19-23 May 1997 University Park Holiday Inn, Ft. Collins, Colorado

13b.8 UNIVERSAL SPECTRUM FOR ATMOSPHERIC LOW FREQUENCY VARIABILITY IN GLOBAL MEAN SEA LEVEL PRESSURE TIME SERIES

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1. INTRODUCTION

Atmospheric flows exhibit long-range spatiotemporal correlations manifested as the fractal geometry to global cloud cover pattern concomitant with inverse power-law form for power spectra of temporal fluctuations from turbulence to climate scales(Tessier et. al.,1993). Such non-local connections are ubiquitous to dynamical systems in nature and are identified as signatures of self-organized criticality(Bak et. al..,1988). Standard meteorological theory cannot explain satisfactorily the observed self-organized criticality in atmospheric flows. A recently developed cell dynamical system model for atmospheric flows (Mary Selvam, 1990) predicts the observed self-organized criticality as a natural consequence of quantumlike mechanics governing flow dynamics.

2. MODEL PREDICTIONS

In summary(Mary Selvam, 1990; Mary Selvam and Joshi,1995; Mary Selvam et. al.,1996), the model is based on Townsend's (Townsend,1956) concept that spatial integration of small scale fluctuations give rise to large eddy circulations. Therefore, the eddy energy spectrum follows statistical normal distribution and the square of the eddy amplitude or variance represents the probability.Such a result that the additive amplitude of eddies, when squared represent probability densities is observed in the subatomic dynamics of quantum systems. Atmospheric flows therefore follow quantumlike mechanical laws. The model predictions are as follows.

(1) The spectra are broadband with embedded dominant wavebands, the bandwidth increasing with period length. The dominant peak periodicities P_n are given as

$$P_n = \tau^n (2+\tau)T \qquad (1)$$

where τ is the golden ~~angle~~ mean equal to $(1+\sqrt{5})/2 \approx 1.618$, T is the primary perturbation time period equal to the diurnal cycle (1 day) of solar heating in the present study and n ranges from positive to negative integers including zero.

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(2) The spectra of fluctuations follow the universal inverse power law form of the statistical normal distribution when plotted as the cumulative percentage contribution to total variance versus the normalized standard deviation t defined as

$$t = \frac{\log L}{\log T_{50}} - 1 \qquad (2)$$

where L is the period in days and T_{50} the period upto which the cumulative percentage contribution to total variance is equal to 50.

3. DATA AND ANALYSIS

TOGA CD-ROM surface pressure data for the 1800 days period from January 1986 to December 1990 for all grid points (2.5 degree resolution) from 50^o N to 50^o S was used for the study. The broadband power spectrum of fluctuations was computed using the simple but very powerful continuous periodogram analysis technique of Jenkinson(1977). The variance spectra were computed as cumulative percentage contribution to total variance versus the normalized standard deviation t (Eq 2). The "goodness of fit" of variance spectra with normal distribution was tested using the standard statistical chi-square test at 95% confidence level. Figure 1 gives the following results for latitudinal means of continuous periodogram analyses as percentages of total number of grid points(144) for each latitude.

(1) Variance spectra which follow normal distribution.
(2) Spectra which exhibit dominant periodicities (days) in wavebands 2-3, 3-4, 4-6, 6-12, 12-20, 20-30, 30-50, 50-80, 80-120, 120-200, 200-300, 300-600, 600-1000 and greater than 1000 which include the model predicted(Eq.1)periodicities 2.2, 3.6, 5.9, 9.5, 15.3, 24.8, 40.1, 64,9, 105.1, 170.0, 275.0, 445.0, 720.0, 1165.0 for values of n ranging from -1 to 12.

4. DISCUSSIONS AND CONCLUSIONS

The spectra are broadband and exhibit dominant wavebands with peak periodicities close to model predicted(Eq.1).In the middle and higher latitudes a majority of variance spectra follow the model perdicted universal inverse power law form of the statistical normal distribution. Universal spectrum for temporal fluctuations rules out linear trends. Manmade greenhouse gas related atmospheric warming will result in intensification of fluctuations of all scales. High frequency fluctuations are more intense in the Southern Hemisphere indicating enhanced turbulent mixing as compared to Northern Hemisphere.

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Acknowledgements: The authors are grateful to Dr.A.S.R.Murty for his keen interest and encouragement during the course of the study.

Figure 1