Particle microphysics in the UTLS region and its association with the prevailing dynamics

Bijoy V. Thampi, S. V. Sunilkumar and K. Parameswaran

Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum-695022, INDIA

Objective:

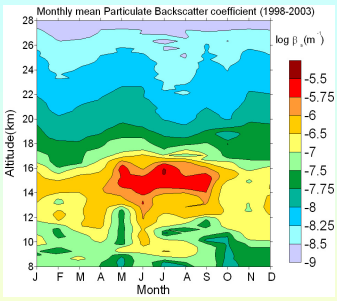
To study the characteristics of particulates in the Upper Troposphere and Lower Stratosphere (UTLS) and its association with the prevailing dynamics at tropics.

Experiment and Data:

Collocated Lidar and Radar observations from Gadanki [13.5°N, 79.2°E], INDIA for the period 1998-2003

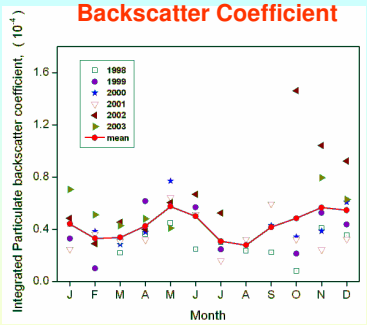
- Lidar operated at 532 nm, with pulse width of 7 ns at 20 Hz rate having dual polarization capability
- MST radar operated at 53 MHz in vertical beam mode
- Radiosonde data from India Meteorology Department, Chennai

Mean Particulate Backscatter Coefficient



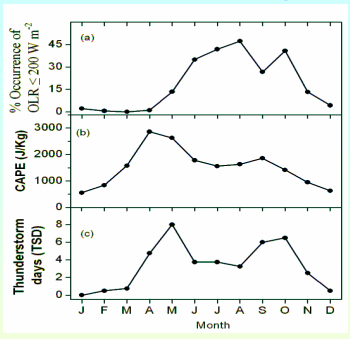
Particulate backscatter coefficient shows significant annual variation. Relatively high values are observed in the UT region during summer and in LS region during winter.

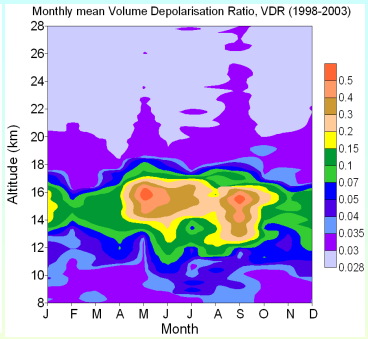
Integrated Particulate Backscatter Coefficient



Integrated backscatter coefficient in LS shows pronounced seasonal variation with relatively high values during winter and pre monsoon

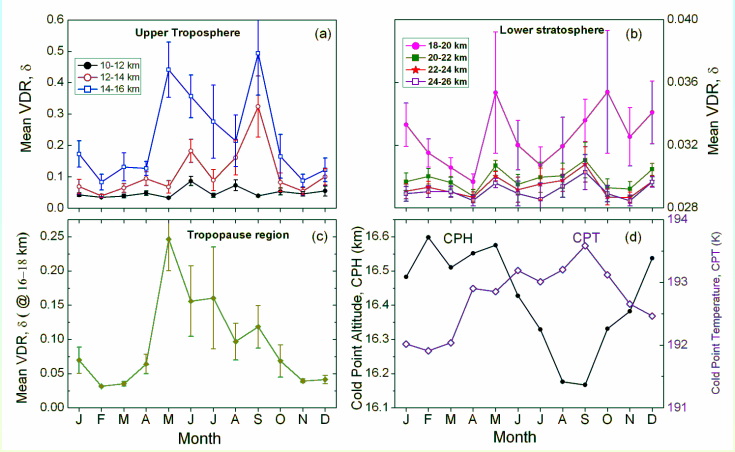
Seasonal variation of OLR, CAPE, Thunderstorm days & Volume Depolarization Ratio (VDR)





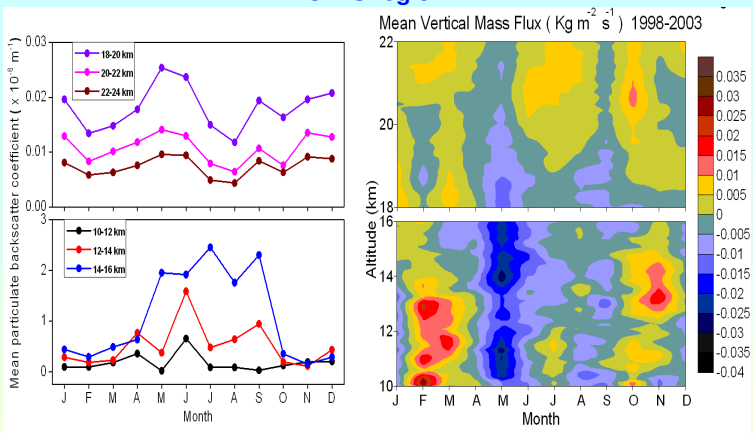
- Annual variation of OLR, CAPE and TSD correlates with observed VDR during southwest monsoon period in association with cirrus particles originated from convective anvils.
- High values of VDR (>0.04) in UT are due to the presence of highly non-spherical ice crystals (in the prevailing cirrus).
- The value of VDR decreases with increase in altitude in the UTLS region indicates decrease in particle non-sphericity with increase in altitude.

Annual variation of integrated VDR & Tropopause characteristics



- General similarity in the annual variation of VDR in the UT and LS indicates that the annual variation of particle habit in these two regions are more or less similar. This suggest that influencing microphysics for the variation in VDR are almost the same indicating the existence of coupling between the two regions. However, a general decrease in VDR from UT to LS suggests that the particles tend to become more regular in shape and smaller in size in the LS region.
- Annual adjustment in tropopause altitude is an important mechanism for exchange processes.

Mean Particulate Backscatter coefficient & Vertical Mass flux in the UTLS region



- Increase in backscatter coefficient corresponds well with the upward motion during winter
- In UT, the upward mass flux dominates during February-March and September-October period and downward mass flux dominates in the April-August months.
- In LS, strong upward mass flux is observed in the January-March and October-November period and a strong downward draft is seen during the May-August period.
- Dip in backscatter coefficient in May in the altitude region 10-14 km corresponds well with the strong downward mass flux.

Summary:

- **The annual variation of particulate backscatter in the UT and LS region display distinctly contrasting features.**
- **The tropospheric convective activity significantly influences the microphysical properties of particulates in the UTLS region.**
- **Relatively low value of VDR in the LS region suggests that the particles are relatively small in size and more-or-less spherical in shape compared to those in the UT region.**

References:

1. Sunilkumar, S.V., K. Parameswaran and B.V. Krishna Murthy, Lidar observations of cirrus cloud near the tropical tropopause: General features, *Atmos. Res.*, 66, 203-227, 2003.
2. Trepte, C. R. and M. H. Hitchman, Tropical stratospheric circulation deduced from satellite aerosol data, Nature, 355, 626-628, 1992.

Email: bijoyvthampi@yahoo.com