

Second review of

“The extratropical tropopause inversion layer and its correlation with relative humidity (original title)”

by Daniel Köhler et al.

1 General

This constitutes the second review of the paper by Köhler et al., submitted to ACP. I see that the manuscript has seen a lot of work; I like in particular the choice of the new metric (new Eq. 8). In spite of the work invested, I suggest a thorough proof reading of the manuscript to remove some smaller grammatical errors (some examples are given below).

As I said in the first review, “I think this is a good helpful paper of interest to the readership of ACP”. And “I think the paper would be more valuable if the message would be much clearer in a revised version”. I think that some further work is needed on the manuscript to make it clearer and more accurate in a revised version.

2 Comments in detail

2.1 Abstract and title

In my first review I mentioned the guidelines for ACP papers, in particular the title, abstract, and concluding section:

https://www.atmospheric-chemistry-and-physics.net/policies/guidelines_for_authors.html

The title has been changed and improved.

However, I am afraid that the abstract is still longer than 250 words (see ACP recommendations). I suggest addressing this issue. I think abstract of the paper could also be a bit clearer about the findings of the paper; would it not be of interest to the reader what the “consistent relationships” and the “differences” are?

I would also suggest replacing “extratropical” with “mid-latitude” in the title, as this paper is not addressing polar issues.

2.2 Comparison of ERA5 and a radiosonde station

In my first review I stated: “As I understand the paper, the basis of the paper is a comparison between the TIL in ERA5 and in the data from a radiosonde station. After a ‘validation’ of the ERA5 data with the radiosonde data, further conclusions for the TIL in the latitude range of the station are drawn.”

The paper has certainly improved as the information on “Idar-Oberstein, Germany” is now much clearer.

However, as stated earlier, the results are relevant for northern hemisphere mid-latitudes (close to 50°N) – is this correct?. I suggest to be clearer about this. The title has changed to “extratropics” (which is not the same thing as mid-latitudes) but this point is not reflected (e.g.) in the abstract. I think the paper should be very clear (in particular in the abstract and in the conclusions) about the range of validity of the analysis.

If the authors argue that the analysis focuses on Northern hemisphere mid-latitudes (e.g., ls. 550/551), my suggestion is to replace “extratropical” with “midlatitude”.

2.3 Timescales

In the first review it was stated: “Here baroclinic waves and radiative (H₂O) processes are relevant, but the time scales involved should not be ignored (and they might be different for the two mechanisms). Does the analysis provided here allow statements about radiative/dynamical time scales?”

I do not think that this question is well answered (manuscript and reply); perhaps, statements about time scales cannot be made based on the analysis, however this point could come across clearer in the paper.

2.4 Tropopause

As stated in my first review, “the entire concept of the TIL is based on using tropopause relative coordinates”.

The paper now cites a number of reviews (e.g., Reichler et al., 2003; Maddox and Mullendore, 2018, which is good), however, Maddox and Mullendore (2018)

report two different interpretations (implementations) of the classic WMO tropopause definition (see their appendix); it is still not clear from the paper which interpretation was used here.

2.5 Radiosondes

If I understand the paper correctly, radiosonde data from one (DWD) station at Idar-Oberstein are considered here. This, to me, seems to be the “anchor”-point of the ERA5 analysis (see also section 2.2).

However, when the radiosonde/ERA5 comparison is described (p. 13, Figs. 4-6), only “the radiosondes” are mentioned. But which sondes, which station, which time period? My guess is that Idar-Oberstein sondes were used here (see also data availability statement), but this point should be clear from the paper. I also suggest adding this information (which radiosondes?) to the captions of Figs. 4, 5, and 6.

Is it also true that the Idar-Oberstein sondes were assimilated in ERA5? I think the answer is yes. This information could be added to the paper, e.g., in line 328.

2.6 Findings of Kunkel et al. (2016)

The study aims at corroborating the findings of Kunkel et al. (2016); e.g., l. 81. Kunkel et al. (2016) state for example “Furthermore, updrafts moisten the upper troposphere and as such increase the radiative effect from water vapor” – this seems to emphasise the radiative effects on the TIL – this emphasis is not obvious from the present manuscript. Perhaps a better link to the paper (and results) by Kunkel et al. (2016) could be made.

3 Minor Points

- l. 6: which radiosonde data?
- l. 13: extent → extend
- l. 14: “relationships” between which variables?
- l. 15: “Differences” between what?
- l. 134: using an adverb (“evenly”) is not appropriate here.

- l. 202: attempts → ways
- l. 212: the point is the “vertical gradient” – correct?
- l. 303: suggest replacing “extratropics” with “midlatitudes”.
- l. 321: exponential → exponentially
- l. 378: weakening → weaken
- l. 482: I would formulate: “mid-latitude region”
- l. 539: What is causing the variable relative humidity?
- l. 540: “sharpening of the TIL”?
- l. 540: drop “the” after “for”
- l. 548: results
- l. 554: drop “we can state that”
- l. 554: “data are”
- l. 554: “kind of investigation”
- l. 555: here it would be helpful to state exactly which findings of Kunkel et al. (2016) are corroborated.
- Fig. 4: state in the caption which altitude range is considered to be UT and LS.
- References: journals should not be in upper-case letters (e.g. l. 579).

References

- Maddox, E. M. and Mullendore, G. L.: Determination of Best Tropopause Definition for Convective Transport Studies, *J. Atmos. Sci.*, pp. 3433–3446, URL <https://doi.org/10.1175/JAS-D-18-0032.1>, 2018.
- Reichler, T., Dameris, M., and Sausen, R.: Determining the tropopause height from gridded data, *Geophys. Res. Lett.*, 30, 2042, <https://doi.org/10.1029/2003GL018240>, 2003.