No.D-3.3

Study on the Ocean Environment Index Based on Satellite Ocean Color Data

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Total Budget for FY1990-1992 25,995,000Yen

Abstract An automated biogeochemical monitoring were conceptually designed using Japan-Korea ferry boat for supplementing the satellite data and for constructing seasonal and long-term time series of phytoplankton biomass and related dissolved nutrients with revealing their spatial changes. In Tsushima Strait (the continental shelf sea), a phytoplankton blooming occurred in spring, which terminated in early summer presumably because of N-limiting. In the Seto Inland Sea, blooming persisted from early spring to early summer. In the termination phase of blooming, dinoflagellates occupied 20% of the phytoplankton biomass in the eastern Inland Sea and the cyanophyceae smaller than 2 micron was dominant in Tsushima Strait, where the NO3-N was the limiting factor for the phytoplankton growth. The ferry monitoring was found to be quite feasible for the above purposes.

Key Words Phytoplankton Blooming, Japan-Korea Ferry Boat, Satellite Ocean color data, Biogeochemical Monitoring, Ship Intake Sensing

1. Introduction

Satellite ocean color data are efficient for mapping the biogeochemical state of the ocean area. However, the aspect of getting full time series is not fulfilled by satellite because of the cloud coverage and the fact that the satellite data are indirect signals and hence is to be validated by some other data. We made a data base to validate the ocean color data[1]). However, the existing ship-based observation data are not sufficient in number to be coincident the satellite data. Some platform that can measure the *in situ* biogeochemical parameters of high resolution with respect to time and spaceis required. And the effort is required to make the phytoplankton chlorophyll an index to indicate the ocean environmental changes such as the eutrophication or the ocean pollutions.

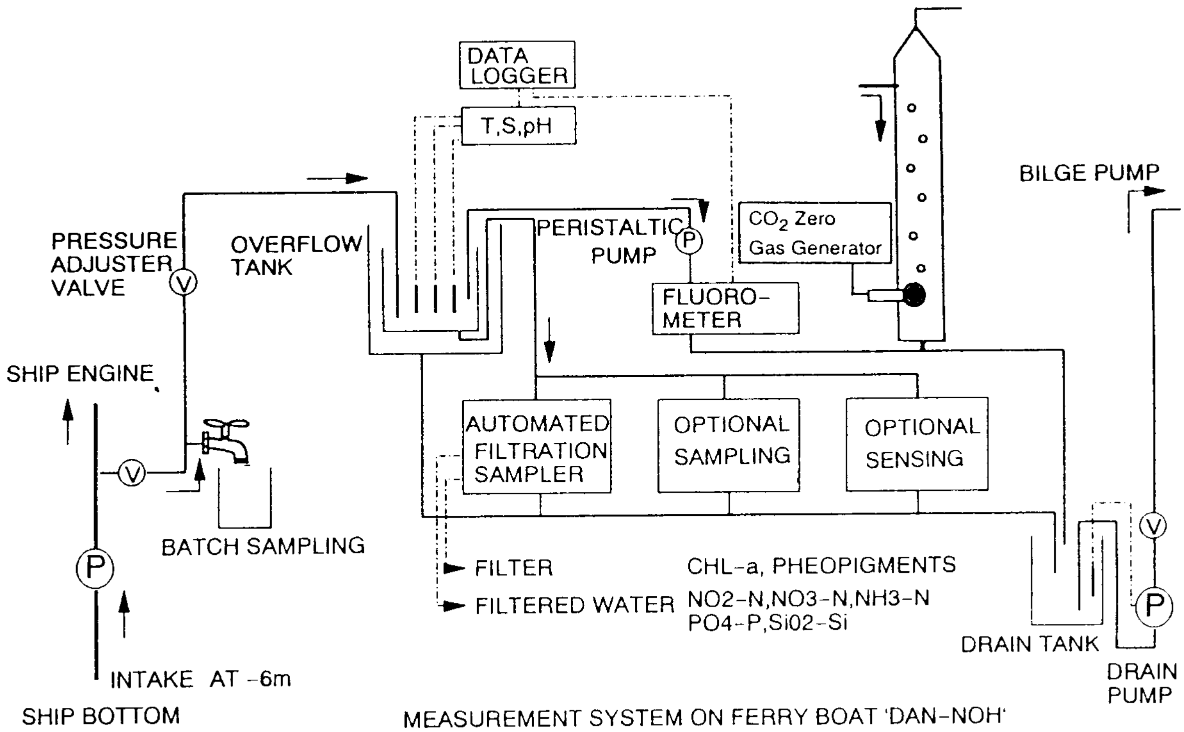
2.Objectives

Some index should be defined that can be measured by continuous and automated way and stand for the ocean environmental factors such as the nutrient concentration and so on. Phytoplankton is the key parameter for this purpose. There are three ways of measuring chlorophyll: (a)satellite ocean color output ; (b)*in vivo* fluorescence as an output of the Turner-Design Fluorometer ; (c)analytical method of the acetone-extract of batch sampling. Here, (b) may be applicable to the VOS(Volunteer Observation Ships), which have sea water intake for cooling engines. Furthermore, the relationship between the chlorophyll and the environmental factors should be clarified.

3.Methods

In the FY1990, we made a conceptual design of the automated continuous monitoring system of biogeochemical parameters and development of apparatus based on the continuous intake of sea water (see Fig.1), which was equipped on a ferry boat between Pusan, Korea and Kobe, Japan[2),3),4),5)]. This monitoring system has been operated by Center for Global Environmental Research, NIES since June of 1991. A part of the data output is shown in the next section.

Fig.1 Conceptual design of the biogeochemical monitoring system (reproduced from Harashima,1993[5)] with modification)



Furthermore, we made R/D of the advanced sensing that could be equipped on the line of the sea water intake. One of the possible sensors was the Bio-particle Counter, which uses fluorescence excited by laser beam via glass fiber.

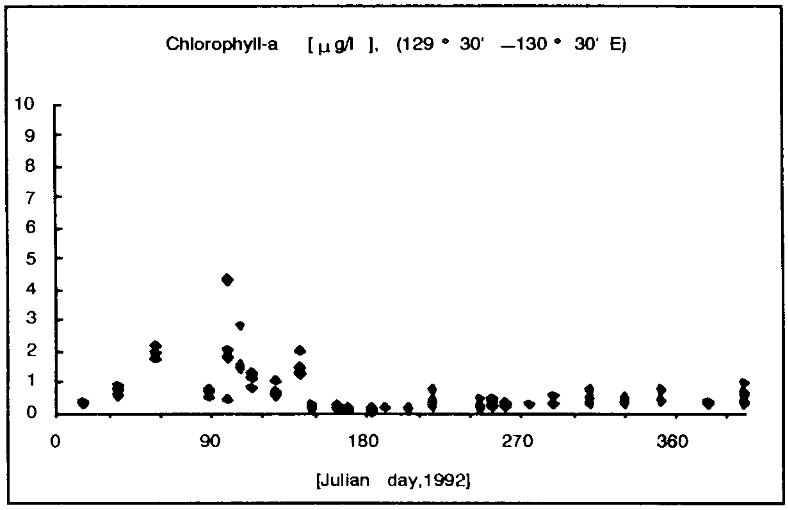
Ancillary data such as the phytoplankton species constituent or the size fraction were sampled during the manned research cruises supplementing the macroscopic parameters such as the biomass and the nutrients.

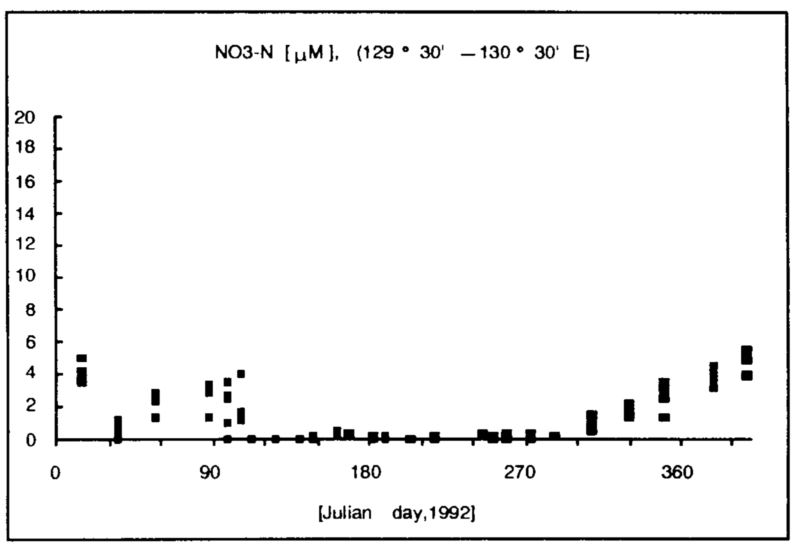
3.Results

The continuous monitoring on the Japan-Korea ferry boat was initiated in June, 1991. Fig.2 shows the seasonal change of chlorophyll-a, NO3-N in Tsusima Strait in 1992. The spring bloom occurred in the period April and terminated in May, when NO3-N decreased and N-limiting states appeared. PO4-P and dissolved Si also decreased during the spring bloom and the time changes of PO4-P was quite similar with that of NO3-N .

In Seto Inland Sea, the level of nutrient and chlorophyll-a were higher than those in Tsushima Strait. The blooming occurred in spring and autumn. In mid-summer, the nutrients

Fig.2 Seasonal change of Chlorophyll-a and NO3-N in Tsushima Strait from the -6m level (ferry's draft depth).





decreased, however, remaining NO3-N and PO4-P existed. The changing portion of NO3-N and PO4-P were quite similar implying that the P/N ratio in uptake by phytoplankton and remineralization from the bottom were conserved. The variation of chlorophyll expressed the variation of nutrients well. Thus it was confirmed that the chlorophyll concentration represented by the fluorescence, which has higher time/space resolution, is a useful indication of marine environment.

During the period (FY1990-1992), six manned research cruise were performed on the ferry, including the measurements of phytoplankton species constituents and size fractions using the same intake of sea water of the ferry boat. Particularly in the termination phase of spring blooming, the portion of dinoflagellates were relatively plenty in the eutrophicated eastern Seto Inland Sea and cyanophyceae of the size smaller than 2 micrometers were dominant in N-limited Tsushima Strait. In the other phases, the diatom were dominant. Thus the monitoring of chlorophyll was found to be quite important in that it shows the phase of blooming. And the feasibility of the ferry as a monitoring platform is stressed.

4.International Cooperation

A cooperative work was performed with Korea Ocean Research & Development Institute (KORDI ; Contact person : Dr. Jae-Ryoung, Oh, Chief of Chemical Oceanography Laboratory) under the title of 'Study on monitoring of the ocean environmental parameters based on Japan-Korea ferry boat', which was authorized as a research theme under the Japan-Korea Science and Technology Agreement.

Reference

1)Harashima, A., & Kikuchi, Y. (1990): Biogeophysical remote sensing: A ground truth data base and graphics system for the northwestern Pacific Ocean. EOS, 71, 314-315.

2)Harashima, A.(1991): Remote sensing for modelling of variation in primary production field, Oceanography of Asian Marginal Seas, Elsevier Oceanography Series 58, 75-84.

3)Harashima, A.(1992): An autonomous biogeochemical monitoring system using intake of sea water on Japan-Korea ferry boat, Proc. Autonomous Bio-optical Ocean Observing System Symposium, (in print).

4)Harashima, A.(1993) Continuous marine biogeochemical monitoring by Japan-Korea ferry boat for the validation of ocean color remote sensing., Proc. Environment '93 Symposium on Remote Sensing in Environmental Research and Global Change, 91-104.

5)Harashima, A. (1993) High frequency marine biogeochemical monitoring from a Japan-Korea ferry,1991 results, Annual Report on Global Environmental Monitoring, 33-45, Center for Global Environmental Research, National Institute for Environmental Studies.

6)Kimoto,K. and Harashima,A.(1993) High resolution time/space monitoring of the surface seawater CO2 partial pressure by ship-of-opportunity, Proceedings of 4th International CO2 Conference World Meteorological Organization, Global Atmosphere Watch Vol.89, 88-91.

7)Harashima, A. *et al.* (1993) A semi-continuous environmetal monitoring and associated chemical and biological measurement using seawater intake of Japan-Korea ferry, Abstracts of the Second Annual Meeting of PICES(North Pacific Marine Science Organization), Seattle, pp.11-12.

8)Tanaka, Y., Tsuda, R., and Harashima, A.(1993) *In situ* monitoring and size spectra of phytoplankton via laser-induced fluorescence through an optical fiber on Japan- Korea ferry, Abstracts of the Second Annual Meeting of PICES(North Pacific Marine Science Organization), Seattle, pp.38.