

Tropical Tropopause Layer (TTL) variability during the Balloon measurement campaigns of the Asian Tropopause Aerosol Layer (ATAL) over Indian region

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Intense layer of pollutants including aerosols are observed over the anti-cyclonic region (15-35°N, 20-120°E) over Indian region during Indian Summer Monsoon (ISM) months (JJA). A series of balloon borne sondes were launched over India to study the physical and chemical properties of the Asian Tropopause Aerosol Layer (ATAL) during 2014 to 2017 in the name of ISRO-NASA BATAL campaigns over three stations Gadanki (13.46°N,79.17°E), Hyderabad (17.47°N,78.58°E) and Varanasi (22.27°N,82.99°E) covering edge to the deep of the anti-cyclone. Several in-situ sondes like Radiosonde, Ozonesonde, Compact Optical Backscatter Aerosol Detector (COBALD), Cryogenic Frost point Hygrometer (CFH) etc. are launched during these campaigns. Ground based remote sensing instruments like Indian Mesosphere Stratosphere Troposphere (MST) radar and Boundary Layer Lidar are also operated. As Tropical Tropopause Layer (TTL) play an important role on the exchange of chemical species between troposphere and stratosphere, it's variability during these campaigns over Indian region is investigated. Significant variability in the TTL (year to year) is noticed within the monsoon season. Very low tropopause temperatures of ~187 K are observed particularly during the BATAL 2015 campaigns over Gadanki. The influence of ISM active and break phases on the TTL is clearly noticed and it is expected such variations on the ATAL layer. Distinct characteristics of TTL temperature and altitude are observed between Gadanki and ATAL region during ISM period. The tropopause height is minimum during ISM period over Gadanki whereas maximum in ATAL region. The tropopause height (increase/decrease) and temperature (decrease/increase) are in opposite phase over Gadanki and ATAL regions. Further, we have also investigated the relation between cloud fraction from CALIPSO with the tropopause height over Gadanki and ATAL region. The tropopause height and cloud fraction illustrates one to one correlation over ATAL whereas anti-correlation over Gadanki. These features are further verified using INSAT-3D/3DR measurements.

Key words: Tropical Tropopause Layer, BATAL, ATAL, Indian Summer Monsoon