Causative Mechanisms of Tropical (10°N-15°N) Mesospheric Inversion Layers

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ABSTRACT

The inversion of temperature gradient from negative to positive superimposed upon the characteristically decreasing mesospheric thermal structure is known as Mesospheric Inversion Layer (MIL). Although MILs have been known for decades through all sorts of available techniques, their study is still of significant relevance for understanding of the energy and momentum budget of mesosphere and lower thermosphere (MLT) region. The dominant causative mechanisms for the occurrence of MILs are: gravity wave (GW) breaking, planetary wave (PW) critical level interaction, GW-tidal interaction and chemical heating. In the present study, a large MIL has been observed using Rayleigh lidar temperatures on the night of 24th January 2007 over a tropical site, Gadanki (13.5°N, 79.2°E). The MIL occurred at ~79-84 km with amplitude and thickness of ~50 K and ~4.5 km respectively. A dominant GW with a period and vertical wavelength of ~33 min (~38 min) and 6.4 km has been observed above 55 km (at 30-55 km). The other wave characteristics are derived from the GW dispersion relation using rocketsonde and MF (medium frequency) radar winds over SHAR (13.7°N,80.2°E) and Tirunelveli (8.7°N,77.8°E) respectively. In addition, the wave amplitude gets saturated at ~80 km (saturation ratio, R>1) and the eddy diffusion coefficient (D_{eddy}) increases from ~54 m^2/sec to ~284 m^2/sec in the inversion region (~80-85 km). The heating/cooling rates (~10 K/hr) observed at the bottom/top levels of the MIL further elucidates the inversion layer occurred mainly due to the turbulence generated by the gravity wave breaking. However the total chemical heating (~9 K/day) by seven major exothermic reactions, R_1:$O+OH \rightarrow H+O_2$, R_2:$H+O_2+M \rightarrow HO_2+M$, R_3:$H+O_3 \rightarrow OH+O_2$, R_4:$O+HO_2 \rightarrow OH+O_2$, R_5:$O+O+M \rightarrow O_2+M$, R_6:$O+O_2+M \rightarrow O_3+M$, R_7:$O+O_3 \rightarrow O_2+O_2$ plays minor role during this MIL event. Further the large MILs observed during January-February 2011 over Gadanki region are mainly due to the total chemical heating (~30 K/day) and the dynamics (GW, PW breaking) play negligible role during these MIL events.