A review on meteor radar techniques for gravity wave observations in the mesosphere lower thermosphere

Karanam Kishore Kumar[1], K.V. Subrahmanyam[1] and Geetha Ramkumar[1]
[1]Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum, India

Email: kishore_nmrf@yahoo.com

Abstract

Atmospheric gravity waves have been the topic of intense research for the past several decades among the middle atmospheric research community**.** The myriad effects produced by these waves such as wave-mean flow and wave-wave interactions, turbulence production, thermal structure modulation and composition changes in the middle atmosphere make them one of the important physical processes to be studied end to end. Meteor wind radar provides wealth of information on gravity waves in the mesosphere lower thermosphere (MLT). In the present review the various techniques to observe the gravity waves in the MLT region are discussed using meteor radar observations over Thumba (8.5^0, 77^0 E). Three techniques viz., (1) High temporal wind measurements (2) Multi-beam observations and (3) Two dimensional mapping are employed to estimate gravity wave variances, momentum flux and drag. Even though the winds are estimated on an hourly basis, information such as zenith angle, azimuth angle, and radial velocity of each detected meteor are archived. Using these details of the meteor, an algorithm is developed to obtain the 15-min temporal resolution wind data. Continuous wind measurements during the high meteor shower periods are used for studying the gravity wave activity in the MLT region. Using this technique the climatology of the gravity wave variance is constructed, which show semi-annual oscillation with maxima near the equinoctial months. By employing multi-beam technique the gravity wave variances, momentum fluxes and drag were estimated and the same are used to study the gravity wave mean flow interactions. The various techniques to remove the background winds are also examined. The observed gravity wave variances in the MLT region varied between 100-400 m^2s^{-2} both in zonal and meridional winds. An attempt has been made to investigate the horizontal structures in the MLT winds using the meteor radar by mapping the wind fields in two-dimension. This is the first attempt to explore the horizontal structures within the radar volume. The radial velocity derived in the 80-100 km region was binned in terms of azimuth and zenith angles and then used to study their spatial evolution with time. Two-dimensional Fourier analysis has been employed to get both spatial and temporal characteristics of observed structure. The presence of a gravity wave structure with ~100 km horizontal wavelength and ~3 hour periodicity comes out explicitly in the analysis. Thus a decade of gravity wave observations over Thumba using various meteor radar techniques are reviewed in the present communication.