Low-latitude Mesospheric Dynamics Revealed by VHF Radar, MF Radar, Rocket and Satellite Borne Observations

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Low-latitude mesospheric dynamics like, echo characteristics, lifetime of mesospheric echoes, and the background mean winds are studied using data collected during last 11 years by the Indian MST radar located at Gadanki (13.5^{o}N, 79.2^{o}E). Mesospheric echoes are found highly intermittent both in space and time. These echoes are frequently observed between 1000-1530 hrs LT in the height region of 68-78 km. Both the percentage occurrence (PO) of echoes and SNR are showing a semi-annual Oscillation (SAO) with maxima during equinoxial months [1,2]. The mechanisms behind the observed features are discussed in the light of mesospheric temperature inversions (MTIs), which are often noticed at this location using Nd:YAG Rayleigh lidar, and wave breaking at these altitudes. In general, the echo persistent time is less than 20 minutes, between 20-40 minutes, and above 40 minutes for 70-90 %, 10-20 %, and 5-15 % of the time, respectively. The persistent times also show clear seasonal variation. These results are also indicating the intermittent nature of the mesospheric echoes. The high persistent echoes are observed mainly in the height region of 70-80 km.

Using the Doppler shift of the mesospheric echoes, the background wind is estimated. These winds are compared with the existing observations like rocket, HRDI, and MF radar and also with HWM93 model. All these comparisons are good in agreement except the MF radar winds. Reasons are being investigated by considering the limitations of the techniques. A clear SAO is observed in mesospheric zonal wind with maxima during equinoxial periods. The first peak of the SAO is larger than the second peak of the SAO and these results are consistent with the earlier observations [3].

Long term variations of low-latitude mesospheric SAO (MSAO) and quasi-biennial oscillation (MQBO) in the zonal wind are also studied using observations available from 1977 to 2006. The MQBO showed large inter-annual variability in the phase difference between 77.5 km and 72.5 km indicating such variability in eddy viscosity. Association of these oscillations with stratospheric QBO (SQBO) is investigated. In general, the MQBO at 77.5 km is out-of-phase with SQBO and this relation fails during strong and long SQBO. The MSAO at 72.5 km and 77.5 km generally shows strong westward phase during strong eastward phase of SQBO. The most striking feature observed in the present study is the strong modulation of the MSAO by MQBO revealing a non-linear type of interaction with presence of sidebands of the MSAO [4].

Ongoing work is focused on the lower atmospheric forcing and its impact on middle atmosphere with special emphasis on wave mean interaction under Study of Atmospheric Forcing and Responses (SAFAR), a NARL campaign. It is also aimed to investigate the solar cycle influence on these large scale motions using

long-term observations available from our low-latitude stations under CAWSES India Phase-II program. Future work should focus on the longitudinal variability of these long-term variations and influence of the solar cycle by considering the network of observations from Asia-Oceania region.

References

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