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Longitudinal and Seasonal Characteristics of the Tropical Mean Temperature Lapse Rate and Tropopause observed by high resolution GPS RO and Radiosonde data

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Objective: To bring out the salient features of longitudinal and seasonal characteristic of the upper tropospheric mean lapse rate and the tropical tropopause

1.Introduction

• Evidence for decadal tropical change includes an observed increase in the tropical mean temperature lapse rate which is not reproduced by the climate models [Gaffen et al,2000]

• IPCC climate change report indicates an increase in lapse rate beginning about 1991. [Houghton et al.,2001]

•Comparison with radiosonde data NCEP Tropical tropopause shows too warm (by 3-5 K) and too high in pressure by (2-3 mb, low in altitude by ~150-400 m). However, these biases are approximately constant in time, so that the range of seasonal variability is reasonable in the NCEP statistics [Randel et al 2000].

• Newell and Gould-Stewart [1981] noted that the tropopause temperatures are cold enough to account for observed water vapor mixing ratio in the lower stratosphere (~3.5ppmv) only during certain months and at certain locations. They used monthly temperature maps at 100mb and showed sufficiently cold temperatures (< -82°C) were frequently found over maritime continental warm pool region in January.

• The most active convective clouds are observed over the maritime continent Indonesia. The region is surrounded by the warmest sea-water in the world, and the dynamical system in the atmosphere are most intense.

2.Data base and methodology

CHAMP GPS RO data: May 2001 to Dec. 2006 within 20° S&N

NCEP data: 2.5° latitude x 2.5° longitude in 17 pressure levels.

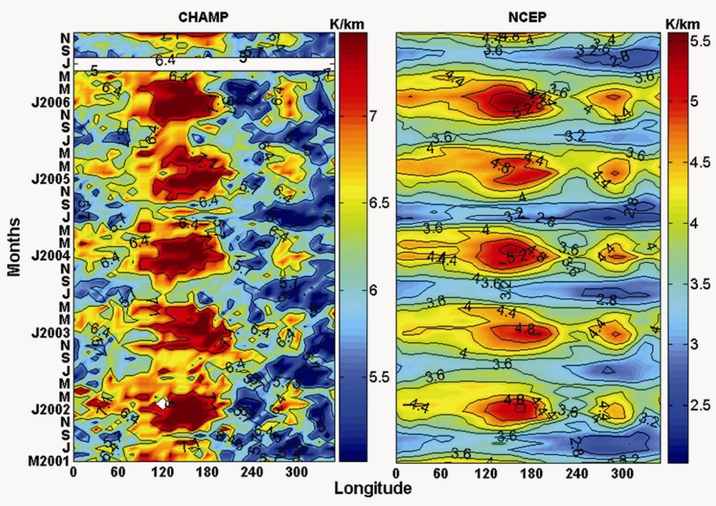
Radiosonde data: 2001-2006, from 12 radiosonde stations namely Ouagadougou, Trivandrum, Gadanki, Truk, Rochambeau, Bogota, Singapore, Tarawa, Nairobi, Seychelles, Darwin, and Ascension distributed across the globe within ±15° from equator where data are available with good vertical resolution.

Methodology:

The average lapse rate is calculated for all the occultations in the latitude 20° S&N in 10 degree longitude bands. The monthly average is calculated in the height region 13-16 km. Similar analysis is done for NCEP data and radiosonde data collected at 00 UT and 12 UT.

3.Results and Discussion

3.1.Longitudinal distribution of monthly mean lapse rate behavior over equatorial (20°S&N) region



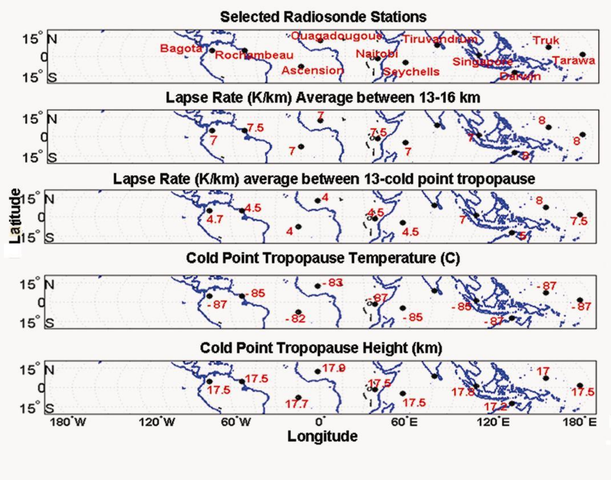
• High lapse rate (~ 7.5 K/km) between 13 and 16 km in the longitude region 100-200°E and also in narrow region around 300°E

•Lapse rate is maximum during northern hemisphere (NH) winter months.

• Detailed features are absent in NCEP data even though more or less similar features are noticed

• However, NCEP show ~2-3 K/km less lapse rate than that observed by CHAMP GPS RO.

3.2.Longitudinal variation of lapse rate and tropopause characteristics within the tropicalregion (NH winter)



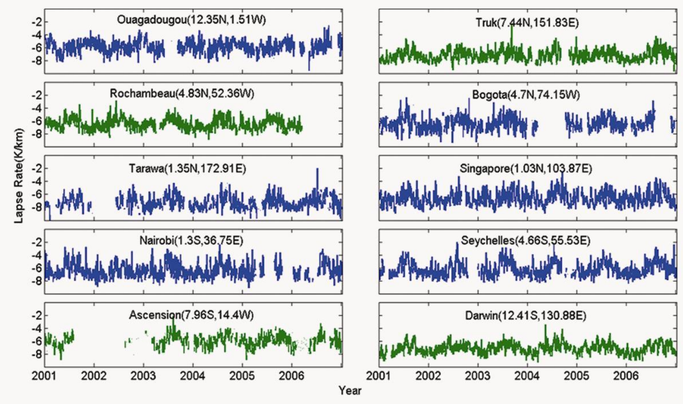
• Mean lapse rate between 13 and 16 km is more not only in the longitude 100°E-180°E but also at other places in western hemisphere.

• However, lapse rate between 13 and cold point tropopause is always higher only over Indonesian region.

• Lowest temperatures not only occur in Indian Ocean region to maritime continent but also at other places in equatorial belt.

• Less than 191K (-82°C) is seen throughout the equatorial belt hence suggesting source region for ST exchange not only occur at Indonesian region.

3.3. Day-to-day variability of mean lapse rate between 13 and 16 km

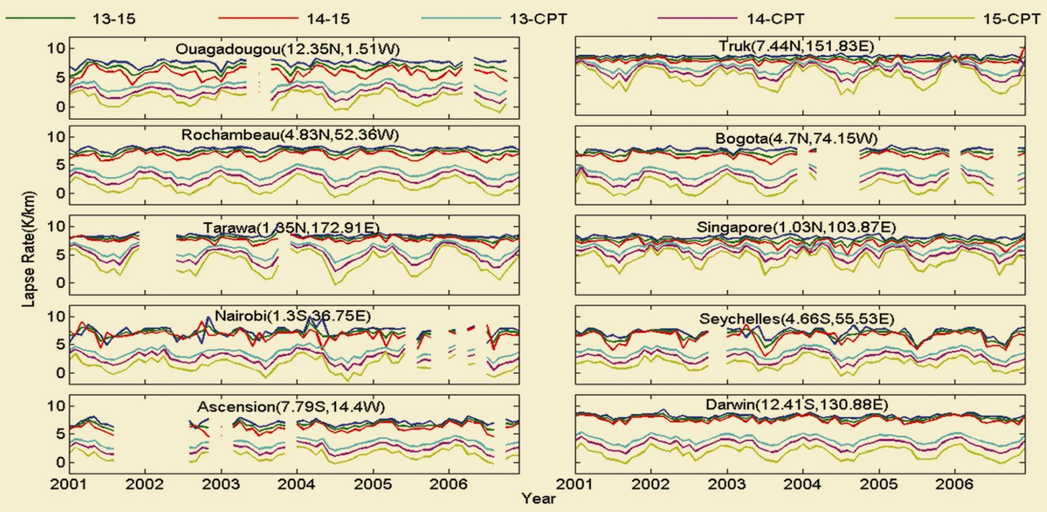


• Mean lapse rate show different characteristics in different stations.

•Day-to day variation of the lapse rate at Nairobi is more than Truk suggesting different characteristics in eastern and western hemispheres within the equatorial belt.

•In general, inter-annul variability is less in eastern hemisphere than in the western hemisphere

3.4. Monthly mean lapse rate at different height regions at different stations

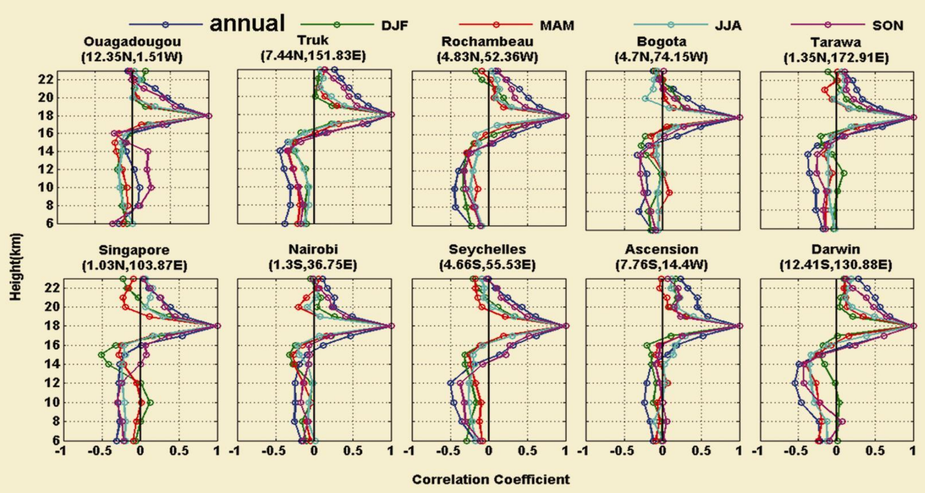


• Clear annual cycle with increase in amplitudes as tropopause is approached from below.

• The lapse rate between 15 km-CPH changed from 6K/km in January to 1K/km in July for the stations Truk, Tarawa and Singapore situated in the longitude zone 103°E - 173°E whereas the rest of the stations showed smaller annual variation.

•This suggests that overshooting of convective turrets into lower stratosphere will take place more easily during winter.

3.5. Correlation between temperature at 18 km and temperature in troposphere and lower stratosphere.



•As expected, negative correlation in troposphere is observed.

•Decreasing correlation in lower stratospheres mainly due to increasing influence of the quasi-biennial oscillation at higher levels.

•CPT is more influenced by stratospheric processes than tropospheric processes irrespective of the season.

4. Summary and Conclusions

➢On an average lapse rate between 13 and 16 km over 20°S to 20°N across the globe show high lapse rate (~ 7.5 K/km) in the longitude region 100-200°E and also in narrow region around 300°E reaching maximum during northern hemisphere (NH) winter months.

➢More or less similar features are also noticed in NCEP data in the same regions although detailed features are absent, however, lapse rate from NCEP show ~2-3 K/km less than that observed by CHAMP GPS RO.

➢It is observed that the cold point tropopause altitude (CPH) is around ~17.5 km and the cold point tropopause temperature (CPT) varied from ~ -82° C to -87° C during NH winter months. Less than 191K (-82°C) is seen throughout the equatorial belt hence suggesting source region for ST exchange not only occur at Indonesian region.

➢The lapse rate average between 13 km and 16 km, 13 km to cold point tropopause (CPT) also show different characteristics among the stations. Day-to day variation of the lapse rate at Nairobi is more than Truk suggesting different characteristics in eastern and western hemispheres within the equatorial belt.

➢The lapse rate between 15km-CPH changed from 6K/km in January to 1K/km in July for the stations Truk, Tarawa and Singapore situated in the longitude zone 103° E - 173° E whereas the rest of the stations showed smaller annual variation.

➢Correlation analysis of temperature data revealed that the CPT is more influenced by stratospheric processes than tropospheric processes irrespective of the season

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