D-3.2 Distribution of chlorophyll and its variability in the Pacific Ocean and the central Japan Sea

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Abstract For the global mapping of chlorophyll biomass using by ocean color remote sensing, ship observations were carried out in the Pacific Ocean and the central Japan Sea. Although satellite data can show surface chorophyll density, vertical distribution pattern should be known for calculating water culumn biomass. Phytoplankton vertical distribution model was established for estimating water column total phytoplankton biomass and primary productivity. The technologies for producing satellite ocean color composite images were developed. The monthly composites of CZCS-derived chlorophyll that covers the north west Pacific 1979-1986, was produced.

Key Words Northwestern Pacific, Japan Sea, CZCS, Composite image

1. Introduction

Global mapping of chlorophyll biomass is necessary to study global biogeochemical cycle of carbon. The international projects, IGBP and JGOFS, are in progress. Ocean color remote sensing is most useful tool for the global mapping of chlorophyll biomass. NASA is in prepation for the launch of Sea WiFS and NASDA is going to launch ADEOS/OCTS in 1996. For useful utilization of the ocean color data obatained from the satelites, we must carry out ship board observation and development of the composite image of ocean color remote sensing.

2. Research methods

Phytoplankton vertical model was established by modifing Platt's (1988) model. The vertical profiles of chlorophyll were produced by the model and the profiles were compared by the profiles obtained in ship observation.

Ship observations were carried out in the northwestern Pacific (Oyashio) in May to June 1993-1995, to elucidate chlorophyll biomass in spring bloom. Observations were conducted in the central Japan Sea in spring, summer and autumn 1993-1995, to obtain chlorophyll and grazing of zooplankton data.

The reliability and quality of ocean color composite images were highly checked. From a data set of about 4,000 CZCS scenes, a montly CZCS-derived chlorophyll maps for the Northwest Pacific during 1976-86 were produced.

3. Results and discussion

Several results in the vertical profiles of chlorophyll obtained by the phytoplankton vertical model and in the ship observation are shownin Figure 1. The percentage of agreement of the profile obtained by the model to that in the observation was 86% for abour 1000 samples in the sea near Japan and 93% for 90 samples in the equatorial region.

The result of the vertical distribution model and field experimental data and are well matched.

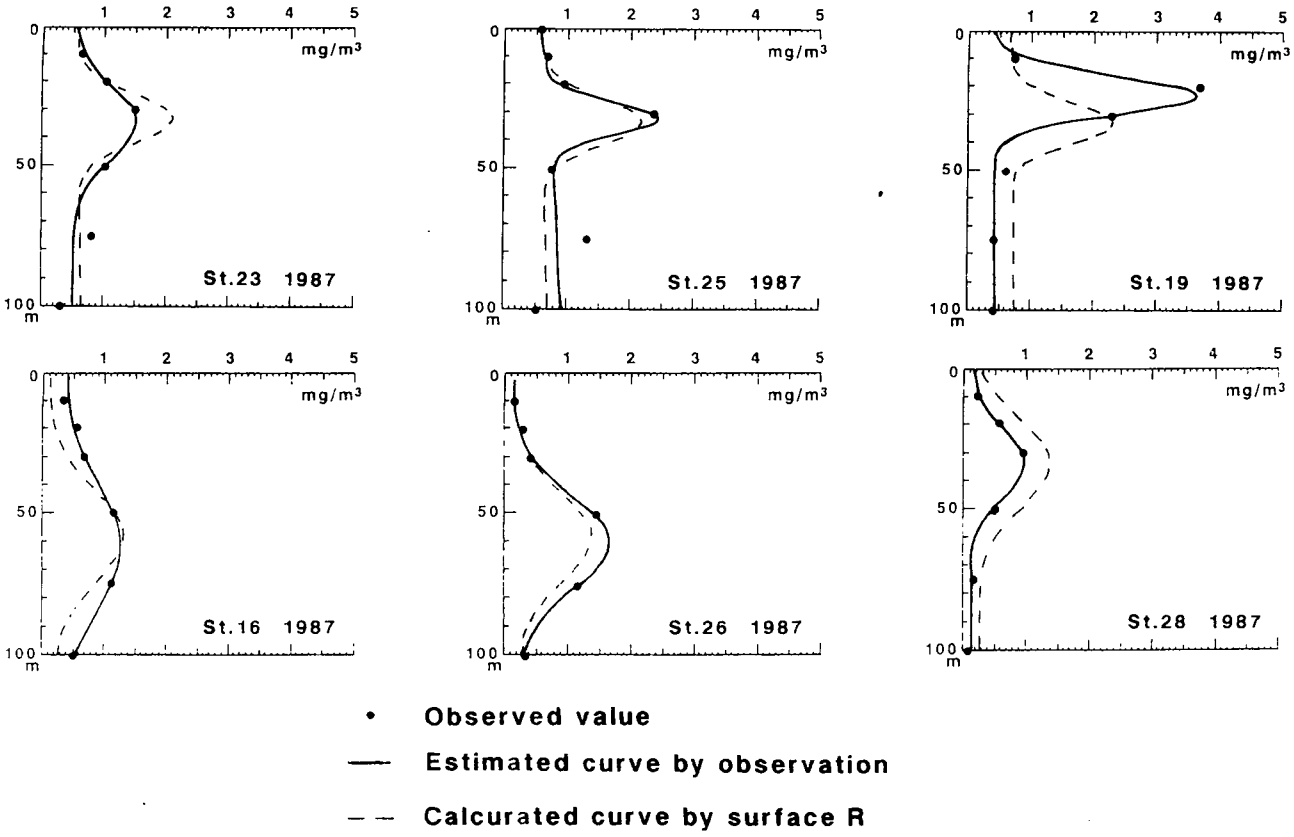


Figure 1 Vertical profiles obtained by the phytoplankton vertical model and in ship observation.

Phytoplankton blooms were observed in the northwestern Pacific in every year (Fig.2). The maximum chlorophyll concentrations were about 10 μ gl^{-1} in 1993, 2-4 μ gl^{-1} in 1994 and 1-3 μ gl^{-1} in 1995.

Water column stability was closely related to the occurrence of bloom. Moreover, silicate may be one of limiting factors in the spring bloom.

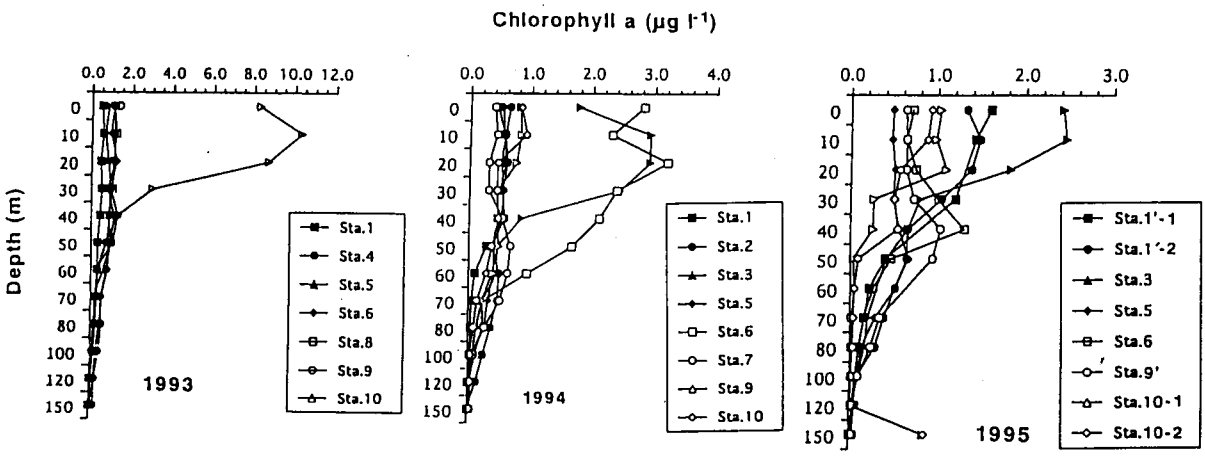


Figure 2 Vertical profiles of chrolophyll concentration (μ gl^{-1}) in the northwestern Pacific in spring

Subsurface chlorophyll maximum (SCM) was found in almost the whole area in the central Japan Sea. SCM occurred at depths between 20-50m and chlorophyll a concentration at SCM was high in spring as compared with these in summer and autumn (Table 1).

	Spring	Summer	Autumn
Depth of SCM (m)	22.6±10.5	48.1±10.9	38.0±5.7
Maximum chl.*a* (mg/m^3)	2.18±0.67	0.95±0.24	1.20±0.41
SCM%* (%)	16.9±3.0	24.2±4.4	28.1±4.6

* Percentage of integrated chl.*a* in the maximum±5m column to that in 0–100m column.

Laboratory experiments showed that the mean ingestion rate of Euphausiacea pacifica increased with cell concentration up to a maximal rate that remains essentially unchanged with further increase in cell concentration (Fig.3). The maximal ingestion rate (daily ration) was highest (375 μ gC ind.$^{-1}$ d^{-1}) in summer, indicating ca. two times as high as those in the other seasons (Fig.3).

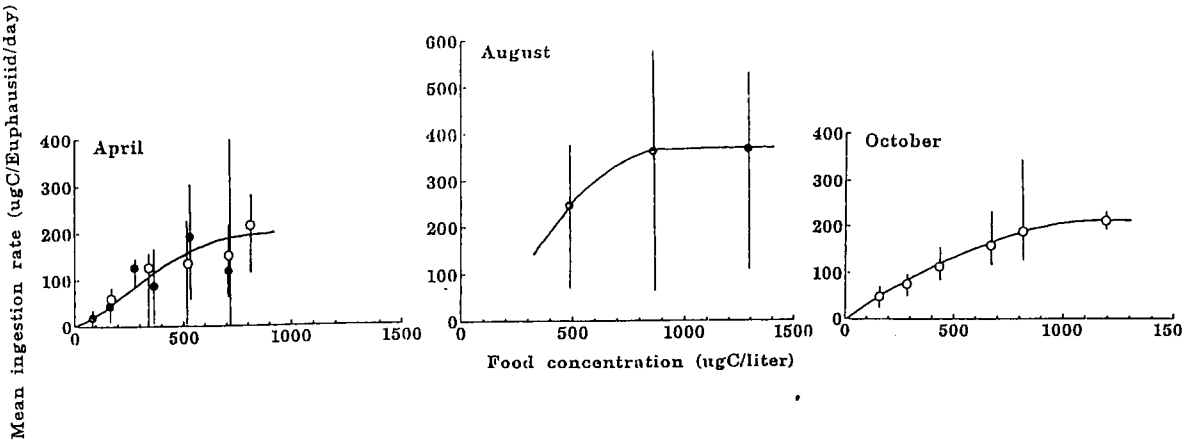
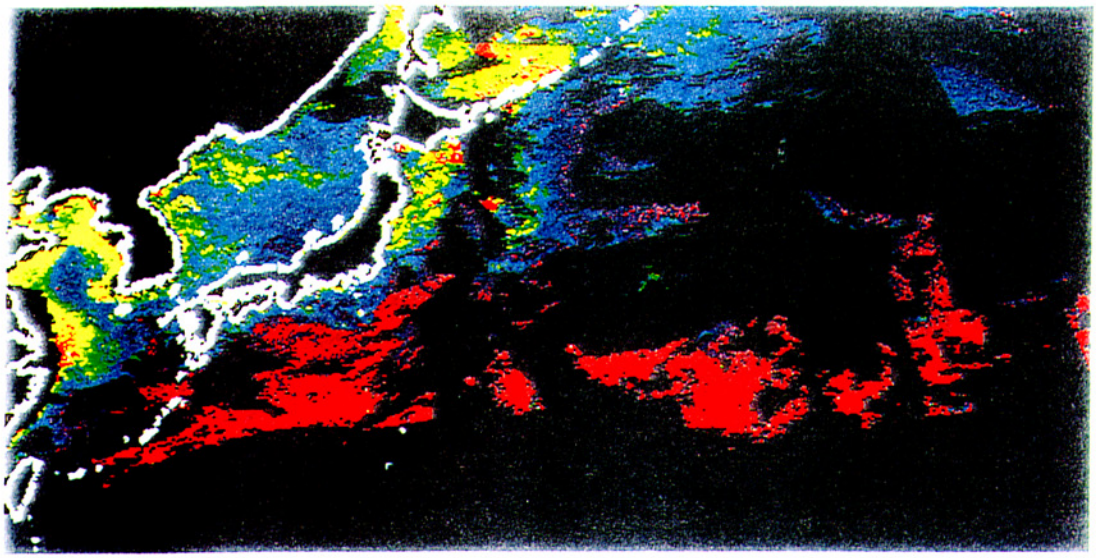
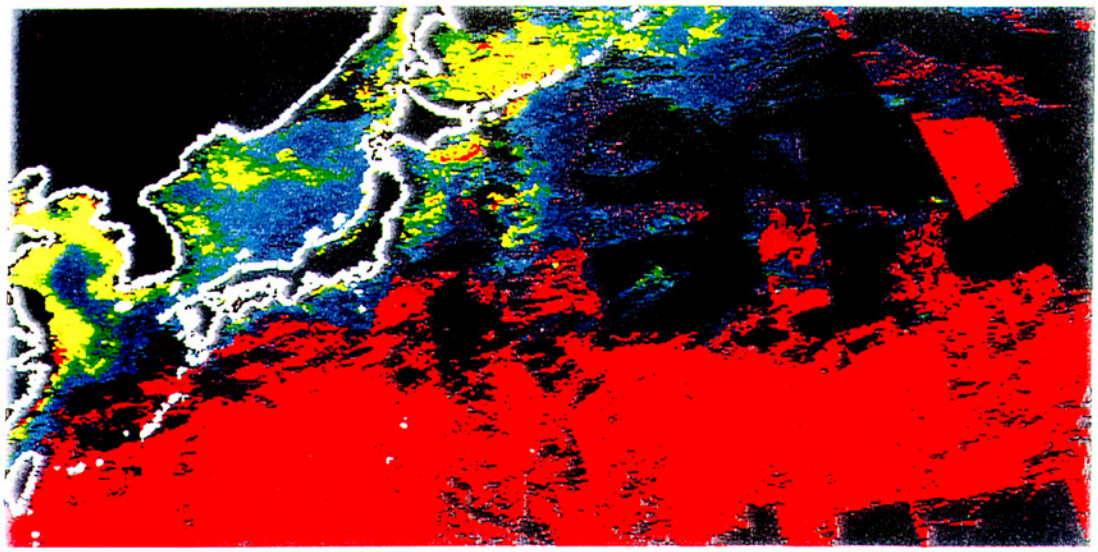


Figure 3 Mean ingestion rates of Euphausiacea pacifica (adults and juveniles) on various concentrations of Chatoceros sociale. Solid circles: 1994, open circles: 1995.

From a data set of about 4,000 CZCS scenes, and in use of the developed data processing system, we have composed a monthly CZCS-derived pigment maps for the Northwest Pacific during 1979-86. We consider the results attain enough high quality either in terms of cloud screening, atmospheric correction, and finer spatial resolution. An example of the monthly composite is shown in Figure 4, together with our older result composed in three years ago.



(a) 3年前に作成した複合画像



(b) 今回作成した複合画像

Figure 4 Phytoplankton pigment concentration composite image of the northwestern Pacific Ocean, May 1980. (a)three years ago. (b)this time.