Ann. Geophys. Discuss.,
https://doi.org/10.5194/angeo-2018-137-RC1, 2019

Annales Geophysicae Discussions

Interactive comment on "High-resolution Beijing MST radar detection of tropopause structure and variability over Xianghe (39.75° N, 116.96° E), China" *by* Feilong Chen et al.

Anonymous Referee #1

Received and published: 21 February 2019

Summary

Chen and co-authors use a VHF wind-profiling radar to examine the structure and variability of the tropopause over Xianghe, China with high temporal resolution. The authors use the gradient of the return power to identify the radar tropopause (RT) and compare with lapse-rate tropopauses (LRT) calculated from radiosondes which are launched some 45km away. The RT and LRT agree fairly well: the authors speculate that the non-perfect correlations are due to the seasonal movement of the subtropical jet. Chen and co-authors also investigate the tropopause sharpness and the relation between RT and the 2PVU dynamical tropopause and briefly mention the syn-

optic meteorology likely contributing to the similarities and differences between these tropopause definitions.

As Chen and co-authors cite in their manuscript, there have been several papers discussing the structure of the RT at varying latitudes in recent years. It seems that there is a bit of a renaissance in papers on this subject following the early study of Gage & Green (1979). The ability of VHF radars to sample sub-diurnal tropopause structure still must be of interest to the community.

Furthermore, the latitude of Xianghe at 40N is interesting for sub-diurnal and synoptic-scale tropopause variability given the seasonal movement of the sub-tropical jet often creating two tropopauses which allows for significant stratosphere-troposphere exchange. Unfortunately, Chen and colleagues choose to reject any analysis of the second, higher, tropopause in this paper which would have added significant interest to their analysis. As such, as it stands, this paper contains little new or interesting science.

I would therefore like the authors to implement the following recommendations in order to increase the scientific value and interest of their study.

Paper references are given at the end.

Major Comments

1) Line 101. You write that you will focus on the first (lowest) tropopause here. Yet I would argue that by neglecting the second tropopause, you are majorly limiting the value of your science. For example, by also characterising the second tropopause, you would likely answer some of your speculations regarding the differences between RT, LRT which you make in the Conclusions. Examining the seasonal variations of both tropopauses with radar would be a useful contribution to the literature and should be done in this paper.

2) Line 230 regarding the low correlations during summer and autumn. Although the RT

and PV tropopauses are both dynamical tropopause definitions, we would not always expect close agreement especially during the passage of cyclones. Still, these larger offsets during summer (Fig 6c) are interesting. Does this suggest that the 2PVU surface is not the best measure of a dynamical tropopause above Beijing during summertime? Given that you only consider 'low-mode' tropopauses, maybe you are missing most of the summer high tropopauses (see Major Point 3 below) which may account for some differences? You should separate the tropopause data into cyclonic / anti-cyclonic conditions, as you should then discover the reasons for the difference – my expectations is that you should see closer agreement between the definitions during anti-cyclonic conditions than during cyclonic. Also, you should separate the data into single tropopause / double tropopause times to investigate the RT – PV tropopause relationships more fully.

3) Discussion section and Figure 12a. I am surprised that you can't detect the thermal (lapse-rate) tropopause in the radiosonde profile at 16km. In such cases, as your radar 'low mode' doesn't reach high enough, you should switch to analysing 'mid-mode' to find the radar tropopause. On line 300 you say that the 16km inversion is the 'second tropopause' but clearly it's the first tropopause, because it is the lowest altitude tropopause. Presumably on this day, you are observing a tropical-like atmosphere with a very high tropopause. You should be aware that at a similar latitude to the Beijing radar is the MU radar in Shigaraki, Japan (35N), where high-time resolution radiosonde and radar analyses over many decades have demonstrated the very high summertime radar and radiosonde tropopauses (first tropopause) at altitudes above 15km (please refer to Tsuda et al., 1991; Hermawan et al., EPS, 1998; Alexander & Tsuda, JTech, 2008, for further details). You need to include analysis of your higher-altitude tropopause in your study, regardless of whether it's the first or second tropopause.

Minor Comments 1) Line 51: 'Radiosonde sounding… impractical [spelling!] in severe weather'. This isn't really true. The sentence suggests to the reader that radiosondes cannot be launched in heavy rainfall yet they are in the tropics, nor in the cold, yet they

are in the polar regions. I suggest removing this sentence.

2) Line 62. So the best way forward is to create a 'blended tropopause' for the globe as Wilcox et al. (QJRMS 2011) did. I suggest you read and cite this paper here.

3) Line 63. Before discussing VHF radars, you should briefly discuss the use of GPS radio occultation satellites which provide highly accurate, climatically stable measurements of temperature and thus of the tropopause. There are many papers on this subject which you can easily find. Some valuable ones include: Schmidt et al., ACP 2005; Son et al., JGR 2011.

4) Line 71. I cannot find the paper Alexander et al (2012). I think you are accidently quoting the ACPD submitted manuscript paper rather than the final ACP paper. You should cite the final, ACP paper as: Alexander et al. (2013). See the 'References' section below for the proper reference.

5) Line 102. For what purpose is the high temporal resolution 'still insufficient'? Why do we care about obtaining the tropopause at hourly time-scales?

6) Line 209, sentence: 'Fig 4 explicitly indicates the good capability of the Beijing MST radar…' No it doesn't. Figure 4 shows that the radar tropopause determined by this radar shows reasonable agreement with radiosonde-derived lapse rate tropopauses and that the differences are mostly under 1km.

7) Line 245: I can't see these differences clearly in Figure 7. On top of your dot points in Figure 7, please plot the mean and standard deviations at each altitude. Please describe in the text what new information this plot shows – after all, the community well knows about the sudden jump in N^2 at the tropopause and the jump in radar power too.

8) Line 312 onwards (comments about Figure 12b and the inversion at 12km). A simple way around this is to set some threshold in your radar tropopause algorithm to avoid these small peaks. And again, you should switch to 'mid-mode' analysis here.

9) Line 326 and comments about cyclones / anti-cyclones. This is easy to investigate and should be done rather than just speculating. See my Major Comments above.

Technical:

1) Line 250: Avoid using the word 'inversion' unless referring to the increase in temperature with altitude

2) Figure 3. I can't see the green asterisks. Please choose a different colour to make this clear

3) Figure 7. The means (and standard deviations) should be overplotted

4) Figure 8. Please clarify the x-axis 'Data acquisition rate'. Is this the percentage of (useful) signal returned, or is it the percentage of wind data collected or what?

5) Figure 12, as discussed in the Minor Comments above, you should be switching to 'mid-mode' to identify the high-altitude tropopause, which in these instances is still the 'first tropopause'

References:

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