Identification of Gravity wave Sources over Tropical Latitudes Using Reverse Ray Tracing technique

M. Pramitha[1], M. Venkat Ratnam[1]*, P.P. Leena[2], Alok Taori[1], D. Pallam Raju[3], B. V. Krishna Murthy[4], and S. Vijaya Bhaskara Rao[5]

[1]*National Atmospheric Research Laboratory (NARL), Gadanki, India.*
[2]*Indian Institute of Tropical Meteorology (IITM), Pune, India.*
[3]*Physics Research Laboratory (PRL), Ahmedabad, India.*
[4]*B1, CEBROS, Chennai, India.*
[5]*Department of Physics, Sri Venkeswara University, Tirupati, India.*

pramitha@narl.gov.in , **vratnam@narl.gov.in*

Abstract

Sources and propagation characteristics of high-frequency gravity waves (GWs) observed in the mesosphere using airglow emissions from Gadanki (13.5°N, 79.2°E) and Hyderabad (17.5°N, 78.5°E) are investigated using reverse ray tracing. Wave amplitudes are also traced back, including both radiative and diffusive damping. For this a climatological model of the background atmosphere for the Gadanki region has been developed using nearly 30 years of observations available from a variety of ground based (MST radar, radiosondes, MF radar) and rocket- and satellite-borne measurements. With the reverse ray-tracing method, the source locations for wave events could be identified to be in the upper troposphere. Uncertainty in locating the terminal points of wave events in the horizontal direction is estimated to be within 50–100 km and 150–300 km for Gadanki and Hyderabad wave events, respectively. This uncertainty arises mainly due to non-consideration of the day-to-day variability in the tidal amplitudes. Interestingly, large (~9ms^{-1} km^{-1}) vertical shears in the horizontal wind are noticed near the ray terminal points (at 10–12 km altitude) and are thus identified to be the source for generating the observed high phase- speed, high-frequency GWs. We also tried to identify the sources for the GWs which are observed during Indo-French campaign conducted during May 2014. Uniqueness of the present study lies in using near-real time background atmosphere data from simultaneous radiosonde and meteor radar covering both source and propagation/dissipation regions of GWs. When we searched for the sources near the terminal points, deep convection is found to be a source for these events.

We also tried to identify the sources of inertia-gravity waves (IGWs) that are observed in the troposphere and lower stratosphere during different seasons using long-term (2006-2014) high resolution radiosonde observations. In general, 53% of the waves observed over this location have convection as source and for only 38% of the cases vertical shear in the horizontal wind is identified as a source. For the rest of the 9% of the cases, these two sources are not found to be active. We also tried to simulate which small scale waves can reach the altitudes of mesosphere. Interestingly we could notice that less number of waves could reach the mesosphere during the monsoon season. In general, waves with 30-100 km horizontal wavelengths and 30-90 minutes periods could only reach the higher altitudes. Thus, exact sources for the spectrum of GWs are identified for the first time and it is expected to play major role in source parameterization of GWs in the GCM models, if implemented.