SPECTRUM OF LATITUDE VARIATIONS IN THE FREQUENCY RANGE 1.4-2.2 CPY AND A SEARCH FOR NEARLY DIURNAL FREE POLAR MOTION

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1. INTRODUCTION

Astronomical latitude observations of the ILS stations seem to indicate the existence of both a retrograde and a direct component of nearly diurnal polar motion with close frequencies (Yatskiv et al. 1975). The latter would manifest itself as a latitude variation with a period of about 204 mean days (m.d.) and with a phase depending on the double longitude of station.

The purpose of this paper is to study the spectrum of latitude variations based on all available data and to search for nearly diurnal polar motion. A total of 30 series of latitute observations carried out from 1900 to 1969 at 22 observatories has been utilized.

2. FILTERING LATITUDE VARIATION DATA

We have used the smoothed latitude variations taken from the book by Fedorov et al. (1972). To get the periodic part of these variations in the range of frequency 1.4-2.2 cpy, a band-pass filter was constructed. The weights of the filter are:

$$h_\tau = \frac{2}{\pi\tau\Delta\tau} \sin \omega_q \tau\Delta\tau \cos 2\pi f_o \tau\Delta\tau \cdot w(\tau)$$

where

ω_q is the width of the filter;
f_o is the central frequency being adopted 1.8 cpy;
$\Delta\tau$ is the data sampling interval being adopted 0.05 year;
$w(\tau)$ is the lag-window given by the formula

$$w(\tau) = \begin{cases} 0.42 + 0.50 \cos \frac{\pi\tau}{m} + 0.08 \cos \frac{2\pi\tau}{m} & , \quad \tau \leq m \\ 0 & , \quad \tau > m \end{cases} .$$

E. P. Fedorov, M. L. Smith and P. L. Bender (eds.), Nutation and the Earth's Rotation, 75–79.

The filtered latitude variations have been calculated for each station by

$$\Delta\tilde{\phi}_t = \sum_{\tau=-m}^{m} h_\tau \, \phi_{t+\tau} \quad .$$

When filtering we lose 2m values of the initial record. To avoid this loss we have used forward and backward predictions of the initial records by means of prediction errors filter proposed by Ulrych et al. (1973).

3. DETERMINATION OF POLAR COORDINATES, COMMON Z-TERM AND THE EFFECT OF NEARLY DIURNAL WOBBLE

The latitude variations of j-th station in the frequency range 1.4-2.2 cpy could contain long-period components of both polar and nonpolar origin and the effects of both the direct and retrograde components of nearly diurnal polar motion.

The values of $\Delta\tilde{\phi}^j_t$ are assumed to be represented by

$$\Delta\phi^j_t = x \cos\lambda_j + y \sin\lambda_j + u \cos 2\lambda_j + v \sin 2\lambda_j + z$$

where x and y are the polar coordinates;

u and v are the components of the direct nearly diurnal polar motion;
z is z-term common for all stations;
λ_j is the longitude of the j-th station.

The estimates of x, y, u, v and z were obtained by the least-squares method. The number of stations used varied from 5 to 30 through the time span 1900-1969. The estimates x, y, u and v will be independent if the number of stations used is large. Therefore the results will be most consistent for the time interval 1949-1969 when the number of stations is large.

4. MAXIMUM ENTROPY SPECTRAL ANALYSIS OF THE x, y, u, v AND z TIME SERIES

Maximum entropy spectral analysis (MESA) proposed by Burg (1970) was applied for studying the structure of the x, y, u, v and z time series. The spectrum calculated are shown in Figs. 1 and 2 and the periods found are given in Table 1.

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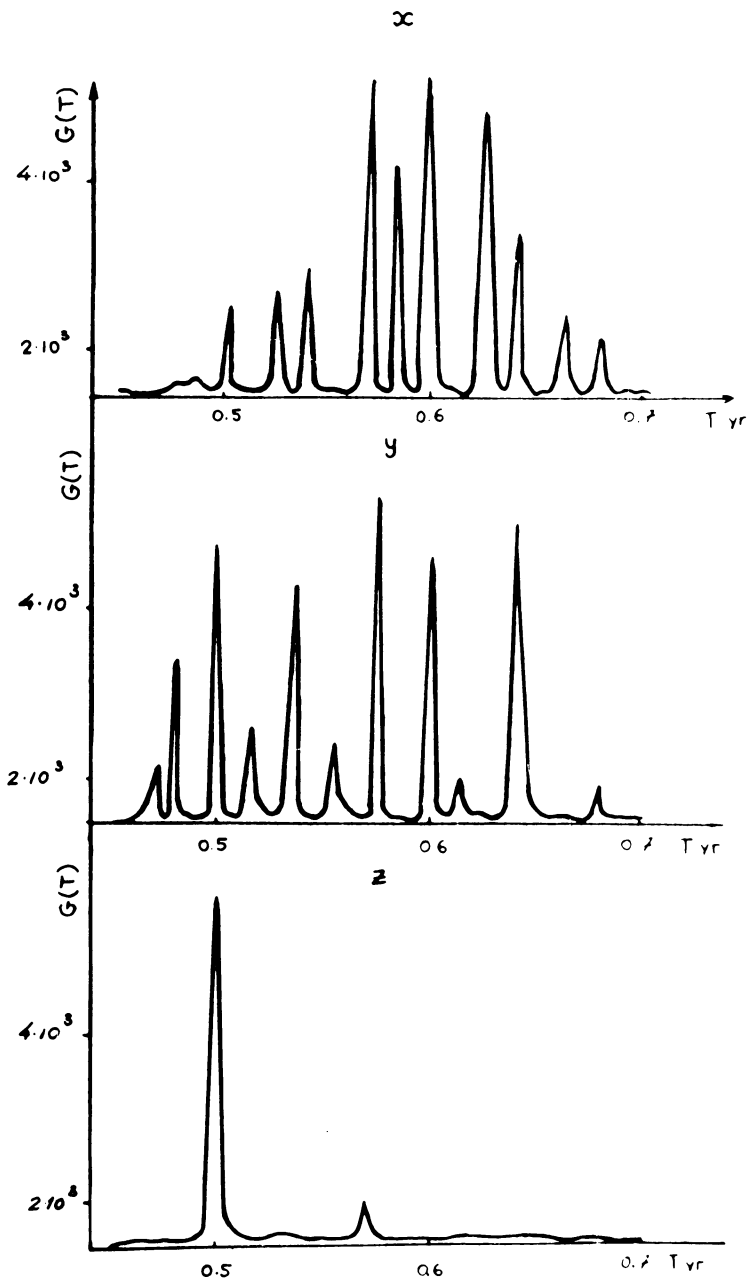

Fig. 1. The ME spectra of the x, y and z time series. Abscissa is period in years. Ordinate is the spectral estimate in $(0''.001)^2$.

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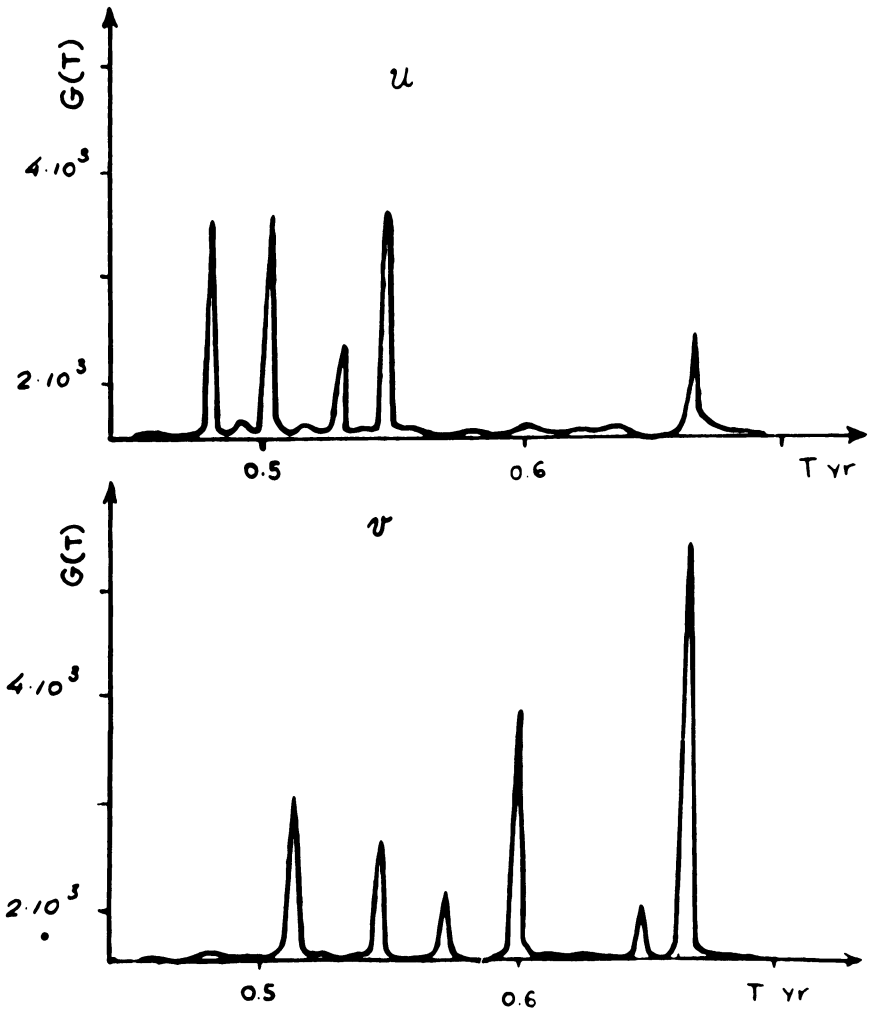

Fig. 2. The ME spectra of the u and v time series. Abscissa and ordinate are the same as in Fig. 1.

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Table 1. Periods, in Years

x,y	0.500	0.538	0.576	0.600	0.640
u,v	0.509	0.546	---	---	0.666
z	0.500	---	0.570	---	---

5. CONCLUSIONS

(1) Semiannual components of polar motion and non-polar latitude variations are determined well.

(2) The periods of 0.54, 0.56, 0.60, and 0.64 years are equal to one-half of the periods found in the Chandler frequency band, namely 1.10, 1.17, 1.20, and 1.24 years (see, for example, Yatskiv et al., 1973). These periodic variations seem to belong to the free polar motion.

(3) The peaks found in the spectra of the u and v time series show slight frequency shifts as compared with the results obtained by Yatskiv et al. (1975). The periods of 0.51, 0.55, and 0.67 years (186, 201, and 244 m.d.) seem to be real.

(4) There is a very small peak in the spectrum of the Z-term at a period of 0.57 year which could be due to the retrograde component of nearly diurnal free polar motion.

(5) The estimates of the amplitudes of oscillations mentioned above are in the range 0".033-0".007 with standard errors about 0".001.

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