Response to Anonymous Referee #1

Referee comments: https://doi.org/10.5194/egusphere-2025-3745-RC1

Manuscript: Reiter, A., Danzer, J., and Steiner, A. K.: The potential of GNSS radio occultation data for the analysis of the tropical width: a comparison with reanalyses, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2025-3745, 2025.

The authors leverage 15 years of GNSS radio occultation (RO) temperature profile data to examine the width of the tropics and its change over time. They compare the resulting diagnoses to longer records from several state-of-the-art reanalyses. Ultimately, it is demonstrated that RO data provide useful characterizations that broadly agree with the reanalysis diagnoses, especially upper troposphere lower stratosphere metrics where RO data are complete and most reliable. While I find the study to be mostly well-constructed and detailed, there are a few aspects that require a bit more clarification which I outline below.

We would like to thank the reviewer for the constructive assessment, for generally finding our study interesting and well-constructed, and for the helpful comments for further improvement. We carefully considered and answered all comments below (comments are quoted in *italic with gray background*, with the responding answers below each comment). Line numbers refer to the original manuscript.

General Comments

#1 There are many instances of "on the NH" or "on the SH" that should all be revised to "in the NH" or "in the SH".

Thank you for noticing it. We corrected it throughout the manuscript.

Specific Comments

#2 Line 7: the opening sentence of the abstract is a too strong of a statement. As the authors acknowledge later, this result is contingent upon the metric used. The language should be softened here.

Thank you for pointing this out. Indeed, the opening sentences was a bit strong, we refined it to:

L7: "The tropical width is changing, with a poleward expansion being linked to anthropogenic climate change."

#3 Line 29: delete unnecessary period after "include"

Thank you for noticing it. We corrected it in the text.

#4 Line 32: "systems" should be "system"

Thank you for noticing it. We corrected it in the text.

#5 Lines 71-75: these sentences are entirely unnecessary

While we agree, that the paragraph includes too many details, we still want to keep a brief overview of the structure of the manuscript. For that reason, we rephrased and shortened the paragraph in the following way:

L71: "This paper is structured as follows: The datasets and methodology are detailed in Sect. 2, while Sect. 3 presents the results for the selected metrics based on RO and reanalysis data. Finally, discussions and conclusions are addressed in Sect. 4."

#6 Line 85: a brief discussion of the wind retrieval is warranted here. It is later stated that the wind isn't a simple geostrophic retrieval, so what is it?

Thank you for this suggestion, we added the following sentences to chapter 2.1. "GNSS RO data" to provide more details on the wind retrieval. The method and application to RO data are explained in detail in Nimac et al. (2025) and Unegg et al. (2025). However, both manuscripts are currently under review and hence cannot be cited in the final version of this manuscript due to the submission guidelines:

L93: "As a novelty the winds are computed using a best-estimate algorithm which dynamically applies the most suitable wind retrieval method dependent on latitude and altitude. Thereby, the method uses the initial corresponding balanced wind estimates (i.e., the geostrophic equation in the troposphere and the gradient wind in the stratosphere) and adds advective contributions on top of these initial wind estimates. Furthermore, in the equatorial region curvature terms are included to the equatorial balanced winds."

#7 Lines 92-93: is a ±2 day Gaussian time-weighting approach appropriate? This could be better justified/explained.

We added a sentence to better explain the approach.

L93: "Temporal and spatial weighting ensures that the observed information is fully utilized, while keeping the number of empty grid points low, with remaining gaps filled using bilinear interpolation **(see further details in Ladstädter et al., 2022; Yessimbet et al., 2024)*."***

#8 Line 250: "extend" should be "extent"

Thank you for noticing it. We corrected it in the text.

#9 Line 257: "then" should be "than"

Thank you for noticing it. We corrected it in the text.

#10 Line 311-312: there are a few studies that have revealed this narrowing via tropopause break metrics – Martin et al. 2020, https://doi.org/10.1175/JCLI-D-19-0629.1; Zou et al. 2023, https://doi.org/10.3389/feart.2023.1177502; Turhal et al. 2024, https://doi.org/10.5194/acp-24-13653-2024

We thank you for your insight and the references. While for example Martin et al. (2020) did look at trends of the tropopause break and also describe a narrowing trend for some longitudes, they specifically mention that they did not find a discontinuity in the dataset. However, our study builds on different presets, Martin et al. (2020) did not check the same specific TPB metric as we did. Nevertheless, we are thankful for the comment and added a sentence to improve clarity.

L311: "While in general, narrowing trends in various TPB metrics for MERRA-2 have been found in other studies (Martin et al., 2020; Zou et al., 2023), this specific difference in the results of the TPB (max $\partial Z/\partial \varphi$) has not been documented."

#11 Line 330: "this a globally" should be "this globally"

Thank you for noticing it. We corrected it in the text.

#12 Line 335: delete unnecessary comma after "(Nimac et al., 2025a)"

Thank you for noticing it. We corrected it in the text.

References

Ladstädter, F., Stocker, M., Yessimbet, K., and Steiner, A. K.: GNSS RO providing a detailed view on the thermal structure and changes in Earth's atmosphere, International Workshop on Occultations for Probing Atmosphere and Climate 2022, Leibnitz, Austria 8–14 September 2022, https://static.uni-graz.at/fileadmin/_files/_event_sites/_opacirowg2022/programme/08.9.22/AM/Session_1/OPAC-IROWG-2022_Ladstaedter.pdf, 2022.

Martin, E. R., Homeyer, C. R., McKinzie, R. A., McCarthy, K. M., and Xian, T.: Regionally Varying Assessments of Upper-Level Tropical Width in Reanalyses and CMIP5 Models Using a Tropopause Break Metric, Journal of Climate, 33, 5885–5903, https://doi.org/10.1175/JCLI-D-19-0629.1, 2020.

Nimac, I., Unegg, J., and Danzer, J.: Climatic higher-order balanced winds beyond geostrophic and gradient wind fields, Earth and Space Science [submitted], 2025.

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Zou, L., Hoffmann, L., Müller, R., and Spang, R.: Variability and trends of the tropical tropopause derived from a 1980–2021 multi-reanalysis assessment, Front. Earth Sci., 11, https://doi.org/10.3389/feart.2023.1177502, 2023.