Meteor trail Decay times: A tool for inferring the thermal structure of mesosphere lower thermosphere region at diurnal scales

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Abstract

The ground based observations of the mesosphere lower thermosphere(MLT) thermal structure is limited to optical domain instruments like lidar. However, the optical systems have inherent limitation in operating during day time and during cloudy seasons. Unlike optical systems, the radio domain instruments such as radar provide diurnal observations and capable of operating in all weather conditions. The meteor wind radar operating at VHF range provides a high temporal resolution information on meteor trail decay times, which can be used to study the thermal structure of the MLT region. Over the past several decades, radar echoes from underdense meteor trails have been used to infer the temperature of the 80-100 km region of the atmosphere. Different methods have been used in the past to derive mesospheric temperature values from the meteor decay times and the method of retrieving temperature has gone through several modifications since its inception. In the present study, we have estimated height profile of ambipolar diffusion coefficient and hence the decay time using temperature and pressure measurements by SABER, which is independent of radar measurements. The comparison of the meteor trail decay time measured by radar and SABER provided very valuable insights into the meteor decay times and also provided much needed validation for assumption of ambipolar diffusion of meteor trail. There is pronounced diurnal variation in the difference profile of decay time derived from SABER and radar. The diurnal variation of difference profile of decay times are quantified for each season and this correction is applied for temperature retrieval, which showed considerable improvement. Further, an attempt is made to derive the diurnal variation of temperature after correcting the meteor decay times, which are used to study the tidal activity in the MLT region along with wind measurements. The significant of the present study lies in deriving the diurnal variation of temperature in the MLT region using corrected meteor trail decay times for the first time.