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Vertical velocity and heating rates associated with tropical cirrus: Combined lidar and MST radar observations

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Upper Troposphere and Lower Stratosphere (UTLS), including tropopause, is the region associated with the large gradients of various atmospheric parameters such as temperature, ozone, water vapor and it plays very key role in dynamics of both stratosphere and troposphere. Cirrus clouds and aerosols influence Earth's radiation budget due to their direct and indirect interactions with solar and terrestrial radiations affecting the local radiative forcing. Thus it is very essential to monitor characteristics of aerosols and cirrus clouds. Combined radio and optical remote sensing of UTLS region offers excellent opportunity to monitor both dynamical and optical characteristics of aerosols and cirrus clouds in this region.

Cirrus clouds are being monitored using high power Nd:YAG lidar system over Gadanki a tropical Indian station. The lidar parameters, scattering and depolarization ratios, have been used to study the characteristics of cirrus clouds. Lidar observations clearly revealed the presence cirrus clouds during different seasons and occurred in the height region of 14-18 km. These clouds are observed to occur just below the tropopause. Variable magnitudes of scattering and depolarization ratios indicate the variability of thickness of clouds and also the non-spherical ice crystals with their variable orientation with respect to the laser beam. On very few occasions, cirrus clouds with thickness as large as about 5 km have been observed. Co-located Mesosphere-Stratosphere- Troposphere (MST) radar, high power VHF radar, has been used to measure vertical velocity and also to monitor stable layer structures in UTLS region. Simultaneous measurements of lidar and MST radar have been utilized to study vertical

wind associated with the cirrus clouds. Results clearly show enhanced vertical wind in the vicinity of cirrus clouds. Such enhancement is noticed to be more for thick cirrus. These vertical velocities have also been used to estimate the diabatic heating rates. Heating rates and mass flux have been estimated for cirrus clouds with different thickness.