A 10-year statistical study of double stratopause structure as observed by LiDAR over a southern sub-tropical site, Reunion Island (21°S, 55°E)

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INTRODUCTION

Stratopause, the layer separates the stratosphere and mesosphere, is becoming an important one for addressing various atmosphere phenomenon. The studies on stratopause provide better understanding of the atmosphere vertical coupling, wave dynamics, meridional circulations, middle atmosphere structure and dynamics, model developments and the atmosphere chemistry.

Globally, the stratopause is found to be located in the height region between 40 km and 60 km. Small changes in the stratopause occur due to atmospheric waves and chemical constituents (mainly ozone). These propagating atmospheric waves may cause different stratopause structure and make difficulty to locate the stratopause height. Here, the present study is focused on interesting features of the middle atmosphere temperature profiles, occurrence of double stratopause structure in the height region from 40 km to 60 km. Using ~10 years of Raleigh lidar measurements from a southern sub-tropical station, Reunion (21°S, 55°E), the characteristics of double (separated) stratopause occurrence are investigated and presented here. Statistical characteristics are obtained for the heights of Normal Stratopause (NS), Lower level of Double Stratopause (LDS) and Upper level of Double Stratopause (UDS).

DATA and METHOD

The lidar data collected for about ~10 years period from 1994 to 2004 are used for the present study. The monthly distribution of number of observations used is shown in the figure-1.

The recorded raw data is in the form of photon count profiles with a height resolution of 300 m and time resolution of 120 s (3000 laser shots were integrated for one profile). The method of deriving the temperature profile from the measured photon count profile closely follows the method adopted by *Hauchecorne and Chanin* [1980].

Figure-2 shows an example of height profile of temperature during the presence and absence of double stratopause structure. The temperature profiles are manually viewed by one another, to identify the double stratopause occurrence and to note the height of occurrence. We made the following notations for describing the results;

(a) Normal Stratopause (NS)

The height at which maximum temperature is found.

(b) Lower level of double stratopause (LDS)

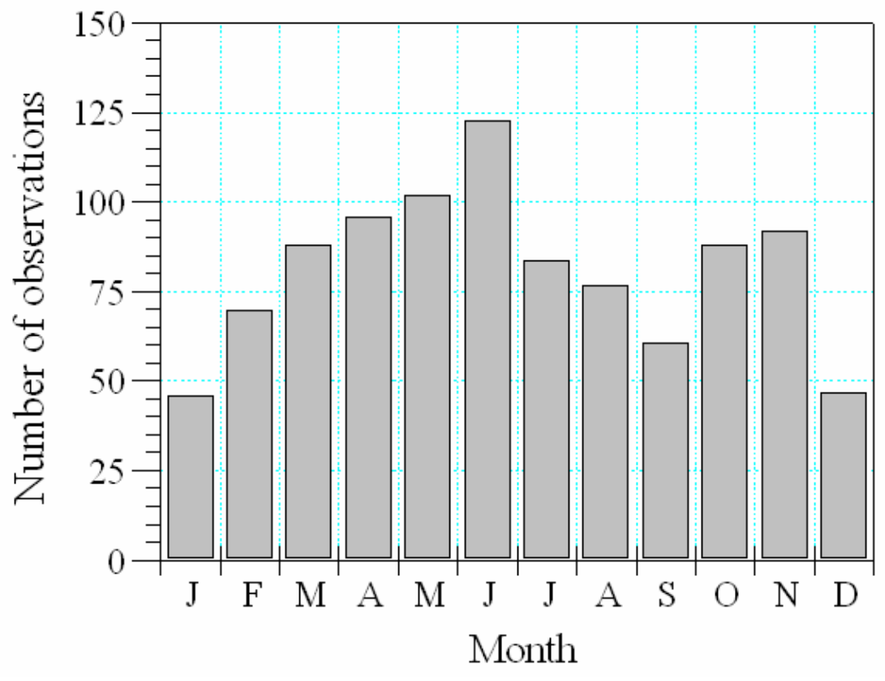
The lower height at which the temperature peak is observed during double stratopause occurrence.

(c) Upper level of double stratopause (UDS)

The upper height at which the temperature peak is observed during double stratopause occurrence.

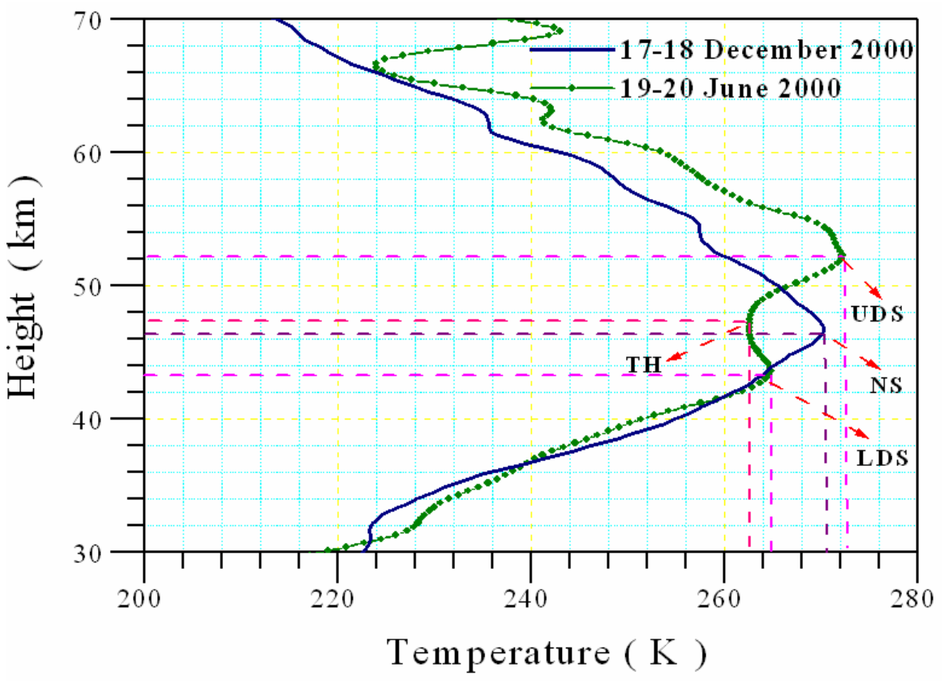
(d) Trough Height (TH)

The height at which the minimum temperature is observed between LDS and UDS.

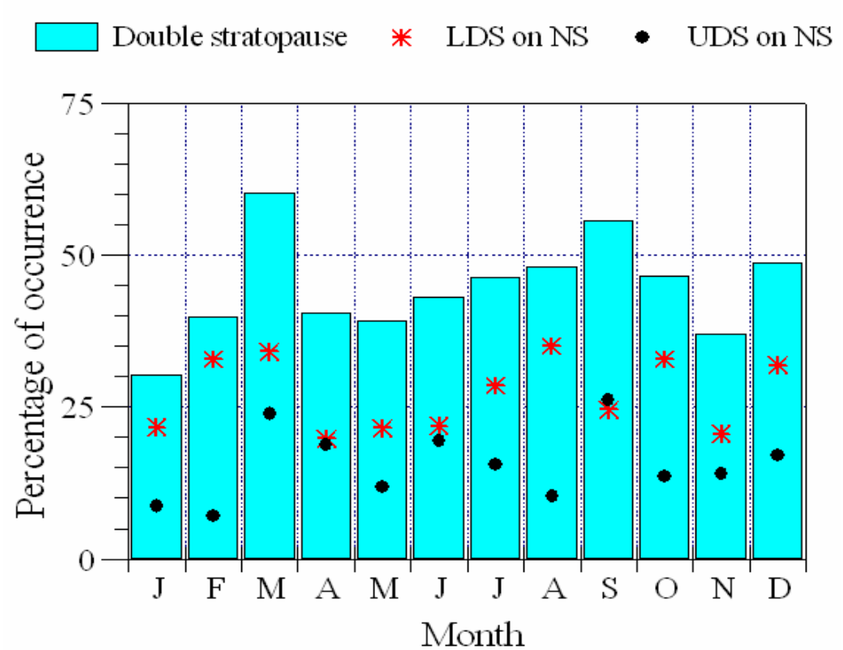


Figure–1: Monthly distribution of number of observations used for the present study.

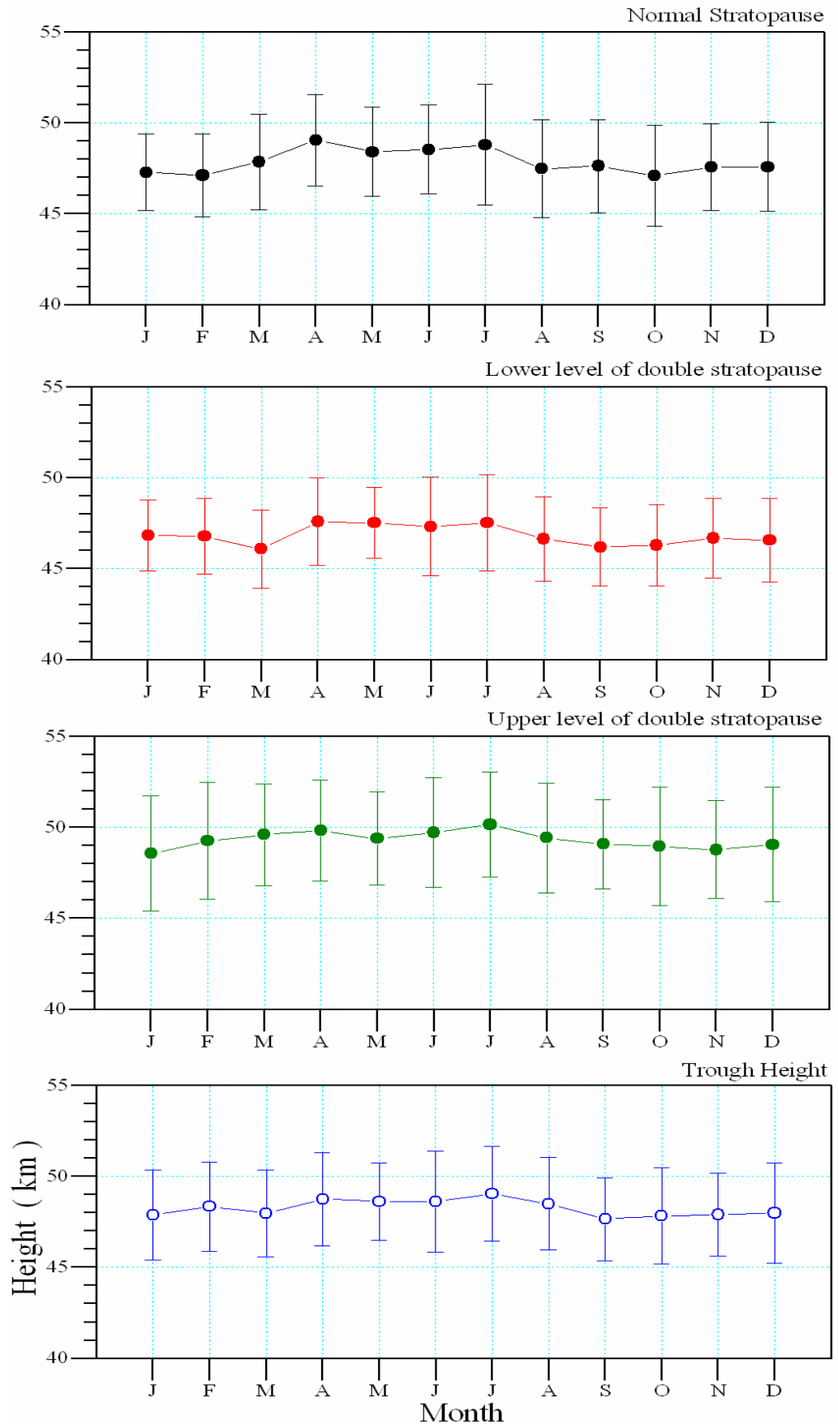
RESULTS



Figure–2: Height profile of temperature illustrating the structure of single or defined stratopause and the occurrence of double stratopause for a given day.



Figure–3: Monthly percentage of occurrence of double stratopause occurrence, NS occurrence on LDS and NS occurrence on UDS.



Figure–4: Monthly mean occurrence of NS, LDS, UDS and TH. The vertical line indicates the standard deviations.

- For the first time, the occurrence of double stratopause structure using the ground based-Rayleigh lidar measurements from a Southern sub-tropical station is presented.
- Double stratopause structures are found to occur for nearly 45 % of cases. The monthly percentage of occurrence shows maximum number of occurrence during March and September. **(Figure-3 – Bar graph).**
- The NS fall on LDS for 27 % cases with maximum number of cases for August (35 %) and minimum during April (19.8 %). Similarly, the percentage of occurrence of NS appear on UDS for 16 % with maximum during September (26 %) and minimum during January (8 %).

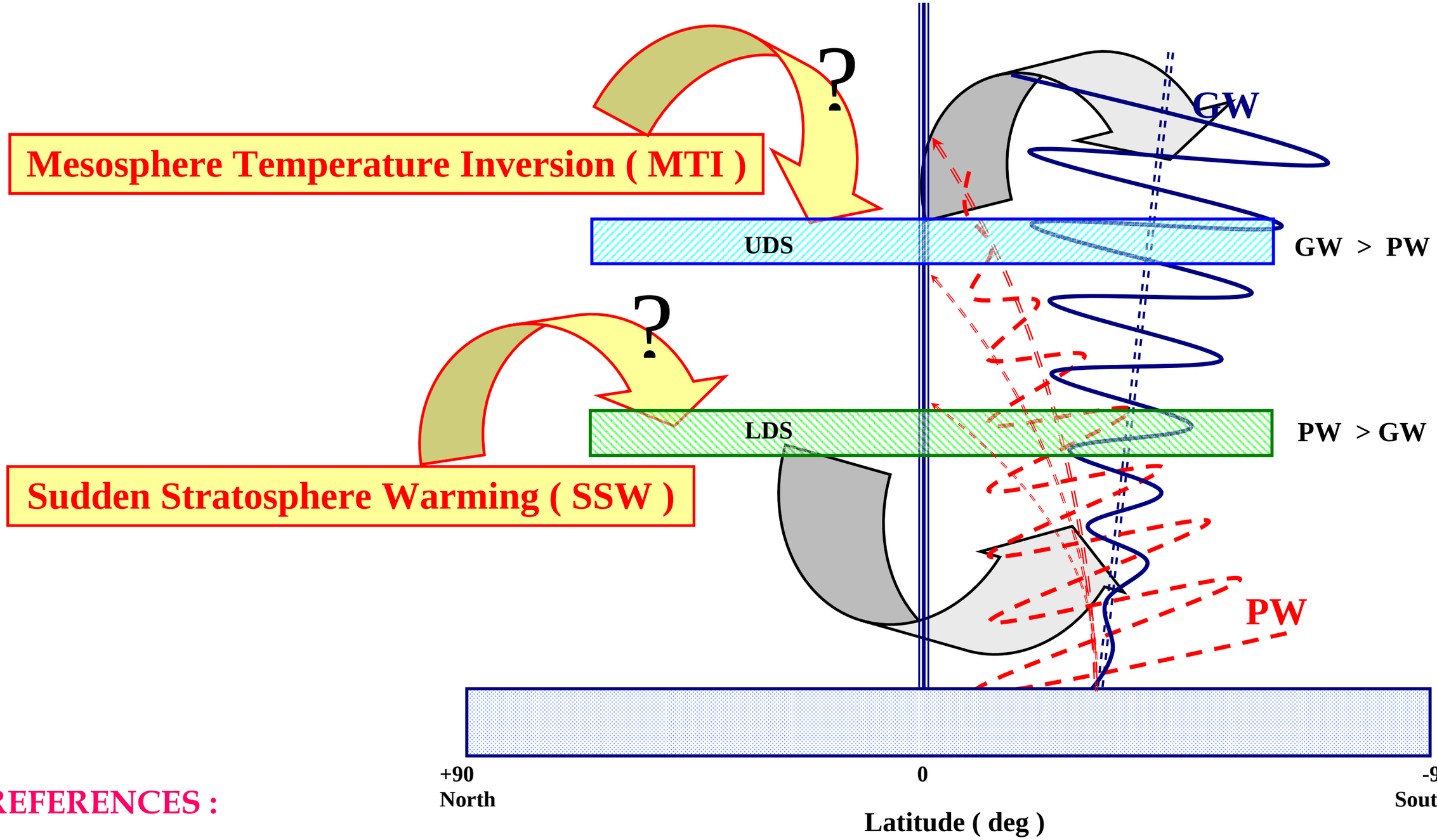
(Legend with Red coloured star and Black coloured dot in the Figure - 3).

- The monthly mean NS shows the height distribution between 47 km and 49 km with the highest NS occurring during April and July and the lowest NS occurring during February and October.

(Figure- 4 – Normal Stratopause).

- The heights of occurrence of LDS and UDS are found in the height range from 46.0 km to 47.5 km and from 48.5 km to 50.0 km, respectively. **(Figure- 4 – Lower and Upper level of Double Stratopause).**
- The distance of separation between LDS and UDS is found to be in between 2 km and 4 km with maximum during March and minimum during January. The mean separation between NS and LDS is in the range from 0.3 km to 2 km with minimum during February and maximum during March. The separation between NS and UDS is distributed between 0.9 km and 2.4 km with maximum during February and minimum during April. In general, LDS is found to be located closer to NS than between UDS and NS.
- The height at which minimum temperature recorded is distributed between 47.6 km and 49.0 km with minimum and maximum values during September and July. **(Figure- 4 – Trough Height).**

CAUSATIVE MECHANISMS



REFERENCES :

- Hauchecorne, A., and Chanin M.L, Density and temperature profiles obtained by lidar between 35 and 70 km, *Geophys. Res. Lett.*, 8, 565-568, 1980.