Long-Term Datasets for the Understanding of Solar and Stellar Magnetic Cycles
Proceedings IAU Symposium No. 340, 2018
D. Banerjee, J. Jiang, K. Kusano & S. Solanki, eds.

doi:10.1017/S1743921318001412

A wavelet analysis of F2 layer critical frequency over solar cycle 23

C. S. Seema and P. R. Prince

Department of Physics, University College, Thiruvananthapuram-695 034, Kerala, India
email: seemaniran@gmail.com, princerprasad@gmail.com

Abstract. Temporal oscillations of F2 layer critical frequency are direct outcome of solar EUV variability. The hourly data of F2 layer critical frequency (f_oF_2) during solar cycle 23 over eight ionosonde stations which falls within same longitudinal span are evaluated using Continuous Wavelet Transform (CWT) to estimate the ionospheric variations. The quasi triennial, annual, semiannual, 27 day and diurnal variations of f_oF_2 are clearly evident in the wavelet power spectra of all the stations. Quasi triennial oscillations which show a clear latitudinal dependence is more evident in southern stations. A strong quasi biennial oscillation (QBO) is also noticed in higher latitudes which was not observable in equatorial latitude. The present study reveals that the semiannual variations are more obvious over the annual variation in the equatorial and low latitude stations while the annual variations are prominent in higher latitudes.

Keywords. wavelet, solar cycle 23

1. Introduction

Long-term variability of solar EUV irradiance and their manifestation in the Earth′s ionosphere are important in the realm of space climate. Earth′s ionosphere is formed mainly due to the photoionization of the upper atmosphere by the solar ultraviolet radiation. The characterization of temporal variations of the F2 layer are remarkable since these variations are direct consequences of electrodynamical coupling between magnetosphere and solar activity. Any trend in ionospheric parameters with a period of several days or even years can be called variations in ionosphere and are mainly owed to geomagnetic, solar and meteorological activities (Rishbeth & Mendillo 2001).

2. Data and Analysis

The study was carried out for eight different stations which fall in different latitudes and in more or less same longitudes so that the local time of the stations falls within a difference of only one hour. The stations selected in the study include an equatorial station Vanimo (2.70^{o}S, 141.30^o E, magnetic latitude 11.19^o S), a low latitude station Townsville (19.63^{o}S, 146.85^{o}E magnetic latitude 28.95^{o}S), a mid latitude station Canberra (35.3^{o}S, 149.1^{o}E, magnetic latitude 45.65^{o}S), a mid-high station Hobart (42.92^{o}S, 147.32^{o}E, magnetic latitude 54.17^{o}S) and a high latitude station Macquarie Island (54.5^{o}S, 158.9^{o}E, magnetic latitude 64.54^{o}S) in the southern hemisphere. The northern stations under study include high-mid latitude station Wakkanai (45.4^{o}N, 141.7^{o}E, magnetic latitude 40.5^{o}N), mid latitude station Kokubunji(35.7^{o}N, 140.1^{o}E, magnetic latitude 26.8^{o}N) and a low latitude station Okinawa(26.5^{o}N, 127^{o}E, magnetic latitude 17^{o}N). The continuous wavelet does the convolution of time series x_n with the scaled and translated version of a normalized mother wavelet (Morlet wavelet) (Torrence & Compo 1998). A high wavelet power indicates the presence of significant periodicities at a particular time period (Jevrejeva 2003).

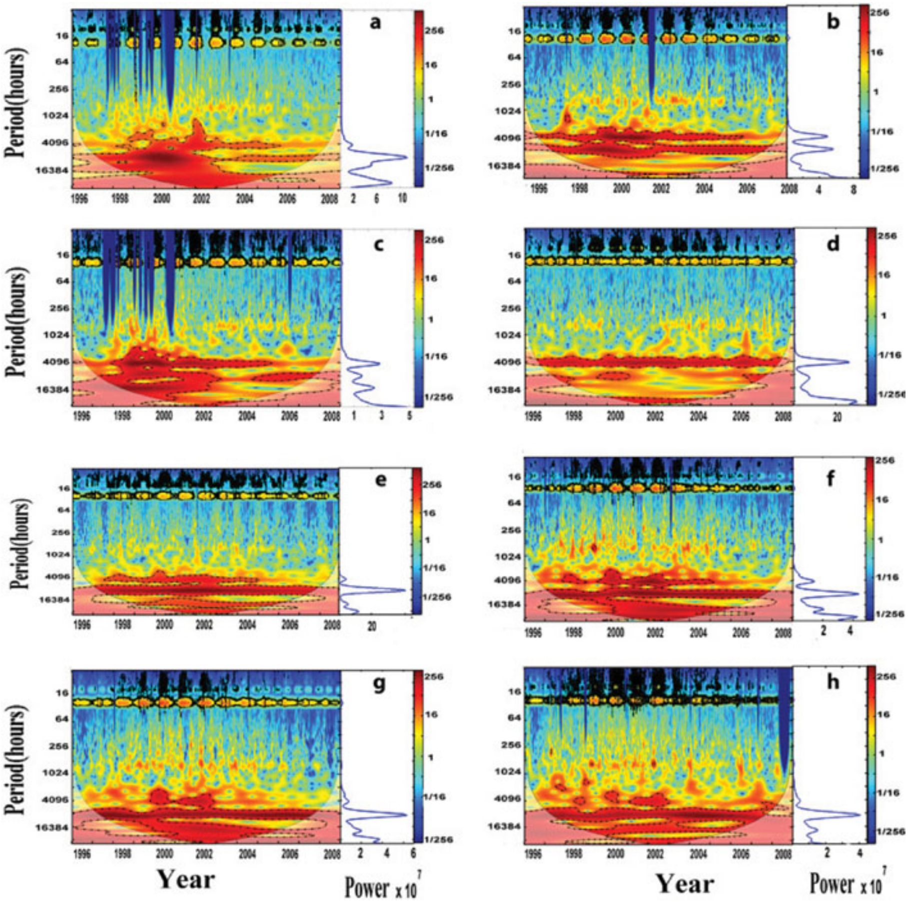

Figure 1. The continuous wavelet power spectrum (left) and the global power spectrum (right) of f_oF_2 of a) Wakkanai b) Kokubunji c) Okinawa d) Vanimo e) Townsville f) Canberra g) Hobart h) Macquarie Island over solar cycle 23.

3. Results and conclusions

Analyzing the wavelet power spectrum and global power spectrum obtained (Fig. 1), major variations of periodicities of 12 hour, 24 hour, 27 days, half year and 1 year are identified in all stations. A quasi biennial oscillation (QBO) of around 2-3 years is also strongly seen in all stations except for the equatorial station Vanimo. Quasi triennial oscillations of around 3.6 years are also prominent in all stations but not clearly evident in northern stations due to sparse data points. The semiannual oscillation and quasi triennial oscillation are found to be stronger in Vanimo, the equatorial station, which declines in power at higher latitudes. Annual and quasi biennial variation is weaker in equatorial station compared to the high latitudes.

References

Rishbeth, H. & Mendillo, M. 2001, *J. Atmos. Solar-Terrestrial Phys.*, 63(15), 1661
Jevrejeva, S. 2003, *J. Geophys. Res.*, 108(D21), 4677
Torrence, C. & Compo, G. P., 1998, *Bull. Am. Meteor. Soc.*, 79, 61

https://doi.org/10.1017/S1743921318001412 Published online by Cambridge University Press