ANALYSIS OF SUPERFICIAL SEA TEMPERATURE ANOMALIES IN COLOMBIAN BASIN -CARIBBEAN SEA

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ABSTRAC

The anomalies of sea surface temperature (SST) in four coastal stations in Colombia Basin (Caribbean Sea) regarding the occurrence of extreme events were analyzed. TSM series were taken from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) for the period 1960-2014. The anomalies were analyzed spectrally, being in all cycles series 11, 6.5, 4, 2 and 1 year, filters were applied and the main components of each series TSM found, these values were correlated so cross-rates of ocean-atmosphere interaction phenomena and its main components: Ocean El Niño Index (ONI), index North Atlantic Oscillation (NAO) index and sea surface temperature in the Caribbean (CAR) and the the deviation of the number of sunspots due. The major correlations found it between TSM anomaly and CAR index, demonstrating a notable increasing in the sea temperature and was found a inverse relationship with the ONI index. Although the TSM anomalies showed a 11 years cycle, did not found a direct relationship with the extreme events of the TSM anomalies.

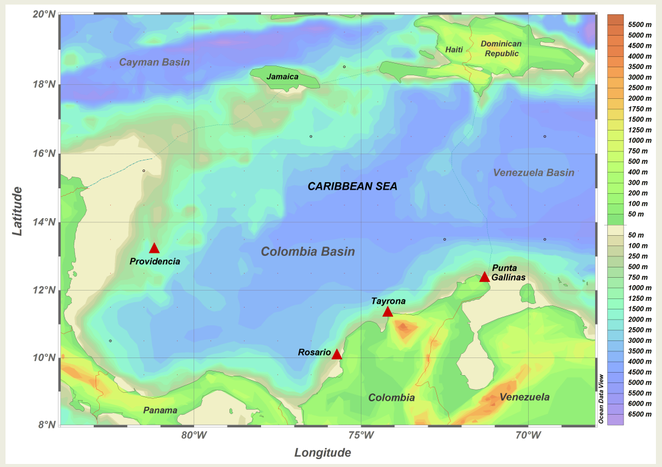

Figure 1. *Location of observation points in the Colombian Basin (Caribbean Sea): Providencia, Punta Gallinas, Tayrona and Rosario (above)*

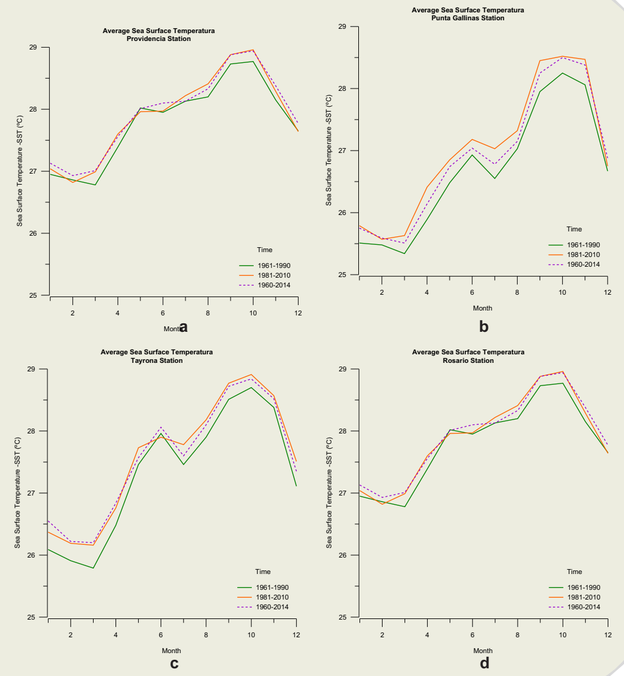

Figure 2. *Average SST to 1961-1990, 1981-2010 and 1960-2014 -a) Providencia, b)Punta Gallinas, c) Tayrona and d) Rosario and (Left)*

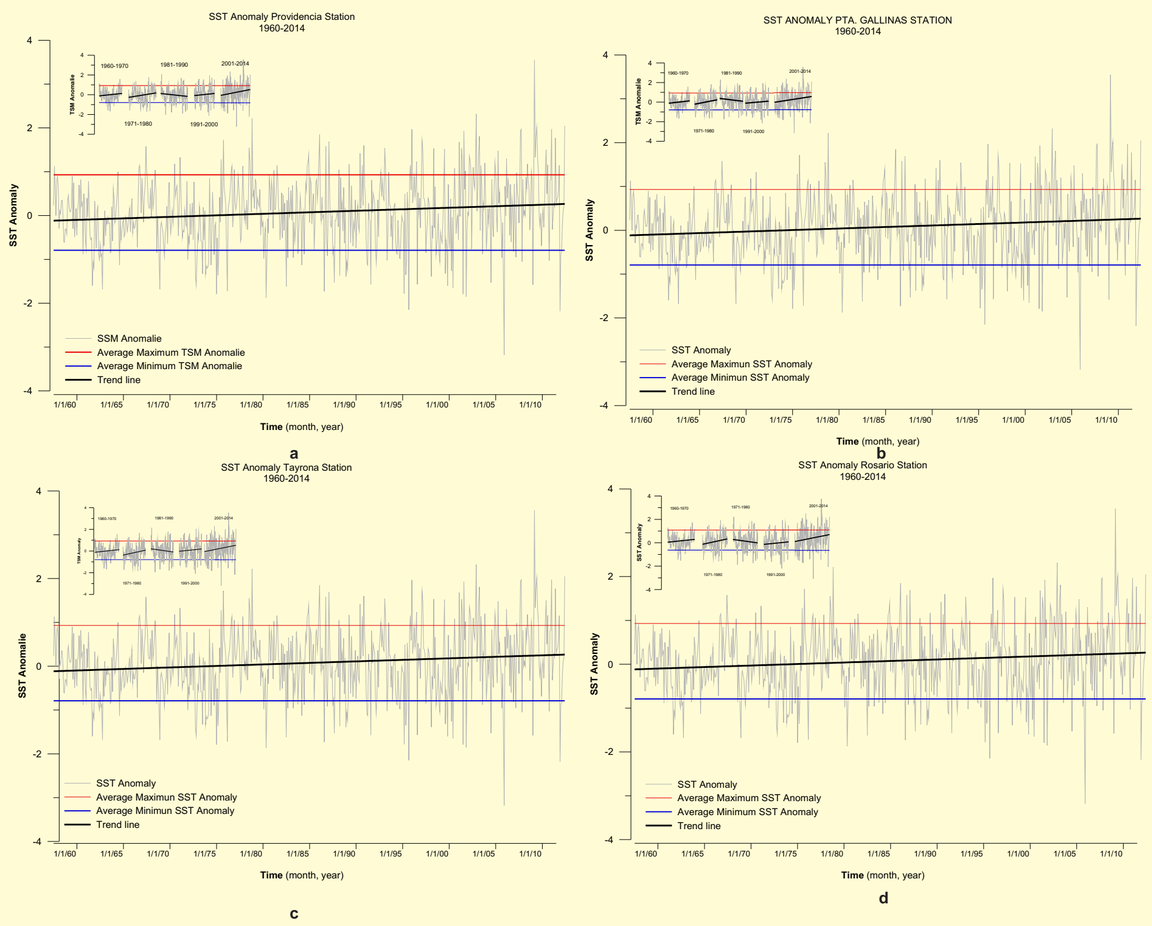

Figure 3. *SST anomaly and trend line to 1960-2014 period. For each station analized, over each graphic is showed the trend line around decadal period: 1960-1970, 1971-1980, 1981-1990, 1991-2000 and 2001-2014. a) Providencia station b) Punta Gallinas station, c) Tayrona and d) Rosario*

INTRODUCTION

The analysis of superficial sea temperature - SST anomalies in Colombian basin -Caribbean sea was carried out using spectral and trend analysis. The spectral analysis is one of the most widely used methods with time series for data analysis in oceanography that makes a relationship between the variance of the signal frequencies, which are repetitive behaviors. Trend analysis identify changes in a time series, the slope of the trend line shows how the growth rate has changed, on average, over time. This study present the increasing anomalies SST series and their correlation with the increase of extreme events.

METODOLOGY

Anomalies of sea surface temperature (SST) in four coastal stations in Colombia Basin -Caribbean Sea (**Fig. 1**) regarding the occurrence of extreme events were analyzed. SST series were taken from the International Comprehensive Ocean-Atmosphere Data Set (ICOADS) for the period 1960-2014. The SST anomalies was calculated taking into account values standardized climatic periods 1960-1990 and 1981-2010 (**Fig. 2**). The minimum and maximum values of SST anomalies of each six month were averaged and used as reference limit for the analysis of extreme values of SST anomaly. In addition was drawn the trend line to complete anomaly SST series (1960-2014) and around each decadal period (**Fig. 3**). Subsequently SST anomalies were analyzed spectrally, filters were applied and the main components of each series SST found (**Table 1**), these values were correlated so cross-rates of ocean-atmosphere interaction phenomena and its main components: Ocean El Niño Index (ONI), index North Atlantic Oscillation (NAO) index and sea surface temperature in the Caribbean (CAR), was taken further in account the deviation of the number of sunspots due to the outstanding 11-year cycle found in all observation points

RESULTS AND CONCLUSIONS

The trend analysis anomalies SST series for the period 1906-2014 shows a gradual increase in the slope of the trend line on the four coastal stations analyzed, however, a decadal analysis (series of periods of 10 years, 1960-1970, 1971-1980, 1981-1990, 1991-2000, 2001-2014, the last period of 13 years), shows that both the sign of the trend, and this slope are significantly different during the 5 periods analysis. It is in the period 2001 - 2014, the increasing trend of SST anomalies and number of extreme events are significantly higher. This behavior is similar in the 4 seasons of SST. The outcomes of the spectral analysis show repetitive behaviors with frequencies in all series of 11, 6.5, 4, 2 and 1 year. Similar principal components were found for CAR, ONI and NAO index, althoug the major spectral power found was the 11 years signal, because this reason was taking account the sun cycle of 11 years, using the number of the sunspot desviation. Although the SST anomalies showed a 11 years cycle, did not found a direct relationship with the SST anomalies neither the extreme events, just the Providencia station showed a correlation index of 0.46 with +5 months of lag . On the other hand, the major correlations found it between SST anomaly and his principal components were CAR index with correlation, demonstrating a notable increasing in the sea temperature and was found a inverse relationship with the ONI index. Similar outcome were found by Bernal *et al. (*2006). The correlations index obteined between initial and principal components and the NAO index were lowest and does not explain the SST anomaly behavior nether the trend in the extreme events of SST anomaly. The frequencies of 4 and 2 years in all series are possibly related to cycles or principal components of ONI (El Niño) with the same frequency.

Table 1.*Periods found in the series by spectra analysis*

Initial Series	*Periods (years)*					
Providencia	11	3	5	2		
Pta. Gallinas	6	11	1	4	2	
Tayrona	11	4	6	1	3	2
Rosario	4	1	11	0,5	2	
ONI	4	5	2,5	3	2	
OAN	1	0,5	3			
CAR	4	12				
SunSpot	11					

Based on the work: A. Rodríguez - Tobar, I. Málikov and N. Villegas, 2015. Hidalgo, E.J. Alfaro and B. Quesada-Montano, 2015. Analysis of Superficial Sea Temperature Anomalues in Colombian Basin - Caribbean Sea, asociated with extreme events during 1960 – 2014. In progress.