1. The temperature limits during the day are:
(a) Cold : Below 20 deg. C. — Unpleasant
(b) Cool : 20 deg. C to 27 deg. C — Pleasant with warm clothes on
(c) Pleasant : Above 27 deg. C but below 32 deg. C.
(d) Warm : 32 deg. C to 39 deg. C — Pleasant under the fan
(e) Hot : Above 39 deg. C. — Unpleasant

2. The temperature limits of different categories at night are:
(a) Very cold : Below 6 deg. C — Unpleasant
(b) Cold : 6 deg. C to 13 deg. C — Pleasant under blanket or quilt
(c) Pleasant : Above 13 deg. C but below 18 deg. C.
(d) Warm : 18 deg. C to 27 deg. C — Pleasant under the fan
(e) Hot : Above 27 deg. C — Unpleasant

(3) Very high humidity, which is experienced in Delhi only in the monsoon months, is not considered unpleasant. On four different dates between mid-July to mid-September, high humidity is considered pleasant under the fan. This is explained by the fact evaporative cooling from the surface of the skin is encouraged by moving air even under conditions of high heat and humidity.

(4) In Delhi, the temperature limits for each bioclimatic category appear to vary significantly from those in mid-latitudes. On the whole it is seen that threshold temperature levels for each category is higher than those of temperate lands, e.g., Lee considers as hot more than 30 deg. C, warm 20 to 30 deg. C, temperature 10 to 20 deg. C and cool less than 10 deg. C.

(5) Temperature, irrespective of humidity appears to be a fair indicator of comfort in Delhi. This may be because for most of the year humidity is reasonably low.

A bioclimatic index for Indian cities — The method explained above is a sound and simple way of studying subjective response to climate in different places.

Owing to organisational and physical limitations it was not possible to conduct this survey at different stations. However, by gathering such information from individuals by using a stratified random sample based on economic level and years of acclimatisation, very useful data can be collected. This could be used to define limits of bioclimatic categories which would be realistic under Indian conditions.

While the above method is adequate in studying climatic comfort at individual stations, for the purpose of comparison of stations or getting an idea of a part of or the entire country, an index would be essential. For this, numerical scores can be given to the sensation of comfort or discomfort signifying the degree of it, e.g., 1 for very pleasant, 2 for cool and warm, 3 for cold and hot. The scores for day and night can then be added giving the bioclimatic index for that place. Spatial analysis of comfort conditions can easily be done also by drawing isolines using bioclimatic indexes for a number of stations.

(6) The scope for developing an index for the purpose of bioclimatic studies with regard to comfort conditions in India is immense. However, it is not only necessary to keep in mind our climatic characteristics, but also that our cultural environment which includes our food, clothing and shelter, is quite distinct from the mid-latitudes where most of the biometeorological indexes have been developed. Should these indexes be used, suitable modifications must be made for Indian conditions.

References
Lakshmanan, V., 1984. Discomfort Index over India in different months of the year, Measam, 35, 4.

(MRS.) MANOSI LAHIRI
University of Delhi, Delhi
20 September 1984

551.590.21 : 551.524(548)

INFLUENCE OF LONG TERM CHANGES IN SUN SPOT ACTIVITY ON ANNUAL MEAN TEMPERATURE OVER SOUTH INDIA

Concern about climatic changes and its effect on human beings has been increasing. Climatic changes affect the food production and the allocation of energy sources. One of the important parameters of the rate is the mean annual temperature.

Several workers have analysed the mean temperature variations in the Northern Hemisphere, especially over high latitudes for about hundred years. Jones et al. (1982) have analysed the surface air temperature over the Northern Hemisphere from 1881 to 1980. It is shown that there is a general warming of the atmosphere during the first part of the twentieth century up to the mid 40's. Then a cooling trend occurs up to 1970's. In the late 70's there has been a renewed warming. This warming cannot be attributed to the increased amount of carbon-dioxide in the atmosphere.
In the present note, the mean annual temperature of eleven south Indian stations lying between 8° North and 18° North have been analysed for over hundred years from 1875.

2. The stations selected for computing the temperature variations in south India are given in Table 1.

The annual mean temperature of these stations have been collected from the Meteorology of India, Annual Weather Summary and India Weather Review published by IMD and analysed. The mean annual temperature variations and the sunspot variations are given in Fig. 1, from 1875 onwards. The running means of the above are given in Fig. 2. It can be seen from Fig. 2 that the temperature is more or less constant but comparatively high during the later part of the last century and at the beginning of the present century upto about 1932. After 1932 it is decreasing and the lowest temperature is attained around 1960, then it starts increasing rapidly.

The main cause of the temperature over the earth is the sun’s radiation. Most of the sun’s energy comes from the photosphere. The main evidence of variation in this region is the occurrence of sunspots. It has been known that the number of sunspots visible in the photosphere varies with the time and there is an eleven year cycle for this variation. There is also an observa-
LETTERS TO THE EDITOR

Fig. 2. Moving averages of temperature over south India and the sunspot number

Fig. 3. The 11-year mean of temperature variation over South India and the 11-year mean of sunspot number

Corroborative evidence for an approximately 90-years cycle (the so-called Gleissberg cycle) that represent the envelope of maxima associated with eight individual eleven year cycles (Agee 1980). The 11-years mean sunspot numbers (the Gleissberg cycle) and the 11-year mean temperature data are given in Fig. 3.

It can be seen from Fig. 2 that when the mean annual sunspot number exceeds about 50, the temperature in the low latitudes especially over South India starts decreasing and it shows the lowest value when the sunspot number shows maximum. The eleven year mean temperature variation curve over South India show almost similar trend as that of Gleissberg cycle in the reverse scale, which means that the period of variation is about 90 years. Since the available data of temperature is only for about 100 years, no statistical comparisons of these cycles can be done. This is an unavoidable weakness of this note.

3. It can be concluded that the temperature variations during the last hundred years in the low latitudes especially over South India is almost following the Gleissberg cycle in the reverse scale.

The above conclusion requires further confirmation after analysing the mean annual temperature for a large number of stations in the low latitudes and for more number of years.

4. The authors are thankful to Dr. N. S. Bhaskara Rao, Regional Director, Regional Meteorological Centre, Madras and Shri M. Jayaram, Director, Meteorological Office, Airport, Madras for going through the manuscript and giving their valuable suggestions. Thanks are also due to the Drawing Unit of Regional Meteorological Centre, Madras for preparing the diagrams.

References


C. P. JOSEPH
B. V. S. AMATYA

Meteorological Office, Madras

6 June 1985