551.46.06 : 551.553.21 (267)

INITIAL STATE OF NORTH INDIAN OCEAN AND SUBSEQUENT SUMMER MONSOON

1. The summer monsoon (June to September), which is the main rainy season in India, has been an important topic of study by the meteorologists. A technique for the prediction of rainfall over India during this season was first developed by Blanford (1884). Significant contributions in this direction have been made by Walker (1910), Thapliyal (1982), Gowariker *et al.* (1989, 1991) and others.

1.1. It is generally recognised that the initial state of north Indian Ocean plays a key role in the performance of subsequent summer monsoon. Some recent studies by Singh (1993) and Singh and Joshi (1993) have revealed that the meteorological and oceanographic conditions prevailing over north Indian Ocean before the commencement of summer monsoon season have significant influence over the subsequent monsoon rainfall over India. It is, therefore, pertinent to identify some useful oceanic predictors from the Indian Ocean for the prediction of quantum of rainfall over India during summer monsoon season. The object of present paper is to determine some probable oceanic predictors which are functions of SST.

2. About 1.25 lakh marine meteorological observations of May for the period, 1961-91, have been utilised in the present study. The entire data of sea surface temperature have been grouped into 5° × 5° squares over the oceanic area bounded by 0°-25°N and 50°-100°E.

2.1. The mean monthly values (for May) of SST have been worked out for each 5° square. From these means the following have been computed :

(*i*) Mean SSTs at 17.5°N both in Arabian Sea and Bay of Bengal.

(*ii*) Mean SSTs at 7.5°N both in Arabian Sea and Bay of Bengal.

Using (*i*) and (*ii*) above, the SST gradients between 17.5° and 7.5°N have been computed seperately for the Arabian Sea and Bay of Bengal. Summer monsoon rainfall data given by Thapliyal (1990) have also been utilised. The following CCs have been computed :

(*i*) CC between mean SST gradient (17.5°-7.5°N) of May over Arabian Sea and all India summer monsoon rainfall departure (June to September).

(*ii*) CC between mean SST gradient (17.5°-7.5°N) of May over Bay of Bengal and all India summer monsoon rainfall departure (June to September).

3. The mean SST gradients (17.5°-7.5°N) for May over Arabian Sea and summer monsoon rainfall departures for India as a whole for the period 1961-91 have been given in the Table 1.

3.1. It is revealed by Table 1 that all those years for which SST gradient in May over Arabian Sea between 17.5° and 7.5°N was less than 0.5°C have been normal or excess monsoon years. As a metter of fact barring 1963 and 1984, during all these years, the rainfall departures were on positive side of the normal. The years are 1961, 1969, 1970, 1975, 1977, 1978, 1983, 1988 and 1989. On the other hand, during the years for which SST gradient was > 1°C, the deficiency of rainfall exceeded −10%. In this category are the years 1968, 1979, 1982 and 1987. It may be mentioned that, normal SST gradient over Arabian Sea between latitudes 17.5° and 7.5°N during the month of May is about 0.6°C. The slack SST gradient in May is due to the fact that May is the transition month for the reversal of north-south SST gradient over the Arabian Sea. Therefore, if north-south SST gradient over Arabian Sea is sufficiently less (*i.e.*, < 0.5°C) during May then there are good chances of normal/excess monsoon and if the gradient is sufficiently large (*i.e.*, > 1°C) then the subsequent monsoon may turn out to be a deficient one.

3.2. The above observations could be given a more quantitative footing by computing the CC between SST gradient and monsoon rainfall departure. The CC value was found to be −0.61 which is significant at 1% level. It can, therefore, be concluded that there exists a negative correlation between north-south SST gradient of May

TABLE 1

Mean SST gradients for May (X) and all India summer monsoon rainfall departures (Y)

S. No.	Year	X(°C)	Y(%)
1.	1961	+0.1	+21.8
2.	1962	+1.0	−2.9
3.	1963	0.0	−2.1
4.	1964	+1.0	+9.9
5.	1965*	—	−18.2
6.	1966*	—	−13.2
7.	1967*	—	+0.1
8.	1968	+1.3	−10.3
9.	1969	+0.3	+0.2
10.	1970	+0.2	+12.3
11.	1971*	—	+4.0
12.	1972	+0.6	−23.4
13.	1973	+0.5	+7.5
14.	1974	+0.6	−12.0
15.	1975	+0.3	+15.0
16.	1976	+0.7	+2.4
17.	1977	+0.1	+4.0
18.	1978	+0.4	+9.0
19.	1979	+1.1	−18.9
20.	1980	+0.8	+3.9
21.	1981	+0.8	−0.2
22.	1982	+2.0	−14.5
23.	1983	+0.1	+12.9
24.	1984	+0.4	−4.3
25.	1985**	—	−7.0
26.	1986	+0.5	−12.7
27.	1987	+1.5	−19.4
28.	1988	−0.2	+19.3
29.	1989	−0.2	+1.0
30.	1990**	—	+7.0
31.	1991	+0.7	−7.0

* SST data erroneous; rejected during the quality control by computer.

** Insufficient SST data.

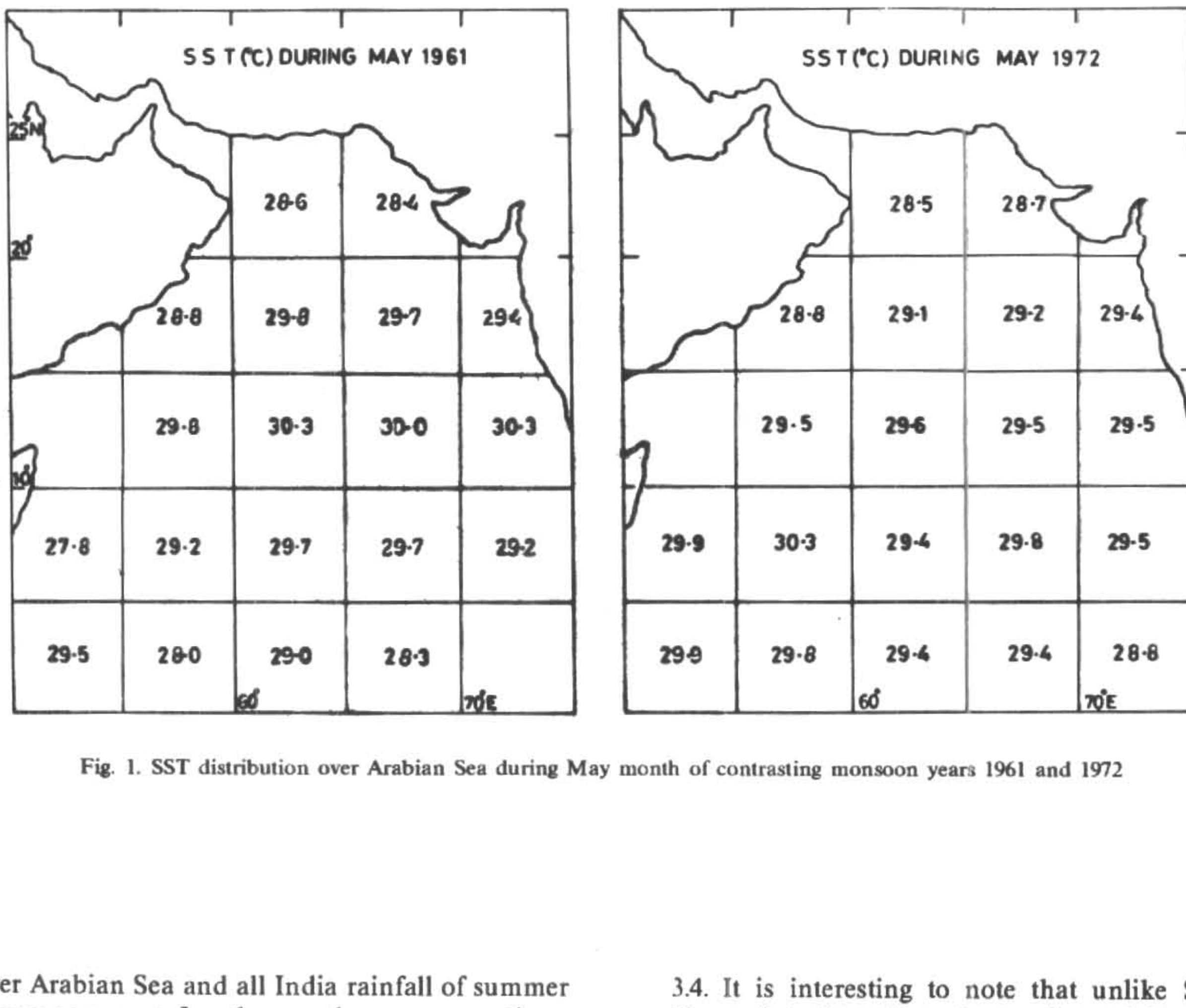

Fig. 1. SST distribution over Arabian Sea during May month of contrasting monsoon years 1961 and 1972

over Arabian Sea and all India rainfall of summer monsoon season. In other words, warmer northern Arabian Sea and colder southern Arabian Sea during May are favourable for subsequent summer monsoon rainfall over India, whereas colder northern Arabian Sea and warmer southern Arabian Sea during the same month are unfavourable for the monsoon rainfall.

3.3. These features are also brought out if we consider the SST distributions over Arabian Sea during contrasting monsoon years 1961 and 1972. These distributions have been depicted in Fig. 1. It may be mentioned that during the entire 31-year period 1961-91, 1961 and 1972 have maximum monsoon rainfall contrast (the monsoon rainfall departures being +21.8% and −23.4% respectively). It is seen from Fig. 1 that SST is generally less during May, 1961 than that of May, 1972 over the latitudinal belt 0°-10°N, whereas it is more during May, 1961 as compared to May, 1972 over the latitudinal belt 10°-20°N.

3.4. It is interesting to note that unlike SST gradient of Arabian Sea, the gradient of Bay of Bengal does not show any significant correlation with the monsoon rainfall. The computed CC between north-south SST gradient of May over Bay of Bengal between the latitudes 17.5° and 7.5°N and summer monsoon rainfall was found to be only −0.22. Although the CC is not significant it is again negative. Thus, generally warmer northern areas of north Indian ocean (10°-20°N) during May appear to be favourable for ensuing summer monsoon rainfall. However, the SST distribution of May over Arabian Sea appears to have more influence on the subsequent monsoon rainfall as compared to the SST distribution of the same month over Bay of Bengal.

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