International Journal of Professional Development
Vol.9, No.2,July-Dec2020 ISSN:2277-517X(Print),2279-0659(Online)
Impact Factor 2.923 (IFSIJ)

A Study of Atmospheric waves of 30-70 day period in zonal wind over mid and high latitude stations

Keshav Kumar
Department of Physics, M. M. H. College Ghaziabad

Abstract
Zonal wind weekly data from radiosonde and roccketsonde flights have been analyzed using FFT technique to study the atmospheric waves of 30-70 day period in a mid and a high latitude station, namely Volgagrad (49N; 44E) and Heiss Island (81N; 53E) from the analysis, some very interesting features of these waves are noticed which have been observed for the first time at high latitudes. These waves are observed at tropospheric as well as stratospheric heights. The wave amplitude is noticed to be larger in stratospheric heights at mid latitude than at higher latitude. These waves are dominant at stratospheric heights during November to March.
Keywords: Zonal wind, Radiosonde, Rocketsonde, Atmospheric Wave.

Introduction

Madden and Julian (1971-1972) identified a 40-50 day oscillation in zonal wind at tropospheric heights using spectral analysis of tropical radiosonde data. Since then, many efforts have been made to explore the characteristics and origin of this oscillation (Yasunai, 1979; krishnamurti et at., 1985; Lau and Chan, 1986). So far these waves have been reported only for tropics and observed at tropospheric heights. These waves seem to have association with the monsoon activity also (Yasunari, 1981; Madden, 1986; Chen, 1987).

Recently, Kumar and Jain (1992) studied the 30-70 day period wave at Thumba (8.5 N; 77 E) using weekly flights wind data of radiosonde and rocketsonde at tropospheric as well as stratospheric heights. Further, Kumar and Jain (1994) extended their studies to SHAR (13.7 N; 80.2E) and Balasore (21.5 N; 87 E) stations to see the latitudinal variations of these waves. The results have shown that these waves do not conform to the characteristics of Kelvin waves since these are observed in the meridional winds as well as in the zonal winds. These waves are observed both in the stratosphere and the troposphere and the phase propagation is found to be advancing downward. It has been also noticed that these waves are observed during south-west as well as north-east monsoon seasons. Therefore, a study of these waves is of considerable interest.

In the present report, a study has been carried out for the 30-70 day period wave in a mid (Volgagrad; 49N, 44E) and a high (Heiss Island; 81N, 53 E) latitudes station for zonal wind, with the help of weekly flights wind data of rocketsonde and radiosonde. The major objective of the study is to see whether these waves are observable at the higher latitudes also.

Data and Method of Analysis

Weekly flights data of zonal wind for the two stations namely, Volgagrad and Heiss Island were scanned for reasonable long sequences with minimum gaps. Two series of weekly data for these stations have thus been selected for detailed analysis. These series are; (i) 15 May 1985 to 22 October 1986 and (ii) 1 July 1987 to 28 June 1989. The data gaps, if any, have been filled by interpolation (using Lagrangian formula) around the missing point using the five degree polynomial. Details of data analysis are described by Kumar and Jain (1992).

The time series of weekly data of zonal wind are used to study the waves of 30-70 day period. Two filters of 30-50 and 50-70 day periods are used. In the former the waves of periodicity lower than 30 days and greater than 50 days are removed using the filter. Similarly, in the later case the waves of periodicity lower than 50 and higher than 70 days are removed. Because of this filter we are losing a total of 14 points (7 at each end) in 30-50 day period wave and a total of 34 points (17 at each end) in 50-70 day period wave.

Before taking the Fast Fourier transformation (FFT), the unfiltered time series of weekly wind data are reduced to zero mean to eliminate linear trend. To lessen the effect of the discontinuities, we make the end regions to have smooth transition to the mean of the measured value by multiplying the sequence of the weekly wind data with the 'weights' of a 'Cosine Bell' window applied to the first and last 10% of the data (Agarwal et al., 1980). The tapered series is extended by adding zeros towards the end to bring the number of data points equal to 2^k, where ^{k} is an integer whose magnitude depends on the length of the data series. Then the FFT is applied to obtain the spectrum of this time series.

Results

Plots of the time-height of zonal wind: Figures 1-4 are the plots of the filtered time series and show the strong activity of 30-50 and 50-70 day period waves in zonal wind at Volgagrad and Heiss Island both at tropospheric and stratospheric heights. The rectangle marked with inclined lines at the x-axis scale is the indication of south-west monsoon season (July to October). The waves of 30-50 day period are noticed throughout the year in troposphere (Fig.1) while in a stratosphere these waves are more dominant during November to March (Fig.2). Figures 3 and 4 show the waves of 50-70 day period for tropospheric and stratospheric heights, respectively. These waves are more dominant at stratospheric heights during November to March (Fig.4). It is noticed that the amplitude of these waves at stratospheric heights is larger than at the tropospheric heights for both the stations.

Height- profile of wave amplitude in Zonal wind: From the spectral analysis, it has been noticed that two dominating waves are generally observed in the spectra at all heights. These waves correspond to spectral periods of 30-50 and 50-70 days. The amplitude-height profiles of 30-50 and 50-70 day period waves in zonal wind are shown in Fig. 5. The waves have significant amplitude in troposphere as well as in stratosphere at both the stations. Two distinct peaks in amplitude have been seen in both (30-50 and 50-70 days period) waves: one below the tropopause and the other one near the stratopause heights. The amplitude of these waves at the stratopause height is larger than the wave amplitude at the tropopause height. At tropospheric heights the amplitude of the waves is comparable at both stations. However, the amplitude of these waves at stratospheric heights is found to be significantly larger at Volgagrad than Heiss island.

Discussion

From above we note that 30-70 day period wave in zonal wind are observed both at mid (Volgagrad) and high (Heiss island) latitudes stations. However, the wave amplitude at stratospheric heights is larger at mid latitude than at the high latitude. The above results indicate that these waves are not confined to tropical zone but are seen at higher latitudes also. These waves are seen throughout the year in troposphere while these waves are found more dominant during November to March in stratospheric heights at both the (mid and high) latitudes. The height-profiles of amplitude for both the waves in zonal wind at stratospheric heights are about 2 times larger than the wave amplitude to tropospheric heights.

The intercomparison of zonal wind wave amplitude between Volgagrad and Heiss Island and Thumba stations (Kumar and Jain 1992) show similarity in their features, with two peaks viz. one below the level of tropopause and the other just below the stratopause. At tropospheric heights, the wave amplitude is comparable for all the stations. However, at stratospheric heights the wave amplitude at Volgagrad is larger compared to that at Heiss island and at Thumba.

Conclusion

An analysis of weekly data of zonal wind shows that 30-70 day period waves are not confined only to tropical zone but observed at mid and high latitude stations also. At stratospheric heights, the wave amplitude is noticed to be larger at mid latitude than at tropical and higher latitudes. The amplitude of the waves is about the same at tropospheric heights for all the latitudes. These waves are dominant at stratospheric Heights During November To March.

Acknowledgements

We are Author expresses sincere thanks to the Center of Aerological Observatory, Mascow, USSR, for making available the Bulletin of results of Rocket sounding of the atmosphere used in the present study.

References

1. Agarwal, A.K., Singh, B.P. and Nityananda, N., An application of complex demodulation technique to geomagnetic data and conductivity anomaly, Proc. Indian Acad. Sci. (Earth Planet. Sci.), 89, 67, 1980.
2. Chen., T.C., 30-50 day oscillation of 200-mb temperature and 850-mb height during the 1979 northern summer, Mon. Wea. Rev., 115, 1589-1605, 1987.
3. Krishnamurti, T.N., Jayakumar, P.K., Shenh, J., Surgi, N. and Kumar, A., Divergent circulations on the 30-50 day time scale, J.Atmos. Sci., 42, 364-375, 1985.
4. Kumar, K. and Jain, A.R., A study of atmospheric waves of 30-70 day period in zonal wind over near-equatorial station Thumba, Ind. J. Radio and Space Phys., 21, 42-46, 1992.
5. Kumar, K. and Jain, A.R., Latitudinal variations of 30-70 day period waves over tropical Indian zone, J. Atmos. Terr Phys., V.59, No.9, P1135, 1994.
6. Lau, K. and Chan, P.H., Aspects of the 40-50 day oscillation during the northern summer as inferred from outgoing longwave radiation, Mon. wea, Rev., 114, 1354-1367, 1986.
7. Madden, R.A. Seasonal Variations of the 40-50 day oscillation in tropics, J. Atmos. Sci., 43, 3138-3158., 1986.
8. Madden, R.A. and Julian, P.R., Detection of a 40-50 day oscillation in the zonal wind in the tropical Pacific, J. Atmos. Sci., 28, 702-708, 1971.
9. Madden, R.A. and Julian, P.R., Description of global scale circulation cells in the tropics with 40-50 day period, J. Atmos. Sci., 29, 1109-1123, 1972.
10. Yasunari, T., Cloudiness fluctuations associated with the northern hemisphere summer monsoon, J.Meteor. Soc. Japan, 57, 227-242, 1979.
11. Yasunari, T., Structure of an Indian monsoon system with around 40-day period, J. Meteor. Soc. Japan, 59, 336-354, 1981

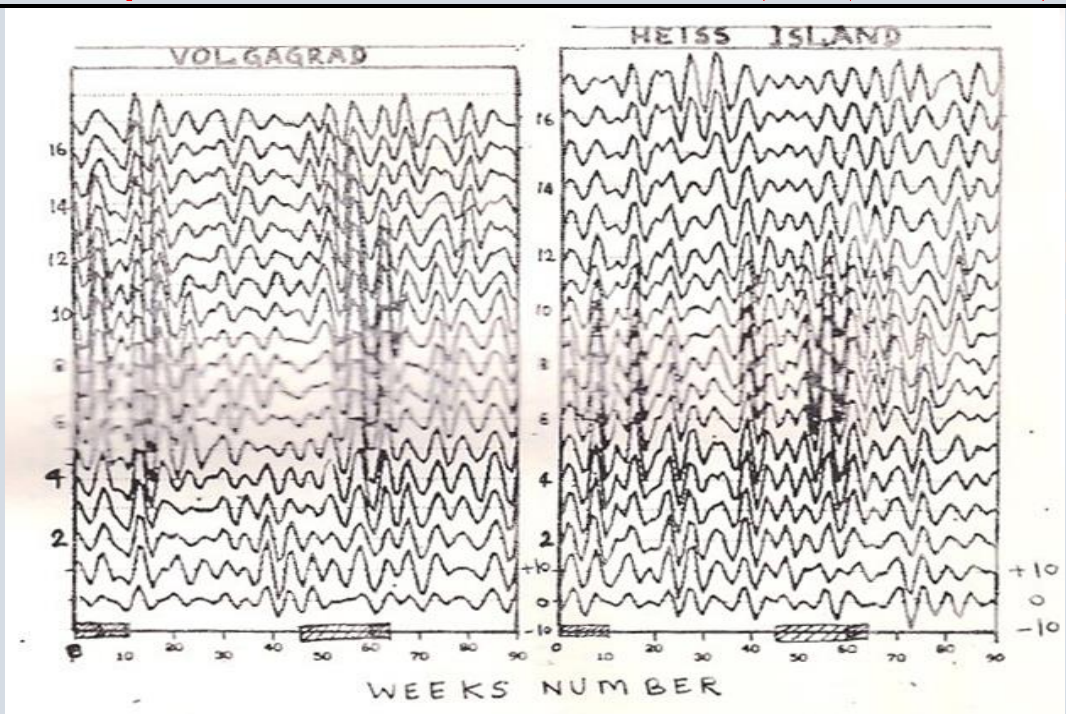

Fig. 1. Zonal wind plots as a function of weeks number showing the 30-50 day period wave activity at tropospheric heights over mid (Volgagrad; 49N, 44E) and high (Heiss island; 81N, 53E) latitudes. In x-axis, 0 stands for August 19, 1987. The scale of wind for first height is given on RHS of each graph in ms^{-1}. The wind values for the subsequent heights are displaced vertically by upsetting 10 ms^{-1}at each height. The numbers on LHS are altitudes in km.

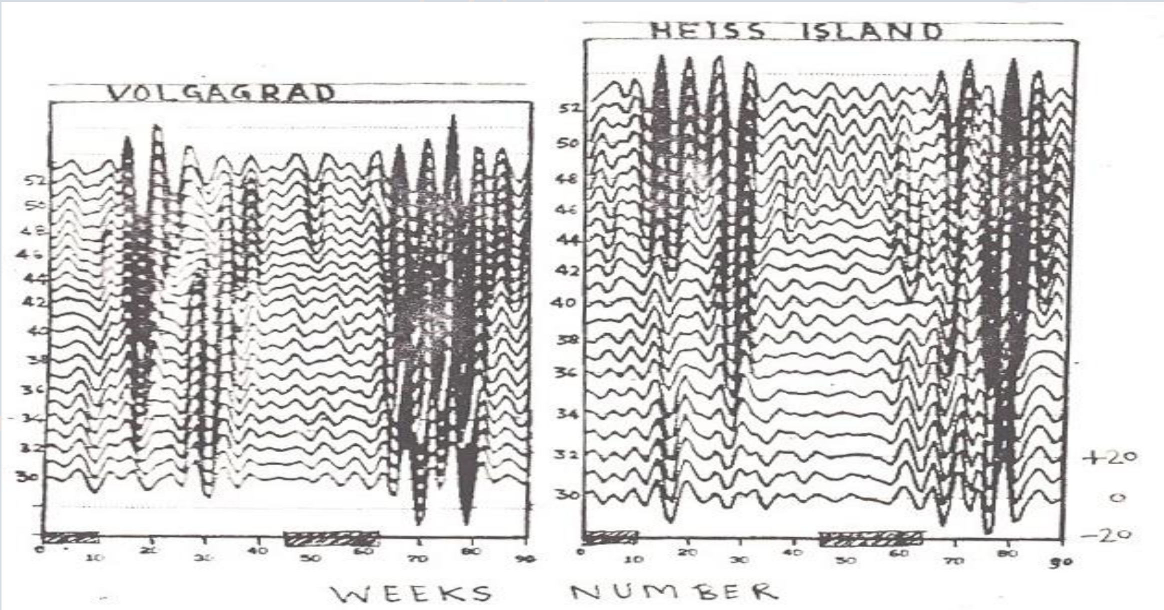

Fig. 2. Same as fig. 1 but for stratospheric heights. The scale of wind for first height is given on RHS in ms^{-1}.

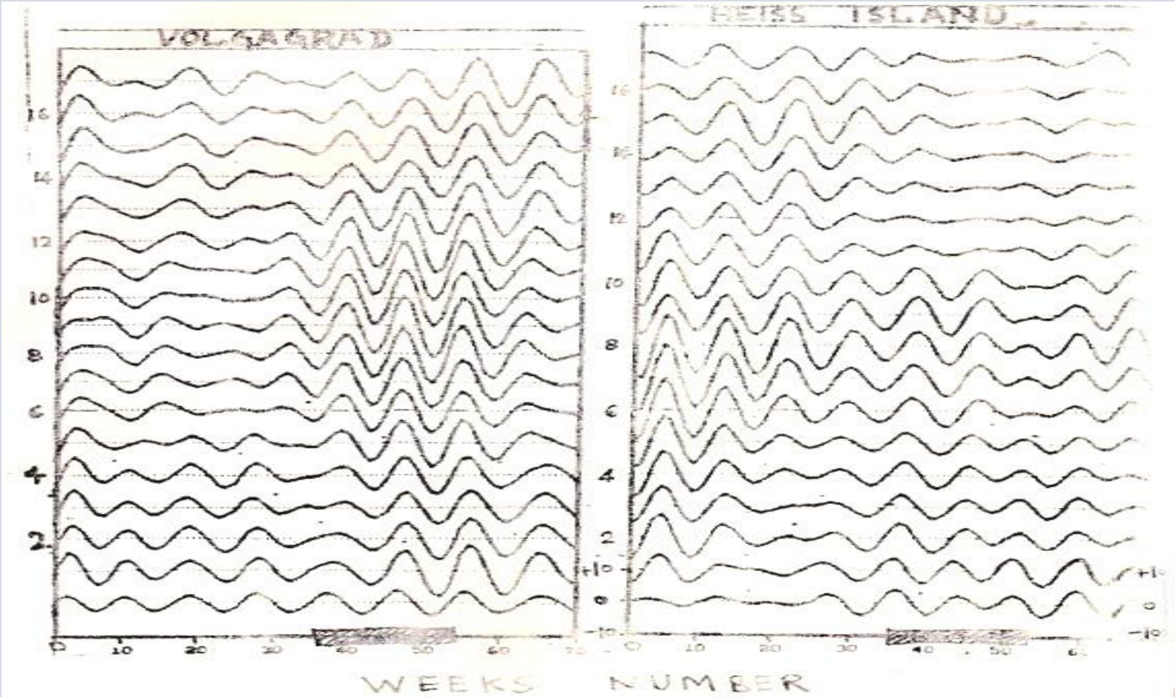

Fig.3. Zonal wind plots as a function of weeks number showing the 50-70 day period wave activity at tropospheric heights over mid (Volgagrad; 49 N, 44E) and high (Heiss Island; 81 N ; 53E) latitudes. In X-axis, 0 stands for October 28, 1987. The scale of wind for first height is given on RHS of each graph in ms^{-1}. The wind values for the subsequent heights are displaced vertically by upsetting 10 ms^{-1} at each height. The numbers on LHS are altitudes in km.

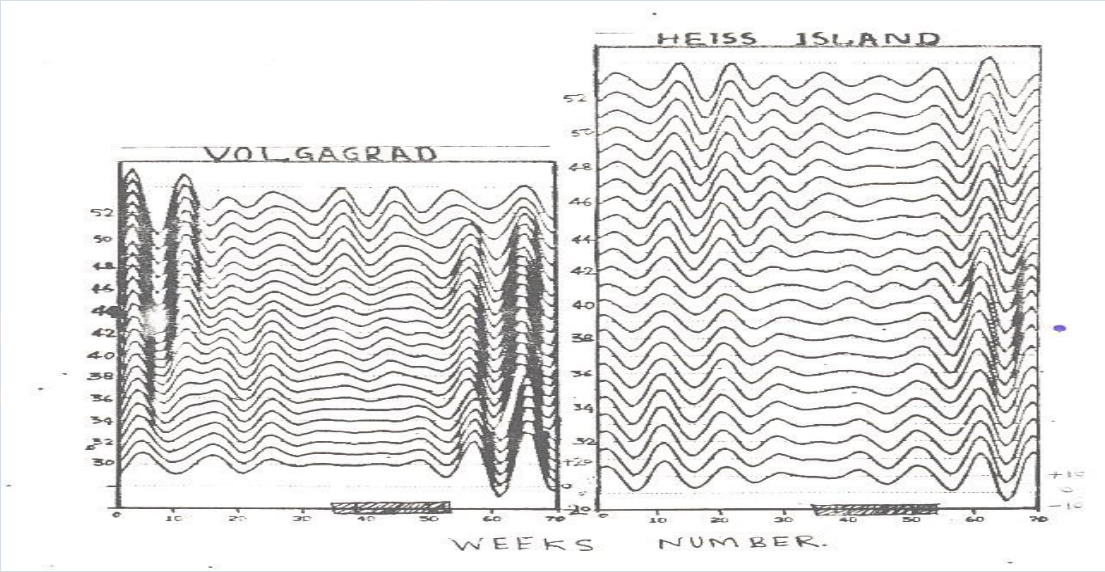

Fig.4. same as fig.3 but for stratospheric heights.

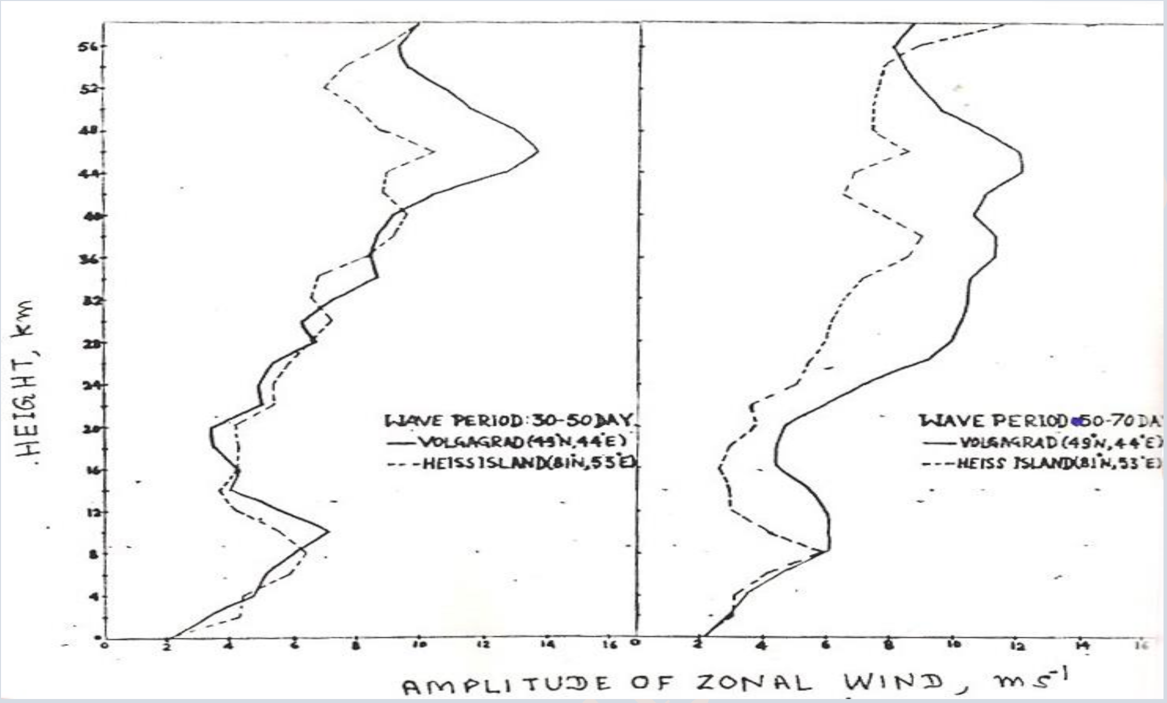

Fig. 5. Amplitude-height profile from FFT using unfiltered time series data for 30-50 and 50-70 day period waves in zonal wind over mid and higher latitude.