551.526.6 : 551.461.2 : 551.465 (267.37)

SEA SURFACE TEMPERATURE AND SEA LEVEL PRESSURE ANOMALIES OVER THE ARABIAN SEA DURING ENSO YEARS

1. The Indian summer monsoon is adversely affected by the ENSO (Gowariker *et al*. 1991). The Arabian Sea plays a key role in the performance of Indian summer monsoon (Singh and Pai 1996). Thus it would be interesting to investigate the response of Arabian Sea to the ENSO episodes. The results of a study of ENSO-related variations in sea surface temperature (SST) and sea level pressure (SLP) fields over the Arabian Sea prior to the summer monsoon have been discussed here.

2. Rasmusson and Carpenter (1982) list four strong / moderate ENSO events during the period 1961-80. These were observed during the years 1965,1969,1972 and 1976. The ENSO events of 1965 and 1972 were strong and those of 1969 and 1976 were moderate. The expanded list of

TABLE 1

SST anomalies (°C) over the Arabian Sea during May of the ENSO years

Latitudinal Belt	SST Anomalies (°C) 1965	1969	1972	1976	Average SST (°C) (1961-80)
0°-5°N	+0.7	+0.2	+0.2	+0.1	29.3
5°-10°N	+0.6	+0.3	+0.1	+0.2	29.7
10°-15° N	-0.2	-0.1	-0.3	-0.2	29.8
15°-20° N	-0.5	-0.2	-0.1	-0.2	29.2
20°-25° N	-0.1	0.0	0.0	-0.4	28.6

Quinn *et al.* (1987) includes the 1963 event and the 1975 'aborted' event in the weak category. In the present study only strong and moderate events have been considered.

2.1. The May month has been chosen for the study of SST and SLP anomalies due to two reasons. Firstly, May just precedes the SW monsoon period (June to September). Therefore, the study of various fluctuations over the Arabian Sea during May could provide an insight into the linkages through which ENSO events affect Indian monsoon. The teleconnection between the ENSO and Indian monsoon is likely to affix its signature over the Arabian Sea prior to the monsoon.

2.2. For the computations of SST and SLP anomalies the surface marine observations of the period 1961-80 archived at the National Data Centre, Pune have been utilised. The SST and SLP data have been grouped into 5° x 5° latitude-longitude squares over the Arabian Sea area ; 0°-25° N, 50°-75°E. Average SSTs and SLPs during May have been computed for each square and for each year during the period 1961-80. The anomalies have been computed for the five latitudinal belts, *i.e.*, 0°- 5°, 5°-10°, 10°-15°, 15°- 20° and 20°-25°N over the Arabian Sea. The standardized anomalies have been computed by dividing the anomalies by the respective standard deviations.

3. Average SSTs for the month of May for different latitudinal belts over the Arabian Sea and the anomalies for the ENSO years have been given in Table 1. The maximum average SST in the Arabian Sea is observed in May over the latitudinal belt 10°-15°N which is 29.8°C. The minimum average SST occurs over the northernmost region of the Arabian Sea (20°- 25°N) which is 28.6°C. The rate of increase of SST from 0°-5° to 10°-15° N (0.6°C /10° lat.) is less than the rate of fall of SST from 10°-15° to 20°-25° N (1.2°C /10° lat.).

3.1. The striking feature brought out by the distribution of SST anomalies is that positive anomalies dominated the southern Arabian Sea area between 0°-10° N and negative ones prevailed over the latitudinal belt 10°-25° N during all the ENSO years. The northernmost region between 20°- 25° N, however, appeared less responsive showing normal SSTs during the ENSO years 1969 and 1972. The magnitudes of anomalies do not appear to be very significant at first glance (ranging from 0.1° to + 0.7°C). Before making any assessment about these small SST anomalies we must remember that the standard deviations of SSTs over the Indian Seas are very small.

TABLE 2

South-north SST gradient anomalies for the region 2.5° to 12.5° N over the Arabian Sea during May of the ENSO years

S.No.	ENSO Year	SST gradient anomaly (°C)	Average SST gradient (°C) (1961-80)
1.	1965	-0.9	
2.	1969	-0.3	
3.	1972	-0.5	+0.5
4.	1976	-0.3	

TABLE 3

SLP anomalies (hPa) over the Arabian Sea during May of the ENSO Years

Latitudinal Belt	SST Anomalies (hPa) 1965	1969	1972	1976	Average SLP (hPa) (1961-80)
0° -5° N	0.0	+0.2	+0.9	+0.9	1010.3
5° -10°N	0.0	0.0	+1.0	+0.8	1009.7
10° -15°N	+0.4	+0.3	+1.3	+1.6	1008.4
15° -20°N	+0.1	+0.4	+0.8	+1.0	1007.9
20° -25°N	+1.2	+1.0	+1.1	+1.3	1006.0

3.2. As pointed out earlier if we interpret the SST anomalies carefully and consider the anomalies of the SST gradient instead of SST anomalies themselves then the signals would appear more pronounced.

3.3. Table 2 shows that during May, 1965 there was a complete reversal of the normal SST gradient between 2.5°N (mid-point of the latitudinal belt 0°- 5°N) and 12.5°N (mid-point of the latitudinal belt 10°-15°N). The SST gradient during May, 1965 was - 0.4°C against the normal gradient of + 0.5°C. Thus the SST gradient anomaly was -0.9°C. It can be seen from Table 2 that the SST gradient anomalies during the remaining ENSO years 1969, 1972 and 1976 were -0.3°, -0.5° and -0.3°C respectively which are all negative. The standard deviation of SST gradient between 2.5° and 12.5°N over the Arabian Sea during May is 0.4°C. Thus the standardized SST gradient anomalies during strong ENSO years, 1965 and 1972, were quite significant which were -2.3° and -1.3°C respectively. The foregoing discussions clearly bring out that there is a tendency of weakening of the normal SST gradient between 2.5° N and 12.5°N over the Arabian Sea during May of the ENSO years.

3.4. The SLP anomalies over the Arabian Sea during the ENSO years are given in Table 3. Entire Arabian Sea was dominated by the positive SLP anomalies during May of all the ENSO years. The magnitudes of the anomalies were generally higher over the northern and central Arabian Sea. It appears that the northernmost area of the Arabian Sea (20° - 25°N) is more responsive to the ENSO episodes in terms of the surface pressure. The SLP anomalies over this area were significantly positive during all the ENSO years.

3.5. The standard deviation of SLPs for the latitudinal belt 20°-25° N over the Arabian Sea during May is 1.0 hPa. Thus the magnitudes of the standardized SLP anomalies over the area 20°- 25°N were 1.2,1.0,1.1 and 1.3 during May of the ENSO years 1965, 1969, 1972 and 1976 respectively. The magnitudes of the anomalies did not show any significant difference during the strong and moderate ENSO years. It is evident from the foregoing discussion that the sea level pressure over the entire Arabian Sea during May tends to remain higher than the normal in ENSO episodes. This tendency is more pronounced over northern Arabian Sea as compared to that over the southern Arabian Sea.

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