

Review of

**Observed Long-Term Changes in Global Tropopause
Characteristic**

by Homeyer et al.

The manuscript analyses long-term change of the lapse-rate tropopause (LRT) and potential temperature gradient tropopause (PTGT) characteristics based on 23-years of radio occultation data. In comparison to existing studies, trends of PTGT altitude, temperature and tropical tropopause occurrence are new results. Furthermore, the analysis of the tropopause sharpness and the occurrence of triple tropopauses are new results for both tropopause definitions. While the manuscript reproduces a relatively large amount of already known findings, it also presents enough new results to warrant publication. The manuscript is well written and clearly structured, and I recommend publication after the following comments have been addressed.

Major comments:

1. It would be very helpful to have a summary of the new aspects of the study and what is already known. The authors provide this information in several places, but usually only for individual diagnostics. For instance, in the first paragraph of the conclusion section where all diagnostics are listed, add 2-3 sentences to make clear which of these diagnostics are truly new and which ones are updates of existing studies.
2. Add a more thorough discussion of how the results here compare to existing results. This is done well for some aspects such as the tropopause temperature and altitude trends, but not for all diagnostics. For instance, how does the tropopause break analysis compare to the existing studies mentioned in the introduction (e.g., Martin et al., 2020; Zou et al., 2023).
3. Given that previous analysis demonstrated the sensitivity of the tropopause break diagnostic to the choice of threshold, the manuscript needs to address this issue. Ideally, the authors would include a sensitivity analysis by using varying threshold values for the tropical tropopause occurrence analysis.
4. The manuscript needs to include the definition of the PTGT. Given that the PTGT is one of the two main quantities analyzed here and has only been defined recently, it seems strange that it is currently not included and readers are forced to look it up in other publications. The data and methods section is relatively short, which should make it easily possible to include the PTGT definition.

Minor comments

Does the abrupt and relatively large change in GNSS-RO profile density in 2006 impact the trend results for the various diagnostics?

Line 133-135: Do you show this here or is this known from other studies? Please clarify.

Line 144: Using two terms for the QBO is usually standard practice in regression studies. Given the downward propagating nature of the QBO, two QBO terms are needed to correctly capture the

QBO variability. These two terms are usually taken as orthogonal time series representing QBO variations, being constructed as the first two empirical orthogonal functions. Alternatively, an optimized time shift of the QBO proxy needs to be found and applied. Please clarify and improve if needed.

Line 192-194: This sentence is not clear to me.

Line 222 states that differences between PTGT and LRT sharpness are greatest in the subtropics and tropics. Why is this case?

Line 264: Which ones are the aforementioned studies? I assume that this does not refer to the previous paragraph but to some earlier part of the manuscript.

Line 288 states that this is the case especially in the tropics and midlatitudes in regions where it is climatologically sharpest. It is not clear what this means. Is the sharpness largest in the tropics and midlatitudes in general or do the authors refer to specific regional features?