MAUSAM, **51**, 4 (October 2000), 365-376

Letters to the Editor

551.553.21 : 551.525 : 551.577 (213.5)

RELATION BETWEEN PRE-MONSOON SOIL TEMPERATURE AND MONSOON RAINFALL IN A TROPICAL STATION

1. Introduction

The most important climatic element for Agriculture in the tropics is the rainfall. The productivity of the lateritic soils in tropical regions is low and unstable because of their special sensitivity to the fluctuations of rainfall, due to their propensity for large run-off. If it becomes possible to forecast critical events such as dry spells and take preventive measures such as protective irrigation, we could expect increase in sustained yields. With this view an attempt has been made to predict the monsoon rainfall (total for the south west monsoon, June to September) utilizing soil temperature data for the months March, April and May (mean for March, April and May).Earlier studies (Indira & Mukherji 1992 and Verma 1993) indicate direct relationship with temperature and monsoon rainfall, showing that warmer temperatures are conducive to good monsoon rainfall over the country and supporting the physically tenable relationship that the strength of monsoon is directly related to the differential heating between land and ocean. Above studies were made, without considering soil temperature as a parameter for finding relation to monsoon rainfall. South-west monsoon is the most important event in Indian Meteorology and more studies have been devoted to understand various facets of this unique phenomena than any features of the weather of India (Retnakumari *et al.* 1996, 1998). Hence, an attempt is made here to find the link between soil temperature and monsoon rainfall.

2. Data

The daily soil temperature (1983-91) collected from Regional Agricultural Research Station (RARS), Pilicode, Northern Kerala formed the material of the study. The soil type is laterite (Ultisols). The depths at which temperatures were recorded were 5, 10, 15, 20,30, 40, 60 and 70 cm from the soil surface. The soil temperatures were recorded at 7.25 am and 2.25 pm. The experimental site (12°12′ N, 75°10′ E) is at 15m above mean sea level and is well-levelled and maintained as barren land without any vegetation. The mean weather parameters at the experimental location for the study period are given in Table 1. A gradual increase in surface maximum air temperature was observed in November and December (Table 1). This is because of the fact that northeast monsoon is not significant at Pilicode because of Geographical reasons. Daily soil temperatures at 7.25am and 2.25pm for the pre-monsoon period for the period 1983 to 1991 are used in this work.

3. Rainfall and soil temperature

To study the influence of soil temperature on ensuing monsoonal rainfall, correlation coefficients were computed using mean soil temperature at 5,10 and 20 cm depth for the period March to May (daily mean for March to May) and total southwest rainfall. The correlation coefficients obtained for monsoonal rainfall and soil temperature at 2.25

TABLE 1

Mean climatological parameters at Pilicode during the study period 1983-91

Month	Parameters						
	Rainfall (mm)	Temp.(max.) (°C)	Temp.(min.) (°C)	RH (%)	Wind (km / hr)	Sunshine (hrs)	Evaporation (mm)
Jan	9.2	32.5	19.0	72.0	2.4	10.4	5.3
Feb	0.0	31.0	17.0	70.5	2.9	9.4	5.1
Mar	97.3	32.8	23.7	80.5	2.7	10.1	5.7
Apr	91.8	33.5	25.5	79.9	3.3	10.9	5.4
May	194.7	33.5	26.1	80.3	3.6	9.5	5.5
Jun	339.6	29.1	23.3	94.4	3.1	2.3	5.6
Jul	417.9	29.5	23.5	91.8	2.0	3.1	3.1
Aug	245.9	30.2	23.5	87.5	2.2	5.0	3.2
Sep	145.2	29.2	22.8	88.0	1.9	5.0	3.0
Oct	140.0	29.2	22.0	91.0	2.0	6.0	1.9
Nov	170.8	32.1	22.3	87.5	1.8	8.1	3.9
Dec	1.8	32.9	19.6	76.5	2.1	10.0	4.0

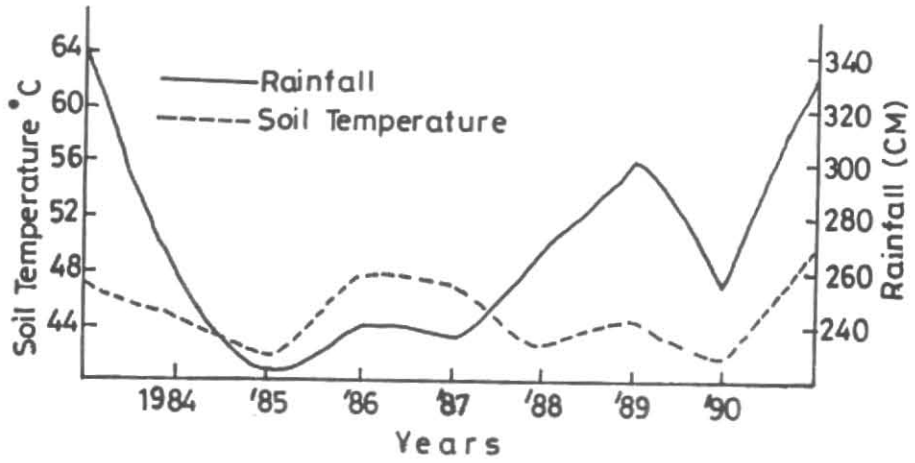

Fig. 1. Variation of rainfall and soil temperature during the period 1983-91

pm are given in Table 2. Correlation coefficients obtained for soil temperature at 7.25 am and monsoonal rainfall were not significant. Hence, not included in this work. Whenever there is a rise of fall in the rainfall in a particular monsoon season from that in the immediately preceding monsoon seasons, the same was broadly indicated by a similar rise or fall in the March-May soil temperature (at 2.25 pm) of that year from that in the immediately preceding hot weather seasons. The variations in rainfall and soil temperature for the period 1983-91 are shown in Fig. 1. A decrease in rainfall was seen in 1985 and 1990 with a decrease in soil temperature at 5 cm depth at 2.25 pm. The soil temperature and rainfall increased in the years 1986,1987 and 1991 after a slight decrease in 1990. This is because of the fact that high soil temperature favours atmospheric warming, leading to a fall in surface pressure, causing heavy rainfall (Retnakumari 1994). The results reported in this work constitute a step into the wide open field of interaction between soil temperature and climate.

For estimating rainfall from soil temperature, regression analysis was done using soil temperature at 5 cm depth (mean of March to May) at 2.25 pm and monsoonal rainfall (total for the months June to September) for the period 1983-91. When regression was worked out the correlation coefficient obtained was 0.4. However with the introduction of a correction factor $\sqrt{Y}$, the modified equation presented below yields a better result relating soil temperature and rainfall.

The modified equation is; $X = 4\ (0.321 + 5.13Y \pm \sqrt{Y})$

where X - rainfall, Y - soil temperature at 5cm depth at 2.25 pm, $\sqrt{Y}$ is a correction factor applied. $\sqrt{Y}$ is subtracted if $Y > 35°C$ added if $Y < 35°C$. The computed and observed values of rainfall are given in Fig. 2 and it can be seen that they compare very favourably. The results show that soil

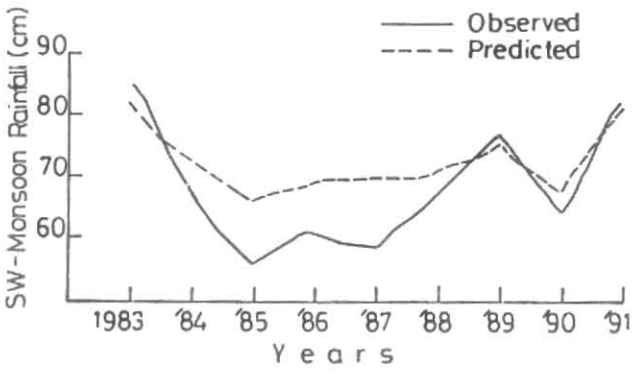

Fig. 2. Observed and predicted values of rainfall for the period 1983-91

TABLE 2

Correlation coefficient(r) obtained for soil temperature at 2.25pm and southwest monsoon activity

Depth (cm)	Correlation coefficient (r) (Significant at 0.1% level)
5	0.4
10	0.4
15	0.3

temperature also can be used as an index to predict the monsoon activity. As far as rainfall pattern in Kerala is concerned, the period of study 1983-91, was a period of rainfall anomaly and the people of Kerala experienced severe agricultural droughts during the period 1984-87 and the year 1982-83 was a disastrous drought year (Retnakumari *et al.* 1997). Hence for efficient prediction more data are required. With the availability of more soil temperature data, the linkage between soil temperature and monsoon activity would become further clear.

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2 June 1998, Modified 24 November 1999