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Research Article

Seasonal Variation of SST in Mediterranean Sea

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Abstract
The study of sea surface temperature (SST) is fairly essential for solving many meteorological and oceanographic problem and climate system of the earth. The aim of this study is to explore the variation of SST of Mediterranean Sea during the period (1980-2009) by using statistical analysis technique such as time series and trend. The data obtained from the Europe center (ECMWF) and the resolution of the grid of the variable is 0.5°x0.5° and selects three locations (points) in the Mediterranean Sea. The seasonal variation of SST has the highest value of trend in summer season (0.06) for the points I, II, III, while the lowest value in the transition season, i.e. in spring (0.01) for point I and III and in Autumn (0.04) for point III.

Keywords: Sea surface temperature, Mediterranean sea abstract, Variation.

الخلاصة
ان دراسة درجة حرارة سطح البحر مهمه بشكل كبير في حل المشاكل الانوائية والبحرية للنظام المناخي للكرة الارضية. الهدف من هذه الدراسة هو لايجاد التغيرات الفصلية لدرجة حرارة سطح البحر الابيض المتوسط خلال الفترة (1980-2009) باستخدام تقنيات التحليل الاحصائي مثل السلاسل الزمنية والانحدار. تم الحصول على البيانات من المركز الاوربي وقدرة التميز للشبكة هي 0.5°x0.5° للمتغير وتم اختيار ثلاثة مواقع (نقاط) على البحر الابيض المتوسط. التغيرات الفصلية لـ SST أظهرت ان اعلى قيمة للانحدار كانت في فصل الصيف (0.06) للنقاط I و II و III واقل قيمة كانت في الفصول الانتقالية، في فصل الربيع كانت (0.01) للنقاط I و III وكانت (0.04) في فصل الخريف للنقطة 3.

Introduction

SST is the temperature of the ocean surface or a measure of how hot or warm the water at the ocean's surface [1]. Sea surface temperature is climatically important because it affects the temperature of the air immediately above the surface and evaporations rate of water this in turn affects air temperature because water vapor is the most important greenhouse gas, as well as cloud formation, Albedo and precipitation [2]. SST and their variability are widely studied due to their large impact on oceanographic and weather patterns [3].

The Mediterranean region in Figure 1 [4], lies in a transition zone between the arid climate of North Africa and the temperature and rainy climate of central Europe and it is affected by interactions between mid-latitude and tropical processes. In winter climate is mostly dominated by the westward movement of storms originating over the Atlantic and impinging upon the western European coasts. In the summer, high pressure and descending motions dominate over the region, leading to dry conditions particularly over the southern Mediterranean [5]. The atmospheric circulation over Mediterranean area is dominated in winter by the westerlies regime and in summer by tropical African circulation, that may give rise to subsidence phenomena influencing the eastern Mediterranean basin. These climatic conditions determine large sea surface temperature (SST) excursions between summer and winter [6].

Figure 1: The Mediterranean Sea basin country [4].

Data and methods

In this work the basic two areas studied are the Mediterranean Sea which is located between (30-45°N)and (-10-35 °E). The data used were taken from the European center (ECMWF) re-analysis data base for the full resolution version model for 30 years. The periods of the data analyzed were from January 1980 to December 2009. The monthly means of SST in °C for the Mediterranean Sea were obtained[1] and using the 0.5° x 0.5° grid. Two programs of FORTRAN were used to change the format of the data file that downloaded in Netcdf to text file and ordered in columns to enter it to the second program to extract the points after input the long.-lat. of these points. The Table 1 below shows these points:

Table 1: The points selected in the mediterranean Sea.

Locations	Lat.(°): N	Long.(°): E
Point I	33.54	32.4
Point II	35.10	22.76
Point III	35.64	14.50

Results and Discussion

The analysis of monthly (SST) in Mediterranean Sea for long term has been examined by the time series for three selected locations. The mean monthly SST for January, April, July and October, are taken under consideration to represent the four seasons respectively as shown in Figures.

Point I

This point I located in the eastern part of Mediterranean Sea basin, nearest to coastline of Middle East. Figure 2 shows the monthly variation of mean SST in January, April, July and October for 30 years (1980-2009) for the period under study. Form the Figure it's easy to see the value of average SST is lowest in January (17 °C) while the value is higher in July (26.4 °C) and (17.6 °C) in winter. This large difference in SST average between July and January caused by the high pressure and descending motions, leads to dry condition in July and could be linked to Asian and African monsoons. While in winter affected by western lays region and westward movement of storms originating over the Atlantic.

The values of trend are represented in Table (2), where the pattern of trend show highest value in July (0.06 °C/month) and the lowest one in April (0.01 °C/month).

In general, the trends values were increased with years as shown in each Figure and the individual variation of SST show highly rang in July, that's mean the data around the mean is slightly. In other word, it is affected by planetary scale process such as global warming, general circulation and teleconnection.

Table 2: Seasonal trend values of SST points.

Month	Point I	Point II	Point III
July	0.03	0.03	0.02
April	0.01	0.02	0.01
July	0.06	0.04	0.05
October	0.03	0.01	0.004

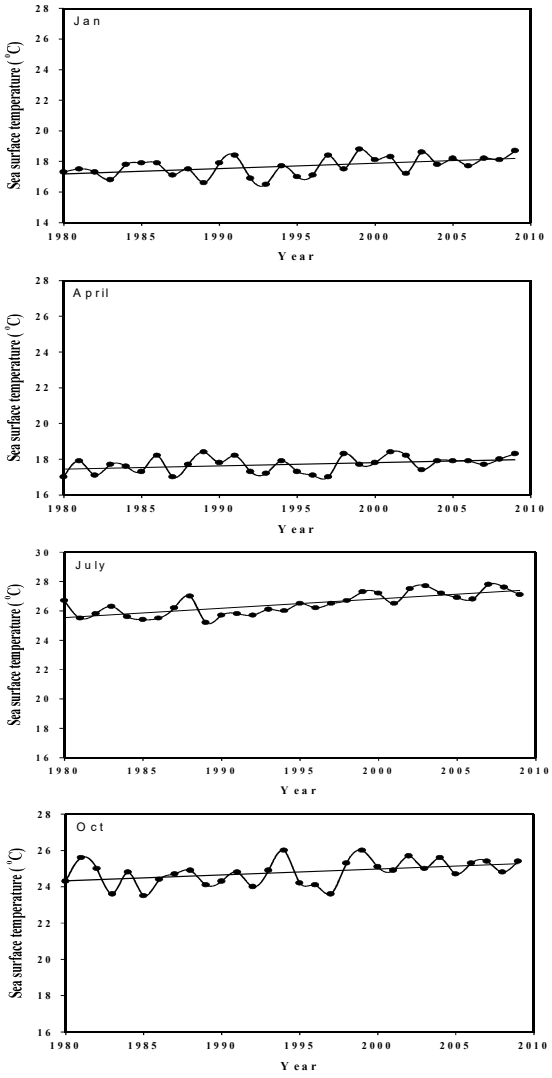
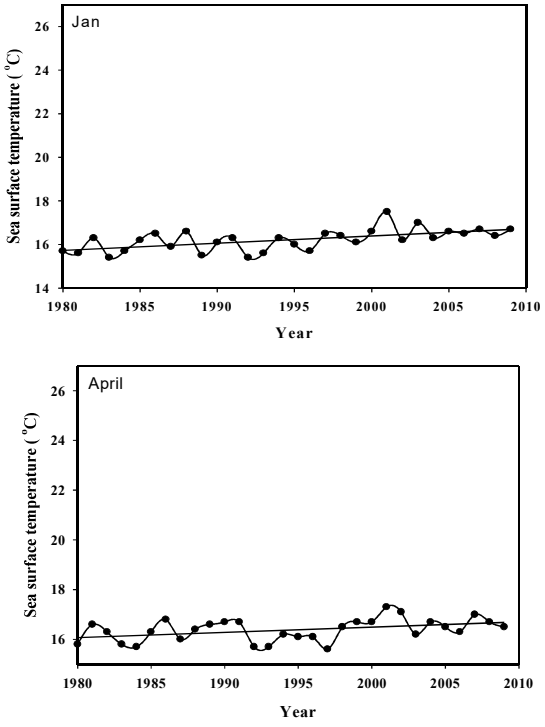


Figure 2: Seasonal trend of SST of point I.

[1] http://www.data-portal.ecmwf.int/

Point II

This point almost located in the central part of the basin which represents the deepest point. The variation of SST of point II illustrated in Figure (3). The Figure shows large contrast of average of SST from January to July, where in July it is (24.5 °C) and (16.6 °C) in January. The trend values recorded in Table (2) were also like point I, the large value is in July (0.04 °C/season) while the lowest one in October (0.01 °C/month). The variation of SST around the mean (solid line) in July is increasing with the time as shown in the Figure. These shifts in climate could be result from the lying of the area under the interaction between mid-latitude and tropical process that just for the large speared of data of the plot in all months as shown in each Figure. The depth of the point also affects the heat exchange and transport because of the geography and topography and salinity water which may identify the water formation and stability and general circulations.



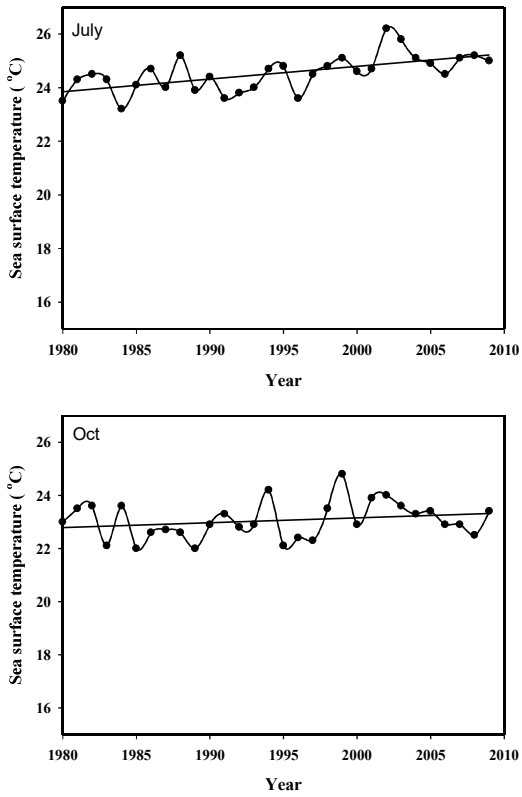


Figure 3: Seasonal trend SST of point II

Point III

This point was taken in the westward side of the Mediterranean Sea basin. Four season of monthly SST variation apply in Figure 4, where the average of SST in July was (24.8 °C) and (15.6 °C) in January. Table (2) included the trend value, where in July recorded the highest value (0.05 °C/season) and the lowest value in April (0.01 °C/season). The Figure shows large variation of SST around the mean in July and October but the plot was clearly slight in January and April, that could by produce from the complexity of this area which is influenced by the strong topographic a coastal current and the circulation included the internal thermohaline driven by deep water in the western basin and global thermohaline circulation and North Atlantic Oscillation of western area.

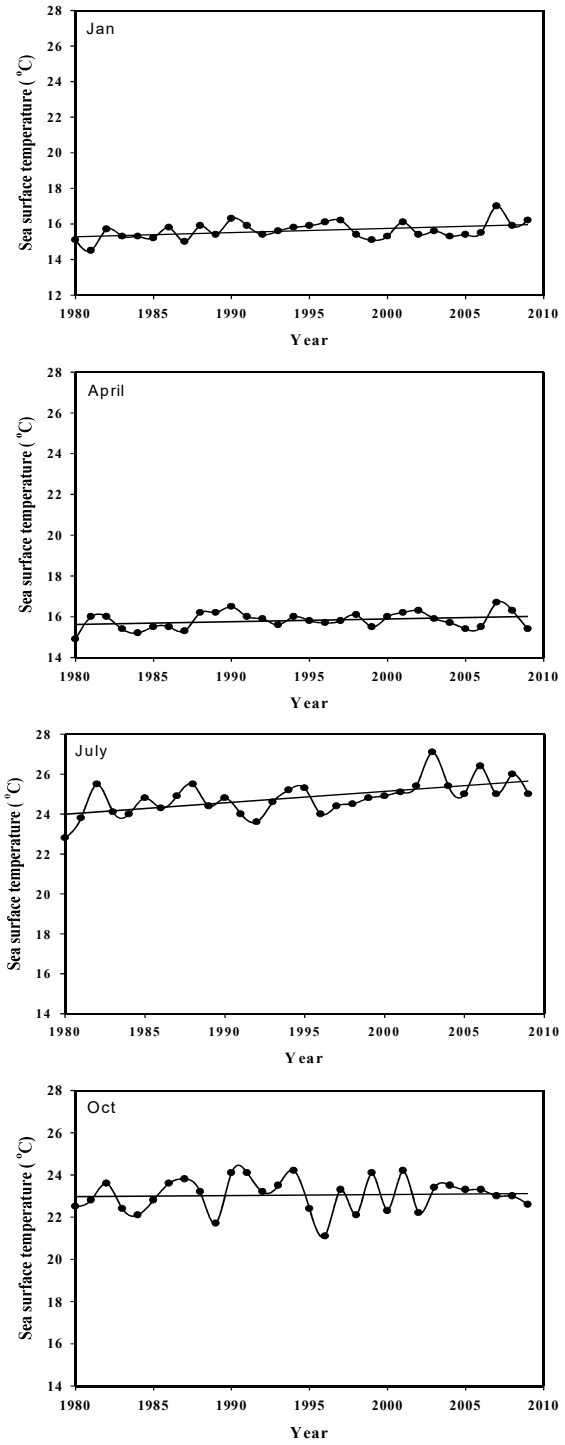


Figure 4: Seasonal variation of SST of point III.

Conclusion

Based on the data used in this work that were obtained from ECMWF center reanalysis of represented means during the period of 1980-2009, the time series of monthly SST were analyzed using some programs written in Fortran. The main concluding remarks can be summarized as:

1. The results show that the variation of SST has largest trend in July for all selected three points.
2. The results show that the lowest value of trend of SST variation finds in points II and III.
3. For point III, the results show the lowest value of trend compared with the other point in all months except in July which have almost higher value.

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