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Lidar and Satellite Observed Temperature Trends and its Association with Ozone over a Sub-tropical Location

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Middle atmospheric temperature characteristics and long-term trends are presented using Rayleigh Lidar and Satellite observations over a sub-tropical high altitude station, Mt. Abu (24.5oN, 72.7oE, Height above sea level ∼1700 m). Monthly mean temperatures reveal two distinct maxima in the stratopause region (∼42-58 km), occurring over February-March and September-October. The mesospheric temperature shows a prominent semi-annual oscillation (SAO) at ∼60 km. A comparison with the satellite (Halogen Occultation Experiment, HALOE onboard UARS, SABER onboard TIMED) data shows qualitative agreement, but quantitatively significant differences are found. The temperatures from Lidar are ∼ 3-5 K warmer in the stratospheric region and 7-10 K warmer in the mesospheric region than temperatures from the satellite. A comparison with the models, Cospar International Reference Atmosphere-86 (CIRA-86), and Mass Spectrometer Incoherent Scatter Extended-90 (MSISE-90) showed differences of about 4 K in the stratosphere and about 6-12 K in the mesosphere, with deviations somewhat larger for CIRA-96. In the altitude region of 55-70 km, both models deviate significantly, with differences exceeding 10-12 K, particularly during equinoctial periods. Heating and cooling rates have been estimated from temperature climatology. An average heating rate of about 2.5 K/month during equinoxes and cooling rate of ∼ 4 K/month during November-December are found in altitude region of 50-70 km. relatively weaker heating and cooling rates are found in 30-50 km region. A detailed study between stratospheric temperature, observed by Lidar, and ozone observed by Total Ozone Measuring Mission (TOMS), HALOE onboard UARS and SABER onboard TIMED, revealed a strong correlation during winter than during summer months. Overall, in the height range of ∼ 30-45 km, a good correlation between temperature and ozone is observed over Mt. Abu. Long series of Lidar and satellite data have revealed significant long-term decreasing temperature trend in the stratosphere and trend is stronger during winter months as compared to the summer months.