MR98-K01 Cruise Summary

Objective of this cruise was the acquisition of biogeochemical data and the verification of biogeochemical material's cycle in the northwestern North Pacific in winter season when enough oceanographic data has not been obtained before. We plannedto visit nine stations located in higher than 42N during the first leg. (October 30 – November 22) and sixteen stations lower than 40N during the second leg. (November 24 – December 16).
Institutions and universities which participated this cruise are as follows:

Japan Marine Science and Technology Center (JAMSTEC)
National Institute of Environmental Science (NIES)
National Institute for Resources and Environment (NIRE)
Japan Meteorological Agency (JMA)
Hokkaido University
Tokyo University
Nagoya University

(*Technical support*)
Marine Works Japan Ltd. (MWJ)
Global Ocean Development, Inc. (GODI)

Unfortunately, we were in trouble for the strong wind and the big wave, especially during the first leg., (Fig.1) and, therefore, could not visit some stations and not conducted scheduled observations prefectly (Fig.2) even if our research vessel "MIRAI" with well-trained crews is one of the biggest ocean R/V in the world. However, we succeeded to carried out various kind of observation and obtain valuable data in winter season in the northwest North Pachific thanks to enthusiastic efforts of cruise participants and crews.
Beside of the meteorolocical observation, conducted observation and analysis were as follows (Instructions in the parentheses are in charge for each observation):

1. Hydrocasting
   At approximately nineteen stations, we conducted water sampling with RMS (Rosette Multi-bottle array water sampling system) with CTD (SBE 9 plus). These sea water were or will be used for the following analysis:

   DO, Nutrients (JAMSTEC, NIES) Carbonate chemistry: pH, TCO_2, TALK, ^{13}C, ^{14}C (JAMSTEC, NIES) Pigments (JAMSTEC, Nagoya Univ.,Hokkaido Univ., NIES) Trace metal (JAMSTEC) Trace gas: DMS, CFCs, N_2, AR (Hokkaido Univ.) Radionuclides (JAMSTEC, NIRE)

   Fig.3 shows the vertical profile in pH (sea water scale at 25 deg.C) at each station (uncorrected). The pH profiles at station KNOT (solid circles and solid squares) and station 1 (open circles) have convex shapes toward the sea surface, which is indicative of that the intensity of upwelling at both stations located in higher than 42N are relatively higher than those at the other stations. At station KNOT, pH profile observed in November (solic circles) showed the clear minimum around 250m. However, this clear minimum disappeared on the pH profile observed in December (solid squares) and the surface mixed layer became ticker. Judging from this difference, it can be said the winter season (from the oceanographic point of view) had come during the second leg.. Ongoing analysis for the above chemical components will show more clear picture concerning the

biogeochemistry this area in winter season.

2. Underway Measurements (JAMSTEC, NIES)
   Along the cruise track, pCO_2, TCO_2, nutrients, and salinity, temperature in the surface sea water were continuously measured by an automated system installed on R/V "MIRAI".

3. Sea floor sediment coring (NIRE)
   Sea floor sediment and sea water above the sea floor was collected at station KNOT (40N, 165E) by a multiple core sampler. Radio- nuclides and nutrients in the sediment and pore water will be measured at the laboratory.

4. Drifting sediment trap experiment (JAMSTEC, NIRE, NIES, Nagoya Univ., Hokkaido Univ.)
   In order to collect settling particulate matters in the shallow water, drifting sediment trap experiments were conducted at station KNOT (44N, 155E) and 20 (40N, 165E). Sediment trap mooring system with 20 sets of "Knauer type trap" was drifted for few days. Thanks to the GPS buoy system, the drifting speed and direction of the mooring system was monitored during the experiment and the mooring system was recovered successfully. Fig.4 show the preliminary result for vertical profiles in the total mass flux. The total mass flux decreased with increased depth and its decrease is drastic above 100m. Some of collected sample was filtered and the others were stored in the refrigerator onboard. These samples will be distributed to the trap group and, in future, organic and inorganic carbon, opal, carbonate, carbon and nitrogen stable isotopes, radionuclides, and zoo-plankton in the sample will be measured.

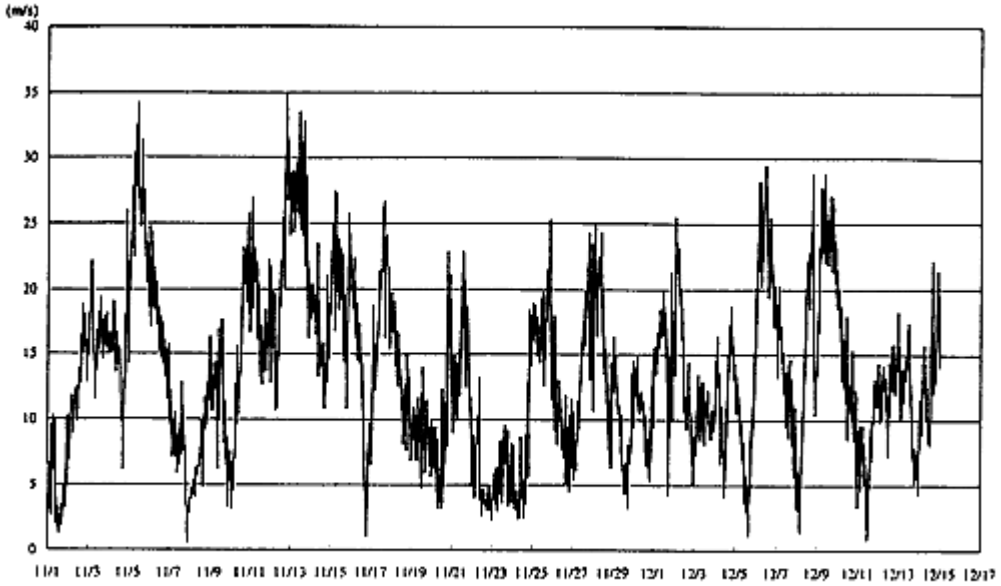
5. Atmosphoeric observation (JAMSTEC, Tokyo Univ.)
   Aerosol over the ocean were collected with the air sampler installed on the flying bridge, and its particle size and concent- rations of organic carbon and inorganic carbon were measured onboard. Aerosol filter and rainwater samples will be analyzed for major inorganic ions (Na^+, Ca^{2+}, NH^{4+}, SO_4^{2-}, NO_3^- and MSA) by ion chromatography.

6. Primary productivity (NIES, Nagoya Univ.) and bio-optical measurement for ocean color remote sensing (Hokkaido Univ.)
   Using ^{13}C as a tracer, *in situ* and *in vitro* incubation experiments were carried out at station KNOT and station 20. ^{13}C uptaked by phytoplankton will be measured by mass spectrometry and primary productivity in winter season in this area will be presented.

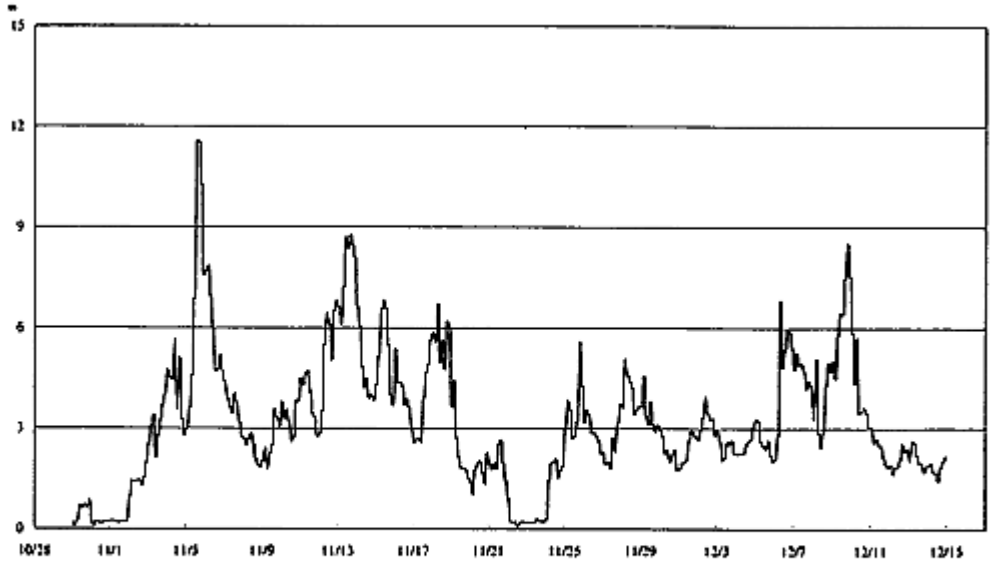
   In addition, the underwater spectral downward irradiance and upward radiance were measured in order to validate and develop bio- optical algorithm for new series ocean color sensors such as Sea WiFS and GLI.

7. XBT / XCP, CTP-ALACE float (JMA)
   In order to investigate the structure and variation of sub-surface temperature and current in the subarctic circulation area focusing on the formation, advection, and diffusion of the North Pacific Intermediate Water (NPIW), XBT / XCTD, and CTP-ALACE float were deployed along the crise track. Fig.5(a) , (b) show some vertical sections in temperature.

8. Geological survey and Doppler radar observation (JAMSTEC, Hokkaido Univ.)
   In addition to the biogeochemical and physical oceanographic observations, geological survey such as magnetic field, gravity and sea floor topography observation, and cloud observation by Doppler radar were also carried out.



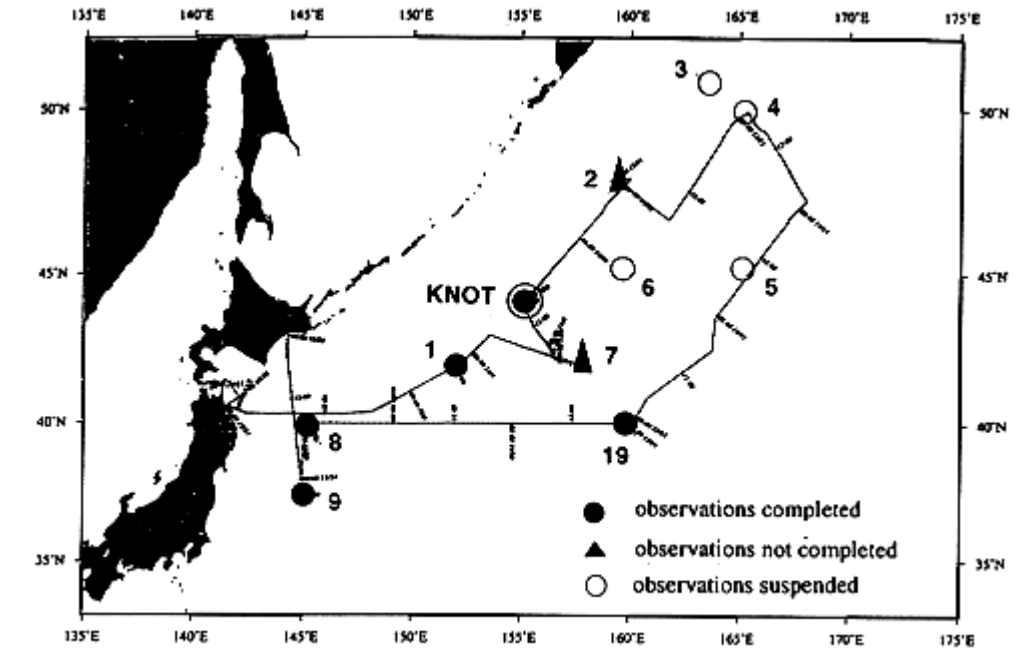
(a) MR98-K01 10 minute Average Wind Speed(m/s) measured at every hour (UTC)



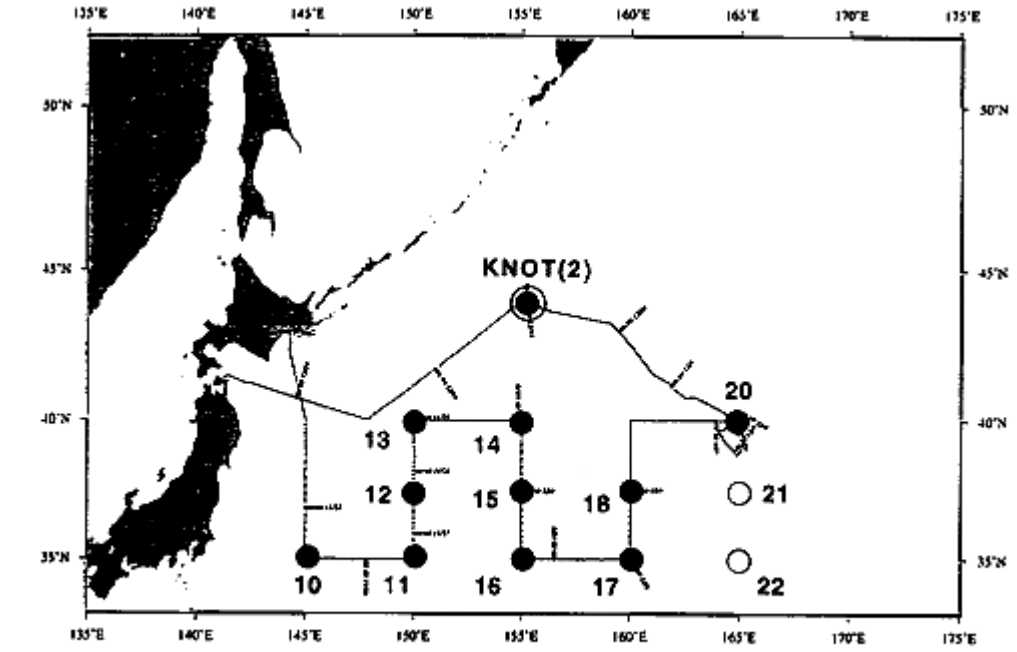
(b) MR98-K01 Significant Wave Height(m) measured first20 minute at every 3 hours(UTC)
(0200,0500,0800,1100,1400,1700,2000,2300)

Fig. 1 Wind speed (a) and wave height (b)

Fig.1



Ship Track (MR98K01, Leg1)



Ship Track (MR98K01, Leg2)

Fig. 2 Cruise truck and stations

Fig.2

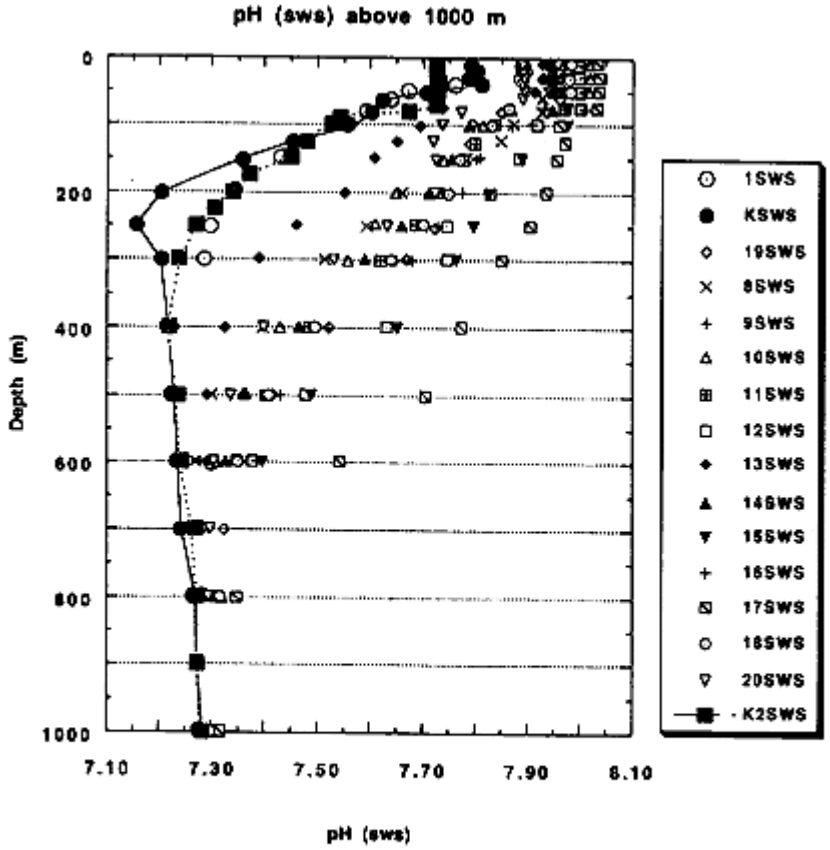


Fig. 3 Vertical profiles in pH (seawater scale at 25°C)

Fig.3

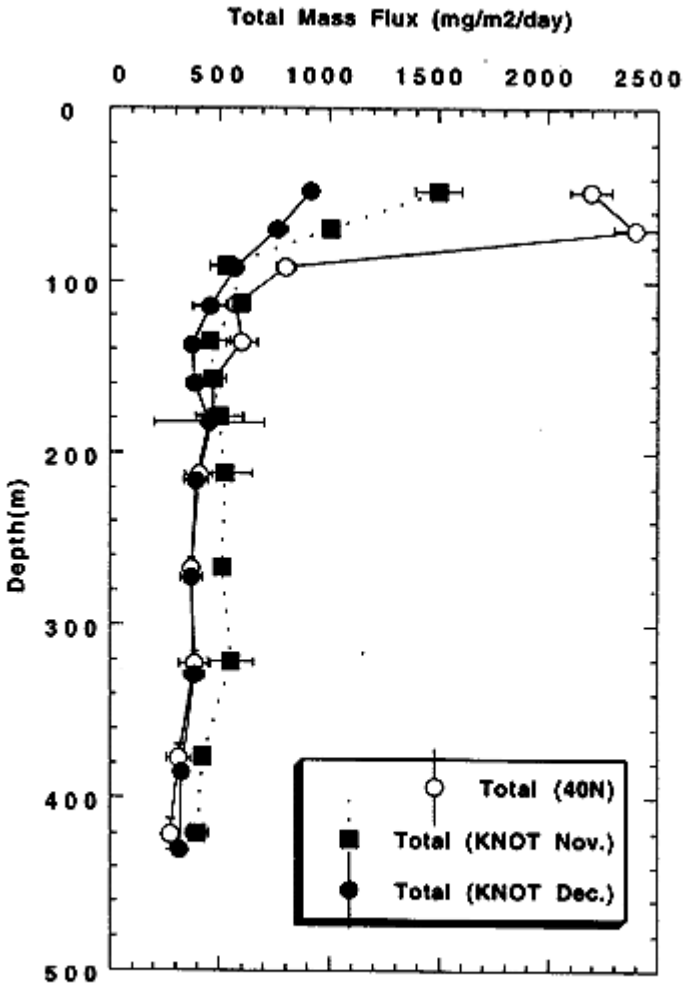
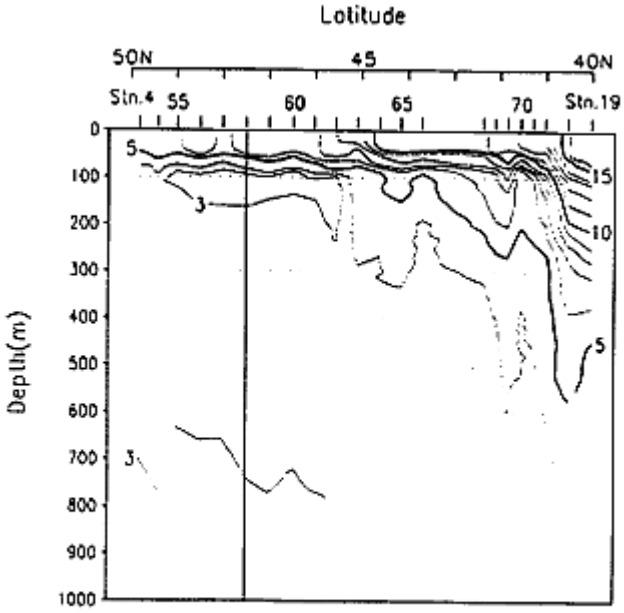


Fig. 4 Vertical profiles in total mass flux observed by drifting sediment trap

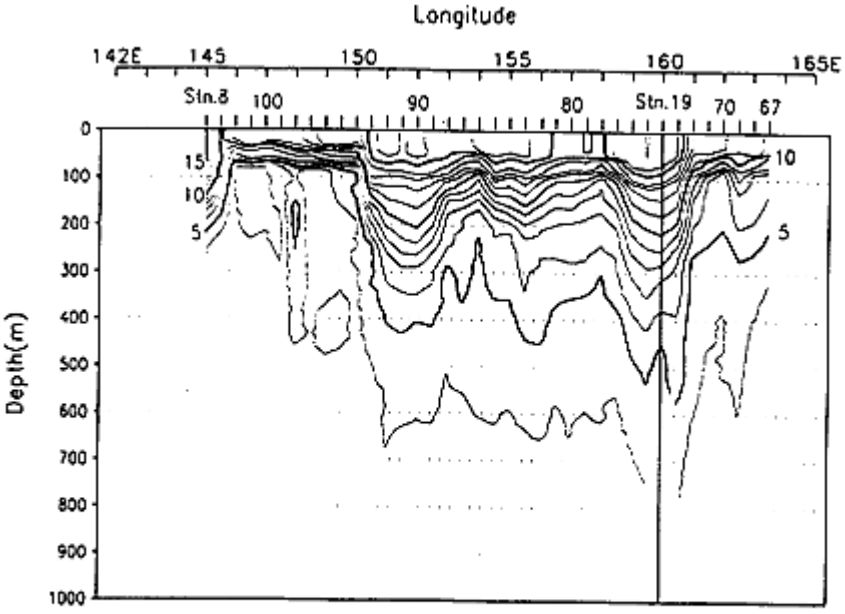
Fig.4



Stn.4 -> Stn.19

(a) 50°N - 40°N

Fig.5 (a)



Stn.8 <- Stn.19

(b) 165°E - 145°E along 40°N

Fig. 5 vertical sections in temperature observed by XBT

Fig.5 (b)