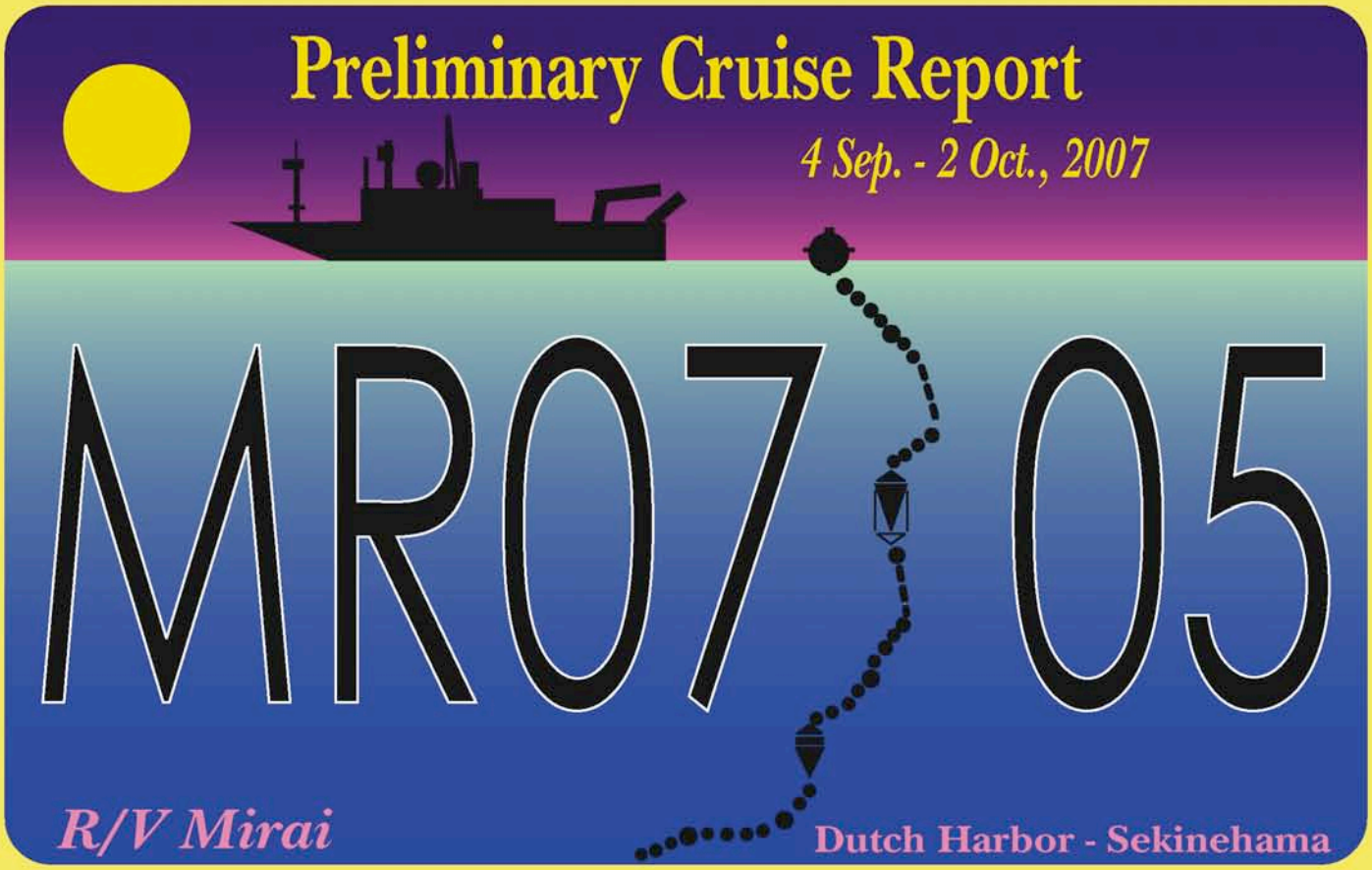
doi : 10.17596/0003511



Nov. 2007

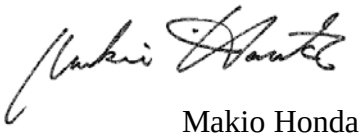
JAMSTEC

Note

This cruise report is a preliminary documentation published in a few months after the end of this cruise. It may not be corrected even if changes on contents are found after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the principal investigator and parsons in charge of respective observations for the latest information and permission before using. Users of data are requested to submit their results to JAMSTEC.

30 November 2007

Principal Investigator of MR07-05



Makio Honda
MIO, JAMSTEC

Cruise Report ERRATA of the Photosynthetic Pigments part

page	Error	Correction
81	Ethyl-apo-8'-carotenoate	trans-β-Apo-8'-carotenal

Contents of MR07-05 Preliminary Cruise Report

Cover sheet
The winning work of "MR07-05 cruise report cover sheet competition" designed by Yoko Iwamoto (University of Tokyo) who was a cruise participant of MR07-05. Image of picture is a number plate of Alaska, USA (original design "Gold Rush" was made in 1960's).

A. Cruise summary

1. Cruise information

(1) Cruise designation (research vessel)
MR07-05 (R/V MIRAI)

(2) Cruise title
Biogeochemical study in the western North Pacific and Study of role of zooplankton on material cycles at time-series station K2 in the northwestern North Pacific

Principal Investigator (PI): Makio Honda
JAMSTEC Mutsu Institute for Oceanography (MIO)

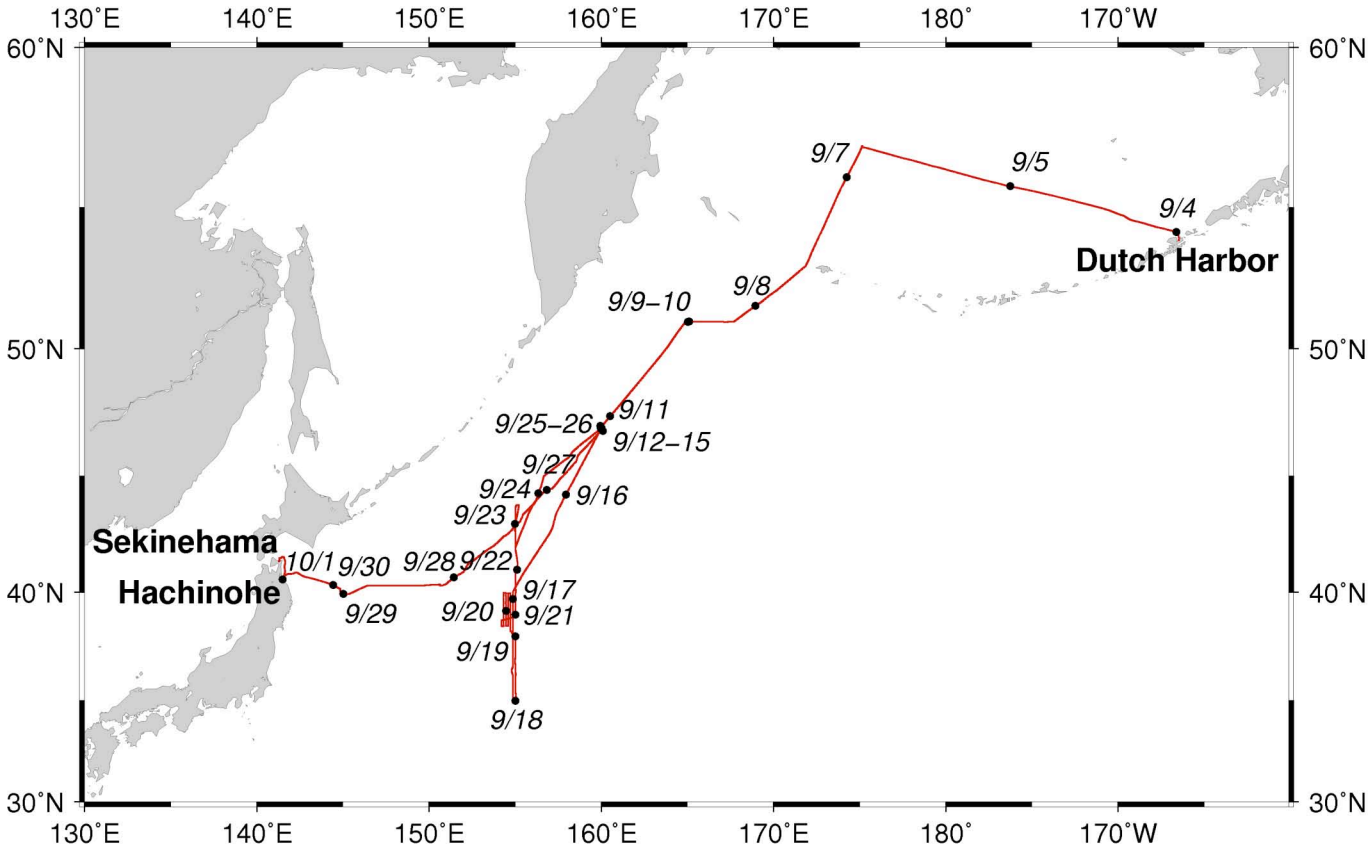
(3) Science proposals of cruise

S/N	Affiliation	PI	Proposal titles
MR07-22	JAMSTEC IORGC	Kinpei Ichiyanagi	Rain Sampling for Stable Isotopes
MR07-23	JAMSTEC IORGC	Toshio Suga	Variation of temperature and salinity in the Subarctic North Pacific: ARGO project
MR07-24	Tokyo Univ.	Mitsuo Uematsu	Air-sea interaction of chemical substances in the North Pacific (IGBP/SOLAS project)
MR07-25	JAMSTEC IORGC	Kunio Yoneyama	Continuous surface meteorological measurements as a basic dataset.
MR07-27	Ryukyu Univ.	Takeshi Matsumoto	Standardization of marine geophysical data and its application to the ocean floor geodynamics studies
MR07-28	Tokyo Univ.	Shigenobu Takeda	Study of dissolution of biogenic opal
MR07-29	NIES	Nobuo Sugimoto	Study of distribution and optical characteristics of ice/water clouds and marine aerosols
MR07-30	Nagoya Univ.	Toshiro Saino	Control system of primary productivity in the Northern North Pacific
MR07-31	NIES	Masao Uchida	Utilization of DOC by bacteria and its contribution on carbon cycle in the ocean
MR07-32	Hokkaido Univ.	Seiichi Saito	Study of primary productivity observed by remotely sensing data of ocean color.
MR07-55	JAMSTEC IFREE	Natsue Abe	Underway Geophysical Survey in the Northwestern Pacific for Study of Petit-spot Intra-plate Volcanism

(4) Cruise period (port call)
4 September 2007 (Dutch Harbor) – 2 October 2007 (Sekinehama)

(5) Cruise region (geographical boundary)
The western North Pacific (57°N – 35°N, 154°E – 175°E)

(6) Cruise truck and stations



2 Cruise Participants

	Name	Affiliation	Appointment	Tel
1	Makio HONDA （Principal Investigator）	Mutsu Institute for Oceanography (MIO) Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Sub Leader	0175-45-1071
2	Minoru KITAMURA （Deputy PI）	Extremobiosphere Research Center (XBR) JAMSTEC	Researcher	046-867-9527
3	Kazuhiko MATSUMOTO	MIO and Institute of Observational Research for Global Change (IORGC) JAMSTEC	Researcher	0175-45-1071
4	Hajime KAWAKAMI	MIO JAMSTEC	Researcher	Same as above
5	Tetsuichi FIJIKI	Same as above	Researcher	Same as above
6	Sanae CHIBA	Frontier Research Center for Global Change (FRCGC) JAMSTEC	Senior Researcher	045-778-5604
7	Yoko IWAMOTO	University of Tokyo	Graduate student	03-5351-6897
8	Sen-ichiro IGATA	Same as above	Same as above	03-5841-5291
9	Suguru OKAMOTO	Hokkaido University	Same as above	0138-40-8843
10	Amane FUJIWARA	Same as above	Same as above	Same as above
11	Masao UTSUMI	Tsukuba University	Lecturer	029-850-2042
12	Gang Chen	Same as above	Visiting Scientist	Same as above
13	Satoshi ITO	Same as above	Graduate student	Same as above
14	Ken-ichiro SATO （Principal Marine Tech.）	Marine Works Japan Inc. (MWJ)	Marine Technician	045-787-0041
15	Toru IDAI	Same as above	Same as above	Same as above
16	Masanori ENOKI	Same as above	Same as above	Same as above
17	Shinsuke TOYODA	Same as above	Same as above	Same as above
18	Ai YASUDA	Same as above	Same as above	Same as above
19	Tatsuya TANAKA	Same as above	Same as above	Same as above
20	Tetsuya INABA	Same as above	Same as above	Same as above
21	Tomoyuki TAKAMORI	Same as above	Same as above	Same as above
22	Takayoshi SEIKE	Same as above	Same as above	Same as above
23	Yasuhiro ARII	Same as above	Same as above	Same as above
24	Hiroki USHIROMURA	Same as above	Same as above	Same as above
25	Ayaka HATSUYAMA	Same as above	Same as above	Same as above
26	Miyo IKEDA	Same as above	Same as above	Same as above
27	Yukiko HAYAKAWA	Same as above	Same as above	Same as above
28	Kanako ISOGAI	Same as above	Same as above	Same as above
29	Ayumi TAKEUCHI	Same as above	Same as above	Same as above
30	Keisuke WATAKI	Same as above	Same as above	Same as above
31	Yuichi SONOYAMA	Same as above	Same as above	Same as above

32	Fuyuki SHIBATA	Same as above	Same as above	Same as above
33	Hideki YAMAMOTO	Same as above	Same as above	Same as above
34	Fujio KOBAYASHI	Same as above	Same as above	Same as above
35	Hiroyuki HAYASHI	Same as above	Same as above	Same as above
36	Minoru KAMATA	Same as above	Same as above	Same as above
37	Wataru TOKUNAGA (Principal Marine Tech.)	Global Ocean Development Inc. (GODI)	Same as above	045-849-6630
38	Ryo KIMURA	Same as above	Same as above	Same as above

3. Overview of MR07-05

(1) Objective

To collect oceanographic data in autumn in the northwestern North Pacific for the sake of understanding cycles of chemical substances focusing on CO_2 and role of zooplankton in its materials' cycle

(2) Overview of MR07-05

Main mission of this cruise is to collect oceanographic data in autumn in the northwestern North Pacific for the sake of understanding cycles of chemical substances focusing on CO_2 and role of zooplankton in its materials' cycle in this area.

As same as previous cruise in this area, we were plagued by bad weather and sea condition. Though we planned to conduct observation at many stations including a station in the Bering Sea and station KNOT, we cannot but suspend many observations at many stations. However we could conduct comprehensive observation at station K2, which is our time-series station.

At first, mooring system was deployed successfully after one-year hiatus. This mooring system consists of automatic water sampler (RAS), optical sensor package (BLOOMS) and sediment trap. Until autumn 2008, time-series samples will be collected in order to study the biological pump in this area, especially focusing on materials' cycles in the "twilight zone".

Secondly, we visited station K2 twice during this cruise and measured chemical substances such as dissolved oxygen, nutrients and carbon chemistry. Compared with previous data, concentrations of nutrients and dissolved inorganic carbon were close to annual minimum and it was suspected that winter mixing would start soon. Concentration of chlorophyll *a* and primary productivity were not low, which was indicative of that particulate organic carbon flux was not low. Analysis of pigments by HPLC revealed that haptophytes such as coccolithophorids was predominant during this cruise. Biological observation with plankton net (IONESS and NORPAC) was also conducted. One of scientific interests is carbon transport by zooplankton ontogenetic migration. Preliminary result showed that some fraction of copepod such as *Neocalanus cristatus* and *Neocalanus plumchrus* still exist in the upper layer and annual carbon export by migration was not over. In addition, onboard incubation was conducted and grazing pressure by micro zooplankton was measured. As a result, 60% of phytoplankton was grazed by micro zooplankton. Microscopic analysis will supply more information about the roll of zooplankton in material's cycle in the northwestern North Pacific.

B. Text

1. Outline of MR07-05

Makio HONDA (JAMSTEC MIO)
Principal Investigator of MR07-05

1.1 Cruise summary

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(2) Overview of MR07-05

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(3) Scientific gears

All hydrocasts were conducted using 36-position 12 liter Niskin bottles carousel system with SBE CTD-DO system, fluorescence and transmission sensors. JAMSTEC MIO scientists and MWJ (Marine Work Japan Co. Ltd.) technician group were responsible for analyzing water sample for salinity, dissolved oxygen, nutrients, CFCs, total carbon contents, alkalinity and pH.

Cruise participants from JAMSTEC XBR and FRCGC, Hokkaido University, Tsukuba University and Tokyo University helped to divide seawater from Niskin bottles to sample bottles for analysis. Graduate students of Hokkaido University collected samples and analyzed Chlorophyll-a contents and bioactivity in seawater. Surface water was collected with bucket.

Optical measurement in air and underwater was conducted with PAR sensor (RAMSES-ACC) and SPMR/SMSR called “Free Fall”.

For collecting suspended particles at stationK2, Large Volume Pump (LVP) was deployed.

GODI technicians group undertook responsibility for underway current direction and velocity measurements using an Acoustic Current Profiler (ADCP), geological measurements (topography, geo-magnetic field and gravity), and collecting meteorological data.

For collection of zooplankton, NORPAC plankton net, and IONESS were deployed.

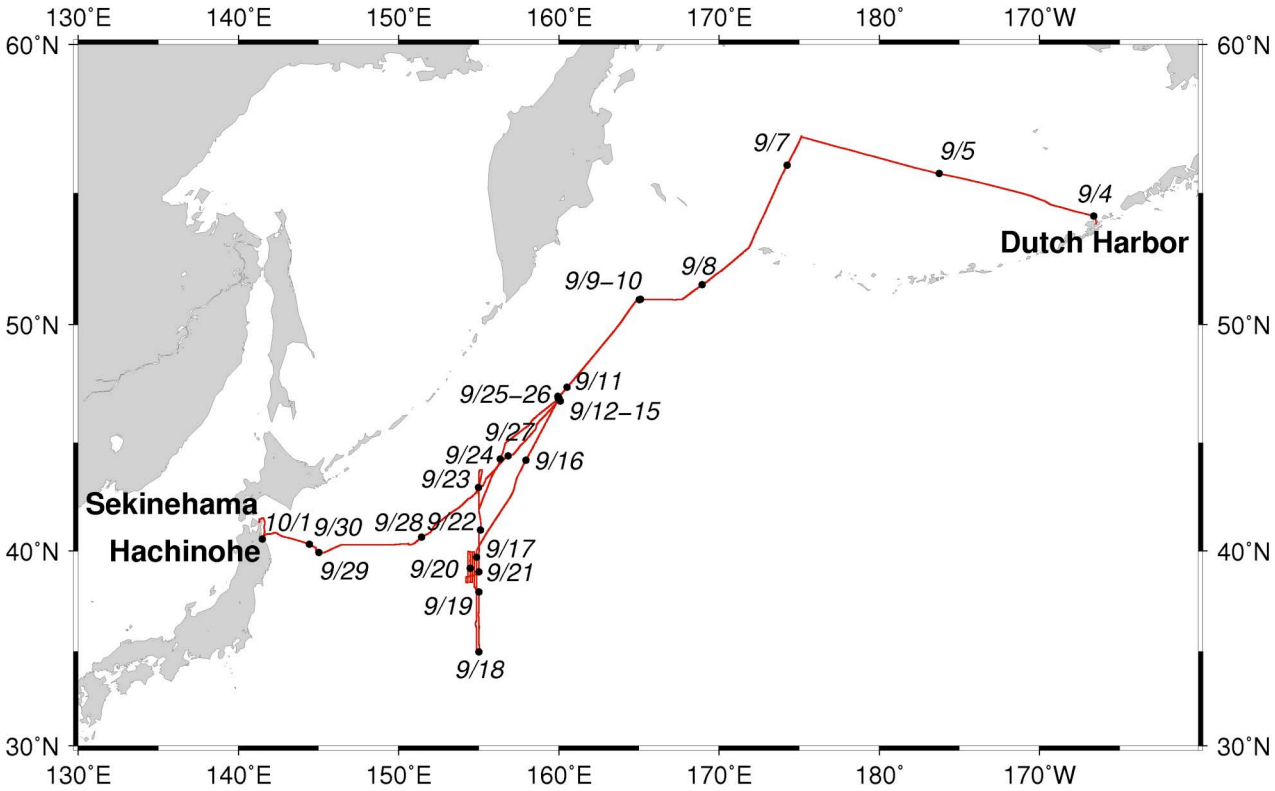
For conducting in situ incubation for measurement of primary productivity and collecting sinking particles at station K2, drifter was deployed at station K2.

For observing vertical profile of primary productivity optically, FRRF was deployed

In order to conduct time-series observation in physical, chemical and biological activity, JAMSTEC BGC mooring was deployed at station K2. The BGC consisted of a optical sensor package (BOLLONS) at around 35 m, two automatic water samplers (RAS) at around 35 m and 200 m, 5 sediment traps at 150, 300, 550, 1000 and 5000 m.

1.2 Track and log

1.2.1 Cruise track



1.2.2 Cruise log

U.T.C.		S.M.T.		Position		Event logs
Date	Time	Date	Time	Lat.	Lon.	
9.4	18:10	9.4	10:10	55-39N	166-34W	Departure from Dutch harbor
9.5	00:00		16:00	-	-	Surface water sampling pump start
	06:00		22:00	-	-	Time adjustment -2 hours (SMT=UTC-10h)
9.6	08:00	9.5	22:00	-	-	Time adjustment -2 hours (SMT=UTC-12h)
	19:00	9.6	07:00	57-00N	175-00E	Arrival as Station No.01 (AB)
	20:00		08:00	-	-	Departure from Station No.1
9.7	10:00		22:00	-	-	Time adjustment -1 hours (SMT=UTC-13h) Passing the International date line (Skipped 9.7 of SMT and SMT=UTC+11h)
9.8	13:12	9.9	00:12	51-00N	165-00E	Arrival at Station No.02 (K1)
	13:24		00:24	50-59.71N	165-01.00E	CTD cast (4,775 m)
	17:50		04:50	50-58.58N	165-03.52E	NORPAC net #01 (50 m)
9.9	07:24		18:24	51-00.05N	165-00.05E	CTD cast (200 m)
	09:02		20:02	50-59.96N	165-00.03E	CTD cast (1,000 m)
	21:18	9.10	08:18	51-00.00N	165-00.02E	Large Volume Pump (LVP) cast #01 (200m, 1 hour)
	23:30		10:30	50-59.98N	165-00.00E	FRRF #01
9.10	23:54		10:54	50-59.81N	165-00.25E	Free fall #01
	00:22		11:22	50-59.67N	165-00.27E	CTD cast (200 m)
	02:32		13:32	50-59.59N	165-00.45E	IONESS #01 (1000 m)
	05:24		16:24	-	-	Departure from Station No.02 (K1)
	10:56		21:56	49-59.99N	163-45.03E	XCTD observation #01 (Station No.03)
	16:31	9.11	03:31	48-59.99N	162-29.98E	XCTD observation #02 (Station No.04)
	21:51		08:51	48-00.00N	161-15.00E	XCTD observation #03 (Station No.05)
9.11	03:18		14:18	47-00N	160-00E	Arrival at Station No.06 (K2)
	03:22		14:22	47-00.13N	160-00.00E	CTD cast (5,156 m)
	21:06	9.12	08:06	47-03.35N	159-50.34E	BGC mooring deployment
			-	47-00.272N	159-58.387E	BGC mooring Fixed position
9.12	02:31		13:31	47-00.04N	159-598.12E	FRRF #02
	03:00		14:00	46-59.85N	159-57.73E	Free fall #02
	04:46		15:46	46-59.86N	159-58.96E	LVP cast #02 (200m, 5 hours)
	16:57	9.13	03:57	46-51.87N	160-00.24E	CTD cast (200 m)
	18:27		05:27	46-52.00N	159-59.89W	Surface drifting float buoy deployment
	19:10		06:10	46-51.98N	159-59.37E	FRRF #03
	20:54		07:54	46-52.86N	159-58.13E	FRRF #04
	21:25		08:25	46-52.95N	159-57.96E	CTD cast (200 m)
	23:01		10:01	46-54.15N	159-57.83E	Free fall #03
	23:26		10:26	46-54.27N	159-57.88E	FRRF #05
9.13	01:00		12:00	46-56.36N	159-57.52E	FRRF #06
	01:20		12:20	46-56.57N	156-57.59E	IONESS #02 (1000 m)

	04:55		15:55	46-54.90N	160-05.96E	FRRF #07
	06:53		17:53	46-56.37E	160-06.25E	FRRF #08
	07:27		18:27	46-56.24N	160-03.35E	LVP cast #03 (200 m, 1 hour)
U.T.C.		**S.M.T.**		**Position**		**Event logs**
Date	**Time**	**Date**	**Time**	**Lat.**	**Lon.**	
	09:23		20:23	46-56.00N	160-05.67E	CTD cast (2,000 m)
	11:18		22:18	46-55.34N	160-04.98E	NORPAC net #02 (50 m, 150 m)
	18:32	9.14	05:32	46-51.59N	159-58.87E	Surface drifting float buoy recovory & re-deployment
	19:39		06:39	46-53.65N	160-00.68E	CTD cast (3,932 m)
	22:39		09:39	46-56.38N	160-03.41E	IONESS #03 (500 m)
9.14	02:10		13:10	46-56N	159-57E	Calibration for magnetometer #01
	03:58		14:58	46-55.86N	159-59.49E	LVP cast #04 (1,000 m, 2 hours)
	09:32		20:32	46-58.52N	160-03.70E	IONESS #04 (1,000 m)
	16:54	9.15	03:54	46-50.61N	160-00.12E	Surface water sampling
	20:25		07:25	46-50.68N	160-03.81E	Surface drifting float buoy recovory
	21:16		08:16	46-49.66N	160-05.15E	CTD cast (5,190 m)
9.15	02:00		13:00	46-49.95N	160-02.95E	Free fall #04
	02:22		13:22	46-50.00N	160-02.39E	FRRF #09
	02:50		13:50	46-49.82N	160-02.24E	NORPAC net #03 (50 m, 150 m)
	06:54		17:54	46-56.13N	160-00.31E	CTD cast (500 m)
	09:32		20:32	46-57.05N	160-03.88E	IONESS #05 (500 m)
	12:42		23:42	-	-	Departure from Station No.06 (K2)
9.16	23:27	9.17	10:27	40-03.49N	154-53.39E	XBT measurment for Sound Velocity Profile (SVP) at Petit spot survey
	23:44		10:44	40-00N	154-51E	Petit spot survey (about 18 hours)
9.17	05:38		16:38	38-33.18N	154-51.02E	XBT measurment for SVP
	11:19		22:19	37-09.05N	154-51.02E	XBT measurment for SVP
	20:00	9.18	07:00	34-59N	154-42E	Calibration for magnetometer #02
	20:54		07:54	35-00N	155-00E	Arrival at Station No.18
	20:56		07:56	34-59.51N	154-59.36E	CTD cast (5,632 m)
9.18	02:01		13:01	34-57.69N	155-00.90E	Free fall #05
	02:22		13:22	34-56.86N	155-01.69E	FRRF #10
	03:35		14:35	34-56.40N	155-02.65E	CTD cast (250 m)
	04:25		15:25	34-55.55N	155-03.28E	ARGO float deployment #01
	04:30		15:30	-	-	Departure from Station No.18
	10:09		21:09	36-00.43N	155-00.31E	XCTD observation #04 (Station No.17)
	16:44	9.19	03:44	37-00.00N	154-59.75E	XCTD observation #05 (Station No.16)
	21:54		08:54	38-00N	155-00E	Arrival at Station No.15
	21:55		08:55	37-59.76N	155-00.17E	CTD cast (75 m)
	22:31		09:31	38-00.05N	155-00.04E	FRRF #11
	23:58		10:58	37-59.65N	155-00.09E	Free fall #06
9.19	00:21		11:21	38-00.05N	154-59.84E	CTD cast (5,994 m)
	07:18		18:18	-	-	Departure from Station No.15
	08:35		19:35	38-15N	154-43E	Petit spot survey (about 27.5 hours)

9.20	03:56	9.20	14:56	39-40.03N	154-27.13E	XBT measurment for SVP
	15:00	9.21	02:00	38-55N	155-04E	Arrival at CTD cable free fall station
	15:01		02:01	38-55.18N	155-04.31E	CTD cable free fall (5,810.5 m)
	20:48		07:48	-	-	Departure from CTD cable free fall station
	22:24		09:24	39-00N	155-00E	Arrival at Station No.14
U.T.C.		**S.M.T.**		**Position**		**Event logs**
Date	**Time**	**Date**	**Time**	**Lat.**	**Lon.**	
	22:30		09:30	38-59.96N	155-00.14E	CTD cast (200 m)
	23:05		10:05	38-59.92N	155-00.03E	Free fall #07
	23:43		10:43	38-59.72N	155-00.02E	FRRF #12
9.21	00:16		11:16	38-59.10N	155-00.23E	CTD cast (5,728 m)
	05:54		16:54	-	-	Departure from Station No.14
	13:00					
	10:06		21:06	40-00N	155-00E	Arrival at Station No.13
	10:08		21:08	39-59.72N	155-00.43E	CTD cast (5,535 m)
	13:00					
	15:28	9.22	02:28	39-58.03N	155-01.21E	ARGO float deployment #02
	15:30		02:30	-	-	Departure from Station No.13
	20:18		07:18	41-00N	155-00E	Arrival at Station No.12
	20:18		07:18	41-01.09N	155-05.37E	CTD cast (5,440 m)
9.22	00:45		11:45	41-00.13N	155-06.70E	Free fall #08
	01:05		12:05	40-59.96N	155-07.26E	FRRF #13
	02:12		13:12	40-59.61N	155-08.27E	CTD cast (200 m)
	02:48		13:48	-	-	Departure from Station No.12
	07:13		18:13	42-00.08N	155-00.03E	XCTD observation #06 (Station No.11)
	11:15		22:15	43-00.11N	155-00.03E	XCTD observation #07 (Station No.10)
	15:30	9.23	02:30	44-00N	155-00E	Arrival at Station No.09 (KNOT)
	15:44		02:44	43-47.66N	155-11.44E	CTD cast (1,000 m)
	17:26		04:26	43-47.00N	155-12.64E	NORPAC net #04 (50 m)
	18:00		05:00	-	-	Departure from Station No.09 (KNOT)
	21:12		08:12	43-00N	155-00E	Arrival at Station No.10
	21:17		08:17	43-00.02N	154-59.79E	CTD cast (200 m)
	22:26		09:26	42-59.69N	154-59.57E	FRRF #14
	22:58		09:58	42-59.59N	154-58.84E	Free fall #09
	23:27		10:27	42-59.45N	154-58.15E	CTD cast (5,344 m)
9.23	04:30		15:30	-	-	Departure from Station No.10
	08:42		19:42	42-00N	155-00E	Arrival at Station No.11
	08:42		19:42	41-59.88N	155-00.01E	CTD cast (5,418 m)
	13:18	9.24	00:18	-	-	Departure from Station No.11
9.24	04:43		15:43	45-00.11N	156-40.11E	XCTD observation #08 (Station No.08)
	11:11		22:11	46-00.01N	158-20.04E	XCTD observation #09 (Station No.07)
	17:18	9.25	04:18	47-00N	160-00E	Arrival at Station No.20 (K2)
	18:42		05:42	46-55.14N	159-58.40E	CTD cast (5,133 m)
	22:59		09:59	46-54.39N	159-58.68E	Free fall #10

	23:13		10:13	46-54.12N	159-58.75E	FRRF #15
9.25	00:19		11:19	46-55.76N	159-59.40E	FRRF #16
	01:06		12:06	46-55.28N	160-00.25E	CTD cast (200 m)
	02:10		13:10	46-57N	160-00E	Calibration for magnetometer #03
	02:53		13:53	46-56.73N	160-00.23E	FRRF #17
	03:19		14:19	46-56.44N	160-00.63E	CTD cast (300 m)
	04:54		15:54	46-56.58N	160-00.09E	FRRF #18
	05:23		16:23	46-56.45N	160-00.60E	CTD cast (1,000 m)
	06:53		17:53	46-56.37N	160-01.23E	FRRF #19
	08:28		19:28	46-59.37N	160-00.47E	NORPAC net #05 (50 m, 150 m)
	09:59		20:59	46-58.84N	160-01.66E	IONESS #06 (1,000 m)

U.T.C.		**S.M.T.**		**Position**		
Date	**Time**	**Date**	**Time**	**Lat.**	**Lon.**	**Event logs**
	16:51	9.26	03:51	46-56.05N	160-00.05E	LVP cast #05 (200 m, 1 hour)
	17:31		04:31	46-55.48N	160-00.37E	Surface water sampling
	18:56		05:56	46-54.60N	160-01.40E	FRRF #20
	20:54		07:54	46-57.07N	159-59.31E	FRRF #21
	21:22		08:22	46-57.32N	159-59.15E	NORPAC net #06 (50 m, 150 m)
	22:54		09:54	46-58.48N	159-59.47E	FRRF #22
9.26	01:01		12:01	46-57.50N	159-59.09E	FRRF #23
	01:49		12:49	46-57.10N	159-58.37E	IONESS #07 (500 m)
	05:00		16:00	-	-	Departure from Station No.20 (K2)
9.27	11:00	9.27	22:00	-	-	Time adjustment -1 hours (SMT=UTC+10h)
9.28	12:00	9.28	22:00	-	-	Time adjustment -1 hours (SMT=UTC+9h=JST)
9.29		9.30	05:54	40-20N	144-24E	Arrival at CTD cable free fall station
			06:08	40-19.79N	144-24.29E	IONESS calibration
			07:09	40-19.72N	144-24.80E	CTD cable free fall
			13:06	40-19.60N	144-25.97E	IONESS calibration
			14:24	-	-	Departure from CTD cable free fall station
			15:30	-	-	Surface water sampling pump stop
9.30	23:30	10.1	08:30	40-34N	141-29E	Arrival at Hachinohe
10.1	06:50		15:50	-	-	Departure from Hachinohe
	09:12		18:12	40-57N	141-38E	Calibration for magnetometer #04
10.2	00:20	10.2	09:20	41-22N	141-14E	Arrival at Sekinehama

1.3 Cruise Participants

	Name	Affiliation	Appointment	Tel
1	Makio HONDA （Principal Investigator）	Mutsu Institute for Oceanography (MIO) Japan Agency for Marine-Earth Science and Technology (JAMSTEC)	Sub Leader	0175-45-1071
2	Minoru KITAMURA （Deputy PI）	Extremobiosphere Research Center (XBR) JAMSTEC	Researcher	046-867-9527
3	Kazuhiko MATSUMOTO	MIO and Institute of Observational Research for Global Change (IORGC) JAMSTEC	Researcher	0175-45-1071
4	Hajime KAWAKAMI	MIO JAMSTEC	Researcher	Same as above
5	Tetsuichi FIJIKI	Same as above	Researcher	Same as above
6	Sanae CHIBA	Frontier Research Center for Global Change (FRCGC) JAMSTEC	Senior Researcher	045-778-5604
7	Yoko IWAMOTO	University of Tokyo	Graduate student	03-5351-6897
8	Sen-ichiro IGATA	Same as above	Same as above	03-5841-5291
9	Suguru OKAMOTO	Hokkaido University	Same as above	0138-40-8843
10	Amane FUJIWARA	Same as above	Same as above	Same as above
11	Masao UTSUMI	Tsukuba University	Lecturer	029-850-2042
12	Gang Chen	Same as above	Visiting Scientist	Same as above
13	Satoshi ITO	Same as above	Graduate student	Same as above
14	Ken-ichiro SATO （Principal Marine Tech.）	Marine Works Japan Inc. (MWJ)	Marine Technician	045-787-0041
15	Toru IDAI	Same as above	Same as above	Same as above
16	Masanori ENOKI	Same as above	Same as above	Same as above
17	Shinsuke TOYODA	Same as above	Same as above	Same as above
18	Ai YASUDA	Same as above	Same as above	Same as above
19	Tatsuya TANAKA	Same as above	Same as above	Same as above
20	Tetsuya INABA	Same as above	Same as above	Same as above
21	Tomoyuki TAKAMORI	Same as above	Same as above	Same as above
22	Takayoshi SEIKE	Same as above	Same as above	Same as above
23	Yasuhiro ARII	Same as above	Same as above	Same as above
24	Hiroki USHIROMURA	Same as above	Same as above	Same as above
25	Ayaka HATSUYAMA	Same as above	Same as above	Same as above
26	Miyo IKEDA	Same as above	Same as above	Same as above
27	Yukiko HAYAKAWA	Same as above	Same as above	Same as above
28	Kanako ISOGAI	Same as above	Same as above	Same as above
29	Ayumi TAKEUCHI	Same as above	Same as above	Same as above
30	Keisuke WATAKI	Same as above	Same as above	Same as above
31	Yuichi SONOYAMA	Same as above	Same as above	Same as above
32	Fuyuki SHIBATA	Same as above	Same as above	Same as above
33	Hideki YAMAMOTO	Same as above	Same as above	Same as above
34	Fujio KOBAYASHI	Same as above	Same as above	Same as above

35	Hiroyuki HAYASHI	Same as above	Same as above	Same as above
36	Minoru KAMATA	Same as above	Same as above	Same as above
37	Wataru TOKUNAGA (Principal Marine Tech.)	Global Ocean Development Inc. (GODI)	Same as above	045-849-6630
38	Ryo KIMURA	Same as above	Same as above	Same as above

2 General observation

2.1 Meteorological observations

2.1.1 Surface Meteorological Observation

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

(1) Objectives

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

(2) Methods

Surface meteorological parameters were observed throughout the MR07-05 cruise. During this cruise, we used two systems for the observation.

i. MIRAI Surface Meteorological observation (SMET) system

ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

i. MIRAI Surface Meteorological observation (SMET) system

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

ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

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

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

b) Zeno Meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.

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

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

We have checked the following sensors, before and after the cruise for the quality control as post processing.

i. Young Rain gauge (SMET and SOAR)

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

ii. Barometer (SMET and SOAR)

Comparison with the portable barometer value, PTB220CASE, VAISALA.

iii. Thermometer (air temperature and relative humidity) (SMET and SOAR)

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

(3) Preliminary results

Figures 2.1.1 shows the time series of the following parameters;

Wind (SOAR)

Air temperature (SOAR)

Relative humidity (SOAR)

Precipitation (SOAR, Capacitive rain gauge)

Short/long wave radiation (SMET)

Pressure (SMET)

Sea surface temperature (SMET)

Significant wave height (SMET)

(4) Data archives

These meteorological data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC just after the cruise. Corrected data sets will be available from K. Yoneyama of JAMSTEC.

(5) Remarks

i. From 21 Sep., 01:51 UTC to 01:52 UTC, SMET Tair/RH data were not available due to the sensor exchange. In addition, data obtained the period of 18 Sep., 09:00 UTC – 21 Sep., 01:59 UTC may contain invalid values because of sensor trouble.

ii. SST (Sea Surface Temperature) data were available in the following periods.

05 Sep., 22:00UTC - 06 Sep., 23:29UTC

08 Sep., 05:50UTC - 26 Sep., 07:04UTC

26 Sep., 00:00UTC - 30 Sep., 06:29UTC

iii. Noises on SOAR ORG data were appeared because of blewing the whistle at the foremast, as follows;

09 Sep., 01:00UTC

27 Sep., 01:00UTC

29 Sep., 03:00UTC

iv. In the following periods, relative wind direction of SOAR anemometer might be incorrect.

27 Sep., 18:15:06UTC - 27 Sep., 19:24:24UTC

v. Three sensors of SOAR system anemometer, capacitive rain gauge and optical rain gauge were sert at 50 - 70 cm higher than their original positions to avoid interference with other equipment during this cruise. Temporary positions are listed in Table.2.1.1-3.

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

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m)
			starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	AP370	Koshin Denki, Japan	captain deck (13 m)
			weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

Table.2.1.1-2 Parameters of MIRAI Surface Meteorological observation system

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

21	Significant wave height (bow)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period (bow)	second	hourly
24	Significant wave period (aft)	second	hourly

Table.2.1.1-3 Instrument and installation locations of SOAR system

Sensors(*Zeno/Met*)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	foremast (23 m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (22 m)
Rain gauge	50202	R. M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24 m)

Sensors (*PRP*)	Type	Manufacturer	Location (altitude from surface)
Radiometer (short wave)	PSP	Epply Labs, USA	foremast (24 m)
Radiometer (long wave)	PIR	Epply Labs, USA	foremast (24m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (24 m)

Table.2.1.1-4 Parameters of SOAR system

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

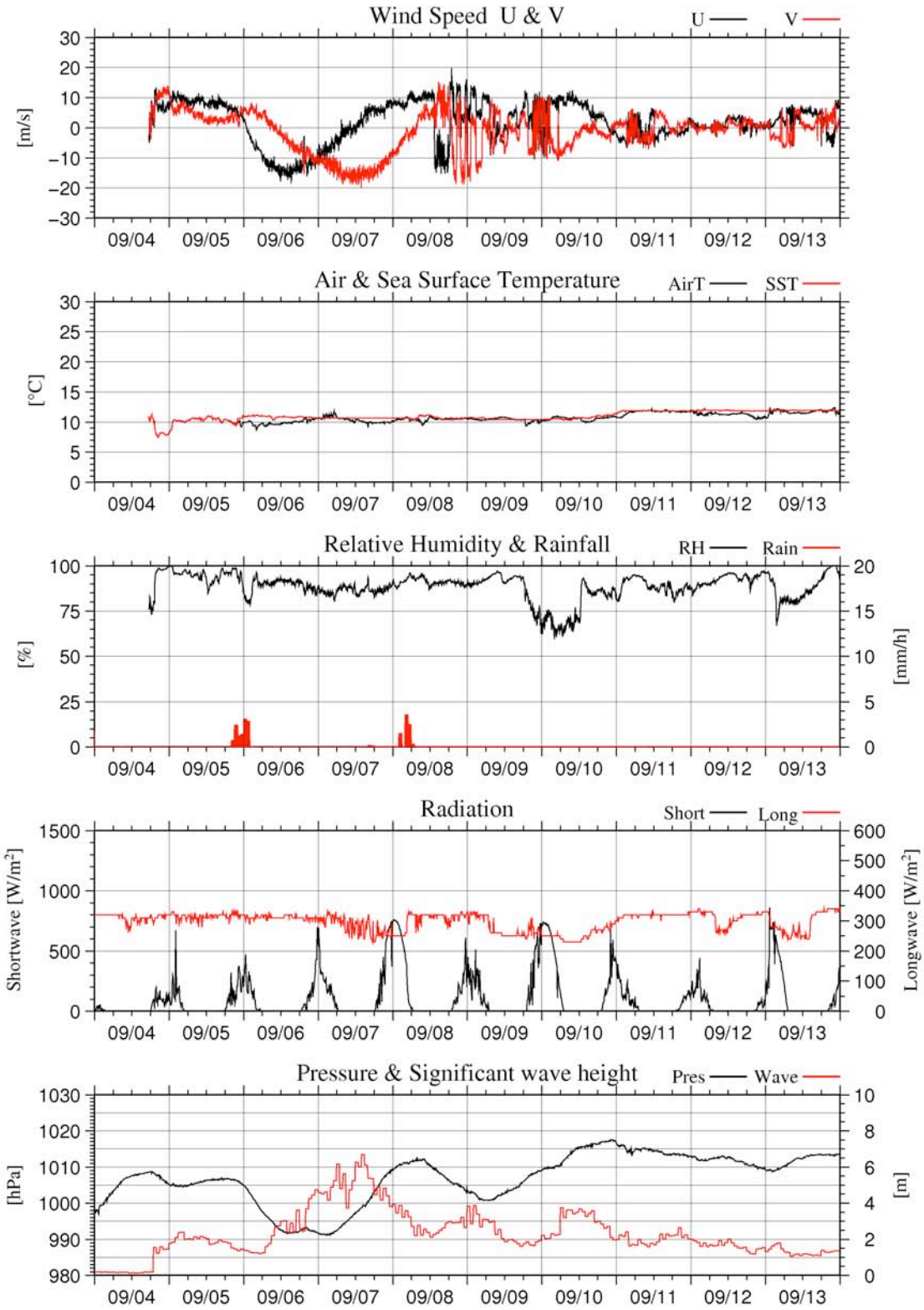


Fig.2.1.1-1 Time series of surface meteorological parameters during the MR07-05 cruise

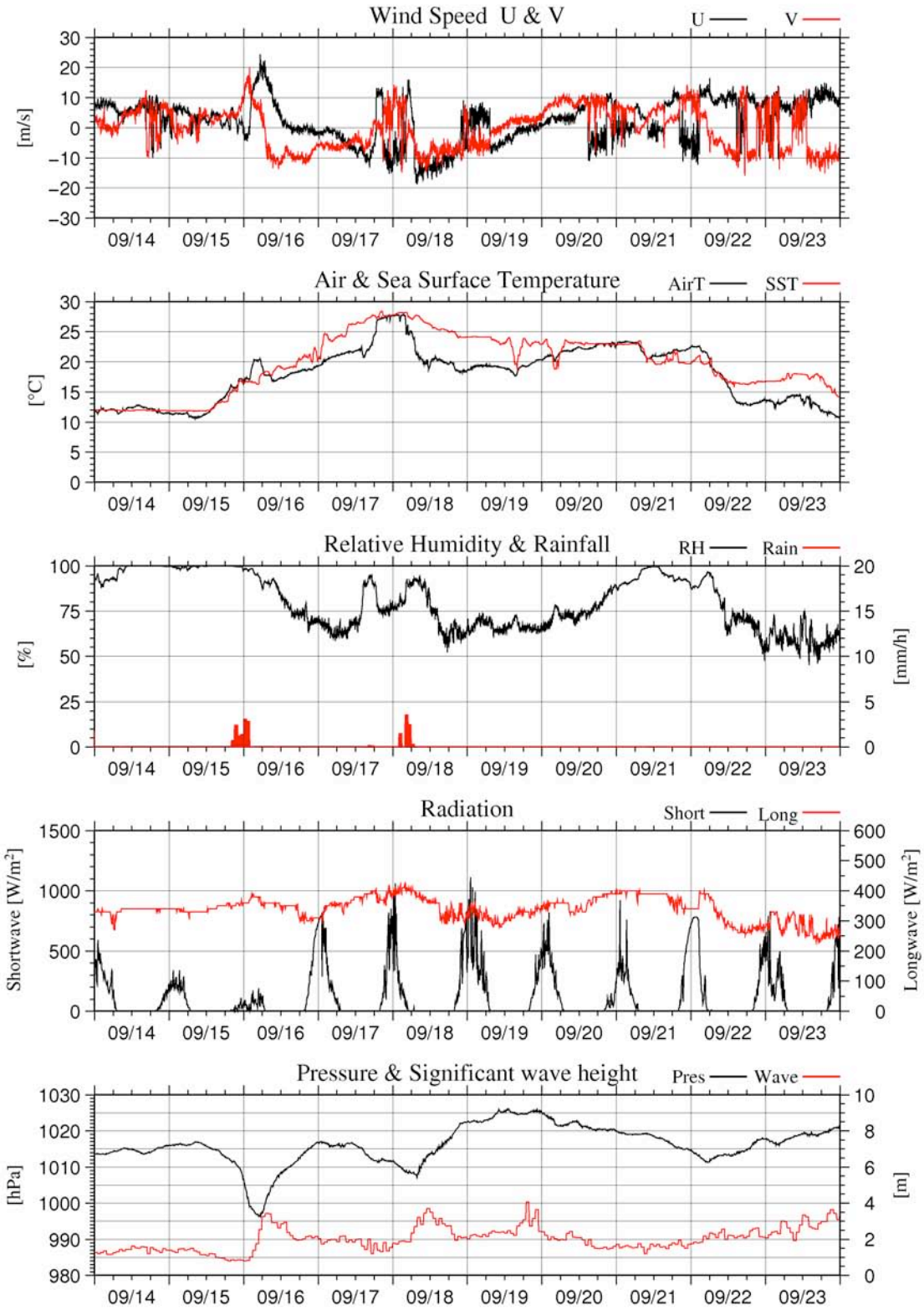


Fig.2.1.1-2 Time series of surface meteorological parameters during the MR07-05 cruise

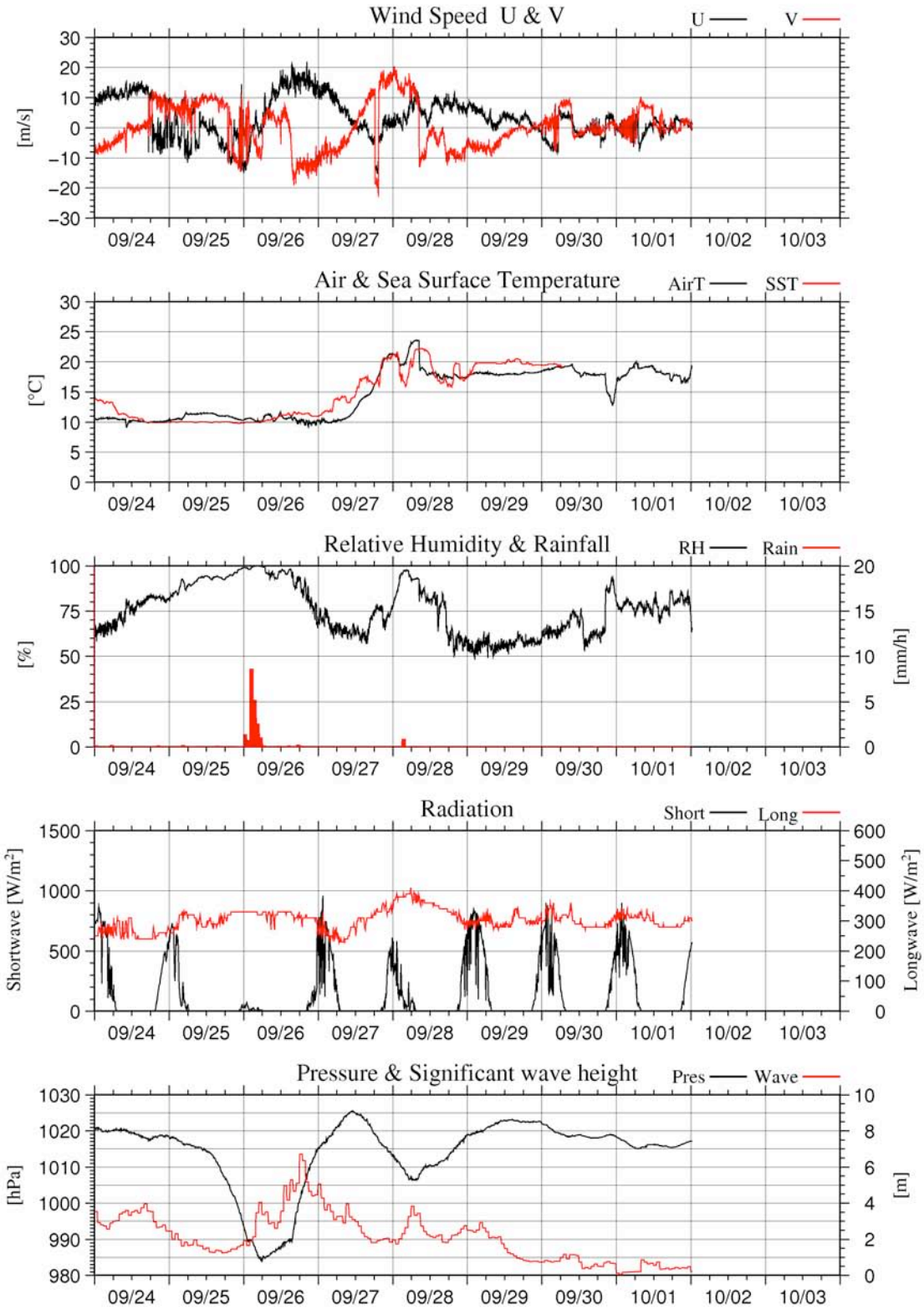


Fig.2.1.1-3 Time series of surface meteorological parameters during the MR07-05 cruise

2.1.2 Ceilometer Observation

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

(1) Objectives

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

(2) Parameters

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

(3) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR07-05 cruise from the departure of Dutch Harbor on 4 September 2007 to arrival of Sekinehama on 2 October 2007.

Major parameters for the measurement configuration are as follows;

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

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

(4) Preliminary results

Figure 2.1.2-1 shows the time series of the lowest, second and third cloud base height.

(5) Data archives

The raw data obtained during this cruise will be submitted to the Marine-Earth Data and Information Department (MEDID) in JAMSTEC.

(6) Remarks

1. We did not collect data in the territorial waters and the EEZ of U.S.A during the following periods.
   04 Sep. 18:10 - 05 Sep. 22:00
   06 Sep. 23:30 - 08 Sep. 05:00
2. Window cleaning;

04 Sep. 17:25, 09 Sep. 07:48, 16 Sep. 22:16, 19 Sep. 00:34, 21 Sep. 01:45, 24 Sep. 23:40

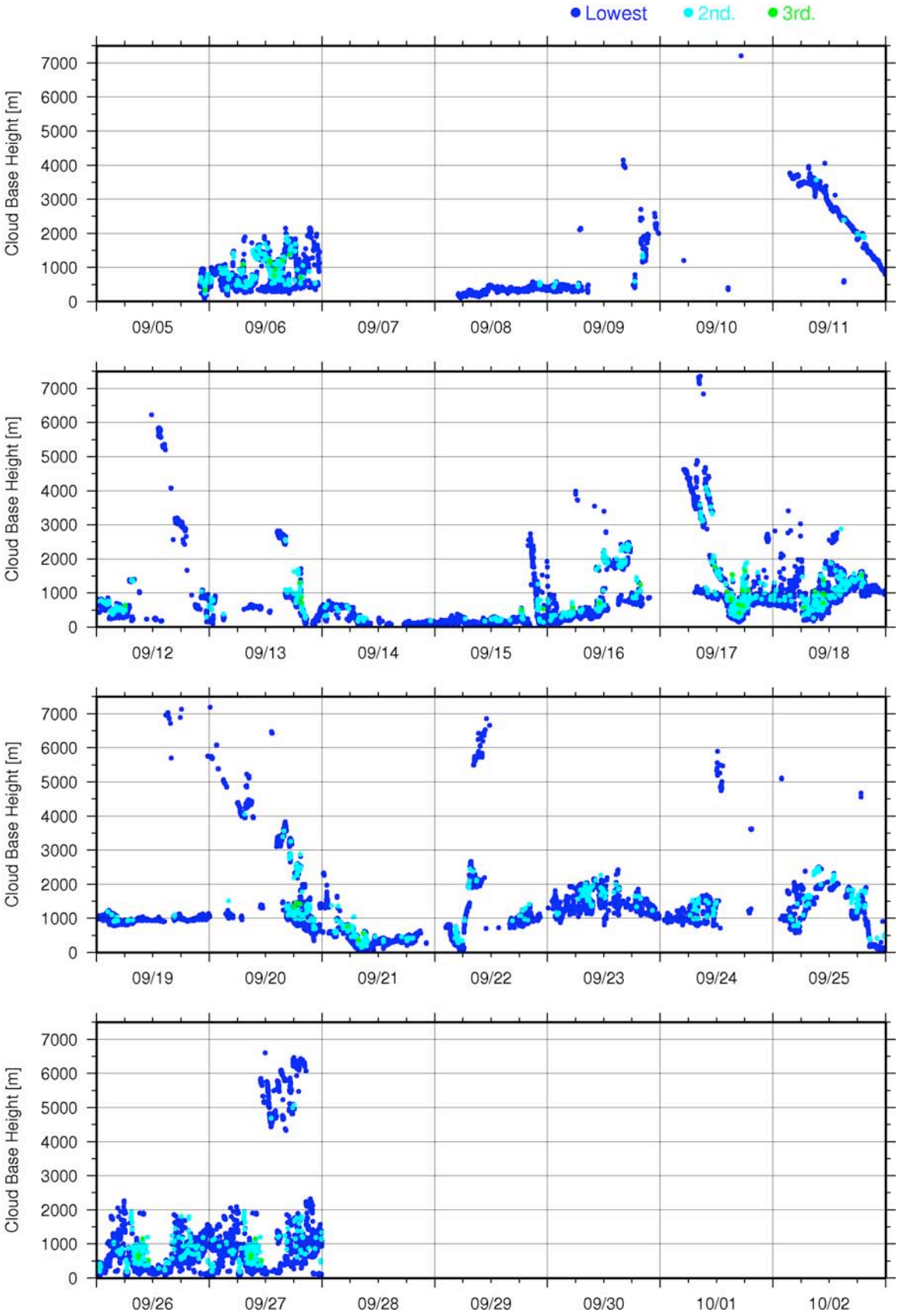


Fig.2.1.2-1 Lowest, 2nd and 3rd cloud base height during the cruise.

2.1.3 Lidar observations of clouds and aerosols

Nobuo SUGIMOTO (National Institute for Environmental Studies, not on board)
Ichiro MATSUI (National Institute for Environmental Studies, not on board)
Atsushi SHIMIZU (National Institute for Environmental Studies, not on board)
*** Lidar operation was supported by GODI.**

(1) Objectives

Objectives of the observations in this cruise is to study distribution and optical characteristics of ice/water clouds and marine aerosols using a two-wavelength lidar.

(2) Measured parameters

- Vertical profiles of backscattering coefficient at 532 nm
- Vertical profiles of backscattering coefficient at 1064 nm
- Depolarization ratio at 532 nm

(3) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 30 mJ per pulse at both of 1064 and 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a transient recorder and stored on a hard disk with a computer. The lidar system was installed in the radiosonde container on the compass deck. The container has a glass window on the roof, and the lidar was operated continuously regardless of weather. Every 15 minutes vertical profiles of four channels (532 parallel, 532 perpendicular, 1064, 532 near range) are recorded.

(4) Results

Lidar raw data have not been collected by NIES because this is unattended subject. So we show here only sample vertical profiles of backscattering intensity which was automatically generated onboard and transferred to NIES by e-mail. Figure 1 shows an atmospheric structure revealed by lidar on September 22, 2007. There was a cloud layer around 8 km. High depolarization ratio (perpendicular to parallel at 532 nm) indicates this layer is consist of non-spherical ice particles. Below the cloud, some structure of aerosol layers was evident. A typical aerosol mixing layer was located blow 1km, but weak aerosol signal was detected between 3 – 5 km. Similar profiles are obtained every 15 minutes, and three dimensional structure of atmospheric scatterers (clouds and aerosols) are revealed in whole troposphere.

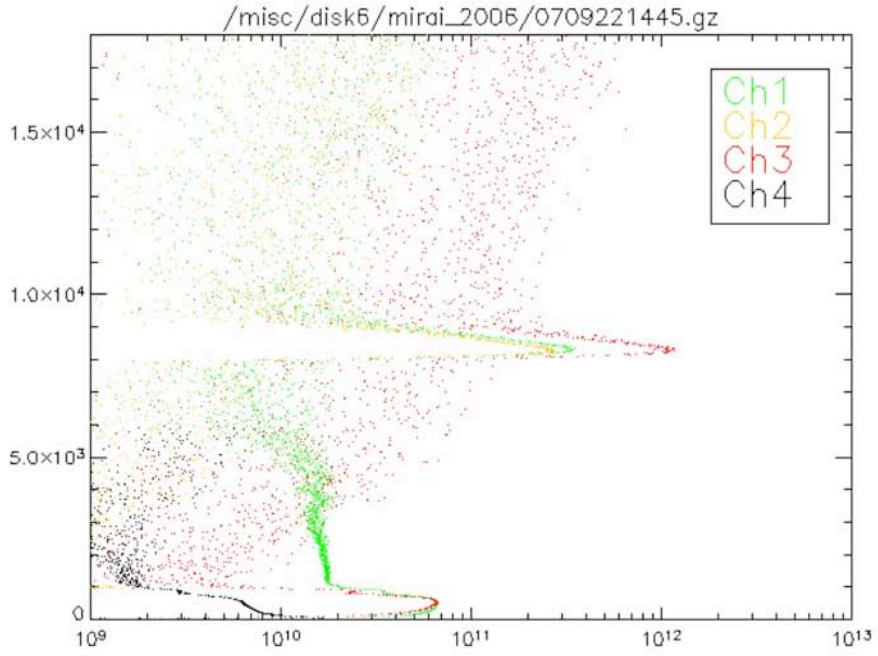


Figure 1: Vertical profiles of backscattering intensity at 532 nm parallel (green), 532 nm perpendicular (yellow), 1064 nm (red) at UTC1445 on September 22, 2007. Black indicates signal from near field telescope (532nm).

(5) Data archive
- raw data
  lidar signal at 532 nm
  lidar signal at 1064 nm
  depolarization ratio at 532 nm
  temporal resolution 10 sec/ vertical resolution 6 m
  data period : September 6, 2007 – September 30, 2007
- processed data
  cloud base height, apparent cloud top height
  phase of clouds (ice/water)
  cloud fraction
  boundary layer height (aerosol layer upper boundary height)
  backscatter coefficient of aerosols
  particle depolarization ratio of aerosols

2.1.4 Rain Sampling for Stable Isotopes

Kimpei ICHIYANAGI (JAMSTEC) (Not on board)

(1) Objective

To determine the spatial distribution of isotopic composition of rainfall on the Ocean

(2) Method

Rainfall samples are collected in 6cc glass bottle with plastic cap. Isotopic compositions for hydrogen and oxygen in rainfall are determined by the Isotope Ratio Mass Spectrometry (IRMS).

(3) Preliminary results

During this cruise, we collected 11 samples in total. Table 1 lists the date and location of rainfall samples. Analysis will be done after the cruise.

(4) Data archive

Original samples will be analyzed by IORGC. Inventory and analyzed digital data will be submitted to JAMSTEC Data Management Office.

Table 1 Dates and locations to show when and where rain water were sampled.

Sample No.	Date (UTC)	Location (lat, long)	Rain (mm)
001	19:30, September 6	56-59N, 175-07E	2.0
002	23:57, September 12	46-55N, 159-58E	5.7
003	00:25, September 15	46-49N, 160-05E	0.0
004	21:24, September 15	45-01N, 158-32E	4.0
005	23:58, September 15	44-26N, 158-06E	14.0
006	04:16, September 16	43-34N, 157-28 E	8.1
007	22:10, September 16	40-20N, 155-05 E	0.2
008	19:01, September 18	37-27N, 155-00 E	10.8
009	04:50, September 26	46-57N, 160-08 E	21.2
010	07:50, September 26	46-29N, 159-29 E	1.4
011	00:00, September 27	44-28N, 156-59 E	1.5

2.1.5 Surface Atmospheric Turbulent Flux Measurement

Kunio YONEYAMA **(JAMSTEC) Principal Investigator / Not-onboard**
Osamu TSUKAMOTO **(Okayama University) Not-onboard**
Wataru TOKUNAGA **(Global Ocean Development Inc.)**
Ryo KIMURA **(Global Ocean Development Inc.)**

(1) Objective

To better understand the air-sea interaction, accurate measurements of surface heat and fresh water budgets are necessary as well as momentum exchange through the sea surface. In addition, the evaluation of surface flux of carbon dioxide is also indispensable for the study of global warming. Sea surface turbulent fluxes of momentum, sensible heat, latent heat, and carbon dioxide were measured by using the eddy correlation method that is thought to be most accurate and free from assumptions. These surface heat flux data are combined with radiation fluxes and water temperature profiles to derive the surface energy budget.

(2) Methods

The surface turbulent flux measurement system (Fig. 2.1.5-1) consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI7500 is a CO2/H2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously.

These signals are sampled at 10 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.). By obtaining the ship speed and heading information through the Mirai network system it yields the absolute wind components relative to the ground. Combining wind data with the turbulence data, turbulent fluxes and statistics are calculated in a real-time basis. These data are also saved in digital files every 0.1 second for raw data and every 1 minute for statistic data.

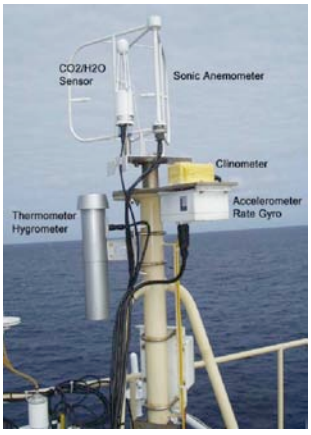


Fig. 2.1.5-1 Turbulent flux measurement system on the top deck of the foremast.

(3) Preliminary results

Data will be processed after the cruise at Okayama University.

(4) Data Archive

All data are archived at Okayama University, and will be opened to the public after quality checks and corrections by K. Yoneyama and O. Tsukamoto. Corrected data will be submitted to JAMSTEC Marine-Earth Data and Information Department.

2.2 Physical observation
2.2.1 CTD casts and water sampling

Masahide WAKITA (JAMSTEC): Principal Investigator
Tomoyuki TAKAMORI (MWJ): Operation Leader
Toru IDAI (MWJ)
Shinsuke TOYODA (MWJ)
Hiroki USHIROMURA (MWJ)

(1) Objective

Investigation of oceanic structure and water sampling of each layer

(2) Method

(2)-1 Overview of the equipment

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 11plus deck unit is a rack-mountable interface which supplies DC power to the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format using a 34,560 Hz carrier-modulated differential-phase-shift-keying (DPSK) telemetry link. The deck unit decodes the serial data and sends them to a personal computer to display, at the same time, to storage in a disk file using SBE SEASOFT software.

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

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

(2)-2 Details of sensors

The system used in this cruise is summarized as follows:

Under water unit:
SBE, Inc., SBE 9plus, S/N 0575
Temperature sensor:
SBE, Inc., SBE 3plus, S/N 03P4188
SBE, Inc., SBE 3-04/F, S/N 031525
Conductivity sensor:
SBE, Inc., SBE 4C, S/N 043064, S/N 043036
SBE, Inc., SBE 4-02/O, S/N 041088
Dissolved Oxygen sensor:

SBE, Inc., SBE 43, S/N 430394

Pump:

SBE, Inc., SBE 5T, S/N 054598, S/N 054595

Altimeter:

Datasonics Inc., PSA-916T, S/N 1157

Deck unit:

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

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 3227443-0391

Deep Ocean Standards Thermometer:

SBE, Inc., SBE 35, S/N 0045

Fluorometer:

Seapoint sensors, Inc., S/N 2579

Transmissometer:

Wetlabs, Inc., S/N CST-207RD

Oxygen Optode:

ALEC ELECTRONICS, S/N AANDERAA 1

(3) Data collection and processing

(3)-1 Data collection

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

The package was lowered into the water from the starboard side and held 10 m beneath the surface for about one minute in order to activate the pump. After the pump was activated the package was lifted to the surface, and the package was lowered again at a rate of about 1.0 m/s to 200m, 500m or Bottom-20m. For the up cast, the package was lifted at a rate of 1.2 m/s except for bottle firing stops. At each bottle firing stops, the bottle was fired.

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

(3)-2 Data processing

SEASOFT consists of modular menu driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with SBE equipment. Raw data are acquired from instruments and are stored as unmodified data. The conversion module DATCNV uses instrument configuration and calibration coefficients to create a converted engineering unit data file that is operated on by all SEASOFT post processing modules. The following are the SEASOFT and original software data processing module sequence and specifications used in the reduction of CTD data in this cruise.

Data processing software

SEASOFT-Win32, version 5.27b

DATCNV converted the raw data to engineering unit data. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 4.4 seconds, and the offset was set to 0.0 second.

TCORP (original module, version 1.0) corrected the pressure sensitivity of the SBE 3 for both profile and bottle information data. One SBE 3 (S/N 4188) was corrected because it had relatively large pressure sensitivity (about +1.8 mk per 6000 dbar).

ROSSUM created a summary of the bottle data. The data were averaged over 4.4 seconds.

ALIGNCTD converted the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. For a SBE 9plus CTD with the ducted temperature and conductivity sensors and a 3000-rpm pump, the typical net advance of the conductivity relative to the temperature is 0.073 seconds. So, the SBE 11plus deck unit was set to advance the primary and the secondary conductivity for 1.75 scans (1.75/24 = 0.073 seconds). Oxygen data are also systematically delayed with respect to depth mainly because of the long time constant of the oxygen sensor and of an additional delay from the transit time of water in the pumped plumbing line. This delay was compensated by 6 seconds advancing oxygen sensor output (oxygen voltage) relative to the temperature data.

ALIGNOPT (original module, version 0.1) also compensated the delay of the AANDERAA optode sensor by advancing relative to the CTD temperature data as a function of temperature (t).

$$\begin{aligned} \text{align (sec)} &= 25 \times \exp(-0.13 \times t) \quad (\text{for } 0 \le t \le 16.3\ ^\circ\text{C}) \\ &= 25 \quad (\text{for } t < 0\ ^\circ\text{C}) \\ &= 3 \quad (\text{for } t > 16.3\ ^\circ\text{C}) \end{aligned}$$

WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to all variables.

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

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

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

SECTION (or original module of SECTIONU, version 1.0) selected a time span of data based

on scan number in order to reduce a file size. The minimum number was set to be the start time when the CTD package was beneath the sea-surface after activation of the pump. The maximum number was set to be the end time when the package came up from the surface. Data for estimation of the CTD pressure drift were prepared before SECTION.

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

DESPIKE (original module, version 1.0) removed spikes of the data. A median and mean absolute deviation was calculated in 1-dbar pressure bins for both down- and up-cast, excluding the flagged values. Values greater than 4 mean absolute deviations from the median were marked bad for each bin. This process was performed 2 times for temperature, conductivity and oxygen voltage data.

DERIVE was used to compute oxygen.

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

DERIVE was re-used to compute salinity, potential temperature, and density (σ_θ.

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

(4) Preliminary results

Total 28 casts of CTD measurements have been carried out (Table 2.2.1).

Table 2.2.1 : MR07-05 CTD cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire	HT Above	Max	Max	CTD	Remark
		(mmddyy)	Start	End	Latitude	Longitude		Out	Bottom	Depth	Pressure	Filename	
S02	1	090807	13:28	17:38	50-59.71N	165-01.01E	4821.0	4840.7	17.1	4775.0	4871.6	S02M01	
S02	2	090907	7:29	8:06	51-00.04N	165-00.04E	4800.0	193.1	-	198.8	200.5	S02M02	
S02	3	090907	9:07	10:27	50-59.95N	165-00.02E	4814.0	996.1	-	989.7	1000.7	S02M03	
S02	4	091007	0:27	1:04	50-59.67N	165-00.26E	4813.0	194.0	-	198.5	200.1	S02M04	
S06	1	091107	3:26	8:07	47-00.13N	159-59.99E	5186.0	5183.5	19.2	5155.8	5262.3	S06M01	
S06	2	091207	17:03	17:34	46-51.87N	160-00.24E	5160.0	196.0	-	198.6	200.6	S06M02	
S06	3	091207	21:28	21:59	46-52.95N	159-57.95E	5166.0	196.4	-	198.7	200.1	S06M03	
S06	4	091307	9:30	11:07	46-56.00N	160-05.67E	5190.0	2001.1	-	1975.1	2001.4	S06M04	
S06	5	091307	19:45	22:27	46-53.64N	160-00.68E	5175.0	3987.3	-	3933.5	4003.6	S06M05	
S06	6	091407	21:23	1:17	46-49.65N	160-05.14E	5221.0	5246.7	19.5	5190.0	5298.1	S06M06	
S06	7	091507	7:00	7:37	46-56.12N	160-00.31E	5162.0	500.9	-	496.6	500.3	S06M07	
S18	1	091707	20:59	1:46	34-59.50N	154-59.36E	5661.0	5680.8	16.0	5633.7	5750.7	S18M01	condactivity sensor (secondary) trabble
S18	2	091807	3:41	4:18	34-56.39N	155-02.65E	5653.0	248.8	-	249.2	251.2	S18M02	condactivity sensor (secondary) trabble
S15	1	091807	21:59	22:15	37-59.76N	155-00.17E	6026.0	69.6	-	75.5	76.3	S15M01	changed condactivity sensor (secondary)
S15	2	091907	0:25	7:14	38-00.05N	154-59.83E	6019.0	6046.3	20.4	5995.0	6126.4	S15M02	
S14	1	092007	22:36	23:09	38-59.96N	155-00.14E	5775.0	196.0	-	199.5	201.0	S14M01	
S14	2	092107	0:21	5:51	38-59.10N	155-00.22E	5756.0	5766.0	18.9	5729.8	5851.8	S14M02	
S13	1	092107	10:14	15:22	39-59.72N	155-00.42E	5570.0	5580.6	20.0	5536.4	5651.7	S13M01	
S12	1	092107	20:22	0:33	41-01.09N	155-05.36E	5452.0	5478.3	17.4	5440.8	5554.3	S12M01	
S12	2	092207	2:16	2:45	40-59.61N	155-08.27E	5477.0	195.4	-	198.9	200.1	S12M02	
S09	1	092207	15:48	17:03	43-47.66N	155-11.43E	5454.0	998.9	-	987.3	998.5	S09M01	
S10	1	092207	21:22	21:50	43-00.01N	154-59.78E	5403.0	198.9	-	200.0	201.7	S10M01	
S10	2	092207	23:32	4:23	42-59.44N	154-58.15E	5375.0	5377.0	20.5	5344.0	5455.1	S10M02	
S11	1	092307	8:47	13:13	41-59.88N	155-00.00E	5451.0	5465.5	20.2	5417.3	5531.5	S11M01	
S20	1	092407	18:48	22:43	46-55.13N	159-58.39E	5162.0	5188.7	18.8	5131.9	5238.1	S20M01	
S20	2	092507	1:10	1:44	46-55.27N	160-00.25E	5206.0	196.4	-	198.9	200.9	S20M02	
S20	3	092507	3:23	4:01	46-56.44N	160-00.63E	5153.0	297.3	-	299.9	301.2	S20M03	
S20	4	092507	5:29	6:26	46-56.45N	160-00.60E	5156.0	1001.8	-	991.5	1001.9	S20M04	

(5) Data archive
All raw and processed CTD data files will be submitted to JAMSTEC.

2.2.2 Salinity measurement

Masahide WAKITA (JAMSTEC): **Principal Investigator**
Fujio KOBAYASHI (MWJ): Operation Leader
Tatsuya TANAKA (MWJ)

(1) Objectives

To measure bottle salinity obtained by CTD casts, bucket sampling, and EPCS.

(2) Instrument and Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles, bucket, and EPCS. The salinity sample bottle of the 250ml brown grass bottle with screw cap was used to collect the sample water. First, each bottle was rinsed three times with the sample water, and then was filled with sample water to the top of the bottle (without overflow). Finally, the level of sample water was adjusted to the shoulder of the bottle. The bottle was stored about 24 hours in the laboratory before the salinity measurement.

The kind and number of samples are shown as follows ;

Table 2.2.2-1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD and Bucket	475
Samples for EPCS	19
Total	494

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR07-05 using the salinometer (Model 8400B "AUTOSAL" ; Guildline Instruments Ltd.: S/N 66183) with additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. One thermometer monitored an ambient temperature and the other monitored a bath temperature.

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

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

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

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

Measurement Range	:	-40 to +180 deg C
Resolution	:	0.001
Limits of error ±deg C	:	0.01 (24 hours @ 23 deg C ±1 deg C)
Repeatability	:	±2 least significant digits

The measurement system was almost same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. An ambient temperature varied from approximately 20 deg C to 24 deg C, while a bath temperature is very stable and varied within ± 0.004 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio that is defined as median of 31 times reading of the salinometer. Data collection was started in 5 seconds after filling sample to the cell and it took about 15 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In case the difference between the double conductivity ratio of these two fillings is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.0003, eighth filling of the cell was done. In case the difference between the double conductivity ratio of these two fillings is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity.

The measurement was conducted about 6 - 14 hours per day and the cell was cleaned with soap and thin-ethanol after the measurement of the day.

(3) Preliminary Result

a. Standard Seawater

Standardization control of the salinometer was set to 414 and all measurements were done in this setting. The value of STANDBY was 5723 ± 0001 and that of ZERO was 0.0-0002 - 0.0+0000. IAPSO Standard Seawater batch P148 whose conductivity ratio was 0.99982 (double conductivity ratio is 1.99964) was used as the standard for salinity. 32 were measured (including 1 bad sample).

Fig.2.2.2-1 shows the history of double conductivity ratio of the Standard Seawater batch P148 (before correction). The average of double conductivity ratio was 1.99962 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity.

Drifts were calculated by data from P148 measured every station to correct nearly equal the determinate value of standard seawater.

Fig.2.2.2-2 shows the history of double conductivity ratio of the Standard Seawater batch P148 after correction. The average of double conductivity ratio after correction was 1.99964 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

The specifications of SSW used in this cruise are shown as follows ;

batch	:	P148
conductivity ratio	:	0.99982
salinity	:	34.993
preparation date	:	10-October-2006

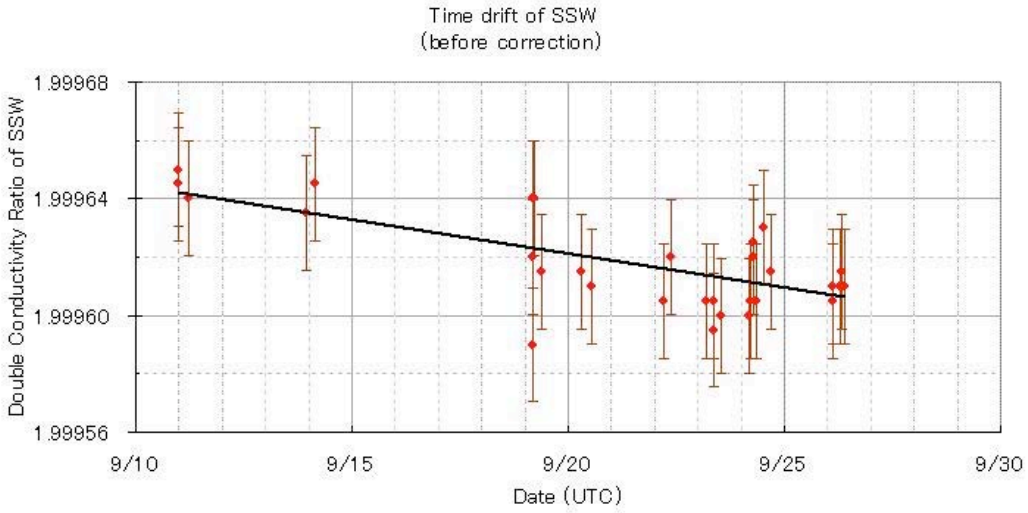


Fig. 2.2.2-1 History of double conductivity ratio for the Standard Seawater batch P148 (before correction)

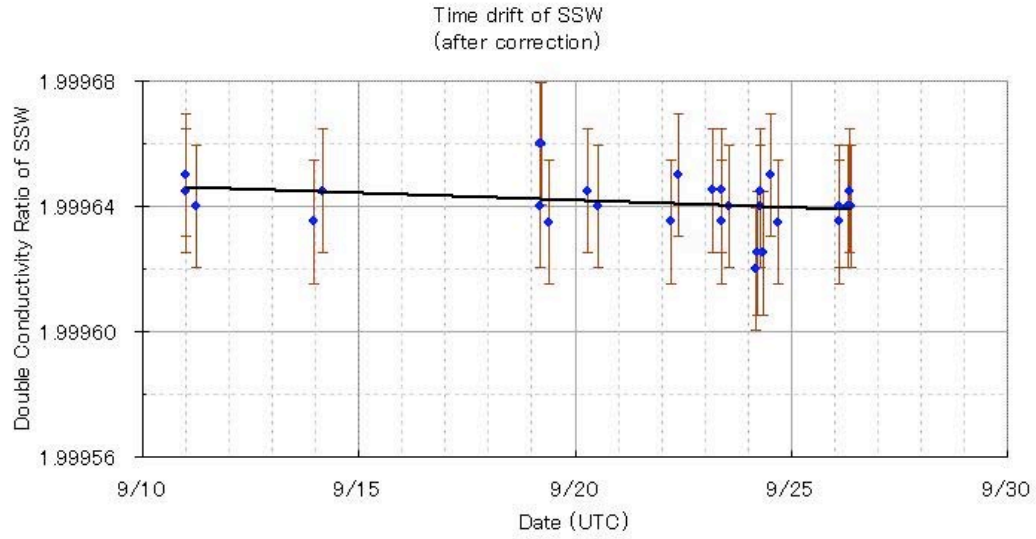


Fig. 2.2.2-2 History of double conductivity ratio for the Standard Seawater batch P148 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 7 samples in order to check the possible sudden drift of the salinometer.

c. Replicate Samples

63 pairs of replicate samples were taken. The standard deviation of the absolute deference of replicate samples was 0.0002 in salinity.

(5) Data archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department (MEDID) Data Integration and Analyses Group and is currently under its control.

(6) Reference

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

UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981

2.2.3 XCTD

Makio HONDA (JAMSTEC): Principal Investigator
Wataru TOKUNAGA (Global Ocean Development Inc.: GODI)
Ryo KIMURA (GODI)

(1) Objectives

Investigation of oceanic structure.

(2) Parameters

According to the manufacturer's nominal specifications, the range and accuracy of parameters measured by the XCTD (eXpendable Conductivity, Temperature & Depth profiler) are as follows;

Parameter	Range	Accuracy
Conductivity	0 ~ 60 mS/cm	±0.03 mS/cm
Temperature	-2 ~ 35 deg-C	±0.02 deg-C
Depth	0 ~ 1000 m	

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.08) provided by Tsurumi-Seiki Co.. We launched 9 probes (X001-X009) by using automatic launcher. The summary of XCTD observations and launching log were shown in Table 2.2.3-1.

(4) Preliminary results

Position of XCTD observations, Vertical section of temperature and salinity with CTD data were shown in Fig. 2.2.3-1 to 2.2.3-3

(5) Data archive

These data obtained in this cruise will be submitted to the Marine-Earth Data and Information Department （MEDID） of JAMSTEC, and will be opened to the public via "R/V MIRAI Data Web Page" in JAMSTEC home page.

Table 2.2.3-1 Summary of XCTD observation and launching log

Station No.	Date	Time	Latitude	Longitude	Measured Depth	Bottom Depth	SST	SSS	Probe S/N
X01	2007/09/10	10:56:04	49-59.9686N	163-44.9992E	1035	5870	10.690	32.730	07054083
X02	2007/09/10	16:30:51	48-59.9825N	162-29.9649E	1035	5613	10.842	32.623	07054082
X03	2007/09/10	21:51:11	47-59.9961N	161-15.0023E	1035	5404	11.125	32.635	07054084
X04	2007/09/18	10:08:37	36-00.4259N	155-00.3108E	1035	5563	26.577	34.282	07054086
X05	2007/09/18	16:43:44	37-00.0027N	154-59.7455E	1034	5679	25.357	34.354	07054085
X06	2007/09/22	07:13:50	42-00.0792N	155-00.0320E	1035	5449	18.190	33.825	07054088
X07	2007/09/22	11:14:57	43-00.1105N	155-00.0301E	1034	5407	17.121	33.730	07054087
X08	2007/09/24	04:43:55	45-00.1052N	156-40.1143E	1035	4912	13.163	33.058	07054090
X09	2007/09/24	11:11:24	46-00.0090N	158-20.0381E	1036	4888	10.742	32.937	07054089

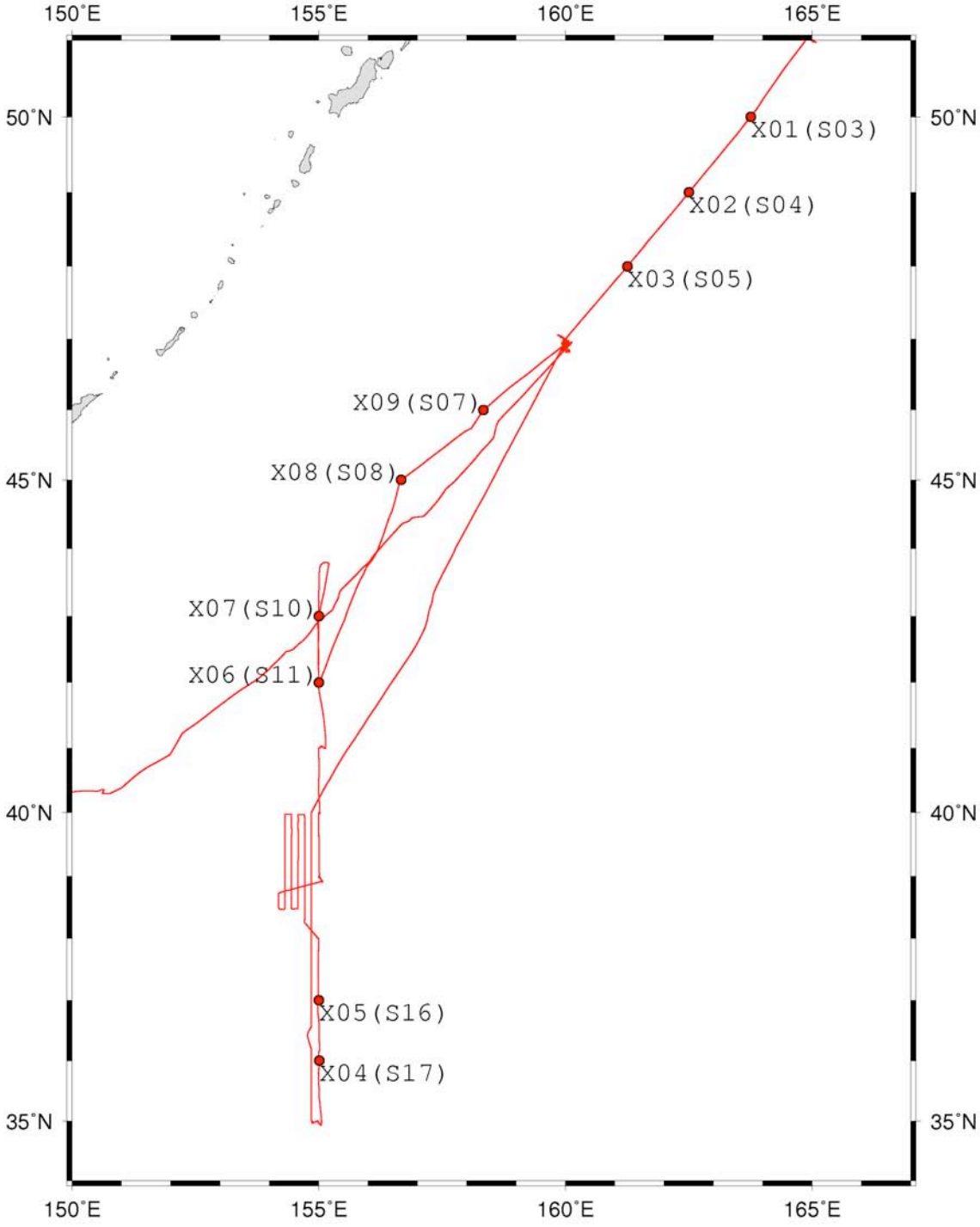


Fig. 2.2.3 Position of XCTD observation

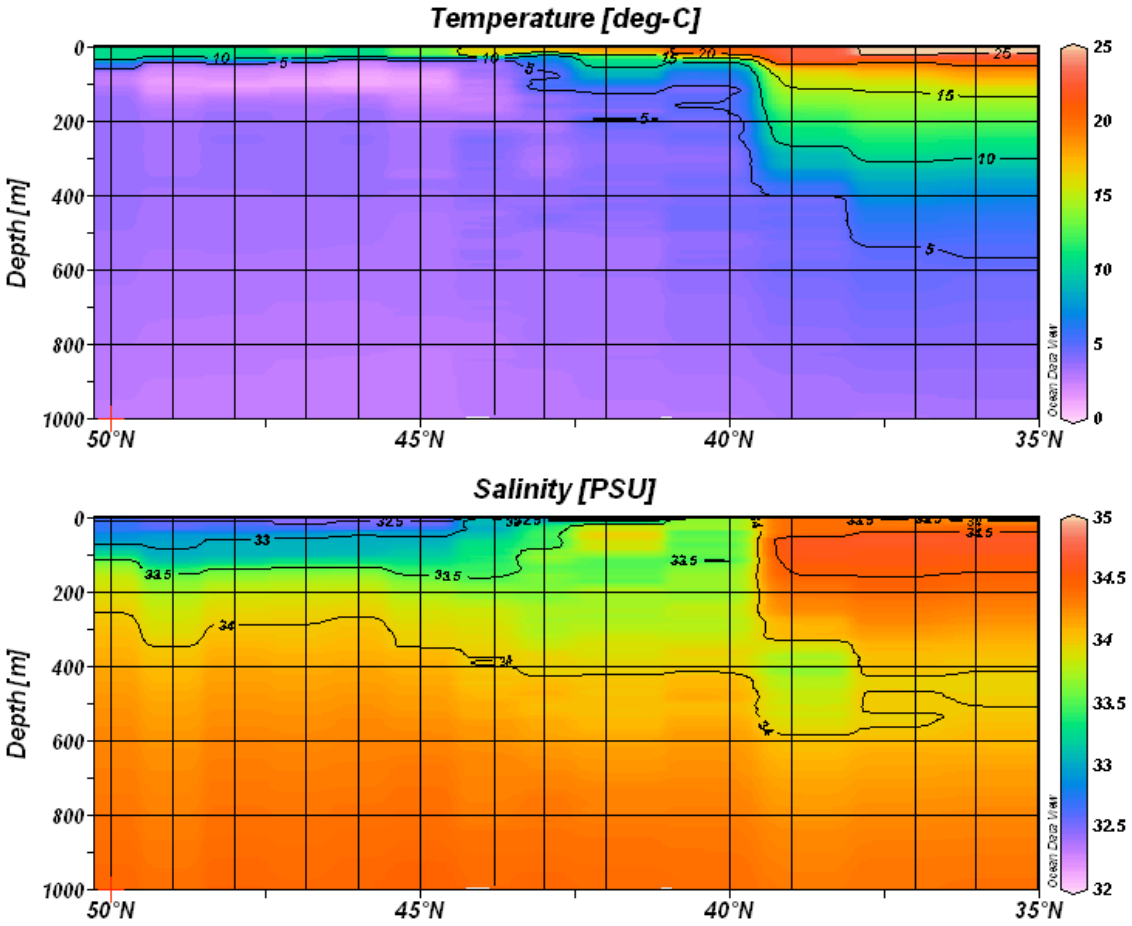


Fig. 2.2.3-2 Vertical section of temperature (upper) and salinity (lower) along ship track.

2.2.4 Shipboard ADCP

Wataru TOKUNAGA (Global Ocean Development Inc., GODI)
Ryo KIMURA (GODI)
Makio HONDA (JAMSTEC): Principal Investigator

(1) Objective

To obtain continuous measurement of the current profile along the ship's track.

(2) Methods

Upper ocean current measurements were made throughout MR07-05 cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. For most of its operation, the instrument was configured for water-tracking mode recording. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made in shallower water region to get the calibration data for evaluating transducer misalignment angle. The system consists of following components;

i) 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;

ii) The Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements to the ADCP.

iii) A GPS navigation receiver (Trimble 4000DS) providing position fixes.

iv) A personal computer running data acquisition software (VmDas version 1.4.0, RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 3 minutes.

v) High-precision attitude information, heading, pitch and roll, are also stored in N2R data files with a time stamp.

The ADCP was configured for 16 m processing bin and 8 m blanking distance. The sound speed at the transducer is calculated from temperature, salinity (constant value; 35.0 PSU) and depth (6.5 m; transducer depth) by equation in Medwin (1975). Data was made at 16-m intervals starting 31-m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown Table 2.2.4-1 Major parameters.

(3) Preliminary results

Fig. 2.2.4-1 and Fig. 2.2.4-2 were showed an hour averaged surface (30 – 60m) and 2nd layer (60 – 100m) current vector along the ship track. These data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

(4) Data archive

These data obtained in this cruise will be submitted to the Marine-Earth Data and Information Department （MEDID） of JAMSTEC, and will be opened to the public via "R/V MIRAI Data Web Page" in JAMSTEC home page.

(5) Remarks

1) Data acquisition was stopped in the EEZ of the USA.
   i) 18:00, 04 September - 22:00, 05 September
   ii) 23:30, 06 September - 05:00, 08 September

Table 2.2.4-1 Major parameters

Bottom-Track Commands

BP = 001	Pings per Ensemble (almost less than 1000m depth) 04 Sep. 18:10 UTC - 04 Sep. 18:10 UTC 30 Sep. 18:10 UTC - 02 Oct. 00:00 UTC
BP = 000	Disable bottom-track ping (almost over 1000m depth) 04 Sep. 18:10 UTC - 30 Sep. 22:00

Environmental Sensor Commands

EA = +00000	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +0001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001	Sensor Source (C; D; H; P; R; S; T) C (1): Sound velocity calculates using ED, ES, ET (temp.) D (0): Manual ED H (2): External synchro P (0), R (0): Manual EP, ER (0 degree) S (0): Manual ES T (1): Internal transducer sensor

Timing Commands

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

Water-Track Commands

WA = 255	False Target Threshold (Max) (0-255 count)
WB = 1	Mode 1 Bandwidth Control (0=Wid, 1=Med, 2=Nar)
WC = 064	Low Correlation Threshold (0-255)
WD = 111 111 111	Data Out (V; C; A PG; St; Vsum; Vsum^2;#G;PO)
WE = 5000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WG = 001	Percent Good Minimum (0-100%)
WI = 0	Clip Data Past Bottom (0 = OFF, 1 = ON)
WJ = 1	Rcvr Gain Select (0 = Low, 1 = High)
WM = 1	Profiling Mode (1-8)
WN = 040	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 1600	Depth Cell Size (cm)
WT = 000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)

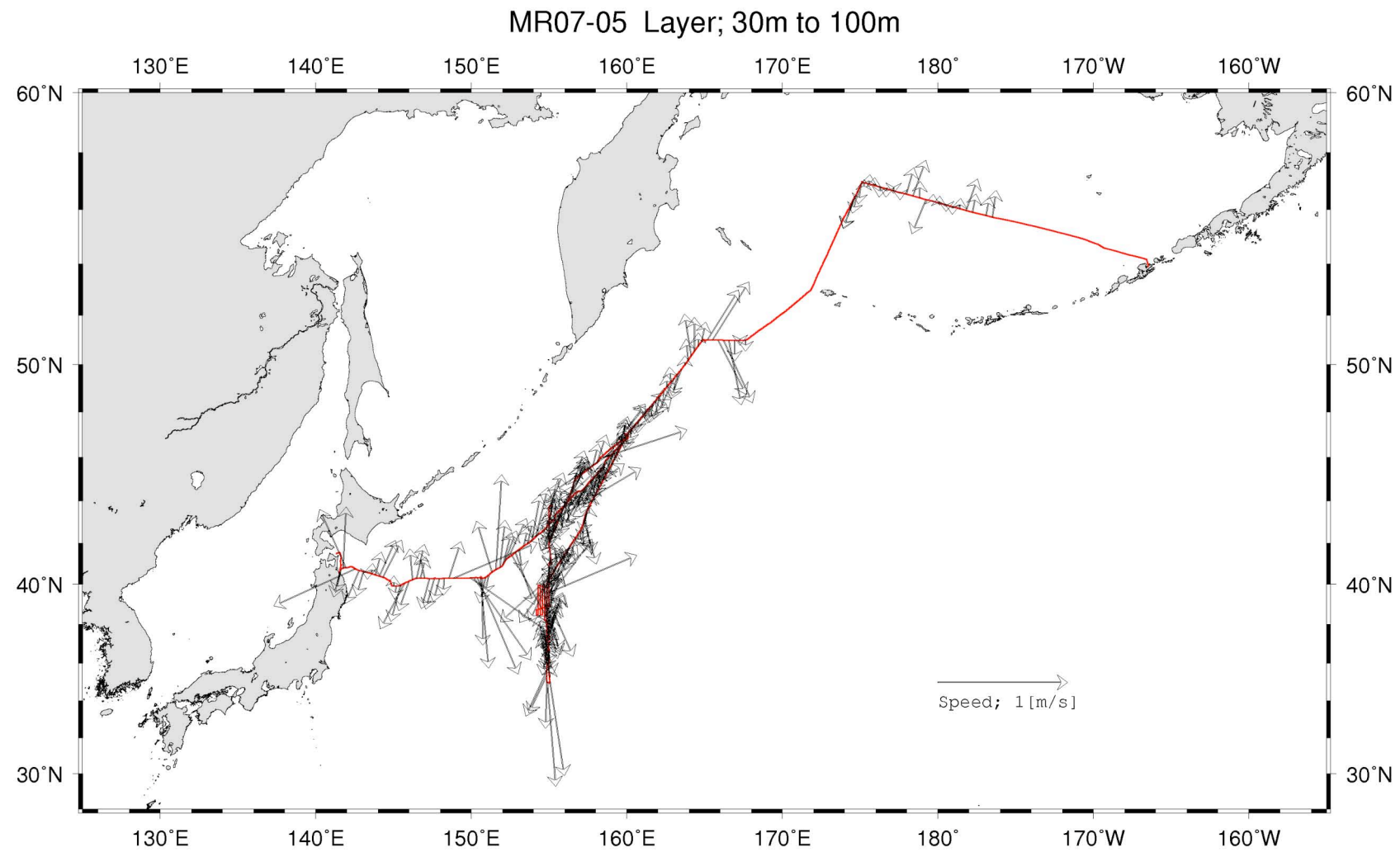


Fig. 2.2.4-1 An hour averaged surface (30 - 100 m) current vector along the ship track.

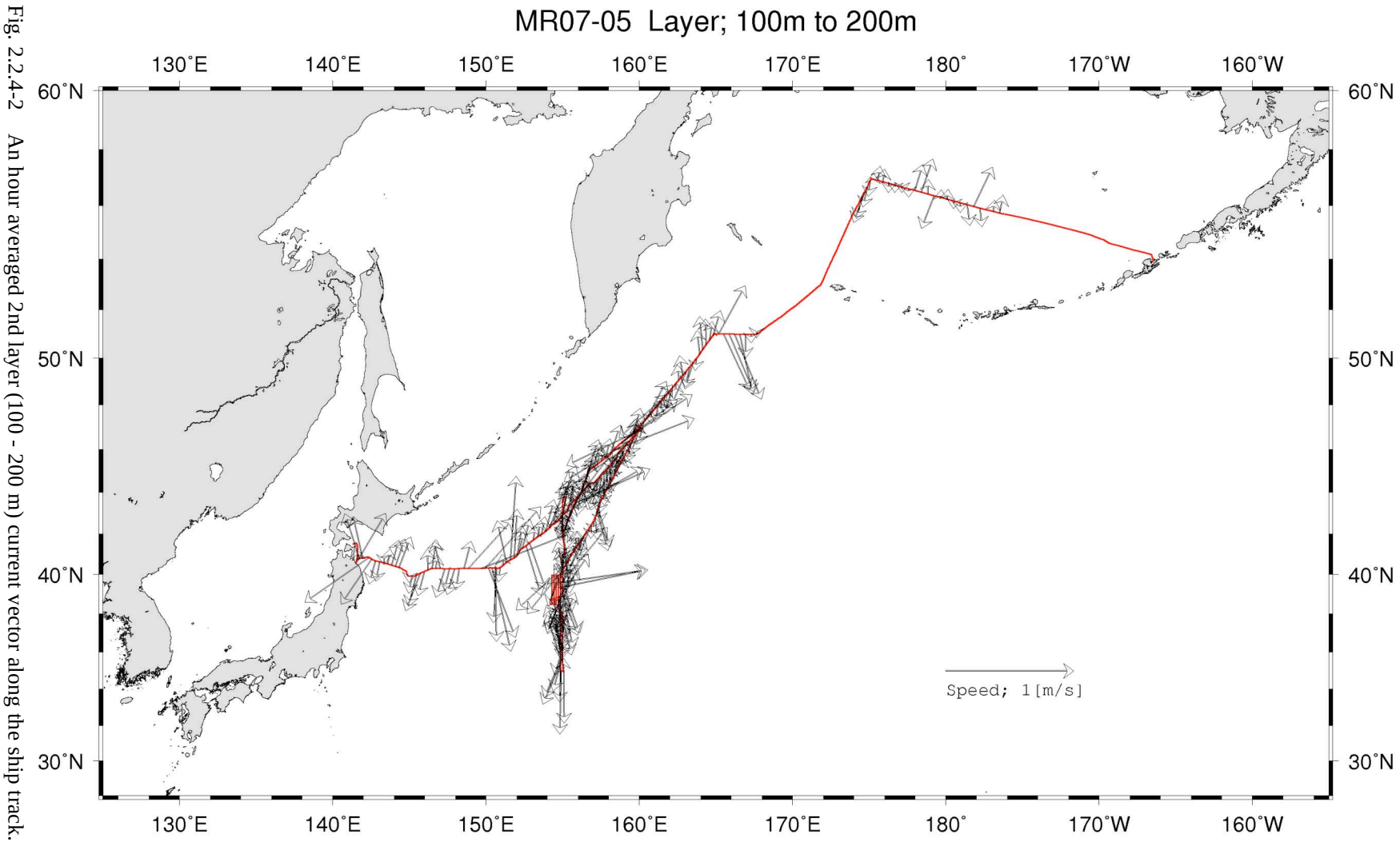


Fig. 2.2.4-2 An hour averaged 2nd layer (100 - 200 m) current vector along the ship track.

2.3 Sea surface monitoring: EPCS

Masahide WAKITA (JAMSTEC): Principal Investigator
Masanori ENOKI (MWJ): Operation Leader
Miyo IKEDA (MWJ): Operator

(1) Objectives

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

(2) Instruments and Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has five kind of sensors and can automatically measure salinity, temperature (two systems), dissolved oxygen and fluorescence in near-sea surface water continuously, every 1-minute. Salinity is calculated by conductivity on the basis of PSS78. This system is located in the "*sea surface monitoring laboratory*" on R/V MIRAI. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

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

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

a) Temperature and Conductivity sensor
SEACAT THERMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number: 2118859-2641
Measurement range: Temperature -5 to +35℃, Conductivity 0 to 6.5 S m^{-1}
Accuracy: Temperature 0.01℃ 6$month^{-1}$,Conductivity 0.001 S m-1 $month^{-1}$
Resolution: Temperatures 0.001℃, Conductivity 0.0001 S m^{-1}

b) Bottom of ship thermometer
Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number: 032175
Measurement range: -5 to +35℃
Resolution: ±0.001℃
Stability: 0.002℃ $year^{-1}$

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

d) Fluorometer

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

e) Flow meter
Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 l min-1
Accuracy: ±1%
Stability: ±1% day-1

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

Start : 2007/9/5	23:34	Stop : 2007/9/6	23:30
Start : 2007/9/8	4:56	Stop : 2007/9/26	7:04

(3) Preliminary Result

Preliminary data of temperature (thermometer of ship bottom), salinity, dissolved oxygen, fluorescence at sea surface during this cruise are shown in Fig.2.3-1. We collected samples to compare a bottle data with a sensor value of salinity, dissolved oxygen and fluorescence. They are shown in Fig.2.3.2, 3.and Table 2.3-1 All salinity samples were analyzed by the Guildline AUTOSAL 8400B, dissolve oxygen samples were analyzed by the KIMOTO DOT-01, fluorescence samples were analyzed by Non-acidification method, using 10-AU-005,TURNER DESIGNS.

(4) Data archive

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

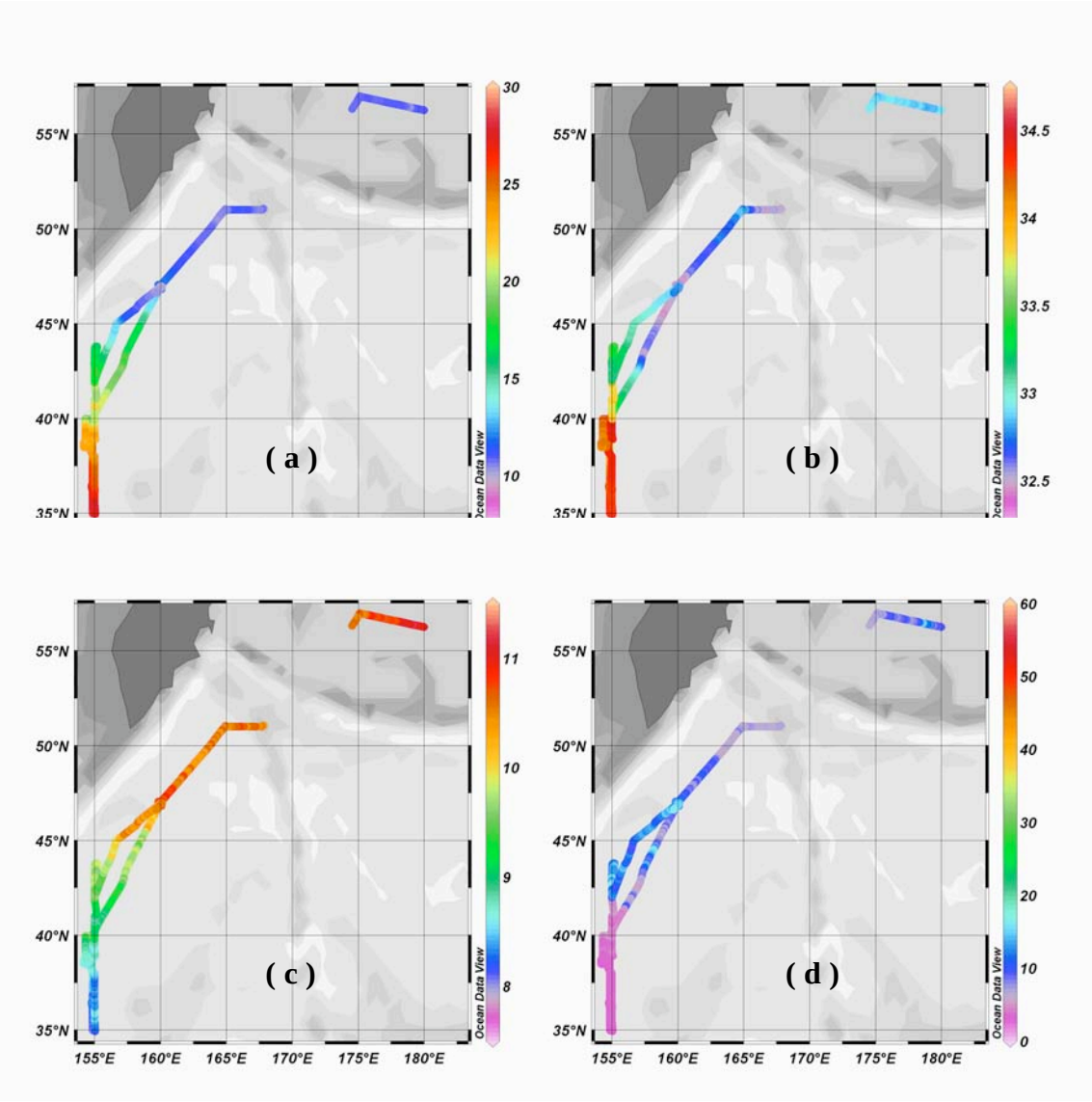


Fig. 2.3-1 Contour line of temperature(a), salinity(b), dissolved oxygen(c), fluorescence(d) of the sea surface water during this cruise.

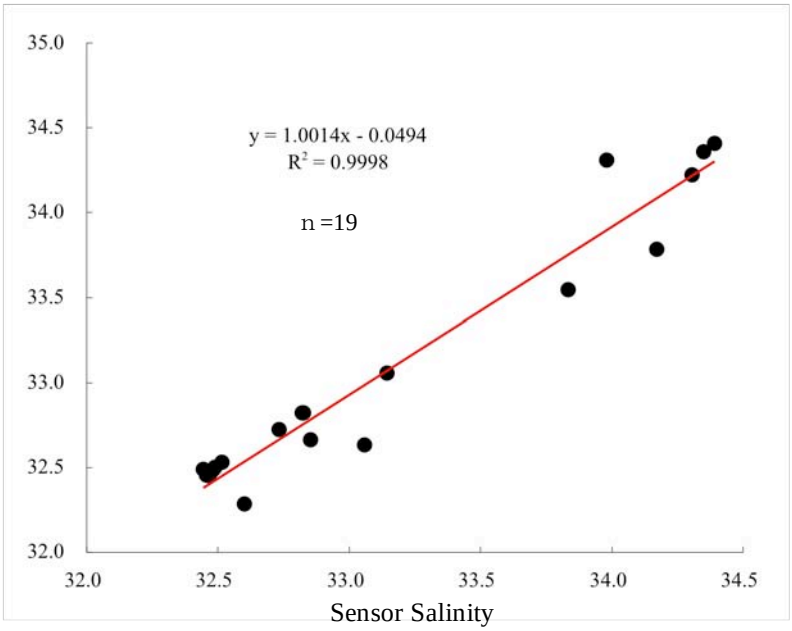


Fig.2.3-2 Comparison between salinity sensor and bottle data.

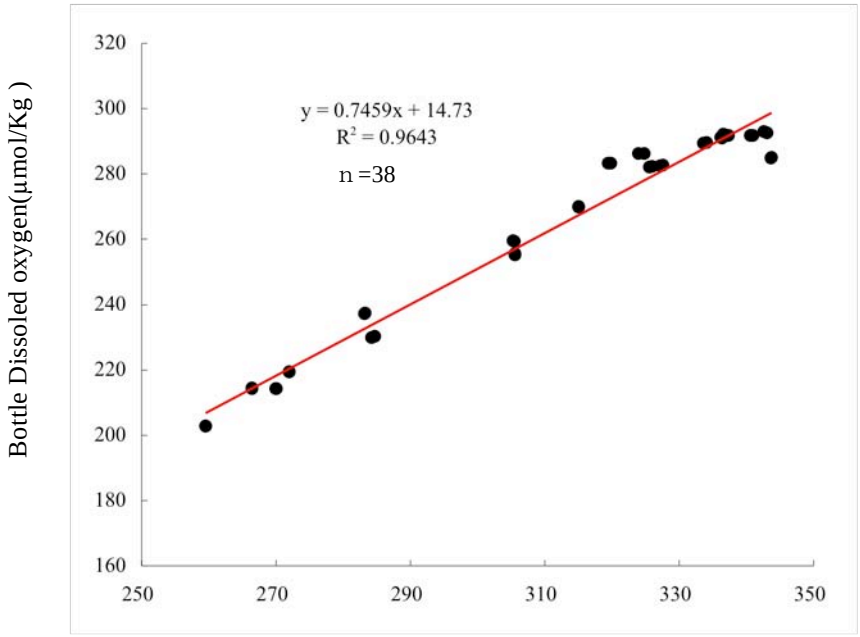


Fig.2.3-3 Comparison between dissolved oxygen sensor and bottle data.

Table 2.3-1 Comparison of the fluorescence with the bottle chlorophyll*a* during MR07-05

Date [UTC]	Time [UTC]	fluorescence	Bottle Chlorophyll *a* (μg/L)	
			Non-Acidification Method	Acidification Method
2007/9/6*1	4:33	8.277	0.65	0.62
2007/9/15*2	5:37	14.387	1.15	1.11
2007/9/15*3	7:43	10.332	1.10	1.06
2007/9/26*4	7:01	16.135	1.08	1.05

*1: Water was sampled immediately after the beginning of the continuous monitoring.

*2: Water was sampled before exchanging the flowcell.

*3: Water was sampled after exchanging the flowcell.

*4: Water was sampled finishing of before the continuous monitoring.

2.4 Dissolved oxygen

Masahide WAKITA (JAMSTEC): Principal Investigator
Masanori ENOKI (MWJ): Operator
Miyo IKEDA(MWJ): Operation Leader

(1) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(2) Measured parameters

Dissolved oxygen of sampled seawater

(3) Instruments and Methods

a. Reagents

Pickling Reagent I: Manganous chloride solution (3M)
Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)
Sulfuric acid solution (5M)
Sodium thiosulfate (0.025M)
Potassium iodate (0.001667M)

b. Instruments:

Burette for sodium thiosulfate;
APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel
Burette for potassium iodate;
APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel
Detector and Software; Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

c. Sampling

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

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

d. Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen

concentration using two sets of the titration apparatus (DOT-01 and DOT-03). Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution without the blank.

e. Standardization and determination of the blank

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

The blank from the presence of redox species apart from oxygen in the reagents was determined as follows. Firstly, 1 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Secondary, 2 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. The blank was determined by difference between the first and second titrated volumes of the sodium thiosulfate.

Table 2.4-1 shows results of the standardization and the blank determination during this cruise.

Table 2.4-1 Results of the standardization and the blank determinations during this cruise.

Date	KIO_3		DOT-01 (cm^3)			DOT-02 (cm^3)			Samples
(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	$Na_2S_2O_3$	E.P.	blank	(Stations)
2007/09/06	7	20070619-07-09	20070413-06-03	3.957	-0.010	-	-	-	S02 cast1, S02 cast3, S02 cast4
2007/09/06		20070619-07-05	-	-	-	20070413-06-04	3.960	-0.008	S02 cast1, S02 cast3, S02 cast4
2007/09/10		20070619-07-06	20070413-06-03	3.960	-0.009	20070413-06-04	3.961	-0.006	S06 cast1, S06 cast2, S06 cast5
2007/09/17		20070619-07-07	20070613-02-01	3.952	-0.007	20070613-02-02	3.954	-0.006	S18 cast1, S15 cast2
2007/09/20	8	20070619-08-01	20070613-02-01	3.952	-0.008	20070613-02-02	3.954	-0.006	S14 cast2, S13 cast1, S12 cast1, S09 cast1,
2007/09/22		20070619-08-02	20070613-02-01	3.953	-0.008	20070613-02-02	3.951	-0.008	S10 cast1, S11 cast1
2007/09/25		20070619-08-03	20070613-02-03	3.951	-0.007	20070613-02-02	3.952	-0.009	S20 cast1, S20 cast2

Batch number of the KIO_3 standard solution.

f. Reproducibility of sample measurement

Replicate samples were taken at every CTD cast; usually these were 5 - 10 % of seawater samples of each cast during this cruise. Results of the replicate samples were shown in Table 2.4-2 and this histogram shown in Fig.2.4-1. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

Table 2.4-2 Results of the replicate sample measurements

Number of replicate sample pairs	Oxygen concentration (μmol/kg) Standard Deviation.
43	0.10

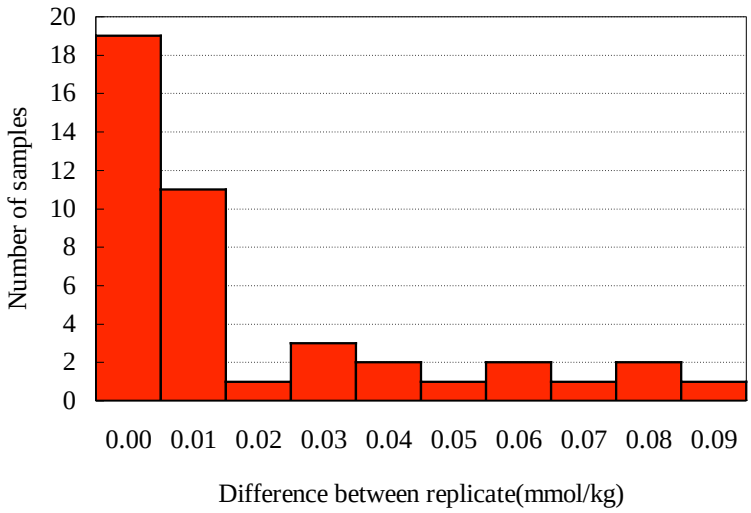


Fig 2.4-1 Results of the replicate samples measurements

(*4) Preliminary Result*

During this cruise, we measured oxygen concentration in 459 seawater samples at 16 stations.

(5) Data archive

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

(6) Reference

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

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

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

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

2.5 Nutrients

Masahide WAKITA (JAMSTEC): Principal Investigator
Takayoshi SEIKE (MWJ) : Operation Leader
Ayumi TAKEUCHI (MWJ)
Kenichiro SATO (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 and Ammonia. See below for further details.

(3) Instruments and Methods

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system. The laboratory temperature was maintained between 22-27 deg C.

a. Measured Parameters

Nitrate + nitrite and nitrite are analyzed according to the modification method of Grasshoff (1970). The sample nitrate is reduced to nitrite in a cadmium tube inside of which is coated with metallic copper. The sample stream with its equivalent nitrite is treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid, which reacts with the sulfanilamide to produce a diazonium ion. N1-Naphthylethylene-diamine added to the sample stream then couples with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

Absorbance of 550 nm by azo dye in analysis is measured using a 3 cm length cell for Nitrate and 5 cm length cell for Nitrite.

The silicate (Although silicic acid is correct, we use silicate because a term of silicate is widely used in oceanographic community) method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid is first formed from the silicic acid in the sample and added molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using L-ascorbic acid as the reductant.

Absorbance of 630 nm by silicomolybdous acid in analysis is measured using a 3 cm length cell.

The phosphate analysis is a modification of the procedure of Murphy and Riley (1962). Molybdic acid is added to the seawater sample to form phosphomolybdic acid, which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant.

Absorbance of 880 nm by phosphomolybdous acid in analysis is measured using a 5 cm length cell.

Ammonia in seawater is mixed with an alkaline solution containing EDTA, ammonia as gas state is formed from seawater. The ammonia (gas) is absorbed in sulfuric acid solution by way of 0.5 μm pore size membrane filter (ADVANTEC PTFE) at the dialyzer attached to analytical system. The ammonia absorbed in acid solution is determined by coupling with phenol and hypochlorite solution to from an indophenol blue compound.

Absorbance of 630 nm by indophenol blue compound in analysis is measured using a 3 cm length cell.

b. Nutrients Standard

Silicate standard solution, the silicate primary standard, was obtained from Merck, Ltd.. This standard solution, traceable to SRM from NIST was 1000 mg per litter. Since this solution is alkaline solution of 0.5 M NaOH, an aliquot of 40ml solution were diluted to 500 ml together with an aliquot of 20 ml of 1M HCl. Primary standard for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Merck, Ltd. and nitrite ($NaNO_2$) and ammonia ($(NH_4)_2SO_4$) were obtained from Wako Pure Chemical Industries, Ltd..

c. Sampling Procedures

Samples were drawn into virgin 10 ml polyacrylates vials that were rinsed three times before sampling without sample drawing tubes. Sets of 5 different concentrations for nitrate, nitrite, silicate, phosphate and 4 different concentrations for ammonia of the shipboard standards were analyzed at beginning and end of each group of analysis. The standard solutions of highest concentration were measured every 12–13 samples and were used to evaluate precision of nutrients analysis during the cruise. We also used reference material for nutrients in seawater, RMNS (KANSO Co., Ltd., lots AU), each runs to secure comparability on nutrient analysis throughout the cruise.

d. Low Nutrients Sea Water (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.45 μm pore size membrane filter. This water is stored in 20-liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in May 2007.

(4) Preliminary Results

Analytical precisions were 0.07% (55 μM) for nitrate, 0.08% (1.2 μM) for nitrite, 0.08% (171 μM) for silicate, 0.11% (3.6 μM) for phosphate and 0.97% (4.0 μM) for ammonia in terms of median of precision, respectively.

Results of RMNS analysis are shown in Tables 2.5.1 for the station's comparability.

(6) Data archives

All data will be submitted to JAMSTEC and is currently under its control.

Reference

Grasshoff, K. (1970), Technicon paper, 691-57.

Grasshoff, K., Ehrhardt, M., Kremling K. et al. (1983), Methods of seawater analysis. 2nd rev. Weinheim: Verlag Chemie, Germany, West.

Murphy, J., and Riley, J.P. (1962), Analytica chim. Acta 27, 31-36.

Table 2.5.1 Results of RMNS Lot. AU analysis in this cruise.

μmol/kg

Serial	Stn.	NO_3	NO_2	SiO_2	PO_4	NH_4
937	S02_1	29.97	0.02	66.49	2.171	-
937	S02_3	29.96	0.02	66.39	2.175	-
845	S02_4	29.89	0.02	66.46	2.180	0.55
221	S02_4	29.86	0.02	66.51	2.183	0.59
235	S06_1	29.93	0.01	66.58	2.169	-
544	S06_2	29.87	0.02	66.60	2.170	-
283	S18	29.96	0.01	66.60	2.177	-
283	S15	29.94	0.02	66.53	2.176	-
283	S14	29.95	0.02	66.40	2.181	-
781	S13	29.93	0.00	66.30	2.170	0.56
781	S12	29.92	0.00	66.44	2.170	-
781	S09_1	29.87	0.02	66.48	2.164	-
346	S09_1	30.02	0.02	66.47	2.170	-
306	S10_1	29.87	0.02	66.45	2.168	0.57

2.6 pH

Masahide WAKITA (JAMSTEC): Principal Investigator
Ayaka HATSUYAMA (MWJ)
Hiroyuki HAYASHI (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on the greenhouse gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that could be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on board measurements of pH during MR07-05cruise.

(2) Measured Parameters

pH (Total hydrogen ion concentration scale)

(3) Apparatus and performance

(3)-1 Seawater sampling

Seawater samples were collected with CTD system mounted 12L Niskin bottles at 11 stations. Seawater was sampled in a 125ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution at least 3 hours and was cleaned by fresh water for 5 times and Milli-Q deionized water for 3 times. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 2 times bottle volume (10 seconds) with care not to leave any bubbles in the bottle. After collecting the samples on the deck, the glass bottles were removed to the lab to be measured. The glass bottles were put in the water bath kept about 25℃ before the measurement.

(3)-2 Seawater analysis

pH ($-\log[H^+]$) of the seawater was measured potentiometrically in the glass bottles at the temperature 25℃. Value of pH determined experimentally from sequential measurements of the electromotive force (the e.m.f.) of electrode cell in a standard buffer of known (defined) pH and in the seawater sample.

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 PHM240). 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 bottle was used. The temperature during pH measurement was monitored with temperature sensor (Radiometer T201) and controlled to 25℃ within ±0.05℃.

To calibrate the electrodes the TRIS buffer (Lot=070702-2: pH=8.0904 pH units at 25℃, Delvalls and Dickson, 1998) and AMP buffer (Lot=070702-1: pH=6.7836 pH units at

25℃, DOE, 1994) in the synthetic seawater (Total hydrogen ion concentration scale) were applied.

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

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

where electrode response "ER" is calculated as follows:

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

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

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

(4) Preliminary results

A replicate analysis was made on every 8th seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.6-1). The average of the difference was 0.001 pH units (n=40 pairs). The standard deviation was 0.001 pH units, which indicates that the analysis was accurate enough according to DOE (1994).

(5) Data Archive

All data will be submitted to JAMSTEC and is currently under its control.

(6) Reference

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

DelValls, T. A. and Dickson, A. G., 1998. The pH of buffers based on 2-amino-2-hydroxymethyl-1,3-propanediol ('tris') in synthetic sea water. Deep-Sea Research Ⅰ 45, 1541-1554.

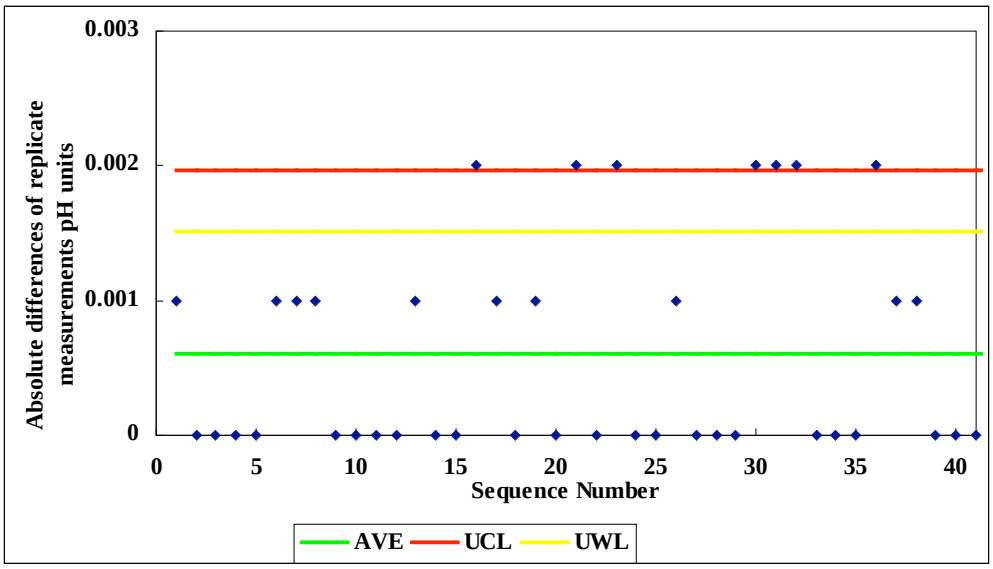


Figure 2.6-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of pH during this cruise.

2.7 Dissolved Inorganic carbon-DIC

Masahide Wakita (JAMSTEC): Principal Investigator
Minoru KAMATA (MWJ)
Yasuhiro ARII (MWJ)

(1) Objective

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} owing to human activities such as burning of fossil fuels, deforestation, and cement production. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the anticipated global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters (alkalinity, dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1994). We here report on board measurements of DIC during MR07-05 cruise.

(2) Methods, Apparatus and Performance

(2)-1 Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 38 stations. Among these stations, deep and shallow casts were carried out for 12 stations. When shallow casts were performed, surface seawater samples were also collected by a bucket. Seawater was sampled in a 300ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution at least 3 hours and was cleaned by fresh water for 5 times and Milli-Q deionized water for 3 times. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 20 seconds with care not to leave any bubbles in the bottle. After collecting the samples on the deck, the glass bottles were removed to the lab to be measured. Prior to the analysis, 3ml of the sample (1% of the bottle volume) was removed from the glass bottle in order to make a headspace. The samples were then poisoned with 100µl of over saturated solution of mercury chloride within one hour from the sampling point. After poisoning, the samples were sealed using grease (Apiezon M grease) and a stopper-clip. The samples were stored in a refrigerator at approximately 5degC until analyzed.

(2)-2 Seawater analysis

Measurements of DIC were made with total CO_2 measuring system (systems C; Nippon ANS, Inc.). The system comprise of seawater dispensing system, a CO_2 extraction system and a coulometer (Model 5012, UIC Inc.)

The seawater dispensing system has an auto-sampler (6 ports), which takes seawater into a glass bottle and dispenses the seawater to a pipette of nominal 21 ml volume by PC control. The pipette was kept at 20 ± 0.05 degC by a water jacket, in which water from a thermostatic water bath (LP-3110, ADVANTEC) set at 20 degC is circulated.

CO_2 dissolved in a seawater sample is extracted in a stripping chamber of the CO_2 extraction system by adding phosphoric acid (10% v/v). The stripping chamber is made approx. 25 cm long and has a fine frit at the bottom. The acid is added to the stripping chamber from the bottom of the chamber by pressurizing an acid bottle for a given time to push out the right amount of acid. The pressurizing is made with nitrogen gas (99.9999 %). After the acid is transferred to the stripping chamber, a seawater sample kept in a pipette is introduced to the stripping chamber by the same method as that for adding an acid. The seawater reacted with phosphoric acid is stripped of CO_2 by bubbling the nitrogen gas through a fine frit at the bottom of the stripping chamber. The CO_2 stripped in the chamber is carried by the nitrogen gas (flow rates of 140ml min^{-1}) to the coulometer through a dehydrating module. The module consists of two electric dehumidifiers (kept at 4 degC) and a chemical desiccant ($Mg(ClO_4)_2$).

The measurement sequence such as 2 % CO_2 gas in a nitrogen base, system blank (phosphoric acid blank), and seawater samples (6 samples) was programmed to repeat. The measurement of 2 % CO_2 gas was made to monitor response of coulometer solutions (from UIC, Inc.).

(3) Preliminary results

During the cruise, 460 samples were analyzed for DIC. A replicate analysis was made on every 8th seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.7-1). The average of the differences was 0.8μmol/kg (n=40). The standard deviation was 0.7μmol/kg, which indicates that the analysis was accurate enough according to DOE (1994).

(4) Data Archive

All data will be submitted to JAMSTEC and is currently under its control.

Reference

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

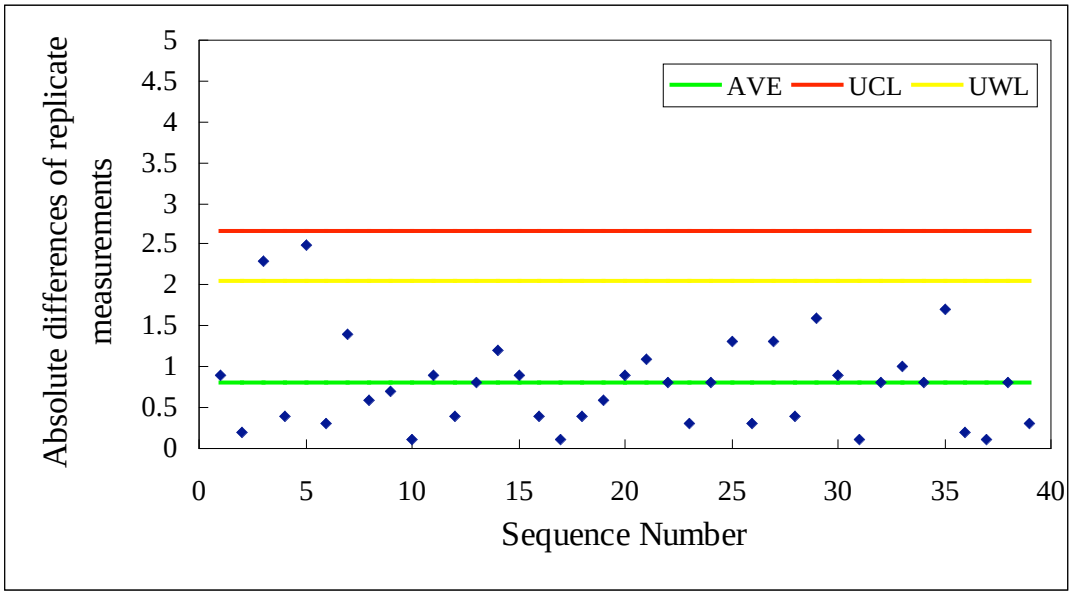


Figure 2.7-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of DIC during the MR07-05 cruise.

2.8 Total Alkalinity

Masahide WAKITA (JAMSTEC): Principal Investigator
Ayaka HATSUYAMA (MWJ)
Hiroyuki HAYASHI (MWJ)

(1) Objective

Since the global warming is becoming an issue world-widely, studies on green house gases such as CO_2 are drawing high attention. Because the ocean plays an important role in buffering the increase of atmospheric CO_2, surveys on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; total alkalinity, total dissolved inorganic carbon, pH and pCO_2. When two of the four parameters are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on-board measurements of total alkalinity in MR07-05 cruise.

(2) Measured Parameters

Total Alkalinity, TA

(3) Apparatus and performance

(3)-1 Seawater sampling

Seawater samples were collected with 12L Niskin bottles attached to CTD system at 11 stations. Seawater was sampled in a 125ml glass bottle (SCHOTT DURAN) that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 3 hours and was cleaned by fresh water and Milli-Q deionized water for 3 times each. The sampling was carried out by connecting a sampling tube to the Niskin bottle. The glass bottles were rinsed 3times, filled from the bottom, and were overflowed for 10 seconds. After collecting the samples on the deck, the glass bottles filled in sample seawater brought to the lab. The bottles were put in the water bath kept about 25℃ before the measurement.

(3)-2 Seawater analysis

Measurement of alkalinity was made using a spectrophotometric systems (Nippon ANS, Inc.).

The system comprises of water dispensing unit and a spectrophotometer (Cary 50 Scan, Varian). For an indicator, bromocresol green sodium (BCG) was used. Calculation of TA was made based on a single step acid addition procedure (Yao and Byrne, 1998).

Sample seawater of approx. 40 ml is transferred from a sample into a water-jacketed (25 ºC), and is introduced into a water-jacketed (25.00± 0.05 ºC) titration and pH cell. The length and volume of the pH cell are 8 cm and 13 ml, respectively. First, absorbencies of seawater only were measured at three wavelengths (750, 616 and 444 nm). Acid addition was made by titrator (Metrohm, Dosimat 765), which was 0.05 M HCl + 4×10^{-5} M BCG in 0.65 M NaCl solution. Final solution was approximately 2-3 μM in BCG. Then the solution was circulated and purged of CO_2 gas with stream of N_2 gas for about 6 minutes to mix the acid-indicator solution and seawater sufficiently. After the pump was stopped, the absorbencies of solution were measured at the same wavelengths. The excess acid

concentration was calculated based on the following equation (Yao and Byrne, 1998):

$$pH_T = 4.2699 + 0.002578(35 - S) + \log\left(\frac{A_{616}/A_{444} - 0.00131}{2.3148 - 0.1299(A_{616}/A_{444})}\right) - \log(1 - 0.01005S)$$

, where A_{616}/A_{444} indicate absorbance ratio at 25ºC and S is Salinity. The alkalinity of a seawater sample that has been acidified and purged of CO_2 can written as follows:

$$A_T = \left[\left(N_A V_A - (H^+)_{ASW}\, dsw\, V_{ASW}\right)/V_{SW} \times 10^{-6}\right]/dsw,$$

where A_T is the alkalinity of a seawater sample (mol/kg), N_A is the concentration of the added acid (mol/l), V_A is the volume of the added acid (ml), V_{SW} is the volume of the seawater sample (ml), $(H^+)_{ASW}$ is the excess hydrogen ion concentration in the acidified seawater (mol/kg), V_{ASW} is the volume of the acidified seawater calculated as $V_{SW} + V_A$ (ml), dsw is sample seawater density at 25ºC and Salinity.

The acid titrant was made by 0.6M HCl solution. Calibration of 0.6M HCl was measured by Na_2CO_3 using Gran's plot technique. The acid titrant concentration was calculated by 0.6M HCl concentration, HCl volume, HCl density and flask volume. The computed acid titrant concentration was 0.049977 mol/l.

(4) Preliminary results

A few replicate samples were taken on every station and the difference between each pair of analyses was plotted on a range control chart (see Figure 2.8-1). The average of the difference was 0.6 μmol/kg (n= 38). The standard deviation was 0.5 μmol/kg, which indicates that the analysis was accurate enough according to DOE (1994).

(5) Data Archive

All data will be submitted to JAMSTEC and is currently under its control.

(6) Reference

Yao, W. and Byrne, R. H. (1998), Simplified seawater alkalinity analysis: Use of linear array spectrometers. Deep-Sea Research Part I, Vol. 45, 1383-1392.

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

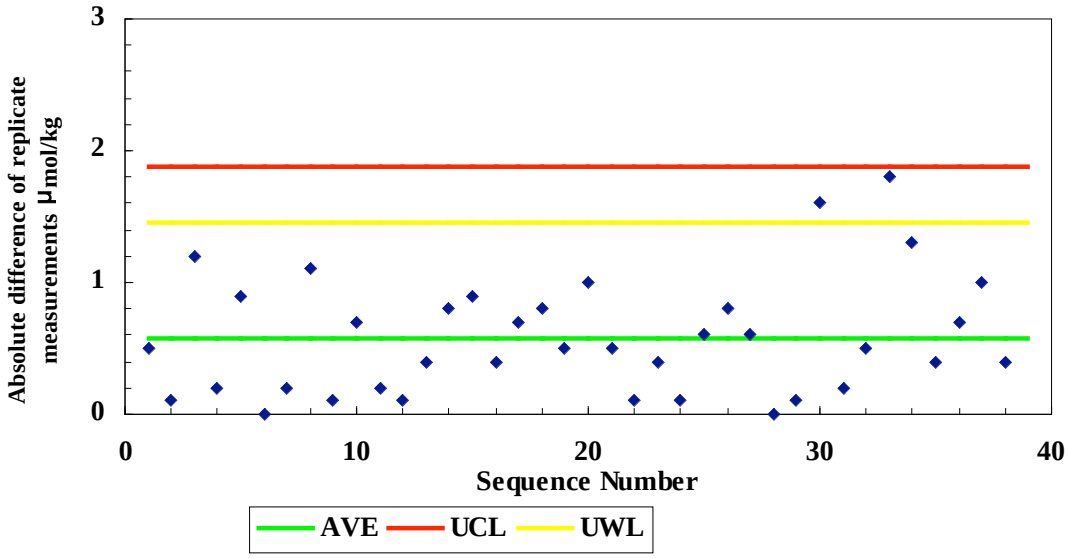


Figure 2.8-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of TA during this cruise.

2.9 Underway pCO_2

Masahide WAKITA (JAMSTEC): Principal Investigator
Minoru KAMATA (MWJ)
Yasuhiro ARII (MWJ)

(1) Objectives

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} owing to human activities such as burning of fossil fuels, deforestation, and cement production. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the anticipated global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters (alkalinity, dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1994). We here report on board measurements of pCO_2 during MR07-05 cruise.

(2) Methods, Apparatus and Performance

Concentrations of CO_2 in the atmosphere and the sea surface were measured continuously during the cruise using an automated system with a non-dispersive infrared gas analyzer (NDIR; BINOS^{TM}).

The automated system was operated by on one and a half hour cycle. In one cycle, standard gasses, marine air and equilibrated air with surface seawater within the equilibrator were analyzed subsequently. The concentrations of the standard gas were 289.75, 349.02, 393.75 and 439.73 ppm.

To measure marine air concentrations (mol fraction) of CO_2 in dry air (xCO_2-air), marine air sampled from the bow of the ship (approx.30m above the sea level) was introduced into the NDIR by passing through a mass flow controller which controls the air flow rate at about 0.5 L/min, a cooling unit, a perma-pure dryer (GL Sciences Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

To measure surface seawater concentrations of CO_2 in dry air (xCO_2-sea), marine air equilibrated with a stream of seawater within the equilibrator was circulated with a pump at 0.7-0.8L/min in a closed loop passing through two cooling units, a perma-pure dryer (GL Science Inc.) and a desiccant holder containing $Mg(ClO_4)_2$. The seawater taken by a pump from the intake placed at the approx. 4.5m below the sea surface flowed at a rate of 5-6L/min in the equilibrator. After that, the equilibrated air was introduced into the NDIR.

(3) Preliminary results

Concentrations of CO_2 (xCO_2) of marine air and surface seawater are shown in Fig. 2.9-1.

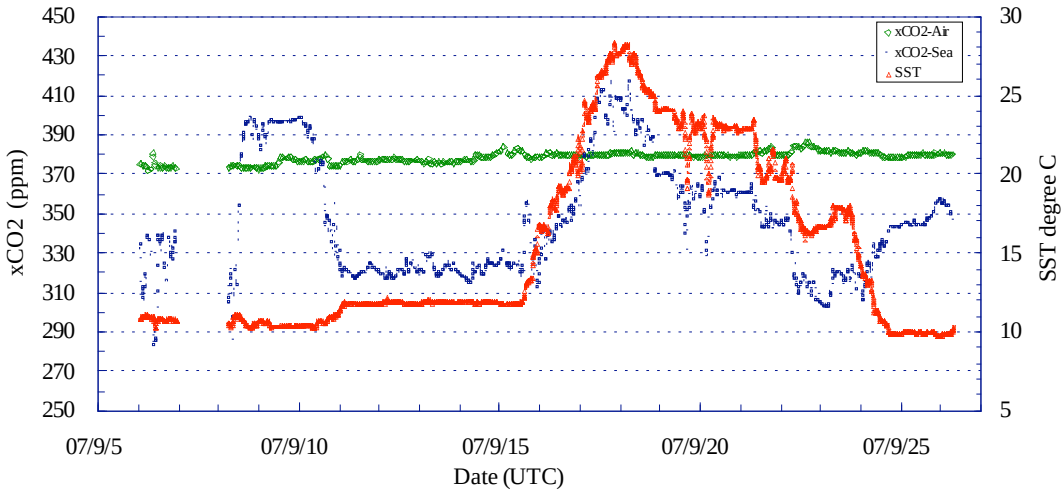


Figure 2.9-1 Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(4) Data Archive

All data will be submitted to JAMSTEC and is currently under its control.

Reference

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

Manual on Oceanographic Observation Part 1 (1999), Japan Meteorological Agency

3. Special observation

3.1 North Pacific Time-series observatory (HiLATS)

Makio HONDA (JAMSTEC)
Toru IDAI (MWJ)

Mutsu Institute for Oceanography (MIO) has been conducting the time-series observation for biogeochemistry focusing on the biological pump and its decadal change in the Northwestern North pacific. Time-series station, K2, was set in the Western Subarctic Gyre in 2001 and mooring system with automatic sampler and sensors has been deployed since then. During this cruise, mooring system was deployed after one-year cleanup period and time-series sampling restarted.

3.1.1 Deployment and Recovery

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

Table 3.1.1-1 Mooring position for respective mooring system

	K-2 BGC K2B070911
Date of deployment	Sep. 11th 2007
Latitude	47° 00.27 N
Longitude	159° 58.39 E
Depth	5,206.2 m

The BGC mooring consists of a 64” syntactic top float with 3,000 lbs (1,360 kg) buoyancy, instruments, wire and nylon ropes, glass floats (Benthos 17” glass ball), dual releasers (Edgetech) and 4,660 lbs (2,116 kg). sinker with mace plate. Two RAS (Remote Access Sampler) are installed on the 40 m and 200 m with Depth sensors (RIGO). BLOOMS (Ocean Optical Sensor) is only installed on the RAS at 200 m. 5 Sediment Traps are installed on the 150 m, 300 m, 540 m, 1,000 m and 5,000 m. Two ARGOS compact mooring locators and one submersible recovery strobe are mounted on all of top floats. This mooring was planned 5,216.2 m depth to keep the following time-series observational instruments are mounted approximately 40 ~ 50 m below sea surface. It is 10 m longer than 5,206.2 m real depth because recovered depth sensor which was installed on the RAS shows 10 m deeper than our expected at MR06-04 by mooring tilt. Two ARGOS compact mooring locators and one submersible recovery strobe are mounted on the top float. Details for each instrument are described later (section 3.1.2). Serial numbers for instruments are as follows:

Table 3.1.1-2 Serial numbers of instruments

	Deployment
Station and type of system	K-2 BGC
Mooring system S / N	K2B070911
ARGOS	18842 / 52112
ARGOS ID	18577 / 5374
Strobe	N02-044
RAS (40m)	ML11241-09
BLOOMS	OCR-504-TCSW
	(FL: FLS674, SP: 57)
RIGO Depth Sensor	DP1142
AREC CT Sensor	1136
RAS (200m)	ML11241-11
RIGO Depth Sensor	DP1158
AREC CT Sensor	10758
Sediment Trap Mark7-21 (150m)	878
Mark7-13 (300m)	ML11241-22
Mark7-13 (540m)	ML11241-25
Mark7-13(1000m)	ML11241-24
Mark7-21(5000m)	989
Releaser	027815
	027825

Table 3.1.1-3 Deployment Record

Deployed BGC Mooring

Mooring Number K2B070911

Project	Time-Series	Depth	5,206.2	m
Area	North Pacific	Planned Depth	5,216.2	m
Station	K-2 BGC	Length	5,186.0	m
Target Position	**47°00.350 N**	Depth of Buoy	30	m
	159°58.326 E	Period	1	year
ACOUCTIC RELEASERS				
Type	Edgetech	Edgetech		
Serial Number	27815	27825		
Receive F.	11.0 kHz	11.0 kHz		
Transmit F.	12.0 kHz	12.0 kHz		
RELEASE C.	**344657**	**344176**		
Enable C.	361035	356736		
Disable C.	361073	356770		
Battery	2 year	2 year		
Release Test	FINE	FINE		
DEPLOYMENT				
Recorder	Tatsuya Tanaka	Start	6.5	Nmile
Ship	R/V MIRAI	Overshoot	527	m
Cruise No.	MR07-05	Let go Top Buoy	21:06	
Date	2007/9/11	Let go Anchor	0:01	
Wather	C	Sink Top Buoy	0:02	
Wave Hight	2.6 m	Pos. of Start	47°03.54	N
Depth	5206.2 m		159°50.34	E
Ship Heading	<120>	Pos. of Drop. Anc.	47°00.17	N
Ship Ave.Speed	1.5 knot		159°58.73	E
Wind	<092> 1.5 m/s	Pos. of Mooring	47°00.27	N
Current	<071> 15.4 cm/sec		159°58.39	E

Note: RIGO Depth Sensor S/N 1142、1158 Start time 2007/9/11 04:00:00 (U.T) 120min. Interval
AREC CT Sensor S/N 1136 (50m) Start time 2007/10/1 00:00:00 (U.T) 10min. Interval
AREC CT Sensor S/N 10758 (200m) Start time 2007/9/11 4:36:00 (U.T) 20min. Interval

Table 3.1.1-4 Deployment Working Time Record

Deployment BGC Mooring

MOORING NO. K2B070911 DATE 2007/9/11 Name : Tatsuya Tanaka

ITEM	S/N		Switch		TIME			DAMAGE	PIN	Note
Top Buoy 015162-02 *ARGOS and Flasher*	A:18842/52112 F:N02-044	☑ ☑	21:58	☑ ☑	21:09					
5m 3/4" PC Chain					21:09	I	☑	☑	☑	
RAS *Depth & Arec CT Sensor*	ML11241-09 DP1142/1136	☑ ☑		☑ ☑		G	☑	☑	☑	
3-TON Swivel						ZE	☑	☑	☑	
106 m 5/16" Wire	B	☑				E	☑	☑	☑	
3m 5/16" Wire Coated	TRAP01	☑				MX	☑	☑	☑	
Sediment Trap 150m	878	☑		☑	21:18	L	☑	☑	☑	
1.5m 16mm T-Chain						D	☑	☑	☑	
40m 5/16" Wire	C-2	☑				E	☑	☑	☑	
3m 5/16" Wire Coated	RAS01	☑				E	☑	☑	☑	
RAS *Depth Sensor*	ML11241-11 DP1158	☑ ☑		☑ ☑	21:23	EZ	☑	☑	☑	
3-TON Swivel						E	☑	☑	☑	
94m 5/16" Wire	G-01	☑				E	☑	☑	☑	
3m 5/16" Wire Coated	TRAP02	☑				M	☑	☑	☑	
Sediment Trap 300m	ML11241-22	☑		☑	21:31	L	☑	☑	☑	
5m 16mm T-Chain						XD	☑	☑	☑	
183m 5/16" Wire	S-05	☑				E	☑	☑	☑	
50m 5/16" Wire Coated	I-4	☑			21:39	E	☑	☑	☑	
Sediment Trap 540m	ML11241-25	☑		☑	21:46	L	☑	☑	☑	
5m 16mm T-Chain						XD	☑	☑	☑	
403m 5/16" Wire	F	☑				E	☑	☑	☑	
43m 5/16" Wire	DK	☑			21:57	E	☑	☑	☑	
3m 5/16" Wire Coated	TRAP04	☑				M	☑	☑	☑	
Sediment Trap 1000m	ML11241-24	☑		☑	22:04	M	☑	☑	☑	
2m 16mm T-Chain						YD	☑	☑	☑	
3-TON Swivel						E	☑	☑	☑	
500m 1/4" Wire	B-6	☑				B	☑	☑	☑	
500m 1/4" Wire	B-7	☑				A	☑	☑	☑	
(8) 17" Glass Balls					22:42	B	☑	☑	☑	
500m 1/4" Wire	B-8	☑				FC	☑	☑	☑	
500m 1/4" Wire	D	☑			22:55	A	☑	☑	☑	
(8) 17" Glass Balls					23:09	B	☑	☑	☑	
368m 1/4" Wire	T	☑				FC	☑	☑	☑	
200m 1/4" Wire	P-05	☑			23:17	A	☑	☑	☑	
100m 1/4" Wire	NN	☑			23:22	A	☑	☑	☑	
100m 1/4" Wire	LL	☑			23:26	A	☑	☑	☑	
100m 1/4" Wire	KK	☑			23:29	A	☑	☑	☑	
(14) 17" Glass Balls					23:35	B	☑	☑	☑	
472m 1/4" Wire	C	☑				FFFC	☑	☑	☑	
368m 1/4" Wire	U	☑			23:47	A	☑	☑	☑	
50m 1/4" Wire	E-2	☑			0:00	A	☑	☑	☑	
3m 5/16" Wire Coated	TRAP05	☑				K	☑	☑	☑	
Sediment Trap 4810m	989	☑		☑	0:06	K	☑	☑	☑	
2m 16mm T-Chain						YD	☑	☑	☑	
300m 1/4" Wire	BB-05	☑			0:06	B	☑	☑	☑	
5m 16mm T-Chain						C	☑	☑	☑	
(48) 17" Glass Balls					0:21	F	☑	☑	☑	
5m 16mm T-Chain					0:30	FFFF	☑	☑	☑	
3-TON Swivel						G	☑	☑	☑	
Dual Releases	27815 27825	☑ ☑	23:40	☑ ☑	0:38	J	☑	☑	☑	
5m 16mm T-Chain						G	☑	☑	☑	
20m 1" Nylon		☑				H	☑	☑	☑	
5m 16mm T-Chain						H	☑	☑	☑	
2.28 ton Mace Anchor					1:46	H	☑	☑	☑	

Table 3.1.1-5 Detail of our mooring system.

Deployment BGC Mooring

	Mooring ID Description	Joint	Depth Item Length (m)	Item Weight (kg)	Mooring Length (m)	Mooring Weight (kg)	Above Bottom (m)	Mooring Depth (m)	
1	64″ Syntatic Sphere		2.27	−1360.78		−1360.78	5185.73	30.47	**30**
2	Hardware	I	0.28	3.63	2.55	−1357.15	5183.46	32.74	
3	**5** Meters 3/4″ Proof Coil Chain		5.00	40.01	7.55	−1317.14	5183.18	33.02	
4	Hardware	G	0.25	2.40	7.80	−1314.74	5178.18	38.02	
5	Instrument − ″RAS″	Z	2.25	51.00	10.05	−1263.74	5177.93	38.27	
6	Hardware	E	0.24	2.00	10.29	−1261.74	5175.68	40.52	
7	3−TON Miller Swivel		0.16	3.17	10.45	−1258.57	5175.45	40.75	
8	Hardware	E	0.24	2.00	10.68	−1256.57	5175.29	40.91	
9	**106** Meters 5/16″ Wire		106.19	22.64	116.87	−1233.93	5175.05	41.15	
10	Hardware	M	0.24	1.93	117.11	−1232.00	5068.86	147.34	
11	**3** Meters 5/16″ Wire Coated		3.00	0.64	120.11	−1231.36	5068.63	147.57	
12	Hardware	L	0.24	2.19	120.35	−1229.17	5065.63	150.57	
13	Sediment Trap	X	3.57	55.68	123.92	−1173.49	5065.39	150.81	**150**
14	Hardware	D	0.06	2.00	123.98	−1171.49	5061.82	154.38	
15	**1.5** Meters 16mm T−Chain		1.50	8.34	125.48	−1163.15	5061.76	154.44	
16	Hardware	E	0.24	2.00	125.71	−1161.15	5060.26	155.94	
17	**40** Meters 5/16″ Wire		40.07	8.54	165.78	−1152.61	5060.02	156.18	
18	Hardware	E	0.24	1.93	166.02	−1150.68	5019.95	196.25	
19	**3** Meters 5/16″ Wire Coated		3.00	0.64	169.02	−1150.04	5019.72	196.48	
20	Hardware	E	0.24	2.00	169.25	−1148.04	5016.72	199.48	
21	Instrument − ″RAS″	Z	2.43	51.00	171.68	−1097.04	5016.48	199.72	**200**
22	Hardware	E	0.24	2.00	171.92	−1095.04	5014.05	202.15	
23	3−TON Miller Swivel		0.16	3.17	172.08	−1091.87	5013.82	202.38	
24	Hardware	E	0.24	2.00	172.31	−1089.87	5013.66	202.55	
25	**94** Meters 5/16″ Wire		94.15	20.07	266.46	−1069.80	5013.42	202.78	
26	Hardware	M	0.24	1.93	266.70	−1067.87	4919.27	296.93	
27	**3** Meters 5/16″ Wire Coated		3.00	0.64	269.70	−1067.23	4919.04	297.16	
28	Hardware	L	0.24	2.19	269.94	−1065.04	4916.04	300.16	
29	Sediment Trap	X	3.70	55.70	273.64	−1009.34	4915.80	300.40	**300**
30	Hardware	D	0.06	2.00	273.70	−1007.34	4912.10	304.10	
31	**1.5** Meters 16mm T−Chain		1.50	8.34	275.20	−999.00	4912.04	304.16	
32	Hardware	E	0.24	2.00	275.43	−997.00	4910.54	305.66	
33	**183** Meters 5/16″ Wire		183.60	39.14	459.03	−957.86	4910.30	305.90	
34	Hardware	E	0.24	2.00	459.27	−955.86	4726.70	489.50	
35	**50** Meters 5/16″ Wire with eal		50.07	10.68	509.34	−945.18	4726.47	489.73	
36	Hardware	L	0.24	2.19	509.58	−942.99	4676.40	539.81	
37	Sediment Trap	X	3.69	55.70	513.27	−887.29	4676.16	540.05	**540**
38	Hardware	D	0.06	2.00	513.33	−885.29	4672.47	543.74	
39	**5** Meters 16mm T−Chain		5.00	27.80	518.33	−857.49	4672.41	543.80	
40	Hardware	E	0.24	2.00	518.56	−855.49	4667.41	548.80	
41	**403** Meters 5/16″ Wire		403.72	86.07	922.28	−769.42	4667.17	549.03	
42	Hardware	E	0.24	2.00	922.52	−767.42	4263.45	952.75	
43	**43** Meters 5/16″ Wire		43.55	9.28	966.07	−758.14	4263.22	952.98	
44	Hardware	M	0.24	1.93	966.30	−756.21	4219.67	996.53	
45	**3** Meters 5/16″ Wire Coated		3.00	0.64	969.30	−755.57	4219.43	996.77	
46	Hardware	M	0.24	2.19	969.54	−753.38	4216.43	999.77	
47	Sediment Trap	Y	3.95	55.70	973.49	−697.68	4216.19	1000.01	**1000**
48	Hardware	D	0.06	2.00	973.55	−695.68	4212.24	1003.96	
49	**2** Meters 16mm T−Chain		2.00	11.12	975.55	−684.56	4212.18	1004.02	
50	Hardware	E	0.24	2.00	975.79	−682.56	4210.18	1006.02	
51	3−TON Miller Swivel		0.16	3.17	975.95	−679.39	4209.95	1006.25	
52	Hardware	B	0.23	1.65	976.18	−677.74	4209.79	1006.41	
53	**500** Meters 1/4″ Wire		501.36	70.50	1477.53	−607.24	4209.56	1006.64	

54	Hardware	A	0.21	1.33	1477.74	-605.91	3708.20	1508.00	
55	**500** Meters 1/4" Wire		501.34	70.50	1979.09	-535.42	3707.99	1508.21	
56	Hardware	B	0.23	1.65	1979.32	-533.77	3206.65	2009.55	
57	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1983.32	-613.13	3206.42	2009.78	
58	Hardware	F	0.24	2.00	1983.55	-611.13	3202.42	2013.78	
59	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	1987.55	-690.49	3202.18	2014.02	
60	Hardware	C	0.24	1.65	1987.79	-688.84	3198.18	2018.02	
61	**500** Meters 1/4" Wire		501.33	70.49	2489.12	-618.34	3197.94	2018.26	
62	Hardware	A	0.21	1.33	2489.33	-617.01	2696.62	2519.58	
63	**500** Meters 1/4" Wire		501.31	70.49	2990.63	-546.52	2696.41	2519.79	
64	Hardware	B	0.23	1.65	2990.86	-544.87	2195.10	3021.10	
65	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	2994.86	-624.23	2194.87	3021.33	
66	Hardware	F	0.24	2.00	2995.10	-622.23	2190.87	3025.33	
67	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	2999.10	-701.59	2190.64	3025.56	
68	Hardware	C	0.24	1.65	2999.34	-699.94	2186.64	3029.56	
69	**368** Meters 1/4" Wire		368.90	51.87	3368.24	-648.07	2186.40	3029.80	
70	Hardware	A	0.21	1.33	3368.45	-646.74	1817.50	3398.70	
71	**200** Meters 1/4" Wire		200.84	28.24	3569.29	-618.50	1817.29	3398.91	
72	Hardware	A	0.21	1.33	3569.50	-617.17	1616.45	3599.76	
73	**100** Meters 1/4" Wire		99.95	14.05	3669.45	-603.11	1616.24	3599.97	
74	Hardware	A	0.21	1.33	3669.66	-601.78	1516.29	3699.91	
75	**100** Meters 1/4" Wire		100.03	14.07	3769.69	-587.72	1516.08	3700.12	
76	Hardware	A	0.21	1.33	3769.90	-586.39	1416.05	3800.15	
77	**100** Meters 1/4" Wire		100.02	14.06	3869.92	-572.32	1415.84	3800.36	
78	Hardware	B	0.23	1.65	3870.15	-570.67	1315.81	3900.39	
79	2-17" Glassballs on 16mm T-Chain		2.00	-39.68	3872.15	-610.35	1315.58	3900.62	
80	Hardware	F	0.24	2.00	3872.39	-608.35	1313.58	3902.62	
81	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	3876.39	-687.71	1313.35	3902.85	
82	Hardware	F	0.24	2.00	3876.62	-685.71	1309.35	3906.85	
83	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	3880.62	-765.07	1309.11	3907.09	
84	Hardware	F	0.24	2.00	3880.86	-763.07	1305.11	3911.09	
85	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	3884.86	-842.43	1304.88	3911.32	
86	Hardware	C	0.24	1.65	3885.10	-840.78	1300.88	3915.32	
87	**472** Meters 1/4" Wire		472.25	66.40	4357.35	-774.38	1300.64	3915.56	
88	Hardware	A	0.21	1.33	4357.56	-773.05	828.39	4387.81	
89	**368** Meters 1/4" Wire		368.98	51.88	4726.54	-721.17	828.18	4388.02	
90	Hardware	A	0.21	1.33	4726.75	-719.84	459.20	4757.00	
91	**50** Meters 1/4" Wire		50.13	7.05	4776.87	-712.79	458.99	4757.21	
92	Hardware	K	0.20	1.33	4777.07	-711.46	408.86	4807.34	
93	**3** Meters 1/4" Wire Coated		3.00	0.42	4780.07	-711.04	408.66	4807.54	
94	Hardware	K	0.20	1.33	4780.27	-709.71	405.66	4810.54	
95	Sediment Trap	Y	3.82	55.70	4784.09	-654.00	405.46	4810.74	**4810.8**
96	Hardware	D	0.06	2.00	4784.15	-652.00	401.64	4814.56	
97	**2** Meters 16mm T-Chain		2.00	11.12	4786.15	-640.88	401.58	4814.62	
98	Hardware	B	0.23	1.65	4786.38	-639.23	399.58	4816.62	
99	**300** Meters 1/4" Wire		301.55	42.40	5087.94	-596.83	399.35	4816.85	
100	Hardware	C	0.24	1.65	5088.18	-595.18	97.80	5118.40	
101	5 Meters 16mm T-Chain		5.00	27.80	5093.18	-567.38	97.56	5118.64	
102	Hardware	F	0.24	2.00	5093.41	-565.38	92.56	5123.64	
103	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5097.41	-644.74	92.32	5123.88	
104	Hardware	F	0.24	2.00	5097.65	-642.74	88.32	5127.88	
105	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5101.65	-722.10	88.09	5128.11	
106	Hardware	F	0.24	2.00	5101.88	-720.10	84.09	5132.11	
107	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5105.88	-799.46	83.85	5132.35	
108	Hardware	F	0.24	2.00	5106.12	-797.46	79.85	5136.35	
109	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5110.12	-876.82	79.62	5136.58	
110	Hardware	F	0.24	2.00	5110.35	-874.82	75.62	5140.58	
111	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5114.35	-954.18	75.38	5140.82	
112	Hardware	F	0.24	2.00	5114.59	-952.18	71.38	5144.82	
113	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5118.59	-1031.54	71.15	5145.05	
114	Hardware	F	0.24	2.00	5118.82	-1029.54	67.15	5149.05	
115	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5122.82	-1108.90	66.91	5149.29	
116	Hardware	F	0.24	2.00	5123.06	-1106.90	62.91	5153.29	
117	4-17" Glassballs on 16mm T-Chain		4.00	-79.36	5127.06	-1186.26	62.68	5153.52	

118	Hardware	F	0.24	2.00	5127.29	−1184.26	58.68	5157.52	
119	4−17″ Glassballs on 16mm T−Chain		4.00	−79.36	5131.29	−1263.62	58.44	5157.76	
120	Hardware	F	0.24	2.00	5131.53	−1261.62	54.44	5161.76	
121	4−17″ Glassballs on 16mm T−Chain		4.00	−79.36	5135.53	−1340.98	54.21	5161.99	
122	Hardware	F	0.24	2.00	5135.76	−1338.98	50.21	5165.99	
123	4−17″ Glassballs on 16mm T−Chain		4.00	−79.36	5139.76	−1418.34	49.97	5166.23	
124	Hardware	F	0.24	2.00	5140.00	−1416.34	45.97	5170.23	
125	4−17″ Glassballs on 16mm T−Chain		4.00	−79.36	5144.00	−1495.70	45.74	5170.46	
126	Hardware	F	0.24	2.00	5144.23	−1493.70	41.74	5174.46	
127	5 Meters 16mm T−Chain		5.00	27.80	5149.23	−1465.90	41.50	5174.70	
128	Hardware	F	0.24	2.00	5149.46	−1463.90	36.50	5179.70	
129	3−TON Miller Swivel		0.16	3.20	5149.63	−1460.70	36.27	5179.93	
130	Hardware	G	0.25	2.40	5149.88	−1458.30	36.11	5180.09	
131	Dual EGG Acoustic Releases	J	1.95	66.04	5151.82	−1392.26	35.86	5180.34	
132	Hardware	G	0.25	2.40	5152.07	−1389.86	33.91	5182.29	
133	5 Meters 16mm T−Chain		5.00	27.80	5157.07	−1362.06	33.66	5182.54	
134	Hardware	H	0.26	2.85	5157.33	−1359.21	28.66	5187.54	
135	**20** Meters 1″ Nylon		21.92	6.54	5179.25	−1352.67	28.40	5187.80	
136	Hardware	H	0.26	2.85	5179.51	−1349.82	6.48	5209.72	
137	5 Meters 16mm T−Chain		5.00	27.80	5184.51	−1322.02	6.22	5209.98	
138	Hardware	H	0.26	2.40	5184.77	−1319.62	1.22	5214.98	**Design**
139	4666 Lb Ww Anchor		0.96	2116.46	5185.73	796.84	0.96	5215.24	**Depth**
	OVERALL MOORING LENGTH		**5185.73**					5216.20	**5216.2**

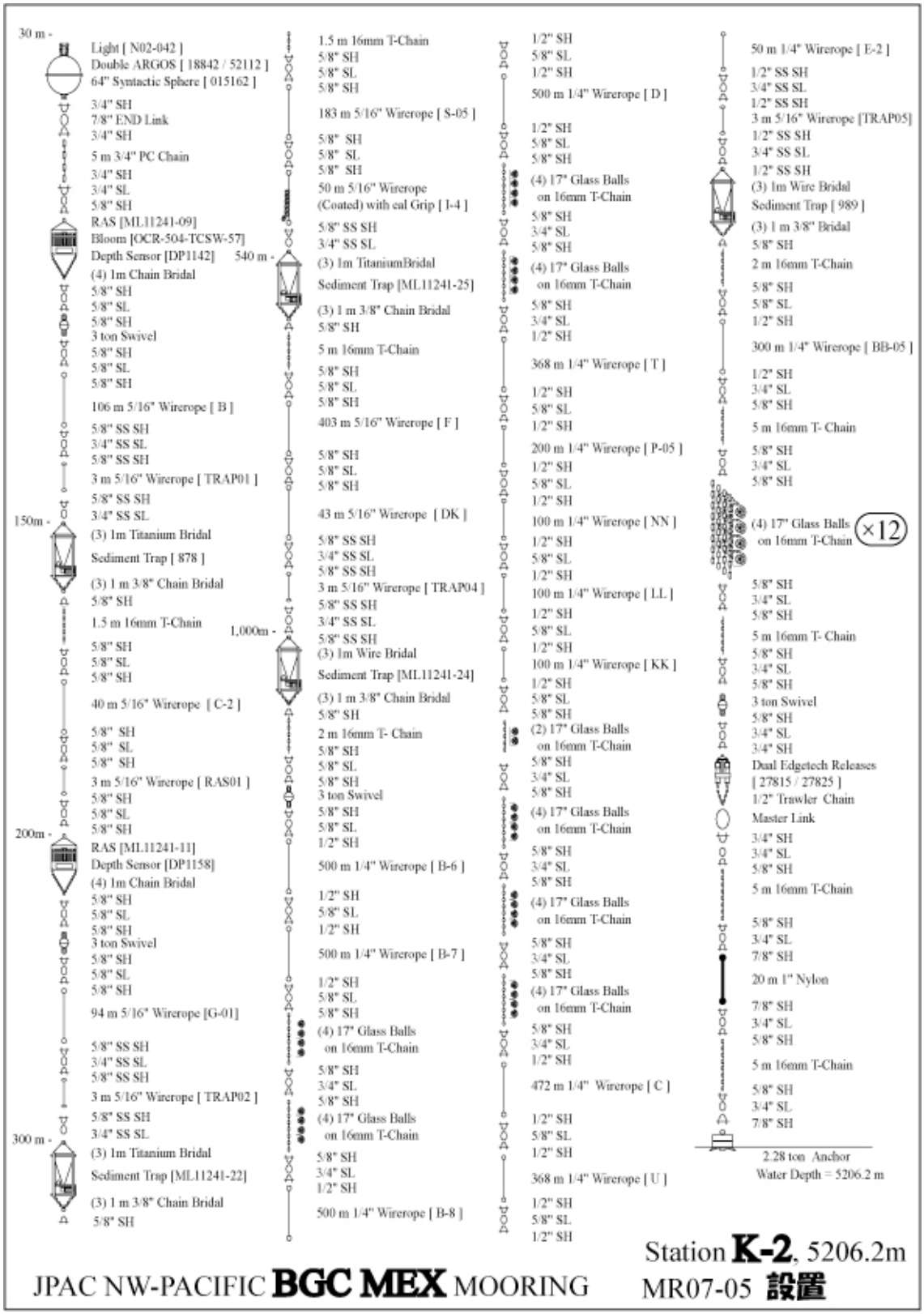


Fig. 3.1.1-1 Deployment BGC Mooring Figure

3.1.2 Instruments

On mooring systems, the following instruments are installed.

(1) ARGOS CML (Compact Mooring Locator)

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

Principle specification is as follows:

(Specification)

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

(2) Submersible Recovery Strobe

The NOVATECH Xenon Flasher is 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)

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.
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.
Max. Depth:	7,300m
Daylight-off:	User selected, standard

Pressure Switch:	On at surface, auto off when submerged below 10m.
Weight in Air:	4 pounds
Weight in Water:	2 pounds
Outside Diameter:	1.7 inches nominal
Length:	21-1/2 inches nominal

(3) Depth Sensor

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

(Specification)

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

(sampling parameter)

Sampling interval:	2 hours

(4) AREC CT Sensor

AREC CT sensor is digital memory type and designed for mounting on the plankton net and instrument for mooring and so on. It is small and right weight for easy handling. Sampling interval is chosen 1 second or 1, 2 and 10 minutes. The data is converted to personal computer using exclusive cable (serial port).

(Specification)

Model:	COMPACT-CT
Operating Depth:	0 ~ 500m
T-Sensor Range:	-5~40℃
T-Sensor Precision:	0.001℃
T-Sensor Accuracy:	±0.02℃
C-Sensor Range:	0~60 mS/cm
C-Sensor Precision:	0.001 mS/cm
C-Sensor Accuracy:	±0.02 mS/cm
Memory:	2Mbyte flash memory
Battery:	lithium battery (CR2) DC3V
Battery Life:	178439 data
Sample interval:	1 seconds or 1, 2 and 10 minutes

Diameter: 40mm
Length: 202mm
Main Material: titanium
Weight in water: 265g

(sampling parameter)

Sampling start time: Oct. 1st 2007 00:00:00
Sampling interval: 10 minutes

(5) RAS (Remotely Access Sampler)

There are four major components mounted within the RAS: (1) the controller housing, (2) the pump assembly, (3) the multi-port valve, and (4) the sample containers. The principle of water sampling is that the pump draws out water in the sample container in which the collapsed sample bag is mounted. This creates a pressure gradient that pushes ambient seawater through the intake and into the inflating sample bag.

Length, width and Height are 73 cm, 73 cm, and 114 cm, respectively, and weight with empty sample containers is 110 kg in air and 57 kg in water. The RAS instruments were loaded with acid-cleaned, 500 ml–capacity bags made of the following 3 laminated layers; a thin exterior Mylar® film for protection, a vacuum coated aluminum foil layer for blocking solar radiation and minimizing gas diffusion and an interior, Teflon® film for reinforcement and insulation of sample water from the Al layer. Each bag was pre-loaded with a preservative solution (1 ml $HgCl_2$ solution: 3.6 g $HgCl_2$ in 100 ml distilled water) (*), connected to a distribution valve and placed within a sturdy 600 ml sample container (acrylic sheathe) within the instrument. The remaining spaces within sheathes were filled with seawater before deployment. There are 49 identical bag assemblages on a RAS. Of these, 48 were used to sample seawater on a scheduled sequence. The remaining bag was filled with 6M HCl that was used to flush the intake path before each water sampling procedure in order to avoid biofouling.

Normally, the RAS multi-port valve resides in a home position that block all intake paths. Five minutes before sampling, the multi-port valve aligns with the intake path and the cleansing acid bag and a 5 ml jet of 6M HCl flushes the intake manifolds(*). After a one-minute pause, the same path was rinsed with 100 ml of *in situ* seawater. Then the multi-port valve aligns the intake valve to a designated sampling bag assemblage. As the seawater is removed from the acrylic sheathe by operating the pump in reverse to the previous flush stage, the resultant low pressure induces the *in situ* water to move into the sampling bag. To minimize cross contamination of water samples, the graphite-gear pump is not exposed to the sample water but only to the evacuated distilled water in the sheathes. Execution records documenting sample timing, estimated sample volume, flushing periods, and electricity consumption were logged by the RAS instruments and retrieved from the memory on recovery.

This time, RAS was installed at approximately 50 m and 200m.

Note 1: $HgCl_2$ of 1 ml (not 2 ml as the previous deployment) was add to respective sampling bag.
Note 2: This time, flushing inlet with HCl was not scheduled in order to avoid the effect of acid on carbonate chemistry.

(6) BLOOMS

The Bio-optical Long-term Optical Ocean Measuring System package (BLOOMS) consisted of a WETLabs fluorometer and a Satlantic Inc. spectral radiometer (OCR-504-ICWS; Halifax, Canada) along with data acquisition / storage systems and a pressure housing. The BLOOMS was mounted on the frame of the RAS for measurements of chlorophyll *a* (chl-*a*)

concentrations as a proxy for phytoplankton biomass (fluorometer) and downwelling spectral irradiance at four wavelengths (412, 443, 490, and 555 nm). The optical system was kept free of biofouling by use of copper shutters.

Measurement started on 28 June 2007 (before cruise). The values of Ed at 4 wavelengths were measured every hour during the local daytime period (19:00 - 7:00 UTC).

(7) Sediment trap

A time-series sediment trap with 21 cups were installed at 150 m and 5000 m. Three traps with 13 cups were installed at 300 m, 550 m and 1000 m. Before deployment, collecting cups were filled up with deep seawater (~ 2000 m) based 10 % buffered formalin. NaCl of 50 g was add to this solution of 10L to increase salinity by 5 per-mil.

3.1.3 Sampling schedule

Sediment trap and RAS will collect samples under the following schedule.

Sediment Trap

	Opening day		Opening day
	21 cup		13 cup
	(150, 5000)		(300, 550, 1000)
int	17	int	34
1	2007.10.1	1	2007.10.1
2	2007.10.18		
3	2007.11.4	2	2007.11.4
4	2007.11.21		
5	2007.12.8	3	2007.12.8
6	2007.12.25		
7	2008.1.11	4	2008.1.11
8	2008.1.28		
9	2008.2.14	5	2008.2.14
10	2008.3.2		
11	2008.3.19	6	2008.3.19
12	2008.4.5		
13	2008.4.22	7	2008.4.22
14	2008.5.9		
15	2008.5.26	8	2008.5.26
16	2008.6.12		
17	2008.6.29	9	2008.6.29
18	2008.7.16		
19	2008.8.2	10	2008.8.2
20	2008.8.19		
21	2008.9.5	11	2008.9.5
	2008.9.22		
		12	2008.10.9
		13	2008.11.12

RAS

	preservative: 1 ml HgCl2		
	No flushing inlet with HCl		
	Interver (days): 7.79		
	Sampling date and time		
1	2007.10.1 0:00	25	2008.4.4 21:26
2	2007.10.8 18:53	26	2008.4.12 16:20
3	2007.10.16 13:47	27	2008.4.20 11:14
4	2007.10.24 8:40	28	2008.4.28 6:07
5	2007.11.1 3:34	29	2008.5.6 1:01
6	2007.11.8 22:28	30	2008.5.13 19:54
7	2007.11.16 17:21	31	2008.5.21 14:48
8	2007.11.24 12:15	32	2008.5.29 9:42
9	2007.12.2 7:08	33	2008.6.6 4:35
10	2007.12.10 2:02	34	2008.6.13 23:29
11	2007.12.17 20:56	35	2008.6.21 18:22
12	2007.12.25 15:49	36	2008.6.29 13:16
13	2008.1.2 10:43	37	2008.7.7 8:10
14	2008.1.10 5:37	38	2008.7.15 3:03
15	2008.1.18 0:30	39	2008.7.22 21:57
16	2008.1.25 19:24	40	2008.7.30 16:51
17	2008.2.2 14:17	41	2008.8.7 11:44
18	2008.2.10 9:11	42	2008.8.15 6:38
19	2008.2.18 4:05	43	2008.8.23 1:31
20	2008.2.25 22:58	44	2008.8.30 20:25
21	2008.3.4 17:52	45	2008.9.7 15:19
22	2008.3.12 12:45	46	2008.9.15 10:12
23	2008.3.20 7:39	47	2008.9.23 5:06
24	2008.3.28 2:33	48	2008.10.1 0:00

MR08-05 cruise	08' 10/13-11/10

3.2 Phytoplankton

3.2.1 Chlorophyll-*a* measurements by fluorometric determination

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1. Objective

Phytoplankton exists as various species and sizes in the ocean. Phytoplankton species are roughly characterized by their cell size. The objectives of this study are to investigate the vertical distribution of phytoplankton abundance and to estimate their size fraction.

2. Sampling, Apparatus and Methods

Sample types and the sampling casts are as follows.

・Total-chlorophyll *a* (Deep-cast, Shallow-cast)
・Size-fractionated chlorophyll *a* (Shallow-cast)

Samples of total-chlorophyll *a* were collected at 6 depths (0, 10, 50, 100, 150 and 200m) for deep-cast and at 11depth, which were determined by the light intensity as 100, 50, 25, 17, 10, 7, 5, 2.5, 1, 0.25 and 0.5% of surface irradiance for shallow-cast. Size-fractionated samples were collected at 8 depths (100, 50, 25, 10, 5, 2.5, 1 and 0.5% of surface irradiance) for shallow-cast. Water samples for total-chlorophyll *a* were vacuum-filtered (<0.02MPa) through 25mm-diameter Whatman GF/F filter. Water samples for size-fractionation were sequentially vacuum-filtered (<0.02MPa) through four different filters in order of the three types of 47mm-diameter nuclepore filters (pore size of 10.0μm, 3.0μm and 1.0μm) and the 25mm-diameter Whatman GF/F filter. Phytoplankton pigments retained on the filters were immediately extracted in a polypropylene tube with 7 mL of N,N-dimethylformamide. The tubes were stored at –20°C under the dark condition to extract chlorophyll *a* for 24 hours or more.

Fluorescence of each sample was measured by Turner Design fluorometer (10-AU-005), which was calibrated using a pure chlorophyll *a* (Sigma chemical Co.). We applied the fluorometric “Non-acidification method” (Welschmeyer, 1994) and “Acidification method” (Holm-Hansen *et al.*, 1965) for the samples of total-chlorophyll *a*, but size-fractionated samples were applied only “Non-acidification method”. Analytical conditions of each method were listed in table 3.2.1-1. Calibrations have been conducted at every station by a working chlorophyll *a* standard.

3. Preliminary Results

The vertical profile of total-chlorophyll *a* concentration in Stn.K2 were shown in Figure 3.2.1-1.

5. Data archives

The processed data file of Chlorophyll *a* will be submitted to the JAMSTEC Data

Management Office (DMO) within a restricted period. Please ask PI for the latest information.

6. Reference

Holm-Hansen, O., Lorenzen, C. J., Holmes, R.W., J. D. H. Strickland 1965.Fluorometric determination of chlorophyll. *J. Cons. Cons. Int. Explor. Mer* :30,3-15.

Welschmeyer, N. A. 1994. Fluorometric analysis of chlrophyll *a* in the presence of chlorophyll *b* and pheopigments. *Limnol.Oceanogr* :39,1985-1992.

Table 3.2.1-1. Analytical conditions of "Non-acidification method" & "Acidification method" for chlorophyll *a* with Turner Designs fluorometer (10-AU-005).

	Non-acidification method	Acidification method
Excitation filter (nm)	436	340-500nm
Emission filter (nm)	680	>665nm
Lamp	Blue F4T5,B2/BP	Daylight white F4T5D

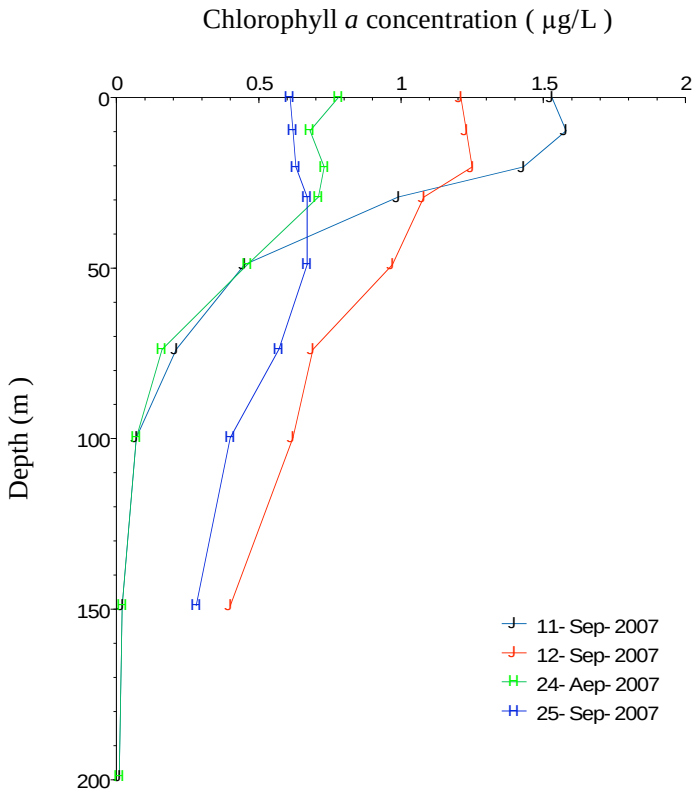

Figure 3.2.1-1. Vertical profile of chlorophyll *a* concentration (µg/L) in Station K2.

3.2.2. HPLC measurements of marine phytoplankton pigments

Kazuhiko MATSUMOTO (JAMSTEC); Principal Investigator
Keisuke WATAKI (MWJ); Operation Leader
Masanori ENOKI (MWJ)
Tetsuya INABA (MWJ)

(1) Objective

The chemotaxonomic assessment of phytoplankton populations present in natural seawater requires taxon-specific algal pigments as good biochemical markers. A high-performance liquid chromatography (HPLC) measurement seems to be an optimum method for separating and quantifying phytoplankton pigments in natural seawater.

In this cruise, we measured the marine phytoplankton pigments by HPLC to investigate the marine phytoplankton community structure at St. K1 and K2.

(2) Methods, Apparatus and Performance

Seawater samples were collected at 8 depths, which were determined by the light intensity as 100, 50, 25, 10, 5, 2.5, 1 and 0.5 % of surface irradiance at shallow-cast using Niskin bottles, except for the surface water (100%), which was taken by a bucket. The water samples (5L) were filtered at a vacuum-pressure below 0.02MPa through the 47 mm-diameter Whatman GF/F filter. To remove retaining seawater in the sample filters, GF/F filters were vacuum-dried in a freezer (about 0 deg. C) within 4 hours. Subsequently, phytoplankton pigments retained on a filter were extracted in a glass tube with 4 ml of N,N-dimethylformamide (HPLC-grade) for at least 24 hours in a freezer (-20 deg. C), and analyzed within a few days.

Residua cells and filter debris were removed through polypropylene syringe filter (pore size: 0.2 μm) before the analysis. The samples (500μl) were injected from the auto-sampler immediately after the addition of pure water (180μl) and internal standard (10μl) into the samples (410μl), and measured with photodiode array detector. Analytical conditions of HPLC system were modified the method of Zapata *et al*. (2000).

(2-1) HPLC System

HPLC System was composed by a Waters modular system (high dwell volume) including 600S controller, 616 pump (low-pressure mixing system), 717 Plus auto-sampler and 996 photodiode array detector (2.4 nm optical resolution).

(2-2) Stationary phase

Analytical separations were performed using a YMC C_8 column (150×4.6 mm). The column was thermostatted at 25 deg. C in the column heater box.

(2-3) Mobile phases

Eluant A was a mixture of methanol : acetonitrile : aqueous pyridine solution (0.25M pyridine) (50 : 25 : 25 v : v : v). Eluant B was acetonitrile : acetone (80 : 20 v : v). Organic solvents for mobile phases were used reagents of HPLC-grade.

(2-4) Standard pigments

We used the standard pigments (Table 1) to calculate the concentrations in samples. We selected Chlorophyll *a*, Chlorophyll *b* (Sigma co.) and other 22 pigments (DHI co.). The

concentrations of pigment standards were determined using its extinction coefficient by spectrophotometer, then the solvents of pigment standards were displaced to N,N-dimethylformamide.

(2-5) Internal standard

Ethyl-apo-8'-carotenoate (Fluka co.) was added into the samples prior to the injection to check the quality control as the internal standard (Figure 1). The average of area value was 185018±5680 (n=88) , the coefficient of variation was 3.1%.

(2-6) Pigment detection and identification

Chlorophylls and carotenoids were detected by photodiode array spectroscopy (350~720nm). Pigment concentrations were calculated from the chromatograms at different four channels (Table 1).

First channel was allocated at 661.4 nm of wavelength, which is the absorption maximum in red band for Divinyl Chlorophyll *a* and Chlorophyll *a*.

Second channel was allocated at 663.9 nm, which is the absorption maximum in red band for Chlorophyllide *a*, Pheophorbide *a* and Pheophytin *a*.

Third channel was allocated at 457.2nm, which is the absorption maximum in red band for Chlorophyll *b*.

Fourth channel was allocated at 460.0 nm for other pigments.

(3) Data archives

The processed data file of pigments will be submitted to the JAMSTEC Data Management Office (DMO) within a restricted period. Please ask PI for the latest information.

Reference

Zapata M, Rodriguez F, Garrido JL (2000) Separation of chlorophylls and carotenoids from marine phytoplankton : a new HPLC method using a reversed phase C8 column and pyridine-containing mobile phases. Mar. Ecol. Prog. Ser. 195 : 29-45

Table 1. Retention time and wavelength of identification for pigment standards.

No.	Pigment	Retention Time (minute)	Wavelength of identification (nm)
1	Chlorophyll *c3*	10.050	460
2	Chlorophyll *c2*	13.872	460
3	Peridinin	16.995	460
4	Pheophorbide *a*	19.287	663.9
5	19'-butanoyloxyfucoxanthin	19.982	460
6	Fucoxanthin	21.083	460
7	Neoxanthin	21.495	460
8	Prasinoxanthin	22.585	460
9	Violaxanthin	23.400	460
10	19'-hexanoyloxyfucoxanthin	23.405	460
11	Diadinoxanthin	25.372	460
12	Antheraxanthin	26.078	460
13	Alloxanthin	26.520	460
14	Myxoxanthophyll	26.548	460
15	Diatoxanthin	26.950	460
16	Zeaxanthin	27.328	460
17	Lutein	27.435	460
18	Ethyl-apo-8’-carotenoate	28.800	460
19	Crocoxanthin	30.300	460
20	Chlorophyll *b*	31.015	457.2
21	Divinyl Chlorophyll *a*	32.178	661.4
22	Chlorophyll *a*	32.525	661.4
23	Pheophytin *a*	35.265	663.9
24	Alpha-carotene	35.450	460
25	Beta-carotene	35.712	460
*	Chlorophylide *a*	------	663.9

* It used MR0701 data.

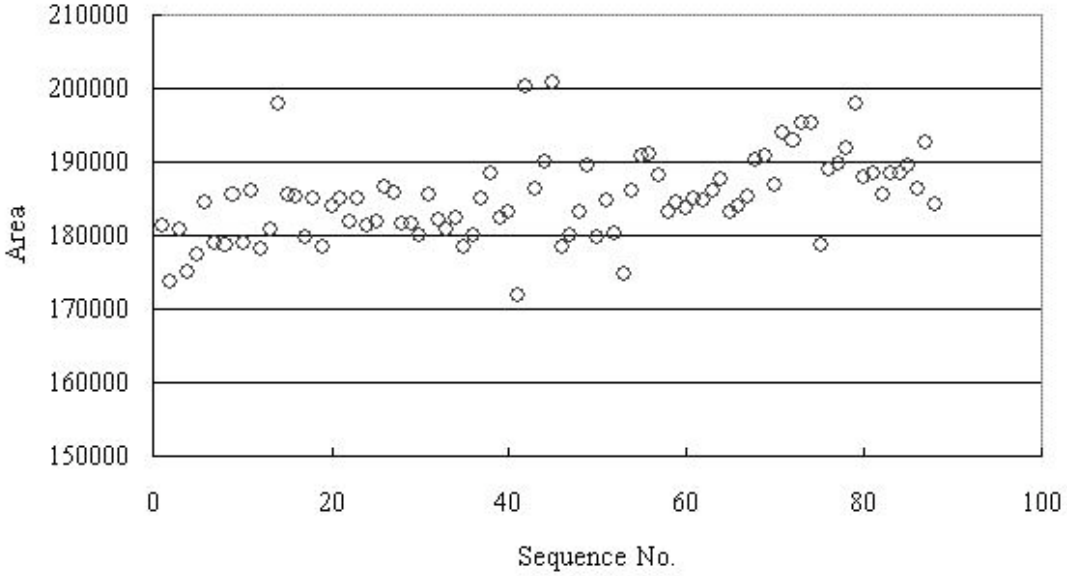

Figure 1. Variabilities of the chromatogram area for the internal standard. After the sequence number of 88.

3.2.3. Phytoplankton abundances

Kazuhiko MATSUMOTO (JAMSTEC)

(1) Objectives

The main objective of this study is to estimate phytoplankton abundances and their taxonomy in the western North Pacific subarctic gyre. Phytoplankton abundances were measured with two kinds of methods: microscopy for large size phytoplankton and flowcytometry for picophytoplankton.

(2) Sampling

Samplings were conducted within the euphotic zone using Niskin bottles, except for the surface water, which was taken by a bucket. Sampling depths were determined to correspond to eight light levels (100%, 50%, 25%, 10%, 5%, 2.5%, 1% and 0.5% of surface irradiance). Samplings were carried out at the three observational stations of S02, S06 and S20.

(3) Methods

1) Microscopy

Water samples were placed in 500 ml plastic bottle and fixed with neutral buffered formalin solution (3% final concentration). The microscopic measurements are scheduled after the cruise.

2) Flowcytometry

2)-1 Equipment

The flowcytometry system used in this research was BRYTE HS system (Bio-Rad Laboratories Inc). System specifications are follows:

Light source: 75W Xenon arc lamp
Excitation wavelength: 350-650 nm
Detector: high-performance PMT
Analyzed volume: 75 µl
Flow rate: 10 µl min^{-1}
Sheath fluid: Milli-Q water
Filter block: B2 as excitation filter block, OR1 as fluorescence separator block
B2 and OR1 have ability as follows:

B2:	Excitation filter	390-490 nm
	Beam-splitter	510 nm
	Emission filter	515-720 nm
OR1:	Emission filter 1	565-605 nm
	Beam-splitter	600 nm
	Emission filter 2	>615 nm

2)-2 Measurements

The water samples were pre-filtered by Nuclepore filter of 3µm pore size but pre-filtered by 10µm pore size for the station S02. The pre-filtered samples were fixed immediately with glutaraldehyde (1% final concentration) and stored in the dark at 4°C. The analysis by the flow cytometer was acquired on board within 24 hours after the

sample fixation. Calibration was achieved with standard beads (Polysciences) of 2.764μm. Standard beads were added into each sample prior to the injection of flow cytometer as internal standard. Phytoplankton cell populations were estimated from the forward light scatter signal. Acquired data were stored in list mode file and analyzed with WinBryte software. Phytoplankton are classified with prokaryotic cyanobacteria (*Prochlorococcus* and *Synechococcus*) and other eukaryotes on the basis of scatter and fluorescence signals. *Synechococcus* is discriminated by phycoerythrin as the orange fluorescence, while other phytoplankton are recognized by chlorophylls as the red fluorescence without the orange fluorescence. *Prochlorococcus* and picoeukaryotes were distinguished with their cell size.

(4) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO). Please ask PI for the latest information.

3.3 Th-234 and export flux

Hajime KAWAKAMI (Mutsu Institute for Oceanography, JAMSTEC)
Makio HONDA (Mutsu Institute for Oceanography, JAMSTEC)

(1) Purpose of the study

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

(2) Sampling

Seawater and suspended particulate sampling for ^{234}Th and POC: 6 stations [stations S1 (K1), S6 (K2-1), and S20 (K2-2)] and 8 depths (10m, 20m, 30m, 50m, 75m, 100m, 150m and 200m) at each station. Settling particulate sampling for ^{234}Th: 1 station [station S6 (K2-1)] and 4 depths (60 m, 100 m, 150 m, 200 m).

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

In situ filtering (suspended particulate) samples were taken from large volume pump sampler (Large Volume Pump WTS-6-1-142V, McLane Inc.). Approximately 200L seawater was filtered through GF/F filter at each station. Approximately 1 m^3 seawater was filtered through Nitex mesh filter (53μm) at station S6 (K2-1). Drifting sediment trap's (settling particulate) samples were filtered with GF/F filter. The filter samples were divided for ^{234}Th and POC.

(3) Chemical analyses

Dissolved, particulate and drifting sediment trap's ^{234}Th was purified using anion exchange method. Purified ^{234}Th was absorbed on 25mm stainless steel disks electrically, and were measured by β-ray counter.

POC was measured with an elemental analyzer (Perkin-Elmer model 2400) in land-based laboratory.

(4) Preliminary result

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

3.4 Optical measurement

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Kazuhiko MATSUMOTO (JAMSTEC MIO)
Suguru OKAMOTO (Hokkaido University)
Amane FUJIWARA (Hokkaido University)

(1) Objective

The objective of this measurement is to investigate the air and underwater light conditions at respective stations and to determine depths for *in situ* or simulated *in situ* measurement of primary production by using carbon stable isotope (C-13) during autumnd. In addition, optical data can be used for the validation of satellite data.

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

(2) Description of instruments deployed

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

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

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

Optical measurements by Free Fall were conducted at our time-series station K2 and other stations at where we stayed during 10:00 – 14:00 (LST). Measurements should be ideally conducted at median time. However observations were conducted irregularly because of limited ship-time and other observation’s convenience (Table 2). The profiler was deployed twice at respective stations to a depth of 150 m. The SMSR was mounted on the anti-rolling system’s deck and was never shadowed by any ship structure. The profiler descended at an average rate of 1.0 m/s with tilts of less than 3 degrees except near surface.

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

Table 2 Locations of optical observation and principle characteristics
(Date and Time in LST: UTC+11hr.)

S/N	Date and Time (LST)	Station	Lat/Long	Surface PAR (quanta/cm2/sec)	Euphotic layer (1% depth) (m)	Smet (W/m2)	JamMet (W/m2)	Surface PAR (uE/m2/sec)
1	2007.9.10 11:00	S2 (K1)	51N/165E	8.56E+16	50	717.0	778.5	1.42E+03
2	2007.9.12 14:05	S6 (K2)	47N/160E	2.83E+16	37	187.0	222.9	4.69E+02
3	2007.9.13 10:05	S6 (K2)	47N/160E	9.07E+15	39	42.9	75.8	1.51E+02
4	2007.9.15 13:04	S6 (K2)	47N/160E	3.47E+16	39	271.8	307.5	5.76E+02
5	2007.9.18 13:05	S18(35N)	35N/155E	2.74E+16	80	198.9	222.0	4.55E+02
6	2007.9.19 11:00	S15(38N)	38N/155E	6.50E+16	79	542.9	602.3	1.08E+03
7	2007.9.21 10:30	S14(39N)	39N/155E	2.37E+16	63	150.0	186.1	3.93E+02
8	2007.9.22 11:50	S12(41N)	41N/155E	9.68E+16	58	774.3	793.8	1.61E+03
9	2007.9.23 10:03	S10(43N)	43N/155E	7.75E+16	36	690.0	729.8	1.29E+03

LST = UTC + 11

* Smet and JamMet are solar irradiance observed by meteorological sensors onboard. These were compared with surface PAR observed by "Free Fall sensor" and empirical equation to estimate surface PAR with solar irradiance was proposed (Fig. 1a, b) in order to know daily integrated PAR during incubation for measurement of primary productivity with meteorological sensors.

(3) Preliminary result

We deployed "Free Fall sensor" 9 times (Table 2). In general, weather was cloudy during this cruise. Surface PAR ranged from 9.1 x 10^{15} to 9.7 x 10^{16} quanta cm^{-2} sec^{-1}. The euphotic layer that is defined as water depth with 1 % of surface PAR ranged from 37 to 80 m. There was tendency that euphotic layer depth increases southward. It is likely that particulate materials, *i.e.* phytoplankton, in the water column were smaller at the southern station than those at the northern station. The euphotic layer at time-series station K2 was approximately 40 m. This depth was comparable to that in spring when biological activity is active. This is supported by high primary productivity observed during this cruise.

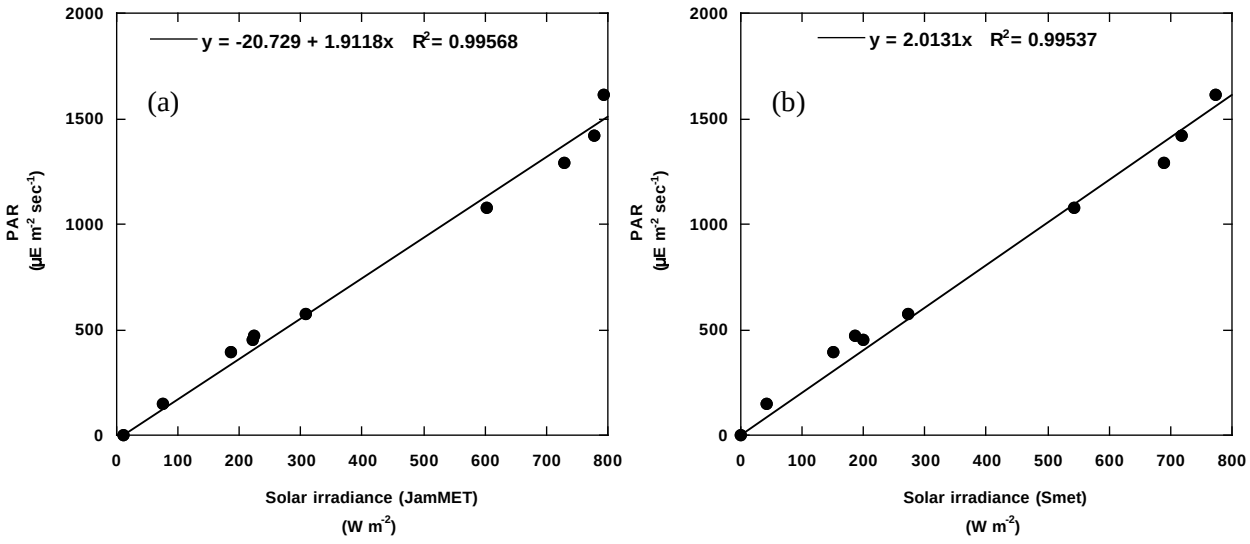

Fig.1 PAR vs Solar irradiance measured by (a) JamMET and (b) Smet

3.5 Primary productivity and drifting sediment trap

Makio HONDA (JAMSTEC MIO)
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Hajime KAWAKAMI (JAMSTEC MIO)
Fuyuki SHIBATA (MWJ)
Ai YASUDA (MWJ)
Kanako ISOGAI (MWJ)

3.5.1 Drifting mooring system

In order to conduct *in situ* incubation for measurement of primary productivity and drifting sediment trap experiment at station K2, drifting mooring system (drifter) was deployed. This drifter consists of radar reflector, GPS radio buoy (Taiyo TGB-100), flush light, surface buoy, ropes and sinker. On this system, incubation bottles at 8 layers and "Knauer" type sediment trap at 4 layers were installed together. Thanks to the effort by MWJ technicians, drifting mooring system was upgraded on board. Final configuration is shown in Fig. 3.5.1.1.

The drifter was deployed at 19:00 on 12 September 2007 (UTC), which is just before sunrise (6:00 on 13 September 2007 in LST) and recovered after 24 hours (or 48 hours for sediment trap). The drifter's position was monitored by using GPS radio buoy (Taiyo TGB-100). Fig. 3.5.1.2 shows tracks of the drifter. In general, the drifter tended to drift southeastward at station K2 with rotation.

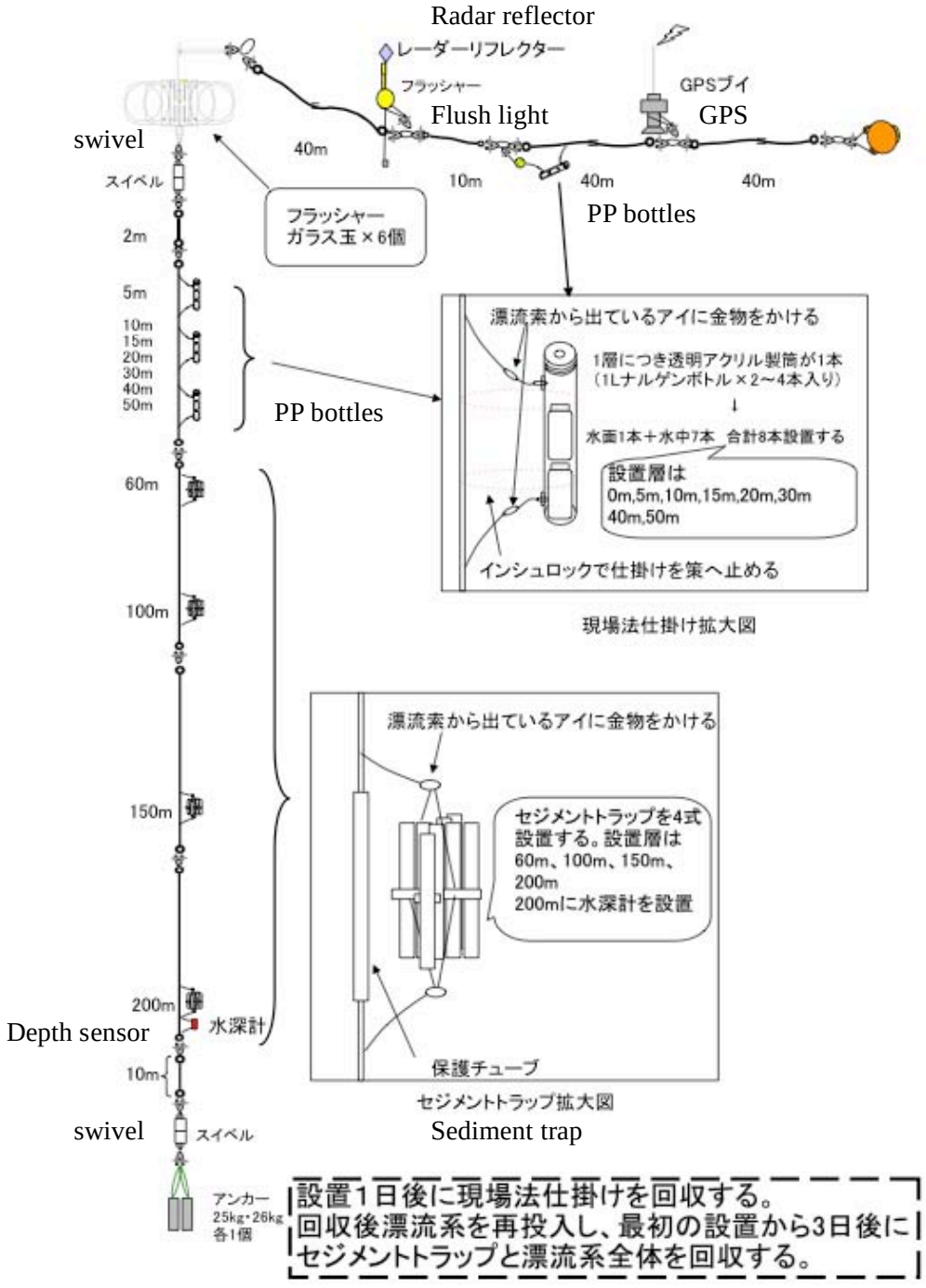

Fig. 3.5.1.1 Drifting mooring system

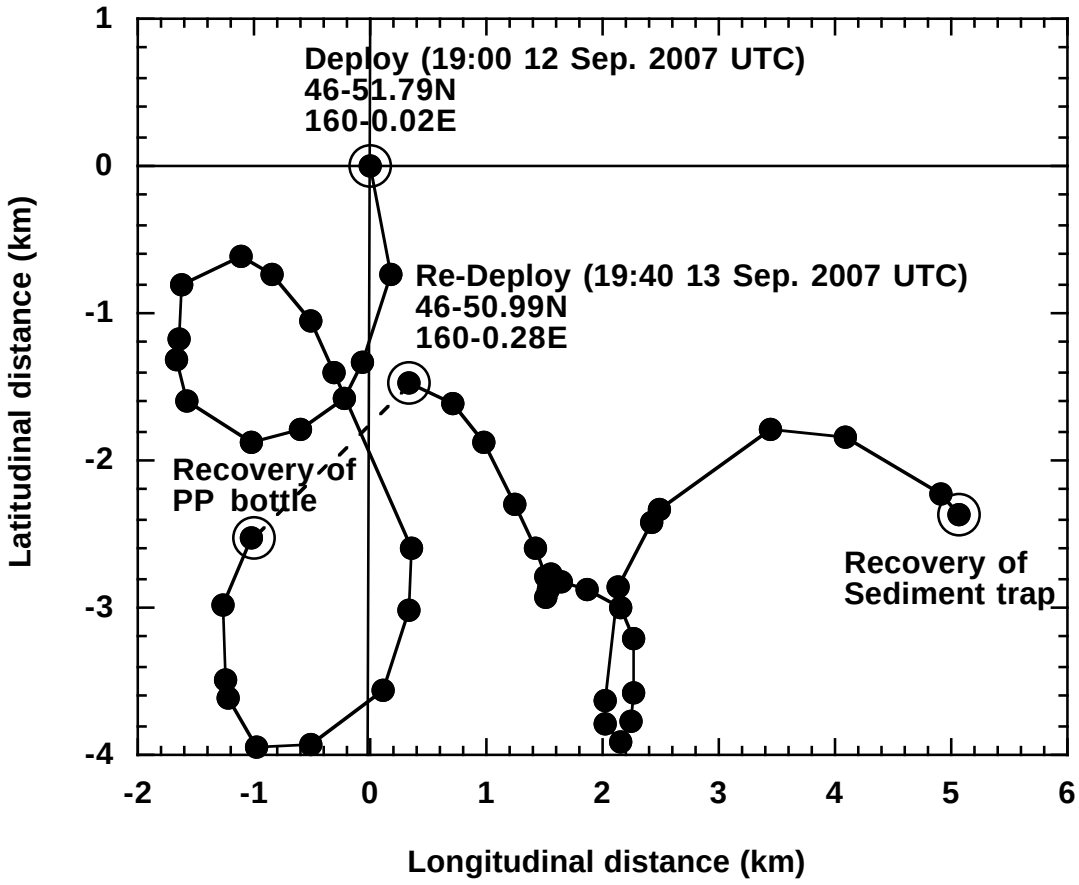

Fig. 3.5.1.2 Track of drifter (GPS buoy) at station K2

3.5.2 Primary productivity

Primary productivity was measured twice at station K2 and once at station K1. PP measurement at station K1 and the second PP measurement at station K2 were conducted by simulated *in situ* incubation method.

(1) *in-situ* or simulated *in situ* incubation

1) Bottles for incubation and filters

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

2) Incubation

Water samples were collected at 8 layers between the surface and seven pre-determined depths by a bucket or Niskin bottle. These depths corresponded to nominal specific optical depths *i.e.* approximately 50%, 25%, 10%, 5%, 2.5%, 1% and 0.5% light intensity relative to the surface irradiance as determined from the optical profiles obtained by "Free Fall sensor". All samples were spiked with 0.2 μmoles/mL of $NaH^{13}CO_3$ solution. After spike, bottles were installed at respective depths on the drifter and *in situ* incubated (Fig.3.5.1.1) or bottles were incubated in the water baths on deck. Natural light was adjusted to the light level for each depth with blue film. After 24 hours incubation, samples were filtrated through grass fiber filters (Wattman GF/F 25mm). GF/F filters were kept in a freezer on board until analysis.

(2) Irradiance and water temperature during incubation

Fig.3.5.2.1 and 3.5.2.2 shows diurnal change of photosynthetically available radiation (PAR) estimated with data of radiometers on *R/V MIRAI* (Smet and JamMet. See section 3.4. Optical measurement) and vertical profile of water temperature measured by EPCS or CTD, respectively. Daily PARs during incubation at station K1 and the first incubation at station K2 were approximately 25 E m^{-2} day^{-1} and comparable. However daily PAR during the second incubation at station K2 was quite low. Surface water temperature during the first incubation at station K2 was 12°C and slightly higher than other incubations. Water temperature was almost constant upper 20 m and decreased below 20 m. At the bottom of the euphotic layer, water temperature was approximately 2°C. SST during the first incubation at station K2 and at station K1 was approximately 10.5°C and constant upper 40 m. Below 40 m, temperature decreased. Water bath on deck for simulated *in situ* incubation was filled up with surface seawater. Thus phytoplankton collected below 40 m was incubated under higher temperature than actual *in situ* temperature.

(3) Measurement

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

Before analysis, inorganic carbon of samples was removed by an acid treatment in a HCl vapor bath for 4 - 5 h.

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

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

This equation is converted to the following equation;

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

where $^{13}C_{(POC)}$ is concentration of ^{13}C of particulate organic carbon after incubation, *i.e.*, measured value (%). $^{13}C_{(0)}$ is that of particulate organic carbon before incubation, *i.e*., that for sample as a blank (1.083 in this cruise).
$^{13}C_{(sw)}$ is concentration of ^{13}C of ambient seawater with a tracer. This value for this study was determined based on the following calculation;

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

where TDIC is concentration of total dissolved inorganic carbon at respective bottle depths (mol l^{-1}) and 0.011 is concentration of ^{13}C of natural seawater (1.1 %). 0.0002 is added ^{13}C (mol) as a tracer. Taking into account for the discrimination factor between ^{13}C and ^{12}C (1.025), primary productivity (PP) was, finally, estimated by

$$PP = 1.025 \times \Delta POC$$

The precision (repeatability: standard deviation / average) ranged from 0.2% to 12% with average of 3.5%.

(4) Preliminary results

Primary productivity (PP) decreased with depth (Fig. 3.5.2.3). Maximum PP of 27 mg m^{-3} day^{-1} was observed at subsurface (5 m) at station K2. Integrated PP at station K1 was approximately 500 mg m^{-2} day^{-1}. Integrated PP during the first incubation at station K2 was approximately 460 mg m^{-2} day^{-1}. On the other hand, integrated PP during the second incubation at station K2 was approximately 300 mg m^{-2} day^{-1}. It is attributed to quite low daily PAR during incubation. Fig. 3.5.2.4 shows seasonal variability in PP observed at station K2 since 2003. Average was estimated to be approximately 400 mg m^{-2} day^{-1}. The first PP and the second PP at station K2 were higher and lower than average, respectively.

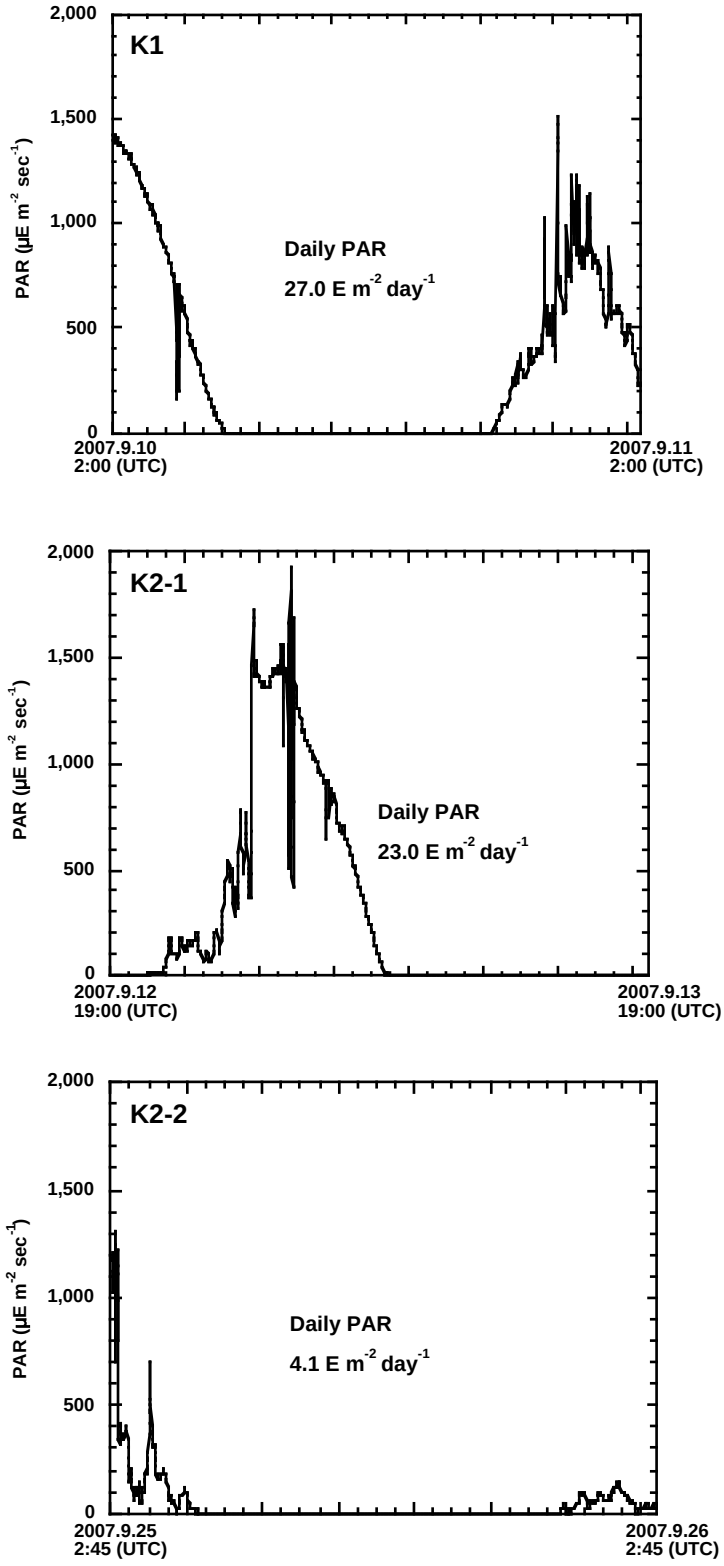

Fig. 3.5.2.1 Photosynthesis Available Radiation (PAR) during *in situ* incubation

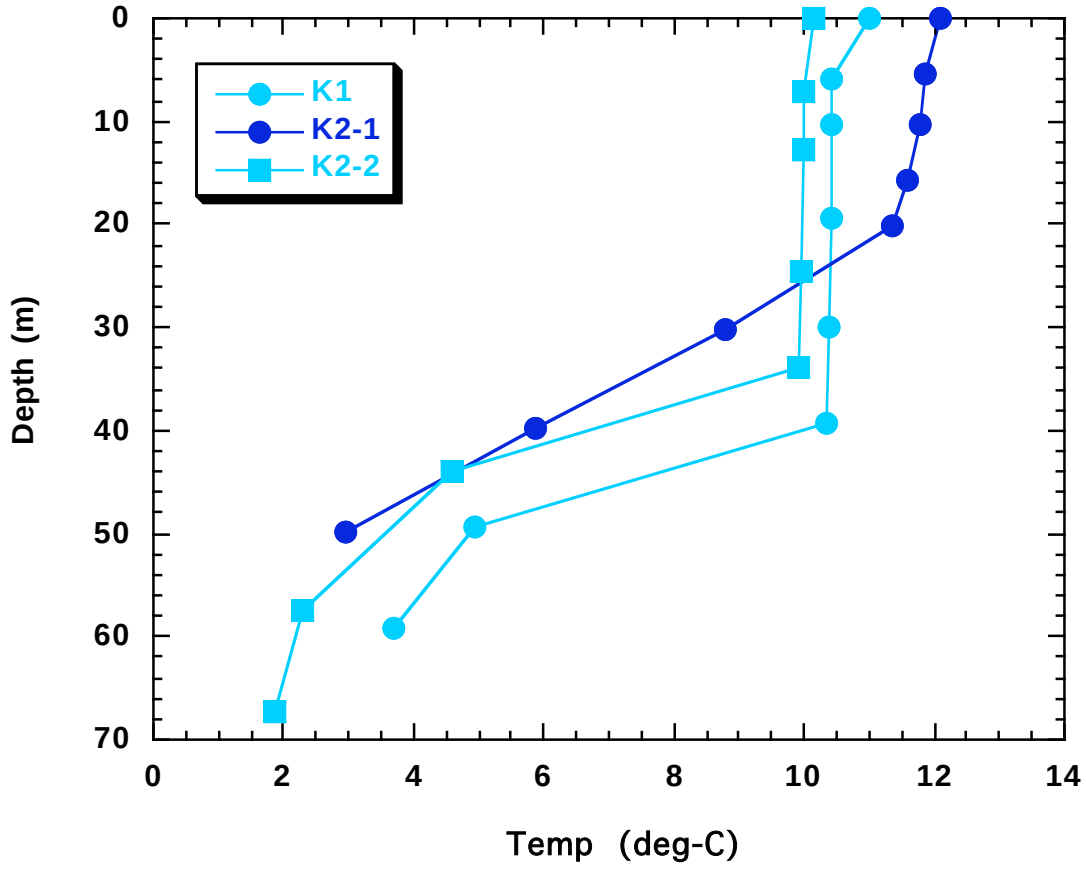

Fig. 3.5.2.2 Water temperature for respective incubations. Surface temperature was average during incubation measured by EPCS system. Water temperature in the water column was observed by CTD when sample were collected.

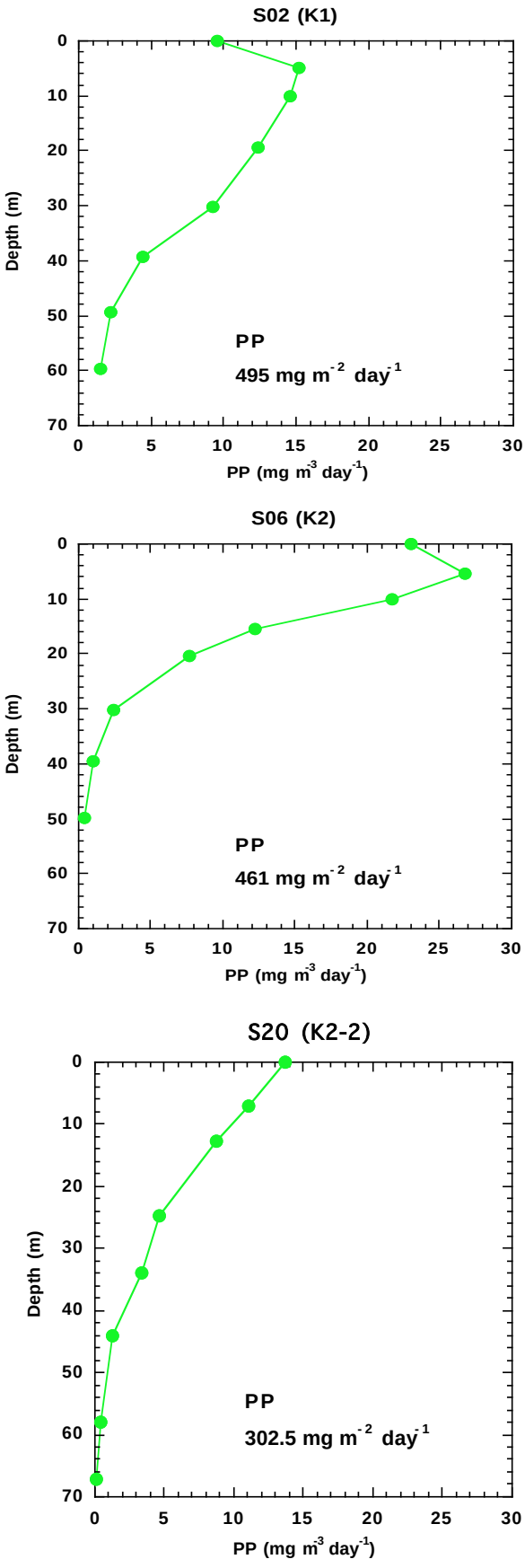

Fig. 3.5.2.3 Primary productivity

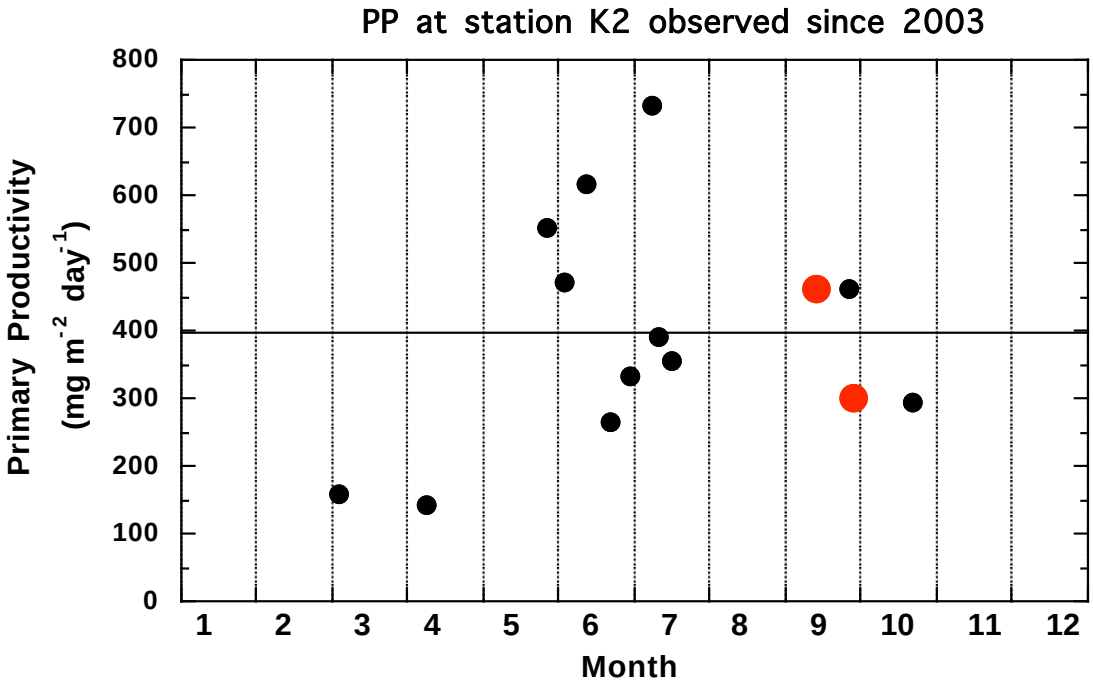

Fig. 3.5.2.4 Seasonal variability in PP at station K2 that have been observed since 2003. Red circles are PP observed during this cruise. Average is approximately 400 mg m^{-2} day^{-1}.

3.5.3 Drifting sediment trap

In order to collect sinking particles and measure carbon flux, radionuclide, and zooplankton, “Knauer type” cylindrical sediment trap (Photo 3.5.3.1) was deployed once at station K2 where measurement of primary productivity and in situ pumping (LVP) were conducted. This trap consists of 8 individual transparent policarbonate cylinders with baffle (collection area: ca. 0.0038 m^2, aspect ratio: 620 mm length / 75 mm width = 8.27), which were modified from Knauer (1979). Before deployment, each trap was filled with filtrated surface seawater, which salinity is adjusted to ~ 39 PSU by addition of NaCl (addition of 100 mg NaCl to 20 L seawater) were placed in tubes. These were located at approximately 60 m, 100 m, 150 m and 200 m. After recovery, sediment traps were left for half hour to make collected particles settle down to the bottle. After seawater in acrylic tube was dumped using siphonic tube, collecting cups were took off. In laboratory on board, seawater with sinking particles were filtrated on various filters for respective purpose. These were kept in freezer by the day when these were analyzed.

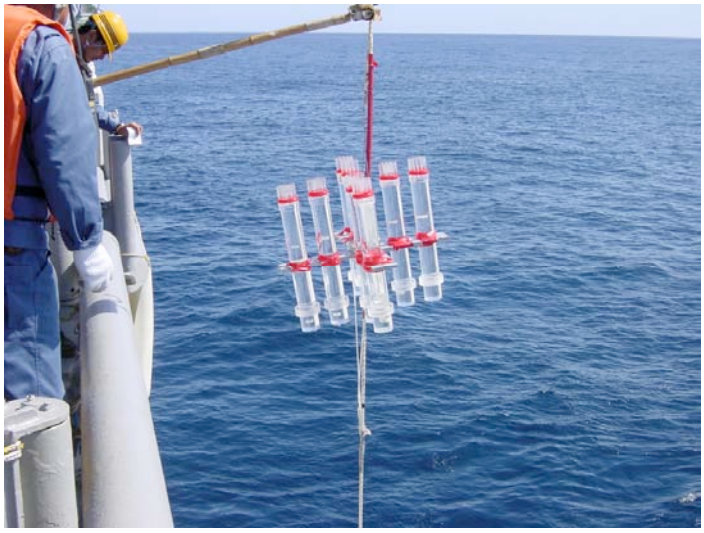

Photo 3.5.3.1 Drifting Sediment Trap

3.5.4 P vs. E curve

Kazuhiko MATSUMOTO (JAMSTEC); PI
Fuyuki SHIBATA (MWJ)
Ai YASUDA (MWJ)
Kanako ISOGAI (MWJ)

(1) Objectives

The objective of this study is to estimate the relationship between phytoplankton photosynthetic rate (P) and scalar irradiance (E) in the western North Pacific.

(2) Sampling

Samplings were carried out at five observational stations of S02, S06, S10, S15 and S20. Sample water were collected at the surface and another two depths of different irradiance level (either 2.5% and 25%, or 5% and 25% of the surface irradiance) at each station using Niskin bottles, except for the surface water, which was taken by a bucket.

(3) Methods

1) Incubation

Three incubators filled in water were used, illuminated at one end by a 500W halogen lamp. Temperature was controlled by circulating water-cooler. Water samples were poured in nine polycarbonate flasks (approx. 1 liter) and arranged in the incubator linearly against the lamp after adding the isotope solutions. The isotope solutions of ^{13}C and ^{15}N were added as same as the primary productivity experiment. All flasks were controlled light intensity by shielding with a neutral density film on lamp side. The light intensities inside the flasks were shown in table 1. We prepared the high light intensity incubator (Bath A) for the surface sample. The incubations were conducted for three hours round about noon in local time.

2) Measurement

After the incubation, samples were treated as same as the primary productivity experiment.

The analytical function and parameter values used to describe the relationship between the photosynthetic rate (P) and scalar irradiance (E) are best determined using a least-squares procedure from the following equation.

$$P=P_{max}\tanh(\alpha E/P_{max})$$

where, P_{max} is the light-saturated photosynthetic rate, α is the initial slope of the P vs. E curve (Jassby and Platt, 1976).

3) Size fractionation experiment

At the station of S06 and S20, the P vs. E curve experiments were conducted for the size fractionated samples. The surface water collected by a bucket was filtrated through 3μm and 10μm Nuclepore filter individually before the incubation. The P vs. E curve of three size fractions for <3μm, <10μm and total were acquired from the incubations of filtrated water and non-filtrated water.

(4) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO). Please ask PI for the latest information.

Table. 1 Light Intensity of P-E measurements

	Light Intensity ($\mu E/m^2/sec$)		
Bottle No.	Bath A	Bath B	Bath C
1	1500	1000	1000
2	780	510	470
3	390	270	265
4	150	105	100
5	75	55	45
6	37.5	25	22.5
7	15.75	10	10
8	6.3	4.4	6.15
9	0.07	0.07	0.07

3.5.5 New Production

Makio HONDA (JAMSTEC MIO)
Kazuhiko MATSUMOTO (JAMSTEC MIO)
Fuyuki SHIBATA (MWJ)
Ai YASUDA (MWJ)

(1) Objective

New production is generally defined as "primary production associated with not old or regenerated nitrogen such as NH_3-N, but newly available nitrogen such as NO_3-N". Under steady state condition, new production should be comparable to production that exported from surface layer or transported to the ocean interior. This export production has been observed by sediment trap, and measurement of nutrients and natural radionuclide. In order to observe the new production, measurement of NO_3 uptake rate was conducted with ^{15}N stable isotope tracer when primary productivity was measured.

(2) Method

When *in situ* or simulated *in situ* incubation for measurement of primary production was conducted, ^{15}N-enriched NO_3, $Na^{15}NO_3$, was injected to the incubation bottle, resulting that the final concentration of additional ^{15}N is 0.5 μmol L^{-1}. After incubation, samples are filtered onto Whatman GF/F glass fiber filter. Particulates are converted to N_2 gas and isotope ratios are determined by mass spectrometry on board.

NO_3 uptake rate or new production (NP) was estimated with following equation:

$$NP\ (\mu g\ L^{-1}\ day^{-1}) = (15N_{excess} \times PON) / (^{15}N_{enrich}) / day$$

where $^{15}N_{excess}$, PON and $^{15}N_{enrich}$ are excess ^{15}N (measured ^{15}N minus ^{15}N natural abundance, 0.366 atom%) in the post-incubation particulate sample (%), particulate nitrogen content of the sample after incubation (mg L^{-1}) and ^{15}N enrichment in the dissolved fraction (%), respectively. $^{15}N_{enrich}$ is expressed as follows:

$$^{15}N_{enrich}\ (\%) = {}^{15}N / (^{15}N + {}^{14}N) \times 100 - {}^{15}N_n$$

where ^{15}N, ^{14}N and $^{15}N_n$ are concentration of labeled N (0.5 μmol L^{-1}), concentration of unlabeled N (dissolved NO_3 measured as "routine", μmol L^{-1}) and natural abundance of ^{15}N (0.366 atom%), respectively.

Precision of measurement (reproducibility) was 7.5% on average (n=24).

(3) Preliminary result

Maximum of NO_3 uptake rate was approximately 2.4 mgN m^{-3} day^{-1} and generally decreased with depth (Table 3.5.5.1). NO_3 uptake rate was converted to carbon uptake rate (new production: mgC m^{-3} day^{-1}) with Redfield ratio (C/N = 6.6) and integrated in the euphotic layer. Integrated new production at stations K1, K2-1 (the first observation at K2) and K2-2 (the second observation at K2) were estimated to be approximately 174, 207 and 303 mgC m^{-2} day^{-1}, respectively. These corresponded to approximately 36, 45 and 22% of primary productivity at K2, K2-1 and K2-2, respectively.

Table 3.5.5.1 New production measured by ^{15}N

Station	Depth (m)	NO3 uptake rate (mgN m^{-3} day^{-1})	average (mgN m^{-3} day^{-1})	deviation (%)	New production: NP (mgC m^{-3} day^{-1})	Inventory (mgC m^{-2} day^{-1})	Primary Productivity: PP (mgC m^{-2} day^{-1})	NP / PP (%)
K1	0	0.527	0.558	5.581	3.684			
	0	0.589						
	6.5	0.873	0.883	1.087	5.825	30.903		
	6.5	0.892						
	10.2	0.895	0.876	2.105	5.783	52.377		
	10.2	0.858						
	19.4	0.822	0.745	10.377	4.914	101.582		
	19.4	0.667						
	30.2	0.555	0.456	21.775	3.006	144.353		
	30.2	0.356						
	39.3	0.156	0.161	3.261	1.062	162.862		
	39.3	0.166						
	49.4	0.011	0.008	32.193	0.056	168.504		
	49.4	0.006						
	59.7	0.166	0.164	1.533	1.080	174.352	491.2	35.5
	59.7	0.161						
Station	Depth (m)	NO3 uptake rate (mgN m^{-3} day^{-1})	average (mgN m^{-3} day^{-1})	deviation (%)	New production: NP (mgC m^{-3} day^{-1})	Inventory (mgC m^{-2} day^{-1})	Primary Productivity: PP (mgC m^{-2} day^{-1})	NP / PP (%)
K2-1	0	1.731	1.650	4.896	10.889			
	0	1.569						
	5.5	2.389	2.397	0.350	15.823	73.459		
	5.5	2.406						
	10.2	1.568	1.669	6.022	11.013	136.525		
	10.2	1.769						
	15.5	0.647	0.736	12.151	4.859	178.586		
	15.5	0.826						
	20.3	0.292	0.277	5.571	1.826	194.632		
	20.3	0.261						
	30.1	0.026	0.026	0.603	0.171	204.416		
	30.1	0.026						
	39.5	0.013	0.016	15.520	0.105	205.712		
	39.5	0.018						
	49.8	0.022	0.021	6.561	0.138	206.961	461.3	44.9
	49.8	0.019						
Station	Depth (m)	NO3 uptake rate (mgN m^{-3} day^{-1})	average (mgN m^{-3} day^{-1})	deviation (%)	New production: NP (mgC m^{-3} day^{-1})	Inventory (mgC m^{-2} day^{-1})	Primary Productivity: PP (mgC m^{-2} day^{-1})	NP / PP (%)
K2-2	0	0.504	0.466	8.112	3.074			
	0	0.428						
	7.1	0.408	0.410	0.330	2.703	20.507		
	7.1	0.411						
	12.8	0.307	0.301	1.831	1.990	33.881		
	12.8	0.296						
	24.7	0.135	0.127	6.044	0.839	50.715		
	24.7	0.119						
	33.9	0.074	0.074	0.009	0.489	56.823		
	33.9	0.074						
	44.1	0.015	0.016	5.278	0.106	59.853		
	44.1	0.017						
	58	0.053	0.050	6.372	0.330	62.877		
	58	0.047						
	67.1	0.028	0.036	22.378	0.241	65.473	302.5	21.6
	67.1	0.045						

3.6 FRRF observation

Tetsuichi FUJIKI (JAMSTEC)
Toshiro SAINO (Nagoya University)

(1) Objective

During the past decade, the utilization of active fluorescence techniques in biological oceanography brought significant progress in our knowledge of primary productivity in the oceans. Above all, the fast repetition rate (FRR) fluorometry reduces the primary electron acceptor (Q_a) in photosystem II (PSII) by a series of subsaturating flashlets and can measure a single turnover (ST) fluorescence induction curve in PSII. The PSII parameters, such as the potential photosynthetic activity (F_v/F_m) and the functional absorption cross-section of PSII (σ_{PSII}), derived from the ST fluorescence induction curve can be used to estimate gross primary productivity. In the present study, to gain a better understanding of variability in phytoplankton productivity in the North Pacific Ocean, we measured the PSII parameters and primary productivity using the FRR fluorometry.

(2) Methods

Using the FRR fluorometer (Kimoto Electric Co., Ltd., Japan) (Fig. 1), the vertical and spatial variations in and PSII parameters and primary productivity were examined at Stns S2, S6, S10, S12, S14, S15 and S18 in the Pacific Ocean. The FRR fluorometer was moved up and down between surface and 100 m at the rate of 0.2 m s^{-1} using a ship winch. The profiling rate of the observation buoy was set to minimal in order to detect small scale variations (~0.5 m) in measurements.

(3) Preliminary results

The profiles of F_v/F_m, σ_{PSII} and primary productivity at Stn S6 (K2) measured using the FRR fluorometer were shown in Figure 2.

(4) Data archives

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

Fig. 1. FRR fluorometer (Diving Flash, Kimoto Electric Co., Ltd., Japan).

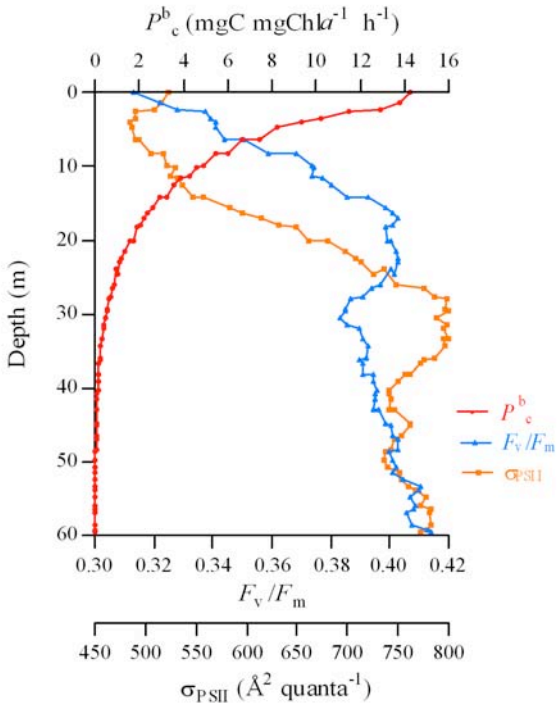

Fig. 2. Vertical profiles of F_v/F_m, σ_{PSII} and primary productivity (P^b_c) at Stn 6 (K2), measured at 10: 00 a. m. on 13 September 2007 (LST).

3.7 Studies on the microbiological metabolic process for dissolved organic carbon (DOC) circulation in marine systems.

Motoo UTSUMI (Univ. of Tsukuba)
Gang CHEN (Univ. of Tsukuba)
Satoshi ITO (Univ. of Tsukuba)
Masao UCHIDA (NIES; National Institute for Environmental Studies)

(1) Objectives

Marine microbes, especially bacteria, are large and essential components of food webs and elemental cycles in the oceans. Marine bacteria include the two deepest divisions, or domains, Bacteria and Archaea. These domains are identified by genetic distance in the composition of the 16S rRNA gene (Woose et al. 1990). Marine bacteria are morphologically simple: microscopic rods, spheres and filaments generally less than 1-2 μm in size, but bacteria are highly diverse in terms of both taxonomy and metabolism. There are many different varieties of bacteria existing in the oceans, but it has been long noted a discrepancy of several orders of magnitude between the number of bacterial cells that can be seen in the oceans by direct count (by epifluorescence microscopy) and the number of colonies that appear on agar plates (e.g. Jannasch and Jones, 1959). In terms of carbon cycling in marine systems, especially for dissolved organic carbon (DOC), one of the most important activities of bacteria is aerobic heterotrophy. Heterotrophic bacteria served primarily as a pathway for regeneration of organic nitrogen, phosphorus, and other bioactive elements, and represented a shunt of carbon and energy from the main phytoplankton-based food web.

In recent years, in addition, it is reported that nonthermophilic archaea represent up to 40% of the free-living prokaryotic community in the water column of the world's oceans (ex. Delong, 1992), and some of their population is chemoautotrophy (ex. Pearson et al. 2001). Therefore, it is important to study the relationship between DOC cycling and bacterial community structure and their metabolic information in the marine systems. One difficult matter for studying these topics, however, it need so huge sea-water sample volume (c.a. 100,000 L) for analyzing the radioactive isotope ratio of specific organic material in POC, DOC and bacterial cell components.

The key aim of this study is to analyze the relationship between community structures and metabolic characteristics of microorganisms, and dissolved organic carbon cycling in the ocean water columns. The objectives of this study are as follow:
1) Collect large volume (ca. 100 L per each sample) of sea-water column samples for measuring stable and radioactive isotope ratio of POC, DOC and bacterial cell membrane lipids, and for analyzing the bacterial diversity and functional gene,
2) collect mega volume (from 50,000 to 100,000 L per each sample) of surface sea-water samples for measuring radioactive isotope ratio of POC and bacterial cell membrane lipids, and for analyzing the composition of small size (less than 0.2 μm) organic carbon materials.

We also collected sea-water samples for measuring the radioactive isotope ratio of DIC. One of the final goals of this study is making a mass balance model for dissolved carbon in the ocean.

1) Large volume filtration

To study the diversity of bacterial community and functional gene, and stable and radioactive isotope ratio of POC, DOC and bacterial cell membrane lipids, we filtered 10-250 L sea-water at each sampling station. Water samples were collected from different depths at the stations with X-Niskin water samplers (12 L, General Oceanic) and immediately transferred to 20 L plastic canteens. Water samples also collected from surface sea-water supply system (100 to 120 L /each sampling time). Each water sample was filtered with quartz fiber filters (Whatman QM-A, with a operational pore size of 0.6 μm, 110 mm and 47 mm in diameter) as soon as possible on board. The filters and filtrates were frozen at -20^{o}C during the cruise. To count the population density of bacteria in the water column, same water samples (10 mL x 3 tubes) were fixed with formalin (final concentration in the sample was 3.6%) immediately and stored at 4^{o}C. Some water samples were filtered with 0.2 μm isopore membrane filter (Whatman, 47 mm in diameter) for comparing the quartz filters, and stored at -80^{o}C.

Figure 1. Photograph of large volume filtration system.

2) Mega volume filtration

To study the radioactive isotope ratio of POC and bacterial cell membrane lipid, and diversity of bacterial community, we filtered surface sea-water (7 samples, from 9,571 to 40,677 L, see Table 1) continuously during the cruise. The filtration equipment is shown in Figure 2. Each filter was exchanged new one when the filtration velocity declined under 5 L/min or the filtration period exceeded 5 day. The filters were frozen at -20^{o}C or -80^{o}C during the cruise.

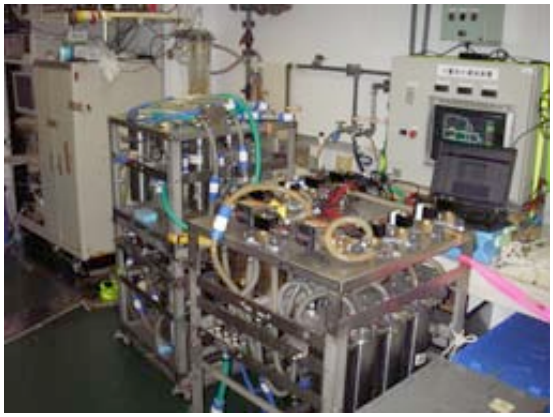

Figure 2. Mega volume filtration system setting up in the surface sea-water analysis room in "MIRAI". The equipment is consist of a) steel-wool parts, b) 10 µm size filter parts, c) 1.0 µm size filter parts, d) 0.5µm size filter parts, e) 0.2µm size filter parts, and f) control units (control panel and data logger PC). The maximum filtration velocity is about 10 L/min.

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Woese, C. R., Kandler, O., and Wheelis, M. L. (1990) Proc. Natl. Acad. Sci. USA 87:4576-4579.

Table 1. List of filtrated sea-water samples during MR07-05.

1) Mega filtration samples of surface sea-water for POM, DOM and bacteria.

sampling date	site information	filtrate volume (L)
2007/9/11 4:19	47-00N, 159-59E	40,677
2007/9/14 3:00	46-55N, 160-00E	23,174
2007/9/15 13:15	46-51N, 159-54E	9,571
2007/9/20 3:12	39-44N, 154-27E	34,251
2007/9/23 21:14	43-34N, 155-51E	28,393
2007/9/27 20:48	41-22N, 152-30E	24,325
2007/9/30 1:00	40-19N, 144-25E	11,421

2) Large filtration samples of surface sea-water for POM, DOM and bacteria.

sampling date	site information	filtrate volume (L)
2007/9/6 21:40	56-40N, 174-51E	100
2007/9/8 7:19	51-00N, 167-13E	120
2007/9/10 2:20	St. K1	100
2007/9/12 7:16	St. K2	100
2007/9/16 23:12	40-06N, 154-55E	120
2007/9/19 21:23	38-35N, 154-34E	120
2007/9/25 21:59	St. K2	100

3) Filtration samples of surface sea-water for DOM.

sampling date	site information	filtrate volume (L)
2007/9/6 21:40	56-40N, 174-51E	2
2007/9/8 7:19	51-00N, 167-13E	2
2007/9/15 4:38	St. K2	2
2007/9/16 23:12	40-06N, 154-55E	2
2007/9/19 3:30	St. S15	2
2007/9/20 0:30	39-02N, 154-27E	2
2007/9/25 23:15	St. K2	2

4) Water samples of surface sea-water for DIC.

sampling date	site information	volume (L)
2007/9/6 21:40	56-40N, 174-51E	0.25
2007/9/8 7:19	51-00N, 167-13E	0.25
2007/9/10 0:32	St. K1	0.25
2007/9/12 8:00	St. K2	0.25
2007/9/15 4:38	St. K2	0.25
2007/9/17 1:25	39-35N, 154-51E	0.25
2007/9/19 5:55	St. S15	0.25
2007/9/20 0:30	39-02N, 154-27E	0.25
2007/9/25 23:15	St. K2	0.25

5) Filtration samples of CTD X-Niskin samplers at each depths for POM and bacteria.

sampling date	site information	total volume (L)
2007/9/8-9	St. K1	420
2007/9/11-16	St. K2	1,420
2007/9/18	St. S18	290
2007/9/19	St. S15	24
2007/9/20-21	St. S14	334
2007/9/22	St. S12	334
2007/9/22	St. Knot	130
2007/9/22-23	St. S10	254
2007/9/23	St. S11	10

6) Filtration samples of CTD X-Niskin samplers at each depth for DOM.

sampling date	site information	total volume (L)
2007/9/8-9	St. K1	100
2007/9/11-16	St. K2	190
2007/9/18	St. S18	20
2007/9/19	St. S15	24
2007/9/20-21	St. S14	54
2007/9/22	St. S12	36
2007/9/22	St. Knot	12
2007/9/22-23	St. S10	46
2007/9/23	St. S11	10

7) Water samples of CTD X-Niskin samplers at each depth for DIC.

sampling date	site information	total volume (L)
2007/9/11-16	St. K2	3.0
2007/9/18	St. S18	0.5
2007/9/20-21	St. S14	0.75
2007/9/22	St. S12	0.75
2007/9/22	St. Knot	0.75
2007/9/22-23	St. S10	0.75

3.8 Chlorophyll *a* concentration, size fractionated HPLC and light absorbance

Suguru OKAMOTO (Hokkaido University)
Amane FUJIWARA (Hokkaido University)

(1) Objective

In Northwestern Pacific, phytoplankton biomass and primary production is high and many species of pelagic fishes live. It is also a major sink for atmospheric CO_2. It is important to understand the variability of primary production in the whole of the Northwestern Pacific in order to understand the environment of prey for nekton and carbon cycle. To assess quantitatively phytoplankton production in this region, it is also important to understand bio-optical characteristic of seawater and which size or group are dominated. The objectives of our study is to clarify the spatial and vertical distribution of Chlorophyll-*a* (Chl-*a*), the temporal variability of Chl-*a* in Northwestern Pacific, and to validate which type of phytoplankton existed in each station and related to bio-optical characteristic of seawater.

(2) Methods

1. Chlorophyll *a* concentration

Seawater samples for Chl-*a* concentration measurement were collected at 11 sampling stations (Table 1, Fig. 1). The 0.2 liter of samples was collected at 9 or 14 depths from surface to 200m with Niskin-X bottles, except for the surface water, which was taken by the bucket. The samples were gently filtrated by low vacuum pressure (<100mmHg) through Whatman GF/F filters (pore size: 0.7µm; diameter: 25mm) in the dark room.

Phytoplankton pigments were immediately extracted in 6ml of N,N-dimethylformamide after filtration and then, the samples were stored in the freezer (-20 degree celsius) until the analysis of fluorometer determination. The measurements were performed at room temperature after the samples were taken out of the freezer. Welschmeyer non-acidification methods were examined for the determinations of Chlorophyll-*a* with Turner design model 10-AU-005 fluorometer.

2. Size fractionated HPLC

Seawater samples for size frationated HPLC were collected at 7 sampling stations (Table 1). The 3 liter of samples was collected at 6 depths, 0, 10, 20, 30, 50 and 75 m by bucket (0 m) and Niskin-X bottles (10-75 m). The samples were filtered by low vacuum pressure (<100mmHg) through three different pore size filters; 20µm nylonmesh, 5µm nylonmesh and Whatman GF/F filters diameter: 47mm) in the dark room. The samples were immediately stored in the deep-freezer (-80 degree celsius) and will be analyzed in the laboratory after the cruise.

3. Light absorbance

At 7 sampling stations (Table 1), seawater sample for absorbance of particle and detritus were collected in 1 gallon brown bottles, and the 0.2 liter of samples for absorbance of colored dissolved organic material (CDOM) was collected at 6 depths, 0, 10, 20, 30, 50 and 75 m by bucket (0 m) and Niskin-X bottles (10-75 m). For particle absorbance samples, the seawater filtered the Whatman GF/F (filter diameter: 25m). The filtering volume was decided by the color of filter after filtration. The absorbance measurements were examined using Shimadzu

UV-2400PC spectrophotometer. After that, phytoplankton pigment on filter was extracted using methanol between 24 and 48 hours, and the absorbance of detritus was measured. For measurement of absorbance of CDOM, seawater was filtered the 0.2μm Nuclepore filter, and analyzed using the spectrophotometer. The measurement stations were same as bio-optical measurement stations.

Table 1 List of sampling station

Station			Date	Samples			
	Lat.(deg-min)	Long.(deg-min)	G.M.T	Chl.a	HPLC	QFT	CDOM
S2(K1)	51-00.00N	165-00.00E	9/9/07	x	x	x	x
S6(K2)	47-00.00N	160-00.00E	9/11/07	x	x	x	x
S18	35-00.00N	155-00.00E	9/18/07	x	x	x	x
S15	38-00.00N	155-00.00E	9/18/07	x	x	x	x
S14	39-00.00N	155-00.00E	9/20/07	x	x	x	x
S13	40-00.00N	155-00.00E	9/21/07	x			
S12	41-00.00N	155-00.00E	9/22/07	x	x	x	x
S9(KNOT)	44-00.00N	155-00.00E	9/22/07	x			
S10	43-00.00N	155-00.00E	9/22/07	x	x	x	x
S11	42-00.00N	155-00.00E	9/23/07	x			
S20(K2)	47-00.00N	160-00.00E	9/24/07	x			

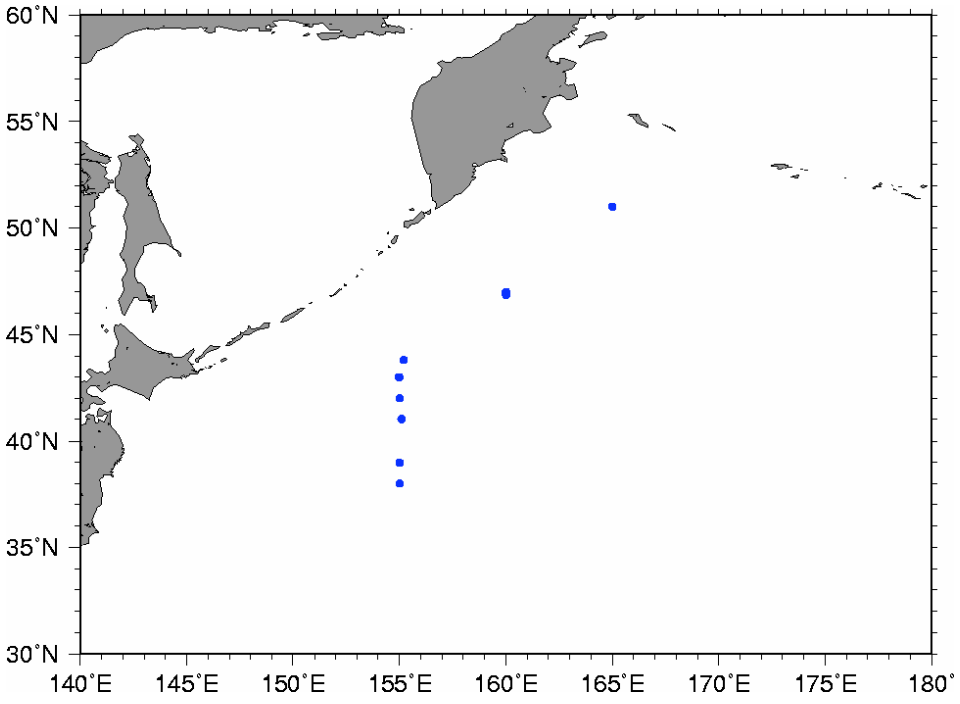

Fig. 1 Map of Chl-*a* concentration sampling station.

(3) Preliminary results

1. Chlorophyll *a* concentration

Fig. 2 shows the section of Chl-*a* concentration on 51 °N to 35 °N line.

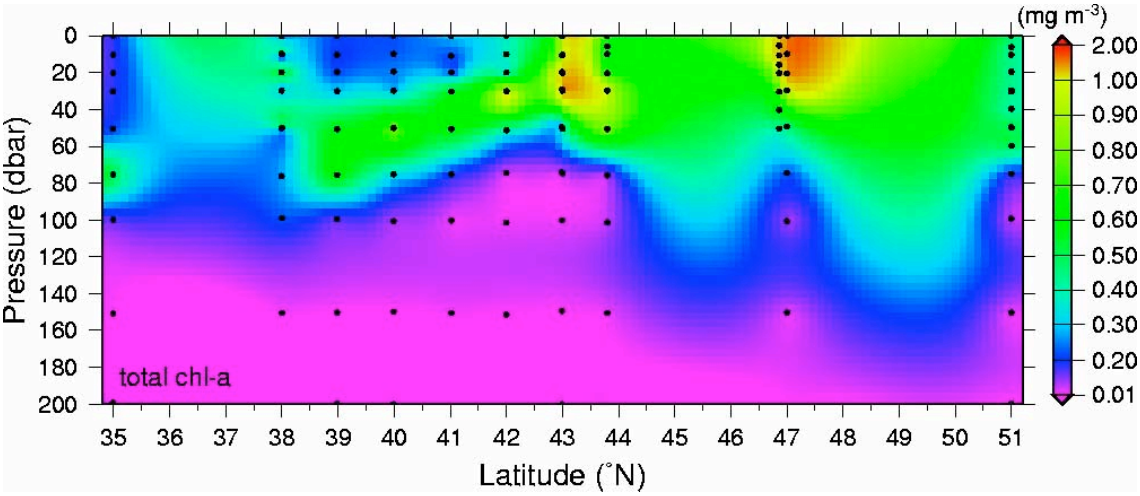

Fig. 2 Section of total Chl-*a* on 51 °N to 35 °N line. The black dots show the sampling depth at each station.

2. Size fractionated HPLC

Under analysis

We will measure the concentration of phytoplankton pigments by HPLC, and investigate the distribution of each phytoplankton group classified with their cell sizes and specific pigments.

3. Light absorbance

Under analysis

We will analyze the absorption coefficients of phytoplankton (a_{ph}) and detritus (a_d), and then calculate a Chlorophyll normalized specific absorption spectra, a^*_{ph} to divide by Chl-*a* concentration. In future study, we will use these Chl-*a* and absorbtion coefficients for the model parameter to estimate primary production from satellite ocean color data.

3.9 Biological observation
3.9.1 Community structure and ecological roles of zooplankton

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(1) Objective

Subarctic western North Pacific is known to be a region with high biological draw down of atmospheric CO_2 due to extensive diatom bloom in spring. Time-series biogeochemical observations conducted at the Station K2 have revealed high annual material transportation efficiency to the deep compared to the other time-series sites set in the subtropical regions.

Zooplankton dominated in this regions are large copepods, which mainly feed on diatoms, and supposed to help enhancing Biological Carbon Pump (BCP) function, by repackaging diatoms through the fecal pellet production. However, the reported zooplankton fecal pellet flux to the deep were smaller than expected from the production in the surface layer, suggesting consumption and biological breakdown occurred in surface and mesopelagic layers. In particular, biological processes in the mesopelagic layer are largely unknown.

Besides the fecal pellet production, “active transport” of carbon by ontogenetic migrating copepods, e.g. *Neocalanus* spp. recently was reported large, even equivalent to amount of carbon flux estimated based on the sediment trap experiments. Other copepods, *Metridia* spp. perform extensive diel vertical migration, and could transport large amount of surface carbon to the several hundred meters deep through respiration. Detailed information of timing and biomass of vertical migration of these copepods should be investigated.

With these background, goal of these research is to investigate roles of zooplankton in vertical material transport in the western subarctic North Pacific. We deployed two types of plankton nets to investigate species and size composition of zooplankton from the surface to the greater deep. Bacteria and microzooplankton were also collected in the surface layer. Since zooplankton researches have been conducted at the K2 during the high productive season, in August 2005, and Jun-July 2006, we hoped to figure out difference in zooplankton roles in BCP function between the high and the post-high-productive seasons

(2) Materials and methods

Mesozooplankton samplings

For collection of stratified sample sets, multiple opening/closing plankton net system, IONESS, was used. This is a rectangular frame trawl with seven nets. Area of the net mouth is 1.5 m^2 when the net frame is towed at 45° in angle, and mesh pore size is 0.33-mm. Researcher can open and close nets at discretion depths and can real time monitor net status. Volume of filtering water of each net is estimated using area of net mouth, towing distance, and filtering efficiency. The area of net mouth is calibrated from frame angle during tow, the towing distance is calculated from revolutions of flow-meter, and the filtering efficiency is 96% which was directory measured. The net system is towed obliquely. Ship speed during net tow was about 2 knot, speeds of wire out and reeling were 0.1-0.7 m/s and 0.1-0.3 m/s, respectively.

Total seven tows of IONESS were done, three in daytime at Station K2, three in nighttime K2 and one in daytime K1. We planned to collect stratified sample series as follows; 0-50, 50-100, 100-150, 150-200, 200-300, 300-400, 400-500, 500-750, 750-1000m,

both the day and nighttime. Although we could collect sample sets according to the plan in the first visiting in stn. K2, planned collection was not done in second visiting in K2 due to bad weather. Instead of the originally planned layers, we could collect stratified samples as follows; 0-50, 50-100, 100-200, 200-300, 300-400, 400-500m in daytime and 0-50, 50-100, 100-250, 250-500, 500-750, 750-1000m in nighttime. Towing data such as date, time, position or filtering volume are summarized in Table 3.9.1-1.

Collected zooplankton were fixed and preserved in 5% formalin-seawater buffered with borax. Sample sets of tows, which numbered I070913a and I070925a, were divided into two subsample sets. One of them was fixed in formalin for analysis of community structure and the other was frozen for stable isotope analysis.

Table 3.9.1-1. Information of IONESS towing.

Stn.	Data file name	Date and Time (LST)		Date and Time (UTC)		Position		Sampling layer (upper, m) and filtering vol. (lower, m³)						
			in		in	Net in	Net out	Net No. 0	1	2	3	4	5	6
			out		out									
K1	I070910a	2007.9.10	13:40	2007.9.10	2:40	50° 59.59' N	51° 02.44' N	0-1065-1000	1000-750	750-500	500-250	250-100	100-50	50-0
			16:08		5:08	165° 00.45' E	164° 55.26' E	-	1638	2240	2128	1106	330	306
K2-1	I070913a	2007.9.13	12:35	2007.9.13	1:35	46° 56.55' N	46° 54.82' N	0-1060-1000	1000-750	750-500	500-250	250-100	100-50	50-0
			15:27		4:27	159° 57.67' E	160° 05.13' E	-	2448.8	2176.3	2297.9	1487.6	434.5	557.5
K2-1	I070914a	2007.9.14	10:07	2007.9.13-14	23:07	46° 56.35' N	46° 55.36' N	0-550-500	500-400	400-300	300-200	200-150	150-100	100-50
			12:43		1:43	160° 03.31' E	159° 56.17' E	-	1119.2	993	864.9	569.1	478.1	519.4
K2-1	I070914b	2007.9.14	21:04	2007.9.14	10:04	46° 58.44' N	46° 54.25' N	0-1050-1000	1000-750	750-500	500-250	250-100	100-50	50-0
			23:58		12:58	160° 03.63' E	159° 58.04' E	-	1834.9	2002.9	1939.8	1196.1	604.3	549.4
K2-1	I070915a	2007.9.15	21:02	2007.9.15	10:02	46° 56.99' N	46° 55.23' N	0-550-500	500-400	400-300	300-200	200-150	150-100	100-100
			23:33		12:33	160° 03.85' E	159° 57.68' E	-	1015.8	1067.5	1184.4	563.9	807.4	0
K2-2	I070925a	2007.9.25	21:05	2007.9.25	10:04	46° 58.79' N	46° 53.77' N	0-1050-1000	1000-750	750-500	500-250	250-100	100-50	50-0
			23:54		12:54	160° 01.65' E	159° 59.19' E		1870.4	2145.1	2125.1	1129.8	385	452.9
K2-2	I070926a	2007.9.26	12:53	2007.9.26	1:52	46° 57.16' N	46° 56.58' N	0-548-500	500-400	400-300	300-200	200-100	100-50	50-0
			14:47		3:47	159° 58.44' E	160° 03.17' E		938.4	898.6	830.2	452.4	188.6	206.8

Role of Small Copepods in BCP Efficiency (NORPAC net sampling)

Smaller non-calanoid copepods, e.g. *Oithona* spp, and *Oncaea* spp. are highly abundant and numerically dominant in the surface subarctic North Pacific. Those species feed on the fecal pellets of large copepods and other organic materials, and thus, are suggested to contribute in break down of these particles, resulting in reducing BCP efficiency. We collected those smaller copepods to quantify their biomass and role in carbon transport to subsurface using a twin-type NORPAC net with fine mesh (64μm and 100 μm) and a flow meter for each.

The net was vertically towed 0-50 m and 0-150 m night and day each at the Station K2-1 and K2-2 (Table 3.9.1-2). Zooplankton collected were subdivided by a splitter and a half was preserved in the 5% buffered formalin seawater for later analysis on species and size composition. The other half was frozen for later analysis of stable isotope (see the next section). The formalin preserved samples will be microscopically analyzed to obtain taxonomic composition. Size composition of those samples will be analyzed using an optical zooplankton analyzing system, ZooScan (RECIF Technologies). Once we gain the species and size composition of each sample, a minimum carbon requirement for each species will be estimated. These data will be compared to information obtained by other biological observations of this cruise, e.g. phytoplankton abundance/composition, microzooplankton grazing, bacterial abundance, and fecal pellet production (Fecal pellets were collected by a floating sediment trap).

Stable isotope analysis of zooplankton

Carbon and nitrogen stable isotope ($\delta^{13}C$ and $\delta^{15}N$, respectively) of organisms can be used for proxy of food web structure of a regional ecosystem. $\delta^{13}C$ of zooplankton mirrors that of

phytoplankton they feed on, and $\delta^{15}N$ of zooplankton roughly indicates their tropic level, herbivorous, omnivorous or carnivorous. We planed to measure $\delta^{13}C$ and $\delta^{15}N$ of zooplankton collected by both IONESS and NORPAC net to investigate their tropic level. As for the NORPAC net samples, smaller non-calanoid species were the major target, but carnivore species, e.g. chaetognaths and amphipods, and other herbivores were also examined. For IONESS samples, we mainly focused on *Neocalanus* and *Eucalanus* collected in the different layers up to 1000 m deep to see if $\delta^{13}C$ and $\delta^{15}N$ differed between developmental stages; immature stages feeding actively in shallow vs. adult stage dormant in deep.

After soon after sampling, zooplankton were collected on the 100 μm mesh, packed in the zip-lock bag and frozen in a deep-freezer (-80°C) for 24 hours and kept in a normal freezer (-20°C) afterward. Several days later, those frozen samples were thawed with filtered sea water, and the target species were extracted under microscopic observation. Several to several tens of individuals extracted for each target species were dried under 60°C in a drying open for 24 hours, grinded into powder, and preserved in a small tube. The 65 samples were prepared in total (Table 3.9.1-3). Measurement of $\delta^{13}C$ and $\delta^{15}N$ of those samples will be completed with Thermo Fisher Scientific, Model Flash EA1112-DELTA V ConFlo Ⅲ System (EA-IRMS) by the end of November 2007.

Table 3.9.1-2. Information of NORPAC net sampling.

	Cast No.	1	2	3	4	5	6	7	8	9	10
	Station	K2-1	K2-1	K2-1	K2-1	K2-1	K2-2	K2-2	K2-2	K2-2	K2-2
	Date	070913	070913	070915	070915	070915	070925	070925	070926	070926	070926
	N/D	N	N	D	D	D	N	N	D	D	D
	Lat (N)	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00	47.00
	Long (E)	160.00	160.00	160.00	160.00	160.00	160.00	160.00	160.00	160.00	160.00
	Target depth (m)	0-50	0-150	0-50	0-50	0-150	0-50	0-150	0-50	0-50	0-150
	Time (in)	2240	2220	1435	1450	1502	2010	2020	0832	0908	0920
	Time (out)	2245	2230	1434	1456	1516	2016	2039	0836	0913	0929
	angle (degree)	50	45	50	40	40	50	50	30	30	40
FM ID	plus wire out (m)	28	62	28	15	46	28	83	8	8	46
#3120	FM read (100um)	1325	2864	900	703	1969	1385	3338	818	779	3376
#2370	FM read (64um)	1175	3172	1175	842	2300	1490	3595	898	906	3230
	Sample inf.(100um)	1/2 formalin 1/2 SI analysis	1/2 formalin 1/2 SI analysis	* 1/2 formalin, 1/2 SI analysis		1/2 formalin *1/2 SI analysis	1/2 formalin 1/2 SI analysis	*'1/2 formalin 1/2 SI analysis	* 1/2 formalin, 1/2 SI analysis		1/2 formalin 1/2 SI analysis
	Sample inf (64um)	1/1	1/1	** lost	1/1	1/1	1/1	1/1	**lost	1/1	*lost
	Misc.	A flock of gulls, feeding surface on fish?		* samples of Cast 3 & 4 preserved in a single bottle ** sample lost, net re-deployed (see Cast No. 4)		*leftover of SI analsis preserved in formalin		* 1 syphozoan jelly removed (parts)	* samples of Cast 8 & 9 preserved in a single bottle ** sample lost, net re-deployed (see Cast No. 9)		* sample lost due to strong wind.

Table 3.9.1-3. Zooplankton Sample information for stable isotope analysis.

sampleID	station	date of sampling	Net	Net	spp* (see below)	stage & individual No	misc.
1	K2-1	20070913	IONESS	6	Np	CV 30	
2	K2-1	20070913	IONESS	5	Nc	CV 20	
3	K2-1	20070913	IONESS	5	Np	CV 35	
4	K2-1	20070913	IONESS	4	Nc	CV 20	
5	K2-1	20070913	IONESS	4	Np	CV 30	
6	K2-1	20070913	IONESS	4	Eb	CV 20	
7	K2-1	20070913	IONESS	4	Ch	12	
8	K2-1	20070913	IONESS	3	Np	CV 30	
9	K2-1	20070913	IONESS	3	Nc	CV 17	
10	K2-1	20070913	IONESS	3	Nc	M 4	whitish
11	K2-1	20070913	IONESS	3	Nf	F 30	
12	K2-1	20070913	IONESS	2	Nc	CV 20	
13	K2-1	20070913	IONESS	2	Nc	F 20	ovary developing
14	K2-1	20070913	IONESS	2	Nc	M 10	
15	K2-1	20070913	IONESS	2	Euchaeta	various 25	
16	K2-1	20070913	IONESS	2	Np	CV 30	
17	K2-1	20070913	IONESS	1	Nc	CV 23	
18	K2-1	20070913	IONESS	1	Nc	F 6	
19	K2-1	20070913	IONESS	1	Nc	M 8	
20	K2-1	20070913	IONESS	1	Np	CV 30	
21	K2-1	20070913	NORPAC	xx13	Ep	J & A 12	Night cast
22	K2-1	20070913	NORPAC	xx13	Ch	8	
23	K2-1	20070913	NORPAC	xx13	Nc	CV 8	
24	K2-1	20070913	NORPAC	xx13	Mp	F x30	
25	K2-1	20070915	NORPAC	xx13	Ch	13	Day cast
26	K2-1	20070915	NORPAC	xx13	Np	CV 31	
27	K2-1	20070915	NORPAC	xx13	Cp?	F19 CV24	remnant prsd in formalin
28	K2-1	20070913	NORPAC	xx13	**small	mix	
29	K2-1	20070913	NORPAC	xx13	Themist	various 50	
30	K2-1	20070913	NORPAC	xx13	Cp?	F20 CV20	Day cast
31	K2-1	20070915	NORPAC	xx13	Mp	F & CV 40	Night cast
32	K2-1	20070915	NORPAC	xx13	Np	CV 30	
33	K2-1	20070915	NORPAC	xx13	Themist	various 12	
34	K2-1	20070915	NORPAC	xx13	**small	mix	
35	K2-2	20070925	NORPAC	xx13	Ch	11	Night cast
36	K2-2	20070925	NORPAC	xx13	Ep	J & A 12	
37	K2-2	20070925	NORPAC	xx13	Themist	various 25	
38	K2-2	20070925	NORPAC	xx13	**small	mix	
39	K2-2	20070925	NORPAC	xx13	Np	CV 30	Night cast
40	K2-2	20070925	NORPAC	xx13	Ch	13	

41	K2-2	20070925	NORPAC	xx13	**small	mix	
42	K2-2	20070926	NORPAC	xx13	**small	mix	Day cast
43	K2-2	20070926	NORPAC	xx13	NP	CV 30	Day cast
44	K2-2	20070926	NORPAC	xx13	**small	mix	
45	K2-2	20070926	IONESS	6	Np	CV 30	
46	K2-2	20070926	IONESS	5	Nc	CV 18	
47	K2-2	20070926	IONESS	5	Np	CV 25	
48	K2-2	20070926	IONESS	4	Ch	20	
49	K2-2	20070926	IONESS	4	Np	CV28	
50	K2-2	20070926	IONESS	4	Mp	F & CV 50	
51	K2-2	20070926	IONESS	3	Nc	CV 20	
52	K2-2	20070926	IONESS	3	Np	CV 46	
53	K2-2	20070926	IONESS	3	Nf	F 25	
54	K2-2	20070926	IONESS	3	Eb	CV & CIV 21	
55	K2-2	20070926	IONESS	2	Np	CV 9	
56	K2-2	20070926	IONESS	2	Ostracod	16	
57	K2-2	20070926	IONESS	2	Pleuro	various 28	
58	K2-2	20070926	IONESS	2	Np	CV 40	
59	K2-2	20070926	IONESS	2	Nf	F 20	
60	K2-2	20070926	IONESS	2	Themist	16	
61	K2-2	20070926	IONESS	1	Nc	F 8	
62	K2-2	20070926	IONESS	1	Nc	M 18	
63	K2-2	20070926	IONESS	1	Np	CV 37	
64	K2-2	20070926	IONESS	1	Nf	F 27	
65	K2-2	20070926	IONESS	1	Mp	F 20	

*

Np=Neocalanus plumchrus

Nc=Neocalanus cristuatus

Nf=Neocalanus flemingeri

Eb=Eucalanus buntgii

Mp=Metridia pacifica

Cp=Calanus pacificus

Euchaeta = Euchaeta sp.

Ch= Chaetognaths

Ep=Euphausia pacifica

Themist=Themist sp.

Pleuro=Pleuromamma sp.

** small: filtered by GG54 & caught on XX13 (size: 100um~330um), target: Oithona & Oncaea

Vertical distribution of surface microzooplankton

Two series of seawater samples were collected on 13 and 25 Sept. (SMT) at Station K2. Each series comprises eight waters which collected using bucket and Niskin bottles at different depths. These depths corresponded to nominal specific optical depths approximately 100%, 50%, 25%, 10%, 5%, 2.5%, 1% and 0.5% light intensity relative to the surface irradiance as determined from the optical profiles obtained by ''Free-Fall Sensor''. CTD cast numbers of these water samplings were S06M2 and S20M02, respectively.

Seawater samples were immediately treated with the final concentration of 1% glutaraldehyde and were kept at 4°C until filtering. Each seawater sample were filtered through 1 μ m pore size Nuclepore fitter, pre-stained by irgalan black, at the low vacuum of 15 cmHg, and were double-stained using DAPI (4'6-diamidino-2-phenylindole dihydrochloride) and proflavine (3-6-diamidino-acridine hemisulfate). Just before the finish of filtering, DAPI was added to sample in filtering funnel for the staining DNA. After the DAPI staining, proflavine was also added for the staining of flagella. Both the staining time is five minute. The working solution of DAPI (10 μ g/ml) and proflavine (0.033%) were pre-filtered through 0.22 μ m pore size of non-pyrogenic Durapore membrane filter (Millipore, Millex-GX). After the filtering, sample filters put on a slide-glass with one drop of immersion oil, and covered with micro cover glass. All preparations were stored in the deep freezer (-80°C) until the observation.

Above mentioned water samples are for analysis of microzooplankton except for tintiniids. Because filtering volume is small (up to 370ml), these samples are not appropriate for tintiniids analysis whose abundance is low. So, additional seawater samples for this taxon were collected in the same depths, same time. Collected water samples were immediately filtered (from 2 to 5L) using 20 μ m hand net and concentrated ones were fixed in 1% formalin-seawater. This is a new sampling started in this cruise.

Sampling data such as depths or filtering volume are summarized in Table 3.9.1-4.

Table 3.9.1-4. Information of microzooplankton samplings.
* Local ship time.

Stn.	Date*	CTD time*	Sample No.	Sampling layer (m)	Irradiance (%)	Filtering vol. for Tintinid (L)	Filtering vol. for others (ml)	Funnel No.	Remarks
K2-1	2007.9.13	3:58-4:36	K2-1, S	0	100	5	100	1	CTD cast No.: S06M2
			K2-1, 8	50	0.5	5	155	2	
			K2-1, 9	40	1	5	175	3	
			K2-1, 10	30	2.5	5	225	4	
			K2-1, 11	20	5	5	200	5	
			K2-1, 12	15	10	5	100	6	
			K2-1, 13	10	25	5	170	4	
			K2-1, 14	5	50	5	150	3	
K2-2	2007.9.25	12:07-12:45	K2-2, S	0	100	5	125	1	CTD cast No.: S20M02
			K2-2, 1	68	0.5	3	355	2	
			K2-2, 2	58	1	2.5	280	3	
			K2-2, 3	44	2.5	4	300	4	
			K2-2, 4	34	5	2	145	5	
			K2-2, 5	24	10	3	170	6	
			K2-2, 6	13	25	5	200	1	
			K2-2, 7	5	50	3.5	365	2	

Vertical distribution of bacteria abundance

Two series of water samples were collected at Station K2. One of them was collected on 11 and 13 Sept. Seawater samples every 100m from 100 to 1000m were collected on 11 and that above 100m on 13. CTD cast numbers were S06M01 and S06M02, respectively.

The other series of samples were collected on 25 Sept. CTD cast number for samples below the 100m was S20M01 and that for above 100m was S20M02, respectively. Seawater samples above 100m were collected from same Niskin bottle and bucket of the maicrozooplankton samples.

Duplicate 10ml seawater samples were collected in each depth. All samples were immediately added paraformaldehyde and frozen in a deep-freezer (-80°C) for 24 hours and kept in a normal freezer (-20°C) afterward.

(3) Preliminary results

Preliminary Observation of Vertical Distribution of Ontogenetically Migrating Copepods

Through the microscopic observation for the stable isotope analysis, we gained a rough picture (though not quantified) of vertical distribution of the ontogenetically migrating copepod species, *Neocalanus cristatus, N. flemingeri, N. plumchrus* and *Eucalanus bungii*, and here will report the overview.

Both immature stages and adults were observed for *N. cristatus*, the advanced copepodid stages were abundant in the upper 200~150 m indicating active feeding was ongoing. On the other hand, many females and males as well as 5th copepodid stages were observed in the deep layers up to 1000 m. Some females showed ovary developed but the others not. Only females were observed for *N. flemingeri* in 400 m and deeper. This species are known to start dormancy in June ~ July at the earlier timing than the other two *Neocalanus* species, and most of their population were considered to be dormant in this season (mid-September). As for *N, plumchrus*, which productive season are late spring to summer, the population dominated by copepodid 5th stages and dense distribution was observed within upper 200 m, suggesting active feeding. Abundance of *E. bungii* was small compared to *Neocalanus*. Population center of copepodid 5th stage of *E. bungii* was around 300 m at which this species are reported to stay dormant.

Neocalanus copepodids in the surface layer suggested that lower trophic level production was still ongoing at the Station K2 during the MR0705 cruise. At the same time, occurrence of adults in dormancy in some species indicates the condition definitely was of post-peak production. In conclusion, our research was conducted during the transition phase from high to post productive seasons in this region. Comparison of results of this cruise to the previous researches undertaken in the high-productive seasons at the St. K2 will provide us with information of seasonality of zooplankton and lower trophic level ecosystem in this region.

(4) Future plans and sample archives

Community structure and ecological role of mesozooplankton

All IONESS samples preserved in formalin are stored at JAMSTEC, Yokosuka. We will analyze as follows; (1) Vertical distribution of biomass in higher taxa revel (copepods, euphausiids, etc.), and taxa composition based on the carbon weight, (2) Vertical distribution, composition, biomass, minimum carbon requirement and diel vertical migration for each species of dominant three taxa, copepods, euphausiids and chaetognaths, (3) Estimation of carbon transport through respiration of the diel migratory species, (4) Vertical distribution and biomass of ontogenetically migrate copepods, estimation of carbon transport by them, and (5) Vertical distribution and composition of gelatinous animals (Cnidaria, Ctenophore, Polychaeta and Mollusca). Sample observation and sorting will be done under the microscope, carbon weight of each taxon will be calculated using its dry weight and specific conversion factor previously reported. Dr. Okutani, JAMSTEC, who has interesting on planktonic mollusca will join to analysis of the community structure of gelatinous.

Environmental (T, S) and net status (net number, towing distance, R/V position, etc.) data were recorded when the IONESS towed. All the data is under Kitamura.

Role of small copepods and stable isotope analysis

All samples preserved in formalin are stored in JAMSTEC, Yokosuka, and frozen samples in JAMSTEC, Yokohama. The formalin preserved samples will be microscopically analyzed to obtain taxonomic composition. Size composition of those samples will be analyzed using an optical zooplankton analyzing system, ZooScan (RECIF Technologies). Once we gain the species and size composition of each sample, a minimum carbon requirement for each species will be estimated. These data will be compared to information obtained by other biological observations of this cruise, e.g. phytoplankton abundance/composition, microzooplankton grazing, bacterial abundance, and fecal pellet production (Fecal pellets were collected by a floating sediment trap).

Dry samples for stable isotope analysis are stored in JAMSTEC, Yokohama. Measurement of $\delta^{13}C$ and $\delta^{15}N$ of the samples will be completed with Thermo Fisher Scientific, Model Flash EA1112-DELTA V ConFlo Ⅲ System (EA-IRMS) by the end of November 2007.

Vertical distribution of surface microzooplankton

Frozen filter samples are stored at Mutsu Institute of oceanography, JAMSTEC. And analysis will be consigned to Marine Biological Research institute of Japan Co. LTD., Shinagawa, Tokyo. Concentrated seawater samples for tintiniids analysis are stored in JAMSTEC, Yokosuka. Kitamura will observe and count under microscope. And vertical distribution of tintiniids biomass will be shown.

Vertical distribution of bacteria abundance

All samples are stored at freeze room (-20°C) in JAMSTEC, Yokosuka. Dr. Hiruyuki Yamamoto, JAMSTEC, will analyze bacteria abundance by flow cytometry.

3.9.2 Grazing pressure of microzooplankton

Minoru KITAMURA (JAMSTEC, XBR)
Sanae CHIBA (JAMSTEC, FRCGC)

(1) Objective

For understand of material export processes from surface to deep ocean, not only estimations of primary productivity or vertical flux but also evaluation of grazing impacts by many types of heterotrophic organisms to the productivity is needed. Grazing by larger organisms might bring about efficient vertical carbon transport through repacking phytoplankton into fecal pellets or active carbon transport by diel and ontogenetic migrator. On the other hand, grazing by smaller organisms might have small impact to vertical export. Identification of influential grazers and quantitative estimation of their grazing rates are essential to discuss the carbon cycle in the ocean. Recently, large grazing pressure of not only the crustacean plankton but also microzooplankton has been recognized in the several area. These micro organisms maybe become important in the northwestern north Pacific in autumn because large calanoid copepods migrate to midwater. Based on this background, we planned to estimate grazing rate of them.

(2) Materials and methods

Three experiments were done at station K2 through the cruise, 13-14, 15-16 and 25-26 September. For each experiment 40 l of surface water were collected using bucket. Water was pre-screened through 200 μ m mesh to exclude larger zooplankton. Dilution series were prepared with 25, 50, 75, and 100% of natural seawater. Filtered water was obtained by direct gravity flow through a compact cartridge filter (ADVANTEC, MCS-020-D10SR). Incubation of the dilute water was done in transparent polycarbonate bottle. Triplicate bottle were prepared. Water samplings were done before sunrise and incubations were started at about sunrise. Incubation lasted for 24 h in a tank with continuous flow of surface seawater under natural light conditions. All the water samplings, filtering, and incubate items were soaked in 10% HCl and rinsed Milli-Q water between each use on board. No nutrient was added in the incubation bottles. To measure initial and final chl.a concentration, experiment water were filtered onto GF/F filter and extracted 6 ml DMF at –20°C until measurement. Chl.a were measured fluorometrically (Welshmeyer method) with a Turner Design fluorometer.

Apparent phytoplankton growth rate (d^{-1}) were calculated using following equation:

$$\text{Apparent growth rate} = (1/t)\ln(P_t/P_0)$$

where t is incubation time (day), P_t and P_0 are final and initial chlorophyll a concentration, respectively. When the apparent phytoplankton growth rate is plotted as a function of dilution factor, the y-intercept and negative slope of the approximate line means true phytoplankton growth (k; d^{-1}) and grazing coefficient of microzooplankton (g: d^{-1}), respectively. According to Verity et al. (1993) and Zhang et al. (2006), microzooplankton grazing pressure on primary production (P_p; %) is calculated as the following equation:

$$P_p = (e^{kt} - e^{(k-g)t}) / (e^{kt}-1)*100$$

Through the three incubation experiments, we tried to estimate true growth rate of phytoplankton, grazing rate of microzooplankton and grazing pressure of microzooplankton on

primary production. Incubation states are summarized in Table 3.9.2-1.

References

Verity, P.G., D.K. Stoecker, M.E. Sieracki & J.R. Nelson. 1996. Grazing, growth and mortality of microzooplankton during the 1989 North Atlantic spring bloom at 47°N, 18°W. Deep-Sea Res., 40: 1793-1814.

Zhang, W., H. Li, T. Xiao, J. Zhang, C. Li & S. Sun. 2006. Impact of microzooplankton and copepods on the growth of phytoplankton in the Yellow Sea and East China Sea. Hydrobiologia, 553: 357-366.

Table 3.9.2-1. Summary of three dilution incubation experiments for estimation of microzooplankton grazing pressure in Station K2 during MR07-05, September 2007.

Stn.	Date*	Time*		Position of water samplings	Water temp.	Weather
		Water sampling	Incuvation start end	Lat. Long.	(°C)	
K2-1	13-14 Sept., 2007	13 Sept., 4:02	13 Sept., 5:30 14 Sept., 5:30	46° 51.87' N 160° 00.24' E	11.95	rain/fine
	15-16 Sept., 2007	15 Sept., 4:00	15 Sept., 5:30 16 Sept., 5:30	46° 50.61' N 160° 00.12' E	no data	cloudy
K2-2	25-26 Sept., 2007	25 Sept., 6:00	25 Sept., 7:05 26 Sept., 7:05	46° 55.14' N 159° 58.40' E	9.2	cloudy

(3) Preliminary results

All measurements of Chl.a and calculations were finished on board. Negative correlation between apparent phytoplankton growth rates and dilution factors is recognized in the second and third experiments. However, we could not get a good result (slightly positive correlation was recognized) in the first experiment on 13-14 September. These results, correlation between apparent growth and dilution factor, is shown in the Figure 3.9.2-2.

From the two sound results, true growth rate of phytoplankton, grazing rate of microzooplankton and grazing pressure of microzooplankton is summarized in Table 3.9.2-1.

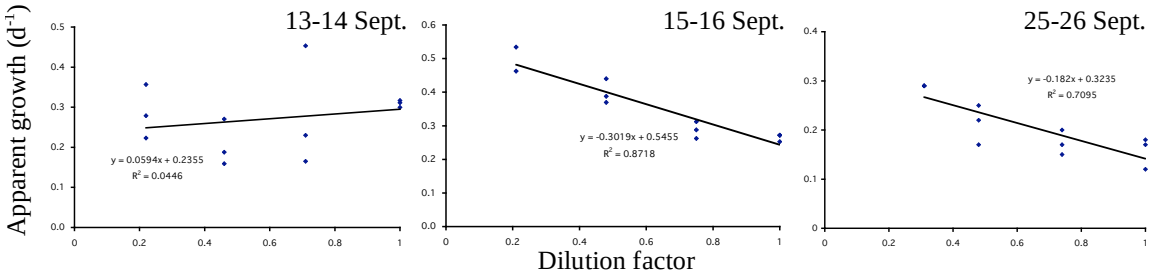

Fig.3.9.2-1. Correlation between apparent growth rates of phytoplankton and dilution factors in the three dilution incubation experiments during MR07-05, September 2007.

Table 3.9.2-2. Results of dilution incubation experiments for estimation of microzooplankton grazing.

	Experiment 1	2	3
Date (Sept. 2007)	13-14	15-16	25-26
Chl.a concentlation (μ g/l)	1.26	0.80	0.69
True graowth rate of phytoplankton (k: d^{-1})	-	0.55	0.32
Grazing rate of microzooplankton (g: d^{-1})	-	0.30	0.18
Grazing pressure of microzooplankton (P_p: %)	-	62	60

3.10 Dissolved Organic Carbon

Masahide WAKITA (Mutsu Institute for Oceanography, JAMSTEC)
Tetsuichi FUJIKI (Mutsu Institute for Oceanography, JAMSTEC)
Kazuhiko MATSUMOTO (Mutsu Institute for Oceanography, JAMSTEC)

(1) Purpose of the study

Fluctuations in the concentration of dissolved organic carbon (DOC) in seawater have a potentially great impact on the carbon cycle in the marine system, because DOC is a major global carbon reservoir. A change by < 10% in the size of the oceanic DOC pool, estimated to be ~ 700 GtC, would be comparable to the annual primary productivity in the whole ocean. In fact, it was generally concluded that the bulk DOC in oceanic water, especially in the deep ocean, is quite inert based upon ^{14}C-age measurements. Nevertheless, it is widely observed that in the ocean DOC accumulates in surface waters at levels above the more constant concentration in deep water, suggesting the presence of DOC associated with biological production in the surface ocean. This study presents the distribution of DOC during summer at Station KNOT, K2 and K1 in the northwestern North Pacific Ocean.

(2) Sampling

Seawater samples were collected at Stations KNOT (Sta. S09, Cast 1), K2 (Sta. S06, Cast 1) and K1 (Sta. S02, Cast 1, 3) and brought the total to ~100. Seawater from each Niskin bottle was transferred into a 100 ml glass bottle rinsed with same water three times. About 100 ml this water was immediately filtered through a Whatman GF/F filter (47 mm) under gravity. The filtrate was distributed into 50 ml glass ampoules with a 50 ml pipette. This distributed seawater was added 500 µl of 6N HCl (final concentration, about 0.06N). Each ampoule was sealed with a torch, quick-frozen, and preserved at ~ -20 °C until the analysis in our land laboratory. Before use, all glassware was muffled at 550 °C for 5 hrs.

(3) Analysis

DOC analysis was basically made with a high-temperature catalytic oxidation (HTCO) system improved a commercial unit, the Shimadzu TOC-V (Shimadzu Co.). In this system, the non-dispersive infrared was used for carbon dioxide produced from DOC during the HTCO process (temperature: 680 °C, catalyst: 0.5% Pt-Al_2O_3).

(4) Preliminary result

The distributions of DOC will be determined as soon as possible after this cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) within 2 years.

3.11 Chlorofluorocarbons

Masahide WAKITA (JAMSTEC): Principal Investigator
Yuichi SONOYAMA (MWJ)
Hideki YAMAMOTO (MWJ)

(1) Objectives

Chlorofluorocarbons (CFCs) are chemically and biologically stable gases that have been artificially synthesized at 1930's or later. The atmospheric CFCs can slightly dissolve in sea surface water and then circulate in the ocean. Three chemical species of CFCs, namely CFC-11 (CCl_3F), CFC-12 (CCl_2F_2), CFC-113 ($C_2Cl_3F_3$) can be used as transient tracers for the decadal time scale ocean circulation. We determined concentrations of these compounds in seawater on board.

(2) Apparatus

Dissolved CFCs are measured by an electron capture detector (ECD) – gas chromatograph attached with a purging & trapping system.

Table 3-7-1 Instruments

Gas Chromatograph:	GC-14B (Shimadzu Ltd.)
Detector:	ECD-14 (Shimadzu Ltd)
Analytical Column:	
Pre-column:	Silica Plot capillary columns [i.d.: 0.53mm, length: 8 m, thick: 0.25μm]
Main column:	Connected two capillary columns (Pola Bond-Q [i.d.: 0.53mm, length: 9 m, thick: 6.0μm] followed by Silica Plot [i. d.: 0.53mm, length: 15 m, thick: 0.25μm])
Purging & trapping:	Own made system. Trap column are 1/16" SUS tubing packed column (Porapak T)

(3) Procedures

a) Sampling

Seawater sub-samples were collected from 12 litter Niskin bottles to 300 ml glass bottles. The bottles were filled by nitrogen gas before sampling. Two times of the bottle volumes of seawater sample were overflowed. The bottles filled by seawater sample were kept in water bathes roughly controlled on sample temperature. The CFCs concentrations were determined as soon as possible after sampling.

In order to confirm CFC concentrations of standard gases and their stabilities and also to check CFC saturation levels in sea surface water, CFC mixing ratios in back ground air were periodically analyzed. Air samples were continuously led into laboratory by 10 mm OD Dekaron® tubing. The end of the tubing was put on a head of the compass deck and another end was connected onto a macro air pump in the laboratory. The tubing was relayed by a T-type union which had a small stop cock. Air sample was collected from the flowing air into a 100ml glass cylinder attached on the cock.

b) Analysis

The analytical system is modified from the original design of Bullister and Weiss (1988). Constant volume of sample water (50ml) is taken into the purging & trapping system. Dissolved CFCs are de-gassed by N_2 gas purge and concentrated in a trap column cooled to -40 degree centigrade. The CFCs are desorbed by electrically heating the trap column to 140 degree centigrade within 1.5 minutes, and lead into the pre-column. CFCs and other compounds are roughly separated in the pre-column and CFCs are sent to main analytical column. And then the pre-column is flushed back by counter flow of pure nitrogen gas (Back flush system). The back flush system is prevent to enter any compounds that have higher retention time than CFCs into main analytical column and permits short time analysis. CFCs which are sent into main column are separated further and detected by an electron capture detector (ECD).

Table 3-7-2 Analytical conditions of dissolved CFCs in seawater.

Temperature	
Analytical Column:	95 deg-C
Detector (ECD):	240 deg-C
Trap column:	-45 deg-C (at adsorbing) & 140 deg-C (at desorbing)
Mass flow rate of nitrogen gas (99.9999%)	
Carrier gas:	11 ml/min
Detector make-up gas:	26 ml/min
Back flush gas:	15 ml/min
Sample purge gas:	150 ml/min
All nitrogen gases through one or two gas purifier tube containing Molecular Sieve 13X (MS-13X). The gas purifier	
Standard gas (Japan Fine Products co. ltd.)	
Base gas:	Nitrogen
CFC-11:	300 ppt (v/v)
CFC-12:	160 ppt (v/v)
CFC-113:	30 ppt (v/v)

c) Performance

The analytical precisions are estimated from replicate sample analyses. The precisions of CFCs were calculated to be ± 0.017 pmol/kg (n = 22), ± 0.011 pmol/kg (n = 22) and ± 0.005 pmol/kg (n = 18) for CFC-11, -12 and -113, respectively.

The standard gases used in this cruise will be calibrated with respect to SIO scale standard gases after the cruise, and then the data will be corrected.

(4) Preliminary results

Vertical distributions of CFC-11, CFC-12, CFC-113 were shown in Figure 3-7-1.

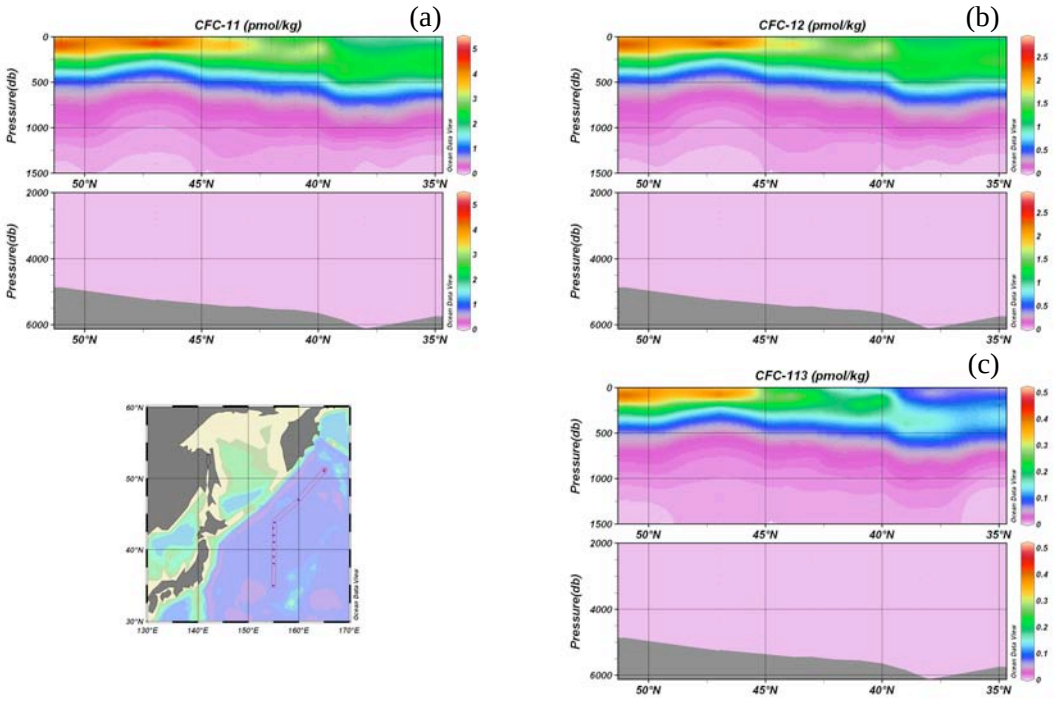

Fig. 3-7-1 Vertical distributions of CFC-11 (a), CFC-12 (b) and CFC-113 (c) in this cruise.

(5) Data archive

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

Reference

Bullister, J.L and Weiss R.F. 1988. Determination of CCl_3F and CCl_2F_2 in seawater and air. Deep Sea Research, 35, 839-853.

3.12 Aerosol and fog water flux measurement over the northwestern North Pacific

Yoko IWAMOTO (Ocean Research Institute, the Univ. of Tokyo)
Mitsuo UEMATSU (Ocean Research Institute, the Univ. of Tokyo) (Not on board)

(1) Objectives

Atmospheric aerosol plays an important role in negative and positive radiative forcing by reflecting or scattering of solar radiation, and modifies cloud properties by acting as cloud condensation nuclei (CCN). In Addition, aerosol transported from land to ocean can be a nutrient supply of marine biota and change oceanic ecosystem.

Sea fog, which is a lower cloud, over the northwestern North Pacific appears high frequently especially in summer. Sea fog contributes to a linkage of chemical materials between surface ocean and lower atmosphere through scavenging process of anthropogenic and/or biogenic aerosols in the atmospheric boundary layer as well as a reflection of solar radiation. However, characteristics and behavior of aerosols and sea fog over the remote ocean are not sufficiently understood due to a low temporal resolution measurement of aerosol and sea fog. The goal of this study is to understand a size distribution and chemical information of aerosol and sea fog.

During the cruise of MR07-05, the eddy covariance method (10 Hz acquisition rate) in a unique integration of aerosols and fog droplets measuring equipment on a ship was employed in order to cover wide areas of the marine boundary layer. Simultaneously, aerosols, fog water, rainwater and seawater samples were collected for post-chemical analysis. In addition, ozone, carbon monoxide and sulfur dioxide, which are good parameters for characterization of air masses in marine boundary layer, were measured.

(2) Measured parameters

i. Turbulent fluxes obtained by eddy covariance system located at the top of the foremast

- Atmospheric aerosol particle flux in one size class from 5 nm to 3 μm particle diameter
- Fog water fluxes in 40 size classes from 2 to 50 μm fog droplet diameter
- CO_2 and water vapor fluxes

ii. Property of trace gas and atmospheric aerosol particles measured at the compass deck

- Aerosol particle number distribution (particle size classes: 0.10, 0.15, 0.20, 0.30, 0.50, 1.0, 2.0, 5.0 μm< diameter)
- Sulfate concentration in aerosol (PM1.0: <1.0 μm in diameter)
- Ozone concentration
- Sulfur dioxide concentration
- Carbon monoxide concentration

iii. Aerosol, fog water, rainwater and seawater sampling for post-chemical analyses

- High volume filter samples of aerosol particles PM2.5 (<2.5 μm in diameter) and PM>2.5 at the compass deck
- Passive string fog water collection at the compass deck
- Rainwater collection at the compass deck
- Seawater sampling at depth of 0-4000 m

(3) Instruments and methods

i. Turbulent fluxes obtained by eddy covariance system located at top of foremast

The configuration and the sensors of the eddy covariance system as deployed at the top of the foremast are depicted in Figure 3.12.1. Each sensor is connected via RS232 through an RS232-LAN server to the recording PC at the environmental research laboratory. The combination of serial communication and TCP/IP-protocol based system enable us to record the data free of noise as well as get besides the parameters also all available status information of the sensors for consecutively quality assurance.

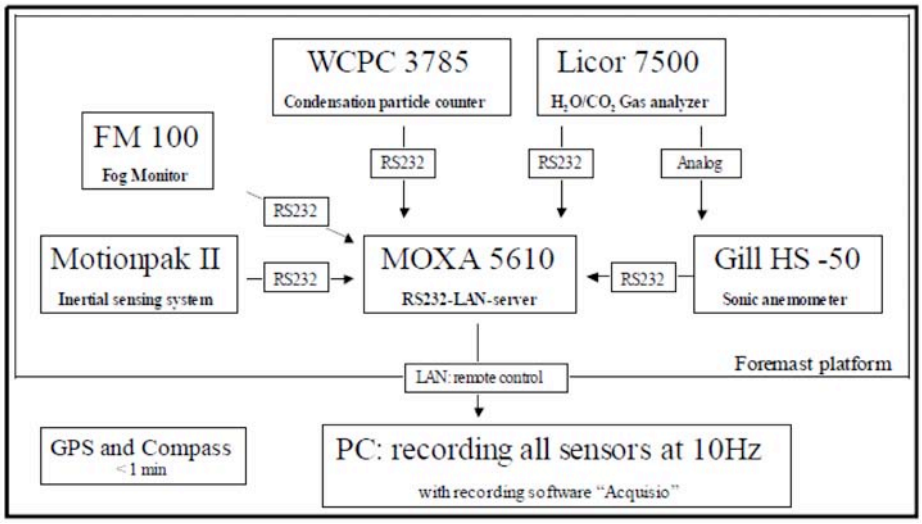

Fig. 3.12.1 Technical layout of the eddy covariance System

ii. Property of trace gas and atmospheric aerosol particles measured at compass deck

Aerosol particle number distribution was measured with 7 size ranges (0.10, 0.15, 0.20, 0.30, 0.50, 1.0, 2.0, 5.0 μm<diameter) by two particle counters (RION, model KC-18 and KC-01D) for every 5 minutes. The concentration of sulfate in aerosols was measured for every 10 minutes by using ambient particulate sulfate monitor (Rupprechet & patashnik Co. Inc., model 8400S). This instrument measured the mass concentration of ambient particulate sulfate contained in fine particles (PM1.0). Ozone concentration was measured every 12 seconds by an ozone monitor (Dylec Corp., model 1150). Carbon monoxide concentration was measured every 1 minute by a CO analyzer (Thermo Fisher Scientific, Inc., model 48C). Sulfur dioxide concentration was measured every 1 minute by a sulfur dioxide analyzer (Kimoto Electronic Co. Ltd., model SA631).

iii. Aerosol, fog water, rainwater and seawater sampling for post-chemical analysis

Size-fractionated aerosols (PM2.5 and PM>2.5) were collected on Teflon filters (ADVANTEC, PF040, 90 mm) by High-volume virtual dichotomous impactors (Kimoto Electric Co. Ltd., model AS9) at 12 hours or 5 days intervals on the compass deck. In order to avoid contamination from ship exhaust, all aerosol samplers were automatically controlled by a wind sector to operate only when the relative wind direction ranged from -100º to 100º of the bow and relative wind speed was higher than 1 m s^{-1}. After collections, the samples were stored at 5 ºC prior to analysis.

Bulk fog water samples were collected using a passive string fog sampler (Usui Co. Inc., FWG-400) on compass deck. This device traps fog droplets by collision with Teflon

strings (0.5 mm in diameter). The fog droplets collide with the strings and drop along the strings into 500 ml Teflon bottle beneath the strings. Rainwater samples were collected in PTFE bottles using rainwater sampler (Shibata Co. Inc., W-102) on the compass deck. Table 3.12.1 and 3.12.2 shows time and location when fog water or rainwater sampling started, respectively. After the collection, pH and electrical conductivity were measured, and samples were filtered by 0.4 μm pore size Nucrepore filters. The filtered fog water and rainwater were stored in plastic bottles (5 ºC), the filters were also stored at 5 ºC.

Seawater samples were collected at depth of 0, 10, 20, 50, 100, 200, 500 and 1000 m at stns K1(S2), KNOT(S9), S13 and S18. At K2(S6 and S20), seawater samples at depth of 2000, 3000 and 4000 m were also collected. These samples were filtered by 10 and 0.4 μm pore size Nucrepore filters and the filters stored at 5 ºC.

Table 3.12.1 Starting time and location of fog water sampling

	Time	Location		Duration	Smpl volume		Conductivity
Smpl #	UTC	Lat. [N]	Long. [E]	[hh:mm]	[mL]	pH	[uS]
F0705-01	2007/9/5 20:16	55.6240	184.4440	1:55	490	5.967	29.3
F0705-02	2007/9/13 22:09	46.8872	160.0505	2:12	69	4.29	71.8
F0705-03	2007/9/14 10:25	46.9652	160.0505	3:48	459	3.824	77.3
F0705-04	2007/9/14 14:03	46.8897	159.9567	5:47	335	3.582	196.8
F0705-05	2007/9/14 19:50	46.8447	160.0677	2:25	40	3.656	304

Table 3.12.2 Starting time and location of rainwater sampling

	Time	Location		Duration	Smpl volume		Conductivity
Smpl #	UTC	Lat. [N]	Long. [E]	[hh:mm]	[mL]	pH	[uS]
R0705-01	2007/9/6 8:48	56.2583	179.9738	4:09	50	3.892	116
R0705-02	2007/9/6 10:57	56.5230	178.2168	6:29	77	4.614	219
R0705-03	2007/9/12 16:50	46.8658	160.0007	2:36	50	4.183	321
R0705-04	2007/9/12 19:26	46.8655	159.9883	2:34	89	4.37	107.3
R0705-05	2007/9/12 22:00	46.8843	159.9625	3:00	34	4.112	108.2
R0705-06	2007/9/15 19:35	45.4148	158.8328	2:50	92	4.301	80
R0705-07	2007/9/15 22:25	44.7685	158.3485	2:22	98	4.335	77.2
R0705-08	2007/9/16 0:47	44.2567	157.9587	2:56	107	4.521	257
R0705-09	2007/9/18 2:00	35.9638	155.0132	3:14	127	4.039	566
R0705-10	2007/9/25 21:01	46.9505	159.9892	7:29	536	4.728	583

(4) Preliminary Results

As examples, concentration of ozone and aerosol number (particle size classes: 0.10, 0.15, 0.20, 0.30, 0.50, 1.0, 2.0, 5.0 μm< diameter) were shown in Figure 3.12.2 and 3.12.3, respectively. The data can be used for further discussions after the elimination of data during the contaminated periods.

(5) Future Plan

Aerosol samples, fog water samples and rainwater samples will be analyzed for major inorganic ions and trace metals. Seawater samples will be analyzed for size and chemical composition of suspended particles by individual particle analysis and bulk chemical analysis. After the determination of data quality, the separation of air masses will be attempted by meteorological data and/or backward air mass trajectories for each atmospheric sample. It may be possible to discuss the interaction processes between atmosphere and surface seawater over

the northern North Pacific Ocean.

(6) Data archives

The data obtained during MR07-05 will be accessible upon request at Ocean Research Institute, The University of Tokyo.

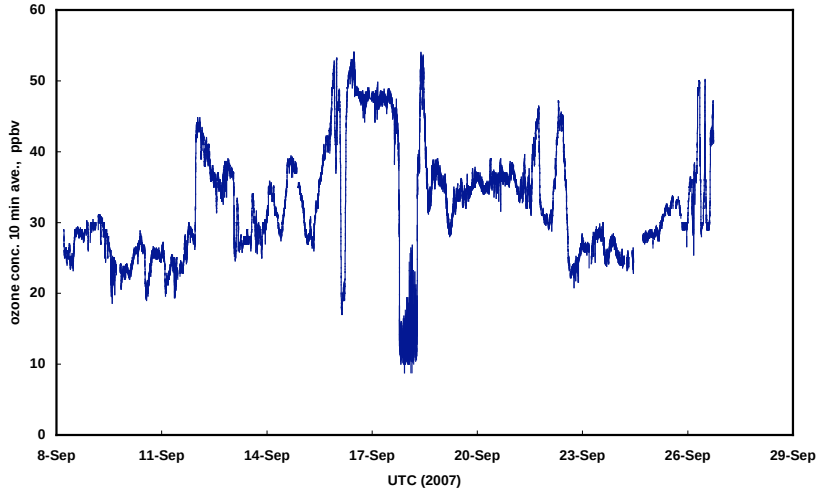

Fig. 3.12.2 Variation of ozone concentration during Mirai MR07-05 cruise.

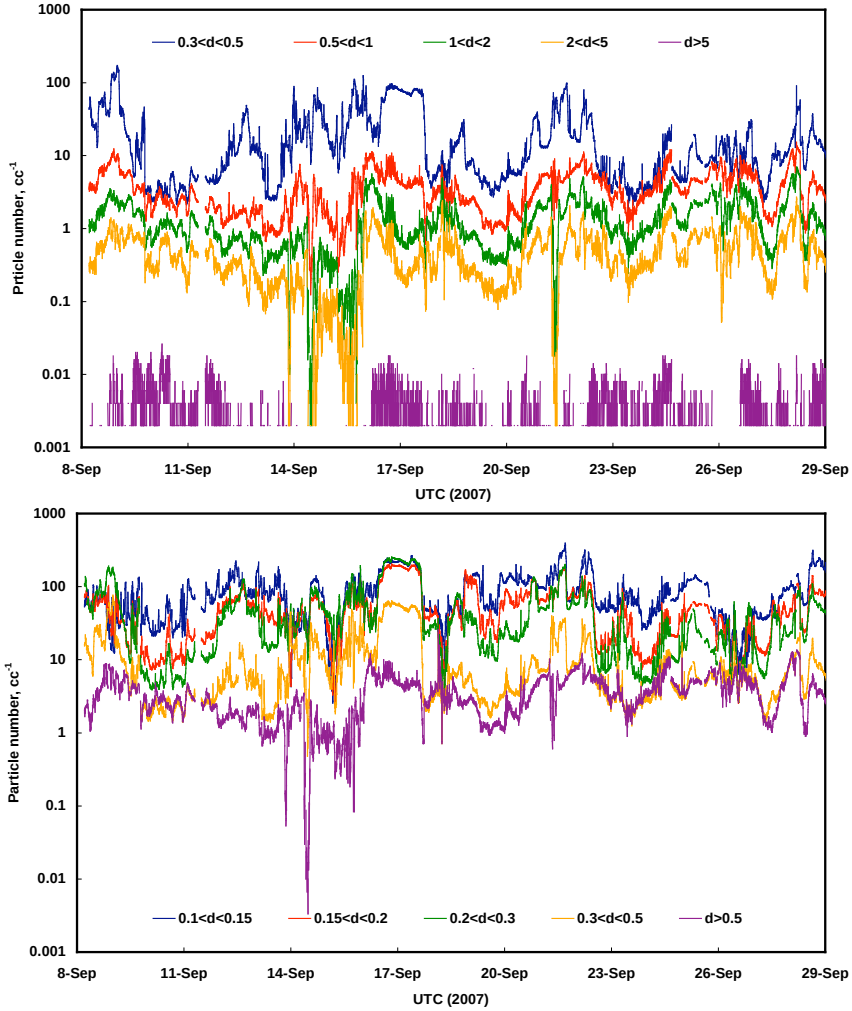

Fig. 3.12.3 Variation of aerosol number concentration during Mirai MR07-05 cruise.

3.13 Dissolution kinetics of diatom frustules in the subarctic NW Pacific Ocean

Senichiro IGATA
Shigenobu TAKEDA
(Department of Aquatic Bioscience, Graduate School of Agricultural and Life Sciences, The University of Tokyo)

(1) Objectives

In the subarctic NW Pacific Ocean, diatom is one of the major phytoplankton groups, which form large blooms in spring and fall. High diatom production and rapid sinking of the large diatom aggregates play an important role in the efficiency of the biological pump. During the sinking and even within the euphotic zone, dissolution of diatom frustules usually occurs soon after the death of the organism and it may have influence on the sinking flux of organic carbon and biogenic silica. Species-specific differences in dissolution rates of diatom frustules may reflect variability in specific surface areas and morphology of the frustules.

The objectives of this work are to collect planktonic diatom samples for analyzing the dissolution rates of diatom frustules in the laboratory, and to observe dissolution processes of each diatom species during the sinking in the water column.

(2) Methods

i) Plankton net sampling for dissolution experiments of diatom frustules

Samples of diatom frustules for the dissolution experiments were collected by a NORPAC net (mesh size 72μm) from 50 m depth to the sea surface at station K1, K2, and KNOT (Table 1). Samples were kept frozen (-20℃) for the later dissolution experiments at the onshore laboratory. The dissolution experiments of the acid-cleaned diatom frustules will be carried out using artificial water.

Dissolution rate coefficients will be calculated according to Kamatani and Riley(1979). Morphological changes in the diatom frustules during the dissolution experiments will be observed by SEM.

Table. 1 Stations and dates of NORPAC net samplings

Sampling station and location		Date
K1	50º 58’ 34” N, 165º 4’ 3” E	9 Sep. 2007
KNOT	43º 47’ 3” N, 155º 12’ 69” E	22 Sep. 2007
K2	46º 55’ 59” N, 160º 5’ 22” E	13 Sep. 2007
		15 Sep. 2007
	46º 59’ 37” N, 160º 0’ 41” E	25 Sep. 2007
		26 Sep. 2007

ii) Sampling of suspended biogenic silica particles in the water column for observation of dissolution processes by SEM

Seawater samples were obtained by Niskin samplers at station K1, K2, and KNOT (Table 2). Suspended particles in the seawater were collected on 0.6, 2.0, and 10 μm pore-size polycarbonate membrane filters. Particles on the filter were brought back to the onshore laboratory for SEM observation. Morphological changes of diatom frustules during the sinking

of the water column will be analyzed for dominant species in the samples.

Table 2. Dates and location of sampling stations

Station	Dates	Sampling depths (water volume)
K1	8-9 Sep. 2007	5 and 50 m (5 L); 100 and 500 m (10 L); 1000, 2000, 3000, 4000, and 4792m(20 L)
K2	13-15 Sep. 2007	5 and 50 m (5 L); 100 and 500 m (10 L); 1000, 2000, 3000, 4000, and 5220m (20 L)
KNOT	22 Sep. 2007	5, 50, 100, 500, and 1000m (10 L)
K2	24 Sep. 2007	10, 50, 100, 500, 1000, 2000, 3000, 4000, 5000, and 5220m (10 L)

(3) Reference

A. Kamatani and J.P. Riley: Rate of Dissolution of Diatom Silica Walls in Seawater. Marine Biology 55, 29-35 (1979)

3.14 Argo floats

Toshio SUGA **(IORGC): Principal Investigator (not on board)**
Nobuyuki SHIKAMA **(IORGC): not on board**
Kanako SATO **(IORGC): not on board**
Mizue HIRANO **(IORGC): not on board**
Tomoyuki TAKAMORI **(MWJ): Technical Staff**

(1) Objectives

The objective of deployment is to clarify the structure and temporal/spatial variability of water masses in the North Pacific such as North Pacific Intermediate Water in the subarctic North Pacific.

The profiling floats launched in this cruise measure vertical profiles of temperature and salinity automatically every ten days. The data from the floats will enable us to understand the phenomenon mentioned above with time/spatial scales much smaller than in previous studies.

(2) Parameters

・water temperature, salinity, and pressure

(3) Methods

i. Profiling float deployment

We launched an APEX float manufactured by Webb Research Ltd. These floats equip an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 1000 dbar (called the parking depth), diving to a depth of 2000 dbar and rising up to the sea surface by decreasing and increasing their volume and thus changing the buoyancy in ten-day cycles. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting the CTD data to the land via the ARGOS system, and then return to the parking depth by decreasing volume. The status of floats and their launches are shown in Table 4.1.1.

Table 4.1.1 Status of floats and their launches

Float

Float Type	**APEX floats manufactured by Webb Research Ltd.**
CTD sensor	**SBE41 manufactured by Sea-Bird Electronics Inc.**
Cycle	**10 days (approximately 9 hours at the sea surface)**
ARGOS transmit interval	**30 sec**
Target Parking Pressure	**1000 dbar**
Sampling layers	**110 (1950, 1900, 1850, 1800, 1750, 1700, 1650, 1600, 1550, 1500, 1450, 1400, 1350, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 975, 950, 925, 900, 875, 850, 825, 800, 775, 750, 725, 700, 675, 650, 625, 600, 580, 560, 540, 520, 500, 490, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220, 210, 200, 195, 190, 185, 180, 175, 170, 165, 160, 155, 150, 145, 140, 135, 130, 125, 120, 115, 110, 105, 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10, 4 dbar)**

Launches

Float S/N	ARGOS ID	Date and Time of Reset (UTC)	Date and Time of Launch(UTC)	Location of Launch	CTD St. No.
3027	**70474**	**2007/9/18 02:14**	**2007/9/18 04:25**	**34-55.55[N] 155-03.28 [E]**	**S18**
3256	**67263**	**2007/9/21 13:06**	**2007/9/21 15:28**	**39-58.03[N] 155-01.21[E]**	**S13**

(5) Data archive

The real-time data are provided to meteorological organizations, research institutes, and universities via Global Data Assembly Center (GDAC: http://www.usgodae.org/argo/argo.html, http://www.coriolis.eu.org/) and Global Telecommunication System (GTS), and utilized for analysis and forecasts of sea conditions.

3.15 Biofouling

Tetsuichi FUJIKI (JAMSTEC)

(1) Objective

When the buoy system is utilized for a long-term observation, the instruments are susceptible to biofouling in the form of microbial and algal films. In order to reduce the biofouling effects, the antifouling tests with copper were carried out during this cruise.

(2) Methods

Non-treated (control) and cupper-treated amorphous Teflon sheets were placed in an on-deck water tank for a period of 3 weeks (Fig. 1). Duplicates were made for each treatment. In order to measure chlorophyll (Chl) *a* content of attached algae on the sheet, each sheet was extracted in N, N-dimethylformamide in the dark at 4^{o}C for 24 h. Chl *a* concentrations were determined using a Turner Design 10-AU fluorometer. The antifouling efficiency was evaluated from the difference between non-treated and cupper-treated samples.

(3) Results

The chl *a* concentrations of non-treated and cupper-treated samples were 17.5 and 8.1 ng cm^{-2}, repetitively (Fig. 2). The cupper-treated samples suppressed 54% of chl-based biofouling compared to controls, indicating that cupper can be used as an effective antifouling tool.

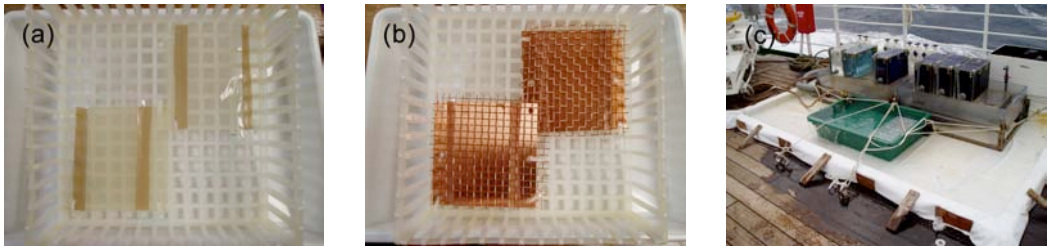

Fig. 1. Photographs of (a) non-treated [control] and (b) copper-treated samples, and (c) the on-deck water tank experiment.

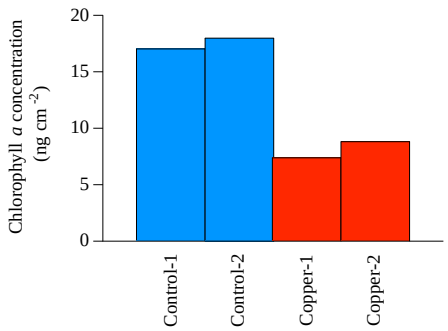

Fig. 2. Chl *a* concentrations of attached algae on non-treated (control) and copper-treated samples.

4. Geophysical observation

4.1 Swath Bathymetry

Takeshi MATSUMOTO (University of the Ryukyus) : Principal Investigator / Not on-board
Natsue ABE (JAMSTEC) Not on-board
Toshiya FUJIWARA (JAMSTEC) Not on-board
Wataru TOKUNAGA (Global Ocean Development Inc.: GODI)
Ryo KIMURA (GODI)
Makio HONDA (JAMSTEC)

(1) Introduction

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.), add system Sub-Bottom Profiler (SBP). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

In addition, we surveyed and collected data at the petit spot area around the 38.5N~40.0N, 155.0E with Sub-Bottom Profiler (SBP), 3-component magneto meter and sea surface gravity meter (see 4.4).

(2) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during the MR07-05 cruise from 4 September 2007 to 2 October 2007, except for the territorial waters and the EEZ of U.S.A.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD and XCTD data by the equation in Mackenzie (1981) during the cruise.

Table 4.1-1 shows system configuration and performance of SEABEAM 2112.004 system.

Table 4.1-1 System configuration and performance

SEABEAM 2112.004 (12 kHz system)	
Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max) 120 degree to 4,500 m 100 degree to 6,000 m 90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m, whichever is greater, over the entire swath. (Nadir beam has greater accuracy; typically within < 0.2% of depth or +/-1m, whichever is greater)

Sub-Bottom Profiler (4kHz system)	
Frequency:	4 kHz
Transmit beam width:	5 degree
Sweep:	5 to 100 msec
Depth Penetration:	As much as 75 m (varies with bottom composition)

Resolution of sediments: Under most condition within < tens-of-centimeters range
(dependent upon depth and sediment type)

(3) Preliminary Results

The results will be published after primary processing.

(4) Data Archives

Bathymetric data obtained during this cruise will be submitted to the Marine-Earth Data and Information Department (MEDID) in JAMSTEC, and will be archived there.

(5) Remark

We did not collect data in the territorial waters and the EEZ of U.S.A at following term.

04 Sep. 18:10 - 05 Sep. 22:00

06 Sep. 23:30 - 08 Sep. 05:00

4.2 Sea surface gravity

Takeshi MATSUMOTO (University of the Ryukyus) : Principal Investigator / Not on-board
Natsue ABE (JAMSTEC) Not on-board
Toshiya FUJIWARA (JAMSTEC) Not on-board
Wataru TOKUNAGA (Global Ocean Development Inc.: GODI)
Ryo KIMURA (GODI)
Makio HONDA (JAMSTEC)

(1) Introduction

The local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface.

In addition, we surveyed and collected data at the petit spot area around the 38-30N~40-00N, 154-00E~155-00E with MBES, SBP and 3-component magneto meter (see 4.4).

(2) Parameters

Relative Gravity [CU: Counter Unit]
[mGal] = (coef1: 0.9946) * [CU]

(3) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during the MR07-05 cruise from 4 September 2007 to 2 October 2007, except for the territorial waters and the EEZ of the U.S.A.

To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (Scintrex gravity meter CG-3M), at Sekinehama as the reference point.

(4) Preliminary Results

Absolute gravity shown in Tabel 4.2-1

Table 4.2-1

No.	Date	U.T.C.	Port	Absolute L&R *2 Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *1 [mGal]	Gravity [mGal]
#1	23 Jul.	06:16	Sekinehama	980371.94	261	615	980372.78	12642.60
#2	02 Oct.	07:03	Sekinehama	980371.94	215	603	980372.64	12642.29

*1: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431
*2: LaCoste and Romberg air-sea gravity meter S-116

Differential	G at sensor	L&R value
No.2 - No.1	-0.16 mGal ---(a)	-0.31 mGal ---(b)
L&R drift value (b)-(a)	-0.16 mGal	71.03 days
Daily drift ratio	**-0.002 mGal/day**	

(5) Data Archives

Surface gravity data obtained during this cruise will be submitted to the Marine-Earth Data and Information Department (MEDID) in JAMSTEC, and will be archived there.

(6) Remark

We did not collect data in the territorial waters and the EEZ of U.S.A at following term.

04 Sep. 18:10 - 05 Sep. 22:00

06 Sep. 23:30 - 08 Sep. 05:00

4.3 Sea Surface three-component magnetic field

Takeshi MATSUMOTO (University of the Ryukyus) : Principal Investigator / Not on-board
Natsue ABE (JAMSTEC) Not on-board
Toshiya FUJIWARA (JAMSTEC) Not on-board
Wataru TOKUNAGA (Global Ocean Development Inc.: GODI)
Ryo KIMURA (GODI)
Makio HONDA (JAMSTEC)

(1) Introduction

Measurements of magnetic force on the sea are required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR07-05 cruise from 4 September 2007 to 2 October 2007, except for the territorial waters and the EEZ of the U.S.A.

In addition, we surveyed and collected data at the petit spot area around the 38-30N~40-00N, 154-00E~155-00E with MBES, SBP and sea surface gravity meter (see 4.4).

(2) Principle of ship-board geomagnetic vector measurement

The relation between a magnetic-field vector observed on-board, **H**ob, (in the ship's fixed coordinate system) and the geomagnetic field vector, **F**, (in the Earth's fixed coordinate system) is expressed as:

$$\mathbf{H}ob = \mathbf{A}\,\mathbf{R}\,\mathbf{P}\,\mathbf{Y}\,\mathbf{F} + \mathbf{H}p \qquad (a)$$

where **R**, $\tilde{\mathbf{A}}$ and **Y** are the matrices of rotation due to roll, pitch and heading of a ship, respectively. $\tilde{\mathbf{A}}$ is a 3 x 3 matrix which represents magnetic susceptibility of the ship, and **H**p is a magnetic field vector produced by a permanent magnetic moment of the ship's body. Rearrangement of Eq. (a) makes

$$\mathbf{B}\,\mathbf{H}ob + \mathbf{H}bp = \mathbf{R}\,\mathbf{P}\,\mathbf{Y}\,\mathbf{F} \qquad (b)$$

where $\mathbf{B} = \mathbf{A}^{-1}$, and $\mathbf{H}bp = -\mathbf{B}\,\mathbf{H}p$. The magnetic field, **F**, can be obtained by measuring **R**, **P**, **Y** and **H**ob, if **B** and **H**bp are known. Twelve constants in **B** and **H**bp can be determined by measuring variation of **H**ob with **R**, **P** and **Y** at a place where the geomagnetic field, **F**, is known.

(3) Instruments on *R/V MIRAI*

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

(4) Data Archives

Magnetic force data obtained during this cruise will be submitted to the Marine-Earth Data and Information Department (MEDID) in JAMSTEC, and will be archived there.

(5) Remarks

1. We did not collect data in the territorial waters and the EEZ of U.S.A at following term.

04 Sep. 18:10 - 05 Sep. 22:00
06 Sep. 23:30 - 08 Sep. 05:00

2. For calibration of the ship's magnetic effect, we made a running like a "Figure eight" turn (a pair of clockwise and anti-clockwise rotation). The periods were follows;

14 Sep. 02:06 - 02:26 about at 46-56N, 159-57E
17 Sep. 20:00 - 20:28 about at 34-59N, 154-42E
25 Sep. 02:09 - 02:28 about at 46-57N, 160-00E
01 Oct. 09:12 - 09:42 about at 40-57N, 141-38E

4.4 Underway Geophysical Survey in the Northwestern Pacific for Study of Petit-spot Intra-plate Volcanism

Natsue ABE (IFREE, JAMSTEC)
Toshiya FUJIWARA (IFREE, JAMSTEC)
Wataru TOKUNAGA (GODI)
Ryo KIMURA (GODI)
Makio HONDA (MIO, JAMSTEC)

1. Introduction

During the R/V *Mirai* MR07-05 cruise, a geophysical box survey, whose items included were bathymetry, gravity, and magnetics, were conducted in the northwestern Pacific. The aim of the survey is to provide detailed geophysical characterization of the lithosphere of the old Pacific Plate and distribution of petit-spot type volcanoes. Our research group has made comprehensive surveys in the region using geological, petrological, and geophysical methods since 2003 for understanding the petit-spot intra-plate volcanism [e.g. Abe et al., 2005]. Geophysical swath mapping of broad areas is one of important items of the comprehensive surveys. Therefore, MR07-05 cruise is an unprecedented opportunity to collect data in this region.

Petit-spot volcanoes ever known are very small in size, hence such small volcanoes have never been discovered unless through the use of high-resolution multi-narrow beam. Hirano et al. [2006] proposes that the origin of petit-spot volcanism is lithospheric flexure. From the perspective of lithospheric flexure, such intra-plate volcanism may be ubiquitous in the areas of front sides of trench outer-rises. For that reason, the survey area is designed to be located on the front side of outer-rise of the Kuril Trench where is ~600 km away from the trench near the MR07-05 survey line along the 155°E longitude (Figure 4.4.1).

In the area, deep-sea drilling DSDP Site 304 **(**39°20'N, 155°04'E) is available for references [Larson, Moberly et al., 1975]. Magnetic anomaly M9 of the Japanese Lineation Set, elongating in the direction of ~70°E, is identified there [e.g. Nakanishi et al., 1989], and crustal age is estimated to be 133 Ma [Larson, Moberly et al., 1975; Gradstein et al., 2004].

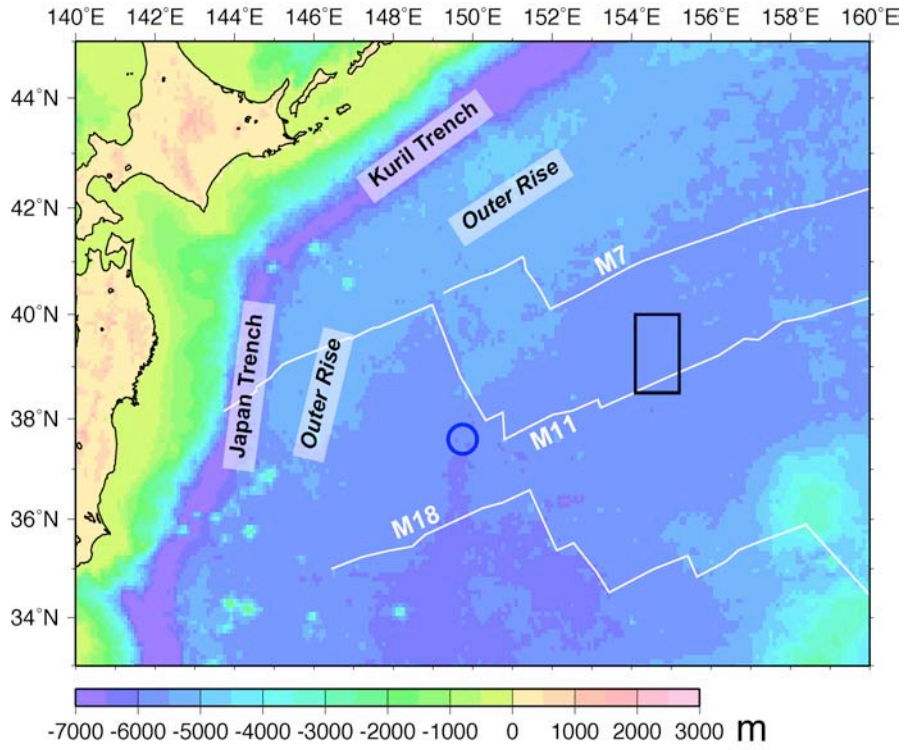

Figure 4.4.1. Bathymetry of the northwestern Pacific showing the location of the survey area. The black square shows the survey area. Known petit-spot is located in the blue circle. White lines show interpreted magnetic isochrons.

2. Data Collection

The main survey tracks consist of one long survey track, laying side-by-side the previous track along 155.0°E, and four tracks extending from 38°30'N to 40°N (Figure 4.4.2). Interval of the tracks is ~11.5 km (8' longitudinal distance). These main survey tracks are oriented to the north-south direction. The direction works for the gravity measurement because it minimizes gravity Eötvös effects. As for the magnetic measurement, it makes identification of magnetic anomaly easy, because the survey lines cross the magnetic lineations with high-angle. Six cross-points are collected to estimate cross over errors.

Survey ship's speed during the survey was 14.5-16 kt, and a total of ~30 hour's ship-time was given for the box survey. After all the survey, an area of 70 km wide and 170 km long was completed. Details on description of the measurements are given in Sections 4.1~4.3.

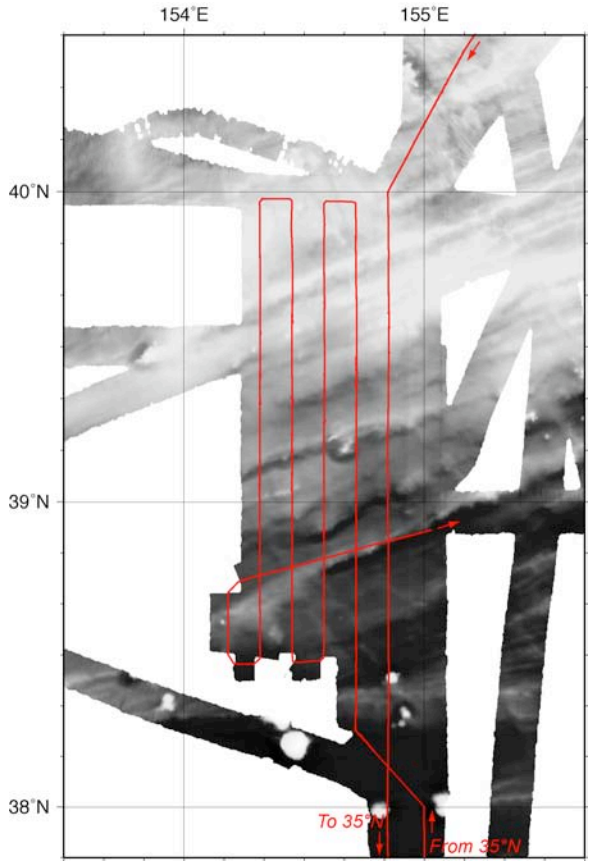

Figure 4.4.2. Ship tracks of the R/V *Mirai* where geophysical data are obtained. The tracks are marked by red lines. The illuminated image shows bathymetry.

3. Preliminary Results

The resultant bathymetric data are merged with previously obtained data. The compiled bathymetry is shown in Figure 4.4.3. In the survey area, orderly consecutive lineated abyssal hills are well developed. The strike of the abyssal hills is sub-parallel to the strike of magnetic lineations. Therefore, the abyssal hill morphology probably originates at a mid-ocean ridge, where the oceanic crust was formed. The abyssal hills are consequences of seafloor spreading and succeeding normal faulting.

The abyssal hills are oriented in a direction of N70°E with a length of 60-70 km in the central belt of the survey area. The strikes of abyssal hills slightly deflect associated with little or no offset. They shows a direction of N57°-60°E in the west, and N65°-75°E in the east of the survey area (Figure 4.4.3). The deflections may suggest non-transform discontinuities and crustal segmentations that originate at the mid-ocean ridge. The segmentation is a characteristic feature of seafloor spreading along the global mid-ocean ridge system. Otherwise, the deflections may suggest crustal deformation during the plate movement. Examination using gravity and magnetic anomaly is necessary to verify the origin in addition to the morphological study.

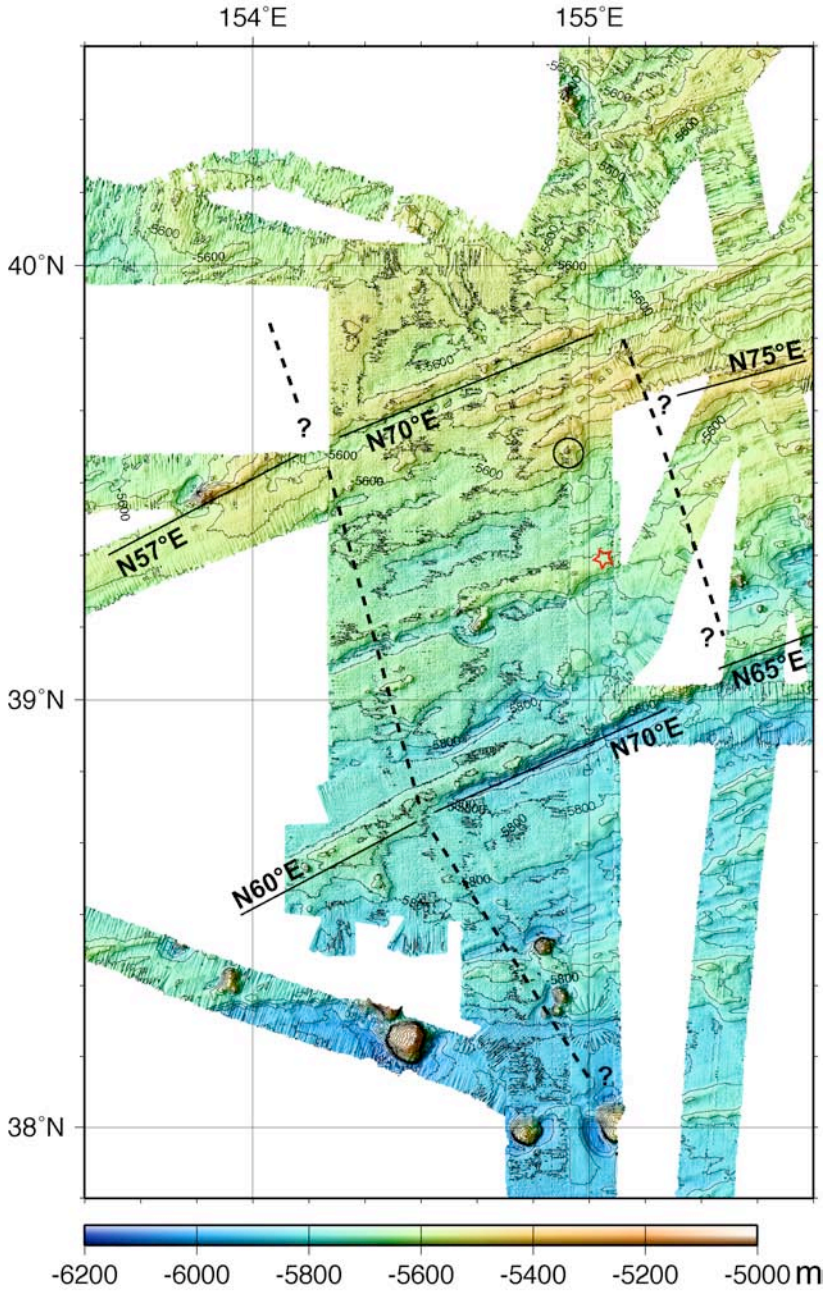

Figure 4.4.3. SeaBeam bathymetry of the survey area. Bathymetric contour interval is 50 m. Symbols and notations denote preliminary interpretations. Solid lines and notations indicate strikes of abyssal hills. Broken lines trace boundaries of change in the strikes. The black circle shows a small knoll having high backscatter (See Figure 4.4.4). The red star points location of DSDP Site 304.

There are no large seamounts and only small knolls are found in the north of 38°30'N. While in the south of the latitude, some seamounts of diameter 1-2 km and relative height 300-800 m are found. SeaBeam side-scan sonar image is shown in Figure 4.4.4. The result shows that variation of backscattering intensity is relatively flat. There is no significant high backscattering suggesting new construction covered with little or no sediment. Exceptionally, one small knoll within an abyssal hill might have high backscatter (arrow, Figure 4.4.4) with

respect to the size. And the knoll is comparable in size to the known petit-spot volcanoes. However the known petit-spot is found to be a cluster of small knolls. The result may suggest that the seafloor is rather old, and newer volcanism does not occur in the survey area, although one small knoll exists.

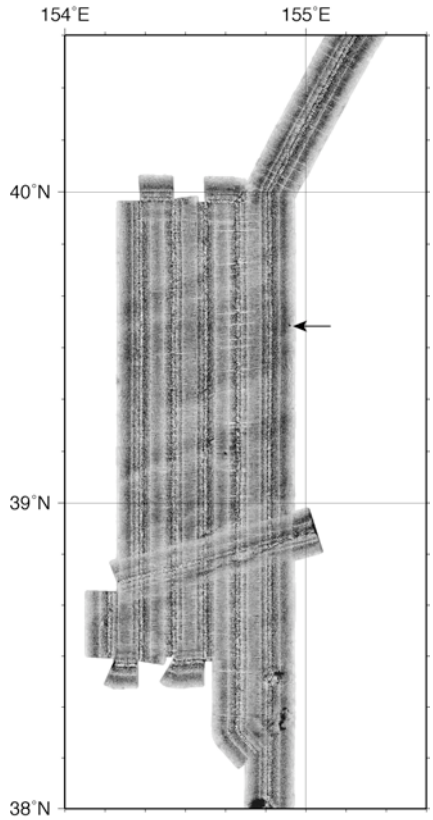

Figure 4.4.4. SeaBeam side-scan sonar image. Black color corresponds to high backscattering intensity. The arrow points high backscatter associated with a small knoll (See Figure 4.4.3).

Results of gravity and magnetic observations are not shown at the time of the preliminary cruise report because of time-consuming processing of the gravity and magnetic anomalies. As a future plan, fine-scale variations appearing on the shipboard data will be investigated. The fine-scale gravity anomaly indicates crustal scale density changes. Regarding the magnetic anomaly, directional changes of the magnetic lineation, and intensity variations of anomaly amplitudes will be examined.

4. Concluding Remarks

The seafloor morphology is characterized by consecutive lineated abyssal hills in the survey area. The abyssal hills are interpreted as indication of directions of plate spreading at a mid-ocean ridge. Therefore, fine-scale structure of the abyssal hill's shapes and strikes gives critical evidences for the plate reconstruction and tectonic studies of the old Pacific Plate.

Certainly, as far as the result of this survey only, we cannot reach the conclusion about the origin of the petit-spot intra-plate volcanism. Though, in this front side of trench outer-rise, clusters of small knolls, similar to the known petit-spot type volcanoes, are not

identified.

We still have plans to continue collecting data in the northwestern Pacific. Measurements using a proton precession magnetometer to know absolute values of the geomagnetic field are ideally desirable. Such an arrangement would be deeply appreciated. This survey was accomplished with the following contributions. Abe and Fujiwara proposed the survey and designed the survey ship tracks. Tokunaga and Kimura coordinated the survey, operated research instruments for the survey, obtained data, and controlled quality of the data. Honda who is the chief scientist of this cruise supervised the survey. We acknowledge onboard and offshore scientists of MR07-05 for being positive about our survey and for giving the survey ship-time for us.

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5. Satellite image acquisition (Aqua/MODIS)

Suguru OKAMOTO (Hokkaido University)
Amane FUJIWARA (Hokkaido University)

(1) Objective

Our objective is to collect data of chlorophyll *a* (Chl-*a*) concentration and sea surface temperature (SST) in MODerate resolution Imaging Spectroradiometer (MODIS) on Aqua satellites.

(2) Methods

We got Aqua/MODIS path data from NASA, and processed the daily composite for Chl-*a* concentration and SST images in the western North Pacific (30 ^{o} – 60 ^{o}N, 140 ^{o}E – 180 ^{o}). From these daily composite data, we made a 23days composite data and images which were from September 4 to 26.

(3) Preliminary results

Fig. 1 and Fig. 2 show Chl-*a* concentration and SST from September 4 to 26 in the western North Pacific.

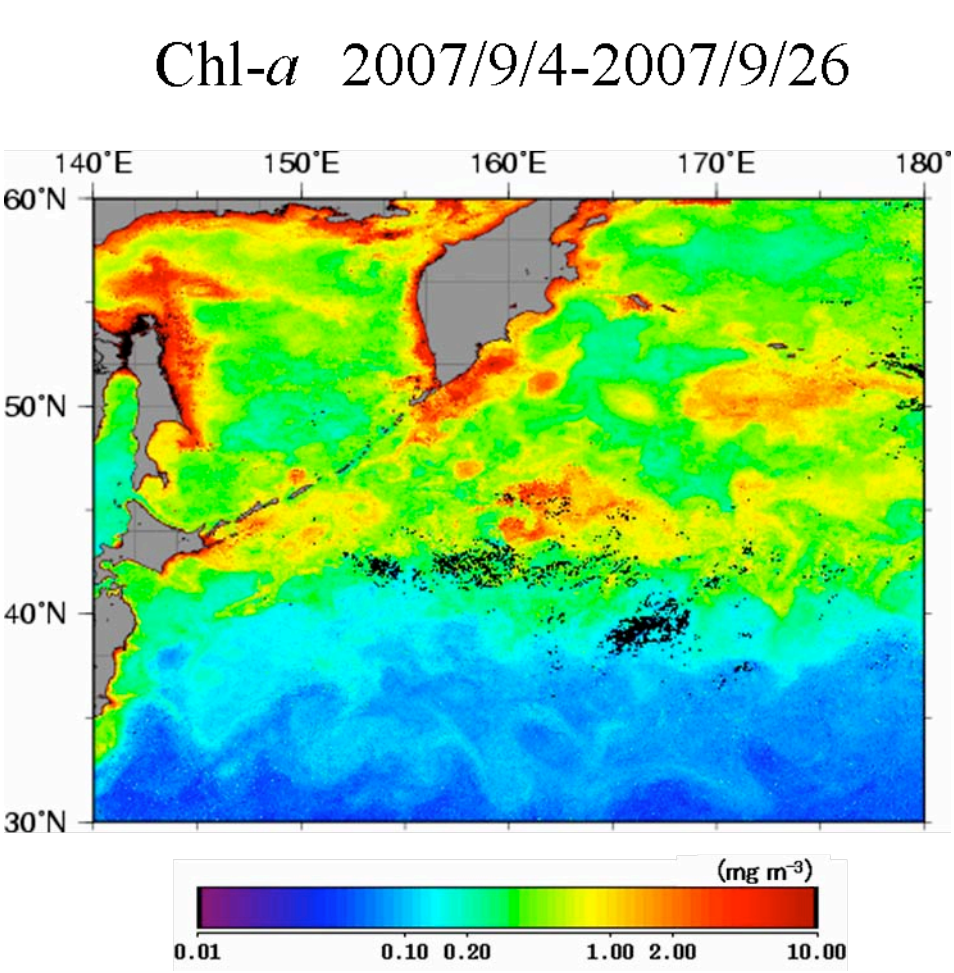

Fig. 1 Chl-*a* concentration averaged between September 4 and 26.

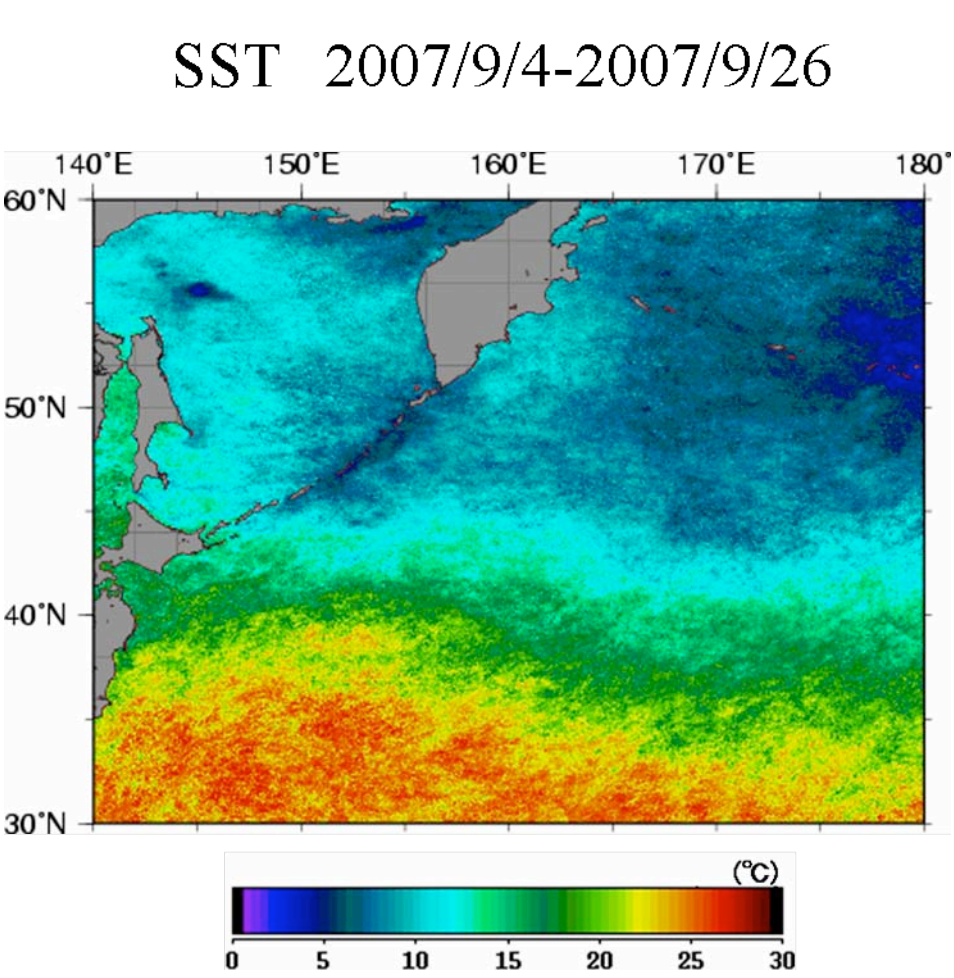

Fig. 2 Sea surface temperature averaged between September 4 and 26.