadjusted data at the fixed pressure levels is an important prerequisite for our methodology, we prefer to show this figure before the method section.

P4, L120: Has the abbreviation “QBO” been introduced?

The name has been added.

P6, 158-170: Is this information really necessary. I have the feeling also here too many details are provided which are not important for understanding this study.

We have considerably shortened this paragraph.

P6, L171-181: I think it would be much more helpful to list these differences in a table.

We have considerably shortened and restructured this section, but decided to not introduce a table given that there are only 3 quantities that would be included in such as table.

P5-7: The reanalysis data section is too long and I had the feeling too many results are presented here that are not necessary for understanding your study.

We have considerably shortened this section by removing some details.

P8, L219-220: If in both cases the same pressure levels have been used the sentence could be formulated much shorter and clearer.

I can't really see how this sentence could be formulated much shorter.

P8, L234-236: The latter part in the sentence “The good agreement of the four trend estimates highlights the consistency of the CPT temperature trends derived from adjusted data sets, which are only half of the cooling trend suggested by unadjusted data.” not clear. Please rephrase.

We have rephrased the sentence as ‘The good agreement of the four trend estimates based on adjusted data highlights the consistency of our method when applied to different pressure levels or data sets. These adjusted trends are only half of the cooling trend suggested by unadjusted data, reaffirming that inhomogeneities in the latter can impact the trend estimates.’

P9, L244: Add “e.g.” before the reference “Randel et al.”.

Done.

P16, L374: Add here one or two sentences summarizing what has been done in this study.

We have added one sentence summarizing what has been done.

P17, L387-389: This is an important result and should be mentioned at several places in the manuscript and not solely in the middle of the discussion.

We have now highlighted this shift in cold-point trends in other parts of the manuscript such as the abstract and overall conclusion section. We also extended the conclusion section with a discussion of the different mechanisms that can impact the shift in temperature trends in the TTL and possible implications

All figures: Put the units in the title in parentheses instead of brackets.

Done.

#### Technical corrections:

P6, L173: space between number and unit missing.

P8, L224: space between number and unit missing.

P11, L283: in the Appendix A section -> in Appendix A

P19, L445: ozon e -> ozone

P25, Appendix: Start with the Appendix on a new page.  
[All changes have been made.](#)