Proceeding Paper

A Study of South-West Monsoon Rainfall in West Bengal & Orissa and It's Correlation with Suns Spot Numbers †

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Abstract: This paper presents a study of the variation of South West Monsoon Rainfall (SWMR) over two East Coastal States of India with the Sun's Spot Number (SSN) of Solar Cycle when SSN is 50% or more of Maximum SSN of any cycle during 1880–2003. Firstly, it is found that in many cases SSN of MAP has tendency to increase with time having imbedded oscillation of period 22 years (similar to double solar cycle period). The analysis of SWMR of those states separately or combinedly reveals that it is moderately influenced by Solar Activities provided SSN lies between 90 and 130. When SSN is less than 90 it becomes too weak to influence—there does not appear any definite pattern of change of SWMR. But when SSN increases from 90 to 130, SWMR tends to decrease. The SSN has inverse significant effect on SWMR. Finally when linear trend lines for SWMR are compared it becomes apparent that gradients of SWMR for West Bengal is slightly positive, that for Orissa is slightly negative and almost zero for total SWMR. This implies that overall there is no change in amount of Rainfall due to South West Monsoon in the combined area of West Bengal and Orissa.

Keywords: Monsoon Rainfall; solar influence; critical sunspot number

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1. Introduction

India in mainly an agriculture based country. So the amount of rainfall over India is of immense importance for maintenance of the stability of the Indian economy. Now, the rainfall in India is mainly due to Monsoon which enters India from South West on 1st June (vide e.g., Chakraborty and Bondyopadhaya 1988) and then covers the whole country (during roughly one month). After this it remains active till September. We shall consider two states West Bengal (22. 57° N, 88. 37° E) in the lower Gangetic plane

(The Ganges is a river originating from Himalaya in the North and extends in the South through a 2500 km long plane land) and Orissa (22.15° N,85.5° E) in the upper Eastern Coastal part of India which are influenced very much by the South West Monsoon Rainfall. But does this rainfall affected by the solar activities which, in turn, is measured by Sun's Spot number? This is an important question which will be dealt here along with an interesting general characteristic feature of it.

The South-West Monsoon Rainfall (SWMR) reaches West Bengal (W.B.) and Orissa almost at the same time (7–8th June). It appears that the total Monsoon Rainfall during this time of season is distributed over these two states (245 thousand sq. km.approx.) and neighboring country Bangladesh (134 thousand sq.km.approx.). However, there are many important investigations and analysis of MR over India e.g., [Ananta Krishnan and Gopalchari (1963), Jagannathan & Bhalme (1973), Chakraborty and Bondyopadhaya (1986), Ananthakrishan and Parthasarathy (1984), Hiremath and Mandi(2004), Jagannathan & Bhalme (1973)], suggested that the SWMR over India is not entirely random. Chakraborty and Bondyopadhaya (1988) mentioned that anomalous fluctuation of this rainfall are associated with the different phases of sunspot cycles. Hiremath (2006) attempted to show that the rainfall all over India and the Sunspot activity is correlated and the overall trend of rainfall variability is high during the low Solar activity than that during high Solar activity. In general, SWMR occurs during June-Sept. But July-Sept is the duration when SWMR is more active. In this piece of work we shall investigate the special features of SWMR during July–September (in brief we call MR).

The introduction should briefly place the study in a broad context and define the purpose of the work and its significance.

For papers that report original research, you should use the titles “Materials and Methods”, “Results”, “Discussion” and “Conclusions” (optional).

2. More Active Period (MAP) of Solar Cycle and Its Characteristic Feature

It is well known that the occurrence of sunspot is a periodic phenomenon of 11 or 22 yrs., and Solar Wind etc are closely related to Sun’s Spot Number (SSN). Therefore, to find any influence of solar activities on Earth it is always suggestible to consider the time when sunspot number becomes comparatively more than it is in other time of a cycle. This is why we consider More Active Period (MAP) when SSN is greater or more than the half of the max. SSN in a cycle. Obviously such time is available both before and after every solar maximum. We first identify such MAPs of Solar cycles during 1880–2005 and calculate the average annual Sun Spot Number (SSN) (vide Table 1, Colm-I). Some of the characteristic features of MAP are the following: The average value of SSN during MAP is oscillating during 1880–1946, at every alternate MAP i.e., at the interval of 22 years. In fact, SSN reaches maxima in 1946, and then it increases up to 1960. After this, time average SSN again oscillates. But the overall Trend of SSN with time is positive (with Correlation Coefficient ≈ 0.7) as shown in Figure 1. It is interesting to note that SSN was always greater than 90 after 1946 except in 1949 (when it was 84)but it was never greater than 90 before1946 except in 1917 (when it was 104).

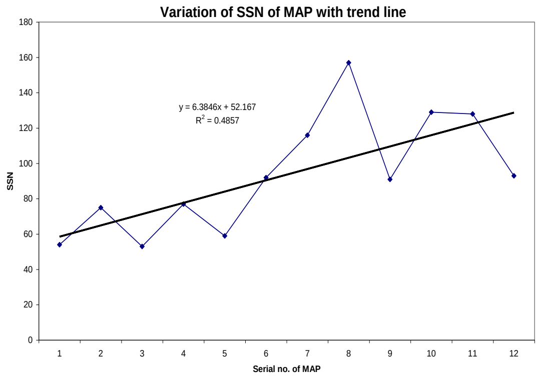


Figure 1.

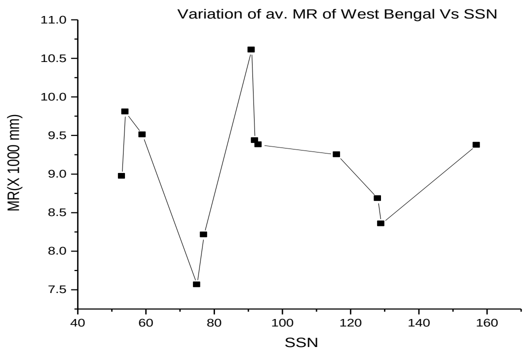
Table 1. Sun Spot Number. (SSN) of MAP and corresponding Monsoon Rainfall (MR). Over West Bengal, Orissa and Combined.

Group no. of MAP	Average Sunspot no.	MR of West Bengal	MR of Orissa	Total MR (WB + Orissa)
1	54	9807	9255	19062
2	75	7563	9844	17407
3	53	8971	9664	18635
4	77	8210	8461	16671

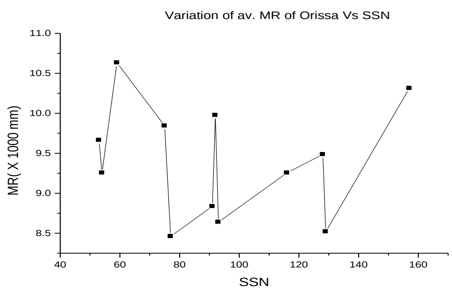
5	59	9508	10633	20141
6	92	9434	9976	19410
7	116	9250	9256	18506
8	157	9374	10313	19687
9	91	10604	8837	19446
10	129	8354	8520	16804
11	128	8681	9486	18167
12	93	9380	8639	18019

3. Variation of MR for Different Range of SSN

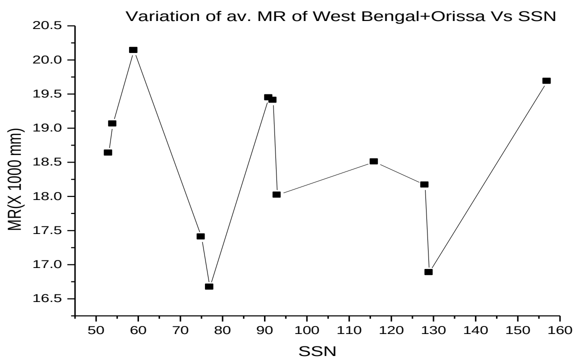
We now investigate the characteristic variation of MR in W.B. & Orissa during MAP of Solar Cycles. From the Figure 2a where MR vs. SSN have been plotted, we observe that MR of W.B. fluctuates when SSN varies from 50 to 90 (Hiremath 2006 also made similar remark for low value of SSN), declines there- after when SSN exceeds 90 until it becomes more than 130 after which it again increases. However, the same rainfall fluctuates when SSN varies from 50 to 80. Similar feature is observed for MR of Orissa (Figure 2b),although there exist slight fluctuation for SSN lying between 90–130 and close to 90. Finaly, when SSN exceeds 130 MR of Orissa begins to increase. This trend is also present for total MR of W.B. and Orissa (See Figure 2c).



(**a**)



(**b**)



(**c**)

Figure 2.

Thus, it appears that MR is an oscillating function of SSN when SSN increases from 0 to 90, and than slowly decreases as SSN increases from 90 to 130. Almost similar observation have been made by Chakraborty and Bondyopadhaya (1988) for Temperature over Eastern India. Let us now compare the MR of W.B. and Orissa during 1880–2003 (see Figure 3). In the early two stages the peaks in MR of W.B. and Orissa are in opposite phases but after that from 4th to 7th solar cycle the phase become more or less similar. In the 8th cycle the phases of MR for these two are slightly shifted. In the last two solar cycles, viz. 11th and 12th the same opposite nature of MR of W.B. and Orissa are seen as it was in the first two cycles. In general, average rate per year of MR of Orissa (9407mm)is more than that of W.B by 10%. During mid of 4–5 cycles up to 9–10 cycles i.e., from 1925 to1975 approximately, the MR of W.B and Orissa remains greater than average.

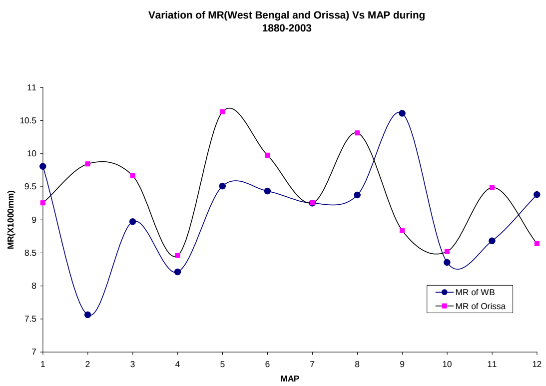


Figure 3

3.1. Correlation

If we calculate correlation coefficient between MR of MAP for all values of SSN of MAP, we find it is extremely small (−0.067). But, if we calculate cor. coef. between MR and those SSN of MAP when it was 30–89 we find it is still very small (−0.077). But the correlation coefficient becomes −0.44 when $90 < S < 116$. Clearely there exists some critical range of SSN, after which SSN becomes effective to influence South West Monsoon Rainfall inversely.

3.2. Critical Range of SSN

It has been observed that small SSN (00-90) is not capable to influence MR But beyond the value 90 of SSN, MR appears to decrease until SSN becomes 130 and then it begins to increases. Therefore, in every likelihood there exist a critical Range of SSN where MR behaves in regular pattern (here MR decreases). In fact, the existence of such critical range of SSN has also been observed for other meteorological parameters (vide e.g., Chakraborty and Bondyopadhaya 1986, 1988). If we write

R = South West Monsoon Rainfall during July-September over W.B. and Orissa
S = Annual Sun Spot Number

Then the above results can be expressed as

d R/dS < 0 when 90 < S < 130,
= fluctuating when S < 90,
>0 when S > 130

We can also observe that when SSN exceeds 90 and much greater than the Critical Range, Solar Influence appears to of inverse nature

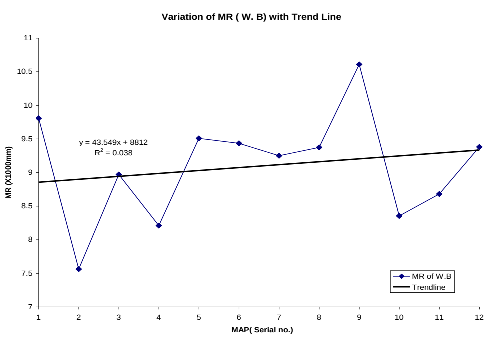
4. Conclusions:

In this study we have discussed some correlative analysis of 124 years (1880–2003) data of the sunspot and the Monsoon Rainfall over Eastern Costal part (West Bengal and Orissa) of India. From this study the significant conclusions are:

1. The MR over West Bengal and Orissa is not affected by the sunspot number until it reaches a critical range of SSN near about 90 After that the amount of MR has a trend to decrease with the increase of SSN from 90 to critical range of value near about 130 beyond which a reverse effect may occur
2. The total MR of West Bengal and Orissa has not changed during 1880–2003 i.e with the temporal variation of Map (More Active Period). This means that the change of MR of one state might have been compensated by another state.

Table 2. Correlation Coefficient for different Range of SNN.

SSN Range	C.C
30–190	−0.067
30–89	−0.077
90–130	−0.44



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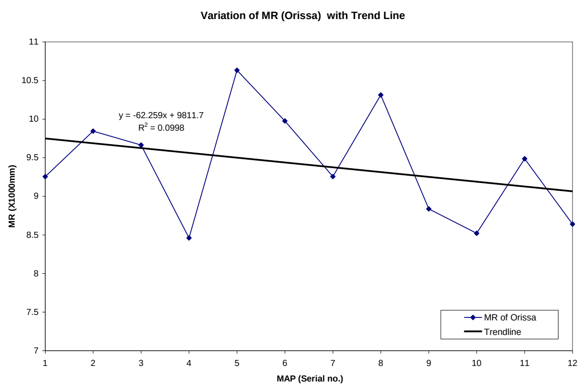

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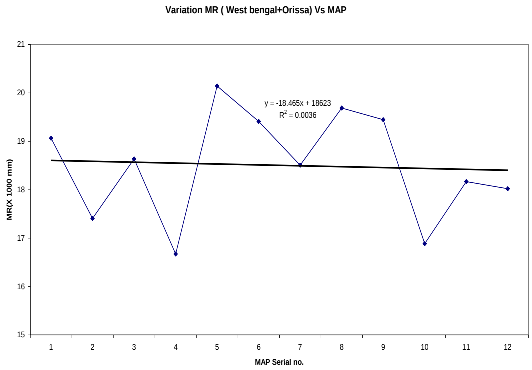

(c)

Figure 4.

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