

## ***Interactive comment on “The tropical tropopause layer in reanalysis data sets” by Susann Tegtmeier et al.***

### **Anonymous Referee #2**

Received and published: 1 August 2019

This paper evaluates the vertical structure of the temperature fields from a number of meteorological reanalyses in the tropical tropopause layer (TTL). While the evaluation of reanalyses in this region is important for the user community and fits the focus of ACP, I found several limitations that should be addressed before publishing in ACP.

### **General comments:**

1. From the title, I would expect that the paper also discusses wind or humidity fields in the TTL from the reanalyses, which is not the case. The title should thus be changed and I suggest “Vertical structure of temperature fields from atmospheric reanalyses in the tropical tropopause layer”. Or maybe you may have a better suggestion.

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2. I understood (Sect. 2.2) that reanalysis temperature fields in the TTL are constrained by satellite radiance observations (from 1978 onward), radiosonde profiles (from 1978 onward) and GNSS-RO (between 2002-2006 onward depending on the reanalysis). On the other hand, reanalysis temperature fields are also evaluated by radiosondes and GNSS-RO data. A proper evaluation should be done with independent datasets (i.e. not assimilated) which seems not to be the case. Please clarify and/or comment.
3. I found that the intercomparison method lack of details and/or clarity. GNSS-RO data used for the validation of the temperature are provided as zonal mean (P5L27). Is it on a daily or a monthly basis? It is also said that GNSS-RO are interpolated at the reanalysis levels (P5L35-37). A proper comparison of the reanalysis with the observations should be done by (1) mapping the reanalyses at the observation geolocation (by using additional information like averaging kernels or weighting function if necessary) to avoid sampling errors and then (2) calculating the cold point and lapse rate tropopause from the reanalyses in the space of the observations to which they are compared. If done differently, it should be justified. Please, comment and/or clarify.
4. It is said that GNSS-RO and radiosonde data are provided at high vertical resolution but their values are not given in the manuscript. Please, provide the vertical resolution of these two datasets.
5. Section 3 discusses the reanalyses between 2002 and 2010. Except that GNSS-RO data are not available before that time, is there other reasons to not show the results at earlier time? If not, I recommend providing similar figures (without GNSS-RO data) than Fig. 6 and 9 for, e.g. 1980-1990 and 1990-2000, in a supplement. This would be very instructive for the users of the reanalyses.
6. There is a long discussion about the use of model- or pressure-levels which is confusing because it seems obvious that using a low resolution standard pres-

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sure grid (only four levels in the TTL) would introduce biases. Fig. 3 is also confusing. I understand that values at 70 and 100 hPa are from the standard pressure but that the CP and LP values are calculated from the model levels. I guess that showing the temperature bias at 70 and 100 hPa from the difference profiles of Fig. 4 would provide (after interpolation) much accurate values. I would suggest to move all the discussion related to the standard pressure levels in a supplement or an appendix and to show in the main body of the paper only results obtained on the model levels

7. Both notations MERRA2 and MERRA-2 are used throughout the paper. Please, choose one of them.

### Technical corrections:

P2 L20-22: “Model simulations. . .” This is not shown in the paper so it should be removed from the abstract.

P3 L11-14: “As the TTL. . .” Please add references at the end of the sentence.

P5 L27: “We use zonal mean. . .” On which time basis? Daily? Monthly? Other?

P6 L15: What do you mean by “full input”?

P6 L24-25: “MERRA-2 . . .” The meaning of this sentence is not clear. Please, clarify.

P6 L26: I would replace “produced” by “constrain” which is more accurate.

P6 L38-40: “Radiance biases. . .” I don’t understand what message the authors want to give with this sentence. Please, clarify.

P6 L41: “. . .from radiosondes which. . .” Are these radiosonde data the same than those used for the evaluation? See also the general comment related to this issue.

P7 L10: “. . .from GNSS-RO instruments. . .” Same comment as above.

P7 L26: “While the reanalyses assimilate versions of these data. . .” Do you mean

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“different versions of these data. . .”?

P7 L27: Replace “exactly” by “within their uncertainty” which is more accurate.

P7 L30-P8 L1: “In general, the. . .” This sentence does not describe data assimilation methodology. Instead, I suggest “Data assimilation systems combines the information from a model, a set of observations and a priori information weighted by their uncertainties.”

P7 L12: I don’t see the “Section 3.1” in the paper.

P9 L21: Please, add a reference to the “bootstrap method”.

P9 L27-28: “The trend error. . .” I don’t understand the meaning of this sentence. Please, clarify.

P10 L19-21: “At 100 hPa, ERA-Interim is. . .” I suggest redoing the figure by using different symbols (star, cross, \*) allowing to see the values of all reanalyses.

P10 L22: Remove “resolution” in “. . .native model level resolution. . .”

P14 L5: I would replace “. . .over the Maritime continent. . .” by “. . .over the sea. . .” because a continent is one of the several large landmasses that make up the Earth.

P14 Figure 7: I would be very interesting to also show the results of ERA5. Is there any reason to not show it?

P15 L13: Replace “to estimating” by “to estimate”.

P16 L4-5: What do you mean by “variability” in “. . .considerable zonal variability. . .”?

P16 Figure 9: Add “pressure” in the upper right panel of the figure, as in Figure 6.

P17 L17: “decrease” would be more appropriate than “improve”.

P17 L29-31: “The influence of ENSO. . .” I do not see any figure showing the influence of ENSO on the TTL temperature. Please, clarify.

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P17 L30: As explained above, change “Maritime Continent” by “sea” or “ocean”.

P17 L37-P19 L5: This part is not very clear because it is never clear to which figure (10 or 11) the text refers. Please, clarify.

P17 Figure 10: Why not starting the time series in 1978 or 1980.

P21 L14-15: “. . .all provide realistic. . .” It should specify that the period of validity of this result is 2002-2010.

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