COASTAL SEA SURFACE TEMPERATURE AS DETECTED BY METEOSAT SATELLITE AND RECEIVED AT THE UNIVERSITY OF ABIDJAN.

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Abstract :

SST images derived from METEOSAT satellite, received at University of Abidjan have been used during the year 1993 to study the upwelling which takes place twice a year along the caost of Côte d'Ivoire and Ghana. This study shows that the use of METEOSAT data is sufficient to detect the surface coolings off Côte d'Ivoire.

Résumé :

Les images en infra-rouge thermiques disséminées par le satellite METEOSAT et recues à la station PDUS installée à l'Unicersité d'Abidjan ont été utilisées au cours de l'année 1993 pour étudier la dynamique spatiale des upwellings qui s'installent deux fois par an le long de la côte ivoirienne et ghanéenne. L'utilisation de ce type de données a montré la capacité du satellite METEOSAT à détecter et localiser les upwellings côtires de Côte d' Ivoire.

1. Introduction

Ocean temperatures and temperature related oceanographic features such as fronts are known to affect the spatial distribution of oceanic pelagic fishes such as tuna, sardinella as well as other large migratory species. Sea Surface Temperature and information derived from SST patterns can be used extensively in estimating annual indices of abundance in fisheries (Brown and Winn, 1989).

Sea surface temperature along the coast of Ghana and Côte d'Ivoire exhibits twice a year, a moderate decrease between January and March (minor upwelling) and between July and September (major upwelling). The resulting seasonaly-induced plankton production has led the development of pelagic fisheries, with increases in sardinella catches in Côte d'Ivoire and Ghana during the last decade and new spatial and seasonal distribution (Binet et al., 1993). Many authors have established a relationship between SST and abundance of fishes using ground measurements. Generaly, the large scale behaviour of coastline upwellings can be better observed from geostationary satellites imagery than by ground SST measurements (Browder and Turner, 1992). The METEOSAT data derived from the thermal infra-red channel have been shown to be appropriate for these studies because it provides the kind of spatial and temporal coverage desired for such investigations.

Since 1991, the METEOSAT high resolution transmission can be received by a Primary Data User Station (PDUS) installed at the of University of Abidjan. This ensures that we receive regular half hourly Visible, Thermal and Infra Red Water Vapour images only a few minutes after they have been scanned.

In this paper, ground measurements and Thermal Infra Red data from METEOSAT are used to study the spatio-temporal evolution of the SST along the coastline of Côte d'Ivoire. Preliminary results are shown and discussed.

2. Data set and its processing.

Two data sources have been used in this study :

– the METEOSAT images used in this preliminary study are from January, 1st until September, 30th 1993. The images acquired during this period must allow to detect the minor and the major upwellings. These data set consists of half hourly Thermal Infra Red images over the area between -10° W to 0° and 0° to 10° N. The size of the selected image consists of 256 lines of 256 pixels.

– the second data source was provided by five coastal stations sampled by the Centre de Rechercheres Océanologiques of Abidjan. These stations are located along the open Ivorian gulf, from Tabou (near Cape Palmas) to Assinie (near the border of Ghana). The available ground SST data have been acquired between January and March 1993.

The differents steps of the processing of image data.

a) The Thermal Infra Red, the adminstrative message and the calibration coefficients are extracted from the raw data. The raw Thermal Infra Red image extracted represents the whole earth disk as seen by METEOSAT Infra Red detectors.

b) The image is transformed into radiance image by using the following formula:

Radiance = (NC -SPC)*IRcal,

where, NC is the numerical count, SPC and IRcal represent calibration coefficients disseminated with the image data. The radiance image is converted into a temperature image through a transcription table sending by ESOC.

c) In our study, the image of the 12^{th} January 1993 has been used to screen the land. As a matter of fact, this image represents a clear sky situation and there is a great contrast between land and sea.

A processing of the 47 daily Thermal InfraRed images is carried out in order to generate a daily synthesis image by maximum of temperature. The presence of cloud cover leads to a severe reduction of our possibility to observe daily the oceanic structures. So, a pentade image using the same algorithm is also carried out every five days.

A mapping of the sea surface temperature is established using a pentade image since January 1993.

3. First Results.

In spite of the abundance of the cloud cover (During the dry season, 45% of the daily images are cloudy) over the study area, the preliminary results which have been obtained about SST are encouraging.

The first minor upwelling appeared during the second pentade of January 1993. The ground SST measurements carried out on differents sites (Assinie, Abidjan, Tabou, San Pedro, Fresco) show that there is a decrease of sea surface temperature from January 5^{th} to January 9^{th} for all sites except Assinie. The corresponding image is on figure 2a. This phenomena coincids with the period called «harmattan». The next years observations will probably provide more tools to understand if there is a relationship between the decrease of the SST and the «harmattan».

The next minor upwelling took place on March (from 22 to 25). It was located in the West coast of Côte d'Ivoire, from Tabou to Grand Lahou along 250 km approximatively. The relative sea surface temperature was about 23°C. We have also got confirmation of this cooling with ground SST measurements. The corresponding image is on figure 2c. The figures 2b (February), 2d (April), 2e (May) and 2f (June) illustrate the SST from January to June.

The intensity of the two minor upwellings is more important in the West than in the East coastline of Côte d'Ivoire. The fact that the intensity of the minor upwelling was more important in the West than in the East can have probably a consequence on the coastal pelagic ecosystem of this area (Pezennec O., Bard F.X., 1992).

The major upwelling began on July and was observed along all the coastline of Ghana and Côte d'Ivoire [the figures 3a and 3b (July), 3c and 3d (August), 3e (September) illustrate the major upwelling]. It took place one month after the end of the rainy season and persisted during the «small» dry season (August). The the mechanism of the minor and major upwellings are probably different. One starts on the dry season and, the other, at the end of the rainy season. A collection of data during a few years will give some keys to understand the relationship between climate and upwellings. The figure 4a is an image from October.

4. Conclusions

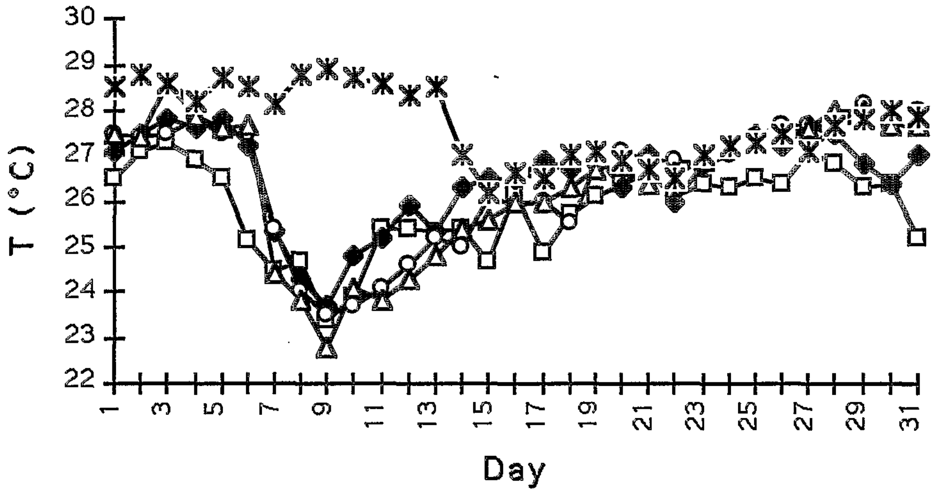
The METEOSAT data used in this study show that twice a year there is decrease of the sea surface temperature along the coastaline of Côte d'Ivoire.

a) During the year 1993, the minor upwelling has been observed two times (on January and on March during the dry season). In the two cases, the phenomena lasts less than a week, however, the relative cooling is detected by the TIR detectors of METEOSAT. Each time the upwelling takes place, we noticed that the sky was clear. So, it seems important for future investigations to study the impact of climate on upwellings and vice- versa.

b) The major upwelling began approximativelly on July and lasted 2 months. The decrease of the coastal sea surface temperature streches out near Cape Palmas as far as to Ghana coastline.

The preliminary results of our study confirm the importance of using satellite information in SST analyses. Spatial analyses of pelagic resources and fishering using satellite-derived METEOSAT data may provide additional perspective for understanding the origin of upwelling and for improved fisherings in the study area. The multitemporal study of the SST along the coastline of Côte d'Ivoire and Ghana associated with climate must be contribute to understand the mechanism of this phenomena.

Figure 1:Temporal evolution of ground SST measurements in January 1993



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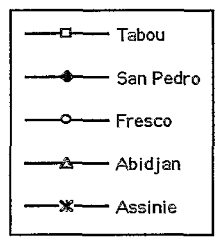

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Browder J.A. and S.C. Turner, 1992. Use of oceanographic data to support stock assement of oceanic pelagic species in the Western North Atlantic. ICCAT Working Document, SCRS/92/130.

Pezennec O., Bard F.X., 1992. Importance écologique de la petite saison d'upwelling ivoiro-ghanéenne et changements dans la pêcherie de sardinella aurita, Aquat. Living ressour., 1992, 5, 249-259.

ANNEX 1: The processing image data

– 47 images from the Thermal Infra Red channel were acquired every day and a daily synthesis image was caried out.

These images are based on a temperature brightness maxima. No correction for atmospheric attenuation is done. Therefore the relative SST value observed are low in comparison with actaul ground SST measurements.

CAPTIONS OF COLOURED IMAGES

Figure 2A : Second five-days period of January 1993.

Figure 2B : A five-days image of February 1993.

Figure 2C : Image of March 23 th, 1993

Figure 2D : A five-days image of April 1993

Figure 2E : A five days image of May 1993

Figure 2F : A five-days image of June 1993

Figure 3A and 3B : Two five-days images of July 1993

Figure 3C and 3D : Two five-days images of August 1993.

Figure 3E : A five-days image of September 1993

Figure 4A : A five-days image of October 1993

« MINOR UPWELLING, THEN WARM SEASON OF YEAR 1993 »

Fig. 2A

Fig. 2C

Fig. 2B

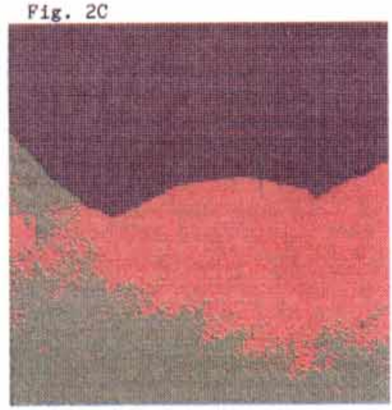

Fig. 2D

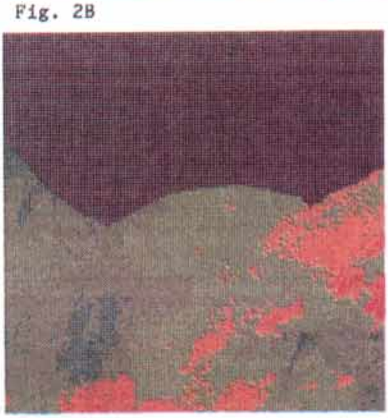

Fig. 2E

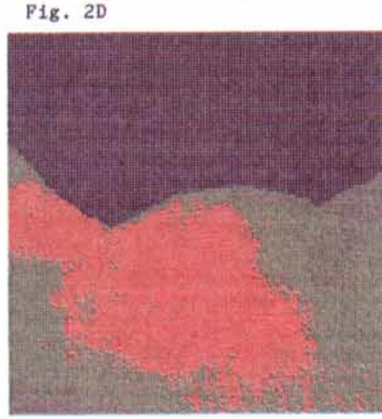

Fig. 2F

« MAJOR UPWELLING OF YEAR 1993 »


Fig. 3A


Fig. 3B


Fig. 3C


Fig. 3D


Fig. 3E


Fig. 4A