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Atmospheric Chemistry and Physics Discussions

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

V. Sivakumar et al.

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General comments: 1. Since the descriptions of lidar systems are available in the published papers, we have not paid much attention to describe them in detail. Following the referee suggestion, a short description of the different lidar systems and on the data set has been added. The LiDAR data sets are all made of nocturnal observations, with typical periods of observation of about 4-6 hours, and height resolution of 300m for both Gadanki and OHP sites and 480m for Mt. Abu.

2. The question raised by the referee about the generating mechanisms (other than GW and PW) and seasonal variability is a very important one. Even though that the most suspected mechanisms are of dynamical kind, one should, through modeling,

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examine other mechanisms likely to contribute/influence as generating sources. The present issue focuses on investigating the double stratopause structure occurrences as derived from ground-based observational datasets at different locations, and how wave activity (GW and PW) may contribute in generating such structures. Because of seasonal variability of wave activity in the stratosphere, we do expect that double stratopause structure occurrences would also depend on the season. In fact, those seasonal and generating mechanisms aspects need more investigation by a dual approach: combining continuous observations and modeling, as suggested in the conclusion. The Gaussian fit is applied in the distribution to derive the mean and deviation values. We agree with the reviewers in some cases, there is also asymmetric distribution.

3. Lidar experiments depend on daily meteorological conditions: Lidar can operate only during cloudless skies. Yet it is difficult to have a continuous dataset. In fact, we examined our datasets for that very singular 40-day period regardless to seasonal variation that may affect GW and PW activity.

Specific comments:

6934/8: It is changed.

6934/24: It is changed.

6935/4-5: We meant that the double stratopause case persist for longer period of time during winter than summer. It is rephrased (see the revised manuscript).

6935/20-21: It is changed into one decimal value for all the locations.

6936/16: We agree that the term “individual” is somehow misleading. It refers to nightly mean profiles. The sentence (and others, when it is necessary) has been reworded accordingly.

6936/18: It is replaced now.

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6936/19-27 and Figure 1: The figure-1 is to illustrate examples of occurrences of double stratopause at different locations. In order to improve the reading of that figure, we added for each plot a legend showing the dates of LiDAR profiles. The grey lines show normal stratopause cases, while the black lines depict examples of double stratopause structures.

2. We agree with the reviewers that the figure-1 and the result valid for the example. It is now mentioned in the text.

6937/3: It is changed.

6937/8-10: The sentence is rewritten as suggested by the reviewer.

6937/12-14: The data during equinoctial periods are very few due to cloud/convective conditions. The lidar observations are normally suspended due to such atmospheric conditions. Thereby, we have used 6 month time period for summer and winter. Besides, at tropical/subtropical latitudes (such as Gadanki and Mt-Abu) temperature climatological profiles can be divided into 2 kinds of profiles: winter and summer profiles. Indeed autumn and winter profiles are similar, as well as spring and summer profiles are.

6937/15: The occurrence rate is calculated by taking the ratio between number of double stratopause observations and the total number of observations.

6937/19: It is changed now.

6937/20: It is changed now.

6937/26: It is changed now.

6937/28: It is changed now.

6938/12: It is changed in the whole text. The standard deviations are discussed now.

6938/18: It is addressed now.

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6939/16-17: Now, it is marked in the figure-3 and 4.

6939/20-24: It is found to be correct and the sentences are modified for further clarity.

6940/10-19: Now, T' is calculated from each single temperature profile and the averaged P.E for the whole night is calculated and the figure-4 is modified for both OHP and Gadanki lidar site.

6940/23: The LDS and UDS height range are selected from the mean and standard deviation values obtained from plots of figure-2. This has changed in this revised version: we have chosen the same height regions for OHP and Gadanki: i.e., 43-48km for LDS and 49-54km for UDS.

6941/5: We intended to say that UDS has higher P.E values than LDS. The sentence has been reworded in the revised manuscript.

6941/22-24: The word 'clearly' is deleted and the causative differences between MTI and UDS are discussed.

6941/26: The sentences are rewritten.

6942/1-2: Our idea is to find the relative role between GW and PW in governing the LDS and UDS structure. We have stated that both could contribute for such structure but the role of PW is high in LDS and the GW in UDS regions. However, the role of long period wave activity needs to be examined by combining mechanistic models.

6942/8: It is rephrased now (see subsection 4.b in the revised manuscript).

6942/18: It is modified now.

6942/24: We have discussed the uncertainty of wavelet technique and corrected the statements. The Torrence and Compo (1998) reference has been added.

6943/1-2: Now, it is discussed. Also, the wave period is determined from 5 to 20 days.

6943/6-7: Please refer to the reply for the comment 6944/1-2 and 6942/1-2.

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6943/23-24: It is LDS height distribution. The sentence has been rewritten.

6944/1-2: This sentence is deleted now.

6944/2-6: Our aim is to find the relative role between GW and PW in governing LDS and UDS structure. We have stated that both could contribute for such structure but the role of PW is higher in LDS whereas, the role of GW is higher in UDS regions.

6944/5-6: It is rewritten.

6944/9: It is true that the GW propagate horizontally and vertically. It is not possible to investigate the horizontal propagation of GW using Rayleigh lidar observations.

6944/10-12: It is rephrased.

6944/14-18: It is shifted to the discussion section, as suggested.

6946/24: We agree with the referee suggestion to add “Part 1: Case studies” at the end of the paper title. This is in accordance with our purpose to investigate furthermore, in Part 2, GW, PW and other generating mechanisms using a dual approach: combining continuous observations and modeling, as suggested in the conclusion. “NS, LDS, and UDS altitudes” is added to Table 2 Caption. It has been added in the table-2 caption. In all text and figure captions we have used the “NS, LDS and UDS” order.

Typing errors:

Title: It is changed.

6936/14: It is changed.

6936/22: It is changed.

6937/5: It is changed.

6937/25: It is deleted

6940/6: It is replaced.

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Table 1, Footnote 1: It is deleted

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