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CHLOROPHYLL PIGMENT CONCENTRATION AND SEA SURFACE TEMPERATURE OF THE BLACK SEA

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ABSTRACT

As an enclosed sea, the Black Sea has countless economic activities (mainly tanker traffic and fisheries) and recreational activities, with the consequence of being threatened by dramatic dangers and pollution. Optical remote sensing can provide a novel look at physical processes and then driving mechanisms. It is worthwhile to know how the temperature and other marine parameters change on seasonal and long-term scales.
In the paper CZCS (Coastal Zone Color Scanner) and AVHRR (Advanced Very High Resolution Radiometer) satellite were used to study the relationship between photosynthesis and SST since phytoplankton forms the very lowest clement in the marine ecosystem. Satellite derived data could provide information on the amount of sea life present in any given area throughout the world. The information could also be useful in connection with studies of global changes m temperature and what effect they could have on the total abundance of marine life.
Present work which used CD-ROM set from NASA did not found evidence of correlation between chlorophyll pigment concentration and SST of the Black Sea with 99.95% certainty, three channel algorithm or the use of fluorescence or chlorophyll absorption peak in the red suggested for future work.

Keywords: Phytoplankton, CZCS, AVHRR. Temperature, Black Sea

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INTRODUCTION

Many studies have been made on the relationship between SST (sea surface temperature) and chlorophyll, for instance by [1,2,3,4].

The upwelling event, due to the interface between cold and warm water masses brings nutrients up from deep waters which is attractive to plankton and therefore it is possible to detect likely areas for plankton concentration by monitoring the sea temperature [5].

Normally the carbon dioxide in the atmosphere is in balance with the carbon dioxide in the ocean. During photosynthesis phytoplankton remove carbon dioxide from seawater and release oxygen as a by-product. This allows the oceans to absorb additional carbon dioxide from the atmosphere. If fewer phytoplankton existed, atmospheric carbon dioxide would increase. Phytoplankton also affect carbon dioxide levels when they die. Phytoplankton, like plants on land, are composed of substances that contain carbon. Dead phytoplankton can sink to the ocean floor. Other material sinking to ocean bottom soon covers the phytoplankton. In this way, the ocean act as a sink, a place to dispose of global carbon, which otherwise would accumulate in the atmosphere as carbon dioxide. Other global sinks include land vegetation and soil. However the carbon sinks are frequently returned to the atmosphere as carbon dioxide by burning or decomposition. Deforestation contributes to the accumulation of carbon dioxide in the atmosphere by reducing the removal of carbon dioxide. Carbon dioxide acts as a 'greenhouse' gas in the atmosphere, and therefore an increase in its concentration may contribute to global warming. The increase of carbon dioxide means less long-wavelength energy emitted from the Earth can escape to space. This would lead to a gradual warming of the Earth, but there are other factors that could counteract this warming effect. This would lead to a gradual warming of the Earth, but there are other factors that could counteract

For example, cloud cover reflects sunlight before it reaches the Earth; an increase in cloud cover would reduce the amount of sunlight that reaches the Earth's surface.

If we can set up a relationship between photosynthesis and temperatures, satellites could aid in determining the amount of sea life present in any given area throughout the world. The information could also be used to explain global changes in temperature and what effect they could have on the total abundance of marine life.

Hood et al. [1] led a two-day cruise in which he collected both satellite thermal data as well as biological data off the coast of northern California. His team found two distinct waters masses, one hot and one cold, which were divided by a front. On the landward side of the front, they found that there was a sharp decline in SST (sea surface temperature) as well as an abundance of phytoplankton biomass. On the seaward side of the front, they observed an increase in SST as well as a decrease in the amount of phytoplankton biomass. However Robinson and LeB. Williams [2] who performed another study in the mid-1980s in the British Antarctic did not support the hypothesis that SST (Sea Surface Temperature) directly affects the amount of chlorophyll concentration. Correlation between SST and chlorophyll pigment concentration has also been investigated by Nykjaer and Van Camp [3] on a Northwest African upwelling area. Nykjaer and Van Camp [3] used ten simultaneous pair of CZCS and NOAA GAC images and the images were analyzed with respect to;

a) Describing the relationship between SST and CHL (total pigment concentration) in terms of similarities, discrepancies and spatial variability

b) Identifying different water masses through the relationship between SST and CHL

c) Inferring concepts of upwelling events based on the SST/CHL relationship. They did not find a linear correlation between pigment concentration and temperature in the surface.

The pigment pattern of the Black Sea has been studied from space using the CZCS by Barale and Murray [7] and Barale and Schlittenhard [6]. Their findings, in all of the CZCS images (they considered composited images) available, showed that major rivers such as the Danube, Dnestr and Dnepr, the Don in the sea of Azov, as well as other minor rivers, mostly along the western and southern coast of the Black Sea, produce distinct plumes interacting with the marine environment. Within the range of plumes, as with coastal runoff in general, it is often impossible for the CZCS to distinguish the signature of biogenic pigments from that of the total load of dissolved and suspended materials present in the water

The main feature of the Black Sea appearing in the OCEAN time series of composite images is the high pigment concentration. This could possibly be related to the combined effect of coastal runoff, strong stratification and circulation in general, on the presence and abundance of suspended and dissolved matter in surface waters. The impact on the surface color field of river discharges along the western coast can readily be evaluated [7].

THE DATA

18-km resolution scenes from the CZCS and the AVHRR CD-ROM (Compact Disc-Read Only Memory) set were used [8] containing chlorophyll pigment concentration and SST respectively. The CD-ROM set was obtained from NASA (National Aeronautics and Space Administration). Two satellite derived data sets presented on the CD·ROM were in co-registered format [8].

DATA ANALYSIS

64 images of the Black Sea were extracted from the NASA CD-ROM set. Statistics were calculated by excluding flag values for the whole basin. 32 of the images were from the CZCS monthly averaged phytoplankton pigment concentration, the other 32 were from AVHRR monthly averaged SST for the same time. The cross-plot of 64 images is presented in Figure 1. Both monthly averaged chlorophyll pigment concentration and SST have been plotted against time in Figure 2.

The satellite data sets gave us the information for the SST and CHL values in the form of a digital number, DN. We then applied the following equations, as suggested by NOAA [8] to determine the SST and CHL.

CHL (in mg/m^3) is given by:

$$CHL\ 10^{(0.012\,DN\ 1.14)} \qquad (1)$$

where DN is an integer between 0-255 from the CD-ROM image data, SST (in °C) is given by:

$$SST\ 0.15\mathrm{DN} \qquad (2)$$

where DN is an integer between 0-255 from the CD-ROM image data.

RESULTS

Figure 1 shows the monthly average chlorophyll pigment concentration and SST of whole basin. Relationship between SST and chlorophyll pigment concentration were not significantly different ($p<0.05$) statistically.

Figure 2 shows the variability of average chlorophyll concentration and SST in a year. The figure were drawn by averaging SST and chlorophyll pigment concentration from 1981-1986. There were decrease in both chlorophyll and SST from November to March and increased from March to June.

Figure 3 shows monthly averaged CZCS data for the Black Sea from 1979-1986 in both the mean and individual year chlorophyll variability. The highest values of chlorophyll pigment concentration was occurred from September to January and there was a significant differences year by year. La Violette [9] used similar data for the North Adriatic region, have found that the highest values of chlorophyll pigment concentration occur in winter months. High chlorophyll pigment concentration in winter could be due to less-stratified (better-mixed by winter winds) water that is more likely to be rich in nutrients.

CONCLUSIONS

As can be seen from the data were obtained on the CD-ROM set, there was no evidence of correlation between chlorophyll pigment concentration and SST of Black Sea. The zero correlation hypothesis was tested and passed with 99.95%, certainty.

As far as is known there are no clear indications as to whether temperature was the principal component in determining biomass growth. There are too many factors which must be taken in to account. Surface flow zones, substrate concentration, temperature gradients, oxygen abundance, and other factors are important [8].

There is no unique algorithm for case 1 waters (those waters for which phytoplankton and their by-products play the dominant role in determining the optical properties of the water body) and case 2 waters (sediment dominated waters) as it seems to be dependent on geographic locations. Thus different waters require different algorithms [10]. As Bowers, Harker and Stephan [11] indicated, inorganic sediment concentration has to be known in order to derive chlorophyll concentration from a blue-green ratio measured by satellite to obtain more accurate results. Bowers, Harker and Stephan [11] suggested using a three channel algorithm or the use of fluorescence or chlorophyll absorption peak in the red.

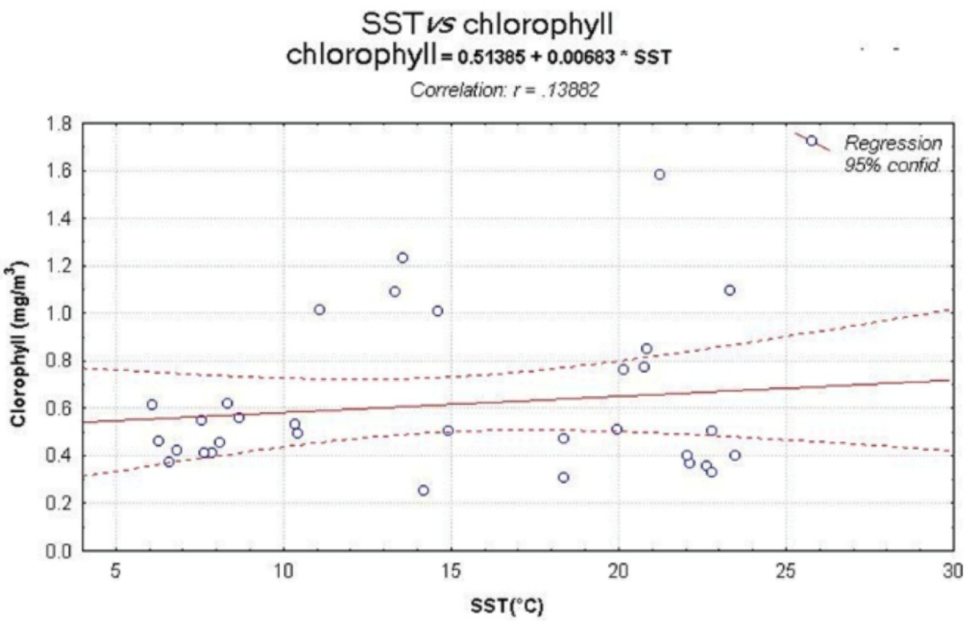

Figure 1. Monthly average chlorophyll pigment concentration and SST of whole basin.

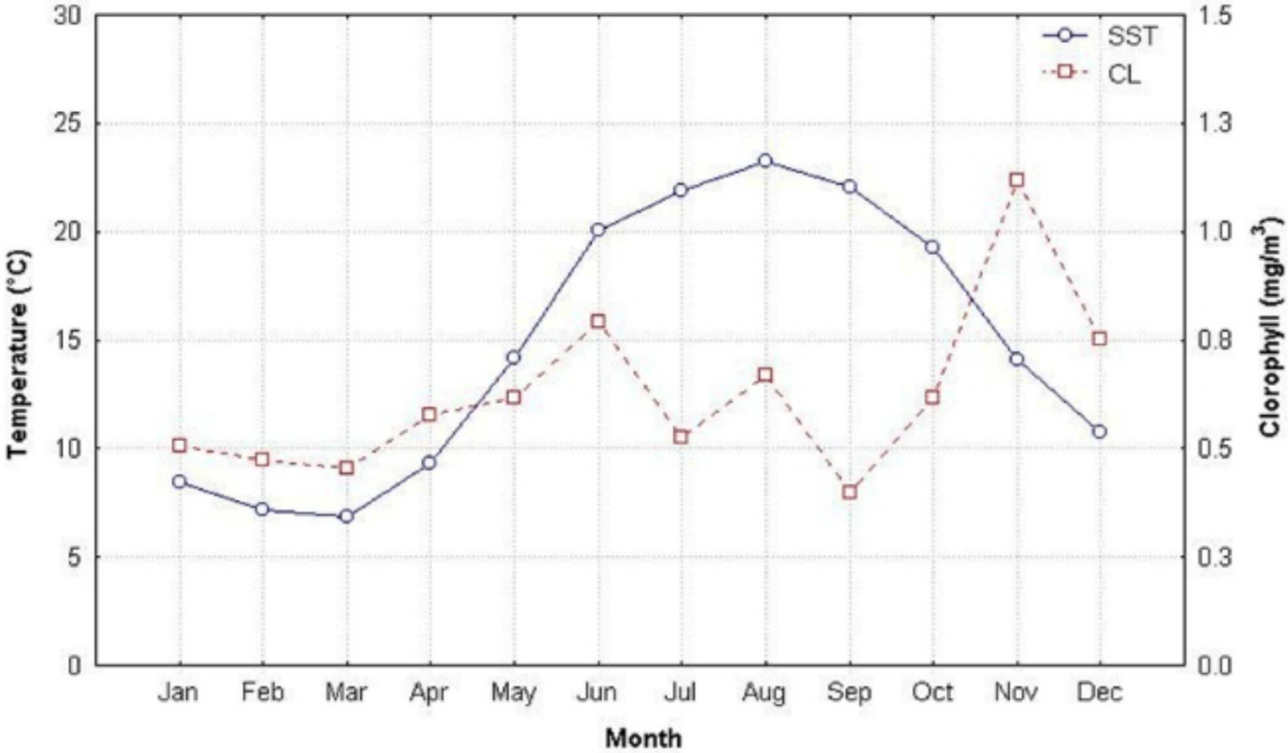

Figure 2. Monthly average variation of SST and chlorophyll pigment concentration on the Black Sea.

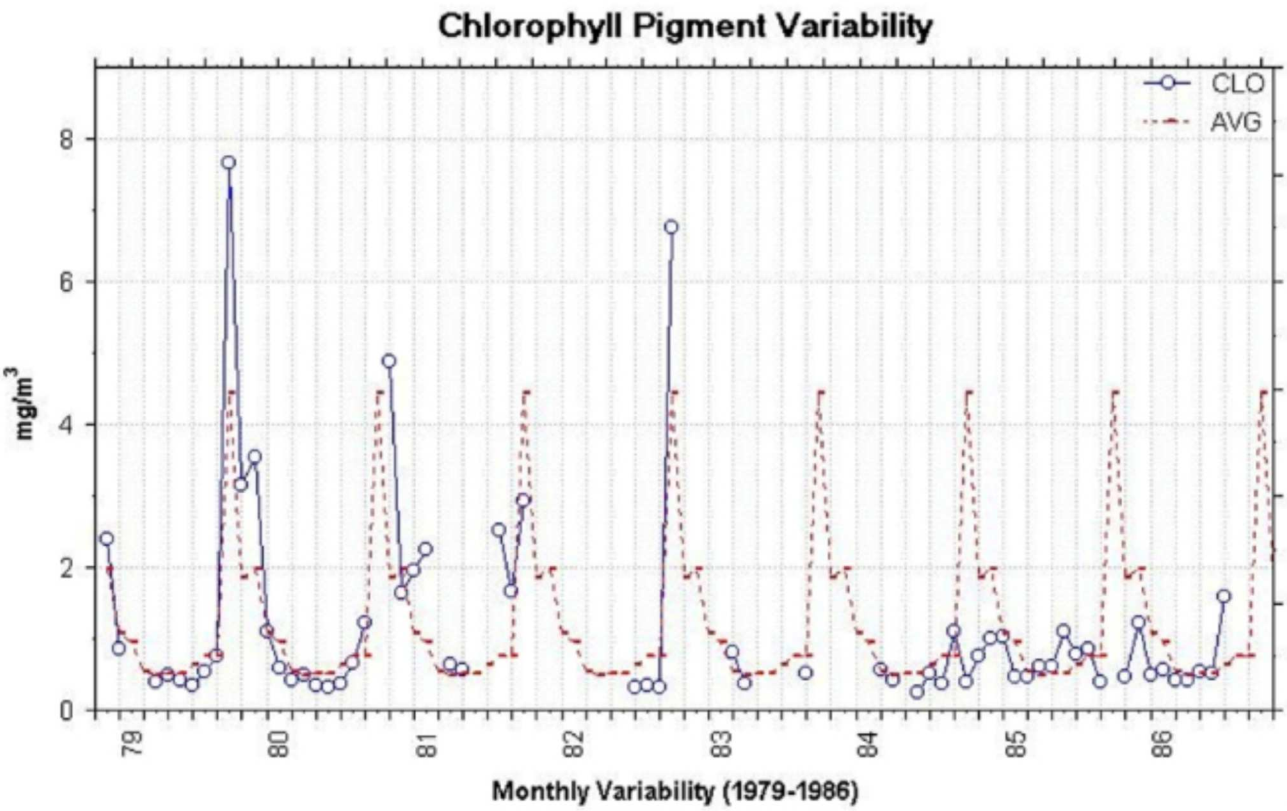

Figure 3. Monthly mean chlorophyll pigment variability from 1979 to 1986.

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