Communications

30-Day Periodicity in Sunspot Activity & Rainfall

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An attempt is made to examine short term periodicities, if any, in the sunspot activity and rainfall. The daily mean relative sunspot numbers for July-Sep. during 1961-70 and the daily sunspot means for July-Sep. 1889-1938, as well as the rainfall series of Tamil Nadu for July-Sep. during 1961-70 have been analyzed by power spectrum. The study has suggested that the sunspot activity and the rainfall contain a concurrent 30-day periodicity which is highly significant during the southwest monsoon period (July-Sep.) when the sun remains at all times in the northern hemisphere.

There are reports that the weather is influenced by the sunspot activity.[1-5] The largest meteorological response to sunspot activity may occur during the winter months.[6] As early as in 1954, a 1-month periodicity was reported[7] both in the sunspot activity and rainfall based on the data over the period 1889-1938. However, this aspect has not received due recognition. As far as the sunspot activity is concerned, it is known that the synodic rotation period of the sunspots in different heliographic latitudes ranges between the extremes 24·4 and 31·2 days, the mean rotation period being 27·275 days.[8]

Recently, periodicities of about 16 and 28 days associated with lunar phase have been identified in the January rainfall of the southern and northern hemispheres.[9] The 27-day rain cycle noticed in the rainfall of Los Angeles is considered to be probably not related to the moon and that, if the periodicity has a solar origin, its phase must be determined by another mechanism.[10]

In a previous study[11] the authors have shown that (i) periodicities of 15 and 30 days are present in the Oct.-Dec. (northeast monsoon) rainfall pattern of Tamil Nadu, and of these the 15-day periodicity is significant, and (ii) the sunspot activity for Oct.-Dec. has periodicities similar to those suggested in the rainfall pattern of Tamil Nadu and of them the 30-day periodicity is significant. As the periodicities which are found significant in the rainfall pattern and the sunspot activity are different, the study made does not support the view that the weather is influenced by the sunspot activity. It may be noted that during the northeast monsoon, which was the period of the study, the sun remains at all times in the southern hemisphere.

It is well known that most part of the Indian subcontinent receives rainfall from the southwest monsoon (July-Sep.), whereas Tamil Nadu receives rainfall both from the southwest monsoon and the northeast monsoon (Oct.-Dec.). Also, during the period of the southwest monsoon, the sun remains at all times in the northern hemisphere. It is, therefore, pertinent to know, for getting a better insight into the problem, whether there are significant periodicities present concurrently in the rainfall of Tamil Nadu and in the sunspot activity during the period of the southwest monsoon. This aspect has now been examined by the authors.

The sunspot activity data considered relate to (i) the daily relative sunspot numbers reported by the Astrophysical Observatory, Kodaikanal (10·2°N, 77·5°E, 2343 m above m.s.l.) for the period July-Sep. during 1961-70 and were extracted from the *Indian Journal of Meteorology and Geophysics*, and (ii) the daily sunspot means (Wolf's relative numbers) for the period July to Sep. 1889-1938, available from a published paper by Gillettee.[7] The rainfall data of the 12 stations in Tamil Nadu, as considered in the previous study[12] were extracted for the period July-Sep. 1961-70, from the daily weather reports published by the India Meteorological Department. The daily mean values of the rainfall and of sunspot numbers for the period July-Sep. 1961-70 have been analyzed by a method of normalization as adopted by Srirama Rao and Lokanadham.[13] The normalized daily mean values of the rainfall and the sunspot numbers referred to above for the period July-Sep. 1961-70 have been subjected to power spectrum analysis following the method of Blackman and Tukey.[14] The daily mean values of the sunspot numbers, as they are, for the period July-Sep. 1889-1938 have also been subjected to power spectrum analysis.

To achieve satisfactory resolution in the spectrum we have chosen lag $m = 30$, which is as large as

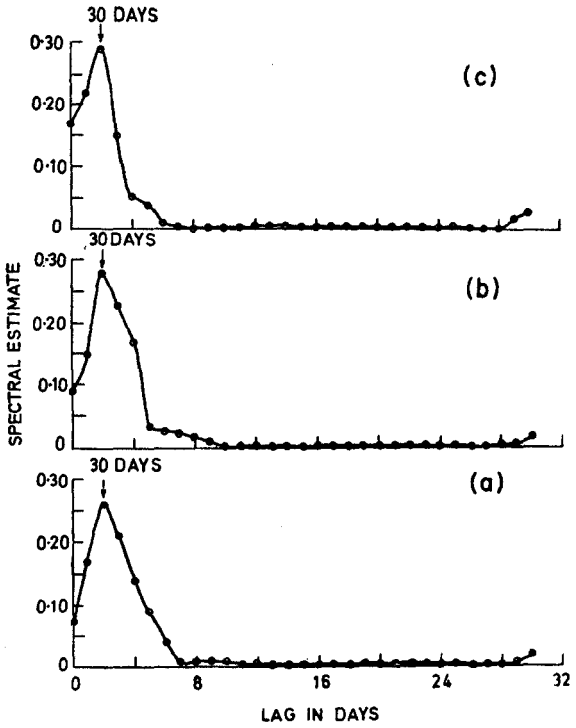

Fig. 1 — Power spectra of : (a) normalized rainfall of Tamil Nadu for the period 1 July-30 Sep. for 1961-70 (maximum lag $m = 30$ days); (b) normalized sunspot numbers of Kodaikanal for the period 1 July-30 Sep. for 1961-70 (maximum lag $m = 30$ days); and (c) sunspot means given by Gillettee for the period 1 July-30 Sep. for 1889-1938 (maximum lag $m = 33$ days)

possible but not exceeding one-third of the total number of days of the record involved in the analysis. The period corresponding to any spectral estimate is given by the relation $P = 2m/L$, where m is the maximum lag (30) and L denotes the lag in days of the spectral estimate in question.

The values obtained by spectral estimate are shown in Fig. 1 (a, b, c). The spectra in all cases are a mixture of red and white noise continuum. The associated 99, 95 and 90 percent confidence limits have been calculated. The spectral peaks at lag in days = 2 in Fig. 1 (a, b, c) correspond to a period of 30 days. These peaks are tested with that of red noise by the method followed by Jagannathan and Parthasarathy.[15] The peaks are found significant at 99% level. Thus the rainfall series and the sunspot numbers point out marked spectral peaks of 30-day periodicity which are significant.

We conclude from the present study that the sunspot activity and the rainfall contain a 30-day periodicity which is highly significant during the southwest monsoon period when the sun remains at all times in the northern hemisphere. The possible association between these periodicities requires investigation.

References

1. Walker G, *Mem. Indian Met. Dept.*, **21** (Part X) (1915), 17.
2. Sen Gupta P K, *Vayu Mandal*, **2** (1972), 4.
3. Jagannathan P & Bhalme H N, *Mon. Weath. Rev. USA*, **101** (1973), 691.
4. Xantakis J, *Solar activity and related inter-planetary and terrestrial phenomena*, edited by J Xantakis (Springer-Verlag, Berlin) 1973, 20.
5. King J W, *Aeronautics Astronautics*, **13** (1975), 10.
6. Wilcox J M, *J. atmos. terr. Phys.*, **37** (1975), 237.
7. Gillettee H P, *Bull. Am. met. Soc.*, **35** (1954), 374.
8. Chapman S & Bartels J, *Geomagnetism*, Vol. 1 (Clarendon Press, Oxford), 1940, 168.
9. Srirama Rao M & Gopalakrishna Murty A, *Indian J. Radio Space Phys.*, **3** (1974), 356.
10. Rosenberg R L & Coleman P J, *Nature, Lond.*, **250** (1974), 481.
11. Reddy R S & Ramana Murty Bh V, *Indian J. Radio Space Phys.*, **5** (1976), 298.
12. Reddy R S & Ramana Murty Bh V, *Indian J. Radio Space Phys.*, **5** (1976), 277.
13. Srirama Rao M & Lokanadham B, *J. atmos. terr. Phys.*, **26** (1964), 301.
14. *WMO tech. note No.* 79 (WMO, Geneva, Switzerland), 1966, 33.
15. Jagannathan P & Parthasarathy B, *Mon. Weath. Rev. USA*, **101** (1973), 371.

A Measurement of Ionospheric Irregularity from Radio Star Scintillations

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The hourly variations of scintillation index and scintillation rate are studied during the nights of a summer month, June 1970, from the radio star scintillation data recorded at Ahmedabad. The variation of scintillation index showed a peak occurrence around 0200-0400 hrs local time and the variation of scintillation rate correlated well with that of the vertical component (V) of earth's magnetic field. The power spectral analysis carried out for different samples of data gave velocity of ionospheric of irregularity ranging from 95 to 133 m/sec at F-region heights.

The study of radio star scintillations had been developed as an important method for investigating the ionospheric irregularities.[1,2] Recently, the use of power spectral analysis technique to the radio star scintillations data has received much attention for studying such irregularities.[3-5]

This communication reports the results of the analysis of the scintillation records of the radio stars Cygnus A and Cassiopia A obtained over Ahmedabad during the nights of June 1970, using a