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MR04-02
Preliminary Cruise Report

(27 Mar. – 17 Apr. 2004)

May 2004

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Preface

Mutsu Institute for Oceanography (MIO) has conducted time-series observational study for biogeochemistry in the northwestern North Pacific with mooring systems. However seasonal variability in biogeochemistry and physical oceanography can not be clarified precisely without traditional repeatable observation by research vessel. It is no doubt that data in winter season are absolutely poor compared with those in other seasons. Therefore main purpose of this cruise was to obtain oceanographic data in the late winter and/or the early spring.

However rough sea toyed us heavily as we expected. We should wait a chance for observation or gave up observation at some stations. Nevertheless valuable data could be obtained during this cruise. For instance, it was certified that surface mixed layer was still thick and extinction rate of light intensity in the water column was small, which is indicative of that amount of suspended matter including living plankton was still a little.

As described above, we were in trouble for bad weather and problem on wire cable and instrument. Thanks to captain Akamine and ship crew, and support stuff from Marine Works Japan and Global Ocean Development, main mission was completed successfully. Especially, Mr. Kita, a new chief officer, did work so hard and devotedly. Owing to his appropriate leadership, every deck work was done smoothly and safely. We would like to welcome him to MIRAI.

As for MIO, this cruise was the first cruise since the last year's cruise we lost mooring system. The scientific cruise without mooring work was not challenging enough. I wish that I will bring our mooring system on board and restart time-series observation with mooring system the next time.

April 16, 2004
Makio Honda
Principal Investigator of MR04-02

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1.Outline of MR04-02

1.1 Cruise summary

Makio HONDA (JAMSTEC MIO)

We planned to visit 8 stations and conducted various observations such as hydrocast, *in-situ* pumping and water column optical measurement. The first station planned was station 1 (K1: time-series observation for our biogeochemical study and one of principal stations). However weather and sea condition did not enable us to do so. We started our observation from station 8

Station 8

When the first hydrocast was conducted, "kink of wire cable" phenomena took place because of rough sea. Thanks to Marine Works' technicians and MIRAI's waisters, cable was repaired and hydrocast work could be re-started and, as a result, three hydrocasts were conducted at this station. This station was close to Hokkaido Island (300 miles off Kushiro) and, therefore, samples which were expected to have land characteristics could be obtained.

Based on the weather condition, we decided to visit station 5 (K3) which is one of our time-series observation point.

Station 5 (K3)

We planned three hydrocasts and two *in-situ* pumpings. However the sea condition was getting worse and worse when we deployed CTD/CMS for routine cast, and we could not but suspend hydrocasts and other observations. As a result, only CTD profile by 1000 m and water upper 300 m (for radio nuclide and trace elements) and water from five layer upper 100 m for "routine" (basic elements such as salinity, nutrients and carbonate chemistry) were obtained. A good thing was that optical measurement could be conducted before leaving this station.

Although we planned to go northward on 160 degree-E meridian line, strong west wind permitted us to do so, and we moved toward station 1 (K1).

Station 1 (K1):

Fortunately weather and sea condition were not so bad and all menu (three hydrocasts, three in-situ pumpings optical measurements, and incubation of primary productivity) were successfully completed. Air temperature was about 1 degree-C and surface water temperature was about 2 degree-C. We had a little snow at this station. Marine works' technicians were freezing during water distribution. Sea condition was still good and we could sequentially conducted observations at station 2 (K2) and station 6 (KNOT).

Station 2 (K2):

As wind was stronger at this station than station K1, we felt colder. Water temperature was about 1 degree-C and lower than that at station 1. Two hydrocasts, and two in-situ pumpings, optical measurements, and incubation of primary productivity were completed. Surface mixed layer defined with 0.125 criteria of sigma-theta was still 130 m and this area is still in winter mode. However we felt that spring has come soon.

Station6 (KNOT):

This station is the former Japanese time-series observation station under umbrella of JGOFS North Pacific Process Study. Some cooperative Japanese scientists including our group try to keep timer-series observation. Two hydrocasts, and two in-situ pumpings, optical measurements, and incubation of primary productivity were completed.

Last four days were the busiest days on this cruise and most of participants suffered from lack of sleep.

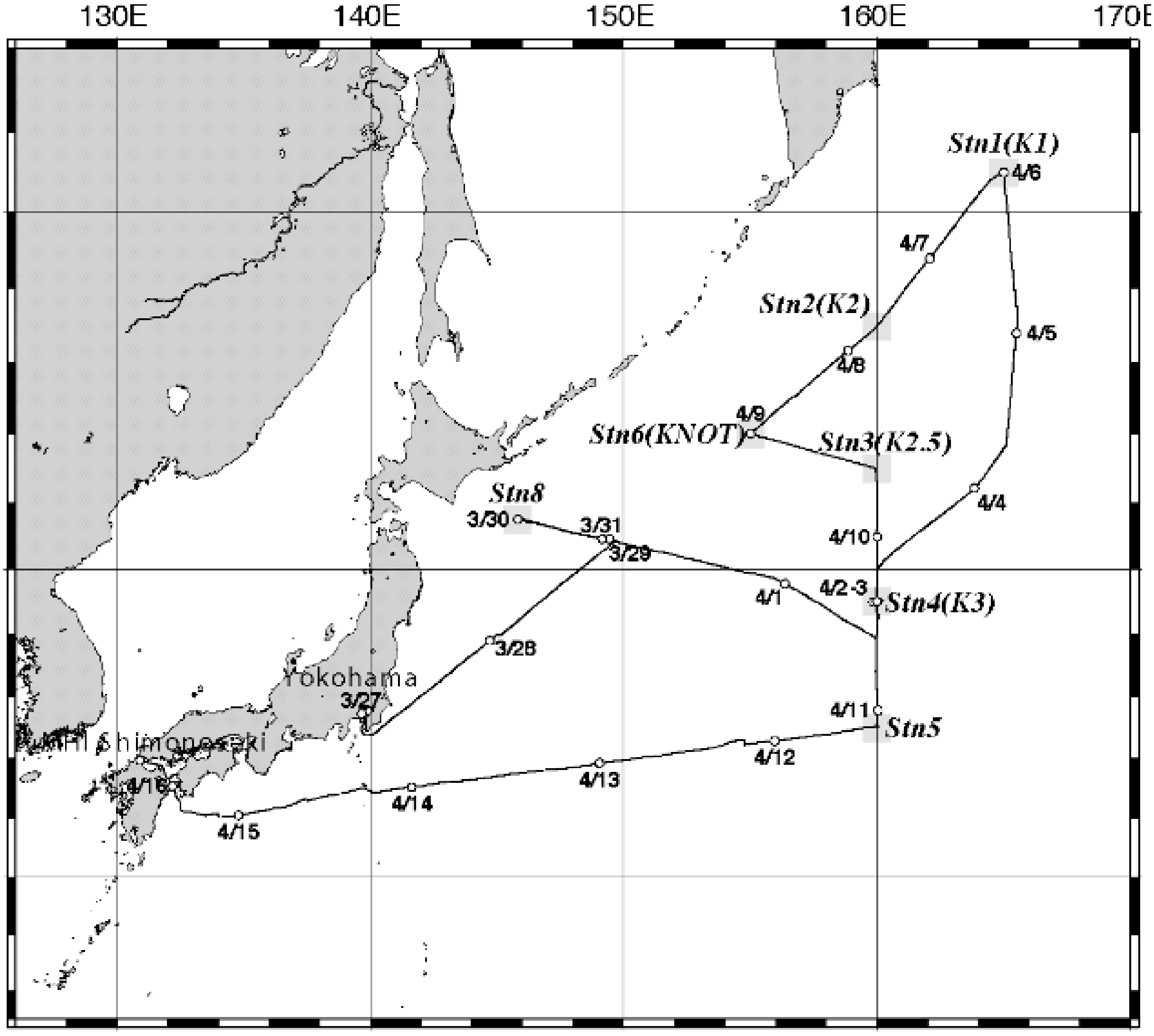
The rest of time for observation was limited. It seemed that observation at only one station was possible. We decided to go to station 3 (K2.5) and go southward to station 5 (35N, 160E) along 160E meridian line without waiting chance for observation if sea condition was not friendly. After all, we skipped full and rest of observation at station 3(K2.5) and 4(K3), respectively. However underway observation such as measurements of water temperature, salinity, chlorophyll, and collection of suspended particles could be done along 160E line from 43N to 35N.

Station 5 (35N)

Meteorological and oceanographic condition was largely different from those at northern stations (north 40N). Air temperature and water temperature were approximately 17 degree-C. We could work on deck with half-sleeves shirts. We conducted two hydrocasts, two *in-situ* pumping and optical measurement. These data will be useful and helpful as reference data against that from northern stations.

After observation at station 5, we discussed more observation at station 4 (K3). However weather report showing horizontal distribution of atmospheric low pressure was pessimistic for observation and time of our cruise was almost out. Therefore we decided to finish our observation during this cruise and made our direction toward Shimonoseki.

1.2 Track and log



U.T.C.		S.M.T.		Position		Events
Date	Time	Date	Time	Lat.	Lon.	
3/27	00:00	3/26	09:00	35-27.13N	139-38.84E	Departure of Yokohama
3/29	20:42	3/30	05:42	41-30N	145-30E	Arrival at Station No.8
3/30	00:29	3/30	09:29	41-29.96N	145-48.07E	CTD-01 cast (300m)
	07:32		16:32	41-29.92N	145-48.38E	CTD-test cast (300m)
	08:41		17:41	41-30.05N	145-48.96E	CTD-02 cast (5,500m)
	14:00		23:00	-	-	Departure of Station No.8
4/1	19:00	4/2	04:00	39-00N	160-00E	Arrival at Station No.4 (K3)
	19:19		04:19	39-04N	160-00E	Calibration for magnetometer
4/2	08:55		17:55	39-00.06N	160-00.09E	CTD-03 cast (300m)
4/3	00:40	4/3	09:40	39-00.11N	160-00.43E	Underwater optical measurement (Free fall) #01
	01:27		10:27	39-00.18N	160-00.48E	CTD-04 cast (1,000m)
	02:30		11:30	-	-	Departure of Station No.4
4/5	19:30	4/6	04:30	51-00N	165-00E	Arrival at Station No.1 (K1)
	20:17		05:17	50-59.95N	165-00.07E	In situ pumping (LVP) #01 (200m, 1 hour)
	22:55		07:55	50-59.98N	165-00.26E	CTD-05 cast (300m)
	23:53		08:53	50-59.74N	164-59.86E	LVP #02 (200m, 1 hour)
4/6	02:13	4/6	11:13	51-00.05N	165-00.49E	Free fall #02
	02:38		11:38	51-00.10N	165-00.29E	CTD-06 cast (3,000m)
	05:45		14:45	51-00.47N	164-59.19E	LVP #03 (200m, 6 hours)
	12:20		21:20	50-59.99N	164-59.93E	CTD-07 cast (51m)
	12:42		21:42	-	-	Departure of Station No.1
4/7	02:27	4/7	11:27	48-20.27N	161-30.74E	Free fall-03 cast
4/7	10:00	4/7	19:00	47-00N	160-00E	Arrival at Station No.2 (K2)
	10:08		19:08	47-00.28N	160-00.11E	LVP #04 (200m, 1 hour)
	12:37		21:37	47-00.01N	160-00.25E	CTD-08 cast (3,000m)
	15:48	4/8	00:48	47-00.07N	160-01.91E	LVP #05 (200m, 1 hour)
	18:18		03:18	47-00.03N	159-59.90E	CTD-09 cast (300m)
	19:13		04:13	46-59.72N	160-00.53E	Free fall #04
	19:30		04:30	-	-	Departure of Station No.2
4/8	14:24	4/8	23:24	44-00N	155-00E	Arrival at Station No.6 (KNOT)
	14:27		23:27	43-59.98N	154-59.61E	CTD-10 cast (3,000m)
	17:24	4/9	02:24	43-58.95N	155-00.34E	LVP #06 (200m, 1 hour)
	19:57		04:57	43-59.96N	155-00.01E	CTD-11 cast (300m)
	21:07		06:07	43-59.57N	154-59.89E	LVP #07 (200m, 1 hour)
	23:22		08:22	44-00.03N	154-59.88E	Free fall #05
4/9	00:00	4/9	09:00	-	-	Departure of Station No.6
4/11	02:24	4/11	11:24	35-00N	160-00E	Arrival at Station No.5
	02:28		11:28	35-00.19N	159-59.92E	Free fall #06
	02:54		11:54	34-59.89N	160-00.01E	CTD-12 cast (3,000m)
	05:56		14:56	35-00.12N	160-01.64E	LVP #08 (200m, 1 hour)
	08:04		17:04	35-02.49N	160-03.13E	CTD-13 cast (300m)
	08:48		17:48	-	-	Departure of Station No.5
4/14	23:23	4/15	08:23	32-07N	134-50E	Calibration for magnetometer
4/16	08:00	4/16	17:00	33-56.20N	130-55.43E	Arrival at MHI Shimonoseki Dock

1.3 List of participants

Name	Affiliation	Address	Tel Fax E-mail
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Gen MIYAZAKI	MWJ	2-16-32-5F Kamariya-higashi Kanazawaku Yokohama 236-0042, Japan	
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2. General observation

2.1 Meteorological Observation

2.1.1. Surface meteorological observationa

Wataru TOKUNAGA (Global Ocean Development Inc.)
Norio NAGAHAMA (GODI)
Not on-board:
Kunio YONEYAMA (JAMSTEC) Principal Investigator
R. Michael REYNOLDS (Brookhaven National Laboratory, USA)

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 MR04-02 cruise from the departure of Yokohama on 27 Feb 2004 to the arrival of Shimonoseki on 16 Apr 2004. At this cruise, we used two systems for the surface meteorological observation:

Mirai meteorological observation system
Shipboard Oceanographic and Atmospheric Radiation (SOAR) System

(2-1) Mirai meteorological observation system

Instruments of Mirai meteorological system (SMET) are listed in Table 2.1.1 and measured parameters are listed in Table 2.1.2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set has 6-second averaged.

(2-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system designed by BNL consists of major 3 parts.

Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.

Zeno meteorological system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.

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 Table 2.1.3 and measured parameters are listed in Table 2.1.4.

Preliminary results

Figure 2.1.1 show the time series of the following parameters from the departure of

Yokohama to the arrival of Shimonoseki; Wind (SOAR), air temperature (SOAR), sea surface temperature (EPCS), relative humidity (SOAR), precipitation (SOAR), short/long wave radiation (SOAR), pressure (SOAR) and 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.

Table 2.1.1 Instruments and installations of Mirai meteorological system

Sensor	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24m)
Thermometer	HMP45A	Vaisala, Finland	compass deck (21m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m) SST
Barometer	F-451	Yokogawa, Japan	weather observation room captain deck (13m)
Rain gauge	50202	R. M. Young, USA	compass deck (19m)
Optical rain gauge	ORG-115DR	Osi, USA	compass deck (19m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10m)

Table 2.1.2 Parameters of Mirai 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 (fore)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period	second	hourly
24	Significant wave period	second	hourly

Table 2.1.3 Instrument and installation locations of SOAR system

Sensors	Type	Manufacturer	Location (altitude from surface)
Zeno/Met			
Anemometer	05106	R.M. Young, USA	foremast (25m)
Tair/RH	HMP45A	Vaisala, Finland	foremast (24m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
Barometer	61201	R.M. Young, USA	foremast (24m)
	with 61002 Gill pressure port (R.M. Young)		
Rain gauge	50202	R. M. Young, USA	foremast (24m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24m)
PRP			
Radiometer (short wave)	PSP	Eppley, USA	foremast (25m)
Radiometer (long wave)	PIR	Eppley, USA	foremast (25m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (25m)

Table 2.1.4 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 50mm
12	Down welling shortwave radiation	W/m^2	
13	Down welling infra-red radiation	W/m^2	
14	Defuse irradiance	W/m^2	

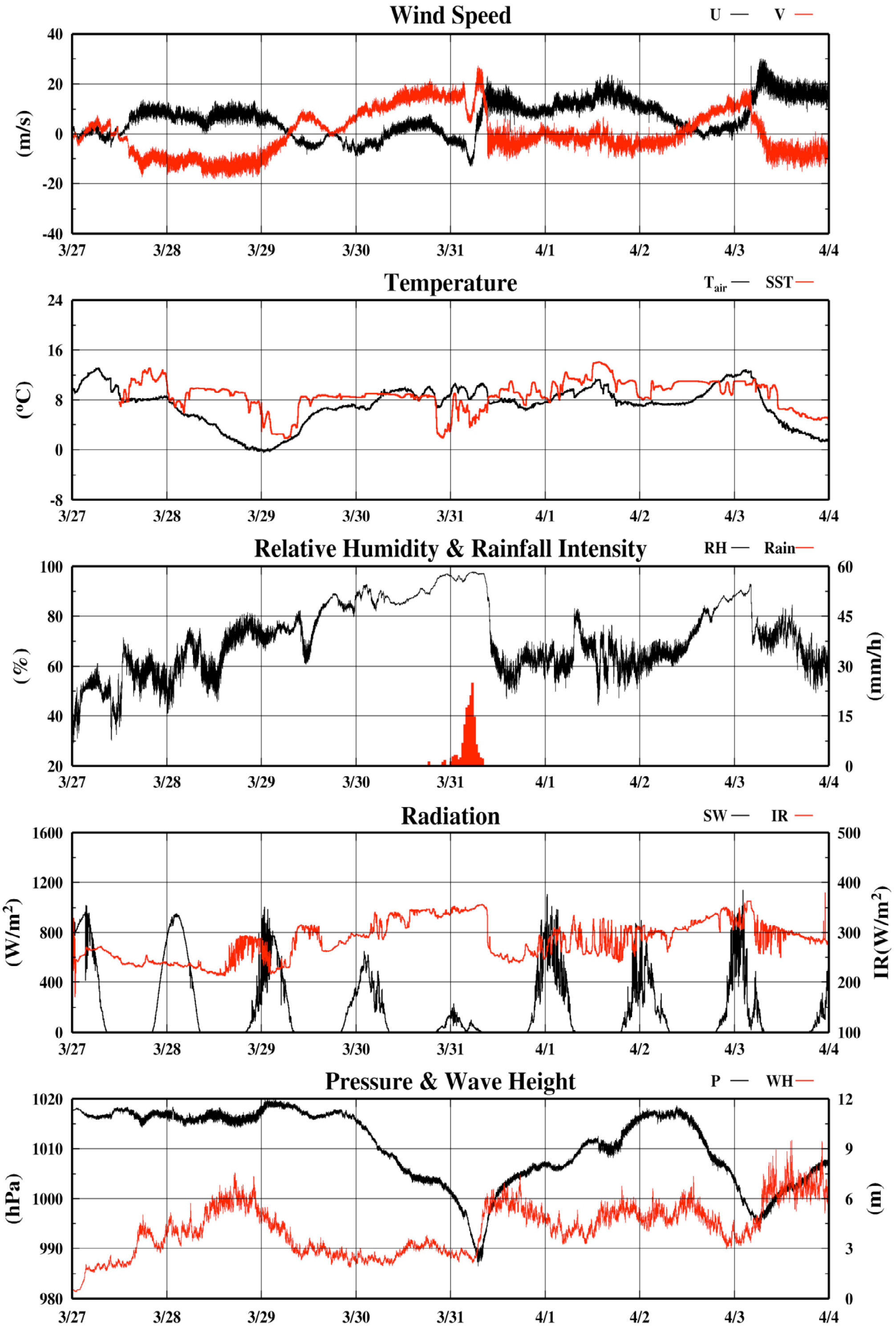
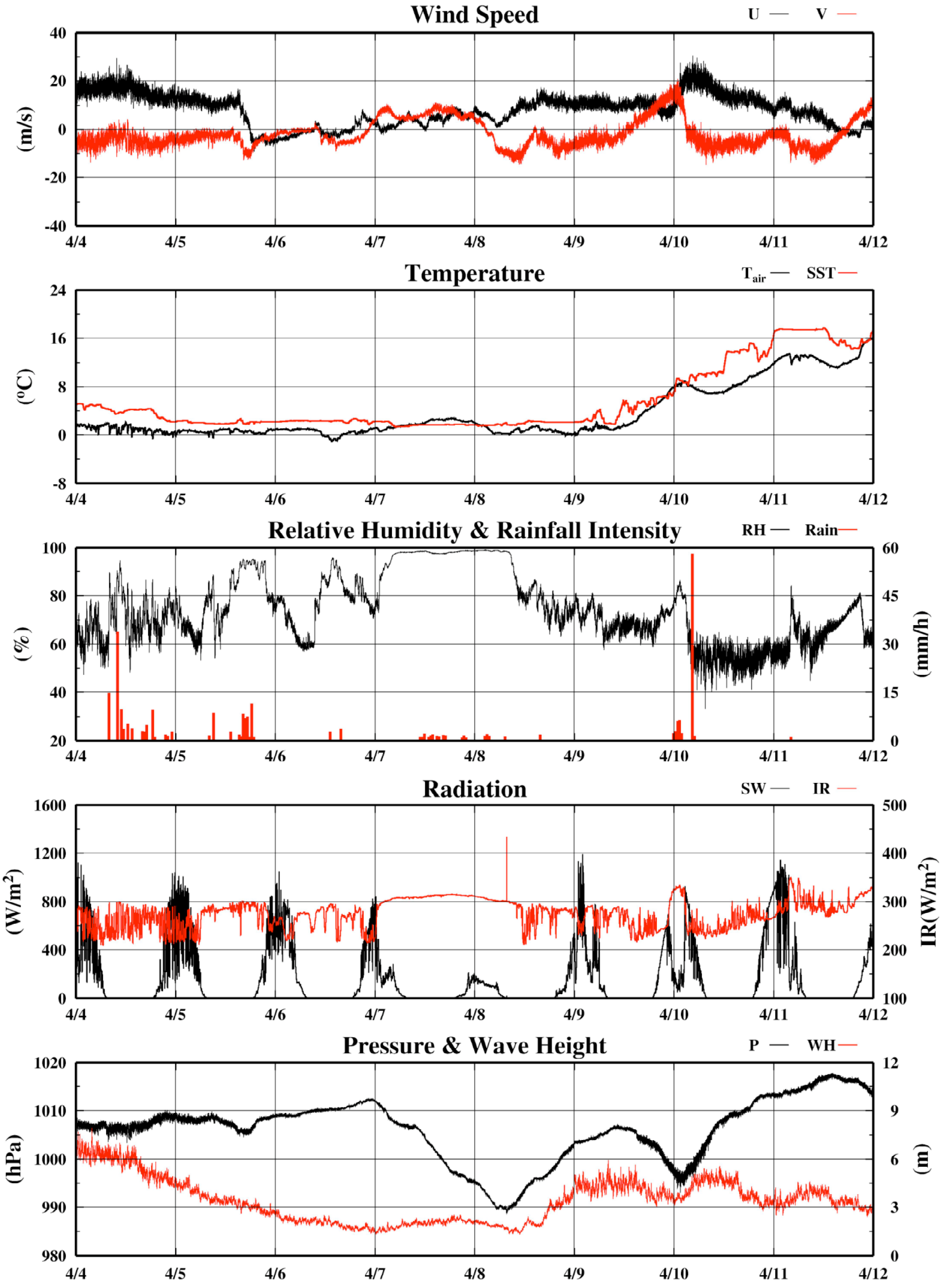


Fig 2.1.1 Time series of surface meteorological parameters during the cruise.



2.1.1 Continued.

2.1.2 Ceilometer Observation

Wataru TOKUNAGA (Global Ocean Development Inc.)
Norio NAGAHAMA (GODI)
Not on-board:
Kunio YONEYAMA (JAMSTEC) Principal Investigator

(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

1. Cloud base height [m].
2. Backscatter profile, sensitivity and range normalized at 30 m resolution.
3. 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 MR04-02 cruise from the departure of Yokohama to 01:29UTC 14 Apr 2004.

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 shows 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.

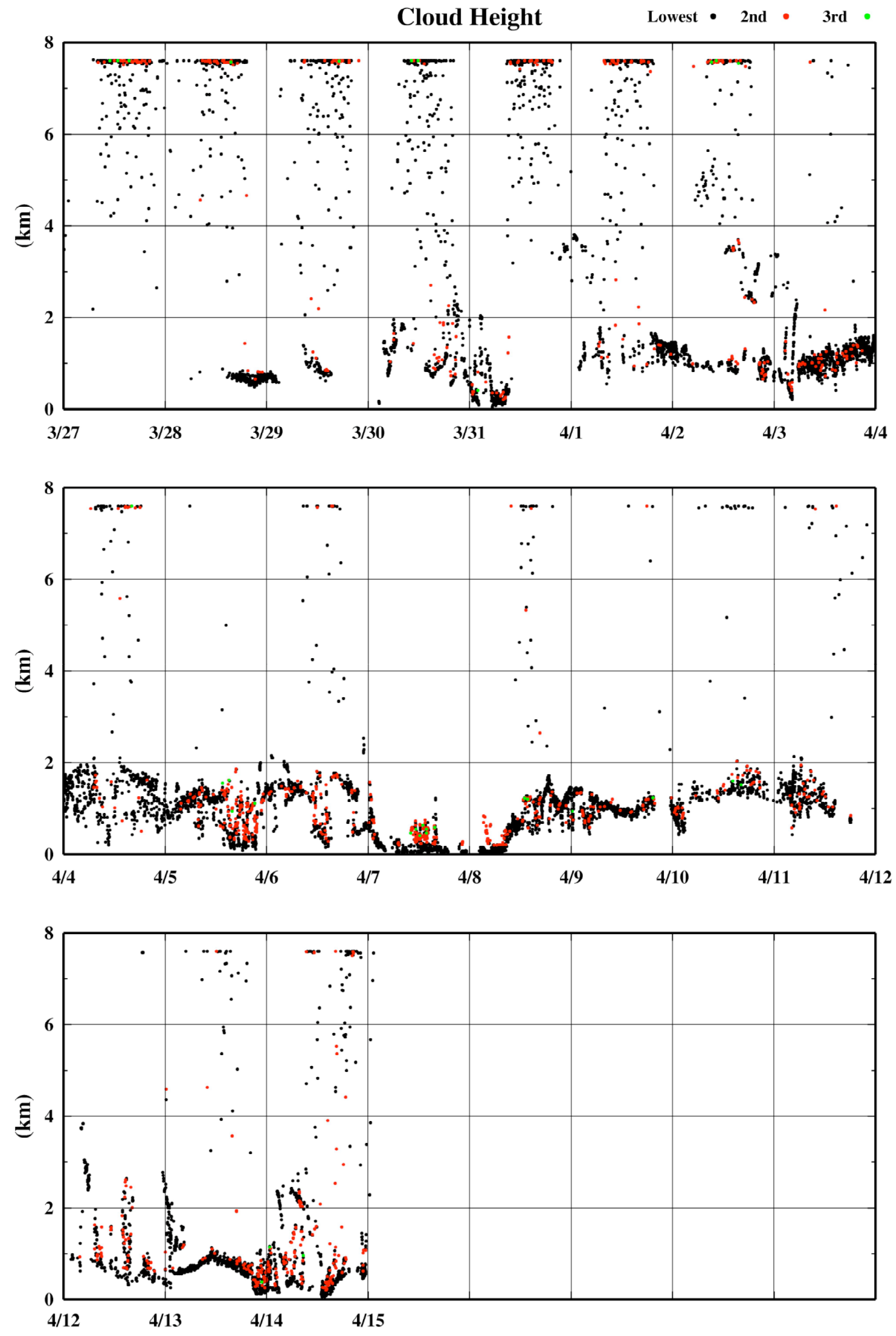


Figure 2.1.2 1st, 2nd and 3rd lowest cloud base height during the cruise.

2.2 Physical Oceanographic observation

2.2.1 CTD casts and water sampling

Fujio KOBAYASHI (MWJ)
Hiroshi MATSUNAGA (MWJ) Operation Leader
Tomoyuki TAKAMORI (MWJ)

(1) Objective

Investigation of oceanic structure and water sampling of each layer.

(2) 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 Windows 98 2nd edition) to display, at the same time, to storage in a disk file using SBE SEASOFT software.

The SBE 911plus system acquires data from primary 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 contaminants from springs.
SBE's temperature (SBE 3F) and conductivity (SBE 4) sensor modules were used with the SBE 9plus underwater unit fixed by a single clamp and "L" bracket to the lower end cap. The conductivity cell entrance is co-planar with the tip of the temperature sensor's protective steel sheath. The pressure sensor is mounted in the main housing of the underwater unit and is ported to outside through the oil-filled plastic capillary tube. A compact, modular unit consisting of a centrifugal pump head and a brushless DC ball bearing motor contained in an aluminum underwater housing pump (SBE 5T) flushes water through sensor tubing at a constant rate independent of the CTD's

motion. Motor speed and pumping rate (3000 rpm) remain nearly constant over the entire input voltage range of 12-18 volts DC. Flow speed of pumped water in standard TC duct is about 2.3 m/s.

The system used in this cruise is summarized as follows:

Under water unit:
SBE, Inc., SBE 9plus, S/N 79511
Temperature sensor:
SBE, Inc., SBE 3-04/F, S/N 031464
Conductivity sensor:
SBE, Inc., SBE 4-04/0, S/N 041203
Pump:
SBE, Inc., SBE 5T, S/N050984
Altimeter:
Datasonics Inc., PSA-900D, S/N 0396
Deck unit:
SBE, Inc., SBE 11plus, S/N 11P9833-0344
Carousel Water Sampler:
SBE, Inc., SBE 32, S/N 3221746-0278
Fluorometer:
Seapoint sensors, Inc., S/N 2579
Water sample bottle:
General Oceanics, Inc., 12-litre Niskin-X

(3) Pre-cruise calibration

3-1 Pressure

The Paroscientific series 4000 Digiquartz high pressure transducer (Paroscientific, Inc., USA) uses a quartz crystal resonator whose frequency of oscillation varies with pressure induced stress with 0.01 per million of resolution over the absolute pressure range of 0 to 15,000 psia (0 to 10,332 dbar). Also, a quartz crystal temperature signal is used to compensate for a wide range of temperature changes at the time of an observation. The pressure sensor (MODEL 415K-187) has a nominal accuracy of 0.015 % FS (1.5 dbar), typical stability of 0.0015 % FS/month (0.15 dbar/month) and resolution of 0.001 % FS (0.1 dbar).

Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA. The following coefficients were used in the SEASOFT:

S/N 79511 02 Jul, 2002
c1 = -6.207294e+04
c2 = -1.176956
c3 = 1.954420e-02
d1 = 2.738600e-02

d2 = 0
t1 = 3.005031e+01
t2 = -4.744833e-04
t3 = 3.757590e-06
t4 = 3.810700e-09
t5 = 0

Pressure coefficients are first formulated into
c = c1 + c2 * U + c3 * U^2
d = d1 + d2 * U
t0 = t1 + t2 * U + t3 * U^2 + t4 * U^3 + t5 * U^4
where U is temperature in degrees Celsius. The pressure temperature, U, is determined according to
U (degC) = M * (12 bit pressure temperature compensation word) – B
The following coefficients were used in SEASOFT:
M = 0.01161
B = -8.32759
(in the underwater unit system configuration sheet dated on May 24, 1994)
Finally, pressure is computed as
P (psi) = c * [1 – (t0^2 / t^2)] * {1 – d * [1 – (t0^2 / t^2)]}
where t is pressure period (microsec). Since the pressure sensor measures the absolute value, it inherently includes atmospheric pressure (about 14.7 psi). SEASOFT subtracts 14.7 psi from computed pressure above automatically.

Pressure sensor calibrations against a dead-weight piston gauge are performed at Marine Works Japan Ltd. in Yokosuka, Kanagawa, JAPAN, usually once in a year in order to monitor sensor time drift and linearity (Figure 2.2.1.1,Figure2.2.1.2). The pressure sensor drift is known to be primarily an offset drift at all pressures rather than a change of span slope. The pressure sensor hysterisis is typically 0.2 dbar. The following coefficients for the sensor drift correction were also used in SEASOFT through the software module SEACON:
S/N 79511 Sep 17, 2003
slope = 0.9998963
offset = 0.71387
The drift-corrected pressure is computed as
Drift-corrected pressure (dbar) = slope * (computed pressure in dbar) + offset

3-2 Temperature

The temperature sensing element is a glass-coated thermistor bead in a stainless steel tube, providing a pressure-free measurement at depths up to 10,500 m (S/N 031464). The sensor output frequency ranges from approximately 5 to 13 kHz corresponding to temperature from –5 to 35 degC. The output frequency is inversely proportional to the square root of the thermistor resistance, which controls the output of a patented Wien Bridge circuit. The thermistor resistance is exponentially related to temperature. The SBE 3F thermometer has a nominal accuracy of 0.001 degC, typical stability of 0.0002 degC/month and resolution of 0.0002 degC at 24 samples per second.

Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA (Figure2.2.1.3, Figure2.2.1.4). The following coefficients were used in SEASOFT:

S/N 031464 13 February, 2004
g = 4.84456799e-03
h = 6.81732733e-04
i = 2.74350587e-05
j = 2.20079687e-06
f0 = 1000.000

Temperature (ITS-90) is computed according to

Temperature (ITS-90) =

$$1 / \{g + h * [\ln(f0 / f)] + i * [\ln^{\wedge}2(f0 / f)] + j * [\ln^{\wedge}3(f0 / f)]\} - 273.15$$

where f is the instrument frequency (kHz).

3-3 Conductivity (SBE 4)

The flow-through conductivity sensing element is a glass tube (cell) with three platinum electrodes to provide in-situ measurements at depths up to 10,500 meters. The impedance between the center and the end electrodes is determined by the cell geometry and the specific conductance of the fluid within the cell. The conductivity cell composes a Wien Bridge circuit with other electric elements of which frequency output is approximately 3 to 12 kHz corresponding to conductivity of the fluid of 0 to 7 S/m. The conductivity cell SBE 4 has a nominal accuracy of 0.0003 S/m, typical stability of 0.0003 S/m/month and resolution of 0.00004 S/m at 24 samples per second.

Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA. The following coefficients were used in SEASOFT:

S/N 041203 12 February, 2004
g = -4.05326765
h = 4.93568515e-01
i = 7.45440089e-05
j = 2.28542024e-05
CPcor = -9.57e-08 (nominal)
CTcor = 3.25e-06 (nominal)

Conductivity of a fluid in the cell is expressed as:

$$C\ (\mathrm{S/m}) = (g + h * f^{\wedge}2 + i * f^{\wedge}3 + j * f^{\wedge}4) / [10\ (1 + CTcor * t + CPcor * p)]$$

where f is the instrument frequency (kHz), t is the water temperature (degC) and p is the water pressure (dbar). The value of conductivity at salinity of 35, temperature of 15 degC (IPTS-68) and pressure of 0 dbar is 4.2914 S/m.

3-4 Altimeter

The Benthos PSA-900 Programmable Sonar Altimeter (Benthos, Inc., USA) determines the distance of the target from the unit in almost the same way as the Benthos 2110. PSA-900 also uses the nominal speed of sound of 1500 m/s. But, PSA-900 compensates for sound velocity errors due to temperature. In a PSA-900 operating at a 350 microsecond pulse at 200 kHz, the jitter of the detectors can be as small as 5 microseconds or approximately 0.4 centimeters total distance. Since the total travel time is divided by two, the jitter error is 0.25 centimeters. The unit (PSA-900D) is rated to a depth of 6,000 meters.

The following scale factors were used in SEASOFT:

S/N 0396
FSVolt * 300 / FSRange = 5
Offset = 0.0

3-5 Fluorometer

The Seapoint Chlorophyll Fluorometer (Seapoint sensors, Inc., USA) is a high-performance, low power instrument to provide in-situ measurements of chlorophyll-a at depths up to 6,000 meters. The instrument uses modulated blue LED lamps and a blue excitation filter to excite chlorophyll-a. The fluorescent light emitted by the chlorophyll-a passes through a red emission filter and is detected by a silicon photodiode. The low level signal is then processed using synchronous demodulation circuitry which generates an output voltage proportional to chlorophyll-a concentration.
The following coefficients were used in SEASOFT through the software module SEACON as user defined polynomial:

S/N 2579 (unknown calibration date)
Gain setting :30X 0-5 ug/l
Offset :0.0

(4) Data collection and processing

4-1 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 3000m.

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.

4-2 Data collection problems

With Station 8, communication trouble happened between things of 9plus and 11plus. So the problem was broken off when changed 9plus.

4-3 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 3.0 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 3.0 seconds.

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 and altimeter 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).

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.

(5) 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, Flourocence are shown in Figure.2.2.1.5 ～Figure.2.2.1.11 We also compared CTD-salinity and Bottle-salinity. The results are shown in Figure.2.2.1.12 and table 2.2.1 (b).

(6) Data archive

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

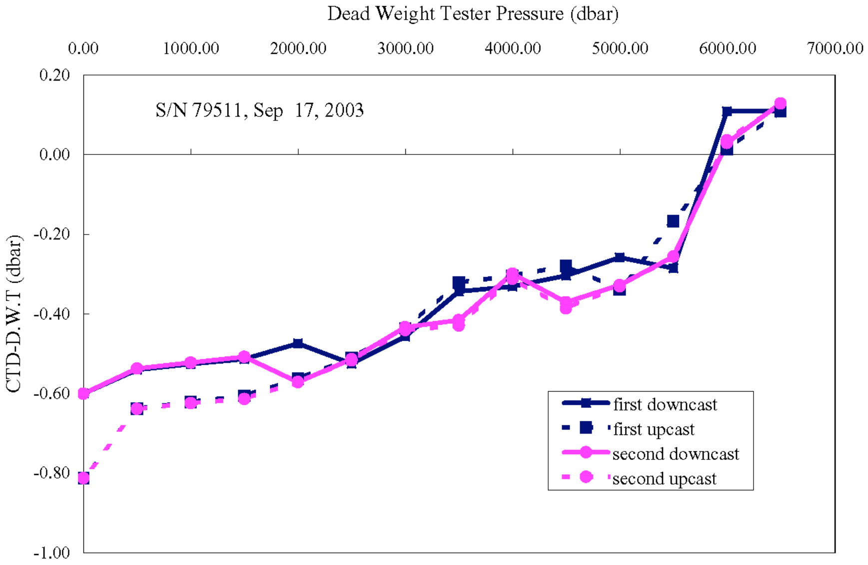


Figure 2.2.1.1: The residual pressures between the Dead Weight Tester and the CTD.

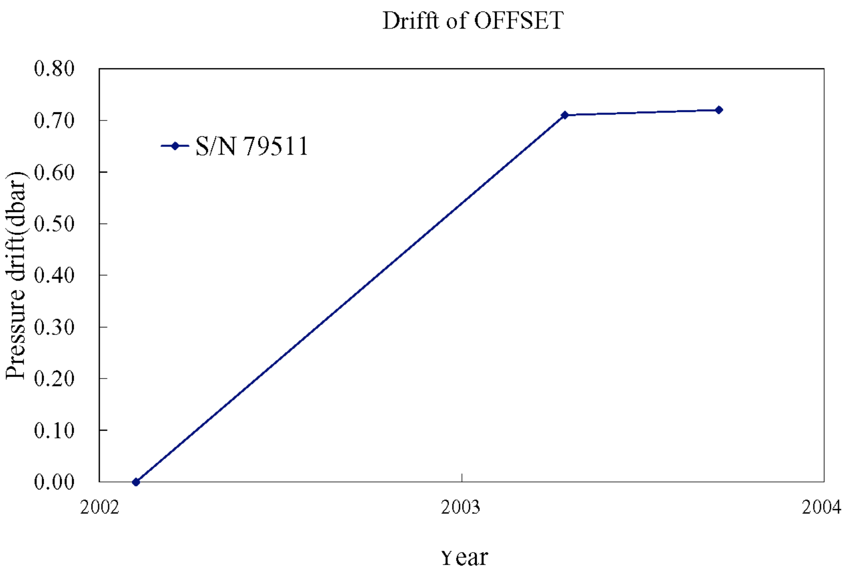


Figure 2.2.1.2: Drift (offset) of the pressure sensor measured by the Dead Weight Tester.

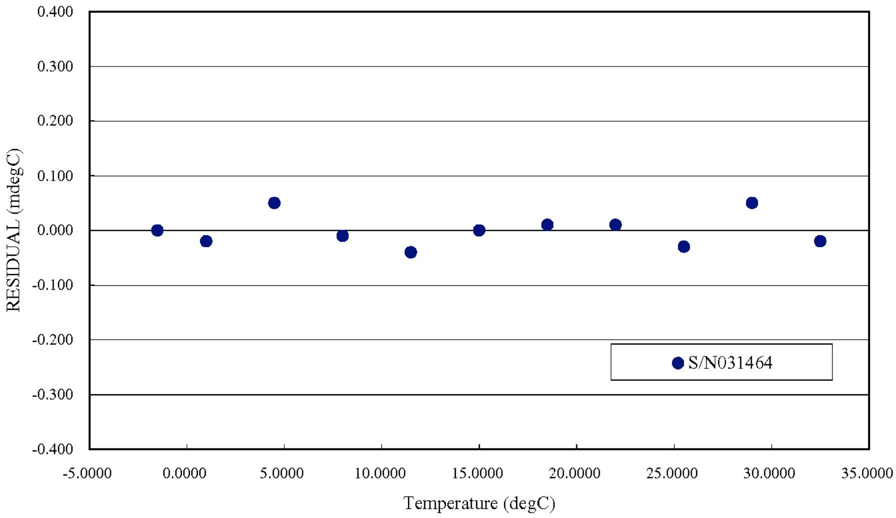


Figure 2.2.1.3: Residual temperature between bath and instrument temperatures.

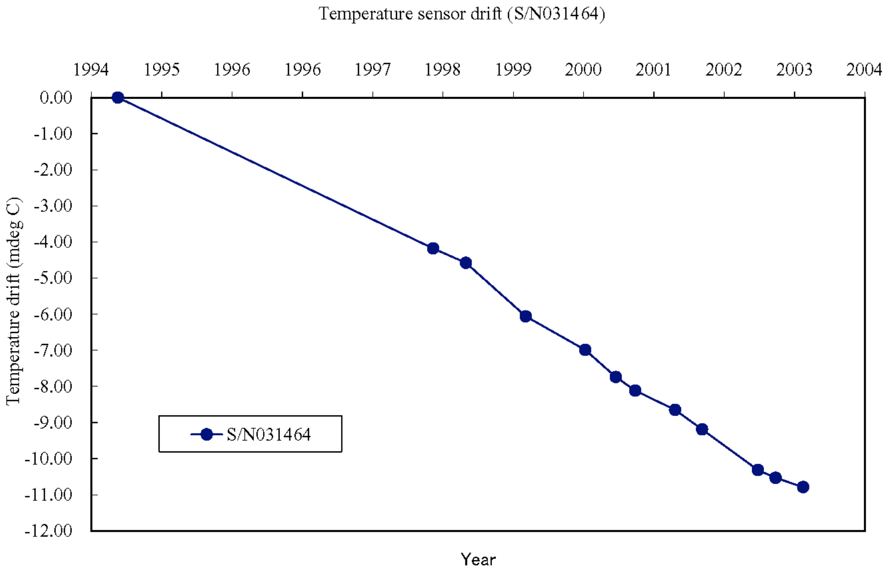


Figure 2.2.1.4: Drift of the temperature sensors based on laboratory calibrations.

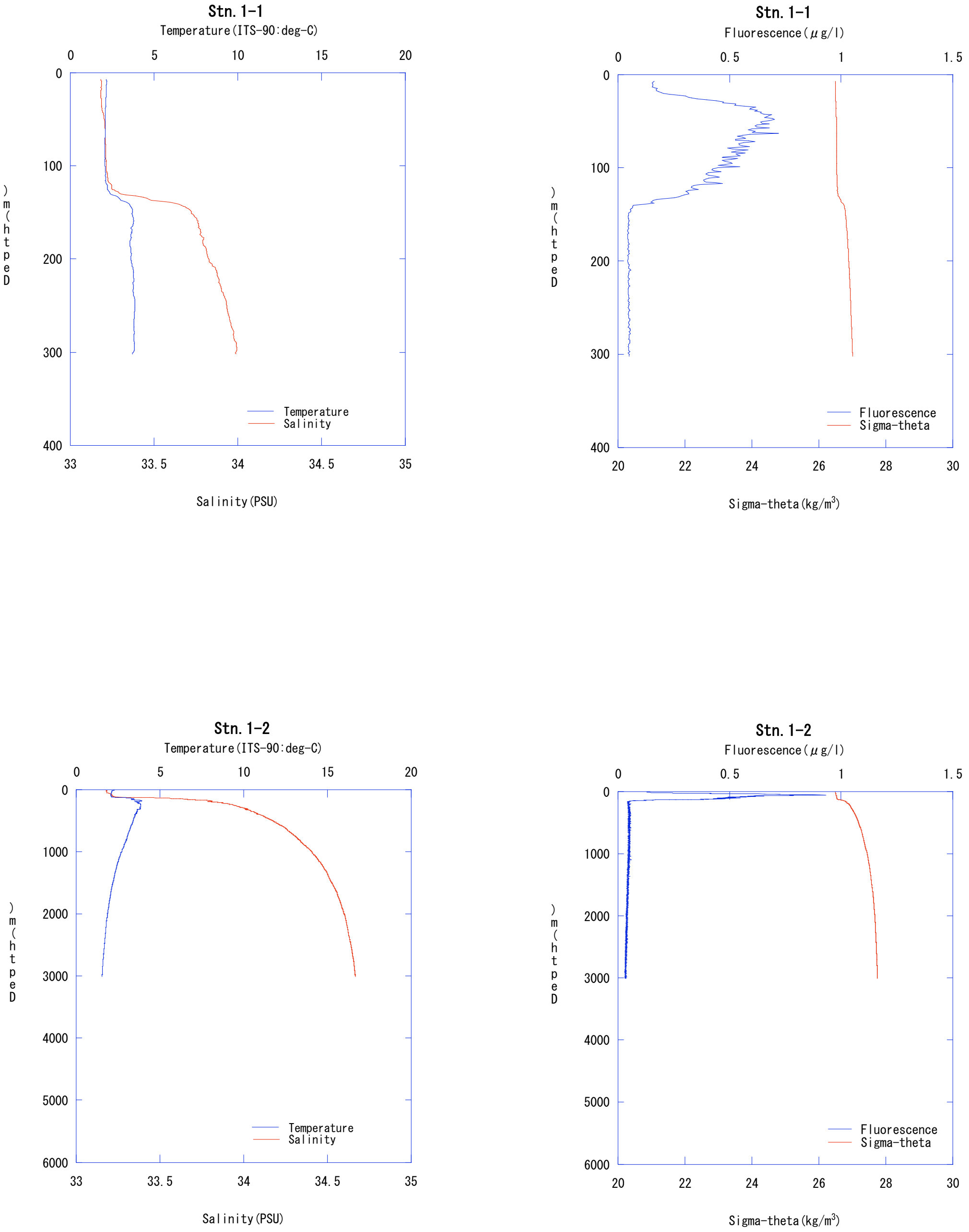


Figure 2.2.1.5: Vertical Profiles

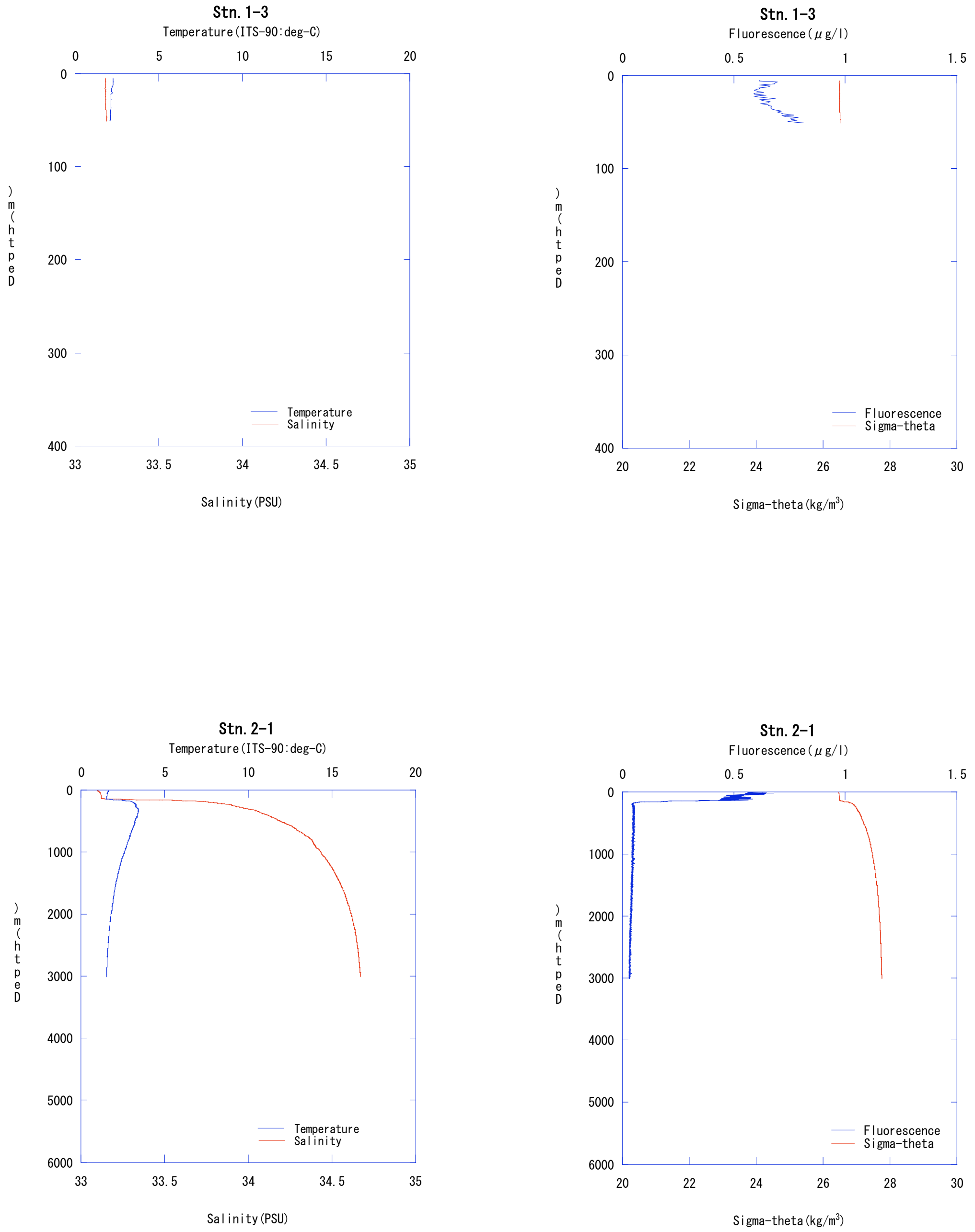


Figure 2.2.1.6: Vertical plofiles

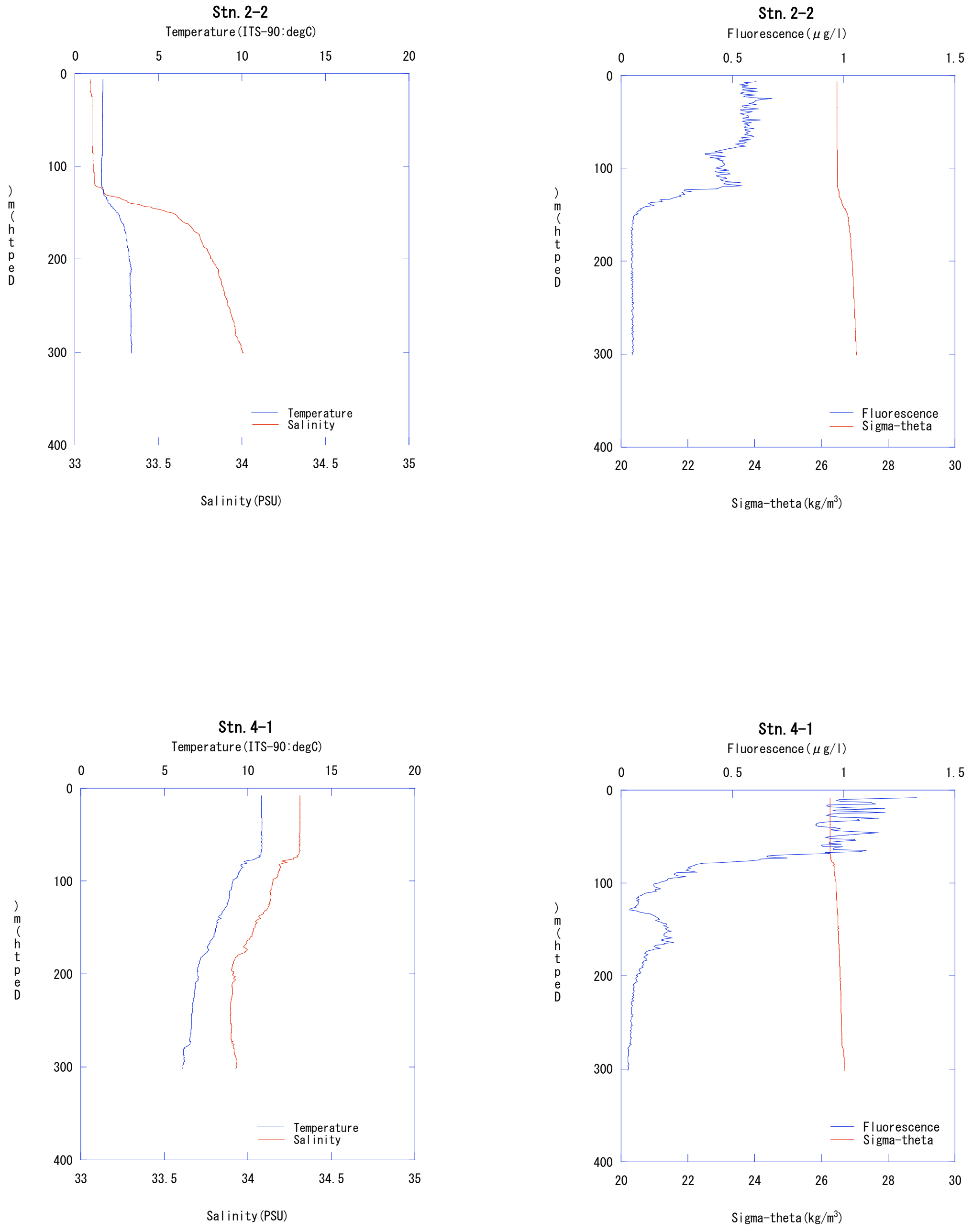


Figure 2.2.1.7: Vertical Profiles

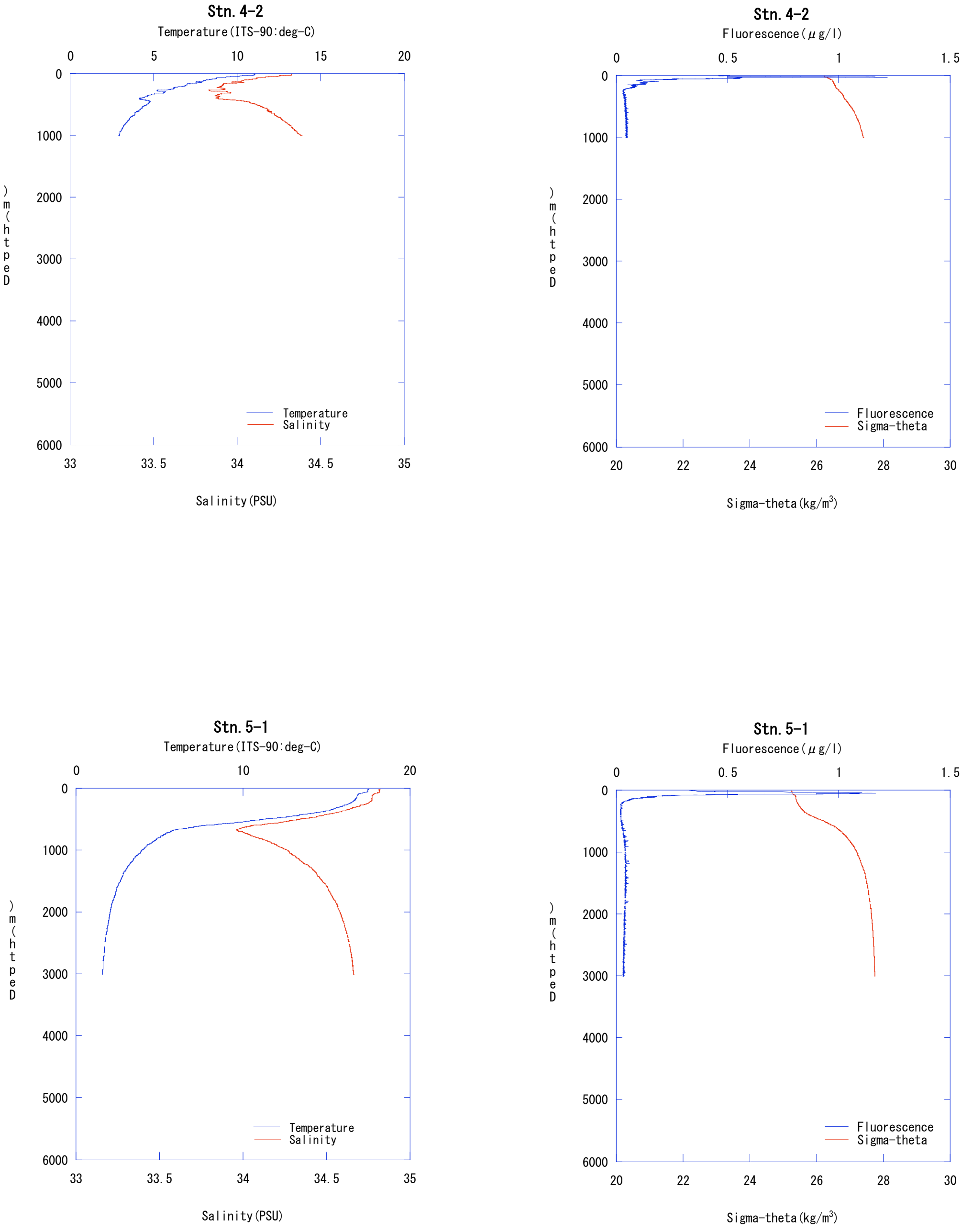


Fig ure2.2.1.8: Vertical plofiles

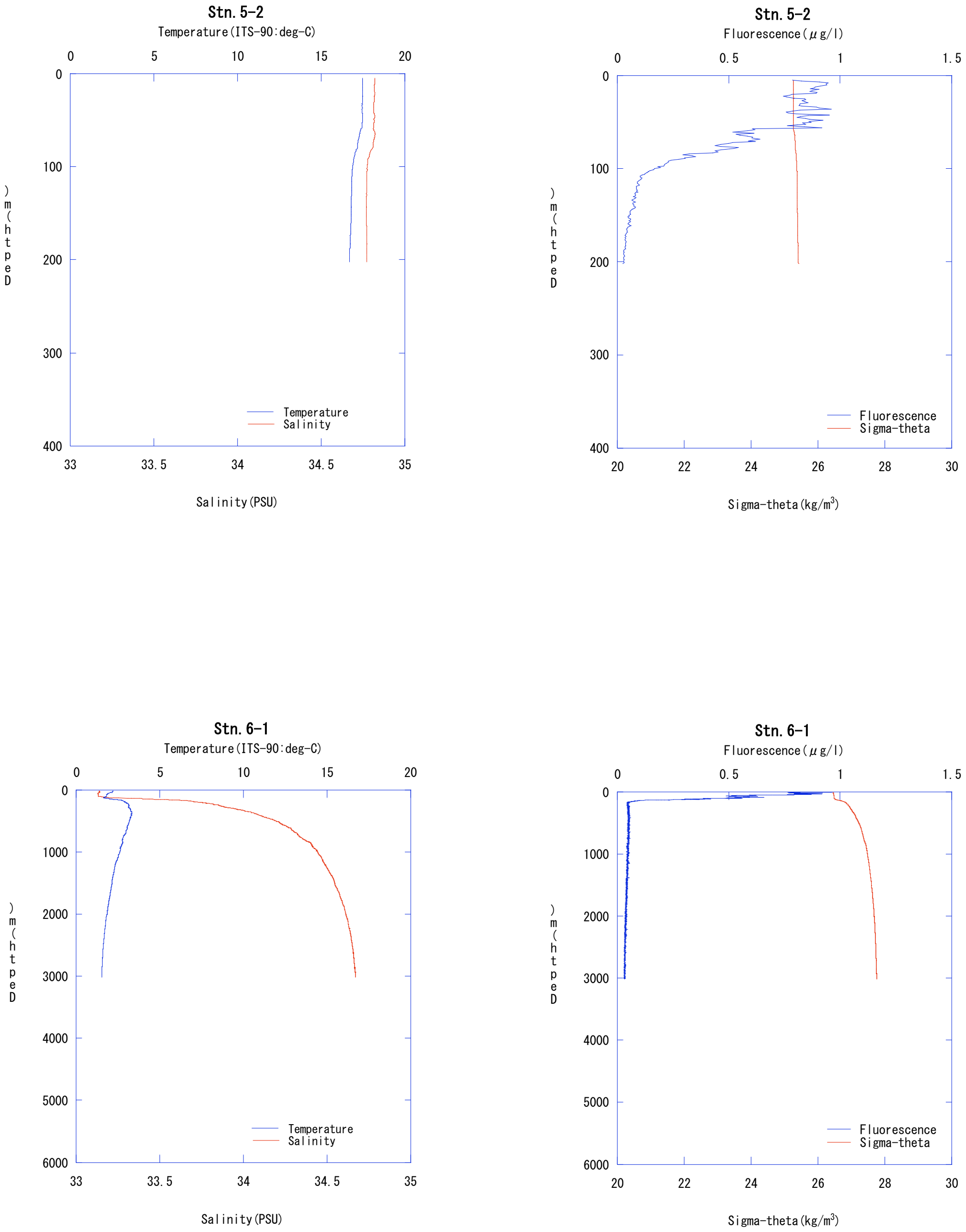


Figure 2.2.1.9: Vertical profiles

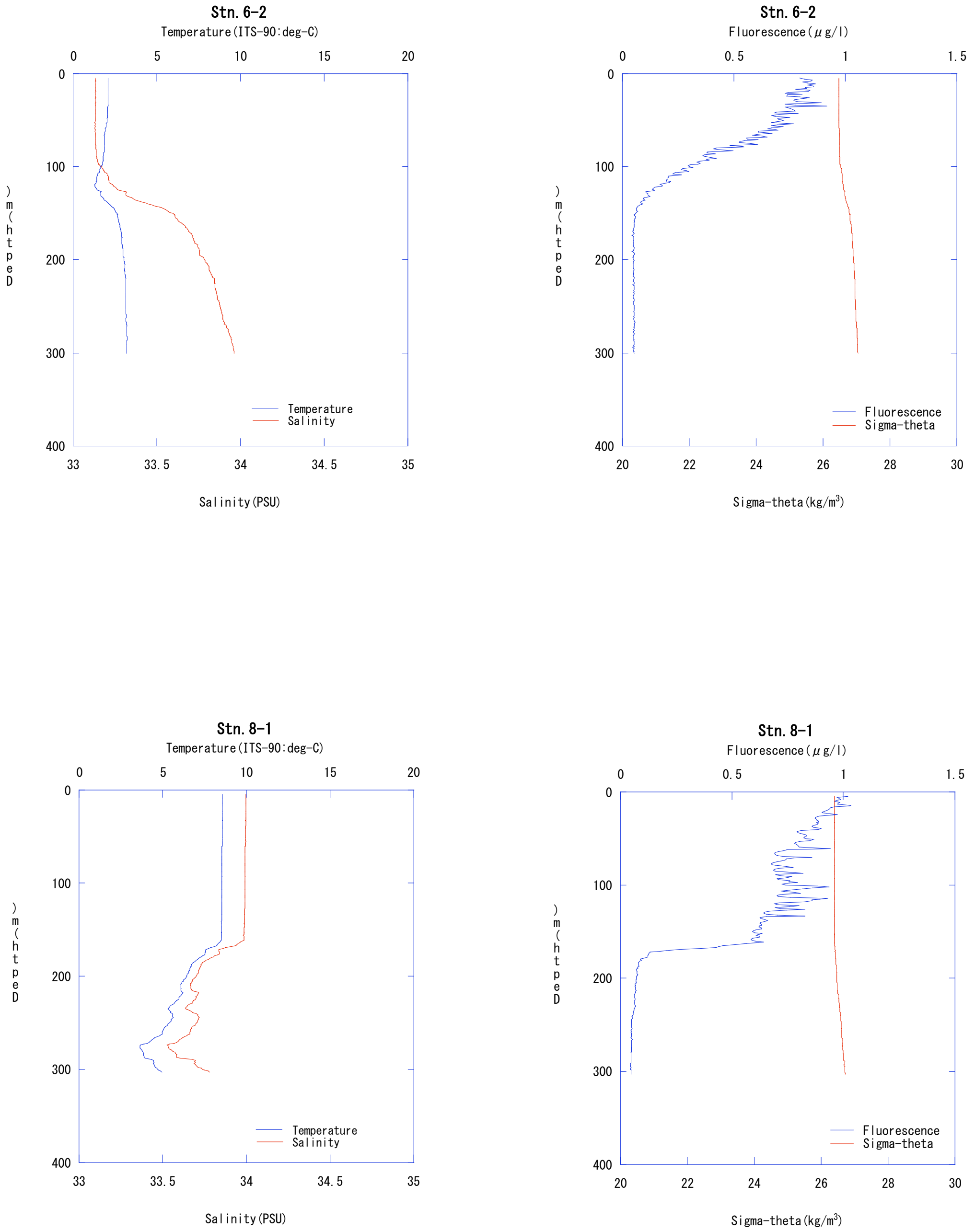


Figure 2.2.1.10: Vertical profiles

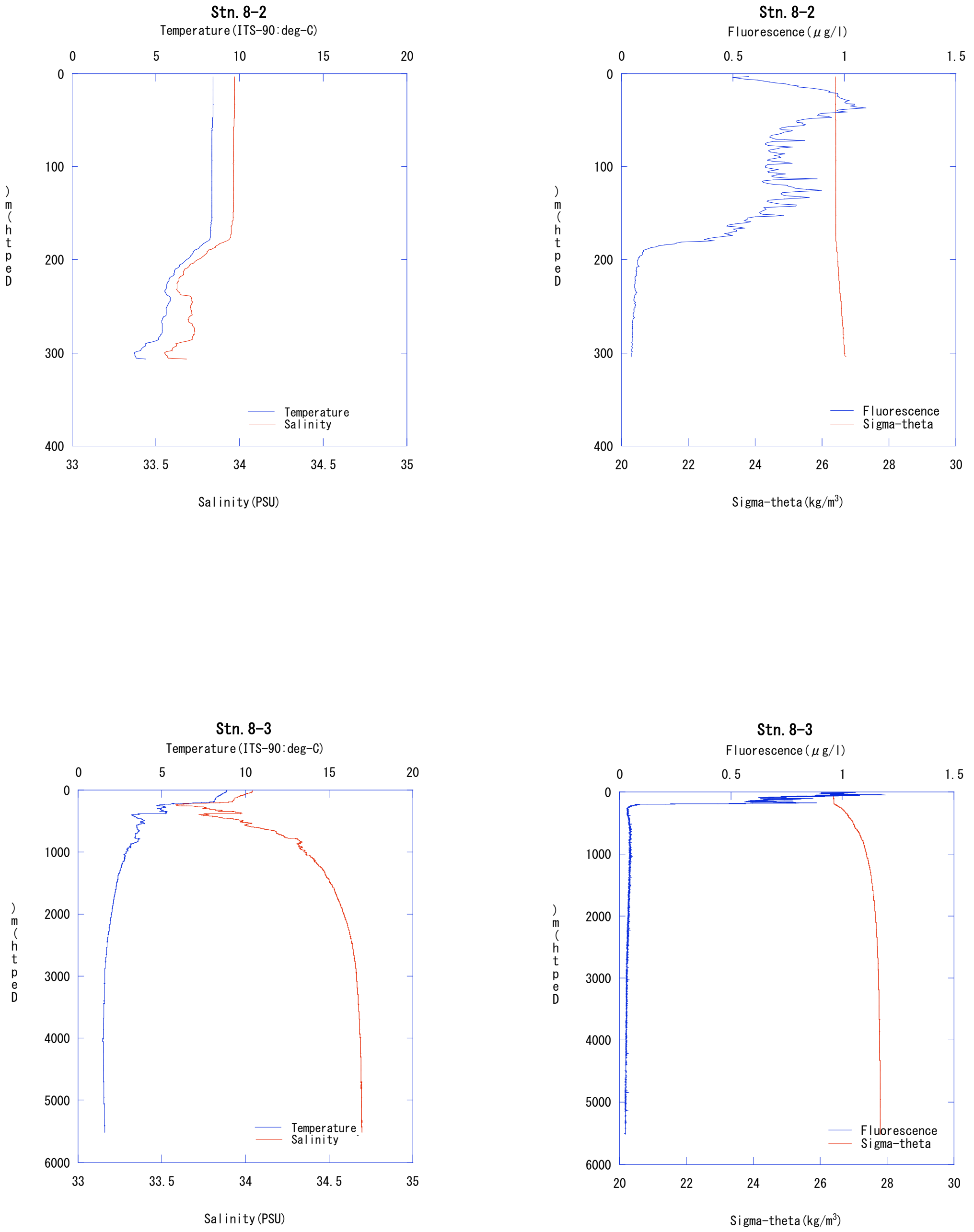


Figure 2.2.1.11: Vertical profiles

Table 2.2.1(a) CTD Cast Table

STNNBR	CASTNO	Sample type	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	Max	CTD data	Remarks
			yyyy/mm/dd	Start	End	Latitude	Longitude	(MNB)	OUT	Depth	file name	
St.8	1	Hydrocast2	2004/3/29	21:02	21:39	41-30.02N	145-48.03E	6939	-	-	008M01	Water sample trouble
	2	Hydrocast2	2004/3/30	0:32	1:15	41-29.96N	145-48.07E	6921	304	301.8	008M03	From 0m to up cast 175m
											test11	From up cast 175m to surface
	3	Hydrocast1	2004/3/30	8:45	13:44	41-30.06N	145-48.95E	6892	5611	5501.0	008M06	
St.4	1	Hydrocast2	2004/4/2	8:59	9:45	39-00.05N	160-00.10E	5505	299	299.2	004M01	
	2	Hydrocast1	2004/4/3	1:31	2:20	39-00.17N	160-00.45E	5507	-	1001.0	004M02	Stop cast by 1000m because of rough sea.
St.1	1	Hydrocast2	2004/4/5	22:59	23:37	50-59.98N	165-00.25E	4806	304	300.6	001M01	
	2	Hydrocast1	2004//4/6	2:42	5:29	51-00.11N	165-00.31E	4806	3024	3003.3	001M02	
	3	Hydrocast3	2004/4/6	12:24	12:34	50-59.99N	164-59.95E	4803	46	50.6	001M03	
St.2	1	Hydrocast1	2004/4/7	12:42	15:35	47-00.00N	160-00.22E	5189	3037	3002.5	002M01	
	2	Hydrocast2	2004/4/7	18:20	19:02	47-00.02N	159-59.84E	5188	300	300.8	002M02	
St.6	1	Hydrocast1	2004/4/8	14:31	17:13	43-59.97N	154-59.61E	5301	3039	3002.6	006M01	
	2	Hydrocast2	2004/4/8	20:01	20:42	43-59.91N	154-59.99E	5306	299	299.7	006M02	
St.5	1	Hydrocast1	2004/4/11	2:58	5:54	34-59.89N	160-00.01E	4542	3026	3001.0	005M01	
	2	Hydrocast2	2004/4/11	8:08	8:46	35-02.53N	160-03.08N	4523	198	200.2	005M02	

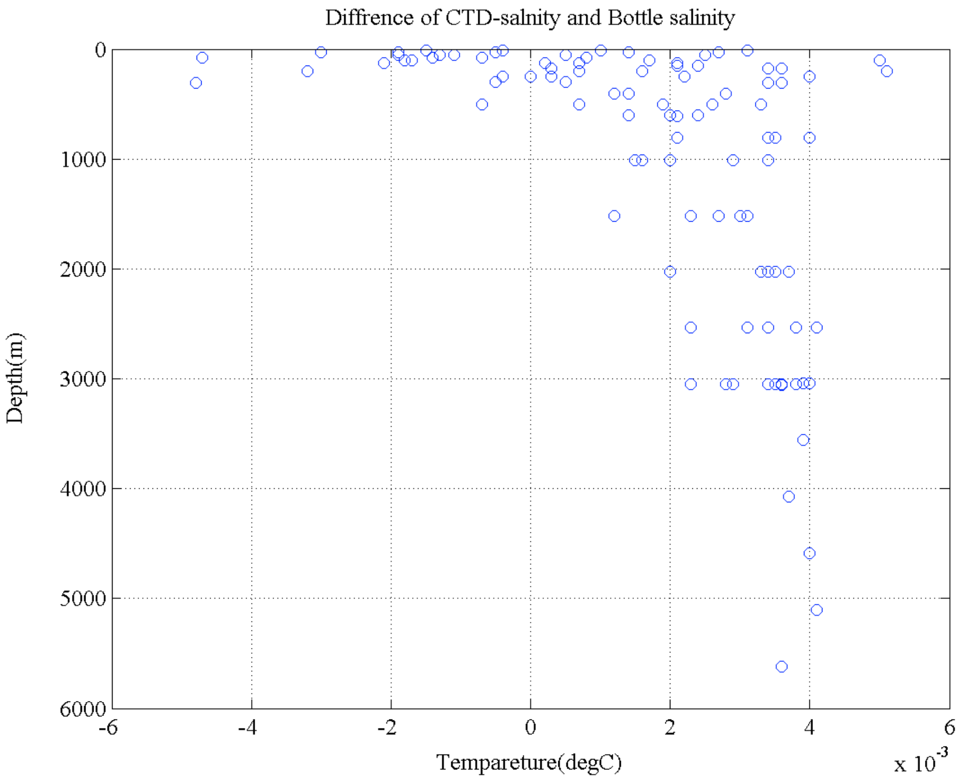


Figure 2.2.1.12: Difference of CTD-salinity and Bottle salinity.

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

	Sample	Average of the absolute deference	Standard deviation of deference
All data	100	0.002	0.002
Data shallower than 1000m	63	0.002	0.002
Data deeper than 1000m	37	0.003	0.001

2.2.2 Salinity measurement

Fujio KOBAYASHI (MWJ)

(1) Objective

Bottle salinity was measured in order to compare with CTD salinity to identify leaking of the bottles and to calibrate CTD salinity.

(2) Instrument and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR04-02 using the Guildline AUTOSAL salinometer model 8400B (S/N 62827), with additional peristaltic-type intake pump, manufactured by Ocean Scientific International, Ltd. We also used two Guildline platinum thermometers model 9450. One thermometer monitored an ambient temperature and the other monitored a bath temperature. The resolution of the thermometers was 0.001 deg C. 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 approximately 23 deg C to 24 deg C, while a bath temperature is very stable and varied within +/- 0.002 deg C on rare occasion.

A double conductivity ratio was defined as median of 31 times reading of the salinometer. Data collection was started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In case the difference between the double conductivity ratio of this two fillings is smaller than 0.00002, the average value of the two double conductivity ratio was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981).

(3-1) Standardization

AUTOSAL model 8400B was standardized at the beginning of the sequence of measurements using IAPSO standard seawater (batch P143, conductivity ratio; 0.99989, salinity; 34.996). Because of the good stability of the AUTOSAL, calibration of the AUTOSAL was performed only once: The value of the Standardize Dial was adjusted at the time. 8 bottles of standard seawater were measured in total, and their standard deviation to the catalogue value was 0.0001(PSU). The value is used for the calibration of the measured salinity.

We also used sub-standard seawater which was obtained from 2,000-m depth and filtered by Millipore filter (pore size of 0.45 μm), which was stored in a 20 liter polyethylene container. It was measured every 10 samples in order to check the drift of the AUTOSAL.

(3-2) Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X (Teflon coating and non-coating) bottle. 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	138
Samples for EPCS	14
Total	152

(4) **Preliminary Results**

The average of difference between measurement data and CTD data were 0.0044 (PSU) and the standard deviation was 0.0069 (PSU). And, we took 16 pairs of replicate samples. The standard deviation of the absolute difference of replicate samples was 0.00014 (PSU).

(5) Data Archive

The data of salinity sample will be submitted to the DMO at JAMSTEC.

(6) 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

Wataru TOKUNAGA (Global Ocean Development Inc.)
Norio NAGAHAMA (GODI)

(1) Parameters

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

(2) Methods

Upper ocean current measurements were made throughout MR04-02 cruise from the departure of Yokohama on 27 Mar 2004 to 01:31UTC 15 Apr 2004. 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 76.8 kHz (VM-75; 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 ADCP was configured for 8-m processing bin, a 8-m blanking interval. The sound speed is calculated from temperature at the transducer head. The transducer depth was 6.5 m; 100 velocity measurements were made at 8-m intervals starting 23 m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged 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:

VM-ADCP Configuration

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 = 00000           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)

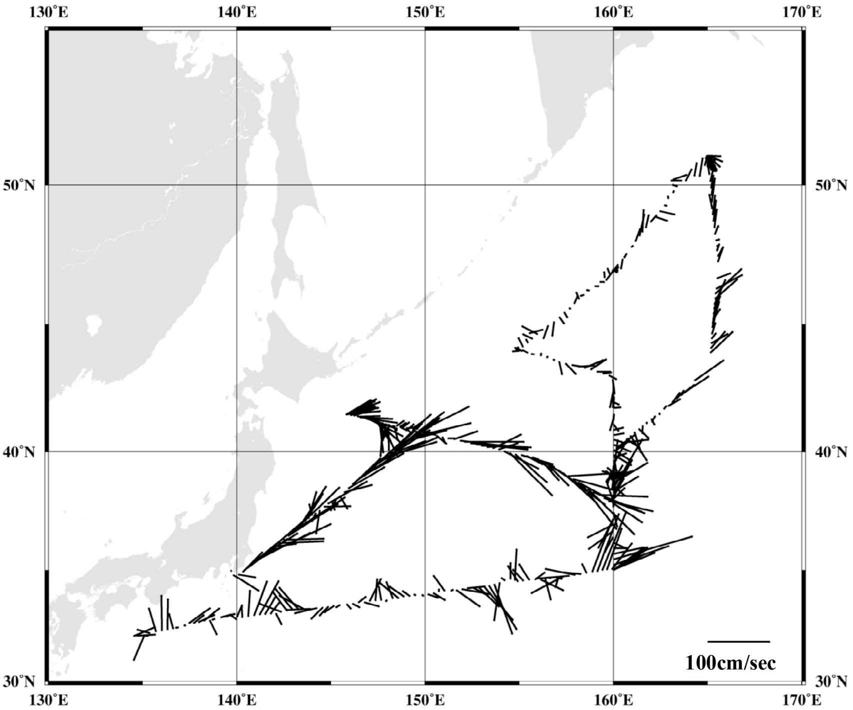
(4) Preliminary result

Fig. 2.2.3-1 show 1-hours averaged current vectors at each layer along cruise track. The data was processed using CODAS (Common Oceanographic Data Access System), developed at the University of Hawaii.

(5) Data archive

These data obtained during this cruise will be submitted to the JAMSTEC Data Management Division, and will be opened to the public via “R/V MIRAI Data Web Page” in JAMSTEC home page.

50－150m



150－250m

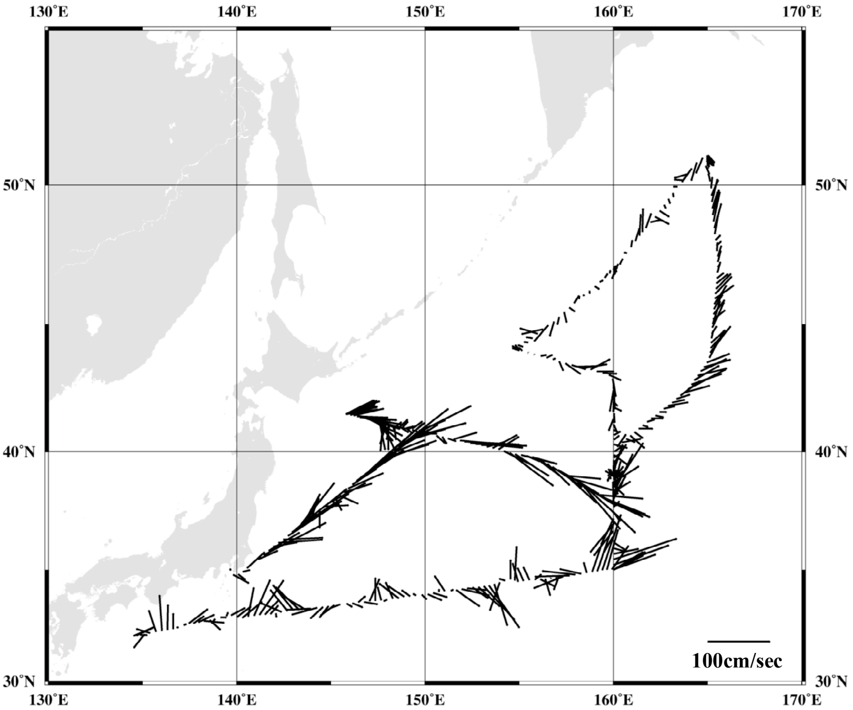


Fig. 2.2.3-1 1-hours averaged surface current vectors at each layer

2.3 Sea surface monitoring

Takayoshi SEIKE (Marine Works Japan Co. Ltd.)

(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 ℃ 6month-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.

7-Nov.-‘03 11:07 to 2-Dec.-’03 17:05

(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).

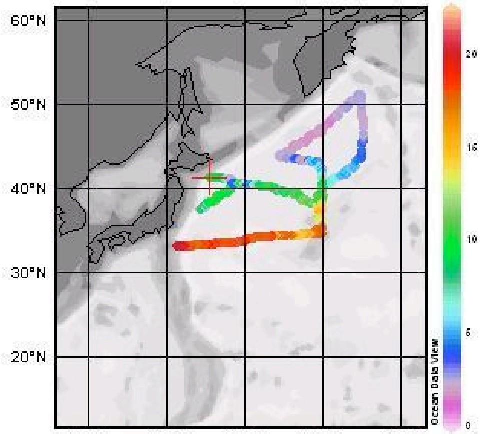


Fig.1 Contour line of temperature.

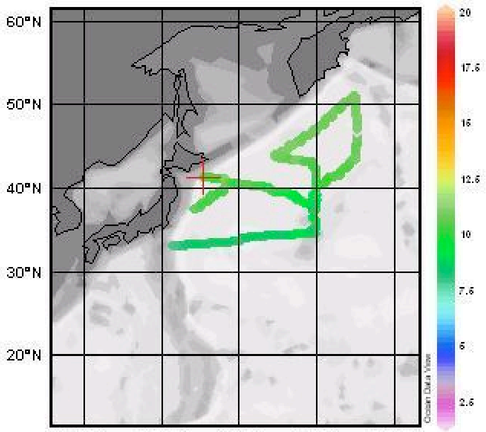


Fig.3 Contour line of dissolved oxygen.

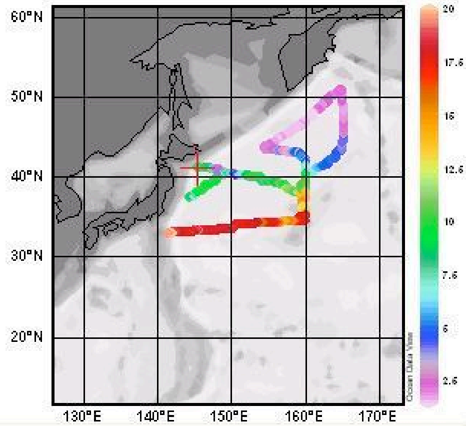


Fig.2 Contour line of salinity.

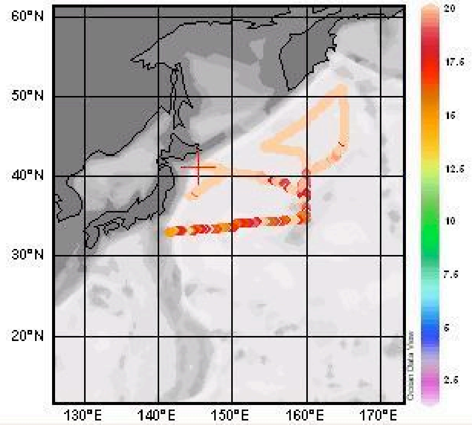


Fig.4 Contour line of fluorescence.

(3) 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

Takayoshi SEIKE (Marine Works Japan Co. Ltd.)

(1) Objectives

Oxygen is one of important chemical tracer that estimates dynamics of carbon dioxide circulation. In this cruise (MR04-02), we measured dissolved oxygen concentration at some stations (St. 1,2,4,5,6,8) in this area.

(2) Methods

1) 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)

2) 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.

3) 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.

4) 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 molarity 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.

5) 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^{o}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) was assumed to be 3.8×10^{-8} mol (Dickson, 1996).

Table 1 shows results of the standardization and the blank determination during this cruise. The blank was less than 0.3 μmol/kg. Reproductively (C.V.) of standardization was less than 0.03 % (n = 5).

Table 1 Results of the standardization and the blank determinations during MR04-02.

Date	Time	KIO_3		DOT-1 (cm^3)			DOT-2 (cm^3)			Samples
(UTC)	(UTC)	#	Bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	blank	(Stations)
03-30-04	18:44	#1	030421-31	040329-1	3.961	0.011	030421-2	3.962	0.012	8
04-03-04	09:43		030421-32	-	-	-	030421-2	3.961	0.013	4
04-06-04	15:57		030421-33	040329-1	3.965	0.010	030421-2	3.961	0.011	1
04-07-04	22:38		030421-34	040329-1	3.964	0.011	030421-2	3.961	0.012	2
04-08-04	05:09		030421-35	040329-1	3.962	0.010	030421-2	3.961	0.013	6
04-11-04	11:07		030421-36	040329-1	3.963	0.011	030421-2	3.960	0.013	5

(3) 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.
22	0.11

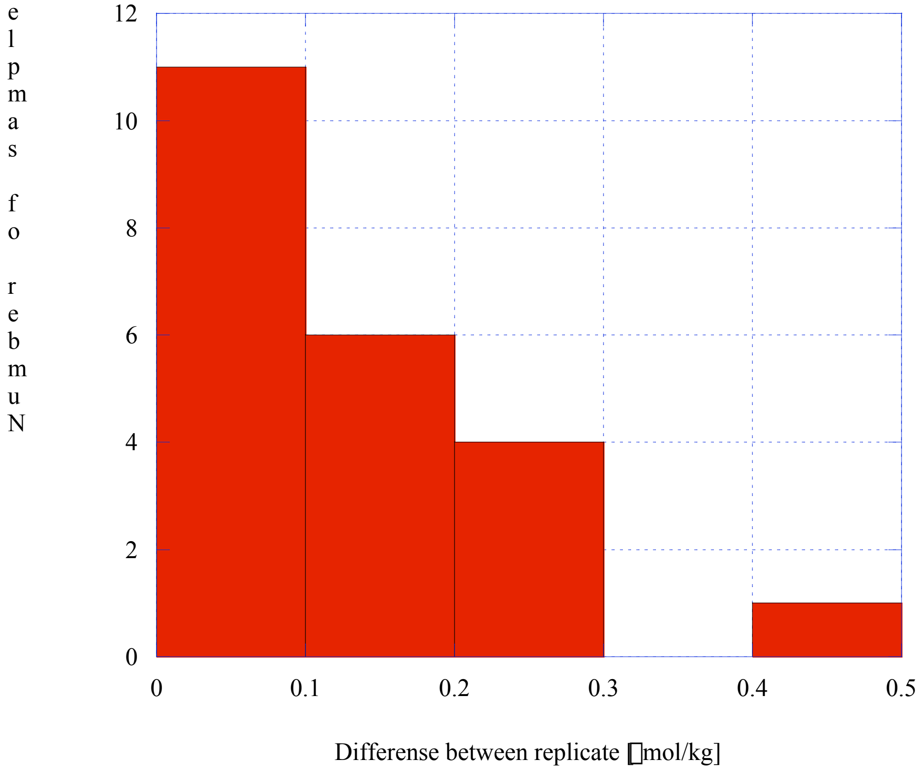
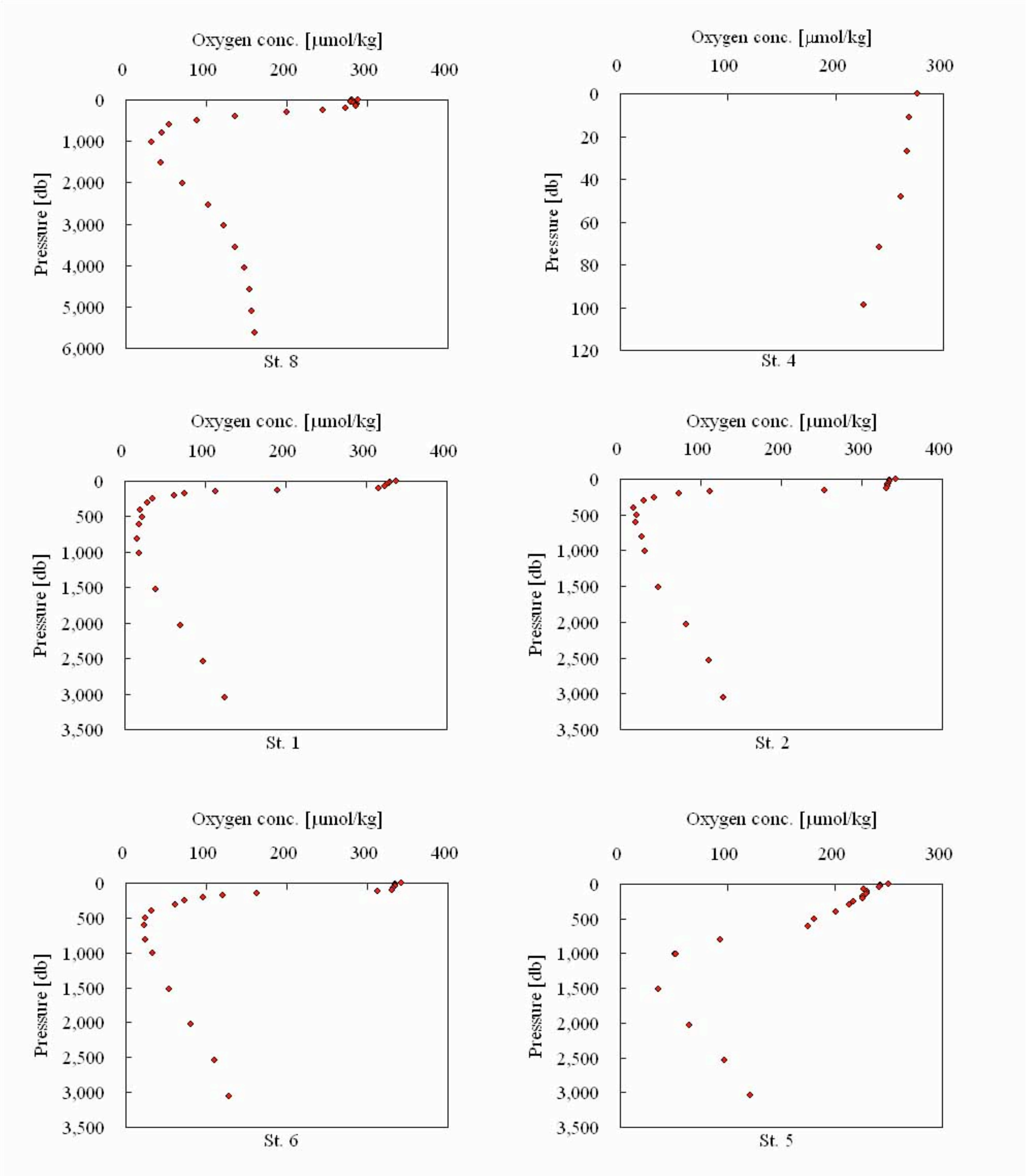


Fig.1 Results of the replicate sample measurements

(3) Preliminary results

During this cruise we measured oxygen concentration in 142 seawater samples at 6 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)
Asako KUBO (MWJ)
Yuki OTSUBO (MWJ)

(1) Objectives

Phytoplankton require nutrient elements for growth, chiefly nitrogen, phosphorus, and silicon. The data of nutrients in seawater is important for investigation of phytoplankton productivity.

(2) Measured parameters

- Nitrate
- Nitrite
- Silicic acid
- Phosphate
- Ammonia

(3) Methods

Seawater samples were transferred into 10 ml PMMA bottles. Sample bottles were rinsed three times before filling. The samples were analyzed as soon as possible. Nutrients were measured by a TRAACS 800 continuous flow analytical system (BRAN+LUEBBE). The following analytical methods were used.

Nitrate: Nitrate in the seawater was reduced to nitrite by reduction tube (Cd-Cu tube), and the nitrite reduced was determined by the nitrite method as shown below. The flow cell was a 3 cm length type.

Nitrite: Nitrite was determined by diazotizing with sulfanilamide by coupling with N-1-naphthyl-ethylendiamine (NED) to form a colored azo compound, and by being measured the absorbance of 550 nm using a 5 cm length flow cell in the system.

Silicic acid: Silicic acid was determined by complexing with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 630 nm using a 3 cm length flow cell in the system.

Phosphate: Phosphate was determined by complexing with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 880 nm using a 5 cm length flow cell in the system.

Ammonia: Ammonia in seawater was mixed with an alkaline solution containing

EDTA, ammonia as gas state was formed from seawater. The ammonia(gas) was absorbed in sulfuric acid solution by way of 0.5 um pore size membrane filter (ADVANTEC PTFE) at the dialyzer attached to analytical system. The ammonia absorbed in acid solution was determined by coupling with phenol and hypochlorite solution to from an indophenol blue compound. That compound produced is measured absorbance of 630 nm using a 3 cm length cell.

(4) Results

Precision of the analysis

Coefficient of variation (CV) of nitrate, nitrite, silicic acid, phosphate and ammonia analysis at each station were less than 0.23% (54 µM), 0.22% (1.6 µM), 0.20% (201 µM), 0.16% (3.7µM), and 0.35% (3.2µM) respectively.

(5) Data Archive

These data are stored Ocean Research Department in JAMSTEC.

2.6 Total Dissolved Inorganic Carbon Measurement

Minoru KAMATA (MWJ)
Toru FUJIKI (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. There are, however, four parameters that could be measured; alkalinity, total dissolved inorganic carbon, pH and pCO_2. If two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on board measurements of total dissolved inorganic carbon (TDIC) during MR04-02 cruise.

(3) Measured Parameters

Total dissolved inorganic carbon

2.6.1 Water column TDIC

(1) Apparatus and performance

(1)-1 Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 6 stations. Seawater was sampled in a 250ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 3 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 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 100_l 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.

(1)-2 Seawater analysis

The analyzer system for total dissolved inorganic carbon was placed on board. This system was connected 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 follows.

The sampling cycle was composed of 3 measuring factors; 70ml of standard CO_2 gas (2.0% 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.

Before measuring a samples, 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.

From the glass bottle, approximately 28ml 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.

By measuring Certified Reference Material (CRM batch 60, Certified value:1991.24 _mol/kg, Scripps Institution of Oceanography) at the start of every run series, the slope was calibrated with the counts of this outcome. We also carried out a reference material (KRM batch G) measurement during every run as well as CRM measurements. The reference material was prepared in KANSO by a similar procedure of CRM preparation. A set of cell solution was changed after approximately 50 seawater samples were measured.

(2) Preliminary results

A duplicate analysis was made on 4-5 seawater samples a station and the difference between each pair of analyses was plotted on a range control chart (see Figure 1). The average of the differences was 0.8 _mol/kg (n=20). The standard deviation was 0.7 _mol/kg which indicates that the analysis was accurate enough according to DOE (1994). CRM measurement results that the average was 1990.6 _mol/kg (n=4) and the standard deviation was 0.6 _mol/kg.

Figure 2 is showing the results of measuring the TDIC concentration of bottle sampling seawater.

(3) 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

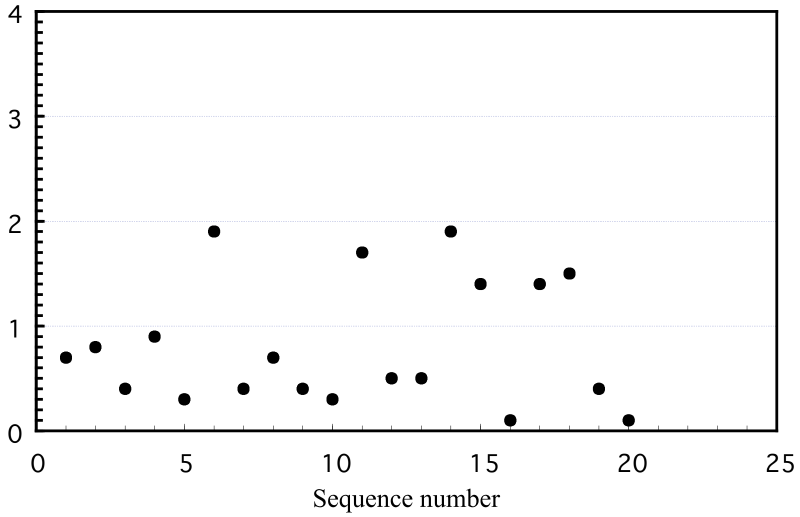
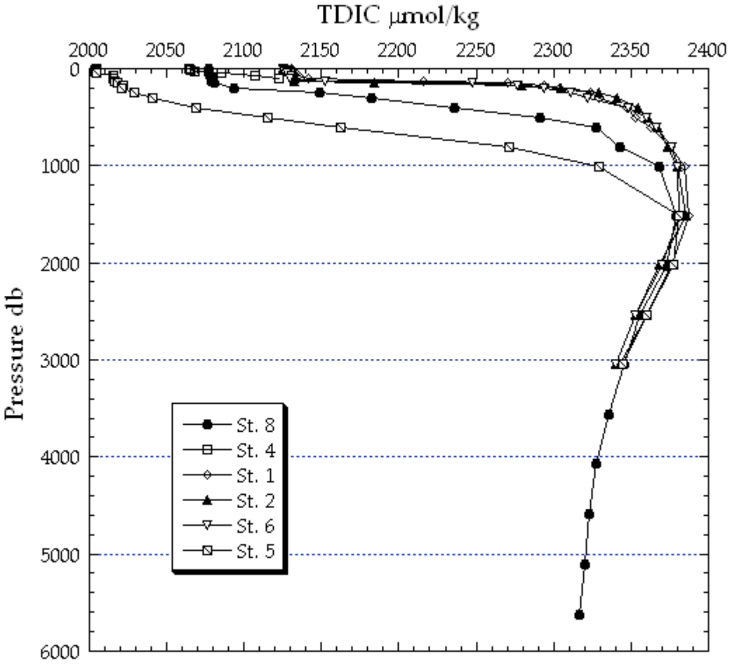


Figure 1 Absolute difference of replicate measurements



2.6.2 Sea Surface TDIC Measurement

(1) Apparatus and performance

Surface seawater was continuously collected from 28th Mar 2004 to 13th Apr 2004 during this cruise. Surface seawater was continuously collected from bottom of this ship (depth of 4.5m) by a pump. The TDIC of the introduced surface seawater was constantly measured by a coulometer that was set to analyze surface seawater specifically. The colometric measurement is same as described in 2.6. 1 except the flow rate of nitrogen gas is 140ml/min.

Before measuring a samples, 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 of RM(batch G; KANSO) every time the cell was filled with fresh anode and cathode solutions, the slope was calibrated with the counts of this outcome. The set of cell solutions was changed in every three days.

(2) Preliminary results

Figure 1 is showing the results of measuring the TDIC concentration of surface seawater sample. During the cruise, 8 bottles of RM(batch G) was analyzed in order to calibrate the slope of the calibration factor. RM measurement results that the standard deviation was 0.9 _mol/kg (n=8). The standard deviation of the absolute differences of duplicate measurements was 1.1 _mol/kg (n=8).

(3) 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

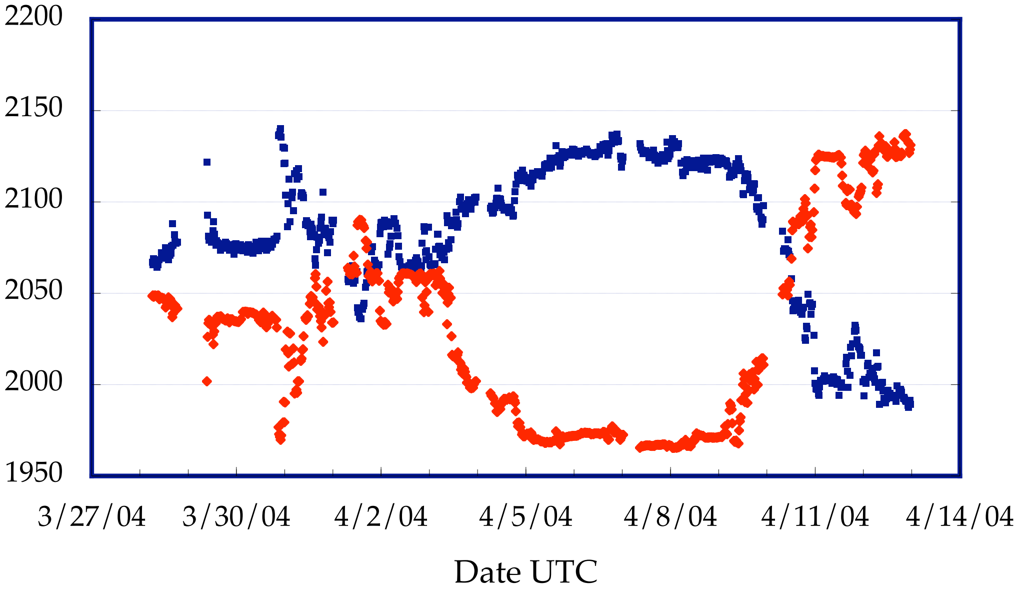


Fig. 1 the results of measuring the TDIC concentration of surface seawater sample.

2.7 Total alkalinity

Taeko OHAMA (Marine Works Japan Ltd.)

(1) Method and Instruments

As for the sample of the obtained seawater, capacity was flowed in the bottle made of the glass of 125ml by 12L Niskin TM bottle. Seawater was filled from the bottom of the sampling bottle, and the two double of the amounts were overflowed. The bottle was sealed with the screw top next, and stored in the refrigerator. The bottles were put in the water bath kept about 25℃ before the titration.

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.

(2) Preliminary results

Preliminary data of total alkalinity were shown in Appendix.

The absolute differences of duplicate measurements were plotted sequentially to evaluate the precision of the measurement process. It was shown in Fig.3.8-1. The average and standard deviation, repeatability of measurements, were 1.6 and 1.4 µmol/kg. As for a lot of samples, the difference of the value of two samples was before and behind 1-2µmol/kg. But, the sample whose difference of two samples is 5_mol/kg or more existed, and influenced accuracy by these samples. However, we achieved the precision of recommended value or less (2µmol/kg) of DOE(1994).

We measured two kinds of control sample, SIO CRM batch 60 and to evaluate the stability of the measurement process. Measurements values of CRM were plotted sequentially and shown in Fig.2.7-2. And Fig.2.7-3 shows the vertical distribution of Total Alkalinity of all Station.

References

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.

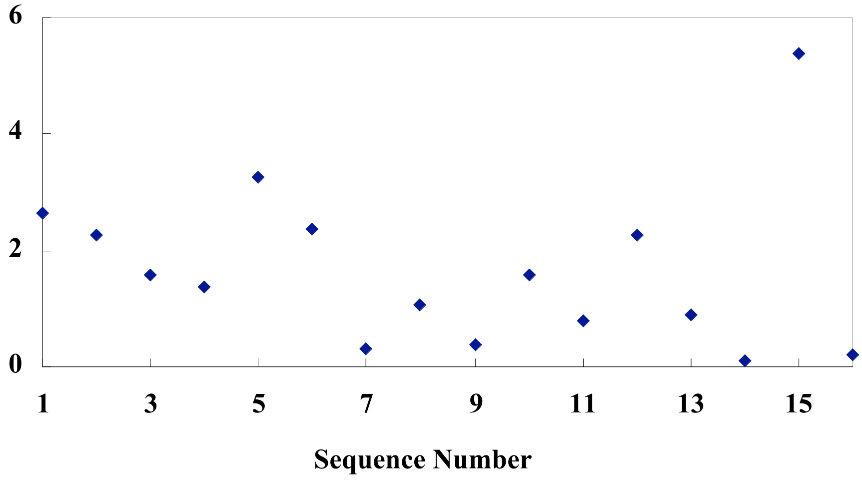


Fig.2.7-1 Differences of duplicate measurements

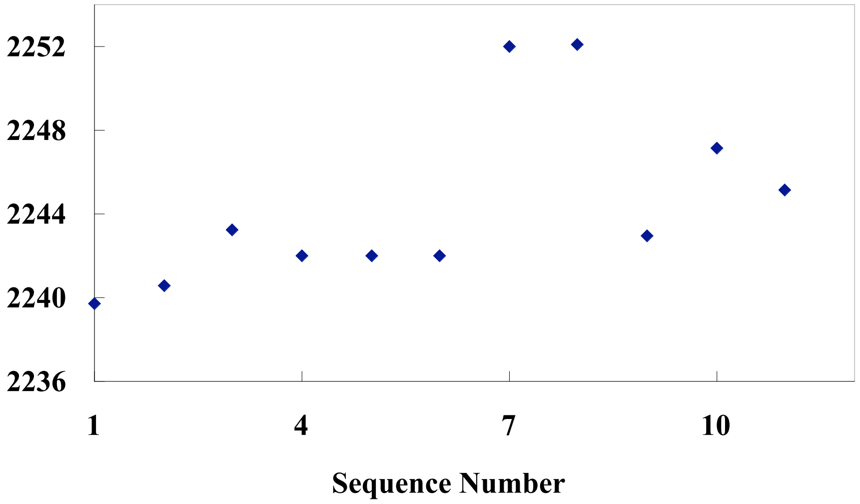


Fig.2.7-2 Measurement results of CRM

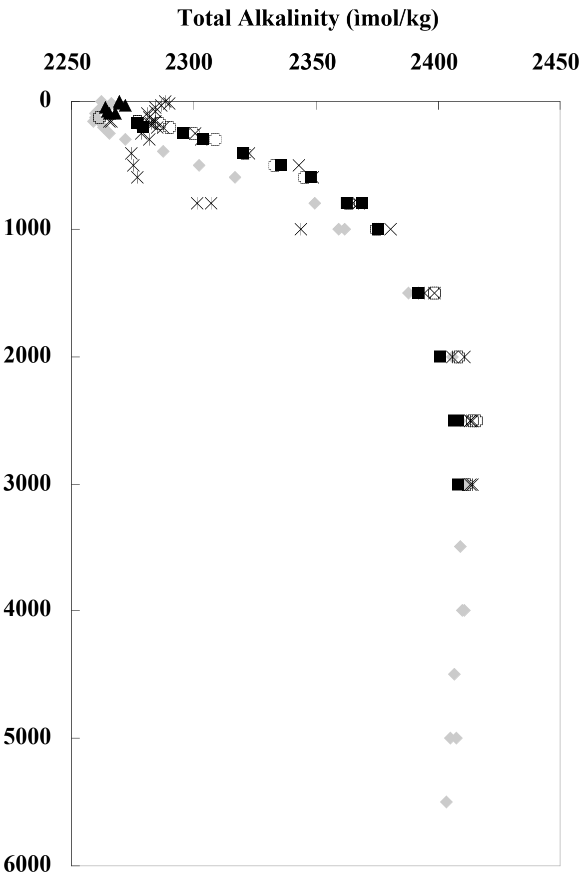


Fig.2.7-3 Vertical distribution of Total Alkalinity from St.K1 to St.K3.

2.8 Chlorophyll *a*

Hajime KAWAKAMI (JAMSTEC MIO)
Makio HONDA (JAMSTEC MIO)

(1) Sampling location

Seawater samples are collected from Station K1, K2, K3, KNOT, 5 and 8 in this cruise used 12 L Niskin sampling bottles with CTD-RMS.

(2) Experimental procedure

The concentration of chlorophyll *a* in seawater samples is measured by fluorometric determination. The method used here utilizes the Turner fluorometer as suggested by Parsons et al. (1984).

Seawater samples (500 ml) are filtered through a glass fiber filter at 1/2 atmospheric pressure. Filters are used Whatman GF/F glass fiber filters (25 mm diameter).

The filters are extracted by 7 ml of *N, N'* -dimethylformamide between overnight in a dark and cold (-20 °C) place.

The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005, TURNER DESIGNS) with a 340-500 nm bound excitation filter and a >665 nm bound emission filer, before and after acidification. The acidification is carried out with 1 or 2 drops of 1 N HCl and the second measurement made 1 minutes after the acidification.

The amount of chlorophyll *a* is calculated from the following equation;

$$\mu\text{g chlorophyll } a \text{ / L} = (\text{fo} - \text{fa}) / (F_{Ch} - F_{ph}) \quad * \text{ v/V}$$

where fo and fa are the fluorescence before and after the acidification, respectively, F_{Ch} and F_{ph} are the fluorescent factor of chlorophyll *a* and phaeophytine *a*, respectively, v is the volume of *N, N'* -dimethylformamide extract, and V is the volume of seawater.

The method is calibrated against a known concentration of chlorophyll *a* as determined by the spectrophotometric method (Porra et al., 1989).

A precision based on replicate measurements is usually less than 5%.

(3) Preliminary result

The preliminary results were shown in Table 2.8 and Figures 2.8.

(4) References

Parsons Timothy R, Yoshiaki Maita and Carol M Lalli. 1984. "A manual of chemical and biological methods for seawater analysis" (Pergamon Press), pp. 101-112.

Porra R. J., W. A. Thompson and P. E. Kriedemann. 1989. Biochim. Biophys. Acta, 975, 384-394.

Table 2.8 The concentrations of Chlorophyll *a* (µg l^{-1}) at MR02-K05.

Depth (m)	St. K1	St. K2	St. K3	St. KNOT
0	0.268	0.329	0.683	0.512
10	0.454	0.327	0.610	0.497
20	0.484	0.329	0.591	0.524
40	0.421	0.360	0.567	0.460
60	0.425	0.357	0.548	0.542
80	0.376	0.309	0.201	0.432
100	0.319	0.308	0.102	0.218
150	0.014	0.016	0.195	0.024
200	0.005	0.006	0.041	0.013

Depth (m)	St. 5	St. 8
0	0.292	0.763
10	0.314	0.827
30	0.302	0.707
50	0.384	0.704
75	0.235	0.662
100	0.119	0.569
125	0.045	0.599
150	0.022	0.564
200	0.014	0.218

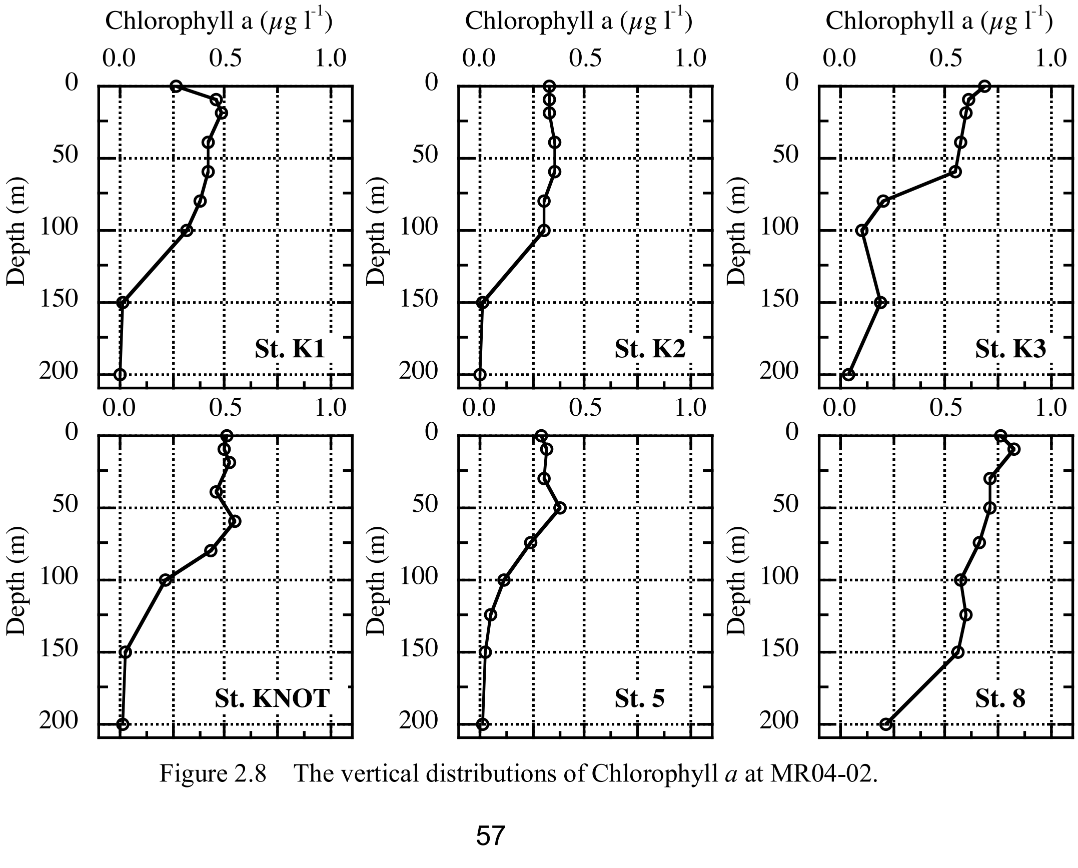


Figure 2.8 The vertical distributions of Chlorophyll *a* at MR04-02.

3.1 Vertical distribution of suspended particles

Kazuhiro HAYASHI (JAMSTEC MIO)
Xuedong XU (JAMSTEC MIO)

(1) Objectives

Understanding the mechanism of export flux is important for research of biological pump. Especially, SPM in the sea surface is the origin of sinking particles, and the behavior of it is important to understand export flux. Sinking particles captured by sediment trap record the seasonal variation and distribution of the SPM at the ocean surface. By clarifying the relation, the amount of reproduction from the euphotic layer to the pelagic layer can be estimated.

The objectives of this investigation are to understand the seasonal variation relationship between chemical tracers and primary production at the northwestern Pacific, and obtain more knowledge of characteristics of the particulate matter and phytoplankton communities in this area.

(2) Sampling

Vertical suspended particulate matters (SPM) were collected on 142mm Millipore HA filter by Large volume pump systems. Samples were collected from St. K-1, St. K-2, St. KNOT, St. 6. Filtered volume was counted by flowmeter. After filtrated, each filter was rinsed over 3 times by milli-Q water. Millipore HA filters were moved to acid clean zip lock bag, which were stored in the refrigerator.

(3) Analytical method

Millipore HA filters are cut in half size by plastic cutter in the clean food, one is digested by using microwave digestion system (Ethoth: Milestone) with HNO_3 and HF. Dissolved samples are transferred to 50ml centrifuge tube. For ICP-AES samples, uptake of 5ml, add Sc as an internal standard, which take for major elements. These samples will be measured by ICP-AES (Optima 3300DV: Perkin-Elmer). After divided for ICP-AES, almost 45ml sample is added spikes, transferred to Teflon beaker, and evaporated to small drop. Teflon beaker wall is rinsed by conc. HNO_3 3 or 4 times. Sample will be measured by ICP-MS with dessolvator (modified Cullen *et al.*, 2001).

Reference

Cullen *et al.*, (2001) Determination of elements in filtered suspended marine particulate material by sector field HR-ICP-MS, J. Anal. At. Spectrom. , 2001, 16, 1307-1312

3.2 Optical measurement

Makio HONDA (JAMSTEC MIO)

(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 winter or early spring.

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 5 points. Measurements should be ideally conducted at median time and, however, were conducted irregularly because of 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 JST)

Station name	K1	K1/K2	K2	KNOT	K3	35N
Location	51N 165N	48-20N 161-31E	47N 160N	44N 155N	39N 160N	35N 160E
Observation Date	Apr. 6 2004	Apr. 7 2004	Apr. 8 2004	Apr. 9 2004	Apr. 3 2004	Apr. 11 2004
Observation Time	11:00	11:30	4:10	8:00	9:30	11:30
Sun rise	3:24	3:39	3:45	4:06	4:01	3:50
Median time	10:03	10:16	10:22	10:41	10:23	10:20
Sun set	16:42	16:54	17:00	17:17	16:46	16:50
Irradiance in air (PAR in air) (□E/sec/m^2)	1152 ±241	414 ±15	15.2 ±0.2	748 ±14	1769 ±334	1775 ±314
1% depth (m)	59	59	67	59	83	75
3□E depth (m)	79	62	17	67	97	113
1□E depth (m)	97	80	33	85	119	150

(3) Preliminary results

1) PAR in air.

Table 2 shows PAR in air. Maximum PAR in air was observed at station K3 and minimum was observed at station K2. Intensity of PAR depends on the time observed and weather during observation.

2) Vertical profile of PAR in the water column

Fig.1 shows vertical profiles of PAR at respective points. One of my interests was to know the depth which weak PAR of 1 – 3 mE/sec/m2 reaches. This PAR is the intensity of PAR with which ARGOS compact mooring locator (CML) of our mooring system is suspected to start transmission of signal about its location. This depth was between 17 m and 33 m at station K2. However observation at station K2 was conducted at the early morning and this depth was expected to be deepen at median time. This depth at northern stations (> 40 N) were between 62 m and 97 m, and 97 and 119 m at station K3 (39N). These results indicates the much possibility that ARGOS CML which was deployed around 50 m started signal transmission in the water.

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. Although absolute surface PAR were different among stations, depth with 1 % intensity, which depth is known as the depth of bottom of euphotic zone, were approximately 60 m for northern stations (K1, K1/K2, K2, KNOT).

Depth of 1 % intensity at station K3 was approximately 80 m and deeper than those at northern stations.　Dotted lines at figures (a) and (b) show relative intensities and depths for simulated in situ incubation for measurement of primary productivity.
We observed time-series primary production by using submersible incubation device (SID) installed on mooring system at station K1 and K3.　Depths of SID were approximately 50 m at both stations.　In the early April, SID received 1.5 % light and 4 % light at stations K1 and K3, respectively based on the above results.

4) Seasonal change in light extinction

Optical observation was also conducted at stations K1, K2, K3 and KNOT during the former cruise (R/V Natsushima and R/V Kairei).　Fig. 3 shows comparison of light extinction （decrease of relative light intensity with depth） between that during this cruise and that during former cruise held in July (Natsushima) and in September or October (Kairei),　The intensity of light extinction in July or September is larger than that in April (this cruise).　It is likely that more suspended particles including living plankton in July and September have the intensity of light extinction high.

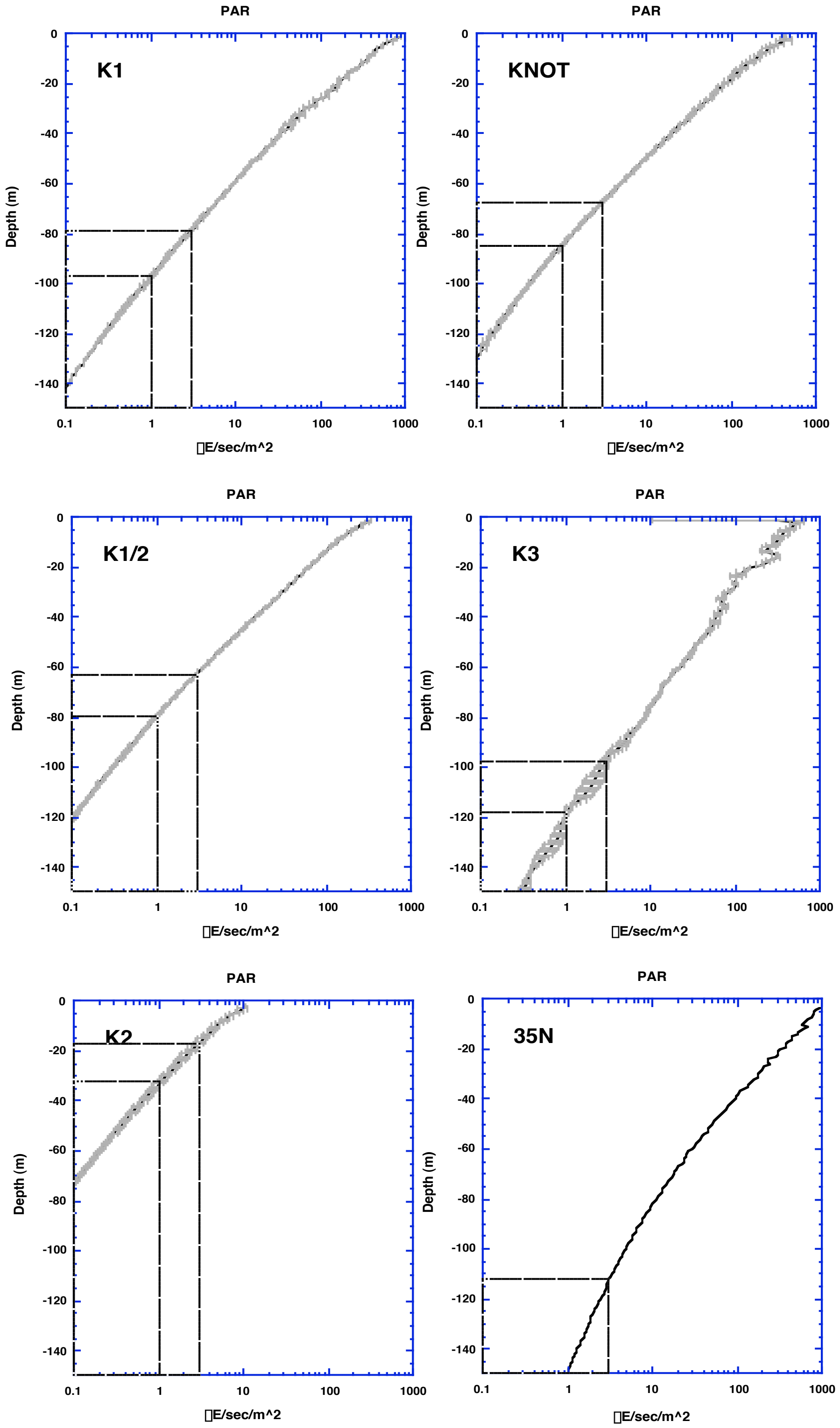


Fig. 1 Vertical profile of PAR

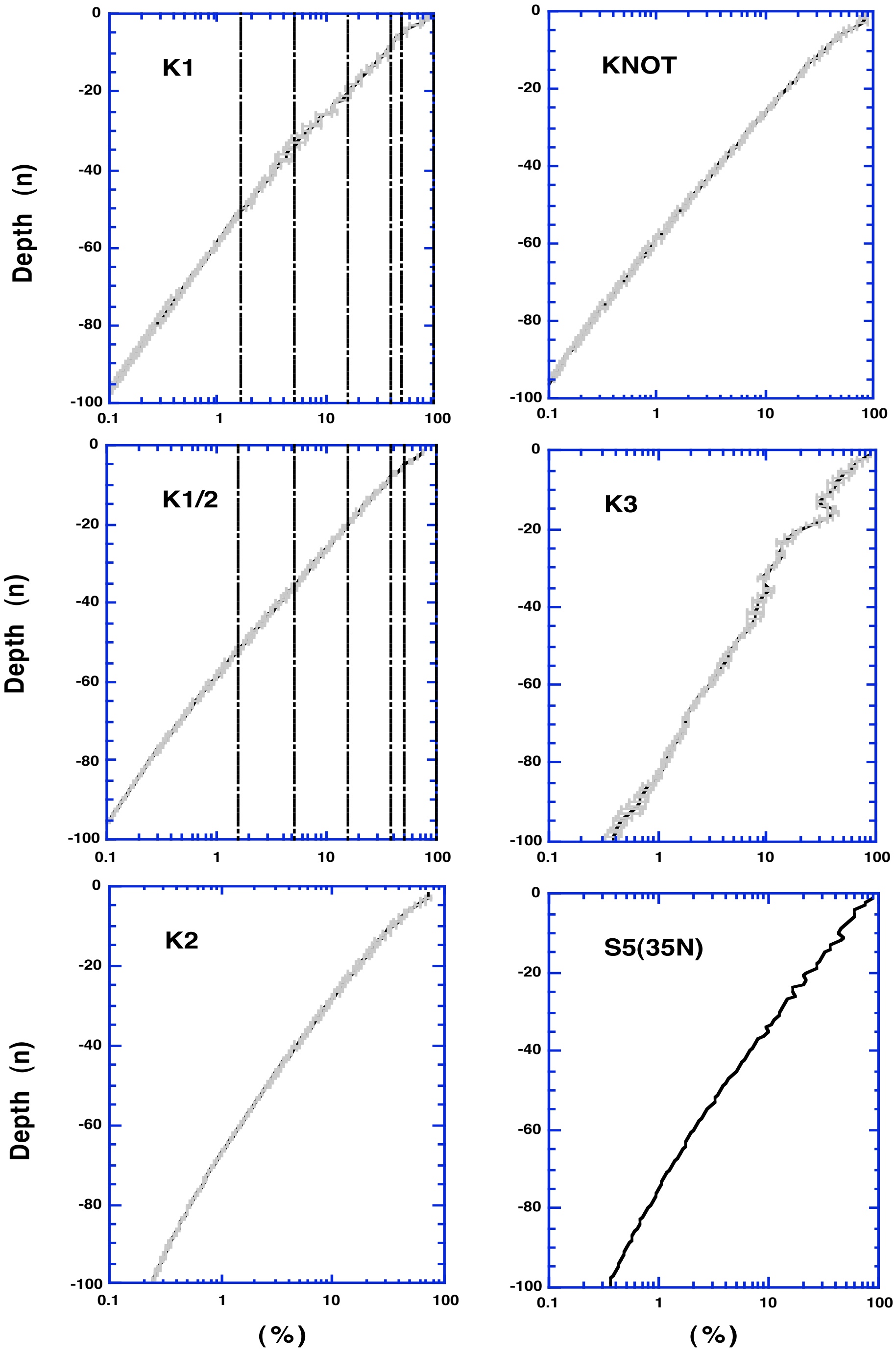


Fig. 2 Relative light intensity

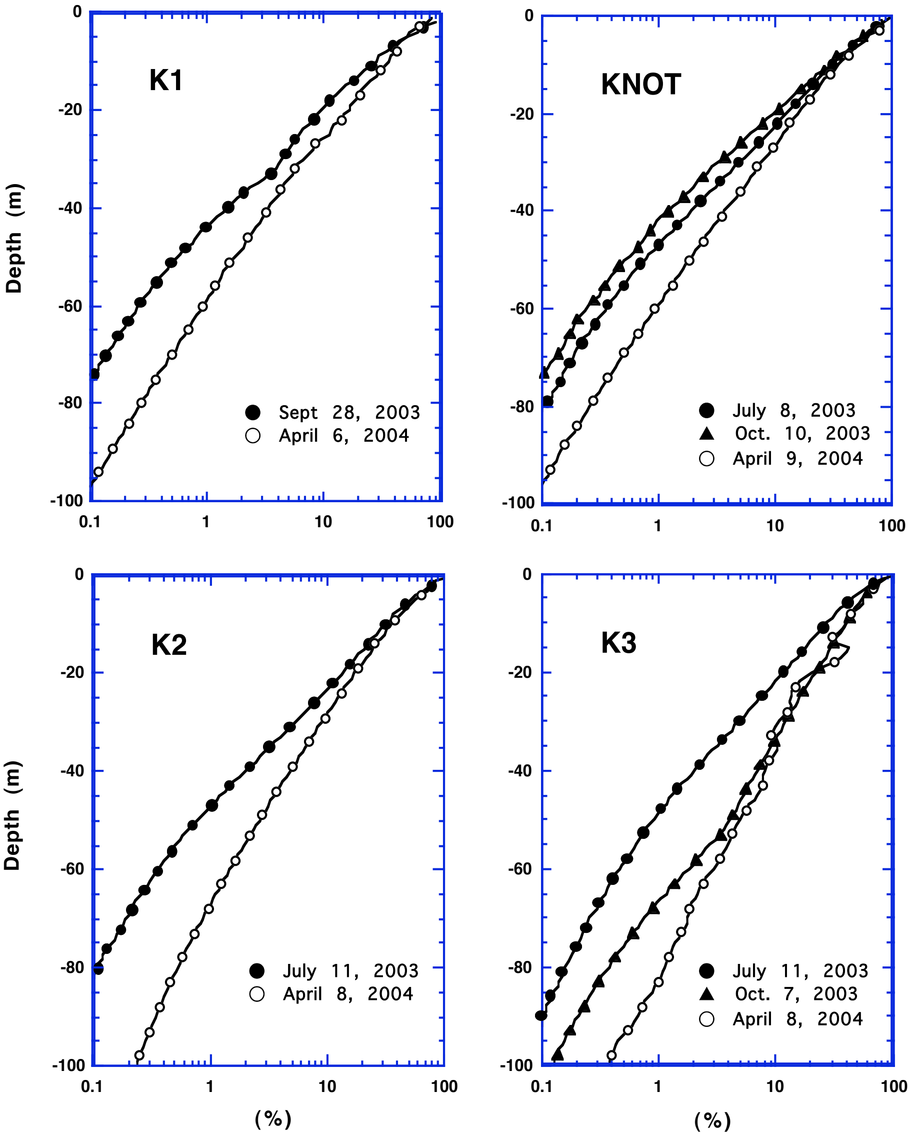


Fig. 3 Seasonal change in light extinction

3.3 Primary productivity

Makio HONDA (JAMSTEC MIO)

(1) Objective

For better understanding the biological pump, measurement of carbon assimilation rate by phytoplankton (primary productivity) is one of principal items. We have conducted time-series observation with mooring system. Time-series primary productivity is also observed by submersible incubation device (SID). Therefore seasonal measurement of primary productivity on board must help us to interpret SID data. During this cruise, measurement of primary productivity at several points was conducted.

(2) Methods (Simulated *in situ* incubation)

Primary productivity was measured by simulated *in situ* method with carbon stable isotope (C-13) as a tracer. Prior to measurement, light intensity in the water column was observed by free fall sensor" (see Optical measurement). Water sample was collected by CTD/CMS at six depths which relative light intensity can be controlled by incubation aquarium and light sield net (100, 49, 29, 16, 5, and 1.5 %). Water sampling and incubation should be begun just before

sunrise. However water sampling and incubation were begun at random hour because of a convenience of other observations. In addition, water sieving through 200mm mesh to remove large-size zooplankton was not conducted. C-13 tracer of 1 m ($NaH^{13}CO_3$ solution in 100 ml distilled water) was injected to respective 1 L water sample in transparent Nalgen polycarbonate plastic bottle. Sequentially, bottles except the surface sample were put into light shield nets and all samples were placed into deck incubators with light shield filter adjusting to the light levels at respective depth. Water temperature for each incubator was also adjusted to those at respective depth. Samples were incubated for 24 hours. Some samples were incubated during only daytime to know "gross" primary productivity.

After incubation, samples were filtered through the Whatman GF / F glass-fiber filter (diameter: 25 mm, pore size: 0.7 mm) pre-combusted with temperature of 450 ℃ for at least 6 hours. These filtered samples were frozen immediately until laboratory analysis. Incubation records and sample list are shown in Table 1.

All samples will be measured by a mass spectrometer (ANCA-SL) at JAMSTEC.

Station	K1	(start at K1 and end at K2)	
Location	51N	165E	
Sampling Date	April 6 2004	Sampling Time	22:00
Sun rise	3:35	(April 1)	
Saun set	16:34		
Incubation Time	23:00 April 6 2004 - 23:00 April 7 2004		
Weather	fine during daytime but rain and snow in the night		

						Sampling		
	Bottle number	tropical aquarium #	Aq. Temp.(deg-C)	Light intensity (%)	Water Depth (m)	Water Depth(m)	Water Temp(deg-C)	Note
1	1	1	3	100	0	0		24 hrs. Incubation
2	1	1	3	100	0	0		24 hrs. Incubation
3	2	1	3	49	5	6	2.29	24 hrs. Incubation
4	2	1	3	49	5	6	2.29	24 hrs. Incubation
5	3	2	3	29	12	12.5	2.28	24 hrs. Incubation
6	3	2	3	29	12	12.5	2.28	24 hrs. Incubation
7	4	2	3	15.8	18	18.5	2.18	24 hrs. Incubation
8	4	2	3	15.8	18	18.5	2.18	24 hrs. Incubation
9	5	3	3	5.1	31.5	31.9	2.14	24 hrs. Incubation
10	5	3	3	5.1	31.5	31.9	2.14	24 hrs. Incubation
11	6	3	3	1.5	51	49.7	2.11	24 hrs. Incubation
12	6	3	3	1.5	51	49.7	2.11	24 hrs. Incubation

Station	K2	(start at K2 and end at KNOT)	
Location	47N	165E	
Sampling Date	April 8 2004	Sampling Time	0:00
Sun rise	3:52	(April 4)	
Saun set	16:54		
Incubation Time	3:50 April 8 2004 - 16:50 April 8 2004 / 3:50 April 9 2004		
Weather	cloudy		

						Sampling		
	Bottle number	tropical aquarium #	Aq. Temp.(deg-C)	Light intensity (%)	Water Depth (m)	Water Depth(m)	Water Temp(deg-C)	Note
1	1	1	4	100	0	0		13 hrs. day time Incubation
2	1	1	4	100	0	0		24 hrs. Incubation
3	2	1	4	49	6	5.5	1.63	Blank (no tracer)
4	2	1	4	49	6	5.5	1.63	24 hrs. Incubation
5	3	2	4	29	12	11.1	1.61	13 hrs. day time Incubation
6	3	2	4	29	12	11.1	1.61	24 hrs. Incubation
7	4	2	4	15.8	20	19.6	1.61	Blank (no tracer)
8	4	2	4	15.8	20	19.6	1.61	24 hrs. Incubation
9	5	3	4	5.1	37	37.1	1.58	13 hrs. day time Incubation
10	5	3	4	5.1	37	37.1	1.58	24 hrs. Incubation
11	6	3	4	1.5	54	53.7	1.54	13 hrs. day time Incubation
12	6	3	4	1.5	51	53.7	1.54	24 hrs. Incubation

Station	5			
Location	35N	165E		
Sampling Date	April 11 2004	Sampling Time	18:00	
Sun rise	4:03			
Sun set	16:50			
Incubation Time	4:00 April 12 2004 - 4:00 April 12 2004			
Weather	fine			

Keep samples untill incubation in the aquariumin dark
inject tracer just before incubation

start position: 34-41N, 157-06E
end position: 34-03N, 150-47E

						Sampling		
	Bottle number	tropical aquarium #	Aq. Temp.(deg-C)	Light intensity (%)	Water Depth (m)	Water Depth(m)	Water Temp(deg-C)	Note
1	1	1	17	100	0	0		24 hrs. Incubation
2	1	1	17	100	0	0		24 hrs. Incubation
3	2	1	17	49	8	8.3	17.46	24 hrs. Incubation
4	2	1	17	49	8	8.3	17.46	24 hrs. Incubation
5	3	2	17	29	17	16.3	17.47	24 hrs. Incubation
6	3	2	17	29	17	16.3	17.47	24 hrs. Incubation
7	4	2	17	15.8	26	26.7	17.46	24 hrs. Incubation
8	4	2	17	15.8	26	26.7	17.46	24 hrs. Incubation
9	5	3	17	5.1	47	48.2	17.46	24 hrs. Incubation
10	5	3	17	5.1	47	48.2	17.46	24 hrs. Incubation
11	6	3	17	1.5	67	67.6	17.36	24 hrs. Incubation
12	6	3	17	1.5	67	67.6	17.36	24 hrs. Incubation

Station	TEST (comparison of NPP with GPP)			
Location	34-02.53N	150-47.27E		
Sampling Date	April 13 2004	Sampling Time	3:00	
Sun rise	4:03			
Sun set	17:40			
Incubation Time	4:00 April 13 2004 - 4:00 April 14 2004			
Weather	fine			

collect surface water sample from underway observation room

artificial night starts at 15:30
end point: 33-13.4N, 143-09.1E

						Sampling		
	Bottle name	tropical aquarium #	Aq. Temp.(deg-C)	Light intensity (%)	Water Depth (m)	Water Depth(m)	Water Temp(deg-C)	Note
1	1-24	1	17	49	4	4	17	24 hrs. Incubation
2	1-24	1	17	49	4	4	17	24 hrs. Incubation
3	1-12	1	17	49	4	4	17	12 hrs. Incubation
4	1-12	1	17	49	4	4	17	12 hrs. Incubation
5	1-BLK	1	17	49	4	4	17	BLK(24hr.).no C-13 tracer
6	1-DRK	1	17	49	4	4	17	DRK(24hr.)wrapped with black plastic bag
7	2-24	2	17	49	4	4	17	24 hrs. Incubation
8	2-24	2	17	49	4	4	17	24 hrs. Incubation
9	2-12	2	17	49	4	4	17	12 hrs. Incubation
10	2-12	2	17	49	4	4	17	12 hrs. Incubation
11	2-BLK	2	17	49	4	4	17	BLK(24hr.)
12	2-DRK	2	17	49	4	4	17	DRK(24hr.)wrapped with black plastic bag
13	3-24	3	17	49	4	4	17	24 hrs. Incubation
14	3-24	3	17	49	4	4	17	24 hrs. Incubation
15	3-12	3	17	49	4	4	17	12 hrs. Incubation
16	3-12	3	17	49	4	4	17	12 hrs. Incubation
17	3-BLK	3	17	49	4	4	17	BLK(24hr.)
18	3-DRK	3	17	49	4	4	17	DRK(24hr.)wrapped with black plastic bag

3.4 Th-234 and export flux

Hajime KAWAKAMI (JAMSTEC MIO)

(1) Purpose of the study

The fluxes of POC were estimated from Particle-reactive radionuclide (^{234}Th) and their relationship with POC in the northwestern North Pacific Ocean.

(2) Sampling

Seawater sampling for ^{234}Th and POC: 3 stations (St.K1, K2 and KNOT) and 8 depths (10m, 20m, 40m, 60m, 80m, 100m, 150m and 200m) at each station.

Seawater samples (20–30 L) were taken from Hydrocast at each depth. The seawater samples were filtered with 47mm GF/F filter on board immediately after water sampling.

In situ filtering samples were taken from large volume pump sampler (LVP) at each depth (see 3.1). The filter samples (150mm GF/F filter) were divided for ^{234}Th and POC.

(3) Chemical analyses

Dissolved ^{234}Th was separated using anion exchange method on board; all Hydrocast samples. Particulate ^{234}Th from LVP samples were separated in land-based laboratory. Separated samples of ^{234}Th were absorbed on 25mm stainless steel disks electrically, and were measured by b-ray counter.

The determinations of POC were used CHN analyzer in land-based laboratory.

(4) Preliminary result

The distributions of dissolved and particulate ^{234}Th will be determined as soon as possible after this cruise. This work will help further understanding of particle dynamics at the euphotic layer.

3.5 Horizontal distribution of suspended particles

Kazuhiro HAYASHI (JAMSTEC MIO)
Xuedong XU (JAMSTEC MIO)

(1) Objectives

Understanding the seasonal variation of the trace metals in the particle matter at the ocean surface is important for study of export fluxes by them. The contents of trace elements in particulate matter differ by dominant phytoplankton communities. The objectives of this investigation are to understand the seasonal variation relationship between chemical tracers and primary production at the northwestern Pacific, and obtain more knowledge of characteristics of the particulate matter and phytoplankton communities in this area.

(2) Sampling

Underway samples were collected at 50m from sea surface by continuous seawater pump on R/V MIRAI. Underway seawater is introduced to stainless steel filter holder (SUS 316) for 142mm filters. Particulate matter was collected by Millipore-HA (0.45mm) **(Table 1)**. Filtered volume was counted by flowmeter. After filtrated, each filter was rinsed over 3 times by milli-Q water. Millipore HA filters were moved to acid clean zip lock bag, which were stored in the refrigerator. In order to obtain horizontal nutrients distribution, seawater samples were collected for nutrients when each filtration started. Seawater samples were stored in refrigerator, and analyzed by autoanalyzer(TRAACS 800; BRAN+LUEBE) within 10 days after sampling.

(3) Analytical method

Millipore HA filters are cut in half size by plastic cutter in the clean food, one is digested by using microwave digestion system (Ethoth: Milestone) with HNO_3 and HF. Dissolved samples are transferred to 50ml centrifuge tube. For ICP-AES samples, uptake of 5ml, add Sc as an internal standard, which take for major elements. These samples will be measured by ICP-AES (Optima 3300DV: Perkin-Elmer). After divided for ICP-AES, almost 45ml sample is added spikes, transferred to Teflon beaker, and evaporated to small drop. Teflon beaker wall is rinsed by conc. HNO_3 3 or 4 times. Sample will be measured by ICP-MS with dessolvator (modified Cullen *et al*., 2001).

Reference

Cullen *et al*., (2001) Determination of elements in filtered suspended marine particulate material by sector field HR-ICP-MS, J. Anal. At. Spectrom. , 2001, 16, 1307-13

Table 1 List of filter sampling data

	Filtering start						Filtering end						
ID	Date	time UTC	Log.	Lon.	Temp SBE (degree-C)	Salinity (psu)	Date	time UTC	Log.	Lon.	Temp SBE (degree-C)	Salinity (psu)	filterate volume Litter
1	03/28/2004	9:34	39.04.53	146.49.65	9.93	36.164	3/28/2004	10:36	39.13.21	147.03.03	9.881	34.165	124.0
2	03/29/2004	21:23	41.30.13	145.48.34	8.723	34.01	3/29/2004	22:52	41.30.15	145.47.90	8.632	33.995	134.2
3	03/30/2004	23:46	40.55.51	149.04.45	3.274	33.389	3/31/2004	1:37	40.49.44	149.40.96	6.752	33.748	155.9
4	03/31/2004	4:07	40.41.51	150.27.74	7.063	33.751	3/31/2004	5:55	40.34.64	151.01.55	4.875	33.434	147.5
5	03/21/2004	22:21	39.43.84	155.55.28	9.535	34.198	4/1/2004	0:05	39.32.77	156.22.92	8.471	34.1	177.9
6	04/01/2004	1:56	39.20.32	156.52.99	10.86	34.239	4/1/2004	4:04	39.03.37	157.26.87	10.491	34.305	160.5
7	04/01/2004	6:14	38.46.92	158.02.46	11.541	34.369	4/1/2004	8:47	38.25.35	158.42.91	11.476	34.365	190.6
8	04/01/2004	12:36	37.57.23	159.45.97	14.017	34.594	4/1/2004	13:53	37.55.27	160.00.00	14.171	34.613	168.6
9	04/01/2004	14:10	37.58.12	160.00.30	14.1	34.602	4/1/2004	18:56	39.00.29	160.00.07	11.321	34.357	283.9
10	04/01/2004	19:28	39.03.93	160.00.39	10.688	34.311	4/2/2004	0:19	38.58.74	159.50.05	8.559	34.076	847.7
11	04/02/2004	0:40	38.58.38	159.49.28	8.349	34.049	4/2/2004	4:02	39.01.94	160.07.77	10.259	34.244	244.8
12	04/03/2004	3:49	39.19.81	160.00.88	10.692	34.284	4/3/2004	6:45	40.02.84	160.03.81	10.149	34.239	193.7
13	04/03/2004	7:05	40.07.03	160.07.23	10.668	34.301	4/3/2004	9:45	40.33.33	160.42.56	10.323	34.272	199.0
14	04/03/2004	10:06	40.36.42	160.47.71	10.565	34.308	4/3/2004	13:02	41.00.70	161.26.96	6.666	33.732	223.7
15	04/03/2004	13:22	41.03.15	161.31.21	6.603	33.734	4/3/2004	16:00	41.23.15	162.06.56	6.153	33.677	227.0
16	04/03/2004	16:18	41.25.66	161.10.51	6.107	33.677	4/3/2004	21:14	42.04.35	163.16.51	5.265	33.537	313.6
17	04/03/2004	21:39	42.07.44	163.21.77	5.03	33.5	4/4/2004	1:56	42.44.63	164.12.00	4.545	33.538	257.5
18	04/04/2004	2:17	42.48.12	164.15.49	4.65	33.473	4/4/2004	5:15	43.19.33	164.45.01	5.162	33.567	227.2
19	04/04/2004	5:34	43.22.56	164.48.20	5.174	33.569	4/4/2004	9:01	43.59.96	165.08.41	4.139	33.364	257.3
20	4/4/2004	9:20	44.03.54	165.08.96	3.851	33.338	4/4/2004	11:48	44.30.88	165.12.64	4.187	33.38	204.2
21	4/4/2004	12:07	44.34.11	165.13.03	4.231	33.388	4/4/2004	14:58	45.05.32	165.16.77	4.343	33.395	226.5
22	4/4/2004	15:13	45.08.09	165.17.02	4.38	33.394	4/4/2004	22:00	46.25.17	165.26.97	2.507	33.166	314.0
23	4/5/2004	22:32	46.31.21	165.27.82	2.547	33.196	4/5/2004	1:24	47.04.80	165.31.58	2.503	33.143	211.9
24	4/5/2004	1:44	47.08.75	165.31.85	2.547	33.134	4/5/2004	4:02	47.36.14	165.30.37	2.18	33.146	184.1
25	4/5/2004	4:16	47.38.85	165.29.93	2.232	33.148	4/5/2004	8:56	48.36.11	165.19.89	2.064	33.158	245.4
26	4/5/2004	9:08	48.38.83	165.19.42	2.068	33.16	4/5/2004	12:37	49.26.34	165.13.55	2.053	33.15	230.0
27	4/5/2004	12:56	49.31.06	165.13.15	2.059	33.156	4/5/2004	14:59	49.59.20	165.09.22	2.591	33.209	165.5
28	4/5/2004	15:16	50.03.94	165.08.71	2.655	33.217	4/5/2004	21:05	51.00.04	165.00.03	2.537	33.205	224.3
29	4/5/2004	21:22	51.00.02	165.00.13	2.361	33.208	4/6/2004	0:30	51.00.04	165.00.02	2.397	33.203	173.2
30	4/6/2004	0:57	51.00.00	165.00.09	2.397	33.203	4/6/2004	6:45	51.00.23	164.59.68	2.57	33.215	238.0
31	4/6/2004	7:02	51.00.10	164.59.88	2.561	33.206	4/6/2004	11:01	50.59.81	165.00.58	2.544	33.203	185.7
32	4/6/2004	15:54	50.28.55	164.03.95	2.477	33.227	4/6/2004	23:16	48.56.74	162.15.74	2.196	33.172	288.5
33	4/6/2004	22:32	48.53.49	162.11.30	2.355	33.176	4/7/2004	3:39	48.11.26	161.19.79	2.279	33.176	234.8
34	4/7/2004	3:58	48.07.57	161.15.84	2.113	33.162	4/7/2004	6:49	47.32.69	160.38.92	1.586	33.177	162.5
35	4/7/2004	7:08	47.28.85	160.33.87	1.605	33.171	4/7/2004	11:02	47.00.11	160.00.08	1.859	33.126	190.6
36	4/7/2004	11:21	47.00.89	160.00.03	1.871	33.126	4/7/2004	17:20	46.59.87	160.00.14	1.915	33.106	192.1
37	4/7/2004	22:30	46.33.76	159.16.08	1.838	33.133	4/8/2004	3:31	45.46.04	157.53.57	1.798	33.13	188.5
38	4/8/2004	3:43	45.44.29	157.50.64	1.788	33.128	4/8/2004	8:37	44.56.49	156.29.96	1.833	33.101	209.3
39	4/8/2004	8:51	44.53.95	156.25.81	1.859	33.092	4/8/2004	11:20	44.29.10	155.45.56	2.088	33.096	155.1
40	4/8/2004	11:35	44.26.46	155.41.79	2.091	33.098	4/8/2004	13:50	44.04.52	155.07.16	2.39	33.171	150.7
41	4/8/2004	15:54	43.59.58	154.59.61	2.422	33.158	4/8/2004	22:17	44.00.03	154.59.95	2.303	33.155	189.9
42	4/9/2004	1:54	43.53.07	155.36.92	2.477	33.167	4/9/2004	8:36	43.26.28	157.48.64	2.131	33.101	179.4
43	4/9/2004	8:53	43.25.25	157.54.27	2.084	33.101	4/9/2004	11:36	43.14.84	158.49.94	5.105	33.612	169.1
44	4/9/2004	11:47	43.14.07	158.52.58	5.619	33.676	4/9/2004	17:44	42.23.06	160.00.49	4.983	33.6	241.9
45	4/9/2004	17:55	42.20.51	160.00.51	5.472	33.609	4/9/2004	22:13	41.22.50	160.00.23	6.386	33.784	243.6
46	4/9/2004	22:26	41.19.33	160.00.29	6.264	33.774	4/10/2004	0:59	40.46.46	160.01.03	9.509	34.185	224.8
47	4/10/2004	1:12	40.43.86	160.01.14	9.531	34.182	4/10/2004	5:54	39.46.77	160.01.34	10.21	34.235	224.5
48	4/10/2004	6:26	39.39.79	160.01.17	10.354	34.265	4/10/2004	11:45	38.29.92	160.02.52	10.4	34.26	203.0
49	4/10/2004	12:04	38.25.91	160.02.26	11.134	34.271	4/10/2004	16:12	37.32.42	159.59.98	14.28	34.62	207.4
50	4/10/2004	16:30	37.27.54	160.00.03	14.205	34.612	4/10/2004	23:46	35.37.09	160.01.30	15.838	34.621	255.2
51	4/11/2004	2:23	35.00.47	159.59.95	17.63	34.823	4/11/2004	8:06	35.02.51	160.03.13	17.546	34.826	219.5
52	4/11/2004	12:40	34.56.11	159.05.02	17.597	34.819	4/11/2004	23:13	34.35.34	156.10.53	15.907	34.742	125.2
53	4/13/2004	6:00	33.50.00	149.00.05	17.868	34.835	4/13/2004	7:11	33.36.28	146.50.55	18.038	34.836	211.0

3.6 Horizontal distribution of Planktonic foraminifera

Kazuhiro HAYASHI (JAMSTEC MIO)
Katsunori KIMOTO (JAMSTEC MIO)

(1) Objective

Planktonic foraminifera in the sediments are well known as useful one of paleo-proxy, species, oxygen isotope and radiocarbon. Especially, the elements / calcium ratio of foraminiferal shells has been used by reconstruction paleoenvironments in past oceans. However, these studies mainly have been foraminiferal fossil in sediment cores still now, and the relation with marine environment to living them is not know well. The results of that recently studies have suggested question that the relation equations about elements / calcium ratio and marine environmental parameter depended on habitat and the other factor.

This study aims at relation equations about them and the ecology of foraminifera in the western North Pacific by investigating the relationship between marine environments and living it.

(2) Sampling

Planktonic foraminifera were collected by using underway-sampling pump equipped in the stem of R/V Mirai. The entry port of seawater is located at ca. 5m under sea surface. Non-filtered seawater in the sea surface water-monitoring laboratory was screened over 100_m mesh for appropriate 4hours time interval. The collected materials were soaked in the mixture of 1:1 volumetric ratio of seawater and ethanol in plastic vials. After addition of small amount of sodium tetra-borate as a pH buffer, the vials were sealed and then stored in the refrigerator. Table 1 is shown on sampling details.

(3) Analytical method

Foraminifera are picked up under microscope from sample bottle, and some of them will be used for DNA analysis to investigate the relationship between genetic and morophlogic species.

The rest will be cleaned up by oxidation-reduction reaction to remove organic matter and salt by ultra-pure reagent in the clean laboratory. Ca, Sr and Mg concentrations in foraminiferal shell are analyzed by ICP-MS, Cd contents are analyzed ICP-MS with dissolvator by Isotope dilution method.

Table 1 List of foraminifera sampling

	Start		Finish			
ID	Log.	Lon.	Log.	Lon.	Sampling volume L	remarked
#1	39.04.53	146.49.65	39.13.21	147.03.03	413.9	
#2	41.30.13	145.48.34	41.30.15	145.47.90	9234.79	St.8
#3	40.55.51	149.04.45	40.49.44	149.40.96	Vlume unknown	
#4	40.41.51	150.27.74	40.34.64	151.01.55	Vlume unknown	
#5	39.43.84	155.55.28	39.32.77	156.22.92	Vlume unknown	
#6	39.20.32	156.52.99	39.03.37	157.26.87	Vlume unknown	
#7	38.46.92	158.02.46	38.25.35	158.42.91	25088.14	
#8	37.57.23	159.45.97	37.55.27	160.00.00	812.98	
#9	37.58.12	160.00.30	39.00.29	160.00.07	3114.67	
#10	39.03.93	160.00.39	38.58.74	159.50.05	3015.57	K-3
#11	38.58.38	159.49.28	39.01.94	160.07.77	2138.08	K-3
#12	39.19.81	160.00.88	40.02.84	160.03.81	1776.26	
#13	40.07.03	160.07.23	40.33.33	160.42.56	1604.82	
#14	40.36.42	160.47.71	41.00.70	161.26.96	1755.5	
#15	41.03.15	161.31.21	41.23.15	162.06.56	1700.83	
#16	41.25.66	161.10.51	42.04.35	163.16.51	3223.45	
#17	42.07.44	163.21.77	42.44.63	164.12.00	2799.84	
#18	42.48.12	164.15.49	43.19.33	164.45.01	1967.67	
#19	43.22.56	164.48.20	43.59.96	165.08.41	2247.62	
#20	44.03.54	165.08.96	44.30.88	165.12.64	1633.26	
#21~22	44.34.11	165.13.03	46.25.17	165.26.97	6417.42	
#23	46.31.21	165.27.82	47.04.80	165.31.58	1871.71	
#24~26	47.08.75	165.31.85	49.26.34	165.13.55	6943.41	
#27	49.31.06	165.13.15	49.59.20	165.09.22	1335.99	
#28	50.03.94	165.08.71	51.00.04	165.00.03	3680.95	
#29~30	51.00.02	165.00.13	51.00.23	164.59.68	5864.11	K-1
#31	51.00.10	164.59.88	50.59.81	165.00.58	2567.96	K-1
#32	50.28.55	164.03.95	48.56.74	162.15.74	4598.1	
#33~35	48.53.49	162.11.30	47.00.11	160.00.08	7288.88	
#37~38	47.00.89	160.00.03	44.56.49	156.29.96	6656.9	K2
#39	44.53.95	156.25.81	44.29.10	155.45.56	1534.14	
#40	44.26.46	155.41.79	44.04.52	155.07.16	1443.62	
#41	43.59.58	154.59.61	44.00.03	154.59.95	4123.29	KNOT
#42	43.53.07	155.36.92	43.26.28	157.48.64	4261.69	
#43~44	43.25.25	157.54.27	42.23.06	160.00.49	5532	
#45~46	42.20.51	160.00.51	40.46.46	160.01.03	2725.68	
#47	40.43.86	160.01.14	39.46.77	160.01.34	4608.8	
#48	39.39.79	160.01.17	38.29.92	160.02.52	3313.63	
#49	38.25.91	160.02.26	37.32.42	159.59.98	2633.73	
#50	37.27.54	160.00.03	35.37.09	160.01.30	4578.4	
#51	35.00.47	159.59.95	35.02.51	160.03.13	4754.79	S6
#52	34.56.11	159.05.02	34.35.34	156.10.53	5318.11	
#53	33.50.00	149.00.05	33.36.28	146.50.55	6766.52	

3.7 Aeolian dust and Ba

Atsushi OOKI (Hokkaido University)
Hisashi NARITA (Tokai University)

3.6.1 Introduction

Atmospheric deposition of metals to the ocean surface is regarded as one of the important passes of trace nutrient supply for the marine phytoplankton. It is important to estimate the contribution of atmospheric deposition to the nutrient supply passes into the ocean surface layer. Particulate metals in the atmosphere are transported from the continent to the ocean as an Aeolian dust or anthropogenic aerosols. We must know the flux of metals (mineral and anthropogenic particles) and their scavenge speed from ocean surface layer to the deep. Particle size essentially determines the dynamics of its motion in the atmosphere and the ocean, e.g. dry deposition rate, collision efficiency with rain droplet, sinking speed in the ocean, and collision efficiency with suspended particles in the ocean. We can read a mineral particle's record and estimate its subsequence by considering the characteristics of its size distribution. It has been reported the size distributions of metals only in the aerosol sample or sediment sample, but those in the atmospheric deposition and the suspended particle in the ocean are unknown. It is necessary to measure the size distributions of particulate metals in the 'surface ocean-Lower atmosphere' environment, and to distinguish their origin. We collected three types of particulate matters in maritime aerosols, atmospheric depositions, and suspended particles in seawater by R/V Mirai cruise (MR04K02). Ba samples in bulk seawater were collected to investigate the characteristics of mineral particles in the ocean.

3.6.2 Method

3.6.2.1 Size fractionated aerosol sampling

Aerosol samples were collected in front of the uppermost deck (17 m above the sea level) of R/V Mirai. Aerosols were size-fractionated on the PTFE sheets (80 mm diameter) by an Andersen type cascade impactor having 50% cut off diameters of 0.45, 0.65, 1.1, 2.1, 3.5, 4.7, 7.5, and 11 _m. The ambient air was pumped at a flow rate of 29.3 liters per minutes (LPM). Sampling pump was automatically stopped to avoid the influence of ship exhaust when the wind was blowing from the stern of R/V Mirai. The total pumping time was 24-48 hours. An aerosol sample on the PTFE sheet was kept in a polystyrene bottle at room temperature.

Major ionic components (Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+}) and metals (Fe, Al, and Mn) in the aerosol samples will be measured by ion-chromatography and atomic absorption spectrophotometer, respectively.

3.6.2.2 Wet deposition sampling

Wet depositions were collected in front of the uppermost deck by a funnel having a 70 cm diameter. A wet deposition sample was kept in a glass bottle to separate the particulate matter and stored in the refrigerator. Major ionic components (Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, and Ca^{2+}) and metals (Fe, Al, and Mn) will be measured by ion-chromatography and atomic absorption spectrophotometer, respectively.

3.6.2.3 Suspended particle sampling

Suspended particles in surface water were continuously collected by filtrating the pumped seawater. We used a 2 stages filter holder system. Large particles (D > 50 _m) were filtered by nylon mesh (300 mesh) having a 47 mm diameter at the first stage, and small particles (2 <D< 50 _m) were collected by PTFE polyflon filter having a 142 mm diameter at the second stage.

Organic material and carbonate in the suspended particles must be removed by chemical treatment to collect the mineral particles from the suspended particle samples. Filter samples will be oxidized by 10 ml of 30% H_2O_2, and boiled by 5 ml of 10% HCl. Mineral particles will be size-fractionated (cut off diameters of 4, 10, 20, 40 _m) by settling method. The concentrations of Fe, Al, and Mn will be analyzed by atomic absorption spectrophotometer.

3.6.2.4 Ba sampling

Twenty-six samples of Ba in surface seawater were collected by pumped seawater. Shallow water samples (10, 25, 50, 75, 100, 125, 150, 175, 200, 250, 300 m depth) were collected by CTD-RMS at all stations during MR04K02 cruise. A seawater sample was kept in a polystyrene bottle at room temperature. Ba concentration in seawater sample will be measured by ICP-MS.

3.6.3 Results

3.6.3.1 Size fractionated aerosols and wet depositions

We collected 10 and 3 samples of size fractionated aerosols and wet depositions during this cruise, respectively. All of aerosol samples in the fine mode rage (D < 1 _m) were blackish. Blackish aerosol sample indicates an influence of anthropogenic soot. Anti-cyclones and cyclones were transported from the East Asian region to the sampling locations in the western North Pacific continuously. Simultaneously, anthropogenic metals (e.g. Fe and Mn) should be transported to the North Pacific far from the Asian continent. We will analyze the contributions of anthropogenic metals to the trace metal flux into the ocean surface.

3.6.3.3 Suspended particles in surface water

We collected 14 samples of suspended particles in the ocean surface by filtrating approximately 500 to 1000 litters of pumped seawater. Huge Asian dust plume had passed over the western North Pacific on March 12. In the northern part of the Japanese Island, a large amount of mineral dust particles had deposited by snowfall. Some amount of mineral dust particles should have deposited to the ocean surface at St. KNOT on March 12. We will confirm the Asian dust influence in the ocean surface layer after a huge Asian dust event.

3.6.3.4 Ba

26 samples of Ba in surface water were collected by pumped seawater. Shallow and

deep water samples were collected by CTD-RMS, and summarized in below table.

Ba samples by CTD-RMS

Depth	Station 8	Station K3	Station K1	Station K2	KNOT	Station K4
5m	−	○	○	○	−	−
10m	○	○	○	○	○	○
25m	○	○	○	○	○	○
50m	○	○	○	○	○	○
75m	○	○	○	○	○	○
100m	○	○	○	○	○	○
125m	○	○	○	○	○	○
150m	○	○	○	○	○	○
175m	○	○	○	○	○	○
200m	○	○	○	○	○	○
250m	○	○	○	○	○	○
300m	○	○	○	○	○	○
500m	○	−	○	−	○	−
750m	○	−	○	−	○	−
1000m	○	−	○	−	○	−
1500m	○	−	○	−	○	−
2000m	○	−	○	−	○	−
2500m	○	−	○	−	○	−
3000m	○	−	○	−	○	−

3.8 Trace elements

Masatoshi KINUGASA (Kyoto University, Institute for Chemical Research)

(1) Objective

The distribution and speciation of trace elements in seawater are controlled by various physical, chemical and biological processes and therefore can provide useful information about the ocean. Our objective is to reveal the behavior of trace elements in seawater and elucidate the processes occurring in the ocean. On the present cruise, we are studying the distribution and speciation of trace bioelements (Fe, Co, Ni, Cu, Zn, Cd, Pb) in seawater.

(2) Measurement Parameters

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

(3) Instruments and Methods

The seawater samples were collected by Niskin-X sampler mounted on a CTD carousel system. The Niskin-X samplers were thoroughly cleaned with detergent and hydrochloric acid before the cruise.

Seawater samples for dissolved, acid dissolvable and particulate trace bioelements were transferred from the sampler to a precleaned low-density polyethylene bottle. We used a silicon tube and plastic bell, wearing plastic gloves, to avoid contamination by airborne particles.

In order to decrease the contamination from the ship, the sampling was usually conducted as soon as possible after arrival at a station using the gallows crane.

Immediately after sampling, seawater samples were filtered through an acid-cleaned Nuclepore filter (0.2 mm pore size) using a closed filtration system in a clean room. The filtered and unfiltered seawater samples were acidified with hydrochloric acid to about pH 2 and stored. The waters and filter samples were brought back to our laboratory for further analysis.

(4) Results

About 300 samples were collected during this cruise. The sampling station were Station1 (K1), 2 (K2), 4 (K3), 5, 6 (KNOT), 8.

(5) Data archive

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

3.9 Remote access sampler samples

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

(1) Objectives

Remote access sampler (RAS) system has characteristic of time series water sampler to be able to collect 48 samples at deployment depth over the one year.

High Latitude Time Series Project (HiLATS) aims to obtain knowledge of seasonal variation in biogeochemistry focusing on the biological pump with using the biogeochemical mooring (BGC mooring). Especially, dissolved nutrients are well known to influence to primary productivity. Therefore, one of goals in this project obtain to seasonal variation in nutrients in the subsurface layer. However, it had been consider that it was difficult to store seawater sample for nutrients' and other chemical components' analysis over one year. Kattner (1999) reported that seawater nutrients can be stored for longer periods (over the one year) by mercuric chloride poisoning and, therefore mercuric chloride poisoning is used for our RAS observation. Our objectives at this cruise was to analyze RAS samples recovered during the last cruise (KR03-11), and to know appropriate concentration of mercuric chlorides for sample preservation by storage test.

(2) Material and method

Time-series RAS samples were recovered during KR03-11 cruise (September / October 2003) from station K-3. Recovered samples were brought back to the shore laboratory. At first, salinity was measured by Inductively coupled salinometer (601Mk1V; YEO-KAL Environmental Electronics). After salinity measurement, samples were again stored in refrigerator under 4°C. Samples were analyzed for dissolved inorganic carbon (DIC) and nutrients during this cruise. First of all, DIC was measured. Sample was introduced to DIC measurement system by adding CO_2 free N_2 gas. After DIC measurement, seawater samples were distributed to 10ml centrifuge tube for nutrients measurement. Nutrients (NO_3, NO_2, Si $(OH)_4$ and PO_4) were measured by auto analyzer (TRAACS 800; BRAN+LUEBE). It was verified that the potential interference of mercuric chloride was negligible based on the results of our shore laboratory test. Therefore, nutrients standard with mercuric chloride was not needed for matrix matching.

Storage test samples were collected during MR03-K01cruise (February / March 2003) from CTD/RMS. These samples were introduced to RAS sample bag by using measuring cylinder to know accurate seawater sample volume in bag. Then mercuric chloride with different volume (0.5, 1, 2.5 and 5ml) were added to respective sample. Initial concentration of DIC and nutrients were measured on board during MR03-K01. These samples stored in refrigerator over the one year were analyzed by same procedure for time-series RAS samples.

(3) Results

1) Time-series RAS samples

Table1 and Fig.1 show time-series variation of salinity, nutrients and DIC normalized to standard salinity of 33. It is noted that RAS samples were obtained from different depth because of motion of mooring system. Salinity varied from 33.4 to 34.4 psu and did not show simple seasonal variability (Fig.1 a). Salinity variability should be attributed not only to natural seasonal variability (mixing, precipitation and evaporation), but also to intensity of dilution by preservative ($HgCl_2$ solution). N-NOx (NO_3 + NO_2) was low at the beginning of observation (November 2002) and increased to March 2003 (Fig.1 b). After March, N-NOx decreased to May. N-Si$(OH)_4$ and N-PO_4 also show same pattern (Fig.1 d, e). These seasonal variabilities are indeed reasonable and can be explained easily: the increase from autumn to the end of winter was caused by winter vertical mixing and the decrease from spring was caused by biological activity switched at spring. N-NOx correlated well with N-Si(OH)4 with SI/N ratio of 1.5 (Fig.3). On the other hand, NO_2 decrease from autumn to the end of winter and increased from spring (Fig. 1 c). Its pattern is mirror image of that of N-NOx. DIC concentrations do not show the above seasonal variability either (Fig. 1 e).

Fig.2 shows vertical profiles of salinity, normalized nutrients and DIC observed during previous cruise for various season. N-NOx, N-Si$(OH)_4$ and N-PO_4 of RAS samples varied within range of each components obtained by shipboard observation previously (Fig.2 b, d and f). Therefore RAS samples were well stored for these components. Variation of salinity observed by RAS was also in the range of natural variation observed by shipboard observation (Fig. 2 a) although RAS samples were diluted by preservative. However NO_2 of RAS samples were significantly higher (Fig.2 c) and DIC of RAS samples were significantly lower than shipboard values (Fig. 2 g). Although nutrients were almost preserved, a part of NO_3 might be reduced (deoxidized) to NO_2. DIC values of RAS sample were significantly lower than those obtained by shipboard observation. One possibility is the depletion of DIC by the degas of CO_2. Based on simple measurement by pH test paper, RAS samples showed low pH of approximately 6. It might be caused by acid remained in the valve or outside of RAS. We will take a sufficient “acid clean delay time” and sufficient volume of water for rinsing valve from the next mooring.

2) Sample storage test

Table 2 and Fig. 4 show results of RAS sample’s storage test for nutrients and DIC.

Concentrations of nutrient and DIC for samples without preservative (reference sample) were significantly different from those measured when seawater samples were taken approximately one year ago. As the cause of the increase of DIC concentration, CO_2 invasion and decomposition of organic materials are candidate. However, the latter is low possibility because N-NOx and N-PO4 did not increase.

On the other hand, concentrations of nutrient and DIC for samples with preservative (preserved sample) did not change significantly after one year nevertheless different preservative concentrations. Therefore it is concluded that mercuric chloride with its concentration of higher than 0.11 v/v % well preserves seawater sample for measurement of nutrients and DIC over one year.

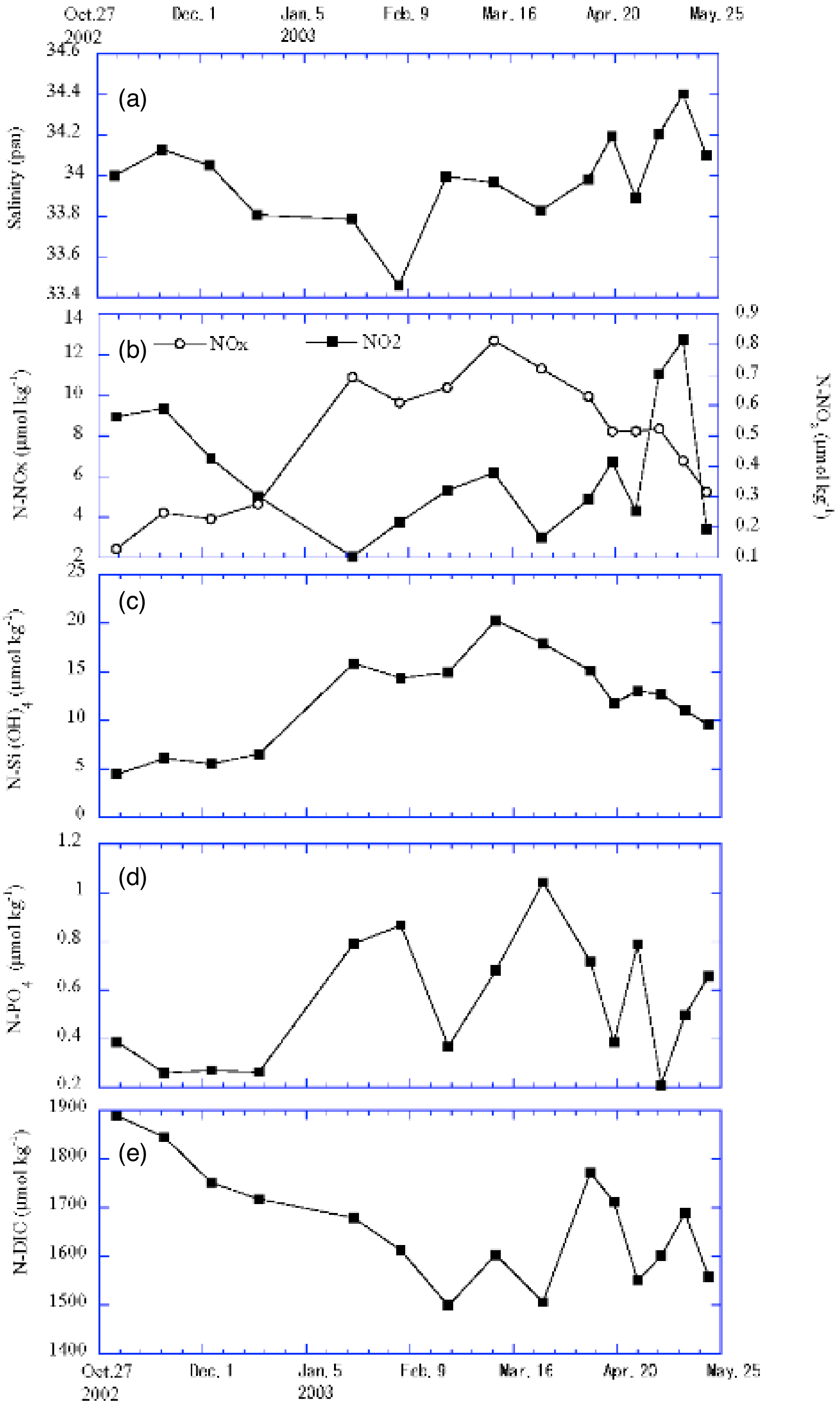


Fig.1 Time-series variation in nutrients and DIC. All data are normalized to standard salinity of 33 psu.

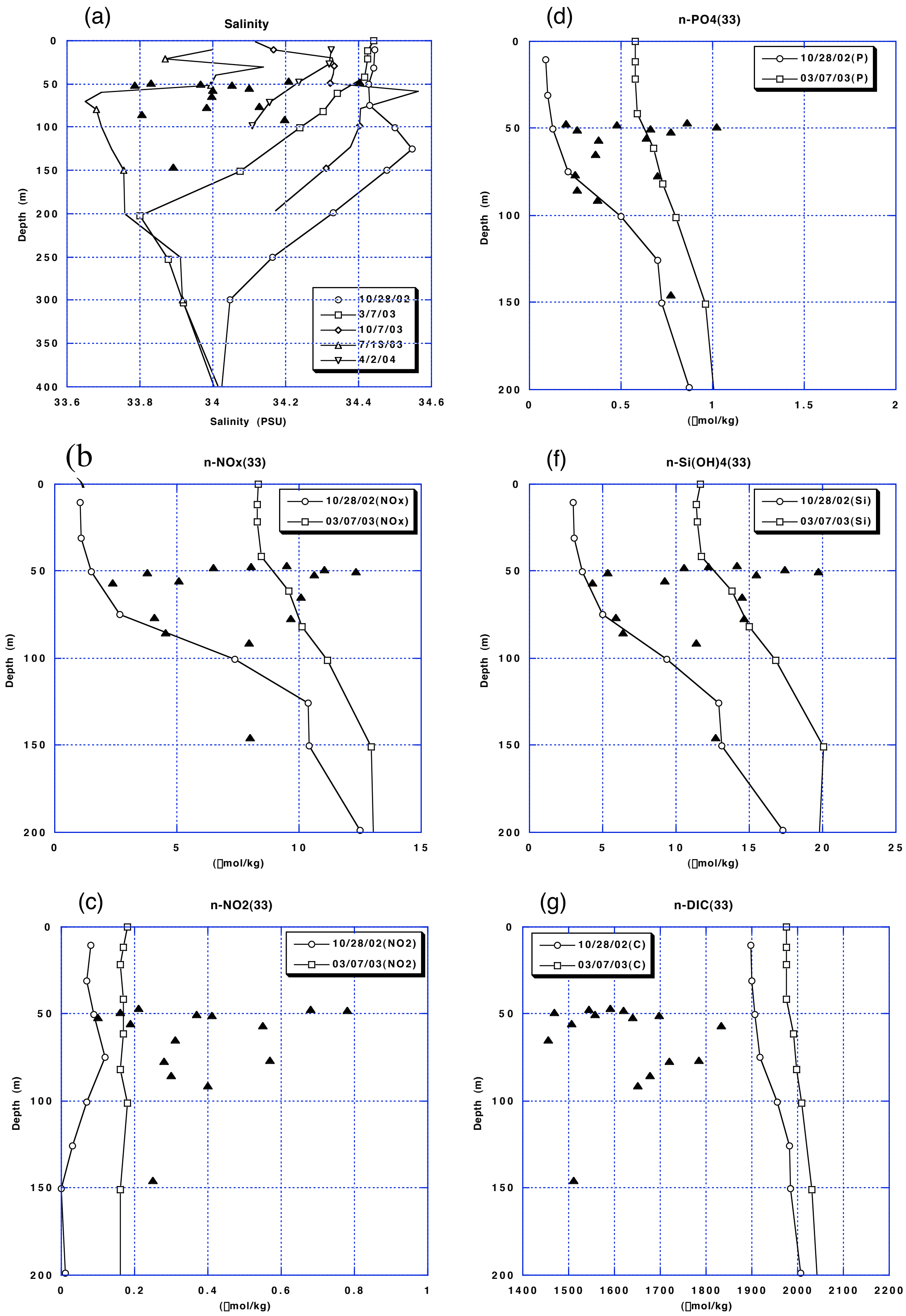


Fig. 2 Comparison of RAS data (solid triangles) with data obtained by CTD/CMS during previous cruises.

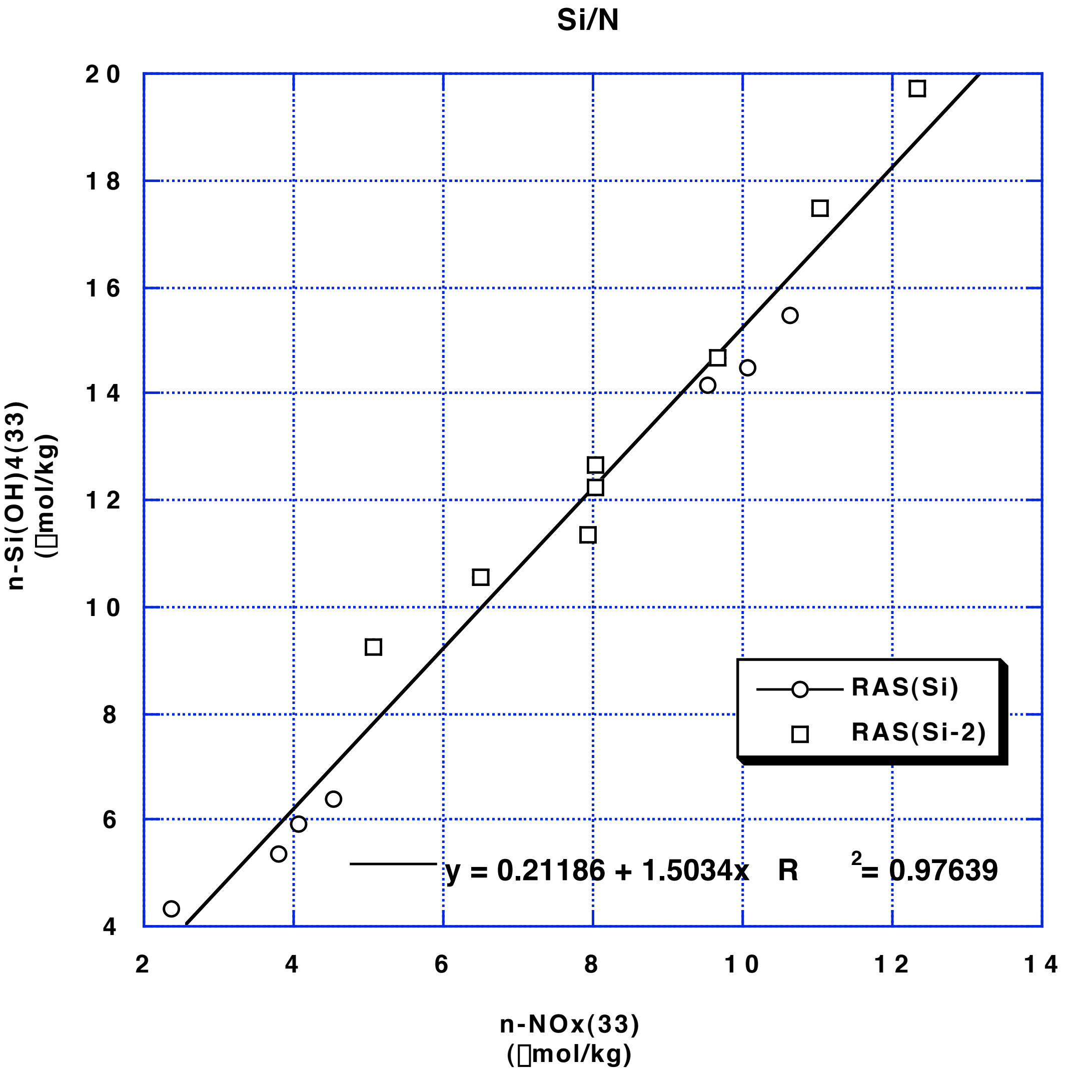


Fig. 3 N-NOx versus N-Si(OH)4. Open squares are data after April 2003.

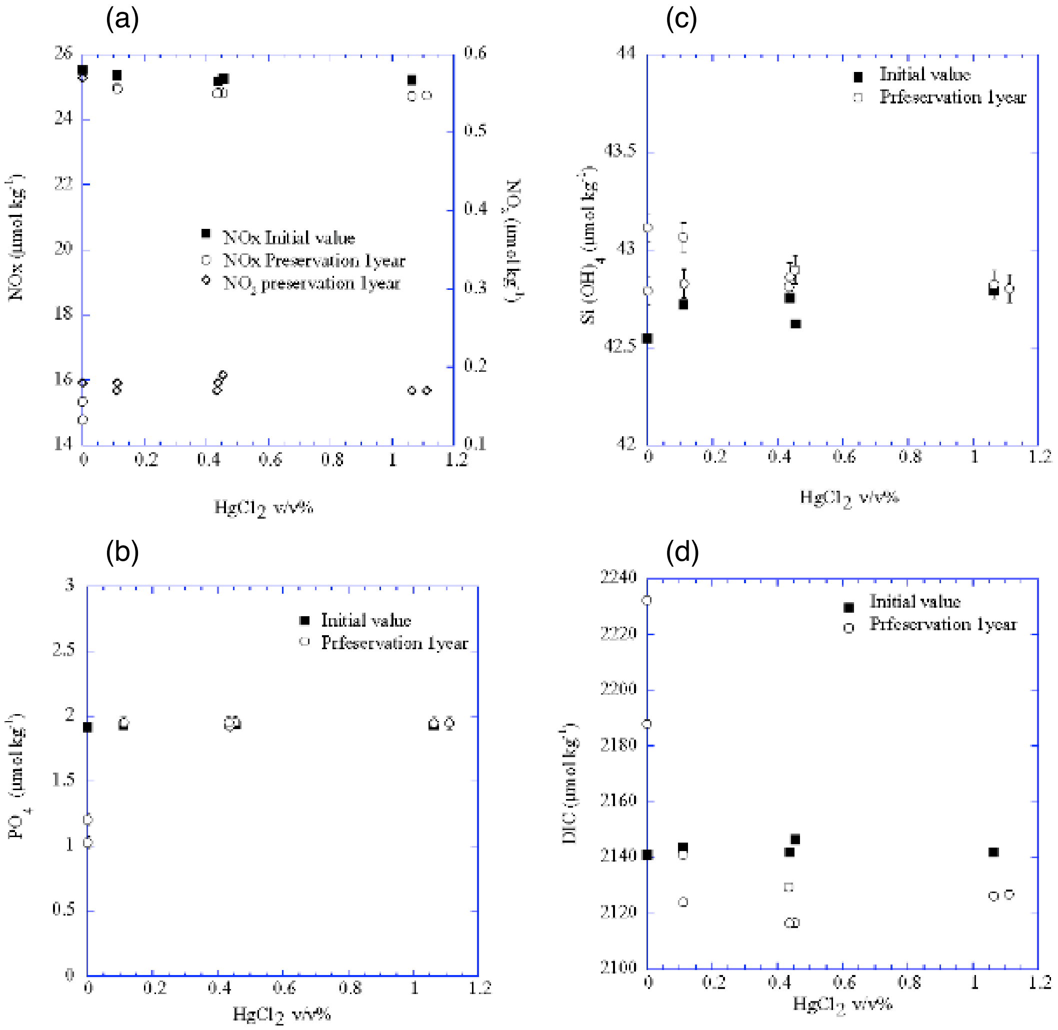


Fig. 4　Results of RAS sample storage test for nutrients and DIC

Table 1 Nutrients and DIC for time-series RAS sample

RAS S/N	Sampling date	Sample weight(g)	Salinity	Sampling depth (m)	DIC (µmol/kg)	NO_3 (µmol/kg)	NO_2 (µmol/kg)	NO_x (µmol/kg)	$Si(OH)_4$ (µmol/kg)	PO_4 (µmol/kg)	□□DIC (µmol/kg)	N-NO_3 (µmol/kg)	N-NO_2 (µmol/kg)	N-NO_x (µmol/kg)	N-$Si(OH)_4$ (µmol/kg)	N-PO_4 (µmol/kg)
2	2002.11.2	502.740	33.9994	56.8	1888.5	1.9	0.6	2.4	4.4	0.4	1833.0	1.82	0.55	2.36	4.31	0.38
4	2002.11.18	527.291	34.1288	76.5	1845.2	3.6	0.6	4.2	6.1	0.3	1784.2	3.51	0.57	4.08	5.90	0.25
6	2002.12.4	528.838	34.0522	51.1	1751.1	3.5	0.4	3.9	5.5	0.3	1697.0	3.38	0.41	3.80	5.37	0.26
8	2002.12.20	529.520	33.8070	85.3	1717.8	4.3	0.3	4.6	6.5	0.3	1676.8	4.24	0.30	4.54	6.38	0.26
12	2003.1.21	536.568	33.7862	51.8	1679.2	10.8	0.1	10.9	15.8	0.8	1640.2	10.53	0.10	10.63	15.48	0.77
14	2003.2.6	541.451	33.4594	46.9	1612.3	9.4	0.2	9.6	14.4	0.9	1590.2	9.30	0.21	9.52	14.17	0.86
16	2003.2.22	512.502	33.9961	64.8	1498.5	10.1	0.3	10.4	14.9	0.4	1454.6	9.77	0.31	10.08	14.49	0.36
18	2003.3.10	530.035	33.9670	50.3	1603.7	12.3	0.4	12.7	20.3	0.7	1558.0	11.97	0.37	12.34	19.70	0.66
20	2003.3.26	523.015	33.8295	49.4	1506.1	11.2	0.2	11.3	17.9	1.0	1469.2	10.88	0.16	11.04	17.46	1.02
24	2003.4.11	503.052	33.9823	77.1	1772.4	9.7	0.3	9.9	15.1	0.7	1721.2	9.37	0.28	9.66	14.67	0.70
26	2003.4.19	546.375	34.1965	91.3	1711.8	7.8	0.4	8.2	11.8	0.4	1651.9	7.54	0.40	7.94	11.36	0.37
28	2003.4.27	526.795	33.8930	145.7	1551.3	8.0	0.3	8.2	13.0	0.8	1510.4	7.78	0.25	8.02	12.68	0.77
30	2003.5.5	517.145	34.2080	47.2	1601.1	7.6	0.7	8.3	12.7	0.2	1544.6	7.37	0.68	8.05	12.24	0.20
32	2003.5.13	499.164	34.4027	48	1689.1	6.0	0.8	6.8	11.0	0.5	1620.2	5.72	0.78	6.50	10.55	0.48
34	2003.5.21	518.247	34.0992	55.4	1558.0	5.1	0.2	5.2	9.6	0.7	1507.8	4.89	0.19	5.07	9.25	0.64

Table 2 RAS sample storage test

	Initial values (measured in Mar 2003)						After one year (measured in Apr. 2004)						
$HgCl_2$ v/v%	DIC (µmol/kg)	NOx (µmol/kg)	$Si(OH)_4$ (µmol/kg)	PO_4 (mmol/kg)	N/P ratio	Si/N ratio	DIC (µmol/kg)	NOx (µmol/kg)	NO2 (µmol/kg)	$Si(OH)_4$ (µmol/kg)	PO_4 (mmol/kg)	N/P ratio	Si/N ratio
0.00	2141.2	25.52	42.55	1.92	13.33	1.67	2188.0	14.78	0.2	42.79	1.20	12.3	2.90
0.00							2232.5	15.34	0.6	43.11	1.03	15.0	2.81
0.11	2143.6	25.36	42.72	1.93	13.16	1.68	2141.1	24.97	0.2	43.06	1.95	12.8	1.72
0.11							2124.0	24.95	0.2	42.83	1.95	12.8	1.72
0.45	2146.5	25.25	42.62	1.93	13.06	1.69	2116.7	24.81	0.2	42.90	1.95	12.7	1.73
0.44	2141.9	25.18	42.75	1.93	13.03	1.70	2116.6	24.82	0.2	42.86	1.92	12.9	1.73
0.43							2129.6	24.81	0.2	42.81	1.95	12.7	1.73
1.06	2142.1	25.21	42.79	1.93	13.09	1.70	2126.2	24.71	0.2	42.82	1.95	12.7	1.73
1.11							2126.9	24.73	0.2	42.80	1.95	12.7	1.73

4. Geological observations

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

4.1 Swath bathymetry

(1) Introduction

R/V MIRAI equipped a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.) The main objective of MNBES survey is collecting continuous bathymetry data along ship's track to make a contribution to geological and geophysical investigations and global datasets. We had carried out bathymetric survey during the MR04-02 cruise from Yokohama on 27 March 2004 to MHI Shimonoseki on 16 April 2004.

(2) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during this cruise. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the surface (6.2m) sound velocity, and the others depth sound velocity calculated temperature and salinity profiles from CTD data by the equation in Mackenzie (1981) during this cruise.

System configuration and performance of SEABEAM 2112.004,

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

The results will be published after primary processing.

(4) Data Archives

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

4.2 Sea Surface Gravity

(1) Introduction

The difference of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR04-02 cruise from Yokohama on 27 March 2004 to MHI Shimonoseki on 17 April 2004.

(2) Parameters

Relative Gravity [mGal]

(3) Data Acquisition

We have measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (LaCosat and Romberg Gravity Meters, Inc.) during this cruise. To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (Scintrex gravity meter CG-3M), at Yokohama Port and MHI Shimonoseki Dock (MHI S.D.) as reference points.

(4) Preliminary Results

Absolute gravity shown in Tabel 4.2-1

Table 4.2-1

Date	U.T.C.	Port	Absolute Gravity [mGal]	Level [cm]	Sea Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R *[2] Gravity [mGal]
Mar/26	04:00	Yokohama	979741.48	320	609	979742.50	12039.9
Apr/16	12:27	MHI S.D.	979674.06	241	540	979647.81	11970.7

*[1]: Gravity at Sensor
= Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431

*[2]: LaCoste and Romberg air-sea gravity meter S-116

Differential	Gravity at sensor	L&R value
	67.69 mGal ---(a)	69.20 mGal ---(b)
L&R drift value (b)-(a)	1.51 mGal	21.35 days
Daily drift ratio	0.071 mGal/day	

(5) Data Archives

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

4.3 Sea Surface Three-Component Magnetic Field

(1) Introduction

Measurements of magnetic force on the sea is 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 MR04-02 cruise from Yokohama on 27 March 2004 to MHI Shimonoseki, on 17 April 2004.

(2) Parameters

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

(3) Method Data Acquisition

A sensor of three-component fluxgate magnetometer is set on the top of foremast. Sampling is controlled by 1pps (pulse per second) standard clock of GPS signals. Every one-second record is composed of navigation information, 8 Hz three-component of magnetic force, and VRU (Vertical Reference Unit) data.

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).

This calibration carried out;

1) 1st April 2004, 19:19 to 19:40 (UTC) about at 39-04N, 160-00E
2) 14th April 2004, 23:23 to 23:52 (UTC) about at 32-07N, 134-50E

(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.

5. Remotely sensing observation

Ichio ASANUMA
Wataru TOKUNAGA (Global Ocean Development Inc.)
Norio NAGAHAMA (GODI)

5.1 NOAA HRPT (Sea surface temperature and IR)

5.1.1 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.

5.1.2 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 inflight 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. A raw data on the pass disk for each pass is also processed into the local area coverage (LAC) formatted data.

We received and processed NOAA data throughout MR04-02 cruise from the departure of Yokohama on 27 March 2004 to arrival of MHI Shimonoseki on 17 April 2004.

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.

5.1.3 Preliminary results

Preliminary result (data composite for cruise period) is shown in Fig. 5.2.1. The precise results will be public after the analysis.

5.1.4 Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control based on the agreement between NASA and JAMSTEC in 1993.

5.2 Ocean color

5.2.1 Objectives

It is our objectives to collect data of chlorophyll-a distribution in a high spatial resolution mode from the Sea Wide Field of View Sensor (SeaWiFS) on the OrbView-2 polar orbit satellite and to build a time and depth resolved primary productivity model.

5.2.2 Method

We receive the down link High Resolution Picture Transmission (HRPT) signal from the OrbView-2 by the HRPT receiving station on the R/V MIRAI. Our receiving station is the TeraScan receiving system, which has 1.2 m antenna in the redome, the down converter, the bit synchronizer, the frame synchronizer, and the workstation to control antenna and to process received. An encrypted SeaWiFS data were decrypted by the decryption key assigned by the Goddard Space Flight Center (GSFC) of the National Aero Space Agency (NASA). The level-1a data were generated on the R/V MIRAI.

We received and processed SeaWiFS data throughout MR04-02 cruise from the departure of Yokohama on 27 March 2004 to arrival of MHI Shimonoseki on 17 April 2004.

The higher product, chlorophyll-a distribution, will be generated at the laboratory using the SeaWiFS Data Analysis System (SEADAS) with the algorithms dedicated for the SeaWiFS. The algorithm called MSL12 in the SeaDAS is the basic function to generate chlorophyll-a distribution as a level-2 data.

The chlorophyll-a distribution data will be applied for the time and depth resolved primary productivity model to determine a standing stock of phytoplankton as a function of chlorophyll-a.

5.2.3 Preliminary results

Preliminary weekly composite are shown in Fig. 5.2.2 for cruise period. The precise results will be public after the analysis.

5.2.4 Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control based on the agreement between NASA and JAMSTEC in 1993.

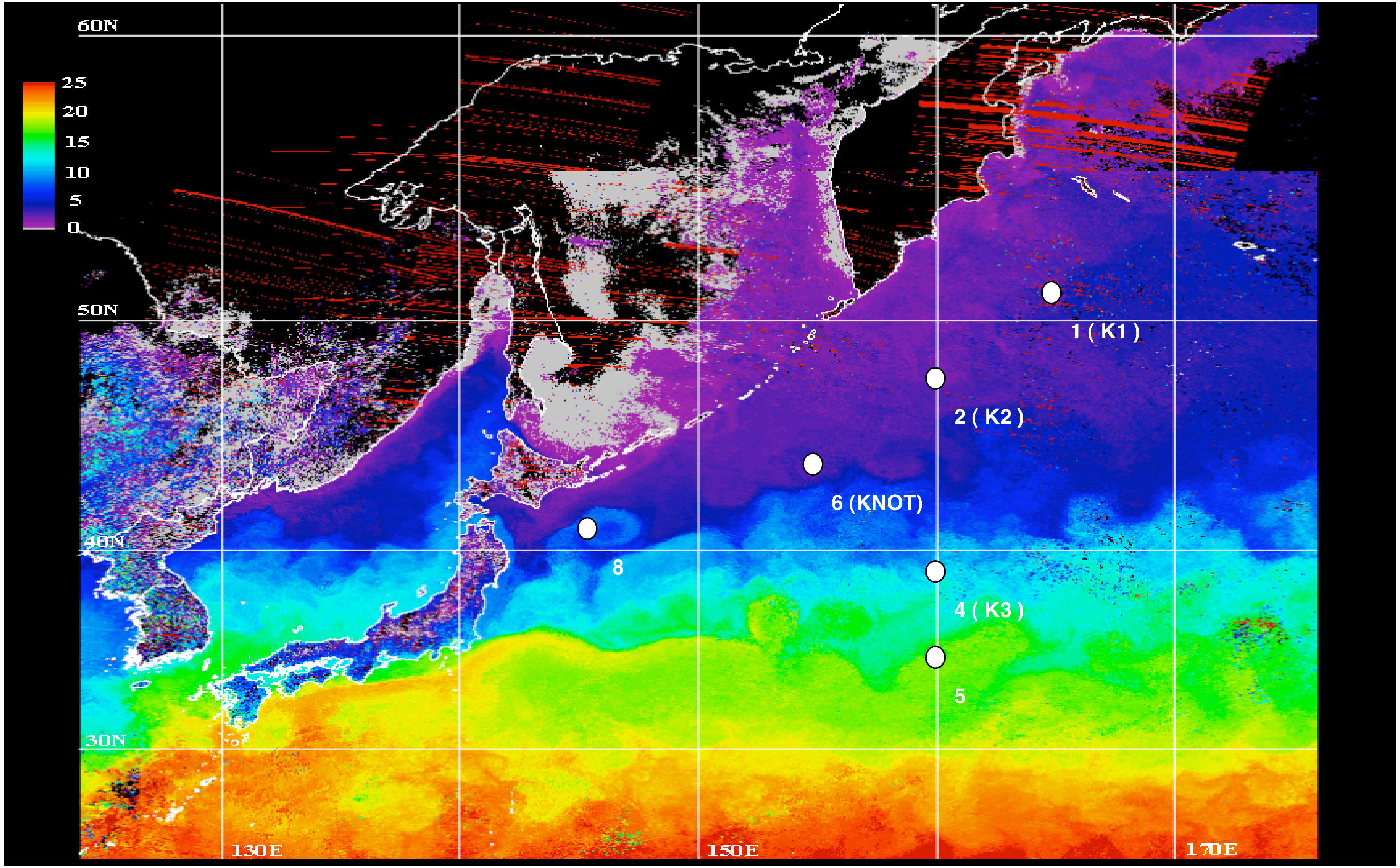


Fig. 5.2.1 MCSST (composite of data during MR04-02: Mar. 27 – Apr.17

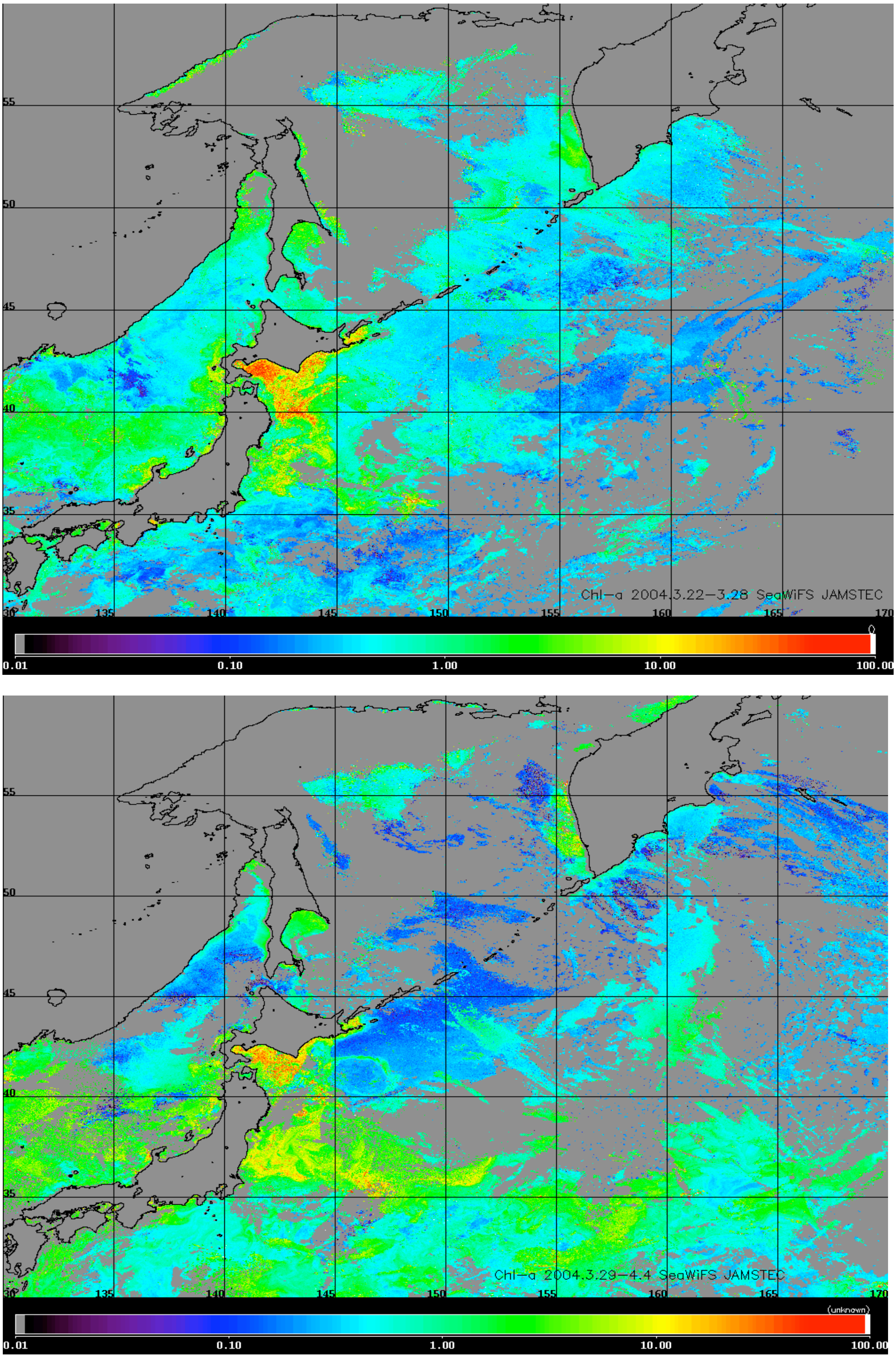


Fig. 5.2.2 weekly composites of chl-a (maximum values)

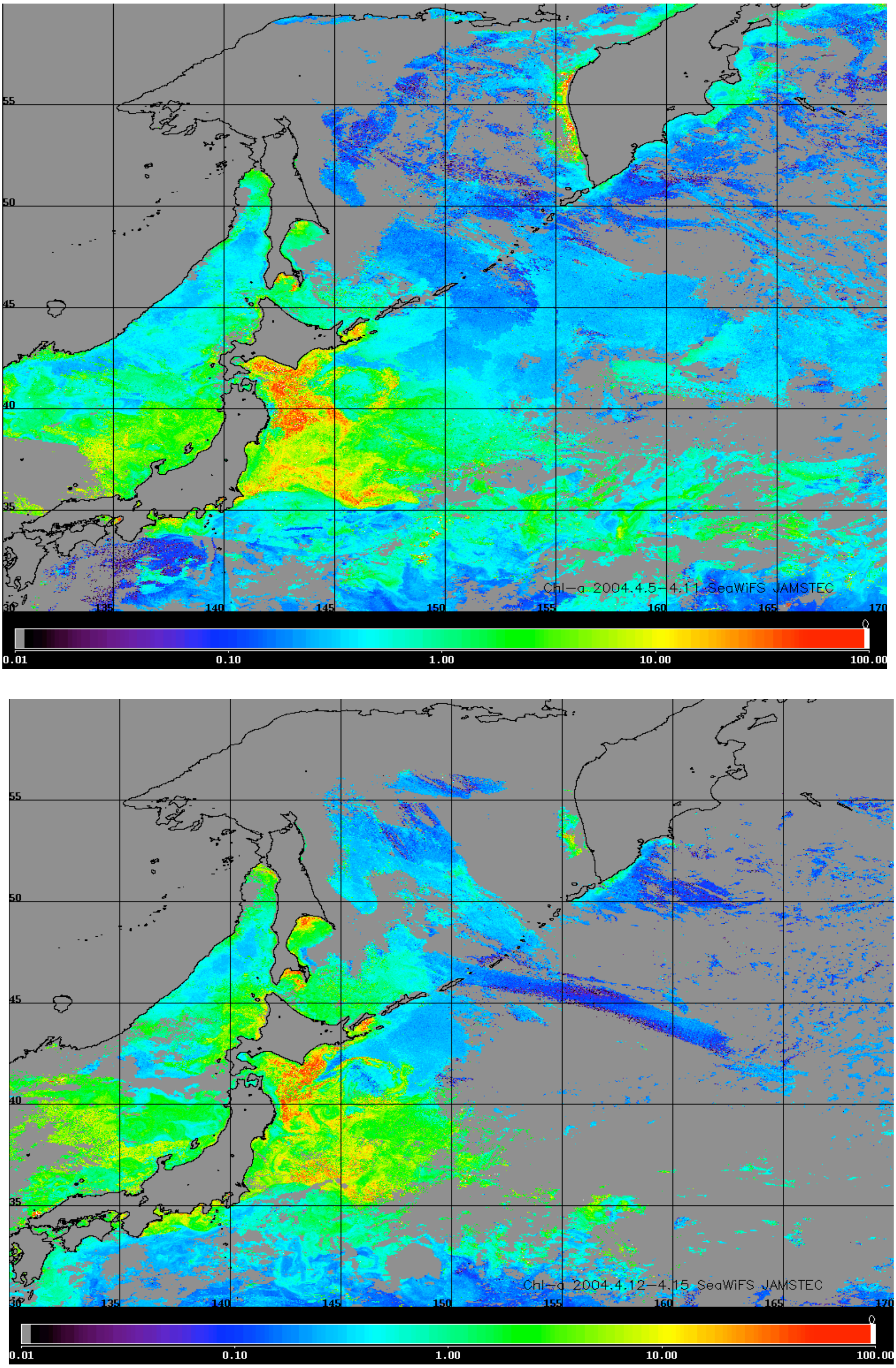


Fig. 5.2.2 weekly composites of chl-a (maximum values)