Volume : 3 | Issue : 1 | Jan 2014 • ISSN No 2277 - 8160

Research Paper

Space

Study of the Climate Variability in Southeastern Bangladesh and its Relation with Teleconnection Parameters of Tropical Pacific Ocean

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ABSTRACT

The present study investigates the relation of temperature, rainfall and pressure anomaly of Cox's Bazar situated at the southeastern Bangladesh with ENSO parameters and pressure anomalies at Tahiti, Darwin, Darwin minusTahiti and Darwin minus Cox's Bazar. The strudy shows that the temperature and rainfall do not exhibit much of systematic relation with SOI. Both temperature and rainfall exhibit weak correlation with SST anomalies of Nino4 region. The correlations of the pressure anomaly of Darwin minus Tahiti and Darwin minus Cox's Bazar are 0.47 with 5 and 11 months moving average data. Tahiti and Darwin pressure anomalies are strongly correlated with Cox's Bazar. The pressure anomaly at Darwin fluctuates in opposite phase with Tahiti and Cox's Bazar. These relations may be used for developing long term prediction model of south-east monsoon of Bangladesh coastal zone.

KEYWORDS : El-Nino, La-Nina, SOI, ENSO, SST, Tahiti and Darwin, Cox's Bazar, SLP

Introduction

Bangladesh is situated in the tropical monsoon region of South Asia. The climate of the country undergoes variations of different scales. The study of climate variability and investigating the link parameters of climate causing such variability is of high importance for developing models of long term climate predictions.

The El Nino and Southern Oscillation are synonyms of the similar processes related to SST and Pressure anomalies for sea surface and surface level of the atmosphere and together it is known as ENSO. ENSO is a dominant mode of interannual climate variability that develops from air-sea interactions in the tropical Pacific, but affects weather patterns globally [1].

During an El Nĩno, air-sea interactions promote the growth of positive sea surface temperature (SST) and sea level anomalies in the central and eastern Pacific and corresponding negative anomalies in the western Pacific. Changes in thermocline depth and surface ocean dynamics and thermodynamics are driven by anomalous atmospheric conditions, most notably westerly surface winds in the central and western Pacific Ocean [2].

Because of the interaction between atmosphere and ocean, the SST of the Indian and Pacific Oceans may influence the variability of the Indian monsoon, and in turn, the monsoon winds and rainfall may affect the variability of SST of the oceans. This mutual interaction introduces the possibility that the monsoon and the oceans form a coupled climate [3]. The interdecadal changes are important in analyzing the appropriateness and robustness of theories for ENSO and the monsoon, and in determining the expected skill of ENSO–monsoon forecasts [4]. Teleconnections associated with ElNino result in an overall warming of the Indian Ocean [5], due to changing cloud cover and wind patterns that relate to changes in ascending and descending branches of the Walker circulation [6]. However, El Nino / Southern Oscillation have been proved to be an active climate variability index which links with the variability of tropical climate. However, the impact of ENSO on the Indian summer monsoon rainfall (ISMR) has apparently weakened in the last two decades of the 20th century [7]. In the present study we have investigated how the climate variability of southeastern Bangladesh relates with the ENSO and related phenomena.

2. Data used and Methods of analysis

In the present work, monthly climate data (temperature, rainfall and sea level pressure) for the period (1951-2012) recorded at Cox's Bazar [91.967^0 E, 21.443^0 N] meteorological station located at the southeastern shore of the Bay of Bengal have been used. The ENSO and related teleconnection data such as sea level pressure anomaly of Tahiti (149.42°W, 17.67°S and Darwin (130.83°E, 12.45°S) have been downloaded from the sites of US NOAA-NCEP. Nino-4 SST anomaly over 160E-150W in the 5^0 N and S of the equator has been used.

The time series analysis techniques have been used. First of all the anomaly was calculated by subtracting the respective mean from the data. The data are on monthly basis. The high frequency mode present in the time series generates problems to identify the prominent temporal pattern in the variability of the climatic parameters. The moving average with sliding windows of 5 and 11 month was applied on the time series for eliminating the high frequency modes. The time series data have been plotted to visualize the pattern of the variability and correlation coefficients have been estimated between the different data series of Cox's Bazar and ENSO parameters. The results are shown and discussed in the following section.

3. Results and Discussions

The results of the analysis are discussed in this section. It is to mention that all the plotted time series correspond to 11 months moving average. However, the correlation coefficients are calculated with original time series and 5 and 11 months moving average [table-1]. The temporal plots of mean temperature anomaly of Cox's Bazar and SOI are plotted in Figure-1. The plot exhibits a mixed pattern in the temporal behavior of these two parameters. The temperature shows increasing trends along with interannual variations.

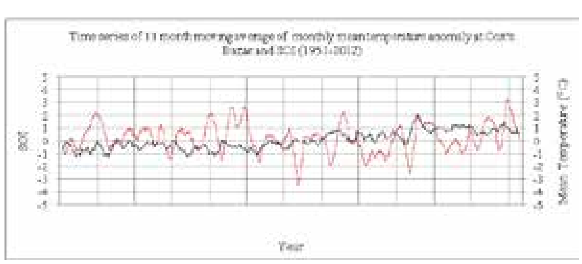

Figure-1: Time series of 11 months moving average of monthly mean temperature anomaly at Cox's Bazar (black line) and SOI (dotted red line)

The opposite phase of relations dominates with occasional occurrence of similar phases. This indicates the non-stationary pattern of relationship with very low correlation. The low correlation is due to the existence of trend in the time series of temperature in addition to the presence of occasional opposite phases. The analysis of monthly mean temperature exhibits negative correlation of -0.17 with the SST of Nino-4 region of the eastern Pacific for 11 months moving average time series (figure-2, table-1) where the data from 1982-2012 have been used. Thus the temperature of Cox's Bazar is found to have almost no correlation with SOI and some weak correlation with El Nino phenomenon.

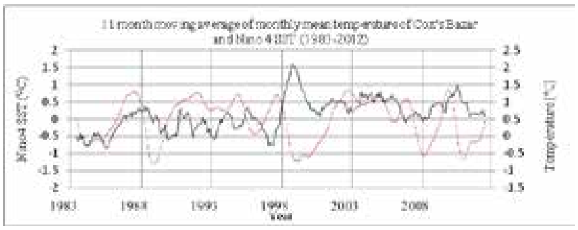

Figure-2: 11 months moving average of monthly mean temperature of Cox's Bazar (black line) and Nino4 SST (dotted red line)

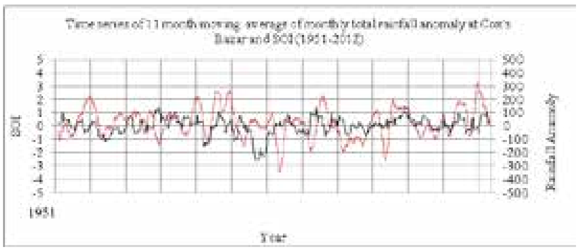

Figure-3: Time series of 11 months moving average of monthly rainfall anomaly at Cox's Bazar (black line) and SOI (dotted red line).

Figure-3 exhibits the plots of time series of monthly rainfall and SOI. The plots of rainfall and SOI indicate the existence of dominant opposite phase of relation with intermittent similar phases. The overall correlation of rainfall with SOI is 0.11 for 11 months sliding. However, the correlation with Nino4 SST anomaly is -0.24. From table 1 it is seen that the correlation improves with moving average data.

The relation of the pressure anomalies of Cox's Bazar with SOI and Nino4 SST anomaly and that of Tahiti and Darwin have been investigated. The time series plots of pressure anomaly of Cox's Bazar and SOI are shown in figure-4. The plots depict that the relationship with opposite phase is prominent. The correlation is found to be -0.32 for original data. For moving average data with 5 and 11 months window shows that the correlations are -0.59 and -0.72. For SST at Nino4 region the correlation are 0.45, 0.63 and 0.69 respectfully for original time series and 5 and 11 months window as shown in table-1.

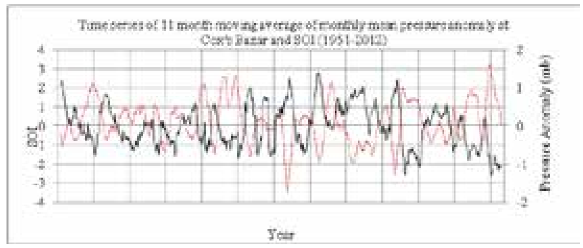

Figure-4: Time series of 11 months moving average of monthly mean pressure anomaly at Cox's Bazar (black line) and SOI (dotted red line).

Figure-5 shows the variation of sea level pressure anomalies in the form of difference of Darwin minus Tahiti and Darwin minus Cox's Bazar which depicts that the time series have similar phases of variation with positive correlation of 0.47. The positive correlation illustrates that the fluctuation of pressure gradient from west to east in the pacific undergoes in phases with that from east to west in the Indian Ocean.

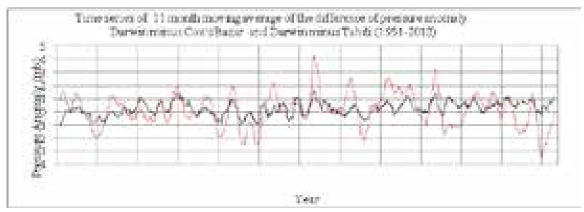

Figure-5: Time series of the difference of pressure anomaly for Darwin minus Cox's Bazar (black line) and Darwin minus Tahiti (dotted red line) with 11 month moving average.

Table-1: The correlation coefficient of SLP anomaly of Cox's Bazar with the teleconnection parameters over tropical Pacific.

Parameters of Cox's Bazar	SOI			SST Of Nino4 Region			Pressure anomaly at Tahiti			Pressure anomaly at Darwin		
	Original	5 month moving	11 month moving	Original	5 month moving	11 month moving	Original	5 month moving	11 month moving	Original	5 month moving	11 month moving
Temperature	0.004	0.02	-0.005	-0.08	-0.12	-0.17	0.07	0.16	0.21	0.05	0.11	0.18
Rainfall	0.003	0.05	0.11	-0.06	-0.13	-0.24	0.06	0.12	0.21	0.04	0.02	-0.001
Pressure anomaly	-0.32	-0.59	-0.72	0.45	0.63	0.69	0.37	0.58	0.68	-0.15	-0.48	-0.65

But some better and stronger negative correlation has been found to exist between sea level pressure anomalies at Darwin and Cox's Bazar (Figure-6). The correlation coefficient is -0.65 for 11 months window. This indicates that the pressure anomalies of Cox's Bazar and Darwin undergo variations with same phase. High positive correlation has been found for the pressure anomalies at Cox's Bazar and Tahiti (Figure-7). The value of the correlation is 0.68 for 11 months window. An analysis using correlations of Cox's Bazar with 8 other stations of Bangladesh shows high positive correlation with coefficients varying from around 0.7 to 0.8. Thus the Darwin and Tahiti pressure anomalies appear to be useful predictors for prediction of climate over Bangladesh.

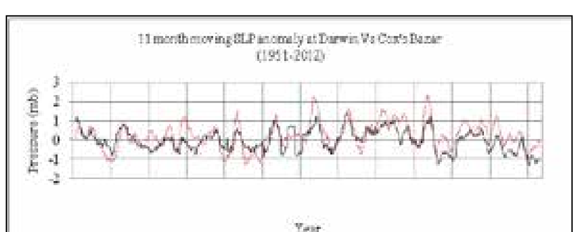

Figure-6: 11 month moving SLP anomaly at Darwin Vs that of Cox's Bazar(1951-2012).

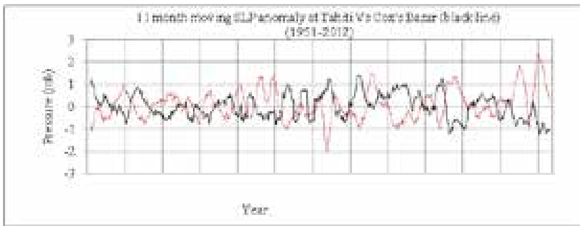

Figure-7: 11 month moving SLP anomaly at Tahiti Vs Cox's Bazar (Correlation = -0.69)

The gradient of pressure of Cox's Bazar and Tahiti from Darwin has been shown in figure-8 for negative and positive phases of SOI respectively. Dotted lines represent the positive SOI and solid lines represent the negative SOI. The figure depicts that the pressure gradient to the east of Darwin is much stronger than that to the west, but have the similar nature with opposite direction. The pressure gradients to the west of Darwin are more dispersed but those to the east are organized. This shape of east-west distribution of pressure gradient provide new ideas of atmospheric teleconnections which are believed to be highly useful for developing prediction models for long-term prediction of climate of Bangladesh coastal zone and country as a whole.

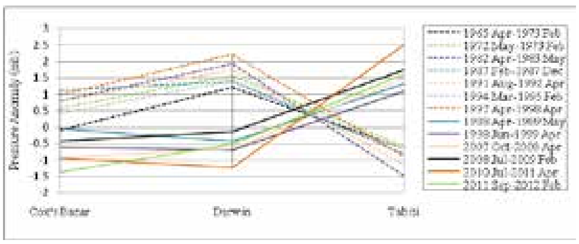

Figure-8: Variations of mean pressure anomaly at Cox's Bazar, Darwin and Tahiti at different period of time coinciding with positive phases of SOI (dotted lines) and negative phases of SOI (solid lines).

Conclusions:

The study has been conducted to investigate the variability of climatic parameters of Cox's Bazar with respect to the ENSO parameters and pressure anomalies at Darwin and Tahiti. The results show that though the SOI does not show much of correlation with temperature and rainfall of Cox's Bazar, however some weak correlation is observed with SST anomaly at Nino4 region.

The pressure anomaly at Tahiti minus Cox's Bazar and Darwin minus Cox's Bazar have correlation of 0.47. Darwin and Tahiti are correlated with Cox's Bazar in their anomalies have the correlations of -0.65 and 0.68 respectively. This depicts that the pressure anomaly at Darwin fluctuates in opposite phase with Tahiti and Cox's Bazar. These relations provide new ideas of atmospheric teleconnections which are believed to be highly useful for developing prediction models of Bangladesh climate.

REFERENCES

[1] McPhaden, M. J., Zebiak, S. E., and Glantz, M. H., 2006: ENSO as an Integrating Concept in Earth Science, Science, 314, 1740–1745, | [2] Wang, C. and Fiedler, P. C., 2006: ENSO variability and the eastern tropical Pacific: a review, Prog. Oceanogr., 69, 239–266. | [3] Webster, P. J., and S. Yang, 1992: Monsoon and ENSO: Selectively interactive systems. Quart. J. Roy.Meteor. Soc., 118, 877-926 | [4] Peter J. Webster, 1999 : Interdecadal Changes in the ENSO–Monsoon System, Program in Atmospheric and Oceanic Sciences, University of Colorado, Boulder, Colorado | [5] Xie, S. P., Hafner, J., Tokinaga, H., Du, Y., Sampe, T., and Hu KaiMing, H. G., 2009: Indian Ocean capacitor effect on Indo-western Pacific climate during the summer following El Nino, J. Climate, 22, 730–747. | [6] Du, Y., Xie, S.-P., Huang, G., and Hu, K., 2009: Role of air–sea interaction in the long persistence of El Nino induced north Indian Ocean warming, J. Climate, 22, 2023–2038. | [7] Kumar, Rajagopalan, K. B., and Cane, M. A., 1999: On the weakening relationship between the Indian monsoon and ENSO. Science, 284, 2156-2159 |