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MR01-K04 Leg.2

28.Aug-15.Sept, 2001

Preliminary Cruise Report

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Japan Marine Science and Technology Center

MR01-K04 Leg2 Preliminary Cruise Report

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Preface

Susumu HONJO (Chief Scientist of MR01-K04 Leg 2: WHOI / JAMSTEC)

Leg.2 of MR01-K04 was devoted to two missions: one is the verification of the coccolithophorids bloom and its impact on carbonate chemistry in the Bering Sea, and the another is the mooring of new designed state of the art time-series instruments in the northwestern North Pacific. Both studies were very important for the verification of the role of biological activity in the uptake of atmospheric carbon dioxide.

R / V Mirai left Dutch harbor on 28, August after more than four 20-feet containers of baggage for the mooring systems were loaded.

In the Bering Sea, a lot of hydrocasting and sediment coring were conducted. Although remarkable coccolithphorids bloom reported previously was not found during this cruise, a lot of physical / chemical / biological / geological data were acquired. Scientists appreciated marine technicians from Marine Works Japan for their hard work for operation of CTD, sediment coring and chemical analysis of basic data such as dissolved oxygen, nutrients and carbon species.

In the Northwestern North Pacific, new designed time-series observational mooring systems were deployed. Research specialists from Woods Hole Oceanographic Institution coordinated mooring work. Thanks to their enthusiastic work, the new designed time-series observational mooring systems (two systems for biogeochemistry and one for physical oceanography) were successfully deployed at two sites in the North Pacific Subarctic Gyre. However mooring work could not be conducted without the devoted work of ship crews from Global Ocean Development.

In addition, a special seminar regarding the biological pump in the ocean was also held. Not only scientists, but also marine technicians and ship crew participated this seminar. That was really good opportunity especially for ship crew and young students to share an ultimate goal of ocean flux study.

In future, the observation in this cruise will contribute ocean science.

(Mario Honda, co-chief scientist, is responsible for the wording of this article.)

1. Outline of MR01-K04 leg 2

1.1 Cruise Summary

Leg. 2 of MR01-K04 cruise had mainly following two objectives.

1.1.1 Observation in the eastern Bering Sea shelf

Akihiko MURATA (JAMSTEC)

Recent reports on ecosystem in the eastern Bering Sea warn that since 1997, oceanic ecosystem has been anomalous (Vance *et al.*, 1998; Hunt *et al.*, 1999). This anomalous condition gives an impact also on carbonate system in the eastern Bering Sea shelf through blooms of *E. huxleyi* coccolithophorid. According to Murata and Takizawa (2001), surface water partial pressures of CO_2 (pCO_2) was in excess of 400 µatm, acting as a source for atmospheric CO_2 in the bloom area, although it is known that the eastern Bering Sea shelf is usually a sink for atmospheric CO_2. They related the high surface water pCO_2 found in the bloom area to weak activity of diatoms.

With a purpose of surveying the coccolithophorid blooms, we conducted biogeochemical observations in the eastern Bering Sea shelf, subsequent to the last year's observation. We re-occupied the observation line at 166ºW from 55ºN to 58ºN. However, the bloom was not so conspicuous as found (distinct aquamarine waters) in the last year, but existed in the northern end of the observation line. We made water sampling at 9 stations along the observation line, and measured various biogeochemical properties. The results will be open to public through academic journals.

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Vance, T.C., Baier, C.T., Brodeur, R.D., Coyle, K.O., Decker, M.B., Hunt Jr., G.L, Napp, J.M., Schumacher, J.D., Stabeno, P.J., Stockwell, D., Tynan, C.T., Whitledge, T.E., Wyllie-Echeverria, T. & Zeeman, S., Aquamarine Waters Recorded for First Time in Eastern Bering Sea. *EOS*, Trans. Am. Geophys. Union, **79**, 122, 126, 199

1.1.2 North Pacific Time-Series Observational Study

Makio HONDA (JAMSTEC)

The importance of time-series observation has been recognized for the better understanding of ocean's role in the uptake of the atmospheric carbon dioxide. Some scientific program such as U.S.JGFS, BATS, HOT and Canadian P have been successfully conducting time series observation. However repeatable observation by ordinary research vessels are tough work economically and physically. Time-series sediment trap experiment is one of useful tactics for time-series observation. As a center of ocean flux study, this experiment has been carried out all over the world oceans. However, time-series observation in the shallow and intermediate water is strongly requested in order to clarify the "biological pump" more precisely.

Under this situation, the North Pacific Time-Series Observational Study initiated in 2000 as a one of research programs at Must Institute for Oceanography (MIO) of JAMSTEC. This program is also a joint program with Joint Pacific Research Center (J-PAC) of Woods Hole Oceanographic Institution (WHOI). For this study, the new mooring systems were designed. Mooring system for physical oceanography has self-descending / ascending CTD with ADCP (MMP). Mooring system for biogeochemistry has water / plankton auto-sampler and autonomous incubation system for the measurement of productivity (SID). The remarkable characteristic is that these new mooring systems stand up from deep-sea floor to the surface euphotic zone. In order to sustain mooring system against the surface strong current, mooring tension is loaded to be approximately 1,500 kg. Therefore wire and nylon ropes used were pre-stretched and measured its length precisely to keep the shallow time-series instruments within the euphotic layer.

Before deployment, sea floor topography and bathymetry was carefully surveyed by Sea-Beam and an altimater. Two mooring points (K1: 50N, 161E, K2 47N, 160E) were selected taking into account for topography and stability in oceanography in the Western Pacific Sub-arctic Gyre.

John Kemp from WHOI was a parson in charge for mooring work. Owing to his enthusiastic work, exact operation of MIRAI by Captain Akamine, devoted work by chief officer Dowaki, boat swain Ishikawa and ship crews. The above mooring systems were installed on the planned points. The above mooring system will be recovered in October 2002

At stations K1 and K2, seawater and particulate materials were also collected by Carousel Water Sampler with CTD and in situ large volume pump, respectively. Hydrographic data shows that cold water exists around 100 m depth, nutrients were not exhausted and both points are located in the NPSG. The future analysis of radiochemistry (thorium and protactinium) on these samples will reveal the behavior of settling particulate materials.

1.2 Cruise Log and cruise track

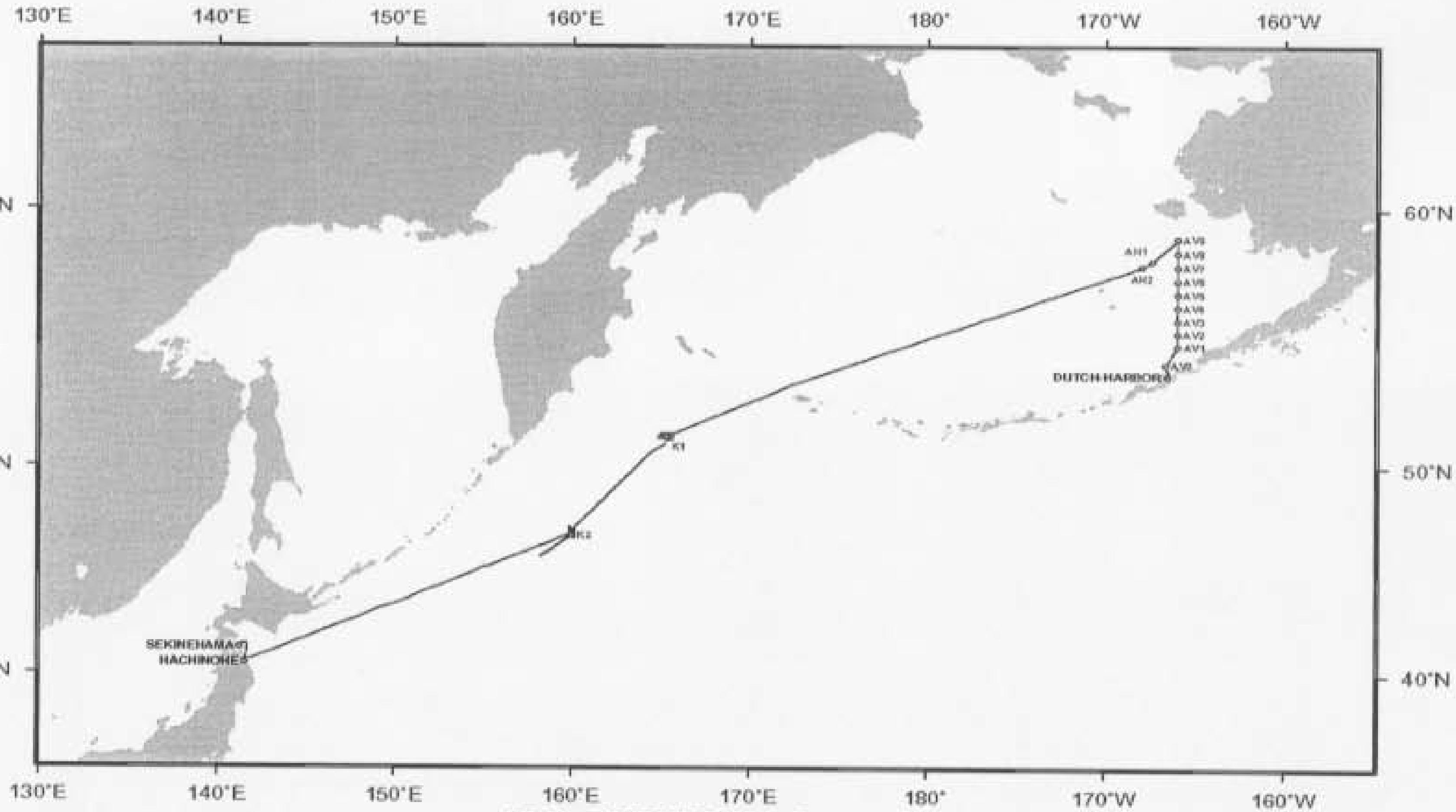
Table 1. Cruise log

Date	Start Time (SMT)	Station	Position (start)		Events
			Lat.	Long.	
2001.8.28	8:00	***(UTC-8h)***	53-51.0N	166-34.4W	Departure from Dutch Harbor
	13:05	AV0	54-17.2N	166-40.7W	Arrival at Station AV0
		AV0	54-17.2N	166-40.7W	CTD/CWS
	14:06	AV0			Departure from Station AV0
	17:30	AV1			Arrival at Station AV1
	17:35	AV1	55-00.1N	165.59.8W	Surface water sampling
	17:46	AV1	55-00.1N	165-59.7W	Bio optical measurment (PUV)
	17:55	AV1	55-00.1N	165-59.7W	Bio optical measurment (PRR)
	18:05	AV1	55-00.1N	165-59.6W	CTD/CWS
	20:00	AV1	54-59.9N	166-00.0W	CTD/CWS
	20:04	AV1	54-59.9N	166-00.0W	Surface water sampling
	20:30	AV1			Departure from Station AV1
	22:48	AV2			Arrival at Station AV2
8.29	1:10	AV2	55-29.9N	165-59.9W	CTD/CWS
	0:57	AV2	55-30.0N	166-00.0W	Surface water sampling
	1:48	AV2			Departure from Station AV2
	4:00	AV3			Arrival at Station AV3
	9:14	AV3	55-59.9N	166-00.1W	CTD/CWS
	8:59	AV3	55-59.9N	166-00.0W	Surface water sampling
	9:06	AV3	55-59.9N	166-00.0W	Bio optical measurment (PUV)
	10:37	AV3	55-59.8N	166-00.1W	CTD/CWS
	11:06	AV3			Departure from Station AV3
	13:18	AV4			Arrival at Station AV4
	16:57	AV4	56-30.0N	165-59.9W	Surface water sampling
	17:07	AV4	56-30.0N	165-59.8	Bio optical measurment (PUV)
	17:15	AV4	56-29.9N	165-59.8W	Bio optical measurment (PRR)
	17:23	AV4	56-29.9N	165-59.7W	CTD/CWS
	19:10	AV4	56-29.9N	165-59.9W	CTD/CWS
	19:36	AV4			Departure from Station AV4

	21:48	AV5			Arrival at Station AV5
	21:50	AV5	56-59.8N	166-00.0W	Multiple Corer
8.30	8:15	AV5	56-59.9N	166-00.0W	CTD/CWS
	8:00	AV5	56-59.9N	166-00.0W	Surface water sampling
	10:18	AV5	56-59.8N	166-00.3W	CTD/CWS
	10:42	AV5			Departure from Station AV5
	12:48	AV6			Arrival at Station AV6
	12:51	AV6	57-30.0N	166-00.0W	Surface water sampling
	12:58	AV6	57-29.9N	166-00.1W	Bio optical measurment (PRR)
	13:11	AV6	57-29.8N	166-00.1W	CTD/CWS
	14:44	AV6	57-29.9N	166-00.4W	CTD/CWS
	15:06	AV6			Departure from Station AV6
	17:18	AV7			Arrival at Station AV7
	18:06	AV7	58-00.0N	165-59.9W	Piston Corer
	20:53	AV7	57-59.5N	166-00.0W	Surface water sampling
	21:05	AV7	57-59.9N	166-00.2W	Bio optical measurment (PRR)
	21:16	AV7	57-59.9N	166-00.2W	CTD/CWS
	22:48	AV7	57-59.9N	166-00.0W	CTD/CWS
	23:18	AV7			Departure from Station AV7
8.31	1:36	AV8			Arrival at Station AV8
	1:37	AV8	58-29.9N	166-00.0W	Surface water sampling
	2:14	AV8	58-30.0N	166-00.0W	CTD/CWS
	2:42	AV8			Departure from Station AV8
	5:24	AV9			Arrival at Station AV9
	6:02	AV9	59-00.0N	165-59.9W	Surface water sampling
	6:11	AV9	58-59.9N	165-59.9W	CTD/CWS
	7:35	AV9	58-59.9N	165-59.9W	CTD/CWS
	7:54	AV9			Departure from Station AV9
	13:00	AH1			Arrival at Station AH1
	13:04	AH1	58-11.9N	167-24.1W	Multiple Corer
	13:08	AH1	58-11.9N	167-24.1W	Surface water sampling
	13:24	AH1			Departure from Station AH1
	15:00	AH2			Arrival at Station AH2
	15:06	AH2	58-00.0N	168-00.1W	Piston Corer

	16:06	AH2			Departure from Station AH2
	22:00	***UTC-9***			Time adjust
9.1	22:00	***UTC-10***			Time adjust
9.2	SKIP				Crossed Date Line
9.3	0:00	***UTC+14***			
	19:16		52-43.9N	169-59.9E	Drifting buoy deployment
	22:00	***UTC+13***			Time adjust
	23:34		52-07.4N	167-59.9E	Drifting buoy deployment
9.4	5:01		51-29.8N	165-59.9E	Drifting buoy deployment
	6:06		51-21.0N	165-38.9E	SeaBeam survey
	6:30	K1			Arrival at Station K1
	11:17	K1	51-17.9N	165-18.0E	CTD/CWS
	14:17	K1	51-17.8N	165-18.1E	Surface water sampling
	15:30	K1	51-17.1N	165-17.8E	Releaser TEST
	16:44	K1	51-16.7N	165-17.9E	Releaser TEST
	18:46	K1	51-17.9N	165-09.6E	CTD/CWS
	22:35	K1	51-17.5N	165-08.6E	In situ Pumping
9.5	3:21	K1	51-18.5N	165-10.8E	SeaBeam survey
	6:15	K1	51-11.9N	165-10.8E	Surface water sampling
	8:00	K1	51-12.0N	165-12.0E	Start MMP mooring work
	13:40	K1	51-18.1N	165-18.3E	SINKER cast
	14:36	K1			Positioning (51-17.9N 165-18.2E)
	18:47	K1	51-20.1N	165-12.1E	CTD/CWS
	22:28	K1	51-19.6N	165-12.4E	In situ Pumping
9.6	4:48	K1	51-23.1N	164-59.8E	SeaBeam survey
	9:05	K1	51-23.8N	165-23.4E	Start BGC mooring work
	14:53	K1	51-19.8N	165-11.8E	SINKER cast
	15:56	K1			Positioning (51-19.9N 165-12.2E)
	21:00	K1			Departure from Station K1
	21:02		51-18.4N	165-19.7E	SeaBeam survey
9.7	21:03		47-16.8N	160-10.0E	SeaBeam survey
	22:30	K2			Arrival at Station K2
9.8	8:16	K2	46-51.9N	159-58.8E	CTD/CWS
	11:24	K2	46-52.3N	159-59.7E	Surface water sampling
	12:25	K2	46-52.4N	160-00.4E	Releaser TEST
	13:31	K2	46-52.7N	160-01.6E	Releaser TEST
	13:50	K2	46-52.7N	160-01.8E	Bio optical measurment (PRR)
	14:39	K2	46-52.7N	160-02.8E	Releaser TEST

	16:15	K2	46-56.1N	159-59.0E	CTD/CWS
	20:23	K2	46-56.7N	159-59.3E	In situ Pumping
9.9	2:50	K2	46-45.0N	159-51.2E	SeaBeam survey
	6:40	K2	46-58.1N	159-57.3E	Surface water sampling
	8:13	K2	46-49.8N	160-08.3E	Start MMP mooring work
	12:43	K2	46-52.3N	159-58.7E	SINKER cast
	14:01	K2			Positioning (46-52.3N 159-59.0E)
	16:22	K2	47-00.6N	159-58.2E	CTD/CWS
	20:53	K2	47-00.0N	159-58.9E	In situ Pumping
9.10	2:45	K2	47-01.5N	159.59.9E	SeaBeam survey
	10:09	K2	47-04.6N	160-09.1E	Start BGC mooring work
	16:40	K2	47-00.2N	159-57.9E	SINKER cast
	17:40	K2			Positioning (47-00.3N 159-58.2E)
	22:00	***UTC+12***			Time adjust
	23:03	K2	46-52.3N	159-51.8E	CTD/CWS
9.11	2:36	K2			Departure from Station K2
	11:00				Altered course to K2
	17:06	K2			Arrival at Station K2
	18:27	K2	46-56.4N	160-01.5E	MMP buoy recovering
	20:54	K2			Departure from Station K2
	22:00	***UTC+11***			Time adjust
9.12	22:00	***UTC+10***			Time adjust
9.13	22:00	***UTC+9***			Time adjust
9.14	8:40		40-33.2N	141-30.0E	Arrival at Hachinohe
	16:20				Departure from Hachinohe
9.15	8:10		41-21.9N	141-14.3E	Arrival at Sekinehama



Station (MR01K04) Leg2

Mercator Projection

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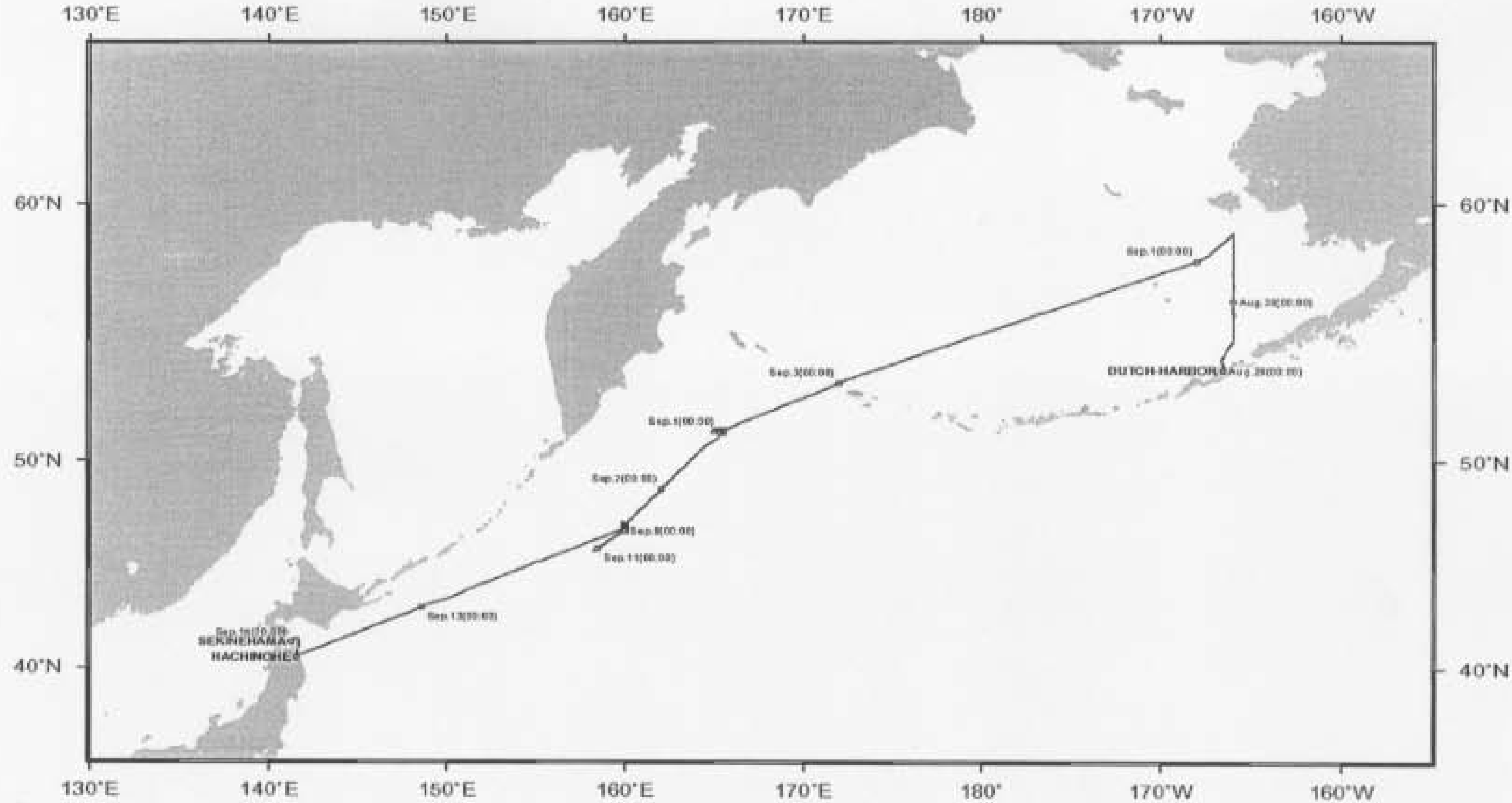

Ship Track (MR01K04) Leg2

Mercator Projection

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2. North Pacific Time-Series Observational study

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Northern North Pacific can be characterized as the highly productive area. Therefore the biological activity should play an important role in the uptake of atmospheric CO_2. This biological activity varies spatially and temporally. In order to clarify an ability of CO_2 fixation quantitatively, time-series observation is requested. Speaking of time-series observation, sediment trap experiments are one of conventional methods. However sediment trap experiments have not necessarily shown a clear picture of surface biological activity. Recently new time-series observational instrument have been developed. In 2000, Mutsu Institute for Oceanography (MIO) in JAMSTEC and Joint Pacific Ocean Research Group (J-PAC) in WHOI decided to start the time-series observation in the Northwestern North Pacific with using mooring system, which consists of new time-series observational instrument such as water sampler and plankton collector. During this cruise, we deployed the following new mooring systems successfully.

2.1 Mooring system

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

The PO mooring consists of a 64” syntactic top float with 3,000 lbs buoyancy, instrument, wire and nylon ropes, glass floats (Benthos 17” glass ball), dual releasers (Edgetech) and 4,660 lbs. sinker with mace plate. Autonomous CTD profiler, MMP (McLane Moored Profiler), is installed on the 4,500m wires for observation. It descends and ascends between 50m and 4,550m with taking vertical profiles of CTD and 3D current direction and velocity. ARGOS compact mooring locator and submersible recovery strobe are mounted on all of top floats. Before cruise, all wires and nylon ropes are pre-stretched by approximately 1.3 ton, which load corresponds to mooring tension and measured exact length using a laser equipment, which error is ± 1 mm.

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

- SID - Submersible Incubation Device with Ocean Optical Sensor
- WTS - Water Access Sampler
- RAS - Remote Access Sampler
- ZPS - Zoo Plankton Sampler

In addition, three Sediment traps are installed at approximately 1,000 m, 2,000 m and 5,000.

Details for each instrument are described later (section 2.3). Serial numbers for instruments are as follows:

Table 3.1 Serial numbers of instruments

Station and type of system Mooring system S / N	K-1 PO K1P010904	K-1 BGC K1B010905	K-2 PO * K2P010908	K-2 BGC K2B010909
ARGOS	18839	18840	18842	18838
ARGOS ID	18557	18558	18577	18556
Strobe	233	236	232	235
MMP	ML11241-01	-	ML11241-03	-
SID	-	ML11241-17	-	ML11241-16
OOS	-		-	DFLS-072
WTS	-	ML11241-14	-	ML11241-15
RAS	-	ML11241-11	-	ML11241-10
ZPS	-	ML11241-19	-	ML11241-21
Sediment Trap (1000m) (2000m) (5000m)	- - -	ML11241-22 ML11241-24 ML11241-25	- - -	ML11241-23 ML11241-26 ML11241-27
Releaser	027867 027809	027824 027864	027865 027866	027825 027868

* Recovery on Sept. 11, 2001

2.2 Deployment

We planned to deployed PO and BGC mooring at two areas in the Western Subarctic Gyre. One of candidates is 51N / 165E, near where gigantic opal flux was observed before (Wong et al., 1997). Another is 47N / 160E, where is close to station KNOT and, however, structure of water mass is more stable than station KNOT. Before deployment, sea floor topography was surveyed with Sea Beam. In order to place the top of mooring systems in the surface euphotic layer, precise water depths for mooring positions was measured by an altimeter (Datasonics PSA900D) mounted on CTD / CWS. Mooring works took approximately 5 hours for PO mooring system and 7 hours for BGC mooring system. After sinker was dropped, we positioned the mooring systems by measuring the slant ranges between research vessel and the acoustic releaser. Each position of the moorings is finally determined as follows:

Table 3.2 Mooring positions for respective mooring systems

	K-1 PO K1P010904	K-1 BGC K1B010905	K-2 PO K2P010908 *	K-2 BGC K2B010909
Date of deployment	Sep. 4th 2001	Sep. 5th 2001	Sep. 8th 2001	Sep. 9th 2001
Latitude	51° 17.959 N	51° 19.935 N	46° 52.304 N	47° 00.324 N
Longitude	165° 18.201 E	165° 12.278 E	159° 59.032 E	159° 58.246 E
Depth	5,140 m	5,132 m	5,121 m	5,206 m

* Recovery on Sept. 11, 2001

Table 3.3 and Fig. 3.1 show detail of our mooring system. Table3.4 shows work sheets for deployment.

2.3 Instruments

On mooring systems, the following instruments are installed.

(1) ARGOS CML (Compact Mooring Locator)

The Compact Mooring Locator is a subsurface mooring locator based on SEIMAC's Smart Cat ARGOS PTT (Platform Terminal Transmitter) technology. Using CML, we can know when our mooring has come to the surface and its position. The CML employs a light sensor inside the acrylic dome. When the CML is mounted beyond the reach of sunlight, the light sensor electronics force the CML to a dormant state. In this mode, the light sensor checked optical condition every five minutes, to test for the presence of light. When the top buoy with the CML comes to the surface, the light sensor will respond to the presence of daylight by activating the main system electronics. Smart Cat transmissions will be initiated at this time, allowing us to locate our mooring. Depending on how to long the CML has been moored, it will transmit for up to 120 days on a 90 second repetition period. Battery life, however, is affected by how long the CML has been moored prior to activation. A longer pre-activation mooring will mean less activation life.

Principle specification is as follows:

(Specification)

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

(2) Submersible Recovery Strobe

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

(Specification)

Power Level:	0.1 watt-second
Repetition Rate:	Adjustable from 2 bursts per second to 1 burst every 3 seconds.
Burst Length:	Adjustable from 1 to 5 flashes per burst. 100 ms between flashes nominal.
Battery Type:	C-cell alkaline batteries, (Eveready E-93 or equivalent).
Life:	Dependent on repetition rate and burst length. 150 hours with a one flash burst every 2 seconds.
Construction:	Awl-grip painted, Hard coat anodized 6061 T-6 aluminum housing.
Pressure Rating:	10,000 psi

Daylight-off:	User selected, standard
Pressure Switch:	Turns unit off below approximately 30 feet.
	Rotary, clockwise – ON, counter clockwise – OFF.
Weight in Air:	4 pounds
Weight in Water:	2 pounds
Outside Diameter:	1.7 inches nominal
Length:	21-1/2 inches nominal

(3) MMP

The McLane Moored Profiler is an autonomous, profiling, instrument platform. The purpose is to make moored profiler technology available to, operable by, and useful to a broad cross-section of the oceanographic community. The platform and software are designed for ease of access, operation, and maintenance. The instrument includes both a CTD and an acoustic current meter. Side and top views of the MMP are shown in Fig. 3.2. The major components of the system are labeled in the figures. There include the controller, the buoyancy elements, the drive motor and guide wheels, the instruments suite, the internal frame, and the hydrodynamically faired external shell. The platform is designed to profile between pressure limits (or physical stops), powered along a conventional, plastic jacketed mooring cable by a traction drive. While profiling it samples the water column with a suite of instruments and stores the measurements for later retrieval. The shape accommodates a cylindrical housing that has sufficient length for batteries and electronics and a 6,000 m depth rating. Two glass spheres are used for buoyancy only. The mooring cable threads through faired retainers at the top and bottom of the vehicle. The retainers can be opened for launch and recovery and are strong enough to support the full weight, including trapped water, of the MMP on a horizontal cable, a normal situation during recovery. Sampling will be conducted each 10 days.

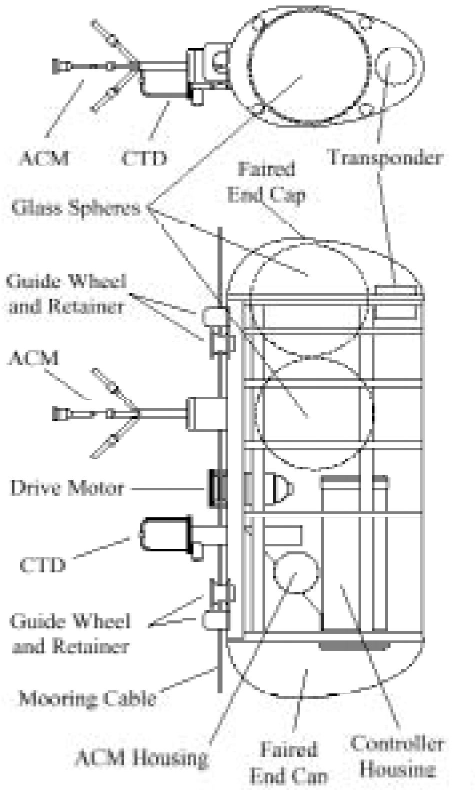


Fig. 3.2 Cut away side and top views of the MMP showing the major components of the system. The overall dimensions of the faired external shell are 124 cm * 51 cm* 34 cm

(4) Submersible Incubation Device (SID) and Spectral radiometer / fluorometer

The time series–submersible incubation device (TS-SID) is a mooring incubation system for conducting multiple *in situ* measurements of primary production. Each incubation involves a cleaning cycle, procurement of a 400 ml sample at depth with simultaneous introduction of an appropriate radioactive tracer and preservation of 47 filtered samples obtained after *in situ* incubations. End point transformation rates (R) are determined from the difference in activity or concentration of the tracer in the particulate fraction at the beginning (a_o) and end (a_t) of a specified incubation (e.g., $R = [a_t - a_o]/t$). Background measurements are for interpolated estimates of a_o,.

Particulate samples are preserved in an array of filter - preservation units that contain a chemical fixative that has been adjusted to be less dense than seawater so that upon completion of sample filtration fixative is quickly transported to the filter by convection.

Sample was collected by Whatman GF / F glass-fiber filter (diameter : 47 mm, pore size : 0.7 μm). Fixative was 0.1 M sulfuric acid.

Between incubations, the incubation chamber (IC) and sample inlet is cleaned by introduction of an acid solution (1 M sulfuric acid) from the acid as IC is filled with water from the environment and allowed to soak. Prior the next incubation, the acidified water is flushed from the system. The biofouling control collar mechanically coupled to the IC floating piston physically removes light-occluding particulate material that may collect on the outer surfaces of the IC.

Radioactive tracer solution contained 1 μCi of $NaH^{14}CO_3$, 0.2 ml of 260 mM solution of NaOH (to keep the pH of the isotope solution), and 0.88 grams of NaCl (to adjust the density of the isotope solution) in 400 ml distilled water. 500 μl is injected for each incubation. After incubation, radioactive filtrates are stored in the waste container.

It was scheduled that incubation will start at 19:00 (UTC), which is 8:00 in the morning (LST) on September 30, 2001. The interval of incubation was 8 days except first nine samples, which were incubated every 16 days. Incubation period is 12 hours centering midday.

In order to know the optical condition and abundance of phytoplankton at the depth, a spectral radiometer which measures up / down welling photosynthetically active radiation (PAR), and a fluorometer are installed on the frame of SID. These sensors are usually covered with shutter for preventing itself from biofouling. PAR was measured every 2 hours during the daytime, and fluorescence was measured every 2 hours through the whole day.

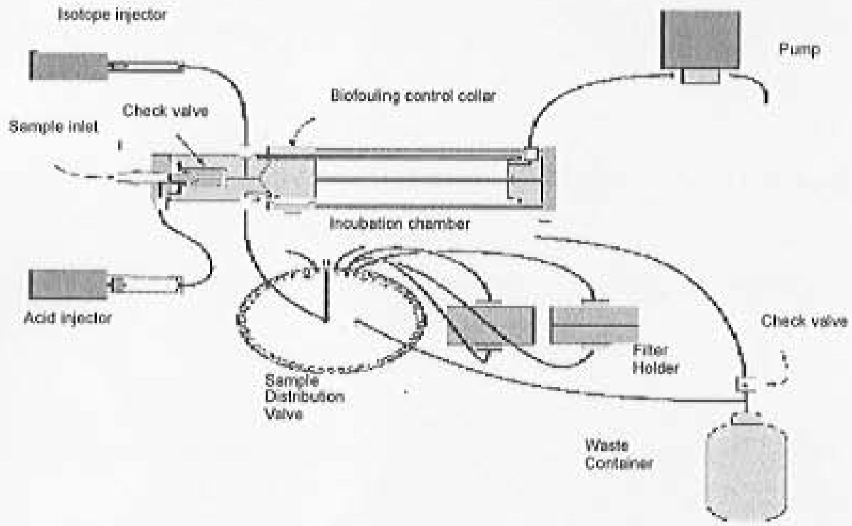


Fig. 3.4 SID

(5) Water Transfer System – Phytoplankton sampler (WTS-PPS)

The water transfer system – phytoplankton sampler (WTS-PPS) collect *in situ* suspended particulate matter especially phytoplankton in an aquatic environment. A dual multi-port valve directs the water through 24 x 47-millimeter filters for a time-series operation. The positive displacement pump is placed downstream from the filters to prevent sample contamination. An internal computer controls both the multi-port valve and the positive displacement pump. Samples are preserved in an array of filter-preservation units that each contain a chemical fixative. Sample was collected on Millipore HA filter (diameter : 47 mm, pore size : 0.45 mm). Fixative was 0.5 % Utermöhl's solution in 70 % (v/v) seawater. Utermöhl's is a neutral solution and have similar composition of Lugol's.

Before taking sample, seawater is flushed through the valve and tube. This becomes clear out any particle and living things in the sampling way. The flow rate is controlled in order to prevent the sample from being crushed onto the filter. The computer records the instantaneous flow rate and total volume at a constant interval of time for each filter.

Sampling will start at 19:00 (UTC, Local time is 8:00 in the morning) on September 30, 2001. The Interval of each sampling is 16 days. Filteration volume, pumping flow rate and flushing volu,e are 500 ml, 100 ml/min. and 100 ml, respectively.

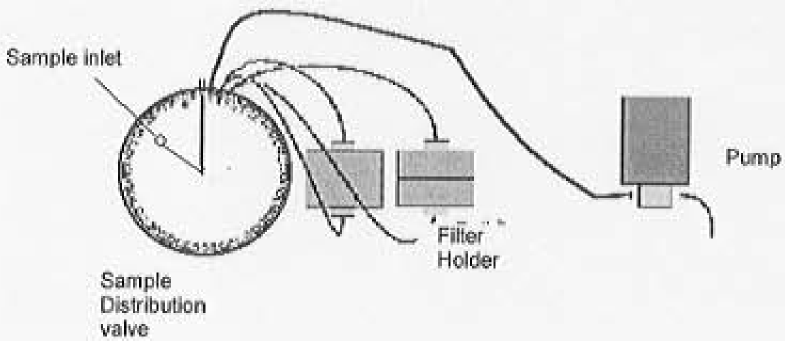


Fig.3.5 Configuration of WTS-PPS

(6) Remote access sampler (RAS)

The remote access sampler (RAS) has characteristic of time series water sampler to be able to collect under non-contamination condition. RAS has 49 acrylic sample containers where contain 500 ml aluminum sample bag coated inside with teflon. One of bags is filled with acid, which is used to wash sampling injector. Therefore, this instrument can collect 48 samples. Aluminum bags are placed in the acrylic container which filled with distilled water. Pumping out this water generates negative

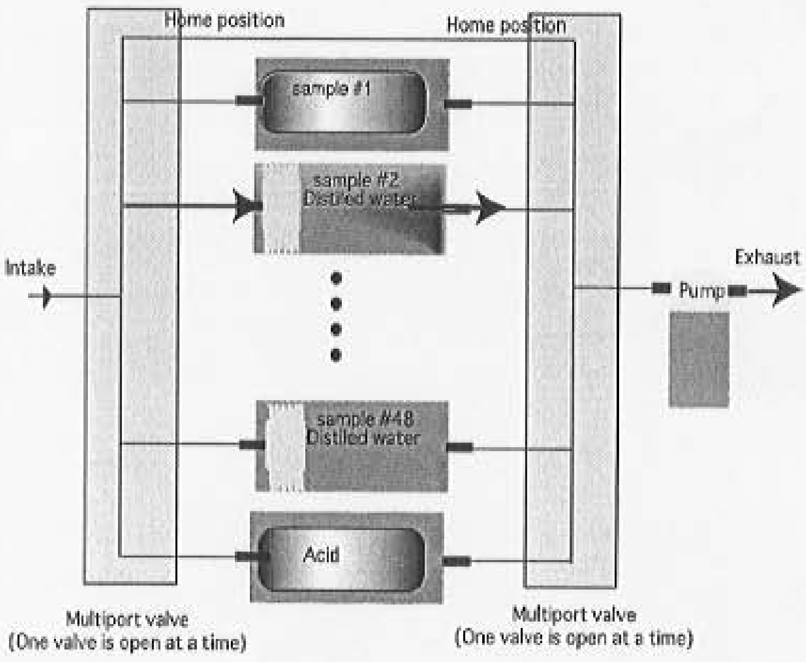


Fig.3.6 RAS

pressure and leads water samples into the sample bag. Before deployment, about 52.5 mg $HgCl_2$ (to make concentration of $HgCl_2$ to be 105 ppm: Kattner, 1999*) is injected to the sample bag as preservative. RAS were deployed at Station K1. Detail sampling schedule is shown in Table 4. In future, we plan to measure nutrient, total dissolved inorganic carbon, alkalinity, and dissolved organic component.

Kattner, G., 1999. Storage of dissolved in organic nutrients in sea water: poisoning with mercuric chloride. *Mar.Chem.* 67. 61-66.

(7) Zooplankton Sampler

Zoo plankton sampler (ZPS) collects zooplankton samples in time-series. A sample is collected using a positive displacement pump that generates negative pressure through a hydrodynamically modeled space between two horizontal disks. Zooplankton are unaware of being drawn towards the sampler until they are well inside and can not escape. Prefilter (*c.a.* 3 mm mesh) covers the mouth of the sample intake path to avoid invasion of large creatures. They are transported onto a 3.5 x 6 cm frame of a special roll of Nitex mesh (100mm mesh). The Zooplankton community retained on a frame is sandwiched by another piece of Nitex mesh for protection and immediately moved to the fixative bath (15 % glutaraldehyde) for storage until recovery of the sampler. A new frame of mesh is positioned automatically to be ready for the next sampling cycle. This procedure can be repeated up to 50 times for each roll of Nitex mesh as instructed by the micro-controller. Before taking sample and every 4 days, seawater is flushed opposite direction. This becomes clear out any particle and living things in the sampling way.

Sampling will start at 13:00 (UTC: it is 2:00 in the midnight in local time) on October 1, 2001. The Interval of each sampling is essentially 8 days, and 4 days in spring bloom season (from April 19, 2002 to May 5, 2002: Table 4). Filteration volume is 100 liters and pumping flow rate is 20 liters / min.

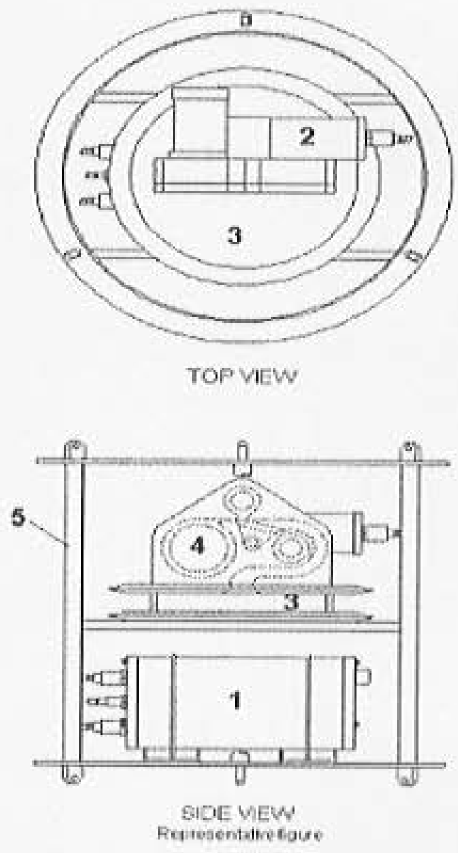


Fig.3.7 ZPS

(8) Sediment trap

Sinking particles flux in the ocean is often expressed as a biological pump and has an important role in the biogeochemical pump. In the study of settling particulate materials, the sediment trap has been a great useful instrument and used as a principle observational method in the ocean flux study such as JGOFS project. In our project, Mark78G-13 time-series sediment trap are selected because a collecting cup has a wide mouth and big volume (500 ml) which has an advantage in the highly productive area. This sediment trap has tilt sensor and direction sensor, which is useful for suspecting capture efficiency and hydrodynamics. Before deployment, collecting cups were filled with sea water based buffered 2 % formalin. Sediment traps were deployed at approximately 1000m, 2000m and 5000m at station K1, K2.

After recovering in 2002, samples will be divided to each 10 sample by splitter device and analyzed for the following components:

1. Organic carbon and inorganic carbon

2. Biogenic opal
3. Major element and the other proxy element
4. Cocolith, foraminifera, and other spices using by microscope
   Radionuclieds

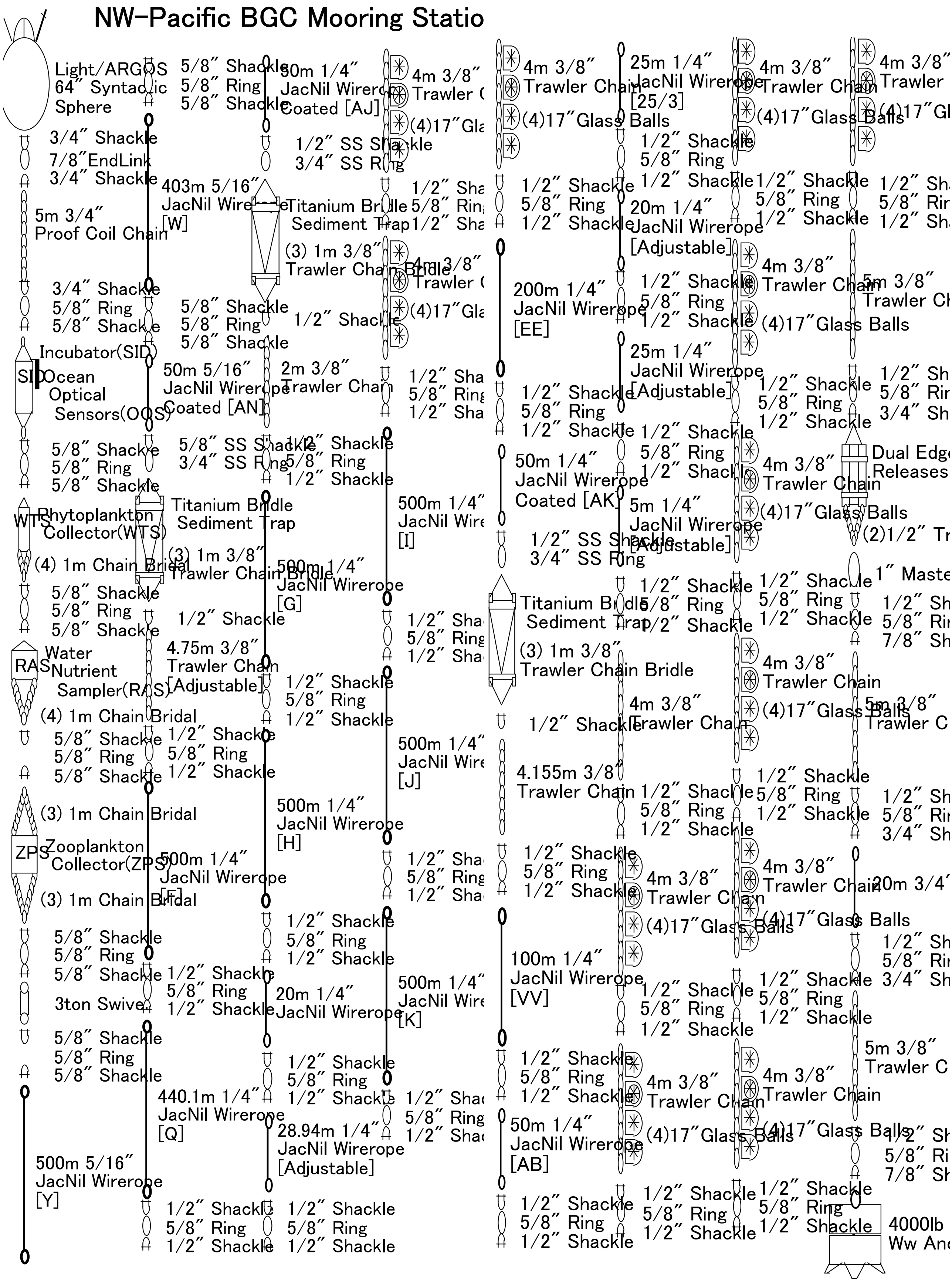


Fig.3.1.1 BGC mooring system at K1

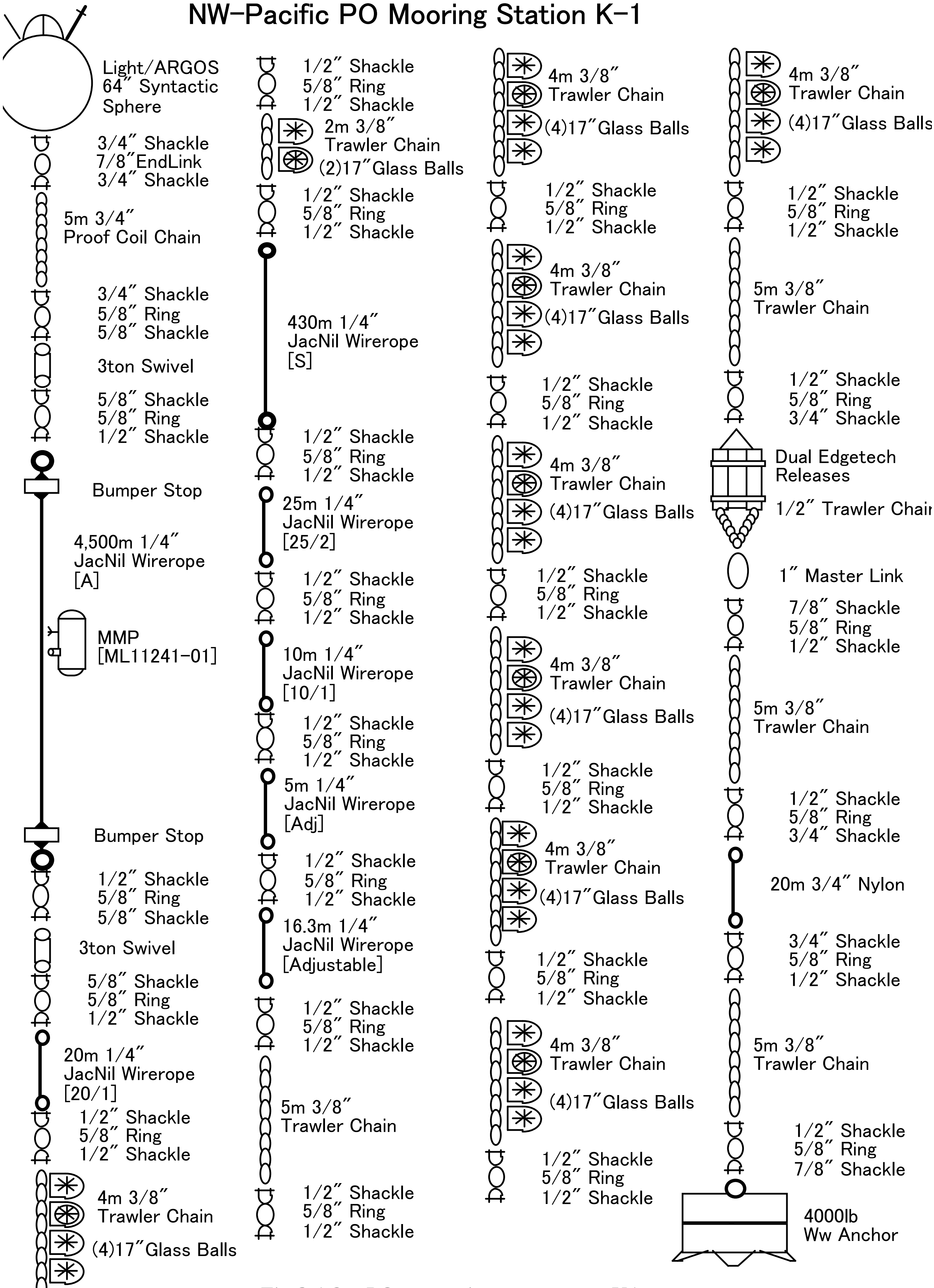


Fig.3.1.2 PO mooring system at K1

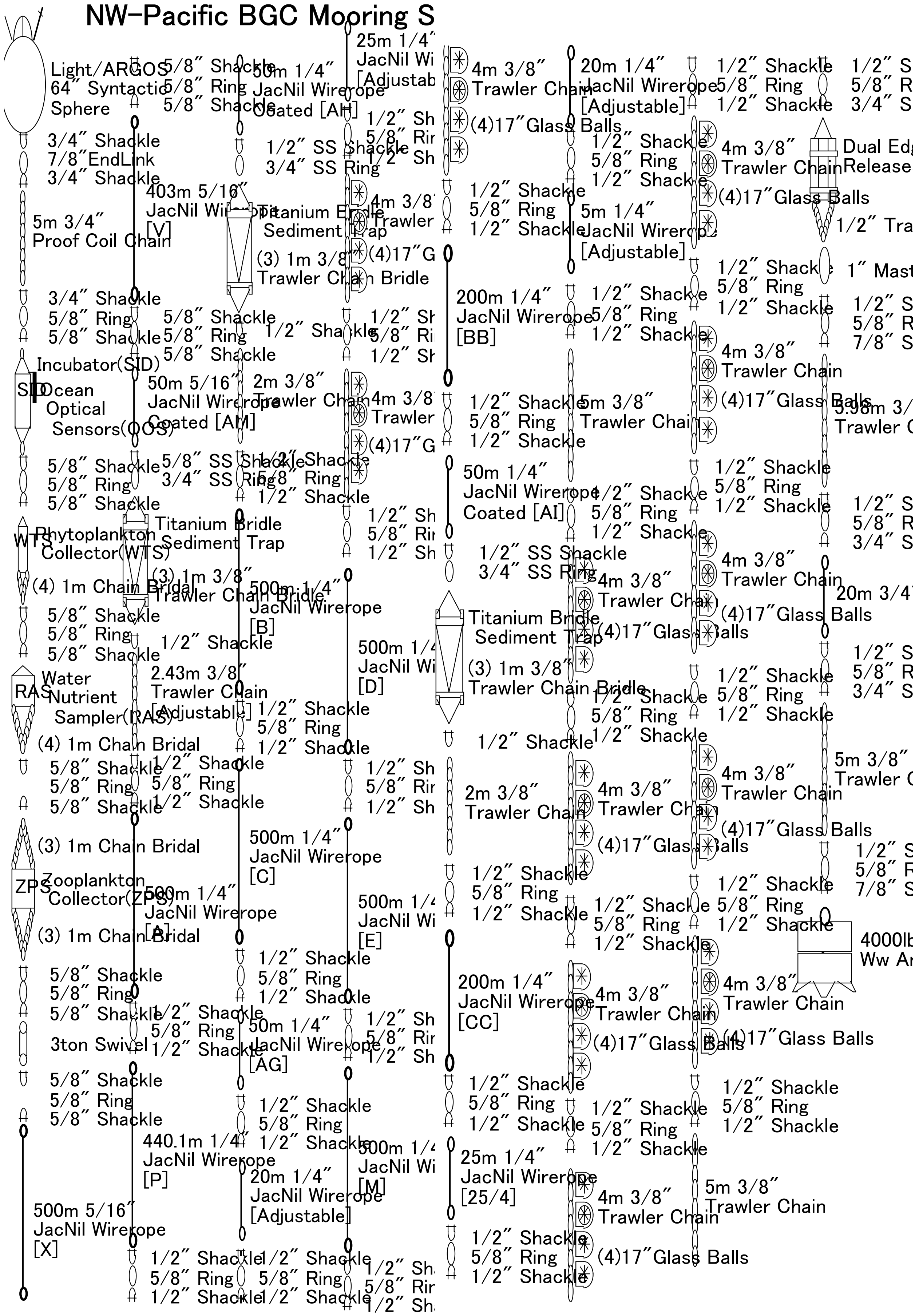


Fig.3.1.3 BGC mooring system at K2

Table 3.3.1 BGC mooring system at K1

PS Mooring for Biogeochemical Sensors and Samples for K-1

Mooring ID	Joint	In the Air			Water Depth						
			Item		Item	Item		Mooring	Mooring	Above	Below
Description		Weight	Quantitiy	Total	Length	Weight	Total	Length	Weight	Bottom	Surface
		(lb/ca)	(#)	(lbs)	(m)	(lbs)	(lbs)	(m)	(lbs)	(m)	(m)
Start of Mooring		0.0	0	0.0	0.0	0.0	0.0	0.0	0	5098.9	33.5
64"3000lb Syntactic sphere		2500.0	1	2500.0	1.0	-3000.0	-3000.0	1.0	-3000.0	5098.9	34.5
(2)3/4"SH, (1)7/8"End Link	[L]	8.0	1	8.0	0.3	8.0	8.0	1.3	-2992.0	5097.9	34.8
5m 3/4" PC		92.2	1	92.2	5.0	88.2	88.2	6.3	-2903.8	5097.6	39.8
(1)5/8"SH, (1)5/8"SL, (1)3/4"SH	[F]	5.3	1	5.3	0.2	5.3	5.3	6.5	-2898.5	5092.6	40.0
SID		198.4	1	198.4	1.8	130.1	130.1	8.3	-2768.4	5092.4	41.9
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	8.5	-2764.1	5090.5	42.1
WTS		99.2	1	99.2	0.3	77.2	77.2	8.9	-2687.0	5090.3	42.4
(4)1m-Bridal,(4)5/8"SH,(8)1/2"SH,(2)5/8SL		33.8	1	33.8	1.0	33.8	33.8	9.9	-2653.2	5090.0	43.4
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	10.1	-2648.9	5089.0	43.6
RAS		325.0	1	325.0	1.1	125.0	125.0	11.2	-2523.9	5088.8	44.8
(4)1m-Bridal,(4)5/8"SH,(8)1/2"SH,(2)5/8SL		33.8	1	33.8	0.8	33.8	33.8	12.0	-2490.1	5087.6	45.6
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	12.2	-2485.8	5086.8	45.8
(3)1m-Bridal,(9)1/2"SH,(1)5/8SL		22.8	1	22.8	1.0	22.8	22.8	13.2	-2463.0	5086.6	46.8
ZPS		167.6	1	167.6	0.9	57.3	57.3	14.2	-2405.7	5085.6	47.7
(3)1m-Bridal,(9)1/2"SH,(1)5/8SL		22.8	1	22.8	1.0	22.8	22.8	15.2	-2382.8	5084.7	48.7
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	15.4	-2378.6	5083.7	48.9
3ton Swivel		7.0	1	7.0	0.2	7.0	7.0	15.6	-2371.6	5083.5	49.1
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	15.8	-2367.3	5083.3	49.3
500m 5/16" wire		344.4	1	344.4	499.3	234.5	234.5	515.0	-2132.8	5083.1	548.6
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	515.2	-2128.6	4583.8	548.8
403.6m 5/16" wire		278.0	1	278.0	402.1	189.3	189.3	917.4	-1939.3	4583.6	950.9
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	917.6	-1935.0	4181.5	951.1
50m 5/16" wire		34.4	1	34.4	50.0	23.5	23.5	967.6	-1911.6	4181.3	1001.1
(1)5/8"SS SH, (1)3/4"SS SL	[I]	4.8	1	4.8	0.2	4.8	4.8	967.8	-1906.8	4131.3	1001.3
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	968.8	-1893.3	4131.1	1002.3
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	970.3	-1816.1	4130.1	1003.8
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	971.3	-1802.6	4128.6	1004.8
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	971.4	-1801.7	4127.6	1004.9
4.75m 3/8"TC		22.6	1	22.6	4.8	21.3	21.3	976.1	-1780.4	4127.5	1009.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	976.3	-1777.5	4122.8	1009.8
500m 1/4" wire		211.6	1	211.6	499.8	155.0	155.0	1476.1	-1622.5	4122.6	1509.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1476.3	-1619.6	3622.8	1509.8
440.1m 1/4" wire		186.2	1	186.2	439.6	136.4	136.4	1915.9	-1483.2	3622.6	1949.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1916.1	-1480.2	3183.0	1949.6
50m 1/4" wire		21.0	1	21.0	50.0	15.5	15.5	1966.1	-1464.7	3182.8	1999.6
(1)1/2"SS SH, (1)3/4"SS SL	[K]	3.1	1	3.1	0.2	3.1	3.1	1966.3	-1461.6	3132.8	1999.8
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	1967.3	-1448.1	3132.6	2000.8
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	1968.8	-1371.0	3131.6	2002.4
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	1969.8	-1357.5	3130.0	2003.4
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	1969.9	-1356.5	3129.0	2003.4
2m 3/8"TC		9.5	1	9.5	2.0	9.0	9.0	1971.9	-1347.5	3129.0	2005.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1972.1	-1344.6	3127.0	2005.6
500m 1/4" wire		211.6	1	211.6	499.8	155.0	155.0	2471.8	-1189.6	3126.8	2505.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	2472.0	-1186.7	2627.0	2505.6
500m 1/4" wire		211.6	1	211.6	499.8	155.0	155.0	2971.8	-1031.7	2626.8	3005.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	2972.0	-1028.8	2127.1	3005.5
20m 1/4" wire		8.4	1	8.4	20.0	6.2	6.2	2992.0	-1022.6	2126.9	3025.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	2992.2	-1019.6	2106.9	3025.7
28.94m 1/4" wire		12.2	1	12.2	28.5	8.8	8.8	3020.7	-1010.8	2106.7	3054.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3020.9	-1007.9	2078.2	3054.4
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	3024.9	-1227.6	2078.0	3058.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3025.1	-1224.6	2074.0	3058.6
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	3029.1	-1444.3	2073.8	3062.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3029.3	-1441.4	2069.8	3062.8
500m 1/4" wire		211.6	1	211.6	499.9	155.0	155.0	3529.2	-1286.4	2069.6	3562.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3529.4	-1283.5	1569.7	3562.9
500m 1/4" wire		211.6	1	211.6	499.7	155.0	155.0	4029.0	-1128.5	1569.5	4062.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4029.2	-1125.5	1069.8	4062.8
500m 1/4" wire		211.6	1	211.6	499.6	155.0	155.0	4528.8	-970.5	1069.6	4562.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4529.0	-967.6	570.1	4562.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	4533.0	-1187.3	569.9	4566.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4533.2	-1184.3	565.9	4566.7
200m 1/4" wire		84.6	1	84.6	199.9	62.0	62.0	4733.0	-1122.3	565.7	4766.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4733.2	-1119.4	365.8	4766.8
50m 1/4" wire		21.0	1	21.0	50.1	15.5	15.5	4783.3	-1103.9	365.6	4816.8
(1)1/2"SS SH, (1)3/4"SS SL	[K]	3.1	1	3.1	0.2	3.1	3.1	4783.5	-1100.8	315.6	4817.1
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	4784.5	-1087.3	315.3	4818.1
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	4786.0	-1010.2	314.3	4819.6
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	4787.0	-996.7	312.8	4820.6
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	4787.1	-995.7	311.8	4820.6
4.155m 3/8"TC		19.8	1	19.8	4.2	18.7	18.7	4791.2	-977.0	311.8	4824.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4791.4	-974.1	307.6	4825.0
100m 1/4" wire		42.3	1	42.3	100.0	31.0	31.0	4891.4	-943.1	307.4	4924.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4891.6	-940.2	207.5	4925.1
50m 1/4" wire		21.0	1	21.0	50.0	15.5	15.5	4941.6	-924.7	207.3	4975.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4941.8	-921.7	157.2	4975.4
25m 1/4" wire		10.6	1	10.6	25.0	7.8	7.8	4966.8	-914.0	157.0	5000.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4967.0	-911.1	132.0	5000.5
20m 1/4" wire		8.4	1	8.4	20.0	6.2	6.2	4987.0	-904.9	131.9	5020.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4987.2	-901.9	111.9	5020.7
25m 1/4" wire		10.5	1	10.5	25.0	7.8	7.8	5012.2	-894.2	111.7	5045.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5012.4	-891.2	86.7	5045.9
5m 1/4" wire		2.1	1	2.1	5.0	1.6	1.6	5017.4	-889.7	86.5	5050.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5017.6	-886.8	81.5	5051.1
4m 3/8" TC		19.0	1	19.0	4.0	17.9	17.9	5021.6	-868.8	81.3	5055.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5021.8	-865.9	77.3	5055.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5025.8	-1085.6	77.1	5059.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5026.0	-1082.7	73.1	5059.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5030.0	-1302.3	72.9	5063.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5030.2	-1299.4	68.9	5063.7
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5034.2	-1519.1	68.7	5067.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5034.4	-1516.2	64.7	5067.9
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5038.4	-1735.8	64.5	5071.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5038.6	-1732.9	60.5	5072.1
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5042.6	-1952.6	60.3	5076.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5042.8	-1949.6	56.3	5076.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5046.8	-2169.3	56.1	5080.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5047.0	-2166.4	52.1	5080.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5051.0	-2386.1	51.9	5084.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5051.2	-2383.1	47.9	5084.7
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5055.2	-2602.8	47.7	5088.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5055.4	-2599.9	43.7	5088.9
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5059.4	-2819.6	43.5	5092.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5059.5	-2816.6	39.5	5093.1
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5064.5	-2794.3	39.3	5098.1
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5064.8	-2789.6	34.3	5098.3
Edgetech Release		77.2	2	154.3	1.0	72.8	145.5	5065.8	-2644.1	34.1	5099.3
1/2" Trawler Dualing Chain		4.8	1	4.8	1.0	4.5	4.5	5066.8	-2639.6	33.1	5100.3
(1)1-1/4" Master Link	[M]	9.5	1	9.5	0.2	9.5	9.5	5067.0	-2630.1	32.1	5100.5
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5067.2	-2624.2	31.9	5100.7
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5072.2	-2601.8	31.7	5105.7
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5072.4	-2597.2	26.7	5106.0
20m 1" Nylon		0.9	1	0.9	20.0	0.6	0.6	5092.4	-2596.6	26.4	5126.0
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5092.6	-2591.9	6.4	5126.2
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5097.6	-2569.5	6.2	5131.2
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5097.9	-2563.6	1.2	5131.4
4,000 lb Mace Anchor		4000.0	1	4000.0	1.0	4000.0	4000.0	5098.9	1436.4	1	5132.4

Table 3.3.2 PO mooring system at K2

PO Mooring for MMP K-1											
Mooring ID	NEW				Water Depth						
			Item		Item	Item		Mooring	Mooring	Above	Below
Description		Weight	Quantity	Total	Length	Weight	Total	Length	Weight	Bottom	Surface
		(lb/ca)	(#)	(lbs)	(m)	(lbs)	(lbs)	(m)	(lbs)	(m)	(m)
Start of Mooring		0.0	0	0.0	0.0	0.0	0.0	0	0	5100.1	39.9
64"3000lb Syntactic sphere		2500.0	1	2500.0	1.0	-3000.0	-3000.0	1.0	-3000.0	5100.1	40.9
(2)3/4"SH, (1)7/8"End Link	[L]	8.0	1	8.0	0.3	8.0	8.0	1.3	-2992.0	5099.1	41.1
5m 3/4" PC		92.3	1	92.3	5.0	86.6	86.6	6.3	-2905.4	5098.9	46.1
(1)5/8"SH, (1)5/8"SL, (1)3/4"SH	[F]	5.3	1	5.3	0.2	5.3	5.3	6.5	-2900.0	5093.9	46.4
3ton Swivel		7.0	1	7.0	0.2	7.0	7.0	6.7	-2893.1	5093.6	46.5
(1)1/2"SH, (1)5/8"SL, (1)5/8"SH	[B]	0.2	1	0.2	3.6	0.2	0.2	10.3	-2892.8	5093.5	50.1
Stopper (35m)		11.4	1	11.4	0.0	0.0	0.0	10.3	-2892.8	5089.9	50.1
4,500m 1/4" wire		1890.0	1	1890.0	4500.0	1395.0	1395.0	4510.3	-1497.8	5089.9	4550.1
MMP		154.3	1	154.3	0.0	0.0	0.0	4510.3	-1497.8	589.9	4550.1
Stopper		11.4	1	11.4	0.5	0.0	0.0	4510.8	-1497.8	589.9	4550.6
(1)1/2"SH, (1)5/8"SL, (1)5/8"SH	[B]	0.2	1	0.2	3.6	0.2	0.2	4514.4	-1497.6	589.4	4554.2
Swivel		11.0	1	11.0	0.2	7.0	7.0	4514.5	-1490.7	585.8	4554.4
(1)1/2"SH, (1)5/8"SL, (1)5/8"SH	[B]	0.2	1	0.2	3.6	0.2	0.2	4518.1	-1490.4	585.6	4558.0
20m 1/4" wire		8.4	1	8.4	20.0	6.2	6.2	4538.1	-1484.2	582.0	4578.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4538.3	-1481.3	562.0	4578.2
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	4542.3	-1701.0	561.8	4582.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4542.5	-1698.1	557.8	4582.4
17" glass balls on 3/8"TC		46.9	2	93.8	2.0	-54.9	-109.8	4544.5	-1807.9	557.6	4584.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4544.7	-1805.0	555.6	4584.6
430m 1/4" wire		181.7	1	181.7	429.4	133.3	133.3	4974.2	-1671.7	555.4	5014.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4974.4	-1668.8	126.0	5014.2
25m 1/4" wire		10.6	1	10.6	25.0	7.8	7.8	4999.4	-1661.0	125.8	5039.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4999.6	-1658.1	100.8	5039.4
10m 1/4" wire		4.2	1	4.2	10.0	3.1	3.1	5009.6	-1655.0	100.6	5049.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5009.8	-1652.1	90.6	5049.6
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5014.8	-1629.7	90.4	5054.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5015.0	-1626.7	85.4	5054.8
16.3m 1/4" wire		6.8	1	6.8	16.3	5.1	5.1	5031.3	-1621.7	85.2	5071.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5031.5	-1618.8	68.9	5071.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5035.5	-1838.4	68.7	5075.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5035.6	-1835.5	64.7	5075.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5039.6	-2055.2	64.5	5079.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5039.8	-2052.3	60.5	5079.7
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5043.8	-2271.9	60.3	5083.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5044.0	-2269.0	56.3	5083.9
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5048.0	-2488.7	56.1	5087.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5048.2	-2485.8	52.1	5088.1
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5052.2	-2705.4	51.9	5092.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5052.4	-2702.5	47.9	5092.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5056.4	-2922.2	47.7	5096.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5056.6	-2919.3	43.7	5096.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5060.6	-3138.9	43.5	5100.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5060.8	-3136.0	39.5	5100.7
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5065.8	-3113.6	39.3	5105.7
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5066.0	-3109.0	34.3	5105.9
Edgetech Release		77.2	2	154.3	1.0	72.8	145.5	5067.0	-2963.4	34.1	5106.9
1/2" Trawler Dualing Chain		4.8	1	4.8	1.0	4.5	4.5	5068.0	-2959.0	33.1	5107.9
(1)1-1/4" Master Link	[M]	9.5	1	9.5	0.2	9.5	9.5	5068.3	-2949.5	32.1	5108.1
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5068.5	-2943.6	31.9	5108.3
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5073.5	-2921.2	31.7	5113.3
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5073.7	-2916.5	26.7	5113.6
20m 1" Nylon		0.9	1	0.9	20.0	0.6	0.6	5093.7	-2915.9	26.4	5133.6
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5093.9	-2911.2	6.4	5133.8
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5098.9	-2888.9	6.2	5138.8
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5099.1	-2882.9	1.2	5139.0
4,666 lb Mace Anchor		4666.0	1	4666.0	1.0	4666.0	4666.0	5100.1	1783.1	1	5140.0

Table 3.3.4 BGC mooring system at K2

PS Mooring for Biogeochemical Sensors and Samples for K-2											
Mooring ID	Joint	In the Air			Water Depth						
			Item		Item	Item		Mooring	Mooring	Above	Below
Description		Weight	Quantitiy	Total	Length	Weight	Total	Length	Weight	Bottom	Surface
		(lb/ca)	(#)	(lbs)	(m)	(lbs)	(lbs)	(m)	(lbs)	(m)	(m)
Start of Mooring		0.0	0	0.0	0.0	0.0	0.0	0.0	0	5170.1	36.1
64"3000lb Syntactic sphere		2500.0	1	2500.0	1.0	-3000.0	-3000.0	1.0	-3000.0	5170.1	37.1
(2)3/4"SH, (1)7/8"End Link	[L]	8.0	1	8.0	0.3	8.0	8.0	1.3	-2992.0	5169.1	37.4
5m 3/4" PC		92.2	1	92.2	5.0	88.2	88.2	6.3	-2903.8	5168.8	42.4
(1)5/8"SH, (1)5/8"SL, (1)3/4"SH	[F]	5.3	1	5.3	0.2	5.3	5.3	6.5	-2898.5	5163.8	42.6
SID		198.4	1	198.4	1.8	130.1	130.1	8.3	-2768.4	5163.6	44.5
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	8.5	-2764.1	5161.7	44.7
WTS		99.2	1	99.2	0.3	77.2	77.2	8.9	-2687.0	5161.5	45.0
(4)1m-Bridal,(4)5/8"SH,(8)1/2"SH,(2)5/8SL		33.8	1	33.8	1.0	33.8	33.8	9.9	-2653.2	5161.2	46.0
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	10.1	-2648.9	5160.2	46.2
RAS		325.0	1	325.0	1.1	125.0	125.0	11.2	-2523.9	5160.0	47.4
(4)1m-Bridal,(4)5/8"SH,(8)1/2"SH,(2)5/8SL		33.8	1	33.8	0.8	33.8	33.8	12.0	-2490.1	5158.8	48.2
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	12.2	-2485.8	5158.0	48.4
(3)1m-Bridal,(9)1/2"SH,(1)5/8SL		22.8	1	22.8	1.0	22.8	22.8	13.2	-2463.0	5157.8	49.4
ZPS		167.6	1	167.6	0.9	57.3	57.3	14.2	-2405.7	5156.8	50.3
(3)1m-Bridal,(9)1/2"SH,(1)5/8SL		22.8	1	22.8	1.0	22.8	22.8	15.2	-2382.8	5155.9	51.3
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	15.4	-2378.6	5154.9	51.5
3ton Swivel		7.0	1	7.0	0.2	7.0	7.0	15.6	-2371.6	5154.7	51.7
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	15.8	-2367.3	5154.5	51.9
500m 5/16" wire		344.4	1	344.4	499.0	234.5	234.5	514.8	-2132.8	5154.3	550.9
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	515.0	-2128.6	4655.3	551.1
403.6m 5/16" wire		278.0	1	278.0	402.3	189.3	189.3	917.2	-1939.3	4655.1	953.4
(2)5/8"SH, (1)5/8"SL	[H]	4.3	1	4.3	0.2	4.3	4.3	917.5	-1935.0	4252.8	953.6
50m 5/16" wire		34.4	1	34.4	50.0	23.5	23.5	967.4	-1911.6	4252.6	1003.6
(1)5/8"SS SH, (1)3/4"SS SL	[I]	4.8	1	4.8	0.2	4.8	4.8	967.6	-1906.8	4202.6	1003.8
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	968.6	-1893.3	4202.4	1004.8
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	970.2	-1816.1	4201.4	1006.3
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	971.2	-1802.6	4199.9	1007.3
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	971.2	-1801.7	4198.9	1007.3
2.43m 3/8"TC		11.6	1	11.6	2.4	10.9	10.9	973.6	-1790.8	4198.9	1009.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	973.8	-1787.9	4196.4	1010.0
500m 1/4" wire		211.6	1	211.6	502.0	155.0	155.0	1475.8	-1632.9	4196.2	1511.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1476.0	-1629.9	3694.3	1512.1
440.1m 1/4" wire		186.2	1	186.2	439.9	136.4	136.4	1915.9	-1493.5	3694.1	1952.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1916.1	-1490.6	3254.2	1952.2
50m 1/4" wire		21.0	1	21.0	50.0	15.5	15.5	1966.1	-1475.1	3254.0	2002.2
(1)1/2"SS SH, (1)3/4"SS SL	[K]	3.1	1	3.1	0.2	3.1	3.1	1966.3	-1472.0	3204.0	2002.4
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	1967.3	-1458.5	3203.8	2003.4
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	1968.8	-1381.4	3202.8	2005.0
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	1969.8	-1367.9	3201.2	2006.0
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	1969.9	-1366.9	3200.2	2006.0
2m 3/8"TC		9.5	1	9.5	2.0	9.0	9.0	1971.9	-1357.9	3200.2	2008.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	1972.1	-1355.0	3198.2	2008.2
500m 1/4" wire		211.6	1	211.6	499.6	155.0	155.0	2471.6	-1200.0	3198.0	2507.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	2471.8	-1197.1	2698.4	2507.9
500m 1/4" wire		211.6	1	211.6	499.7	155.0	155.0	2971.5	-1042.1	2698.3	3007.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	2971.7	-1039.1	2198.6	3007.8
50m 1/4" wire		21.0	1	21.0	50.0	15.5	15.5	3021.7	-1023.6	2198.4	3057.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3021.9	-1020.7	2148.4	3058.0
20m 1/4" wire		8.4	1	8.4	20.0	6.2	6.2	3041.9	-1014.5	2148.2	3078.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3042.1	-1011.6	2128.2	3078.2
25m 1/4" wire		10.5	1	10.5	25.0	7.8	7.8	3067.1	-1003.8	2128.0	3103.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3067.3	-1000.9	2103.0	3103.4
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	3071.3	-1220.6	2102.8	3107.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3071.5	-1217.6	2098.8	3107.6
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	3075.5	-1437.3	2098.6	3111.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3075.7	-1434.4	2094.6	3111.8
500m 1/4" wire		211.6	1	211.6	499.9	155.0	155.0	3575.6	-1279.4	2094.4	3611.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	3575.8	-1276.5	1594.5	3611.9
500m 1/4" wire		211.6	1	211.6	499.9	155.0	155.0	4075.6	-1121.5	1594.3	4111.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4075.8	-1118.5	1094.4	4112.0
500m 1/4" wire		211.6	1	211.6	499.6	155.0	155.0	4575.5	-963.5	1094.2	4611.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4575.7	-960.6	594.6	4611.8
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	4579.7	-1180.3	594.4	4615.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4579.9	-1177.3	590.4	4616.0
200m 1/4" wire		84.6	1	84.6	200.0	62.0	62.0	4779.9	-1115.3	590.2	4816.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4780.1	-1112.4	390.2	4816.2
50m 1/4" wire		21.0	1	21.0	50.0	15.5	15.5	4830.1	-1096.9	390.0	4866.2
(1)1/2"SS SH, (1)3/4"SS SL	[K]	3.1	1	3.1	0.2	3.1	3.1	4830.3	-1093.8	340.0	4866.4
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	4831.3	-1080.3	339.8	4867.4
Sediment Trap		167.6	1	167.6	1.5	77.2	77.2	4832.8	-1003.2	338.8	4869.0
1m 3/8" TC Bridle		4.8	3	14.3	1.0	4.5	13.5	4833.8	-989.7	337.2	4870.0
(1)1/2"SH	[J]	0.9	1	0.9	0.1	0.9	0.9	4833.9	-988.7	336.2	4870.0
2m 3/8"TC		9.5	1	9.5	2.0	9.0	9.0	4835.9	-979.7	336.2	4872.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	4836.1	-976.8	334.2	4872.2
200m 1/4" wire		84.6	1	84.6	200.0	62.0	62.0	5036.0	-914.8	334.0	5072.2
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5036.2	-911.9	134.0	5072.4
25m 1/4" wire		10.6	1	10.6	25.0	7.8	7.8	5061.2	-904.1	133.8	5097.4
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5061.4	-901.2	108.8	5097.6
20m 1/4" wire		8.4	1	8.4	20.0	6.2	6.2	5081.4	-895.0	108.6	5117.6
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5081.6	-892.1	88.6	5117.8
5m 1/4" wire		2.1	1	2.1	5.0	1.6	1.6	5086.6	-890.5	88.4	5122.8
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5086.8	-887.6	83.4	5123.0
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5091.8	-865.2	83.2	5128.0
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5092.0	-862.3	78.2	5128.1
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5096.0	-1081.9	78.1	5132.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5096.2	-1079.0	74.1	5132.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5100.2	-1298.7	73.9	5136.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5100.4	-1295.8	69.9	5136.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5104.4	-1515.4	69.7	5140.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5104.6	-1512.5	65.7	5140.7
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5108.6	-1732.2	65.5	5144.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5108.8	-1729.3	61.5	5144.9
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5112.8	-1948.9	61.3	5148.9
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5113.0	-1946.0	57.3	5149.1
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5117.0	-2165.7	57.1	5153.1
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5117.2	-2162.8	53.1	5153.3
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5121.2	-2382.4	52.9	5157.3
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5121.4	-2379.5	48.9	5157.5
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5125.4	-2599.2	48.7	5161.5
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5125.6	-2596.2	44.7	5161.7
17" glass balls on 3/8"TC		46.9	4	187.6	4.0	-54.9	-219.7	5129.6	-2815.9	44.5	5165.7
(2)1/2"SH, (1)5/8"SL	[A]	2.9	1	2.9	0.2	2.9	2.9	5129.8	-2813.0	40.5	5165.9
5.98m 3/8" TC		28.4	1	28.4	6.0	26.8	26.8	5135.7	-2786.2	40.3	5171.9
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5136.0	-2781.6	34.3	5172.1
Edgetech Release		77.2	2	154.3	1.0	72.8	145.5	5137.0	-2636.1	34.1	5173.1
1/2" Trawler Dualing Chain		4.8	1	4.8	1.0	4.5	4.5	5138.0	-2631.6	33.1	5174.1
(1)1-1/4" Master Link	[M]	9.5	1	9.5	0.2	9.5	9.5	5138.2	-2622.1	32.1	5174.3
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5138.4	-2616.2	31.9	5174.5
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5143.4	-2593.8	31.7	5179.5
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5143.6	-2589.1	26.7	5179.8
20m 1" Nylon		0.9	1	0.9	20.0	0.6	0.6	5163.6	-2588.5	26.4	5199.8
(1)1/2"SH, (1)5/8"SL, (1)3/4"SH	[C]	4.7	1	4.7	0.2	4.7	4.7	5163.8	-2583.9	6.4	5200.0
5m 3/8" TC		23.8	1	23.8	5.0	22.4	22.4	5168.8	-2561.5	6.2	5205.0
(1)1/2"SH, (1)5/8"SL, (1)7/8"SH	[D]	5.9	1	5.9	0.2	5.9	5.9	5169.1	-2555.6	1.2	5205.2
4,000 lb Mace Anchor		4000.0	1	4000.0	1.0	4000.0	4000.0	5170.1	1444.4	1	5206.2

Table 3.4.1 BGC mooring position at K1

MOORING No. **K1B010905**

PROJECT	Time Series	TIME	Sep. 5th 2001
AREA	North Pacific	RECORDER (D) :	Naoko Takahashi
POSITION	Station K-1	RECORDER (R) :	

DEPTH	5,132.4 m	Planned Depth	5,130 m		
PERIOD	1 year	NAVIGATION SYSTEM :			
No. of DAYS					
LENGTH :	5,098.9 m	DEPTH of BUOY :	33.5 m	BUOYANCY :	1,360 kg

ACOUSTIC RELEASERS

TYPE	Edgetech			TYPE	Edgetech		
S/N	027824			S/N	027864		
RECEIVE F.	(A) 11.0	(B) 9.0	kHz	RECEIVE F.	(A) 11.0	(B) 9.0	kHz
TRANSMIT F.	(A) 12.0	(B) 11.0	kHz	TRANSMIT F.	(A) 12.0	(B) 11.0	kHz
RELEASE C.	344674			RELEASE C.	344421		
ENABLE C.	(A) 361121	(B) 361144		ENABLE C.	(A) 357724	(B) 357741	
DISABLE C.	361167			DISABLE C.	357762		
BATTERY	1 year			BATTERY	1 year		
RELEASE TEST	OK			RELEASE TEST	OK		

DEPLOYMENT

DATE	Sep. 5th 2001		SHIP	MIRAI		CRUISE No.	MR01-K04
WATHER	O	CONDITIONS smooth	DEPTH	5,132.40 m		DEPTH of A.R.	5,099.3 m
DIR. And VEL. of WIND	<240> 9.6 m/s		DIR. And VEL. of CURRENT			<215> 0.3	knot
POS. of START	51¡23'.811N	165¡23'.421E		BUOY	20:08		
POS. of DEP.	51¡19'.82N	165¡11'.85E		ANCHOR	01:53	DISAPPEAR	2:30
POS. of MOORING	51¡19'.935N	165¡12'.278E				LANDING	:

Table 3.4.2 PO mooring position at K1

MOORING No. **K1P010904**

PROJECT	Time Series	TIME	Sep. 4th 2001
AREA	North Pacific	RECORDER (D) :	Miki Yoshiike
POSITION	Station K-1	RECORDER (R) :	

DEPTH	5,140m	Planned Depth	5,130 m		
PERIOD	1 year	NAVIGATION SYSTEM :			
No. of DAYS					
LENGTH :	5,100.1 m	DEPTH of BUOY :	39.9 m	BUOYANCY :	1,360 kg

ACOUSTIC RELEASERS

TYPE	Edgetech			TYPE	Edgetech		
S/N	027867			S/N	027809		
RECEIVE F.	(A) 11.0	(B) 9.0	kHz	RECEIVE F.	(A) 11.0	(B) 9.0	kHz
TRANSMIT F.	(A) 12.0	(B) 11.0	kHz	TRANSMIT F.	(A) 12.0	(B) 11.0	kHz
RELEASE C.	344573			RELEASE C.	344535		
ENABLE C.	(A) 360536	(B) 360553		ENABLE C.	(A) 360320	(B) 360345	
DISABLE C.	360570			DISABLE C.	360366		
BATTERY	1 year			BATTERY	1 year		
RELEASE TEST	OK			RELEASE TEST	OK		

DEPLOYMENT

DATE	Sep. 4th 2001		SHIP	MIRAI		CRUISE No.	MR01-K04
WATHER	bc	CONDITIONS smooth	DEPTH	5,140 m		DEPTH of A.R.	5,106.9 m
DIR. And VEL. of WIND	<045> 5.0 m/s		SHIP'S HEAD			<020> 1.0	knot
POS. of START	51¡12'.00N		165¡12'.06E	BUOY	19:21		
POS. of DEP.	51°18'.18 N		165¡18'.34E	ANCHOR	00:39	DISAPPEAR	14:19
POS. of MOORING	51¡17'.9597N		165¡18'.2019E			LANDING	:

Table 3.4.5 BGC mooring position at K2

MOORING No. **K2B010909**

PROJECT	Time Series	TIME	Sep. 9th 2001
AREA	North Pacific	RECORDER (D) :	Naoko Takahashi
POSITION	Station K-1	RECORDER (R) :	

DEPTH	5,206.2 m Planned Depth 5,267 m
PERIOD	1 year NAVIGATION SYSTEM :
No. of DAYS	
LENGTH :	5,170.1 m DEPTH of BUOY : 36.1 m BUOYANCY : 1,360 kg

ACOUSTIC RELEASERS

TYPE	Edgetech	TYPE	Edgetech
S/N	027868	S/N	027825
RECEIVE F.	(A) 11.0 (B) 9.0 kHz	RECEIVE F.	(A) 11.0 (B) 9.0 kHz
TRANSMIT F.	(A) 12.0 (B) 11.0 kHz	TRANSMIT F.	(A) 12.0 (B) 11.0 kHz
RELEASE C.	335534	RELEASE C.	344176
ENABLE C.	(A) 322710 (B) 322733	ENABLE C.	(A) 356736 (B) 356753
DISABLE C.	322756	DISABLE C.	356770
BATTERY	1 year	BATTERY	1 year
RELEASE TEST	OK	RELEASE TEST	OK

DEPLOYMENT

DATE	Sep. 9th 2001	SHIP	MIRAI	CRUISE No.	MR01-K04
WATHER O	CONDITIONS smooth	DEPTH	5,206.2 m	DEPTH of A.R.	5,173.1 m
DIR. And VEL. of WIND	<223> 2.9 m/s	DIR. And VEL. of CURRENT		<050> 0.2 knot	
POS. of START	47¡04'.680N 160¡09'.114E	BUOY	21:33		
POS. of DEP.	47¡00'.205N 159¡57'.924E	ANCHOR	03:40	DISAPPEAR	04:15
POS. of MOORING	47¡00'.324N 159¡58'.246E	LANDING	:		

4　Table 3.5　Sampling schedule

(UCT)

	ST		RAS		ZPS		WTS-PPS		SID		MMP	Distance
Sam.	13	Sam.	48	Sam.	50	Sam.	24	Sam.	40 (sample) + 7 (blank)	Sam.		(m)
Int.	28.08	Int.	8	Int.	8	Int.	16	Int.	8	Int.	10	27,000
1	2001.10.1 0:00	1	2001.10.1 1:00	1	2001.10.1 13:00	1	2001.9.30 19:00	1	2001.9.30 19:00	1	2001.9.6 4:00	27,000
2	2001.10.29 1:50	2	2001.10.9 1:00	2	2001.10.9 13:00	2	2001.10.16 19:00			2	2001.9.16 4:00	54,000
3	2001.11.26 3:41	3	2001.10.17 1:00	3	2001.10.17 13:00	3	2001.11.1 19:00	3	2001.10.16 19:00	3	2001.9.26 4:00	81,000
4	2001.12.24 5:32	4	2001.10.25 1:00	4	2001.10.25 13:00	4	2001.11.17 19:00			4	2001.10.6 4:00	108,000
5	2002.1.21 7:23	5	2001.11.2 1:00	5	2001.11.2 13:00	5	2001.12.3 19:00	5	2001.11.1 19:00	5	2001.10.16 4:00	135,000
6	2002.2.18 9:13	6	2001.11.10 1:00	6	2001.11.10 13:00	6	2001.12.19 19:00			6	2001.10.26 4:00	162,000
7	2002.3.18 11:04	7	2001.11.18 1:00	7	2001.11.18 13:00	7	2002.1.4 19:00	7	2001.11.17 19:00	7	2001.11.5 4:00	189,000
8	2002.4.15 12:55	8	2001.11.26 1:00	8	2001.11.26 13:00	8	2002.1.20 19:00			8	2001.11.15 4:00	216,000
9	2002.5.13 14:46	9	2001.12.4 1:00	9	2001.12.4 13:00	9	2002.2.5 19:00	9	2001.12.3 19:00	9	2001.11.25 4:00	243,000
10	2002.6.10 16:36	10	2001.12.12 1:00	10	2001.12.12 13:00	10	2002.2.21 19:00			10	2001.12.5 4:00	270,000
11	2002.7.8 18:27	11	2001.12.20 1:00	11	2001.12.20 13:00	11	2002.3.9 19:00	11	2001.12.19 19:00	11	2001.12.15 4:00	297,000
12	2002.8.5 20:18	12	2001.12.28 1:00	12	2001.12.28 13:00	12	2002.3.25 19:00			12	2001.12.25 4:00	324,000
13	2002.9.2 22:09	13	2002.1.5 1:00	13	2002.1.5 13:00	13	2002.4.10 19:00	13	2002.1.4 19:00	13	2002.1.4 4:00	351,000
14	2002.10.1 0:00	14	2002.1.13 1:00	14	2002.1.13 13:00	14	2002.4.26 19:00			14	2002.1.14 4:00	378,000
		15	2002.1.21 1:00	15	2002.1.21 13:00	15	2002.5.12 19:00	15	2002.1.20 19:00	15	2002.1.24 4:00	405,000
		16	2002.1.29 1:00	16	2002.1.29 13:00	16	2002.5.28 19:00			16	2002.2.3 4:00	432,000
		17	2002.2.6 1:00	17	2002.2.6 13:00	17	2002.6.13 19:00	17	2002.2.5 19:00	17	2002.2.13 4:00	459,000
		18	2002.2.14 1:00	18	2002.2.14 13:00	18	2002.6.29 19:00	18	2002.2.13 19:00	18	2002.2.23 4:00	486,000
		19	2002.2.22 1:00	19	2002.2.22 13:00	19	2002.7.15 19:00	19	2002.2.21 19:00	19	2002.3.5 4:00	513,000
		20	2002.3.2 1:00	20	2002.3.2 13:00	20	2002.7.31 19:00	20	2002.3.1 19:00	20	2002.3.15 4:00	540,000
		21	2002.3.10 1:00	21	2002.3.10 13:00	21	2002.8.16 19:00	21	2002.3.9 19:00	21	2002.3.25 4:00	567,000
		22	2002.3.18 1:00	22	2002.3.18 13:00	22	2002.9.1 19:00	22	2002.3.17 19:00	22	2002.4.4 4:00	594,000
		23	2002.3.26 1:00	23	2002.3.26 13:00	23	2002.9.17 19:00	23	2002.3.25 19:00	23	2002.4.14 4:00	621,000
		24	2002.4.3 1:00	24	2002.4.3 13:00	24	2002.10.3 19:00	24	2002.4.2 19:00	24	2002.4.24 4:00	648,000
		25	2002.4.11 1:00	25	2002.4.11 13:00			25	2002.4.10 19:00	25	2002.5.4 4:00	675,000
		26	2002.4.19 1:00	26	2002.4.19 13:00			26	2002.4.18 19:00	26	2002.5.14 4:00	702,000
		27	2002.4.27 1:00	27	2002.4.27 13:00			27	2002.4.26 19:00	27	2002.5.24 4:00	729,000
		28	2002.5.5 1:00	28	2002.5.5 13:00			28	2002.5.4 19:00	28	2002.6.3 4:00	756,000
		29	2002.5.13 1:00	29	2002.5.13 13:00			29	2002.5.12 19:00	29	2002.6.13 4:00	783,000
		30	2002.5.21 1:00	30	2002.5.21 13:00			30	2002.5.20 19:00	30	2002.6.23 4:00	810,000
		31	2002.5.29 1:00	31	2002.5.29 13:00			31	2002.5.28 19:00	31	2002.7.3 4:00	837,000
		32	2002.6.6 1:00	32	2002.6.6 13:00			32	2002.6.5 19:00	32	2002.7.13 4:00	864,000
		33	2002.6.14 1:00	33	2002.6.14 13:00			33	2002.6.13 19:00	33	2002.7.23 4:00	891,000
		34	2002.6.22 1:00	34	2002.6.22 13:00			34	2002.6.21 19:00	34	2002.8.2 4:00	918,000
		35	2002.6.30 1:00	35	2002.6.30 13:00			35	2002.6.29 19:00	35	2002.8.12 4:00	945,000
		36	2002.7.8 1:00	36	2002.7.8 13:00			36	2002.7.7 19:00	36	2002.8.22 4:00	972,000
		37	2002.7.16 1:00	37	2002.7.16 13:00			37	2002.7.15 19:00	37	2002.9.1 4:00	999,000
		38	2002.7.24 1:00	38	2002.7.24 13:00			38	2002.7.23 19:00	38	2002.9.11 4:00	1,026,000
		39	2002.8.1 1:00	39	2002.8.1 13:00			39	2002.7.31 19:00	39	2002.9.21 4:00	1,053,000
		40	2002.8.9 1:00	40	2002.8.9 13:00			40	2002.8.8 19:00	40	2002.10.1 4:00	1,080,000
		41	2002.8.17 1:00	41	2002.8.17 13:00			41	2002.8.16 19:00	41	2002.10.11 4:00	1,107,000
		42	2002.8.25 1:00	42	2002.8.25 13:00			42	2002.8.24 19:00			
		43	2002.9.2 1:00	43	2002.9.2 13:00			43	2002.9.1 19:00			
		44	2002.9.10 1:00	44	2002.9.10 13:00			44	2002.9.9 19:00			
		45	2002.9.18 1:00	45	2002.9.18 13:00			45	2002.9.17 19:00			
		46	2002.9.26 1:00	46	2002.9.26 13:00			46	2002.9.25 19:00			
		47	2001.11.2 1:00	47	2002.10.4 13:00			47	2002.10.3 19:00			
		48	2001.4.3 1:00	48	2002.10.12 13:00			48	2002.10.11 19:00			
				49	2001.4.15 13:00							
			duplicate	50	2001.4.23 13:00				blank befor incubation			

Solar noon time: ca. 01:00 (UCT)
Mid night: ca. 13:00 (UCT)　　　　(in August of the Northwestern North Pacific)

3. General observation

3.1 Meteorological observations

3.1.1 Surface meteorological observation

Kunio Yoneyama (JAMSTEC): (Shore-side participant)
Masaki Hanyu (GODI): Operation Leader
Shinya Iwamida (GODI)

(1) Objective

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

(2) Methods

The surface meteorological parameters were observed throughout MR01-K04 Leg2 cruise from the departure of Dutch Harbor on 28 August 2001 to the arrival of Sekinehama on 15 September 2001.

This cruise, we used 2 systems for the surface meteorological observation.

1. Mirai meteorological observation system
2. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

(3-1) Mirai meteorological observation system

Instruments of Mirai met system are listed in Table 3.1.1-1 and measured parameters are listed in Table 3.1.1-2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin Denki, Japan. The data set has 6-second averaged every 6-second record and 10-minute averaged every 10-minute record.

Table 3.1.1-1: Instruments and their installation locations of Mirai met system

Sensors	Type	Manufacturer	location (altitude from baseline)
Anemometer	KE-500	Koshin Denki, Japan	foremast (30m)
Thermometer	FT	Koshin Denki, Japan	compass deck (27m)
Dewpoint meter	DW-1	Koshin Denki, Japan	compass deck (27m)
Barometer	F451	Yokogawa, Japan	weather observation room captain deck (20m)
rain gauge	50202	R. M. Young, USA	compass deck (25m)
optical rain gauge	ORG-115DR	SCTI, USA	compass deck (25m)
radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (33m)
radiometer (long wave)	MS-200	Eiko Seiki, Japan	radar mast (33m)
wave height meter	MW-2	Tsurumi-seiki, Japan	Bow (16m)

Table 3.1.1-2: Parameters of Mirai meteorological observation system

	Parameters	units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log
4	Ship's heading	degree	Mirai gyro
5	relative wind speed	m/s	6 sec. / 10 min. averaged
6	relative wind direction	degree	6 sec. / 10 min. averaged
7	True wind speed	m/s	6 sec. / 10 min. averaged
8	True wind direction	degree	6 sec. / 10 min. averaged
9	barometric pressure	hPa	adjusted to the sea surface level 6 sec. / 10 min. averaged
10	Air temperature (starboard side)	degC	6 sec. / 10 min. averaged
11	Air temperature (port side)	degC	6 sec. / 10 min. averaged
12	dewpoint temperature (stbd side)	degC	6 sec. / 10 min. averaged
13	dewpoint temperature (port side)	degC	6 sec. / 10 min. averaged
14	relative humidity (starboard side)	%	6 sec. / 10 min. averaged
15	relative humidity (port side)	%	6 sec. / 10 min. averaged
16	Rain rate (optical rain gauge)	mm/hr	6 sec. / 10 min. averaged
17	Rain rate (capacitive rain gauge)	mm/hr	6 sec. / 10 min. averaged
18	down welling shortwave radiometer	W/m^2	6 sec. / 10 min. averaged
19	down welling infra-red radiometer	W/m^2	6 sec. / 10 min. averaged
20	sea surface temperature	degC	-5m
21	significant wave height (fore)	m	3 hourly
22	significant wave height (aft)	m	3 hourly
23	significant wave period (fore)	second	3 hourly
24	significant wave period (aft)	second	3 hourly

(3-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system, designed by BNL (Brookhaven National Laboratory, USA), is consisted of 3 parts.

1. Portable Radiation Package (PRP) designed by BNL – short and long wave down welling radiation
2. Zeno meteorological system designed by BNL – wind, Tair/RH, pressure and rainfall measurement
3. Scientific Computer System (SCS) designed by NOAA (National Oceanographic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets

SCS recorded PRP data every 6.5 seconds, Zeno/met data every 10 seconds.

Instruments and their locations are listed in Table 3.1.1-3 and measured parameters are listed in Table 3.1.1-4

Table 3.1.1-3: Instrument installation locations of SOAR system

Sensors	type	manufacturer	location (altitude from the baseline)
Zeno/Met			
Anemometer	05106	R. M. Young, USA	foremast (31m)
T/RH	HMP45A	Vaisala, USA	foremast (30m)
	with 43408 Gill aspirated radiation shield (R. M. Young)		
Barometer	61201	R. M. Young, USA	foremast (30m)
	with 61002 Gill pressure port (R. M. Young)		
rain gauge	50202	R. M. Young, USA	foremast (30m)
Optical rain gauge	ORG-115DA	ScTi, USA	foremast (30m)
PRP			
radiometer (short wave)	PSP	Eppley labs, USA	foremast (31m)
radiometer (long wave)	PIR	Eppley labs, USA	foremast (31m)
fast rotating shadowband radiometer		Yankee, USA	foremast (31m)

Table 3.1.1-4: Parameters of SOAR System

	parameters	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 irradiation	W/m^2	

(3) Preliminary results

Wind (converted to U, V component, from SOAR), Tair (from SOAR) / SST (from EPCS), RH (from SOAR) / precipitation (from SOAR), solar radiation (from SOAR) and pressure (from Mirai/met) observed during the cruise are shown in Figure 3.1.1-1 and Figure 3.1.1-2. In the figures, accumulated precipitation data from SOAR capacitive rain gauge was converted to the precipitation amount in every minute and obvious noises were eliminated but not calibrated. Other figures are showing uncorrected data.

(4) Data archives

These raw data will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise.

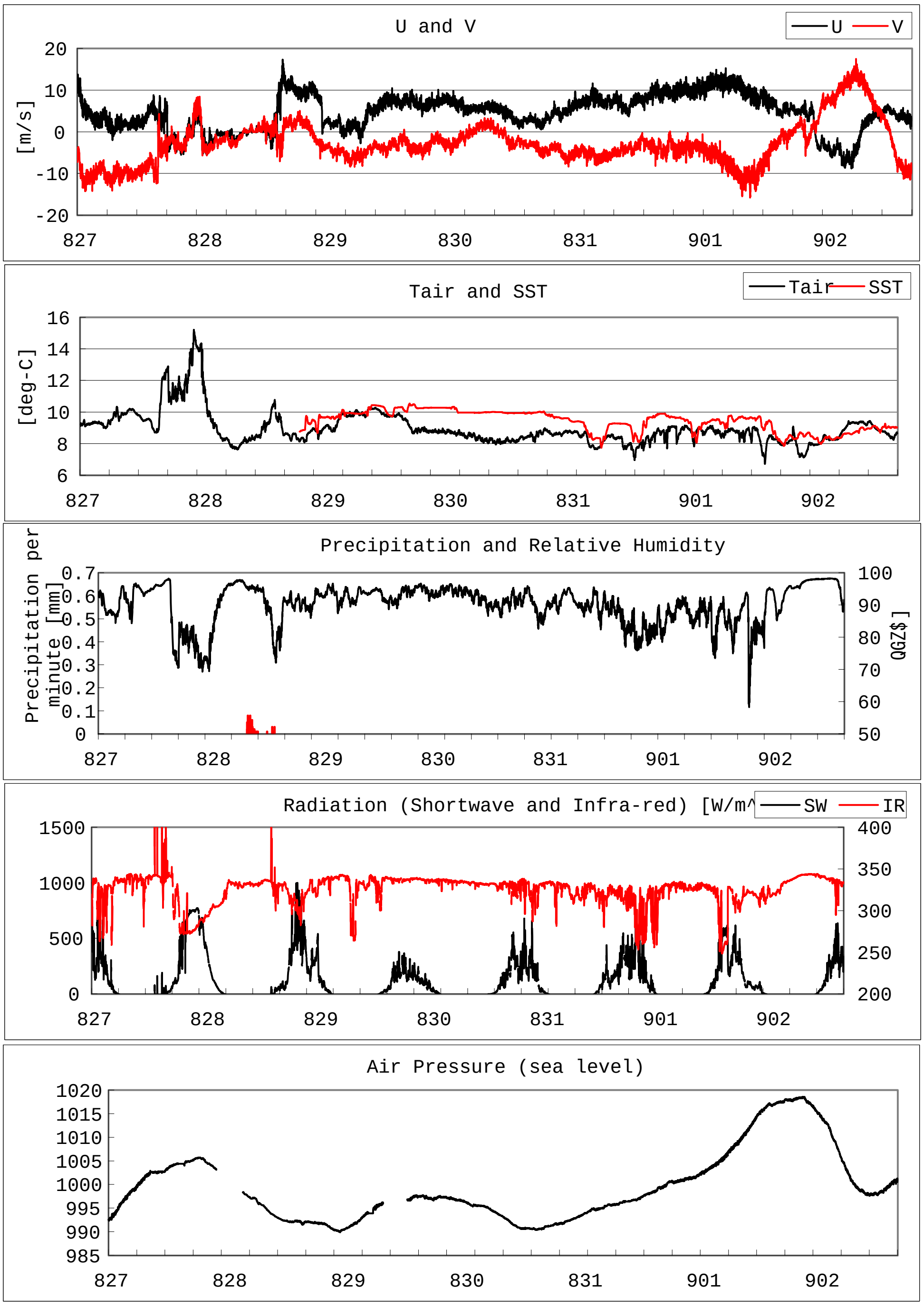


Figure 3.1.1-1: Time series of measured parameters

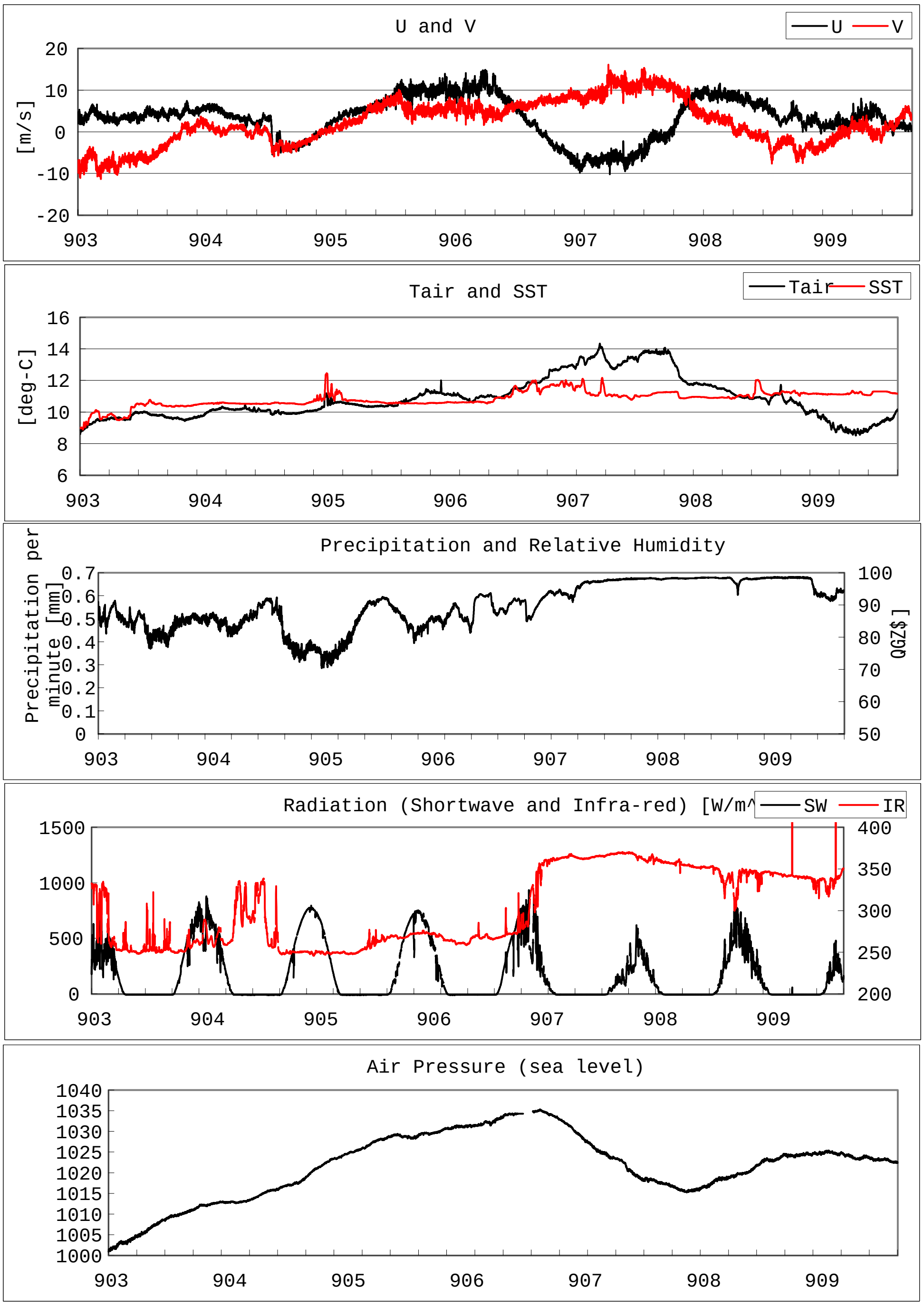


Figure 3.1.1-2 (continued)

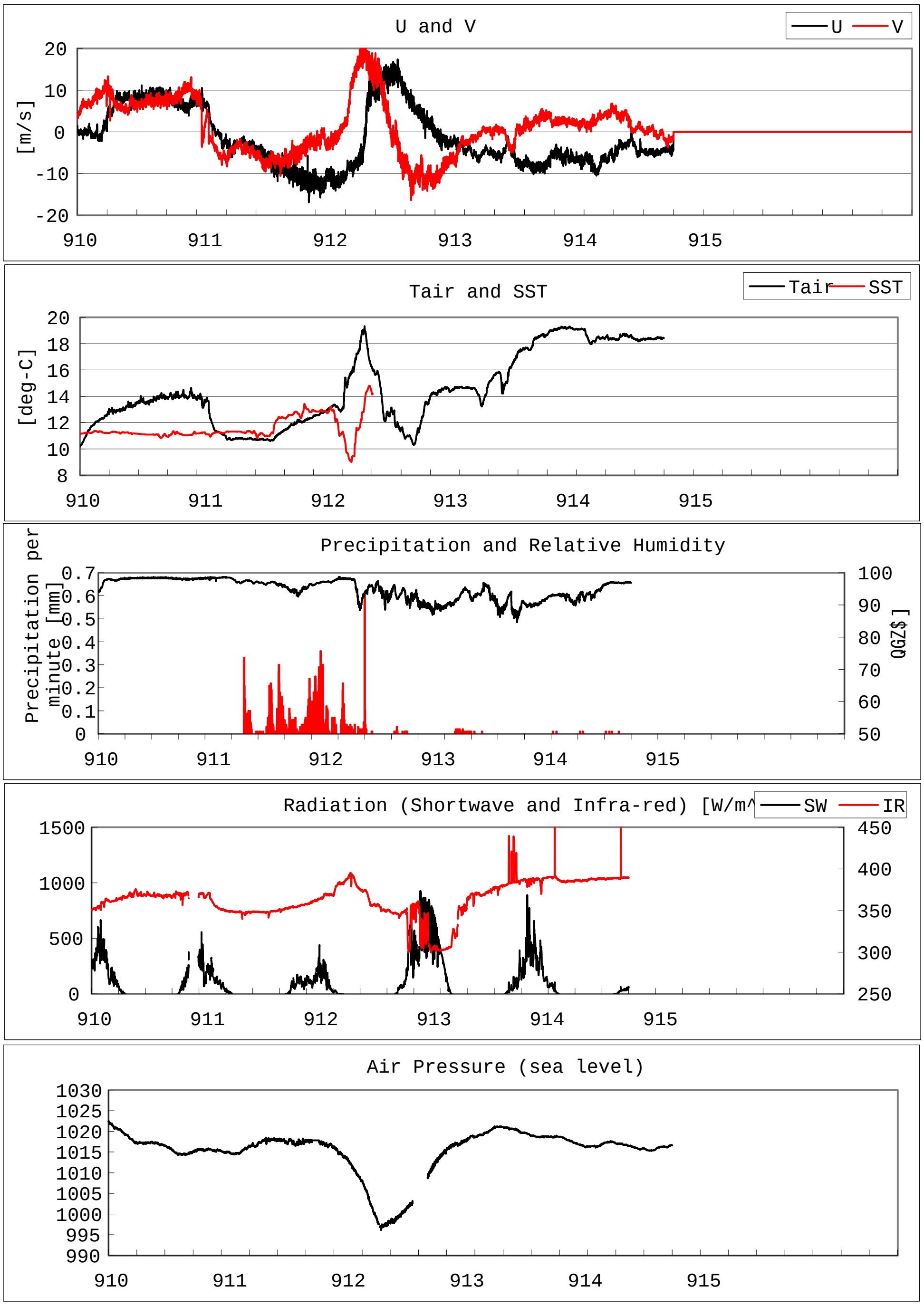


Figure 3.1.1-3 (continued)

3.1.2 Ceilometer Observations

Kunio Yoneyama (JAMSTEC):	(Shore-side participant)
Masaki Hanyu (GODI):	Operation Leader
Shinya Iwamida (GODI)	

(1) Objective

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

(2) Methods

We measured cloud base height and backscatter profiles using CT-25K ceilometer (Vaisala, Finland) throughout MR01-K04 Leg2 cruise from the departure of Dutch Harbor on 28th August to the arrival of Sekienehama on 15th September 2001.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode Laser
Transmitting wave length:	905 +/- 5 nm at 25 deg-C
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.

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

(3) Preliminary results

The first, second and third lowest cloud base height which the ceilometer detected during the cruise are plotted in Fig. 3.1.2-1. Sometimes the ceilometer records calculated vertical visibility and the height of detected highest signal instead of the cloud base height. But they are not plotted in the figure.

(4) Data archives

These raw data will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise.

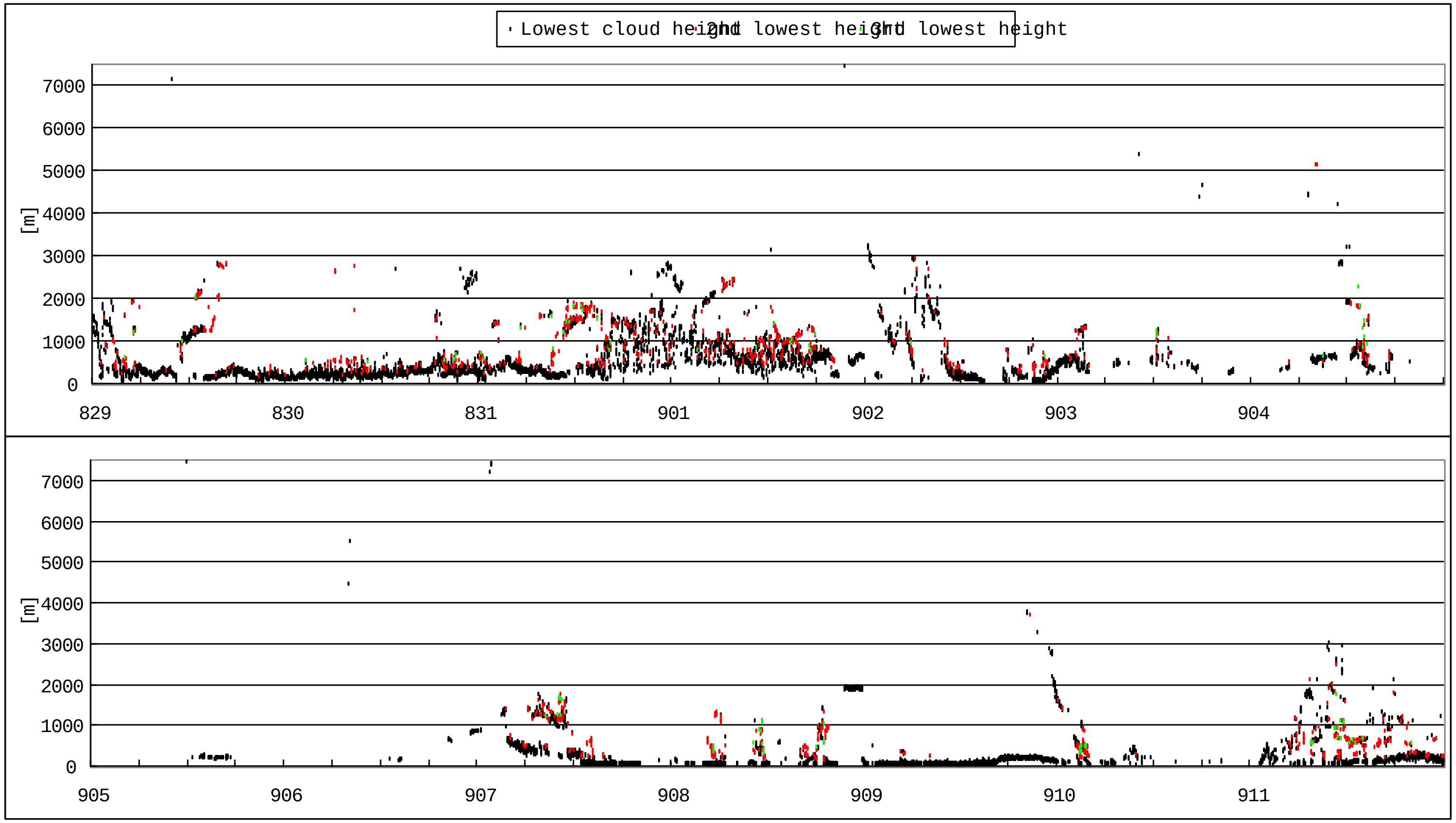


Figure 3.1.2-1: Variation of the cloud base height (29 Aug - 11 Sep, 2001)

3.2 Physical oceanographic observation

3.2.1 CTD cast and water sampling

Hiroshi Matsunaga (MWJ):Operation leader
Miki Yoshiike (MWJ)
Naoko Takahashi (MWJ)
Kenichi Katayama (MWJ)

(1) Objectives:

To investigate the oceanic structure.

(2) Measured parameters:

Temperature
Conductivity
Pressure
Dissolved Oxygen (below D.O.) concentration
Fluorescence
Light Transmission

(3) Methods:

We observed vertical profile of temperature and salinity by CTD/Carousel (Conductivity Temperature Depth profiler / Carousel Water Sampler). The sensors attached on CTD were temperature, conductivity, pressure, D.O., and Fluorometer, Transmissometer, altimeter sensors. Salinity was calculated by measurement values of pressure, conductivity and temperature. The CTD/Carousel was deployed using new a winch (DYNACON,Inc), which was installed in April-2001, from starboard on working deck. Descending rate and ascending rate were kept about 1.2 m/s respectively.

The CTD raw data was acquired in real time by using the SEASAVE utility from SEASOFT software (ver.4.249) provided by SBE and stored on the hard disk of an IBM personal computer.

Water samplings were made during up-cast by sending a fire command from the computer.

Total in 25 casts of CTD measurements have been carried out. (Show table 3.2.1-1)

The CTD raw data was processed using SEASOFT (ver.4.249). Data processing procedures and used utilities of SEASOFT were as follows:

SEASAVE: Acquire the data at 24Hz.
DATCNV: Converts the binary raw data to output on physical unit.
This utility selects the CTD data when bottles closed to output on another
File.
SECTION: Remove the unnecessary data.
ALIGNCTD: ALIGNCTD aligns oxygen measurements in time relative to pressure.
Oxygen sensor relative to pressure = 3.0 seconds
WILDEDIT: Obtain an accurate estimate of the true standard deviation of the data.
Std deviations for Pass 1:2
Std deviations for Pass 2:10

Points per block: 48

CELLTM: Remove to conductivity cell thermal mass effects from the measured conductivity.

Primary alpha = 0.03, 1/beta = 7.0

FILTER: Run a low-pass filter on one or more columns of data.

Filter A = 0.15sec

Variable to Filter: Pressure: Low Pass Filter A

LOOPEDIT: Marks scans bad by setting the flag value associatedwith the scan to bad flag in input.cnv files that have pressure slowdowns or reversals.

Minimum Velocity Selection = Fixed Minimum Velocity

Minimum CTD Velocity [m/sec] = 0.0

Exclude Scan Marked Bad in LOOPEDIT = Yes

DERIVE: Calculates oceanographic parameters from the input.cnv file.

BINAVG: Calculates the averaged data in every 1db or 1m.

SPLIT: Splits the data made in CNVfiles into upcast and downcast files.

ROSSUM: Edits the data of water sampled to output a summary file.

(4) Instruments:

Specifications of sensors are listed below.

- Under water unit: CTD 9plus (S/N 42423, Sea-bird Electronics, Inc.)
  Calibration Date: 24-May-1994
- Temperature Sensor: SBE3-04/F (S/N 031359, Sea-bird Electronics, Inc.)
  Calibration Date: 28-Jun-2001
- Conductivity Sensor: SBE4-04/0 (S/N 041202, Sea-bird Electronics, Inc.)
  Calibration Date: 04-Aug-2001
- D.O. sensor: SBE13-04 (S/N 130540, Sea-bird Electronics, Inc.)
  Calibration Date: 18-Jun-2001
- Altimeter: Datasonics PSA-900 (S/N 396, Datasonics, Inc.)
- Fluorometer: (S/N 2148, Seapoint Sensors, Inc.)
- C Star Transmissometer: (S/N CST-207RD, WET Labs, Inc.)
  Calibration Date: 19-May-1998
- Deck unit: SBE11 (S/N 11P7030-0272, Sea-bird Electronics, Inc.)
- Carousel water sampler: SBE32 (S/N3221746-0278, Sea-bird Electronics, Inc.)

(5) Results:

Cross sections of temperature and salinity, D.O., Fluorometer, Transmissometer on first cast from stn.AV01 to stn.AV09 are shown in the Fig 3.2.1-a. And time variations of the vertical profile (Stn.AV00,K-1,K-2) are shown in the Fig 3.2.1-b～Fig 3.2.1-e. Note that in these figures, the correction of salinity data by sampled water is not applied.

(6) Data archive:

All raw and processed CTD data file were copied into magnetic optional disk (MO) and submitted to JAMSTEC Data Management Office (DMO) and will be under their control.

Stn.	Date(UTC)	Time(UTC)		Start Position		Raw data file name	Cast	Depth	Altimeter	Max pressure	Remarks
	yy/mm/dd	Start	End	Latitude	Longitude						
AV00	2001/8/28	21:04	22:04	54-17.25N	166-40.74W	000S01.dat	test	966	-	814	
AV01	2001/8/29	02:10	02:38	55-00.14N	165-59.63W	001S01.dat	cast1,cast3	139	7.0	130	
AV01	2001/8/29	04:05	04:27	54-59.94N	166-00.01W	001S02.dat	cast2	140	5.2	132	
AV02	2001/8/29	09:10	09:40	55-29.97N	165-59.97W	002S01.dat	cast1,cast3	124	8.9	115	
AV03	2001/8/29	17:18	17:40	55-59.92N	166-00.14W	003S01.dat	cast2	117	7.3	107	
AV03	2001/8/29	18:42	19:01	55-59.87N	166-00.08W	003S02.dat	cast1,cast3	117	6.0	109	
AV04	2001/8/30	01:23	01:49	56-29.97N	165-59.75W	004S01.dat	cast1,cast3	89	9.5	78	
AV04	2001/8/30	03:10	03:31	56-30.00N	166-00.05W	004S02.dat	cast2	89	-	41	
AV05	2001/8/30	16:20	16:36	56-59.97N	166-00.05W	005S01.dat	cast1,cast3	75	6.0	66	
AV05	2001/8/30	18:01	18:08	56-59.92N	166-00.12W	005S02.dat	-	75	6.4	66	Not Sampling
AV05	2001/8/30	18:22	18:38	56-59.86N	166-00.51W	005S03.dat	cast2	74	6.0	66	
AV06	2001/8/30	21:16	21:32	57-29.85N	166-00.19W	006S01.dat	cast1,cast3	69	7.1	59	
AV06	2001/8/30	22:48	23:02	57-29.97N	166-00.48W	006S02.dat	cast2	69	-	41	
AV07	2001/8/31	05:16	05:39	57-59.97N	166-00.26W	007S01.dat	cast1,cast3	60	5.1	52	
AV07	2001/8/31	06:48	07:17	57-59.97N	166-00.07W	007S02.dat	cast2	60	4.7	52	
AV08	2001/8/31	10:13	10:37	58-30.01N	166-00.01W	008S01.dat	cast1,cast3	47	6.3	39	
AV09	2001/8/31	14:18	14:31	58-59.91N	165-59.89W	009S01.dat	cast1,cast3	30	5.3	25	
AV09	2001/8/31	15:39	15:49	58-59.97N	165-59.83W	009S02.dat	cast2	30	5.2	25	
K-1	2001/9/3-4	22:18	02:11	51-17.93N	165-18.05E	K01S01.dat	Hydrocast1	5148	9.5	5233	Survey with Altimeter
K-1	2001/9/4	05:48	09:17	51-17.93N	165-09.64E	K01S02.dat	Hydrocast2	5137	6.3	5232	Survey with Altimeter
K-1	2001/9/5	05:54	09:15	51-20.17N	165-12.15E	K01S03.dat	Hydrocast3	5142	7.1	5240	Survey with Altimeter
K-2	2001/9/7	19:20	23:11	46-51.99N	159-58.83E	K02S01.dat	Hydrocast1	5165	11.5	5249	Survey with Altimeter
K-2	2001/9/8	03:19	07:15	46-56.18N	159-59.03E	K02S02.dat	Hydrocast2	5177	19.6	5265	Survey with Altimeter
K-2	2001/9/9	03:27	07:49	47-00.68N	159-58.27E	K02S03.dat	Hydrocast3	5211	10.1	5306	Survey with Altimeter
K-2	2001/9/10	11:08	14:30	46-52.38N	159-51.93E	K02S04.dat	Hydrocast4	5146	9.2	5242	

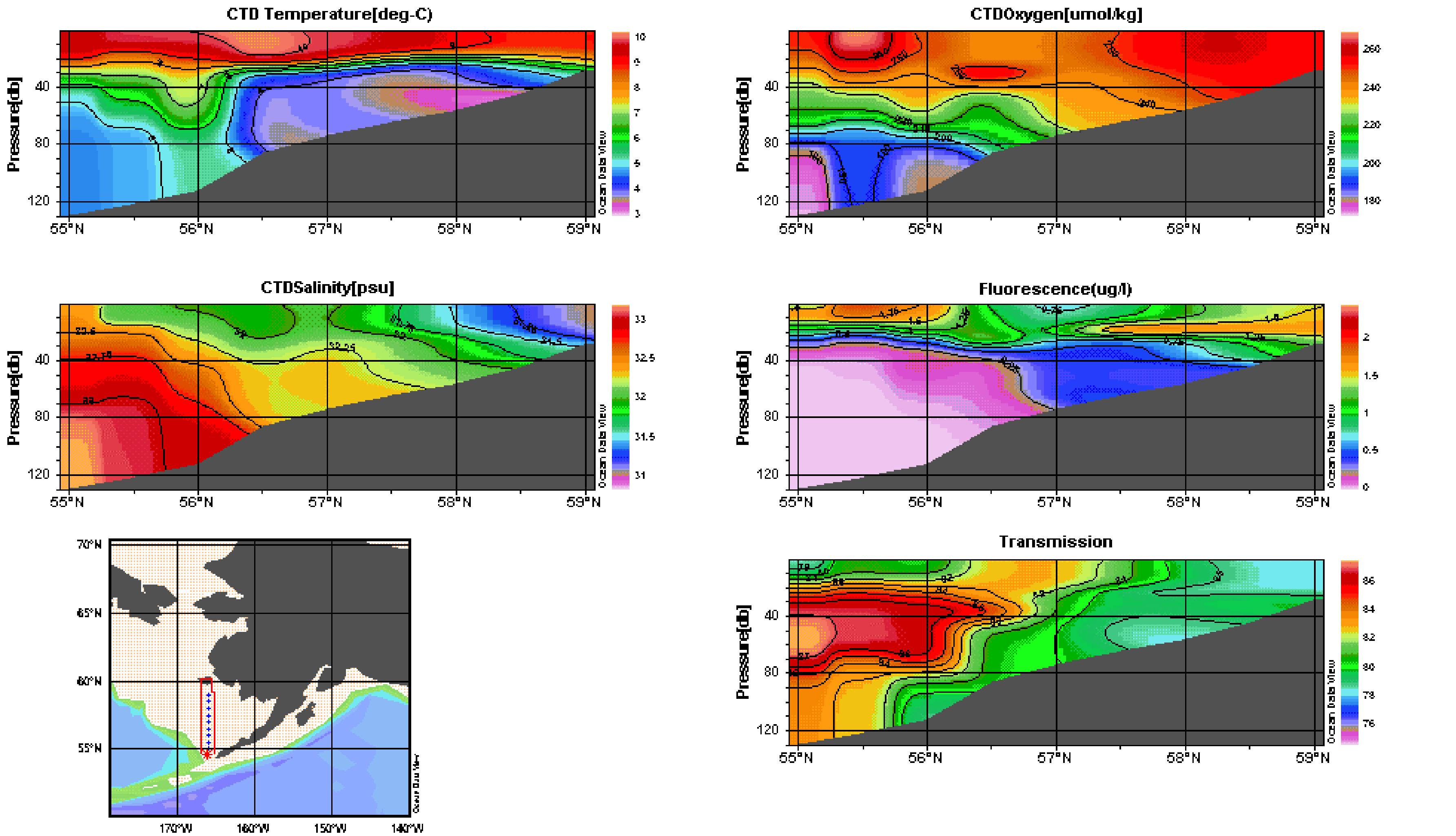
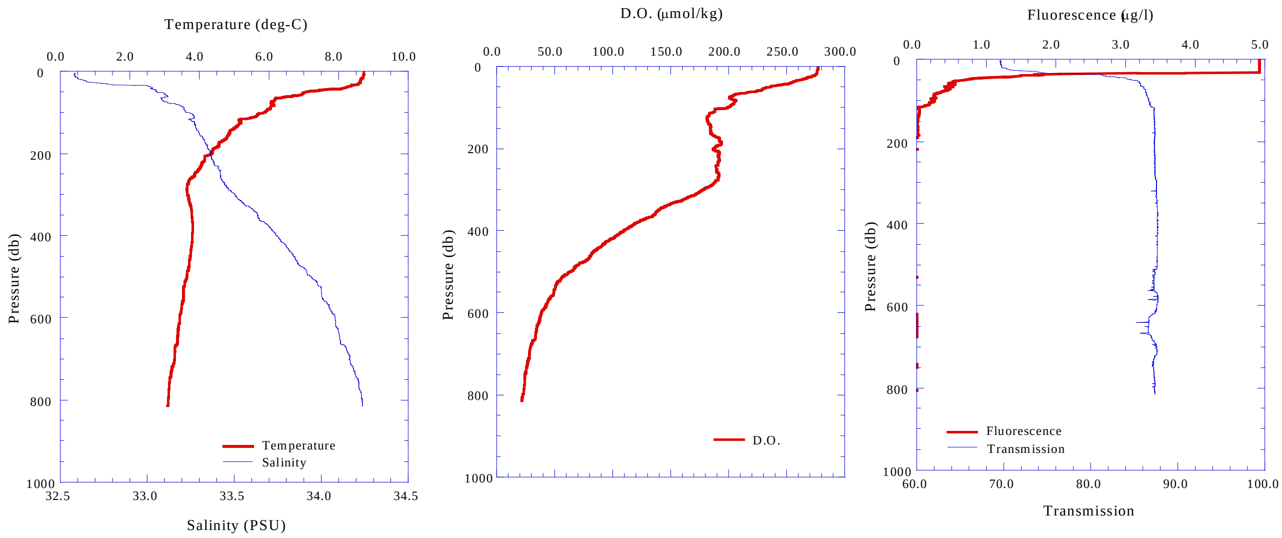

CTD Temperature[deg-C)
CTDOxygen[umol/kg]
CTDSalinity[psu]
Fluorescence(ug/l)
Transmission
Pressure[db]
55°N
56°N
57°N
58°N
59°N
170°W
160°W
150°W
140°W
70°N
65°N
60°N
55°N
Ocean Data View

Fig.3.2.1-a

Stn.AV00



Stn.K-1(cast1)

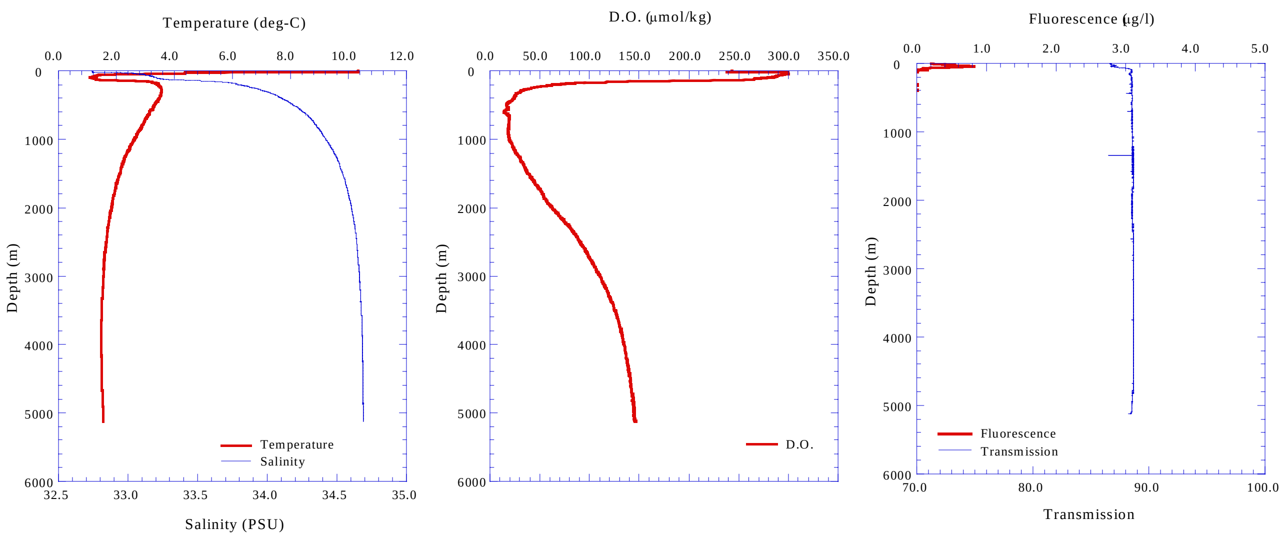
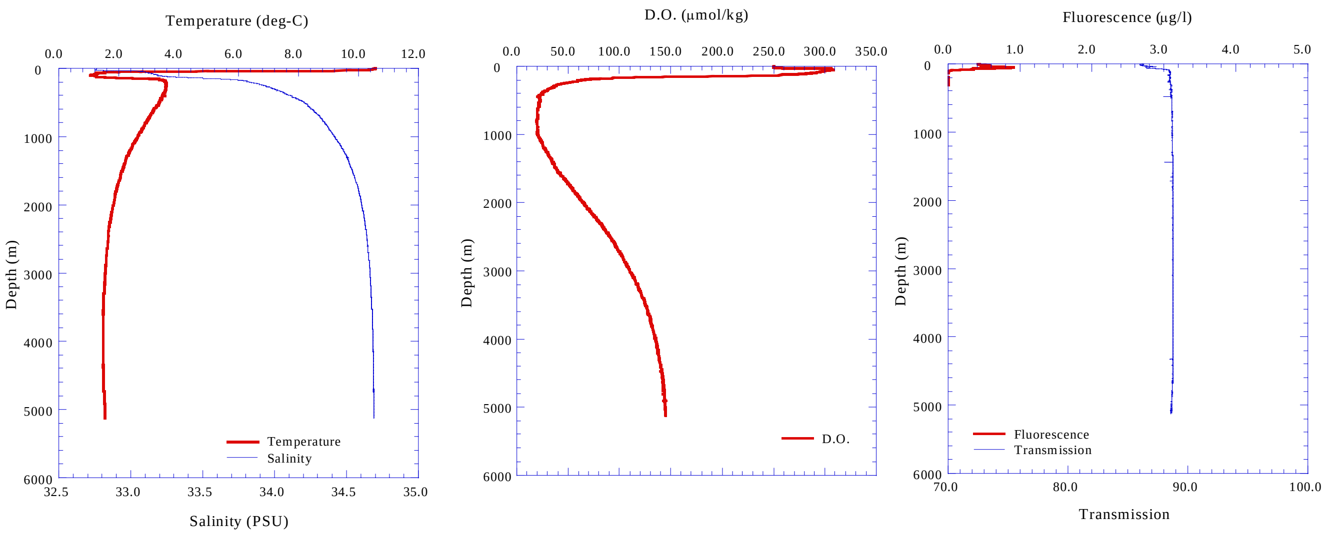


Fig.3.2.1-b

3.2.1,6

Stn.K-1(cast2)



Stn.K-1(cast3)

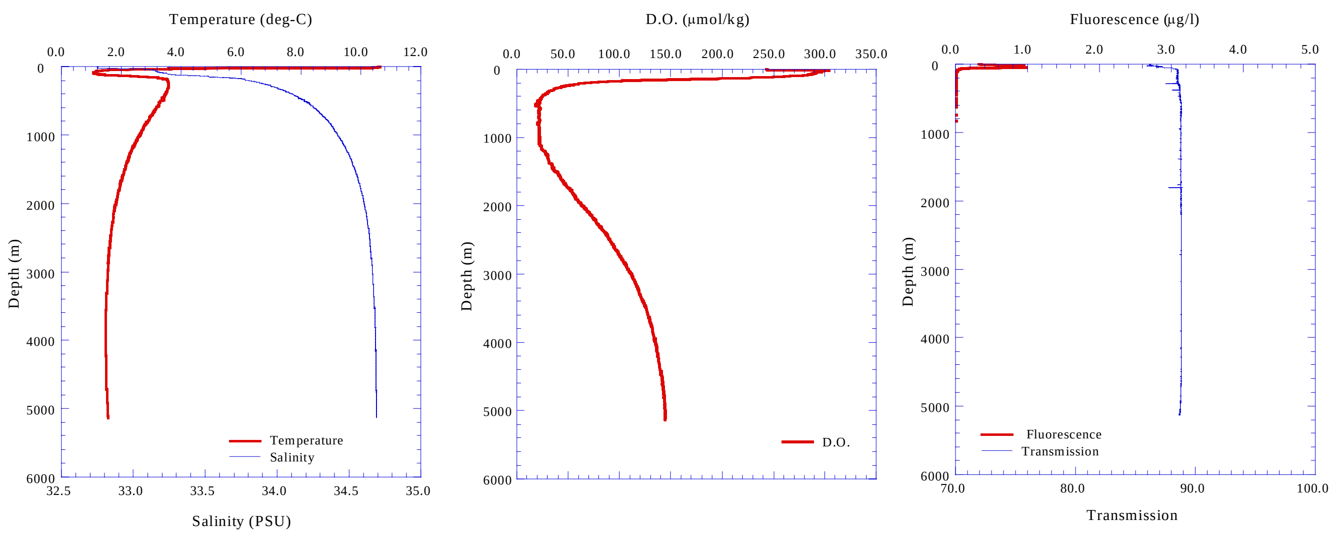
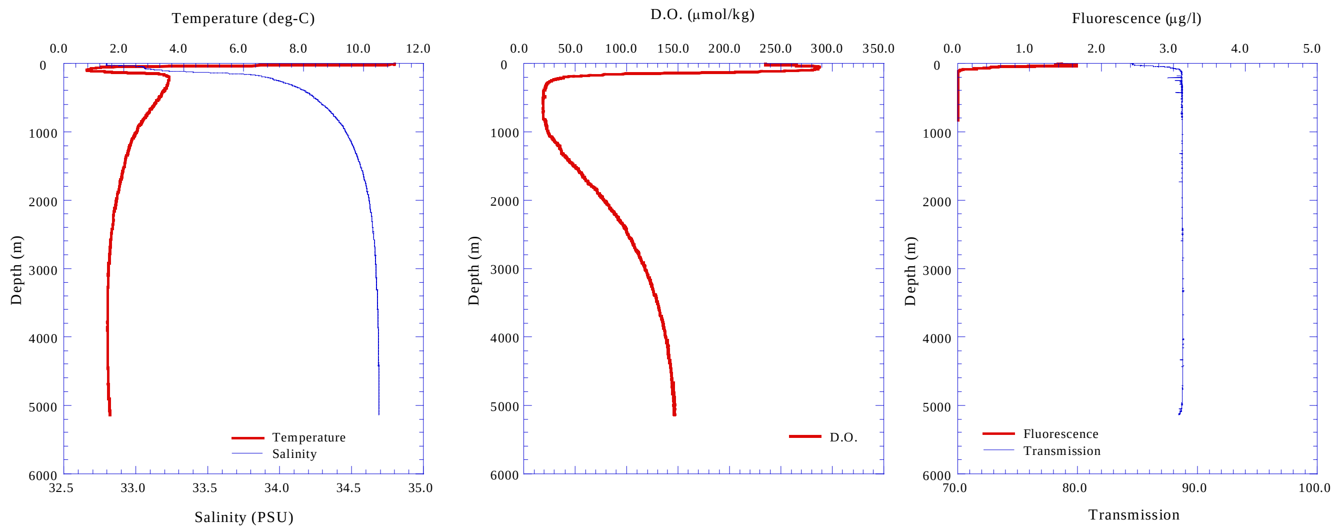


Fig.3.2.1-c

3.2.1,7

Stn.K-2(cast1)



Stn.K-2(cast2)

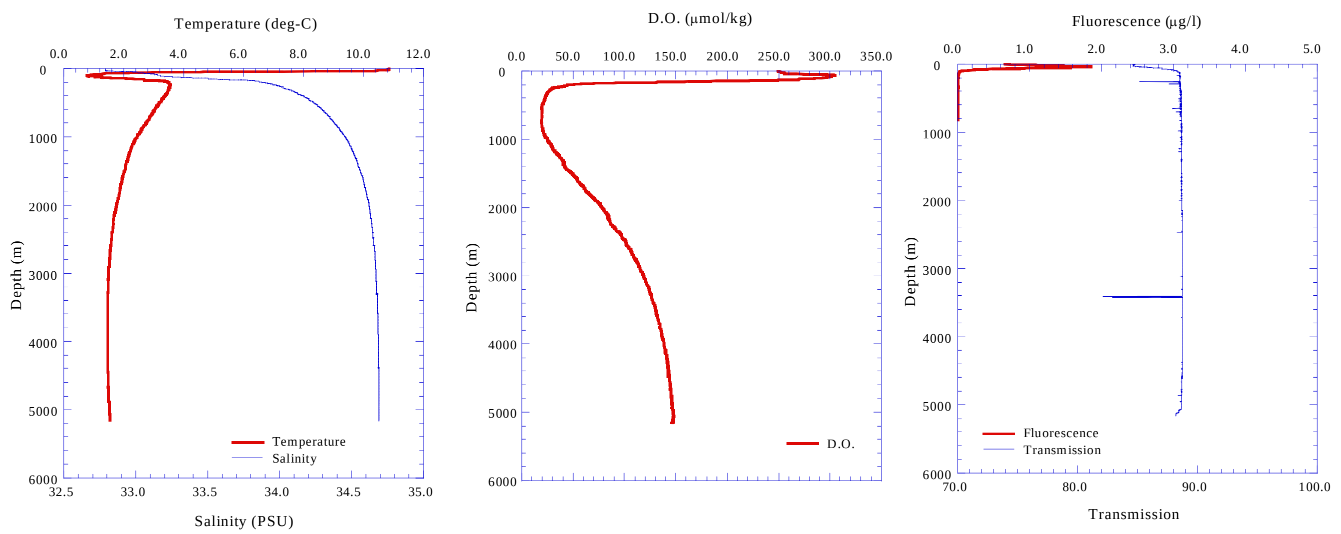
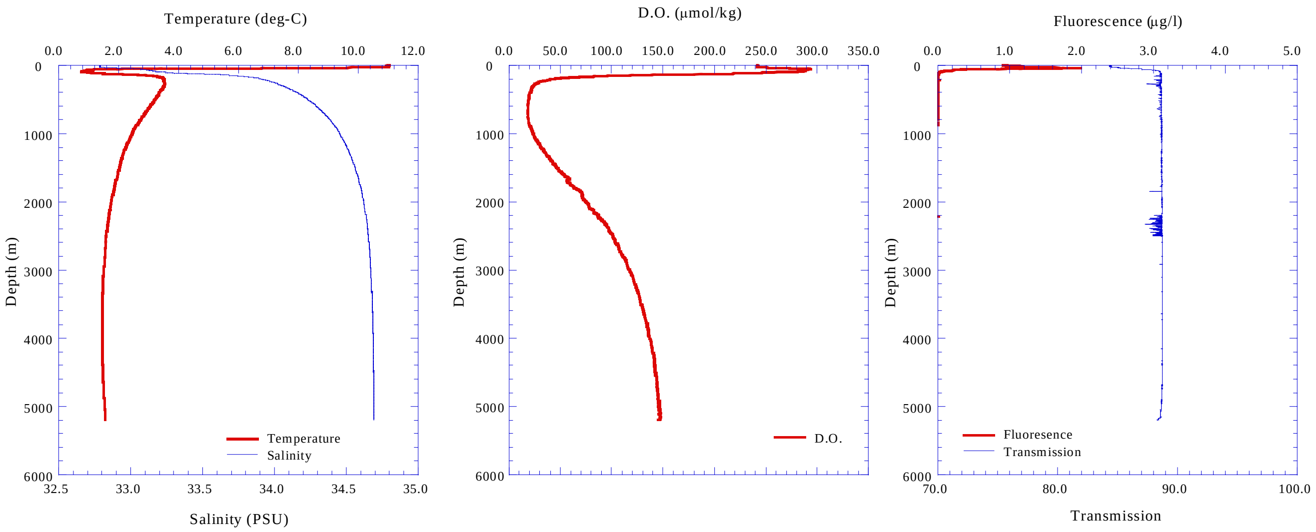


Fig.3.2.1-d

3.2.1,8

Stn.K-2(cast3)



Stn.K-2(cast4)

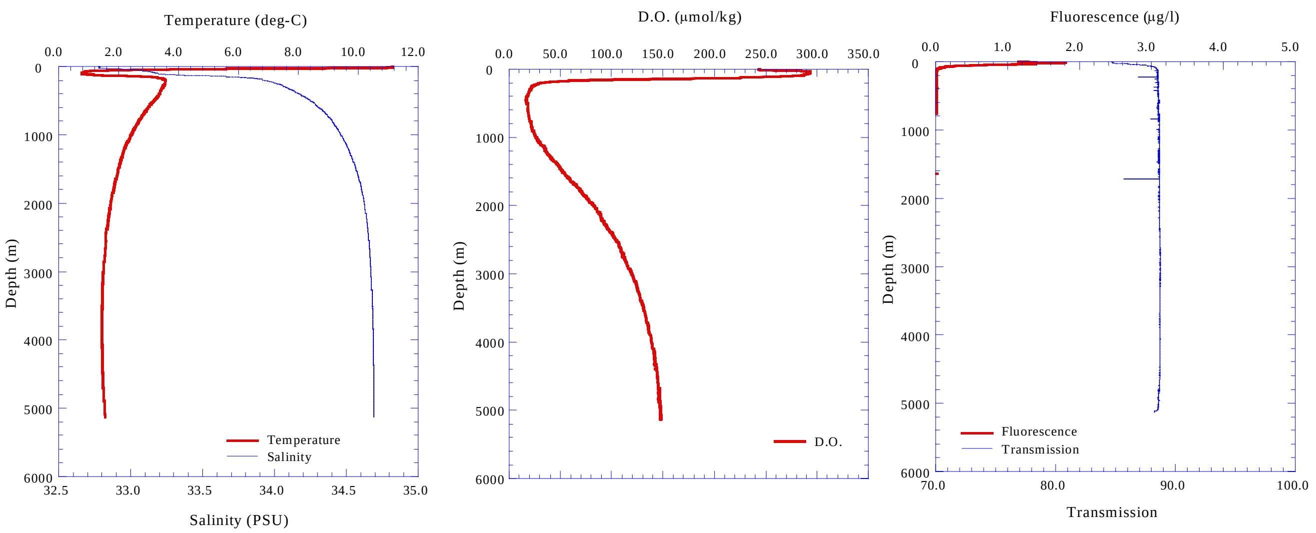


Fig.3.2.1-e

3.2.1,9

3.2.2 Salinity

Hiroshi Matsunaga (MWJ)
Miki Yoshiike (MWJ)
Kenichi Katamaya (MWJ)
Naoko Takahashi (MWJ)

(1) Objectives

To calibrate the salinity obtained by CTD.

(2) Measured Parameters

Salinity of sampled water

(3) Method

Seawater samples were collected with 12 liter NiskinX bottle. The salinity sample bottle of the 250 ml brown grass bottle with screw cap was used to collect the sample water.

After rinsed three times with the sample water, the bottle 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 salinity was measured by a Guildline Autosal salinometer (model 8400B), attached with an Ocean Science International peristaltic-type sample intake pump. A double conductivity ratio was defined as median of 31 times reading of the salinometer. Data collection started 5 seconds and it took about 10 seconds to collect 31 times reading by a personal computer.

The instrument was operated in the Autosal Room with a bath temperature 24ºC.

The salinometer was standardized before and after sequence of measurement by the IAPSO Standard Seawater batch P139 (conductivity ratio was 0.99993, salinity was 34.997).

We also used sub-standard seawater. It was measured every 8 samples in older to check the drift of the salinometer.

(4) Results

The results are shown in *Table3.2.2-Ⅰ* and *Table3.2.2-Ⅱ*.

(5) Data archive

The data of sample measured and worksheets of calculation of salinity concentration were stored on Floppy Disk. The data of sample will be submitted to JAMSTEC Data Management Office (DMO).

Table3.2.2-Ⅰ Salinity comparison between CTD and Autosal(Stn.AV)

Stn.No	Niskin.No	Bottle.No	Pressure(dbr)	Sal(CTD)	Sal(Autosal)	Difference	Duplicate Dif.
AV00	1	1	800.973	34.23570	34.22902	0.00669	
	1	2	800.973	34.23570	34.22882	0.00688	0.00019
AV01	-	3	SURFACE	-	32.43147		
	1	4	129.427	33.19270	33.19165	0.00105	
	1	5	129.427	33.19270	33.19165	0.00105	0.00000
	3	7	109.117	33.18730	33.18560	0.00170	
	4	8	99.559	33.18120	33.17956	0.00164	
	5	9	75.387	33.02670	33.11029	-0.08358	
	6	10	49.622	32.81300	32.81502	-0.00202	
	7	11	40.156	32.74070	32.74607	-0.00537	
	8	12	29.964	32.50380	32.53806	-0.03426	
	9	13	20.326	32.47670	32.49079	-0.01409	
	10	14	9.545	32.44090	32.46930	-0.02840	
	11	15	4.876	32.43530	32.44314	-0.00784	
	12	16	17.058	32.47680	32.48379	-0.00699	
AV02	-	18	SURFACE	-	32.04181		
	1	19	113.924	33.07530	33.07439	0.00091	
	1	20	113.924	33.07530	33.07449	0.00081	0.00010
	2	21	109.567	33.07300	33.07254	0.00046	
	3	22	100.455	33.06620	33.06503	0.00118	
	4	23	75.887	33.05950	33.05898	0.00053	
	5	24	59.971	32.94610	32.90661	0.03950	
	6	25	50.751	32.86920	32.86461	0.00460	
	7	26	39.253	32.85450	32.80918	0.04532	
	8	27	31.252	32.68480	32.68112	0.00368	
	9	28	21.269	32.58010	32.58117	-0.00106	
	10	29	10.361	32.04150	32.14754	-0.10603	
	11	30	5.639	32.03940	32.04084	-0.00144	
	12	31	14.459	32.30970	32.47533	-0.16562	
AV03	-	32	SURFACE	-	31.97136		
	1	33	107.451	32.91500	32.91655	-0.00155	
	1	34	107.451	32.91500	32.91616	-0.00116	0.00039
	3	36	100.607	32.91570	32.91538	0.00033	
	4	37	75.432	32.91050	32.91021	0.00029	
	5	38	60.498	32.72200	32.72922	-0.00721	
	6	39	49.293	32.64250	32.64141	0.00109	
	7	40	40.814	32.46550	32.47581	-0.01031	
	8	41	29.573	32.32320	32.33183	-0.00862	
	9	42	19.906	32.10090	32.12142	-0.02051	

	10	43	9.536	31.99180	32.02046	-0.02866	
	11	44	4.747	31.98620	31.99115	-0.00495	
	12	45	18.066	32.07490	32.09860	-0.02370	
	12	46	18.066	32.07490	32.09859	-0.02369	0.00001
AV04	-	47	SURFACE	-	31.91538		
	1	48	76.978	32.25030	32.25166	-0.00136	
	1	49	76.978	32.25030	32.25282	-0.00252	0.00116
	2	50	75.836	32.25130	32.25292	-0.00162	
	3	51	59.996	32.24760	32.25409	-0.00649	
	4	52	51.003	32.25400	32.25438	-0.00038	
	5	53	41.377	32.17890	32.18948	-0.01058	
	6	54	34.419	32.08200	32.09462	-0.01262	
	7	55	30.666	32.03330	32.05162	-0.01832	
	8	56	20.296	31.92030	31.91956	0.00074	
	9	57	10.029	31.91590	31.91645	-0.00055	
	10	58	4.216	31.91620	31.91665	-0.00045	
	12	59	25.359	31.92070	31.93935	-0.01865	
AV05	-	60	SURFACE	-	32.09773		
	1	61	65.962	32.32120	32.32376	-0.00256	
	1	62	65.962	32.32120	32.32425	-0.00305	0.00049
	4	65	60.216	31.28420	32.32317	-1.03897	
	5	66	50.01	32.01300	32.32405	-0.31105	
	6	67	40.04	31.72510	32.32347	-0.59836	
	7	68	35.243	32.01360	32.32405	-0.31045	
	8	69	29.941	32.06280	32.32376	-0.26096	
	9	70	20.213	32.07200	32.13656	-0.06456	
	10	71	9.984	32.08720	32.09501	-0.00780	
	11	72	4.847	32.08700	32.09394	-0.00694	
	12	73	14.628	32.08860	32.09423	-0.00563	
	12	74	14.628	32.08860	32.09375	-0.00514	0.00048
AV06	-	75	SURFACE	-	31.88464		
	1	76	58.932	32.27620	32.27682	-0.00062	
	1	77	58.932	32.27620	32.27731	-0.00111	0.00049
	5	78	50.296	32.27700	32.27663	0.00038	
	6	79	40	32.27680	32.27682	-0.00002	
	7	80	30.307	32.27690	32.27643	0.00047	
	8	81	20.24	31.91190	32.26070	-0.34879	
	9	82	9.881	31.89040	31.92790	-0.03749	
	10	83	4.799	31.88980	31.89841	-0.00860	
	12	84	23.328	32.27630	32.27653	-0.00023	
AV07	-	85	SURFACE	-	31.48583		
	1	86	51.811	31.99230	31.99329	-0.00099	
	1	87	51.811	31.99230	31.99271	-0.00041	0.00058

	6	92	50.415	31.99320	31.99300	0.00020	
	7	93	40.302	31.99310	31.99281	0.00030	
	8	94	30.289	31.99370	31.99261	0.00109	
	9	95	20.26	31.84010	31.95836	-0.11825	
	10	96	10.324	31.49230	31.55282	-0.06052	
	11	97	4.917	31.49430	31.50006	-0.00576	
	12	98	18.079	31.56320	31.87475	-0.31154	
AV08	-	99	SURFACE	-	31.28167		
	1	100	38.304	31.45770	31.45775	-0.00005	
	1	101	38.304	31.45770	31.45775	-0.00005	0.00000
	3	102	29.926	31.45540	31.45591	-0.00051	
	5	103	20.257	31.44990	31.45291	-0.00301	
	7	104	10.491	31.26600	31.26629	-0.00029	
	9	105	5.302	31.26510	31.26504	0.00007	
AV09	-	106	SURFACE	-	30.84318		
	1	107	24.802	30.87710	30.86316	0.01394	
	1	108	24.802	30.87710	30.86267	0.01443	0.00048
	3	110	19.954	30.87080	30.87223	-0.00143	
	4	111	9.88	30.84570	30.84838	-0.00268	
	5	112	4.952	30.84820	30.84636	0.00184	

Table3.2.2- Ⅱ Salinity comparison between CTD and Autosal(Stn.K)

Stn.No	Niskin.No	Bottle.No	Depth(m)	Sal(CTD)	Sal(Autosal)	Difference	Duplicate Dif.
K-1	-	120	SURFACE	-	32.74811		
	10	150	10.0470	32.74750	32.74577	0.00173	
	11	149	30.2760	33.00590	32.97903	0.02687	
	12	148	49.8570	33.08660	33.08444	0.00216	
	13	147	75.1320	33.16560	33.16580	-0.00020	
	14	146	100.1890	33.18560	33.19234	-0.00673	
	15	145	151.7830	33.49770	33.51783	-0.02013	
	16	144	197.7630	33.79410	33.80095	-0.00684	
	17	143	297.6410	33.99180	33.98862	0.00318	
	18	142	502.0390	34.18720	34.18490	0.00230	
	19	141	749.5430	34.32920	34.34446	-0.01525	
	20	140	1001.5720	34.42370	34.42354	0.00016	0.00019
	20	139	1001.5720	34.42370	34.42335	0.00035	
	21	138	1249.1400	34.49620	34.49196	0.00424	
	22	137	1497.4090	34.54410	34.55205	-0.00795	
	23	136	1999.4890	34.60800	34.60636	0.00164	0.00030
	23	135	1999.4890	34.60800	34.60606	0.00194	
	24	134	2400.1220	34.63780	34.63563	0.00217	
	25	133	2799.2210	34.65640	34.65390	0.00250	
	26	132	3200.4070	34.66990	34.66805	0.00185	0.00010
	26	131	3200.4070	34.66990	34.66795	0.00195	
	27	130	3601.6470	34.67830	34.67601	0.00229	
	28	129	4002.0640	34.68370	34.68171	0.00180	0.00020
	28	128	4002.0640	34.68370	34.68191	0.00199	
	29	127	4400.2070	34.68710	34.68564	0.00146	
	30	126	4600.9620	34.68870	34.69193	-0.00323	
	31	125	4899.9400	34.69040	34.68898	0.00142	
	32	124	4999.1960	34.69080	34.68770	0.00310	0.00020
	32	123	4999.1960	34.69080	34.68750	0.00330	
	33	121	5100.8480	34.69130	34.68986	0.00144	
K-2	-	161	SURFACE	-	32.80041		
	1	162	5.0020	32.80340	32.80168	0.00173	
	2	163	10.0530	32.80350	32.80655	-0.00305	
	3	164	19.4840	32.80210	32.80528	-0.00318	
	4	165	30.4020	32.82240	32.90631	-0.08391	
	5	166	39.6690	33.01550	33.00632	0.00918	
	6	167	51.3360	33.03320	33.04601	-0.01281	
	7	168	74.4300	33.07700	33.07790	-0.00090	
	8	169	100.5080	33.17360	33.18902	-0.01541	

9	170	151.9590	33.71850	33.72600	-0.00750	
10	171	199.2290	33.90170	33.90578	-0.00408	
11	172	298.8260	34.05910	34.05798	0.00112	
12	173	500.2490	34.25090	34.25157	-0.00066	
13	174	749.7600	34.37210	34.37124	0.00087	
14	175	999.7110	34.45700	34.45632	0.00068	
14	176	999.7110	34.45700	34.45632	0.00068	0.00000
15	177	1252.8210	34.51800	34.51758	0.00042	
16	178	1501.7910	34.56240	34.56128	0.00113	
17	179	1999.4150	34.62160	34.61982	0.00178	
17	180	1999.4150	34.62160	34.61991	0.00169	0.00009
18	181	2401.9270	34.64860	34.65007	-0.00147	
19	182	2798.8960	34.66440	34.66079	0.00361	
20	183	3198.9930	34.67500	Bad sample		
20	184	3198.9930	34.67500	34.67346	0.00154	
21	185	3599.0610	34.68220	34.68151	0.00069	
22	186	3999.8320	34.68710	34.68633	0.00077	
22	187	3999.8320	34.68710	34.68701	0.00009	0.00068
23	188	4398.6010	34.69000	34.68396	0.00604	
24	189	4598.6440	34.69100	34.68888	0.00212	
25	190	4897.9080	34.69190	34.69104	0.00086	
26	191	4998.3770	34.69210	34.69104	0.00106	
26	192	4998.3770	34.69210	34.69458	-0.00248	0.00354
27	193	5096.9870	34.69240	34.69143	0.00097	

3.2.3 Shipboard ADCP Observation

Masaki Hanyu (GODI): Operation Leader
Shinya Iwamida (GODI)

(1) Objective

The ocean current profiles are measured for the use of large fields of oceanography, as the basic dataset.

(2) Methods

We measured current profiles by VM-75 (RD Instruments Inc. U.S.A.) shipboard ADCP (Acoustic Doppler Current Profiler) throughout MR01-K04 Leg2 cruise from departure of Dutch Harbor on 28th August to the arrival of Sekienehama on 15th September 2001. The E-W (East-West) and N-S (North-South) velocity components of each depth cell [cm/s], and echo intensity of each cell [dB] are measured.

Major parameters are as follows;

Frequency:	75kHz
Averaging:	every 300 sec.
Depth cell length:	800cm
Number of depth cells:	80
Ping per ADCP raw data:	60

Direct command settings for the measurement are as follows;

(3-1) 1610UTC 28th August to 0129UTC 29th August 2001

Bottom track:

BAnnn	N/A
BCnnn	N/A
BDnnn	N/A
BEnnnn	N/A
BFnnnnn	N/A
BGnnn	N/A
BKn	N/A
BLmmm,nnnn,ffff	N/A
BMn	N/A
BPnnn	BP000
BRn	N/A
BXnnnn	N/A
BZnnn	N/A

Control:

CBnnn	default (411)
CFnnnnn	default (11010)
CGn	default (0)
CLn	default (1)
CPnnn	default (255)
CQnnn	default (8)
CTn	default (0)
CXn	default (0)

Environmental sensor:

EA+/-nnnnn	EA4500
EB+/-nnnnn	default (+0)
ECnnnn	default (1500)

EDnnnn	ED0065
EHnnnnn	default (0)
EP+/-nnnn	default (+0)
ER+/-nnnn	default (+0)
ESnn	ES35
ET+/-nnnn	default (+2500)
EXnnnnn	EX11000
EZnnnnnnn	EZ1020001

Performance and testing:

PDnnn	default (0)
PInnnnnn	default (011111)

Speed log:

SDa...r	SD1111111111111111

Timing:

TEhhmmssff	default (00000000)
TPmmssff	TP000200

Water-track:

WAnnn	default (255)
WBn	default (0)
WCnnn	default (64)
WDnnn nnn nnn	WD111111111
WEnnnn	WE5000
WFnnnn	WF800
WGnnn	WG001
WHnnn nnn nnn	default (111 100 000)
WIn	default (0)
WJn	default (1)
WLsss,eee	default (0,5)
WMn	WM1
WNnnn	WN080
WPnnnnn	WP00060
WQn	default (0)
WRnnn	default (12)
WSnnnn	WS0800
WTnnn	default (0)
WVnnn	WV999
WWnnn	default (4)
WXnnn	default (999)
WZnnn	default (10)

(3-2) 0237UTC 29th August to 0223UTC 30th August 2001

Bottom track:

BAnnn	default (30)
BCnnn	default (245)
BDnnn	default (0)
BEnnnn	default (1000)
BFnnnnn	default (0)
BGnnn	default (25)
BKn	default (0)
BLmmm,nnnn,ffff	default (640,1280,1920)
BMn	default (5)
BPnnn	BP060

BRn	default (0)
BXnnnn	default (9999)
BZnnn	default (5)
Control:	
CBnnn	default (411)
CFnnnnn	default (11010)
CGn	default (0)
CLn	default (1)
CPnnn	default (255)
CQnnn	default (8)
CTn	default (0)
CXn	default (0)
Environmental sensor:	
EA+/-nnnnn	EA4500
EB+/-nnnnn	default (+0)
ECnnnn	default (1500)
EDnnnn	ED0065
EHnnnnn	default (0)
EP+/-nnnn	default (+0)
ER+/-nnnn	default (+0)
ESnn	ES35
ET+/-nnnn	default (+2500)
EXnnnnn	EX11000
EZnnnnnnn	EZ1020001
Performance and testing:	
PDnnn	default (0)
PInnnnnn	default (011111)
Speed log:	
SDa...r	SD11111111111111111
Timing:	
TEhhmmssff	default (00000000)
TPmmssff	TP000200
Water-track:	
WAnnn	default (255)
WBn	default (0)
WCnnn	default (64)
WDnnn nnn nnn	WD111111111
WEnnnn	WE5000
WFnnnn	WF800
WGnnn	WG001
WHnnn nnn nnn	default (111 100 000)
WIn	default (0)
WJn	default (1)
WLsss,eee	default (0,5)
WMn	WM1
WNnnn	WN080
WPnnnnn	WP00060
WQn	default (0)
WRnnn	default (12)
WSnnnn	WS0800
WTnnn	default (0)
WVnnn	WV999

WWnnn	default (4)
WXnnn	default (999)
WZnnn	default (10)

(3-3) 0251UTC 30th August to the end of measurement

Bottom track:

BAnnn	default (30)
BCnnn	default (245)
BDnnn	default (0)
BEnnnn	default (1000)
BFnnnnn	default (0)
BGnnn	default (25)
BKn	default (0)
BLmmm,nnnn,ffff	default (640,1280,1920)
BMn	default (5)
BPnnn	BP010
BRn	default (0)
BXnnnn	default (9999)
BZnnn	default (5)

Control:

CBnnn	default (411)
CFnnnnn	default (11010)
CGn	default (0)
CLn	default (1)
CPnnn	default (255)
CQnnn	default (8)
CTn	default (0)
CXn	default (0)

Environmental sensor:

EA+/-nnnnn	EA4500
EB+/-nnnnn	default (+0)
ECnnnn	default (1500)
EDnnnn	ED0065
EHnnnnn	default (0)
EP+/-nnnn	default (+0)
ER+/-nnnn	default (+0)
ESnn	ES35
ET+/-nnnn	default (+2500)
EXnnnnn	EX11000
EZnnnnnnn	EZ1020001

Performance and testing:

PDnnn	default (0)
PInnnnnn	default (011111)

Speed log:

SDa...r	SD1111111111111111

Timing:

TEhhmmssff	default (00000000)
TPmmssff	TP000200

Water-track:

WAnnn	default (255)
WBn	default (0)
WCnnn	default (64)

WDnnn nnn nnn	WD111111111
WEnnnn	WE5000
WFnnnn	WF800
WGnnn	WG001
WHnnn nnn nnn	default (111 100 000)
WIn	default (0)
WJn	default (1)
WLsss,eee	default (0,5)
WMn	WM1
WNnnn	WN080
WPnnnnn	WP00050
WQn	default (0)
WRnnn	default (12)
WSnnnn	WS0800
WTnnn	default (0)
WVnnn	WV999
WWnnn	default (4)
WXnnn	default (999)
WZnnn	default (10)

(3) Preliminary results

2-hourly current vectors of 2-hour running mean averaged data are plotted along ship's track of 30.85m layer in Figure 3.1.3-1. This plot comes from uncorrected data.

(4) Data archives

These raw data will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise.

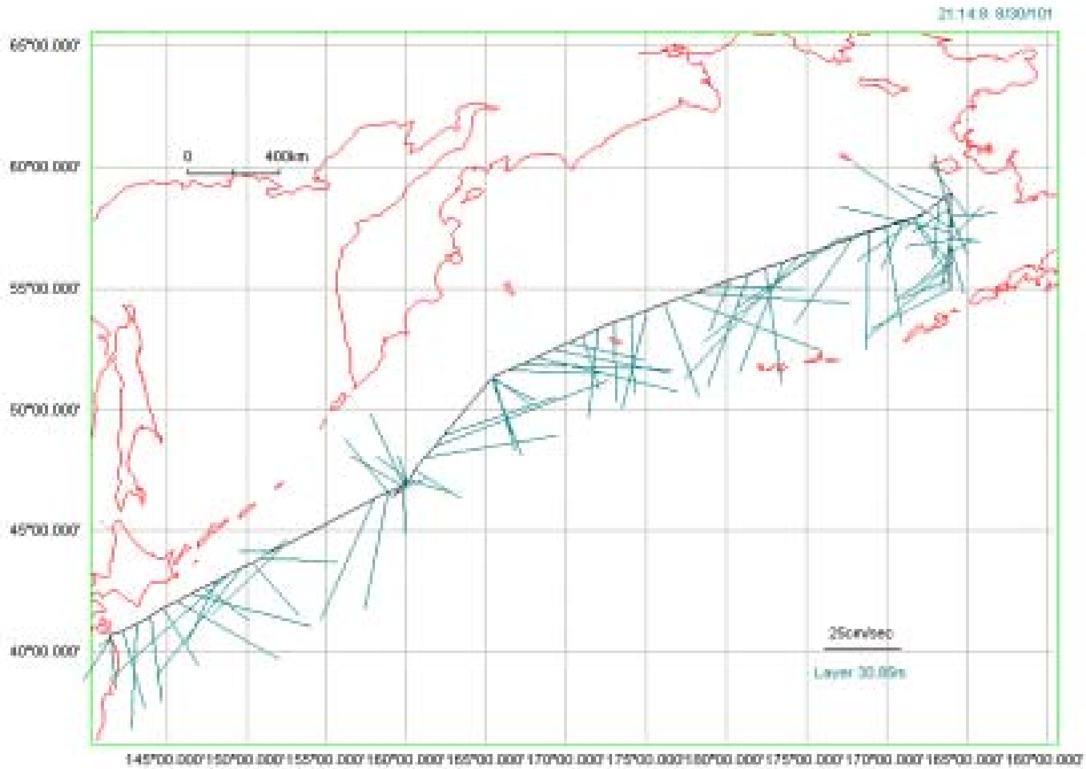


Figure 3.2.3-1: ADCP plot

3.3 Sea surface water monitoring

Nobuharu Komai (Marine Works Japan): Operation leader
Katsunori Sagishima (Marine Works Japan)

(1) Objectives

Measurements of Temperature, salinity, dissolved oxygen, fluorescence, particle size of plankton in the near-surface water.

(2) Instruments and Methods

The *Sea Surface Water Monitoring System* (Nippon Kaiyo Co., Ltd.) is located in the "*sea surface monitoring laboratory*" on R/V Mirai. It can automatically measure temperature, salinity, dissolved oxygen, fluorescence and particle size of plankton in the near-surface water every 1-minute. Sea surface temperature is measured by the ship bottom oceanographic thermometer situated on the suction side of the uncontaminated seawater supply in the forward hold. Measured data are saved every one-minute together with time and the position of ship, and displayed in the data management PC machine. This system is connected to shipboard LAN-system and provides the acquired data for p-CO_2 measurement system, etc. WGS 84 used geodetic reference system for the positioning at this cruise.

Near-surface water was continuously pumped up at the rate of about 200 l/min from the intake at the depth of 4.5 m below the sea surface to the laboratory. Then the water was distributed among the *Sea Surface Water Monitoring System* and p-CO_2 measurement system etc. The flow rate of surface water for this system was 12 l/min, which controlled by some valves and passed through some sensors except with fluorometer (about 0.3 l/min) through vinyl-chloride pipes.

Specification and calibration date of the each sensor in this system are:

a-1) Temperature and salinity sensors

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number:	2121156-2754
Measurement range:	Temperature -5 to +35 deg-C, Salinity 0 to 6.5 S/m
Accuracy:	Temperature 0.01 deg-C/6month, Salinity 0.001 S/m/month
Resolution:	Temperature 0.001 deg-C, Salinity 0.0001 S/m
Calibration date:	08-Jun-99 (mounted on 24-Jul.-01 in this system)

a-2) Ship bottom oceanographic thermometer (mounted at the back of the pump for surface water)

Model:	SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number:	032607
Measurement range:	-5 to +35 deg-C
Initial Accuracy:	0.001 deg-C per year typical
Stability:	0.002 deg-C per year typical
Calibration date:	27-Apr.-01 (mounted on 4-Jun.-01 in this system)

b) Dissolved oxygen sensor

Model:	2127, Oubisufair Laboratories Japan INC.
Serial number:	31757
Measurement range:	0 to 14 ppm
Accuracy:	±1% at 5 deg-C of correction range
Stability:	1% per month
Calibration date:	24-Jul.-01 (at Hachinohe)

c) Fluorometer

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

d) Particle size sensor
Model: P-05, Nippon Kaiyo Co. Ltd.
Serial number: P5024
Accuracy: ±10% of range
Measurement range: 0.02681mm to 6.666mm
Reproducibility: ±5%
Stability: 5% per week
Calibration date: 17-Apr.-00

e) Flow meter
Model: EMARG2W, Aichi Watch Electronics Ltd.
Serial number: 8672
Measurement range: 0 to 30 L/min
Accuracy: ±1%
Stability: ±1% per day

(4) Preliminary Result
(4-1) Salinity sensor

We sampled each day for salinity validation and in situ salinity calibration during this cruise. We collected two times each day during this cruise. The water was taken midway of flow line from the intake to the system when the ship was on station or in the regions with weak horizontal gradients of salinity. All samples were analyzed on the Guildline 8400B.

The results were shown in Table 3.3-1 and Figure 3.3-1. It seemed that salinity of the sensor tended to be lower than the sample during this cruise. It may be caused that the temperature and the conductivity sensor of SBE21 were drifting.

The precision of the sensor at each leg was summarized in Table 3.3-2.

Table 3.3-2 Precision of Salinity at this cruise

	Difference of salinity (Sctd-Ssal)
Average	-0.0137
Standard Deviation	0.0269
Average of absolute difference	0.0141
Standard Deviation of absolute difference	0.0267
R.M.S.	0.0211
Min	-0.1494
Max	0.0055
n	28

We calculated the Root Mean Squares (R.M.S.) of difference of salinity and conductivity value for 28 samples. R.M.S. of salinity (one sigma) was 0.0211. There was one sample which difference of salinity was higher than three times of standard deviation in this cruise. We suspected that these differences might be caused by the sampling. The final results omitted the one sample were shown in Table 3.3-3 and figure 3.3-2.

Table 3.3-3 Precision of Salinity omitted one sample at this cruise

	Difference of salinity (Sctd-Ssal)
Average	-0.0087
Standard Deviation	0.0055
Average of absolute difference	0.0091
Standard Deviation of absolute difference	0.0033
R.M.S.	0.0068
Min	-0.0159
Max	0.0055
n	27

These results showed that the validation of salinity was within 0.009.

(4-2) Dissolved Oxygen (D.O.) sensor

D.O. sensor of this system was calibrated at Hachinohe. To estimate of accuracy of the sensor, we collected the samples from the course of the system and analyzed by Winkler method. The standardization and pure water blank determination have been performed before the sample titration.

The results were shown in Table 3.3-4 and Figure 3.3-3. The average and standard deviation (one sigma) of differences at this cruise was summarized in Table 3.3-5.

Table 3.3-5 Precision of the D. O. sensor at this cruise.

	Difference (mg/l)
Average	0.555
Standard Deviation	0.085
n	8

(4-3) Fluorometer

During this cruise, fluorescence from the fluorometer decreased irregularly. We checked the fluorometer but we couldn’t elucidate on board. So be careful to use the fluorescence obtained at this cruise.

We cleaned the flow cell of fluorometer one time during this cruise. In order to calibrate the data of fluorescence from this system, we collected surface seawater samples that pumped up from the ship’s bottom few times each day.

We determined the concentrations of chlorophyll *a* and phaeopigments board. The method of measurement was indicated below. Sea surface water samples (0.5 liter) were filtered through a Nucrepore filters (pore size: 0.4 µm; diameter: 47 mm) in the dark room. The filters were immediately extracted in 6 ml of N,N’-dimethylformamide (DMF) and then, the samples were stored at -20 deg-C in the dark until the analysis.

Fluorescence of extracts was measured by Turner fluorometer (10-AU-005, TURNER DESIGNS). After the each sample measurement, the extracts were acidified with 2 drops of 1N HCl and the second measurement was done. The concentration of chlorophyll *a* and phaeopigments were calculated from the following equation:

$$\text{chlorophyll } a\ (\mu g/L) = (Fm/Fm-1)\times(F_0-Fa)\times Kx\times(vol_{ex}/\ vol_{filt})$$

$$\text{Phaeopigments } (\mu g/L) = (Fm/Fm-1)\times[Fm\cdot Fa] - F_0\ ]Kx\times(vol_{ex}/\ vol_{filt})$$

Fm = acidification coefficient (F_0/Fa) for pure Chl *a* (1.89)

F_0 = fluorescence of seawater sample before acidification

Fa = fluorescence of seawater sample after acidification

Kx = door factor from calibration calculations (0.91)

vol_{ex} = extraction volume

vol_{filt} = filter volume

The results of analysis were shown in table 3.3-6.

(5) Data archive

All the files of raw data, Microsoft excel files of raw data were stored on a magneto-optical disk. All the data will be submitted to the Data Management Office at JAMSTEC

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(6) Reference

Culberson, C. H. (1991) Dissolved Oxygen, in WHP Operations Methods, Woods Hole, pp.1-15.

SEACAT THERMOSALINOGRAPH SBE21 OPERATING MANUAL, APPLICATION NOTE No. 2D, Revised January 1998

T. J. Muller and H. -W. Schenk (1991) Near-Surface Temperature, salinity, and Bathymetry Measurements, in WHP Operations Methods, Woods Hole, pp.1-4.

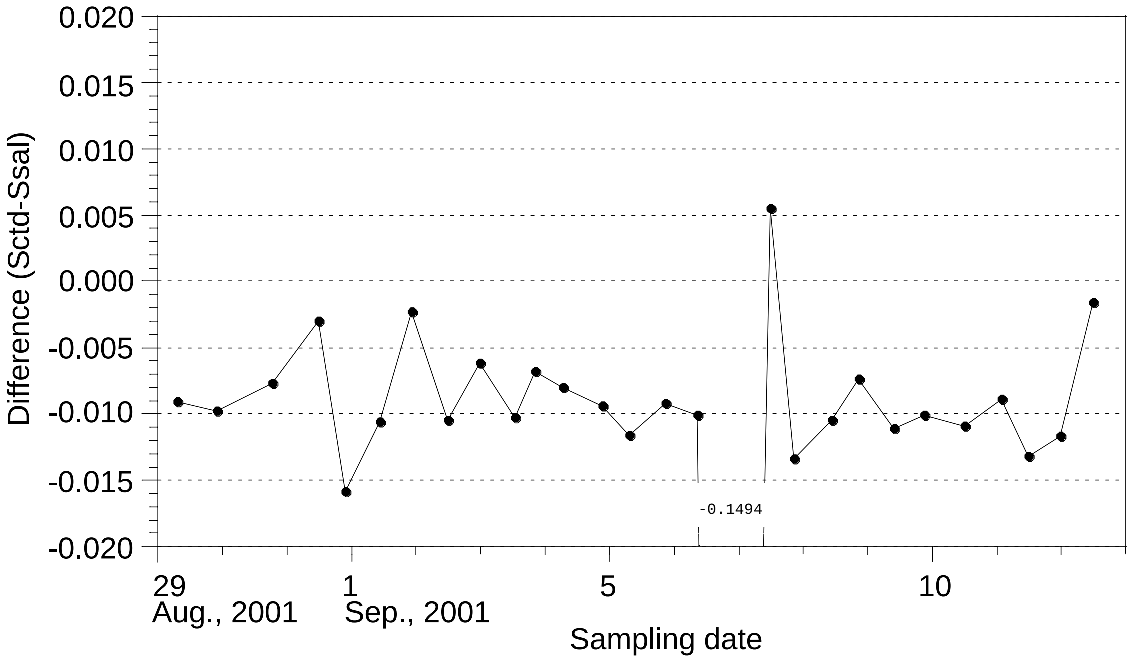

Figure 3.3-1 Difference between the salinities measured by conductivity and temperature sensor (Sctd) of Sea Surface Monitoring System and the Autosal salinometer (Ssal).

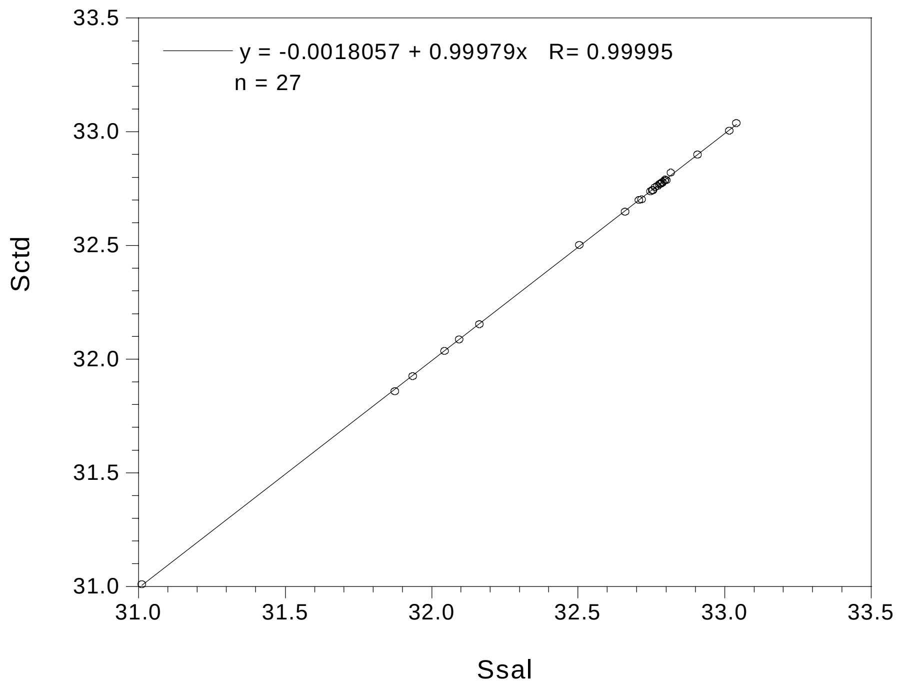

Figure 3.3-2 Comparison between the salinity values measured by SBE21 of Sea Surface Monitoring System and by the Autosal salinometer.

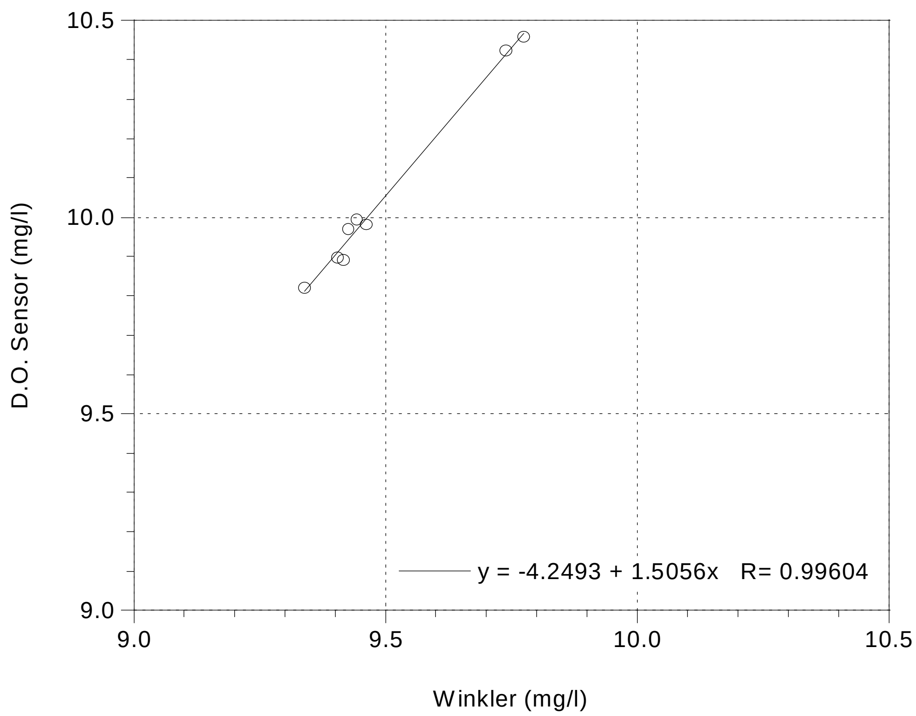

Figure 3.3-3 Comparison between the D.O. values measured by the D.O. sensor of Sea Surface Monitoring System and by the Winkler method.

BLANK

BLANK

3.4 Dissolved Oxygen

Nobuharu Komai (Marine Works Japan Ltd.)
Katsunori Sagishima (Marine Works Japan Ltd.)

(1) Introduction

Dissolved oxygen is major parameter for deciding the seawater characteristic on oceanography. In this cruise, the method of dissolved oxygen determination is based on WHP Operations and Methods manual (Culberson,1991, Dickson, 1994).

(2) Methods

(a) Instruments and Apparatus

Glass bottle: Glass bottle for D.O. measurements consist of the ordinary BOD flask(ca.180 ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966).

Dispenser: Eppendorf Comforpette 4800 / 1000µl
OPTIFIX / 2 ml (for MnCl2 & NaOH / NaI aq.)

Metrohm Model 725 Multi Dosimat / 20 ml (for KIO3)

Titrator: Metrohm Model 716 DMS Titrino / 10 ml of titration vessel
Metrohm Pt Electrode / 6.0403.100 (NC)

Software: Data acquisition and endpoint evaluation / “The Brinkmann Titrino Workcell”

(b) Methods

Sampling and analytical methods were based on to the WHP Operations and Methods (Culberson, 1991, Dickson, 1994).

(b-1) Sampling

Sea water samples for dissolved oxygen measurement were collected from 12 litter Niskin bottles to calibrated dry glass bottles. During each sampling, 3 bottle volumes of seawater sample were overflowed to minimize contamination with atmospheric oxygen and the seawater temperature at the time of collection was measured for correction of the sample volume. After the sampling, MnCl2 (aq.) 1ml and NaOH / NaI (aq.) 1ml were added into the glass bottle, and then shook the bottle well. After the precipitation has settled, we shook the bottle vigorously to disperse the precipitate.

(b-2) D.O. analysis

The samples were analyzed by Metrohm titrator with 10 ml piston burette and Pt Electrode using whole bottle titration. Titration was determined by the potentiometric methods and the endpoint for titration was evaluated by software of Metrohm, “The Brinkmann Titrino Workcell”.

Concentration of D.O. was calculated by equation (10) and (13) of WHP Operations and Methods (Dickson, 1994). Salinity value of the equation (14) was used from the value of salinity of AutoSal. The amount of D.O. in the reagents was reported 0.0017 ml at 25.5 deg-C (Murray et. al., 1968). However in this cruise, we used the value (=0.0027 ml at 21 deg-C) measured at 1995

WHCE cruise of R/V Kaiyo D.O. concentrations we calculated were not corrected by seawater blank.

We prepared and used one batch of 5 liter of 0.07N thiosulfate solutions and 5 liter of 0.0100N standard KIO3 solutions (JM010711).

(3) Preliminary Result

(3-1) Comparison of our KIO3 standards to CSK standard solution.

After this cruise, we compared our standards with CSK standard solution (Lot. ELQ9442) which is the commercially available standard solution prepared by Wako Pure Chemical Industries, Ltd. The results are shown in table 3.4.-1.

Table 3.4-1. Comparison of each standards

Titrator	KIO3 Lot No. n	Nominal Normality	Average Titer (ml)	Standard Deviation	n
	ELQ9442	0.0100	1.4104	0.0005	10
	JM010711	0.010017	1.4122	0.0006	10

(3-2) Reproducibility

In this cruise, 170 samples for D.O. samples were collected. 31 pairs (23.3%) of total samples were analyzed as “duplicates” which were collected from same Niskin bottle. Results of each stations show Fig.3.4.-1 (1) – (3)

(4) References

Culberson, C.H.(1991) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole., ppl-15

Culberson, C.H., G.Knapp, R.T.Williams and F.Zemlyak(1991) A comparison of methods for the determination of dissolved oxygen in seawater. (WHPO 91-2)

Dickson, A.G. (1994) Determination of dissolved oxygen in sea water by Winkler titration, in WHP Operations and Methods, Woods Hole., ppl-14.

Green, E.J. and D.E.Carritt (1996) An Improved Iodine Determination Flask for Whole-bottle Titrations, Analyst, 91, 207-208.

Murray, N., J.P.Riley and T.R.S. Wilson (1968) The solubility of oxygen in Winkler regents used for the determination of dissolved oxygen, Deep-Sea Res., 15, 237-238.

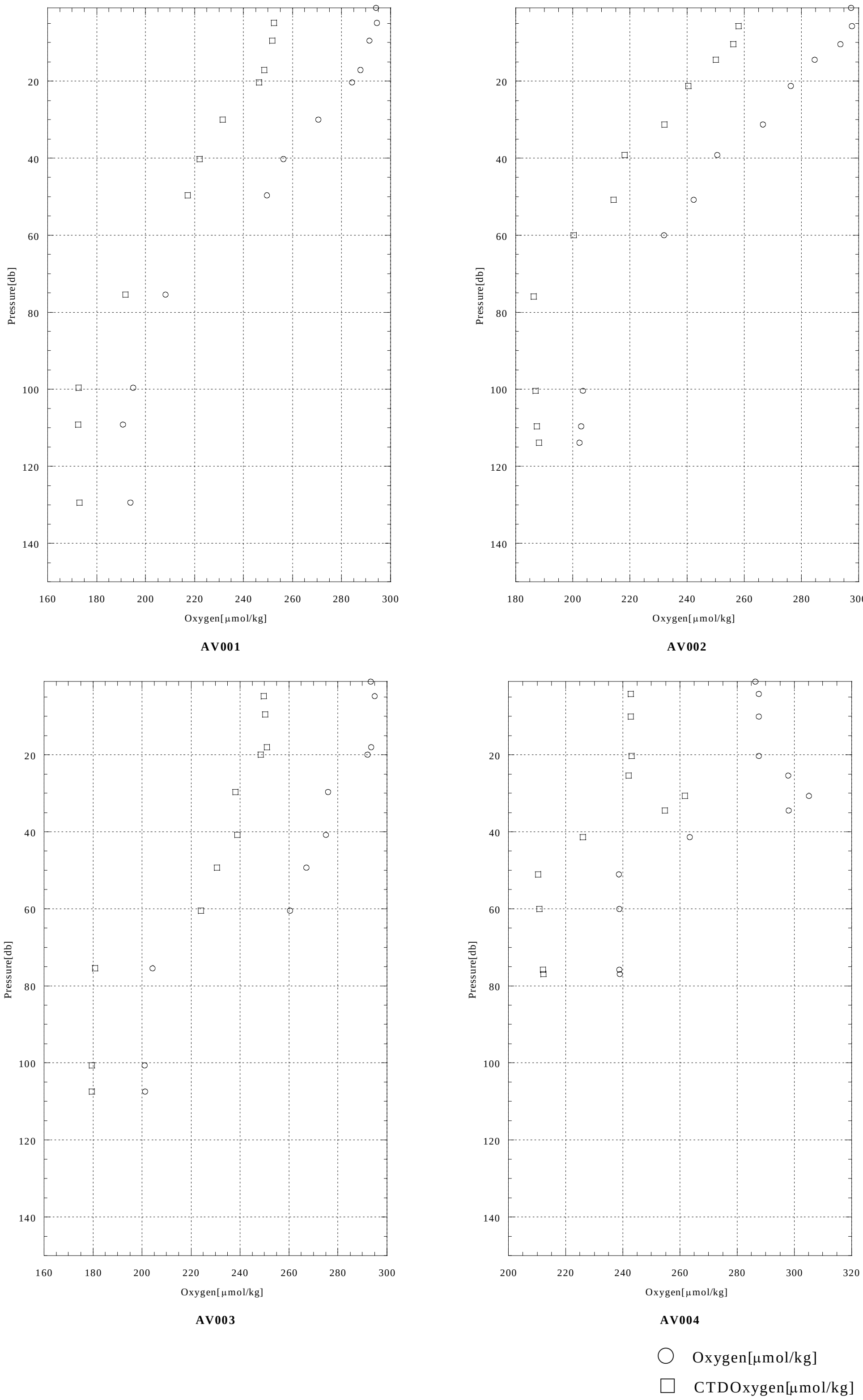

Fig.3.4 -1 (1) Vertical profiles at each stations.

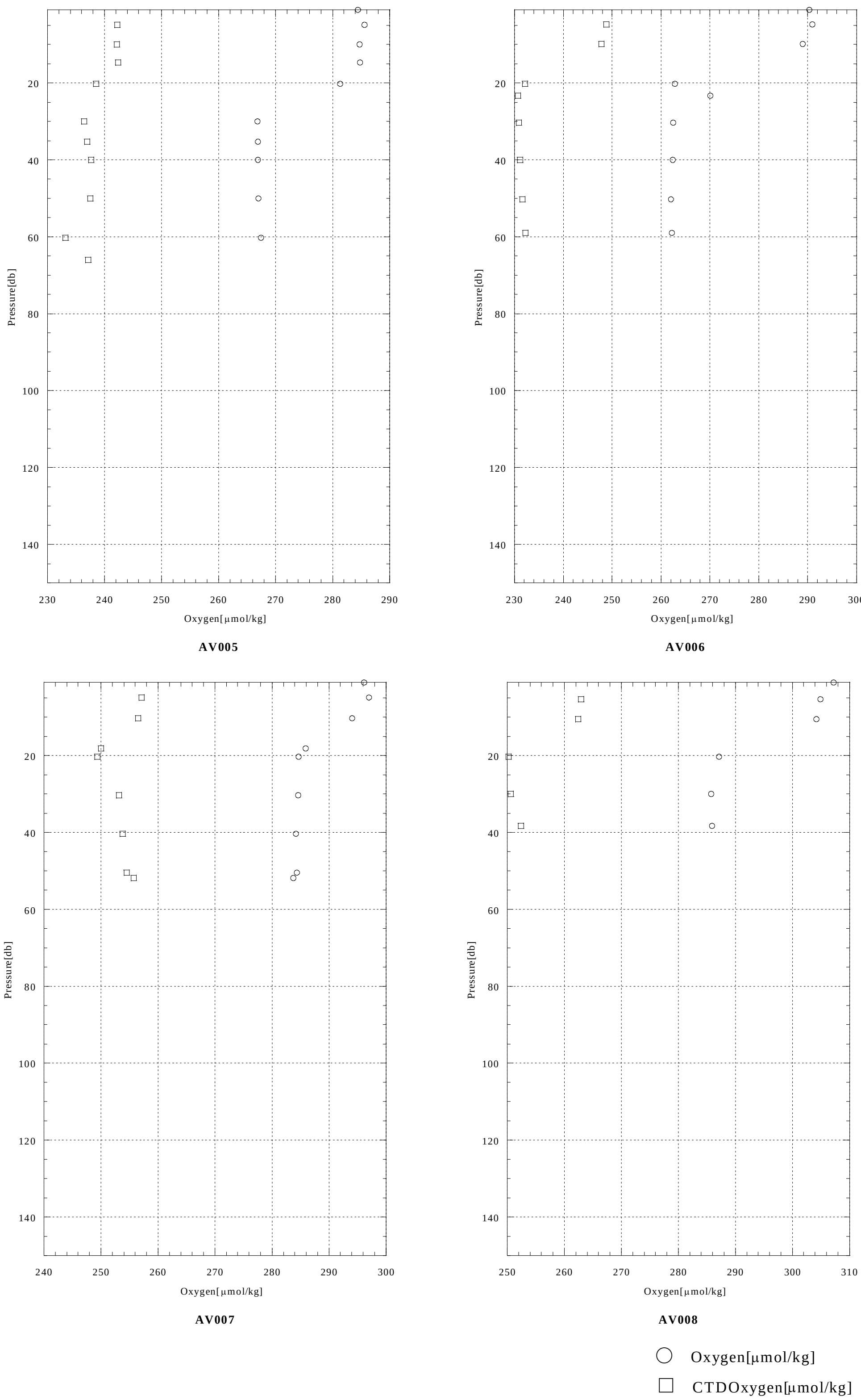

Fig.3.4 -1 (2) Vertical profiles at each stations.

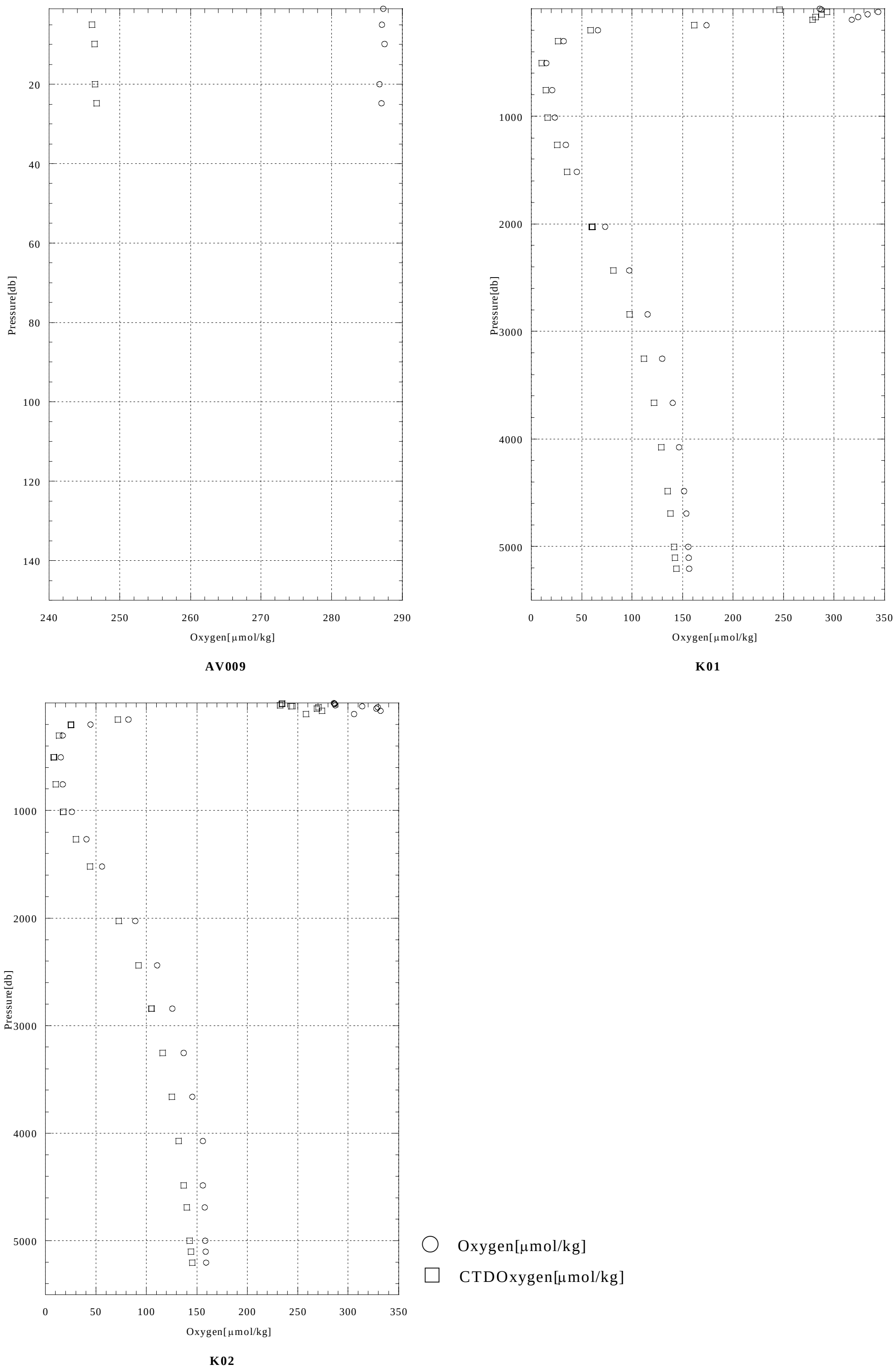

Fig.3.4 -1 (3) Vertical profiles at each stations.

3. 5 Nutrients

3. 5. 1 Water column nutriens

Asako Kubo (MWJ)
Ai Yasuda (MWJ)
Kaori Akizawa (MWJ)

(1) Objectives

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

(2) Measured parameters

- Nitrate
- Nitrite
- Silicate
- Phosphate
- Ammonia

(3) Methods

There are 2 TRAACS 800 systems, which is BRAN+LUEBBE continuous flow analytical 4-channel system model, in the R/V MIRAI to analyze the nutrients in seawater. We usually used one system for nitrate + nitrite (1ch.), nitrite (2ch.), silicate (3ch.) and phosphate (4ch.). And the other one was for ammonia (3ch.) measurement, which was almost constructed for closed line system.

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

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

Silicate: The standard AAII molybdate-ascorbic acid method was used. Temperature of the sample was maintained at 45-50 deg C using a water bath to reduce the reproducibility problems encountered when the samples were analyzing at different temperatures. The silicomolybdate produced is measured absorbance of 630 nm using a 3 cm length cell.

Phosphate: The method by Murphy and Riley (1962) was used with separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate. Temperature of the samples was adjusted to be 45-50 deg C using a water bath. The phospho-molybdate produced is measured absorbance of 880 nm using a 5 cm length cell.

Ammonia: Ammonia in seawater was determined by coupling with phenol and sodium hypochlorite to form a colored indophenol blue and by being measured the absorbance of 630 nm using 3 cm length flow cell.

Sampling Procedures

Samples were drawn into polypropylene 100 ml small mouth bottles. These were rinsed three times before filling. The samples were analyzed as soon as possible. Five ml sample cups were used for analysis.

Low Nutrients Sea Water (LNSW)

Ten containers (20L) of low nutrients seawater were collected in February, 2001 at equatorial Pacific and filtered with 0.45mm pore size membrane filter (Millipore HA). They are used as preparing the working standard solution.

(4) Results

Precision of the analysis

We have made the repeat analysis at each station. Repeat analysis range of CV (concentration average to standard deviation) was 0.06 to 1.33 % at stn.AV01～AV06, K1 and K2 except for nitrite and ammonia. Repeat analysis range of CV at other stations was –5.38 to 3.86 %. These stations were very shallow area.

(5) Data Archive

These data are stored Ocean Research Department in JAMSTEC.

3.5.2 Nutrients monitoring in surface seawater

Asako Kubo (MWJ)
Ai Yasuda (MWJ)
Kaori Akizawa (MWJ)

(1) Objective

We revealed the distribution of nutrients in surface seawater that is important to investigate primary production.

(2) Measured parameters

・Nitrate
・Nitrite
・Silicate
・Phosphate

(3) Methods

The nutrients monitoring system was performed on BRAN+LUEBBE continuous monitoring system Model TRAACS 800 (4 channels). It was located at the surface seawater laboratory for monitoring in R/V Mirai. The seawater of 4.5 m depth under sea surface was continuously pumped up to the laboratory inner R/V Mirai. The seawater was poured in 5 L of polyethylene beaker through a faucet of the laboratory. The seawater was introduced direct to monitoring system with narrow tube continuously. The methods are as follows.

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

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 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 800 nm using 5 cm length flow cell in the system.

Silicate: Silicate was determined by complexing with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 800 nm using 3 cm length flow cell in the system.

Monitoring period (UTC) during this cruise is listed below.

(Ⅰ) 2001/8/29 - 2001/9/5
(Ⅱ) 2001/9/6 - 2001/9/8
(Ⅲ) 2001/9/9 – 2001/9/12

Except for the above period was not measured due to malfunction, adjustment and changing reagent.

(4) Preliminary results

The nutrients monitoring was operated during the period of Dutch Harbor to Hachinohe. Monitoring data was obtained every 1 minute. We made a recalculation for this data by TRAACS 800 (4 channels) method.

(5) Data archive

All data will be archive at JAMSTEC Data Management Office.

3.6 Partial pressure of CO_2 (pCO_2)

Akihiko MURATA (JAMSTEC)
Minoru KAMATA (MWJ)

(1) Objectives

It is to measure continuously partial pressure of CO_2 in the atmosphere and surface seawater.

(2) Instrument and Methods

Concentrations of CO_2 in the atmosphere and the sea surface were measured continuously during the entire cruise by the automated system with a non-dispersive infrared (IR) analyzer (BINOS^{TM}). It runs on one and half hour cycle during which four standards, an ambient air sample, and a headspace sample from the equilibrator were analyzed.

The ambient air sample taken from the bow is introduced into the IR through a mass flow controller which controls the air flow rate at about 0.5L/min, a cooling unit, a parma pure dryer, and a desiccant holder ($Mg(ClO_4)_2$).

The equilibrator has shower head space in the top through which surface water is forced at a rate of 5-8L/min. Air in the head space is circulated with an air pump at 0.5-0.8L/min. in a closed loop through two cooling units, a perma pure dryer, and the desiccant holder. For calibration, compressed gas standards with nominal mixing ratios of 298, 321, 372 and 441 ppmv (parts per millions by volume) were used.

(3) Preliminary Results

The Preliminary results are shown in Fig.3.6 -1

(4) Data archive

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

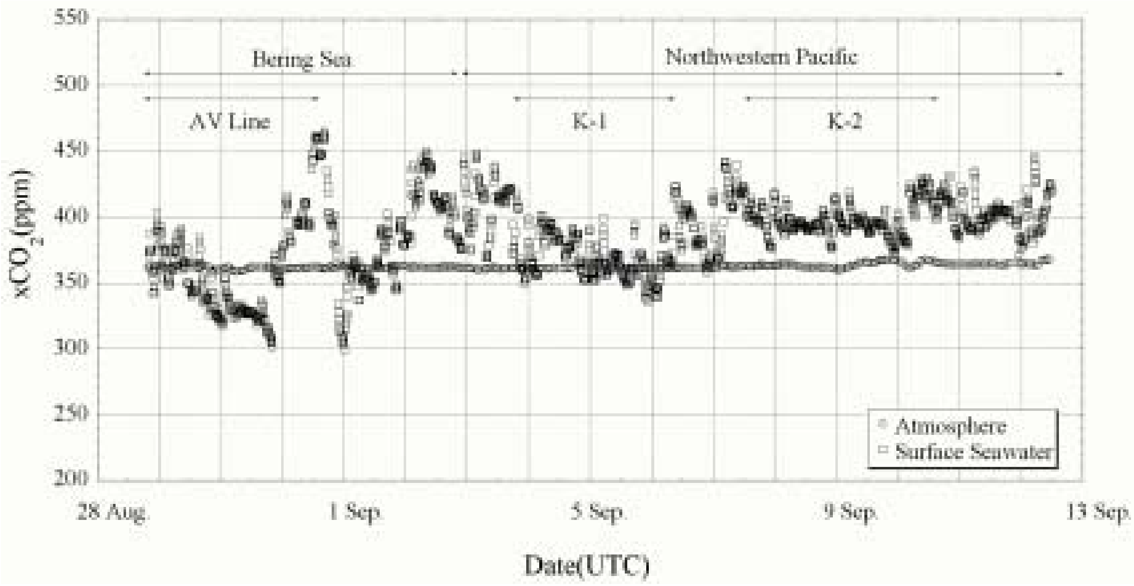

Fig.3.6-1 Variations of xCO_2 in the atmosphere and surface seawater for Leg 2 of MR01-K04

3.7 Total Dissolved Inorganic Carbon (TDIC)

Akihiko MURATA (JAMSTEC)
Minoru KAMATA (MWJ)
Fuyuki SHIBATA (MWJ)
Taeko OHAMA (MWJ)
Keisuke WATAKI (MWJ)

Objective

Global warming caused by green house gas such as carbon dioxide has become much attention all over the world. In order to verify carbon dioxide parameters in the Bering Sea and Northwestern Pacific, TDIC was measured with analytical instruments installed on R/V MIRAI in this cruise.

3.7.1 Water column TDIC

(1) Instruments and Methods

Seawater samples were drawn from 12L Niskin TM bottles into 250ml grass bottles with sampling tubes. Bottles were not rinsed and filled from the bottom, overflowing a volume while taking care not to entrain any bubbles. After sampling, 3ml seawater (1% of the bottle volume) was removed from grass bottle by a plastic pipette, and saturate mercuric chloride was added into bottle, and bottles were sealed using Apiezon M grease and stopper, and stored refrigerator.

Concentration of TDIC was measured by a coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.). The method of TDIC measurement was that approx. 35ml of seawater was taken into a receptacle and $2cm^3$ of 10%(v/v) phosphoric acid was added. The CO_2 gas evolved was purged by nitrogen gas (CO_2 free) for 12 minutes at the flow rate of $110cm^3$ min^{-1} and absorbed into an electrolyte solution. Acids formed by reacting with the absorbed CO_2 in the solution were titrated with hydrogen ions using the coulometer. Calibration of the coulometer was carried out using sodium carbonate solutions (0-2.5mM). All the data were referenced to the CRM of SIO. The standard deviation of the absolute differences of duplicate measurements was 1.4 mol kg^{-1}.

(2) Preliminary results

Preliminary data of TDIC were shown in Fig 3.7.1-1 and 3.7.1-2.

(3) 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.

3.7.2 Sea surface TDIC

(1) Instruments and Methods

Concentration of TDIC in the surface seawater collected by a pump from a depth of 4.5m was continuously measured by a coulometer (Carbon Dioxide Coulometer Model 5012,UIC Inc.). Seawater was introduced into a receptacle (nominal 30cm^3) and 2 cm^3 of 10 percents (v/v) phosphoric acid was added to evolve CO_2 gas. The evolved CO_2 gas was purged by CO_2 free nitrogen gas (purity 99.9999%) for 13 minutes at a flow rate of 130 cm^3/min. and was absorbed into an electrolyte solution. Acids formed by reacted with the absorbed CO_2 in the solution were titrated with hydrogen ions. The titration was monitored by the coulometer. Calibration of the coulometer was carried out using sodium carbonate solutions (0-2.5mM). The coefficient of variation of 3 replicate determinations was approximately less than 0.1 percents for 1 sigma. TDIC were determined from titration values. All the values reported are set to the Dickson's CRM (Batch #54).

(2) Preliminary results

The Preliminary results are shown in Fig.3.7.2-1.

(3) Data archive

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

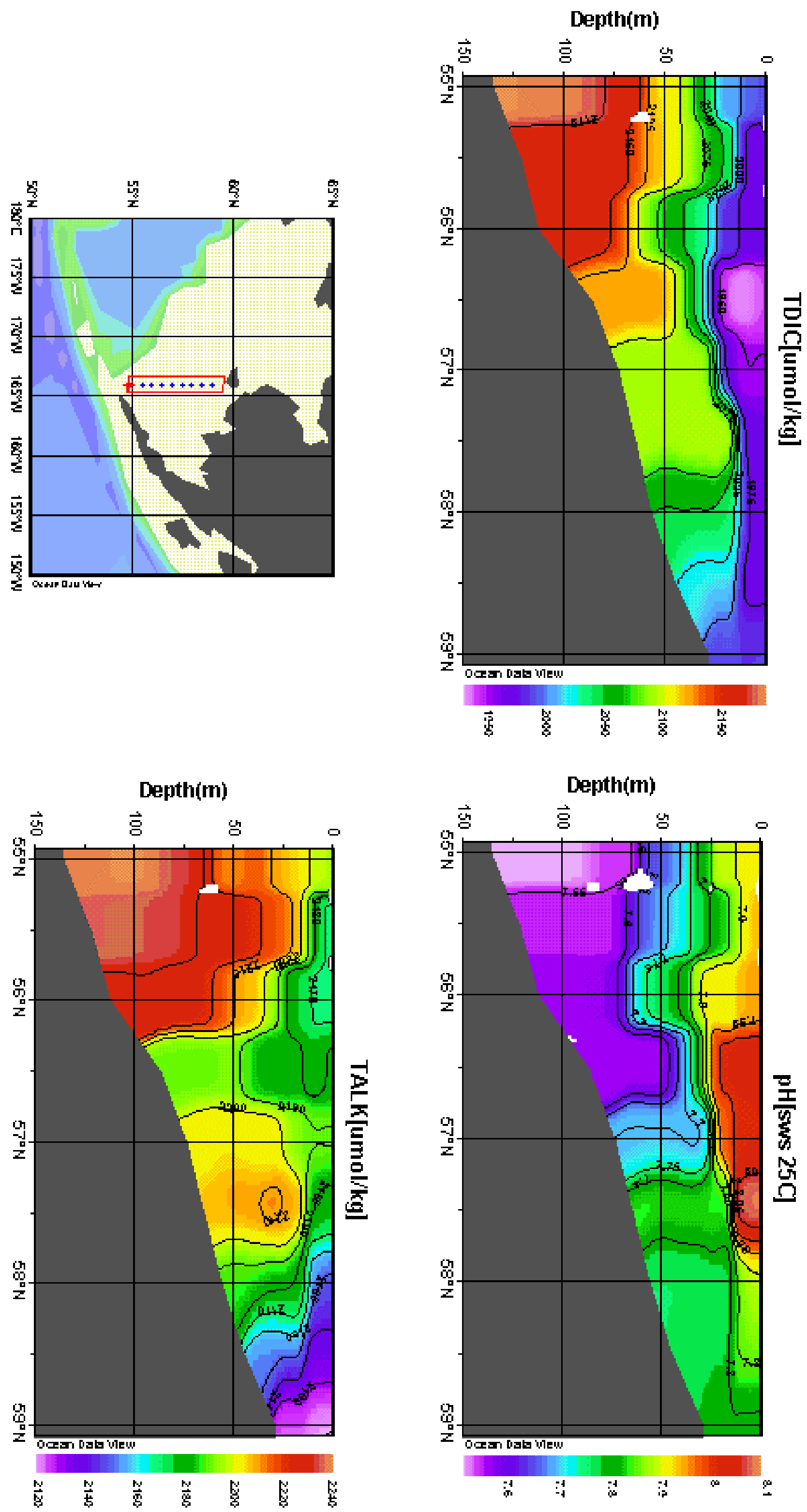

Fig.3.7.1-1 Contour plots of TDIC, total alkalinity and pH values at AV-line(Bering sea)

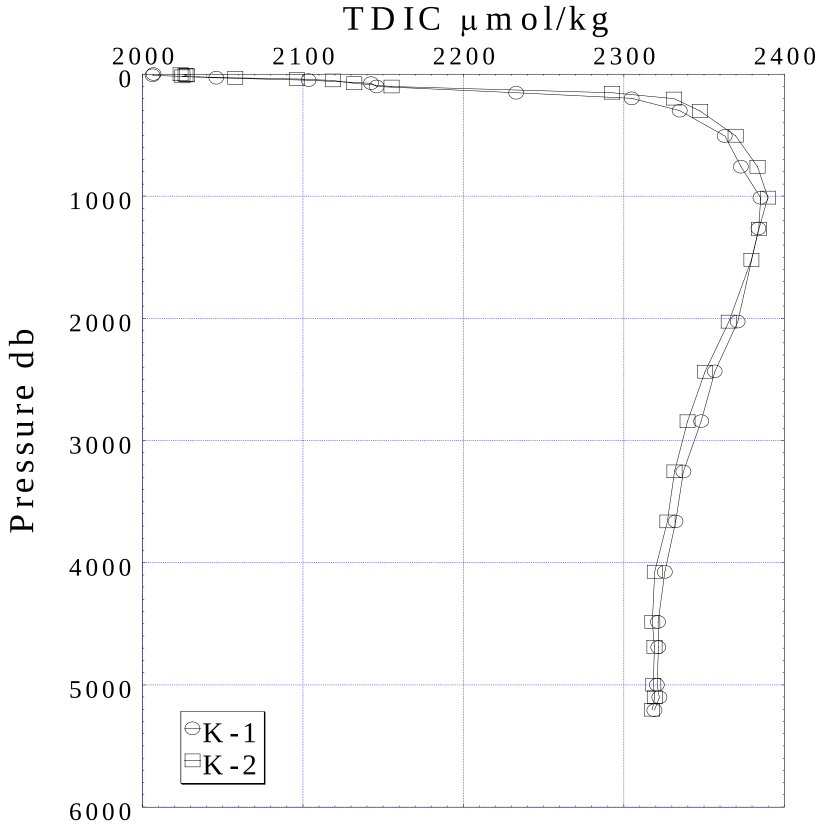

Fig.3.7.1.2 Vertical profiles of TDIC in the Northwestern Pacific

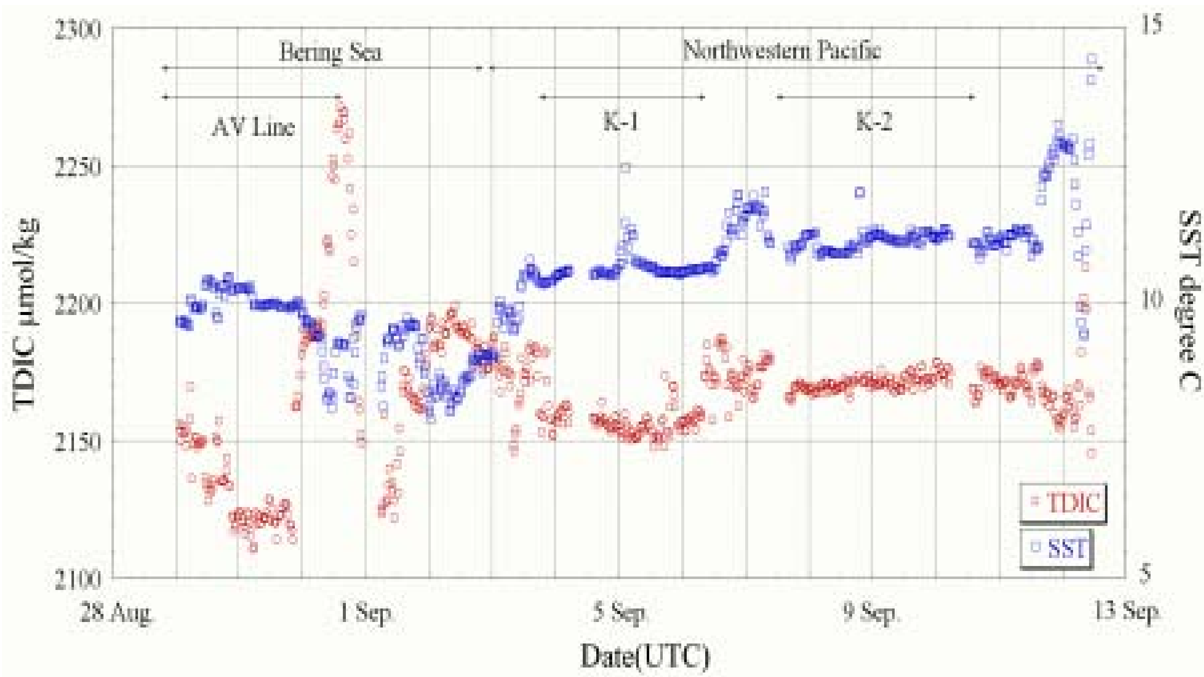

Fig.3.7.2-1 Variations of normalized TDIC(S=35psu) and temperature in the sea surface for LEG 2 of MR01-K04

3.8 Total alkalinity

Akihiko MURATA (JAMSTEC)
Fuyuki SHIBATA (MWJ)
Keisuke WATAKI (MWJ)
Minoru KAMATA (MWJ)

(1) Introduction

Global warming caused by green house gas such as carbon dioxide has become much attention all over the world. And in the flux study of Bearing sea and northwestern pacific, to understand its volume of transportation is very important. In order to verify carbon dioxide parameters with analytical instruments installed on R/V MIRAI in this cruise.

(2) Methods

Seawater samples were drawn from 12L Niskin TM bottles into 250ml Nalgene polyethylene bottles with sampling tubes. Bottles were rinsed twice and filled from the bottom, overflowing a volume while taking care not to entrain any bubbles. The bottles were then sealed by screw cap with an inner cap and stored at refrigerator. Before titration, bottles were in the water bath about 25 degree C.

The method of total alkalinity measurement was that approx. 100ml of seawater was placed in a 200ml tall beaker with a Knudsen pipette, and titrated with a solution of 0.1M hydrochloric acid. The acid was made up in a solution of sodium chloride background (0.7M) to approximate 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.

(3) 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 1.3 and 1.5 mol/kg.

We measured two kinds of control sample, SIO CRM batch 54, JAMSTEC RM and KANSO RM batch K (RMK) to evaluate the stability of the measurement process. Measurements values of CRM were plotted sequentially and shown in Fig.3.8.2.Measurements values of RM, RMK were corrected by CRM measurement values, plotted sequentially and shown in Fig.3.8.3-4.

(4) 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.

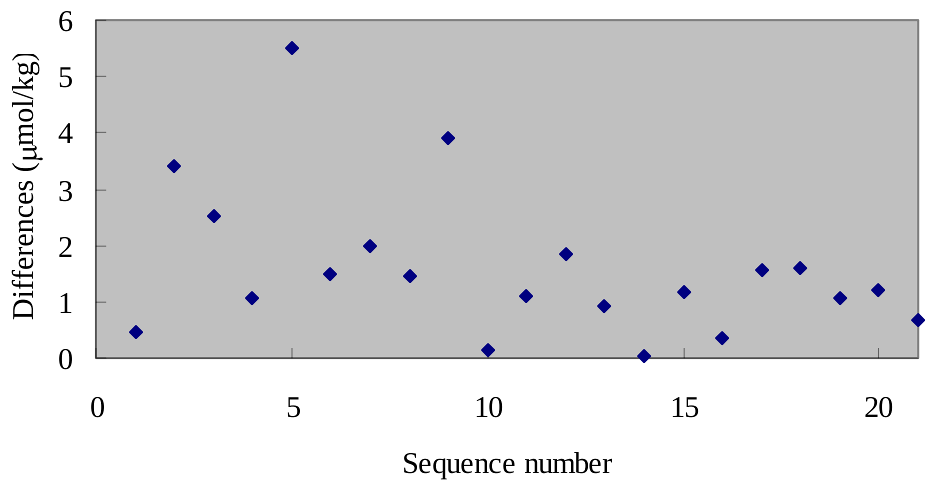

Fig.3.8.1 Differences of duplicate measurements

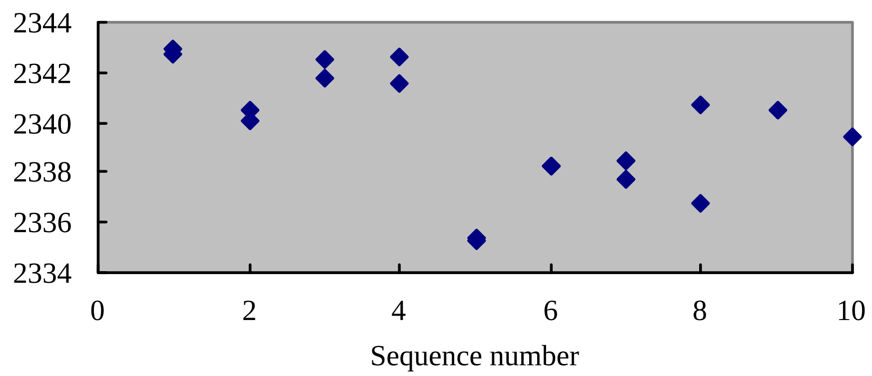

Fig.3.8.2 Measurements of CRM

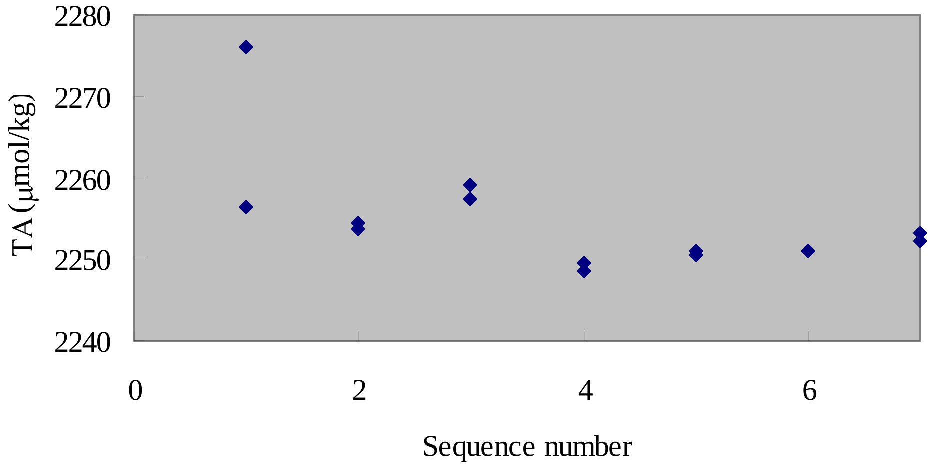

Fig.3.8.3 Measurements of RM

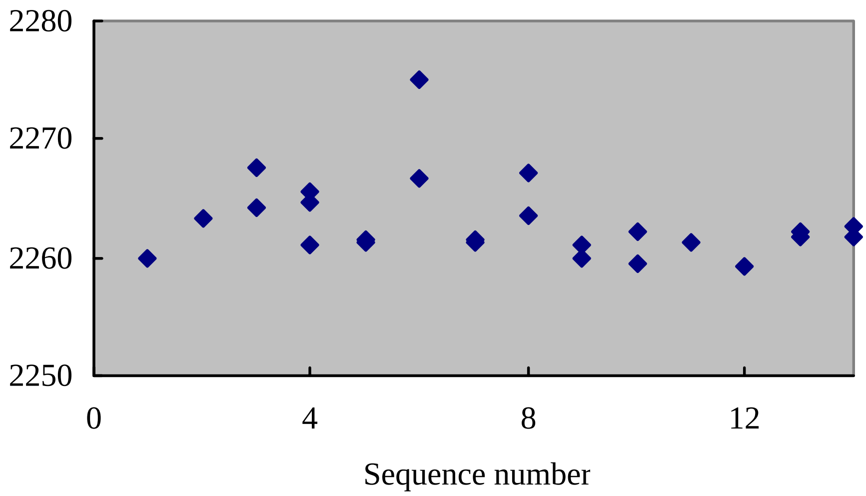

Fig.3.8.4 Measurements of RMK

3.9 pH

Akihiko MURATA (JAMSTEC)
Taeko OHAMA (MWJ)
Fuyuki SHIABATA (MWJ)
Keisuke WATAKI (MWJ)

(1) Method and Instruments

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

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

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

To calibrate the electrodes the TRIS (pH=8.0936 pH unit at 25℃, Delvalls and Dickson, 1998) and AMP (pH=6.786 pH unit at 25℃, Dickson and Goyet, 1996) in the synthetic seawater (S=35 PSU) (Total hydrogen scale) were applied.

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

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

where electrode response "ER" is calculated as fllows:

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

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

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

(2)Preliminary results

Contour plots in Fig.3.7.1-1 were made from values of the pH_{25} at AV line (Bering sea). And Fig.3.9.1 shows the vertical distribution of pH_{25} in the St.K-1 and K-2.

The duplicate data of pH_{25}(T) at each station was shown Table 3.9.-1. The repeatability was calculated to be 0.001 (pH unit).

REFERENCES

Dickson, A.G. and Goyet C. (Eds.). Handbook of Methods for the Analysis of the Various Parameters of the Carbon Dioxide System in Seawater, ORNL/CDIAC-74. 1994. 107p.

Devalls T.A. and Dickson A.G.. The pH of buffers based on 2-amino-2-hydroxymethyl-1,3-propanediol ('tris') in the synthetic sea water. 1998. V.45, P.1541-1554.

Table3.9-1 Duplicate data of the pH_{25}(T)

St.No.	Depth(m)	pH Value1	pH Value2	Difference
AV01	40.2	7.707	7.709	0.002
AV01	109.1	7.522	7.522	0.000
AV02	39.3	7.725	7.726	0.001
AV02	100.5	7.559	7.560	0.001
AV03	40.8	7.811	7.813	0.002
AV03	100.6	7.571	7.571	0.000
AV04	30.7	7.828	7.825	0.003
AV04	60.0	7.567	7.566	0.001
AV05	35.2	7.701	7.705	0.004
AV05	50.0	7.705	7.707	0.002
AV06	30.3	7.841	7.839	0.001
AV07	10.3	7.857	7.859	0.002
AV08	10.5	7.860	7.860	0.000
AV09	5.0	7.793	7.792	0.001
K-1	757.5	7.325	7.323	0.002
K-1	2026.8	7.449	7.451	0.002
K-1	3664.7	7.575	7.573	0.002
K-1	5000.7	7.602	7.601	0.002
K-2	30.7	7.842	7.840	0.002
K-2	201.1	7.251	7.248	0.002
K-2	1520.5	7.409	7.410	0.001
K-2	4073.6	7.590	7.589	0.000
			Average	0.002
			S.D.	0.001

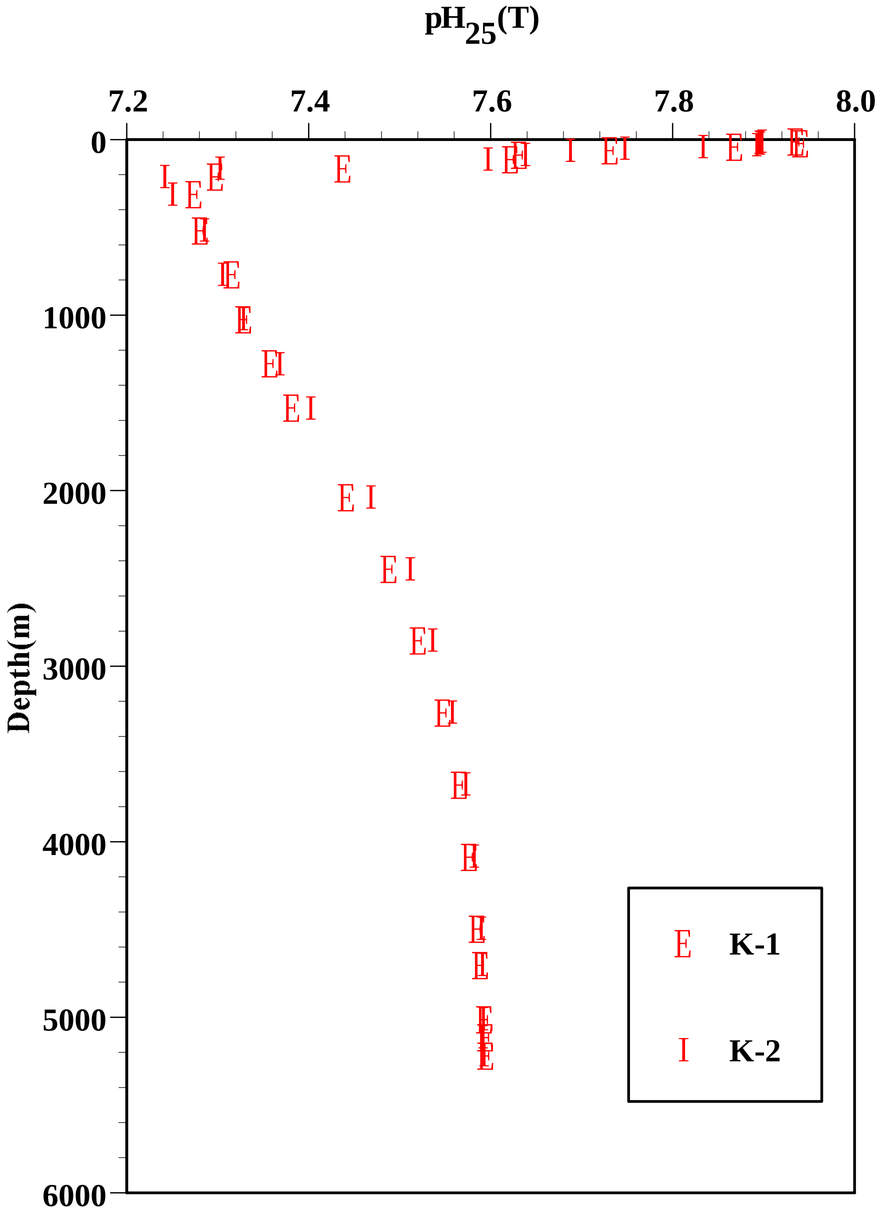

Fig 3.9-1 Vertical distribution of pH_{25}(T) at St.K-1 and K-2.

3.10 Pre-treatment of Seawater Samples for Dissolved Organic Carbon (DON) and Dissolved Organic Nitrogen (DON)

Munehito KIMURA(KANSO)
Akihiko MURATA(JAMSTEC)

(1) Objective

To quantify the partitioning of carbon and nitrogen, which are assimilated into organic matters by biological activity, into dissolved organic matters (DOC and DON).

(2) Instruments and Methods

① Seawater Sampling

Seawater samples for DOC and DON were taken without using a tube from 12L Niskin-X bottles into 250ml glass bottles of a ground mouth. The glass bottles were rinsed three times by the seawaters. After that, seawaters were filled into the glass bottles carefully so that air does not enter the glass bottles. Immediately after the sampling, the seawater samples were stored in a refrigerator (4˚C) in the laboratory of the Mirai.

②Pre-treatment for DOC

Seawater samples were subjected to pressure filtration with a filtering device consisting of a 100ml-glass syringe, a stainless filter holder, a filter (Whatman, GF/F) and a stainless stopcock valves. The glass syringe was washed by the seawater samples three times. The filters and stopcock valves were washed by filtering the seawater samples of 20 to 30 ml. The filtered samples were collected into 5ml ampules for the freezing preservation, which were washed three times by the filtered samples beforehand. To remove dissolved inorganic carbons in the filtered samples, a 6N HCl of 50µl was added into it, and mixed gases of high purity nitrogen and oxygen were passed through the filtered samples by bubbles to 10 minutes. Then the ampules were closed by a gas burner, and were freezed quickly by liquid nitrogen. The ampules were stored in a freezer (-80˚C) in the laboratory of the Mirai.

③Pre-treatment for DON

Filtered samples for DON were taken into polyethylene bottles of 100ml (washed by the filtered samples beforehand), when the filtered samples for DOC were shared into ampules. Decomposition of DON by wet chemical oxidation was made by a high pressureproof glass tubes. The high pressureproof glass tubes were washed in a dry oven by a heating of 120˚C (1 hour) with 10% HCl. After that, the high pressureproof glass tubes were rinsed by Milli-Q TOC water. The filtered samples of 20ml were taken into the high pressureproof glass tubes, and a oxidation reagent of 3ml was added. The high pressureproof glass tubes were heated (1.5 hours) at 120˚C in a dry oven. After the heating, The high pressureproof glass tubes were cooled to a room temperature. Then concentrated HCl of 0.5ml was added into the high pressureproof glass tubes in order to dissolve depositions in the high pressureproof glass tubes. At this stage, pH of the solutions became approximately 2. In this solution, a concentrated NH4Cl of 0.5ml was added, and 0.5N NaOH of 4ml was added so that pH of the solutions became 7~8. The solutions were transferred into 100ml polyethylene and stored in a refrigerator. This time, used instrument is the capacity certified. DON is required by deducting dissolved inorganic nitrogen (NO3, NO2, NH3) from total dissolved nitrogen (DON+DIN) . TDN and DIN used Traacs-800 measurement result.

(3) Results

Stations for water column (CTD) samples are: AV001, AV002, AV003, AV004, AV005, AV006, AV007, AV008, AV009

The vertical profiles of DON were shown in Fig. 3.10-1

(4) Data Archive

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

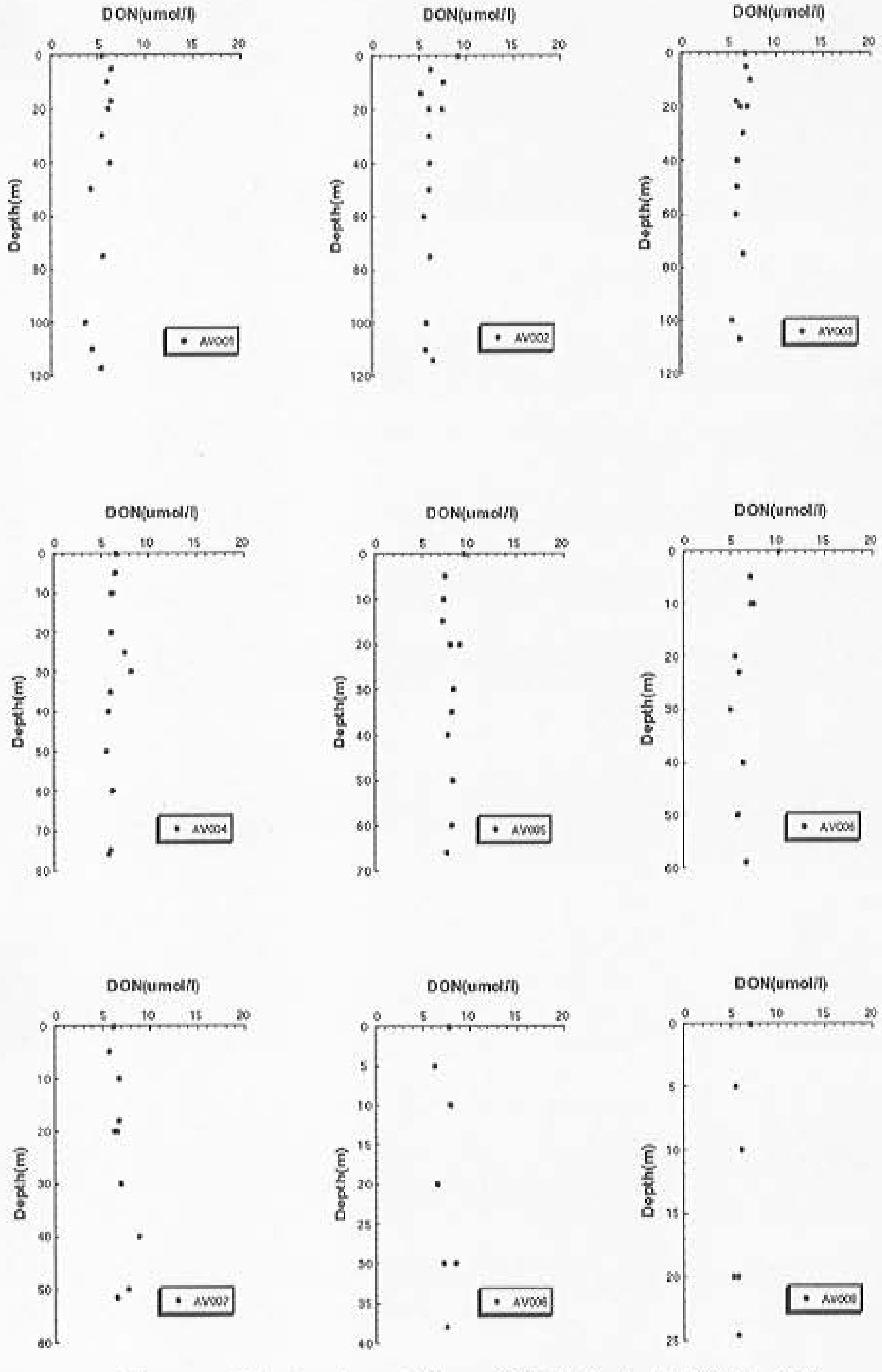

Figure Vertical profiles of DON at AV001~009.

3.11 Filteration of seawaters for particulate organic carbon (POC) and nitrogen (PON), particulate inorganic carbon (PIC) and alkenone

Akihiko MURATA

(1) Objective

To quantify the partitioning of carbon and nitrogen, which are assimilated by biological activity into particulate organic matters (POC and PON) and particulate inorganic carbon (PIC), and to clarify environmental factors which affect synthesis of alkenone.

(2) Instruments and methods

Particulate organic cabon (POC) and nitrogen (PON) were collected by filtering a seawater of approximately 3L on baked GF/F (25mm). Particulate inorganic carbon (PIC) was collected by filtering a seawater of approximately 2L on baked GF/F (25mm). For alkenone, a seawater of 5 L and greater was filtered by the same method as for POC, PON and PIC. All the filters were stored in a freezer.

(3) Results

Information on water sampling (station, depth and volume of water filtered) for the filteration is listed below.

AV01

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
13	129.427	3720	2000		
14		3630	2000		
15	109.117	3510	2000		
16	99.559	3560	2000		
17	75.387	3680	2000		
18	49.622	3420	2000		
19	40.156	3590	2000		
20	29.964	2880	2000		
21	20.326	3460	2000		
22	9.545	3420	2000		
23	4.876	2260	2000	3500	
24	17.058	3590	2000	4000	Chl-a Max.

AV02

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
23	5.639	3550	2000	4000	
24	14.459	3540	2000	5470	Chl-a Max.

AV03

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
23	4.747	3570	2000	4000	
24	18.066	3650	2000	5530	Chl-a Max.

AV04

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
22	4.216	3510	2000	5550	
24	25.359	3530	2000	5510	Chl-a Max.

AV05

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
23	4.847	3640	2000	5650	
24	14.628	3670	2000	5550	Chl-a Max.

AV06

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
22	4.799	3410	2000	5490	
24	23.328	3460	2000	5560	Chl-a Max.

AV07

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
19	40.302	3560	2000		
20	30.289	3470	2000		
21	20.260	3100	2000		
22	10.324	3290	2000		
23	4.917	3390	2000	5490	
24	18.079	3280	2000	5520	Chl-a Max.

AV08

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
13	38.304	3500	2000	5660	
15	29.926	3520	2000		
17	20.257	3560	2000		
19	10.491	3620	2000		
21	5.302	2470	2000	5480	

AV09

Btl. Num.	Pressure(db)	POC(ml)	PIC(ml)	Alkenone(ml)	Remark
7	24.802	3600	2000	5660	
9	19.954	3530	2000		
10	9.880	3590	2000		
11	4.952	2710	2000	5600	
12		3570	2000		

(4) Data archive

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

4. Research topics on R/V Mirai Cruise MR01-K04 (Leg 2) carried by Observational Frontier Research Program

Naoaki UZUKA (IARC-Frontier Program)
Laodong GUO (IARC-Frontier Program)
Tomoyuki TANAKA (IARC-Frontier Program)

Research topics on this cruise are to investigate

1. Distribution of Sulfur-Bearing Biogenic Compounds in Bering Sea
2. Nitrogen Isotopic Composition and Redfield C/N ratio of marine dissolved organic matter
3. Variation of Nitrogen and Carbon Isotope Ratio and Biological Processes

Description of each research topics are as follows:

4.1. Biogenic Sulfur-bearing compounds in the Bering Sea

4.1.1 Objective

Dimethylsulfide (DMS) is the most abundant biogenic sulfur-bearing compound emitted from the ocean to the atmosphere. DMS is oxidized in the atmosphere and condensed as aerosols, which affect the solar radiation on the earth. The precursor of DMS, dimethylsulfonio-propionate (DMSP), is produced by marine phytoplankton. Some phytoplankton species, such as coccolithophore, are known for their efficient DMSP production compared to diatoms. This observation study was conducted to improve our knowledge of the relationship between coccolithophore blooms and DMS production in the Bering Sea.

4.1.2 Sampling and Methods

Water samples were collected with Niskin bottles from 2-11 depths within the upper 150 m at 8 stations in the Bering Sea and 2 stations in the northwestern North Pacific. Surface water samples were collected with a plastic bucket. The sample water was filled into a 50 ml glass syringe and kept in the dark at 0 degree C until analysis. All samples were analyzed within 24 hours after sampling. For DMS measurement, a 20 ml aliquot of seawater was transferred to a glass purge chamber filtering through Whatman GF/F filter. DMS dissolved in seawater was purged with He gas and concentrated using a purge-and-trap system (Tekmar 4000J). The extracted DMS was introduced into a gas chromatograph equipped with a flame photometric detector (Shimadzu GC-17A) for the separation and the detection. DMSP was determined as DMS by adding NaOH to the seawater sample. NaOH decompose non-volatile DMSP into gaseous DMS. Dissolved DMSP (dDMSP) was determined by adding 4 ml of 6 M NaOH into the DMS-purged seawater after the DMS measurement. For particulate DMSP (pDMSP) measurement, concentrations for of DMS and DMSPs in a 5 ml aliquot unfiltered seawater was determined first by adding 1 ml of 6M NaOH. Subsequently, The concentration of pDMSP was derived by subtracting the concentrations of DMS and dDMSP measured in a filtered aliquot. The analytical precision was about 10 %.

4.1.3 Preliminary results

Figure 1 shows vertical profiles of the concentrations of DMS and dissolved and particulate DMSP. Along the transection on 166W in the Bering Sea, concentrations of DMS and DMSPs were extremely high especially at station AV6, 7 and 8 (57.5N to 58.5N), where the coccolithophore bloom was visible. A mean concentration of 4.8 nmol/l DMS in surface seawater between 57.5N to 58.5 N indicates a considerable amount of DMS is emitted from coccolithophore bloom area to the atmosphere. In the northwestern Pacific area, relatively high concentrations of these sulfur compounds were also found at station K2, where coccolithophore seemed to be abundant. These results suggest that the recent increase of the coccolithophore bloom in this region has significantly influences the production of the DMS related compounds in the ocean and consequently has an impact on the environment.

4.2. Nitrogen isotopic composition and Redfield C/N ratio of marine dissolved organic matter.

4.2.1 Objectives

1) Collect dissolved organic matter (DOM) samples for method development for stable nitrogen isotopic composition of oceanic DOM. Together with measurements of nitrogen isotopic composition of particulate organic matter (POM) and inorganic nitrate (NO3), our measurements of nitrogen isotopic composition of DOM will add new insight into a better understanding of nitrogen isotope biogeochemistry in the ocean.

2) Determine Redfield C/N ratios of size fractionated organic matter, namely particulate (POM), colloidal (COM) and dissolved (DOM) organic matter fractions, to examine how C/N ratio changes with size fractionated marine organic matter and degradation dynamics of organic matter in the ocean.

4.2.2 Methods

Seawater was filtered through a pre-combusted GF/F filter (Whatman, 0.7 µm). Particulate organic matter (POM) was defined as the >0,7 µm fraction while dissolved organic matter (DOM) was the 0.7 µm GF/F filter-passing fraction. In addition, ultrafiltration methods were used to separate different size fractionated organic matter for further chemical analysis.

DOC and TN will be measured on a Shimadzu TOC/TN analyzer for the determination of C/N ratio in the size fractionated seawater samples in the laboratory at the IARC/UAF. Stable nitrogen isotopic composition will be measured on both DOM and POM using Finnegan MAT Delta Plus GC Combustion III Unit with Carlo Erba Elemental Analyzer at the University of Alaska Fairbanks. DOM will be further concentrated and seasalts be removed in the laboratory before the isotopic analysis.

4.2.3 Expected Results

There is no report, so far, on stable nitrogen isotopic composition of marine dissolved organic matter pool due to the difficulty encountered in separating trace amount of DOM from large concentration of seasalts. However, it is indispensable in better understand the nitrogen isotope biogeochemistry in the ocean. Recently, few measurements of nitrogen isotopes were made on high molecular weight DOM, which is only a fraction of bulk DOM pool in the ocean. We will combine all nitrogen isotopic data in both inorganic and organic and both particulate and dissolved phases to provide a more complete picture of nitrogen cycling in the ocean.

Furthermore, by examining the C and N composition in size fractionated DOM samples, we expect to see a heterogeneous organic composition in the bulk DOM pool.

4.3. Nitrogen Isotopic Composition and Redfield C/N ratio of marine particulate organic matter

4.3.1 Objective

The objective of this study is to estimate the contribution of nitrate to phytoplankton for better understanding nitrogen cycling in the Bering Sea.

4.3.2 Method

Vertical distribution of isotopic composition of C and N - For the determination of 13C and 15N in particulate organic matter (PON) and 15N in nitrate, 9liter seawater samples were collected from the surface to bottom layer at station AV1, AV3, AV5, AV7, AV9, K1 and K2. These samples were filtered thought precombusted Whatman GF/F filter with 47mm diameter. After filtration, the filters were frozen -20 degree until analyses of ^{13}C and ^{15}N in PON and 2.5 liter filtered seawater samples were stored in glass bottles with addition of 8ml conc. HCl.

4.3.3 Expected results

Phytoplanton in the Bering Sea and North Pacific utilized nitrate which supply from deep seawater in the North Pacific. However, it is not clear the effect of supply North Pacific derived water to the Bering Sea on nitrate utilization by phytoplankton. The purpose of this study is to identify the contribution of nitrate to the Bering marine phytoplankton by using isotopic composition of nitrate-nitrogen and particulate nitrogen. The results from this study will contribute to estimate the nitrate utilization by phytoplankton.

All data presented here is not final and subject to change due to more precise calibration of the instruments and procedures afterward. Therefore, those cannot be cited in any means.

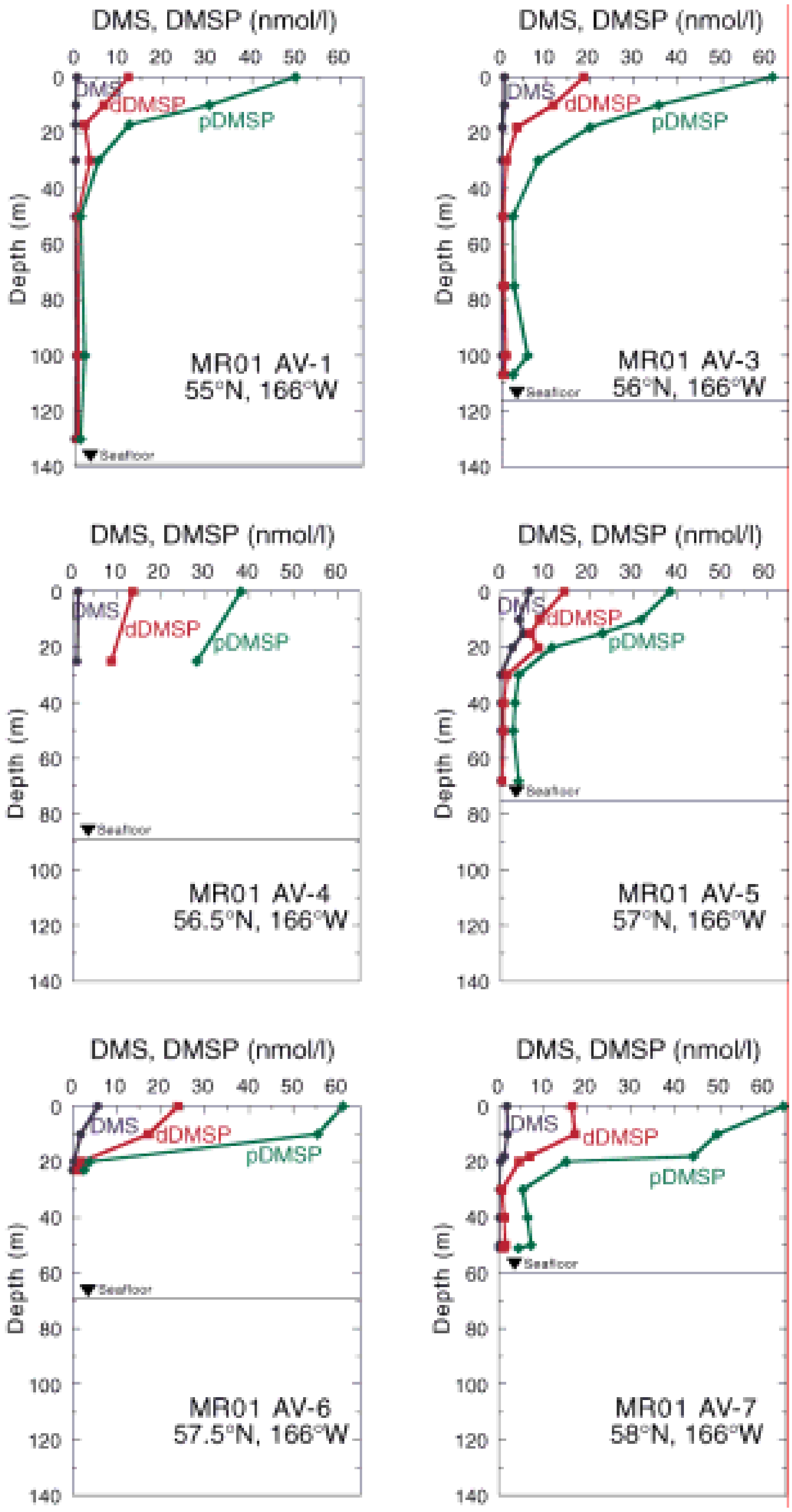

Figure 4.1. Vertical profiles of DMS, dissolved DMSP and particulate DMSP.

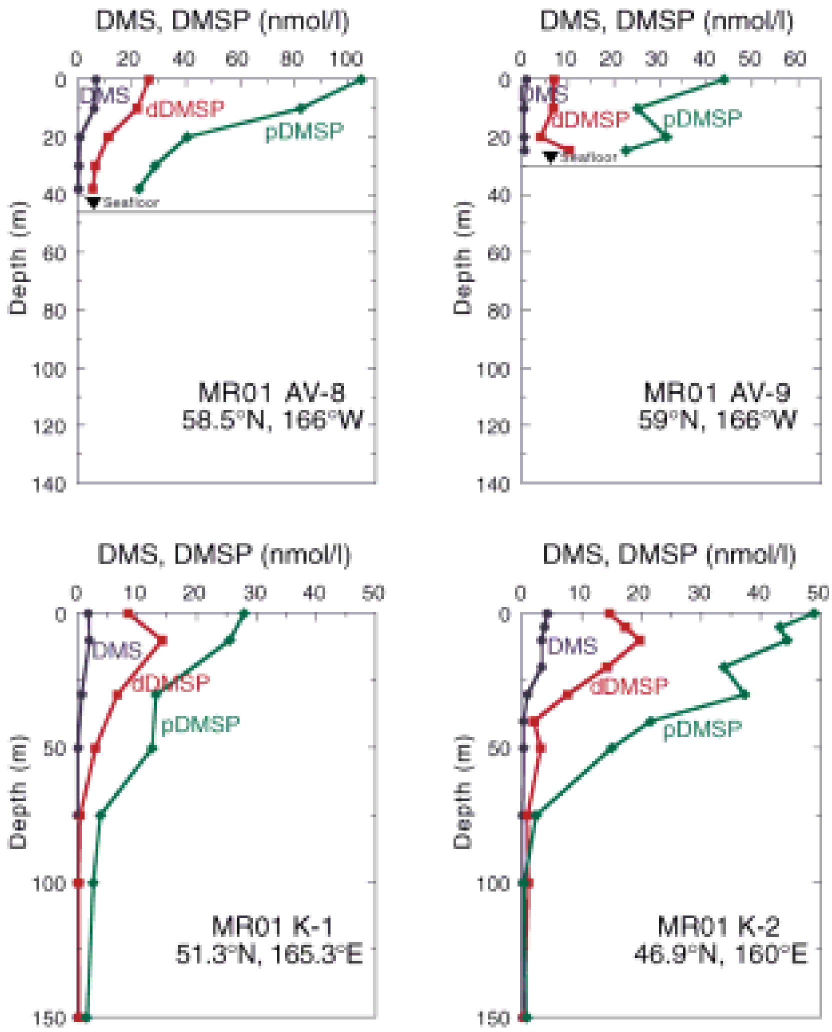

Figure 4.1 (continued). Vertical profiles of DMS, dissolved DMSP and particulate DMSP.

5. Rare earth element geochemical characters and the mechanism of the coccolithopore bloom in the Eastern Bering Sea

Mariko HATTA, HirokoYAMAKOSHI, Sawako HONMA and Jing ZHANG
(Toyama University)

(1) Introduction

It is well known that the coccolithopores are one of the major phytoplankton groups in the oceans. They influence the global climate system by contributing to the inorganic and organic carbon pumps (photosynthesis) and by emitting dimethyl-sulphide (DMS). Their calcite platelets (coccoliths) are major contributors to the carbonate content in deep-water sediments. Recent analyses of satellite imagery have found that large-scale coccolithopores, the ubiquitous species *Emiliania huxleyi*, have bloomed in early summer from 1997 in the cooler, N-deficient waters of the Bering shelf. These data also showed that their occurrence mechanisms play an important role in understanding the carbon cycles in the area. In order to understand the ecology of coccolithophore and their blooming mechanisms, it is essential to elucidate the water mass's geochemical character and the transformation of living biocoenoses in the coccolith carbonate oozes at the sea flour.

Due to the simplicity and predictability of their chemical systematics, rare earth elements (REEs) have been receiving increased attention in marine geochemistry, and the recent studies indicate that the REEs, especially the ratios of their neighboring trivalent HREEs (heavy REEs), are particularly useful as tracers of different water masses. In this study, water sampling and dissolved/particulate REE measurements were carried out. In order to clarify the material transportation and cycles, such as the denitrification on the continental shelf in the Bering Sea, analyses were made during this expedition on the nutrients and other chemical components of the pore water in the sediment, which was also collected for further analysis with a multiple-core sampler.

(2) Objectives

Dissolved and particulate REE (rare earth element) concentrations of seawater have been investigated in this study, and the purposes of this work include:

1) To complete vertical profiles of dissolved and particulate REEs in Bering Sea water columns;
2) To clarify the REE fractionation between the dissolved and particulate phases in the surface seawater, thus gaining an understanding of their physical-chemical reactions during the scavenging process;
3) To demonstrate the REE transportation mechanism between the continental shelf and the open ocean and calculate the budget of their fluxes;
4) To investigate the water mass's geochemical character and comprehend the ecology of coccolithophores and their blooming mechanisms.

(3) Instruments and Analytical Methods

1) Surface seawater and particles:

Surface seawater, about 20 liters each sample, was collected from 5 stations (table 1) with a handmade pre-cleaned bucket for dissolved REE determination.

Table 1 Surface water locations for dissolved/particulate REEs collected by bucket.

Sampling Date	Station Number	Length in core and number of segments
29th. August	AV5 (MC-1)	16 cm (19 segments)
30th. August	AV7 (PL-1)	14 cm (18 segments)
31st. August	AV9 (MC-7)	18 cm (20 segments)

Immediately after collection, all seawater samples (2 liters) were filtered through 0.1-μm membrane filters. The residues and filters were stored in a refrigerator, and the filtrate was acidified to pH<1.6 for analysis on land in the near future.

2) Seawater in water column:

To measure dissolved REEs, a total of 22 seawater samples (2 liters each) were obtained at 6 stations (Table 2) for column water in the Eastern Bering Sea with standard

Table 2 Sample locations for dissolved REEs collected by NISKIN-X.

Sampling Date	Station Number
28th. August	AV1
29th. August	AV3
30th. August	AV5
31st. August	AV7
31st. August	AV8
31st. August	AV9

CTD/Niskin-Rossete and X-NISKIN bottles. After collection, all seawater samples were filtered at once through 0.1-μm membrane filters and also acidified to pH<1.6.

3) Pore water in sediments:

Sediment coring was conducted at 3 stations (table 3.) with a multiple core sampler produced by Rigosha Co. After recovery, the sediment was cut at 0.5- to 1-cm

Table 3 Sample locations for pore water of sediments by multiple core sampler.

Sampling Date	Station Number	Sample Depth in water column
28th. August	AV1	20, 40, 60, 80, 131m
29th. August	AV3	20, 30, 40, 80, 106m
30th. August	AV5	10, 25, 30, 65m
31st. August	AV7	20, 30, 50m
31st. August	AV8	20, 30, 38m
31st. August	AV9	10, 25m

depth intervals and passed into plastic disposable syringes that were then plugged into a squeeze system. The pore water was acquired while keeping it cold (3 to 4℃) in a refrigerator, which approximated the bottom water temperature where these sediments were sampled. The nutrients in the pore water were analyzed on board the boat after being filtered through a 0.22-μm filter capping the syringe. The other chemical components will be determined at a university laboratory after this expedition.

(5) Data Archive

All of the raw and processed data on the seawater and sediment will be submitted to the JAMSTEC Data Management Office (DMO) as soon as analysis is completed and will remain under its control.

6. Effect of ultraviolet radiation on phytoplankton assemblages in the North Pacific Ocean

Nozomi FUKUSHIMA(Soka university)：Leg1,2
Tokue TAKANO(Soka university)：Leg1,2

(1) Introduction

Since underwater instrument has been developed recently to determine a penetration of ultraviolet radiation, the penetration characteristics have been recognized in various waters. Ultraviolet radiation-B (UV-B) can penetrate even to a deep part of euphotic zone. The decrease of ozone concentration has enhanced the penetration of ultraviolet radiation. Phytoplankton seems to be suffered from the deeply penetrated ultraviolet radiation.

It is important to investigate the effect of the ultraviolet radiation on the phytoplankton which supports the ecosystem of the ocean.

(2) Objectives

The effect of the ultraviolet radiation on the phytoplankton in the North Pacific Ocean is evaluated by the following objectives;

A) Shipboard experiment of photosynthesis curve (P vs I curve) is carried out using surface sea water and sea water at 1 % light penetration depth in order to evaluate the effect of the ultraviolet radiation on the photosynthesis of phytoplankton.
B) The 24 hour incubation experiment is carried out using surface radiation on sea water on board in order to evaluate the effect of the ultraviolet radiation on pigments and DNA of phytoplankton.

(3) Materials and Methods

A) Observation of ultraviolet radiation quantity and photosynthetically available radiation (PAR)

Ultraviolet radiation in air and PAR were observed continuously on the deck. Underwater ultraviolet radiation and PAR were measured at stations (Table 1).

B) Photosynthesis experiment (P vs I curve).

Surface waters (40L) were sampled in the morning by the bucket at stations (Table 2), and P vs I curve experiment was carried out.

Surface water sample was distributed to 10 light bottles and 1 darkness bottle, and NaH13CO3 aqueous solution was inoculated to start the incubation experiment for 3 h at surface water temperature. Subsamples for chlorophyll pigments particulate organic carbon (POC), was collected. Subsamles for nutrient and microscopic observation were collected at time zero.

C) Simulated *in situ* incubation experiment.

Surface sea water (100～140L) was collected at station before sunrise (Table 3). The culture bottle, the quartz bottle and the acrylic container were used. The each container was cultivated in incubator installed on the deck for 24 hours.

Subsamplesfor pigments, POC, PON, size fractionation of phytoplankton, DNA were collected at the beginning and end of the incubation. Subsamples for nutrient microscopic observation were also collected.

Table 1. Sampling location for ultraviolet radiation and PAR observation.

Station 1	Station 4	Station 7

Table 2. Sampling location for P vs I curve experiment.

Station 1	Station 4	Station 7

Table 3. Sampling location for simulated *in situ* incubation experiment.

AV Q	K1	K2

5) Data sharing.

All samples will be analyzed as soon as possible and made available for the public.

7. Research of the coccolithophorid bloom and the chemical environment

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Noriyuki TANAKA (Hokkaido Univ./ IARC-Frontier Program)
Keiri IMAI (Core Research for Evolutional Science and Technology)
Zhang JING (Toyama Univ.)
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Tomoyuki TABNAKA (IARC-Frontier Program)
Seiiti SAITO (Faculty of Fisheries, Hokkaido Univ.)

(1) Introduction

Coccolithophores are one of the main groups of calcifying organisms in the marine environment. *Emiliania huxleyi* is the most common coccoithophorid and is one of the species which has a worldwide distribution. *Emiliania huxleyi* detected by satellite forms huge blooms in coastalor open ocean, sometimes exceeding 100,000 km^2 in area and persisting for several weeks. Thus, *Emiliania huxleyi* can contribute to primary production or export production, and influence the oceanic carbon cycles but also the global climate system, because CO_2 was released from the ocean surface during calcification by this organism and dimethylsulfonio-propionate (DMSP), which is the precursor of dimethyl-sufide (DMS), are more produced by this species. A better understanding of coccolithophore ecology also need to use them as a proxy of past climate change from sedimentary record.

In the Bering Sea, blooms of *E. huxleyi* develop past 5 years in early summer as revealed by satellite imagery. In order to understand the generating factor of the coccoithophorid bloom in the Bering Sea and its impact on oceanic environment, we conducted seawater sampling, batch culture experiments and bio-optical measurements in this cruise.

(2) Method

2-1. Measurement of primary production rate

For understanding the inorganic ^{13}C uptake by phytoplankton photosynthesis and calcification, incubation experiments carried out vertically in the station AV004, AV006 and AV007 and K2, and at surface water in the station AV003, AV008, AV009 and in near K2 station of this cruise. Water samples were collected using Niskin-X bottles attached CTD/CWSS from the 6 layers corresponding to 100, 34, 17, 8.5, 4, 0.9 % of surface irradiant decided using the underwater unit, PRR-600 and drained into 250 ml and 1000 ml of acid-cleaned polycarbonate bottles. After addition of ^{13}C -$NaHCO_3$ those bottles were incubated for 24 hrs. Particle matter was filtered onto precombusted grass fiber filter after incubation. Primary production and calcification rate will be calculated with concentration, ^{13}C atm % of particulate organic carbon (POC) and inorganic carbon (PIC) will be determined by tracer. We also took the samples for measuring nutrients of and total dissolved carbon dioxide at each layer.

2-2. Measurement of total phosphorus, particulate phosphorus and chlorophyll a concentrations

Water samples for total phosphorus, particulate phosphorus and chlorophyll a were collected using Niskin-X bottles attached CTD/CWSS at all stations. Total phosphorus samples were poured into 100 ml acid-cleaned polyethylene bottles, and were kept in a freezer (-20°C) immediately after sampling. Particulate phosphorus samples were collected into a 10-L of acid cleaned polyethylene bottles. Particulate matter was filtered onto precombusted grass fiber filter (Whatman GF/F). The filter after filtration was rinsed with filtered seawater and stored under –85°C in a freezer until analysis. Chlorophyll a samples were carried out size fraction with nuclepore filter (with the pore size in 2 and 10 μm) and grass fiber filter (Whatman GF/F). Samples were collected in 1,000 ml of dark polyethen bottles and filtered though each filter. Filtering volume were 200 ml for GF/F filter, 500 ml for 2 μm of nuclepore filter and 1,000 ml for 10 μm of nuclepore filter. Filtered samples were extracted in 6 ml of N, N-dimethylformamide and stored keeping in cold and dark condition until analysis. Chlorophyll a was determined by the fluorometer method with a Turner Designs Fluorometer. The vertical section of Chlorophyll a concentrations is shown in Figure. 1.

2-3. Culture Experiment

In order to understand the optimum oceanic environment for coccolithoporid growing, the batch culture experiments were carried out in the station AV006, AV007, AV009 and MC2 in the Bering Sea and at the station K2 and near K2 station in the northern North Pacific. Surface water samples were collected using Niskin-X bottles or acid-cleaned plastic bucket in each station. Seawater was poured into 9 L polycarboonate bottles. After one to 5 days, the bottles were either spiked with organic phosphorus, ammonia and left as controls, and were incubated in shipboard incubations at surface-water temperature for more 4-5 days under natural light condition. The treated water and controls were sampled every day for chlorophyll a, nutrients including total phosphorous and cell counting of coccolithophorids. After 2 days from making condition, tracer experiment using ^{13}C-$NaCO_3$ were carried out at each condition, in order to estimate phytoplankton photosynthesis and calcification rate.

(3) Future work

The phytoplankton photosynthesis and calcification rate will be estimated by using ^{13}C tracer experiments from various oceanic environments, namely field experiments and culture experiments, and then compared each other. The results about the generating factor of the coccoithophorid bloom in the Bering Sea and its impact on oceanic environment from chemical and physical oceanic field will be discussed.

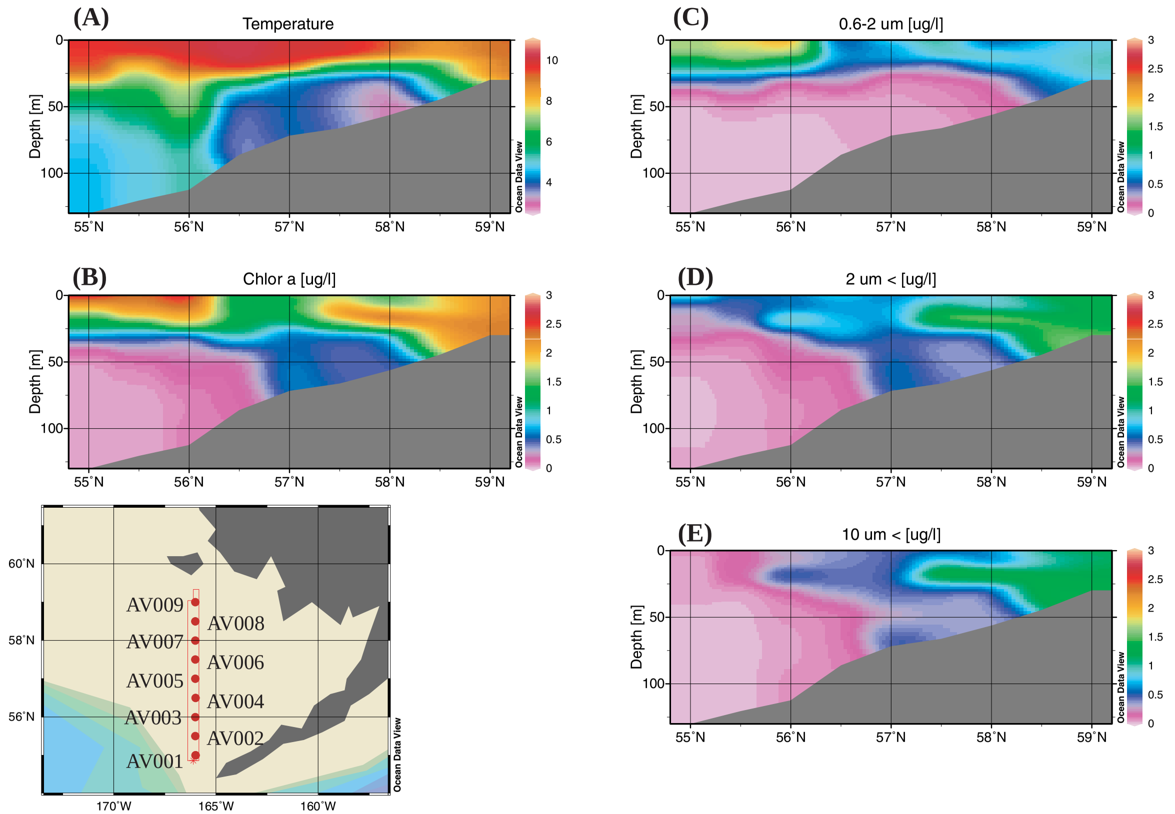

Fig. 1 Vertical section of (A) temperature, (B) chlorophyll a, (C) chlorophyll a from 0.6 m to 2 m, (D) chlorophyll a over 2 m and (E) chlorophyll a over 10 m during the transect of stations AV001 to AV009 across the Bearing shelf on late Aug. 2001 in MR01-K04 curise.

8. Sediment core sampling

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Wataru YAHAGI(Toyama Univ.) and Toshiya KANAMATSU (JAMSTEC)
Yuuko YAMAKOSHI and Jing ZHANG (Toyama Univ.)
Laodong GUO and Kyung Hoon SHIN (IARC-Frontier Program)
Aya KATO, Yutaka MATSUURA and Soiti MORIYA (Marine Works Japan, Co.)

(1) Objective

Objective of sediment coring in this cruise is follows: (1) to understand biogeochemical processes on the continental shelf and fate of lithogenic materials transported from the rivers to the Bering Sea coupling with sea water analysis and (2) to understand and reconstruct past changes of biogeochemical cycles and oceanic environments related to global climate.

(2) Coring equipment

Multiple core sampler consists of 620 kg weight and 8 acrylic sub-core tubes (length: 600 mm, I.D.: 73 mm) to recover the sediment/water interface. Piston core sampler consists of a 1500kg-weight, a total 10m-long duralumin pipe (5m x 2), 15m-long duralumin pipe (5m x 3), and a pilot core sampler. The inner diameter of pipe is 80mm. We used a multiple core sampler “Ashura” equipped with an 80kg-weight and three sub-cores of 60cm in length and 73mm I.D. for a pilot core sampler.

(3) Sampling location

Tow multiple cores and one piston core were obtained from the eastern Bering Shelf. Sampling locations and cored length were listed in Table 1 with collected data. The geographic positions were determined by using the global positioning system (GPS) of WGS84. In order to comprehend bathymetric and sub-bottom refection distributions, site survey for coring was carried out also using the 12 kHz SEA BEAM 2100 Multi Narrow Beam Bathymetric Survey System with 4 kHz Sub-bottom Profiler (SeaBeam Instruments, Inc.) in some station.

(4) Onboard measurements

1) Multi-Sensor Core Logging (MSCL)

Gamma-ray attenuation (GRA) and magnetic susceptibility (MS) measurements were performed on Multi-Sensor Core Logger (MSCL; GEOTEK, Ltd.) using whole-core sections. GRA measurement was carried out each 1cm of whole core. Gamma-ray (at 660 keV) emitted from ^{137}Cs source was counted for 10 seconds using NaI scintillation counter to estimate bulk density of the sediment. The calibration was achieved using the telescoping aluminum rod (five elements of varying thickness) mounted in a piece of core inner and filled with pure water. The fractional porosity was calculated from the bulk density provided from GRA data using core diameter and average mineral density. Magnetic susceptibility measurement was simultaneously carried out using Bartington MS-2C system within the MSCL. The results for PC-02 are shown in Fig. 1.

2) Sediment color

Color reflectance of the split core surface was carried out using Minolta CM2002 reflectance photospectrometer using 400 to 700 nm in wavelengths. The measurement was run through a commercial grade polyvinylethylene sheet wrapped on the sediment surface of split half core at 0.5 to 1 cm after calibrated the zero value of the reflectance using white color calibration plate (Minolta Co., Ltd.). The color reflectance data was indicated as second CIE (Commission International d'Eclairage) 1976 color space in therms of L*, a* and b* values. L* value indicates psychometric lightness and corresponds to black (L* = 0) and white (L* = 100). a* and b* are psychometric chomaticness. The Plus values of a* correspond reddish, the minus one is greenish. For b* value, plus values correspond to yellow, minus ones to blue. The results for PC-02 are shown in Fig. 2.

3) Visual core description, photograph and Soft-X photograph

Visual core description and Smear slide observation were executed to represent lithologic features, components and sedimentary stratigraphy. Schematic illustrations of visual core description for PC-2 are shown in Fig. 3.

Photograph and soft X-ray photograph observation were also conducted to identify sediment structures. For sectional photographs, archive halves were taken using a Nikon single-lens reflex camera and a Fujifilm digital camera. When using the Nikon reflex camera, shutter speed was selected on 1/100, 1/200 and 1/320. Sensitivity ISO 100 was used on negatives. For soft X-ray photograph, PRO-TEST 150 (SOFTEX) was conducted after picking up the sediment samples from split core using plastic cases (200 x 30 x 7 mm). X-ray photographs of samples through the plastic cases were taken under a standard condition that is practically known (50kVp, 3mA, in 200 seconds).

(5) General results

These cores are composed chiefly grayish olive sometimes containing olive black colored silty clay or sandy silt containing medium sand. Coccolithophorids are identified at the core top, microfossils of diatom are common in those sediments also. The bioturbation is mainly developed at top to 10 cm, sometimes at deeper part. Shell fragments are identified in the sediments. In PC-02, the dropstones are identified below Section 2. For piston core samples, the sediments were disturbed entirely for PC-01 and below 288 cm for PC-02, due to slip out when the corer was pulled out from sediment.

(6) Sample distribution and land analysis

Core samples were distributed into 4 organizations. After sampling, archive materials were placed into polyethylene bags, then tightly sealed and transferred to cold storage (4°C) aboard R/V Mirai. These materials are going to be stored in the cold storage (4°C) in JAMSTEC after the cruise, and other samples will be used for various analysis in each laboratory.

Table 1 Summary of sediment core sampling during the cruise MR01-K04.

Core #	Station	Date (UTC)	Latitude*	Longitude*	Water dpeth (m)	Cored length (cm)	Remarks
MC-01	AV005	30.Aug.2001	56-59.84N	166-00.03W	75	16.0	
MC-02	-	1.Sep.2001	58-11.94N	167-24.14W	73	18.5	
PC-01	AV007	31.Aug.2001	57-59.94N	166-00.18W	60	582.0	False, disturbed entirely
PC-02	-	1.Sep.2001	57-59.98N	168-00.17W	70	671.5	Disturbed below 288 cm

* The geographic positions are on the scale of WGS84 for Global Positioning SyStem (GPS).

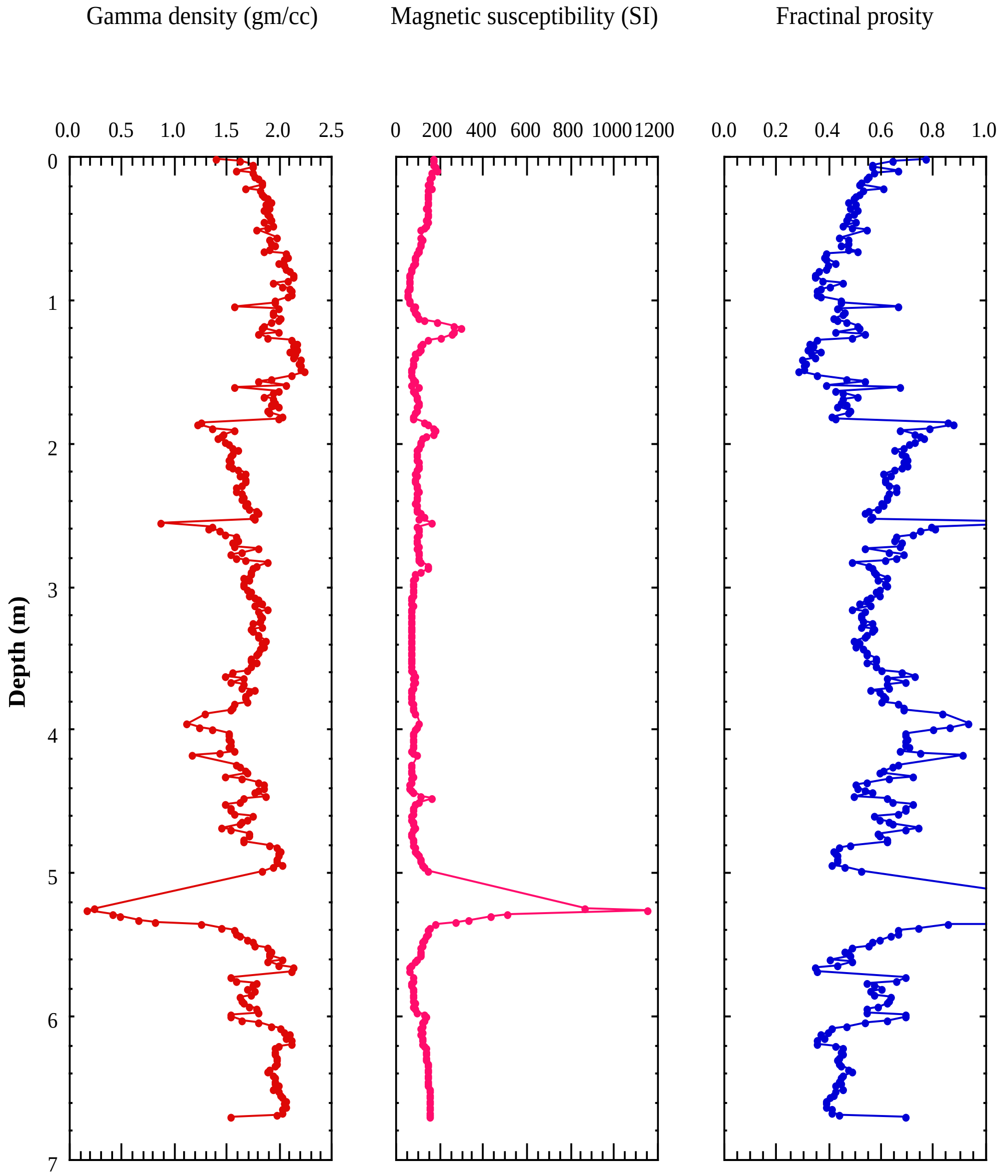


Fig. 1 Down-core variations of physical properies in core PC-02.

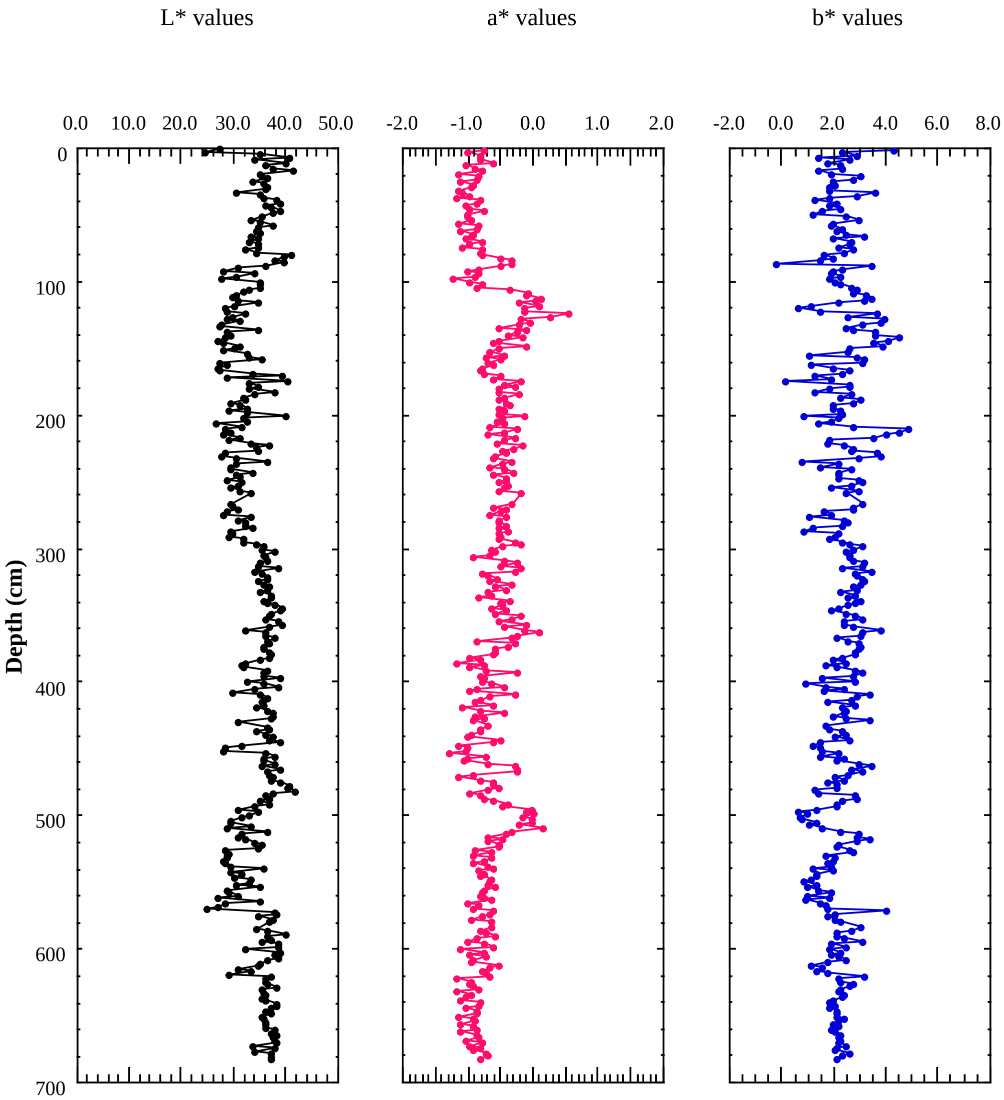


Fig. 2 Down-core variations of color reflectance in core PC-02.

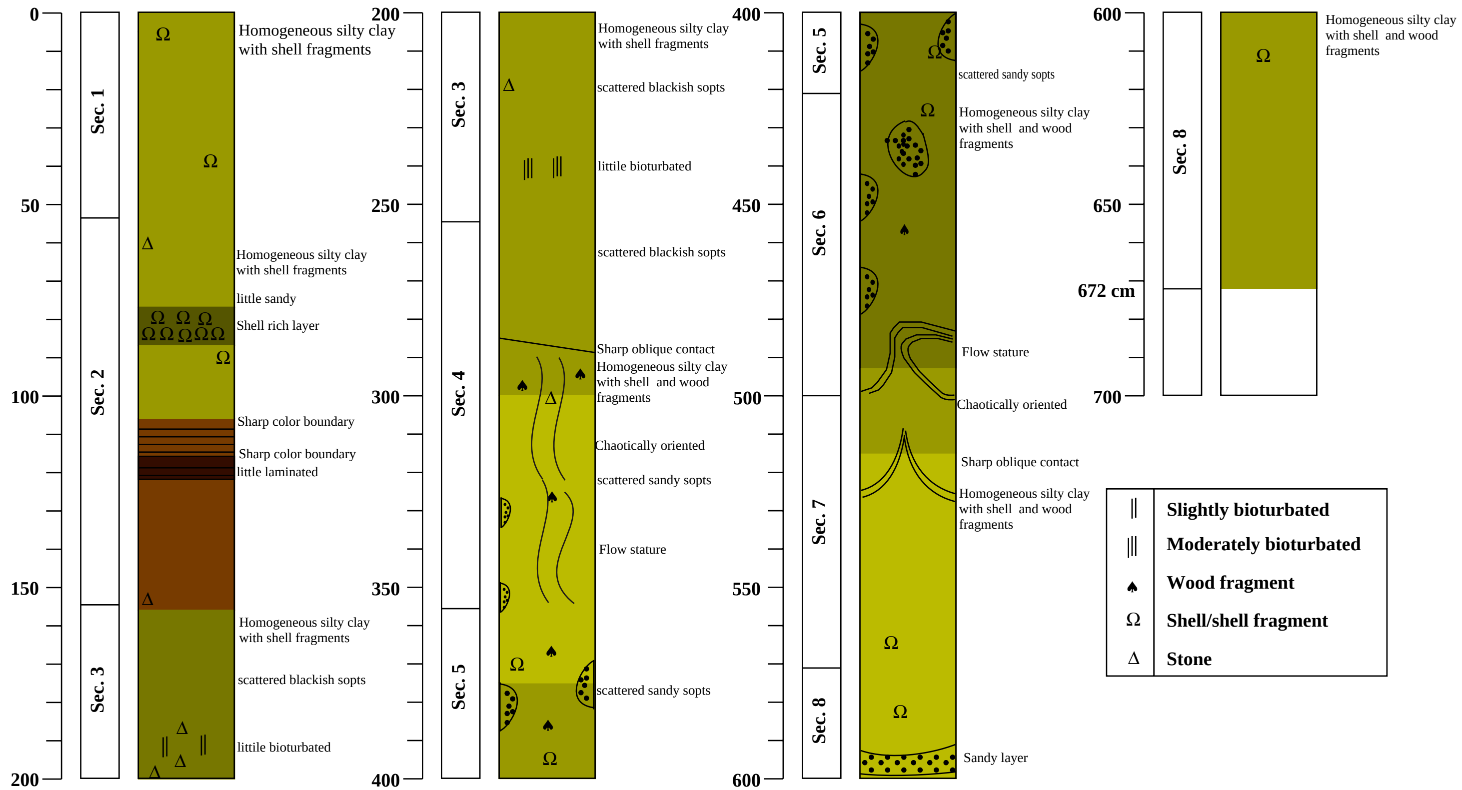


Fig. 3 Visual distribution of core PC-02.

9. Geophysical Survey

Masaki HANYU (GODI):
Akinori UCHIYAMA (GODI)
Naoto MORIOKA (Mirai crew)
Shinya IWAMIDA (GODI)

9.1 Sea Bottom Topography Measurement

(1) Objective

a) To obtain the bathymetry data for the contribution of geophysical investigation.

b)To obtain the bathymetry data for the sea water sampling, core sampling and mooring ADCP buoys during the cruise.

(2) Methods

Bathymetry data was obtained by using SeaBeam2112.004 (SeaBeam, Inc., USA) 12kHz multi-narrow beam echo sounding system with 4kHz sub-bottom profiler.

(3) Preliminary results

Figure 9.1-1 and Figure 9.1-2 show bathymetric map around Station K1 and K2 respectively.

(4) Data archives

This raw dataset will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise by CD media.

9.2 Sea Surface Gravity Measurement

(1) Objective

To obtain gravity data for the contribution of geophysical investigation.

(2) Methods

The sea surface gravity data was obtained by using S-116 (LaCoste-Romberg, USA) gravity meter. For the calibration, the shore side gravity was measured at Dutch Harbor on the beginning of the cruise and Sekinehama on the end of the cruise by using CG-3M (Scintrex) portable gravity meter.

(3) Data archives

This raw dataset will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise by CD media.

Remarks concerning about data quality are as follows;

9.3 Surface Three Component Magnetic Field Measurement

(1) Objective

To obtain surface 3-component magnetic field data for the contribution of geophysical investigation.

(2) Method

The surface 3-component magnetic field data was obtained by using 3-component magnetometer (Tera Technica, Japan) at the sampling rate 8Hz. We observed continuously through this cruise.

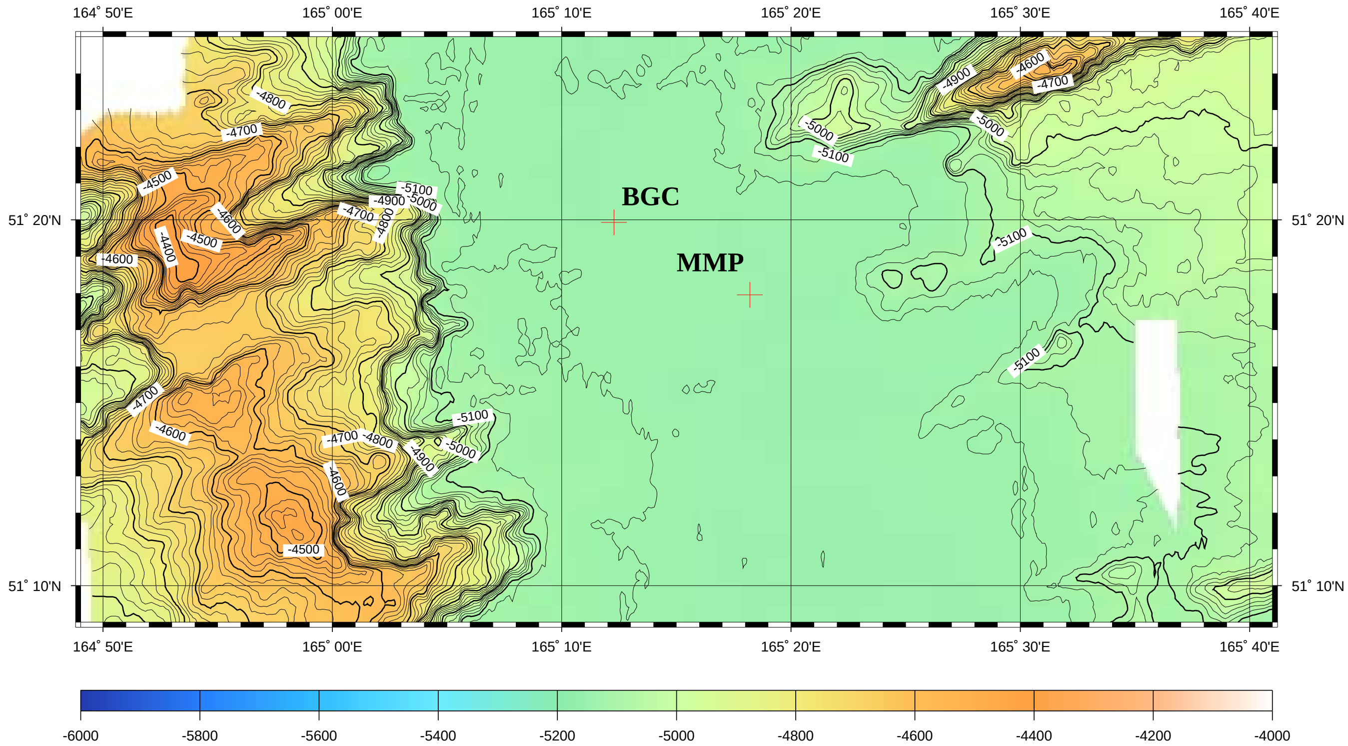
(3) Data archives

This raw dataset will be submitted to the Data Management Office (DMO) in JAMSTEC just after the cruise by CD media.

Remarks concerning about data quality are as follows;

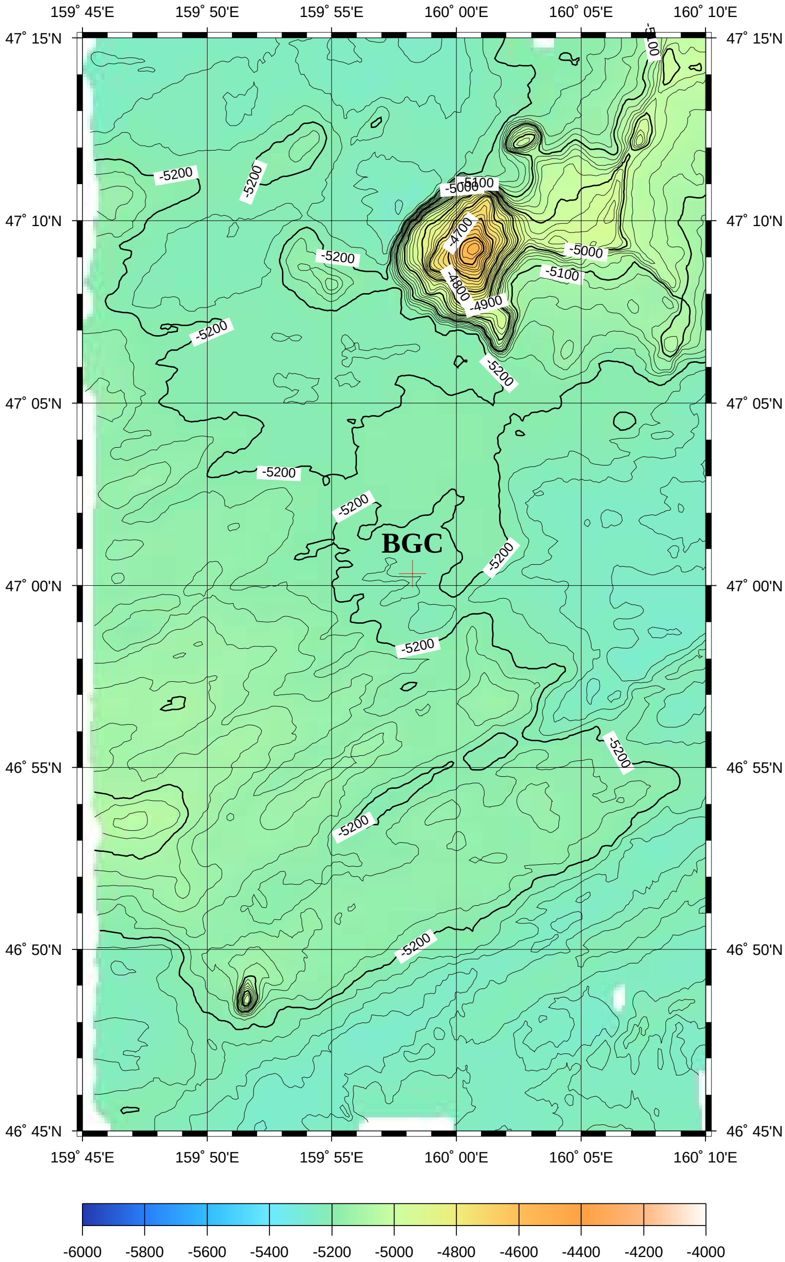
1. Ship's motion data was stopped in the following period because of the Doppler radar INU alignment;
   1) From 25/0614UTC to 25/0634UTC May 2001

MR01-K04 K1



20m Contour

MR01-K04 K2



20m Contour

10 Radionuclieds

Kazuhiro HAYASHI (JAMSTEC - MIO)
Roger FRANCOIS (WHOI - JPAC)

(1) Objective

^{230}Th (half life 75,400 yr) and ^{231}Pa (half life 32,760yr) are produced in seawater from radioactive decay of ^{238}U and ^{235}U. Both nuclides are rapidly adsorbed on sinking particles and removed from seawater. Therefore, these nuclides concentrations of particles and seawater are considered as proxy of biological pump. The purpose of this study is to obtain information on the dissolved and particle concentration of ^{230}Th and ^{231}Pa in the Northwest Pacific.

(2) Method

The samples were collected at station K1 and K2. Sampling layer and filteration volume are shown in Table 1.

1) Particulate sampling

Particulate samples were collected by Large Volume Pump (LVP: McLane WTS-6-1-142V). LVP is designed for large volume, *in situ* collection of particles and maximum volume 25,000 L for 4 L min^{-1} pump head with 30 Ahr alkalinity battery. LVP can be deployed to a depth of 5,500m in water temperature from 0~50^{o}C. LVP was attached on Piston corer cable (17 mm o. d.). Vaspor filter (142 mm, 0.8 μm) were used and collection about ~400L same layer seawater sampling. After filteration, filters were moved to pettri dish and stored under room temperature.

2) Dissolved sampling

The sea water samples (~ 20 L) are immediately filtered gravitationally using 0.8μM Vaspor filter from the hydrocast bottles into 20L polyethylene collapsible cubitainers and weighed by a computerized balance with a precision of better than 2%. The samples are acidified with 30 ml 6M - HCl and spiked with ^{229}Th, ^{233}Pa, and $FeCl_3$. After overnight for equilibration, the pH is adjusted to about 9 by adding NH_4OH to precipitate $Fe(OH)_3$ that adsorbed dissolved and entrain particulate Th and Pa. After decantation, overlying water was removed. When the volume of water is reduced to ~ 1 L, the sample was transferred to a plastic beaker to continue decantation. As a result, each supernatant is separated by centrifuging in 50 ml polypropylene centrifuge tubes and returned to the laboratory for chemical separation and analysis.

(3) Future works

Each sample will be separated by ion exchange, using a procedure that is modified by Fleer and Bacon (1991). ^{230}Th and ^{231}Pa are measurement by High Resolution Inductive Coupled Plasma Mass Spectrometry.

Reference

Fleer A. P. and Bacon M. P., (1991) Notes on some techniques of marine particle analysis used at WHOI. *In Marine Particles: Analysis and Characterization* (ed. D. C. Hurd and D. W. Spencer), pp 223-226. Geophysical monograph 63, AGU.

Table1 LVP and Hydrocast sampling layer and filteration volume

StationK1		StationK2	
depth/m	Filteration volume /L	depth/m	Filteration volume /L
30	3.785	30	102.952
30	43.906	**30**	**102.195**
100	241.483	100	239.969
200	134.3675	200	269.1135
500	386.07	500	264.5715
1000	451.929	**1000**	**345.5705**
1500	362.2245	**1500**	**329.6735**
1500	425.8125	**2000**	**364.4955**
2000	**110**	**2000**	**386.07**
2800	**2**	**2800**	**352.762**
2800	**391**	3600	399.3175
3600	**0**	3600	363.7385
4400	**1**	**4400**	**241.8615**
4900	**0**	**4900**	**336.4865**
4900	**1**	5100	332.7015
5050	**0**	5100	310.7485

*) Bold style characters mean second cast for LVP

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11.2 Studies on behaviors and climate influence of atmospheric aerosols over the subpolar region of the Western North Pacific Ocean

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Hisashi NARITA (Graduate school of earth environmental science, Hokkaido University)
Tamio TAKAMURA (Center of environmental remote sensing science, Chiba University)
Sachio OHTA (Engineering environmental resource laboratory, Graduate school of engineering, Hokkaido University)
Teruyuki NAKAJIMA (Center of climate system research, University of Tokyo)

Abstract

Objective theme is the investigation of horizontal distribution on the concentration and size distribution and optical properties of atmospheric aerosols at the surface and optical thickness of columnar aerosol over the ocean.

To clear and solve the problems of horizontal distribution and optical properties of aerosols, some observations were carried out over the sub-polar region of the North Pacific Ocean. Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously

To obtain the data for calibration and validation between remote sensing and surface measurements over the ocean, a series of simultaneous observations has been carried out about optical properties like as scattering and absorption coefficients and radiative properties as optical properties of atmospheric aerosols, the concentration and size distribution of surface aerosols over the ocean region of the sub-polar region of the North Pacific Ocean 19 days from 28 August 2001 to 15 September 2001. In addition of that, a sky radiometer was examined for to a fully automated ship-borne instrument and improved to the practical usage on same board.

(1) Objects / Introduction

One of the most important objects is the collection of calibration and validation data from the surface (Nakajima et al.1996, 1997 and 1999). It may be considered for the observation over the widely opening of the huge ocean to be desired ideally because of horizontal homogeneity. Furthermore, the back ground values of aerosol concentration are easily obtained over there (Ohta et al.1996, Miura et al. 1997 and Takahashi et al. 1996) and vertical profile of aerosol concentration are obtained by means of extrapolation up to the scale height. It is desired to compare the integrated value of these profile of aerosol concentration with optical thickness observed by the optical and radiative measurement (Hayasaka et al. 1998, Takamura et al.1994). Facing this object, the optical and radiative observations were carried out by mean of the Sky Radiometer providing more precise radiation data as the radiative forcing for global warming.

(2) Observational duration

From 28 August 2001 to 15 September 2001 (19 days)

(3) Area of ocean

Sub-polar area of North Pacific Ocean

(4) Measuring parameters

Atmospheric optical thickness, Ångström coefficient of wave length efficiencies, Direct irradiating intensity of solar, and forward up to back scattering intensity with scattering angles of 2-140degree and seven different wave lengths

GPS provides the position with longitude and latitude and heading direction of the vessel, and azimuth and elevation angle of sun. Horizon sensor provides rolling and pitching angles.

Concentration and size distribution of atmospheric aerosol.

(5) Methods

The instruments used in this work are shown as following in Table 11.2.1.

Sky Radiometer was measuring irradiating intensities of solar radiation through seven different filters with the scanning angle of 2-140 degree. These data will provide finally optical thickness, Ångström exponent, single scattering albado and size distribution of atmospheric aerosols with a kind of retrieval method.

Optical Particle Counter was measuring the size of large aerosol particle and counting the number concentration with laser light scattering method and providing the size distribution in 0.3,0.5,1.0,2.0 and 5.0 micron of diameter with real time series display graphically.

(6) Results

Information of data and sample obtained are summarized in Table 11.2.2. The sky radiometer has been going well owing to more calm and silent condition and circumstances about shivering problems provided by the R/V Mirai whose engines are supported by well defined cushions. Therefore, measured values will be expected to be considerably stable and provide good calculated parameters in higher quality. However, some noise waves were found to interfere the 16,13 and 12channel marine bands of VHF from sky radiometer. Fortunately the origin and source were identified by using a VHF wide band receiver and the interference waves were kept by fairly separating from two VHF antennae and decreased to recovery of 100%.

Aerosols size distribution of number concentration have been measured by the Particle Counter and data obtained are displayed in real time by a kind of time series *in situ* with 5stages of size range of 0.3, 0.5, 1.0, 2.0, and 5.0 micron in diameter.

(7) Data archive

This aerosol data by the Particle Counter will be able to be archived soon and anytime. However, the data of other kind of aerosol measurements are not archived so soon and developed, examined , arranged and finally provided as available data after a certain duration. All data will archived at ILTS (Endoh), Hokkaido University, CCSR(Nakajima), University of Tokyo and CEReS (Takamura), Chiba University after the quality check and submitted to JAMSTEC within 3-year.

Data Inventory

Table 11.2.1 Information of obtained data inventory (Method)

Item, No.data	Name	Instrument	Site position
Optical thickness Ångström exponent.	Endoh	Sky Radiometer(Prede,POM-01MK2)	roof of stabilizer
Aerosol Size distribution	Endoh	Particle Counter(Rion,KC-01C)	compass deck(inlet) & environmental research laboratory

Table 11.2.2 Data and Sample inventory

Data/Sample	rate	site	object	name	state	remarks
Sun & Sky Light	1/5min (fine& daytime)	roof of stabilizer	optical thickness Ångström expt.	Endoh	land analysis	8/28’01-9/15’01
Size distribution of aerosols	1/2.5min	compass deck	concentration of aerosols	Endoh	on board	8/28’01-9/15’01

References

Takamura, T., et al., 1994: Tropospheric aerosol optical properties derived from lidar, sun photometer and optical particle counter measurements. Applied Optics, Vol. 33, No. 30,7132-7140.

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Goals, Objectives and Significance

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The overarching goal of the Mutsu Institution for Oceanography (MIO), Mutsu City, established in 2000 under the auspice of Japan Marine Science and Technology Center, Yokosuka, is to extend our understanding of the delicate balance between the Earth's planetary environment and life through the study of the carbon cycles in the North Pacific. The principal scientific goal of MIO is to understand the ocean dynamics and the biogeochemical cycles in the modern North Pacific. In parallel, MIO aims to reconstruct the last Glacial Period of the North Pacific that contributes to a prognostic global environmental model by combining it with the modern proxies. The foundation of this long-term program was discussed at the First International MIO Workshop that was held in March 2001 in Tokyo. The questions, objectives, and methodology proposed by MIO were supported by the Workshop's conclusion. The participants of the Workshop reached general agreement on the time-series mooring locations and annual transects of R/V Mirai for this project. (http://jpac.whoi.edu/archives/index.html.)

The Northwestern Pacific or Boreal North Pacific pose a host of significant questions for environmental oceanography and delivers exciting hypotheses that may provide a paradigm change in the understanding of the global biogeochemical cycles. This distinctive ocean is characterized by a vigorous biological pump system with high primary production associated with a large export flux that removes atmospheric CO_2 to the ocean interiors in a millennium time scale. Notably, the relationship between ocean dynamics and biogeochemical cycles appears to be more clearly represented in this basin than in most other areas of the world's ocean. The highly active oceanfronts, including the North Pacific Sub-arctic Front, also function as clear biogeochemical boundaries. These boundaries delineate the distribution of a silicate sequestering (diatom) community, (the north side of the Sub-arctic Front), and carbonate secreting (coccolithophorids) that remove alkalinity from the surface ocean, to the south. Such contrast in biodiversity significantly affects the ocean's capability for absorbing atmospheric CO_2. In addition, the North Pacific intermediate water that occupies the mesopelagic zones of the Northwestern Pacific is a globally significant sink of atmospheric CO_2 with the shorter, perhaps decadal, retaining cycles. The fate of Thermohaline Circulation here in the northwestern corner of the Pacific is not well understood. Does the divergence of global deep-water circulation in the North Pacific finally upwell here by finding topographic walls? Arguably the highest global nutrient concentration in this area may be attributed to the upwelling of deep water and positively coupled with the vigorous biological pump that withdraws atmospheric CO_2. However, the possible ventilation of the deep-layered CO_2 that is induced by the upwelling may enhance global warming.

The long range tasks of MIO includes answering the following 10 significant questions about the Northwest Pacific by observational means: (http://jpac.whoi.edu/archives/index.html.)

Why and how are the dissolved-nutrient rich intermediate and deep-water zones formed in the northern North Pacific?

1. How are the oceanic front systems in the North Pacific formed?
2. What is the reality of the Thermohaline Circulation at the end of its global transportation? Is it possible to expect a basin-scale divergence of deep water in this area before it turns into surface flow?
3. In reality, how large is the primary production in this area by zones?
4. What are the processes, rates and scale of the North Pacific Biological Pump by zones?
5. What would be the realistic rate of sequesterization of CO_2 at the mesopelagic layers and the oceanic interior of the North Pacific?
6. How does the biodiversity of phytoplankton (such as coccoliths vs. diatoms) control the carbon cycles in the North Pacific?
7. How significant is the CO_2 ventilation if an upwelling of deep water is imminent in this area?
8. What are the processes and scale of the North Pacific Intermediate Water? How is the dissolved CO_2 trapped and maintained in this water mass?
9. How does the North Pacific Ocean environment vary inter-annually? Is such variability linked with basin-scale climatological oscillations?

The 2001 R/V Mirai cruise (MR01-K04, Dutch Harbor, Alaska, to Mutsu City, Aomori) was *the inauguration voyage* of MIO in seeking the answers on the above questions together with Japanese and international ocean researchers. MIO's main strategy onboard the R/V Mirai for the 2001 cruise was to deploy autonomous, long-term, time series instrumentation to gather measurements of biogeochemical properties (BGC), particularly at the euphotic layers, and to observe the biogeochemical response throughout the mesopelagic layers to the ocean interior as well as to gather seamless, full-water column measurements of the physical oceanographic properties (PO).

Although it was operated as an independent program in regards to the inception and the funding scheme, the recurrent program on "Coccolithophorid bloom study in the Bering Shelf" by Dr. Murata, JAMSTEC and Dr. Narita, Hokkaido University was co-conducted onboard this cruise. As described in this report, recent and recurrent sightings of E. Huxleyi bloom by Dr. Murata's group, within the area that has been defined as "Silica Ocean" in the past, has cast a serious question on the stability of the biogeochemical boundaries and its possible consequences for bio-complexity and CO_2 ocean chemistry.

As the result of 2001 R/V Mirai Cruise (MR01-K04), MIO achieved the following

1. Deployment of MIO Mooring Array with BGC instruments at 2-key stations with the expectation that the Mirai Platforms will be maintained and turned-around for many years (ie a decade) by annual dedicated cruises.

2. These stations includes full-water column hydrographic/3-D current profiling (PO) to further the understanding of the North Pacific Intermediate Water and Deep/Bottom Currents by deploying separate moorings in close proximity.

3. At K-1 and K2 stations, we conducted CTD profiling/water casting, collection of suspended particles for radio-chemical proxy studies applying an in situ filteration pump array and preliminary collection of bio-particles for possible molecular proxy investigations for the next cruise.

4. CTD profiling and rosette water sampling for full carbonate and nutrient chemistry in the Bering Shelf region and near K-2 station for the coccolithophorid bloom research by Dr. Murata's group. Piston coring in Bering shelf to depict possible geological coccolith sequences by Dr. Narita's group.

Above mentioned MIO mooring array in the Northwest Pacific will be recovered in October 2001 by R/V Mirai and samples and data will be brought back to the shore-laboratories. Moorings and instruments will be turned around and re-deployed at the same location. MIO plans to add one more station (K-3) in a area just the north of Shatskiy Raise in 2002 while keeping K-1 and K-2 Stations.

Deployment of MIO's A-PS Mooring Array

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The tolerance of depth range is merely approximately 10 m where an array of time-series instruments situated in the upper euphotic layer is still deep enough to avoid the severe (winter) wave turbulence. In order to cover a deep water column, as deep as over 5-km, and yet the top of the underwater platform is placed at 30-m from the sea-surface requires high precision moorings that have been developed by the Rigging Laboratory, Woods Hole Oceanographic Institution, Woods Hole, MA, USA (John Kemp).

Mooring Preparation

It was necessary to keep the precision of the total mooring length to be at an order of centimeters, that is two orders of magnitudes more precise than an ordinary deep ocean mooring length. On the other hand, under water moorings are forced to extend at unpredictable rates (3 to 6 %) because of the enhanced buoyancy that is needed for the stability of a large, deep ocean mooring as well as the impact when a mooring descends and bounces after landing at the bottom. Thus the mooring height could very likely miss the narrow tolerance of the summit depth.

In order to keep the summit of a mooring at the required depth throughout the deployment term, all shots of twined wire-ropes that subject to extend by buoyancy stress were dynamically stretched on shore applying the forces that were expected during the deployment as well as after the mooring was settled (pre-stretching process, or PSP). Finally the lengths of the artificially extended mooring shots were re-measured at the end of the PSP by using a laser-optical infereometer which measures precision within a mm. We call the moorings constructed by the above-mentioned process advanced pre-stretched moorings or A-PS Moorings.

Sensors and Autonomous Data/Sample Collection systems

Two types of A-PS moorings were prepared for deployment as part of the MIO time-series program. The PO-Mooring is a self-profiling instrument mooring that consists of a 4,500 m pre-stretched shot which enables a moored profiler (MMP) to shuttle between the abysso-pelagic and the euphotic layers. A BGC-mooring was designed to deploy time-series instruments to gather biogeochemical data and samples particularly to understand the biological pump in the Northwestern Pacific Basin. A BGC-mooring consists of many shorter shots all of which were pre-stretched. A cluster of automated, time-series instruments were deployed in series as shallow as possible. Sediment traps were deployed in a lower mesopelagic layer and two were deployed in bathypelagic layers.

During the MR01-K04 cruise a single moored profiler (MMP) was deployed with PO-moorings. Sensors on board were a CTD-unit and a 3-D current meter. The precision of both sensors exceeds the WOCE standards. An MMP seamlessly covers the water column that ranges between 50 m and 4,550 m along K-1 and K-2 PO-moorings both at 26 cm sec^{-1}, or a total of approximately 1,000-km. The vertical resolution of the measurements throughout the water column is approximately 10 cm.

BGC moorings have the following identical set of time-series instrumentation in descending order. All instruments were time-synchronized in regards to the collection and measurement events.

1. SID (Submersible Incubation Devise): An autonomous, C-14 incubator for in situ productivity estimation with upwell, downwell radiometer and a fluorometer in a package (BLOOMS, University of California, Santa Cruz, Tommy Dickey). There will be 47 incubations, including standard runs for calibration during one year of deployment. The BLOOMS package measures the optical properties every 10-minutes during daylight hours.

2. RAS (Remote Access Sampler): Water samplers to understand time-series variability of nutrients, DOC and other dissolve ocean chemical properties. A 500 ml sample collected at each of 48-events in biofouling free condition will be collected in one year. During the 2001-2002 deployment, HCl was used as the preservative of sample water.

3. WTS (Water Transfer System): Phytoplankton samplers to understand the time-series variability of the phytoplankton community for a year in 24-collection events. In order to preserve the hard, soft tissues and DNA of phytoplankton, 0.5 % Utermohl’s solution in 70 % seawater was used during the 2001-2002 deployment.

4. ZPS (Zooplankton Sampler): Time-series samplers designed to collect micro and mesozooplankton as bias-free as possible in 50-events. Zooplankton between 5 mm and 125 micrometers in XX litters of water are caught on Nitex™sam ple chambers and transferred to a tank with a preservative solution (15 % glutaraldehyde).

Mooring Deployment

In order to keep the summit of a mooring in the very narrow zone of the upper euphotic layer, pre-stretching of the twined wire shots and exact control the of the mooring length are essential as mentioned previously. An additional critical requirement to deploy an A-PS Mooring as planned is to mount the anchor at the location where the depth is known exactly. MIO/WHOI prepared a set of adjustment PS-shots in numerous lengths, ranging from one meter to 500 m. When the mooring location and the depth is determined, a computer software chooses the combination of shots that brings the total height of the mooring to the desired length.

The critical requirement of the A-PS-Mooring location is that the bottom topography be flat. MIO used POSODS digital bathymetric information to select a 5-degree grid. Much of the coverage of digital bathymetry was not expected in the area near Kamchatka Peninsula and the Western Aleutian Arc area but such preliminary statistical investigations of relative flatness of the sea-floor significantly helped to save ship time. We surveyed approximately 400 sq. miles by SeaBeam sounding with 20 m contour lines. The four stations were settled when a 20 m flat spread for 2 to 3 miles. Bringing the R/V Mirai to an approximate center of the flat, we lowered the CTD and large rosette sampler from Dynacon Wave Compensator: A precision acoustic altimeter (0.5 % resolution) was extended from the rosette package and the depth bottom depth was decided from a) the altimeter return, the CTD's wire pay-off length and SeaBeam sounding depth after corrected for density. The CTD rosette with altimeter were hovered for about 5 to 10 minutes at the same location while the R/V Mirai was held stationary with the help of the dynamic location system. The data, often sigmoidal reflecting the oscillation of the CTD wire, were statistically processed and the depth was determined. We hoped to achieve 10 cm accuracy at 5, 000 m water depth. Then we allowed the R/V Mirai to drift with the sea and 1 m contours were constructed in an area approximately 100 m by 100 m.

Mooring deployment was followed by the ordinary "anchor-last" method. Kemp's (WHOI) model allowed to depict the behavior of the descending anchor and it position relative to the anchor drop position at the surface. The error from the planned anchor position to the actual location where an anchor settled were 15 m to 70 m within a range where the topography was known to a precision within 1 m. A Doppler sounder produced the underwater image of the summit of a mooring, a 64" diameter Syntactic apex, in order to check the resulting depth. For example, we concluded that the summit of K-1 BGC mooring was 27 m bellow the sea surface. We concluded that one of our most important technical objectives for the deployment cruise had been achieved. We have to wait for the recovery cruise to see how the initial depth of a summit will be maintained.

The surfacing of the PO-Mooring at the K-2 station several hours after deployment was indicated from ARGOS locator signals to WHOI's J-Pac office and then telephoned to the R/V Mirai. We recovered all instruments, flotation and PS-wire shots except releases. The cause of this incident was pinned down to the cold-roll steel 3/8 inch chain having snapped at the very bottom of the mooring. We suspect that a 3/8" shackle pin that connected the chain to the release assemblage, was slightly larger and the cold-rolled steel failed to tolerate the slight deformation of a chain link (that link was not recovered).