TELECONNECTION BETWEEN THE PRECIPITATION RATES OVER

P 2.27 THE RED SEA AND EL NINO/SOUTHERN OSCILLATION (ENSO)

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ABSTARCT

Teleconnection between precipitation rate over the Red Sea and El Nino-Southern Oscillation (ENSO) has been investigated. The NCEP/NCAR reanalysis data of annual and monthly mean precipitation rate over Red Sea the Southern Oscillation (SO) and El-Nino3 indices for the period (1948-2005) have been used through the present study. Correlation coefficient technique, Monte Carlo, has been used to indicate the relationship between precipitation over the Red Sea and both of El-Nino3 and SOI. The results revealed that the precipitation rate in the Red Sea response to ENSO particularly over the southern part of the Red Sea region. The relationship between the precipitation rate and ENSO varied from month to month and from region to region during the period of study. It is noticed that the sign of the significant correlation values between the monthly mean precipitation and ENSO varies form month to month and from region to region through the period of study. In addition to that, it is found that the sign of the significant correlation between the precipitation rate over the Red Sea and El-Nino3 is contradicting to SOI for almost of the months of the year during the period of study.

1. INTRODUCTION

The Red Sea is an inlet of the Indian Ocean between Africa and Asia. The connection to the ocean is in the south through the Bab el Mandeb sound and the Gulf of Aden. In the north are the Sinai Peninsula, the Gulf of Aqaba or the Gulf of Eilat and the Gulf of Suez (leading to the Suez Canal) . Fig. (1) illustrates the Red Sea and its adjacent land areas of a domain [(10°N – 35°N) and (30°E – 45°E)]. The southern oscillation index (S OI) is defined as the difference between sea level pressure at Tahiti (145°W and 18°S) and Darwin (135°E and 16 °S). SOI is coupled with El-Nino3 which is called ENSO. Where, El Nino is the name given to the phenomenon which occurs when Sea Surface Temperatures (SSTs) in the equatorial Pacific Ocean off the South American coast becomes warmer than normal. El-Nino3 is defined as the Sea Surface Temperature at the Pacific Ocean in the region (90° W - 150° W, 5° S - 5° N), Trenberth, (1997). El Nino can have severe consequences for the living conditions on earth Philander, (1990). Many studies have shown that ENSO has a significant influence on climate in many parts of the globe (Eugene and Carpenter, 1982; Shukla and Paolino, 1983; Ropelewski and Halpert, 1987 ; Schonher and Nicholson, 1989; Diaz and Markgraf, 2000; and recently Zengrui, 2007). The present work aims to investigate the teleconnection between mean precipitation rate over the Red Sea and its adjacent land areas with the climatic indices SOI, and El- Nino3 through the period of 1948-2005. However, the Red Sea is regarded as one of the most regions for the sustainable development.

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Fig. 1: The area of the Red Sea region

2. DATA AND METHODOLOGY

Data of annual and monthly mean precipitation rate over the Red Sea and its adjacent land areas [(10° N – 35°N) and (30°E – 45°E)] have been used through the period of 1948-2005 (Xie and Arkin, 1996). The NCEP/NCAR Reanalysis data for the precipitation rate, the Southern Oscillation Index SOI and El-Nino3 (Kalnay and Co-authors, 1996) obtained from the NOAA – CIRES, Climate Diagnostics Centre (CDC) through the Web Site http://www.cdc.noaa.gov/composites. The methodology of Monte Carlo had been used in the present study whereas a correlation of +/- 0.3124 would be significant, (Livezey and Chen, 1983).

3. RESULTS

3.1 CHARACTERISTICS OF PRECIPITATION RATE OVER THE RED SEA

Analysis of annual mean precipitation rate for the domain of study revealed that there are two distinct regions of maximum precipitation values. The first one is in the northern part of the study region, with maximum value of 1 mm/day. The second maximum can be observed over the southern part of the Red Sea with a value of 6 mm/day. The Middle parts of the Red Sea can be observed to have a rate of less than 0.5 mm/day. Thus, one can divided the domain of the present study into three distinct regions. The first, region (I), which covers 28° N – 33° N, the middle part, region (II), that existed from latitude 28° N to 19° N, while the thi rd part is region (III) which lays to the south of latitude 19° N. The value of monthly and annual mean precipitation rates over the deferent regions of the Red Sea have been illustrated in Table (1).

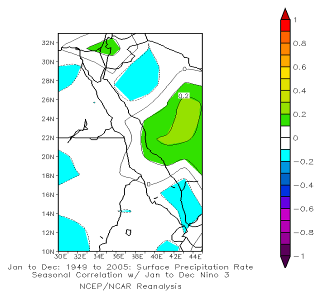
Table 1: The maximum value of monthly and annual mean precipitation rate (mm/day) over the deferent regions of the Red Sea during the period (1948-2005).

Precipitation rate for the Red Sea Regions / Month and annual	Region (I) (mm/day)	Region (II) (mm/day)	Region (III) (mm/day)
Jan.	2.5	0.5	2
Feb.	2.5	0.25	0.5
Mar.	1	0.5	3.5
Apr.	1	1.5	3.5
May.	2	0.5	5
Jun.	0.5	0.5	11
Jul.	0.5	0.5	10
Aug.	0.5	0.5	11
Sep.	0.5	0.5	10
Oct.	0.5	0.5	6
Nov.	0.5	0.5	4
Dec.	4	2	3
Annual	1	0.5	6

3.2 TELECONNECTION BETWEEN THE PRECIPITATION RATES OVER THE RED SEA AND EL -NINO3 AND SOI

The monthly and annual mean NCEP/NCAR data of the precipitation rate over the Red Sea and its adjacent land areas have been correlated to the Sea Surface Temperature in the central Pacific for the period of 1948-2005. Fig. (2a) shows correlation between annual mean precipitation rate and El-Nino3, a weak correlation appears during the period of study over the whole domain of study. The monthly mean precipitation rate correlated to El-Nino3 during the period of study. The maximum values of correlation for the three distinct regions have been tabulated in Table (2). The results revealed the following: Two significant values (-0.4, +0.4) can be noticed during the months of April and October respectively, over region (I). In addition to that, over region (II), there existed three significant values (+0.4, +0.5, +0.4) during the months of January, October and November respectively. Also, four significant values of correlation (+0.4, -0.5, +0.4, -0.4) can be noticed for the months of February, March, April, and October respectively. In addition to that, correlation coefficient between annual and monthly mean precipitation rate over the Red Sea and SOI have been shown in Table (3). The results indicate week's correlation between annual mean precipitation rate over the Red Sea and SOI for the three distinct regions as shown in Fig. (2b). Correlation coefficient between monthly mean precipitation rate and SOI indicate that there is a significant monthly correlation. Where, two significant values of correlation can be obtained over region (I). The first one is +0.4 occurred in April and the other is –0.4 occurred in December. While, there is only one significant correlation value –0.5 existed in January month. In addition to that over region (III) there are a five significant values (-0.4, -0.5, +0.4, -0.4 and –0.5) have been found through months of January, February, May, October and November respectively as shown in Table (3). Also, it is noticed that the sign of the significant correlation values between the monthly mean precipitation and SOI varies form month to month and from region to region through the period of study. Where, there is a positive significant correlation through the region (I) and it is a negative value in region (II). For region (III) it is clear that there is an outstanding negative correlation except that, for May it is found a significant positive value. From Tables (2 and 3) it is noticed that the sign of the significant correlation between the precipitation rate over the Red Sea and El-Nino3 is contradicting with SOI for almost of the months of the year during the period of 1948-2005.

(a)



(b)

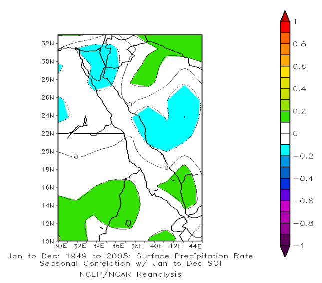


Fig. 2: Represents the correlation coefficient distribution between the annual mean precipitation rate over the Red Sea region and (a) El- Nino3, (b) SOI through the period (1948-2005).

Table 2: The correlation coefficient between the monthly and annual mean precipitation rate composite and the El- Nino3 index over the Red Sea and its adjacent area during the period (1948-2005).

Correlation coefficient for the Red Sea Regions / Month and annual	Region (I)	Region (II)	Region (III)
Jan.	-0.3	+0.4*	+0.2
Feb.	+0.2	-0.2	+0.4*
Mar.	-0.2	+0.3	-0.5*
Apr.	-0.4*	+0.3	+0.4*
May.	-0.2	-0.2	-0.2
Jun.	-0.3	-0.3	-0.3
Jul.	-0.3	-0.3	-0.3
Aug.	+0.2	+0.2	-0.2
Sep.	+0.2	+0.3	-0.3
Oct.	+0.4*	+0.5	-0.4*
Nov.	+0.3	+0.4*	+0.2
Dec.	-0.3	-0.3	+0.2
Annual	-0.1	+0.3	-0.1

(*) means that there is a significant level > 95%.

Table 3: The correlation coefficient between the monthly and annual mean precipitation rate composite and the SOI over the Red Sea and its adjacent area during the period (1948- 2005).

Correlation coefficient for the Red Sea Regions / Month and annual	Region (I)	Region (II)	Region (III)
Jan.	-0.3	-0.5*	-0.4*
Feb.	0	-0.1	-0.5*
Mar.	+0.2	0	+0.2
Apr.	+0.4*	+0.3	+0.2
May.	0	+0.2	+0.4*
Jun.	-0.3	+0.2	+0.2
Jul.	+0.3	0	+0.2
Aug.	+0.2	-0.3	+0.3
Sep.	+0.2	-0.3	+0.3
Oct.	-0.3	-0.3	-0.4*
Nov.	-0.3	0	-0.5*
Dec.	+0.4*	+0.2	-0.2
Annual	-0.2	-0.2	+0.2

4. DISCUSSION AND CONCLUSION

Teleconnection between the precipitation rate over the Red Sea and El Nino/Southern Oscillation (ENSO) has been investigated. The analysis of annual mean precipitation rate for the domain of study revealed that there are two distinct regions of maximum precipitation values. The first one, in region (I) and second maximum observed over the region (III). The Middle parts of the Red Sea have been observed to have rate of less than 0.5 mm/day. Study of the correlation between annual mean precipitation rate over the Red Sea and El- Nino3 through the period of study shows a weak correlation appears over the whole domain of study. For the monthly correlations with El-Nino3 two significant values (-0.4, +0.4) have been noticed during the months of April and October respectively over region (I). Over region (II), there existed three significant correlation values (+0.4, +0.5, +0.4) during the months of January, October, and November respectively. Also, Four significant values of correlation (+0.4, -0.5, +0.4, -0.4) have been observed for the months of February, March, April and October respectively. Correlation coefficient between monthly mean precipitation rate and SOI indicate that there is a significant monthly correlation. Two significant values of correlation (+0.4 and –0.4) have been noticed over region (I) in April and December respectively. One significant correlation value (–0.5) existed in January month over the region (II). Over region (III) there are a five significant values have been found through months of January, February, May, October and November. Generally, one can conclude that the Red Sea region has different responses to ENSO through the study period. The precipitation rate in region (III) has connected to ENSO more than those other two regions. In addition to that there are contradicting inferences of El-Nino3 and SOI in the precipitation rate over the Red Sea.

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