Changes in MCSST and Chlorophyll-a Off Sanriku Area (38-43N, 141-150N) from NOAA/AVHRR and SeaWiFS Data

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Abstract:

The purpose of this study is to describe the change of the spring bloom and oceanographic condition. The variation of pigment concentration derived from the satellite ocean color data has been analyzed. According to the movement of blooming area, blooming was very concerned with a rising trend of sea surface temperature and a supply of nutrients. A nutrient rich water carried by the Oyashio encounters with the warm Core ring, where mixings and blooms are observed. We examined the correlation by using the satellite observations of the temperature and chlorophyll-a for the spring seasons (May, June, July) of 1998 the off Sanriku area (38-43N, 141-150E).

Using the SeaWiFS data, we process the data into the level-3, which contains the geophysical value of chlorophyll-a. And chlorophyll-a data is mapped for the water between 110E and 160E, and 15N and 52N with a 0.08 * 0.05 degree grid for each image.

And Sea Surface Temperature (SST) data is produced using the AVHRR onboard the NOAA. The SST is derived by the MCSST. Then, the data is mapped for the water as much as chl-a data. And these gridded image was made by detection of each water masses, which are Kuroshio Extension, the warm-core ring and the Oyashio Intrusion, etc., using those satellite images to determine short term change.

Off Sanriku is a place where warm-water pool and the Oyashio are mixed. When warm streamer has intruded in cold water, the volume of phytoplankton increases at the tip of warm streamer. Warm water streamer was trigger of occurring blooming. And also, SeaWiFS images provided as much information for the studies of chlorophyll-a concentrations in the surface.

1. Introduction

The OrbView-2 was launched by NASA in August of 97, and the SeaWiFS (Sea-viewing Wide Field-of view Sensor) started its observation since September of 97. SeaWiFS is a successor to OCTS(Ocean Color and Temperature Scanner), which was the real optical sensor for ocean observation. JAMSTEC processes the SeaWIFS data into the level-3 from the level-0. The SeaWiFS data was processed by the processing software, as the atmospheric correction, and processed by the post-processing software to generate the concentration of chlorophyll-a. As an important element for production in the ocean, temporal and spatial variations of phytoplankton biomass have been studied for many years.

The purpose of this study is to describe the change

of the spring bloom and to make clear the relationship between the changes of surface chlorophyll a concentrations and sea surface temperature. According to the movement of blooming area, blooming was very concerned with a rising trend of sea surface temperature. A cold water, where is called as the Oyashio intrusion, encounters with warm waters as the warm core ring of the Kuroshio extension Off the Sanriku. The cold water also carries nutrients to this area. This temperature rise with much nutrients was very important factor for plankton to occur blooming.

We examined the relationship between the temperature and chlorophyll-a by the satellite observations. Temporal and spatial distribution of chlorophyll and SST distribution in the Off Sanriku and adjacent waters were analyzed by using SeaWiFS and AVHRR/NOAA data during the period May to July, 1998. Off Sanriku area (38-43N, 141-150E) is a place where warm-water pool and the Oyashio are mixed. Oceanographic conditions were made by detection of each water masses, which are the Kuroshio Extension, the warm-core ring, the Oyashio Intrusion, etc., using the satellite images to determine short term change.

Using the SeaWiFS data, we process the data into the level-3, which contains the geophysical value of chlorophyll-a. And chlorophyll-a data is mapped for the water between 110E and 160E and 15N and 52N with a 0.08 * 0.05 degree grid for each image. And Sea Surface Temperature (SST) is produced using the AVHRR (Advanced Very High Resolution Radiometer) onboard the NOAA. The SST is derived by the MCSST equation. Then, the data is mapped for the water as much as chl-a data.

In this paper we investigate the relationship between the variation of sea surface temperature and chlorophyll pigment concentration by use of those satellite data.

2. Method and MCSST ,SeaWiFS Data

2.1 Receiving system

JAMSTEC operates a HRPT receiving station to capture a HRPT data from NOAA polar orbit satellites and from OrbView-2.This receiving station is a products of SeaSpace, U.S. A parabolic antenna with a diameter of 1.2m tracks satellites by a scheduler within a workstation, HRPT signals from NOAA or OrbView-2 are immediately recorded on the hard disk of the workstation

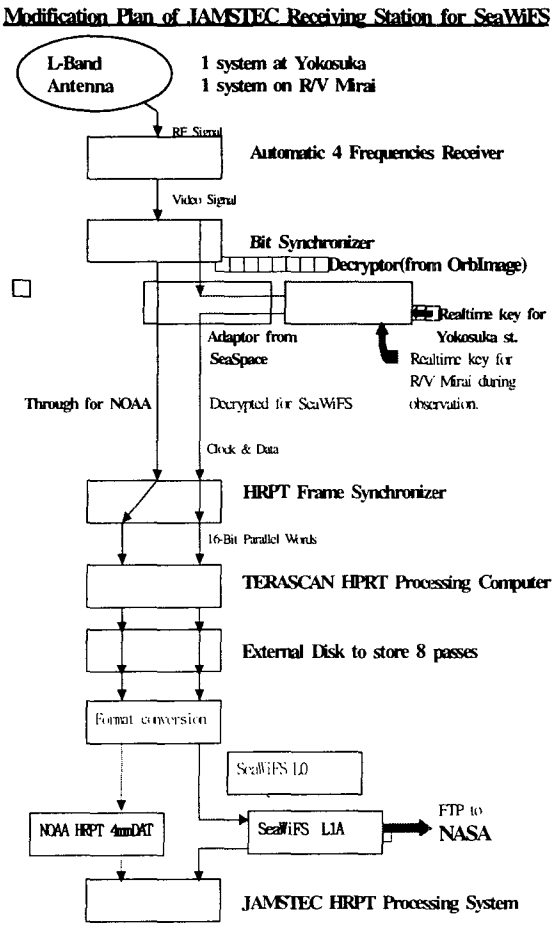

Figure 1. Receiving System

2.2 Chl-a

The receiving system processes the SeaWIFS data into the level-1 from the level-0 by scheduler. Following to this process, SeaWiFS team in GSFC/NASA copies the level-1 data into their computer from our computer through the Internet synchronizing to our notification message that we produced level-1a data. SeaWiFS team processes the data into the level-3, which contains the geophysical value of chlorophyll-a. An image size of received SeaWiFS data is about 1085 (pixel)* 2500~4000 (line). Then, the data is mapped on their global coverage data sets at GSFC. It is possible to browse our data through the HRPT Browse of SeaWiFS home page. (http:// seawifs.gsfc.nasa.gov/ cgibrs/ hrpt_browse.pl)

JAMSTEC has been working for the software to receive and to process SeaWiFS data with NASA. JAMSTEC has processed the SeaWiFS data and could produce the image of chlorophyll-a on Dec.2, 97. The SeaWiFS has multiple channels in the visible region to observe the ocean color. The SeaWiFS data was processed by the pre-processing software, as the atmospheric correction, and processed by the post-processing software to generate the concentration of chlorophyll-a, which is supported by GSFC as SeaDAS.

Figure 2 shows a distribution of chlorophyll-a concentration between 120E-170E and 10N-60N, observed by SeaWiFS at about 03:04 am UTC on May 11, 1998. This image of level-3 data is the one which had been processed for analysis purposes. The SeaWiFS data was processed the data into the level-3, which contains the geophysical value of chlorophyll-a concentration. The red area means highest concentration while the blue area indicates lower concentration. Regional high chlorophyll area was found at the southeast side of the Hokkaido.

2.3 MCSST data

Each HRPT data is geometrically adjusted by the operator with modifying each orbit information. AVHRR data is extracted from HRPT data an inflight calibration for thermal bands. The SST was calculated using thermal band channel 3,4 and 5 by the MCSST (Multi-Channel Sea Surface temperature)

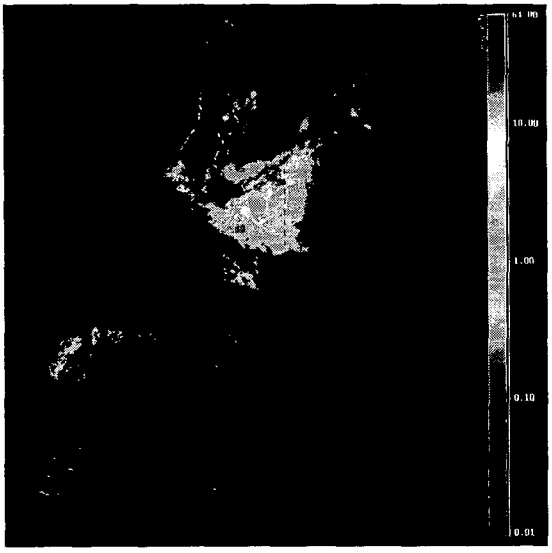

Figure 2. Level-3 image (May 11,1998)

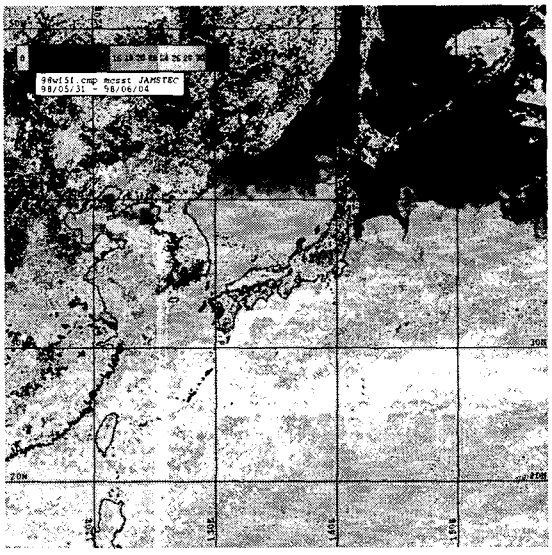

Figure 3. Weekly composite image MCSST

NOAA equation. And MCSST was mapped for our study area with 2.4Km resolution, 2048*2048 size for daily composite and weekly composite image. Fig 3 shows the weekly composite image, May 31-June 4.It is very good to show to Kuroshio Extension.

2.4 Gridding of data to compare

Geophysical image data of AVHRR and SeaWiFS have a different coordinates value on longitude and latitude. We used the subsampled image on the SeaWiFS image data. SeaWiFS data is subsampled from full-resolution data with every second pixel of a scan line and every fifth scan line and creating the reduced resolution image.

Figure 4 is shown of the difference from adjacent pixel for the longitude and latitude information of SeaWiFS image. In order to match the each geophysical position we made the gridded image by covering the lattice of the unit 0.08 degree in longitude and 0.05 degree in latitude.

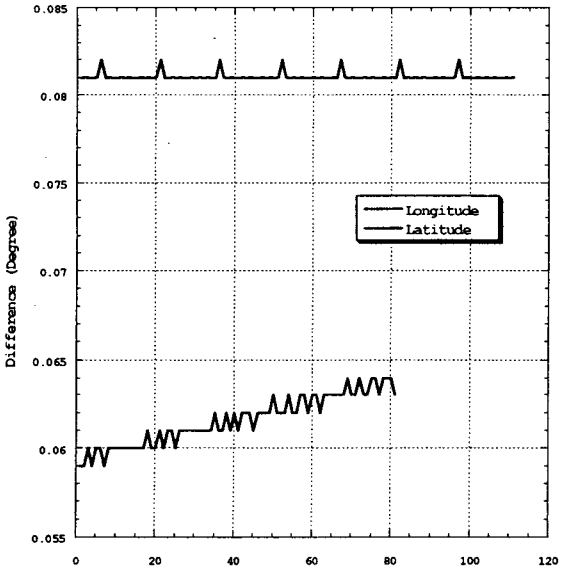

Figure 4. The Difference from adjacent pixel

3 Temperature vs Chlorophyll-a relationship

3.1 Temperature change of MCSST and Chl-a

The main data used here are 24 scenes of NOAA data and 24 scenes of SeaWiFS data, April ~ June 1998. We selected an intensive study area Off Sanriku between 43N-38N and 141E-150E.

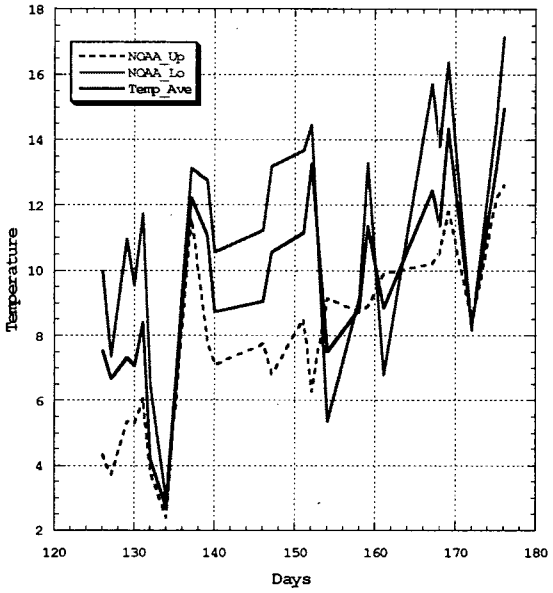

Figure 5. Average of MCSST

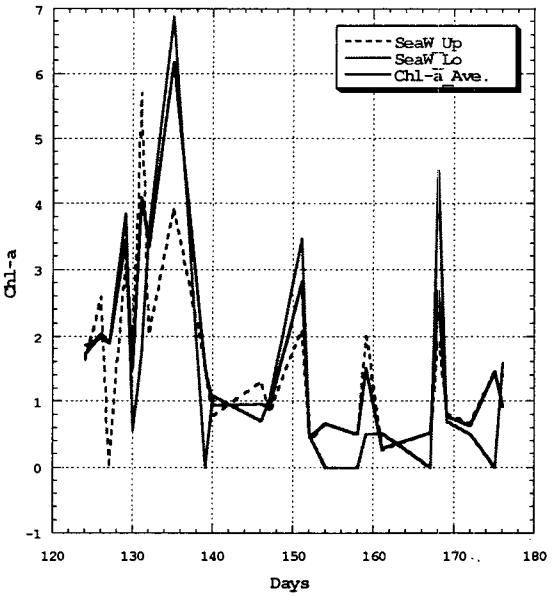

Figure 6. Average of Chl-a

Fig 5 shows the average of MCSST on 125-176 days data. Here Temp_Ave is the average of MCSST for the intensive study area and NOAA_Up and NOAA_LO are average of MCSST on the upper and lower area, respectively of the intensive study area. We can observe some Oyashio intrusion from a decrease of temperature. In Fig 5, it shows sometimes a rapidly increasing of SST, because Oyashio intrusion is trapped by warm cores and those waters were mixed with warm waters and heated.

Fig 6 shows a average of the Chl-a for the same period. Where Chl-a is average of chl-a average for the intensive study area, upper area and lower area. Oyashio is a source of nutrients for a primary production. When warm streamer intrudes in cold water or Oyasihio encounters the warm core, the phytoplankton shows blooms at the tip of warm streamer and at the mixing area. The increase of chl-a concentration on Fig 6 was synchronized with the increase of SST

3.2 Temperature vs Chlorophyll-a scatter plots

Fig 7 and 8 show relationship between temperature and chl-a. In Fig 7 (May 11, 1998), a high concentration of chl-a were observed around 10deg-C. This shows the bloom of phytoplankton was generated at this temperature, which is corresponding to the water of mixing. In Fig 8 (July 25, 1998), two blooming regions were identified by two different temperature regions. In the temperature 14~14.5 deg-C area, water between warm cores with Oyashio intrusion and Oyashio is held and getting warm. The temperature 9~10 deg-C area is mixing area with a head of Oyashio Intrusion and warm core Extension. As the spring bloom has terminated in the middle of May, the population of chl-a in Fig 8 was quite small compare to Fig 7.

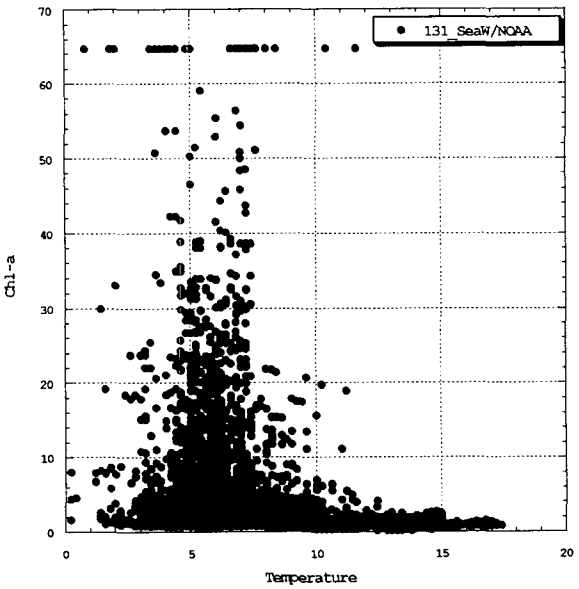

Figure 7. The scatter plots of 131 days

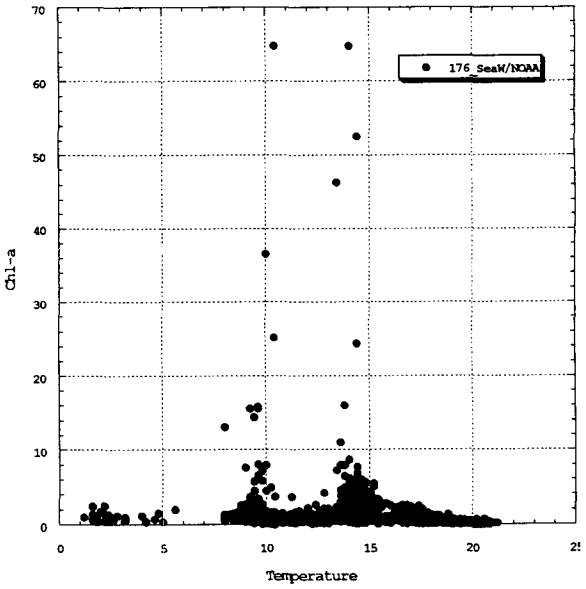

Figure 8. The scatter plots of 176 days

4. Conclusion

A time series SeaWiFS images demonstrated an usefulness satellite ocean color remote sensing for monitoring of spring bloom and visualization of surface flow which were not detected by sea surface

temperature images. Ocean color images from space may provide a valuable information from the viewpoint of biological productivity.

By a discussion on the relationship between MCSST and chl-a, we could identify an increase of chl-a concentration following to an increase of SST at a mixing area.

Also scatter plots presented the different type of chl-a distribution as function of SST, which was corresponding a different mechanism of a mixing Off Sanriku

5. References

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