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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics of the tropical tropopause inversion layer using high-resolution temperature profiles retrieved from COSMIC GNSS Radio Occultation" *by* Noersomadi Noersomadi et al.

Anonymous Referee #3

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This manuscript presents global characteristics of static stability in different vertical coordinate systems and closely investigates its characteristics in the tropical tropopause region. The authors use ten years (2007 to 2016) of GNSS RO data from the COSMIC satellite constellation. Data from an FSI RO retrieval are used. These profiles have a much better vertical resolution than profiles from other RO processing centers. The tremendous vertical resolution of this data set is exploited by investigating atmospheric characteristics in detail. Spatial, inter-annual, annual, and intra-interannual variability of tropopause sharpness and the thickness of the tropopause inversion layer (TIL) are

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discussed. In my opinion, this is an interesting study with important scientific results. To a large extend, the manuscript is clearly and concisely written. Exceptions are some parts of the introduction and data description (see minor comment below). More importantly, I have some doubts regarding the vertical resolution of the data set and the conclusions drawn (see major comment below).

1 General comments

1. The vertical resolution of the data set is specified to be 100 m. However, in some sections of the manuscript (mainly in section 3.3), the authors discuss characteristics with a distinctively better vertical resolution. Middle panels of Fig. 10 and also Fig. 13, e.g., show dH characteristics with a 10 m vertical resolution. I doubt somehow that this appropriate. Similarly, the authors find an uncertainty of the thickness of the TIL of 40 m. It is important to add a discussion and prove that these features can really be retrieved with this data set. See also minor comments on the retrieval and the uncertainty of the vertical grid.

2 Minor comments

- I have difficulties in following the logical structure of some parts of the introduction (section 1) and data description (section 2). More specifically, paragraphs 3, 4, and 5 of section 1 (pages 2 and 3), and several paragraphs of section 2 (i.e., the first paragraph of section 2, 2.1, and 2.2, the last paragraph of section 2.1 (concerning the TIL definition)) should be revised.
- Add some more detailed discussion about the data retrieval. What input data are used for the FSI retrieval? What is the vertical coordinate of your data set (height

above ellipsoid, height above geoid, geopotential height)? What is the uncertainty of the vertical grid? Scherllin-Pirscher et al. (2017, doi:10.1002/2016JD025902) also discuss some of these issues.

- Introduce all acronyms at their first occurrence.
- Abstract, line 22: It is not clear at this point what "S-ab anomaly (S-ab*)" and "OLR anomaly" refer to. Please rewrite this sentence.
- Introduction, page 2, paragraph 3: At least for a non-expert reader, the first two sentences "The vertical profile of N^2 across the tropopause (i.e., the sharpness) and the thickness of the layer of maximum N^2 above the tropopause have been determined in previous studies using both ground- and satellite-based observations. For example, Bell and Geller (2008) analyzed the twice daily standard radiosonde data from the WMO stations and found that the thickness was $\sim$1 km at low latitudes." are not clear. Does "the thickness" refer to the layer between the tropopause and maximum N^2 above the tropopause? Please clarify.
- Introduction, page 2, paragraph 4: the better reference for the COSMIC data set is Anthes et al. (2008, doi:10.1175.BAMS-89-3-313).
- Introduction, page 3, paragraph 2: Add the Noersomadi and Tsuda (2017)-reference.
- Section 2.1, page 3, line 27: As far as I know, COSMIC does not provide 1500 to 2000 profiles anymore. Please clarify.
- Section 2.1 page 4, lines 6/7: I do not understand the explanation "caused by different truncations of the GNSS signals in the lower atmosphere". It is true that the penetration depth is different for each RO measurement. It is also true that the penetration depths of the retrieved profiles can be different for different RO retrievals. However, I do not understand the connection between penetration depth

and the number of profiles. Is there a specific quality indicator which reduces the number of profiles for cosmicfsi? Please clarify.

- Section 2.1, page 4, lines 15/16: "which is located within 115 km horizontal radius": Does this number refer to the mean tangent point location? How is it defined? Did you account for the tangent point drift? Please explain.
- Section 2.2, page 4, line 36 to page 5, line 5: I recommend referring to the right panel of Fig. 2 for this explanation. Furthermore, the figure should include all parameters introduced in this section.
- Section 3.1, page 5, lines 33/34: "Figure 3a-d...": This sentence is a general statement, which should be made earlier in this paragraph.
- Section 3.1, page 6, line 1: "the LRT should be the same as the lowest CPT" and line 40: "the LRT and CPT are at the same location/height". In the tropics, LRT is usually lower than CPT because LRT refers to a specific temperature gradient and CPT to the temperature minimum. Please clarify.
- Section 3.1, page 6, lines 39 to 42: I do not understand this explanation. Please rewrite.
- Section 3.1, page 7, lines 15/16: I do not understand the sentence "The level of increasing temperature can be determined as the LRT height when the WMO definition is attained" as the LRT is not determined by increasing temperatures but only a temperature gradient threshold.
- Section 3.2, page 7, Figure 9: The class widths of several panels of Fig. 9 seem to be either non-equidistant or floating numbers causing rounding errors. Please use well defined and equidistant classes.
- Section 3.2, page 7, lines 28/29: Since Fig. 9 shows that mean S-aCPT is smaller than 6.6×10^{-4} s^{-2} this statement cannot be true. Please clarify.

- Section 3.3, page 8, lines 13/14: "The highest values, up to $16 - 18 \times 10^{-4}$ s^{-2}, are associated with low OLR values...": In DJF, S-ab is clearly above average ($17 - 18 \times 10^{-4}$ s^{-2}) west of South America, where OLR values are about 260 W/m^2, defined as "non-convective" on page 8, lines 33/34. Above the convective regions in South America, however, where OLR values are really low, the S-ab only reaches about 14×10^{-4} s^{-2}. So this statement seems to be wrong for the South American region. Please clarify.
- Section 3.4, page 9, line 22: How big are the cross-correlations between S-ab and OLR at different lags?

3 Figures

Note there are also some other comments above.

- I recommend adding a background grid in Figs. 1, 2, 11, 12, 13, 14, 16, 18
- Please also add minor ticks on x-axis of Figs. 11, 14, right panel of Fig. 18, and on y-axis of Figs. 12, 13, 16
- I recommend adding "MC" and "PO" next to the longitudinal information in the figure titles of Figs. 3, 5, 6, 7, 14, 15, 16.
- Please indicate MC, PO, Atlantic, and Indian Ocean in Figs. 4, 7, and 8 (e.g., arrows below the x-axis).
- Indicate MC and PO in the figure legends of Figs. 12, 13 (could be one two panel figure) and also in the right panel of Fig. 16.
- I suggest indicating the LRT and CPT for all data sets in Fig. 1

- Indicate El Nino events 2008/2009 and 2014/2015 in both panels of Figs. 14 and 15.

4 Editorial

- Page 1, line 15: "in the range" → "in the range of"
- Page 3, line 8: "Centre" → "Center"
- Page 3, line 17: "cosmic2013 only" → "cosmic2013 data only"
- Page 4, line 5: "within a 183-day period" → "within the 183-day period in 2011/2012".
- Page 4, line 16: According to Table 1, Surabaya station is located at 112.78°E, 7.37°S. Please clarify.
- Page 4, line 18: "less than 30 min": This is only true for the UTLS.
- Page 4, line 21: "within a 183-day period" → "within the 183-day period".
- Page 6, line 4: "height-longitude" → "longitude-height"
- Page 6, line 10: "height-latitude" → "latitude-height"
- Page 6, line 30: "Fig. 6b" → "Fig. 6c"
- Page 7, line 4: "height-longitude" → "longitude-height"
- Page 7, line 19: "than in JJA." → "than in JJA (Fig. 8)".
- Page 7, line 27: "entire latitude range" → "entire region from"

- Page 10, line 27: "15 April 2012" might be "13 April 2012"

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