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Comment

Interactive comment on “Rayleigh lidar observations of double stratopause structure over three different northern hemisphere stations” by V. Sivakumar et al.

Anonymous Referee #1

Received and published: 4 September 2006

The paper describes a valuable approach to examine the stratopause region from tropical to mid latitudes. The extensive database consists of hundreds of days of accurate lidar measurements and allows a comprehensive statistical study. Unfortunately the description of the data set is incomplete and there are also some gaps in the interpretation of the data. I recommend some revision, acknowledging the following topics:

General comments:

1. There is hardly any description of the different lidar systems and on the data set. Do the various data sets cover nighttime and/or daytime soundings? Does the evaluation base on nightly/daily means only? What is the typical sounding period per day/night

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and is there some lower limit for this period. Is there some variation of the daily sounding time throughout the year? What is the height resolution of the lidars

2. A discussion of the results is missed. E.g. topics like the influence of the (different) sounding periods on the results should be examined. Due to different sounding periods the fraction of resolved GW varies between the stations. Is there any expected effect on the results? Is there any effect of the different altitude resolutions (easily visible from Fig. 1). Can the observed double stratopause structures also be generated by other mechanisms? Are the results dependent on the choice of the seasons? Are the results dependent on the distribution of soundings within the seasons (there are some gaps in Mt. Abu and some inhomogeneities at the other stations)? What are the reasons for the choice of Gaussian fits? From the figures also asymmetric distributions are reasonable.

3. The possible effects of GW and PW are only examined for the 40day period. Is there also some correlation with the seasonal variation of GW and PW activity?

Specific comments:

6934/8: Replace “at the middle level” with “in between”

6934/24: Add “stratosphere” to the bracketed expression

6935/4-5: What is meant by “during winter with time persistence”? Please rephrase.

6935/20-21: Please use same accuracy for all locations (no decimal or one decimal). Please adapt the whole text.

6936/16: What are “individual” profiles in this context? Are daily/nightly mean profiles used for this study or profiles with shorter integration time? Please explain. (cp. General comments)

6936/18: Replace “warm” with “warmest”.

6936/19-27 and Figure 1: What are the dates/times of the particular soundings? Why

are they selected as typical? The description suggests that the given altitudes for the various levels are typical for the different locations. This is in some contrast to table 2. Please make clear, that the numbers are only valid for the examples. The same is true for the large LDS-UDS difference at Gadanki that can not be found in the average numbers of table 2.

6937/3: “heights of occurrences” should only read “heights”

6937/8-10: The first part of the sentence is not clear for the reader. Please rephrase and maybe split the sentence in 2.

6937/12-14: Why are winter and summer defined as the described periods and not e.g. symmetrically to the solstices? Please explain.

6937/15: Are the decimals in the occurrence rates justified? The standard deviation should be given to demonstrate the variability of the rates.

6937/19: “global” should e.g. read “general”. A latitudinal extension between 13°N and 44°N is not really “global”.

6937/20: “frequency distribution of heights of occurrence” should be simplified to “height distribution”

6937/26: “at the centre level” should read “in between”

6937/28: Please write “distribution at Gadanki” and delete “for Gadanki” at the end of the sentence

6938/12: “mean heights of occurrence” should read “mean heights” throughout the whole text. Are the seasonal differences of the average altitudes significant? Please include the standard deviations in the argumentation and discuss the influence of the limited data set.

6938/18: The differences of altitudes of summer-UDS, winter-LDS and winter-UDS at Mt. Abu and OHP should also be acknowledged.

6939/16-17: The interpolated values are not visible from the plot. Please mark in Fig. 3 or mention in the text.

6939/20-24: The OHP numbers for LDS and UDS are permuted. In the following, there is no opposition between OHP and Gadanki.

6940/10-19: If T' is calculated from the nightly/daily mean T profiles, a large fraction of the GW spectrum is smoothed out by the averaging process. It depends on the typical sounding period (averaging time) which part of the spectrum remains. An offset towards the activity of long-period waves might occur. It is recommended to calculate T' on a single-profile basis and e.g. average afterwards the PE number of the whole night.

6940/23: How are the height ranges for PE calculation selected? E.g. there are both LDS and UDS extending the selected ranges.

6941/5: What is meant by “except showing a high value for UDS”? That UDS values are higher than LDS? Or that OHP data contains very high UDS values?

6941/22-24: There are several UDS above 55 km (cp. Figure 2). Therefore the term “clearly” should be deleted. It should be discussed whether there are causative differences between MTI and UDS and not only partly differing altitude ranges.

6941/26: Are the last two sentences of this paragraph still regarded to MTI, as suggested by “moreover” and “thereby”? Please make (more) clear.

6942/1-2: How can a process (like GW) contribute to only one of the double temperature maxima? Obviously an atmospheric process can cause the splitting of the stratopause into two maxima, or the relative strength of one maximum compared to the other (i.e. whether the LDS or UDS is NS). But if a gravity wave causes an additional temperature maximum above the previous stratopause, then it inherently causes also the lower maximum. This would not exist as “lower” when there is no “upper”.

6942/8: What is meant by “extract into a good time-frequency resolution”? Please

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rephrase.

6942/18: Please refer to comment on 6940/23.

6942/24: At the edges of the time domain the amplitudes and exact frequencies of dominant waves can not be exactly determined by wavelet technique [Torrence and Compo, Bull. Amer. Met. Soc., 79, 61-78, 1998]. This “edge” covers about one full period of the wave under examination. Therefore calculated amplitudes of a 5-7 day wave are not trustable between day 0-7 and 33-40. Please discuss this uncertainty of wavelet technique!

6943/1-2: Periods larger than about 20 days can not be determined exactly from this data set. The amplitude of an 20d-wave can only be calculated around day 20. Especially towards the beginning and end of the data set the calculated amplitudes become unreliable. Compare previous comment. Please discuss all edge effects carefully.

6943/6-7: How can a process be responsible for the occurrence of only one temperature maximum of a double layer? Compare comment 6942/1-2.

6943/23-24: What is meant by LDS height occurrence? The general occurrence of a lower double stratopause, the height distribution of LDS (cp. Fig. 2), or the occurrence rate of LDS at a particular altitude?

6944/1-2: Please delete “that the structure exists over the globe with”, because 3 stations do not provide real global coverage.

6944/2-6: Again, how can a process like GW or PW be responsible for only one of LDS or UDS? If there is some misunderstanding, please rephrase.

6944/5-6: Please rephrase for correct grammar.

6944/9: Most of the GW propagate also horizontally. In fact, the horizontal wavelength is often much larger than the vertical.

6944/10-12: I absolutely do not understand this sentence! Please rephrase.

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6944/14-18: Please avoid adding new aspects within the conclusions. Please shift this in a discussion section.

6946/24: Please add “Part 1: Case studies” at the end of the paper title. Table 2, caption: Please add “NS, LDS, and UDS altitudes” for clarity Figure 2: Please use always the same order in text and figures: NS, LDS, UDS or LDS, NS, UDS

Typing errors:

Title: “structure” should read “structures”

6936/14: lowercase for “upper” and “lower”

6936/22: “their” should read “the”

6937/5: “number detected” should read “number of detected”

6937/25: “with” should be deleted

6940/6: Please replace “P.E” with “PE” within the whole text

Table 1, Footnote 1: delete “and”

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 6933, 2006.

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