This ferry platform can scan the contrast between the semi-enclosed seas which are heavily impacted by anthropogenic inputs and the continental shelf seas with a temporal resolution of a few days. Spatial coverage is around 600 km. The Tsushima Strait and the Seto Inland Sea are connected by the Kanmon Strait. This strait is very narrow and characterized by strong tidal currents and consequently, intense vertical convection throughout the year. In both directions, the Dan-Noh always passes through the Kanmon Strait at midnight.

This single monitoring scheme is important as a part of the efforts to understand global-scale environmental change. The *in situ* biomass data can be used to calibrate/validate basin-scale photosynthetic pigment concentration estimates derived from ocean color data from such satellites as the CZCS (1979 ~ 1986), the coming SeaWiFS (1993 ~), and OCTS (1997 ~), (Gordon *et al.* 1985, Mueller *et al.* 1992). Harashima *et al.* (1990) constructed a database for the validation of satellite ocean color data from the existing ship observations in the western North Pacific. However, the coincidence of satellite data and *in situ* ocean observations was rather insufficient despite the compilation of data from around 500 observation points per year. Semi-continuous monitoring from this platform will improve coverage.

Today satellite information is increasing in quantity and quality. However, most satellite data is available only under clear sky conditions and satellites cannot collect complete time series data sets. Therefore both satellite and VOS monitoring should be developed. Development and standardization of monitoring from VOS's will make it possible to establish a monitoring network with multiple ferries.

The problem "How do we generalize the coastal to the global?" has been discussed in the context of physical-biological modeling (Hoffman, 1991). The *in situ* time series of oceanographic data from our ferry monitoring program will enable physical-biological models to be tuned and validated. Establishment of reliable models will lead to their application to general global environmental issues.

Many studies have described the phenomenon of regional eutrophication and the red tides it causes. This issue should be generalized to certain scenarios in the context of perturbations of elemental cycles. One such scenario has been proposed by Smetacek *et al.* (1991) based on the results of long term monitoring in the German Bight. The normal spring bloom due to the diatom consumes N, P and Si. The secondary bloom due to dinoflagellates, which are more harmful to culture fisheries, occurs in early summer using excess N and P under Si-limitation. Diatoms are prevented from growing rapidly during summer due to this Si-limitation. The N and P source is largely of anthropogenic origin and the Si source is natural weathering of the land. From the long term monitoring data, the phytoplankton biomass during the secondary bloom was found to have been increasing. The number of long term data sets which permit us to understand scenarios such as this is quite limited. More monitoring sites and platforms are needed to expand the number of long term data sets which will be available in the future.

2.2 Monitoring apparatus

The intake for the ferry Dan-Noh's engine cooling system lifts sea water from 6 m depth (Fig. 2). Water from this depth lies in the upper mixed layer during most seasons. A part of the cooling water is poured into an overflow tank for measurements at the rate of approximately 30 liters per minute.

The measurements consist of continuous monitoring and automated bottle sampling. The continuous monitoring is performed by tank mounted electronic sensors for water temperature (resistance thermometer), salinity (two poles, AC conductivity sensor), and pH (glass electrode) and a fluorometer (Turner Design, Model 10) which receives water from a peristaltic pump. The analog output from these sensors is converted to digital format and stored on a floppy disk. The sampling interval is ten seconds, which corresponds to a spatial resolution of around 100 meters because the mean ship speed is 20 nautical miles per hour. The residence time of the water in the overflow tank is less than 10 seconds as its volume is 4 litters.

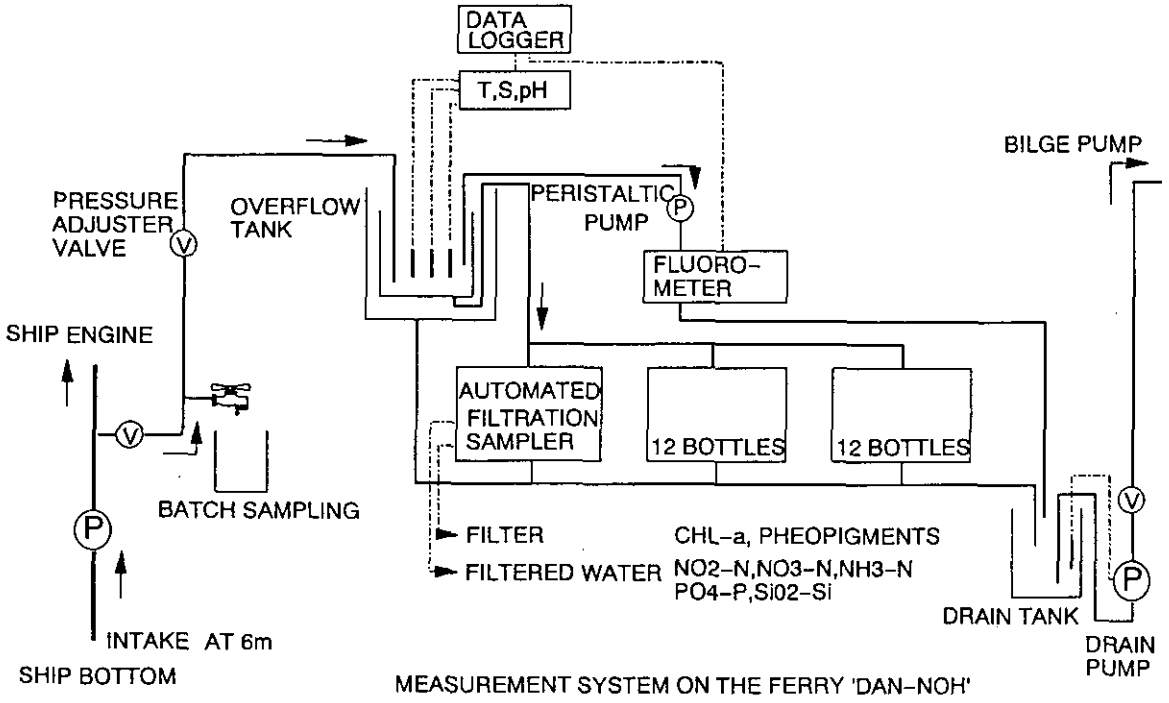

Fig. 2 Flow diagram of the measurement system on the ferry "Dan-Noh"

The nutrient samples are collected by three automated filtration samplers, by which up to 36 sea water samples per cruise are obtained. The sampling is done by relay-controlled electromagnetic valves as follows: 1) introduction of sea water, 2) rinsing the upper tank with the sea water, 3) discarding the rinse water, 4) filling the upper tank with sea water, 5) vacuum filtering through a GFC-filter into each sample bottle. The entire process takes about 5 minutes. The sampling time is adjusted so that procedure 4) is performed at the recorded sample time. The air in the sampler is kept between 5 to 8 °C.

The automated filtration sampling is operated during cruises from Pusan (Wednesday) to Kobe (Thursday) around twenty-four times each year while the continuous monitoring units are operated every cruise. On the regular maintenance day at Kobe Harbor, the filtered water samples are forwarded to the lab for analysis of nitrite-N (Sulphanilamide and N-(1-naphthyl)-ethylenediamine 2HCl method), nitrate-N (Modified Morris and Riley method), ammonium-N (Indophenol method), phosphate-P (Molybdenum blue method), and dissolved silicon (Molybdenum yellow method and reduction method). Concentrations of chlorophyll-a and pheopigments are determined from acetone-extracts of particulate matters on the filters by the fluorescence method in order to supplement the continuous measurements of fluorescence. These analyses are based on the methods in Strickland *et al.* (1968)

In addition to the above equipment, a faucet permits batch sampling and R/D of sensing techniques with sea water from the intake. During three 1991 manned research cruises (March 25 to 28, June 17 to 20, December 2 to 5) phytoplankton and zooplankton taxonomies and phytoplankton size fractionation using a laser technique were done using this water. Results from these studies will be published elsewhere.