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MR05-01

(28 February 2005 - 24 March 2005)

Preliminary Cruise Report

May 2005

JAMSTEC

Contents of MR05-01 Preliminary Cruise Report

1. Outline of MR05-01
1.1 Cruise summary

Makio HONDA (JAMSTEC MIO)

Main mission of this cruise was test of mooring system for certification of its safety and deployment of mooring system for time-series observation for biogeochemistry.
Since one of our mooring systems was lost in October 2003, time-series observation using mooring system has been suspended. During this period, cause of accident (partition of mooring system) and its prevention countermeasure have been investigated. Thanks to much effort by all concerned, every preparation was completed before this cruise and our cruise could start on 28 February. However during this 24 days' winter cruise, deployment, recovery and re-deployment of two mooring systems should be conducted. In addition, short-term mooring for test should be conducted longer than ten days. The above works looked impossible in winter.

Fortunately, we could deployment PO mooring system and BGC mooring system on 3 March and 5 March, respectively, without critical delay at station K2. After deployment and during short-term mooring for test, we conducted the following observation at respective stations.

(Station K2)
- Hydrocasting for basic components' analysis (routine) such as DO, Nuts, carbonate chemistry
- Hydrocasting for trace elements' analysis
- In situ pumping for collection of suspended materials
- Measurements of primary productivity
- Optical observation

(Station K1)
- Hydrocasting routine
- Hydrocasting for trace elements' analysis
- In situ pumping
- Measurements of primary productivity
- Optical observation

(Station 35N)
- Hydrocasting routine
- Hydrocasting for trace elements' analysis
- In situ pumping
- Measurements of primary productivity
- Optical observation

However rough sea condition forced us to give up observation at station K3. In addition, only hydrocasting for routine and trace elements could be conducted at station KNOT.

During the above observation and short-term mooring, several low pressure masses attacked station K2 and, based on weather chart, significant wave height was expected to be higher than 8 m. Due to rough sea, we could not be back to station K2 by 16 March. After two mooring systems were recovered on board successfully, tension during mooring period and damage of mooring system were investigated.

Fortunately there was no problem and valuable dynamical data for mooring system were obtained. Right after the above investigation, preparation for re-deployment was quickly conducted and BGC mooring system with automatic sample collectors was deployed successfully on 18 March. Unfortunately, sea condition did never permit us to re-deploy PO mooring by the time limit. However success of redeployment of BGC mooring, which is our main mooring system, enabled us to restart time-series observatory for biogeochemistry. This BGC mooring system will be recovered during MIRAI autumn cruise (MR05-04).

1.2 Track and log

1.2.1 Cruise track

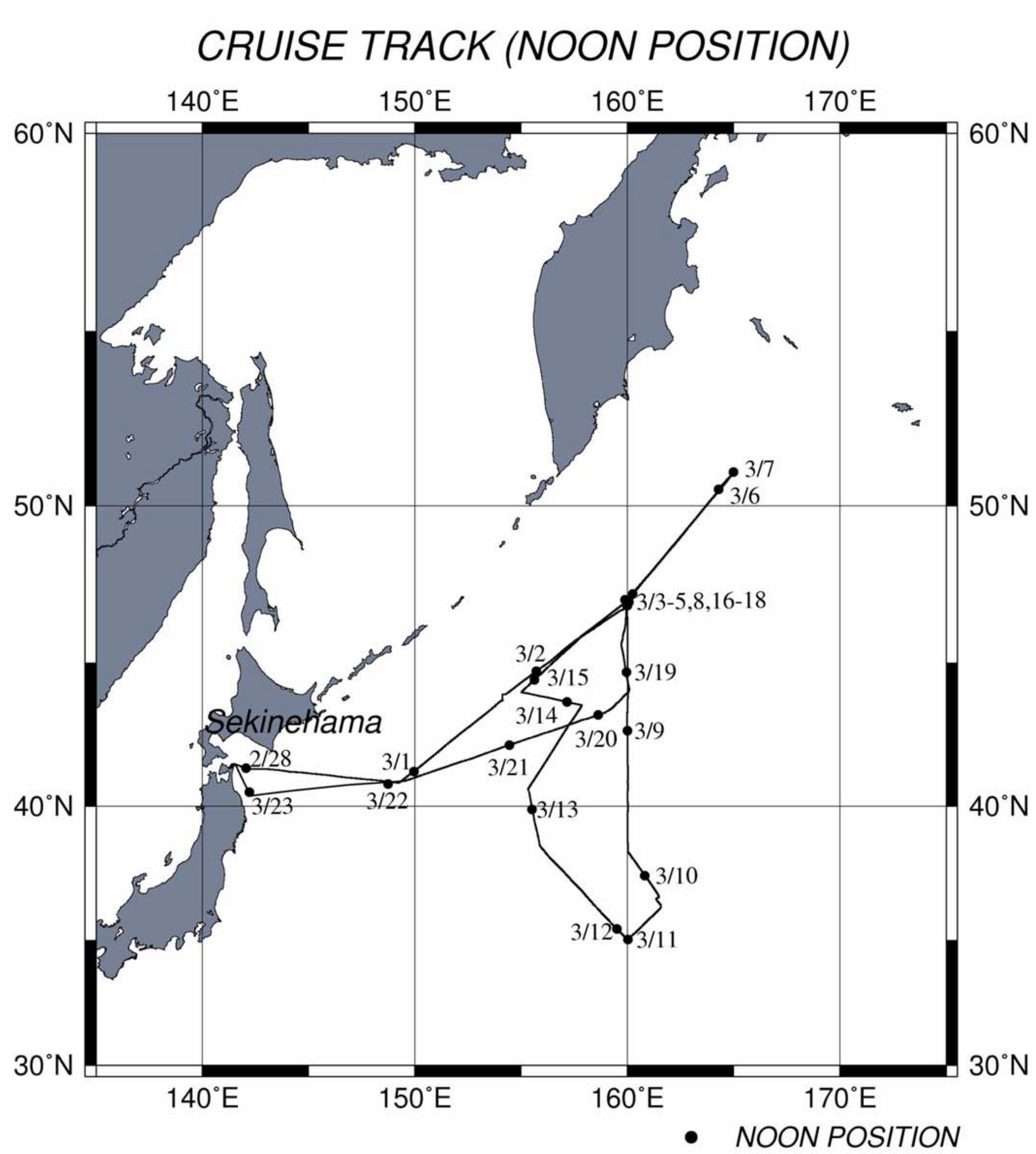

Figure 1.2.1-1 Cruise track

1.2.2 Cruise log

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Lat.	Lon.	
2.28	00:00	2.28	09:00	41-21.97N	141-14.38E	Departure from Sekinehama
3.1	13:00	3.1	22:00	-	-	Time adjustment +1 hours (SMT=UTC+10h)
3.2	01:21	3.2	11:21	44-41.61N	155-40.73E	Free Fall
	12:00		22:00	-	-	Time adjustment +1 hours (SMT=UTC+11h)
	17:12	3.3	04:12	47-00N	160-00E	Arrival at Station K2
	21:16		08:16	46-51.30N	159-59.06E	PO mooring deployment
	-		-	46-52.382N	159-58.958E	PO mooring Fixed position
3.3	04:27	3.3	15:27	46-52.63N	159-59.68E	CTD cast (300m)
	07:56		18:56	46-53.78N	159-58.72E	Calibration for magnetometer
3.4	06:51	3.4	17:51	47-01.39N	160-00.31E	CTD cast (5,139m)
	19:30	3.5	06:30	46-56.16N	160-10.30E	CTD cast (200m)
	21:25		08:25	46-55.05N	160-10.14E	BGC mooring deployment
	-		-	47-00.477N	159-57.967E	BGC mooring Fixed position
3.5	06:30	3.5	17:30	-	-	Departure from Station K2
3.6	00:24	3.6	11:24	50-28.06N	164-16.51E	Free Fall
	03:36		14:36	51-00N	165-00E	Arrival at Station K1
	06:28		17:28	50-59.31N	165-00.68E	CTD cast (400m)
	17:58	3.7	04:58	51-00.12N	164-59.81E	CTD cast (200m)
	19:02		06:02	51-00.16N	164-59.26E	CTD cast (2000)
	21:22		08:22	50-59.09N	165-00.02E	Large Volume Pump (LVP) cast (800m, 2 hour)
3.7	00:53	3.7	11:53	50-59.91N	164-59.62E	CTD cast (4,860m)
	04:30		15:30	-	-	Departure from Station K1
3.8	00:22	3.8	11:22	47-16.76N	160-17.95E	Free Fall
	02:00		13:00	47-00N	160-00E	Arrival at Station K2
	02:03		13:03	47-05.18N	159-59.66E	LVP cast (800m, 2 hours)
	06:28		17:28	-	-	Checked BGC moornig position
	07:38		18:38	-	-	Checked PO moornig position
	07:54		18:54	-	-	Departure from Station K2
3.9	01:55	3.9	12:55	49-29.50N	159-59.33E	Free Fall
3.10	20:30	3.11	07:30	35-00N	160-00E	Arrival at Station 35N
	21:02		08:02	34-59.47N	159-59.23E	CTD cast (4,582m)

U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Lat.	Lon.	
3.11	02:08	3.11	13:08	35-00.09N	160-00.34E	Free Fall
	02:36		13:36	34-59.84N	159-59.34E	CTD cast (3,000m)
	17:54	3.12	04:54	34-59.99N	160-00.01E	CTD cast (200m)
	18:45		05:45	35-00.07N	160-00.07E	LVP cast (800m, 2 hours)
	22:30		09:30	-	-	Departure from Station 35N
3.14	16:30	3.15	03:30	44-00N	155-00E	Arrival at Station KNOT
	17:03		04:03	43-59.84N	155-00.17E	CTD cast (300m)shallow
	18:34		05:34	44-00.81N	155-00.18E	CTD cast (5,263m)deep
	22:30		09:30	-	-	Departure from Station KNOT
3.15	16:54	3.16	03:54	47-00N	160-00E	Arrival at Station K2
	21:38		08:38	46-52.40N	159-59.22E	PO mooring recovery
3.16	20:03	3.17	07:03	47-00.52N	159-58.18E	BGC mooring recovery
3.17	21:06	3.18	08:06	47-04.90N	159-51.73E	BGC mooring deployment
3.18	03:35	3.18	14:35	47-00.468N	159-58.057E	BGC mooring Fixed position
	04:42		15:42	-	-	Departure from Station K2
3.21	11:00	3.21	22:00	-	-	Time adjustment -1 hours (SMT=UTC+10h)
3.22	12:00	3.22	22:00	-	-	Time adjustment -1 hours (SMT=UTC+9h)
3.24	00:00	3.24	09:00	41-21.97N	141-14.21E	Arrival at Sekinehama

1.3 List of participants

Name	Affiliation	Address	Tel Fax E-mail address
Makio HONDA	Japan agency for Marine-Earth Science and Technology (JAMSTEC) Mutsu Institute for Oceanography (MIO)	2-15 Natsushima, Yokosuka, 237-0061, Japan	
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Satoru KIMURA	JAMSTEC MIO	Same as above	
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Tomohide NOGUCHI	MWJ	Same as above	
Fuyuki SHIBATA	MWJ	Same as above	
Masaki MORO	MWJ	Same as above	
Yoshiko ISHIKAWA	MWJ	Same as above	
Ai YASUDA	MWJ	Same as above	
Takuhei SHIOZAKI	MWJ	Same as above	
Junko HAMANAKA	MWJ	Same as above	
Yuki OTSUBO	MWJ	Same as above	
Kimiko NISHIJIMA	MWJ	Same as above	
Wataru TOKUNAGA	Global Ocean Development Inc. (GODI)	13-8 Kamiookanishi 1-chome, Konan-ku, Yokohama, 236-0002, Japan	
Ryo OHYAMA	GODI	Same as above	

2. General observation
2.1 Meteorological observations
2.1.1 Surface Meteorological Observation

Makio HONDA (JAMSTEC) : Principal Investigator
Wataru TOKUNAGA (Global Ocean Development Inc., GODI)
Ryo OHYAMA (GODI)
Not on-board:
Kunio YONEYAMA (JAMSTEC)

Objectives

The surface meteorological parameters are observed as a basic dataset of the meteorology. These parameters bring us the information about the temporal variation of the meteorological condition surrounding the ship.

Methods

The surface meteorological parameters were observed throughout the MR05-01 cruise from the departure of Sekinehama on 28 February 2005 to arrival of Sekinehama on 24 March 2005. At this cruise, we used two systems for the surface meteorological observation.

1) MIRAI Surface Meteorological observation (SMet) system
2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

1) MIRAI Surface Meteorological observation (SMet) system

Instruments of SMet system are listed in Table 2.1.1-1 and measured parameters are listed in Table 2.1.1-2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set has 6-second averaged.

2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system designed by BNL (Brookhaven National Laboratory, USA) consists of major three parts.

i) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
ii) Zeno Meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.

iii) Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

SCS recorded PRP data every 6 seconds, Zeno/Met data every 10 seconds. Instruments and their locations are listed in Table2.1.1-3 and measured parameters are listed in Table 2.1.1-4.

We have carried out inspecting and comparing about following three sensors, before and after the cruise.

a) Young Rain gauge (SMet and SOAR)

Inspecting the linearity of output value from the rain gauge sensor to change input value by adding fixed quantity of test water.

b) Barometer (SMet and SOAR)

Comparing with the portable barometer value, PTB220CASE, VAISALA.

c) Thermometer (air temperature and relative humidity) (SMet and SOAR)

Comparing with the portable thermometer value, HMP41/45, VAISALA.

Preliminary results

Figures 2.1.1-1 show the time series of the following parameters;

Wind (SOAR)

Air temperature (SOAR)

Relative humidity (SOAR)

Precipitation (SOAR)

Short/long wave radiation (SOAR)

Pressure (SOAR)

Sea surface temperature (SMet)

Significant wave height (SMet)

Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division. Corrected data sets will also be available from K. Yoneyama of JAMSTEC.

Remarks

1. The following period, SST(Sea Surface Temperature) data was valid during this cruise.

   28 Feb. 2005 02:00UTC - 20 Mar. 2005 02:06UTC

2. When we have carried out inspecting about Young Rain gauge (SOAR) after this cruise, test water flushing value was irregularity.

Table 2.1.1-1 Instruments and installations of MIRAI Surface Meteorological system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST RFN1-0		Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	F-451	Yokogawa, Japan	captain deck (13 m) weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

Table 2.1.1-2 Parameters of MIRAI Surface Meteorological observation system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log, DS-30 Furuno
4	Ship's heading	degree	Mirai gyro, TG-6000, Tokimec
5	Relative wind speed	m/s	6sec./10min. averaged
6	Relative wind direction	degree	6sec./10min. averaged
7	True wind speed	m/s	6sec./10min. averaged
8	True wind direction	degree	6sec./10min. averaged
9	Barometric pressure	hPa	adjusted to sea surface level 6sec. averaged
10	Air temperature (starboard side)	degC	6sec. averaged
11	Air temperature (port side)	degC	6sec. averaged
12	Dewpoint temperature (starboard side)	degC	6sec. averaged
13	Dewpoint temperature (port side)	degC	6sec. averaged
14	Relative humidity (starboard side)	%	6sec. averaged
15	Relative humidity (port side)	%	6sec. averaged
16	Sea surface temperature	degC	6sec. averaged
17	Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18	Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19	Down welling shortwave radiation	W/m^2	6sec. averaged
20	Down welling infra-red radiation	W/m^2	6sec. averaged
21	Significant wave height (bow)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period (bow)	second	hourly
24	Significant wave period (aft)	second	hourly

Table 2.1.1-3 Instrument and installation locations of SOAR system

Sensors (*Zeno/Met*)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	foremast (24 m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (24 m)
Rain gauge	50202	R. M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24 m)

Sensors (*PRP*)	Type	Manufacturer	Location (altitude from surface)
Radiometer (short wave)	PSP	Epply Labs, USA	foremast (25 m)
Radiometer (long wave)	PIR	Epply Labs, USA	foremast (25 m)
Fast rotating shadowband radiometer(FRSR)		Yankee, USA	foremast (25 m)

Table 2.1.1-4 Parameters of SOAR system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	SOG	knot	
4	COG	degree	
5	Relative wind speed	m/s	
6	Relative wind direction	degree	
7	Barometric pressure	hPa	
8	Air temperature	degC	
9	Relative humidity	%	
10	Rain rate (optical rain gauge)	mm/hr	
11	Precipitation (capacitive rain gauge)	mm	reset at 50 mm
12	Down welling shortwave radiation	W/m^2	
13	Down welling infra-red radiation	W/m^2	
14	Defuse irradiance	W/m^2	

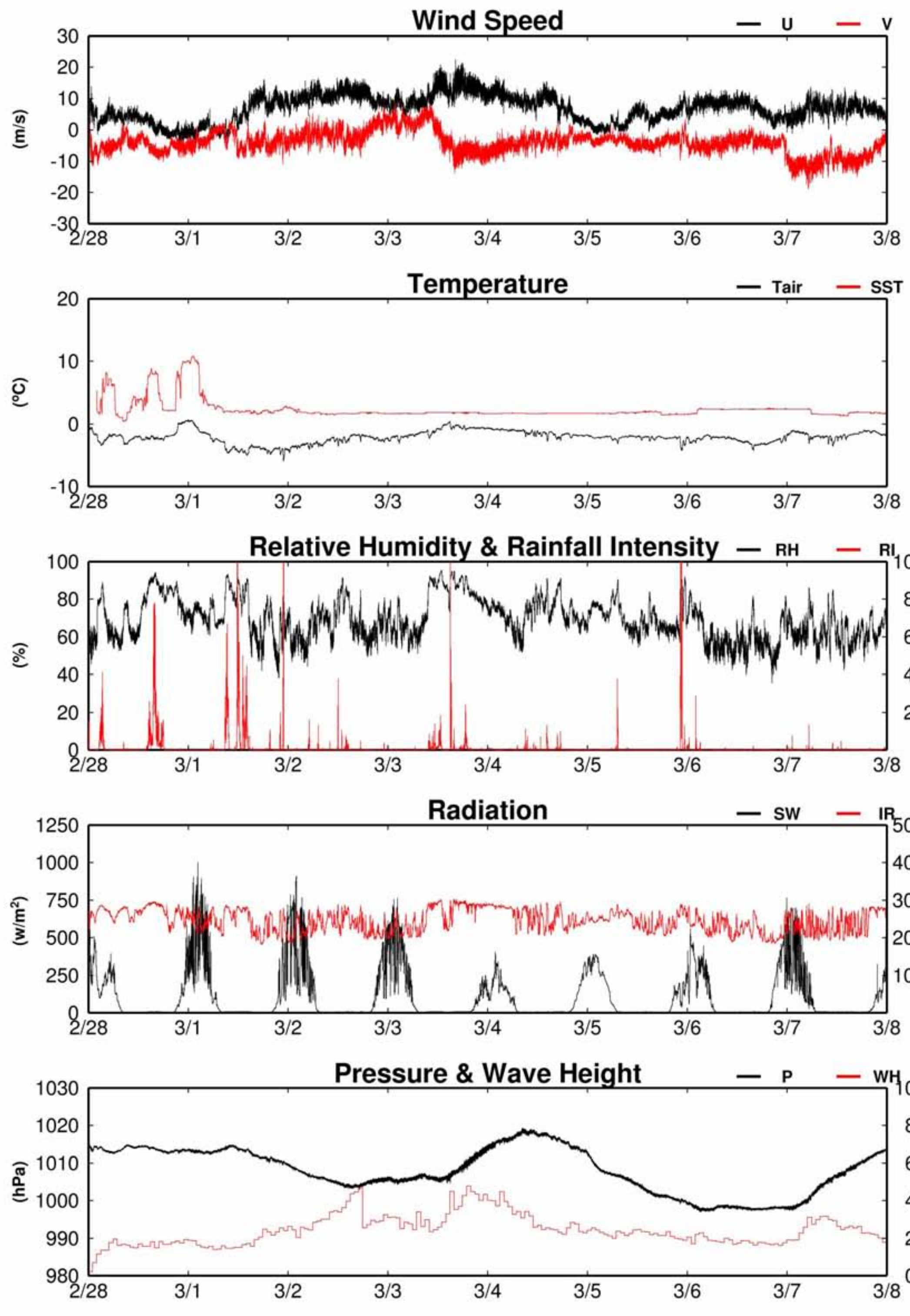


Fig.2.1.1-1 Time series of surface meteorological parameters during the cruise

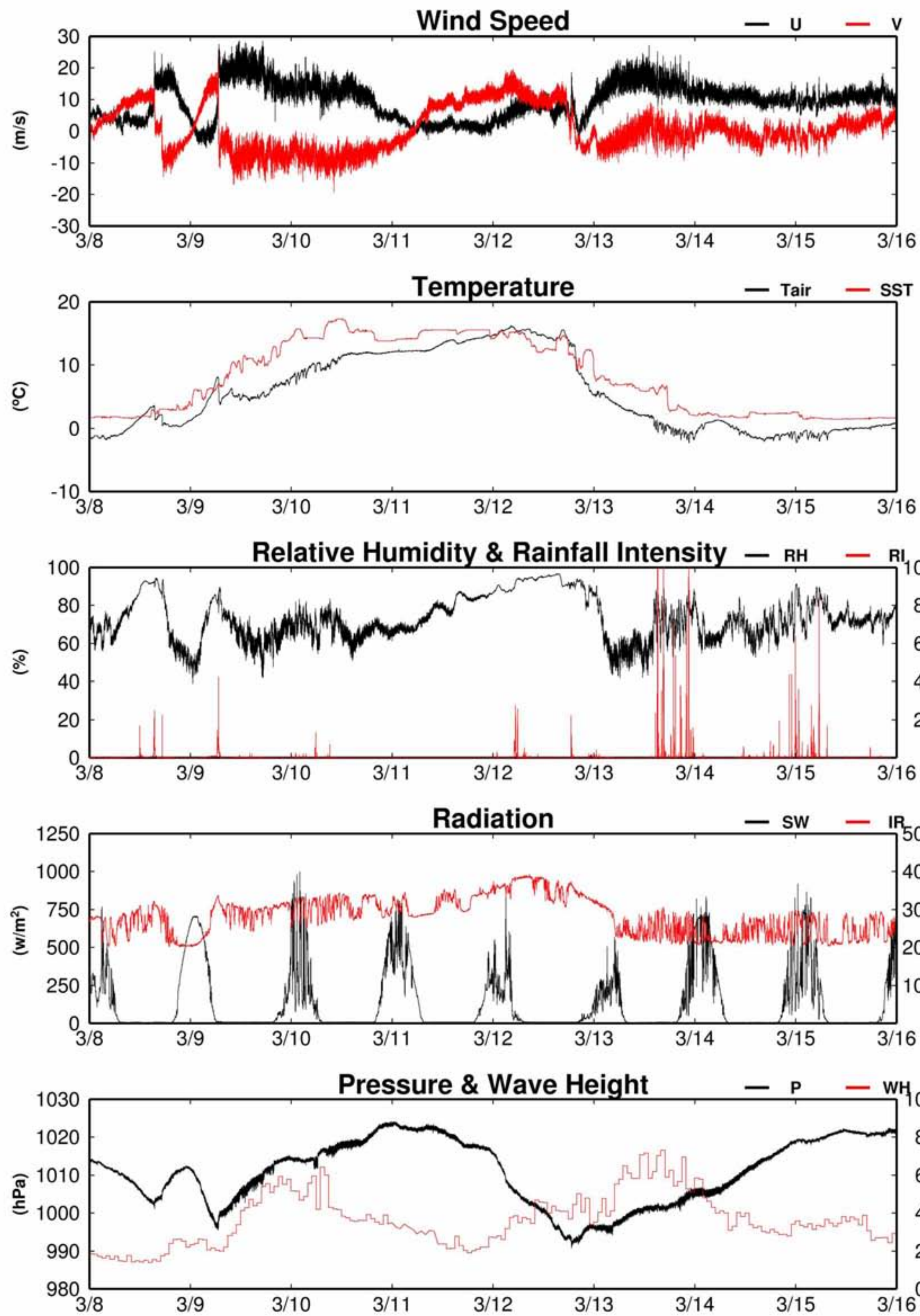


Fig.2.1.1-1　Continue

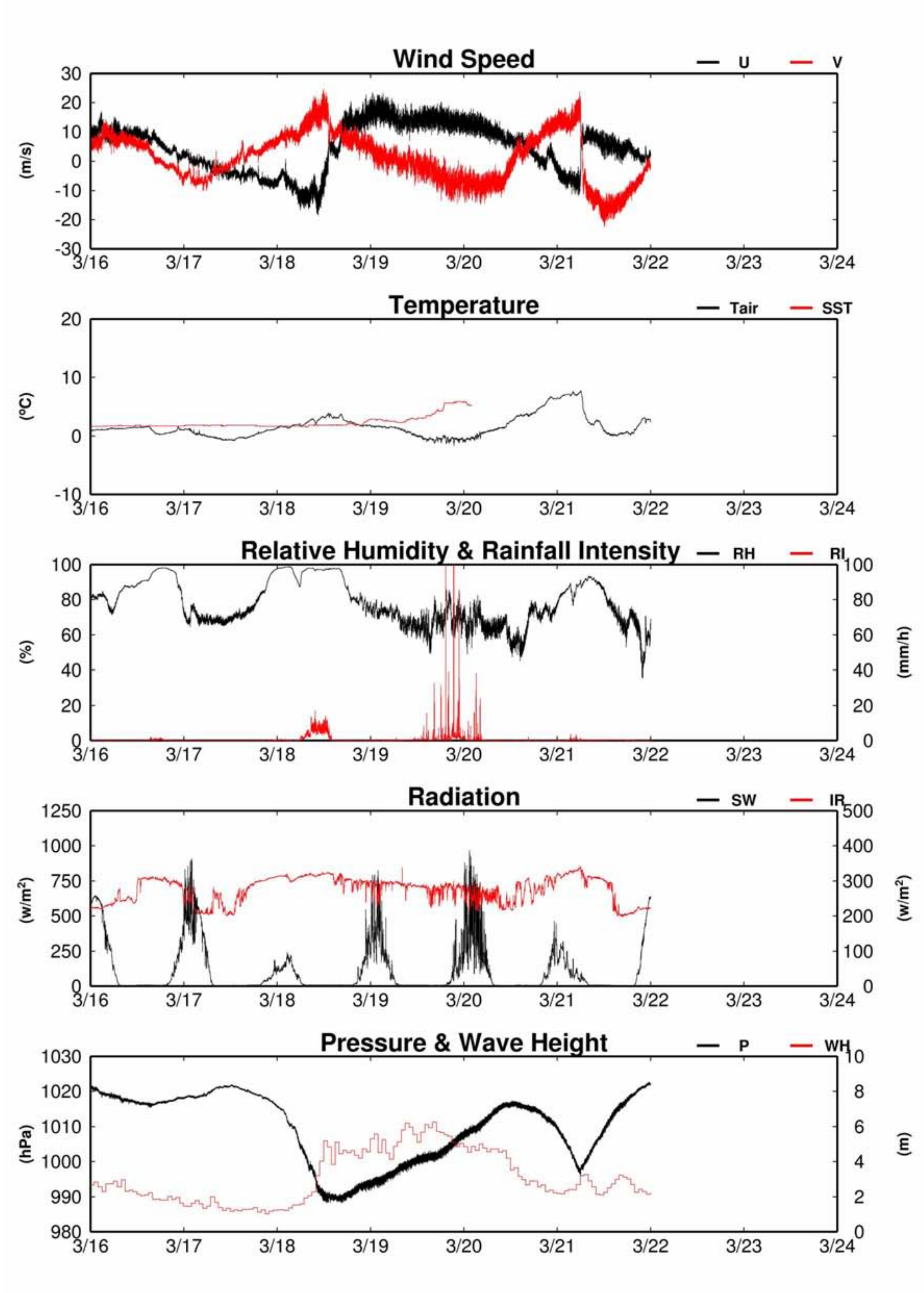


Fig.2.1.1-1 Continue

2.1.2 Ceilometer Observation

Makio HONDA (JAMSTEC) : Principal Investigator
Wataru TOKUNAGA (Global Ocean Development Inc., GODI)
Ryo OHYAMA (GODI)
Not on-board:
Kunio YONEYAMA (JAMSTEC)

(1) Objectives

The information of cloud base height and the liquid water amount around cloud base is important to understand the process on formation of the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(2) Parameters

Cloud base height [m].
Backscatter profile, sensitivity and range normalized at 30 m resolution.
Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm.

(3) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR05-01 cruise from the departure of Sekinehama on 28 February 2005 to arrival of Sekinehama on 24 March 2005.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode
Transmitting wavelength:	905±5 mm at 25 degC
Transmitting average power:	8.9 mW
Repetition rate:	5.57 kHz
Detector:	Silicon avalanche photodiode (APD) Responsibility at 905 nm: 65 A/W
Measurement range:	0 ~ 7.5 km
Resolution:	50 ft in full range
Sampling rate:	60 sec
Sky Condition	0, 1, 3, 5, 7, 8 oktas (9: Vertical Visibility) (0: Sky Clear, 1:Few, 3:Scattered, 5-7: Broken, 8: Overcast)

On the archive dataset, cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft).

(4) Preliminary results

The figure 2.1.2-1 show the time series of the first, second and third lowest cloud base height.

(5) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division.

(6) Remarks

Window cleaning: 06 Mar. 2005
15 Mar. 2005
21 Mar. 2005

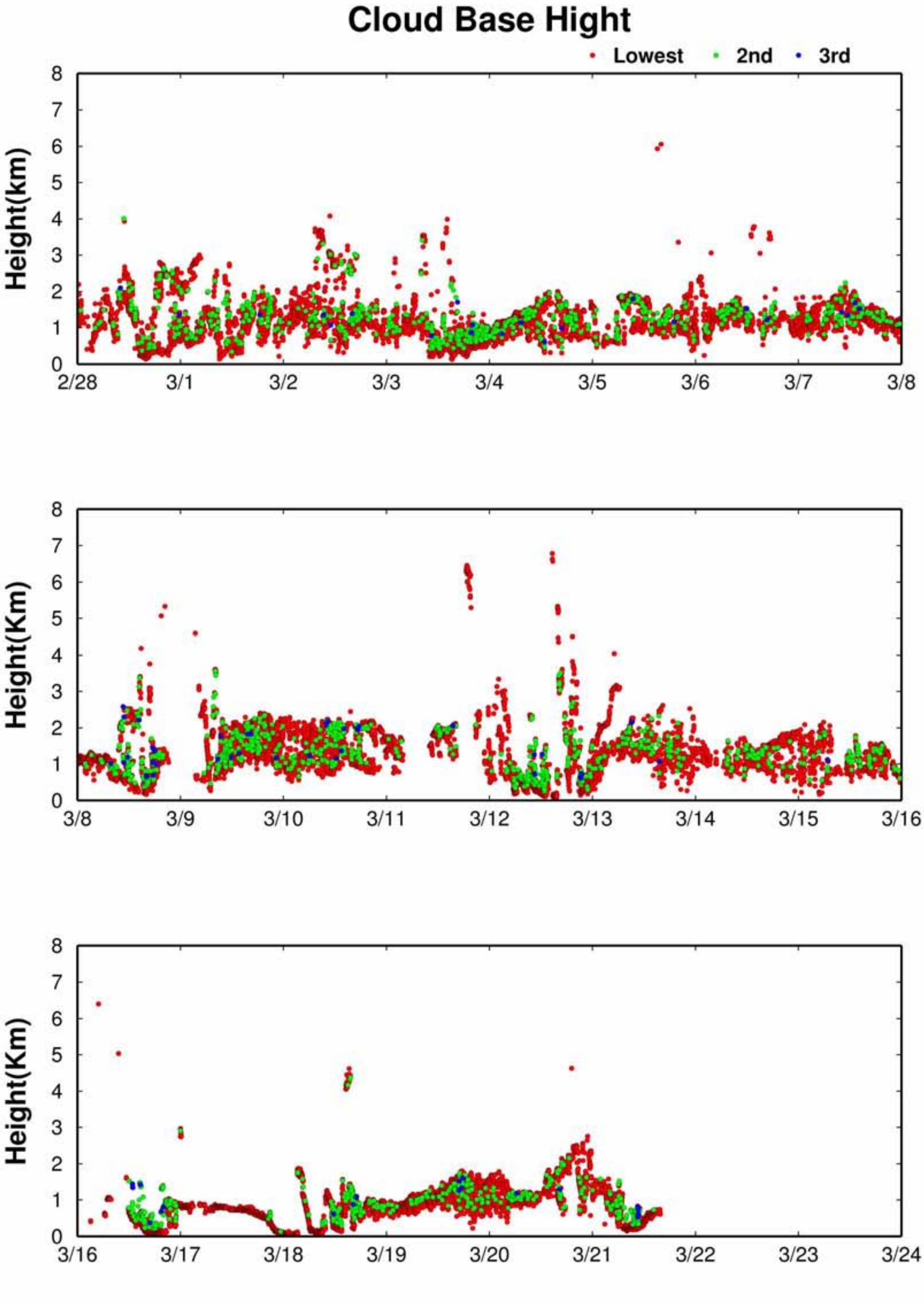


Fig.6.1.2-1 1st, 2nd and 3rd lowest cloud base height during the cruise.

2.2 Physical oceanographic observation
2.2.1 CTD casts and water sampling (MWJ)

Fujio KOBAYASHI (MWJ)
Naoko TAKAHASHI (MWJ): Operation Leader
Tomohide NOGUCHI (MWJ)

(1) Objective

Investigation of oceanic structure and water sampling of each layer.

(2) Method

(2)-1 Overview of the equipment

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 11plus deck unit is a rack-mountable interface which supplies DC power to the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format using a 34560 Hz carrier-modulated differential-phase-shift-keying (DPSK) telemetry link. The deck unit decodes the serial data and sends them to a personal computer (Hewlett Packard Vectra VL, Intel(r) Celeron(tm), Microsoft Windows98 2nd edition) to display, at the same time, to storage in a disk file using SBE SEASOFT software.

The SBE 911pus system acquires data from primary, secondary and auxiliary sensors in the form of binary numbers corresponding to the frequency or voltage outputs from those sensors at 24 samples per second. The calculations required to convert from raw data to engineering units of the parameters are performed by the SBE SEASOFT in real-time. The same calculations can be carried out after the observation using data stored in a disk file.

The SBE 911plus system controls the 36-position SBE 32 Carousel Water Sampler. The Carousel accepts 12-litre water sample bottles. Bottles were fired through the RS-232C modem connector on the back of the SBE 11plus deck unit while acquiring real time data. The 12-litre Niskin-X water sample bottle (General Oceanics, Inc., USA) is equipped externally with two stainless steel springs. The external springs are ideal for applications such as the trace metal analysis because the inside of the sampler is free from contaminants from springs.

(2)-2 Details of sensors

The system used in this cruise is summarized as follows:

Under water unit:

(It was used Stn.K2 Cast 1,2,and3)
SBE, Inc., SBE 9plus, S/N 42423
(It was used from Stn.K2 Cast 4 to final cast)
SBE, Inc., SBE 9plus, S/N 79492

Temperature sensor:

SBE, Inc., SBE 3-04F, S/N 031525 (primary)

SBE, Inc., SBE 3-04/F, S/N 031359 (secondary)

Conductivity sensor:

SBE, Inc., SBE 4C, S/N 042240 (primary)

SBE, Inc., SBE 4-04/0, S/N 041206 (secondary)

Pump:

(It were used until Stn.K2 Cast 4)

SBE, Inc., SBE 5T, S/N 053293 3K (primary)

SBE, Inc., SBE 5T, S/N 053118 3K (secondary)

(It were used from Stn.K1 cast1 to final cast)

SBE, Inc., SBE 5T, S/N 050984 3K (primary)

SBE, Inc., SBE 5T, S/N 050627 3K (secondary)

Altimeter:

Datasonics Inc., PSA-916T, S/N 1100

Deck unit:

(It were used until Stn.K2 Cast 4)

SBE, Inc., SBE 11plus, S/N 11P7030-0272

(It were used from Stn.K1 cast1 to final cast)

SBE, Inc., SBE 11plus, S/N 11P9833-0344

Carousel Water Sampler:

(It were used until Stn.K1 Cast 2)

SBE, Inc., SBE 32, S/N 3221746-0278

(It were used from Stn.K1 cast3 to final cast)

Fluorometer:

Seapoint sensors, Inc., S/N 2579

Transmissometer:

Wetlabs,Inc., CST-207RD job no.9804015

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X (Normal) : #1-#24 bottles

General Oceanics, Inc., 12-litre Niskin-X (Teflon-coating) : #25-#36 bottles

(3) **Data collection and processing**

(3-1) Data collection

CTD measurements were made using a SBE 9plus CTD equipped with temperature-conductivity sensors. The SBE 9plus CTD (sampling rate of 24 Hz) was mounted horizontally in a 36-position carousel frame. Auxiliary sensors included altimeter, dissolved oxygen sensors, fluorometer.

The package was lowered into the water from the starboard side and held 10 m beneath the surface for about one minute in order to activate the pump. After the pump was activated the package was lifted to the surface the package was lowered again at a rate of about 1.0 m/s to Bottom-30m. For the up cast, the package was lifted at a rate of 1.0 m/s except for bottle firing stops. At each bottle firing stops, the bottle was fired.

The SBE 11plus deck unit received the data signal from the CTD. Digitized data were forwarded to a personal computer running the SEASAVE module of the SEASOFT acquisition and processing software, version 5.27b. Temperature, conductivity, salinity, and descent rate profiles were displayed in real-time with the package depth and altimeter reading.

(3-2) Data collection problems

Data error were caused by transmit from 11Plus to 9 plus. It followed that data had some missing value. Table2-2-1(b)and (c) 'Log of data processing ' are shown processes of data and part that be cut missing value

.

(3-3) Data processing

SEASOFT consists of modular menu driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with SBE equipment, and is designed to work with a compatible personal computer. Raw data are acquired from instruments and are stored as unmodified data. The conversion module DATCNV uses the instrument configuration and calibration coefficients to create a converted engineering unit data file that is operated on by all SEASOFT post processing modules. Each SEASOFT module that modifies the converted data file adds proper information to the header of the converted file permitting tracking of how the various oceanographic parameters were obtained. The converted data is stored in rows and columns of ASCII numbers. The last data column is a flag field used to mark scans as good or bad.

The following are the SEASOFT-Win32 (Ver. 5.27b) processing module sequence and specifications used in the reduction of CTD data in this cruise. Some modules are originally developed for additional processing and post-cruise calibration.

DATCNV converted the raw data to scan number, pressure, depth, temperatures, conductivities. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3 seconds, and the offset was set to 0.0 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperatures, conductivities and altitude were averaged over 3 seconds.

ALIGNCTD converted the time-sequence of oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. For a SBE 9plus CTD with the ducted temperature and conductivity sensors and a 3000 rpm pump, the typical net advance of the conductivity relative to the temperature is 0.073 seconds. So, the SBE 11plus deck unit S/N11P7030-0272 was set to advance the primary conductivity for 1.73 scans (1.75/24 = 0.073 seconds). The secondary conductivity for 1.73 scans advance in ALIGNCTD. Oxygen data are also systematically delayed with respect to depth mainly because of the long time constant of the oxygen sensor and of an additional delay from the transit time of water in the pumped plumbing line. This delay was compensated by 4 seconds advancing oxygen sensor output (oxygen voltage) relative to the pressure.

WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, temperatures, conductivities, oxygen voltage, altimeter, fluorescence and transmission outputs.

CELLTM used a recursive filter to remove conductivity cell thermal mass effects from the measured conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

FILTER performed a low pass filter on pressure with a time constant of 0.15 seconds. In order to produce zero phase lag (no time shift) the filter runs forward first then backwards.

WFILTER performed a median filter to remove spikes in the Fluorometer data. A median value was determined from a window of 49 scans.

SECTION selected a time span of data based on scan number in order to reduce a file size. The minimum number was set to be the starting time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up from the surface. (Data to check the CTD pressure drift were prepared before SECTION.)

LOOPEDIT marked scans where the CTD was moving less than the minimum velocity of 0.0 m/s (traveling backwards due to ship roll).

DERIVE was used to compute Oxygen.

BINAVG averaged the data into 1 m bins. The center value of the first bin was set equal to the bin size. The bin minimum and maximum values are the center value plus and minus half the bin size. Scans with pressures greater than the minimum and less than or equal to the maximum were averaged. Scans were interpolated so that a data record exists every m.

DERIVE was re-used to compute salinity, sigma-theta, potential temperature and sigma-T.

SPLIT was used to split data into the down cast and the up cast.

(4) **Preliminary results**

Total 14 casts of CTD measurements have been carried out (table 2-2-1(a)). Vertical profiles of Temperature and salinity, sigma-θ, Fluorescence for routine cast are shown in Figure.2.2.1.1～Figure.2.2.1.4, from Figure 2.2.1.5 to 2.2.1.7 are shown for vertical profiles of Primary Production cast, and from Figure 2.2.1.8 and 2.2.1.10 are shown for vertical profile of Trace Metal cast.

We also compared CTD-salinity and Bottle-salinity. The results are shown in Figure.2.2.1.11 and table 2.2.1 (d).

Table 2-2-1(a): MR05-01 CTD Cast table

STNNBR	CASTNO	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	HT ABOVE	Max	Max	CTD data	Remarks
		yyyy/mm/dd	Start	End	Latitude	Longitude		OUT	BOTTOM	Depth	Pressure	file name	
K02	1	2005/3/3	4:32	4:56	46-52.59N	159-59.71E	5151.0	596.8	-	298.5	301.3	K02m01	for trace metal(Down Omly)
			5:01	5:25	46-52.43N	159-59.95E	5159.0	-	-			K02m02	for trace metal(Up Only)
	2	2005/3/3	7:03	7:35	46-52.72N	159-59.58E	5148.0	-	-	-	-	K02m03	ERROR cast
	3	2005/3/4	6:56	8:29	47-01.40N	160-00.29E	5189.0	5151.5	40.0	5139.3	5245.6	K02m04	for Routine(Down,#1)
			8:30	9:33	47-01.31N	160-00.16E	-					K02m05	for Routine(#5,2,26,3,27,4,28,29,30)
			9:43	10:06	47-00.98N	159-59.77E	5205.0	3017.4				K02m06	for Routine(3000m#6)
			10:11	11:23	47-00.90N	159-59.50E	-	-	-	-	-	K02m07	for Routine(from2500m to Surface)
	4	2005/3/4	18:35	18:54	46-57.87N	160-09.13E	5214.0	199.5	-	202.0	204.2	K02m08	for primary production
K01	1	2005/3/6	3:50	4:17	50-59.91N	164-59.91E	4811.0	-	-	-	-	K01m01	ERROR
	2	2005/3/6	6:33	-	50-59.28N	165-00.60E	4849.0	448.1	-	447.7	452.0	K01m02	for trace metal
			-	7:10	50-59.20N	165-00.66E	4844.0	-	-	-	-	K01m03	
	3	2005/3/6	18:05	18:21	51-00.06N	164-59.76E	4807.0	198.4	-	202.2	-	K01m04	for primary production
	4	2005/3/6	19:07	20:27	51-00.14N	164-59.18E	4830.0	2011.7	-	2001.9	2029.9	K01m05	for RM(Nut.)
	5	2005/3/7	0:58	4:18	50-59.89N	164-59.55E	4816.0	4830.0	32.2	4764.0	4861.0	K01m06	for Routine
35N	01	2005/3/10	21:05	0:18	34-59.85N	159-59.91E	4532.0	4562.8	33.4	4502.0	4582.2	35Nm01	for Routine
	02	2005/3/11	02:.39	4:44	34-59.96N	159-59.66E	4548.0	3028.2	-	3000.2	3041.3	35Nm02	for tm & experience
	03	2005/3/11	17:57	18:14	34-59.99N	160-00.05E	4543.0	199.7	-	201.1	202.5	35Nm03	for primary production
Knot	01	2005/3/14	17:07	17:33	43-59.81N	155-00.16E	5313.0	303.0	-	300.6	303.4	KNOTm01	for trace metal
	02	2005/3/14	18:38	22:24	44-00.32N	154-59.84E	5305.0	5278.8	35.6	5263.6	5372.1	KNOTm02	for Routine

Table 2.2.1 (b) Log of data processing (Pressure Bin)

Station	cast	Filename	Datcnv	Rossum	AlignCTD	Wildedit	CellTM	Filter	Wfilter	Section	loopedit	Derivedo	Binavg	Derive	Split	Remark
K02	1(down)	K02m01	○	—	sec.cond:0.073 pri.oxy:4	○	○	○	○	17780 49173	○	○	○	○	○	The data from scan no.34051 was cut. It was altered the Header information of '.cnv'file
	1(up)	K02m02	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 30766	○	○	○	○	○	It was altered the Header information of '.cnv' and '.btl'file
	3(down)	K02m04	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	11717 143662	○	○	○	○	○	The data from scan no. 103869 to 103883 were cut. The data of scan no.74853 and 74873 has abnormal value at the parameter of secondary sensors(T、S、theta、PT)
	3(up)	K02m05	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 89300	○	○	○	○	○	
	3(up)	K02m06	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 25408	○	○	○	○	○	
	3(up)	K02m07	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	4 104030	○	○	○	○	○	
	4	K02m08	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	11281 38233	○	○	○	○	○	
K01	2	K01m02	○	—	sec.cond:0 pri.oxy:4	○	○	○	○	19393 42308	○	○	○	○	○	The data of scan no.32266 and 32507 has abnormal value at the parameter of altimeter.
	2(up)	K01m03	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	2 26952	○	○	○	○	○	
	3	K01m04	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	13849 39193	○	○	○	○	○	
	4	K01m05	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	13801 128165	○	○	○	○	○	
	5	K01m06	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	14161 302820	○	○	○	○	○	
35N	1	35Nm01	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	19035 296305	○	○	○	○	○	
	2	35Nm02	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	5132 186193	○	○	○	○	○	
	3	35Nm03	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	8561 32257	○	○	○	○	○	
KNOT	1	KNOTm01	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	16633 52729	○	○	○	○	○	It was altered the Header information of '.cnv' and '.btl'file
	2	KNOTm02	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	12937 339289	○	○	○	○	○	

Table 2.2.1 (c) Log of data processing (Depth Bin)

Station	cast	Filename	Datcnv	Rossum	AlignCTD	Wildedit	CellTM	Filter	Wfilter	Section	loopedit	Derivedo	Binavg	Derive	Split	Remark
K02	1(down)	K02m01	○	–	sec.cond:0.073 pri.oxy:4	○	○	○	○	17780 49173	○	○	○	○	○	The data from scan no.34038 to 34062 were cut. It was altered the Header information of '.cnv'file
	1(up)	K02m02	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 30766	○	○	○	○	○	It was altered the Header information of '.cnv' and '.btl'file
	3(down)	K02m04	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	11717 143662	○	○	○	○	○	The data from scan no. 87452 to 91186, and from 103869 to 103883 were cut. The data of scan no.74853 and 74873 has abnormal value at the parameter of secondary sensors(T、S、theta、PT)
	3(up)	K02m05	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 89300	○	○	○	○	○	
	3(up)	K02m06	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	2 25408	○	○	○	○	○	The data from scan no. 18760 to 24198, and 25130 were cut.
	3(up)	K02m07	○	○	sec.cond:0.073 pri.oxy:4	○	○	○	○	4 104030	○	○	○	○	○	
	4	K02m08	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	11281 38233	○	○	○	○	○	The data from scan no. 14982 to 14984, and from 14479 to 14477 were cut.
K01	2	K01m02	○	–	sec.cond:0 pri.oxy:4	○	○	○	○	19393 42308	○	○	○	○	○	The data of scan no.32266 and 32507 has abnormal value at the parameter of altimeter.
	2(up)	K01m03	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	2 26952	○	○	○	○	○	The data scan no. 32255, 32280, and 32281were cut
	3	K01m04	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	13849 39193	○	○	○	○	○	
	4	K01m05	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	13801 128165	○	○	○	○	○	
	5	K01m06	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	14161 302820	○	○	○	○	○	
35N	1	35Nm01	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	19035 296305	○	○	○	○	○	
	2	35Nm02	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	5132 186193	○	○	○	○	○	
	3	35Nm03	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	8561 32257	○	○	○	○	○	
KNOT	1	KNOTm01	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	16633 52729	○	○	○	○	○	It was altered the Header information of '.cnv' and '.btl'file
	2	KNOTm02	○	○	sec.cond:0 pri.oxy:4	○	○	○	○	12937 339289	○	○	○	○	○	

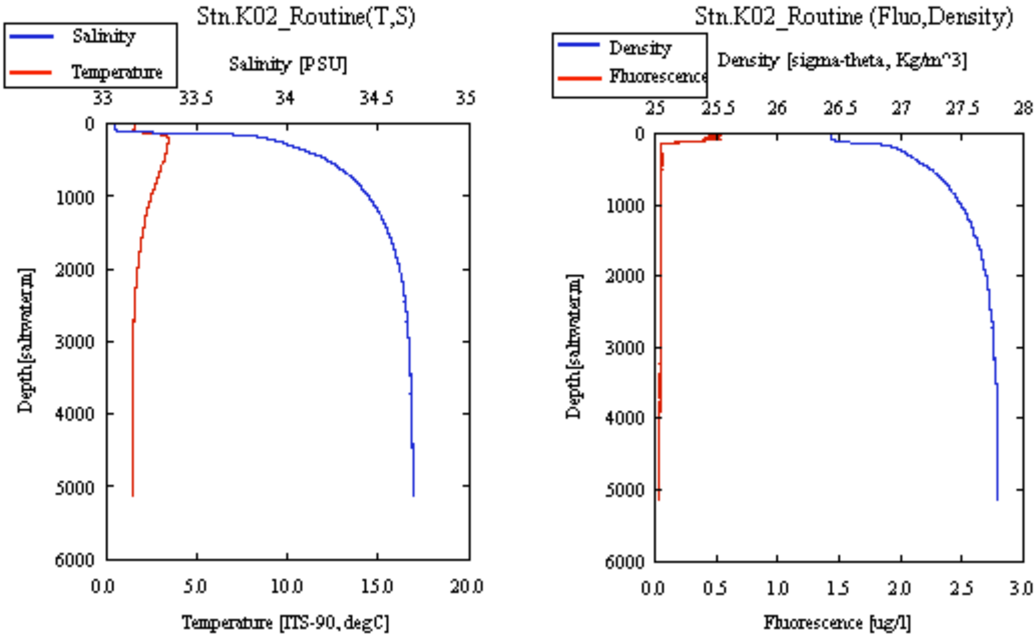


Figure2.2.1.1: Vertical profiles for Routine cast of Stn.K02

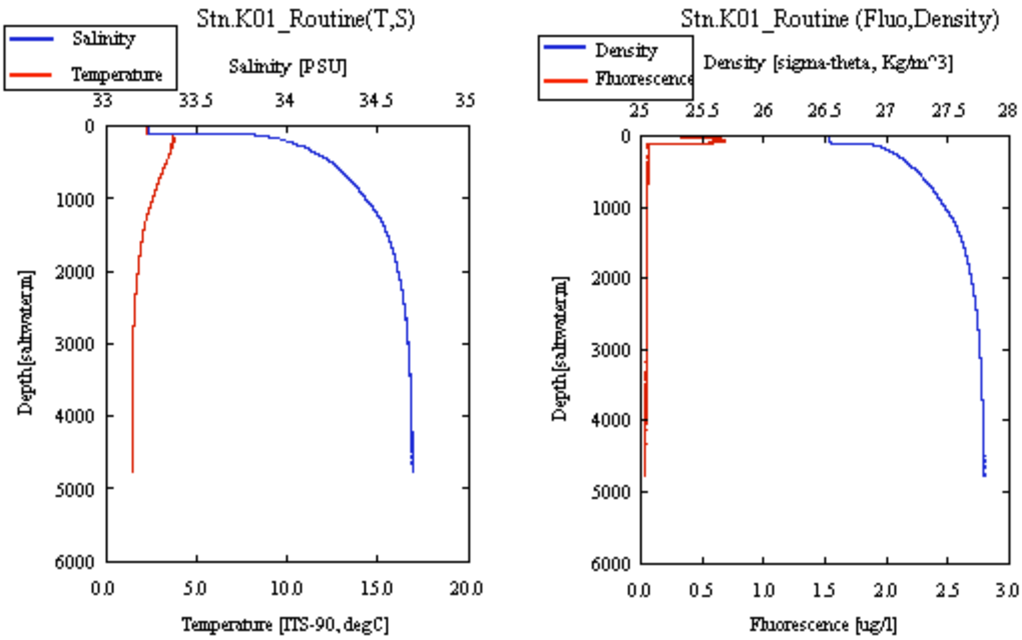


Figure 2.2.1.2: Vertical profiles for Routine Cast of Stn.K01

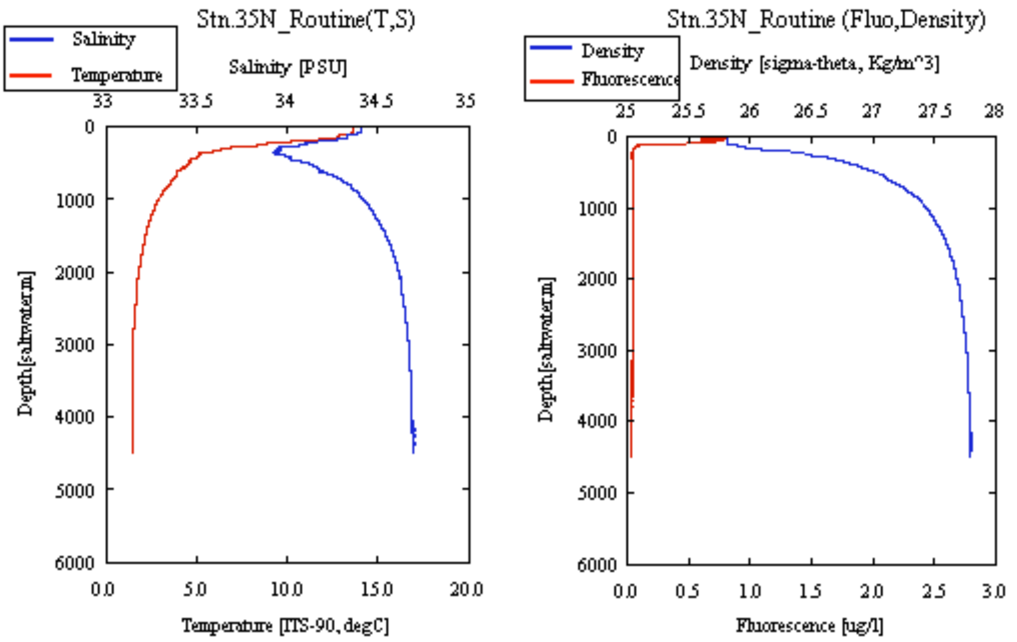


Figure 2.2.1.3: Vertical profiles for the routine cast of Stn.35N

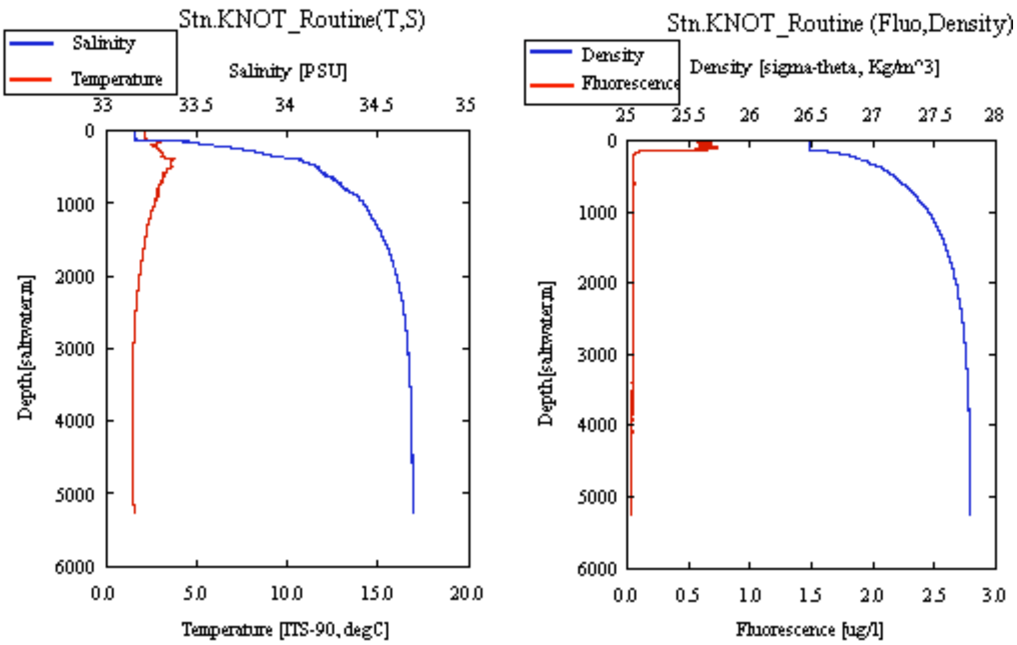


Figure 2.2.1.4: Vertical profiles for the routine cast of Stn.KNOT

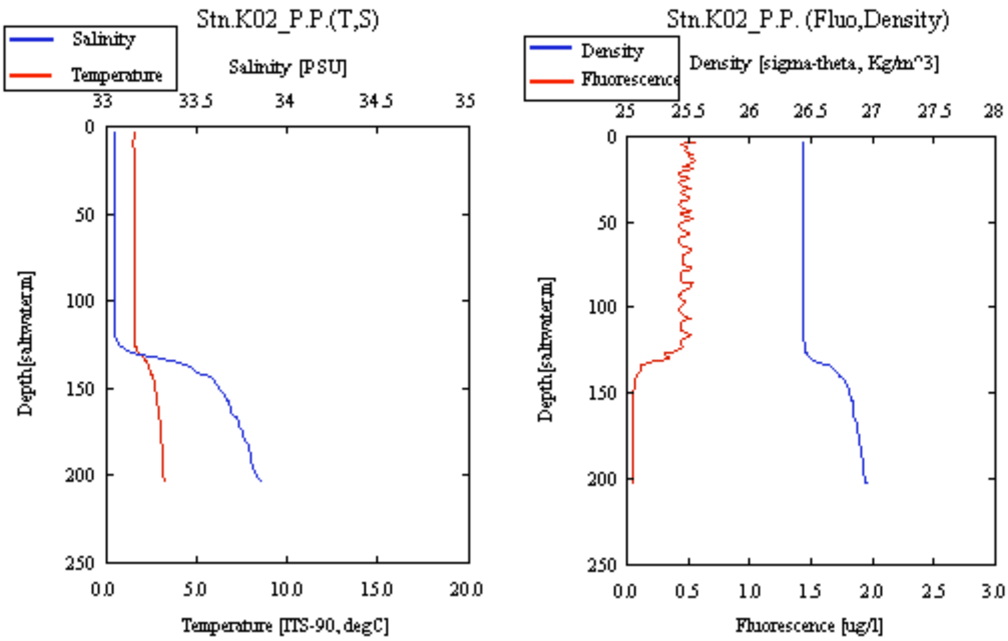


Figure 2.2.1.5: Vertical profiles for the cast of Primary Production of Stn.K02

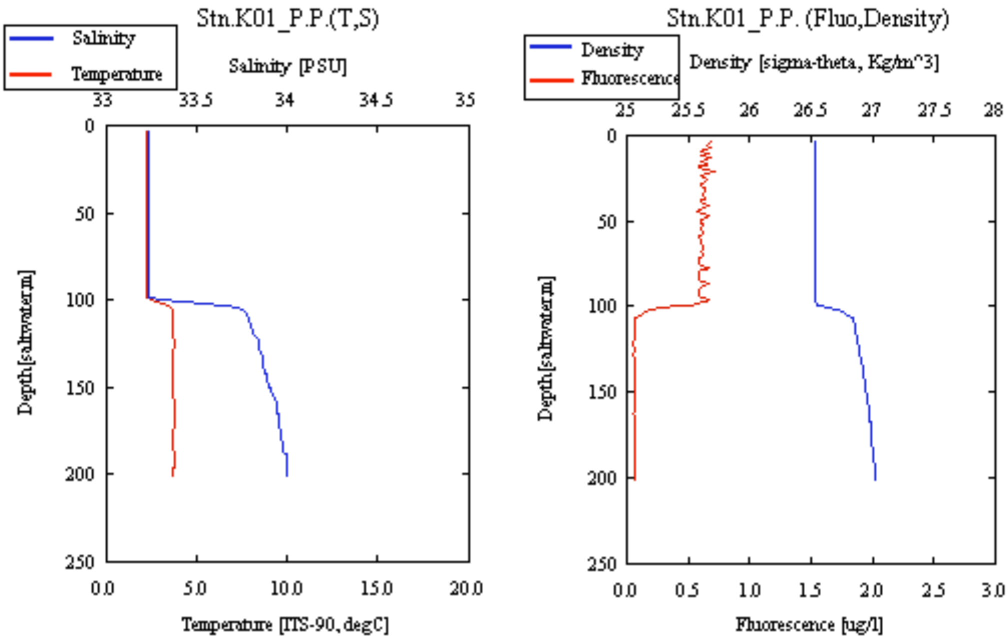


Figure 2.2.1.6: Vertical profiles for the cast of Primary Production of Stn.K01

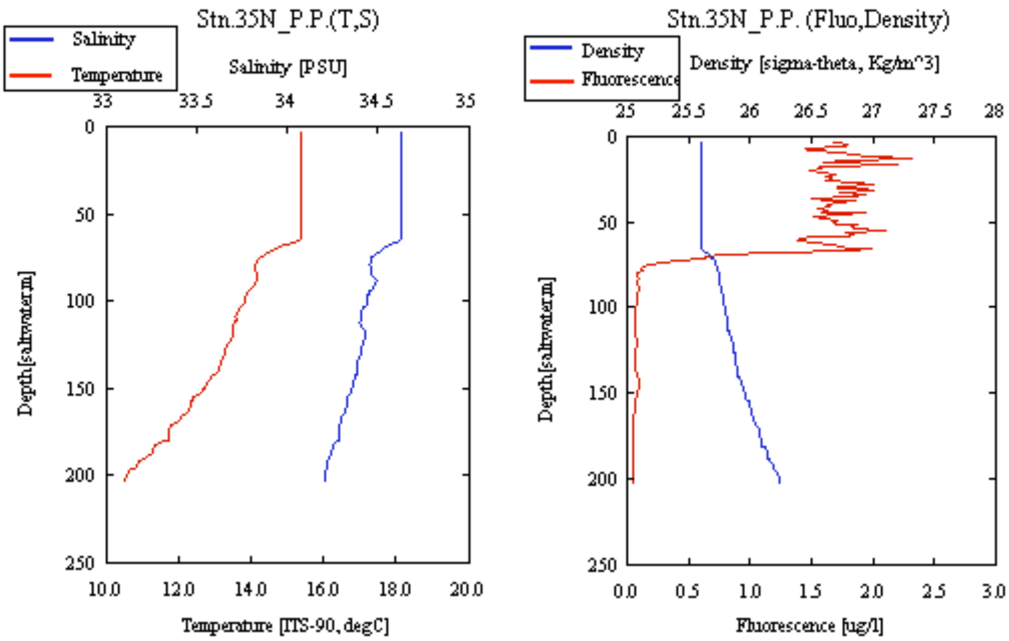


Figure 2.2.1.7: Vertical profiles for the cast of Primary Production of Stn.35N

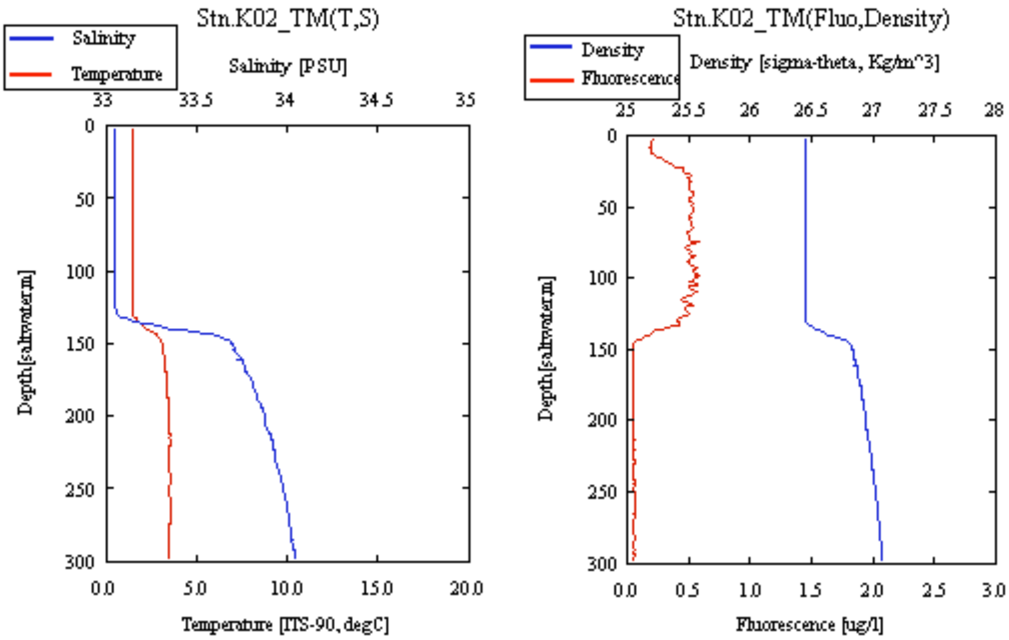


Figure 2.2.1.8: Vertical profiles for the cast of Trace metal of Stn.K02

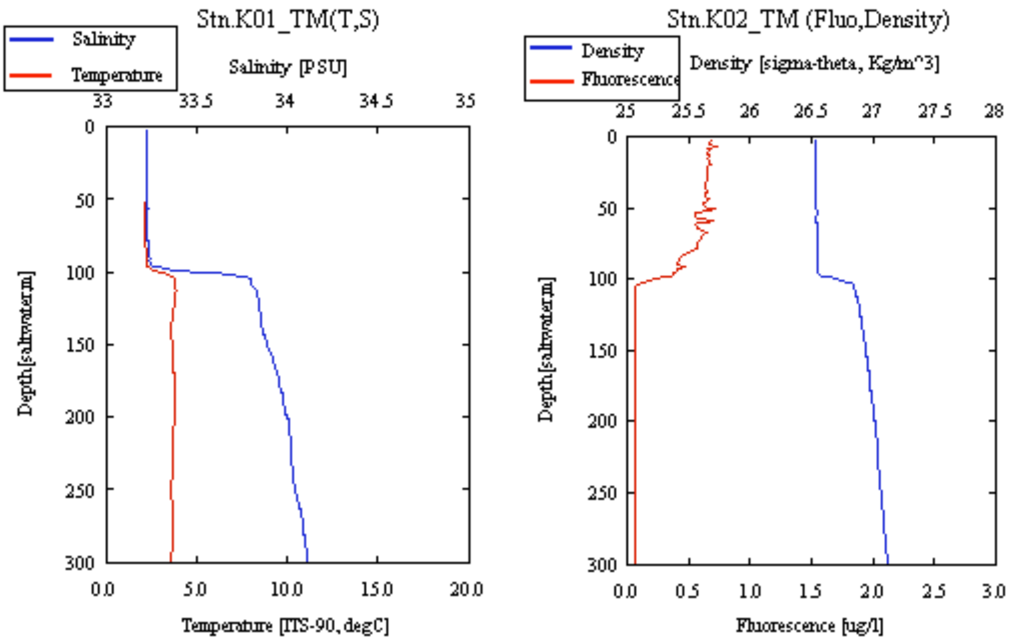


Figure 2.2.1.9: Vertical profiles for the cast of Trace metal of Stn.K01

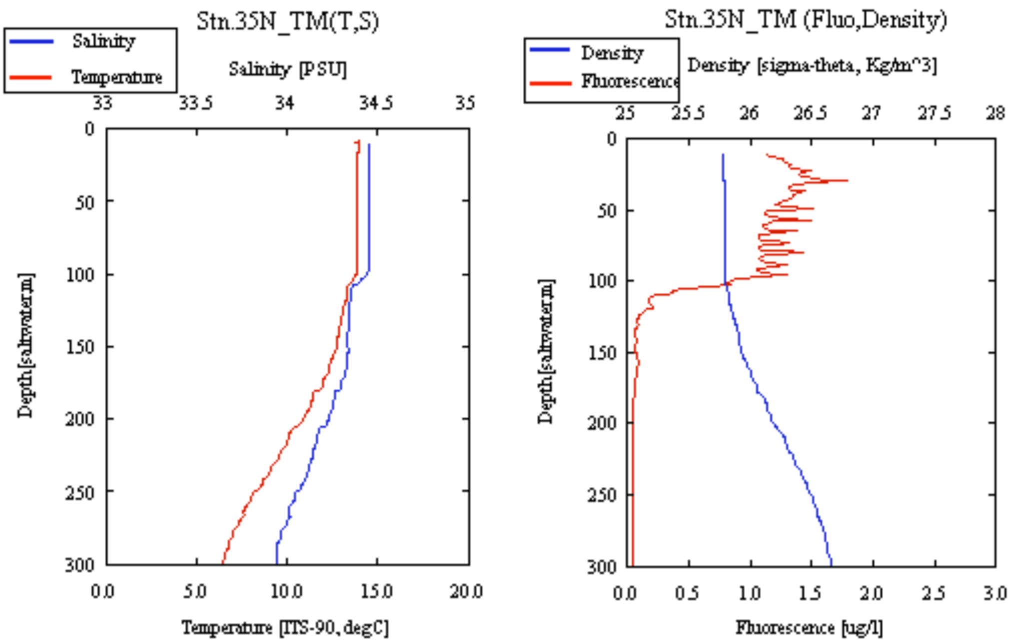


Figure 2.2.1.10: Vertical profiles for the cast of Trace metal of Stn.35N

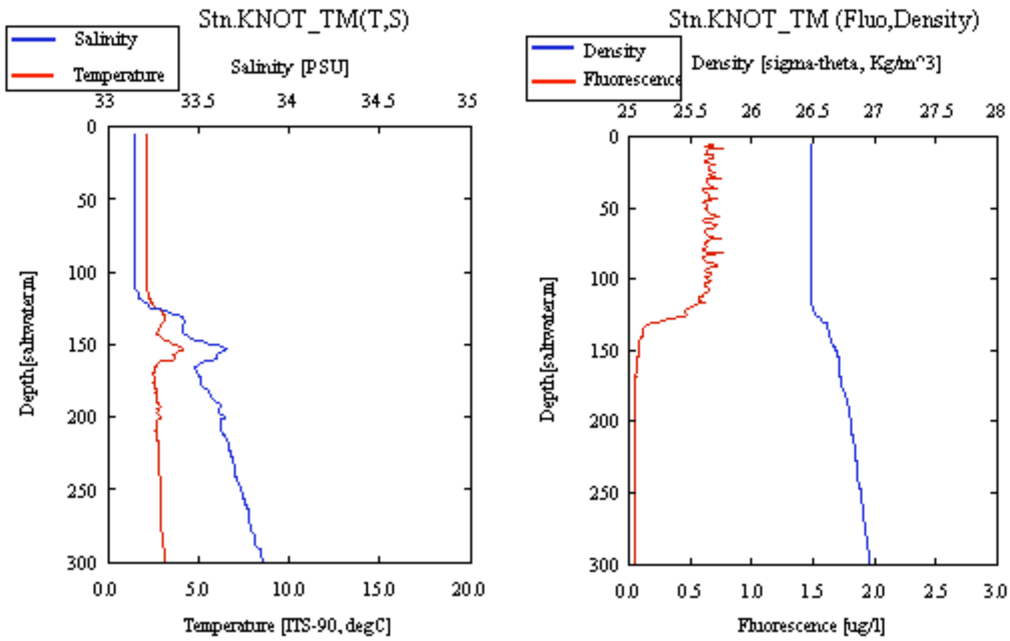


Figure 2.2.1.11: Vertical profiles for the cast of Trace metal of Stn.KNOT

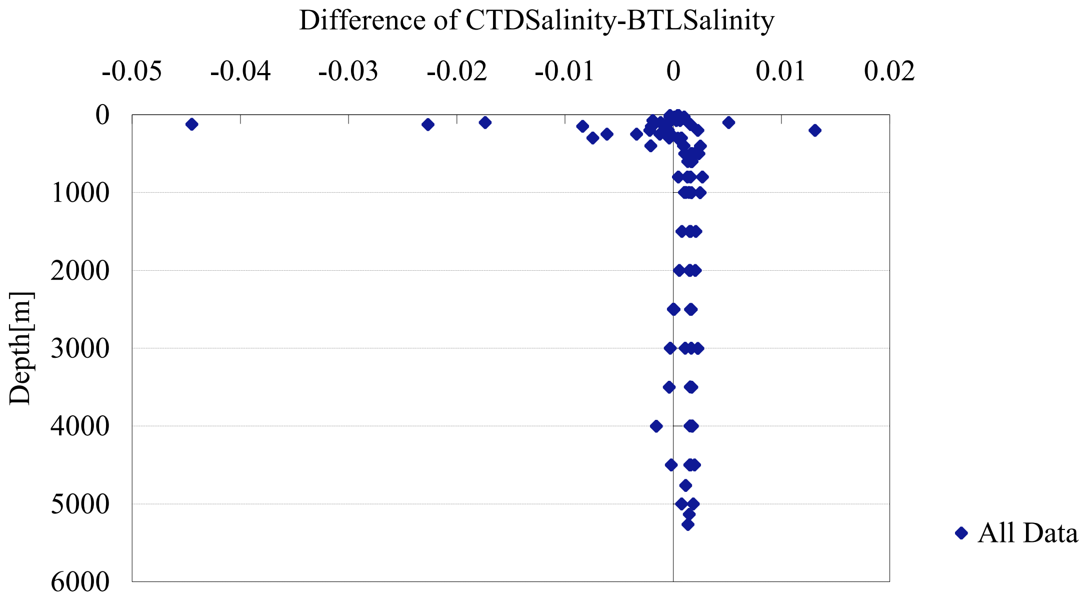


Figure 2.2.1.12: Difference of CTD-salinity and Bottle salinity.

Table 2.2.1 (d) Comparison CTD-salinity and Bottle-salinity

	Sample	Average of the absolute deference	Standard deviation of deference
All data	94	0.004	0.01
Data shallower than 1000m	57	0.006	0.01
Data deeper than 1000m	37	0.001	0.001

(5) **Data archive**

All raw and processed CTD data files will be submitted to JAMSTEC Data Management Office (DMO).

2.2.2 Salinity measurement

Fujio KOBAYASHI (MWJ)

(1) Objective

1. To measure salinity of the samples obtained by CTD casts, bucket sampling, and EPCS.
2. To identify salinity of CTD through comparing that of CTD with that of samples.

(2) Instrument and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR05-01 using the salinometer (Model 8400B "AUTOSAL"; Guildline Instruments Ltd.: S/N 62827) with additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). I also used two precision digital thermometers (Model 9540; Guildline Instruments Ltd.: S/N 62525 and 66723). One thermometer monitored an ambient temperature and the other monitored a bath temperature.

The specifications of AUTOSAL salinometer and thermometer are shown as follows,

Salinometer (Model 8400B "AUTOSAL"; Guildline Instruments Ltd.)

Measurement Range : 0.005 to 42 (PSU)
Accuracy : Better than ±0.002 (PSU) over 24 hours without restandardization
Maximum Resolution : Better than ±0.0002 (PSU) at 35 (PSU)

Thermometer (Model 9540; Guildline Instruments Ltd.)

Measurement Range : -180 to +240 deg C
Resolution : 0.001
Limits of error ±deg C: 0.01 (24 hours @ 23 deg C ±1 deg C)
Repeatability : ±2 least significant digits

The measurement system was almost same as Aoyama *et al.* (2003). The salinometer was operated in the air-conditioned ship's laboratory 'AUTOSAL ROOM' at a bath temperature of 24 deg C. An ambient temperature varied from 22.0 deg C to 24.6 deg C, while a bath temperature is very stable and varied within +/- 0.002 deg C on rare occasion.

The measurement values were determined as median of 31 times reading of the salinometer. Data collection was started in 10 seconds after filling sample to the cell and it took about 10 seconds to collect 31 readings by a personal computer. In case the difference between the measurement values of this two fillings is smaller than 0.00002, the average value of them was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981).

(2-1) Standardization

AUTOSAL model 8400B was standardized at the beginning of the sequence of measurements using IAPSO standard seawater (SSW). SSW salinity changes equivalent to less than 0.001 after 3 years storage on catalogue.

This standardization was done by adjusting the value on the display of AUTOSAL to the double conductivity ratio that is a double-fold value of conductivity ratio indicated the label of SSW bottles. In this cruise, the standardization of the AUTOSAL was performed twice. I measured 7 bottles of SSW in total.

I used sub-standard seawater (SUB) that was sampled and filtered by Millipore filter (pore size: 0.45μm), which was stored in a 20 liters polyethylene container. It was measured every about 10 samples in order to check the drift of the AUTOSAL.

The specifications of SSW and SUB used in this cruise are shown as follows,

Standard seawater (SSW)

batch : P145
conductivity ratio : 0.99981
salinity : 34.983
preparation date : 15-Jul.-2004

Sub standard seawater (SUB)

sampling cruise ID: MR03-K01
sampling depth : 2,000m
sampling date : 27-Feb.-2003

(2-2) Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X (Teflon coating and non-coating) bottle, bucket, and the EPCS. The salinity sample bottle of the 250ml brown grass bottle with screw cap was used to collect the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. Its cap was also thoroughly rinsed. The bottle was stored more than 24 hours in 'AUTOSAL ROOM' before the salinity measurement.

The kind and number of samples are shown as follows,

Table 2.2.2-1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD	121
Samples for EPCS	18
Total	139

(3) Preliminary Results

(3-1) Replicate Samples

22 pairs of replicate samples were collected from the same bottle to identify accuracy of measurement for raw seawater. The average and standard deviation of the absolute difference between each pair of replicate or duplicate samples were obtained. The results of replicate and duplicate samples are shown as Table 2.2.2-2. The frequency distribution for replicate samples is shown as Fig. 2.2.2-1.

Table 2.2.2-2 Results of replicate samples

Kind of Samples	Number of Samples	Average	Standard deviation
Replicate	22	0.0003	0.0004

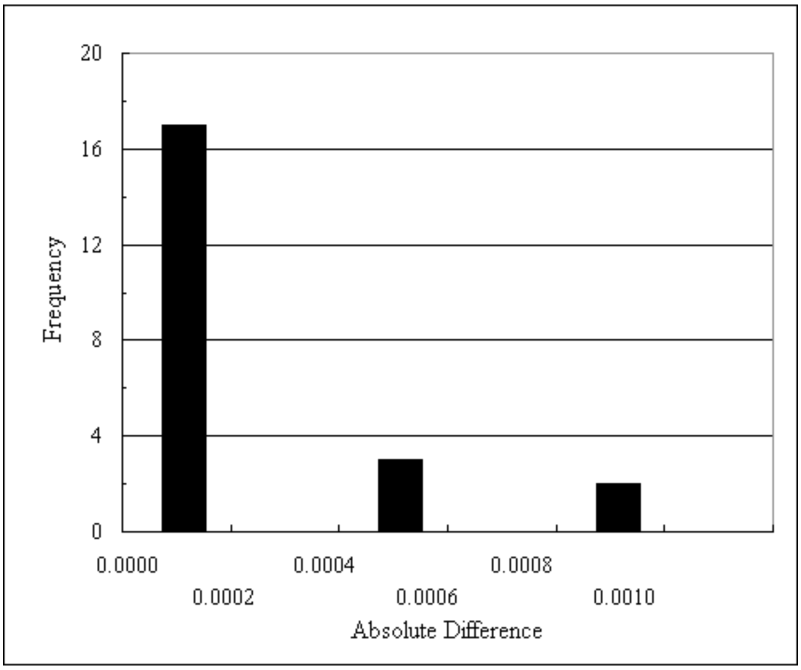


Fig. 2.2.2-1 Frequency distribution for replicate samples

According to these results, measurement and water sampling were done correctly.

(3-2) Comparison between CTD data and Salinity measurement data

The average and standard deviation of difference between measurement data and CTD data including replicate samples is shown as Table 2.2.2-3.

Table 2.2.2-3 Results of comparison between CTD data and Salinity measurement data

Kind of samples	Number of samples	Average	Standard deviation
Primary sensor (all data)	116	-0.0013	0.0114
Primary sensor (more than 1,000m)	55	0.0012	0.0009

According to these results, almost CTD data were considered reasonable and proper with exception of one bad sample (Stn.K2, Cast No. 3 for routine sampling, Sample No. 24, Sampling depth 10m).

(4) Data Archive

All processed salinity data were submitted to Principal Investigator according to the data management policy of JAMSTEC.

(5) Reference

・ Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki : Standard seawater comparison up to P129. Deep-Sea Research, I, Vol. 49, 1103～1114, 2002

・ UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 19

2.2.3 Shipboard ADCP observation

Wataru TOKUNAGA (Global Ocean Development Inc.)
Ryo OHYAMA (GODI)

(1) Objective

Current velocity of each depth cell [m/s]
Echo intensity of each depth cell [dB]

(2) Methods

Upper ocean current measurements were made throughout MR05-01 cruise (Departure of Sekinehama on 28 February 2005 to the arrival at Sekinehama on 24 March), using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. The system consists of following components;

1) a 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating at 75 KHz (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
2) the Ship's main gyro compass (TG-6000, Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;
3) a GPS navigation receiver (Leica MX9400n) providing position fixes;
4) an IBM-compatible personal computer running data acquisition software (VmDas version 1.3 ; RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 10 minutes.

The water sound velocity was calculated from water temperature (thermistor near the transducer head) and salinity (constant value; 35.0 PSU) using formula of Medwin (1975). Each pings were recorded as raw ensemble data (.ENR). And also, 60 seconds and 300 seconds average data were recorded as short term average (.STA) and long term average (.LTA) data., respectively. Major parameters for the measurement (Direct Command) are as follows:

Bottom-Track Commands;

BP = 001 Pings per Ensemble (Enable single-ping bottom track)
27 Feb. 2005 23:28UTC - 28 Feb. 2005 03:00UTC
23 Mar. 2005 02:20UTC - 24 Mar. 2005 00:00UTC
BP = 000 Disenable bottom track
28 Feb. 2005 03:03UTC - 23 Mar. 2005 02:12UTC

Environmental Sensor Commands;

EA = +00000 Heading Alignment (1/100 deg)
EB = +00000 Heading Bias (1/100 deg)
ED = 00065 Transducer Depth (0 - 65535 dm)
EF = +0001 Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]

EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 11000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001	Sensor Source (C;D;H;P;R;S;T)
	C(1): Sound velocity calculate using ED, ES, ET(temp.)
	D(0): Manual ED
	H(2): External synchro
	P(0), R(0): Manual EP, ER (0 degree)
	S(0): Manual ES
	T(1): Internal transducer sensor

Timing Commands;

TE = 00:00:02.00	Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:02.00	Time per Ping (min:sec.sec/100)

Water-Track Commands;

WA = 255	False Target Threshold (Max) (0-255 counts)
WB = 1	Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar)
WC = 064	Low Correlation Threshold (0-255)
WD = 111 111 111	Data Out (V;C;A PG;St;Vsum Vsum^2;#G;P0)
WE = 5000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WG = 001	Percent Good Minimum (0-100%)
WI = 0	Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1	Rcvr Gain Select (0=Low,1=High)
WM = 1	Profiling Mode (1-8)
WN = 100	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 0800	Depth Cell Size (cm)
WT = 000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)

(3) Preliminary results

Fig. 2.2.3-1 to Fig. 2.2.3-5 were showed 30-minutes averaged water current vector along the ship track. The data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

(4) Data archive

These data obtained in this cruise will be submitted to the JAMSTEC Data Management Division.

(5) Remarks

GPS data was not collected as following terms;

08 Mar. 2005 01:40UTC - 01:47UTC

13 Mar. 2005 01:00UTC - 01:25UTC

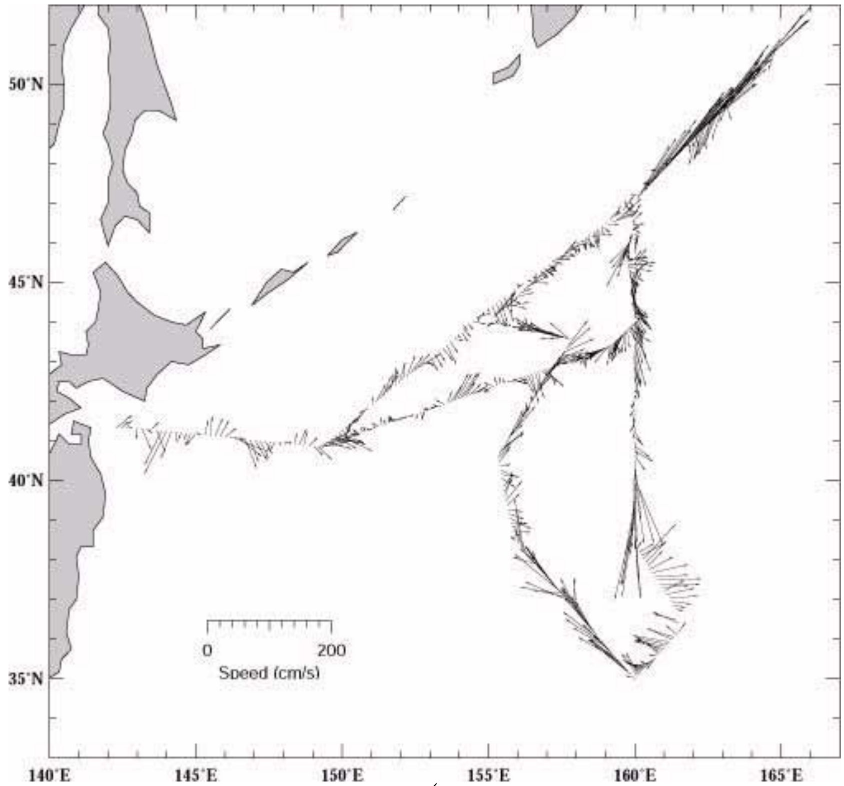


Fig. 2.2.3-1 Water current vector. (Water depth layer: 50 m to 100 m)

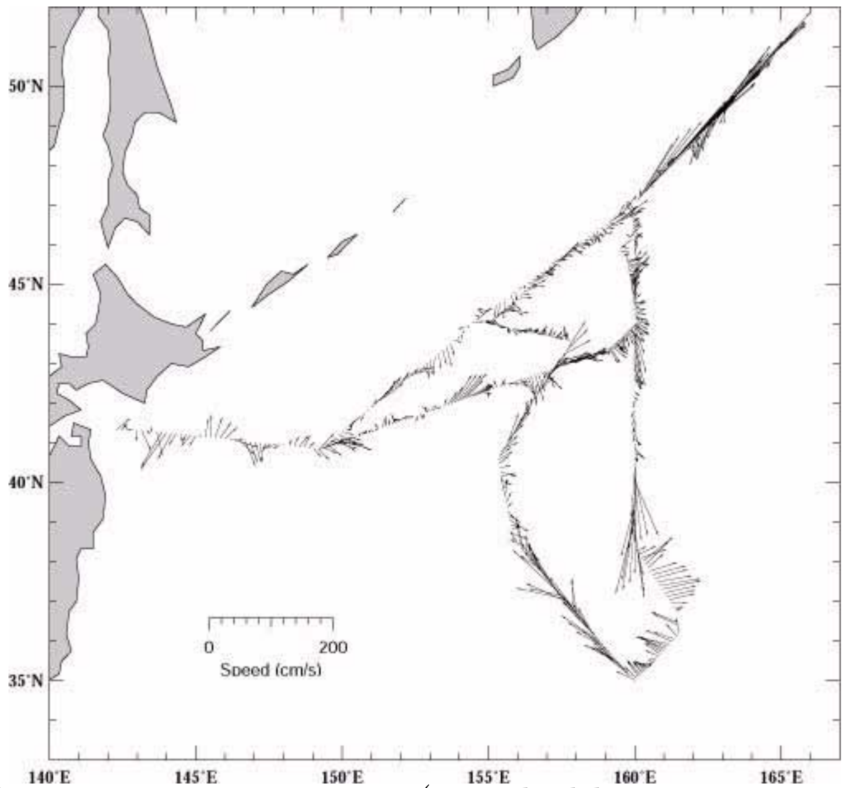


Fig. 2.2.3-2 Water current vector. (Water depth layer: 100 m to 200 m)

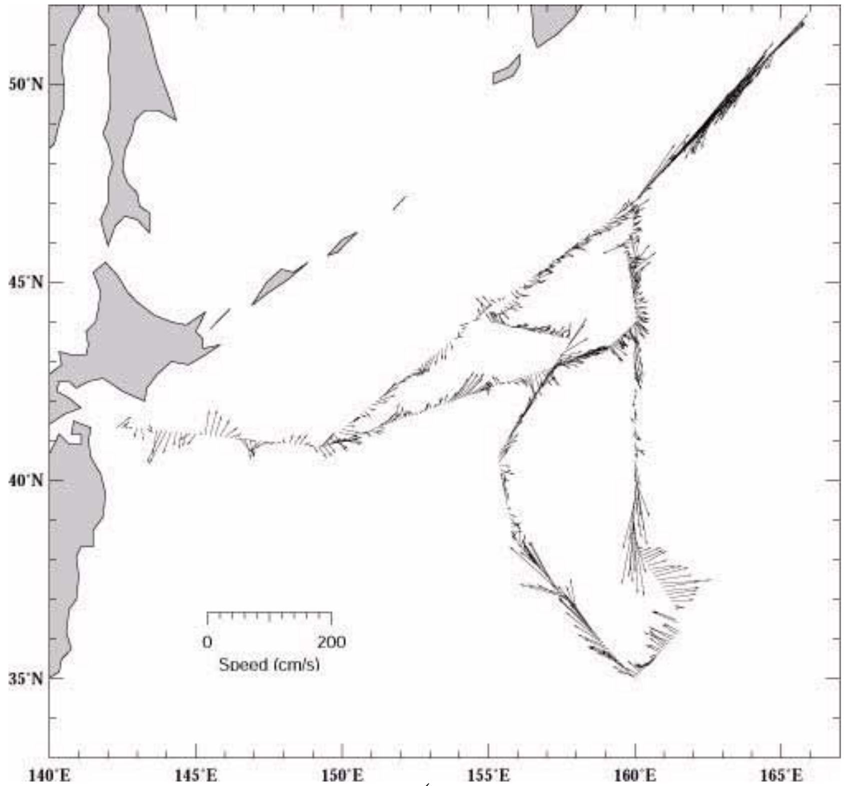


Fig. 2.2.3-3 Water current vector. (Water depth layer: 200 m to 300 m)

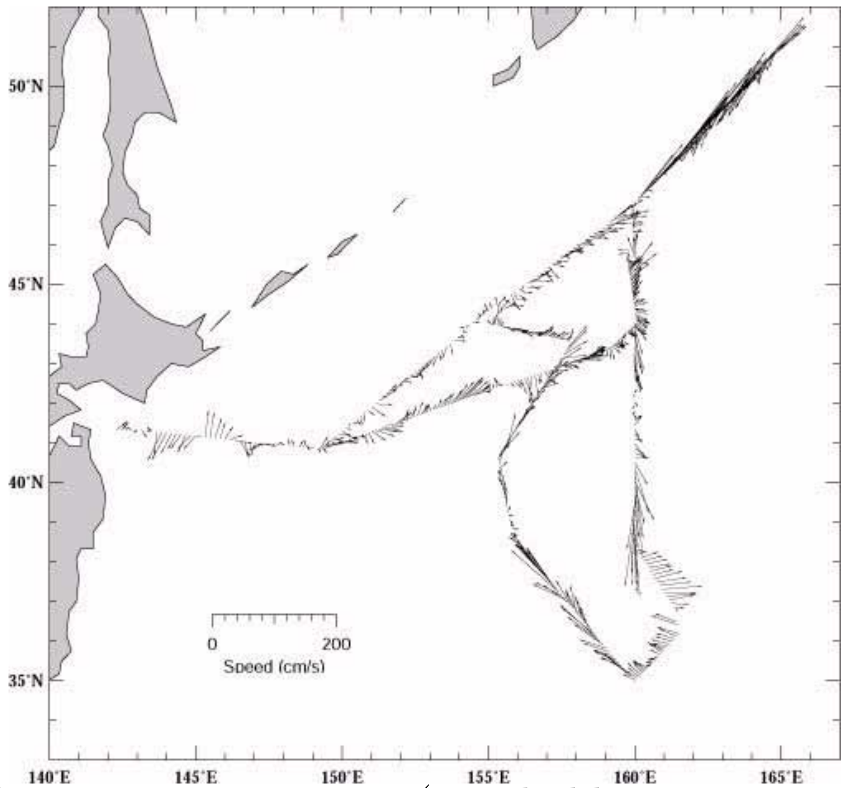


Fig. 2.2.3-4 Water current vector. (Water depth layer: 300 m to 400 m)

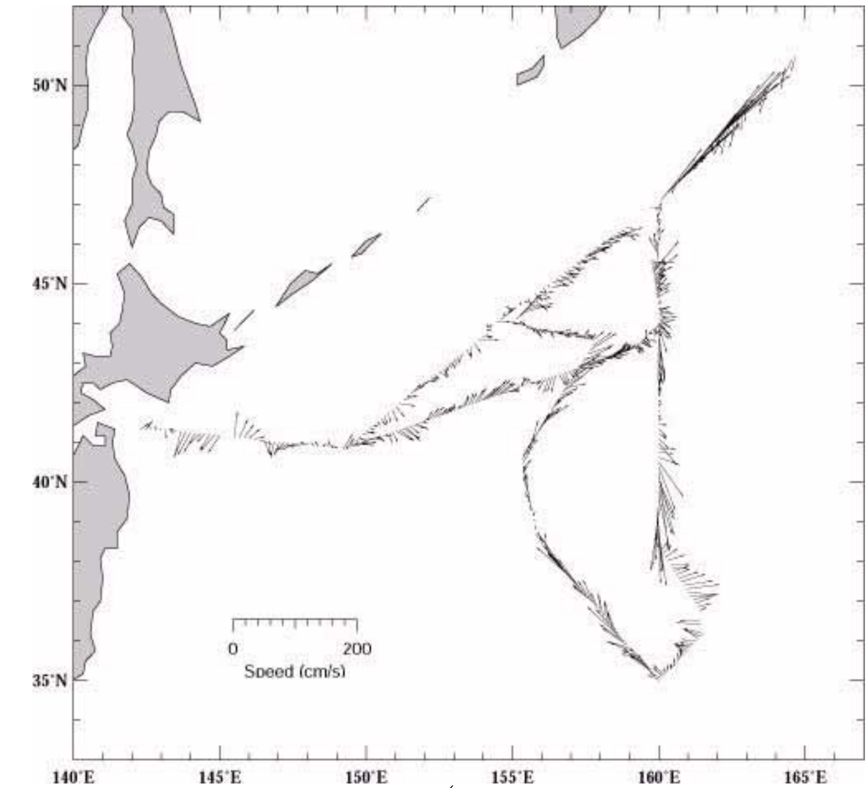


Fig. 2.2.3-5 Water current vector. (Water depth layer: 400 m to 500 m)

2.3 Sea surface monitoring

Kimiko NISHIJIMA (MWJ)

(1) Objective

To measure salinity, temperature, dissolved oxygen, and fluorescence of near-sea surface water.

(2) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has six kind of sensors and can automatically measure salinity, temperature, dissolved oxygen, fluorescence and particle size of plankton in near-sea surface water continuously, every 1-minute. This system is located in the "*sea surface monitoring laboratory*" on R/V MIRAI. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

Near-surface water was continuously pumped up to the laboratory and flowed into the *Continuous Sea Surface Water Monitoring System* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and was 12L/min except with fluorometer (about 0.3L/min). The flow rate is measured with two flow meters.

Specification of the each sensor in this system of listed below.

a) Temperature and Salinity sensor

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.	
Serial number:	2118859-3126	
Measurement range:	Temperature -5 to +35℃,	Salinity0 to 6.5 S m^{-1}
Accuracy:	Temperature 0.01 ℃ 6$month^{-1}$,	Salinity0.001 S m^{-1} $month^{-1}$
Resolution:	Temperatures 0.001℃,	Salinity0.0001 S m^{-1}

b) Bottom of ship thermometer

Model:	SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number:	032607
Measurement range:	-5 to +35℃
Resolution:	±0.001℃
Stability:	0.002 ℃ $year^{-1}$

c) Dissolved oxygen sensor

Model:	2127A, HACH ULTRA ANALYTICS JAPAN, INC.
Serial number:	44733
Measurement range:	0 to 14 ppm
Accuracy:	±1% at 5 ℃ of correction range
Stability:	1% $month^{-1}$

d) Fluorometer

Model: 10-AU-005, TURNER DESIGNS
Serial number: 5562 FRXX
Detection limit: 5 ppt or less for chlorophyll a
Stability: 0.5% month-1 of full scale

e) Particle Size sensor

Model: P-05, Nippon Kaiyo LTD.
Serial number: P5024
Measurement range: 0.2681 mm to 6.666 mm
Accuracy: ±10% of range
Reproducibility: ±5%
Stability: 5% $week^{-1}$

f) Flow meter

Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 l min^{-1}
Accuracy: ±1%
Stability: ±1% day^{-1}

The monitoring Periods (UTC) during this cruise are listed below.

28-Feb.-’05 23:31 to 19-Mar.-’05 05:05

(3) Preliminary Result

Preliminary data of temperature (Bottom of ship thermometer), salinity, dissolved oxygen, fluorescence at sea surface between this cruise are shown in Figs. 1-4. These figures were drawn using Ocean Data View (R. Schlitzer, http://www.awi-bremerhaven.de/GEO/ODV, 2002).

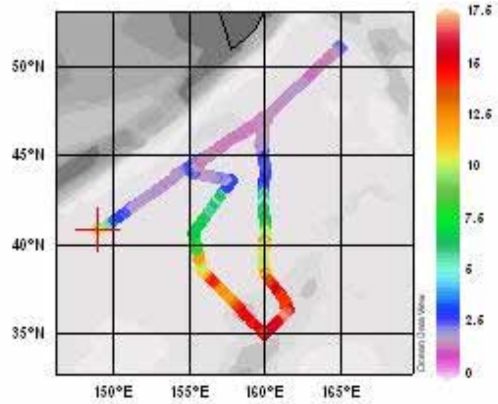


Fig.1 Contour line of temperature.

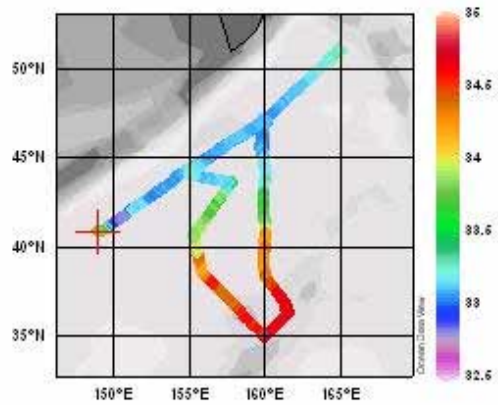


Fig.2 Contour line of salinity.

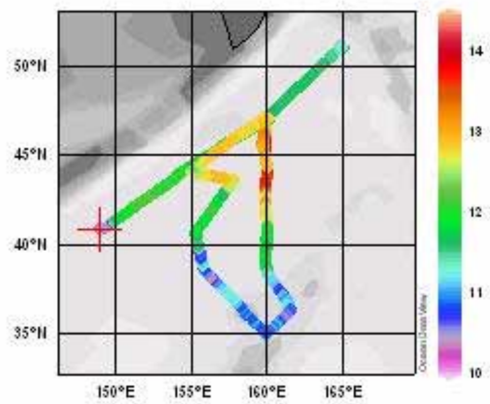


Fig.3 Contour line of dissolved oxygen.

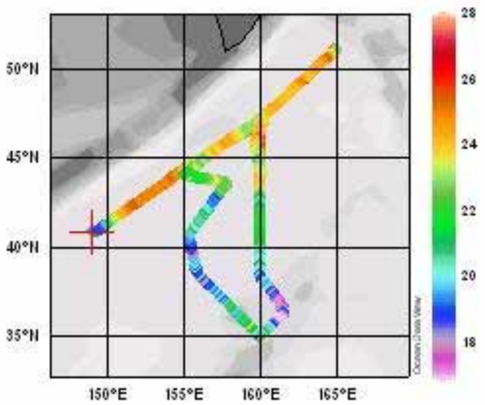


Fig.4 Contour line of fluorescence.

(4) Date archive

The data were stored on a magnetic optical disk, which will be submitted to the Data Management Office (DMO) JAMSTEC, and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC homepage.

2.4 Dissolved oxygen

Kimiko NISHIJIMA (MWJ)

(1) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(2) Methods

Reagents:

Pickling Reagent I: Manganous chloride solution (3M)

Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)

Sulfuric acid solution (5M)

Sodium thiosulfate (0.025M)

Potassium iodate (0.001667M)

(3) Instruments:

Burette for sodium thiosulfate;

APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel

Burette for potassium iodate;

APB-410 manufactured by Kyoto Electronic Co. Ltd. / 20 cm^3 of titration vessel

Detector and Software; Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

(4) Sampling

Following procedure is based on the WHP Operations and Methods (Dickson, 1996).

Seawater samples were collected with Niskin bottle attached to the CTD-system. Seawater for oxygen measurement was transferred from Niskin sampler bottle to a volume calibrated flask (ca. 100 cm^3). Three times volume of the flask of seawater was overflowed. Temperature was measured by digital thermometer during the overflowing. Then two reagent solutions (Reagent I, II) of 0.5 cm^3 each were added immediately into the sample flask and the stopper was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

(5) Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen concentration using two sets of the titration apparatus (DOT-1 and DOT-2). Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution without the blank.

(6) Standardization and determination of the blank

Concentration of sodium thiosulfate titrant (ca. 0.025M) was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130°C. 1.7835 g potassium iodate weighed out accurately was dissolved in deionized water and diluted to final volume of 5 dm^3 in a calibrated volumetric flask (0.001667M). 10 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 90 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Amount of sodium thiosulfate titrated gave the morality of sodium thiosulfate titrant.

The blank from the presence of redox species apart from oxygen in the reagents was determined as follows. 1 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Just after titration of the first potassium iodate, a further 1 cm^3 of standard potassium iodate was added and titrated. The blank was determined by difference between the first and second titrated volumes of the sodium thiosulfate. The oxygen in the pickling reagents I (0.5 cm^3) and II (0.5 cm^3) were assumed to be 3.8 x 10^{-8} mol (Dickson, 1996).

Table 1 shows results of the standardization and the blank determination during this cruise.

Table 1 Results of the standardization and the blank determinations during this cruise.

Date	KIO$_3$		DOT-1 (cm^3)			DOT-2 (cm^3)		
(UTC)	#	Bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	Blank
2005/3/2	#1	040723-138	20050301-1	3.963	-0.004	20050301-2	3.968	-0.006
2005/3/7		040723-139	20050301-1	3.960	-0.004	20050301-2	3.966	-0.003
2005/3/10		040723-140	20050301-1	3.959	-0.004	20050301-2	3.968	-0.002
2005/3/15		040723-141	20050301-1	3.955	-0.005	20050301-2	3.971	-0.003

(7) Reproducibility of sample measurement

Replicate samples were taken at every CTD cast; usually these were 5 - 10 % of seawater samples of each cast during this cruise. Results of the replicate samples were shown in Table 2 and this histogram shown in Fig.1. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

Table 2 Results of the replicate sample measurements

Number of replicate sample pairs	Oxygen concentration (μmol/kg)
	Standard Deviation.
166	0.087

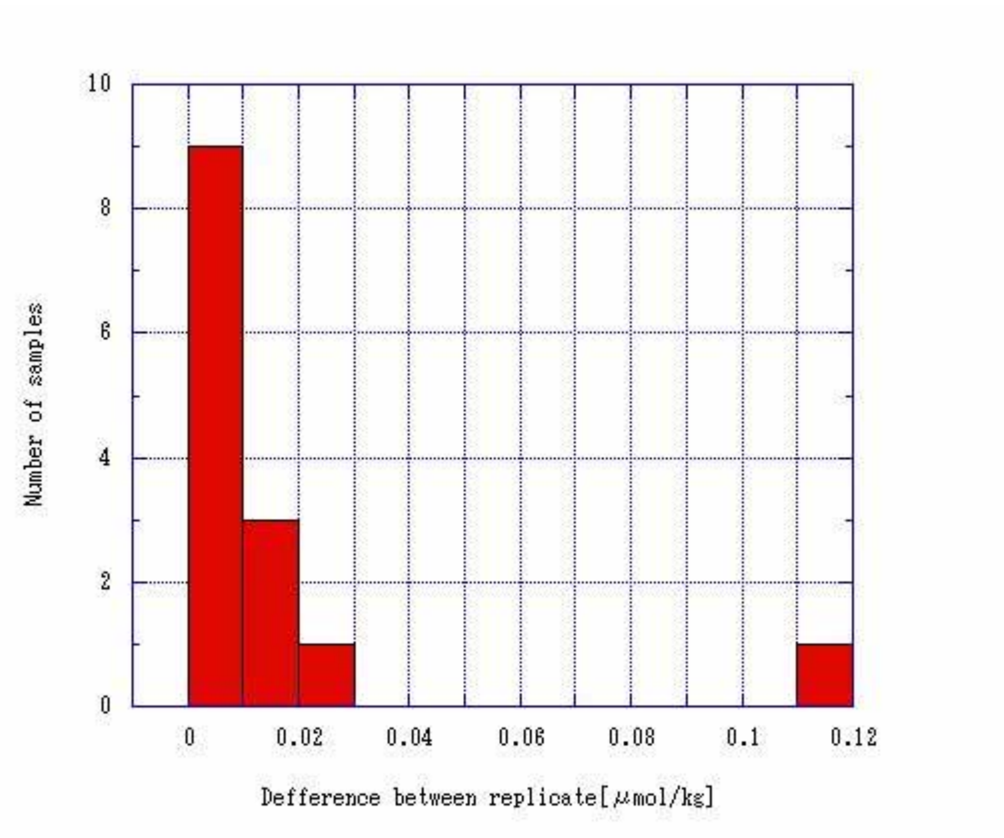
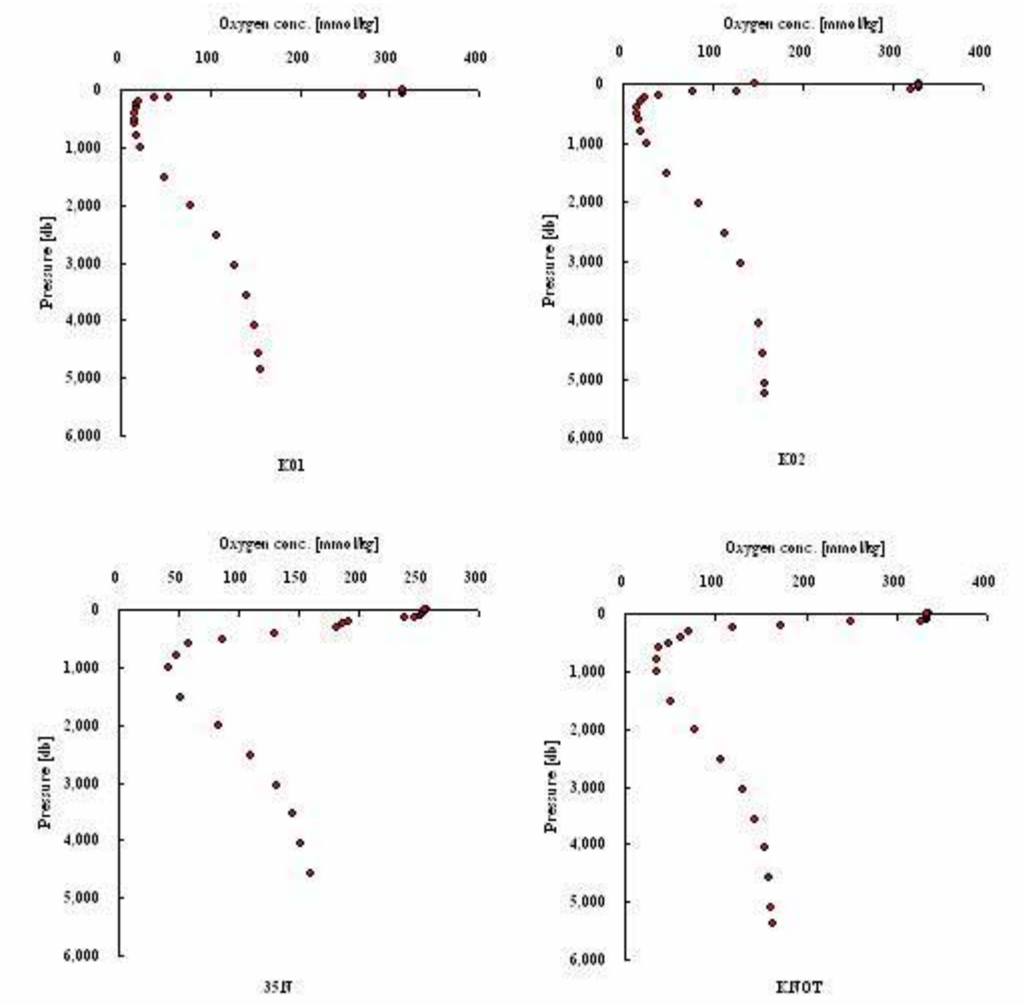


Fig.1 Results of the replicate sample measurements

(8) Preliminary results

During this cruise we measured oxygen concentration in 166 seawater samples at 4 stations. Vertical profiles show Figs 2 at each cast.



Figs.2 Vertical profiles at each station

References:

Dickson, A. (1996) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole, pp1-13.

DOE (1994) Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2. A.G. Dickson and C. Goyet (eds), ORNL/CDIAC-74.

Emerson, S, S. Mecking and J.Abell (2001) The biological pump in the subtropical North Pacific Ocean: nutrient sources, redfield ratios, and recent changes. *Global Biogeochem. Cycles*, 15, 535-554.

Watanabe, Y. W., T. Ono, A. Shimamoto, T. Sugimoto, M. Wakita and S. Watanabe (2001) Probability of a reduction in the formation rate of subsurface water in the North Pacific during the 1980s and 1990s. *Geophys. Res. Letts.*, 28, 3298-3292.

2.5 Nutrients

Junko HAMANAKA (MWJ)
Yuki OTSUBO (MWJ)

1. Objectives

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. During this cruise nutrient measurements will give us the important information on the mechanism of the primary production or seawater circulation.

2. Methods or Apparatus & Performance

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system that have 4-channel analyzing systems for nitrate, nitrite, silicate and phosphate. The system of analysis was improved which proposed for nutrients of seawater by BRAN+LUEBBE. The new system is shown in Figures 2.5.1 - 4.

The laboratory temperature was maintained between 24-26 deg C.

a. Measured Parameters

Nitrite: Nitrite was determined by diazotizing with sulfanilamide and coupling with N-1-naphthyl-ethylenediamine (NED) to form a colored azo dye that was measured absorbance of 550 nm using 5 cm length cell.

Nitrate: Nitrate in seawater is reduced to nitrite by reduction tube (Cd - Cu tube), and the nitrite determined by the method described above, but the flow cell used in nitrate analysis was 3 cm length cell. Nitrite initially present in the sample is corrected.

Silicate: The standard AAII molybdate-ascorbic acid method was used. The silicomolybdate produced is measured absorbance of 630 nm using a 3 cm length cell.

Phosphate: The method by Murphy and Riley (1962) was used with separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate. The phospho-molybdate produced is measured absorbance of 880 nm using a 5 cm length cell.

Nutrients reported in micromoles per kilogram were converted from micromoles per liter by dividing by density calculated at sample temperature.

b. Nutrients Standard

Silicate standard solution, the silicate primary standard, was obtained from Kanto Chemical CO., Inc. This standard solution was 1000 mg per litter with 0.5 M KOH and prepared for ICP analysis. Primary standard for nitrate (KNO_3), nitrite ($NaNO_2$) and phosphate (KH_2PO_4) were obtained from Wako Pure Chemical Industries, Ltd.

c. Sampling Procedures

Samples were drawn into two of virgin 10 ml polyacrylates vials that were rinsed three times before sampling without sample drawing tubes. Sets of 5 different concentrations of the shipboard standards were analyzed at beginning, halfway and end of each group of analysis. The standard solutions of highest concentration were measured every 12–13 samples and were used to evaluate precision of nutrients analysis during the cruise. We also used three concentrations of reference material for nutrients in seawater, RMNS (KANSO Co., Ltd., lots AS, AT and AU), for all runs to secure traceability on nutrient analysis throughout the cruise.

d. Low Nutrients Sea Water (LNSW)

Low nutrients seawater was collected in January 2002 at equatorial Pacific and filtered with 0.45 μm pore size membrane filter (Millipore HA), which was used for the shipboard standard solution.

4. Preliminary Results

Analytical precisions of nitrate, nitrite, silicate, and phosphate were less than 0.13% (54 μM), 0.18% (1.2 μM), 0.10% (172 μM) and 0.15% (3.7μM), respectively. Results of RMNS analysis are shown in Table 2.5.1.

5. Profile or Contour

The vertical profiles of nutrients are shown in Figure 2.5.5.

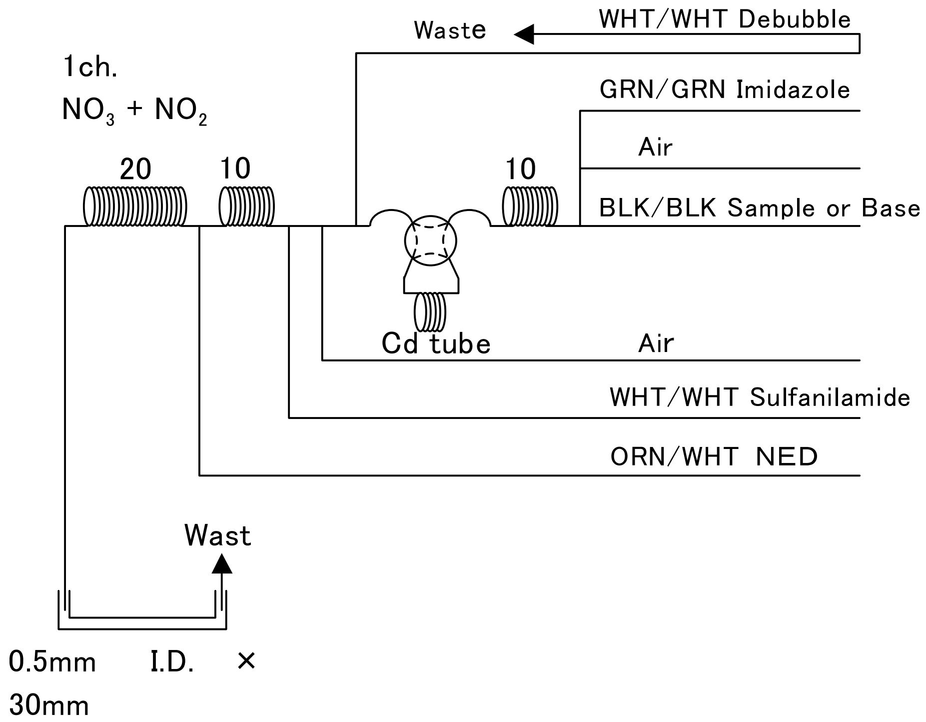


Figure 2.5.1 1ch. (NO_3+NO_2) Flow diagram.

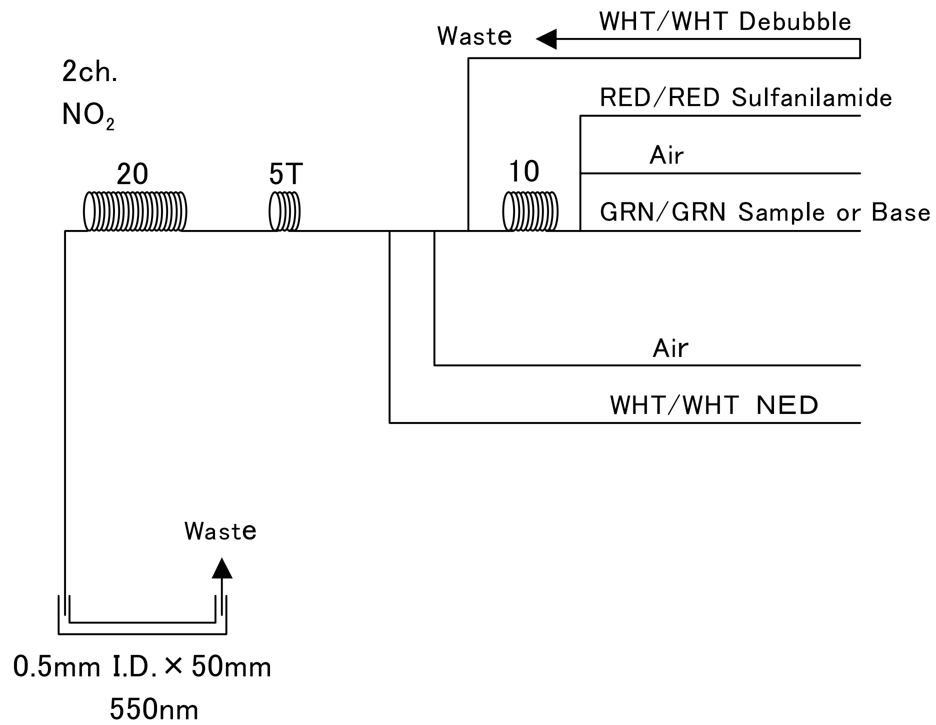


Figure 2.5.2 2ch. (NO_2) Flow diagram.

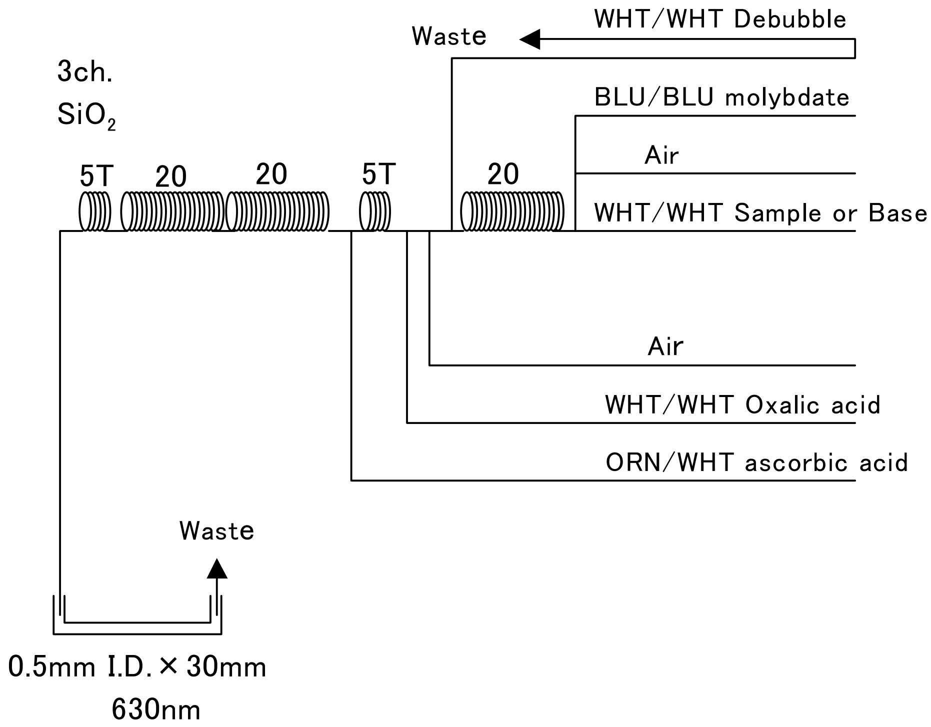


Figure 2.5.3 3ch. (SiO_2) Flow diagram.

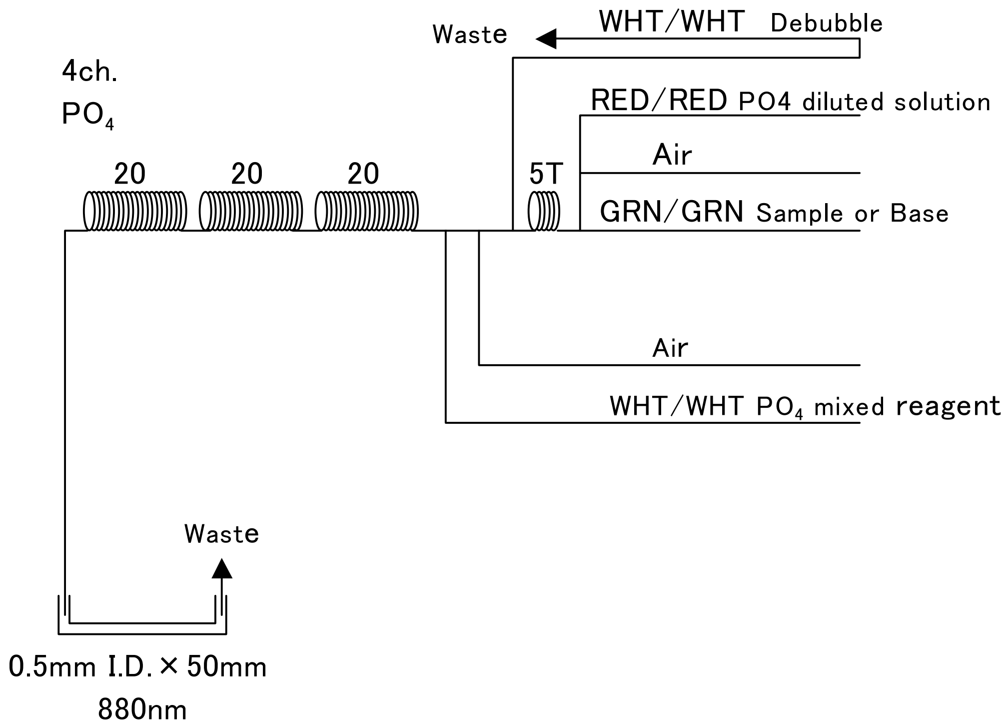


Figure 2.5.4 4ch. (PO_4) Flow diagram.

Table 2.5.1 Summary of RMNS concentrations

μmol/kg

		NO3	NO2	SiO2	PO4
RM-AS	avg	0.10	0.01	1.68	0.08
	stdev	0.02	0.00	0.03	0.00
	n=	4	4	4	4
RM-AT	avg	7.49	0.02	18.32	0.59
	stdev	0.01	0.00	0.07	0.00
	n=	4	4	4	4
RM-AU	avg	29.96	0.01	67.95	2.19
	stdev	0.04	0.00	0.23	0.01
	n=	8	8	8	8

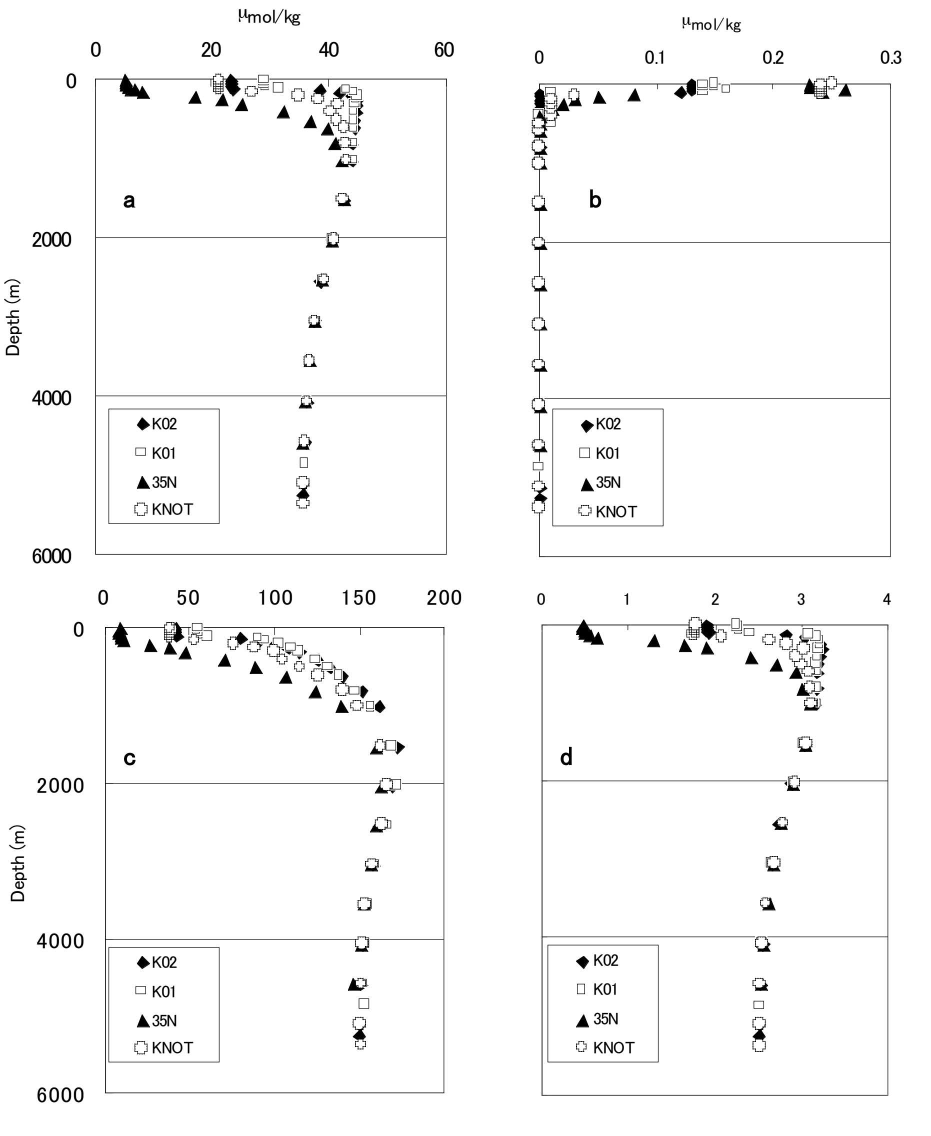


Figure 2.5.5 The vertical profiles of (a) NO_3, (b)NO_2, (c)SiO_2 and (d)PO_4.

2.6 pH measurement

Fuyuki SHIBATA (MWJ)
Masaki MORO (MWJ)
Yoshiko ISHIKAWA (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. In stead, there are four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that could be measured and if two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). The following measurements were carried out in order to acquire data of pH during MR05-01 cruise.

(2) Measured Parameters

pH

(3) Apparatus and performance

(3-1) Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 4 stations. Seawater was sampled in a 125ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 2 hours and was cleaned by fresh water and Milli-Q deionized water for 3 times each. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 12 seconds with care not to leave any bubbles in the bottle. After collecting the samples on the deck, the glass bottles were removed to the lab to be analyzed. The bottles were put in the water bath kept about 25℃ before the measurement.

(3-2) Seawater analysis

pH(-log[H^+]) of the seawater was measured potentiometrically in the closed cell at the temperature 25 ℃ (pH_{25}). The cell with liquid junction or 'salt bridge' (saturated solution of KCl) was applied.

Ag, AgCl| solution of KCl || test solution |H+ -glass –electrode.

The e.m.f. of the glass / reference electrode cell was measured with a pH / Ion meter (Radiometer PHM95). Separate glass (Radiometer PHG201) and reference (Radiometer REF201) electrodes were used. In order not to have seawater sample exchange CO_2 with the atmosphere during pH measurement, closed glass container with water jacket was used. The temperature during pH measurement was monitored with temperature sensor (Radiometer T901) and controlled to 25℃ within ±0.1℃.

To calibrate the electrodes the TRIS (pH=8.0887 pH unit at 25℃, Delvalls and Dickson, 1998) in the synthetic seawater (S= 33.5999 PSU) and AMP (pH=6.7891 pH unit at 25℃, Dickson and Goyet, 1996) in the synthetic seawater (S= 34.1729 PSU) (Total hydrogen scale) were applied.

pH_{sws} of seawater sample (pH_{samp}) is calculated from the expression

$$pH_{samp} = pH_{TRIS} + (E_{TRIS} - E_{samp}) / ER$$

where electrode response "ER" is calculated as follows:

$$ER = (E_{AMP} - E_{TRIS}) / (pH_{TRIS} - pH_{AMP})$$

ER value should be equal to the ideal Nernst value as follows:

$$ER = RT\ LN(10) / F = 59.16\ mV / pH\ unit\ at\ 25℃$$

(4) Preliminary results

A duplicate analysis was made on every 8th seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.6-1). The average of the difference was 0.001 pH unit (n= 16 pairs). The standard deviation was 0.0012 pH unit, which indicates that the analysis was accurate enough according to DOE (1994).

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

(6) Reference

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74

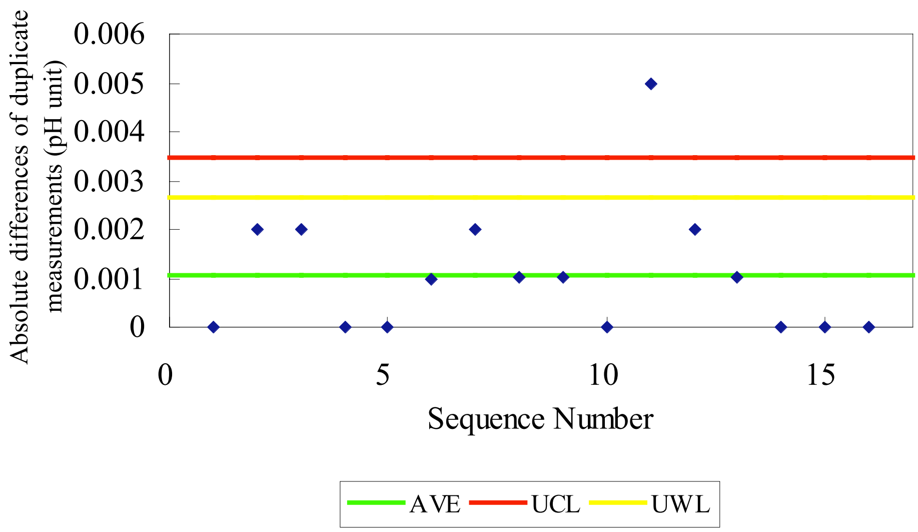


Figure 2.6-1 Range control chart of the absolute differences of duplicate measurements carried out in the analysis of pH during the MR04-06 cruise.

2.7. Total Dissolved Inorganic Carbon (TDIC)
2.7.1. Water column TDIC

Fuyuki SHIBATA (MWJ)
Yoshiko ISHIKAWA (MWJ)
Masaki MORO (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. In stead, there are four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that could be measured and if two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). The following measurements were carried out in order to acquire data of total dissolved inorganic carbon (TDIC) during MR05-01 cruise.

(2) Measured Parameters

Total dissolved inorganic carbon

(3) Apparatus and performance

(3-1) Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 4 stations. Seawater was sampled in a 250ml glass bottle. The glass bottle was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 3 hours and was cleansed by fresh water and Milli-Q deionized water for 3 times each. A sampling tube was connected to the Niskin bottle when the sampling was carried out in order to let the sample calmly be introduced to the bottle. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 20 seconds with care not to leave any bubbles in the bottle. After collecting the samples on the deck, the glass bottles were removed to the lab to be analyzed. Prior to the analysis, 3ml of the sample (1% of the bottle volume) was removed from the glass bottle in order to make a headspace. The samples were then poisoned with 100μl of over saturated solution of mercury chloride within one hour from the sampling point. After poisoning, the samples were sealed using grease (Apiezon M grease) and a stopper-clip. The samples were stored in a refrigerator at approximately 5℃ until analyzed.

(3-2) Seawater analysis

The system was connected to a Model 5012 coulometer (Carbon Dioxide Coulometer, UIC Inc.), an automated sampling and CO_2 extraction system controlled by a computer (JANS, Inc.). The concentration of TDIC was measured as followings.

The sampling cycle was composed of 3 measuring factors; 70ml of standard CO_2 gas

(2% CO_2 - N_2 gas), 2ml of 10%-phosphoric acid solution and 6 seawater samples. The standard CO_2 gas was measured to confirm the constancy of the calibration factor during a run and phosphoric acid was measured for acid blank correction.

From the glass bottle, approximately 20ml of seawater was measured in a receptacle and was mixed with 2ml of 10%-phosphoric acid. The carbon dioxide gas evolving from the chemical reaction was purged by nitrogen gas (carbon dioxide free) for 12 minutes at the flow rate of 140ml/min. and was absorbed into an electrolyte solution. In the electrolyte solution, acids forming from the reaction between the solution and the absorbed carbon dioxide were titrated with hydrogen ions in the coulometer and the counts of the titration were stored in the computer.

Before any of the samples were measured, the calibration factor (slope) was calculated by measuring series of sodium carbonate solutions (0~2.5mM) and this calibration factor was applied to all of the data acquired throughout the cruise. By measuring Certified Reference Material (CRM batch 65: Scripps Institution of Oceanography) at the beginning of every run series, the slope was calibrated with the counts of this outcome. A reference material (JRM batch BGL) was also measured for every run in the beginning and in the end to calibrate the inclination of the outcome that occurs during the run due to the drift in the reaction of the solution. JRM was prepared in JAMSTEC by a similar procedure of CRM preparation. A fresh set of cell solution was limited to measure samples from only 2 stations (approximately 60 samples).

(4) Preliminary results

During the cruise, 112 samples were analyzed for TDIC. A duplicate analysis was made on every forth seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.7.1.-1.). The average of the differences was 1.56 μmol/kg (n=15). The standard deviation was 1.32 μmol/kg which indicates that the analysis was accurate enough according to DOE (1994).

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

Reference

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74

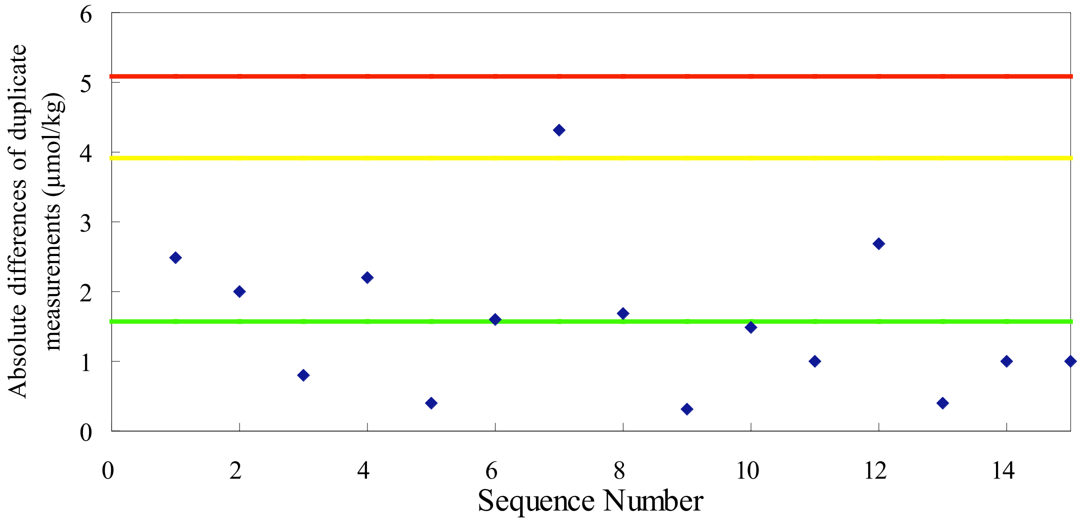


Figure 2.7.1-1 Range control chart of the absolute differences of duplicate measurements carried out in the analysis of TDIC during the MR05-01 cruise.

2.7.2. Sea surface TDIC

Fuyuki SHIBATA (MWJ)
Yoshiko ISHIKAWA (MWJ)
Masaki MORO (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. In stead, there are four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that could be measured and if two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). The following measurements were carried out in order to acquire data of TDIC of surface seawater during MR05-01 cruise.

(2) Measured Parameters

Total dissolved inorganic carbon

(3) Materials and Methods

Surface seawater was continuously collected from 28th February 2005 to 19th March 2005 during this cruise. Surface seawater was continuously collected by a pump placed at the bottom of the vessel (depth of 4.5m). The TDIC of the introduced surface seawater was constantly measured by a coulometer that was set to analyze surface seawater specifically. The basic coulometric measurement principles were the same as described in 2.7.1. For the measuring cycle, standard gas and acid blank were both measured prior to every 5 sample measurements.

A reference material (JRM batch BGL2 and BGL) was measured for every run in the beginning and in the end to calibrate the inclination of the outcome that occurs during the run due to the drift in the reaction of the solution. The set of cell solutions was changed once every three days.

(4) Preliminary results

Figure 2.7.2-1 is showing the results of measuring the TDIC concentration of surface seawater samples. During the cruise, 4 bottles of RM (batch Q10) was analyzed in order to calibrate the slope of the calibration factor. The standard deviation of the absolute differences of duplicate measurements was 0.7 µmol/kg (n=16).

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

Reference

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon

dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74

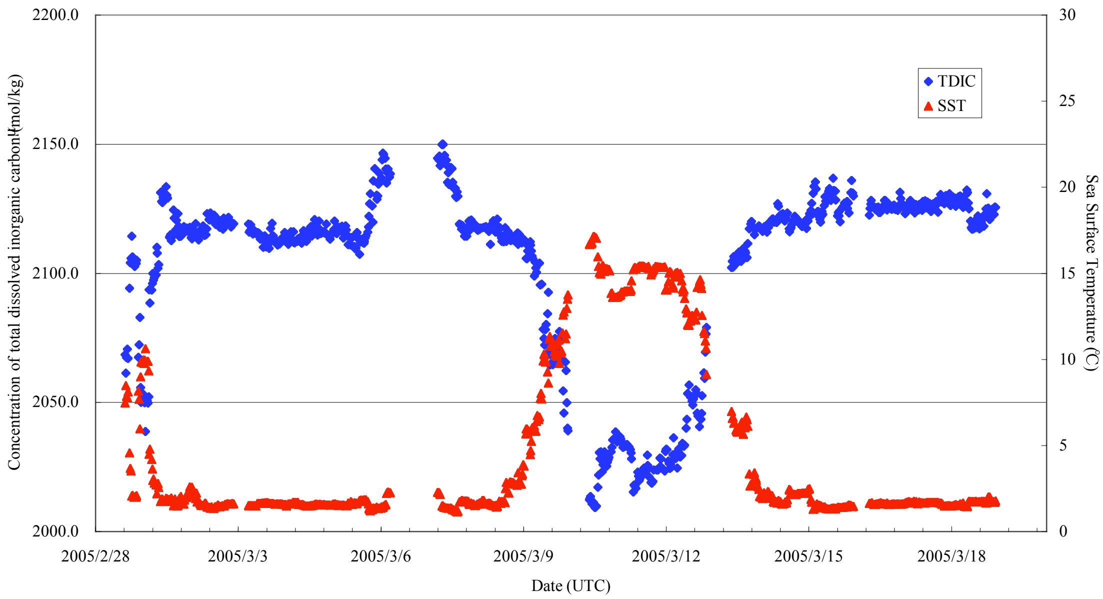


Figure 2.7.2-1 Result of the analysis of the surface seawater carried out during MR05-01 cruise. Blue dots indicate the concentration of the total dissolved inorganic carbon (TDIC) in surface seawater and red dots indicate the sea surface temperature (SST).

2.8 Total alkalinity measurement

Fuyuki SHIBATA (MWJ)
Masaki MORO (MWJ)
Yoshiko ISHIKAWA (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. In stead, there are four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that could be measured and if two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). The following measurements were carried out in order to acquire data of total alkalinity (TA) during MR05-01 cruise.

(2) Measured Parameters

Total alkalinity

(3) Apparatus and performance

(3-1) Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 4 stations. Seawater was sampled in a 125ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 2 hours and was cleaned by fresh water and Milli-Q deionized water for 3 times each. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 12 seconds. After collecting the samples on the deck, the glass bottles were removed to the lab to be analyzed. The bottles were put in the water bath kept about 25℃ before the titration.

(3-2) Seawater analysis

The method of total alkalinity measurement was that approx. 50ml of seawater was placed in a 100ml tall beaker with a Knudsen pipette, and titrated with a solution of 0.05M hydrochloric acid. The acid was made up in a solution of sodium chloride background (0.7M) to approx. the ionic strength of seawater. The titration carried out adding the acid to seawater past carbonic acid point with a set of electrodes used to measure electromotive force at 25 degree C. After titration, the data of titrated acid volume and electromotive force and seawater temperature pipetted were calculated to total alkalinity.

The titration system consisted of a titration manager (Radiometer, TIM900), an auto-burette (Radiometer, ABU901), a pH glass electrode (pHG201-7), a reference electrode (Radiometer, REF201), a thermometer (Radiometer, T201) and two computers, the one was installed burette operation software (Lab Soft, Tim Talk 9) and the another one was for calculated total alkalinity.

. Before any of the samples were measured, the calibration factor (acid concentration) was calculated by measuring series of sodium carbonate solutions (0~2.5mM) and this calibration factor was applied to all of the data acquired throughout the cruise. By measuring Certified Reference Material (CRM batch 65: Scripps Institution of Oceanography) after all samples were measured, the factor was calibrated. A reference material (QRM batch Q10) measurement during every run was carried out after samples were measured. QRM was prepared in JAMSTEC by a similar procedure of CRM preparation.

(4) Preliminary results

A duplicate analysis was made on every 8th seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.8-1). The average of the difference was 1.3 µmol/kg (n= 13 pairs). The standard deviation was 1.05 µmol/kg which indicates that the analysis was accurate enough according to DOE (1994).

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

(6) Reference

DOE (1994), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74

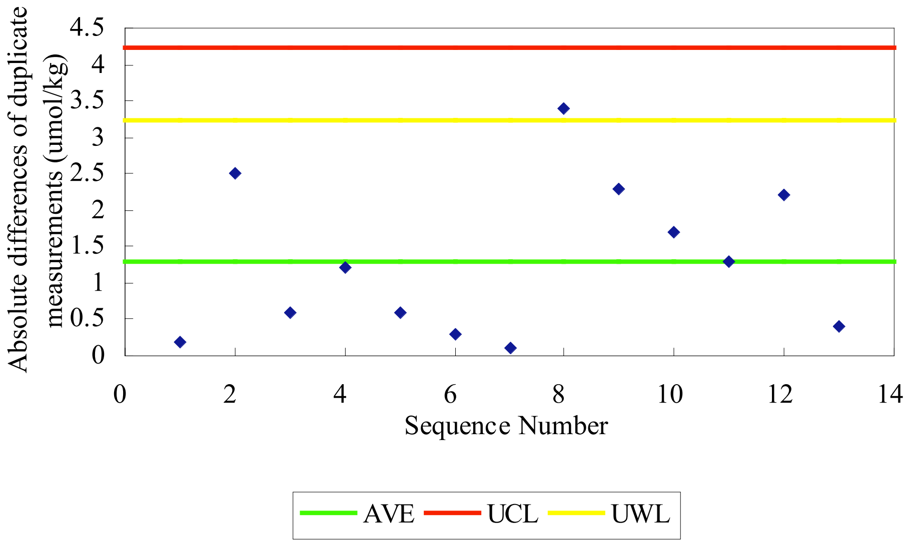


Figure 2.8-1. Range control chart of the absolute differences of duplicate measurements carried out in the analysis of TA during the MR04-06 cruise.

2.9 Chl-a

Makio HONDA (JAMSTEC MIO)：Principal Investigator
Takuhei SHIOZAKI (MWJ)：Operation Leader

1. Objective

Chlorophyll *a* is one of the most convenient indicators of phytoplankton stock, and has been used extensively for the estimation of phytoplankton abundance in various aquatic environments. The object of this study is to investigate the vertical distribution of phytoplankton in various light intensity depth.

2. Sampling elements

Chlorophyll *a*

3. Materials and Method

Seawater samples were collected 0.5 liter at 8 depths from surface to about 100m with Niskin bottles, except for the Surface water, which was taken by the bucket. The samples were gently filtrated by low vaccum pressuer(<15cmHg) through Whatman GF/F filter(diameter 25mm) in the dark room. Phytoplankton pigments were immediately extracted in 7ml of N,N-dimethylformamide(DMF) after filtration and then, the samples were stored in the freezer(-20℃) until the analysis of fluorometric determination(over 24 hours).The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005,TURNER DESIGNS) with a 340-500nm bound excitation filter and a >665nm bound emission filter, before and after acidification. We had the measurements twice. At first, we measured the fluororescence of samples, after that we dropped 1N HCL to the samaple and measured.

4. Results

The results of Chlorophyll *a* ware showed in Figure 2.9-1.

5. Data archives

All processed salinity data were submitted to Principal Investigator according to the data management policy of JAMSTEC.

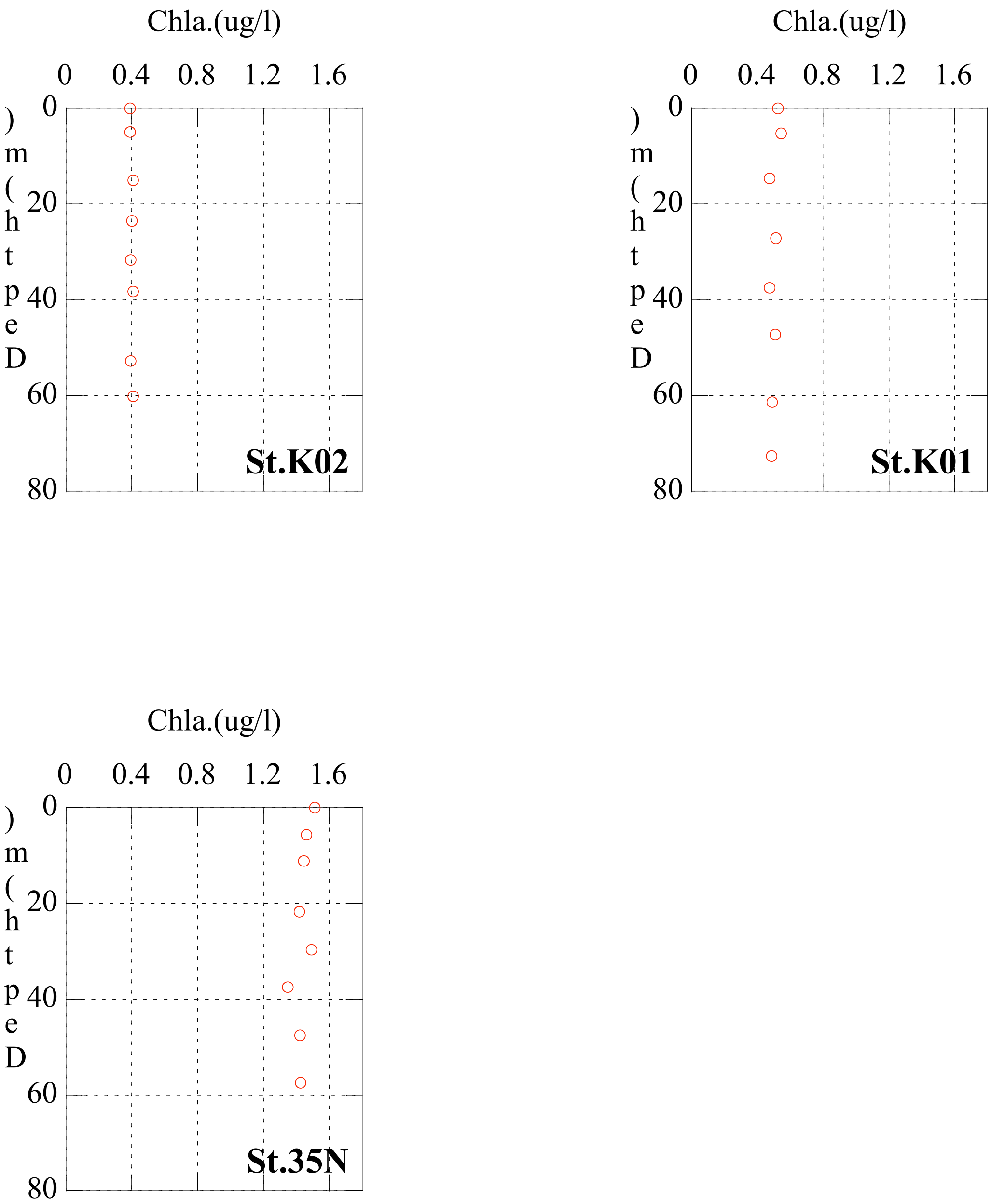


Figure 2.9-1 The vertical distributions of chlorophyll *a* at MR05-01

3. Special observation
3.1 North Pacific Time-series observatory (HiLATS)

3.1.1 Short-term test mooring
Makio HONDA (JAMSTEC MIO)
Toru IDAI (JAMSTEC MIO)

Since autumn in 2003 when one of mooring system with radionuclide (14C) was lost, time-series observation with mooring system has been postponed. During this period, the cause of this accident and a measure of safety has been investigated and discussed. Last year a final report of this accident was completed and a conversion fo design of mooring system such as change of chain, addition of sievel were conducted and underwater load cell and compass were prepared for special measurements. And finally, during this cruise, we conducted short period test-mooring (approximately two weeks). Although we were in trouble for rough sea condition, we successfully conducted this test-mooring and valuable data of variability of tension, rotation and depth of mooring systems were obtained.

3.1.1.1 Deployment and Recovery

Two types of mooring systems were designed and deployed: one for physical oceanography (PO mooring) and another for biogeochemistry (BGC mooring).

The PO mooring consists of a 64" syntactic top float with 3,000 lbs buoyancy, instrument, wire and nylon ropes, glass floats (Benthos 17" glass ball), dual releasers (Edgetech) and 4,660 lbs. sinker with mace plate. Two autonomous CTD profilers, MMP (McLane Moored Profiler), are installed on the 500 m and 3,500 m wires for observation. Shallow MMP descends and ascends between 50 m and 500 m and deep MMP descends and ascends between 500 m and 4,550 m with acquisition of vertical profiles of CTD and 3D current direction and velocity. Two ARGOS compact mooring locators and submersible recovery strobe are mounted on all of top floats. Depth sensor (RIGO) is installed on the top of 500 m wire. Load-cell (KYOWA) is mounted above the dual releasers to observe the tension during whole processes of mooring. Before cruise, all wires and nylon ropes are pre-stretched by approximately 1.3 ton, which load corresponds to mooring tension and measured exact length using a laser equipment, which error is ± 1 mm.

The BGC mooring consists of a top float, instruments, mooring wire and rope, glass floats, dual releasers and sinker. The following time-series observational instruments are mounted approximately 40 ~ 50 m below sea surface.

- RAS - Remote Access Sampler with Ocean Optical Sensor
- WTS - Water Access Sampler with Depth Sensor
- ZPS - Zoo Plankton Sampler
- Sediment Trap – 150 m, 300 m, 540 m, 2,000 m and 5,000 m

In addition, load-cell and Compass Sensor (ALEC) are mounted above the dual releasers. Details for each instrument are described later (section 3.1.1.2).

We planned to deploy PO and BGC moorings at Station K-2 in the Western Subarctic Gyre. It is 47N / 160E, where is close to station KNOT and, however, structure of water mass is more stable than station KNOT. Before deployment, sea floor topography was surveyed with Sea Beam. In order to place the top of mooring systems in the surface euphotic layer, precise water depths for mooring positions was measured by an altimeter (Datasonics PSA900D) mounted on CTD / CWS. Mooring works took approximately 5 hours for PO mooring system and 6 hours for BGC mooring system. After sinker was dropped, we positioned the mooring systems by measuring the slant ranges between research vessel and the acoustic releaser. Each position of the moorings is finally determined as follows:

Table 1 Mooring positions for respective mooring systems

	K-2 PO K2P050302	K-2 BGC K2B050304
Date of deployment	Mar. 2nd 2005	Mar. 4th 2005
Latitude	46° 52.38 N	47° 00.48 N
Longitude	159° 58.96. E	159° 57.97 E
Depth	5,152.0 m	5,206.2 m

We recovered short-term test PO and BGC mooring at K-2 completely. Serial numbers for instruments are as follows:

Table 2 Serial numbers of instruments

Station and type of system Mooring system S / N	K-2 PO K2P050302	K-2 BGC K2B050304
ARGOS	18842 / 18840	52111 / 52112
ARGOS ID	18577 / 3807	5373 / 5374
Strobe	233 / 243	232 / 234
MMP (Shallow) / (Deep)	ML11241-04 / ML11241-05	-
RAS	-	ML11241-10
OOS	-	DFLS-072
WTS	-	ML11241-13
Depth Sensor	DP1158	DP1142
ZPS	-	ML11241-21
Sediment Trap (150m)	-	878
(300m)	-	ML11241-22
(540m)	-	0256
(2000m)	-	ML11241-24
(5000m)	-	ML11241-25
Compass Sensor	-	01
Load-Cell	4A7950001	496450001
Releaser	027824 027864	027809 027867

Table 3 Deployment and Recovery Record

K-2 PO Mooring

Mooring Number K2P050302

Project	Time-Series		Depth	5,152.0	m
Area	North Pacific		Planned Depth	5,152.0	m
Station	K-2 PO		Length	5,121.8	m
Target Position	**46°52.240**	**N**	Depth of Buoy	30	m
	159°59.060	**E**	Period	10	days
ACOUCTIC RELEASERS					
Type	Edgetech		Edgetech		
Serial Number	27824		27864		
Receive F.	11.0	kHz	11.0	kHz	
Transmit F.	12.0	kHz	12.0	kHz	
RELEASE C.	**344674**		**344421**		
Enable C.	361121		357724		
Disable C.	361167		357762		
Battery	2 year		2 year		
Release Test	FINE		FINE		
DEPLOYMENT					
Recorder	Fujio Kobayashi		Start	5.4	Nmile
Ship	MIRAI		Overshoot	742	m
Cruise No.	MR05-01		Let go Top Buoy	21:16	
Date	2005/3/2		Let go Anchor	2:01	
Wather	bc		Sink Top Buoy	2:02	
Wave Hight		m	Pos. of Start	46°51.30	N
Depth	5,239	m		160°06.96	E
Ship Heading	<280>		Pos. of Drop. Anc.	46°52.52	N
Ship Ave.Speed	1.25	knot		159°58.63	E
Wind	<257> 10.3	m/s	Pos. of Mooring	46°52.38	N
Current	<040> 13.0	cm/sec		159°58.96	E
RECOVERY					
Recorder	Tomohide Noguchi		Work Distance	0.8	Nmile
Ship	MIRAI		Send Enable C.	21:41	
Cruise No.	MR05-01		Slant Renge	3431	msec
Date	2005/3/15		Send Release C.	21:47	
Wather	bc		Discovery Buoy	21:49	
Wave Hight	3.5	m	Pos. of Top Buoy	—°—.—	N
Depth	5,154	m		—°—.—	E
Ship Heading	<250>		Pos. of Start	46°52.42	N
Ship Ave.Speed	0.3	knot		159°59.36	E
Wind	<250> 13.5	m/s	Pos. of Finish	46°52.73	N
Current	<028> 0.3	knot		159°58.32	E

K-2 BGC Mooring

Mooring Number K2B050304

Project	Time-Series	Depth	5,206.2	m
Area	North Pacific	Planned Depth	5,206.2	m
Station	K-2 BGC	Length	5,177.2	m
Target Position	**47°00.350 N**	Depth of Buoy	30	m
	159°58.326 E	Period	10	days

ACOUCTIC RELEASERS

Type	Edgetech		Edgetech	
Serial Number	27867		27809	
Receive F.	11.0	kHz	11.0	kHz
Transmit F.	12.0	kHz	12.0	kHz
RELEASE C.	**344573**		**344535**	
Enable C.	360536		360320	
Disable C.	360553		360366	
Battery	2 year		2 year	
Release Test	FINE		FINE	

DEPLOYMENT

Recorder	Fujio Kobayashi		Start	8.8	Nmile
Ship	MIRAI		Overshoot	858	m
Cruise No.	MR05-01		Let go Top Buoy	21:25	
Date	2005/3/4		Let go Anchor	3:14	
Wather	bc		Sink Top Buoy	4:01	
Wave Hight	3.2	m	Pos. of Start	46°55.05	N
Depth	5205	m		160°10.14	E
Ship Heading	<300>		Pos. of Drop. Anc.	47°00.58	N
Ship Ave.Speed		knot		159°57.74	E
Wind	<300> 5.5	m/s	Pos. of Mooring	47°00.48	N
Current	<350> 18.6	cm/sec		159°57.97	E

RECOVERY

Recorder	Tomohide Noguchi		Work Distance	3	Nmile
Ship	MIRAI		Send Enable C.	20:03	
Cruise No.	MR05-01		Slant Renge	3449	msec
Date	2005/3/16		Send Release C.	20:04	
Wather	bc		Discovery Buoy	20:06	
Wave Hight	2.3	m	Pos. of Top Buoy	__°__.__	N
Depth	5,216	m		__°__.__	E
Ship Heading	<123>		Pos. of Start	47°50.52	N
Ship Ave.Speed	0.6	knot		159°58.18	E
Wind	<290> 3.7	m/s	Pos. of Finish	46°59.38	N
Current	<030> 0.1	knot		160°01.29	E

Table 4 Deployment and Recovery Working Time Record

K-2 PO Mooring

T I M E R E C O R D

MOORING NO. **K2P050302**

		DEPLOYMENT		RECOVERY	
		DATE : 2005/3/2		DATE : 2005/3/15	
		START : 21:16		START : 21:38	
		FINISH : 1:43		FINISH : 1:41	
I T E M	S/N etc.	T I M E	MEMO	T I M E	MEMO
Syntactic Sphere ARGOS and Flasher	A:18842/18840 F:243/233	21:18		23:50	float 23:37
Bumper (40m)		21:18		23:50	
500m 1/4" JacNil Wire	[#DQ]	21:18		0:07	
MMP	ML11241-04	21:21〜21:32		0:07	
Bumper (530m)		22:12		0:07	
Bumper (540m)		22:12		0:07	
3500m 1/4" JacNil Wire	[#D]	22:12		0:56	
MMP	ML11241-05	22:31		0:56	
Bumper (4,050m)		23:28		0:56	
20m 1/4" JacNil Wire	[#4/20]	23:28		1:03	
(8) 17" Glass Balls		23:35		1:05	
500m 1/4" JacNil Wire	[#DP]	23:35		1:41	Tangle
(8) 17" Glass Balls		23:49		1:41	
430m 1/4" JacNil Wire	[#CH]	23:49		1:32	
50m 1/4" JacNil Wire	[#AE]	0:04		1:35	
(32) 17" Glass Balls		0:07		1:41	
Load-Cell	4A7950001 [2]	1:25		1:41	
Edgetech Releasers	27824 27864	1:25		1:41	
20m Nylon		1:25			
4,000lb Anchor		1:43			

ARGOS : Model ID 18577/3807
Flasher : Model 204-RS
Depth Sensor DP1158 Start Time 21:15
Tension Meter S/N 4A7950001 Start time 3/2 21:00 Sample int. 1min.

T I M E R E C O R D

MOORING NO. **K2B050304**

		DEPLOYMENT		RECOVERY	
		DATE : 2005/3/4		DATE : 2005/3/16	
		START : 21:24		START : 20:02	
		FINISH : 3:14		FINISH : 1:17	
I T E M	S/N etc.	T I M E	MEMO	T I M E	MEMO
Syntactic Sphere ARGOS and Flasher	A:52112/52111 F:234/232	21:38		21:47	
RAS WTS ZPS	ML11241-10 ML11241-13 ML11241-21	21:36	21:35 restart for RAS tube	21:59	
50m 5/16" Wire	[#W]	21:36		22:02	
50m 5/16" Wire Coated	[#DE]	21:42		22:07	
Sediment Trap_150m	878	21:48		22:08	
50m 5/16" Wire	[#V]	21:48		22:14	
43.4m 5/16" Wire	[#DI]	21:51		22:17	
50m 5/16" Wire Coated	[#U]	21:55		22:22	
Sediment Trap_300m	ML11241-22	22:00		22:24	
143m 5/16" Wire	[BC]	22:00		22:33	
43m 5/16" Wire	[CE]	22:04		22:36	
50m 5/16" Wire Coated	[#DG]	22:07		22:38	
Sediment Trap_540m	0256	22:12		22:41	
403m 5/16" Wire	[#S]	22:12		22:59	
50m 5/16" Wire Coated	[#DH]	22:42		23:03	
Sediment Trap_1000m	ML11241-24	22:48		23:04	
500m 1/4" Wire	[BJ]	22:48		23:16	
(12) 17" Glass Balls		23:01		23:18	
500m 1/4" Wire	[BL]	23:01		23:28	
500m 1/4" Wire	[CD]	23:09		23:35	
500m 1/4" Wire	[CE]	23:18		23:45	
(10) 17" Glass Balls		23:29		23:47	
500m 1/4" Wire	[CF]	23:29		23:56	
500m 1/4" Wire	[CG]	23:37		0:03	
387m 1/4" Wire	[CI]	23:45		0:18	Super Tangle
(8) 17" Glass Balls		23:54		0:17	
200m 1/4" Wire	[CK]	23:54		0:38	
100m 1/4" Wire	[TT]	23:59		0:44	
25m 1/4" Wire	[adj]	0:03		0:46	
10m 1/4" Wire	[adj]	0:03		0:47	
50m 1/4" Wire Coated	[#Y]	0:04		0:50	
Sediment Trap_4818m	ML11241-25	0:19		0:51	
200m 1/4" Wire	[CL]	0:19		1:03	
50m 1/4" Wire	[AF]	0:24		1:05	
25m 1/4" Wire	[adj]	0:27		1:07	
10m 1/4" Wire	[adj]	0:28		1:11	
(52) 17" Glass Balls		0:36		1:17	Tangle
Compass & Tite Sensor	01	3:01		1:17	
Load-Cell	496450001 [1]	3:01		1:17	
Dual Releases	27809 27867	3:01		1:17	
20m 1" Nylon	[#04]	3:06			
4,666lb Mace Anchor		3:14			

ARGOS : Model ID 5374/5373 Start time
Flasher : Model 204-RS
Rigo Depth Sensor on WTS : Model DP500 S/N DP1142 Start time 21:15 Sample int. 2min.
Tension Meter S/N 496450001 Start time 3/4 22:00 Sample int. 1min.
Compass and Tilt Sensor Model ACP-8M S/N 01 Start time 3/4 23:34 Sample int. 2sec.

Table 5 Detail of our mooring system.

K-2 PO Mooring

	Mooring ID Description	Joint	Water Depth Item Length (m)	Total (kg)	Mooring Length (m)	Mooring Weight (kg)	Above Bottom (m)	Below Surface (m)	
1	64" Syntatic Sphere		2.27	-1360.78	2.3	-1360.8	5121.8	30.2	**30**
	Hardware	L	0.28	3.60	2.6	-1357.2	5119.5	32.5	
2	3/4" Proof Coil Chain		5.00	40.01	7.6	-1317.2	5119.2	32.8	
	Hardware	F	0.26	2.42	7.8	-1314.8	5114.2	37.8	
3	3-TON Miller Swivel		0.16	3.20	8.0	-1311.6	5114.0	38.0	
	Hardware	B	0.24	1.60	8.2	-1310.0	5113.8	38.2	
4	500 Meters 1/4" Wire (#DQ)		500.00	70.31	508.2	-1239.6	5113.6	38.4	**38**
	Hardware	A	0.21	1.30	508.4	-1238.3	4613.6	538.4	**538**
5	3500 Meters 1/4" Wire (#D)		3517.48	494.61	4025.9	-743.7	4613.4	538.6	**538**
	Hardware	B	0.23	1.60	4026.1	-742.1	1095.9	4056.1	**4055**
6	3-TON Miller Swivel		0.16	3.20	4026.3	-738.9	1095.7	4056.3	
	Hardware	B	0.23	1.60	4026.5	-737.3	1095.5	4056.5	
7	20 Meters 1/4" Wire		20.00	2.81	4046.5	-734.5	1095.3	4056.7	
	Hardware	B	0.23	1.60	4046.7	-732.9	1075.3	4076.7	
8	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4050.7	-812.3	1075.1	4076.9	
	Hardware	B	0.23	1.60	4051.0	-810.7	1071.1	4080.9	
9	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4055.0	-890.0	1070.8	4081.2	
	Hardware	B	0.23	1.60	4055.2	-888.4	1066.8	4085.2	
10	500 Meters 1/4" Wire (#DP)		500.00	70.31	4555.2	-818.1	1066.6	4085.4	
	Hardware	B	0.23	1.60	4555.4	-816.5	566.6	4585.4	
11	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4559.4	-895.9	566.4	4585.6	
	Hardware	H	0.24	1.93	4559.6	-894.0	562.4	4589.6	
12	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4563.6	-973.3	562.1	4589.9	
	Hardware	B	0.23	1.60	4563.9	-971.7	558.1	4593.9	
13	430 Meters 1/4" Wire - (#CH)		428.62	60.27	4992.5	-911.5	557.9	4594.1	
	Hardware	A	0.21	1.30	4992.7	-910.2	129.3	5022.7	
14	50 Meters 1/4" Wire (#AE)		50.04	7.04	5042.7	-903.1	129.1	5022.9	
	Hardware	B	0.23	1.60	5043.0	-901.5	79.0	5073.0	
15	3 Meters 16mm T-Chain		3.00	16.68	5046.0	-884.8	78.8	5073.2	ADJ.
	Hardware	H	0.24	1.93	5046.2	-882.9	75.8	5076.2	
16	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5050.2	-962.3	75.6	5076.4	
	Hardware	H	0.24	1.93	5050.4	-960.3	71.6	5080.4	
17	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5054.4	-1039.7	71.3	5080.7	
	Hardware	H	0.24	1.93	5054.7	-1037.8	67.3	5084.7	
18	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5058.7	-1117.1	67.1	5084.9	
	Hardware	H	0.24	1.93	5058.9	-1115.2	63.1	5088.9	
19	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5062.9	-1194.6	62.9	5089.1	
	Hardware	H	0.24	1.93	5063.1	-1192.6	58.9	5093.1	
20	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5067.1	-1272.0	58.6	5093.4	
	Hardware	H	0.24	1.93	5067.4	-1270.1	54.6	5097.4	
21	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5071.4	-1349.4	54.4	5097.6	
	Hardware	H	0.24	1.93	5071.6	-1347.5	50.4	5101.6	
22	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5075.6	-1426.9	50.2	5101.8	
	Hardware	H	0.24	1.93	5075.9	-1424.9	46.2	5105.8	
23	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5079.9	-1504.3	45.9	5106.1	
	Hardware	H	0.24	1.93	5080.1	-1502.4	41.9	5110.1	
24	5 Meters 16mm T-Chain		5.00	27.80	5085.1	-1474.6	41.7	5110.3	
	Hardware	H	0.24	1.93	5085.3	-1472.6	36.7	5115.3	
25	Tension Meter		0.45	39.00	5085.8	-1433.6	36.5	5115.5	
	Hardware	H	0.24	1.93	5086.0	-1431.7	36.0	5116.0	
26	3-TON Miller Swivel		0.16	3.20	5086.2	-1428.5	35.8	5116.2	
	Hardware	F	0.26	2.42	5086.4	-1426.1	35.6	5116.4	
27	Dual EGG Acoustic Releases	M	1.95	66.04	5088.4	-1360.0	35.4	5116.6	
	Hardware	F	0.26	2.42	5088.6	-1357.6	33.4	5118.6	
28	5 Meters 16mm T-Chain		5.00	27.80	5093.6	-1329.8	33.2	5118.8	
	Hardware	G	0.25	2.70	5093.9	-1327.1	28.2	5123.8	
29	20 Meters 1" Nylon (#07)		21.76	0.30	5115.6	-1326.8	27.9	5124.1	
	Hardware	G	0.25	2.70	5115.9	-1324.1	6.2	5145.8	
30	5 Meters 16mm T-Chain		5.00	27.80	5120.9	-1296.3	5.9	5146.1	
	Hardware	F	0.26	2.42	5121.1	-1293.9	0.9	5151.1	**Design**
31	4000 Lb Ww Anchor		0.66	2267.96	5121.8	974.1	0.7	5151.3	**Depth**
	OVERALL MOORING LENGTH		**5121.79**				0.0	5152.0	**5152**

K-2 BGC Mooring

Mooring ID	Description	Joint	Water Depth Item Length (m)	Item Weight (kg)	Mooring Length (m)	Mooring Weight (kg)	Above Bottom (m)	Mooring Depth (m)	
1	64" Syntactic Sphere		2.27	-1360.78		-1360.78	5177.02	29.18	**30**
	Hardware	L	0.28	3.63	2.55	-1357.15	5174.75	31.45	
2	**5** Meters 3/4" Proof Coil Chain		5.00	40.01	7.55	-1317.14	5174.47	31.73	
	Hardware	F	0.26	2.42	7.81	-1314.72	5169.47	36.73	
4	Instrument - "RAS"	N	2.25	72.03	10.06	-1242.69	5169.22	36.98	
	Hardware	H	0.24	1.93	10.29	-1240.76	5166.97	39.23	
5	Instrument - "WTS"	N	2.83	50.33	13.12	-1190.43	5166.73	39.47	
	Hardware	H	0.24	1.93	13.36	-1188.50	5163.90	42.30	
6	Instrument - "ZPS"	N	2.42	41.33	15.78	-1147.17	5163.67	42.53	
	Hardware	H	0.24	1.93	16.01	-1145.24	5161.25	44.95	
7	3-TON Miller Swivel		0.16	3.17	16.17	-1142.07	5161.01	45.19	
	Hardware	H	0.24	1.93	16.41	-1140.14	5160.85	45.35	
8	**50** M 5/16" Wire [#W]		50.08	10.68	66.49	-1129.46	5160.61	45.59	
	Hardware	H	0.24	1.93	66.72	-1127.53	5110.53	95.67	
9	**50** Meters 5/16" Wire [DE]	P	50.36	10.74	117.08	-1116.80	5110.30	95.90	
	Hardware	I	0.06	2.19	117.14	-1114.61	5059.94	146.26	
10	Sediment Trap [878]	O	3.89	55.68	121.03	-1058.92	5059.88	146.32	**150**
	Hardware	H	0.24	1.93	121.26	-1057.00	5055.99	150.21	
15	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	123.26	-1040.99	5055.76	150.44	
	Hardware	H	0.24	1.93	123.50	-1039.06	5053.76	152.44	
16	**50** Meters 5/16" Wire [#V]		50.17	10.70	173.67	-1028.37	5053.52	152.68	
	Hardware	H	0.24	1.93	173.90	-1026.44	5003.36	202.84	
16	**43** Meters 5/16" Wire [#DI]		43.56	9.29	217.46	-1017.15	5003.12	203.08	
	Hardware	H	0.24	1.93	217.70	-1015.22	4959.56	246.64	
17	**50** Meters 5/16" Wire [#U]	P	50.10	10.68	267.80	-1004.54	4959.33	246.88	
	Hardware	I	0.06	2.19	267.86	-1002.35	4909.22	296.98	
18	Sediment Trap [ML11241-22]	O	3.74	55.70	271.60	-946.65	4909.16	297.04	**300**
	Hardware	H	0.24	1.93	271.83	-944.72	4905.42	300.78	
19	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	273.83	-928.72	4905.19	301.01	
	Hardware	H	0.24	1.93	274.07	-926.79	4903.19	303.01	
24	**143** Meters 5/16" Wire [BC]		143.85	30.67	417.92	-896.12	4902.95	303.25	
	Hardware	H	0.24	1.93	418.15	-894.19	4759.11	447.10	
24	**43** Meters 5/16" Wire [CE]		43.47	9.27	461.62	-884.93	4758.87	447.33	
	Hardware	H	0.24	1.93	461.86	-883.00	4715.40	490.80	
25	**50** Meters 5/16" Wire [#DG]	P	51.04	10.88	512.89	-872.12	4715.16	491.04	
	Hardware	I	0.06	2.19	512.96	-869.93	4664.13	542.07	
26	Sediment Trap [0256]	O	3.92	55.70	516.88	-814.22	4664.07	542.14	**540**
	Hardware	H	0.24	1.93	517.11	-812.29	4660.15	546.06	
31	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	519.11	-796.29	4659.91	546.29	
	Hardware	H	0.24	1.93	519.35	-794.36	4657.91	548.29	
32	**403** Meters 5/16" Wire [#S]		403.79	86.08	923.13	-708.28	4657.68	548.53	
	Hardware	H	0.24	1.93	923.37	-706.35	4253.89	952.31	
33	**50** Meters 5/16" Wire [#DH]	P	50.54	10.78	973.91	-695.58	4253.65	952.55	
	Hardware	I	0.06	2.19	973.97	-693.39	4203.11	1003.09	
34	Sediment Trap ML11241-24]	O	3.73	55.70	977.70	-637.68	4203.05	1003.15	**1000**
	Hardware	H	0.24	1.93	977.94	-635.75	4199.32	1006.88	
35	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	979.94	-619.75	4199.08	1007.12	
	Hardware	H	0.24	1.93	980.17	-617.82	4197.08	1009.12	
36	3-TON Miller Swivel		0.16	3.17	980.33	-614.65	4196.85	1009.35	
	Hardware	B	0.23	1.63	980.56	-613.02	4196.69	1009.51	
37	**500** Meters 1/4" Wire [BJ]		500.68	70.40	1481.24	-542.62	4196.46	1009.74	
	Hardware	B	0.23	1.63	1481.47	-540.99	3695.78	1510.42	
38	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1485.47	-620.35	3695.55	1510.65	
	Hardware	H	0.24	1.93	1485.70	-618.42	3691.55	1514.65	
39	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1489.70	-697.78	3691.32	1514.88	
	Hardware	H	0.24	1.93	1489.94	-695.85	3687.32	1518.88	
39	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1493.94	-775.21	3687.08	1519.12	
	Hardware	B	0.23	1.63	1494.17	-773.58	3683.08	1523.12	
40	**500** Meters 1/4" Wire [BL]		500.63	70.40	1994.79	-703.19	3682.86	1523.34	
	Hardware	A	0.21	1.33	1995.00	-701.86	3182.23	2023.97	
44	**500** Meters 1/4" Wire [CD]		498.09	70.04	2493.09	-631.82	3182.02	2024.18	
	Hardware	A	0.21	1.33	2493.30	-630.49	2683.93	2522.27	
45	**500** Meters 1/4" Wire [CE]		498.46	70.09	2991.75	-560.40	2683.72	2522.48	

	Hardware	B	0.23	1.63	2991.98	-558.77	2185.27	3020.93	
46	2-17" Glassballs on 16mm T-Chain		2.00	-39.68	2993.98	-598.45	2185.04	3021.16	
	Hardware	H	0.24	1.93	2994.22	-596.52	2183.04	3023.16	
46	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	2998.22	-675.88	2182.81	3023.39	
	Hardware	H	0.24	1.93	2998.45	-673.95	2178.81	3027.39	
47	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	3002.45	-753.31	2178.57	3027.63	
	Hardware	B	0.23	1.63	3002.68	-751.68	2174.57	3031.63	
48	**500** Meters 1/4" Wire [CF]		498.45	70.09	3501.12	-681.59	2174.35	3031.86	
	Hardware	A	0.21	1.33	3501.33	-680.26	1675.90	3530.30	
49	**500** Meters 1/4" Wire [CG]		498.48	70.09	3999.82	-610.17	1675.69	3530.51	
	Hardware	A	0.21	1.33	4000.03	-608.84	1177.21	4028.99	
50	**387** Meters 1/4" Wire [CI]		387.59	54.50	4387.62	-554.34	1177.00	4029.20	
	Hardware	B	0.23	1.63	4387.84	-552.71	789.41	4416.79	
51	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4391.84	-632.07	789.18	4417.02	
	Hardware	H	0.24	1.93	4392.08	-630.14	785.18	4421.02	
52	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4396.08	-709.50	784.94	4421.26	
	Hardware	B	0.23	1.63	4396.30	-707.87	780.94	4425.26	
53	**200** Meters 1/4" Wire [CK]		199.25	28.02	4595.55	-679.85	780.72	4425.48	
	Hardware	A	0.21	1.33	4595.76	-678.52	581.47	4624.73	
54	**100** Meters 1/4" Wire [TT]		99.95	14.05	4695.71	-664.47	581.26	4624.94	
	Hardware	A	0.21	1.33	4695.92	-663.14	481.31	4724.89	
55	**25** Meters 1/4" Wire		25.00	3.52	4720.92	-659.62	481.10	4725.10	
	Hardware	A	0.21	1.33	4721.13	-658.29	456.10	4750.10	
	10 Meters 1/4" Wire		10.00	1.41	4731.13	-656.89	455.89	4750.31	
	Hardware	A	0.21	1.33	4731.34	-655.56	445.89	4760.31	
56	**50** Meters 1/4" Wire [#Y]	Q	50.17	7.06	4781.52	-648.50	445.68	4760.52	
	Hardware	K	0.20	1.33	4781.72	-647.17	395.50	4810.70	
57	Sediment Trap [ML11241-25]	O	3.73	55.70	4785.45	-591.47	395.30	4810.90	**4810.8**
	Hardware	H	0.24	1.93	4785.68	-589.54	391.57	4814.63	
58	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	4787.68	-573.54	391.34	4814.86	
	Hardware	B	0.23	1.63	4787.91	-571.91	389.34	4816.86	
62	**200** Meters 1/4" Wire [CL]		199.34	28.03	4987.25	-543.88	389.11	4817.09	
	Hardware	A	0.21	1.33	4987.46	-542.55	189.77	5016.43	
63	**50** Meters 1/4" Wire [AF]		50.04	7.04	5037.50	-535.51	189.56	5016.64	
	Hardware	A	0.21	1.33	5037.71	-534.18	139.52	5066.68	
63	**25** Meters 1/4" Wire		25.00	3.52	5062.71	-530.67	139.31	5066.89	
	Hardware	A	0.21	1.33	5062.92	-529.34	114.31	5091.89	
64	10 Meters 1/4" Wire		10.00	1.41	5072.92	-527.93	114.10	5092.10	
	Hardware	B	0.23	1.63	5073.15	-526.30	104.10	5102.10	
66	5 Meters 16mm T-Chain		5.00	27.80	5078.15	-498.50	103.87	5102.33	
	Hardware	H	0.24	1.93	5078.38	-496.57	98.87	5107.33	
67	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5082.38	-575.93	98.64	5107.56	
	Hardware	H	0.24	1.93	5082.62	-574.00	94.64	5111.56	
68	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5086.62	-653.36	94.40	5111.80	
	Hardware	H	0.24	1.93	5086.85	-651.43	90.40	5115.80	
67	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5090.85	-730.79	90.17	5116.03	
	Hardware	H	0.24	1.93	5091.09	-728.86	86.17	5120.03	
68	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5095.09	-808.22	85.93	5120.27	
	Hardware	H	0.24	1.93	5095.32	-806.29	81.93	5124.27	
69	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5099.32	-885.65	81.70	5124.50	
	Hardware	H	0.24	1.93	5099.56	-883.73	77.70	5128.50	
70	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5103.56	-963.09	77.46	5128.74	
	Hardware	H	0.24	1.93	5103.79	-961.16	73.46	5132.74	
71	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5107.79	-1040.52	73.23	5132.97	
	Hardware	H	0.24	1.93	5108.03	-1038.59	69.23	5136.97	
72	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5112.03	-1117.95	68.99	5137.21	
	Hardware	H	0.24	1.93	5112.26	-1116.02	64.99	5141.21	
73	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5116.26	-1195.38	64.76	5141.44	
	Hardware	H	0.24	1.93	5116.50	-1193.45	60.76	5145.44	
74	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5120.50	-1272.81	60.52	5145.68	
	Hardware	H	0.24	1.93	5120.73	-1270.88	56.52	5149.68	
75	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5124.73	-1350.24	56.29	5149.91	
	Hardware	H	0.24	1.93	5124.97	-1348.31	52.29	5153.91	
76	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5128.97	-1427.67	52.05	5154.15	
	Hardware	H	0.24	1.93	5129.20	-1425.74	48.05	5158.15	
77	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5133.20	-1505.10	47.82	5158.38	
	Hardware	H	0.24	1.93	5133.44	-1503.17	43.82	5162.38	
78	5 Meters 16mm T-Chain		5.00	27.80	5138.44	-1475.37	43.58	5162.62	
	Hardware	H	0.24	1.93	5138.67	-1473.44	38.58	5167.62	
79	Tension Meter		0.45	39.00	5139.12	-1434.44	38.35	5167.85	
	Hardware	H	0.24	1.93	5139.36	-1432.51	37.90	5168.30	

80	Compass,Tilt&Depth Meter		1.06	12.00	5140.42	-1420.51	37.66	5168.54	
	Hardware	H	0.24	1.93	5140.65	-1418.58	36.60	5169.60	
81	3-TON Miller Swivel		0.16	3.20	5140.81	-1415.38	36.37	5169.83	
	Hardware	F	0.26	2.42	5141.07	-1412.96	36.21	5169.99	
82	Dual EGG Acoustic Releases	M	1.95	66.04	5143.01	-1346.92	35.95	5170.25	
	Hardware	F	0.26	2.42	5143.27	-1344.50	34.01	5172.19	
83	5 Meters 16mm T-Chain		5.00	27.80	5148.27	-1316.70	33.75	5172.45	
	Hardware	G	0.25	2.70	5148.51	-1314.00	28.75	5177.45	
84	**20** Meters 1" Nylon [#08]		22.05	6.57	5170.56	-1307.42	28.51	5177.69	
	Hardware	G	0.25	2.70	5170.81	-1304.72	6.46	5199.74	
85	5 Meters 16mm T-Chain		5.00	27.80	5175.81	-1276.92	6.21	5199.99	
	Hardware	F	0.26	2.42	5176.06	-1274.50	1.21	5204.99	**Design**
86	4666 Lb Ww Anchor		0.96	2116.46	5177.02	841.96	0.96	5205.24	**Depth**
	OVERALL MOORING LENGTH		**5177.02**					5206.20	**5206.2**

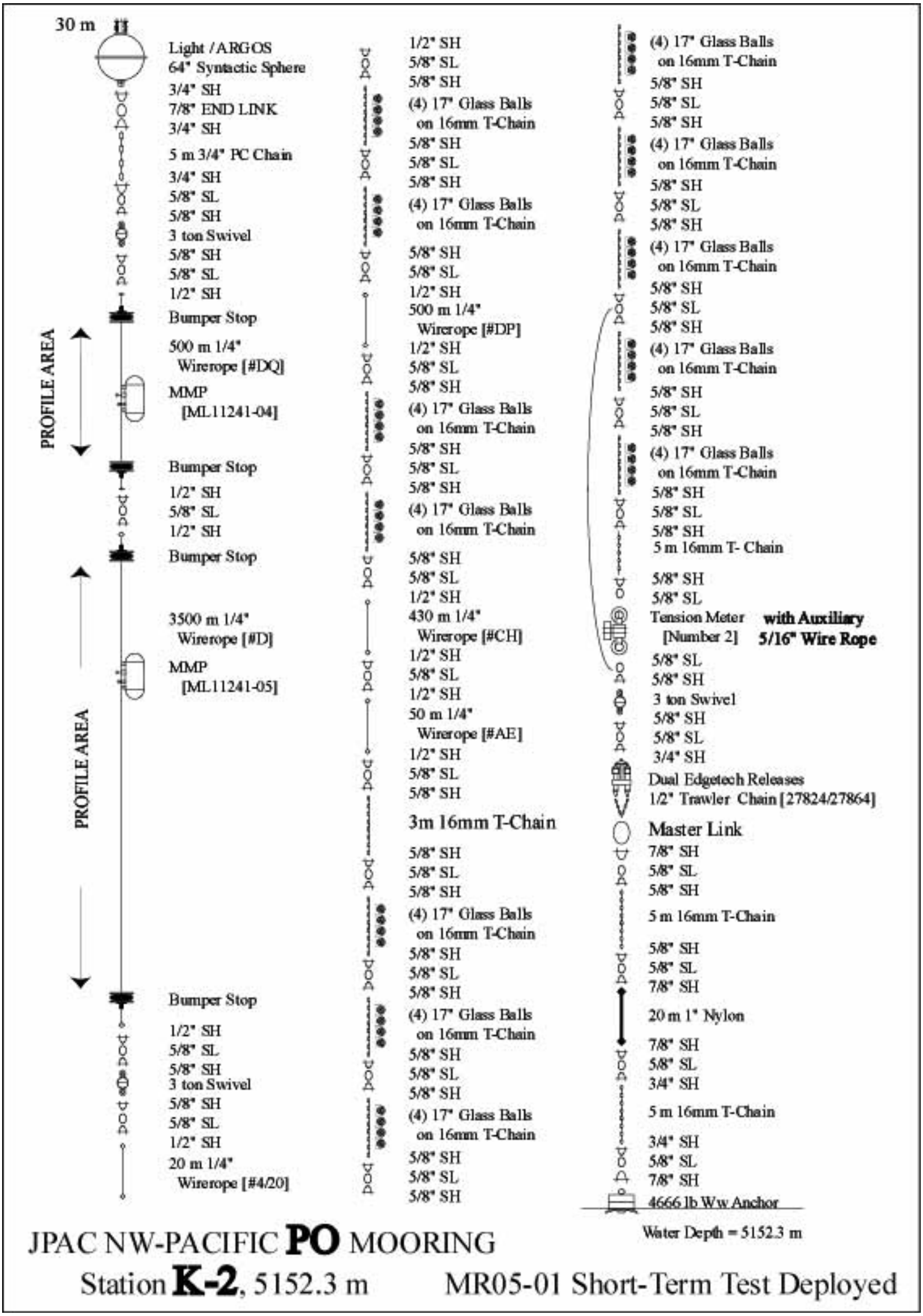


Fig. 1-1 K-2 PO Mooring

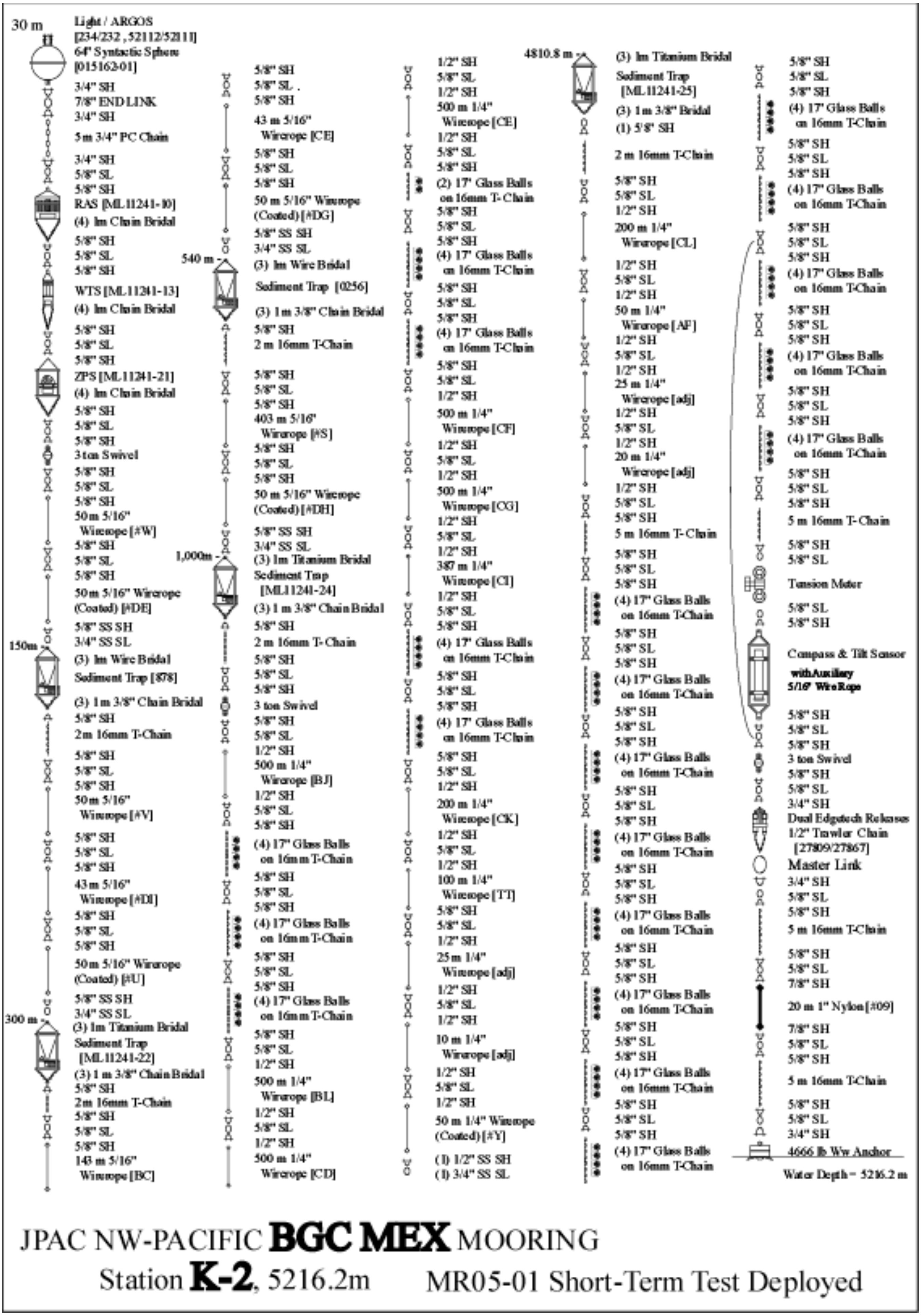


Fig. 1-2 K-2 BGC Mooring

3.1.1.2 Instruments

On mooring systems, the following instruments are installed.

(1) ARGOS CML (Compact Mooring Locator)

The Compact Mooring Locator is a subsurface mooring locator based on SEIMAC's Smart Cat ARGOS PTT (Platform Terminal Transmitter) technology. Using CML, we can know when our mooring has come to the surface and its position. The CML employs a pressure sensor at the bottom. When the CML is turned ON, the transmission is started immediately every 90 seconds and then when the pressure sensor works ON by approximately 10 dbar, the transmission is stopped. When the top buoy with the CML comes to the surface, the pressure sensor will work OFF and the transmission will be started. Smart Cat transmissions will be initiated at this time, allowing us to locate our mooring. Depending on how long the CML has been moored, it will transmit for up to 120 days on a 90 second repetition period. Battery life, however, is affected by how long the CML has been moored prior to activation. A longer pre-activation mooring will mean less activation life.

Principle specification is as follows:

(Specification)

Transmitter:	Smart Cat PTT
Operating Temp.:	+35 [deg] to –5 [deg]
Standby Current:	80 μAmp.
Power Control.:	Ext. Magnetic Switch
Smart Cat Freq.:	401.650 MHz
Battery Supply:	7-Cell alkaline D-Cells
Ratings:	+10.5VDC nom., 10 Amp Hr
Hull:	6061-T6 Aluminum
Max Depth:	1,000 m
Length:	22 inches
Diameter:	3.4 inches
Upper flange:	5.60 inches
Dome:	Acrylic
Buoyancy:	-2.5 (negative) approx.
Weight	12 pounds approx.

(2) Submersible Recovery Strobe

The Benthos 204 - RS is fully self-contained 0.1 watt - second strobe intended to aid in the marking or recovery of oceanographic instruments, manned vehicles, remotely operated vehicles, buoys or structures. Due to the occulting (firing closely spaced bursts of light) nature of this design, it is much more visible than conventional marker strobes, particularly in poor sea conditions.

(Specification)

Power Level:	0.1 watt-second
Repetition Rate:	Adjustable from 2 bursts per second to 1 burst every 3 seconds.

Burst Length:	Adjustable from 1 to 5 flashes per burst. 100 ms between flashes nominal.
Battery Type:	C-cell alkaline batteries, (Eveready E-93 or equivalent).
Life:	Dependent on repetition rate and burst length. 150 hours with a one flash burst every 2 seconds.
Construction:	Awl-grip painted, Hard coat anodized 6061 T-6 aluminum housing.
Pressure Rating:	10,000 psi
Daylight-off:	User selected, standard
Pressure Switch:	Turns unit off below approximately 30 feet. Rotary, clockwise – ON, counter clockwise – OFF.
Weight in Air:	4 pounds
Weight in Water:	2 pounds
Outside Diameter:	1.7 inches nominal
Length:	21-1/2 inches nominal

(3) MMP

The McLane Moored Profiler is an autonomous, profiling, instrument platform. The purpose is to make moored profiler technology available to, operable by, and useful to a broad cross-section of the oceanographic community. The platform and software are designed for ease of access, operation, and maintenance. The instrument includes both a CTD and an acoustic current meter. Side and top views of the MMP are shown in Fig. 2. The major components of the system are labeled in the figures. There include the controller, the buoyancy elements, the drive motor and guide wheels, the instruments suite, the internal frame, and the hydrodynamically faired external shell. The platform is designed to profile between pressure limits (or physical stops), powered along a conventional, plastic jacketed mooring cable by a traction drive. While profiling it samples the water column with a suite of instruments and stores the measurements for later retrieval. The shape accommodates a cylindrical housing that has sufficient

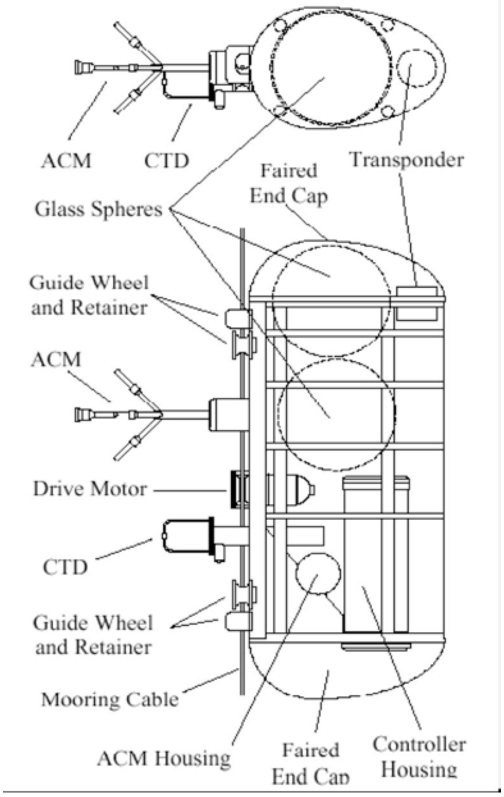


Fig. 2 Cut away side and top views of the MMP showing the major components of the system. The overall dimensions of the faired external shell are 124 cm * 51 cm* 34 cm

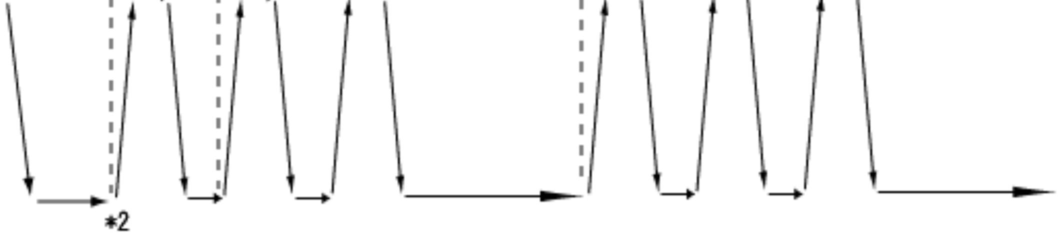
length for batteries and electronics and a 6,000 m depth rating. Two glass spheres are used for buoyancy only. The mooring cable threads through faired retainers at the top and bottom of the vehicle. The retainers can be opened for launch and recovery and are strong enough to support the full weight, including trapped water, of the MMP on a horizontal cable, a normal situation during recovery. Sampling will be conducted once a day.

(Specification)

Dimensions	Height:	130.5 cm
	Width:	33.3 cm
	Length:	50.5 cm
	ACM Sting:	45.2 cm
Weight	With Sensors (air):	70.5 kg
	Without Sensors (air):	64.3 kg
Depth Rating	Max Depth:	6000 m
	Endurance:	1000 km
Other	Frame:	ultra high molecular weight polyethylene
	Skin:	medium density polyethylene
	Mounting Posts:	316 stainless steel
	Housing:	Titanium
	Spheres:	borosilicate glass
	Cable jackets:	neoprene, polyvinyl chloride
	Drive wheel:	urethane, PBT, titanium

Table 6 MMP Setting Parameter

Station MMP S / N	K-2 PO Shallow ML11241-04	K-2 PO Deep ML11241-05
*1 Initialize Down	09:00:00 Mar.3rd 2005	09:00:00 Mar.3rd 2005
*2 Sampling Start	00:00:00 Mar.4th 2005	00:00:00 Mar.4th 2005
*3 Profile Interval	6 hours	9 hours
*4 Burst Interval	1 day	1 day
Burst (up and down)	twice	twice
Shallow Depth [db]	35	550
Deep Depth [db]	550	4050
Shallow Error [db]	50	100
Deep Error [db]	50	100
Profile Time Limit	3 hours	6 hours
Stop Check Interval	30 sec	30 sec



(4) Depth Sensor

RMD Depth sensor is digital memory type and designed for mounting on the plankton net and instrument for mooring and so on. It is small and right weight for easy handling. Sampling interval is chosen between 2 and 127 seconds or 1 and 127 minutes and sampled Time and Depth data. The data is converted to personal computer using exclusive cable (printer interface).

(Specification)

Model:	RMD-500
Operating Depth:	0 ~ 500m
Precision:	0.5% (F.S.)
Accuracy:	1/1300
Memory:	65,534 data (128kbyte)
Battery:	lithium battery (CR2032) DC6V
Battery Life:	65,000 data or less than 1 year
Sample interval:	2 ~ 127 seconds or 1 ~ 127 minutes
Broken Pressure:	20MPa
Diameter:	50mm
Length:	150mm
Main Material:	vinyl chloride resin
Cap material:	polyacetal resin
Weight:	280g

(sampling parameter)

Sampling interval: 2 minutes

(5) Compass Sensor

Compass sensor APC-8M made by ALEC Electronics Co. Ltd. is measured compass, tilt and depth and digital memory type. This is consists of Titanium housing, memory pack logger, control panel, battery each sensor and electronics. There are two type of observation mode. They are continuous mode and another burst mode for long term observation.

(Specification)

Model:	APC-8M	
Operating Depth:	0 ~ 7,000 m	
Precision:	Compass Sensor	±2°
	Tilt Sensor±2°	
	Depth Sensor	0.3% (F.S.)
Accuracy:	Compass Sensor	0.1°
	Tilt Sensor0.03°	
	Depth Sensor	2 m
Memory:	8 M byte	
Battery:	lithium battery DC10V	
Sample:	131,040 data	
Sample interval:	0.5 ~ 2 seconds	

Diameter:	100 mm
Length:	608 mm
Main Material:	Titanium
Weight:	9,500g (in the air) , 4,500g (in the water)

(sampling parameter)

Sampling interval: 2 seconds

(6) Load-Cell

Load-Cell was designed to measured the mooring tension during deployment, moored and recovery even short term and long term at about 5,000 m depth. This system consists of waterproof load-cell, digital strain recorder, housing and connecting cable.

(Specification)

Waterproof Load-Cell

Model:	LTF-A-50KNS49106
Max. Tension:	50 kN
Rated Output:	0.5 mV/V (1000*10^{-6} strain)
Nonlinearity:	±1 %RO
Operating Temp.:	+50 [deg] to –10 [deg]
Diameter:	135 mm
Length:	567 mm
Weight:	30 kg

Digital strain recorder

Model:	RMH-201A-0 M10
Sample:	30,720 data
Sample Interval:	1 minutes ~ 99 hours 59 minutes
Operating Temp.:	+50 [deg] to –20 [deg], 10-95 %RH
Battery:	DC6-15V Battery Pack
Size:	180 mm * 70 mm * 55 mm
Weight:	800 g

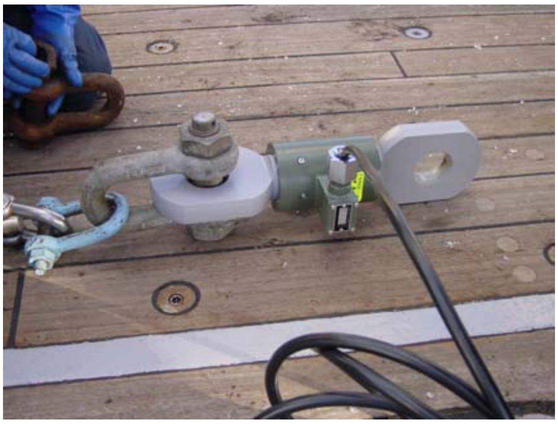
(sampling parameter)

Sampling interval: 1 minutes

3.1.1.3 Results of test mooring

(1) **Tension**

In order to investigate the tension or load on mooring system, the on deck load cell and underwater load cell were installed just above the releaser system (photo 1) and tension during towing, descending with sinker and approximately 2 weeks mooring were measured.



(a) On deck load cell

(b) Underwater load cell

Photo 1 Load cells

1) Tension during towing (measured by the on deck load cell and underwater load cell)

After most of parts of BGC and PO mooring went to the sea surface, BGC and PO moorings were towed for two hours and one hours, respectively to the "target point". Fig. 1 shows tensions for BGC mooring and PO mooring during towing measured by on deck load cell. Average and standard deviation of tensions were 857±192 kg for PO mooring and 1024±296 kg for BGC mooring under ship speed of 2 knots (log). Figs. 2(a) and 3(a) also show tensions during towing for PO mooring and BGC mooring, respectively, measured by underwater load cell. These results also show that tensions during towing were approximately 1 ton. These values coincided well with values simulated previously (1 ton). It was certified that towing mooring system with 2 knots does not load heavy tension over 3 ton that is the breaking load of 1/4" wire rope.

2) Tension during descending with sinker (measured by underwater load cell)

Tension during descent of sinker and mooring increased with depth and on average approximately 2.2 ton (Figs. 2(a) and 3(a)). This is mixing force of weight of sinker weight of sinker and horizontal force. These results also coincide well with simulated tension previously. It is noted that it took 40 min. for sinker of PO mooring and 55 min. for that of BGC mooring to arrive at seafloor.

3) Tension during mooring period

Both mooring systems were moored for 13 days. Tensions during mooring were 1.4±0.1 ton for PO mooring (Fig. 2(b)) and 1.6±0.0 ton for BGC mooring (Fig. 3(b)). These tensions are almost coincident with designed tension or static load for PO mooring (1.4 ton) and slightly higher than that for BGC mooring. During the late of mooring period (13 – 15 March), significant wave height was expected to be 8 – 10 m. However tension ranged only from 1.2 to 1.7 ton. It is indicative of that surface wave does not affect mooring tension significantly.

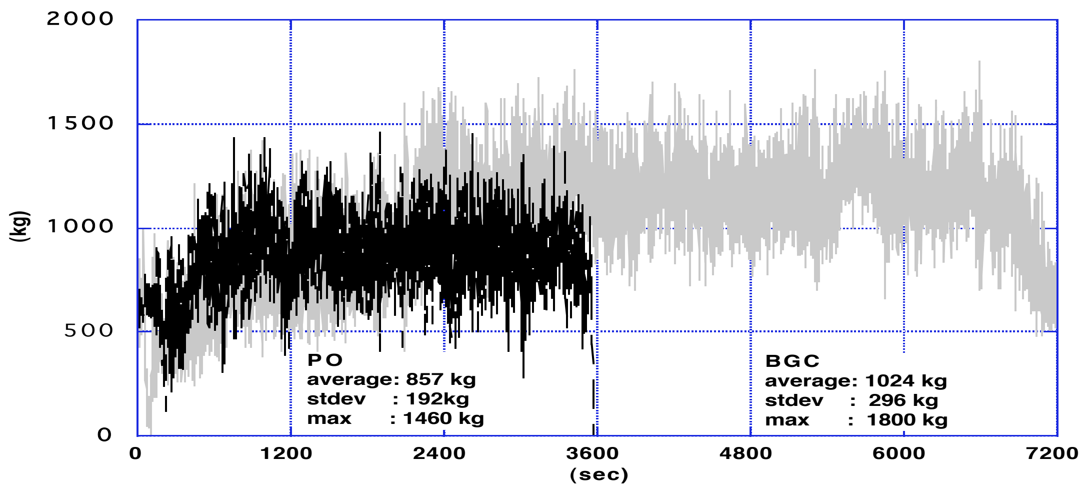


Fig. 1 Tension during towing measured by on board load cell. Black line and gray line shows variability of tension for PO mooring and BGC mooring, respectively.

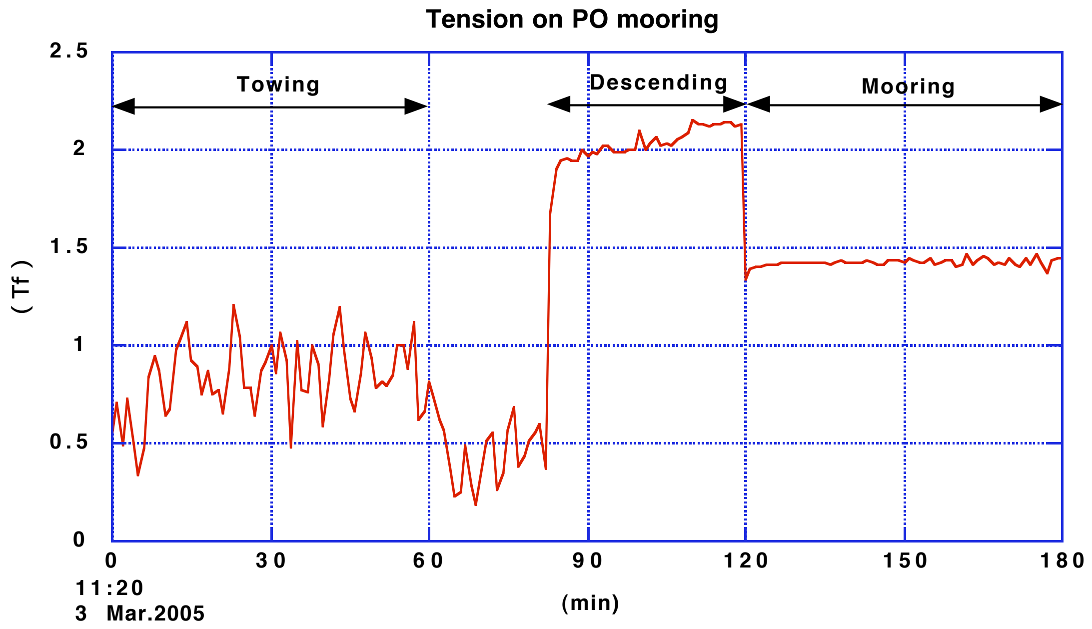


Fig. 2(a) Tension of PO mooring during towing, sinker descending and mooring after sinker landing measured by underwater load cell.

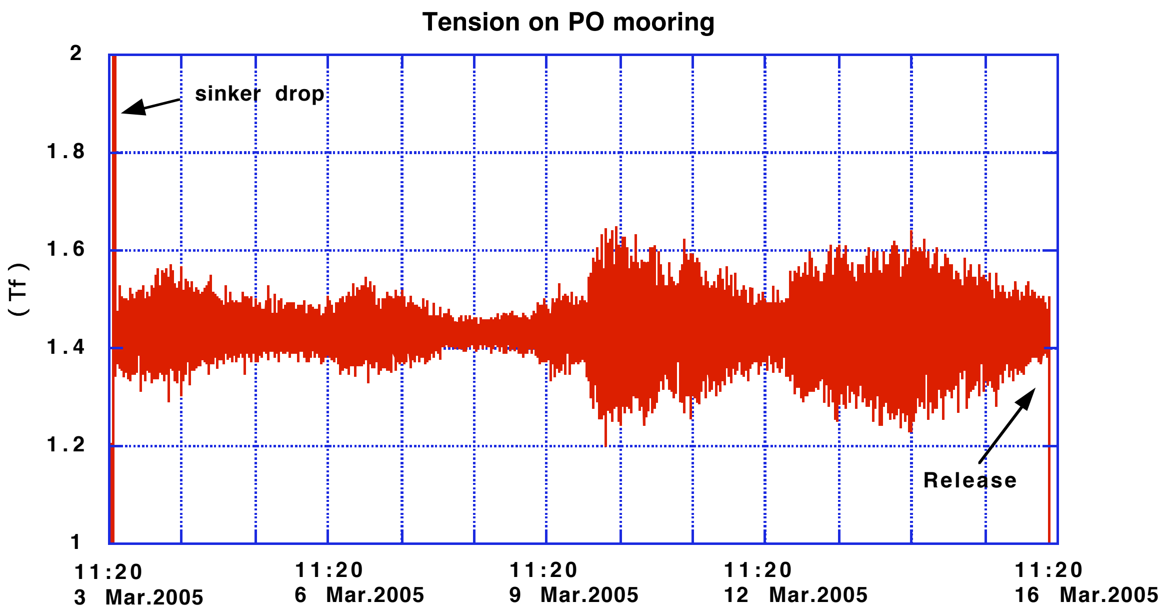


Fig. 2(b) Variability of tension of PO mooring during 14 days mooring

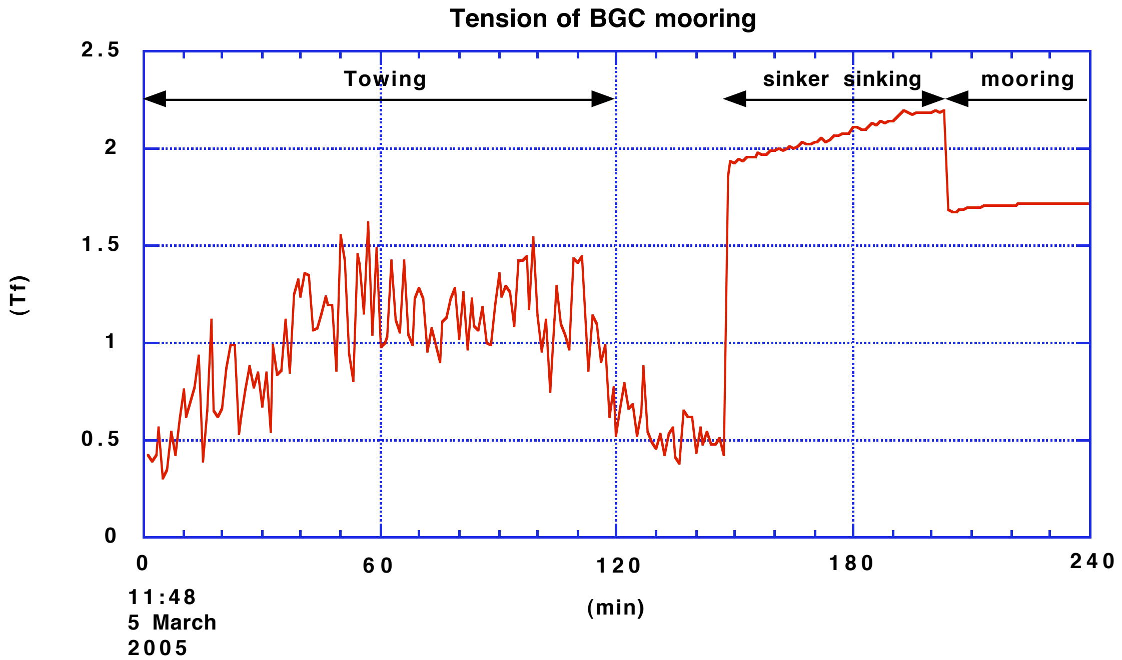


Fig. 3(a) Tension of BGC mooring during towing, sinker descending and mooring after sinker landing measured by underwater load cell.

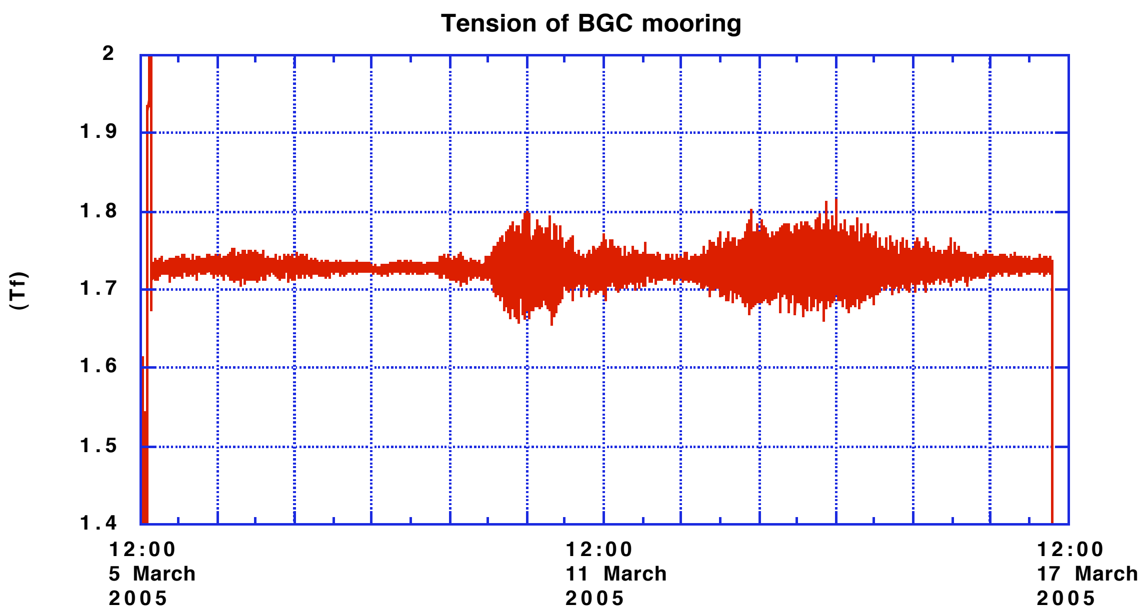


Fig. 3(b) Variability of tension of BGC mooring during 13 days mooring

(2) Rotation of mooring system

After one mooring system was lost by chain partitioning and the tangle of chain was suspected as the cause of partition, it has been worried that the rotation of mooring system during descending let chain tangled. As a measure for safety, two more swivels were inserted in the mooring system. In order to certify the rotation of mooring system after the above measure, an underwater compass with depth sensor was installed on BGC mooring above sinker and rotation of mooring system was measured. Fig. 4 (a) (b) shows change of direction of mooring system Direction of mooring system changed largely during the first 30 seconds and by approximately 60 m. However mooring system never turned around. After 10 min. and 1000 m, its direction became stable with small variation (Fig. 4(b)). After sinker arrived at seafloor, its direction became constant. As a result, mooring system did not rotate largely and it is indicative of that tangle of chain did not occur during descending. It is noted that it took approximately 55 minutes for sinker to arrive at seafloor of 5200 m just 5 minutes after top buoy disappeared from the sea surface.

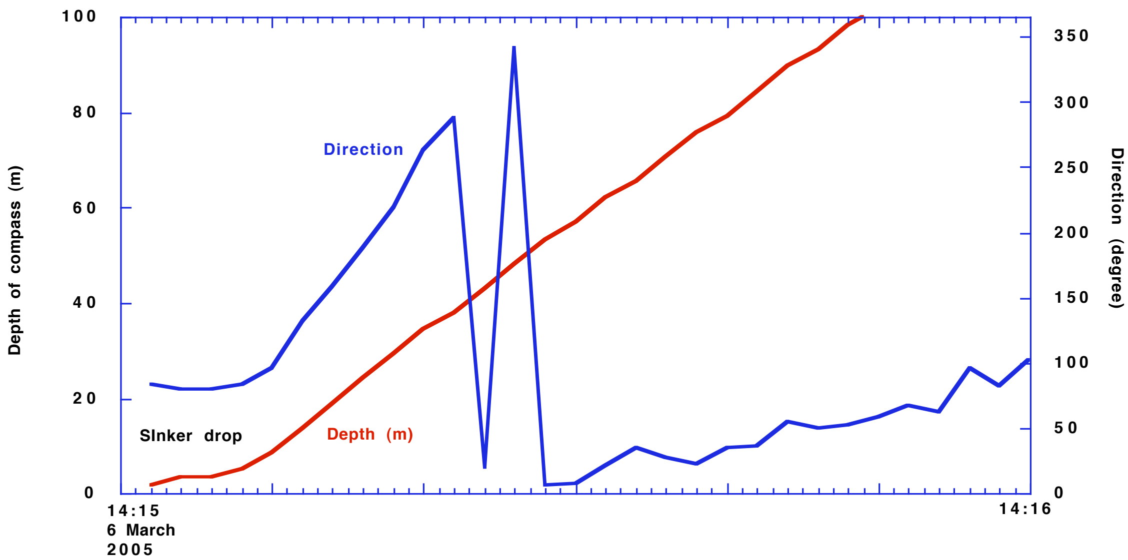


Fig. 4(a) Rotation of mooring system during the first one minute after sinker drop

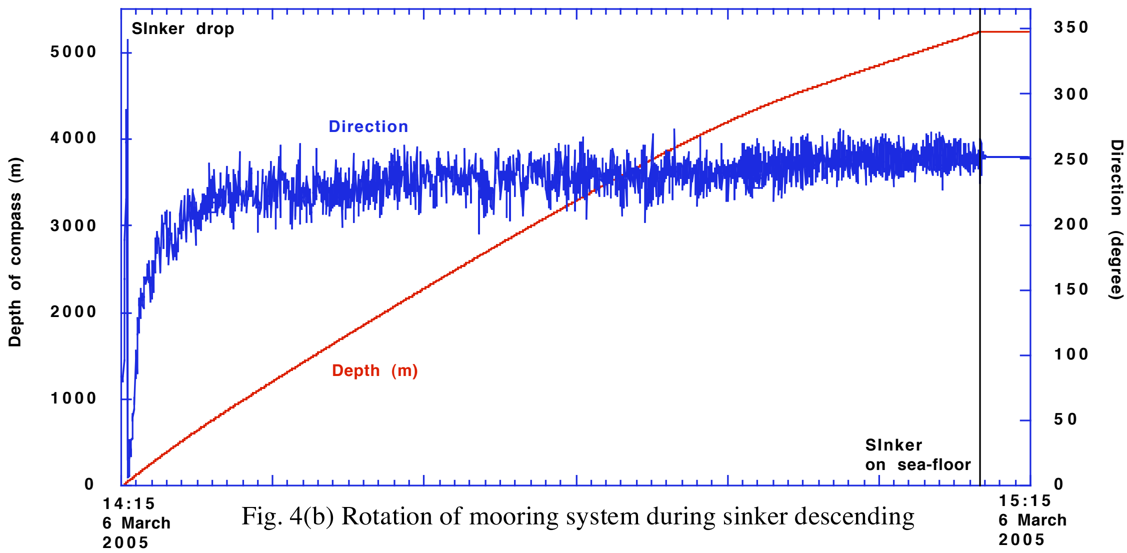


Fig. 4(b) Rotation of mooring system during sinker descending

(3) Variation of depth

Depth sensors (RIGO RMD 500) were installed at approximately 39 m on both mooring systems. Fig. 5(a) shows variability in depth of depth sensor for PO mooring. Average depth of sensor between 15:00 on 3 March and 8:40 on 16 March was 37.0±1.2 m with maximum of 42.5 m and minimum of 33.1 m. Variability increased during 10 March and 15 March when significant wave height was expected to be higher than 5 m. During period, variability in tension of mooring also increased and both variations tended to synchronize. Fig. 5(b) shows variability of sensor depth during the first 200 minutes. It is noted that sensor was pull down to approximately 300 m and decreased its depth gradually after sinker arrived at sea floor. It took approximately 2 hours for depth sensor to be located at its “home position.

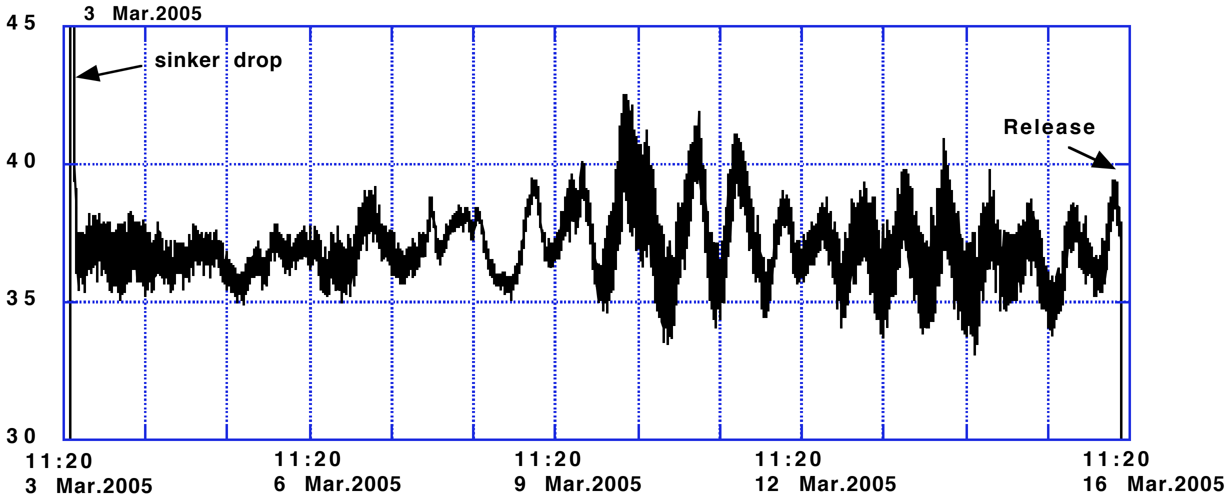


Fig. 5(a) Variation of water depth of depth sensor installed just above the shallowest MMP bumper during short-term mooring

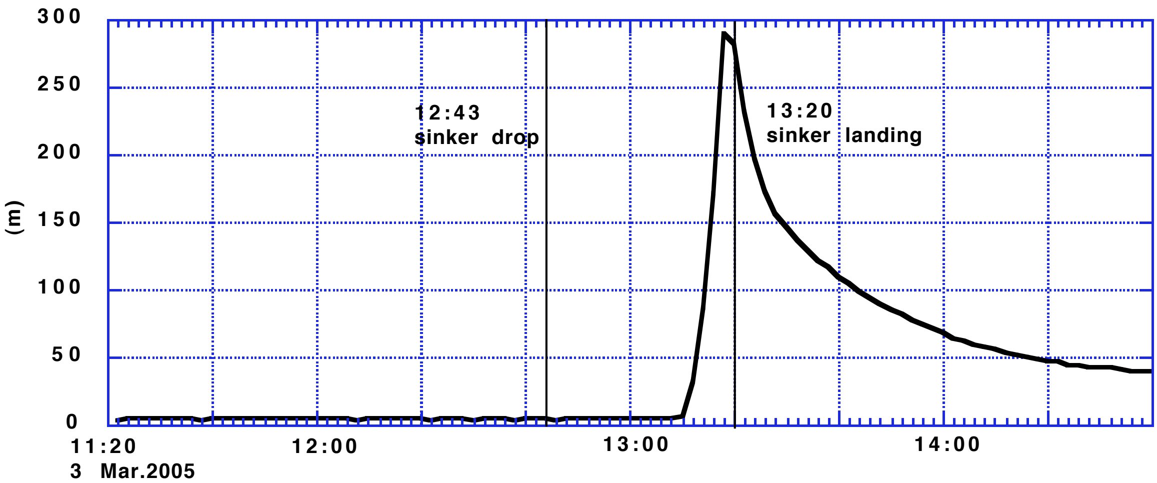


Fig. 5(b) Change of water depth of depth sensor after sinker drop

Fig. 6(a) shows variability in depth of depth sensor installed on WTS for BGC mooring. Average depth of sensor was approximately 60 m with maximum of 73 m and minimum of 55 m. Unlike PO mooring, variability of sensor or top buoy did not synchronize well with that of wave heights. Fig. 6(b) shows variability of sensor depth during the first 200 minutes. It is noted that sensor was pull down to approximately 300 m and decreased its depth gradually after sinker arrived at sea floor. It took approximately 2 hours for depth sensor to be located at its "home position" as same as PO mooring.

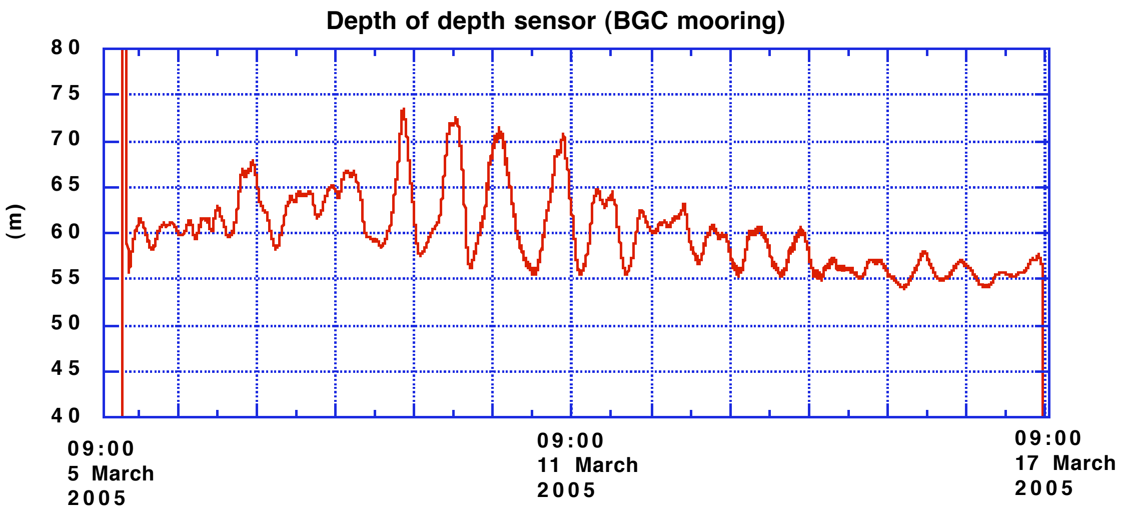


Fig. 6(a) Variation of water depth of depth sensor installed on WTS during short-term mooring

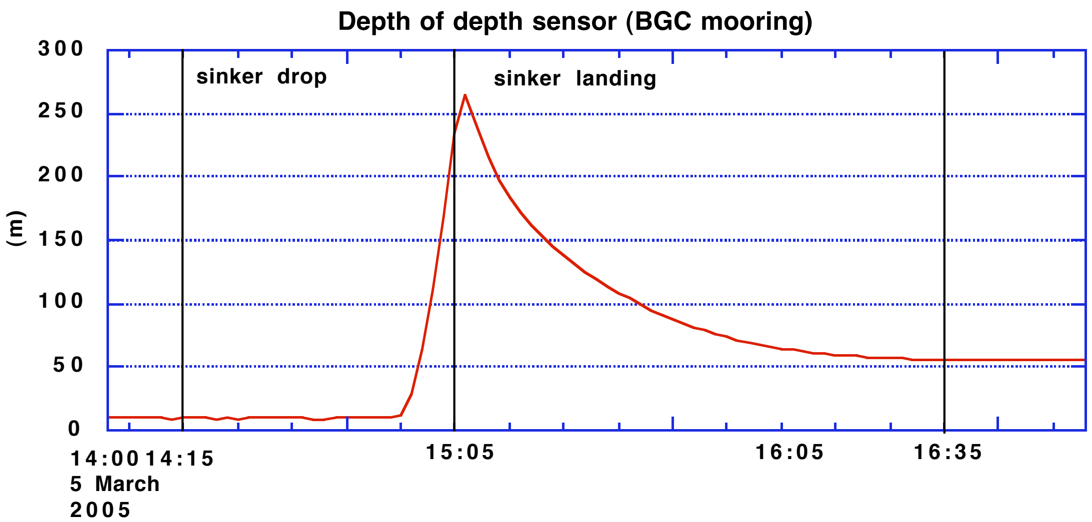


Fig. 6(b) Change of water depth of depth sensor after sinker drop

(2) **Sampling and results**

During short-term test mooring, various samples were collected by autonomous sample collectors in order to check respective instruments and observe chemical and physical condition during this cruise. Sampling schedule is as follows:

Table 1 Sampling schedule (short test mooring)

		A: ST (13 cups)		B: ST (21 cups)		WTS-PPS			ZPS		RAS	
Samp.		2		2		10*2			10		22	
Int.	#	4 days	#	4 days	#	twice per 1 day		#	1day	#		
	1	2005.3.6 1:00	1	2005.3.6 1:00	1	2005.3.6 1:00	*	1	2005.3.5 13:00	1	2005.3.6 1:00	**
	2	2005.3.10 1:00	2	2005.3.10 1:00	2	2005.3.6 4:00		2	2005.3.6 13:00	2	2005.3.6 7:00	**
		2005.3.14 1:00		2005.3.14 1:00	3	2005.3.7 1:00	*	3	2005.3.7 13:00	3	2005.3.6 13:00	**
					4	2005.3.7 4:00		4	2005.3.8 13:00	4	2005.3.6 19:00	**
					5	2005.3.8 1:00	*	5	2005.3.9 13:00	5	2005.3.7 1:00	
					6	2005.3.8 4:00		6	2005.3.10 13:00	6	2005.3.7 2:00	*
					7	2005.3.9 1:00	*	7	2005.3.11 13:00	7	2005.3.7 3:00	**
					8	2005.3.9 4:00		8	2005.3.12 13:00	8	2005.3.7 4:00	
					9	2005.3.10 1:00	*	9	2005.3.13 13:00	9	2005.3.7 5:00	*
					10	2005.3.10 4:00		10	2005.3.14 13:00	10	2005.3.7 6:00	**
					11	2005.3.11 1:00	*			11	2005.3.7 7:00	
					12	2005.3.11 4:00				12	2005.3.7 8:00	*
					13	2005.3.12 1:00	*			13	2005.3.7 9:00	**
					14	2005.3.12 4:00				14	2005.3.7 10:00	
					15	2005.3.13 1:00	*			15	2005.3.7 11:00	*
					16	2005.3.13 4:00				16	2005.3.7 12:00	**
					17	2005.3.14 1:00	*			17	2005.3.7 13:00	
					18	2005.3.14 4:00				18	2005.3.7 14:00	*
					19	2005.3.15 1:00	*			19	2005.3.7 15:00	**
					20	2005.3.15 4:00				20	2005.3.7 16:00	
										21	2005.3.7 17:00	*
					*	GF/F filter				22	2005.3.7 18:00	**
						Nuclepore Filt.						
										no	Preservation test HgCl2 0ml	
										*	Preservation test HgCl2 1ml	
										**	Preservation test HgCl2 2ml	

a. Sediment Trap

Sediment traps were installed at approximately 150, 300, 540, 1000 and 4810 m on BGC mooring. Sampling of 4 days interval were conducted twice from 1:00 on 6 March to 1:00 14 March 2005 (UTC). Before deployment, collecting cups were filled with 5 % buffered formalin.

Sediment trap located at 150 m did not work because of malfunction. After recovery, collecting cups were sealed and stored in refrigerator. Although sample volume corrected for 4 days in winter might not be enough for sufficient chemical analysis, this sample should be useful for study of vertical change in carbon flux and comparison with suspended particle and primary productivity.

b. Phytoplankton sampler (WTS-PPS)

Phytoplankton and/or suspended particles were collected twice a day from 6 March to 15 March 2005 (UTC). Seawater of approximately 10 L was filtrated in situ and suspended particles were collected on two filter: GF/F filter and Nucleopore filter. Before deployment, 5 % buffered formalin was stored in filter holder. After recovery, sample on filter were stored in the freezer. On shore laboratory, carbon and other components will be measured.

c. Zooplankton sampler (ZPS)

Sampling of zooplankton by ZPS was conducted once a day between 5 March and 14 March 2005 (UTC). Seawater of 500L were filtrated in situ and stored in seawater based 7 % glutaraldehyde. Table 2 shows record of ZPS schedule and condition. In many cases, ZPS did not filtrate 500 L. It is likely that invasion of seawater at connector disturbed the normal function. After recovery, zooplankton sample were flushed out with seawater and collected in the glass bottle with 7 % glutaraldehyde. These bottle with samples will be stored in refrigerator by the laboratory analysis.

Table 2 Record of ZPS sampling schedule and condition

Parameter			
flow	rate	[liters/min]	= 25
flow	rate	[liters/min]	= 12
volume	[liters]	= 500	
limit	[minutes]	= 42	
flush	volume	[liters]	= 5
flush	interval	[minutes]	= 0
delay	[minutes]	= 10	

	Start Date & Time		Volume (L)	Stop time	Note		
1	03/05/105	13:10:17	258.72	13:21:29	Sudden	pressure	release.
2	03/06/105	13:10:17	192.18	13:18:43	Sudden	pressure	release.
3	03/07/105	13:10:17	188.41	13:18:33	Sudden		
4	03/08/105	13:10:17	373.45	13:33:16	Min	flow	reached.
5	03/09/105	13:10:17	501.92	13:41:33	Volume	reached.	
6	03/10/105	13:10:17	502.17	13:41:59	Volume	reached.	
7	03/11/105	13:10:17	500.58	13:43:20	Min	flow	reached.
8	03/12/105	13:10:17	21.84	13:11:42	Sudden	flow	obstruction.
9	03/13/105	13:10:17	18.69	13:11:33	Sudden	flow	obstruction.
10	03/14/105	13:10:17	12.54	13:11:15	Sudden	flow	obstruction.

d. Seawater sampler (RAS)

RAS collected seawater of approximately 450 ml at around 50 m automatically. As preservative, mercuric chloride solution (3.5 g-$HgCl_2$ in 100 ml distilled water: This is saturated concentration of $HgCl_2$ at 0°C) was used. The first 4 samples with $HgCl_2$ solution of 2 ml were collected at 1:00, 7:00, 13:00 and 19:00 on 6 March 2005 (UTC) in order to investigate the daily change in concentrations of dissolved inorganic carbon (DIC), nutrients (Nuts: NO_2+NO_3, PO_4, $Si(OH)_4$) and salinity (Samples # 1 – 4). The following 18 samples were collected on 7 March. In order to test preservative effect on sample preservation, different volume of $HgCl_2$ solution were add before deployment: 0 ml for samples of # 5, 8, 11, 14, 17, 20; 1 ml for

Samples of # 6, 9, 12, 15, 18 and 21; 2 ml for Samples of # 7, 10, 13, 16, 19 and 22. The samples of # 1 – 10 were analyzed for DIC, Nuts and salinity on board.

Table 2 shows results. Values (NO_3, NO_2, NO_x, $Si(OH)_4$ and PO_4) of RAS sample without preservative (ave(0ml)) were slightly higher than those obtained from hydrocasting (routine data). RAS sample were kept for approximately two weeks in refrigerator till analysis. Decomposition of suspended particles might occur. However DIC concentration was coincident well with routine data. On the other hand, RAS samples were collected on different day from the day of routine casting. Although surface mixed layer is more than 100 m and water mass upper 100 m is though to be homogenous, slight difference of water mass between routine water and RAS samples might exist.

The above values of RAS samples with preservative of $HgCl_2$ (1 ml or 2 ml) were also different from routine data. Although we do not know precise volume of RAS seawater sample, RAS samples were diluted by $HgCl_2$ solution and its dilution rates should depend on the amount of preservative: 0.22 % for 1 ml and 0.44 % for 2 ml when volumes of RAS seawater are 450 ml, and 0.20 % for 1 ml and 0.40 % for 2 ml when volumes of RAS seawater are 500 ml. DIC values for RAS samples decreased with volume of $HgCl_2$ solution. However its decrease ratio was smaller than expected one (DIC value with preservative of 2 ml and seawater of 500 ml should become 2166 μmol/l against measured value of 2170.2 μmol/l). The values of $Si(OH)_4$ also decreased with volume of preservative. However its decrease rate were bigger than expected rate unlike DIC. On the other hand, NOx did not decrease with volume of preservative. RAS samples were collected at different time. DIC and nutrients among RAS samples of # 1 – 4 shows difference although these samples were collected on same day. In small scale, water mass in the mixed layer might not be homogenous. In order to know dilution rate, we measured salinity of RAS samples by other salinometer (AutoLab). However all values were approximately 0.3 psu higher than those for routine data. It is hard to think that RAS sample was condensed during storage. Autolab should have systematic error and, therefore, we could not determined dilution rate from salinity measurement.

Samples # 11 – 22 will be analyzed for the above component after 6 months and 1 year on R/V Mirai with using same instruments.

Table 3 DIC and nutrients for RAS samples measured on board

S/N		Depth (m)	Sampling Date & Time	Analysis Date	HgCl2 (ml)	DIC (µmol/l)	NO_3 (µmol/l)	NO_2 (µmol/l)	NOx (µmol/l)	$Si(OH)_4$ (µmol/l)	PO_4 (µmol/l)	Sal (PSU)			Density (kg/l)
						Results(meas)									
routine		50.9	2005.3.4 11:19	2005.3.4	0	2173.1	23.62	0.13	23.75	41.86	1.94	33.056	*		1.0233
routine		75.5	2005.3.4 11:18	2005.3.4	0	2175.0	23.59	0.13	23.72	41.91	1.93	33.056	*		1.0233
					average	2174.0	23.61	0.13	23.74	41.88	1.93	33.056			
					CV(%)	0.04	0.25	0.12	0.25	0.07	0.15	0.015			
					(uM)	1.0	0.06	0.00	0.06	0.03	0.00	0.005			
1	R-1	59.7	2005.3.6 1:00	2005.3.18	2	*1415.9*	24.54	0.16	24.69	41.64	1.94	33.247			
2	R-2	59.2	2005.3.6 7:00	2005.3.18	2	2169.0	24.35	0.16	24.51	41.75	1.94	33.238			
3	R-3	58.8	2005.3.6 13:00	2005.3.18	2	2168.4	23.87	0.14	24.01	41.57	1.94	33.241			
4	R-4	66.4	2005.3.6 19:00	2005.3.18	2	2170.0	23.86	0.15	24.01	41.68	1.94	33.253			
5	P0-1	58.9	2005.3.7 1:00	2005.3.19	0	2174.8	23.83	0.14	23.97	42.79	1.95	33.320			
6	P1-1	57.6	2005.3.7 2:00	2005.3.18	1	2175.3	23.90	0.14	24.05	41.62	1.94	33.311			
7	P2-1	57.7	2005.3.7 3:00	2005.3.18	2	2168.5	24.75	0.15	24.89	41.88	1.94	33.229			
8	P0-2	59.0	2005.3.7 4:00	2005.3.19	0	2174.8	23.83	0.15	23.97	42.41	1.95	33.336			
9	P1-2	60.6	2005.3.7 5:00	2005.3.18	1	2170.1	23.73	0.15	23.88	42.59	1.94	33.259		factor	
10	P2-2	62.0	2005.3.7 6:00	2005.3.18	2	2175.3	24.57	0.14	24.72	42.43	1.94	33.200	stdev	RAS/routine	
					ave(0 ml)	2174.8	23.83	0.14	23.97	42.60	1.95	33.328	0.011	1.008	
					ave(1 ml)	2172.7	23.82	0.15	23.96	42.10	1.94	33.285	0.036	1.007	
					ave(2 ml)	2170.2	24.28	0.15	24.43	41.86	1.94	33.232	0.019	1.005	

WTS depth - 1m   DIC for #1 (number with underline) should be wrong.   * CTD

On board, measurements of DIC and nutrients for RAS samples taken approximately tow years ago and stored in refrigerator were also conducted. Table ** shows results. Results of previous analysis conducted after one year was also shown. Concentrations of $Si(OH)_4$ and PO_4 increased by 2.6 % and 5.35 %, respectively, after two years. DIC also increased and, however, its increase was smaller than others. Inversely, NOx decreased by 0.8 %. DIC and NOx were closer to initial values than previous data of one year preservation. It might be systematic error of measurements between cruises. However it can be conclude that RAS samples were well preserved for study of biogeochemical cycle. It is noted that concentration of $HgCl_2$ solution was quite higher than that used for this cruise (5 ml of 7.4 g-$HgCl_2$ in 100 ml distilled water for initial preservation against 2 ml of 3.5 g-$HgCl_2$ in 100 ml distilled water for this cruise)

Table 4 Preservation test of RAS samples

	Initial values (measured in Mar 2003) MR03-K02				After one year (measured in Apr. 2004) MR04-02				**After two year (measured in Mar. 2005) This Cruise**			
$HgCl_2$ v/v%	DIC (mmol/kg)	NOx (mmol/kg)	$Si(OH)_4$ (mmol/kg)	PO_4 (mmol/kg)	DIC (mmol/kg)	NOx (mmol/kg)	$Si(OH)_4$ (mmol/kg)	PO_4 (mmol/kg)	**DIC (mmol/kg)**	**NOx (mmol/kg)**	**Si(OH)4 (mmol/kg)**	**PO4 (mmol/kg)**
0.00	2141.2	25.52	42.55	1.92	2188.0	14.78	42.79	1.20				
0.00					2232.5	15.34	43.11	1.03				
0.11	2143.6	25.36	42.72	1.93	2141.1	24.97	43.06	1.95				
0.11									**2149.5**	**25.1**	**43.3**	**1.99**
0.11					2124.0	24.95	42.83	1.95				
0.43					2129.6	24.81	42.81	1.95				
0.43									**2149.8**	**25.1**	**44.3**	**2.07**
0.44	2141.9	25.18	42.75	1.93	2116.6	24.82	42.86	1.92				
0.45	2146.5	25.25	42.62	1.93	2116.7	24.81	42.90	1.95				
1.06	2142.1	25.21	42.79	1.93	2126.2	24.71	42.82	1.95				
1.11					2126.9	24.73	42.80	1.95				
1.11									**2150.6**	**24.9**	**43.4**	**2.00**
		Initial values			(without screened data)							
average	2143.1	25.3	42.7	1.93	2125.9	24.8	42.9	1.95	**2149.6**	**25.1**	**43.8**	**2.03**
stdev	2.1	0.1	0.1	0.01	8.4	0.1	0.1	0.01	**0.2**	**0.0**	**0.7**	**0.06**
			Ratio to initial values (%)		99.2	98.1	100.4	100.9	**100.3**	**99.2**	**102.6**	**105.35**

routine data

	DIC (mmol/kg)	NOx (mmol/kg)	$Si(OH)_4$ (mmol/kg)	PO_4 (mmol/kg)
(40m)	2130.0	24.68	42.58	1.91
(60m)	2128.9	24.67	42.57	1.91

e. MMP

Shallow MMP (50 – 550 m) did not work after 7 March. In addition, working record shows that shallow MMP didi not work on initial schedule. This cause should be solved in near future. Table 5 and Figures 3 and 4 shows working record of MMP and vertical sections of temperature, salinity and density observed by MMP.

Table 7 Recovered MMP at K-2 Engineering Result

K-2 Shallow MMP S/N ML11241-04

Profile	Start Date	Time	FinishDate	Time	min_Pre	max_Pre	Distance[m]
1	3 3 2005	9:11:56	3 3 2005	10:20:26	39	501	462
2	3 3 2005	11:28:28	3 3 2005	11:42:28	323	501	178
3	3 3 2005	13:45:00	3 3 2005	15:13:05	54	501	447
4	3 3 2005	16:01:32	3 3 2005	16:17:35	358	501	143
5	3 3 2005	18:18:04	3 3 2005	20:06:44	81	500	419
6	3 3 2005	20:34:36	3 3 2005	21:16:46	236	501	265
7	3 3 2005	22:51:08	3 4 2005	0:14:42	77	500	423
8	3 4 2005	1:07:40	3 4 2005	1:23:43	359	500	141
9	3 4 2005	3:24:12	3 4 2005	4:43:15	38	500	462
10	3 4 2005	5:40:44	3 4 2005	6:01:17	291	501	210
11	3 4 2005	7:57:17	3 4 2005	9:06:17	37	500	463
12	3 4 2005	10:13:49	3 4 2005	10:33:51	303	501	198
13	3 4 2005	12:30:21	3 4 2005	13:32:51	38	500	462
14	3 4 2005	14:46:53	3 4 2005	15:13:57	265	501	236
15	3 4 2005	17:03:24	3 4 2005	18:03:24	38	502	464
16	3 4 2005	19:19:56	3 4 2005	19:44:58	232	501	269
17	3 4 2005	21:36:29	3 4 2005	22:34:59	37	501	464
18	3 4 2005	23:53:01	3 5 2005	0:34:43	224	500	276
19	3 5 2005	2:09:33	3 5 2005	3:06:33	36	499	463
20	3 5 2005	4:26:05	3 5 2005	5:09:16	217	500	283
21	3 5 2005	6:42:37	3 5 2005	7:39:37	37	500	463
22	3 5 2005	8:59:09	3 5 2005	9:38:49	192	501	309
23	3 5 2005	11:15:41	3 5 2005	12:11:41	37	500	463
24	3 5 2005	13:32:13	3 5 2005	13:59:45	195	501	306
25	3 5 2005	15:48:45	3 5 2005	16:44:45	38	501	463
26	3 5 2005	16:44:45	3 5 2005	16:44:45	41	41	0
27	3 5 2005	18:05:17	3 5 2005	18:27:48	38	199	161
28	3 5 2005	20:21:48	3 5 2005	20:43:19	212	501	289
29	3 5 2005	22:38:21	3 5 2005	23:34:52	38	501	463
30	3 6 2005	0:00:02	3 6 2005	0:43:09	79	501	422
31	3 6 2005	0:54:53	3 6 2005	1:52:23	38	500	462
32	3 6 2005	3:11:26	3 6 2005	3:31:26	229	501	272
33	3 6 2005	5:27:58	3 6 2005	6:30:28	37	499	462
34	3 6 2005	7:44:29	3 6 2005	8:22:41	301	501	200
35	3 6 2005	8:22:41	3 6 2005	8:22:41	499	499	0
36	3 6 2005	10:01:01	3 6 2005	10:43:09	82	501	419
37	3 6 2005	12:17:34	3 6 2005	13:26:34	37	500	463
38	3 6 2005	14:34:06	3 6 2005	14:49:06	312	502	190
39	3 6 2005	16:50:38	3 6 2005	17:53:38	39	502	463
40	3 6 2005	19:07:10	3 6 2005	19:21:10	320	502	182
41	3 6 2005	21:23:42	3 6 2005	22:26:12	38	502	464

42	3 6 2005	23:40:14	3 7 2005	0:09:20	296	501	205
43	3 7 2005	1:56:46	3 7 2005	2:58:16	37	500	463
44	3 7 2005	4:13:17	3 7 2005	4:49:55	256	500	244
45	3 7 2005	6:29:50	3 7 2005	7:28:50	37	501	464
46	3 7 2005	8:46:22	3 7 2005	9:09:52	186	501	315
47	3 7 2005	11:02:54	3 7 2005	11:56:54	39	502	463
48	3 7 2005	13:19:26	3 7 2005	13:46:56	122	501	379
49	3 7 2005	15:35:57	3 7 2005	16:29:58	38	501	463
50	3 7 2005	17:52:29	3 7 2005	18:22:29	92	502	410
51	3 7 2005	20:09:02	3 7 2005	21:02:32	38	502	464
52	3 7 2005	22:25:34	3 7 2005	22:56:05	78	502	424
53	3 8 2005	0:42:05	3 8 2005	1:35:06	39	502	463
54	3 8 2005	2:58:38	3 8 2005	3:29:38	73	501	428
55	3 8 2005	5:15:11	3 8 2005	6:08:11	37	501	464
56	3 8 2005	7:31:43	3 8 2005	8:22:57	91	500	409
57	3 8 2005	8:22:57	3 8 2005	8:22:57	499	499	0
58	3 8 2005	9:48:15	3 8 2005	10:40:27	84	500	416
59	3 8 2005	12:04:47	3 8 2005	12:58:47	37	500	463
60	3 8 2005	14:21:19	3 8 2005	14:49:49	108	502	394
61	3 8 2005	16:37:51	3 8 2005	17:33:21	40	503	463
62	3 8 2005	18:00:03	3 8 2005	18:32:33	54	503	449
63	3 8 2005	18:54:23	3 8 2005	19:49:23	39	503	464
64	3 8 2005	21:10:55	3 8 2005	21:49:31	160	501	341
65	3 8 2005	23:27:27	3 9 2005	0:25:27	38	500	462
66	3 9 2005	1:43:58	3 9 2005	2:00:28	283	501	218
67	3 9 2005	4:00:31	3 9 2005	5:07:01	40	502	462
68	3 9 2005	5:07:01	3 9 2005	5:07:01	48	48	0
69	3 9 2005	6:17:03	3 9 2005	7:23:03	40	502	462
70	3 9 2005	8:33:35	3 9 2005	8:50:05	283	503	220
71	3 9 2005	8:59:39	3 9 2005	10:02:10	39	502	463
72	3 9 2005	10:50:07	3 9 2005	11:12:38	190	501	311
73	3 9 2005	11:12:38	3 9 2005	11:12:38	498	498	0
					Total Dist.		25290

K-2 Deep MMP S/N ML11241-05

Profile	Start Date	Time	FinishDate	Time	min_Pre	max_Pre	Distance[m]
1	3 4 2005	0:00:01	3 4 2005	0:46:31	542	1031	489
2	3 4 2005	9:00:01	3 4 2005	15:00:31	502	3608	3106
3	3 5 2005	0:00:01	3 5 2005	2:54:31	541	2776	2235
4	3 5 2005	9:00:01	3 5 2005	15:00:31	503	3833	3330
5	3 6 2005	0:00:01	3 6 2005	3:45:31	545	3602	3057
6	3 6 2005	9:00:01	3 6 2005	15:00:31	503	3500	2997
7	3 7 2005	0:00:01	3 7 2005	2:28:31	543	2422	1879
8	3 7 2005	9:00:01	3 7 2005	14:58:31	505	4003	3498
9	3 8 2005	0:00:01	3 8 2005	3:54:01	545	3918	3373
10	3 8 2005	9:00:01	3 8 2005	14:34:01	505	3983	3478
11	3 9 2005	0:00:01	3 9 2005	4:00:01	547	3787	3240
12	3 9 2005	9:00:01	3 9 2005	15:58:41	549	3672	3123
13	3 10 2005	0:00:01	3 10 2005	1:20:02	545	1345	800

14	3 10 2005	9:00:01	3 10 2005	15:00:02	601	2875	2274
15	3 11 2005	0:00:01	3 11 2005	0:57:32	545	1151	606
16	3 11 2005	9:00:01	3 11 2005	15:00:02	720	3483	2763
17	3 12 2005	0:00:01	3 12 2005	2:22:02	543	2293	1750
18	3 12 2005	9:00:01	3 12 2005	17:00:04	627	3742	3115
19	3 13 2005	0:00:01	3 13 2005	2:00:02	541	1901	1360
20	3 13 2005	9:00:02	3 13 2005	14:03:42	723	2473	1750
21	3 14 2005	0:00:02	3 14 2005	0:47:02	545	968	423
22	3 14 2005	9:00:02	3 14 2005	15:00:02	810	3069	2259
23	3 15 2005	0:00:02	3 15 2005	1:12:32	543	1340	797
24	3 15 2005	9:00:02	3 15 2005	15:00:02	778	3805	3027
25	3 16 2005	0:00:02	3 16 2005	0:42:32	437	2192	1755
					Total Dist.		56484

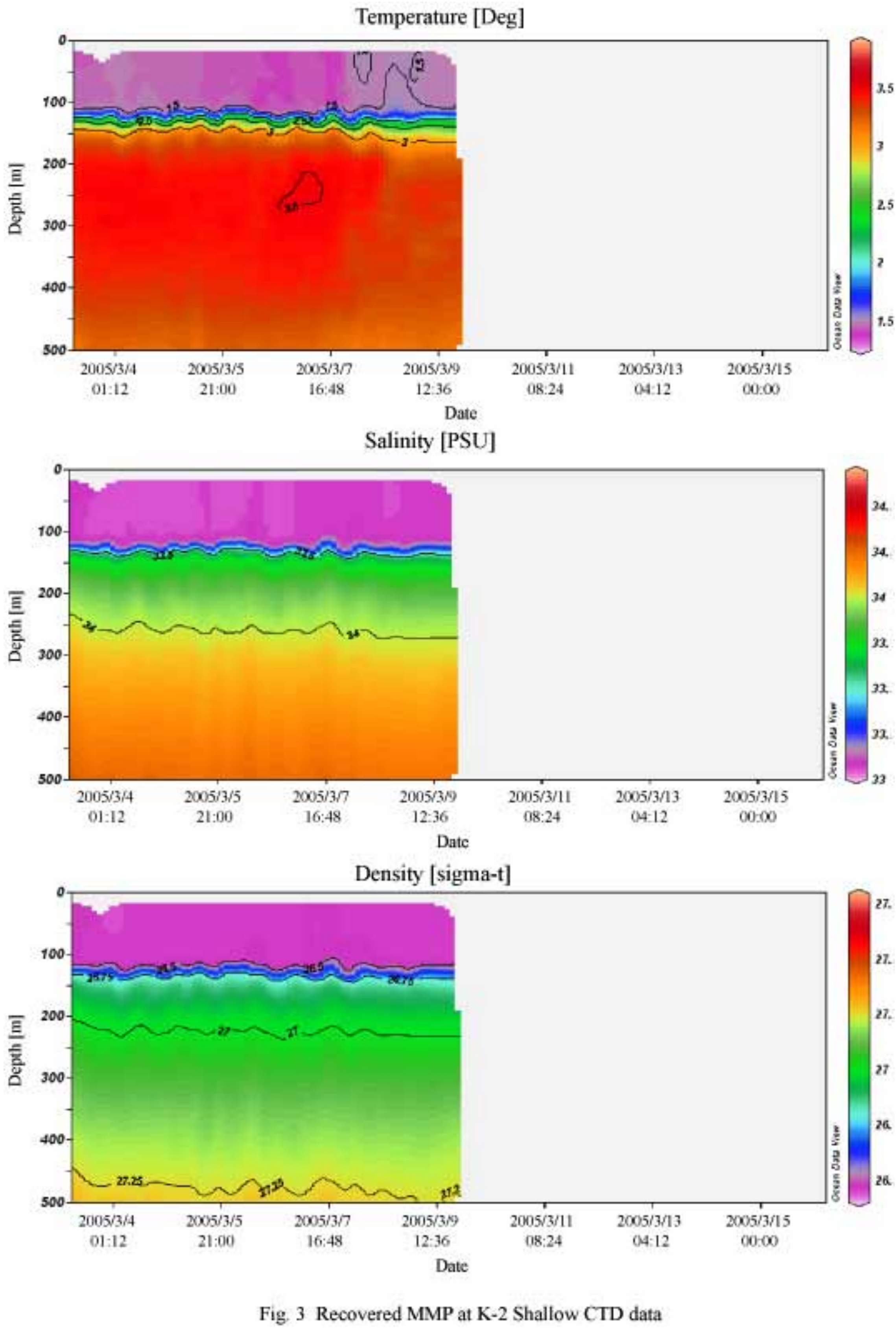


Fig. 3 Recovered MMP at K-2 Shallow CTD data

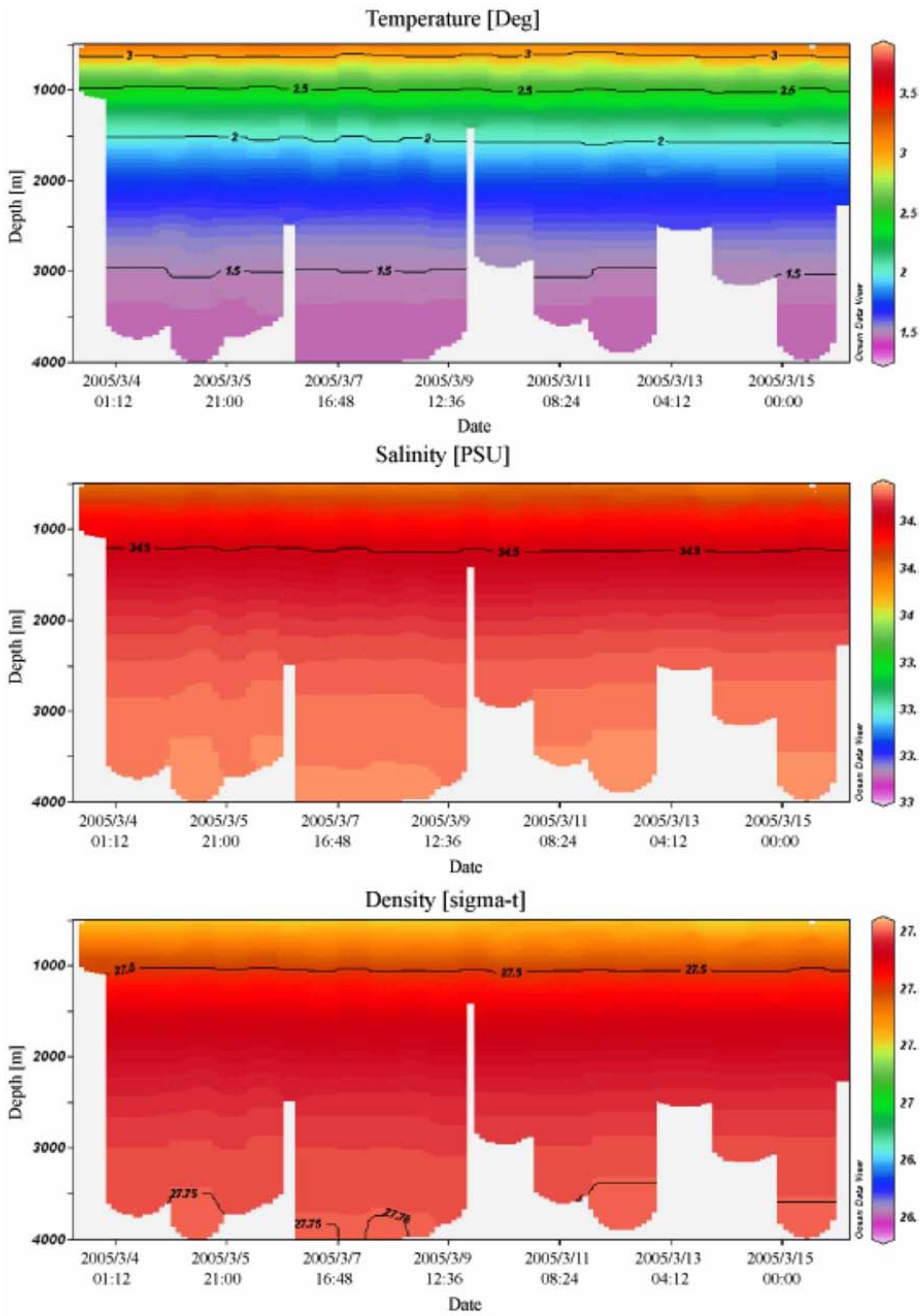


Fig. 4 Recovered MMP at K-2 Deep CTD data

3.1.2 Long-term mooring

3.1.2.1 Deployment

We deployed BGC mooring almost same short-term test deployed at Station K-2 in the Western Subarctic Gyre. The BGC mooring consists of a top float, instruments, mooring wire and rope, glass floats, dual releasers and sinker. Two ARGOS compact mooring locators and one submersible recovery strobe is mounted on all of top floats. Load-cell (KYOWA) is mounted above the dual releasers to observe the tension during whole process of mooring. Before cruise, all wires and nylon ropes are pre-stretched by approximately 1.3 ton, which load corresponds to mooring tension and measured exact length using a laser equipment, which error is ± 1 mm. The following time-series observational instruments are mounted approximately 40 ~ 50 m below sea surface.

- RAS - Remote Access Sampler with Ocean Optical Sensor
- WTS - Water Access Sampler with Depth Sensor
- ZPS - Zoo Plankton Sampler
- Sediment Trap – 150 m, 300 m, 540 m, 2,000 m and 5,000 m

The position of the moorings is finally determined as follows:

Table 1 Mooring positions for respective mooring systems

	K-2 BGC K2B050317
Date of deployment	Mar. 4th 2005
Latitude	47° 01.20 N
Longitude	159° 57.20 E
Depth	5,206.2 m

Table 2 Serial numbers of instruments

Station and type of system Mooring system S / N	K-2 BGC K2B050317
ARGOS	52111 / 52112
ARGOS ID	5373 / 5374
Strobe	232
RAS	ML11241-10
OOS	DFLS-072
WTS	ML11241-13
Depth Sensor	DP1142
ZPS	ML11241-21
Sediment Trap (150m)	878
(300m)	ML11241-22
(540m)	0256
(2000m)	ML11241-24
(5000m)	ML11241-25
Load-Cell	496450001
Releaser	027809 027867

Table 3　Deployment and Recovery Record

K-2 BGC Mooring

Mooring Number　　K2B050317

Project	Time-Series		Depth	5,206.2	m
Area	North Pacific		Planned Depth	5,216.2	m
Station	K-2 BGC		Length	5,184.3	m
Target Position	**47°00.350**	**N**	Depth of Buoy	30	m
	159°58.326	**E**	Period	6	month
ACOUCTIC RELEASERS					
Type	Edgetech		Edgetech		
Serial Number	27867		27809		
Receive F.	11.0	kHz	11.0	kHz	
Transmit F.	12.0	kHz	12.0	kHz	
RELEASE C.	**344573**		**344535**		
Enable C.	360536		360320		
Disable C.	360553		360366		
Battery	2 year		2 year		
Release Test	FINE		FINE		
DEPLOYMENT					
Recorder	Tomohide Noguchi		Start	7.0	Nmile
Ship	MIRAI		Overshoot	343.9	m
Cruise No.	MR05-01		Let go Top Buoy	21:06	
Date	2005/3/17		Let go Anchor	2:01	
Wather	o		Sink Top Buoy	2:51	
Wave Hight	1.4	m	Pos. of Start	47°04.90	N
Depth	5,212	m		159°51.73	E
Ship Heading	<135>		Pos. of Drop. Anc.	47°00.22	N
Ship Ave.Speed	1.4	knot		159°58.51	E
Wind	<115> 9.5	m/s	Pos. of Mooring	47°01.20	N
Current	<010> 0.2	knot		159°57.20	E

Table 4 K-2 BGC Mooring Deployment Check List

MOORING NO. K2B050317 DATE 2005/3/17 Name : Tomohide Noguchi

ITEM	S/N		Switch	TIME
Syntactic Sphere	A:52112/52111	☑	☑	21:09
ARGOS and Flasher	F:234	☑	☑	
5m 3/4" PC Chain				21:08
RAS	ML11241-10	☑	☑	21:08
WTS	ML11241-15	☑	☑	21:08
Depth Sensor	DP1142	☑	☑	
ZPS	ML11241-21	☑	☑	21:07
50m 5/16" Wire	DN	☑		21:07
50m 5/16" Wire Coated	#DE	☑		21:12
Sediment Trap 150m	0256	☑	☑	21:24
2m 16mm T-Chain				21:24
50m 5/16" Wire	#V	☑		21:24
43m 5/16" Wire	#DI	☑		21:27
50m 5/16" Wire Coated	#U	☑		21:30
Sediment Trap 300m	878	☑	~~☐~~	21:35
2m 16mm T-Chain				21:35
143m 5/16" Wire	BC	☑		21:36
43m 5/16" Wire	CE	☑		21:40
50m 5/16" Wire Coated	#DG	☑		21:42
Sediment Trap 540m	ML11241-22	☑	☑	21:47
2m 16mm T-Chain				21:47
403m 5/16" Wire	#S	☑		21:47
50m 5/16" Wire Coated	#DH	☑		21:54
Sediment Trap 1000m	ML11241-24	☑	☑	21:59
2m 16mm T-Chain				21:59
500m 1/4" Wire	CG	☑		21:59
(12) 17" Glass Balls				22:15
500m 1/4" Wire	CF	☑		22:15
500m 1/4" Wire	CE	☑		22:24
500m 1/4" Wire	CD	☑		23:32
(10) 17" Glass Balls				22:43
500m 1/4" Wire	BL	☑		22:44
500m 1/4" Wire	BJ	☑		22:52
387m 1/4" Wire	CJ	☑		23:03
(8) 17" Glass Balls				23:12
200m 1/4" Wire	CN	☑		23:13
100m 1/4" Wire	TT	☑		23:17
29m 1/4" Wire	#1/29	☑		23:20
50m 1/4" Wire Coated	#Y	☑		23:21
Sediment Trap 4810m	ML11241-25	☑	☑	23:27
2m 16mm T-Chain				23:27
200m 1/4" Wire	CL	☑		23:27
50m 1/4" Wire	AF	☑		23:32
25m 1/4" Wire	#4/25	☑		23:34
20m 1/4" Wire	#3/20	☑		23:35
5m 16mm T-Chain				23:43
(52) 17" Glass Balls				23:57
5m 16mm T-Chain				1:36
Tension Meter	1	☑	☑	1:37
Dual Releases	27809	☑	☑	1:37
	27867	☑	☑	
5m 16mm T-Chain				1:37
20m 3/4" Nylon	#09			1:42
5m 16mm T-Chain				2:01
4,666lb Mace Anchor				2:01

Joint		DAMAGE	PIN	PHOTO
L	☑	☑	☑	☑
F	☑	☑	☑	☑
H	☑	☑	☑	☑
H	☑	☑	☑	☑
HSH	☑	☑	☑	☑
H	☑	☑	☑	☑
I	☑	☑	☑	☑
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HSB	☑	☑	☑	☑
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HHB	☑	☑	☑	☑
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HSH	☑	☑	☑	☑
MF	☑	☑	☑	☑
G	☑	☑	☑	☑
G	☑	☑	☑	☑
F	☑	☑	☑	☑

Table 5 Detail of our mooring system.

K-2 BGC Mooring

	Mooring ID	Joint	Water Depth						
	Description		Item Length (m)	Item Weight (kg)	Mooring Length (m)	Mooring Weight (kg)	Above Bottom (m)	Mooring Depth (m)	**Design Depth**
1	64" Syntatic Sphere		2.27	-1360.78		-1360.78	5184.27	31.93	**30**
	Hardware	L	0.28	3.63	2.55	-1357.15	5182.00	34.20	
2	**5** Meters 3/4" Proof Coil Chain		5.00	40.01	7.55	-1317.14	5181.72	34.48	
	Hardware	F	0.26	2.42	7.81	-1314.72	5176.72	39.48	
3	Instrument - "RAS"	N	2.25	72.03	10.06	-1242.69	5176.46	39.74	
	Hardware	H	0.24	1.93	10.29	-1240.76	5174.21	41.99	
4	Instrument - "WTS"	N	2.83	50.33	13.12	-1190.43	5173.98	42.22	
	Hardware	H	0.24	1.93	13.36	-1188.50	5171.15	45.05	
5	Instrument - "ZPS"	N	2.42	41.33	15.78	-1147.17	5170.91	45.29	
	Hardware	H	0.24	1.93	16.01	-1145.24	5168.49	47.71	
6	3-TON Miller Swivel		0.16	3.17	16.17	-1142.07	5168.26	47.94	
	Hardware	H	0.24	1.93	16.41	-1140.14	5168.10	48.10	
7	**50 M 5/16" Wire [DN]**		50.13	10.69	66.54	-1129.45	5167.86	48.34	
	Hardware	H	0.24	1.93	66.77	-1127.52	5117.73	98.47	
8	**50 Meters 5/16" Wire [DE]**	P	50.36	10.74	117.13	-1116.79	5117.49	98.71	
	Hardware	I	0.06	2.19	117.19	-1114.60	5067.14	149.06	
9	Sediment Trap [0256]	O	3.92	55.68	121.11	-1058.91	5067.08	149.12	**150**
	Hardware	H	0.24	1.93	121.35	-1056.98	5063.16	153.04	
10	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	123.35	-1040.98	5062.92	153.28	
	Hardware	H	0.24	1.93	123.58	-1039.05	5060.92	155.28	
11	**50 Meters 5/16" Wire [#V]**		50.17	10.70	173.75	-1028.36	5060.69	155.51	
	Hardware	H	0.24	1.93	173.98	-1026.43	5010.52	205.68	
12	**43 Meters 5/16" Wire [#DI]**		43.56	9.29	217.54	-1017.14	5010.28	205.92	
	Hardware	H	0.24	1.93	217.78	-1015.21	4966.72	249.48	
13	**50 Meters 5/16" Wire [#U]**	P	50.10	10.68	267.88	-1004.53	4966.49	249.71	
	Hardware	I	0.06	2.19	267.94	-1002.34	4916.39	299.81	
14	Sediment Trap [878]	O	3.89	55.70	271.83	-946.64	4916.33	299.87	**300**
	Hardware	H	0.24	1.93	272.07	-944.71	4912.44	303.76	
15	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	274.07	-928.71	4912.20	304.00	
	Hardware	H	0.24	1.93	274.30	-926.78	4910.20	306.00	
16	**143 Meters 5/16" Wire [BC]**		143.85	30.67	418.15	-896.11	4909.97	306.23	
	Hardware	H	0.24	1.93	418.38	-894.18	4766.12	450.08	
17	**43 Meters 5/16" Wire [CE]**		43.47	9.27	461.86	-884.91	4765.88	450.32	
	Hardware	H	0.24	1.93	462.09	-882.98	4722.41	493.79	
18	**50 Meters 5/16" Wire [#DG]**	P	51.04	10.88	513.13	-872.10	4722.18	494.03	
	Hardware	I	0.06	2.19	513.19	-869.91	4671.14	545.06	
19	Sediment Trap [ML11241-22]	O	3.74	55.70	516.93	-814.21	4671.08	545.12	**540**
	Hardware	H	0.24	1.93	517.16	-812.28	4667.34	548.86	
20	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	519.16	-796.28	4667.10	549.10	
	Hardware	H	0.24	1.93	519.40	-794.35	4665.10	551.10	
21	**403 Meters 5/16" Wire [#S]**		403.79	86.08	923.19	-708.27	4664.87	551.33	
	Hardware	H	0.24	1.93	923.42	-706.34	4261.08	955.12	
22	**50 Meters 5/16" Wire [#DH]**	P	50.54	10.78	973.96	-695.56	4260.85	955.35	
	Hardware	I	0.06	2.19	974.03	-693.37	4210.30	1005.90	
23	Sediment Trap ML11241-24]	O	3.73	55.70	977.76	-637.67	4210.24	1005.96	**1000**
	Hardware	H	0.24	1.93	977.99	-635.74	4206.51	1009.69	
24	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	979.99	-619.74	4206.28	1009.92	
	Hardware	H	0.24	1.93	980.23	-617.81	4204.28	1011.92	
25	3-TON Miller Swivel		0.16	3.17	980.39	-614.64	4204.04	1012.16	
	Hardware	B	0.23	1.63	980.61	-613.01	4203.88	1012.32	
26	**500** Meters 1/4" Wire [CG]		498.48	70.09	1479.10	-542.92	4203.65	1012.55	
	Hardware	B	0.23	1.63	1479.32	-541.29	3705.17	1511.03	
27	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1483.32	-620.65	3704.95	1511.25	
	Hardware	H	0.24	1.93	1483.56	-618.72	3700.95	1515.25	
28	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1487.56	-698.08	3700.71	1515.49	
	Hardware	H	0.24	1.93	1487.79	-696.15	3696.71	1519.49	

29	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1491.79	-775.51	3696.48	1519.72	
	Hardware	B	0.23	1.63	1492.02	-773.88	3692.48	1523.72	
30	**500** Meters 1/4" Wire [CF]		498.45	70.09	1990.46	-703.79	3692.25	1523.95	
	Hardware	A	0.21	1.33	1990.67	-702.46	3193.80	2022.40	
31	**500** Meters 1/4" Wire [CE]		498.46	70.09	2489.13	-632.37	3193.59	2022.61	
	Hardware	A	0.21	1.33	2489.34	-631.04	2695.14	2521.06	
32	**500** Meters 1/4" Wire [CD]		498.09	70.04	2987.42	-561.01	2694.93	2521.27	
	Hardware	B	0.23	1.63	2987.65	-559.38	2196.84	3019.36	
33	2-17" Glassballs on 16mm T-Chain		2.00	-39.68	2989.65	-599.06	2196.62	3019.58	
	Hardware	H	0.24	1.93	2989.89	-597.13	2194.62	3021.58	
34	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	2993.89	-676.49	2194.38	3021.82	
	Hardware	H	0.24	1.93	2994.12	-674.56	2190.38	3025.82	
35	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	2998.12	-753.92	2190.15	3026.05	
	Hardware	B	0.23	1.63	2998.35	-752.29	2186.15	3030.05	
36	**500** Meters 1/4" Wire [BL]		500.63	70.40	3498.98	-681.89	2185.92	3030.28	
	Hardware	A	0.21	1.33	3499.19	-680.56	1685.29	3530.91	
37	**500** Meters 1/4" Wire [BJ]		500.68	70.40	3999.87	-610.16	1685.08	3531.12	
	Hardware	A	0.21	1.33	4000.08	-608.83	1184.40	4031.80	
38	**387 Meters 1/4" Wire [CJ]**		392.32	55.17	4392.40	-553.66	1184.19	4032.01	
	Hardware	B	0.23	1.63	4392.63	-552.03	791.87	4424.33	
39	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4396.63	-631.39	791.64	4424.56	
	Hardware	H	0.24	1.93	4396.86	-629.46	787.64	4428.56	
40	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	4400.86	-708.82	787.40	4428.80	
	Hardware	B	0.23	1.63	4401.09	-707.19	783.40	4432.80	
41	**200 Meters 1/4" Wire [CN]**		199.39	28.04	4600.48	-679.16	783.18	4433.02	
	Hardware	A	0.21	1.33	4600.69	-677.83	583.79	4632.41	
42	**100 Meters 1/4" Wire [TT]**		99.95	14.05	4700.64	-663.77	583.58	4632.62	
	Hardware	A	0.21	1.33	4700.85	-662.44	483.63	4732.57	
43	**29 Meters 1/4" Wire [#1/29]**		29.09	4.09	4729.94	-658.35	483.42	4732.78	
	Hardware	A	0.21	1.33	4730.15	-657.02	454.33	4761.87	
44	**50 Meters 1/4" Wire [#Y]**	Q	50.17	7.06	4780.32	-649.97	454.12	4762.08	
	Hardware	K	0.20	1.33	4780.52	-648.64	403.94	4812.26	
45	Sediment Trap [ML11241-25]	O	3.73	55.70	4784.25	-592.94	403.74	4812.46	**4810.8**
	Hardware	H	0.24	1.93	4784.49	-591.01	400.01	4816.19	
46	**2** Meters 3/4" Proof Coil Chain		2.00	16.00	4786.49	-575.00	399.78	4816.42	
	Hardware	B	0.23	1.63	4786.71	-573.38	397.78	4818.42	
47	**200 Meters 1/4" Wire [CL]**		199.34	28.03	4986.06	-545.35	397.55	4818.65	
	Hardware	A	0.21	1.33	4986.27	-544.02	198.21	5017.99	
48	**50 Meters 1/4" Wire [AF]**		50.04	7.04	5036.31	-536.98	198.00	5018.20	
	Hardware	A	0.21	1.33	5036.52	-535.65	147.96	5068.24	
49	**25 Meters 1/4" Wire [adj]**		25.00	3.52	5061.52	-532.13	147.75	5068.45	
	Hardware	A	0.21	1.33	5061.73	-530.80	122.75	5093.45	
50	**20 Meters 1/4" Wire [adj]**		20.00	2.81	5081.73	-527.99	122.54	5093.66	
	Hardware	B	0.23	1.63	5081.95	-526.36	102.54	5113.66	
51	5 Meters 16mm T-Chain		5.00	27.80	5086.95	-498.56	102.31	5113.89	
	Hardware	H	0.24	1.93	5087.19	-496.63	97.31	5118.89	
52	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5091.19	-575.99	97.08	5119.12	
	Hardware	H	0.24	1.93	5091.42	-574.06	93.08	5123.12	
53	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5095.42	-653.42	92.84	5123.36	
	Hardware	H	0.24	1.93	5095.66	-651.49	88.84	5127.36	
54	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5099.66	-730.85	88.61	5127.59	
	Hardware	H	0.24	1.93	5099.89	-728.92	84.61	5131.59	
55	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5103.89	-808.28	84.37	5131.83	
	Hardware	H	0.24	1.93	5104.13	-806.35	80.37	5135.83	
56	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5108.13	-885.71	80.14	5136.06	
	Hardware	H	0.24	1.93	5108.36	-883.78	76.14	5140.06	
57	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5112.36	-963.14	75.90	5140.30	
	Hardware	H	0.24	1.93	5112.60	-961.21	71.90	5144.30	
58	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5116.60	-1040.57	71.67	5144.53	
	Hardware	H	0.24	1.93	5116.83	-1038.64	67.67	5148.53	
59	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5120.83	-1118.00	67.43	5148.77	
	Hardware	H	0.24	1.93	5121.07	-1116.07	63.43	5152.77	
60	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5125.07	-1195.43	63.20	5153.00	
	Hardware	H	0.24	1.93	5125.30	-1193.51	59.20	5157.00	

61	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5129.30	-1272.87	58.96	5157.24	
	Hardware	H	0.24	1.93	5129.54	-1270.94	54.96	5161.24	
62	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5133.54	-1350.30	54.73	5161.47	
	Hardware	H	0.24	1.93	5133.77	-1348.37	50.73	5165.47	
63	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5137.77	-1427.73	50.49	5165.71	
	Hardware	H	0.24	1.93	5138.01	-1425.80	46.49	5169.71	
64	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5142.01	-1505.16	46.26	5169.94	
	Hardware	H	0.24	1.93	5142.24	-1503.23	42.26	5173.94	
65	5 Meters 16mm T-Chain		5.00	27.80	5147.24	-1475.43	42.02	5174.18	
	Hardware	H	0.24	1.93	5147.48	-1473.50	37.02	5179.18	
66	Tension Meter		0.45	39.00	5147.93	-1434.50	36.79	5179.41	
	Hardware	H	0.24	1.93	5148.16	-1432.57	36.34	5179.86	
67	3-TON Miller Swivel		0.16	3.20	5148.32	-1429.37	36.10	5180.10	
	Hardware	F	0.26	2.42	5148.58	-1426.95	35.94	5180.26	
68	Dual EGG Acoustic Releases	M	1.95	66.04	5150.52	-1360.90	35.69	5180.51	
	Hardware	F	0.26	2.42	5150.78	-1358.48	33.74	5182.46	
69	5 Meters 16mm T-Chain		5.00	27.80	5155.78	-1330.68	33.49	5182.71	
	Hardware	G	0.25	2.70	5156.02	-1327.99	28.49	5187.71	
70	**20** Meters 1" Nylon [#09]		21.78	6.49	5177.81	-1321.49	28.24	5187.96	
	Hardware	G	0.25	2.70	5178.05	-1318.79	6.46	5209.74	
71	5 Meters 16mm T-Chain		5.00	27.80	5183.05	-1290.99	6.21	5209.99	
	Hardware	F	0.26	2.42	5183.31	-1288.57	1.21	5214.99	**Design**
72	4666 Lb Ww Anchor		0.96	2116.46	5184.27	827.89	0.96	5215.24	**Depth**
	OVERALL MOORING LENGTH		**5184.27**					5216.20	**5216.2**

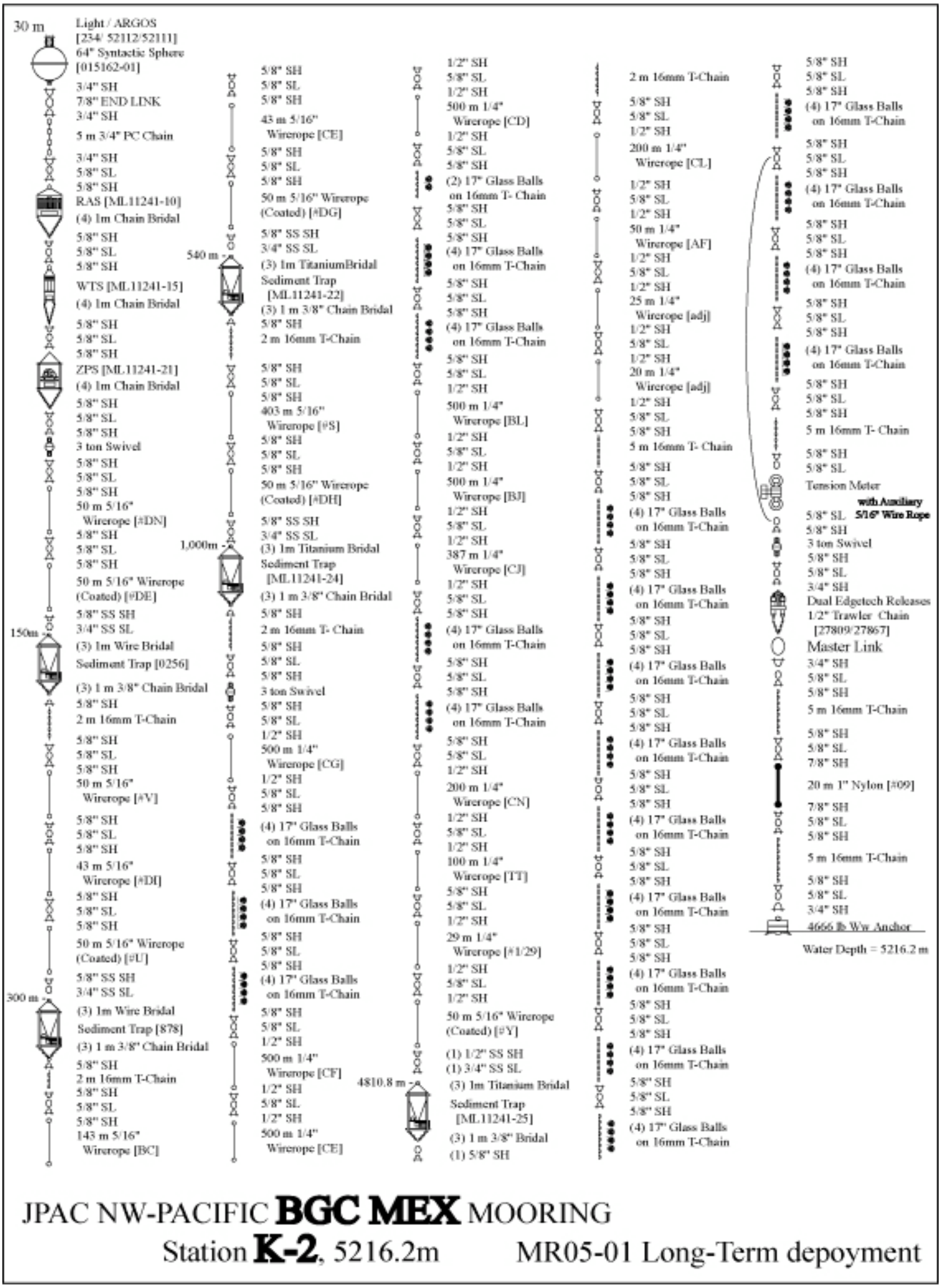


Fig. 1 K-2 BGC Mooring Figure

3.1.2.2 Instruments

On mooring systems, the following instruments are installed.

(1) ARGOS CML (Compact Mooring Locator)

The Compact Mooring Locator is a subsurface mooring locator based on SEIMAC's Smart Cat ARGOS PTT (Platform Terminal Transmitter) technology. Using CML, we can know when our mooring has come to the surface and its position. The CML employs a pressure sensor at the bottom. When the CML is turned ON, the transmission is started immediately every 90 seconds and then when the pressure sensor is worked ON by approximately 10 dbar the transmission is stopped. When the top buoy with the CML comes to the surface, the pressure sensor will work OFF and the transmission will be started. Smart Cat transmissions will be initiated at this time, allowing us to locate our mooring. Depending on how to long the CML has been moored, it will transmit for up to 120 days on a 90 second repetition period. Battery life, however, is affected by how long the CML has been moored prior to activation. A longer pre-activation mooring will mean less activation life.

Principle specification is as follows:

(Specification)

Transmitter:	Smart Cat PTT
Operating Temp.:	+35 [deg] to –5 [deg]
Standby Current:	80 μAmp.
Power Control.:	Ext. Magnetic Switch
Smart Cat Freq.:	401.650 MHz
Battery Supply:	7-Cell alkaline D-Cells
Ratings:	+10.5VDC nom., 10 Amp Hr
Hull:	6061-T6 Aluminum
Max Depth:	1,000 m
Length:	22 inches
Diameter:	3.4 inches
Upper flange:	5.60 inches
Dome:	Acrylic
Buoyancy:	-2.5 (negative) approx.
Weight	12 pounds approx.

(2) Submersible Recovery Strobe

The Benthos 204 - RS is fully self-contained 0.1 watt - second strobe intended to aid in the marking or recovery of oceanographic instruments, manned vehicles, remotely operated vehicles, buoys or structures. Due to the occulting (firing closely spaced bursts of light) nature of this design, it is much more visible than conventional marker strobes, particularly in poor sea conditions.

(Specification)

Power Level:	0.1 watt-second
Repetition Rate:	Adjustable from 2 bursts per second to 1 burst every 3 seconds.

Burst Length:	Adjustable from 1 to 5 flashes per burst. 100 ms between flashes nominal.
Battery Type:	C-cell alkaline batteries, (Eveready E-93 or equivalent).
Life:	Dependent on repetition rate and burst length. 150 hours with a one flash burst every 2 seconds.
Construction:	Awl-grip painted, Hard coat anodized 6061 T-6 aluminum housing.
Pressure Rating:	10,000 psi
Daylight-off:	User selected, standard
Pressure Switch:	Turns unit off below approximately 30 feet.
	Rotary, clockwise – ON, counter clockwise – OFF.
Weight in Air:	4 pounds
Weight in Water:	2 pounds
Outside Diameter:	1.7 inches nominal
Length:	21-1/2 inches nominal

(3) Depth Sensor

RMD Depth sensor is digital memory type and designed for mounting on the plankton net and instrument for mooring and so on. It is small and right weight for easy handling. Sampling interval is chosen between 2 and 127 seconds or 1 and 127 minutes and sampled Time and Depth data. The data is converted to personal computer using exclusive cable (printer interface).

(Specification)

Model:	RMD-500
Operating Depth:	0 ~ 500m
Precision:	0.5% (F.S.)
Accuracy:	1/1300
Memory:	65,534 data (128kbyte)
Battery:	lithium battery (CR2032) DC6V
Battery Life:	65,000 data or less than 1 year
Sample interval:	2 ~ 127 seconds or 1 ~ 127 minutes
Broken Pressure:	20MPa
Diameter:	50mm
Length:	150mm
Main Material:	vinyl chloride resin
Cap material:	polyacetal resin
Weight:	280g

(sampling parameter)

Sampling interval:	2 hours

(6) Load-Cell

Load-Cell was designed to measured the mooring tension during deployment, moored and recovery even short term and long term at about 5,000 m depth. This system consists of waterproof load-cell, digital strain recorder, housing and connecting cable.

(Specification)

Waterproof Load-Cell

Model:	LTF-A-50KNS49106
Max. Tension:	50 kN
Rated Output:	0.5 mV/V (1000*10^{-6} strain)
Nonlinearity:	±1 %RO
Operating Temp.:	+50 [deg] to –10 [deg]
Diameter:	135 mm
Length:	567 mm
Weight:	30 kg

Digital strain recorder

Model:	RMH-201A-0 M10
Sample:	30,720 data
Sample Interval:	1 minutes ~ 99 hours 59 minutes
Operating Temp.:	+50 [deg] to –20 [deg], 10-95 %RH
Battery:	DC6-15V Battery Pack
Size:	180 mm * 70 mm * 55 mm
Weight:	800 g

(sampling parameter)

Sampling interval:	30 minutes

(7) Sampling schedule of instruments

Time-series instruments on BGC mooring system were RAS, BLOOMS, WTS, ZPS and 5 sediment traps. Table 6 shows sampling schedule.

SAMPLING SCHEDULE for MR05-01 MIRAI "revenge" cruise

		A: ST (13 cups)		B: ST (21 cups)		WTS-PPS		ZPS		RAS		MMP			MMP	
Samp.		13		21		12*2		50		48		shallow(50-550)	running dist.		deep(550-4050)	running dist.
Int.		14		7		14		4		4		4			16	
	1	2005.3.20 1:00	1	2005.3.20 1:00	1	2005.3.20 1:00	1	2005.3.20 13:00	1	2005.3.20 1:00	1	2005.3.20 1:00	1,000	1	2005.3.20 1:00	7,000
	2	2005.4.3 1:00	2	2005.4.3 1:00	2	2005.4.3 1:00	2	2005.3.24 13:00	2	2005.3.24 1:00	2	2005.3.24 1:00	2,000	2	2005.4.5 1:00	14,000
	3	2005.4.17 1:00	3	2005.4.17 1:00	3	2005.4.17 1:00	3	2005.3.28 13:00	3	2005.3.28 1:00	3	2005.3.28 1:00	3,000	3	2005.4.21 1:00	21,000
	4	2005.5.1 1:00	4	2005.5.1 1:00	4	2005.5.1 1:00	4	2005.4.1 13:00	4	2005.4.1 1:00	4	2005.4.1 1:00	4,000	4	2005.5.7 1:00	28,000
	5	2005.5.15 1:00	5	2005.5.15 1:00	5	2005.5.15 1:00	5	2005.4.5 13:00	5	2005.4.5 1:00	5	2005.4.5 1:00	5,000	5	2005.5.23 1:00	35,000
	6	2005.5.29 1:00	6	2005.5.22 1:00	6	2005.5.29 1:00	6	2005.4.9 13:00	6	2005.4.9 1:00	6	2005.4.9 1:00	6,000	6	2005.6.8 1:00	42,000
	7	2005.6.12 1:00	7	2005.5.29 1:00	7	2005.6.12 1:00	7	2005.4.13 13:00	7	2005.4.13 1:00	7	2005.4.13 1:00	7,000	7	2005.6.24 1:00	49,000
	8	2005.6.26 1:00	8	2005.6.5 1:00	8	2005.6.26 1:00	8	2005.4.17 13:00	8	2005.4.17 1:00	8	2005.4.17 1:00	8,000	8	2005.7.10 1:00	56,000
	9	2005.7.10 1:00	9	2005.6.12 1:00	9	2005.7.10 1:00	9	2005.4.21 13:00	9	2005.4.21 1:00	9	2005.4.21 1:00	9,000	9	2005.7.26 1:00	63,000
	10	2005.7.24 1:00	10	2005.6.19 1:00	10	2005.7.24 1:00	10	2005.4.25 13:00	10	2005.4.25 1:00	10	2005.4.25 1:00	10,000	10	2005.8.11 1:00	70,000
	11	2005.8.7 1:00	11	2005.6.26 1:00	11	2005.8.7 1:00	11	2005.4.29 13:00	11	2005.4.29 1:00	11	2005.4.29 1:00	11,000	11	2005.8.27 1:00	77,000
	12	2005.8.21 1:00	12	2005.7.3 1:00	12	2005.8.21 1:00	12	2005.5.3 13:00	12	2005.5.3 1:00	12	2005.5.3 1:00	12,000	12	2005.9.12 1:00	84,000
	13	2005.9.4 1:00	13	2005.7.10 1:00			13	2005.5.7 13:00	13	2005.5.7 1:00	13	2005.5.7 1:00	13,000	13	2005.9.28 1:00	91,000
		2005.9.18 1:00	14	2005.7.17 1:00			14	2005.5.11 13:00	14	2005.5.11 1:00	14	2005.5.11 1:00	14,000	14	2005.10.14 1:00	98,000
			15	2005.7.24 1:00			15	2005.5.15 13:00	15	2005.5.15 1:00	15	2005.5.15 1:00	15,000			
			16	2005.7.31 1:00			16	2005.5.19 13:00	16	2005.5.19 1:00	16	2005.5.19 1:00	16,000			
			17	2005.8.7 1:00			17	2005.5.23 13:00	17	2005.5.23 1:00	17	2005.5.23 1:00	17,000			
			18	2005.8.14 1:00			18	2005.5.27 13:00	18	2005.5.27 1:00	18	2005.5.27 1:00	18,000			
			19	2005.8.21 1:00			19	2005.5.31 13:00	19	2005.5.31 1:00	19	2005.5.31 1:00	19,000			
			20	2005.8.28 1:00			20	2005.6.4 13:00	20	2005.6.4 1:00	20	2005.6.4 1:00	20,000			
			21	2005.9.4 1:00			21	2005.6.8 13:00	21	2005.6.8 1:00	21	2005.6.8 1:00	21,000			
				2005.9.11 1:00			22	2005.6.12 13:00	22	2005.6.12 1:00	22	2005.6.12 1:00	22,000			
							23	2005.6.16 13:00	23	2005.6.16 1:00	23	2005.6.16 1:00	23,000			
							24	2005.6.20 13:00	24	2005.6.20 1:00	24	2005.6.20 1:00	24,000			
							25	2005.6.24 13:00	25	2005.6.24 1:00	25	2005.6.24 1:00	25,000			
				14 days interval		GF/F NF one pair	26	2005.6.28 13:00	26	2005.6.28 1:00	26	2005.6.28 1:00	26,000			
							27	2005.7.2 13:00	27	2005.7.2 1:00	27	2005.7.2 1:00	27,000			
	*	540m1	*	150m			28	2005.7.6 13:00	28	2005.7.6 1:00	28	2005.7.6 1:00	28,000			
		1000m					29	2005.7.10 13:00	29	2005.7.10 1:00	29	2005.7.10 1:00	29,000			
		4810m					30	2005.7.14 13:00	30	2005.7.14 1:00	30	2005.7.14 1:00	30,000			
							31	2005.7.18 13:00	31	2005.7.18 1:00	31	2005.7.18 1:00	31,000			
							32	2005.7.22 13:00	32	2005.7.22 1:00	32	2005.7.22 1:00	32,000			
							33	2005.7.26 13:00	33	2005.7.26 1:00	33	2005.7.26 1:00	33,000			
							34	2005.7.30 13:00	34	2005.7.30 1:00	34	2005.7.30 1:00	34,000			
							35	2005.8.3 13:00	35	2005.8.3 1:00	35	2005.8.3 1:00	35,000			
							36	2005.8.7 13:00	36	2005.8.7 1:00	36	2005.8.7 1:00	36,000			
							37	2005.8.11 13:00	37	2005.8.11 1:00	37	2005.8.11 1:00	37,000			
							38	2005.8.15 13:00	38	2005.8.15 1:00	38	2005.8.15 1:00	38,000			
							39	2005.8.19 13:00	39	2005.8.19 1:00	39	2005.8.19 1:00	39,000			
							40	2005.8.23 13:00	40	2005.8.23 1:00	40	2005.8.23 1:00	40,000			
							41	2005.8.27 13:00	41	2005.8.27 1:00	41	2005.8.27 1:00	41,000			
							42	2005.8.31 13:00	42	2005.8.31 1:00	42	2005.8.31 1:00	42,000			
							43	2005.9.4 13:00	43	2005.9.4 1:00	43	2005.9.4 1:00	43,000			
							44	2005.9.8 13:00	44	2005.9.8 1:00	44	2005.9.8 1:00	44,000			
							45	2005.9.12 13:00	45	2005.9.12 1:00	45	2005.9.12 1:00	45,000			
							46	2005.9.16 13:00	46	2005.9.16 1:00	46	2005.9.16 1:00	46,000			
							47	2005.9.20 13:00	47	2005.9.20 1:00	47	2005.9.20 1:00	47,000			
NEXT CRUISE: 13 Sept. 2003 Lv. Sekinehama、20 Sept. Ar. station K2 (tentative)							48	2005.9.24 13:00	48	2005.9.24 1:00	48	2005.9.24 1:00	48,000			
		Solar noon time:	ca. 1:00 (UCT)				49	2005.9.28 13:00			49	2005.9.28 1:00	49,000			
		Mid night:	ca. 13:00 (UCT)				50	2005.10.2 13:00			50	2005.10.2 1:00	50,000			

3.2 Vertical distribution of suspended particle – in situ pumping -

Makio HONDA (JAMSTEC MIO)
Kazuhiro HAYASHI (JAMSTEC MIO)

(1) Objectives

For better understanding vertical and horizontal transportation of particulate materials in the ocean, distribution and chemical composition of suspended particulate materials (SPM) should be investigated as well as sinking particles.

(2) Sampling

SPM at 8 layers (from 10 m to 800 m) were collected by Large Volume Pump (McLane WTS-LVP) at stations K1, K2 and 35N. Seawater was filtrated with initial pumping speed of 4 ml/min. through GF/F filter (150 mm diameter) for 2 hours. Volumes of filtrated seawater were counted by flow meter attached at outlet. After recovery, each filter was rinsed 3 times with milli-Q water and GF/F filter with SPM were stored in acid clean zip lock bag and kept in freezer. Table 1 shows LVP record. Except 600 m at station K1, volumes of seawater filtrated were more than 270 L with maximum of 420 L.

(3) Analysis

In future, organic carbon, inorganic carbon and chemical components such as Si, Ca, Al and Fe for SPM will be measured by elemental analyzer and ICP-AES.

Table 1 Sampling depth and filtrated volume

Station	K1	
Date	7.Mar.05	(LST)
Time	09:00-11:00	(LST)

		Depth(m)		Filtration Volume(L)		Note
S/N	wire out	corrected depth	±	Flow meter	CPU record	
1	10	10		371.3	433.2	
2	50	48		368.3	399.0	
3	100	96		300.9	347.4	lower battery voltage
4	150	144.1	7.7	425.1	433.2	
5	200	194		392.1	433.2	
6	400	396		364.9	433.2	
7	600	597		13.6	15.4	water leak
8	800	798.5	8.0	423.9	433.2	

Station	K2	
Date	8.Mar.05	(LST)
Time	14:00-16:00	(LST)

		Depth(m)		Filtration Volume(L)		Note
S/N	wire out	corrected depth	±	Flow meter	CPU record	
1	10	10		373.6	433.2	
2	50	49		356.2	381.3	
3	100	99		275.2	313.7	lower battery voltage
4	150	148		398.6	402.4	
5	200	197		386.4	433.2	
6	400	393.9	1.0	365.6	433.2	
7	600	597		400.8	433.2	
8	800	800.1	1.2	419.4	433.2	

Station	35N	
Date	12.Mar.05	(LST)
Time	05:45-08:45	(LST)

		Depth(m)		Filtration Volume(L)		Note
S/N	wire out	corrected depth	±	Flow meter	CPU record	
1	10	10		330.1	433.2	
2	50	49		378.1	404.6	
3	100	99		400.5	433.2	
4	150	148		413.3	424.6	
5	200	198		388.0	433.2	
6	400	395.0	0.4	365.6	433.2	
7	600	597		390.2	433.2	
8	800	800.0	0.5	415.6	433.2	

3.3 Optical measurement

Makio HONDA (JAMSTEC MIO)
Hiroaki SAKOH (JAMSTEC MIO)
Fujio KOBAYASHI (MWJ)

(1) Objective

The objective of this measurement is to investigate the air and underwater light conditions at respective stations and to determine depths for simulated *in situ* measurement of primary production by using carbon stable isotope (C-13) during late autumn.

In addition, our group (JAMSTEC-MIO / WHOI-JPAC) have been conducting time-series observation with using mooring systems in the northwestern North Pacific (NWNP). On these mooring systems, optical sensor package called BLOOM are installed. The BLOOM measures spectral downwelling irradiance and upwelling radiance for four wavelengths (412 nm, 443 nm, 490 nm and 555 nm) and chlorophyll. Another objective of optical observation during this cruise was to know the optical characteristics and to contribute to the evaluation of observed values by BLOOM.

(2) Description of instruments deployed

The instrument consisted of the SeaWiFS Profiling Multichannel Radiometer (SPMR; and SeaWiFS Multichannel Surface Reference (SMSR). The SPMR was deployed in a free fall mode through the water column. The profiler has a 13 channel irradiance sensors (Ed), a 13 channel radiance sensors (Lu), tilt sensor, and fluorometer. The SMSR has a 13 channel irradiance sensors (Es) and tilt meter (Table 1). These instruments observed the vertical profiles of visible and ultra violet light and chlorophyll concentration.

Table 1. Center wavelength (nm) of the SPMR/SMSR

Es	379.5	399.6	412.2	442.8	456.1	490.9	519.0	554.3	564.5	619.5	665.6	683.0	705.9
Ed	380.0	399.7	412.4	442.9	455.2	489.4	519.8	554.9	565.1	619.3	665.5	682.8	705.2
Lu	380.3	399.8	412.4	442.8	455.8	489.6	519.3	554.5	564.6	619.2	665.6	682.6	704.5

Measurements were conducted 4 stations. Measurements should be ideally conducted at median time and at each station. However observations were conducted irregularly because of limited ship-time and other observation’s convenience (Table 2). The profiler was deployed twice at respective stations to a depth of 200 m. The reference (SMSR) was mounted on the anti-rolling system’s deck and was never shadowed by any ship structure. The profiler descended at an average rate of 1.0 m/s with tilts of less than 3 degrees except near surface.

Observed data was analyzed by using software “Satlantic PPROSOFT 6” and extinction rate and photosynthetically available radiation (PAR) were computed.

Table 2 locations of optical observation and principle characteristics

(Date and Time in LST: UTC+11hr.)

For	K2	K1	K2	K3	35N
Free Fall Position	44-41.61N 155-40.73E	50-28.06N 164-16.51E	47-16.76N 160-17.95E	42-29.51N 159-59.32E	35-00.09N 160-00.34E
Observation Date	Mar. 2 2004	Mar. 6 2004	Mar. 8 2004	Mar. 9 2004	Mar. 11 2004
Observation Time	11:21	11:24	11:22	12:55	13:08
Irradiance in air (PAR in air) (E/sec/m^2)	927±434 1238±368	219±28 823±87	418±8 525±20	885±300 1189±158	1482±78 1524±75
1% depth (m)	45	61	67	70	47.5

(3) Preliminary results

1) PAR in air.

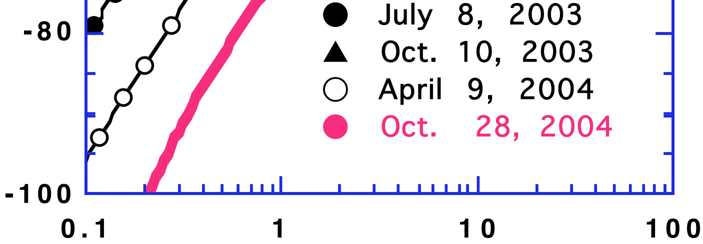
Table 2 shows PAR in air. Maximum PAR in air was observed at station 35N and minimum was observed at station K1. Intensity of PAR depends on the weather condition during observation.

2) Comparison of PAR observed by SPMR with solar radiation observed by meteorological instrument

During observation of light intensity in the water column, PAR in the air is simultaneously observed by SPMR. On the other hand, a radiometer (MS-80, Eiko Seiki, Japan) installed on a radar mast (28m) of R/V Mirai observes short wave solar radiation every one minute. During this cruise, both data was compared. Fig. 1 shows PAR against solar radiation. As a result, PAR correlates well with solar radiation observed by radiometer. Although solar radiation data is supplied with unit of "W m^{-2}", it is possible to convert this unit to "μE m^{-2} sec^{-1}" using this empirical equation. This relation can be used for estimation of daily PAR using solar radiation data.

3) Vertical profile of relative intensity in the water column

Fig. 2 shows relative intensity of PAR to surface PAR at respective stations. Relative intensity decreases with depth exponentially. Depth with 1 % intensity, which depth is known as the depth of bottom of euphotic zone was approximately 65 m at station K1 and K3. This depth at station K2 ranged from approximately 45 m and 70 m between two observations. At station 35N, depth of 1 % intensity was approximately 50 m and shallower than other stations. This is supported by the fact that surface chlorophyll-a is higher at stations 35N than other stations.



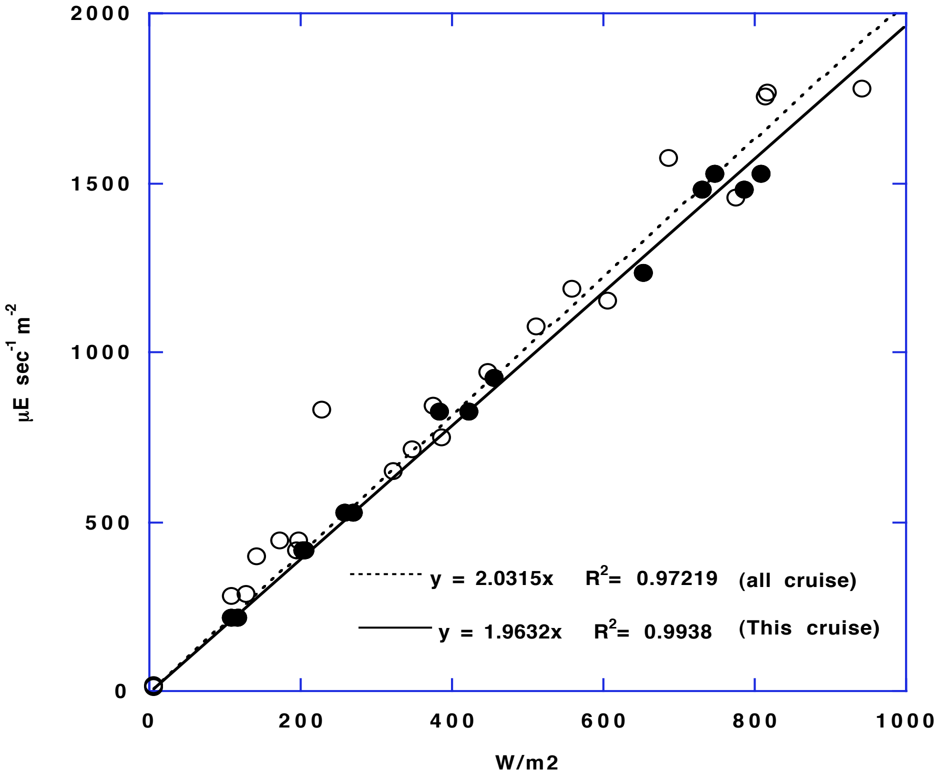


Fig.1 Solar radiation against PAR

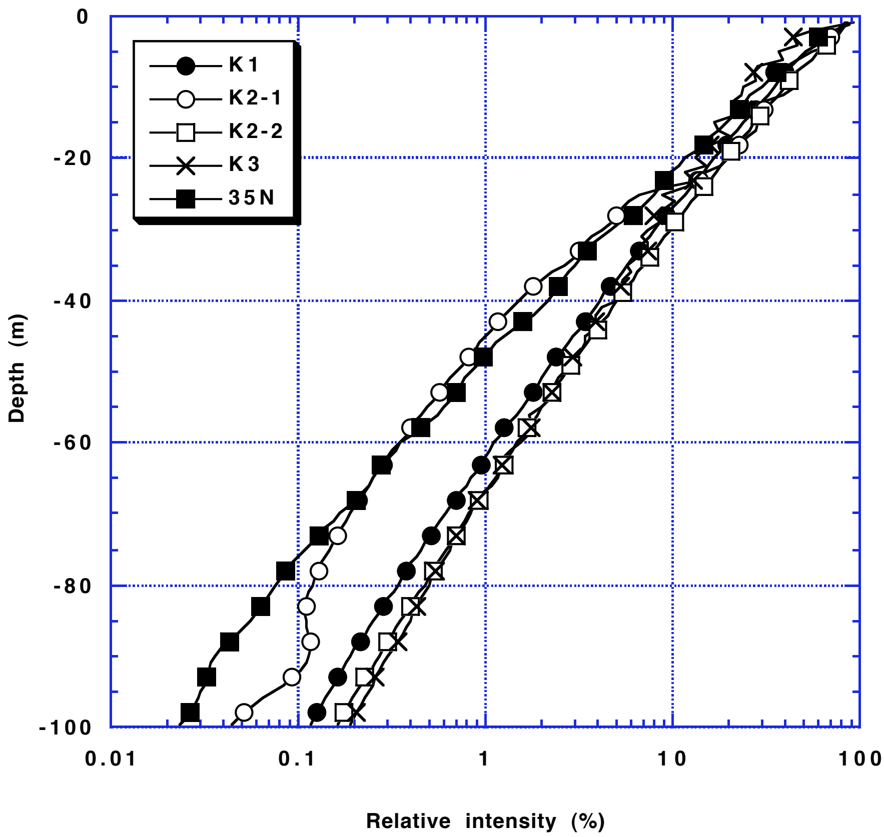


Fig.2 Vertical change in relative light intensity

3.4 Primary productivity

Makio HONDA (JAMSTEC MIO)
Hiroaki SAKOH (JAMSTEC MIO)
Ai YASUDA (Marine Works Japan LTD)
SHIOZAKI (Marine Works Japan LTD)

(1) Simulated in-situ incubation

1) Bottles for incubation and filters

Bottles for incubation are ca. 1 liter Nalgen polycarbonate bottles with screw caps. Grass fiber filters (Wattman GF/F 25mm) pre-combusted with temperature of 450° C for at least 2 hours were used for a filtration of phytoplankton after incubation.

2) Simulated in-situ incubation

Water samples were collected at 8 layers between the surface and seven pre-determined depths by a bucket or Niskin bottle at Station K1, K2 and 35N. These depths corresponded to nominal specific optical depths *i.e.* 50%, 25%, 10%, 5%, 2.5%, 1% and 0.5% light intensity relative to the surface irradiance, PAR, as determined from the optical profiles.

All samples were spiked with 0.2 μmoles/mL of $NaH^{13}CO_3$ solution. After spike, bottles were placed into incubators corresponding to nominal light levels at the respective depths. Two samples of each layer were incubated in a bath on the deck for 24 hours. In addition, one sample from surface and at depth with 10 % light intensity at station K1 was incubated in a bath on the deck for 12 hours in order to consider net primary productivity and gross primary productivity.

At the end of the incubation period, samples were filtrated through grass fiber filters (Wattman GF/F 25mm). GF/F filters were kept in a freezer till on board.

Table 1 shows log sheets for respective incubation.

(2) Irradiance and water temperature during incubation

Fig.1 shows diurnal change of light irradiance during daytime observed by solar radiation measurement system (SMET), and SST or temperature of incubators observed by EPSM system during incubation. As respective incubations started at respective stations and, however, finished on the way to the next station, solar irradiance, incubation temperature and primary production did not always represent these at respective stations. Dairy solar irradiances at respective incubations were approximately 20 E m^{-2} day^{-1}. Water temperature for incubations at stations K2 and K1 were less than 1°C and stable while that was higher than 10°C with large variability at station 35N.

(3) Measurement

^{13}C of samples were measured by using a mass spectrometer ANCA-SL system on board.

Before analysis, inorganic carbon of samples was removed by an acid treatment in a HCl vapor bath for 4 - 5 h. Table 3 shows total particulate organic carbon (POC) and concentrations of ^{13}C of POC for respective samples.

Based on the balance of ^{13}C, assimilated organic carbon (ΔPOC) is expressed as follows (Hama *et al.*, 1983):

$$^{13}C_{(POC)} * POC = {}^{13}C_{(sw)} * \Delta POC + (POC - \Delta POC) * {}^{13}C_{(0)}$$

This equation is converted to the following equation;

$$\Delta POC = POC * ({}^{13}C_{(POC)} - {}^{13}C_{(0)}) / ({}^{13}C_{(sw)} - {}^{13}C_{(0)})$$

where $^{13}C_{(POC)}$ is concentration of ^{13}C of particulate organic carbon after incubation, *i.e.*, measured value (%). $^{13}C_{(0)}$ is that of particulate organic carbon before incubation, *i.e.*, that for sample as a blank (1.084).
$^{13}C_{(sw)}$ is concentration of ^{13}C of ambient seawater with a tracer. This value for this study was determined based on the following calculation;

$$^{13}C_{(sw)} (\%) = [(TDIC * 0.011) + 0.0002] / (TDIC + 0.0002) * 100$$

where TDIC is average concentration of total dissolved inorganic carbon upper 75 m (mol l^{-1}) and 0.011 is concentration of ^{13}C of natural seawater (1.1 %). 0.0002 is added ^{13}C (mol) as a tracer.

	TDIC (mol/l)	$^{13}C_{(sw)}$ (%)
K1	0.002195	9.358
K2	0.002169	9.450
35N	0.002083	9.765

Taking into account for the discrimination factor between ^{13}C and ^{12}C (1.025), primary productivity (PP) was, finally, estimated by

$$PP = 1.025 * \Delta POC$$

Table 3 also shows estimated primary productivity. The precision (repeatability: standard deviation / average) ranged from 2 % to 22 % with average of 9 %.

(5) Preliminary results

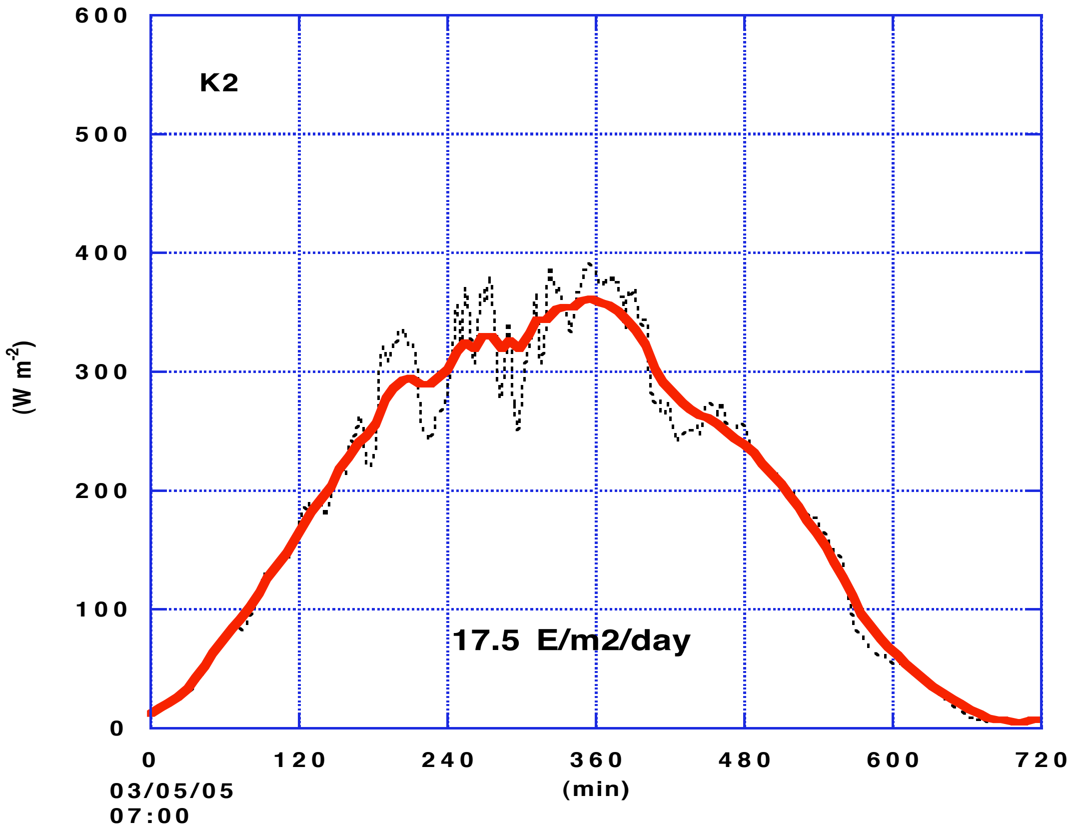
1) Vertical profile of PP

Fig. 2 shows vertical profiles of PP for respective stations. PP at surface layer was the highest and decreased with depth at all stations. Trapezoidal integrated primary productivity in the euphotic layer was also estimated (Table 2). Integrated primary productivity was estimated to be approximately 160 and 230 mg m^{-2} day^{-1} at stations K2 and K1, respectively. On the other hand, integrated primary productivity at station 35N was approximately 730 mg m^{-2} day^{-1}. This high PP might be supported by high chl-a concentration.

It is noted that incubation was carried out with surface temperature even for water sample below surface although mixing layer during this cruise was approximately 100 m and water temperature was assumed to be constant in the layer. More precise experiment is requested in future.

2) Gross PP and Net PP

Table 2 (b) shows PP for 12 hrs. incubation. It can be assumed that PP for 12 hrs. incubation is gross primary productivity (GPP) without nighttime respiration while PP for 24 hrs. incubation is net primary productivity (NPP). The ratio of NPP to GPP at surface and 10 % intensity depth were 1.46 +/- 0.38 and 0.83 +/- 0.00, respectively. Although data are limited, the ratio of NPP to GPP tended to increase with depth.



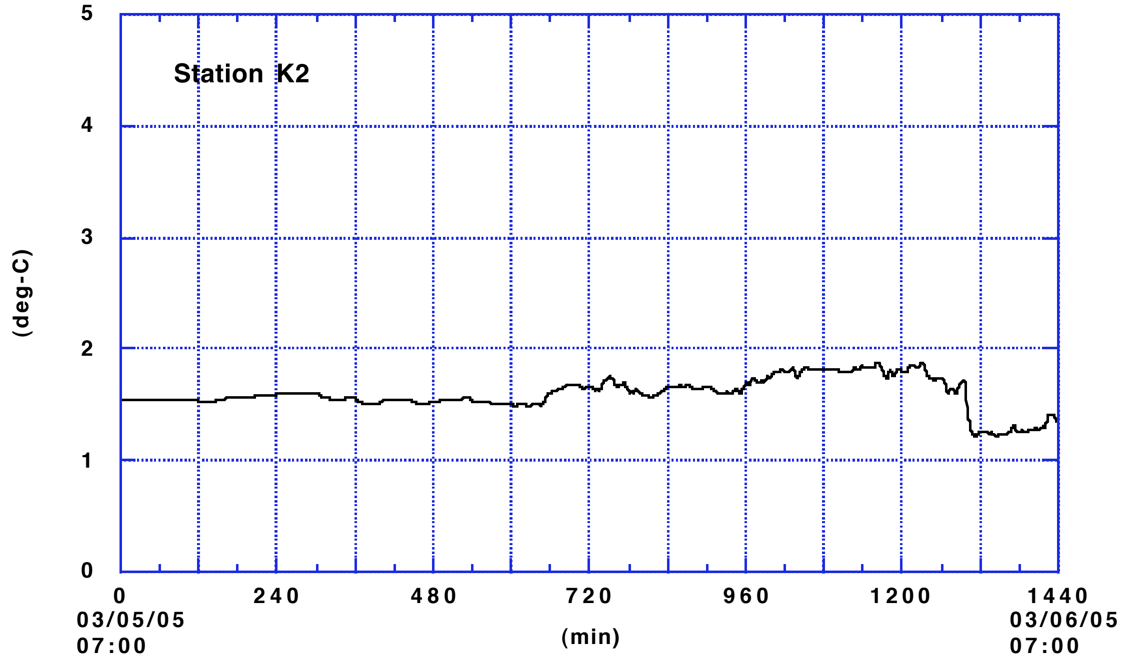


Fig. 1 (a) Solar irradiance and water temperature during incubation at station K2

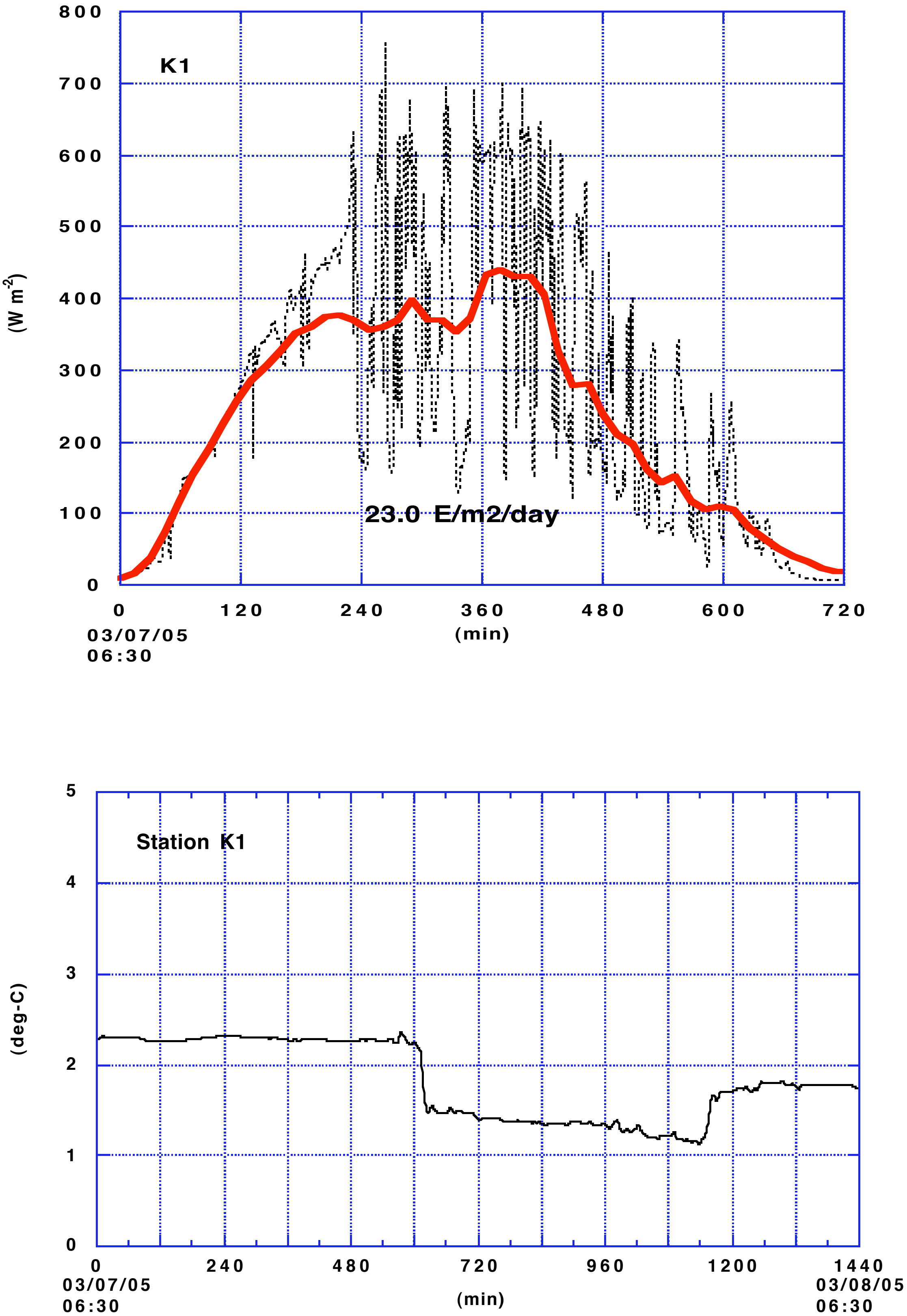
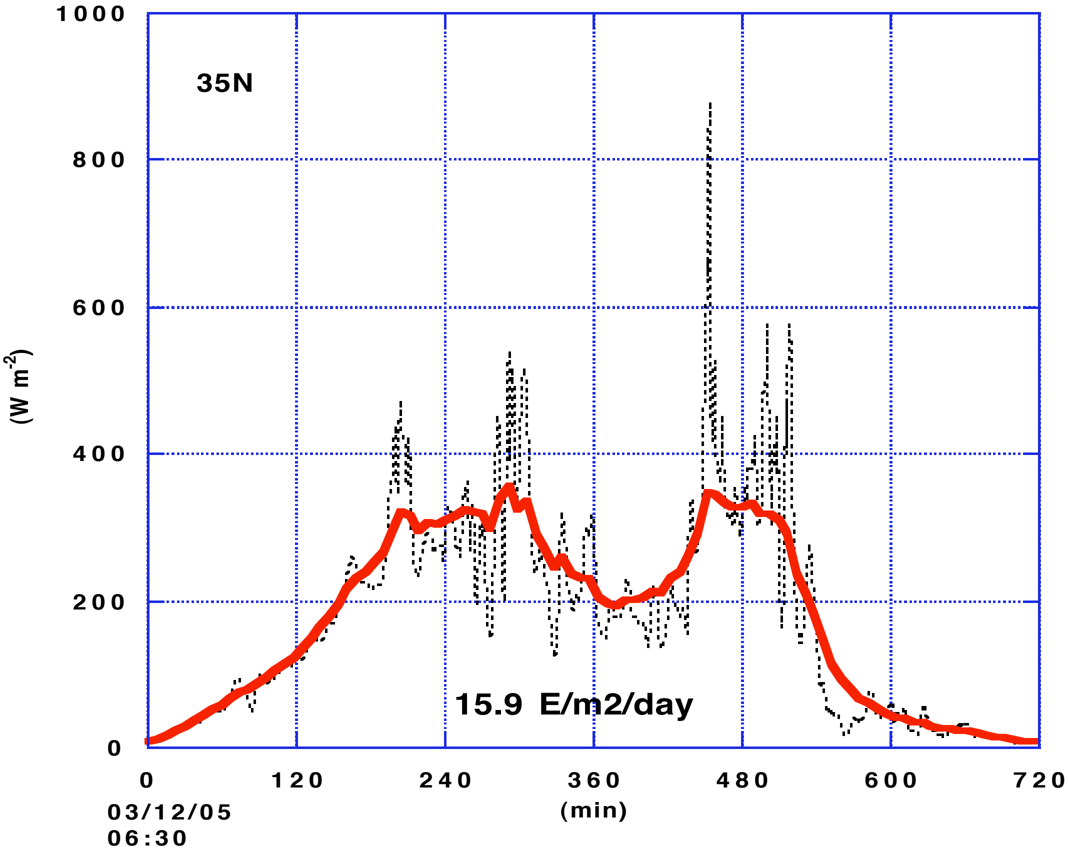


Fig. 1 (b) Solar irradiance and water temperature during incubation at station K1



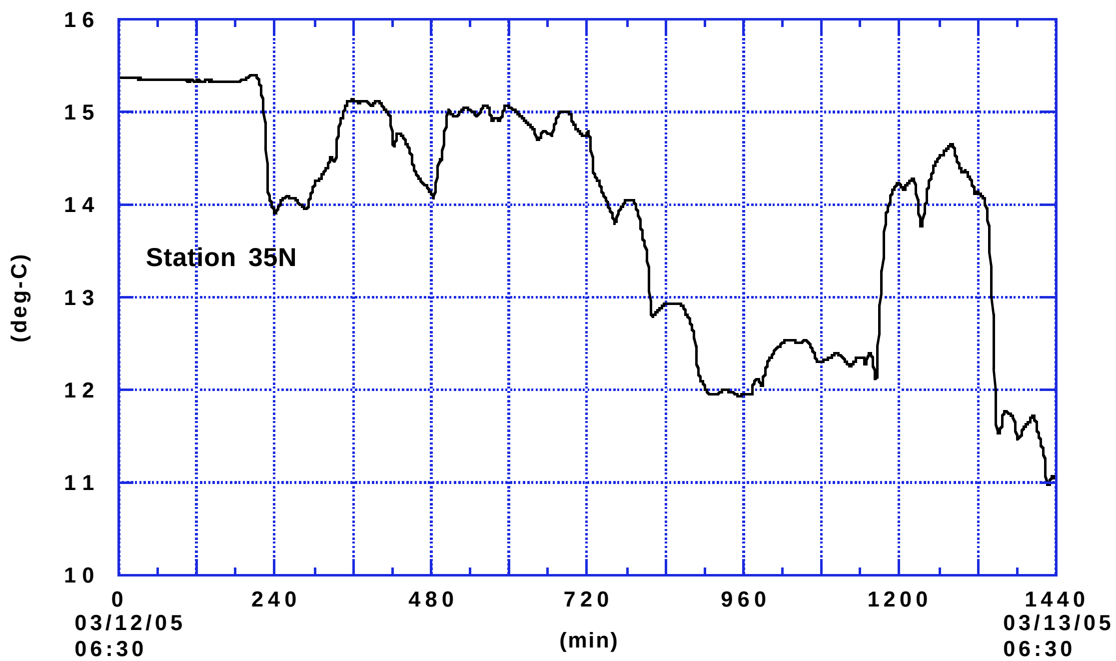


Fig. 1 (c) Solar irradiance and water temperature during incubation at station 35N

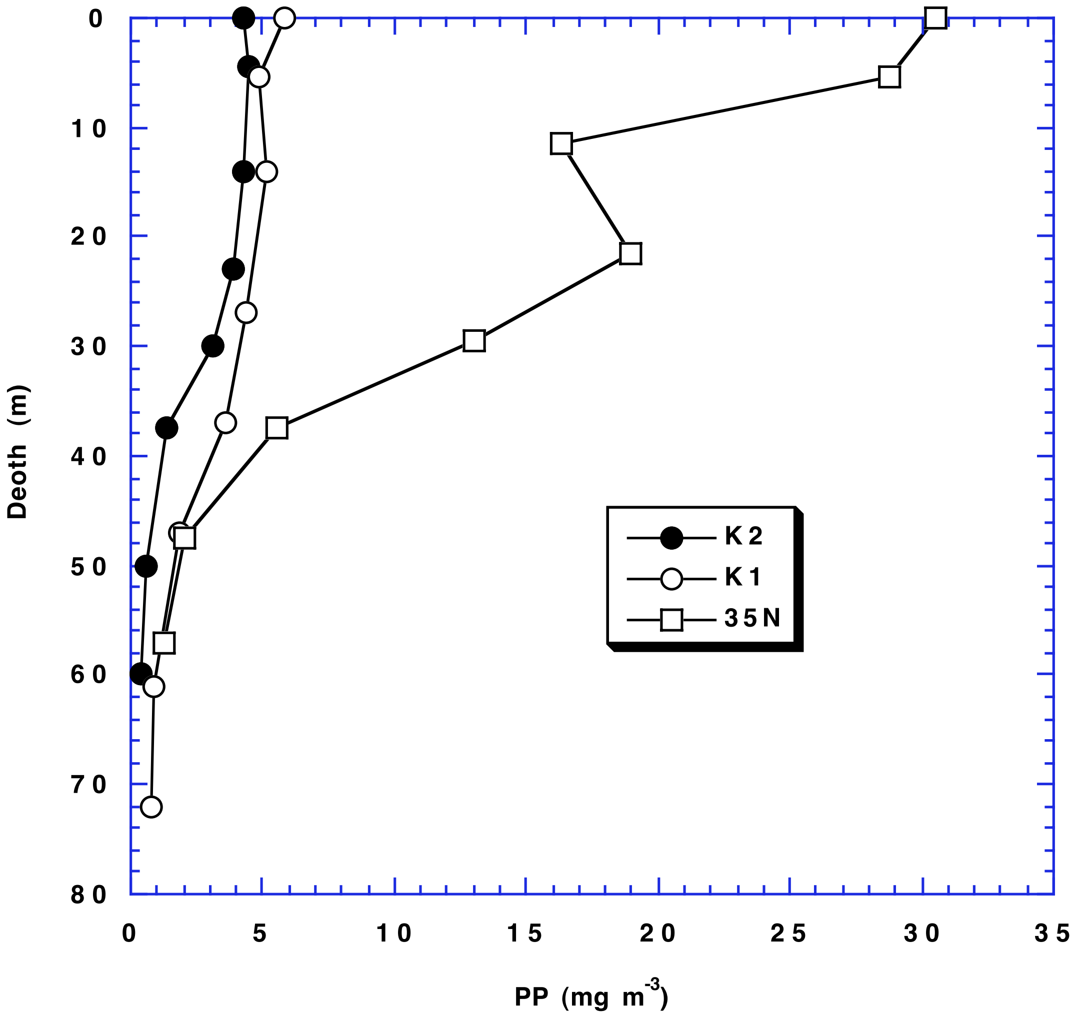


Fig. 2 Vertical profile of primary productivity at respective stations

Table 1 (a) Log sheets for primary productivity at station K2

Log sheets for Primary Productivity
(simulated in situ incubation)

No. 1

Cruise :	MR05-01	Sampling Date & Time（UTC） : 2005/3/4 18:27～18:57	Sampling location 46-57.87N, 160-09.08E
Station :	St.02	Incubation Date & Time A (LST) : 2005/3/5 6:55～7:00 → 2005/3/6 6:55～7:00	
Cast No. :	K02m08 (CTDfilename)	Incubation Date & Time B (LST) :	

Relative light Intensity	Niskin No.	Sapling layer （m）	Incubation Type （LST）	Bottle No.	13C add (mL)	Filtration Time	Note
100%	bucket	0m	A	100%-A	1.0	7:00～8:30	
				100%-B	1.0		
				100%blank	-		
50%	31	4.5m	A	50%-A	1.0		
				50%-B	1.0		
25%	30	14m	A	25%-A	1.0		
				25%-B	1.0		
10%	29	23m	A	10%-A	1.0		Filter up side down
				10%-B	1.0		
5%	28	30m	A	5%-A	1.0		
				5%-B	1.0		
2.5%	27	37.5m	A	2.5%-A	1.0		
				2.5%-B	1.0		
1%	26	50m	A	1%-A	1.0		
				1%-B	1.0		
0.5%	25	60m	A	0.5%-A	1.0		
				0.5%-B	1.0		

MEMO
Water sampling by Honda, Sakoh, Shiozaki, Yasuda
Pore size of GF/F Filter at tube outlet: 200 μ
13C add by Yasuda
・UTC+11h = LST
・SST = 1.4℃
・6:00 onDeck, 6:30 13C add completed
・At least five GF/F Filters used up side down

Table 1 (b) Log sheets for primary productivity at station K1

Log sheets for Primary Productivity
(simulated in situ incubation)

No. 2

Cruise :	MR05-01	Sampling Date & Time (UTC) : 2005/3/6 17:54～18:25	Sampling location 51-00.03N, 164-59.74E
Station :	St.K1	Incubation Date & Time A (LST) : 2005/3/7 6:25～6:30 → 2005/3/8 6:30～6:35	
Cast No. :	K01m04(CTDfilename)	Incubation Date & Time B (LST) : 2005/3/7 6:25～6:30 → 2005/3/7 18:30～18:35	

Relative light Intensity	Niskin No.	Sapling layer (m)	Incubation Type (LST)	Bottle No.	13C add (mL)	Filtration Time	Note
100%	bucket	0m	A	100%-A	1.0	6:30～7:30	
				100%-B	1.0		
				100%blank	-		filter up side down
50%	33	5.5m	A	50%-A	1.0		
				50%-B	1.0		
25%	30	14m	A	25%-A	1.0		
				25%-B	1.0		
10%	29	27m	A	10%-A	1.0		
				10%-B	1.0		
5%	28	37m	A	5%-A	1.0		
				5%-B	1.0		
2.5%	27	47m	A	2.5%-A	1.0		Dirty filter
				2.5%-B	1.0		filter up side down
1%	26	61m	A	1%-A	1.0		
				1%-B	1.0		
0.5%	25	72m	A	0.5%-A	1.0		
				0.5%-B	1.0		
10%	29	27m	B	10%12h	1.0	18:35～19:00	filter up side down
100%	バケツ	0m	B	100%12h	1.0		

MEMO
Water sampling by Honda, Shiozaki, Yasuda, Noguchi
Pore size of GF/F Filter at tube outlet: 200 μ
13C add by Yasuda

Table 1 (c) Log sheets for primary productivity at station 35N

Log sheets for Primary Productivity
(simulated in situ incubation)

No. 3

Cruise :	MR05-01	Sampling Date & Time (UTC) : 2005/3/11 17:51～18:14	Sampling location 35-59.99N, 160-00.00E
Station :	St.35N	Incubation Date & Time A (LST) : 2005/3/12 6:30 →2005/3/13 6:30	
Cast No. :	35Nm03(CTDfilename)	Incubation Date & Time B (LST) :	

Relative light Intensity	Niskin No.	Sapling layer (m)	Incubation Type (LST)	Bottle No.	13C add (mL)	Filtration Time	Note
100%	bucket	0m	A	100%-A	1.0		
				100%-B	1.0		
				100%blank	-		
50%	31	5.5m	A	50%-A	1.0		
				50%-B	1.0		
25%	30	11.5m	A	25%-A	1.0		
				25%-B	1.0		
10%	29	21.5m	A	10%-A	1.0		
				10%-B	1.0		
5%	28	29.5	A	5%-A	1.0		
				5%-B	1.0		
2.5%	27	37.5m	A	2.5%-A	1.0		
				2.5%-B	1.0		
1%	26	47.5m	A	1%-A	1.0		
				1%-B	1.0		
0.5%	25	57m	A	0.5%-A	1.0		
				0.5%-B	1.0		

MEMO
Water sampling by Sakoh, Yasuda, Shiozaki, Noguchi
Pore size of GF/F Filter at tube outlet: 200 μ
13C add by Yasuda

Table 2 (a) Primary productivity at station K2

MR05-01 St.K2 SIS Data

light Intensity (%)	Bottle No.	Niskin No.	Depth(m)	POC (μg)	13C (%atom)	d-POC (μg / l /day)	average	+/-	PP (mg m^{-2} day^{-1})	d-POC/t	Incubation Time (h)	chl.a (μg/L)	PB (mgC/mgchl.a/h)
0.5	0.5%A	25	60	71.18	1.1333	0.4301	0.429	0.001	5.306	0.0179	24	0.40	0.04429
	0.5%B			78.91	1.1282	0.4274				0.0178		0.40	0.04401
1	1%A	26	50	71.88	1.1532	0.6093	0.632	0.023	12.684	0.0254		0.39	0.06470
	1%B			62.05	1.1702	0.6556				0.0273		0.39	0.06962
2.5	2.5%A	27	37.5	74.99	1.2361	1.3977	1.397	0.001	17.041	0.0582		0.41	0.14367
	2.5%B			77.22	1.2316	1.3964				0.0582		0.41	0.14354
5	5%A	28	30	114.16	1.3013	3.0394	3.147	0.108	24.734	0.1266		0.39	0.32275
	5%B			141.21	1.2721	3.2550				0.1356		0.39	0.34565
10	10%A	29	23	134.25	1.3227	3.9256	3.920	0.006	37.045	0.1636		0.40	0.40425
	10%B			135.04	1.3205	3.9136				0.1631		0.40	0.40302
25	25%A	30	14	75.87	1.5712	4.5290	4.313	0.216	41.879	0.1887		0.41	0.46555
	25%B			130.58	1.3400	4.0964				0.1707		0.41	0.42109
50	50%A	31	4.5	136.68	1.3538	4.5174	4.504	0.014	19.782	0.1882		0.39	0.47970
	50%B			120.96	1.3870	4.4903				0.1871		0.39	0.47683
100	100%A	buket	0	150.23	1.3119	4.1947	4.288	0.093		0.1748		0.39	0.44544
	100%B			101.87	1.4351	4.3817				0.1826		0.39	0.46530
	100% BLANK			102.30	1.0835	-0.0067				-0.0003		0.39	-0.00071
							Integrated PP		158.471				

Table 2 (b) Primary productivity at station K1

MR05-01 St.K1 SIS Data

Light Intensity (%)	Bottle No.	Niskin No.	Depth(m)	POC (μg)	13C (%atom)	d-POC	average	+/-	PP (mg m-2 day-1)	d-POC/t	Incubation Time (h)	chl.a (μg/L)	PB (mgC/mgchl.a/h)
0.5	0.5%A	25	72	48.57	1.2051	0.7286	0.760	0.031	9.130	0.0304	24	0.48	0.0627
	0.5%B			52.57	1.2055	0.7913				0.0330		0.48	0.0682
1	1%A	26	61	55.19	1.2105	0.8650	0.900	0.035	19.330	0.0360		0.49	0.0736
	1%B			54.95	1.2214	0.9350				0.0390		0.49	0.0795
2.5	2.5%A	27	47	53.18	1.3707	1.8886	1.861	0.027	27.527	0.0787		0.51	0.1548
	2.5%B			64.69	1.3129	1.8340				0.0764		0.51	0.1504
5	5%A	28	37	55.85	1.6008	3.5759	3.644	0.068	40.184	0.1490		0.48	0.3135
	5%B			54.85	1.6303	3.7123				0.1547		0.48	0.3254
10	10%A	29	27	68.59	1.6008	4.3912	4.393	0.001	61.925	0.1830		0.51	0.3564
	10%B			53.30	1.7494	4.3940				0.1831		0.51	0.3566
25	25%A	30	14	56.76	1.8182	5.1626	5.134	0.028	42.456	0.2151		0.47	0.4561
	25%B			53.14	1.8596	5.1061				0.2128		0.47	0.4511
50	50%A	33	5.5	53.98	1.8499	5.1220	4.855	0.267	29.528	0.2134		0.54	0.3920
	50%B			48.18	1.8528	4.5888				0.1912		0.54	0.3512
100	100%A	buket	0	61.66	1.6547	4.3595	5.882	1.522		0.1816		0.52	0.3462
	100%B			49.89	2.2821	7.4043				0.3085		0.52	0.5879
	100% BLANK			56.51	1.0799	-0.0290				-0.0012		0.52	-0.0023
10	10%12h	29	27	53.33	1.8813	5.2678				0.4390	12	0.51	0.8551
100	100%12h	buket	0	58.19	1.6411	4.0158				0.3346	12	0.52	0.6377
							Integrated PP		230.080				

Table 2 (c) Primary productivity at station 35N

MR05-01 St.35N SIS Data

Light Intensity (%)	Bottle No.	Niskin No.	Depth(m)	POC (μg)	13C (%atom)	d-POC	average	+/-	PP (mg m^{-2} day^{-1})	d-POC/t	Incubation Time (h)	chl.a (μg/L)	PB (mgC/mgchl.a/h)
0.5	0.5%A	25	57	70.48	1.2381	1.2822	1.242	0.040	15.736	0.0534	24	1.43	0.0375
	0.5%B			80.37	1.2107	1.2027				0.0501		1.43	0.0351
1	1%A	26	47.5	67.25	1.3606	2.1960	2.070	0.126	37.919	0.0915		1.42	0.0644
	1%B			71.94	1.3130	1.9449				0.0810		1.42	0.0570
2.5	2.5%A	27	37.5	74.80	1.6477	4.9788	5.513	0.535	74.292	0.2075		1.35	0.1541
	2.5%B			84.67	1.6890	6.0480				0.2520		1.35	0.1872
5	5%A	28	29.5	97.95	2.2615	13.6174	13.060	0.558	128.072	0.5674		1.49	0.3807
	5%B			88.91	2.2749	12.5017				0.5209		1.49	0.3495
10	10%A	29	21.5	93.25	2.8971	19.9631	18.958	1.005	176.467	0.8318		1.42	0.5869
	10%B			90.41	2.7658	17.9538				0.7481		1.42	0.5278
25	25%A	30	11.5	86.67	2.6583	16.1096	16.335	0.225	135.474	0.6712		1.44	0.4651
	25%B			98.92	2.5019	16.5601				0.6900		1.44	0.4781
50	50%A	31	5.5	103.59	3.4363	28.7717	28.823	0.052	163.207	1.1988		1.46	0.8212
	50%B			111.91	3.2691	28.8747				1.2031		1.46	0.8242
100	100%A	buket	0	143.23	3.0687	33.5639	30.525	3.039		1.3985		1.61	0.8679
	100%B			123.49	2.9690	27.4859				1.1452		1.61	0.7107
	100% BLANK			156.64	1.0838	-0.0042				-0.0002		1.61	-0.0001
							Integrated PP		731.167				

3.5 Trace elements

M. Lutfi Firdaus (Institute for Chemical Research, Kyoto University)

(1) Objective

Trace elements distributions in seawater are controlled by a complex interaction between their source strengths, their removal strengths and water circulation patterns. One of the objective of our study is to determine vertical profiles and seasonal variations of trace element in the seawater. On the present cruise, we collected two kind of samples, the first is for studying the distribution and speciation of trace bioelements (Fe, Co, Ni, Cu, Zn, Cd, Pb) and the second sample is for studying the distribution and speciation of Zr, Nb, Hf, Ta, and W which are of great interest in geochemistry.

(2) Measurement Parameter

1. Dissolved trace elements (passed through a 0.2 μm pore size Nuclepore filter)
2. Acid dissolvable trace elements (without filtration)
3. Particulate trace elements (retained on a 0.2 μm pore size Nuclepore filter)

(3) Instrumentation and Method

The seawater samples were collected by Niskin-X sampler mounted on a CTD carousel system. Seawater samples for dissolved, acid dissolvable and particulate trace elements were transferred from the sampler to a precleaned low-density polyethylene bottle. To avoid contamination by airborne particles, we used a silicon tube and plastic bell, wearing plastic gloves. Immediately after sampling, seawater samples were filtered through an acid-cleaned Nuclepore filter (0.2 μm pore size) using a closed filtration system in the clean room laboratory. The filtered and unfiltered seawater samples were acidified with hydrochloric acid for trace bioelement and with hydrochloric acid - hydrofluoric acid for Zr, Nb, Hf, Ta and W to about pH 2 and stored. The samples were then brought back to our laboratory for further analysis.

(4) Results

About 400 samples were collected during this cruise. The sampling station were K1, K2, 35N, and KNOT.

(5) Data archive

Raw data of trace elements will be submitted to DMO (Data Management Office), JAMSTEC and will be under its control.

3.6 A study of atmospheric microbiology, the influence of desert dust on surface water microbial ecology, and the vertical distribution of bacteria and viruses in the North Pacific.

Dale W. GRIFFIN (U.S. Geological Survey, Center for Coastal and Wetland Studies)

Project Summary

The primary goal of this project is to investigate issues in atmospheric and surface water microbial ecology (to include magnetotactic and magnetite reducing bacteria) associated with Asian desert dust as it moves through Earth's atmosphere. These data will provide a foundation of knowledge, which will aid future investigations in understanding the impact of desert dust on downwind ecosystems.

Overview

Estimates on the quantity of terrestrial soils that move some distance in Earth's atmosphere each year range from 1 to 2 billion tons [*Moulin et al*., 1997; *Perkins*, 2001; *Pewe*, 1981]. The majority of this soil is lifted into the atmosphere by storm activity, and large dust-events are commonly referred to as dust storms. Significant sources of airborne dust are the Gobi and Takla Makan deserts of Asia. It has been estimated that 800 Tg of dust is emitted from China each year and that 50% is transported vast distances over the Pacific [*Zhang et al*., 1997]. The Asian dust season usually runs from February through April of each year when the southeast coast of Asia is an active frontal zone for low pressure cell development which enhances rapid transport of aerosols across the Pacific [*Hammond et al*., 1989]. Analysis of data obtained during a 5 day Asian dust event that impacted Alaska in 1976 concluded that a similar event originating in Asian deserts could carry as much as 4,000 tons of dust into the Arctic per hour (Rahn et al. 1977). Dust clouds originating in these deserts are capable of global dispersion and reports of their impact on air quality in Asia, the Arctic, Americas, Europe, and the Caribbean are not uncommon (Figure 1) [*Chen et al*., 2003; *Grousset et al*., 2003; *Husar et al*., 2001; *Jaffe et al*., 2003; *Kwon et al*., 2000; *Park et al*., 2003; *VanCuren and Cahill*, 2002; *Yeo and Kim*, 2002].

Microbial ecology studies have shown that a single gram of desert soil may contain as many as a billion bacteria cells [*Whitman et al*., 1998] and African dust studies have shown that a significant number of microorganisms are capable of long range atmospheric transport [*Griffin et al*., 2002; *Griffin et al*., 2001b]. Interestingly, approximately 30% of the organisms identified in African dust clouds are species known to be capable of causing disease in a wide range of organisms (plants, trees, sea fans, humans) [*Griffin et al*., 2003; *Griffin et al*., 2001b; *Kellogg et al*., 2004]. In addition, desert dust contains nutrients such as iron which marine organisms can utilize for growth and reproduction [*Betzer et al*., 1988; *Bonnet and Guieu*, 2004; *Lenes et al*., 2001; *Young et al*., 1991].

Objectives

The primary objective of this proposal was to evaluate the biological constituents (atmospheric transport of microorganisms) of Asian desert dust impacting JAMSTEC, MR05-

K08, mission sites in the northwest Pacific, February 28th through March 24th, 2005. In addition, surface water direct counts of bacteria and viruses were taken daily to evaluate the influence of Asian dust on population flux. Vertical profiles of bacteria and viruses using direct count assay were also completed at select sites in order to compliment shipboard research. Aliquots of water samples were also collected for later screening for select bacteria (magnetotactic and magnetite reducing).

Measured Parameters

1. Utilize established culture assay to identify microorganisms (pathogenic and non-pathogenic bacteria, and fungi) in atmospheric samples as published with ship board modification.
2. Use microbial direct count assay (enumeration of total bacterial and viral populations) to analyze marine surface waters and two vertical water column profiles (24 sample cast, 10 meters below sea surface to ~ 30 meters above sea floor).
3. Determine if magnetotactic bacteria and bacteria which can reduce magnetite are present in marine waters impacted by dust clouds.

Methods – Apparatus and performance

Air sample equipment setup.

An air intake line (18 mm inside diameter rubber hose) was run from the atmospheric research lab (located starboard on the 'Navigation Deck' directly behind the radio office) through a wiring portal, to an atmospheric instrument tower located atop the front starboard side of the 'Compass Deck' (Figure 2). The intake of the hose was located at a height of approximately 2 meters with a slight downward position (to limit sea-spray/snow uptake which could clog the line via freezing and/or contaminate the filters) facing bow-starboard. The laboratory end of the hose was fitted through the center of a filter funnel lid using glue and parafilm to create a seal. The line was secured in the laboratory with string above the filtration manifold and pump for stability and to allow easy connection to the filter funnels (Figure 3).

Tracking desert dust cloud formation, movement and atmospheric concentration.

Upon return to the U.S. Geological Survey laboratory in St. Petersburg, Florida, NASA's 'SeaWiFS' and 'Earth Probe – TOMS' satellites will be utilized to evaluate Asian dust activity and movement to the mission site. Both of these satellite systems have been used to track dust transport around the globe and provide researchers with daily access to global view images. The Naval Aerosol Analysis and Prediction System Global Aerosol Model (surface concentration, 12:00Z, $\mu g/m^3$, www.nrlmry.navy.mil/aerosol/) will also be employed to obtain model-based near-sea-surface atmospheric dust concentrations ($\mu g/m^3$) for each respective daily position (average lat./long.) of the *R/V Mirai* [*Hogan and Brody*, 1991b; *Hogan and Rosmond*, 1991a].

Experimental procedures

Particle counts

Atmospheric particle counts were taken using a Model 229, HACH Ultra Analytics (Grants Pass, OR) MET ONE Laser Particle Counter. Atmospheric counts were taken by placing a filter-less (Nitrocellulose and support filter removed) funnel housing on the manifold so that when the intake line lid was attached, air could freely flow through the housing and out the exhaust line of the pump. A small plastic bag was placed over the exhaust line and the measurement was made by placing the particle counter intake in the bag while the vacuum pump was running. Additionally, a reading of the particle count in the atmospheric laboratory was taken as a comparison. The particle counter measures particles larger than 0.5 μm for one minute and reports the total number particles in 0.1 ft^3. This value was converted and reported as total particles in 1.0 m^3/minute.

Culture and molecular assay for microbial isolation and identification.
Presterilized filter housings containing 47mm diameter analytical test filters with a pore size of 0.20um were obtained from Fisher Scientific (catalog # 09-74030G. Atlanta, GA). To take an air sample, the filter was removed from its sterile bag, placed on the filter manifold, lid removed, intake line/lid attached (and sealed to the filter housing with parafilm) and vacuum applied using a vacuum pump. Airflow rate through each filter was 17.4 liters/minute. Filtration times were ~ 1 hour, ~9 hours and ~12 hours (3 samples per day, ~24 hour coverage). To control for handling contamination, an additional filter was removed from its bag, the filter placed on the manifold and allowed to sit without removing the lid (one negative control every other day). The filter was then removed from the manifold, covered with its original lid, replaced in its respective bag and transported to the laboratory. All analysis was conducted using sterile technique. R2A agar (Fisher Scientific, Atlanta, GA), was utilized for microbial analysis. Each filter was placed on R2A agar sample side up. Filters were incubated in the dark at room temperature (23.5^{o}C) and monitored for growth over a 1 week period. Fungi and bacterial colonies were isolated from each other by isolation streaking on fresh plates of R2A. Once isolated, colonies were grown overnight in 0.5ml of tryptic soy broth. The following day 200ul of sterile glycerol was added to the culture. These pure cultures were then stored at –70^{o}C for cataloging and shorebased identification using genetic sequencing.

Upon returning to the U.S. Geological Survey laboratory in St. Petersbur, Florida, the polymerase chain reaction (PCR) will be utilized for 16S and 18S rDNA amplification using universal prokaryote and fungal primer sets [EF3 and EF4 for fungi] respectively [*Grasby et al.*, 2003; *Smit et al.*, 1999]. DNA will be extracted, purified, and target genes amplified as previously described [*Griffin*, 2001a; *Griffin et al.*, 2003]. Amplified bacteria and fungi DNA will be cleaned and sequenced by Northwoods DNA, Inc. (Becida, MN). GenBank Blast search (http://www.ncbi.nlm.nih.gov/BLAST/) will be used for amplicon/isolate identification.

Surface water direct count analysis.
Fifty ml aliquots of water were obtained from the surface water intake line in the 'Sea Surface Water Monitoring Laboratory, 4th Deck' or in the case of the vertical profile samples, a rosette bottle. The water chemistry laboratory intake line used to acquire the sample is a short shunt located on a real-time surface water instrument line which continually flows. The line (~1 ft on length from the free flowing real-time line) was run for 1 minute before the sample was taken. Ten-ml aliquots of the sample were then filtered through a 0.02um pore size glass Whatman Anodisc filters (Fisher Scientific, Atlanta, GA) in duplicate. After filtration the filters were placed sample-side up on top of a drop of diluted SYBR Gold nucleic acid stain (Molecular Probes,

Eugene, OR: 97.5µl of 0.02µm filtered H_2O + 2.5µl of a 1/10 dilution of SYBR Gold) and incubated at room temperature in the dark for ~15 minutes. The filters were then removed from the drop of diluted SYBR Gold, excess stain removed by blotting the back of the filter on tissue paper, and placed on a glass slide. Twenty-three microliters of antifade solution (990.0µl 50% 1X PBS/50% Glycerin + 10.0µl 10% P-phenylene diamine) was placed on a coverslip, and the coverslip placed over the filter. The coverslip was lightly pressed to expel any trapped air and the slide was then refrigerated in the dark until counted by epifluorescent microscopy. Fifteen fields per slide were counted. The average numbers of microbe-like particles were obtained by averaging both field and sample counts. A negative control filter consisted of 10 ml of funnel rinse water (0.02 μm, autoclaved, Millipore), processed as above (one filter, 1 field counts).

Vertical water column water direct count analysis

Fifty-ml water column samples were collected from the R/V Mirai rosette bottles at station K1 and 35N. Ten-ml aliquots from each depth (24 samples station K1, 22 samples station 35N, depth ranged from ~10 to 4500m) were processed in duplicate as outlined in the surface water direct count protocol above. Surface water counts and negative control counts obtained for each respective vertical profile sample date were utilized for zero-depth and control counts.

Magnetite reducing and magnetotactic bacteria.

Ailquots of surface and subsurface water will be screened for the presence of magnetotactic and magnetite reducing species of bacteria. PCR will be utilized upon return to the U.S. Geological Survey laboratory to detect the organisms of interest. Ten-ml aliquots of sample were transferred to a 15ml in tube which was placed in a magnetic stand (the magent which was designed for molecular magnetic seperation assays was obtained from Dynal, Inc.). The sample was allowed to sit for a minimum of 15 minutes after which the water was removed by slow pipetting. Another 10 ml volume was then added and again allowed to sit for a minimum of 15 minutes. Nine ml was then removed by slow pipetting, the tube capped, shaken, and stored by freezing.

Preliminary results and discussion

Atmospheric microbiology

Table 1 and Figure 4 list and illustrate the particle count and aeromicrobiology data from the 28^{th} of February to the 10^{th} of March, 2005 (~1/2 of data set). The entire data set for the cruise and the identification of the bacterial and fungal isolates will be completed upon return to the U.S. Geological laboratory in St. Petersburg, Florida (due to required incubation periods of samples). This updated information will be submitted at a later date. Figure 4 shows that the concentration of atmospherically suspended particles decreased as the *R/V Mirai* moved from port to her assigned duty stations. This was expected as wind patterns were transporting local land based particulate matter to sea. In general the atmospheric particle counts demonstrated a relatively clean atmosphere with a few small peaks in concentrations. Microbial isolates were noted at the beginning of the cruise when near land and then while at sea on the 8^{th} and 9^{th} of March (two, and twenty-three bacterial isolates, respectively). Satellite data and DNA sequencing will be used to determine source (dust or marine aerosols) at a later date.

Surface water direct count analysis

Table 2 and Figure 5 list and illustrate the surface water direct count data for the entire data set, 1st through the 19th of March, 2005. The bacterial data showed a flux of high and relatively lower concentrations from south to north locations. Bacterial cell counts ranged from 2.90×10^5 to 5.42×10^5/ml, with the highest concentration occurring at the southern most station (~35N), with relatively similar concentrations occurring at some of the more northern latitudes. Statistical analysis of the bacteria data set showed that concentrations between sites were not significantly different (Pearson's correlation coefficient = -0.43, $P = 0.861$, N=19, $\alpha = 0.01$, 2-tailed). Viral concentrations ranged from 8.99×10^5 to 1.77×10^6/ml, with the higher concentrations typically occurring in the more northern latitudes. Statistical analysis of the viral data set showed a strong correlation between virus concentrations and latitude (Pearson's correlation coefficient = 0.662, $P = 0.002$, N=19, $\alpha = 0.01$, 2-tailed). These data will be compared with water chemistry results (nutrient concentrations, etc,) at a later date in order to address the observed trends. The February 28th data included in the data files was not included as the DNA staining was weak, which compromised the accuracy of the viral counts.

Vertical water column water direct count analysis

Table 3, Figures 6 (Station K1), and 7 (Station 35N), lists and illustrates the vertical profile data for the two research sites. The average concentration of bacteria and virus-like particles/ml of water at site K1 was 1.37×10^5 (range, 1.42×10^4 to 4.55×10^5) and 2.27×10^5 (range, 3.31×10^4 to 1.27×10^6), respectively. The highest concentrations of bacteria and viruses at K1 occurred at the bottom of the mixing layer and the surface, respectively, which was distinctly different from the mixing layer concentration profile observed at Station 35N. Unlike site K1, the maximum bacteria concentrations at site 35N occurred at the surface (5.42×10^5) and while the highest concentration of viruses also occurred at the surface (8.99×10^5), the concentration (virus) was lower than that observed at site K1 (in line with the previously discussed observation of a general trend of higher surface water virus concentrations with an increase in latitude). Below the mixing layer at both sites concentrations dropped with depth and the profiles were similar. The average concentration of bacteria and virus-like particles/ml at 35N was 1.69×10^5 (range, 1.18×10^4 to 5.42×10^5), and 2.31×10^5 (3.44×10^4 to 8.99×10^5), respectively. These data will be compared with water chemistry results (nutrient concentrations, etc,) at a later date in order to address the observed trends.

Data archives

Digital copies of all data files including this report were given to Dr. Makio Honda, Mission PI, for JAMSTEC storage. Files include:

1. MSWord 2003 – Mission Report, file name – *JAMSTEC.Cruise report.griffin*
2. MS Excel 2003 data spread sheet – file name – *JAMSTEC atmospheric data.griffin* (sample time, air volumes screened, atmospheric conditions, results, etc.).
3. MS Excel 2003 data spread sheet – file name – *JAMSTEC water data.griffin* (sample collection time, atmospheric parameters, summarized direct count data, etc.).
4. MS Excel 2003 data spread sheet – file name – *JAMSTEC direct count data.griffin* (complete direct count data for daily surface water samples).

5. MS Excel 2003 data spread sheets – file names – *K1 vertical direct counts*, and *35N vertical direct counts* (complete direct count data for individual vertical profile samples).

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Table 1. Atmospheric microbiology and particle data (Feb. 28th to March 10th, 2005). This data set represents ~ ½ of the study period and will be updated at a later date. Bacterial and Fungal colony forming units (CFU) expressed per cubic meter of air.

Sample Date	Latitude (N)	Longitude (W)	Air volume assayed in liters	Particle count/m^3	Bacterial CFU/m^3	Fungal CFU/m^3
2/28/2005	41-20	141-15	1218	14,504,519	0.82	0.82
2/28/2005	41-16	143-44	9169.8	11,900,112	0.00	0.33
3/1/2005	40-55	148-14	1026.6	10,808,556	0.00	0.00
3/1/2005	42-16	151-37	11953.8	12,624,402	0.00	0.00
3/1/2005	43-55	154-08	10300.8	6,297,546	0.10	0.00
3/2/2005	44-06	154-36	1165.8	6,297,546	0.00	0.00
3/2/2005	45-41	157-29	11832	5,704,977	0.00	0.00
3/2/2005	46-51	160-06	12597.6	1,797,483	0.00	0.00
3/3/2005	46-51	160-05	1444.2	2,233,611	0.00	0.00
3/3/2005	46-53	159-59	10353	2,761,908	0.00	0.00
3/3/2005	47-00	160-02	12997.8	4,044,159	0.00	0.00
3/4/2005	47-01	160-00	1183.2	2,318,717	0.00	0.00
3/4/2005	47-00	159-59	13328.4	2,910,227	0.00	0.00
3/4/2005	46-55	160-10	10579.2	2,483,280	0.00	0.00
3/5/2005	46-56	160-08	1078.8	1,040,704	0.00	0.00
3/5/2005	47-14	160-14	9552.6	968,663	0.00	0.00
3/5/2005	49-52	163-32	13398	1,312,621	0.07	0.00
3/6/2005	50-03	163-46	1078.8	822,463	0.00	0.00
3/6/2005	50-58	165-02	10126.8	2,259,743	0.00	0.00
3/6/2005	50-59	164-59	13050	690,036	0.00	0.00
3/7/2005	50-59	164-59	1165.8	1,343,345	0.00	0.00
3/7/2005	49-54	163-35	10701	776,555	0.00	0.00
3/7/2005	48-00	161-11	10857.6	1,111,685	0.00	0.00
3/8/2005	47-4	160-47	1200.6	1,017,749	0.00	0.00
3/8/2005	46-4	159-58	10892.4	1,688,362	0.00	0.00
3/8/2005	43-41	160-00	12388.8	2,223,369	0.24	0.00
3/9/2005	40-57	160-00	11344.8	2,104,714	2.03	0.00
3/9/2005	38-08	160-11	12632.4	1,901,306	0.00	0.00
3/10/2005	37-51	160-26	1131	1,901,306	0.00	0.00

Table 2. Bacterial and viral concentrations in surface water samples for the study period (1^{st} - 19^{th}, March 2005). Concentrations expressed as the number of bacteria cells or virus-like particles per ml of water.

Sample Date	Latitude (N)	Longitude (W)	Bacterial cell counts/ml	Viral-like particle counts/ml
3/1/2005	41-25	150-14	342959.81	1007763.21
3/2/2005	44-53	156-03	355856.87	1121432.22
3/3/2005	46-52	159-59	295668.96	1518501.39
3/4/2005	46-59	159-57	346195.00	1565907.20
3/5/2005	47-00	159-57	292435.39	1771108.91
3/6/2005	50-53	164-50	332598.44	1346336.56
3/7/2005	50-59	164-58	362866.46	1270557.22
3/8/2005	47-05	159-58	363028.38	1492663.55
3/9/2005	42-21	159-59	290293.16	1137462.47
3/10/2005	36-56	159-59	307327.32	1220241.68
3/11/2005	34-59	159-59	542303.19	899631.92
3/12/2005	35-46	159-03	341978.56	991718.39
3/13/2005	40-21	155-23	303889.73	1382487.19
3/14/2005	43-44	156-47	528026.56	1470896.42
3/15/2005	44-51	156-16	518797.02	1439807.46
3/16/2005	46-53	160-01	469734.76	1473616.70
3/17/2005	46-58	159-58	472649.35	1554448.00
3/18/2005	47-00	159-57	434759.68	1583593.90
3/19/2005	44-26	160-00	546971.39	1397060.14

Table 3. Vertical water column bacterial and viral-like direct count concentrations observed at mission research sites K1 and 35N. Listed concentrations are bacterial cells and viral-like particles/ml of water.

Sample Depth in meters	Station K1 …location, bottom depth 4829m		Station 35N …location, bottom depth 4551m	
	Bacteria/ml	Virus-like particles/ml	Bacteria/ml	Virus-like particles/ml
Surface ~4.5	362866.46	1270557.22	542303.19	899631.92
10	304088.89	314892.30	374709.41	507624.43
30	277533.74	298701.76	388796.59	497423.36
50	289839.78	399415.41	341677.39	497423.36
75	325138.71	324933.07	398511.89	478964.29
100	455323.73	340803.01	356736.10	415814.84
125	189448.35	284784.59	343782.37	398327.30
150	172932.34	263726.68	300711.20	336149.38
200	159395.69	302272.13	196433.65	248063.99
250	118623.81	212561.05	151063.20	229345.85
300	119109.58	277658.42	90731.19	146701.03
400	90935.21	211788.68	64888.49	85980.41
500	74516.35	197026.28	71397.74	84037.35
600	55862.98	84902.01	57893.47	63635.22
800	54697.14	79757.76	42931.91	71990.37
1000	45807.64	76690.15	45555.04	67618.49
1500	51491.09	96560.37	24375.69	51976.86
2000	43038.78	67123.01	22238.32	39346.97
2500	21179.35	64018.97	19032.27	42164.40
3000	18459.07	54488.26	15826.22	52948.39
3500	20013.52	33124.32	15534.76	36723.83
4000	14281.49	62080.77	13397.40	34489.32
4500	14475.80	54590.27	11842.95	46827.75
4764	20887.90	89769.37	N/A	N/A

Figure 1. NASA Earth Probe TOMS satellite image of Gobi desert dust moving across the Pacific Ocean on 11 April 2001. The large red to green cloud seen over the North Pacific Ocean is a cloud of desert dust which originated in the Gobi desert of China and impacted air quality in China, Korea, Japan, America and Europe.

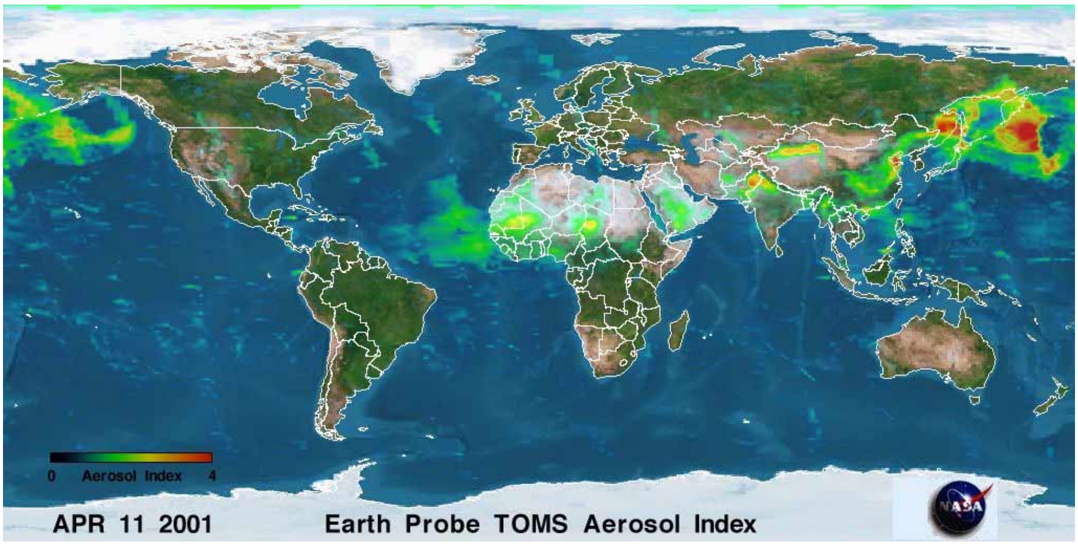


Figure 2. Location of the air intake line aboard the *R/V Mirai*. The arrow identifies the atmospheric instrument tower which is located bow-starboard atop the 'Compass Deck,' that the intake hose was attached. The intake height was ~2 meters above the base of the tower.

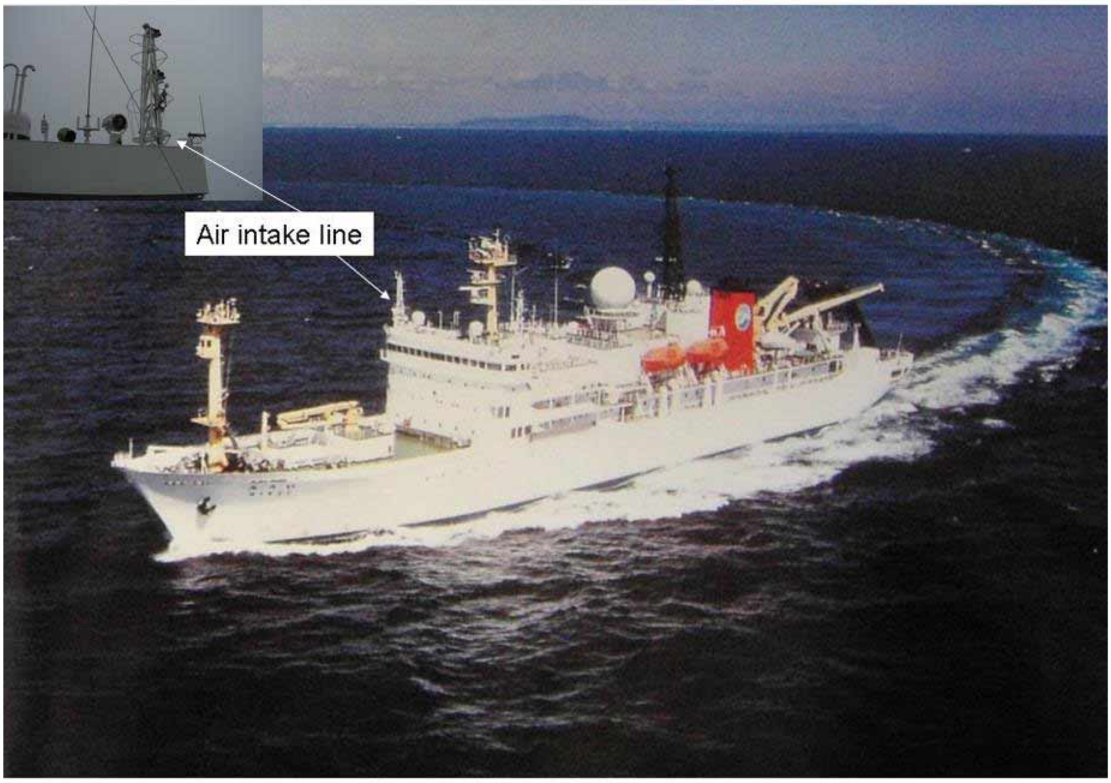


Figure 3. Atmospheric laboratory equipment set-up. The intake line was routed from its location atop ship, through a wiring portal and into the laboratory. The image shows the intake hose attached to the filter funnel/manifold/pump set-up as a sample was being collected.

Figure 4. Atmospheric microbiology and particle data (Feb. 28th to March 10th, 2005). Total microbial colony forming units (bacterial and fungal) and particle counts are expressed per cubic meter. This data set represents ~ ½ of the study period and will be updated at a later date.

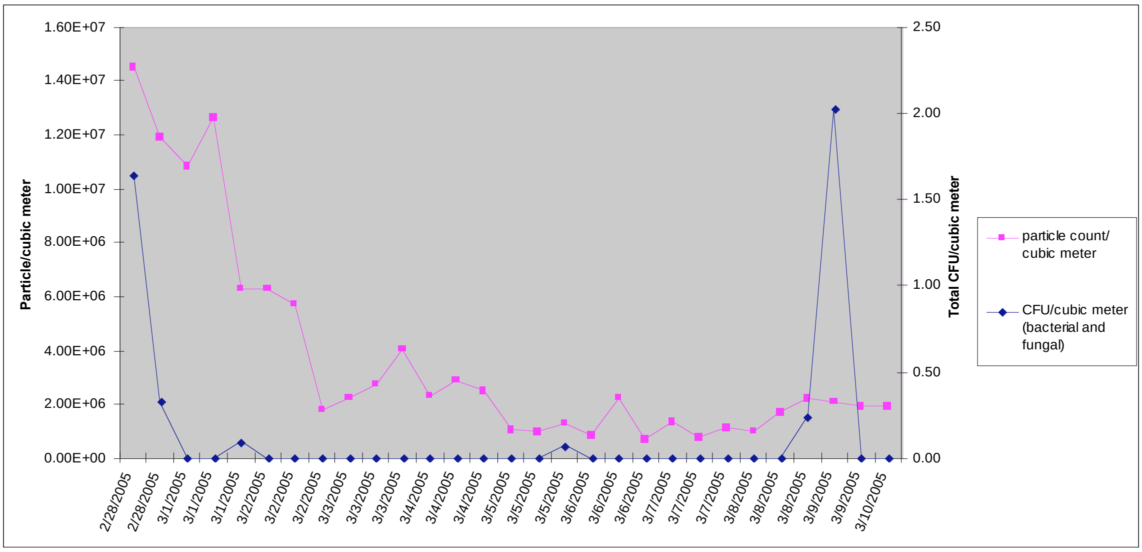


Figure 5. Bacterial and viral concentrations/ml of surface water (Y axis), at the listed latitudes (X axis).

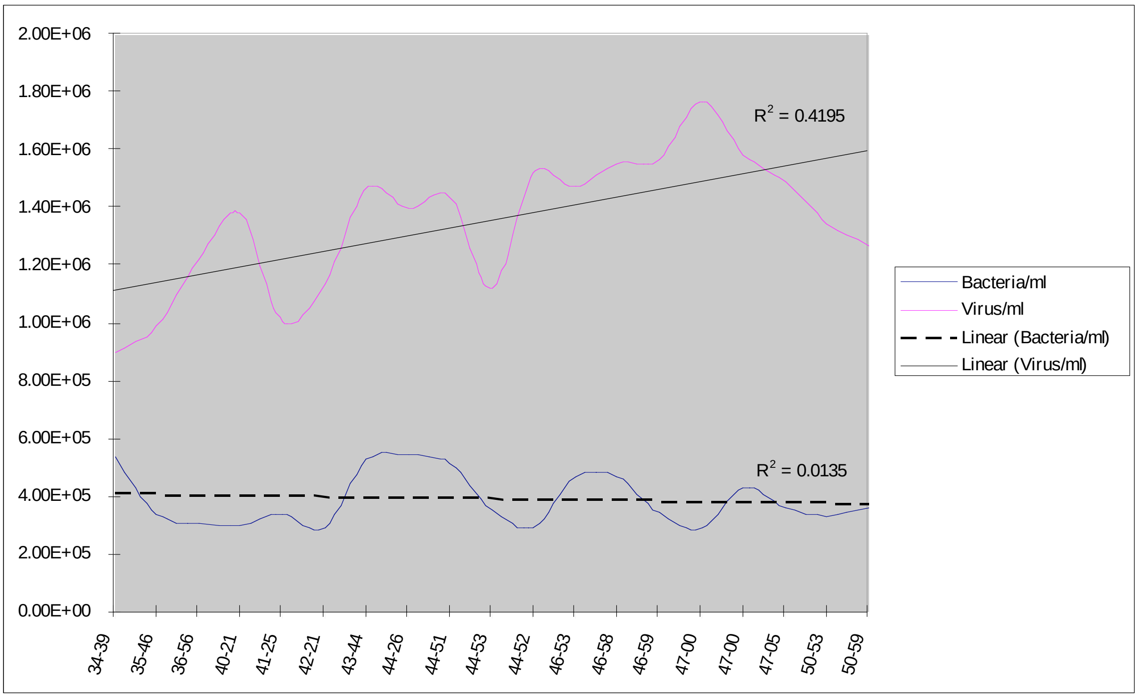


Figure 6. Vertical water column bacterial and viral-like direct count concentrations observed at mission research site K1. Concentrations are bacterial cells and viral-like particles/ml of water. The black line at ~120m represents the mixing layer.

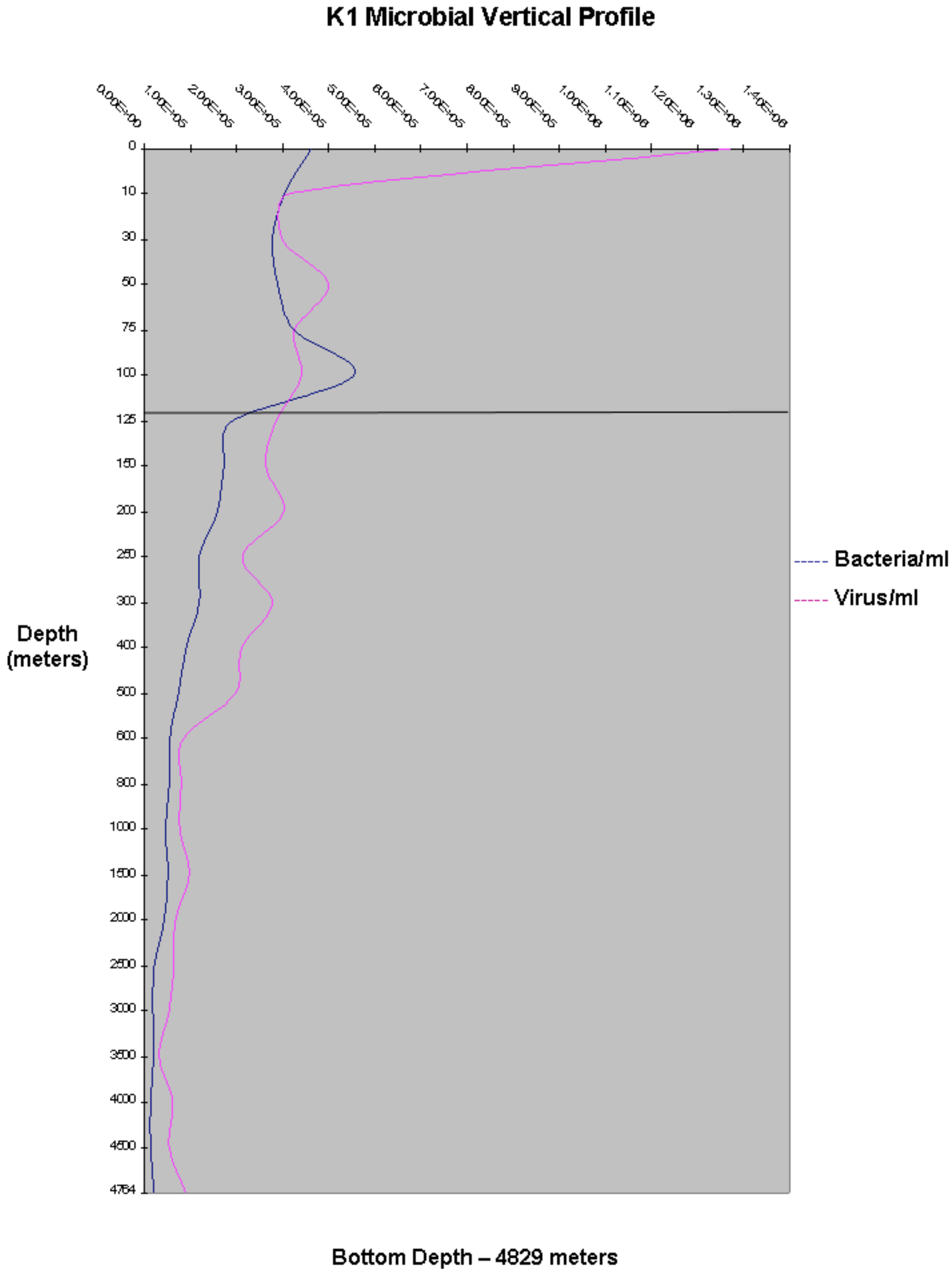
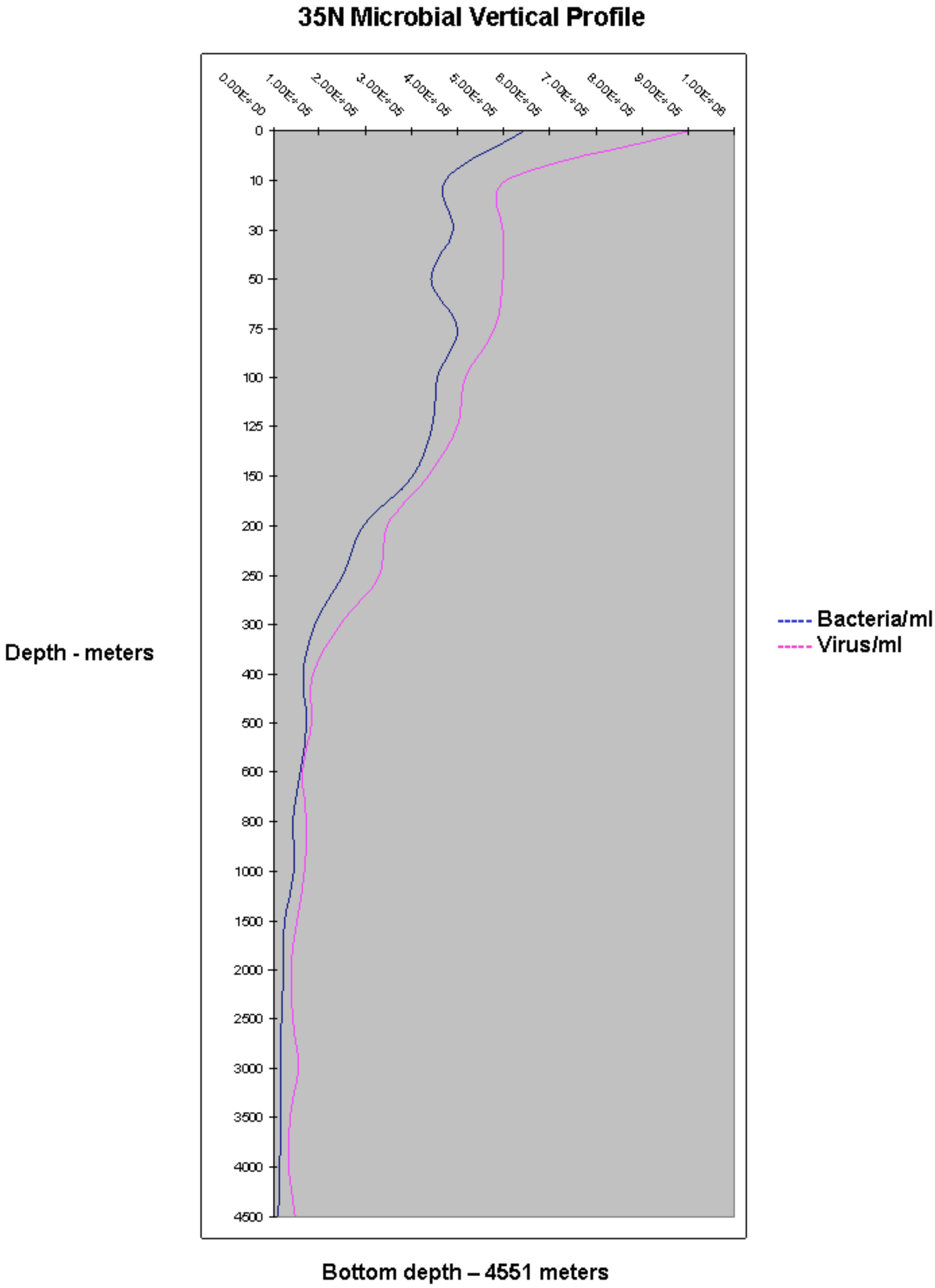


Figure 7. Vertical water column bacterial and viral-like direct count concentrations observed at mission research site 35N. Concentrations are bacterial cells and viral-like particles/ml of water.



4. Geological Observation
4.1 Swath Bathymetry

Wataru TOKUNAGA (Global Ocean Development Inc.)
Ryo OHYAMA (GODI)
Not on-board:
Toshiya FUJIWARA (JAMSTEC): Principal Investigator

(1) Introduction

R/V MIRAI equipped a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). The main system of "SeaBeam 2100", 12 kHz system, provides swath bathymetry data.

The major objective of MNBES is collecting continuous bathymetry data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

In addition, we surveyed around the estimate developing point depth of mooring buoys.

(2) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during MR05-01 cruise from 28 February 2005 to 23 March 2005. For data quality management, applying applicable sound velocity profile is the most important. Sound velocity profile was calculated using formula of Mackenzie (1981), which parameter were water temperature and salinity from CTD. Variations of sound velocity at transducer face have a large influence on measurement depth, especially side beams. So that this system has Surface Sound Velocimeter (SSV), which measuring sound velocity in the surface intake (6.2 m) water continuously.

Obvious bad data was flagged automatically by real-time data screening function of the system.

System configuration and performance of SEABEAM 2100, 12 kHz system;

Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max)
	120 degree to 4,500 m
	100 degree to 6,000 m
	90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m, whichever is greater, over the entire swath. (Nadir beam has greater accuracy; typically within < 0.2% of

depth or +/-1m, whichever is greater)

(3) Preliminary Results

We carried out survey mapping at the Stations K2 and KNOT. The result of survey mapping was shown in Fig. 4.

(4) Data Archives

The data obtained during this cruise will be submitted to the JAMSTEC Data Management Division, and archived there.

(5) Remarks

Navigation data (Time, Position, SOG, COG, Heading, etc) was not collected as following terms;

08 Mar. 2005 01:45:18UTC - 01:47:59UTC
13 Mar. 2005 01:00:50UTC - 01:24:49UTC
20 Mar. 2005 13:26:10UTC - 13:39:08UTC

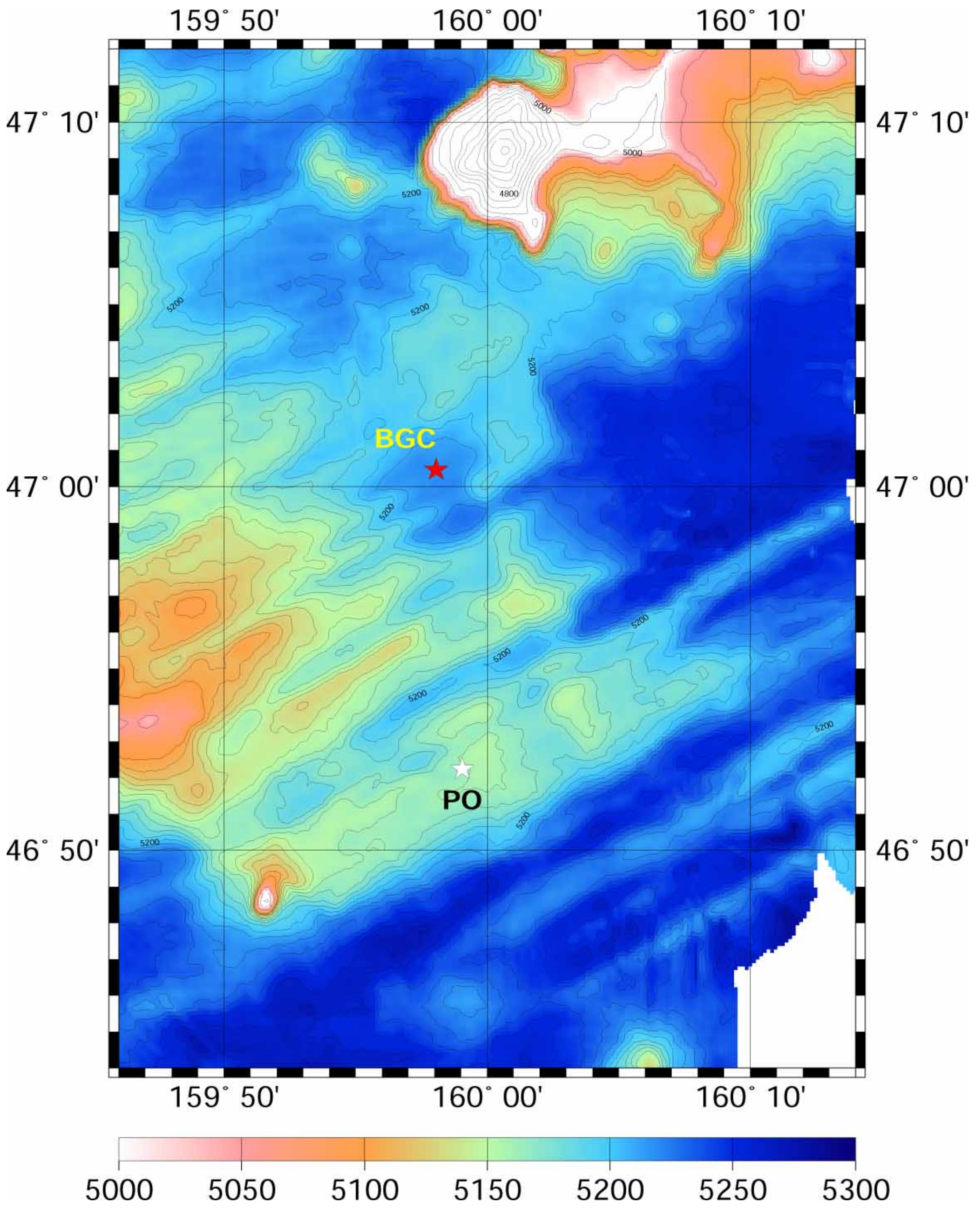


Fig. 4 (a) Fixed point of BGC mooring buoy and target point of PO mooring buoy at the Station K2

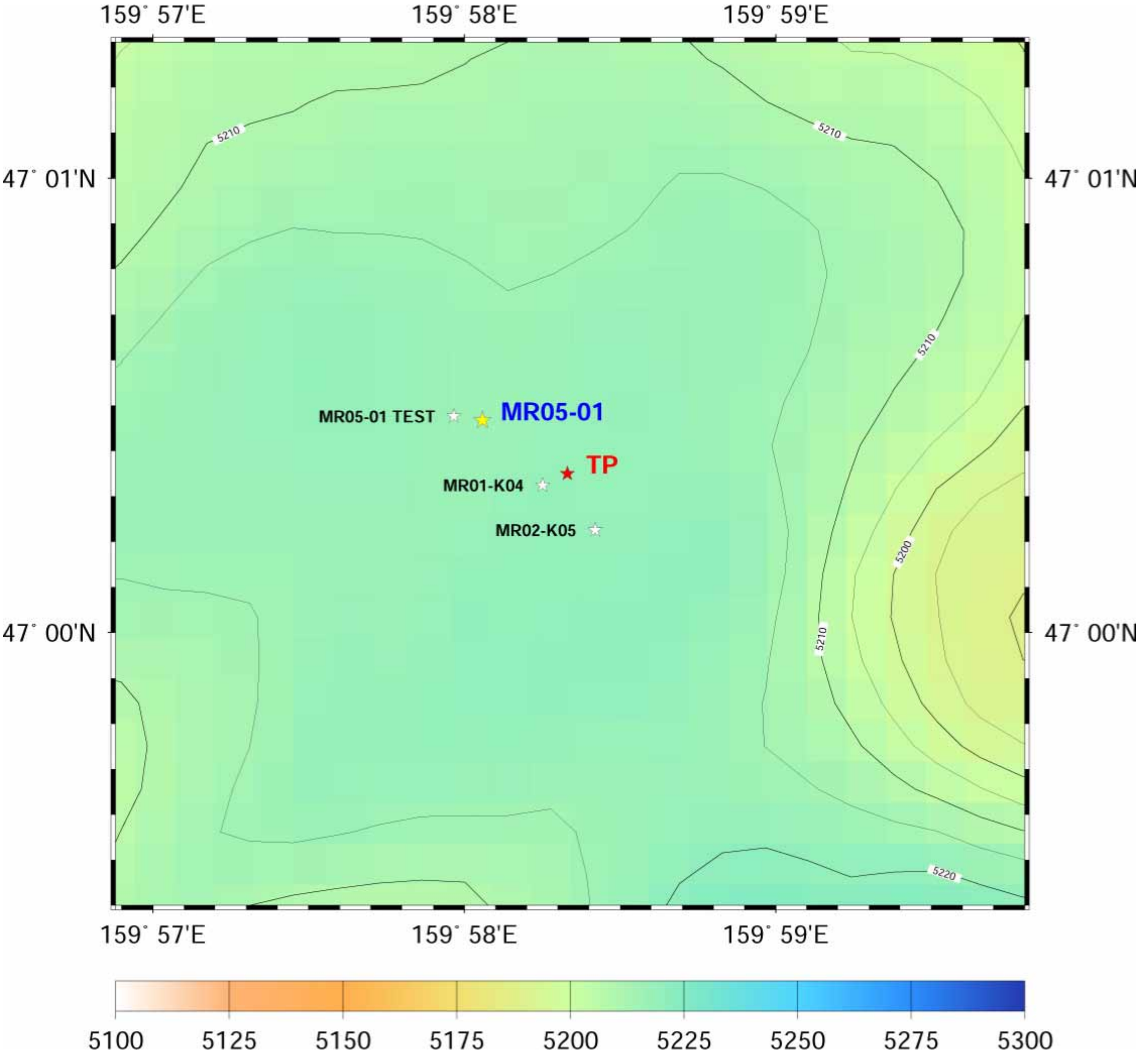


Fig. 4 (b) Detail topography around BGC mooring point at station K2.
Target point (TP) and previous “fixed points” are also shown.

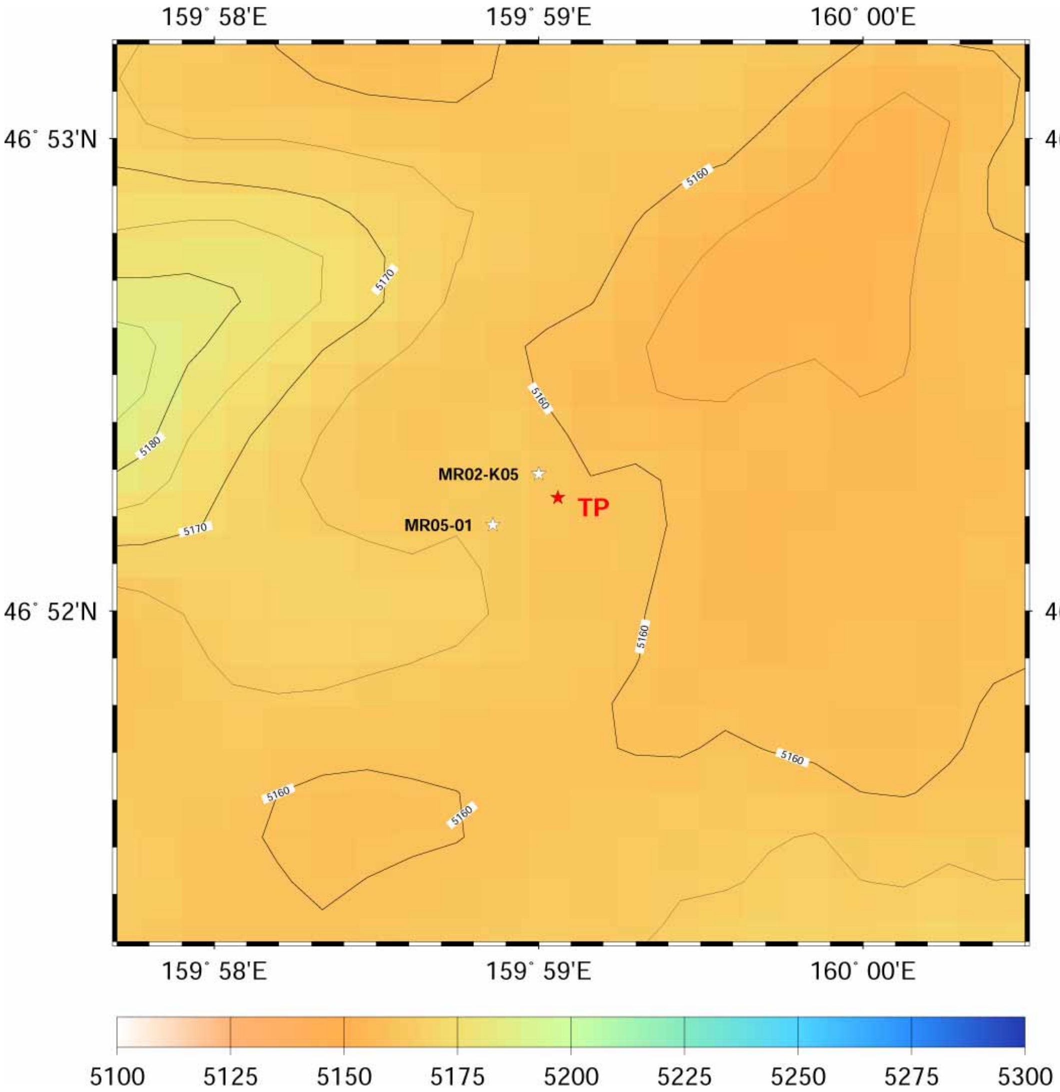


Fig. 4 (c) Detail topography around PO mooring point at station K2.
Target point (TP) and previous "fixed points" are also shown.

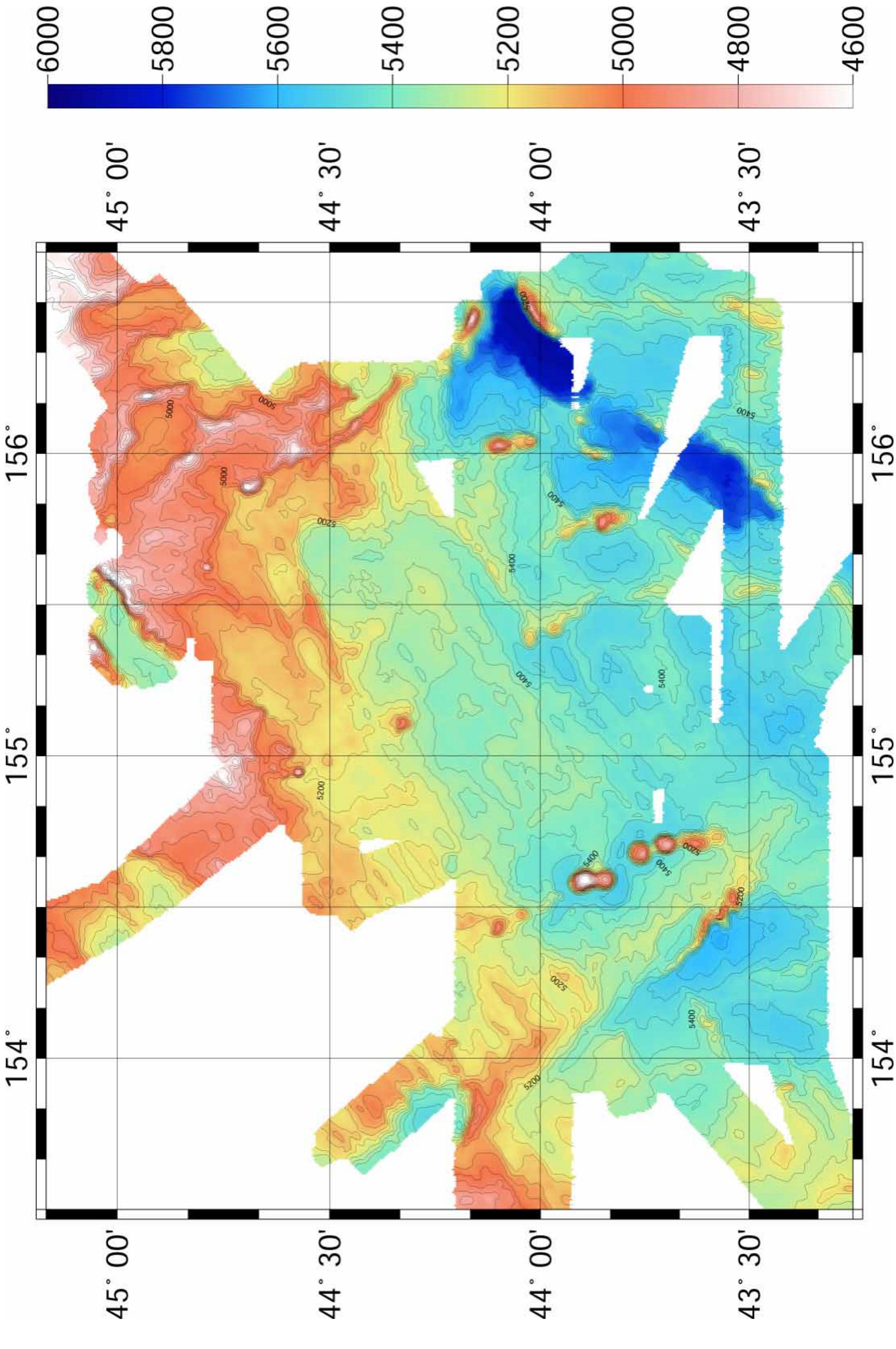


Fig. 4 (d) Topography of the sea bed around station KNOT

4.2 Sea Surface three-component magnetic field

Wataru TOKUNAGA (Global Ocean Development Inc.)
Ryo OHYAMA (GODI)
Not on-board:
Toshiya FUJIWARA (JAMSTEC) : Principal investigator

(1) Introduction

Measurements of magnetic force on the sea are required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR05-01 cruise from 28 February 2005 to 24 March 2005.

(2) Parameters

Three-component magnetic force [nT]
Ship’s attitude [1/100 deg]

(3) Instruments on *R/V MIRAI*

A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board *R/V MIRAI*. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs of the sensors are digitized by a 20-bit A/D converter (1 nT/LSB), and sampled at 8 times per second. Ship's heading, pitch, and roll are measured utilizing a ring-laser gyro installed for controlling attitude of the Doppler radar Vertical Reference Unit (VRU). Ship's position (GPS) and speed data (COG) are taken from LAN every second.

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

Magnetic force data obtained during this cruise will be submitted to the JAMSTEC Data Management Division, and archived there.

(6) Remarks

1) For calibration of the ship’s magnetic effect, we made a running like a “Figure of 8” (a pair of clockwise and anti-clockwise rotation). The periods were follows;
   03 Mar. 2005 07:57 - 08:20
2) The following period, ship’s navigation data were invalid;
   02 Mar. 2005 20:45:46UTC - 20:45:52UTC
   04 Mar. 2005 16:31:48UTC - 16:31:54UTC
   06 Mar. 2005 19:39:26UTC - 19:39:32UTC, 21:55:46UTC - 21:55:52UTC
   08 Mar. 2005 01:01:15UTC - 01:01:31UTC
   13 Mar. 2005 01:00:56UTC - 01:24:49UTC
   20 Mar. 2005 13:26:09UTC - 13:39:09UTC

5. Satellite observation (MCSST)

Wataru TOKUNAGA (Global Ocean Development Inc., GODI)
Ryo OHYAMA (GODI)

(1) Objectives

It is our objectives to collect data of sea surface temperature in a high spatial resolution mode from the Advance Very High Resolution Radiometer (AVHRR) on the NOAA polar orbiting satellites and to build a time and depth resolved primary productivity model.

(2) Method

We receive the down link High Resolution Picture Transmission (HRPT) signal from NOAA satellites by the same way as the signal of OrbView-2. We processed the HRPT signal with the in-flight calibration and computed the sea surface temperature by the Multi-Channel Sea Surface Temperature (MCSST) method. A daily composite map of MCSST data is processed for each day on the R/V MIRAI for the area, where the R/V MIRAI located.

We received and processed NOAA data throughout MR05-01 cruise from the departure of Sekinehama on 00:00UTC 28 February 2005 to the arrival at Sekinehama on 00:00UTC 24 March 2005.

The sea surface temperature data will be applied for the time and depth resolved primary productivity model to determine a temperature field for the model.

(3) Preliminary results

Fig.5-1 shows sea surface temperature about northwest Pacific Ocean. It is composite map of MCSST data during the cruise from 28 February 2005 to 21 March 2005.

(4) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control.

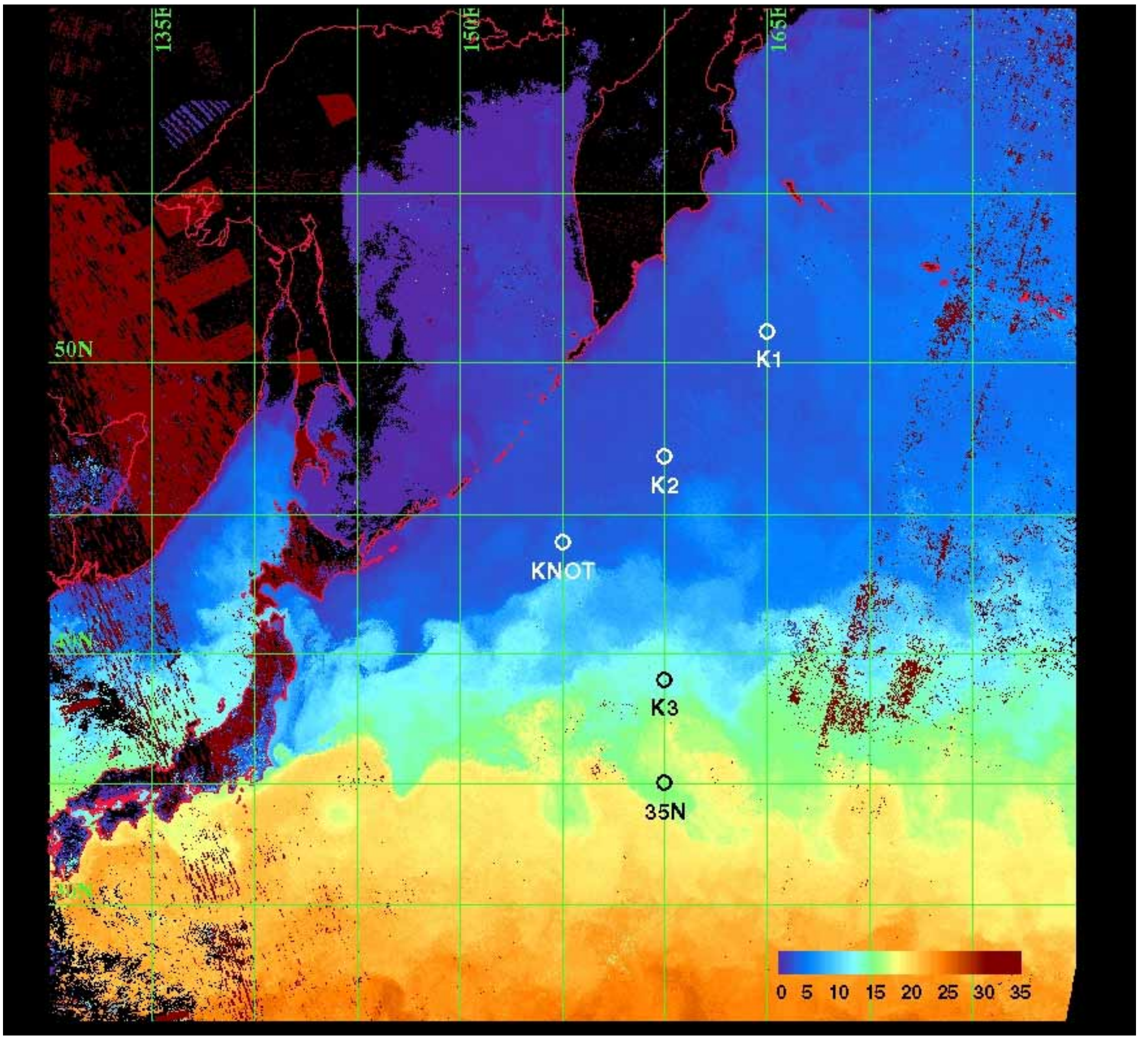


Fig.5-1 Composite map of MCSST data

The map shows sea surface temperature about northwest Pacific Ocean during the cruise from 28 February 2005 to 21 March 2005.

6. Ship`s handling

6.1 Ship's Handling for the Deployment of the MMP / BGC moorings

Masaharu AKAMINE (Master of R/V MIRAI)
and ship's Crew

(1) Objectives

・**To deploy it surely and efficiently in the site of which the moorings is required**

・**To prevent damage of an observation equipment and a sensor**

Results are analyzed from the standpoint of ship's maneuvering to achieve two purposes that mentioned above, and it aims to make the results useful for observation work in the future.

(2) Observation parameters

・Ship's position, course, speed

・Directions of the wind and the current, velocities of the wind and the current

・ Vectors of the wind and the current, the resultant force

・ Working hours

・ Tension of the towing

・ Position of sinker

(3) Methods

(3.1) Measurement of the actual ship-movement

Measurement of the ship-movement at engine stopped is executed by a set-drift which is measured before deploying the MMP/BGC moorings in order to make in advance a comparison between reality and expectation. A direction and a velocity of the ship-movement in the external force influence is measured by a radio navigation device " Sains" assembled by Sena Co., Ltd. Japan and a Doppler sonar "DS-30" assembled by FURUNO Electric Co., Ltd. Japan.

(3.2) Measurement of the wind and the current

The wind direction and speed is measured by KOAC-7800 weather data processor and sensors assembled by Koshin Denki.

The current direction and speed are continuously measured by a Doppler sonar "DS-30" installed at the bottom of the ship.

(3.3) Ship's speed

According to the results measured in past, and the instruction from the marine technician of WHOI, on the deploy of the MMP/BGC moorings, the ship's speed is set up so as to keep her speed on 1.0~ 2.0 knots at ship's through-the-water while the mooring lines are paid out, to keep her speed on about 1 knot at ship's through-the-water while the various instruments such as sensors, sediment traps, glass balls /releasers/sinker etc. are attached. In order to avoid their instrument accident and to maintain a safety of the works, an average speed through all the works around 1.5 knots at through-the-water becomes one aim.

About the deployment of the BGC mooring, the ship's way is most stopped while some instruments are attached in the top buoy at the stage of the start.

(3.4) Ship's course

The standard of the ship's course is to make the ship proceed to upwind. The final decision is done in consideration of the external force influence such as the wind-drift, the wave, the current, and the swell, making reference to the data of the set-drift carried out before the deploying operation of the MMP/BGC moorings.

It is important to lessen the angle between the ship's course and the wind direction in order to prevent the ship drifting to the lee. The ship shall be managed to make the mooring lines paid out from the stern, straight behind.

It is also necessary to consider the direction of the swell.

(3.5) Working hours for the deployment of the MMP/BGC moorings

The time that the ship needs in each work is investigated and recorded referring to past data.

An example in principle is given as follows; Dist means the navigating distance from the work beginning to the sinker dropping. As for this matter, 7 miles becomes a standard according to data in past. Ship's speed is the numerical value of the above standard in (4.3).

MMP mooring

Works	Time	Ship's speed	Dist
Stand by the top-buoy	0.1 hour	1.0 knot	0.1 mile
Paying out the mooring lines	3.0	1.5	4.5
Attachment of the various instruments	0.5	1.0	0.5
Towing	1.0	1.7	1.7
Setting the sinker	0.4	1.0	0.4
Total	5.0 hours	1.4 knots	7.2 miles

BGC mooring

Works	Time	Ship's speed	Dist
Stand by the top-buoy	0.5 hour	0 knot	0 mile
Attachment of the sediment traps	4.0	1.0	4.0
Paying out the mooring lines	0.5	1.5	0.8
Towing	1.0	1.7	1.7
Setting the sinker	0.5	1.0	0.5
Total	6.5 hours	1.4 knots	7.0 miles

(3.6) Tension of the wire cable and the nylon ropes

The tension of the cable/the ropes streamed astern can be measured with the tension-meter temporarily equipped next to the upper end of releaser of the mooring system, when towing it. The maker of the tension-meter “CL-5T” is NMB Co. Ltd.

The analysis of the tension is mainly done to the BGC mooring as it has a big resistance of water by some sediment traps in comparison with MMP mooring. The speed of the ship and revolutions of the winch are adjusted so as not to hang a big stress in the cable/ropes actually paid out from her stern, checking the above-mentioned data and the cable/ropes tension measurement by skilled hands of marine technicians and chief officer at ship’s stern.

(3.7) Designated mooring location (Target)

Targets at K2 station are fixed based on the sounding result of execution in 2001.

MMP mooring **: lat.46° 52’24N, Long. 159° 59’.06E** Depth 5152.3 meters
BGC mooring**: lat.47° 00’.35N, Long. 159° 58’.32E** Depth 5206.2 meters

(3.8) Decision of the anchored position

As soon as the sinker dropped into the ocean, the ship returns to the position of the top-buoy, watches the top-buoy disappearing from the surface by the ship’s radars and etc.

The position of the sinker arrived at the seabed is fixed by an acoustic transducer which is lowered over the stern, a radio navigation device.

The acoustic transducer: Edgetech Inc. USA
The radio navigation device: “Sains” assembled by Sena Co., Ltd. Japan.
The ship’s radar: “JMA9000 X band” and ”JMA 9000 S band “ assembled by JRC Ltd.
“MM950 X & S band” assembled by Consilium Selesmar, Italy.

(4) Results

(4.1) Ship’s speed

The results are shown in Fig.6.1-1 & 6.1-2.

An approximate speed at through-the-water in each work is shown in the following.

Test mooring

	MMP mooring		BGC mooring	
At the beginning of work	0.6	knots	0.3	knots
During the paying out mooring line	1.5	with sediment traps	1.7	
During the towing at the final stage	1.9		2.0	
At the dropping sinker	0.8		1.0	
The average speed during the deployment	1.45		1.56	

The above-mention speed pattern is almost the same as the standard for the deployment.

Long-term mooring

	BGC mooring	
At beginning of work	0.3	knots
During the setting sediment traps	1.1	
During the towing at the final stage	1.9	
At the dropping sinker	1.0	
The average speed during the deployment	1.33	

The speed in the sediment installation was reduced than one in the test, in consideration of the test result.

(4.2) Ship's course (Table 6.1-1 and 2)

The course of the ship was set to receive the wind in the bow in order to handle the ship easily. Fig.6.1-3 & 6.1-4 show the relative wind that the ship received. The matter that the ship is keeping her head into the wind is cleared.

The gyro course and the true course of the ship are shown in followings.

	Gyro Co.	True Co.	Sinker Co.
MMP (Test)	<270>	<282>	<314>
BGC (Test)	<300>	<303>	<300>
BGC (Long)	<130>	<135>	<135>

"True Co." is " Course-made-good ". It means the furrow that the ship actually navigated. "Sinker Co." means the course that the ship is passing a certain distance beyond the target point. It is shown in (5.5) Sinker's position. It is demanded that there is no difference between "True Co." and "Sinker Co." so that the sinker hits the target point. The requirement was satisfied with the BGC moorings.

Fig.6.1-5 to 6.1-8 show the current influence. Firstly the direction and the speed of the current are shown by absolute value. Next, the speed of the current is divided into the direction of X (lateral force) and Y (longitudinal force). Because X moves the ship laterally, the amount of it influences the ship's control. It is mainly adjusted by using the side-thrusters. Y influences the speed of the ship. In this time, the current influence became small in the stage at the end of the deployment though the influence at the first stage of it was big in each.

(4.3) Working hours

BGC mooring (Long-term)

The result is shown in Table 6.1-4 and the following figure.

In comparison with the results in past, the time spent in setting the sediment traps on the mooring became short by the worker's skill and the change of the setting way. The shortening in the sediment installation time was shifted to the increase in the towing time because the standard 7 miles for the deployment distance does not change. The total hours that the ship needs in the work is almost the same as each deployment with others.

The time spent in setting top buoy and instrument	18 minutes
The time spent in paying out mooring lines with sediment traps (including the time spent in setting glass balls)	2 hours 45 minutes
The time spent on towing	1 hour 42 minutes
The time spent in setting releasers and sinker	25 minutes
Total	5 hours 10 minutes

(4.4) Tension of towing the MMP/BGC moorings

The results are shown in Fig 6.1-9 and a correlation formula between speed and tension is found in each. Following data are calculated by the correlation formula.

	Towing speed at through-the-water	Towing tension
MMP mooring (Test)	1.9 knots	880 kgs
BGC mooring (Test)	2.0 knots	1110 kgs
BGC mooring (Long-term)	1.9 knots	1065 kgs
	(2.0 knots)	(900 kgs)

( ) is the simulation result of the BGC mooring executed in advance.

Even if the angle of the CPP is fixed, the ship's speed fluctuates by the external force influence such as the wind, the wave and the swell, etc. The amplitude of the speed appears in the size of the tow tension. An error is within the amplitude, and there is no big difference between the measurement result and the simulation result.

(4.5) Sinker's position (Fig 6.1-10 & 6.1-11)

The difference between the position of **the sinker dropped** and the position of **the sinker reached the seabed** are shown in the following numerical data.

	Dropped	Fixed	Difference
	direction/ distance	direction/ distance	Sin/ Cos
MMP (Test)	314 degrees/ 755 meters	330 degrees/ 288 meters	79/478 meters
BGC (Test)	300 degrees/ 850 meters	298 degrees/ 506 meters	18/344 meters
BGC (Long-term)	135 degrees/340 meters	309 degrees/736 meters	77/-392 meters

Above-mentioned numerical value shows that the straight-line distance between the target point and the sinker dropped position /the fixed position.

"Dropped" means the distance from the target point to the position of **the sinker dropped,** which is obtained by the MWJ's simulation calculation.

"Fixed" means the distance between **the target point** and the position of **the sinker reached the seabed,** which is obtained with the software of WHOI after the measurement of the transducer to decide the fixed position.

"Sin of Difference"

= Sin (direction of "Fixed" – direction of "Dropped") X distance of "Fixed"

"Cos of Difference"

= distance of "Dropped" − Cos (direction of "Fixed" – direction of "Dropped") X distance of "Fixed".

The "Sin of Difference" and the "Cos of Difference" are an amount of difference in the X/Y directions to the final course for dropping the sinker.

As for the "Sin of Difference" (Y direction), its deviation is within 100 meters respectively.

As for the "Cos of Difference" (X direction), a big deviation is caused in all though it does not influence the required depth of water for the deployment.

In case of the BGC test mooring, it guesses that the deviation was caused by the flow that was caught at the last stage of the deployment.

These numerical values are not included the about 88 meters of the distance between the bridge with which GPS is equipped and the ship's stern where the acoustic transducer is lowered to decide the fixed position.

Fig. 6.1-13 & 6.1-14 were shown that the direction from the position of **the sinker dropped** to the position of **the sinker reached the seabed** was almost the same course line as the ship was finally towing in all cases.

(4.6) Required depth (Long-term mooring only)

The BGC mooring was actually anchored within the same depth contour as shown in Fig 6.1-12.

Site No.	Actual	Demanded
K2-BGC	(5214 meter)	5206.2 meters (5215 meters)

( ) the depth of water was measured by a SEA-BEAM 2000 with depth accuracy within 0.5%.

In 2001, an original depth is the one sounded by the CTD and the altimeter in details. The depth of water measured by the SEA-BEAM 2000 was 5215 meters at that time. The difference between the original depth and the SEA-BEAM's depth was 8.8 meters.

It is able to guess that it is within error margin though there is a difference of 6 - 10 meters between the original depth and the depth measured by SEA-BEAM. Because the depth is checked again with SEA-BEAM by passing over the designated mooring location, it is convinced that the sinker is to be set to the demanded depth. In this time, the difference of it was 1meter.

(4.7) Distance for Deployment MMP/BGC mooring

Results are shown in the following table.

Unit: miles

	Actual	Tow	T/A
MMP (Test)	5.8	1.89	32.5 %
BGC (Test)	10.16	4.38	43.1 %

BGC (Long-term)	6.79	3.25	47.8%

"Actual" is the distance from the starting point to the position of the dropped sinker. "Tow" is the distance to the releaser installation point from the point where the tow begins. The distance of "Actual" includes that of "Tow".

"T/A" is the ratio of the distance for towing to the actual distance. As for this rate, 25% becomes a standard. A result grows big from this standard gradually. This reason is that workers are progressing in their skill, and the speed of paying out the mooring line with the sediment traps reduced in consideration of the margin of the safety. It is necessary to reexamine the standard of 7 miles for the deployment distance if the standard of 25% for the towing ratio needs to be maintained.

The distance to the site in which the sinker was dropped from the stage that the releaser was set to the stern was as follows.

Mooring No.	Distance (Time)
MMP (Test)	0.26 miles (18 minutes)
BGC (Test)	0.26 miles (12 minutes)
BGC (Long-term)	0.41 miles (25 minutes)

During this navigation, the distance to the dropped point was one by one informed with the communication device from the bridge to a team of technician and deck personnel. And the bridge counted down from 10 meters before the point dropping the sinker.

After the sinker had been dropped, the ship made a U-turn and pursued it so as to make sure that the top buoy disappeared from surface. The time to disappearing of the top buoy from dropping of the sinker was as follows.

MMP (Test mooring) 30 minutes
BGC (Test mooring) 47 minutes, BGC (Long-term mooring) 50 minutes

Meanwhile the time that the sinker arrived at the seabed and the time that the top buoy disappeared from the surface were measured by the tension-meter that are connected near the top and the end of the mooring. (see 3.1.1.2 Results of test mooring)

In case of the test mooring of BGC at K2, each relation is shown in the followings. (Fig 6.1-13)

Mar.5,'05 **0314 UTC** 47-00.58N, 159-57.74E The sinker was dropped into the ocean
Mar.5,'05 **0401 UTC** 46-59.93N, 159-59.41E The top buoy disappeared from the surface
Mar.5,**'05 0411 UTC** 47-00.48N, 159-57.97E The sinker arrived at the seabed

Namely, the sinker dropped arrived at the bottom of water 57 minutes later, and then after the top buoy disappeared from the surface, that was after 10 minutes.

From the point where the top buoy disappeared from the surface to the point where the sinker arrived at the seabed was at the horizontal distance of about 2100 meters in the direction of 300 degrees. When the top buoy went down from the surface of the water, it guesses that the sinker was a distance of about 500 meters over the bottom of the sea. In this case the horizontal distance as a straight line between the sinker and the top buoy is calculated at 2155 meters. It seems that there is no big difference between the two though the catenary effect of the mooring line is not considered.

(5) Data archive

All data will be archived on board.

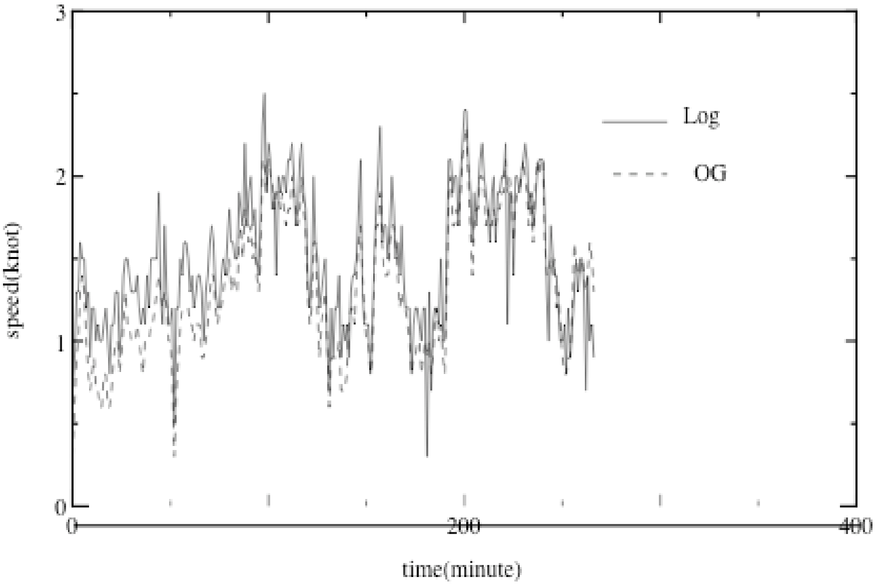
(6) Remarks

In this time, the tests of the MMP/BGC moorings were conducted before the deployment of the long-term mooring, and the measurement of the towing tension with high accuracy was carried out. These are worthy of remark.

The valuable data obtained here contributes greatly to more efficient work in the future.

Fig6.1−1 Ship's Speed Stn k2 Deployment(Test)

MMP



BGC

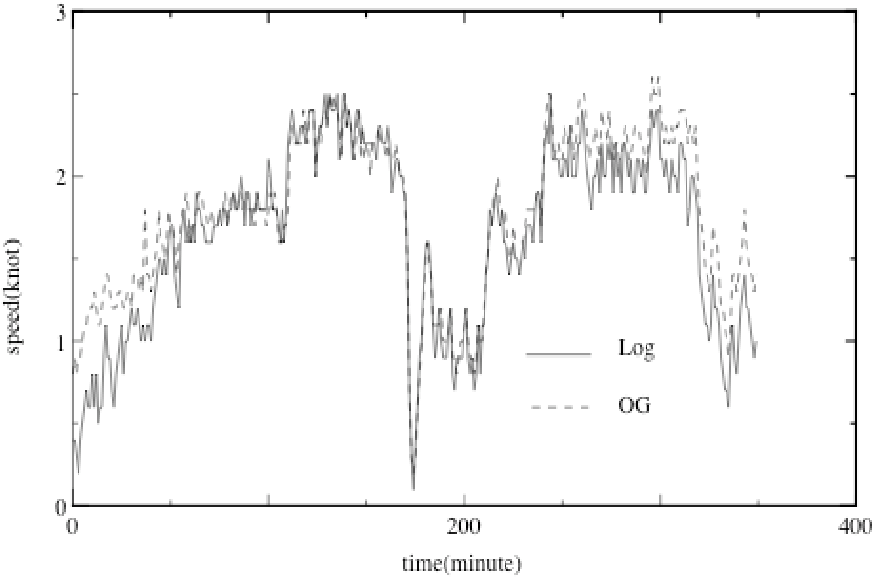


Fig6.1–2 Ship's Speed Stn k2 Deployment(Long–term)

BGC

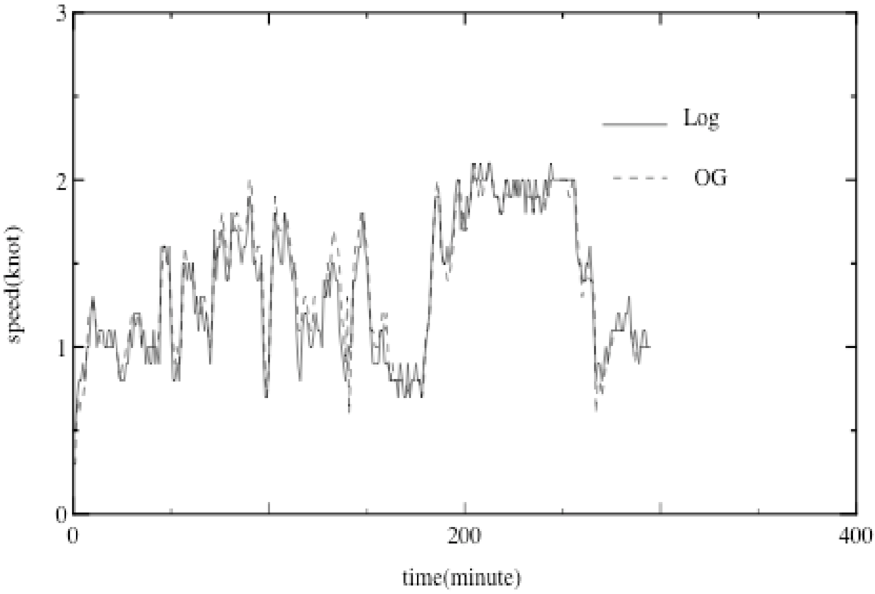


Fig6.1–3 External force influence(relative wind) Stn K2(Test)

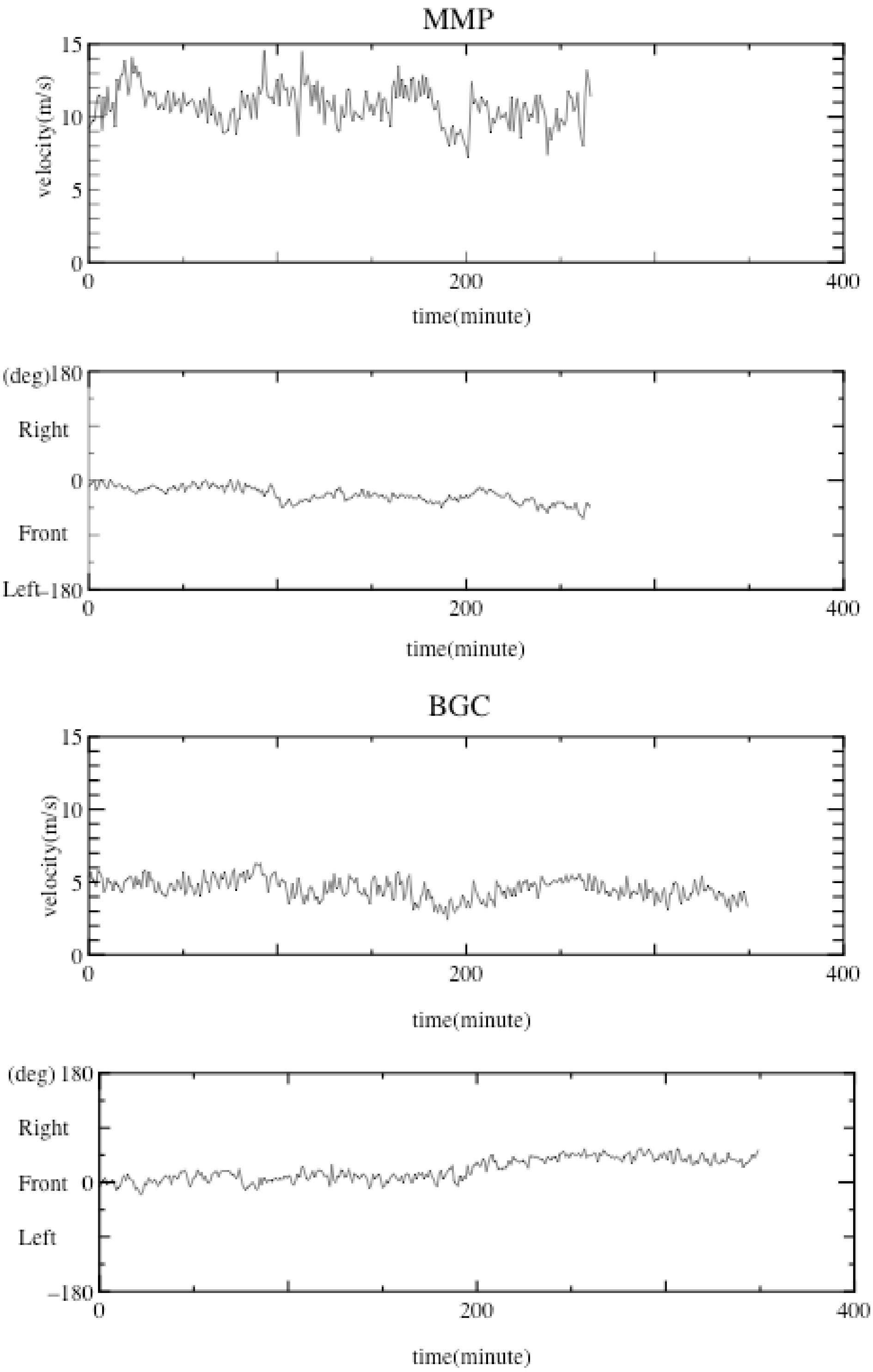
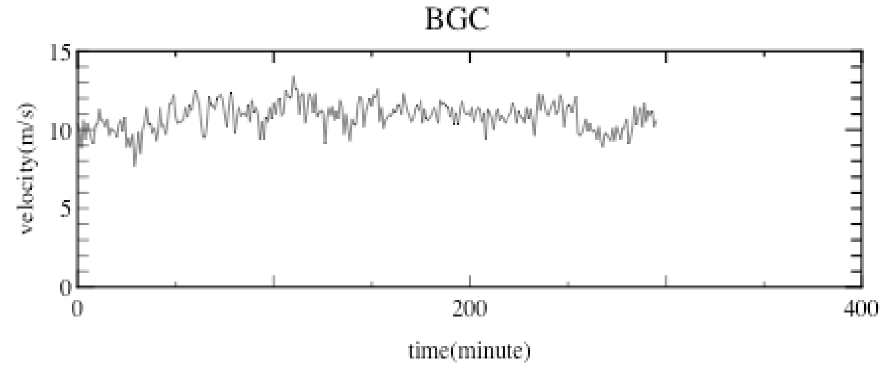


Fig6.1–4 External force influence(relative wind) Stn K2(Long–term)



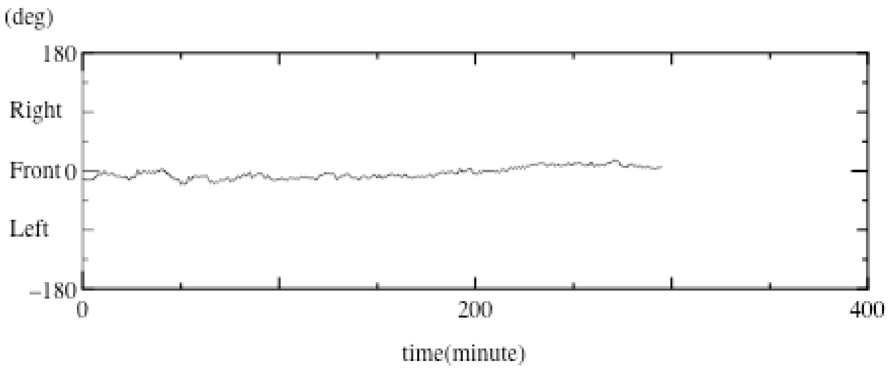
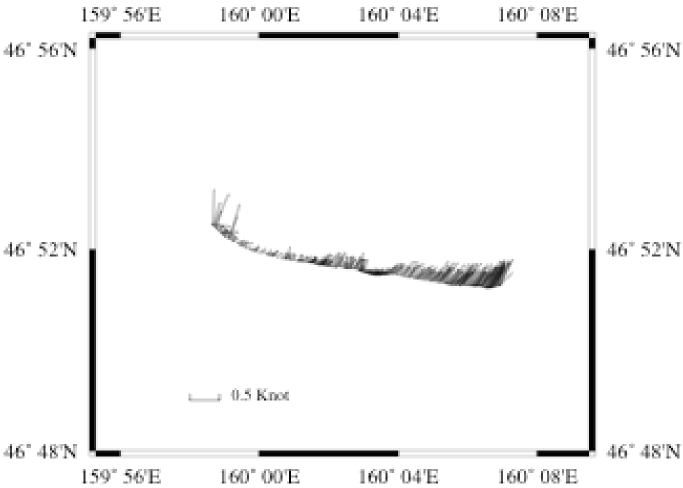


Fig 6.1-5 True current Stn K2 (Test)

MMP



BGC

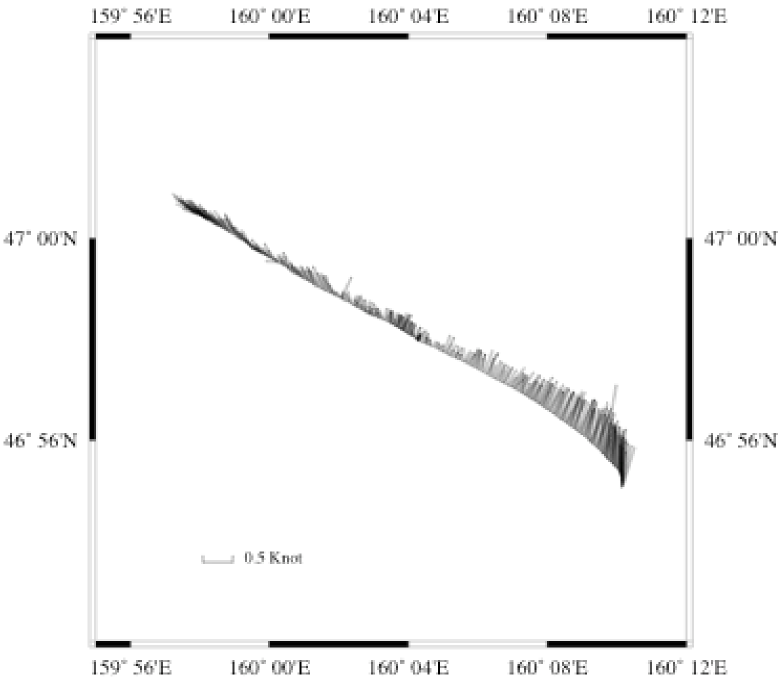


Fig 6.1-6 True current Stn K2 (Long-term)

BGC

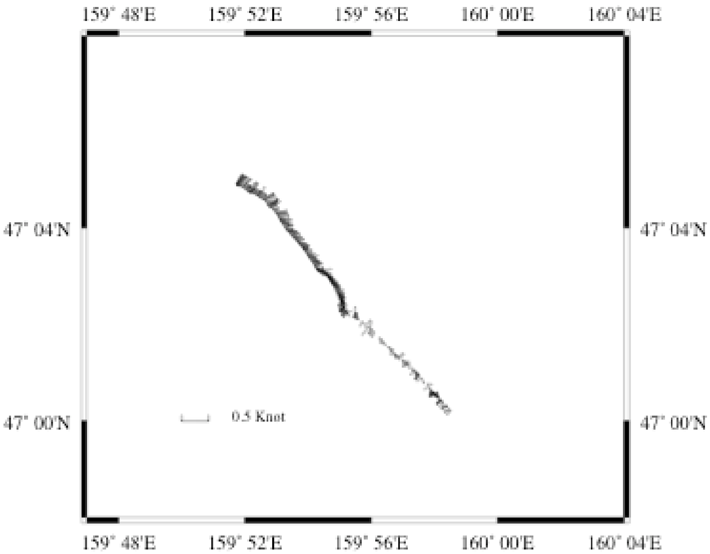
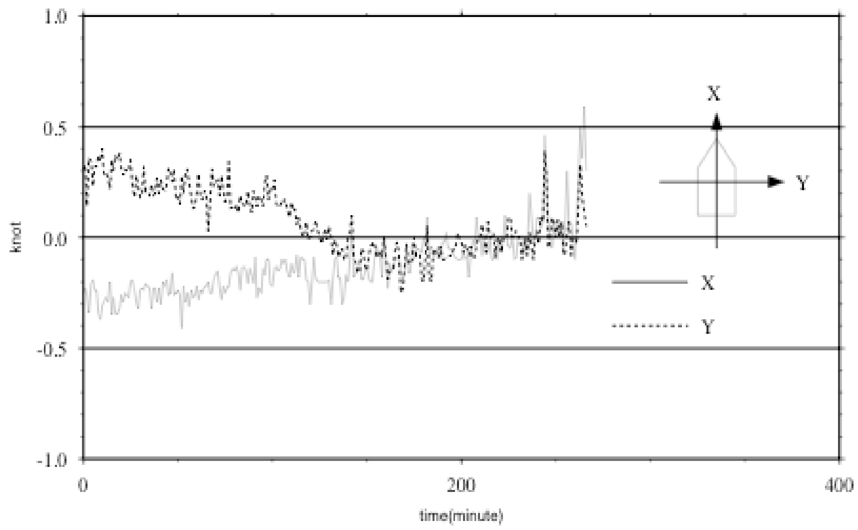


Fig 6.1-7 External force influence(Current) Stn k2 (Test)

MMP



BGC

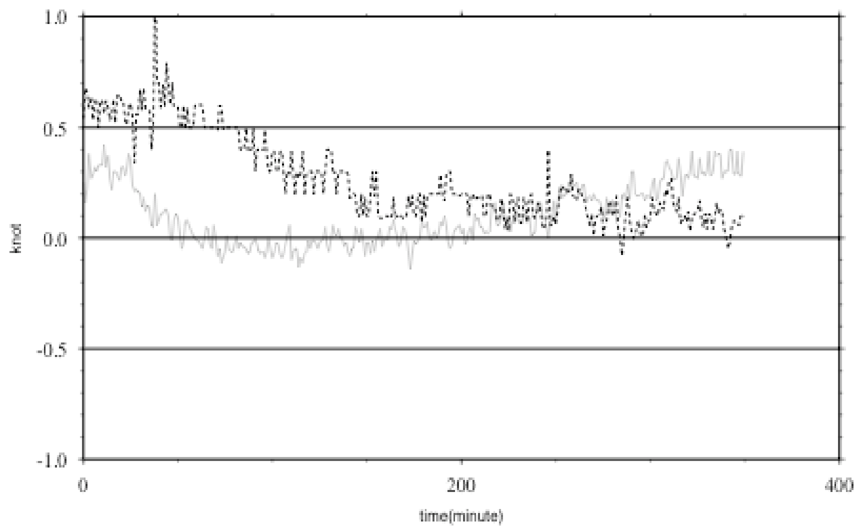


Fig 6.1-8 External force influence(Current) Stn k2(Long-term)

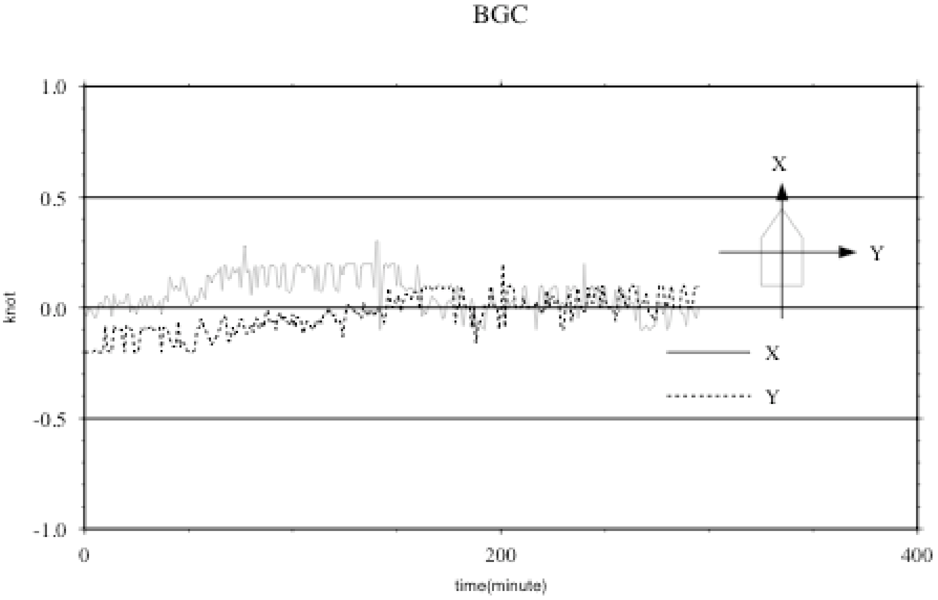


Fig 6.1-9 Tention of towing

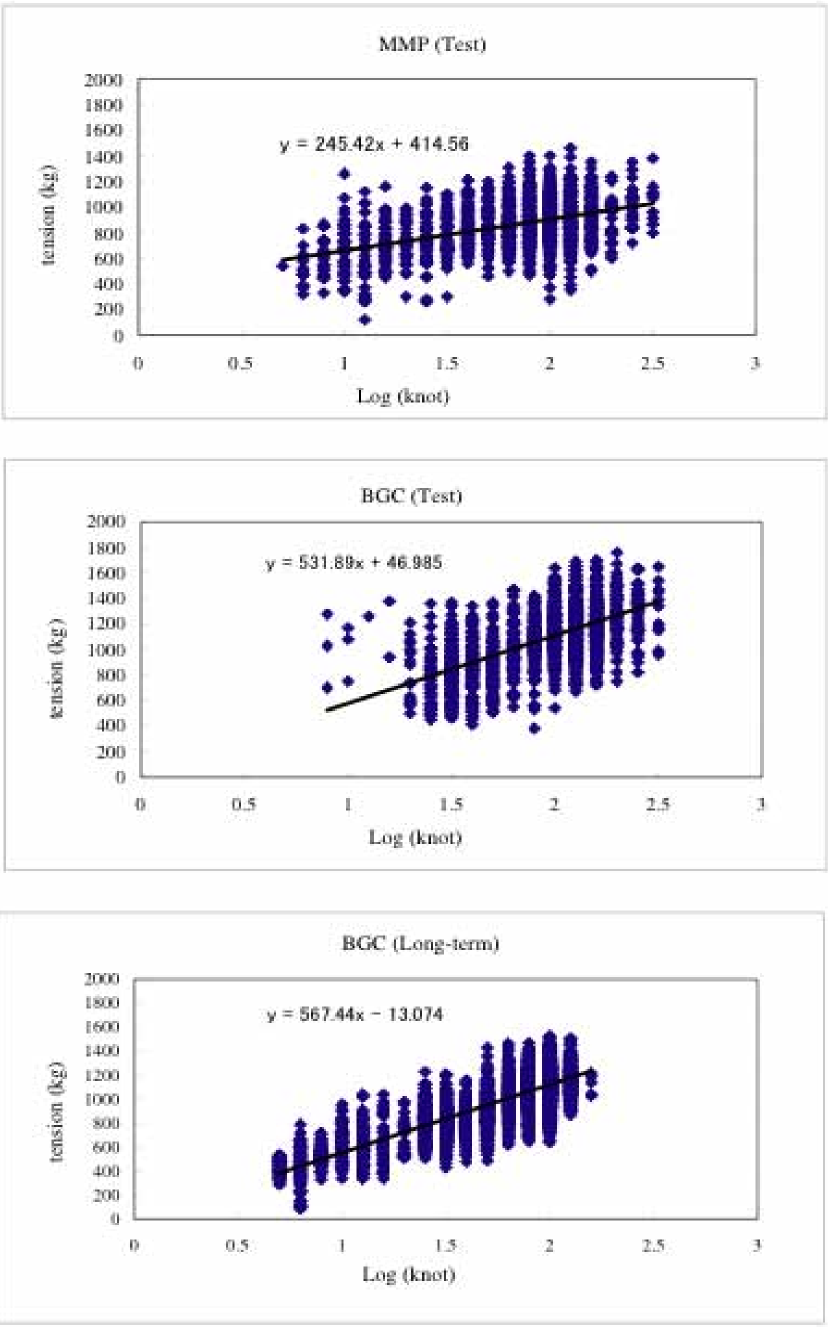
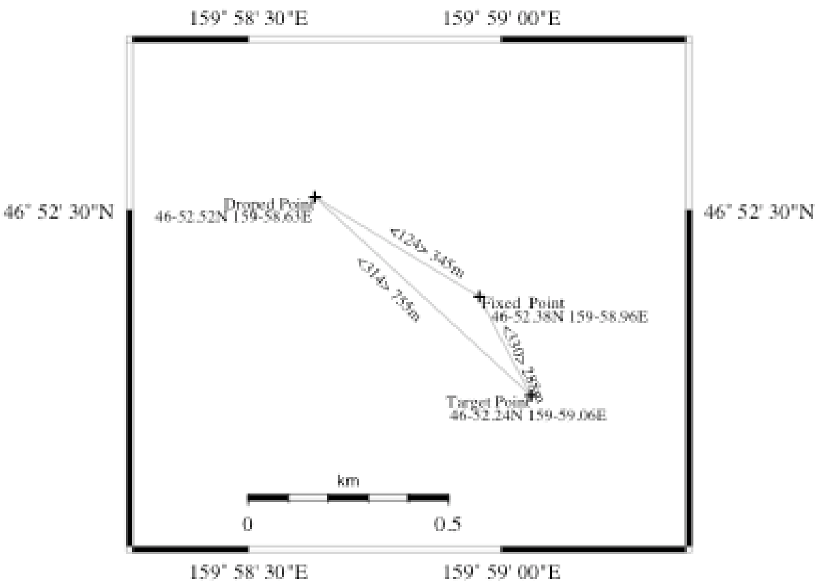


Fig 6.1-10 Mooring Point(Test)

K2-MMP



K2-BGC

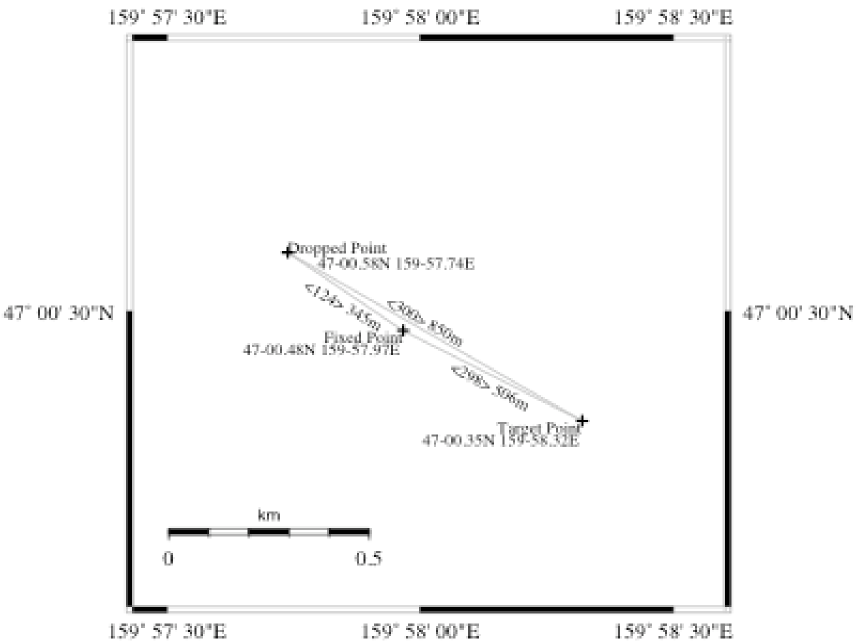


Fig 6.1-11 Mooring Point(Long-term)

K2-BGC

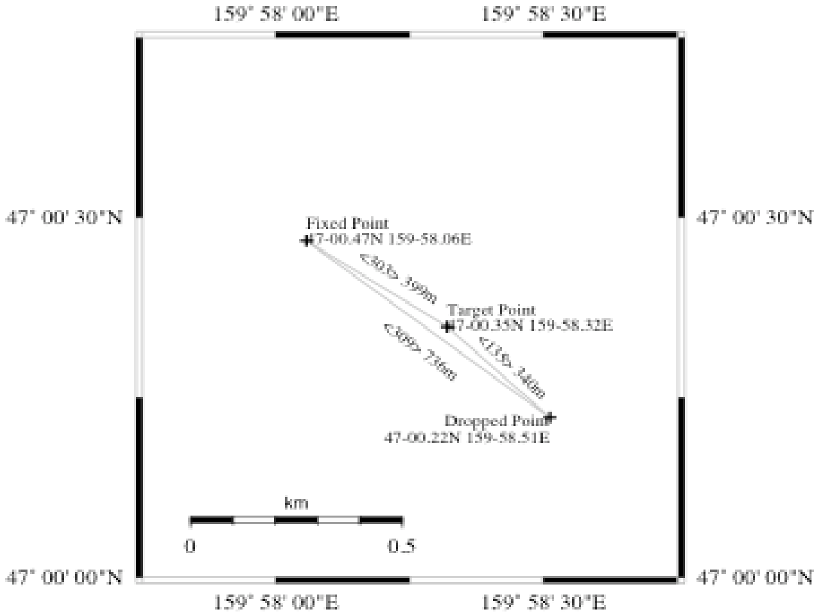


Fig 6.1-12 Stn K2 BGC Mooring

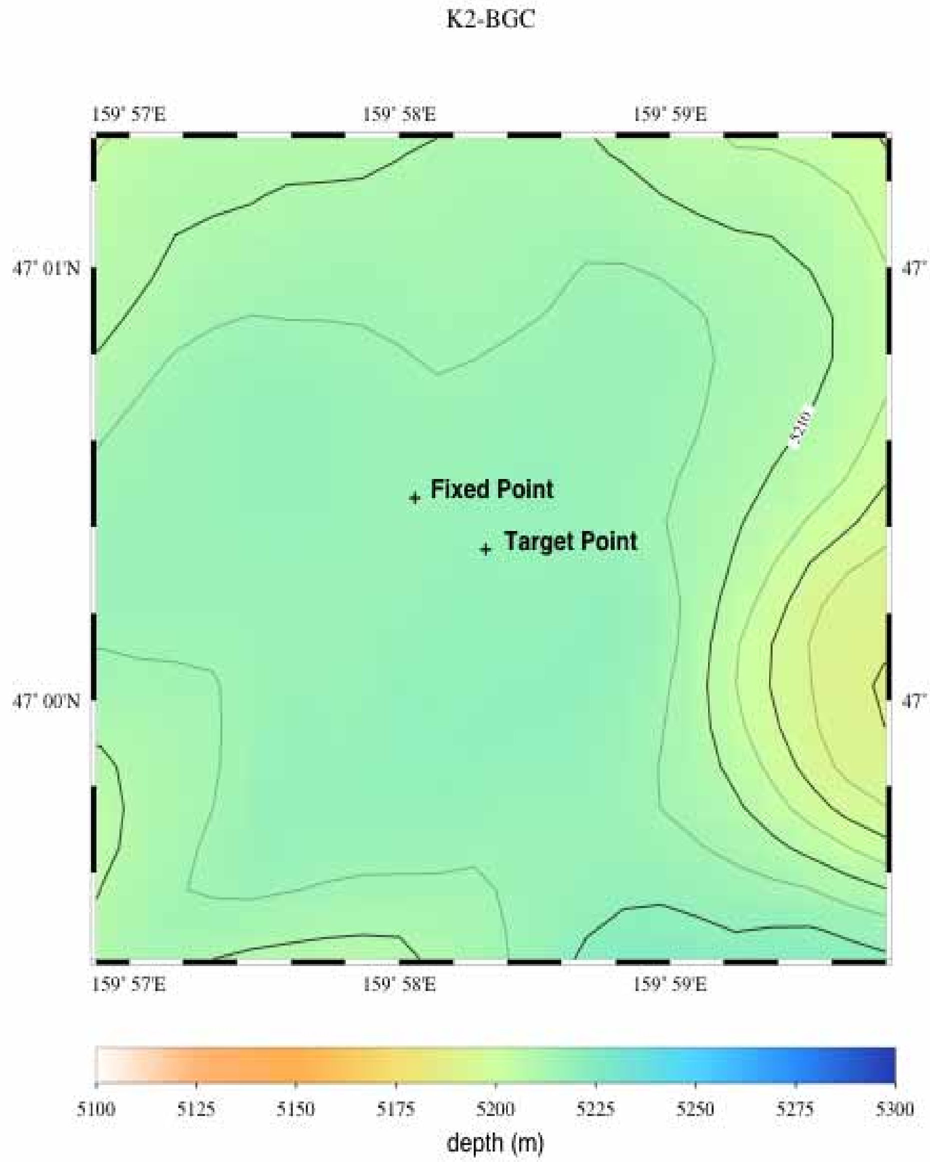


Fig 6.1-13 Ship's track for deployment of BGC Stn k3(Test)

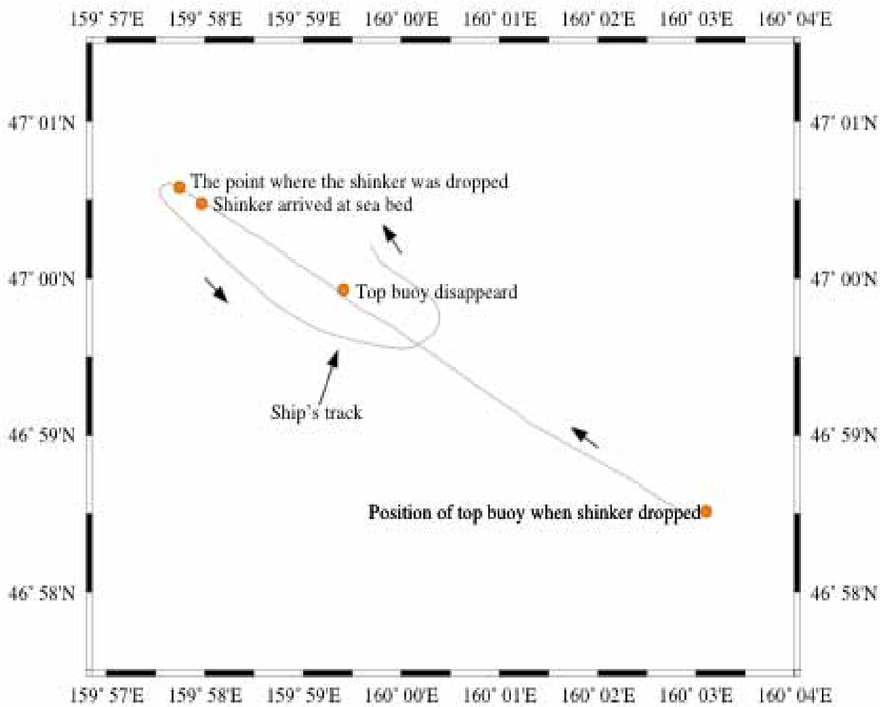


Table 6.1-1

MMP

time(UTC)	OG(knot)	Course (deg.)	Log(knot)	Heading (deg.)	True Wind direction (Deg.)	True Wind speed(m/s)	Current direction(deg.)	Current Speed(knot)
21:10	0.2	226.8	0.6	255.0	249	8.7	26.5	0.4
21:20	1.0	247.2	1.3	254.3	254	9.1	27.8	0.5
21:30	0.7	257.3	1.1	255.7	250	10.4	32.8	0.4
21:40	1.0	276.0	1.3	260.0	242	13.5	30.9	0.4
21:50	1.1	267.0	1.4	259.5	251	10.8	33.9	0.3
22:00	1.3	277.7	1.5	260.2	246	9.5	36.9	0.3
22:10	0.7	277.9	1.2	259.8	251	10.5	38.1	0.3
22:20	1.1	295.0	1.3	260.1	256	9.0	45.6	0.3
22:30	1.2	282.1	1.3	259.6	252	8.3	34.5	0.4
22:40	1.3	282.8	1.5	266.6	263	9.8	48.3	0.3
22:50	1.6	274.7	1.8	272.1	245	13.7	53.4	0.3
23:00	1.8	286.5	1.9	275.4	228	11.6	52.2	0.2
23:10	1.9	268.5	2.0	270.3	233	13.8	52.2	0.1
23:20	1.6	285.0	2.0	270.2	241	10.6	65.8	0.2
23:30	0.9	280.3	0.9	269.4	258	8.5	97.0	0.1
23:40	1.2	282.4	1.4	269.5	241	9.4	115.8	0.2
23:50	0.9	294.0	1.1	272.8	248	10.5	102.8	0.2
0:00	1.7	279.4	2.0	272.4	244	10.4	136.4	0.2
0:10	0.8	281.3	0.8	275.0	246	10.5	130.5	0.2
0:20	0.8	288.3	0.7	274.7	235	10.2	159.0	0.2
0:30	2.0	276.3	2.1	269.9	233	8.5	151.8	0.1
0:40	1.7	285.4	1.9	269.3	245	11.5	119.0	0.1
0:50	1.7	287.3	1.6	268.9	251	8.1	134.1	0.1
1:00	2.0	277.1	1.9	274.8	248	8.1	272.1	0.1
1:10	1.7	296.8	1.8	280.3	244	8.9	133.3	0.1
1:20	1.4	312.0	1.0	284.2	228	7.1	326.2	0.1
1:30	0.9	316.8	1.2	276.8	229	9.4	323.1	0.1
1:40	1.4	315.9	1.4	289.4	241	11.1	323.1	0.6
1:50	4.7	46.9	5.2	81.2	247	7.4	206.1	0.1

BGC

time(UTC)	OG(knot)	Course (deg.)	Log(knot)	Heading (deg.)	True Wind direction (Deg.)	True Wind speed(m/s)	Current direction(deg.)	Current Speed(knot)
21:20	0.8	340.6	0.3	299.4	303	5.4	8.3	0.7
21:30	1.0	357.0	0.5	300.7	301	5.6	2.2	0.6
21:40	1.2	345.2	0.6	299.8	315	4.5	8.0	0.6
21:50	1.3	315.7	1.1	300.8	295	4.9	0.7	0.7
22:00	1.4	311.8	1.0	289.1	302	3.7	6.2	0.6
22:10	1.6	311.2	1.5	289.6	314	3.8	11.5	0.7
22:20	1.7	312.7	1.6	290.4	295	3.9	12.4	0.6
22:30	1.9	306.2	1.8	289.4	312	4.5	13.1	0.5
22:40	1.8	303.2	1.8	289.8	299	4.0	26.3	0.5
22:50	1.9	303.5	1.9	289.3	297	4.2	25.4	0.4
23:00	1.8	305.4	1.8	289.6	295	3.5	28.6	0.4
23:10	1.6	307.1	1.7	289.0	307	3.4	31.9	0.4
23:20	2.2	298.0	2.2	289.3	312	2.9	37.1	0.3
23:30	2.2	297.3	2.2	289.3	289	4.0	22.8	0.3
23:40	2.4	301.2	2.5	290.0	312	3.0	12.4	0.3
23:50	2.3	296.1	2.4	289.6	307	3.0	4.0	0.1
0:00	2.2	297.2	2.1	290.2	305	3.4	21.6	0.3
0:10	2.2	293.3	2.1	289.2	292	3.7	358.2	0.1
0:20	0.3	329.7	0.4	290.4	311	3.0	26.1	0.1
0:30	1.1	307.2	0.9	290.7	317	2.4	14.3	0.2
0:40	0.9	318.3	0.7	290.9	323	2.9	29.7	0.2
0:50	0.8	297.1	0.7	290.4	308	4.1	6.5	0.2
1:00	1.9	293.7	1.8	289.1	320	2.5	9.7	0.2
1:10	1.7	291.0	1.6	289.6	332	3.9	305.3	0.1
1:20	1.8	300.2	1.6	299.2	343	4.1	341.5	0.1
1:30	2.3	301.7	2.1	294.4	356	4.3	353.3	0.1
1:40	2.3	296.5	2.0	294.9	346	4.5	344.7	0.3
1:50	2.2	307.1	1.8	293.9	350	5.0	331.5	0.3
2:00	2.2	303.5	2.2	295.8	348	3.6	299.0	0.1
2:10	2.1	301.2	2.1	294.3	355	4.8	272.0	0.2
2:20	2.4	296.7	2.2	295.4	343	4.4	299.2	0.2
2:30	2.2	305.9	1.9	294.8	342	3.8	327.7	0.3
2:40	2.3	305.7	1.8	301.0	336	3.9	327.0	0.4
2:50	1.3	293.6	1.0	296.1	341	5.0	321.0	0.3
3:00	0.9	303.8	0.6	297.4	338	3.8	320.2	0.4
3:10	1.5	297.4	1.2	296.3	340	3.8	310.0	0.3
3:20	2.6	169.2	3.2	141.3	335	2.9	268.3	0.3

Table 6.1-2

BGC

time(UTC)	OG(knot)	Course (deg.)	Log(knot)	Heading (deg.)	True Wind direction (Deg.)	True Wind speed(m/s)	Current direction(deg.)	Current Speed(knot)
21:00	0.5	141.0	0.6	129.5	120.0	9.4	34.9	0.2
21:10	0.7	144.4	0.8	130.5	117.0	9.0	30.7	0.2
21:20	1.0	122.8	1.1	124.4	119.0	9.7	72.7	0.1
21:30	0.8	110.9	0.8	124.6	111.0	10.4	35.2	0.2
21:40	1.2	119.6	1.2	119.4	117.0	9.8	29.1	0.1
21:50	1.1	135.0	0.9	124.2	119.0	9.8	63.4	0.2
22:00	0.9	115.5	0.8	132.8	123.0	10.2	60.0	0.1
22:10	1.2	144.4	1.1	132.5	119.0	8.9	95.0	0.2
22:20	1.6	149.1	1.6	134.4	123.0	11.0	111.2	0.2
22:30	1.8	135.0	1.7	128.4	123.0	10.1	100.5	0.2
22:40	1.6	135.7	1.4	128.6	121.0	9.7	118.6	0.1
22:50	1.8	144.4	1.7	132.4	117.0	10.0	114.0	0.2
23:00	1.4	149.5	1.1	132.5	122.0	11.6	85.0	0.1
23:10	1.3	100.3	1.2	122.8	118.0	10.6	83.6	0.2
23:20	1.6	140.4	1.4	129.3	124.0	11.2	135.6	0.2
23:30	1.6	144.9	1.4	132.5	123.0	11.4	112.8	0.2
23:40	1.0	157.0	0.9	133.4	126.0	10.0	168.1	0.1
23:50	0.8	163.4	0.8	132.5	128.0	11.1	242.0	0.1
0:00	0.8	168.1	0.8	133.7	125.0	10.8	214.4	0.1
0:10	1.7	131.2	1.7	128.4	126.0	9.5	230.4	0.0
0:20	1.6	123.2	1.7	125.6	124.0	9.4	276.6	0.0
0:30	2.0	138.6	2.1	132.5	131.0	10.3	225.1	0.1
0:40	2.0	137.8	2.0	132.4	135.0	10.3	4.8	0.0
0:50	1.9	132.8	1.9	130.8	138.0	9.4	151.9	0.1
1:00	1.9	127.3	1.9	130.3	143.0	10.1	95.5	0.1
1:10	2.0	133.8	2.1	134.6	144.0	9.9	146.6	0.1
1:20	1.9	134.5	2.0	135.5	149.0	11.1	126.2	0.0
1:30	1.4	138.7	1.6	137.3	148.0	9.2	214.3	0.1
1:40	1.0	139.2	1.0	132.4	142.0	8.8	348.7	0.1
1:50	1.1	137.0	1.3	132.4	141.0	10.9	216.7	0.0
2:00	1.0	136.9	1.0	132.6	137.0	9.7	251.7	0.1
2:10	8.1	329.2	8.1	330.2	142.0	10.0	318.0	0.4

Table 6.1-3 SUMMARY OF WORKING TIME FOR DEPLOYMENT MMP MOORING DURING MR0501

	Mooring No.	K2 (Test)	K2	K2	
	Target point lat.	46-52.24N	46-52.24N	46-52.24N	
	Long.	159-59.06E	159-59.06E	159-59.06E	
	Works Date	3.Mar.05	9.Sep.01	24.Oct.02	
	Depth (m)	5152.3	5152.3	5152.3	
	Com'ced	8:16	8:13	13:24	
	Buoy into sea	8:19	8:15	13:25	
	Set MMP	9:30	8:44	13:54	
	Set Bumper stop	10:27	11:04	16:15	
	Set floats (Middle)	10:49	11:07	16:21	
	Set floats (Bottom)	11:21	11:35	16:42	
	Set Releaser	12:25	12:31	17:23	
	Let go sinker	12:43	12:43	17:53	Average
H	for top buoy	0:03	0:02	0:01	0:01
o	for wire rope	2:08	2:49	2:50	2:49
u	for floats	0:54	0:31	0:27	0:29
r	for towing	1:04	0:56	0:41	0:48
s	for S/B sinker	0:18	0:12	0:30	0:21
Total		4:27	4:30	4:29	4:29
Length of wirerope(m)		**4000**	**4500**	**4500**	4,500
Length of rope(m/h)		**1,875**	**1,598**	**1,588**	1,593
D	for buoy/rope (mile)	2.54	4.09	4.31	4.20
I	for floats (mile)	1.11	0.73	0.7	0.72
					0.00
s	for towing (mile)	1.89	1.69	0.79	1.24
t	for sinker (mile)	0.26	0.25	0.66	0.46
Total (mile)		5.8	6.76	6.46	6.61
S	for buoy/rope (knot)	1.2	1.4	1.5	1.5
p	for glass balls (knot)	1.2	1.4	1.6	1.5
ee	for towing (knot)	1.8	1.8	1.2	1.5
d	for sinker (knot)	0.9	1.3	1.3	1.3
	Average OG speed (knot)	1.3	1.5	1.4	1.5
	Average Log speed (knot)	1.45	1.4	1.4	0.5

Table 6.1-4 SUMMARY OF WORKING TIME FOR DEPLOYMENT BGC MOORING DURING MR0501

	Mooring No.	K2(Test)	K2(Long-term)	K2	K2	Average
	Location	47-00.35N 159-58.326E	47-00.35N 159-58.326E	47-00.35N 159-58.326E	47-00.350N 159-58.326E	
	Works Date	5.Mar.05	18.Mar.05	9.Oct.01	25.Oct.02	
	Depth (m)	5206.2	5206.2	5206.2	5206.2	
	Com'ced deployment	8:25	7:51	10:09	10:30	
	Top buoy into sea	8:38	8:09	10:32	10:54	
	Sediment(1) into sea	8:47	8:24	11:23	11:19	
	Sediment(2) into sea	8:59	8:36	12:09	13:09	
	Sediment(3) into sea	9:11	8:48	14:22	15:02	
	Sediment(4) into sea	9:44	9:00			
	Sediment(5) into sea	11:15	10:29			
	Set Glass balls	11:47	10:54	14:48	15:31	
	Set Releaser	14:02	12:36	16:20	15:59	
	Let go sinker	14:14	13:01	16:40	16:11	
H	for top buoy/sensors	0:13	0:18	0:23	0:24	0:23
o	for sediments	3:09	2:45	4:16	4:37	4:26
u	for towing	2:15	1:42	1:32	0:28	1:00
r	for S/B sinker	0:12	0:25	0:20	0:12	0:16
Total		5:49	5:10	6:31	5:41	6:06
D	for top buoy (mile)	0.15	0.23	0	0.09	0.05
I	for sediments (mile)	5.37	2.9	5.29	6.69	5.99
s	for towing (mile)	4.38	3.25	2.56	0.71	1.64
t	for sinker (mile)	0.26	0.41	0.45	0.28	0.37
Total (mile)		10.16	6.79	8.30	7.77	8.04
S	for top buoy (knot)	0.7	0.8	0.0	0.2	0.1
p	for sediments (knot)	1.7	1.1	1.2	1.4	1.3
ee	for towing(knot)	1.9	1.9	1.7	1.5	1.6
d	for sinker (knot)	1.3	1.0	1.3	1.4	1.4
	Average OG speed (knot)	1.7	1.3	1.3	1.4	1.3
	Average LOG speed (knot)	1.56	1.33	1.7	1.3	1.5

6.2 Ship's Handling for the recovery of the MMP/BGC moorings

(1) Objectives

When a mooring of a MMP or a BGC is recovered, after separating it from the seabed, it is important to know in what direction it will be adrift by the wind, the current, and the swell, etc. in order to catch it safely, and efficiently. Moreover, it is greatly helpful to grasp actual working hours when performing future work.

It aims at reqording results of recovering the mooring systems such as the MMP/BGC from the standpoint of the ship's handling.

(2) Observation parameters

- Movements of the MMP and the BGC moorings released from the seabed
- Ship's position, course, speed
- Directions of the wind/the current/the swell, velocities of the wind/the current

(3) Methods

(3.1) Measurement of the actual ship-movement

Measurement of the ship-movement at coming close to the top buoy and the glass ball floats is carried out in a radio navigation device assembled by Sena Co., Ltd. Japan.

(3.2) Measurement of the wind and the current

The wind direction and speed are measured by KOAC-7800 weather data processor and sensors assembled by Koshin Denki.

The current direction and speed are continuously measured by a Doppler sonar installed at the bottom of the ship. The Doppler sonar is assembled by FURUNO Electric Co., Ltd.

(3.3) Measurement of the releaser-movement in the sea

The releaser is operated with an acoustic transducer which is made by Edgeteh Inc. USA.

(4) Maneuver

(4.1) Surfacing of the moorings

(a) The ship is located downwind or downstream on a distance of 200 - 400 meters from the mooring point of the MMP/BGC moorings. The clutches of the CPP are disengaged and the operation of the Stern thruster and the SEABEAM are suspended except the bow thruster for adjusting the ship's head. The "Enable" signal is sent from the stern of the ship by the transducer and the signal reception is confirmed. It is demanded to be nearly over the mooed point when the signal reception is difficult. After the reception is confirmed, it is necessary to go away from the moored point by 400,500 meters because the point where the top buoy surfaces might shift by about 200 meters. In this time the clutches of the CPP are engaged.

(b) The MMP/BGC moorings are released from the seabed by using the acoustic transducer on 11 and 12 kHz at the mooring deck of the ship's stern.

(c) On the assumption that the mooring point is correct, a top buoy of each mooring is surfaced in the direction of the current. In case there is hardly a flow, the top buoy surfaces right above the mooring point. The top buoy receives the influence of the wind after it surfaces, and drifts.

(4.2) How to approach the top buoy/the glass ball floats

(a) When the ship approaches buoys etc, the angle between the ship's course and the wind direction is made as small as possible in order to lessen the external force influence of the wind. In addition the ship's course is decided to make her locate in the lee of buoys/glass ball floats.

(b) To prevent the ropes etc. from twining round the ship's propeller, the clutch of the propeller in the recovery-side is discharged until the handling rope is connected to buoy etc. from the time that the ship approaches buoys etc.

(c) In case of calm sea state, the work to catch the top buoy is carried out with the working boat after all of the system surfaces. When the working boat is lowered, and the working boat is drawn up, the ship makes the lee to have calm water, an ample berth for it.

(d) In case of rough sea state, the ship is handled to approach the top buoy most and the top buoy is caught from the upper deck of the ship by a grapnel or a hook and a long pole because the working boat is not able to use due to rough sea. Because delicate measuring instruments are installed under the top buoy, it is prohibited to push the buoy strongly, and to hit it the discharging current from CPP and propeller of the side-thruster.

Be careful when the hook/pole is used to catch the top buoy since the various instruments installed under the top buoy might be damaged. Therefore the hook installed the end of the long pole, a long rope connected with the hook is used as the second plan.

(e) While recovering mooring ropes/cables, the ship is steered by side thrusters in order to tow them straight behind. It is easy to carry out the work if the ship proceeds to upwind.

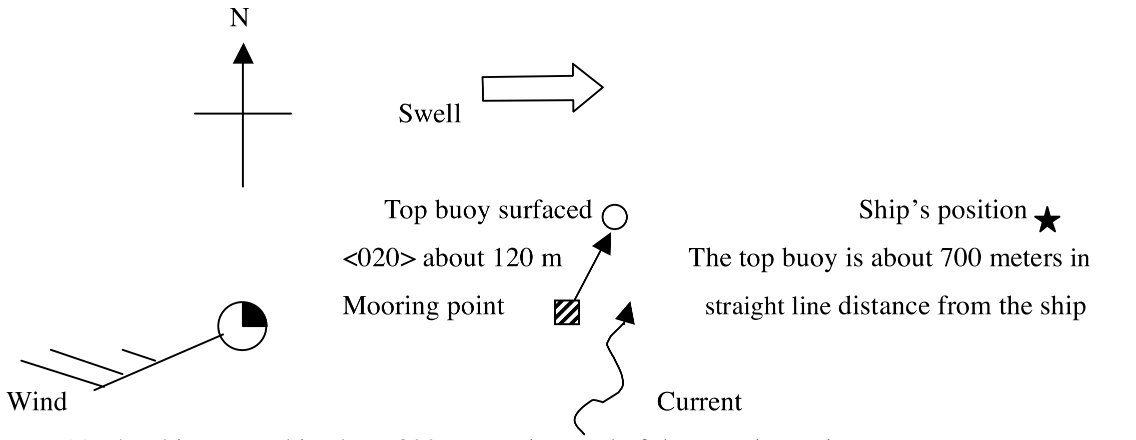
(f) Since the BGC mooring in which a lot of observation equipments and sediment traps are installed, it cannot be strongly towed. The ship's speed is kept about 1 knot or less. When these observation equipments are slung up the ship, Care is needed in handling them not to upset the observation equipment.

(5) Results

(5.1) Surfacing of the mooring (Fig 6.2-1 & 2)

The results are shown in following figures and these are characterized as follows.

8.1 <u>In case of MMP at K2 site (Test mooring)</u>

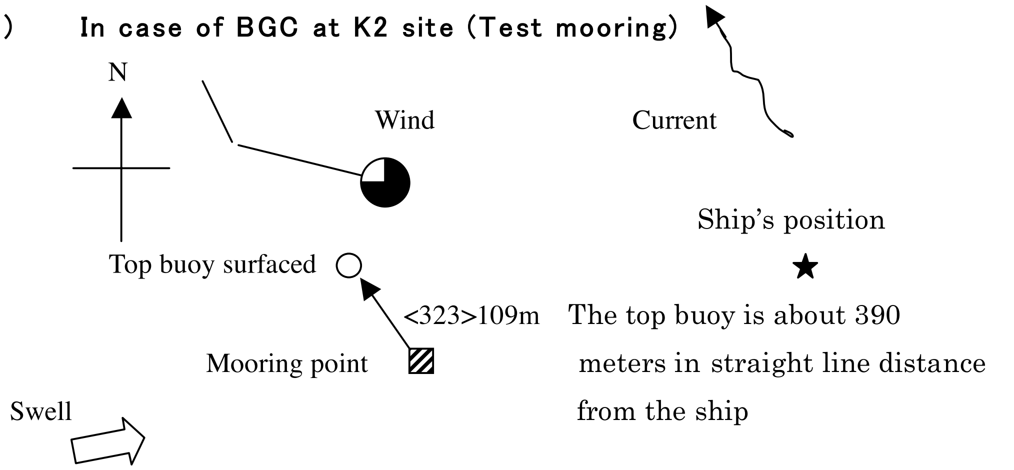


(a) The ship stopped in about 300 meters leeward of the mooring point.

(b) The ship received the wind from the starboard bow and the acoustic transducer was lowered over the starboard stern. After the release signal on 11 and 12 kHz was sent, the mooring freed its anchor.

(c) The top buoy surfaced in about 120 meters from the mooring point in the flow direction. The fixed position in the deployment is assumed to be correct according to this result.

(1) In case of BGC at K2 site (Test mooring)



(a) The ship stopped in about 250 meters leeward of the mooring point.

(b) The ship received the wind from the starboard bow and the acoustic transducer was lowered over the starboard stern. After the release signal on 11 and 12 kHz was sent, the mooring was separated immediately from the seabed.

(c) The top buoy surfaced in about 100 meters from the mooring point in direction of the stream.

(5.2) Working hours for recovering the MMP/BGC moorings

The result is shown in Table 6.2-1 and the following matters are pointed out.

(a) The time consumed in recovery of the mooring was as follows.

MMP mooring: 4 hours and 4 minutes.

BGC mooring: 5 hours and 15 minutes.

The working hours of the BGC mooring are long in comparison with the MMP mooring because the BGC mooring is with many instruments such as sediment traps.

(b) Receipt of the release' acoustic response of the MMP mooring was late due to rough seas.

(c) The MMP mooring was caught by the grapnel from the port side and was recovered over the ship going toward the windward owing to the strong wind.

(d) The BGC mooring was caught by the grapnel from the starboard side and was recovered over the ship going toward the leeward because of a few influence of the wind.

(e) As for the MMP mooring, the middle floats and the bottom floats were coiled around in each other and they were recovered together.

(f) As for the BGC mooring, the bottom floats composed of 52 glass balls were recovered in 1 lump. And a wire rope near the end of the mooring was recovered under the condition which entangled itself.

(6) Data archive

All data will be archived on board.

(7) Remarks

As for the recovery work in this time, only the tests of the MMP/BGC moorings were carried out.

In rough seas, the method of catching the surfacing top buoy by using the grapnel without the working boat was confirmed.

Fig.6.2-1 FIGURE OF RECOVERY ＭＭＰ

Location: 46-52.38Ｎ, 159-58.96E

Date: 16th March 2005

Wind: <240> 13 m/s, Current: <020> 0.4 knot

Swell: West, Wave height: 3.6 m, 7.5 sec

Weather: bc,　Depth:5152.3m

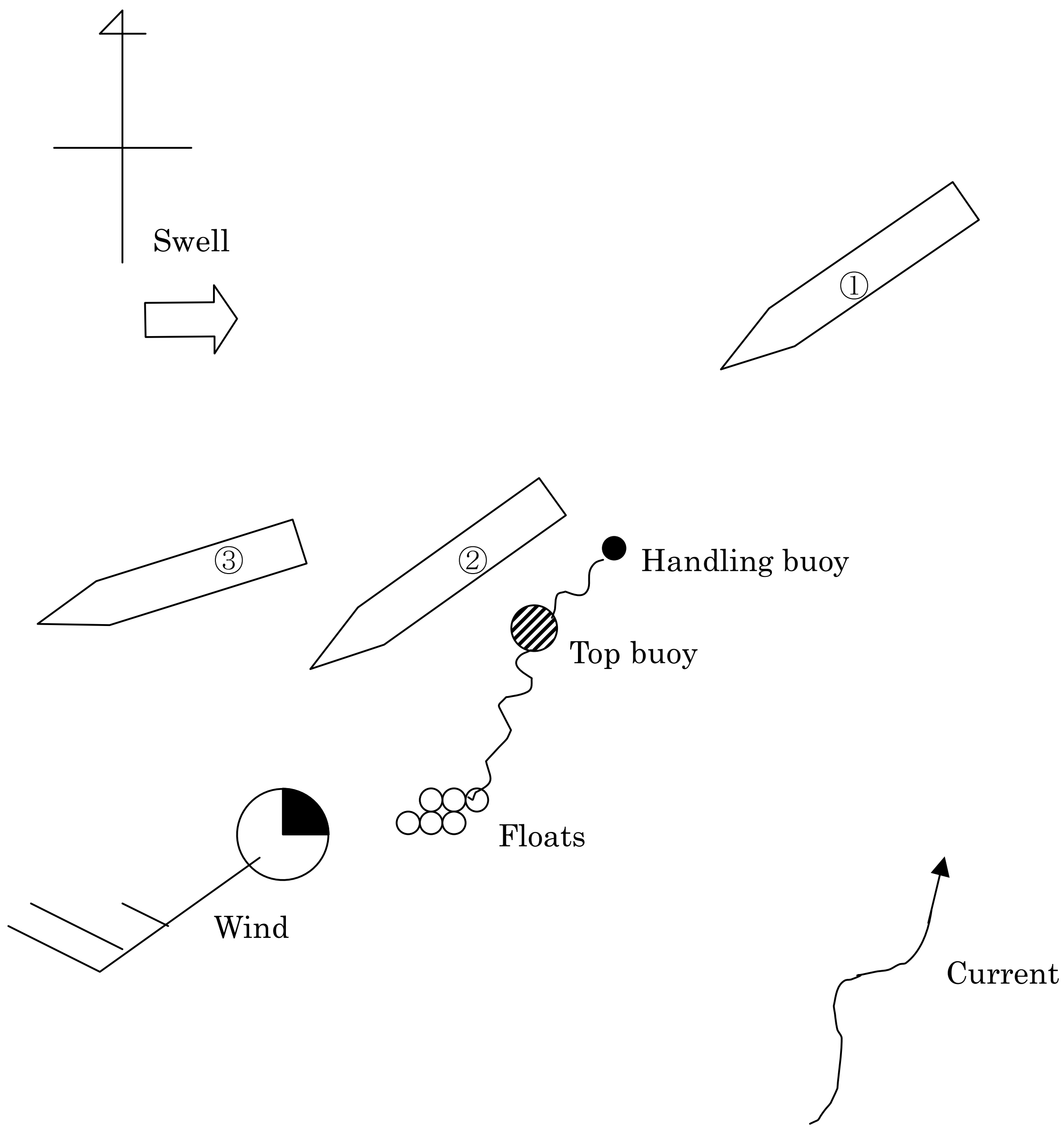


Fig.6.2-2 FIGURE OF RECOVERY　ＢＧＣ

Location: 47-00.48Ｎ, 159-57.97E

Date: 17th October 2002

Wind: <290> 3.7 m/s, Current: <VAR> 0.2 knot

Swell: WSW, Wave height: 2.4 m, 7.2 sec

Weather: c, Depth: 5206.2 m

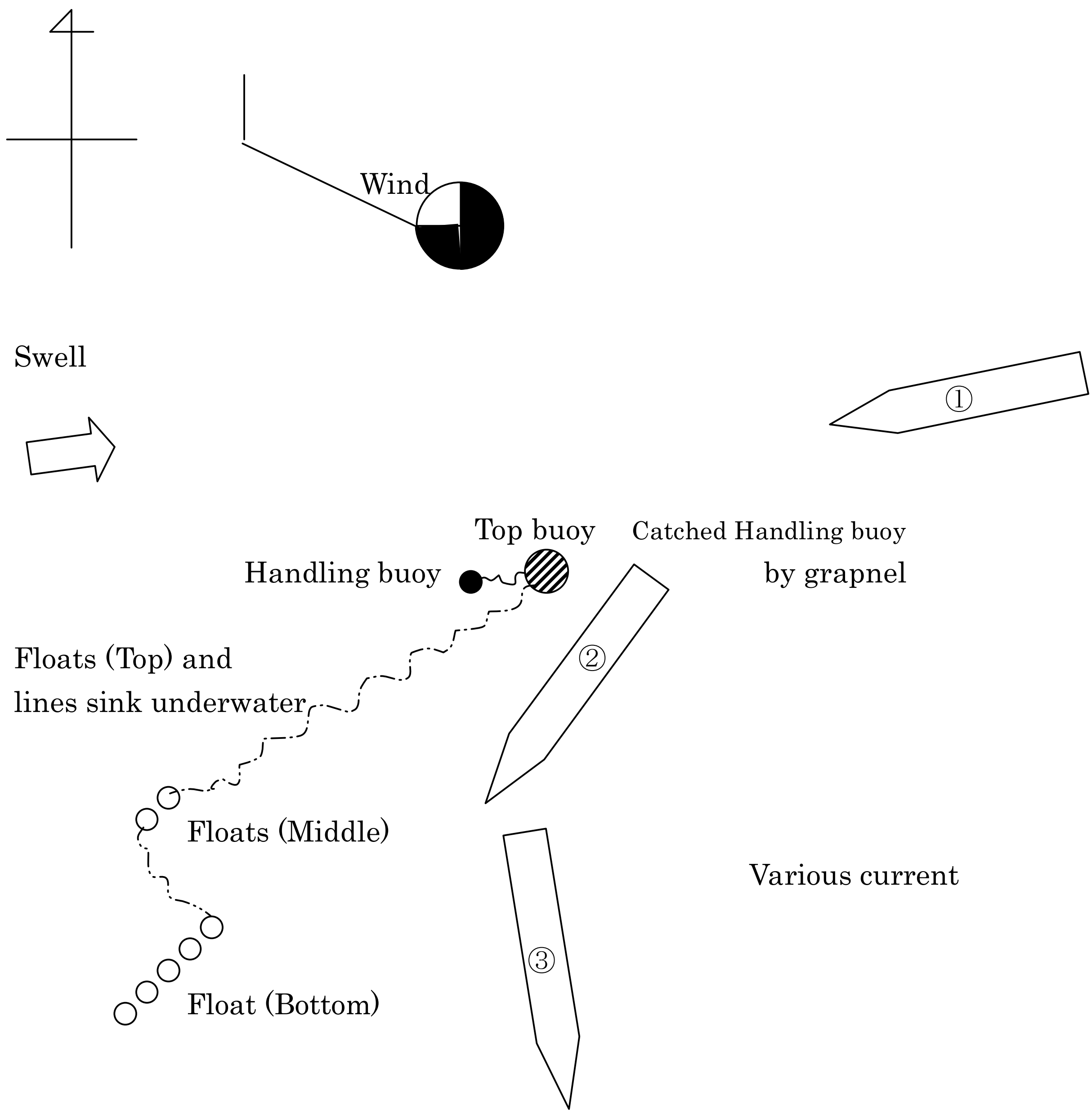


Table 6.2-1 RECOVERY OF MMP/BGC TEST MOORINGS DURING MR05-01

Mooring No.		K2-MMP
Location	lat	46-52.38N
	Long	159-58.96E
Date		16.Mar.05
Water depth (m)		5152.3
Com'ced work (Set transducer)		8:38
Released from sinker		8:48
Top buoy surfaced		8:49
Floats (Top) surfaced		9:38
Catched handling buoy by grapnel		10:28
Slinged top buoy stern		10:35
Winded up top buoy on deck		10:50
Recovery of MMP (Shallow)		11:08
Recovery of MMP (Deep)		11:57
Recovery of floats(Top)		12:10
Recovery of floats (Middle)		12:34
Recovery of floats (Bottom)/releaser		12:34
Finished work		12:42
Total working hours		4:04

Time consumed

in preparation for recovery	0:10
in rising of floats (Top) in depth 4200m	0:50
in catching of buoy	0:50
in recovery of top buoy	0:22
in recovery of MMP (Deep)	1:07
in recovery of floats/releaser	0:45
Total working hours	4:04

Maneuvering data

MOORING NUMBER	K2-MMP
Course when approaching (deg)	250
Course when catching b'y (deg)	250
Wind direction (deg)	240
Wind velocity (m/s)	13
Current direction (deg)	20
Current velocity (knot)	0.4
Swell direction	WEST
Wave height (m)	3.6

Mooring No.		K2-BGC
Location	lat	47-00.48N
	Long	159-57.97E
Date		17.Mar.05
Water depth (m)		5206.2
Com'ced work (Set transducer)		7:03
Released from sinker		7:05
Top buoy surfaced		7:06
Floats (Bottom) surfaced		7:53
Catched top buoy by grapnel		8:34
Slinged top buoy stern		8:41
Winded up top buoy (on deck)		8:47
Recovery of equipments		8:57
Recovery of sediment (1)		9:08
Recovery of sediment (3)		9:41
Recovery of sediment (5)		11:52
Recovery of Float (Bottom)/releaser		12:16
Finished work		12:18
Total working hours		5:15

Time consumed

in preparation for recovery	0:02
in rising of glass balls (Bottom)	0:48
in catch of top buoy	0:41
in recovery of top buoy	0:13
in recovery of sediment	3:05
in recovery of floats/releaser	0:26
Total working hours	5:15

Maneuvering data

MOORING NUMBER	K2-BGC
Course when approaching (deg)	260
Course when catching b'y (deg)	220
Wind direction (deg)	290
Wind velocity (m/s)	3.7
Current direction (deg)	Various
Current velocity (knot)	0.2
Swell direction	WSW
Wave height (m)	2.4