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R/V *MIRAI*

MR07-01 Preliminary Cruise Report

－Biogeochemical study in the western North Pacific－

17 February 2007 – 26 March 2007

Edited by
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Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

Note

This cruise report is a preliminary documentation as of 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.

Cruise Report ERRATA of the Photosynthetic Pigments part

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

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1. Outline of MR07-01

1.1. Cruise summary

1.1.1. Objectives

The main objective is to observe the distributions of materials such as carbon dioxide in the western North Pacific for better understanding of ocean's roll in controlling the global environment. Additionally, we have planned the observation for the study of horizontal and vertical transportation of materials and of decadal change in biogeochemistry along 155E between the equator and 44N.

1.1.2. Cruise code

MR07-01

1.1.3. Ship

R/V MIRAI

1.1.4. Cruise title

Biogeochemical study in the western North Pacific

1.1.5. Period of the cruise (port of calls)

17, February 2007	Sekinehama (departure)
11, March 2007	Chichi-jima (call)
26, March 2007	Sekinehama (arrival)

1.1.6. Undertaking institution

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Mutsu Institute for Oceanography (MIO)
690 Kitasekine, Sekine, Mutsu-city, Aomori 035-0022, Japan

1.1.7. Principal Investigator

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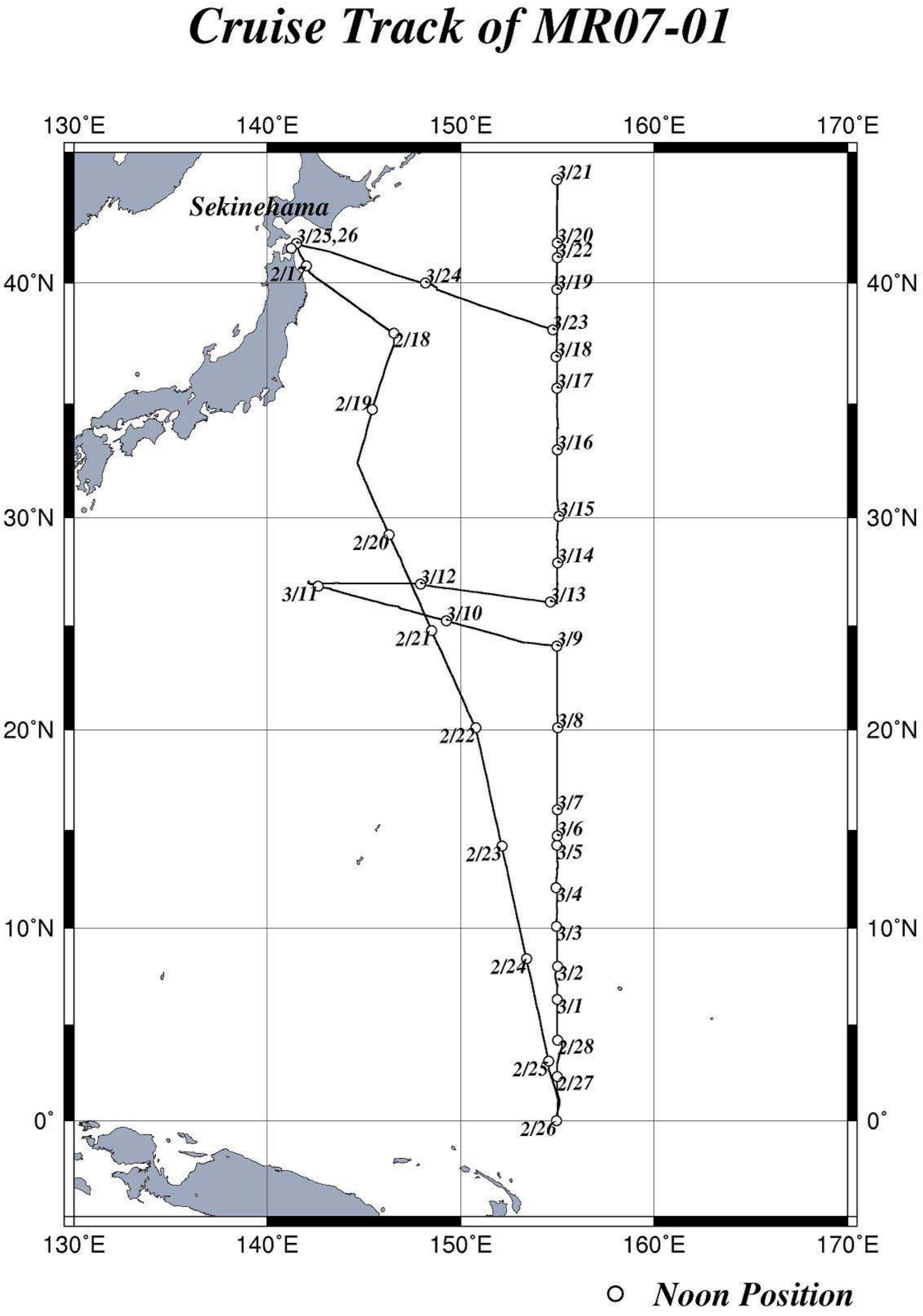
1.1.8. Overview

During MR07-01 cruise, the hydrocastings by CTD with carousel water sampler were carried out along 155E between the equator and 44N. We deployed J-KEO buoy at 37.9N, 146.6E to monitor the ocean surface flux in the region of the Kuroshio Extension. Additionally, we deployed 8 ARGO floats between 3N and 22N, and released radio-sonde at every station in the north of 30N.

Missions of MR07-01 had been planned originally to conduct CTD hydrocasts on every other degree of latitude along 155E between the equator and 44N. However, some stations were passed without hydrocasting between 16N and 25N, since MIRAI called at Chichi-jima exigently due to the trouble of CTD sensor. After returning 155E, MIRAI encountered with many storms at high-latitude station. Though 10 storms caught us during 10 days, we successfully carried out the observation almost entirely at the station in the north of 25N. It was an outgrowth of the big efforts by MIRAI’s captain and his crew, marine technician and scientists. Consequently, we could conduct the precise analysis of materials such as carbon species, dissolved oxygen and nutrients along 155E. In addition, we carried out the observation for phytoplankton at several stations along 155E. We found clear heterogeneity of phytoplankton abundance, primary productivity and distributions of their species and size in this cruise between high-latitude and low-latitude.

1.2. Track and Log

1.2.1. Cruise Track



1.2.1. Cruise Log

S.M.T.		U.T.C.		Position		Events
Date	Time	Date	Time	Lat.	Lon.	
2/17	7:00	2/16	22:00	41-22N	141-14E	Departure of Sekinehama
2/18	4:48	2/17	19:46	38-05.45N	146-17.74E	XCTD (for sound velocity correction)
2/18	5:12	2/17	20:12	37-53N	146-30E	Arrival at M07001 station
	5:15		20:15	-	-	Site Survey (1.5hour)
	9:12	2/18	0:12	38-00.9N	146-32.0E	J-KEO buoy deployment started
	14:27		5:27	37-55.20N	146-35.00E	J-KEO buoy deployment finished
				37-55.33N	146-34.64E	Sinker Position (5,415m)
	17:55		8:55	37-54.54N	146-34.61E	Radiosonde #1
	18:11		9:11	37-54.85N	146-34.56E	CTD cast #1 (1,000m)
	18:43		9:43	37-54.95N	146-34.60E	Plankton net #1
	20:00		11:00	-	-	Departure of M07001 station
2/19	22:07	2/19	13:07	32-24.48N	144-40.92E	Radiosonde #2
2/21	7:42	2/20	22:42	24-46N	148-31E	Arrival at M07001A
	7:56		22:56	24-46.05N	148-31.33E	CTD cast #2 (3,500m)
	10:04	2/21	1:04	24-46.08N	148-31.22E	Plankton net #2
	10:41		1:41	24-46.06N	148-31.14E	Free Fall (Optical Profiler) #1
	11:10		2:10	24-46.47N	148-30.95E	FRRF #1
	12:56		3:56	24-46.74N	148-29.37E	CTD cast #3 (200m)
	13:42		4:42	-	-	Departure of M07001A
2/22	9:42	2/22	0:42	20-13N	150-43E	Arrival at M07001B
	10:01		1:01	20-12.84N	150-42.89E	mass water pumping up
	10:56		1:56	20-13.04N	150-44.85E	Calibration for magnetometer #1
	11:30		2:30	-	-	Departure of M07001B
2/25	17:53	2/25	8:53	2-03.50N	154-46-69E	Calibration for magnetometer #2
2/26	5:06	2/25	20:06	0-00N	155-00E	Arrival at M07002

	5:21		20:21	0-00.12S	154-59.37E	CTD cast #4 (2,500m)
	6:44		21:44	0-00.33S	154-59.97E	Plankton net #3
	10:00	2/26	1:00	0-00.00S	154-59.97E	Free Fall (Optical Profiler) #2
	10:28		1:28	0-00.00S	154-59.86E	FRRF #2
	11:12		2:12	0-00.26N	154-58.63E	CTD cast #5 (200m)
	12:00		3:00	-	-	Departure of M07002
2/26	16:06	2/26	7:06	1-00N	155-00E	Arrival at M07003
	16:11		7:11	0-00.26N	154-58.63E	CTD cast #6 (2,638m)
	18:30		9:30	-	-	Departure of M07003
2/26	21:06	2/26	12:06	1-31.7N	154-59.2E	MNBES bathymetry accuracy test
2/27	5:12	2/26	20:12	2-00N	155-00E	Arrival at M07004
	5:25		20:25	2-00.54N	154-59.44E	CTD cast #7 (2,735m)
	7:01		22:01	2-00.99N	154-59.17E	Plankton net #4
	9:59	2/27	0:59	2-00.01N	154-59.95E	FRRF #3
	10:42		1:42	-	-	Departure of M07004
2/27	14:48	2/27	5:48	3-00N	155-00E	Arrival at M07005
	14:52		5:52	3-00.28N	154-59.90E	CTD cast #8 (2,638m)
	17:13		8:13	3-00.47N	154-59.96E	ARGO float deployment #1
	17:18		8:18	-	-	Departure of M07005
2/28	5:12	2/27	20:12	4-00N	155-00E	Arrival at M07006
	5:25		20:25	4-10.27N	155-00.06E	CTD cast #9 (3,383m)
	7:20		22:20	4-10.65N	155-00.14E	Plankton net #5
	9:59	2/28	0:59	4-10.65N	155-00.14E	Free Fall (Optical Profiler) #3
	10:24		1:24	4-10.26N	155-00.3E	FRRF #4
	11:08		2:08	4-10.49N	155-00.38E	CTD cast #10 (200m)
	11:54		2:54	-	-	Departure of M07006
2/28	15:36	2/28	6:36	5-00N	155-00E	Arrival at M07007
	15:42		6:42	5-06.62N	154-59.94E	CTD cast #11 (3,539m)
	18:25		9:25	5-07.59N	155-00.00E	ARGO float deployment #2
	18:30		9:30	-	-	Departure of M07007

3/1	5:12	2/28	20:12	6-00N	155-00E	Arrival at M07008
	5:25		20:25	6-00.22N	155-00.09E	CTD cast #12 (4,254m)
	7:47		22:47	6-00.61N	155-00.11E	Plankton net #6
	9:58	3/1	0:58	6-00.22N	155-00.09E	FRRF #5
	10:42		1:42	-	-	Departure of M07008
3/1	14:48	3/1	5:48	7-00N	155-00E	Arrival at M07009
	14:51		5:51	7-00.98N	155-00.74E	CTD cast #13 (4,228m)
	18:00		9:00	-	-	Departure of M07009
3/2	5:12	3/1	20:12	8-00N	155-00E	Arrival at M07010
	5:25		20:25	8-00.63N	154-59.91E	CTD cast #14 (3,835m)
	9:58	3/2	0:58	8-00.00N	155-00.01E	Free Fall (Optical Profiler) #4
	10:24		1:24	8-00.50N	155-00.28E	FRRF #4
	11:09		2:09	8-01.01N	155-00.46E	CTD cast #15 (200m)
	11:59		2:59	8-01.42N	155-00.65E	ARGO float deployment #3
	12:00		3:00	-	-	Departure of M07010
3/2	16:12	3/2	7:12	9-00N	155-00E	Arrival at M07011
	16:15		7:15	9-00.40N	154-59.64E	CTD cast #16 (5,299m)
	20:00		11:00	-	-	Departure of M07011
3/3	5:12	3/2	20:12	10-00N	155-00E	Arrival at M07012
	5:25		20:25	10-00.39N	154-59.19E	CTD cast #17 (5,500m)
	8:36		23:36	10-01.06N	154-58.89E	Plankton net #7
	9:57	3/3	0:57	10-00.07N	154-58.75E	FRRF #7
	10:40		1:40	10-00.09N	154-57.38E	CTD cast #18 (500m)
	11:32		2:32	10-00.34N	154-57.38E	ARGO float deployment #4
	11:36		2:36	-	-	Departure of M07012
3/3	15:42	3/3	6:42	11-00N	155-00E	Arrival at M07013
	15:45		6:45	11-00.76N	154-59.34E	CTD cast #19 (5,736m)
	19:48		10:48	-	-	Departure of M07013
3/4	5:18	3/3	20:18	12-00N	155-00E	Arrival at M07014
	5:24		20:24	12-00.03N	154-59.71E	CTD cast #20 (5,880m)

	9:01	3/4	0:01	12-02.26N	154-57.37E	Plankton net #8
	9:59		0:59	12-03.26N	154-56.88E	Free Fall (Optical Profiler) #5
	10:27		1:27	12-03.95N	154-56.75E	FRRF #8
	11:12		2:12	12-04.54N	154-56.11E	CTD cast #21 (200m)
	12:00		3:00	12-04.85N	154-55.63E	ARGO float deployment #5
	12:00		3:00	-	-	Departure of M07015
3/4	16:24	3/4	7:24	13-00N	155-00E	Arrival at M07015
	16:27		7:27	13-00.48N	154-59.06E	CTD cast #22 (6,016m)
	20:36		11:36	-	-	Departure of M07015
3/5	5:18	3/4	20:18	14-00N	155-00E	Arrival at M07016 (drifting)
	16:00	3/5	7:00	-	-	Completed drifting
3/6	5:18	3/5	20:18	15-00N	155-00E	Arrival at M07017
	5:25		20:25	15-00.52N	154-59.83E	CTD cast #23 (5,587m)
	8:36		23:36	15-01.13N	154-59.60E	Plankton net #9
	9:57	3/6	0:57	14-59.96N	155-00.23E	FRRF #9
	10:36		1:36	-	-	Departure of M07017
3/6	15:06	3/6	6:06	14-00N	155-00E	Arrival at M07016
	15:09		6:09	14-00.59N	154-59.81E	CTD cast #24 (6,055m)
	19:31		10:31	14-00.86N	154-59.60E	ARGO float deployment #6
	19:36		10:36	-	-	Departure of M07016
3/7	5:18	3/6	20:18	16-00N	155-00E	Arrival at M07018
	5:24		20:24	16-00.23N	154-59.48E	CTD cast #25 (4,958m)
	8:09		23:09	16-01.01N	154-59.84E	Plankton net #10
	9:59	3/7	0:59	15-59.76N	155-00.24E	Free Fall (Optical Profiler) #6
	10:23		1:23	16-00.01N	155-00.30E	FRRF #10
	11:07		2:07	16-00.45N	154-59.96E	CTD cast #26 (178m)
	11:54		2:54	16-00.92N	154-59.82E	XCTD #1
	11:54		2:54	-	-	Departure of M07018
3/7	16:03	3/7	7:03	17-00.00N	154-59.98E	XCTD #2 (Station M07019)

3/7	20:15	3/7	11:15	17-59.98N	155-00.01E	XCTD #3 (Station M07020)
3/8	0:26	3/7	15:26	19-00.01N	154-59.98E	XCTD #4 (Station M07021)
3/8	5:12	3/7	20:12	20-00N	155-00E	Arrival at M07022
	5:25		20:25	20-01.17N	155-00.16E	CTD cast #27 (5,704m)
	8:45		23:45	20-02.04N	155-00.77E	Plankton net #11
	9:34	3/8	0:34	20-02.50N	155-01.04E	Free Fall (Optical Profiler) #7
	9:57		0:57	20-02.69N	155-01.33E	FRRF #11
	10:50		1:50	20-04.11N	155-01.55E	CTD cast #28 (200m)
	13:42		4:42	20-08.01N	155-01.05E	ARGO float deployment #7
	13:47		4:47	20-08.33N	155-01.14E	XCTD #5
	13:48		4:48	-	-	Departure of M07022
3/8	18:27	3/8	9:27	21-20.02N	155-00.01E	XCTD #6 (Station M07023)
3/8	21:02	3/8	12:02	22-00.02N	154-59.96E	XCTD #7 (Station M07024)
3/9	1:04	3/8	16:04	23-00.01N	155-00.14E	XCTD #8 (Station M07025)
3/9	5:30	3/8	20:30	24-00N	155-00E	Arrival at M07026
	5:35		20:35	24-00.85N	155-00.24E	CTD cast #29 (5,492m)
	8:45		23:45	24-01.38N	154-59.68E	Plankton net #12
	9:35	3/8	0:35	24-01.98N	154-59.61E	Free Fall (Optical Profiler) #8
	10:07		1:07	24-02.50N	154-59.81E	FRRF #12
	10:50		1:50	24-02.91N	154-59.52E	CTD cast #30 (200m)
	12:25		3:25	24-03.03N	154-58.38E	CTD cast #31 (500m)
	13:11		4:11	24-03.14N	154-58.12E	ARGO float deployment #8
	13:17		4:17	24-03.32N	154-57.73E	XCTD #10
	13:18		4:18	-	-	Departure of M07026
3/11	14:36	3/11	5:36	-	-	Arrival at Chichi-jima (Offshore Futami)
	15:42		6:42	-	-	Departure of Chichi-jima
3/13	13:24	3/13	4:24	26-00N	155-00E	Arrival at M07028
	13:28		4:28	26-04.00N	155-00.08E	CTD cast #32 (5,893m)

	16:48		7:48	26-03.90N	155-00.29E	Plankton net #13
	17:30		8:30	-	-	Departure of M07028
3/13	21:30	3/13	12:30	27-00N	155-00E	Arrival at M07029
	21:35		12:35	26-04.00N	155-00.08E	CTD cast #33 (5,883m)
3/14	1:42		16:42	-	-	Departure of M07029
3/14	6:06	3/13	21:06	28-00N	155-00E	Arrival at M07030
	6:08		21:08	27-58.84N	155-00.54E	CTD cast #34 (5,813m)
	9:39	3/14	0:39	27-57.86N	155-01.13E	Plankton net #14
	10:23		1:23	27-57.43N	155-01.23E	Free Fall (Optical Profiler) #9
	10:49		1:49	27-56.96N	155-00.95E	FRRF #13
	11:39		2:39	27-55.78N	155-01.34E	CTD cast #35 (200m)
	12:24		3:24	-	-	Departure of M07030
3/14	19:14	3/14	10:14	29-00.00N	154-59.61E	XCTD #10 (Station M07031)
3/15	5:18	3/14	20:18	30-00N	155-00E	Arrival at M07032
	5:20		20:20	30-00.04N	155-04.18E	Radiosonde #3
	5:25		20:25	29-59.91N	155-02.92E	CTD cast #36 (5,755m)
	8:45		23:45	29-59.69N	155-02.85E	Plankton net #15
	9:59	3/15	0:59	29-59.94N	155-03.19E	FRRF #14
	10:42		1:42	29-59.77N	155-03.25E	CTD cast #37 (500m)
	11:45		2:45	30-00.45N	155-05.27E	Radiosonde #4
	11:48		2:48	-	-	Departure of M07032
3/15	16:24	3/15	7:24	31-00N	155-00E	Arrival at M07033
	16:28		7:28	30-59.55N	155-00.29E	Radiosonde #5
	16:31		7:31	30-59.16N	154-59.99E	CTD cast #38 (5,562m)
	20:25		11:25	30-58.29N	154-59.44E	Radiosonde #6
	20:30		11:30	-	-	Departure of M07033
3/16	1:03	3/15	16:03	32-00.01N	154-59.66E	XCTD #11 (Station M07034)
	1:21		16:21	32-02.79N	155-00.37E	Radiosonde #7
3/16	5:34	3/15	20:34	32-59.97N	155-00.06E	Radiosonde #8

3/16	5:36	3/15	20:36	33-00N	155-00E	Arrival at M07035
	5:37		20:37	33-00.02N	154-59.99E	CTD cast #39 (5,309m)
	8:34		23:34	32-59.98N	154-59.96E	Plankton net #16
	9:58	3/16	0:58	32-59.89N	155-00.08E	Free Fall (Optical Profiler) #10
	10:23		1:23	33-00.05N	154-59.65E	FRRF #15
	11:08		2:08	32-59.83N	154-59.71E	CTD cast #40 (200m)
	11:56		2:56	32-59.88N	154-59.66E	Radiosonde #9
	11:48		2:48	-	-	Departure of M07035
3/16	16:26	3/16	7:26	33-59.69N	154-59.95E	Radiosonde #10
3/16	16:30	3/16	7:30	34-00N	155-00E	Arrival at M07036
	16:30		7:30	33-58.67N	155-01.31E	CTD cast #41 (5,831m)
	20:33		11:33	33-57.29N	155-02.47E	Radiosonde #11
	20:36		11:36	-	-	Departure of M07036
3/17	0:54	3/16	15:54	35-00.02N	154-59.34E	XCTD #12 (Station M07037)
	1:05		16:05	35-01.28N	155-00.18E	Radiosonde #12
3/17	5:12	3/16	20:12	36-00N	155-00E	Arrival at M07038
	5:21		20:21	35-59.92N	155-00.23E	Radiosonde #13
	5:28		20:28	35-59.70N	154-59.46E	CTD cast #42 (5,493m)
	8:37		23:37	35-59.54N	154-59.41E	Plankton net #17
	9:57	3/17	0:57	35-59.17N	154-59.18E	FRRF #16
	10:43		1:43	35-58.99N	154-58.71E	Radiosonde #14
	10:48		1:48	-	-	Departure of M07038
3/17	14:30	3/17	5:30	35-00.68N	154-59.76E	Radiosonde #15
3/17	14:36	3/17	5:36	35-00N	155-00E	Arrival at M07037
	14:36		5:36	35-00.28N	155-00.08E	CTD cast #43 (5,648m)
	18:30		9:30	-	-	Departure of M07037
	23:13		14:13	35-59.96N	154-59.20E	Radiosonde #16
3/18	5:11	3/17	20:11	36-59.48N	154-59.40E	Radiosonde #17

3/18	5:18	3/17	20:18	37-00N	155-00E	Arrival at M07039
	5:27		20:27	36-59.02N	154-59.16E	CTD cast #44 (5,660m)
	8:38		23:38	36-58.47N	154-58.81E	Plankton net #18
	9:57	3/18	0:57	36-57.84N	154-58.01E	Free Fall (Optical Profiler) #11
	10:00		1:00	36-57.34N	154-57.62E	FRRF #17
	10:55		1:55	36-56.32N	154-56.67E	CTD cast #45 (200m)
	11:38		2:38	36-55.62N	154-56.35E	Radiosonde #19
	11:42		2:42	-	-	Departure of M07038
3/18	16:24	3/18	7:24	38-00N	155-00E	Arrival at M07040
	16:39		7:39	37-54.96N	154-59.23E	Radiosonde #20
	17:38		8:38	37-59.19N	154-59.51E	XCTD #13
	17:53		8:53	37-58.32N	154-58.17E	XCTD #14
	18:00		9:00	-	-	Departure of M07040
3/19	5:12	3/18	20:12	39-00N	155-00E	Arrival at M07041
	5:23		20:23	38-59.88N	155-01.02E	Radiosonde #21
	5:32		20:32	38-59.99N	155-00.67E	XCTD #15
	5:36		20:36	-	-	Departure of M07041
3/19	10:54	3/19	1:54	39-43N	155-00E	Arrival at M07042
	11:02		2:02	39-43.32N	154-59.54E	Free Fall (Optical Profiler) #12
	11:40		2:40	39-43.69N	154-59.28E	FRRF #18
	13:13		4:13	39-44.90N	154-57.31E	CTD cast #46 (200m)
	14:51		5:51	39-45.25N	154-56.47E	CTD cast #47 (5,496m)
	18:49		9:49	39-45.25N	154-55.75E	Radiosonde #22
	18:54		9:54	-	-	Departure of M07042
3/20	5:24	3/19	20:24	41-00N	155-00E	Arrival at M07043
	5:24		20:24	40-59.78N	155-00.51E	Radiosonde #20
	5:31		20:31	41-00.07N	155-00.47E	XCTD #16
	5:36		20:36	-	-	Departure of M07043
3/20	15:50	3/20	6:50	41-59.61N	155-00.25E	Radiosonde #21
3/20	15:54	3/20	6:54	42-00N	155-00E	Arrival at M07044

	15:54		19:43	41-59.04N	155-00.13E	CTD cast #48 (5,435m)
	19:46		10:46	41-58.41N	154-59.65E	Radiosonde #22
	19:48		10:48	-	-	Departure of M07044
3/21	6:42	3/20	21:42	44-00N	155-00E	Arrival at M07046
	6:47		21:47	43-59.77N	154-59.79E	Radiosonde #23
	7:01		22:01	43-59.24N	154-59.06E	CTD cast #49 (5,300m)
	10:13	3/21	1:13	43-58.86N	154-58.65E	Plankton net #19
	11:00		2:00	43-59.02N	154-58.37E	Free Fall (Optical Profiler) #13
	11:27		2:27	43-59.49N	154-58.57E	FRRF #19
	12:45		3:45	44-00.25N	154-59.05E	CTD cast #50 (200m)
	15:06		6:06	44-00.66N	155-01.32E	CTD cast #51 (3,000m)
	17:30		8:30	44-00.28N	155-01.58E	Radiosonde #24
	17:36		8:36	-	-	Departure of M07046
3/21	21:41	3/21	12:41	43-00.55N	154-59.64E	Radiosonde #25
3/21	21:48	3/21	12:48	43-00N	155-00E	Arrival at M07045
	21:53		12:53	43-00.18N	154-59.04E	CTD cast #52 (5,390m)
3/22	1:46		16:46	42-59.77N	154-57.96E	Radiosonde #26
	1:48		16:48	-	-	Departure of M07045
3/22	9:50	3/22	0:50	41-00.06N	154-59.29E	Radiosonde #27
3/22	10:00	3/22	1:00	41-00N	155-00E	Arrival at M07043
	10:05		1:05	40-59.70N	154-59.69E	CTD cast #53 (5,494m)
	14:02		5:02	40-58.60N	154-59.21E	Radiosonde #28
	14:06		5:06	-	-	Departure of M07043
3/22	22:03	3/22	13:03	39-00.24N	155-00.24E	Radiosonde #29
3/22	22:06	3/22	13:06	39-00N	155-00E	Arrival at M07041
	22:09		13:09	39-00.00N	154-59.99E	CTD cast #54 (5,754m)
3/23	2:14		17:14	38-59.55N	154-59.23E	Radiosonde #30
	2:18		17:18	-	-	Departure of M07041

3/23	6:18	2/22	21:18	38-00N	155-00E	Arrival at M07040
	6:18		21:18	38-00.04N	155-00.19E	Radiosonde #31
	6:20		21:20	38-00.20N	155-00.08E	CTD cast #55 (6,000m)
3/23	10:48	3/23	1:48	-	-	Departure of M07040
3/23	10:49		1:49	38-00.19N	154-58.97E	Calibration for magnetometer #3
3/26	9:00	3/26	0:00	41-22N	141-14E	Arrival at Sekinehama

1.3. List of Participants

1.3.1 Researcher

Name	Affiliation	Assignment
Kazuhiko Matsumoto (Principal Investigator)	JAMSTEC/MIO	Researcher
Masahide Wakita (Deputy PI)	Same as above	Same as above
Ken’ichi Sasaki	Same as above	Same as above
Tetsuichi Fujiki	Same as above	Same as above
Hiroki Tokinaga	JAMSTEC/IORGC	Same as above
Hiroyuki Tomita	Same as above	Same as above
Kristene E. Mctaggart	NOAA/PMEL	Same as above
J. Michael Strick	Same as above	Same as above
V. V. S. S. Sarma	Nagoya Univ./HyARC	Same as above
Satoshi Kitajima	The Univ. of Tokyo	Graduate student
Takuhei Shiozaki	Same as above	Same as above
Nguyen Van Nguyen	Same as above	Same as above
Taketoshi Kodama	Same as above	Student
Takayoshi Seike (Principal Marine Technician)	Marine Works Japan Ltd. (MWJ)	Marine Technician
Tomoyuki Takamori	Same as above	Same as above
Hirokatsu Uno	Same as above	Same as above
Katayama Kenichi	Same as above	Same as above
Shinsuke Toyoda	Same as above	Same as above
Naoko Takahashi	Same as above	Same as above
Akinori Murata	Same as above	Same as above
Fuyuki Shibata	Same as above	Same as above
Ai Yasuda	Same as above	Same as above
Hideki Yamamoto	Same as above	Same as above
Katsunori Sagishima	Same as above	Same as above
Shinichiro Yokogawa	Same as above	Same as above
Yoshiko Ishikawa	Same as above	Same as above
Minoru Kamata	Same as above	Same as above

Ayaka Hatsuyama	Same as above	Same as above
Keisuke Wataki	Same as above	Same as above
Miyo Ikeda	Same as above	Same as above
Yuichi Sonoyama	Same as above	Same as above
Masanori Enoki	Same as above	Same as above
Ayumi Takeuchi	Same as above	Same as above
Junji Matsushita	Same as above	Same as above
Kazuho Yoshida (Principal Marine Technician)	Global Ocean Development Inc. (GODI)	Same as above
Ryo Oyama	Same as above	Same as above

1.3.2. Crew member

Name	Assignment
Masaharu Akamine	Master
Haruhiko Inoue	Chief Officer
Tomoo Hikichi	1st Officer
Yasushi Ishioka	Jr. 1st Officer
Nobuo Fukaura	2nd Officer
Hajime Matsuo	3rd Officer
Hiroyuki Doi	Chief Engineer
Koji Masuno	1st Engineer
Kosaku Monji	2nd Engineer
Toshio Kiuchi	3rd Engineer
Kazuo Sagawa	C/R Officer
Kunihiko Omote	Boatswain
Masami Sugami	Able Seaman
Akito Hodai	Able Seaman
Yukiharu Suzuki	Able Seaman
Susumu Kanzaki	Able Seaman
Masaru Suzuki	Able Seaman
Yosuke Kuwahara	Able Seaman
Kazuyoshi Kudo	Able Seaman
Tsuyoshi Sato	Able Seaman
Takeharu Aisaka	Able Seaman
Atsuhiro Yabugami	Able Seaman
Yukitoshi Horiuchi	No.1 Oiler
Toshimi Yoshikawa	Oiler
Yoshihiro Sugimoto	Oiler
Nobuo Boshita	Oiler
Kazumi Yamashita	Oiler
Ryo Kobayakawa	Oiler
Hitoshi Ota	Chief Steward
Hatsuji Hiraishi	Cook
Ryoji Takesako	Cook
Tatsuya Hamabe	Cook
Kozo Uemura	Cook
Kanjyuro Murakami	Cook

2. General observation

2.1. Meteorological observations

2.1.1. Surface Meteorological Observation

Kunio Yoneyama (JAMSTEC) : Principal Investigator (Not on-board)
Kazuho Yoshida (Global Ocean Development Inc., GODI)
Ryo Ohyama (GODI)

(1) Objectives

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

(2) Methods

The surface meteorological parameters were observed throughout the MR07-01 cruise from the departure of Sekinehama on 17 February 2007 to arrival of Sekinehama on 26 February 2007.

. At this cruise, we used two systems for the surface meteorological observation.

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

1) MIRAI Surface Meteorological observation (SMet) system

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

2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

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

i) Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
ii) Zeno Meteorological (Zeno/Met) system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.
iii) Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

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

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

a) Young Rain gauge (SMet and SOAR)
   Inspecting the linearity of output value from the rain gauge sensor to change input value by adding fixed quantity of test water.
b) Barometer (SMet and SOAR)
   Comparing with the portable barometer value, PTB220CASE, VAISALA.
c) Thermometer (air temperature and relative humidity) (SMet and SOAR)
   Comparing with the portable thermometer value, HMP41/45, VAISALA.

(4) Preliminary results

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

Wind (SOAR)
Air temperature (SOAR)
Relative humidity (SOAR)
Precipitation (SOAR, Young Raingauge)
Short/long wave radiation (SOAR)
Pressure (SOAR)
Sea surface temperature (EPCS)
Significant wave height (SMet)

(5) Data archives

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control. Corrected data sets will also be available from K. Yoneyama of JAMSTEC.

(6) Remarks

1. Following period, Zeno/met data was not acquired invalid because of logging error.
    20:22UTC 1 Mar. 2007 - 20:24UTC 1 Mar. 2007
    20:25UTC 1 Mar. 2007 - 20:54UTC 1 Mar. 2007
    22:54UTC 1 Mar. 2007 - 00:23UTC 2 Mar. 2007

2. Following period, JamMet data was not acquired because of system reboot.
    00:16UTC 2 Mar. 2007 - 00:23UTC 2 Mar. 2007

3. Following period, Sea Surface Temperature data was valid because surface water pump worked.
    04:42UTC 17 Feb. 2007 - 04:24UTC 24 Mar. 2007

4. Following period, Smet young rain gauge data is error.
    1 hour accumulative rainfall amount
        05:36UTC 18 Feb. 2007 - 6:00UTC
        20:33UTC 1 Mar. 2007 - 21:00UTC
    12 hour accumulative rainfall amount
        05:36UTC 18 Feb. 2007 - 12:00UTC
        20:33UTC 1 Mar. 2007 - 24:00UTC

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

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	AP-370	Koshin Denki, Japan	captain deck (13 m) weather observation room
Capacitive 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 6.2.1-2 Parameters of MIRAI Surface Meteorological observation system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log, DS-30 Furuno
4	Ship's heading	degree	Mirai gyro, TG-6000, Made by 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 6.2.1-3 Instruments and installation locations of SOAR system

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

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

Table 6.2.1-4 Parameters of SOAR system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	SOG	knot	
4	COG	degree	
5	Relative wind speed	m/s	
6	Relative wind direction	degree	
7	Barometric pressure	hPa	
8	Air temperature	degC	
9	Relative humidity	%	
10	Rain rate (optical rain gauge)	mm/hr	
11	Precipitation (capacitive rain gauge)	mm	reset at 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	

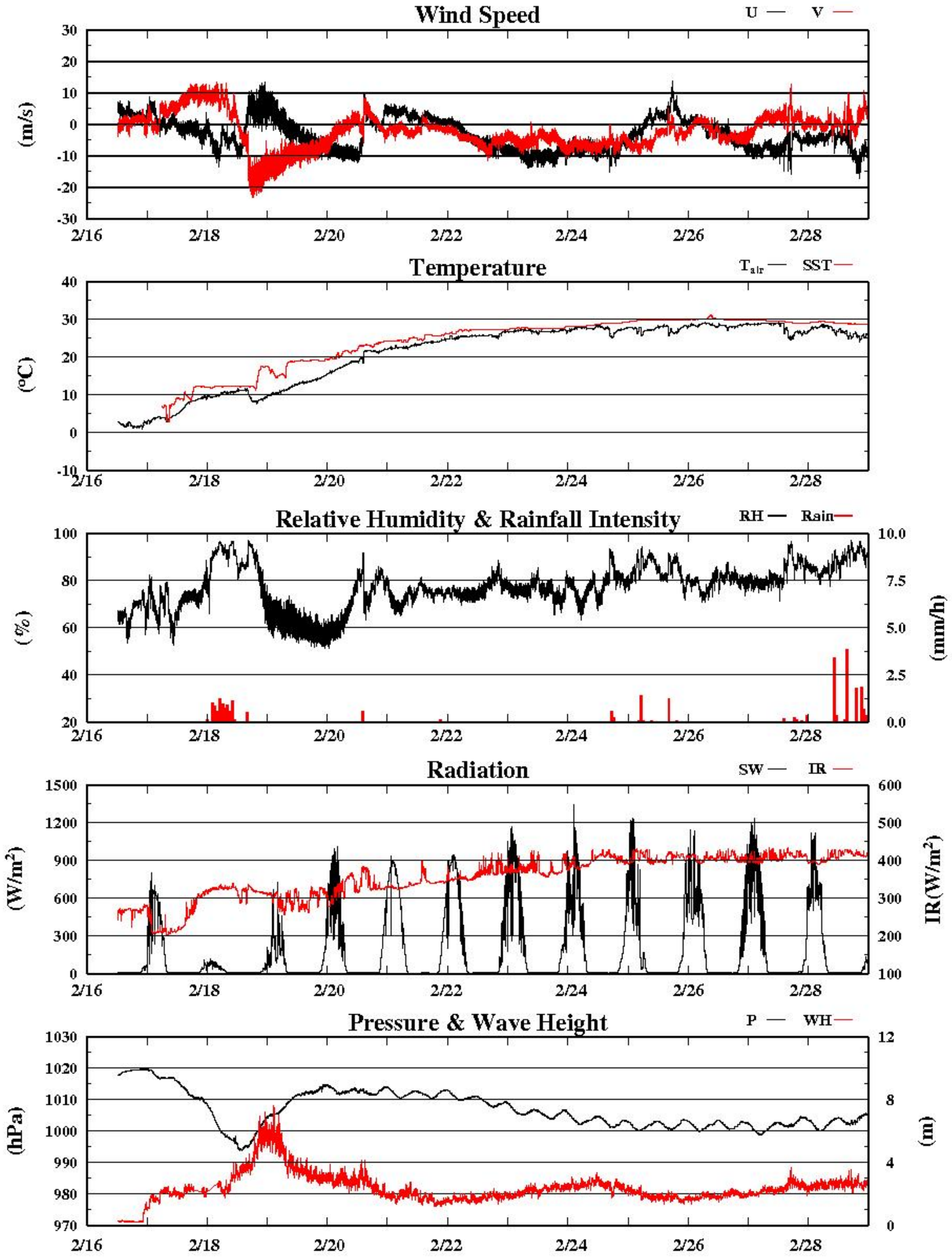


Fig.2.1.1 Time series of surface meteorological parameters during the cruise

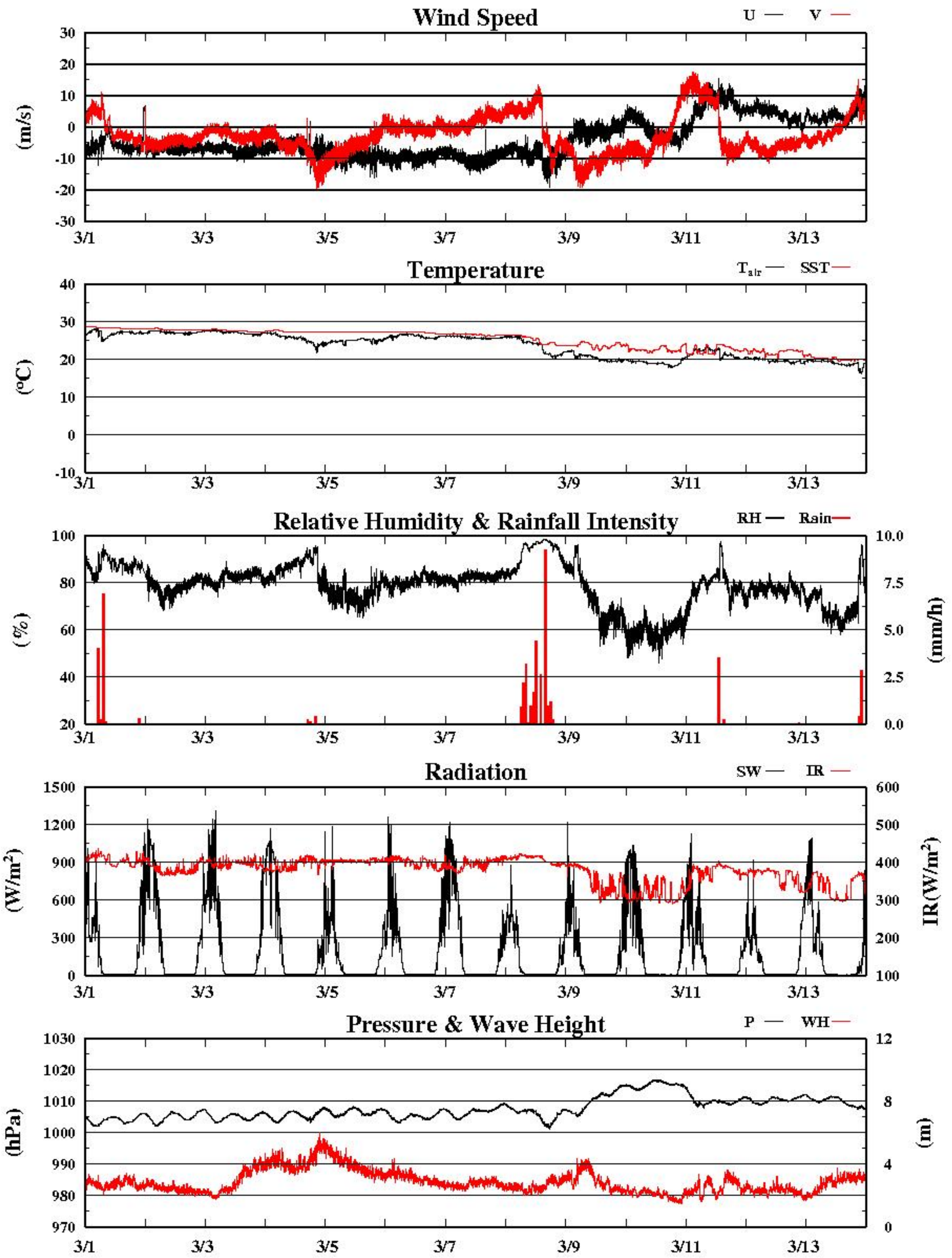


Fig.2.1.1 Continue

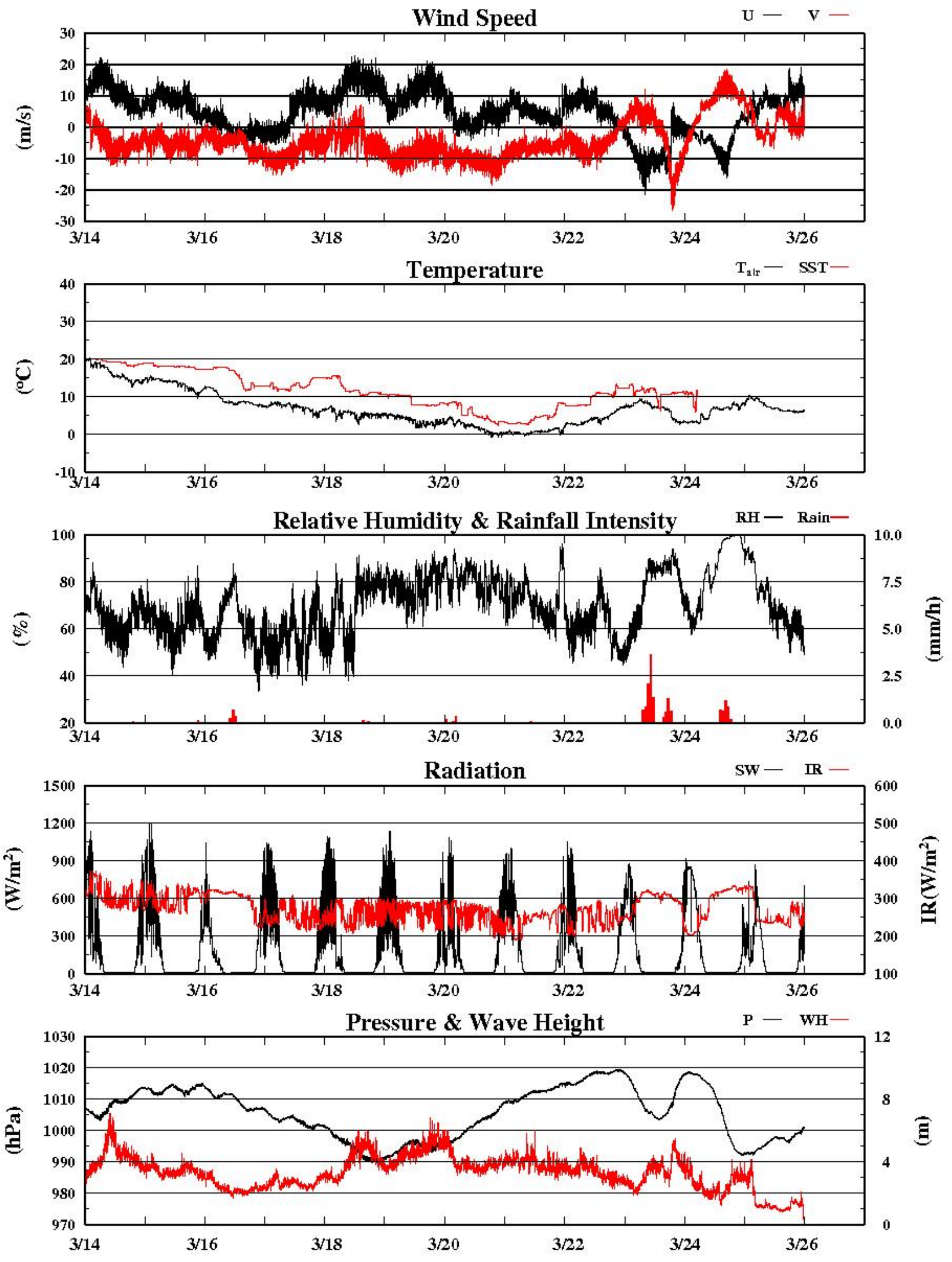


Fig.2.1.1 Continue

2.1.2 Ceilometer Observation

Kunio Yoneyama (JAMSTEC) : Principal Investigator (Not on-board)
Kazuho Yoshida (Global Ocean Development Inc., GODI)
Ryo Ohyama (GODI)

(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 MR07-01 cruise from 16 February 2007, the departure of Sekinehama, to 26 March 2007, the arrival of Sekinehama.

Major parameters for the measurement configuration are as follows;

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

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

(4) Preliminary results

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

(5) Data archives

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.

(6) Remarks

Window cleaning (UTC): 16 Feb. 2007 21:16
20 Feb. 2007 23:28
3 Mar. 2007 7:11
10 Mar. 2007 0:12
16 Mar. 2007 22:45
22 Mar. 2007 1:51

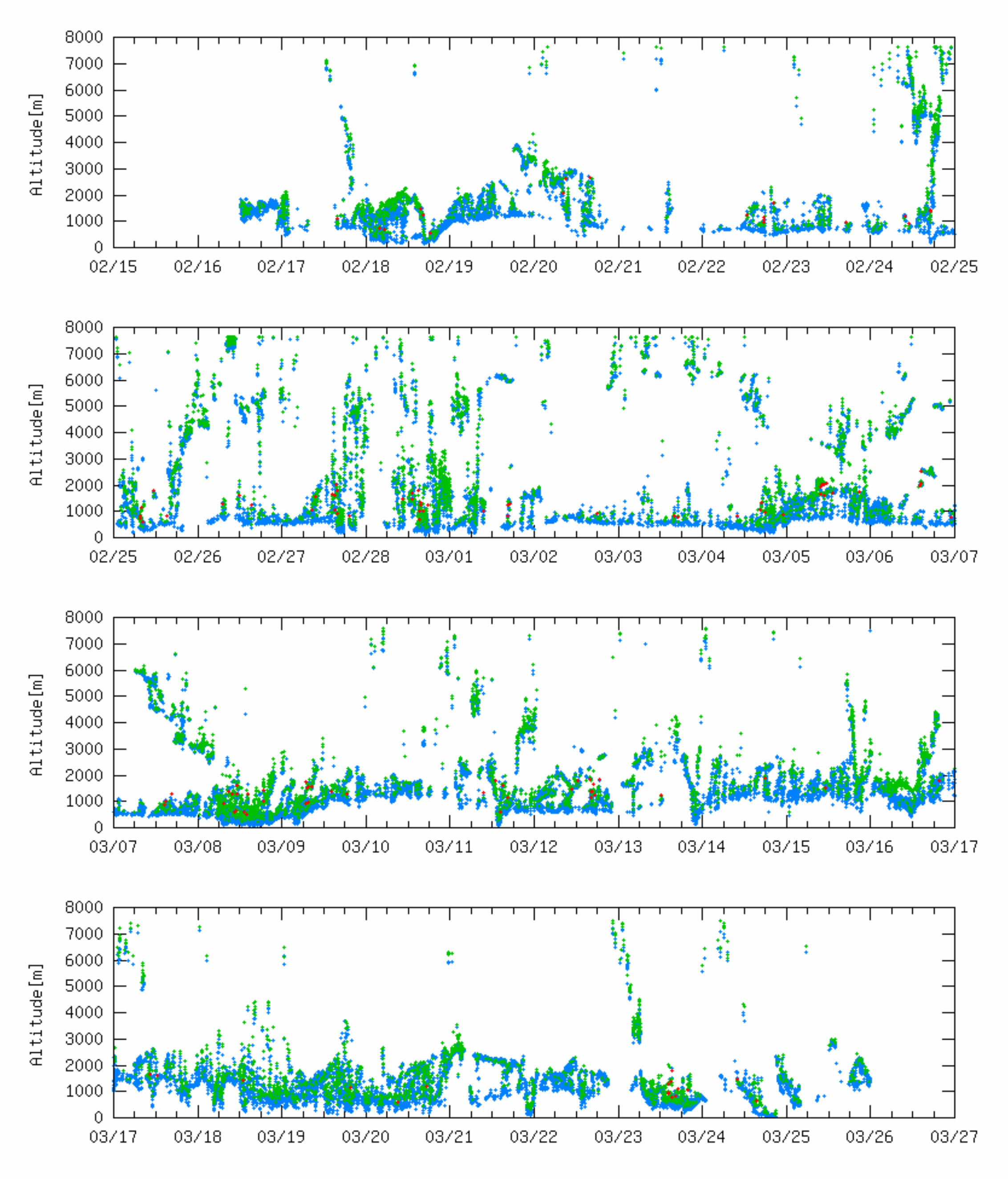


Fig.2.1.2 1st (blue) 2nd (green) and 3rd (red) lowest cloud base height during MR07-01 cruise.

2.1.3 Surface Atmospheric Turbulent Flux

Kunio Yoneyama (JAMSTEC) Principal Investigator / Not-onboard
Osamu Tsukamoto (Okayama University) Not-onboard
Kazuho Yoshida (Global Ocean Development Inc., GODI)
Ryo Ohyama (GODI)

(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. 2.1.3) 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 gas analyzer(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 CO_2/H_2O sensor that measures turbulent fluctuations of carbon dioxide and water vapor simultaneously.

These signals are sampled at 100 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.) and averaged over 0.1second basis. By obtaining the ship speed and heading information through the Mirai network system it yields the absolute wind components relative to the ground. Combining the averaged 10Hz turbulence data with the ship motion 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.

(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 open to public after quality checks and corrections by K. Yoneyama and/or O. Tsukamoto. Corrected data will be submitted to JAMSTEC Data Management Division.

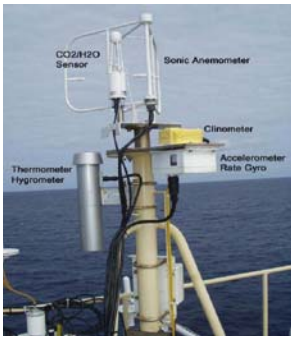


Fig. 2-1-3 Turbulent flux measurement system on the top deck of foremast

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 18 samples in total. Table 2.1.4 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 2.1.4 Dates and locations to show when and where rain water were sampled.

Sample No.	Date (UTC)		Location (lat/lon)		Rain (mm)
001	2007/02/19	05:03	34-19.1N	145-17.7E	11.9
002	2007/02/20	22:53	24-46.2N	148-31.5E	1.2
003	2007/02/25	07:23	02-16.5N	154-42.2E	2.1
004	2007/02/25	19:30	00-05.7N	155-00.3E	3.2
005	2007/02/27	21:40	04-10.38N	155-00.10E	33.2
006	2007/03/01	00:45	06-00.77N	155-00.25E	74.2
007	2007/03/01	06:03	07-00.1N	155-00.3E	5.1
008	2007/03/02	08:45	09-00.4N	154-59.7E	1.5
009	2007/03/05	01:50	14-10.8N	154-58.8E	3.1
010	2007/03/09	02:30	24-02.9N	154-59.3E	44.1
011	2007/03/12	02:10	26-58.6N	147-40.5E	18.0
012	2007/03/13	22:45	27-58.8N	155-00.5E	4.6
013	2007/03/16	00:15	32-59.9N	154-59.9E	0.4
014	2007/03/17	00:30	35-58.8N	154-58.1E	3.8
015	2007/03/20	07:13	41-59.5N	155-00.3E	2.5
016	2007/03/22	02:25	40-59.8N	154-59.8E	1.5
017	2007/03/22	21:04	38-02.2N	154-59.9E	0.5
018	2007/03/24	00:20	39-48.0N	148-46.1E	17.1

2.1.5 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
Kazuho Yoshida (Global Ocean Development inc., GODI)
Ryo Ohyama (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 10 seconds vertical profiles of three channel are recorded.

(4) Results

Full lidar raw data is still under data processing and analysis. So we show here only sample vertical profiles of backscattering intensity, Figure 2.5.1 shows an atmospheric structure revealed by lidar on March 23, 2007. There was a cloud layer around 5 km. Below it, some structure of aerosols is evident. Similar profiles are obtained every 15 minutes, and three dimensional structure of atmospheric scatterers (clouds and aerosols) are revealed in whole troposphere.

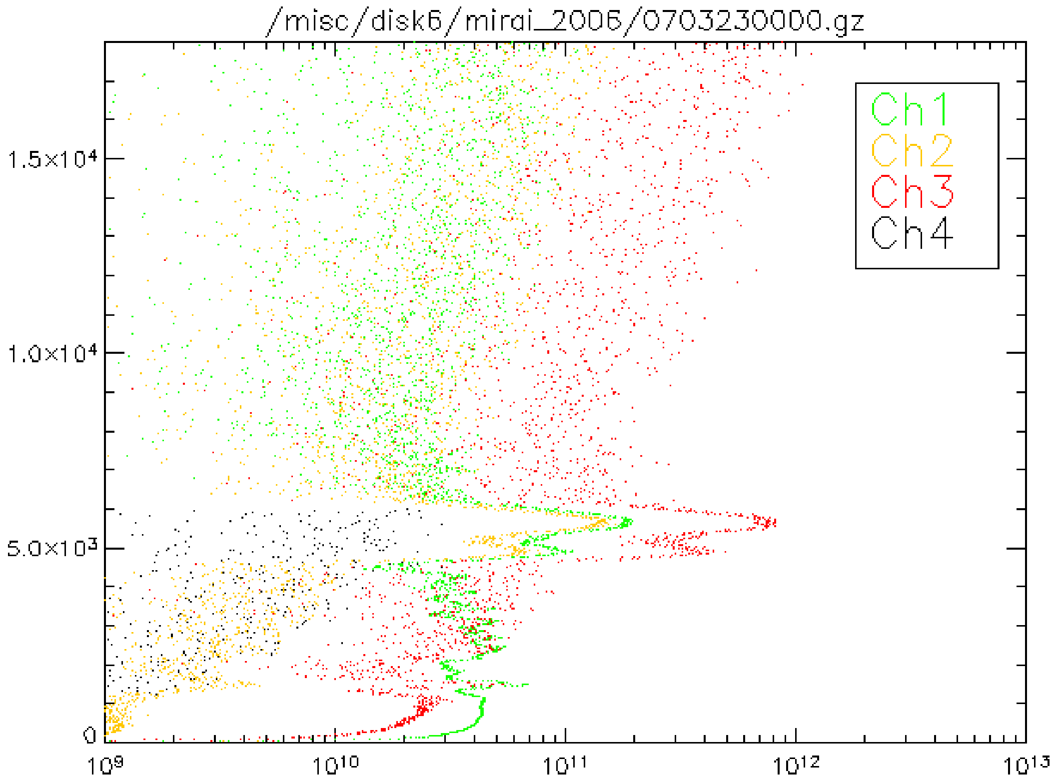


Figure 2.1.5: Vertical profiles of backscattering intensity at 532 nm parallel (green), 532 nm perpendicular (yellow), 1064 nm (red) on March 23, 2007. Black indicates signal from near field telescope (532nm).

(5) Data archive

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

- 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 : February 17, 2007 – March 25, 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

2.2 Physical oceanographic observation

2.2.1 CTD casts and water sampling

Personnel	**Tomoyuki Takamori**	**(MWJ): Operation Leader**
	Hirokatsu Uno	**(MWJ)**
	Kenichi Katayama	**(MWJ)**
	Shinsuke Toyoda	**(MWJ)**

(1) Objective

Investigation of oceanic structure and water sampling of each layer

(2) Method

(2)-1 Overview of the equipment

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 11plus deck unit is a rack-mountable interface which supplies DC power to the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format using a 34560 Hz carrier-modulated differential-phase-shift-keying (DPSK) telemetry link. The deck unit decodes the serial data and sends them to a personal computer 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, S/N 0677, S/N 0357

Temperature sensor:

SBE, Inc., SBE 3-04F, S/N 031525, S/N 03P2730, S/N 031359

Conductivity sensor:

SBE, Inc., SBE 4C, S/N 041206, S/N 042240, S/N 043036, S/N 041088, S/N 041203

Dissolved Oxygen sensor:

SBE, Inc., SBE 43, S/N 430394, 430330

Pump:

SBE, Inc., SBE 5T, S/N 052627, S/N 050984

Altimeter:

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

Deck unit:

SBE, Inc., SBE 11plus, S/N 11P8010-0308

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

Carousel Water Sampler:

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

Deep Ocean Standards Thermometer:

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

Fluorometer:

Seapoint sensors, Inc., S/N 2579

Transmissometer:

Wetlabs, Inc., CST-207RD

(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 and transmissometer.

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-10m. For the up cast, the package was lifted at a rate of 1.0 m/s except for bottle firing stops. At each bottle firing stops, the bottle was fired.

The SBE 11plus deck unit received the data signal from the CTD. Digitized data were forwarded to a personal computer running the SEASAVE module of the SEASOFT acquisition and processing software, version 5.27b. 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, and is designed to work with a compatible personal computer. Raw data are acquired from instruments and are stored as unmodified data. The conversion module DATCNV uses the instrument configuration and calibration coefficients to create a converted engineering unit data file that is operated on by all SEASOFT post processing modules. Each SEASOFT module that modifies the converted data file adds proper information to the header of the converted file permitting tracking of how the various oceanographic parameters were obtained. The converted data is stored in rows and columns of ASCII numbers. The last data column is a flag field used to mark scans as good or bad.

The following are the SEASOFT-Win32 (Ver. 5.27b) processing module sequence and specifications used in the reduction of CTD data in this cruise

DATCNV converted the raw data to scan number, pressure, depth, temperature, conductivity, oxygen voltage, fluorescence, transmission, user poly 0, user poly 1, descent rate, modulo error count, and pump status. 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 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperature, conductivity, fluorescence, transmission, user poly 0, user poly 1 were averaged over 3 seconds.

ALIGNCTD converted the time-sequence of oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. 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 pressure.

WILDEDIT marked extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, temperature, conductivity, oxygen voltage, fluorescence, transmission, user poly 0, user poly1, and descent rate outputs.

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

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

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

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

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

DERIVE was used to compute Oxygen.

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

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

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

(4) Preliminary results

Total 57 casts of CTD measurements have been carried out (table 2.2.1).

(5) Data archive

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

Table 2.2.1 ： MR07-01 CTD cast table

Stnnbr	Castno	Date(UTC)	Time(UTC)		StartPosition		Depth	Wire	HT Above	Max	Max	CTD	Remark
		(mmddyy)	Start	End	Latitude	Longitude		Out	Bottom	Depth	Pressure	Filename	
M07001	1	021807	09:14	10:21	37-54.69N	146-34.52E	5417	1000.3	-	993.3	1002.5	001M01	
M07001A	1	022007	23:01	01:33	24-46.14N	148-31.48E	4951	3469	-	3451.0	3502.1	001AM01	
M07001A	2	022107	04:02	04:38	24-46.74N	148-29.41E	4836	200.4	-	201.2	202.1	001AM02	
M07002	1	022507	20:26	22:24	00-00.03N	154-59.67E	2517	2536.6	8.7	2534.3	2504.9	002M01	
M07002	2	022607	02:20	02:53	00-00.18N	154-58.88E	2471	150.2	-	144.4	145.2	002M02	
M07003	1	022607	07:18	09:24	00-59.99N	155-07.79E	2654	2652.2	10.0	2638.6	2669.6	003M01	DO sensor added (secondary)
M07004	1	022607	20:31	22:44	02-00.04N	154-59.80E	2748	2814	11.4	2737.1	2770.2	004M01	
M07005	1	022707	05:57	08:05	03-00.17N	154-59.93E	2800	2800.2	8.3	2788.9	2823.3	005M01	
M07006	1	022707	20:30	22:58	04-09.90N	155-00.05E	3397	3416.0	8.4	3385.7	3432.7	006M01	
M07006	2	022807	02:14	02:50	04-10.45N	155-00.37E	3396	198.2	-	200.8	202.0	006M02	
M07007	1	022807	06:47	09:19	05-06.13N	155-00.05E	3561	3578.7	8.3	3540.0	3588.9	007M01	
M07008	1	022807	20:30	23:23	06-00.01N	155-00.05E	4277	4271.3	7.7	4252.8	4320.8	008M01	
M07009	1	030107	05:55	08:53	07-00.03N	155-00.18E	4240	4265	9.9	4228.7	4295.6	009M01	
M07010	1	030107	20:29	23:12	08-00.20N	155-00.06E	3841	3864.1	6.9	3836.5	3893.2	010M01	
M07010	2	030207	02:15	02:51	08-00.98N	155-00.44E	3834	195.4	-	199.8	200.7	010M02	
M07011	1	030207	07:20	10:50	08-59.93N	154-59.93E	5322	5335.6	9.8	5299.3	5397.0	011M01	
M07012	1	030207	20:29	00:11	09-59.85N	154-59.81E	5532	5600.7	10.2	5501.4	5603.4	012M01	
M07012	2	030307	01:46	02:25	10-00.07N	154-57.98E	5548	504.9	-	495.8	498.8	012M02	
M07013	1	030307	06:51	10:43	10-59.97N	154-59.86E	5761	5832.5	6.8	5737.2	5847.9	013M01	
M07014	1	030307	20:29	00:36	12-00.03N	154-59.70E	5907	6128.9	9.1	5880.8	5996.7	014M01	Primary C sensor changed (041206→043036)
M07014	2	030407	02:16	02:50	12-04.50N	154-56.17E	5906	193.2	-	199.2	202.1	014M02	
M07015	1	030407	07:32	11:31	12-59.98N	155-00.02E	6050	6091.7	9.2	6017.6	6135.2	015M01	Fl, X sensor removed
M07017	1	030507	20:30	00:14	15-00.20N	154-59.91E	5597	5615.7	9.3	5587.4	5695.6	017M01	Fl, X sensor attached
M07016	1	030607	06:14	10:23	14-00.16N	154-59.96E	6078	6093	9.1	6055.5	6179.4	016M01	Fl, X sensor removed
M07018	1	030607	20:29	23:49	15-59.94N	154-59.81E	4988	4993.2	8.8	4958.2	5045.6	018M01	9 Plus changed (0575→0677) Primary T-C sensor ⇔ Secondary T-C sensor Fl, X sensor attached 11plus changed(0308→0344)
M07018	2	030707	02:13	02:47	16-00.40N	154-59.97E	4951	173.5	-	178.8	179.2	018M02	
M07022	1	030707	20:29	00:21	20-00.34N	154-59.87E	5720	5806.3	8.8	5705.8	5817.5	022M01	
M07022	2	030807	01:55	02:26	20-03.99N	155-01.52E	5728	199.3	-	200.2	202.3	022M02	
M07022	3	030807	03:31	03:43	20-06.38N	155-01.13E	5720	201.3	-	203.7	205.0	022M03	Observation was interrupted

M07026	1	030807	20:40	00:22	24-00.38N	155-00.36E	5505	5541.7	10.3	5492.1	5599.5	026M01	9 plus changed (0677→0357) Primary T sensor changed (032730→031525) Secondary T sensor changed (031525→031359)
M07026	2	030907	01:55	02:27	24-02.87N	154-59.52E	5502	192.7	-	199.2	201.2	026M02	
M07026	3	030907	03:30	04:06	24-02.94N	154-58.49E	5470	501.4	-	493.9	498.1	026M03	
M07028	1	031307	04:32	08:20	26-03.80N	154-59.91E	5916	5924.3	8.7	5894.5	6015.4	028M01	Primary C sensor changed (042240→041088) Secondary C sensor changed (043036→042240)
M07029	1	031307	12:40	16:38	26-59.95N	155-00.01E	5899	5905.4	8.2	5881.4	6003.7	029M01	Secondary C sensor changed (042240→041203)
M07030	1	031307	21:15	01:12	27-59.87N	155-00.09E	5828	5927.8	6.8	5813.8	5935.5	030M01	11plus changed(0344→0308)
M07030	2	031407	02:44	03:19	27-56.14N	155-01.14E	5739	195.1	-	201.1	201.7	030M02	
M07032	1	031407	20:32	00:18	30-00.09N	155-03.15E	5765	5794.0	6.6	5873.4	5756.4	032M01	
M07032	2	031507	01:48	02:28	29-59.82N	155-03.23E	5768	493.0	-	498.0	502.0	032M02	
M07033	1	031507	07:36	11:20	30-59.50N	155-00.38E	5592	5619	7.9	5565.4	5678.0	033M01	molded new pig tail cable
M07035	1	031507	20:40	00:11	33-00.04N	155-00.10E	5328	5333.6	10.6	5308.5	5411.0	035M01	
M07035	2	031607	02:13	02:49	32-59.85N	154-59.71E	5330	198.4	-	200.5	201.1	035M02	
M07036	1	031607	07:37	11:25	33-59.65N	155-00.42E	5859	6011.9	8.7	5831.7	5954.5	036M01	
M07038	1	031607	20:34	00:11	35-59.85N	155-00.20E	5506	5572	10.3	5493.4	5606.0	038M01	
M07037	1	031707	05:41	09:24	35-00.28N	155-00.14E	5673	5673.8	9.9	5647.0	5764.5	037M01	
M07039	1	031707	20:34	00:17	36-59.91N	154-59.86E	5673	5755	9.8	5662.3	5780.1	039M01	
M07039	2	031807	01:59	02:32	36-56.40N	154-56.73E	5639	195.1	-	199.4	201.6	039M02	
M07040	1	031807	07:33	07:46	37-55.01N	154-59.15E	5888	214.9	-	227.1	222.0	040M01	Observation was interrupted
M07042	1	031907	04:18	04:51	39-44.94N	154-57.41E	5504	199.5	-	201.8	204.1	042M01	cut out 400m of sea cable molded new pig tail cable
M07042	2	031907	05:56	09:43	39-46.14N	154-57.56E	5515	5589.2	9.7	5497.4	5611.1	042M02	Because the sea was rough condition, fired without stopping winding up (the wire speed was slow)
M07044	1	032007	06:59	10:40	41-59.57N	155-00.40E	5453	5460.2	10.3	5435.1	5547.0	044M01	
M07046	1	032007	22:08	01:46	43-59.69N	154-59.82E	5331	5404.3	8.6	5299.8	5411.2	046M01	
M07046	2	032107	03:51	04:33	44-00.27N	154-59.06E	5306	202.0	-	201.3	202.6	046M02	
M07046	3	032107	06:10	08:27	44-00.90N	155-01.22E	5321	2974.3	-	2955.7	3000.2	046M03	
M07045	1	032107	12:56	16:39	43-00.54N	154-59.82E	5398	5477.2	9.5	5388.1	5502.6	045M01	
M07043	1	032207	01:08	05:01	41-00.12N	154-59.98E	5478	5599.3	10.8	5492.7	5608.2	043M01	
M07041	1	032207	13:17	17:09	39-00.18N	155-00.38E	5776	5801.2	9.9	5754.2	5877.2	041M01	
M07040	1	032207	21:26	01:38	38-00.12N	155-00.07E	6018	6031.7	10.2	6001.3	6132.7	040M01	

2.2.2 XCTD observation

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Hiroki Tokinaga	**(JAMSTEC IORGC)**
Hiroyuki Tomita	**(JAMSTEC IORGC)**
Kazuho Yoshida	**(Global Ocean Development Inc.: GODI)**
Ryo Ohyama	**(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 16 probes by using automatic launcher. The summary of XCTD observation and launching log were shown in Table. 2.2.2-1.

(4) Preliminary results

Position of XCTD observation, Vertical temperature and salinity sections were shown in the following Fig. 2.2.2-1.

(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 2.2.2-1 Summary of XCTD observation and launching log

Station No.	Date	Launched time	Finish time	Launch Position Latitude	Longitude	Measured Depth [m]	Water Depth [m]	Surface Temp. [deg-C]	Surface Salinity [PSU]	Probe S/N
M07018	2007/3/7	2:54:59	3:00	16-00.9239 N	154-59.8324 E	1035	4971	26.917	34.712	06037396
M07019	3/7	7:03:20	7:08	17-00.0036 N	154-59.9830 E	1034	5688	26.734	34.798	06090159
M07020	3/7	11:15:01	11:20	17-59.9781 N	155-00.0120 E	1035	5660	26.607	34.837	06090162
M07021	3/7	15:25:30	15:31	19-00.0128 N	154-59.9809 E	1035	5603	26.451	34.814	06090171
M07022	3/8	4:47:00	4:52	20-08.3319 N	155-01.1372 E	1035	5719	26.525	34.873	06090163
M07023	3/8	9:27:16	9:32	21-20.0224 N	155-00.0111 E	1035	4581	25.944	34.961	06090169
M07024	3/8	12:02:00	12:07	22-00.0163 N	154-59.9553 E	1035	5541	25.135	35.007	06090172
M07025	3/8	16:04:07	16:09	23-00.0070 N	155-00.1381 E	1033	5131	24.031	35.005	06090170
M07026	3/9	4:17:50	4:23	24-03.3170 N	154-57.7292 E	1035	5468	23.766	35.033	06090160
M07031	3/14	10:14:10	10:19	28-59.9975 N	154-59.6057 E	1034	5948	19.309	34.814	05115772
M07034	3/15	16:02:42	16:08	32-00.0133 N	154-59.6573 E	1035	4474	18.101	34.758	05115775
M07037	3/16	15:55:58	16:01	35-00.0160 N	154-59.3449 E	1034	5665	12.031	34.311	05114776
M07040	3/18	8:38:24	8:43	37-59.1782 N	154-59.5094 E	1035	6018	11.449	34.318	05115773
M07040	3/18	8:53:23	8:58	37-58.3159 N	154-58.1723 E	1035	5904	11.489	34.323	05115774
M07041	3/18	20:32:12	20:37	38-59.9916 N	155-00.6714 E	1035	5776	11.101	34.303	06079406
M07043	3/19	20:31:07	20:36	41-00.0700 N	155-00.4669 E	1035	5504	7.678	33.928	05115777

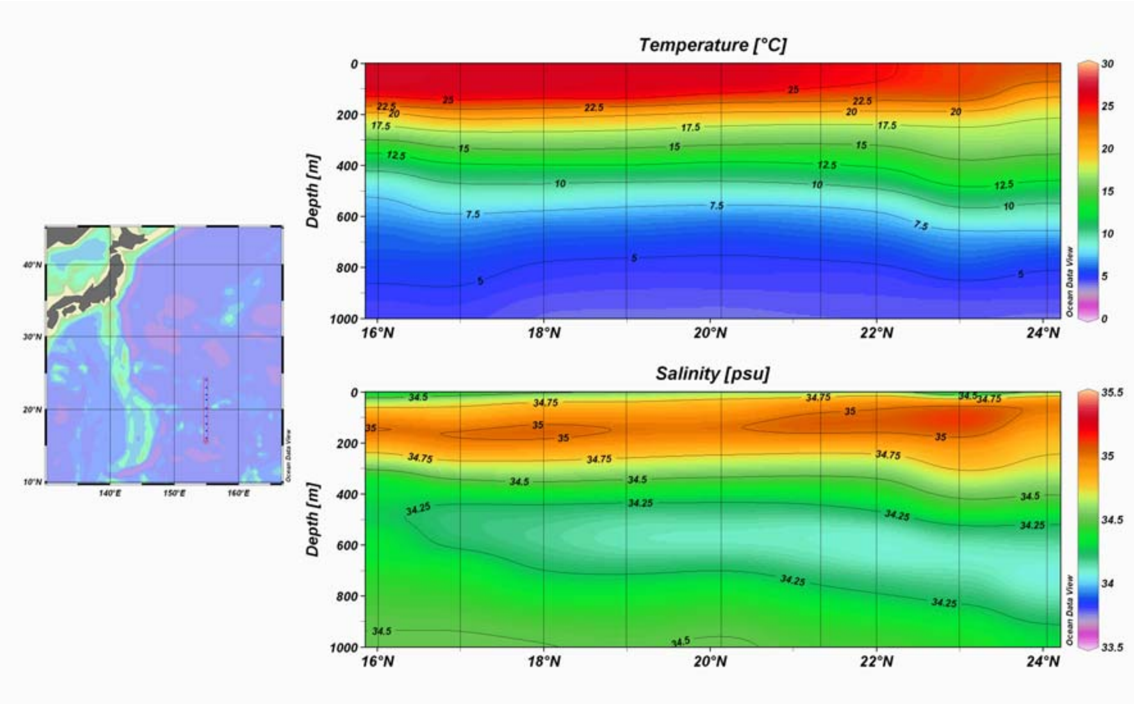


Fig. 2.2.2-1 Position of XCTD observation (left) and
Vertical section of Temperature (upper) Salinity (lower) along 155E line(16N-24N).

2.2.3 Salinity measurement

Naoko Takahashi (MWJ) : Operation leader
Akinori Murata (MWJ)

(1) Objectives

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

(2) Methods, Apparatus and Performance

(2) –1 Salinity Sample Collection

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

The kind and number of samples are shown as follows ;

Table 2.2.3.1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD and Bucket	1,618
Samples for EPCS	36
Total	1,654

(2) –2 Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR07-01 using the salinometer (Model 8400B "AUTOSAL" ; Guildline Instruments Ltd.: S/N 62556) with additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). We also used two pairs of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.). One thermometer monitored an ambient temperature and the other monitored a bath temperature.

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

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

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

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

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

The measurement system was almost same as Aoyama *et al.* (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 21 deg C to 25 deg C, while a bath temperature is very stable and varied within +/- 0.002 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 and it took about 10 seconds to collect 31 readings by a personal computer. Data were sampled 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 0.00003, we measured eighth filling of the cell. In case the double conductivity ratio of eighth filling did not satisfy the criteria above, we measured ninth and tenth filling of the cell and the average of the double conductivity ratios of five fillings are used to calculate the bottle salinity.

The measurement was conducted about 12hours per day (typically from 8:00 to 20:00) and the cell was cleaned with soap and thin-ethanol after the measurement of the day. We measured 1,654 samples in total.

We also used sub-standard seawater which was 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 every six samples in order to check the possible sudden drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

(3) Preliminary Result

(3) –1 Standard Seawater

Standardization control was set to 894 and all the measurements were done by this setting STANDBY was 5170 +/- 0001 and ZERO was 0.0+0000. We used IAPSO Standard Seawater batch P146 which conductivity ratio was 0.99979 (double conductivity ratio is 1.99958). We measured 69 bottles of P146. There was 1 bad bottle which conductivity is extremely high. Data of this bottle is not taken into consideration hereafter.

Fig.2.2.4.1 shows the history of double conductivity ratio of the Standard Seawater batch P146. The average of double conductivity ratio was 1.99957, and the standard deviation was 0.00002, which is equivalent to 0.0004 in salinity.

We added a value to data among two value of standard seawater that were measured about every 40 sample to correct nearly equal the determinate value of standard seawater.

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

Standard seawater (SSW)

batch	:	P146
conductivity ratio	:	0.99979
salinity	:	34.992
preparation date	:	12-May.-2005

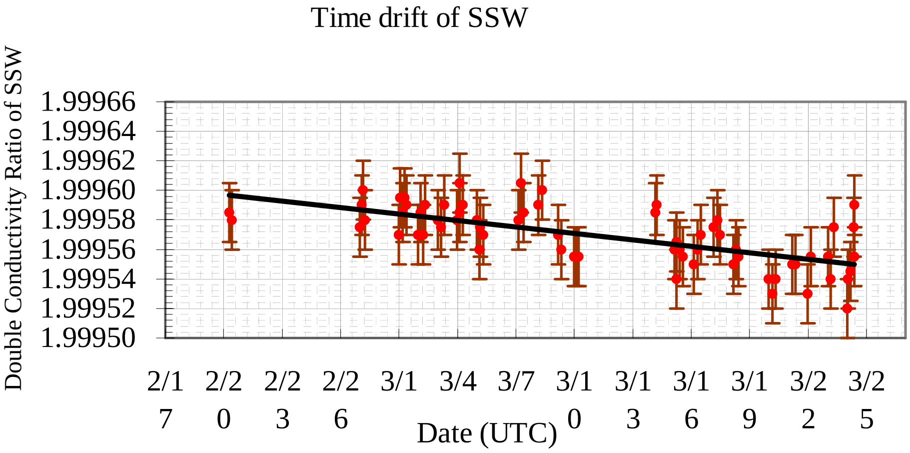


Fig. 2.2.4.1 History of double conductivity ratio of the Standard Seawater batch P146. X and Y axes represent time and double conductivity ratio, respectively.

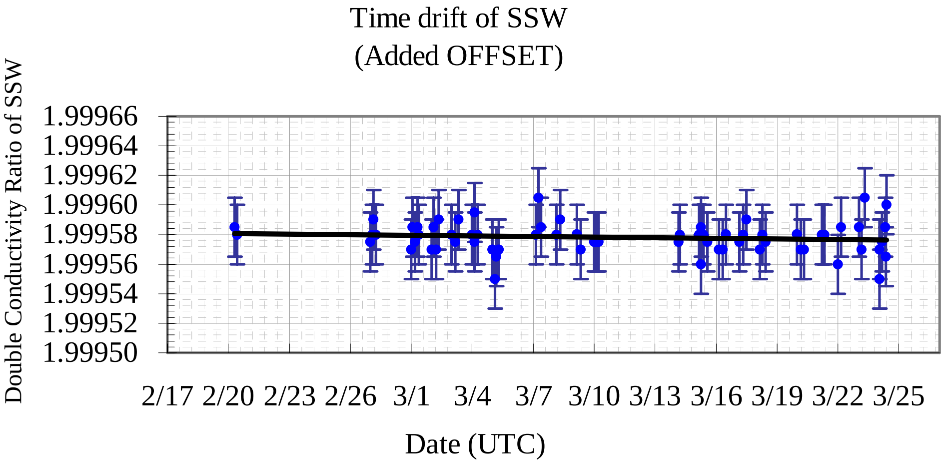


Fig. 2.2.4.2 History of double conductivity ratio of the Standard Seawater batch P146. X and Y axes represent time and double conductivity ratio (after add offset), respectively.

(3) –2 Replicate Samples

We took 243 pairs of replicate samples. Fig.2.2.4.3 shows the histogram of the absolute difference between replicate samples, respectively. There were 5 questionable measurement of replicate samples. The standard deviation of the absolute deference of replicate samples was 0.0004 in salinity.

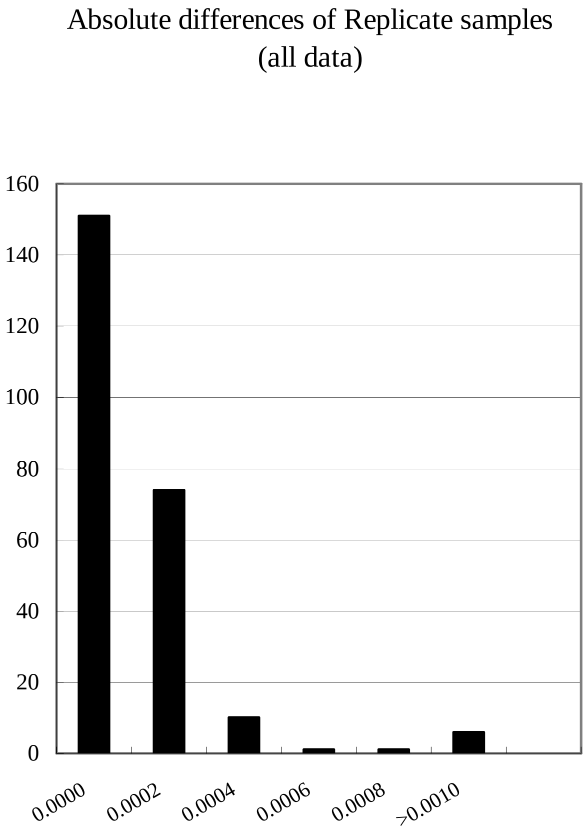


Fig. 2.2.4.3 the histogram of the difference between replicate samples (Include bad sample)

(4) Future plan and data archives

(4) –1 Further data quality check

None.

(4) –2 Data archive

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

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., 198

2.2.4 Shipboard ADCP

Kazuhiko Matsumoto (JAMSTEC): Principal Investigator
Takuhei Shiozaki (Tokyo University)
Kazuho Yoshida (Global Ocean Development Inc., GODI)
Ryo Ohyama (GODI)

(1) Objective

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

(2) Methods

Upper ocean current measurements were made throughout MR07-01 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 10 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 8 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 8-m intervals starting 23-m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown Table 2.2.4-1 Major parameters.

(3) Preliminary results

Fig. 2.2.4 were showed water current vector along the ship track. The data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

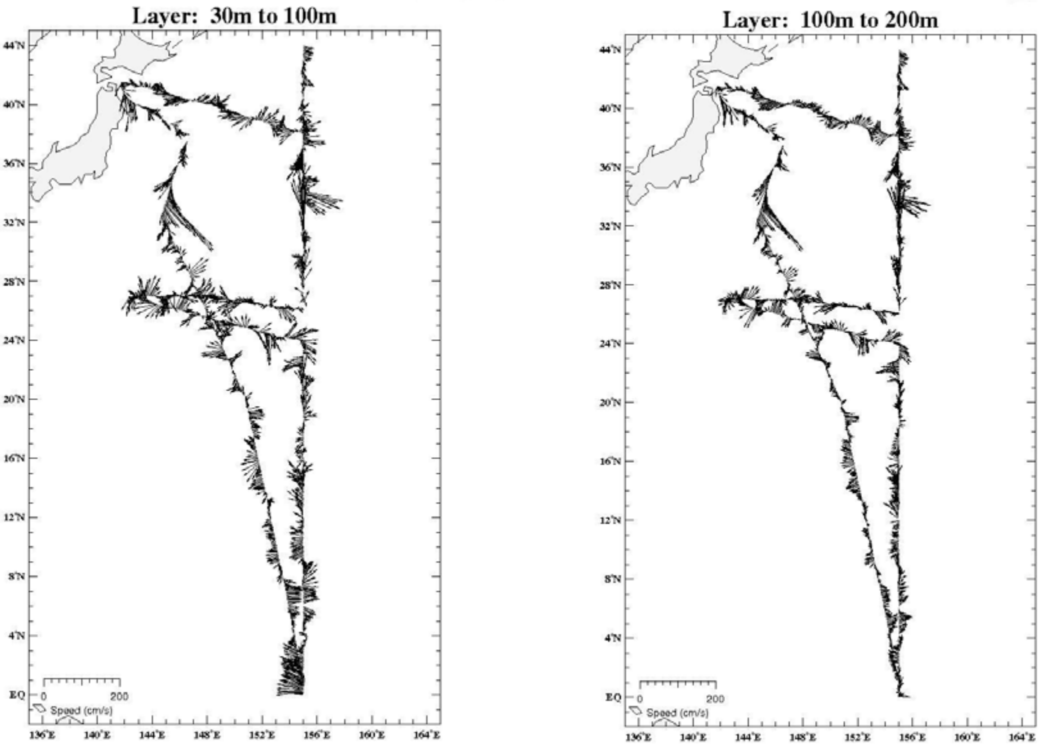
(4) Data archive

These data obtained in this cruise will be submitted to the 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

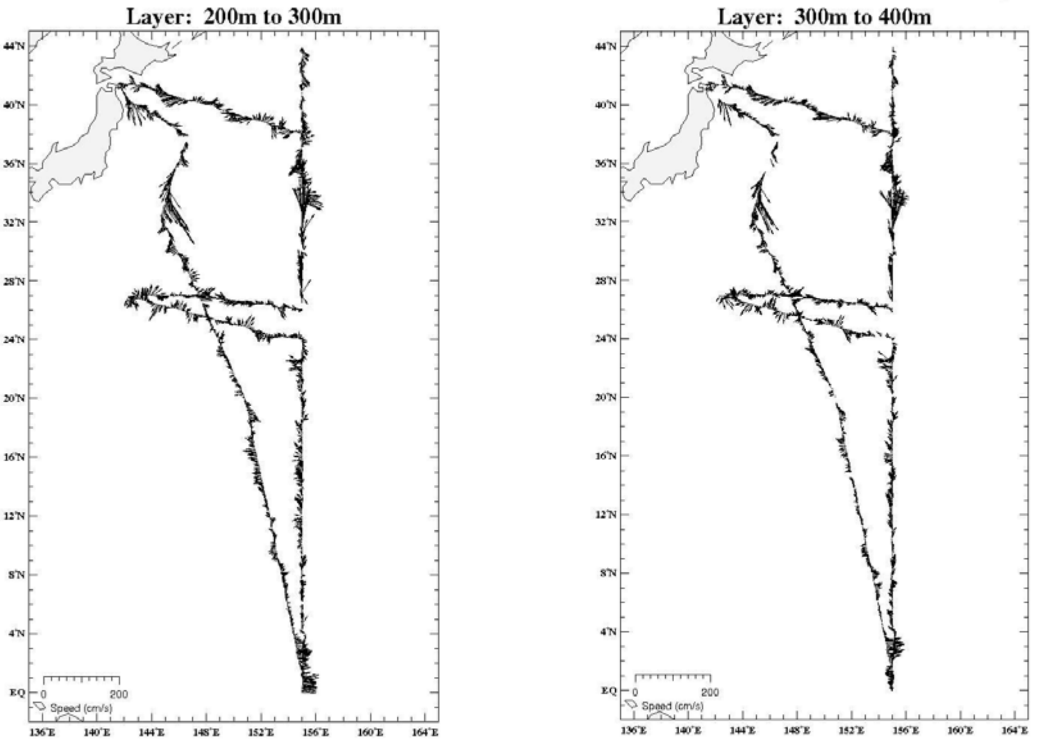
Table 2.2.4 Major parameters

Bottom-Track Commands	
BP = 001	Pings per Ensemble
Environmental Sensor Commands	
EA = +00000	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +0001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001	Sensor Source (C;D;H;P;R;S;T) C(1): Sound velocity calculate using ED, ES, ET(temp.) D(0): Manual ED H(2): External synchro P(0), R(0): Manual EP, ER (0 degree) S(0): Manual ES T(1): Internal transducer sensor
Timing Commands	
TE = 00:00:00.00	Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:00.00	Time per Ping (min:sec.sec/100)
Water-Track Commands	
WA = 255	False Target Threshold (Max) (0-255 counts)
WB = 0	Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar)
WC = 064	Low Correlation Threshold (0-255)
WD = 111 000 000	Data Out (V;C;A PG;St;Vsum Vsum^2;#G;P0)
WE = 5000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WG = 001	Percent Good Minimum (0-100%)
WI = 0	Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1	Rcvr Gain Select (0=Low,1=High)
WM = 1	Profiling Mode (1-8)
WN = 050	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 1600	Depth Cell Size (cm)
WT = 0000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)



Water depth: 30 m to 100 m

Water depth: 100 m to 200 m



Water depth: 200 m to 300 m

Water depth: 300 m to 400 m

Fig. 2.2.4 Water current vector.

2.3 Sea surface monitoring: EPCS

(1) Personnel

Keisuke WATAKI (Marine Works Japan Co. Ltd.)
Miyo IKEDA (Marine Works Japan Co. Ltd.)

(2) Objectives

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

(3) Instruments and Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has five sensors of salinity, temperature (two kinds), dissolved oxygen and fluorescence, and can continue to measure the surface nearby seawater automatically every 1 minute. Salinity is calculated from conductivity on the basis of PSS78. There is this system 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 0.5L/min). The flow rate is measured with two flow meters.

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

a) Temperature and Salinity sensor

SEACAT THERMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number: 2126391-3126
Measurement range: Temperature -5 to +35℃, Salinity 0 to 6.5 S m-1
Accuracy: Temperature ±0.01 ℃ 6month-1, Salinity ±0.001 S m-1 month-1
Resolution: Temperatures 0.001℃, Salinity 0.0001 S m-1

b) Bottom of ship thermometer

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

c) Dissolved oxygen sensor

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

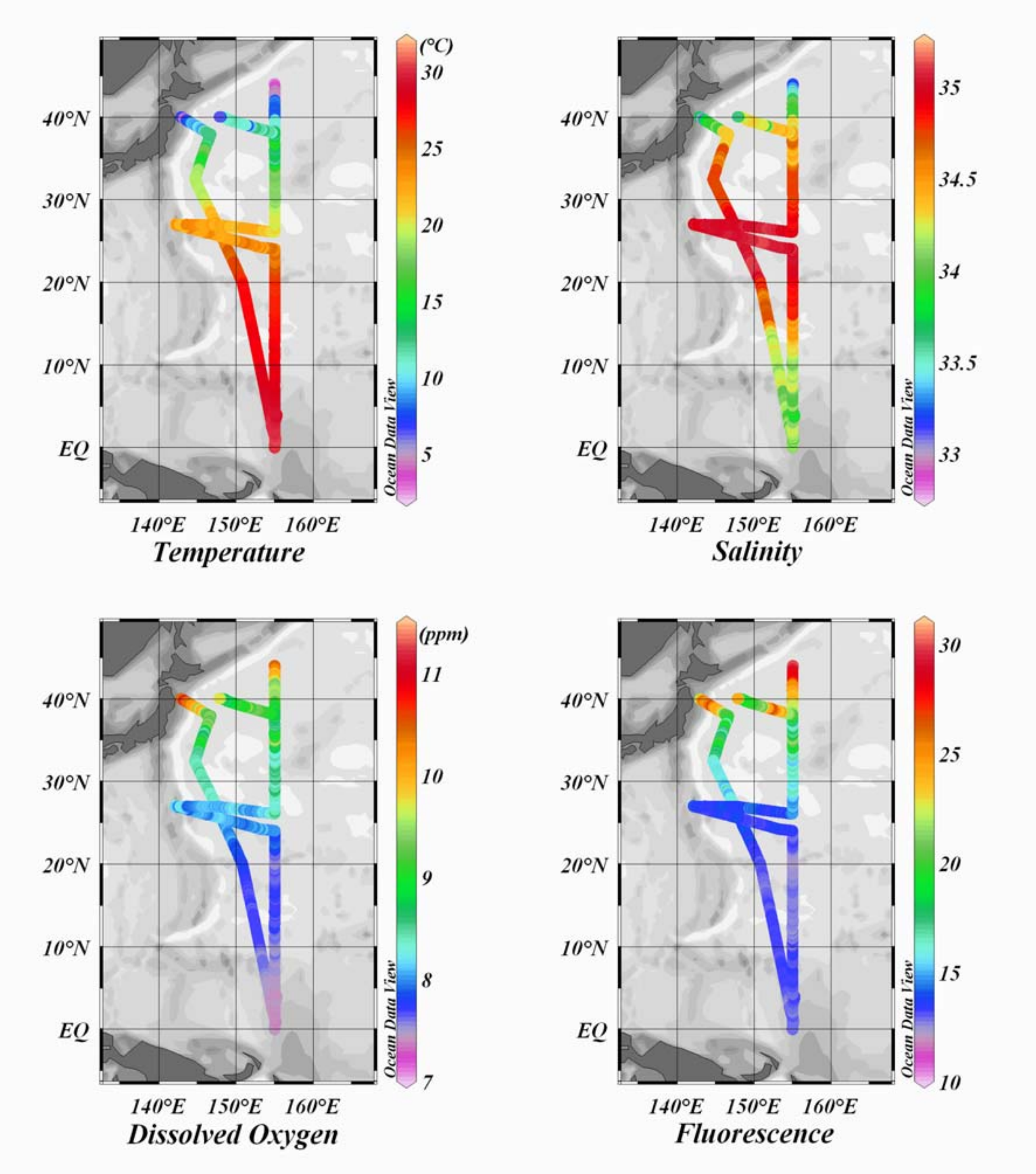
Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 l min-1
Accuracy: ±1%
Stability: ±1% day-1

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

Start : 2007/02/17 06:10 Stop : 2007/03/24 04:25

(4) Preliminary Result

Preliminary data of temperature (Bottom of ship thermometer), salinity, dissolved oxygen, fluorescence at sea surface between this cruise are shown in Fig.2.3-1. These figures were drawn using Ocean Data View (R. Schlitzer, http://www.awi-bremerhaven.de/GEO/ODV, 2002). We collected samples to compare a bottle data with a sensor value of salinity once a day. This is shown in Fig.2.3-2. It measured all salinity samples with AUTOSAL 8400B(Guildline Instruments).



Temperature

Salinity

Dissolved Oxygen

Fluorescence

Fig.2.3-1 Contour line of temperature, salinity, dissolved oxygen and fluorescence of the surface sea water during this cruise.

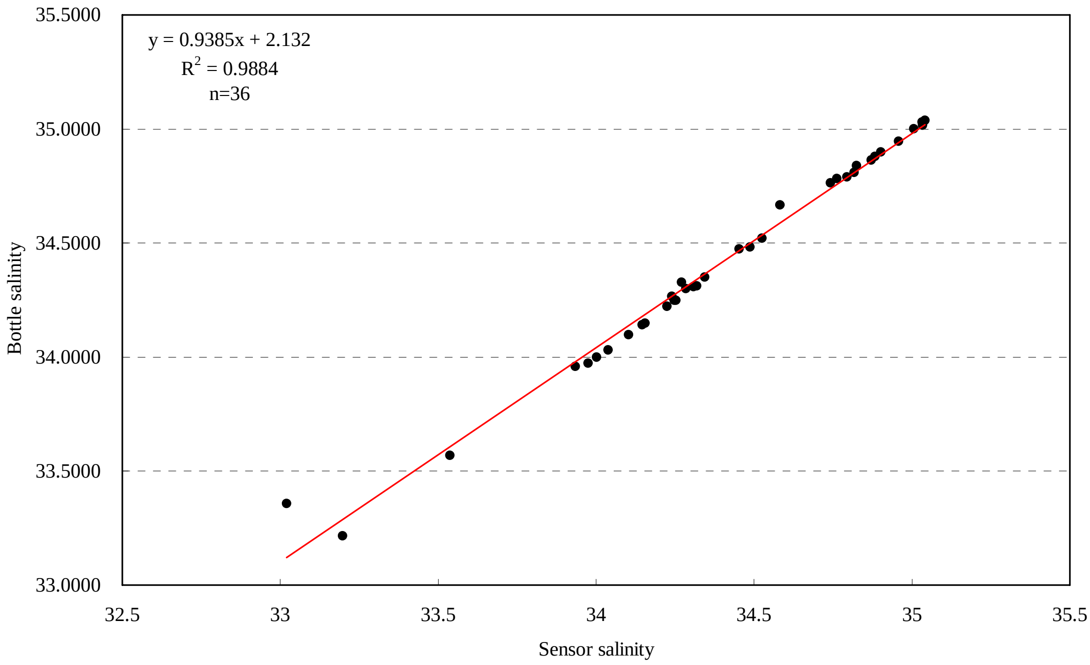


Fig.2.3-2 Comparison between salinity sensor and bottle data.

(5) Date archive

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

2.4 Dissolved oxygen measurement

(1) Personnel

***Keisuke WATAKI* (Marine Works Japan Co. Ltd.)**
***Miyo IKEDA*(Marine Works Japan Co. Ltd.)**

(2) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(3) Measured parameters

Dissolved oxygen of sampled seawater

(4) 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-410 manufactured by Kyoto Electronic Co. Ltd. / 20 cm^3 of titration vessel
Detector and Software; Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

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-02). 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^{o}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. Firstry, 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)
2007/02/18	9	20060419-09-07	20070213-1	3.964	-0.008	20070213-2	3.962	-0.007	001
2007/02/25	10	20060419-10-01	20070213-1	3.963	-0.008	20070213-2	3.960	-0.006	002-1,2,003
2007/02/27		20060419-10-02	20070213-3	3.963	-0.008	20070213-4	3.963	-0.007	004,005,006-1,2,007
2007/02/28		20060419-10-03	20070213-3	3.963	-0.008	20070213-4	3.963	-0.007	008,009,010-1,2,011
2007/03/02		20060419-10-04	20070303-1	3.958	-0.008	20070303-2	3.960	-0.008	012,013,014-1,2,015
2007/03/06		20060419-10-06	20070303-1	3.957	-0.007	20070303-2	3.958	-0.005	016,017,018-1,2
2007/03/08		20060419-10-07	20070303-3	3.958	-0.007	20070303-4	3.962	-0.008	022-1,2,026-1,2
2007/03/13	11	20060419-11-01	20070303-3	3.959	-0.009	20070303-4	3.962	-0.005	028,029,030-1,2
2007/03/14		20060419-11-02	20070312-1	3.961	-0.008	20070312-2	3.962	-0.007	032,033,035-1,2,036
2007/03/16		20060419-11-03	20070312-1	3.960	-0.008	20070312-2	3.962	-0.006	038,037,039-1,2
2007/03/19		20060419-11-04	20070312-3	3.962	-0.008	20070312-4	3.958	-0.007	042-1,2,044
2007/03/20		20060419-11-05	20070312-3	3.963	-0.006	20070312-4	3.958	-0.007	046-1,2,045,043,041
2007/03/23		20060419-11-06	20070323-1	3.967	-0.009	20070323-2	3.961	-0.006	040

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.
174	0.09

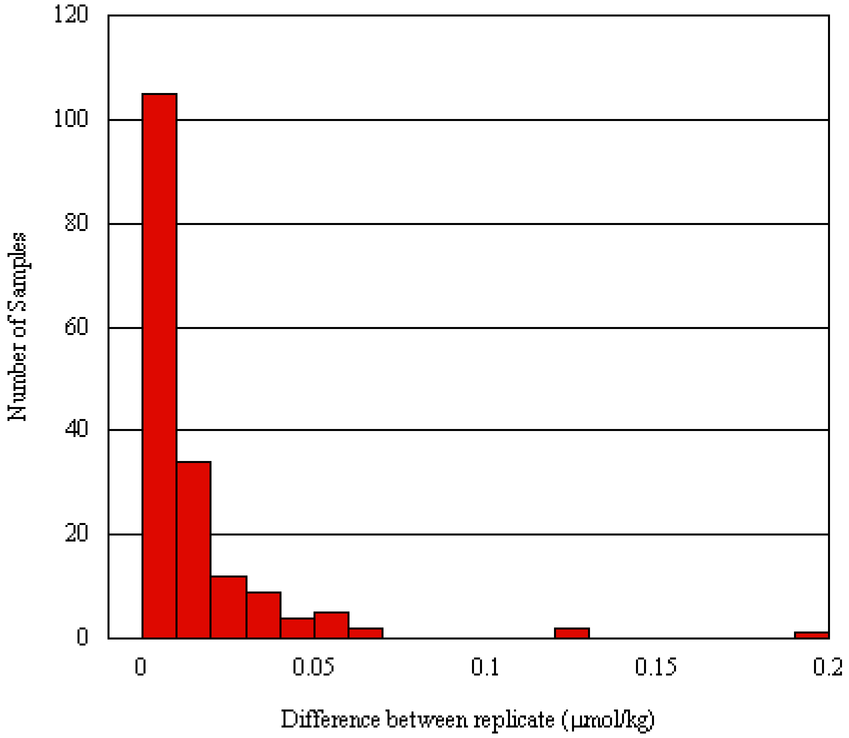


Fig 2.4-1 Results of the replicate sample measurements

(5) Preliminary Result

During this cruise, we measured oxygen concentration in 1992 seawater samples at 37 stations. Concentrations of Dissolved oxygen in vertical section shown in Fig. 2.4-2.

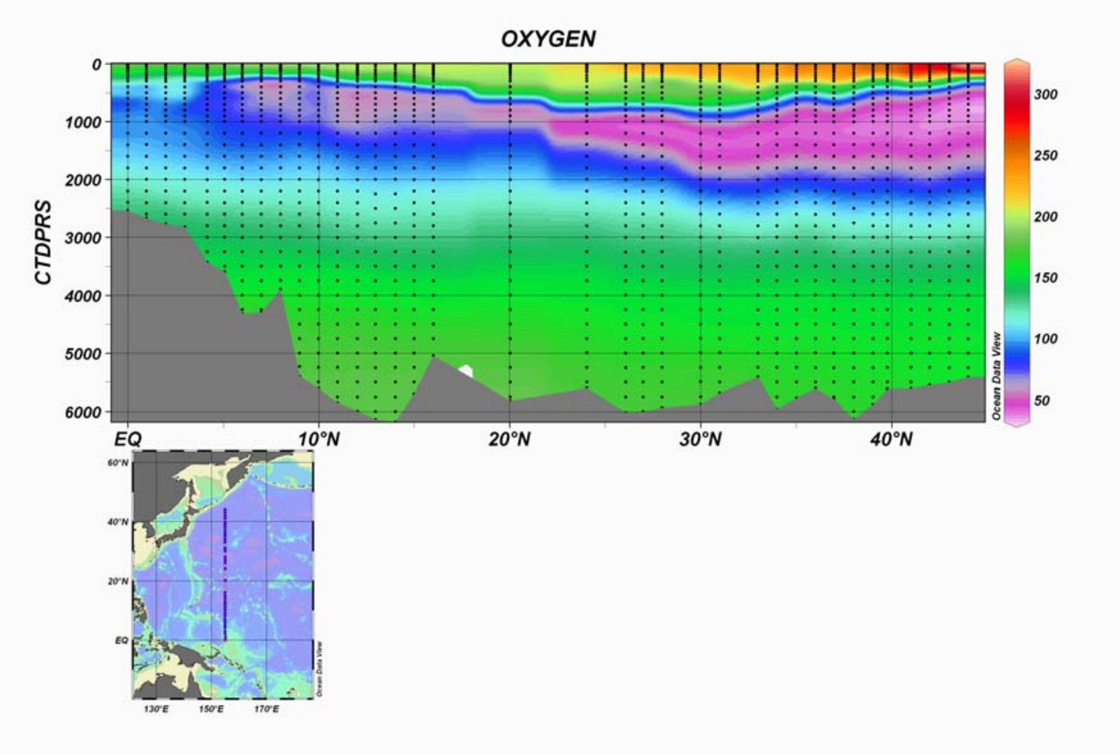


Fig 2.4-2 Vertical section of Dissolved oxygen.

(6) Data archive

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

(7) 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.

2.5 Nutrients

Takayoshi SEIKE, Ayumi TAKEUCHI, Junji MATSUSHITA (MWJ)

(1) Objectives

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

(2) Methods

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system. The laboratory temperature was maintained between 25-28 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 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 um 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 7–13 samples and were used to evaluate precision of nutrients analysis during the cruise. We also used three concentrations of reference material for nutrients in seawater, RMNS (KANSO Co., Ltd., lots AS, AT and AU), for all runs to secure 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 um 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 April 2006.

(3) Preliminary Results

Analytical precisions were 0.08 % (55 uM) for nitrate, 0.09 % (1.2 uM) for nitrite, 0.07 % (171 uM) for silicate, 0.10 % (3.6 uM) for phosphate and 0.33 % (4.0 uM) for ammonia in terms of median of precision, respectively.

Results of RMNS analysis are shown in Tables 2.5.1-2.5.3 for the station’s comparability, and in Table 2.5.4 for the cruise’s comparability.

(4) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) 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.AS analysis in this cruise.

umol/kg

	serial	Stn.	NO_3	NO_2	SiO_2	PO_4	NH_4
RM-AS	367	M07001	0.10	0.01	1.61	0.080	-
RM-AS	534	M07002	0.07	0.01	1.68	0.079	0.79
RM-AS	534	M07003	0.07	0.01	1.63	0.080	-
RM-AS	714	M07004	0.10	0.02	1.62	0.094	-
RM-AS	714	M07005	0.08	0.01	1.66	0.079	-
RM-AS	958	M07006	0.08	0.02	1.56	0.079	0.85
RM-AS	958	M07007	0.08	0.01	1.59	0.099	-
RM-AS	705	M07008	0.08	0.02	1.68	0.079	-
RM-AS	705	M07009	0.08	0.02	1.67	0.075	-
RM-AS	76	M07010	0.06	0.02	1.67	0.076	0.77
RM-AS	76	M07011	0.08	0.02	1.65	0.077	-
RM-AS	121	M07012	0.08	0.02	1.65	0.080	-
RM-AS	121	M07013	0.09	0.01	1.71	0.075	-
RM-AS	348	M07014	0.10	0.01	1.67	0.089	0.83
RM-AS	348	M07015	0.05	0.02	1.57	0.080	-
RM-AS	361	M07016	0.08	0.01	1.68	0.084	-
RM-AS	361	M07017	0.07	0.01	1.68	0.087	-
RM-AS	685	M07018	0.07	0.01	1.64	0.095	0.81
RM-AS	593	M07022	0.09	0.01	1.68	0.086	0.83
RM-AS	671	M07026	0.08	0.01	1.70	0.082	0.84
RM-AS	331	M07028	0.07	0.02	1.66	0.088	-
RM-AS	331	M07029	0.07	0.01	1.61	0.082	-
RM-AS	9	M07030	0.09	0.02	1.64	0.080	0.80
RM-AS	240	M07032	0.08	0.01	1.72	0.091	-
RM-AS	240	M07033	0.08	0.01	1.74	0.079	-
RM-AS	679	M07035	0.08	0.01	1.70	0.075	0.82
RM-AS	679	M07036	0.08	0.02	1.65	0.078	-
RM-AS	233	M07037	0.09	0.01	1.67	0.078	-
RM-AS	233	M07038	0.08	0.01	1.63	0.077	-
RM-AS	7	M07039	0.08	0.01	1.65	0.079	0.78
RM-AS	968	M07040	0.08	0.02	1.72	0.091	-
RM-AS	608	M07041	0.09	0.01	1.68	0.082	-
RM-AS	31	M07042	0.09	0.01	1.67	0.092	0.83
RM-AS	31	M07042	0.09	0.02	1.70	0.090	-
RM-AS	608	M07043	0.08	0.01	1.66	0.103	-
RM-AS	126	M07044	0.08	0.02	1.73	0.087	-
RM-AS	581	M07045	0.07	0.01	1.63	0.093	0.85
RM-AS	581	M07046	0.07	0.01	1.68	0.086	-

Table 2.5.2 Results of RMNS Lot.AT analysis in this cruise.

umol/kg

	serial	Stn.	NO_3	NO_2	SiO_2	PO_4	NH_4
RM-AT	46	M07001	7.47	0.02	17.97	0.592	-
RM-AT	707	M07002	7.45	0.02	17.99	0.595	0.72
RM-AT	707	M07003	7.48	0.02	17.91	0.597	-
RM-AT	435	M07004	7.49	0.02	17.93	0.606	-
RM-AT	435	M07005	7.51	0.02	17.99	0.594	-
RM-AT	182	M07006	7.45	0.02	17.88	0.605	-
RM-AT	182	M07007	7.49	0.02	17.94	0.611	0.76
RM-AT	71	M07008	7.47	0.01	17.99	0.587	-
RM-AT	71	M07009	7.42	0.03	17.97	0.586	-
RM-AT	375	M07010	7.47	0.01	18.06	0.600	0.70
RM-AT	375	M07011	7.47	0.02	18.01	0.595	-
RM-AT	188	M07012	7.44	0.02	17.99	0.600	-
RM-AT	188	M07013	7.44	0.02	17.99	0.585	-
RM-AT	511	M07014	7.49	0.02	17.99	0.596	-
RM-AT	511	M07015	7.52	0.02	17.92	0.596	0.73
RM-AT	757	M07016	7.48	0.02	17.89	0.598	-
RM-AT	757	M07017	7.46	0.01	17.96	0.594	-
RM-AT	572	M07018	7.44	0.02	17.94	0.598	0.72
RM-AT	745	M07022	7.51	0.01	18.04	0.588	0.73
RM-AT	684	M07026	7.43	0.01	17.97	0.596	0.77
RM-AT	894	M07028	7.44	0.01	18.06	0.598	-
RM-AT	894	M07029	7.46	0.02	17.90	0.597	-
RM-AT	361	M07030	7.42	0.02	18.00	0.591	0.72
RM-AT	338	M07032	7.47	0.01	18.04	0.596	-
RM-AT	338	M07033	7.48	0.02	18.02	0.592	-
RM-AT	205	M07035	7.47	0.02	17.92	0.590	0.72
RM-AT	205	M07036	7.49	0.02	17.92	0.578	-
RM-AT	951	M07037	7.49	0.02	17.96	0.589	-
RM-AT	951	M07038	7.49	0.01	17.98	0.586	-
RM-AT	411	M07039	7.49	0.02	17.96	0.599	0.70
RM-AT	633	M07040	7.41	0.02	18.03	0.597	-
RM-AT	650	M07041	7.44	0.02	17.97	0.596	-
RM-AT	105	M07042	7.49	0.02	18.01	0.598	0.77
RM-AT	105	M07042	7.45	0.02	18.00	0.600	-
RM-AT	650	M07043	7.44	0.03	17.97	0.607	-
RM-AT	248	M07044	7.50	0.02	17.98	0.588	-
RM-AT	390	M07045	7.46	0.01	17.95	0.590	0.75
RM-AT	390	M07046	7.45	0.02	17.95	0.608	-

Table 2.5.3 Results of RMNS Lot.AU analysis in this cruise.

umol/kg

	serial	Stn.	NO_3	NO_2	SiO_2	PO_4	NH_4
RM-AU	136	M07001	29.84	0.01	66.47	2.185	-
RM-AU	563	M07001	29.92	0.01	66.56	2.187	-
RM-AU	718	M07002	29.86	0.01	66.57	2.194	0.51
RM-AU	353	M07002	29.90	0.01	66.60	2.196	0.53
RM-AU	718	M07003	29.87	0.02	66.40	2.189	-
RM-AU	353	M07003	29.89	0.01	66.59	2.195	-
RM-AU	569	M07004	29.88	0.02	66.45	2.183	-
RM-AU	718	M07004	29.89	0.01	66.65	2.194	-
RM-AU	569	M07005	29.97	0.01	66.56	2.188	-
RM-AU	718	M07005	29.97	0.01	66.66	2.194	-
RM-AU	772	M07006	29.84	0.01	66.61	2.194	0.55
RM-AU	569	M07006	29.89	0.01	66.53	2.198	0.56
RM-AU	772	M07007	29.87	0.01	66.53	2.196	-
RM-AU	569	M07007	29.90	0.01	66.53	2.197	-
RM-AU	852	M07008	29.81	0.02	66.54	2.187	-
RM-AU	772	M07008	29.80	0.02	66.59	2.183	-
RM-AU	852	M07009	29.86	0.02	66.64	2.187	-
RM-AU	772	M07009	29.78	0.02	66.67	2.188	-
RM-AU	282	M07010	29.89	0.01	66.66	2.193	0.52
RM-AU	852	M07010	29.85	0.02	66.69	2.199	0.52
RM-AU	282	M07011	29.97	0.02	66.65	2.181	-
RM-AU	852	M07011	29.93	0.02	66.75	2.181	-
RM-AU	742	M07012	29.90	0.01	66.67	2.191	-
RM-AU	282	M07012	29.90	0.02	66.73	2.190	-
RM-AU	742	M07013	29.90	0.01	66.62	2.190	-
RM-AU	282	M07013	29.97	0.01	66.71	2.194	-
RM-AU	238	M07014	29.98	0.03	66.76	2.184	0.54
RM-AU	742	M07014	30.02	0.01	66.89	2.186	0.55
RM-AU	238	M07015	29.90	0.02	66.49	2.185	-
RM-AU	742	M07015	29.93	0.02	66.56	2.194	-
RM-AU	46	M07016	29.90	0.02	66.46	2.192	-
RM-AU	238	M07016	29.91	0.02	66.53	2.193	-
RM-AU	46	M07017	29.84	0.01	66.64	2.184	-
RM-AU	238	M07017	29.88	0.01	66.59	2.184	-
RM-AU	365	M07018	29.85	0.01	66.51	2.192	0.51
RM-AU	46	M07018	29.91	0.01	66.57	2.199	0.53
RM-AU	755	M07022	29.89	0.01	66.61	2.193	0.55
RM-AU	365	M07022	29.98	0.01	66.64	2.201	0.54
RM-AU	243	M07026	29.80	0.01	66.47	2.187	0.55
RM-AU	755	M07026	29.87	0.01	66.51	2.188	0.57
RM-AU	949	M07028	29.89	0.02	66.68	2.192	-
RM-AU	243	M07028	29.91	0.01	66.77	2.199	-
RM-AU	949	M07029	29.87	0.01	66.54	2.194	-
RM-AU	243	M07029	29.88	0.01	66.54	2.197	-
RM-AU	748	M07030	29.87	0.01	66.65	2.176	0.54
RM-AU	949	M07030	29.91	0.01	66.69	2.178	0.54

RM-AU	135	M07032	29.91	0.01	66.79	2.193	-
RM-AU	748	M07032	29.94	0.01	66.76	2.196	-
RM-AU	135	M07033	29.99	0.01	66.53	2.187	-
RM-AU	748	M07033	30.01	0.01	66.53	2.185	-
RM-AU	657	M07035	29.89	0.01	66.63	2.186	0.54
RM-AU	135	M07035	29.89	0.01	66.52	2.187	0.54
RM-AU	657	M07036	29.90	0.01	66.55	2.184	-
RM-AU	135	M07036	29.90	0.01	66.49	2.188	-
RM-AU	68	M07037	29.98	0.02	66.51	2.188	-
RM-AU	657	M07037	29.96	0.02	66.62	2.189	-
RM-AU	68	M07038	29.91	0.01	66.59	2.190	-
RM-AU	657	M07038	29.95	0.01	66.58	2.187	-
RM-AU	169	M07039	29.96	0.01	66.53	2.196	0.52
RM-AU	68	M07039	29.99	0.02	66.63	2.198	0.54
RM-AU	920	M07040	29.80	0.02	66.51	2.188	-
RM-AU	775	M07040	29.80	0.02	66.64	2.197	-
RM-AU	775	M07041	29.81	0.01	66.46	2.190	-
RM-AU	122	M07041	29.84	0.01	66.52	2.194	-
RM-AU	309	M07042	29.95	0.02	66.54	2.188	0.55
RM-AU	309	M07042	29.98	0.01	66.53	2.195	-
RM-AU	169	M07042	29.98	0.02	66.52	2.188	0.55
RM-AU	169	M07042	29.97	0.01	66.54	2.204	-
RM-AU	775	M07043	29.87	0.03	66.47	2.197	-
RM-AU	122	M07043	29.86	0.02	66.49	2.193	-
RM-AU	833	M07044	29.90	0.02	66.61	2.171	-
RM-AU	309	M07044	29.96	0.02	66.62	2.177	-
RM-AU	122	M07045	29.94	0.01	66.54	2.176	-
RM-AU	833	M07045	29.85	0.01	66.54	2.176	-
RM-AU	122	M07046	29.96	0.01	66.47	2.189	0.55
RM-AU	833	M07046	29.94	0.01	66.62	2.190	0.56

Table 2.5.4 Summary of RMNS Lot.AS, AT, AU analysis in MR04-04, MR05-05, MR05-04, MR06-03, and MR07-01 cruise.

umol/kg

RM-AS		NO_3	NO_2	SiO_2	PO_4	NH_4
MR07-01	median	0.08	0.01	1.67	0.081	0.82
	stdev	0.01	0.00	0.04	0.007	0.03
	n=	38	38	38	38	12
MR06-03	median	0.10	0.01	1.67	0.065	0.84
	stdev	0.01	0.00	0.07	0.008	0.03
	n=	49	50	49	49	12
MR05-04	median	0.14	0.01	1.68	0.078	0.82
	stdev	0.02	0.00	0.04	0.011	0.02
	n=	15	15	16	15	14
MR05-01	median	0.09	0.01	1.65	0.077	ND
	stdev	0.03	0.00	0.06	0.005	ND
	n=	16	16	16	16	ND
MR04-04	median	0.11	0.01	1.63	0.072	ND
	stdev	0.02	0.00	0.10	0.014	ND
	n=	41	41	42	41	ND

umol/kg

RM-AT		NO_3	NO_2	SiO_2	PO_4	NH_4
MR07-01	median	7.47	0.02	17.97	0.596	0.73
	stdev	0.03	0.00	0.05	0.007	0.03
	n=	38	38	38	38	12
MR06-03	median	7.47	0.02	17.97	0.576	0.76
	stdev	0.03	0.00	0.06	0.008	0.02
	n=	49	50	49	49	12
MR05-04	median	7.49	0.02	18.40	0.591	0.71
	stdev	0.03	0.00	0.05	0.011	0.02
	n=	15	15	16	15	14
MR05-01	median	7.49	0.02	18.31	0.587	ND
	stdev	0.06	0.00	0.07	0.005	ND
	n=	16	16	16	16	ND
MR04-04	median	7.47	0.01	18.32	0.582	ND
	stdev	0.04	0.00	0.10	0.012	ND
	n=	41	41	42	41	ND

umol/kg

RM-AU		NO_3	NO_2	SiO_2	PO_4	NH_4
MR07-01	median	29.90	0.01	66.57	2.190	0.54
	stdev	0.06	0.00	0.09	0.006	0.01
	n=	76	76	76	76	24
MR06-03	median	29.90	0.01	66.53	2.174	0.56
	stdev	0.07	0.00	0.12	0.008	0.01
	n=	94	96	94	94	12
MR05-04	median	29.99	0.01	68.25	2.186	0.52
	stdev	0.06	0.00	0.15	0.011	0.02
	n=	28	28	30	28	13
MR05-01	median	29.97	0.01	67.92	2.191	ND
	stdev	0.09	0.00	0.21	0.007	ND
	n=	28	28	28	28	ND
MR04-04	median	29.94	0.01	68.00	2.176	ND
	stdev	0.08	0.00	0.17	0.012	ND
	n=	102	102	104	102	ND

2.6 pH measurement

Minoru KAMATA (MWJ)
Ayaka HATSUYAMA (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 MR07-01cruise.

(2) Methods, Apparatus and Performance

(2)-1 Seawater sampling

Seawater samples were collected with CTD system mounted 12L Niskin bottles at 37 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.

(2)-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=060502-4: pH=8.0905, 070213-1: pH=8.0906 pH units at 25℃, Delvalls and Dickson, 1998) and AMP buffer(Lot=060802-2: pH=6.7839, 070213-1: pH=6.7839 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:

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

(3) 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=131 pairs). The standard deviation was 0.001 pH units, which indicates that the analysis was accurate enough according to DOE (1994).

(4) Data Archive

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

Reference

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

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.

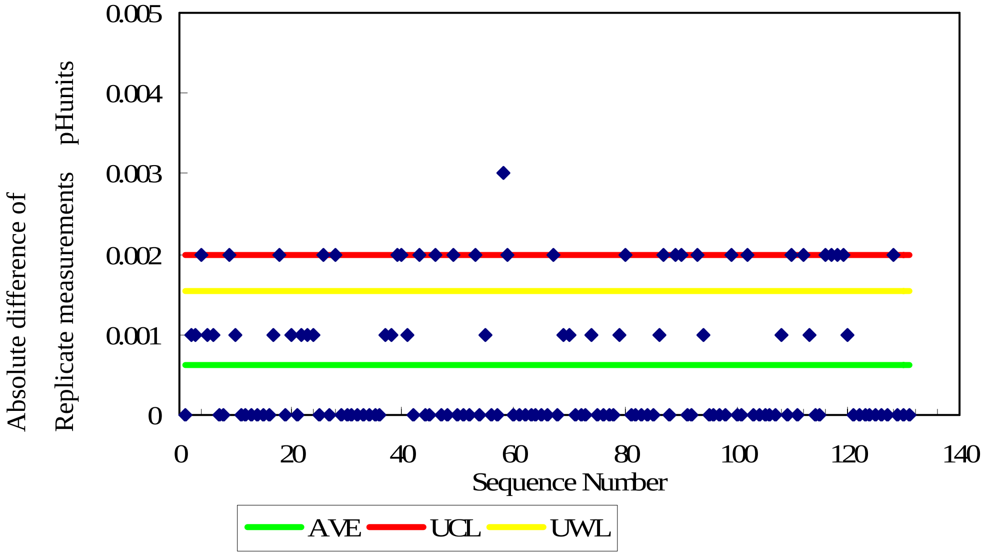


Figure 2.6-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of pH during this cruise.

2.7 Total dissolved inorganic carbon-TDIC

Shinichiro YOKOGAWA (MWJ)
Yoshiko ISHIKAWA (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 MR07-01 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 two total CO_2 measuring systems (systems A and C; Nippon ANS, Inc.), which are slightly different from each other. The systems comprise of a seawater dispensing system, a CO_2 extraction system and a coulometer (system A: Model 5012, UIC Inc., system C: New type model, Nippon ANS, Inc. and JAMSTEC).

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 (system A and C) volume by PC control. The pipette was kept at 20 degC by a water jacket, in which water from a water bath 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. To degas CO_2 as quickly as possible, a heating wire kept at 40 degC (system A) is rolled from the bottom to a 1/3 height of the stripping chamber. 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. For system A, the module consists of two electric dehumidifiers (kept at 0.5 - 2 degC) and a chemical desiccant ($Mg(ClO_4)_2$). For system C, the module consists of two electric dehumidifiers (kept at 6 degC).

The measurement sequence such as 2 % CO_2 gas in a nitrogen base, system blank (phosphoric acid blank), and seawater samples (6) 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, 1,563 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 1.4μmol/kg (n=166). The standard deviation was 1.3 μmol/kg, which indicates that the analysis was accurate enough according to DOE (1994).

(4) Data Archive

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

Reference

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

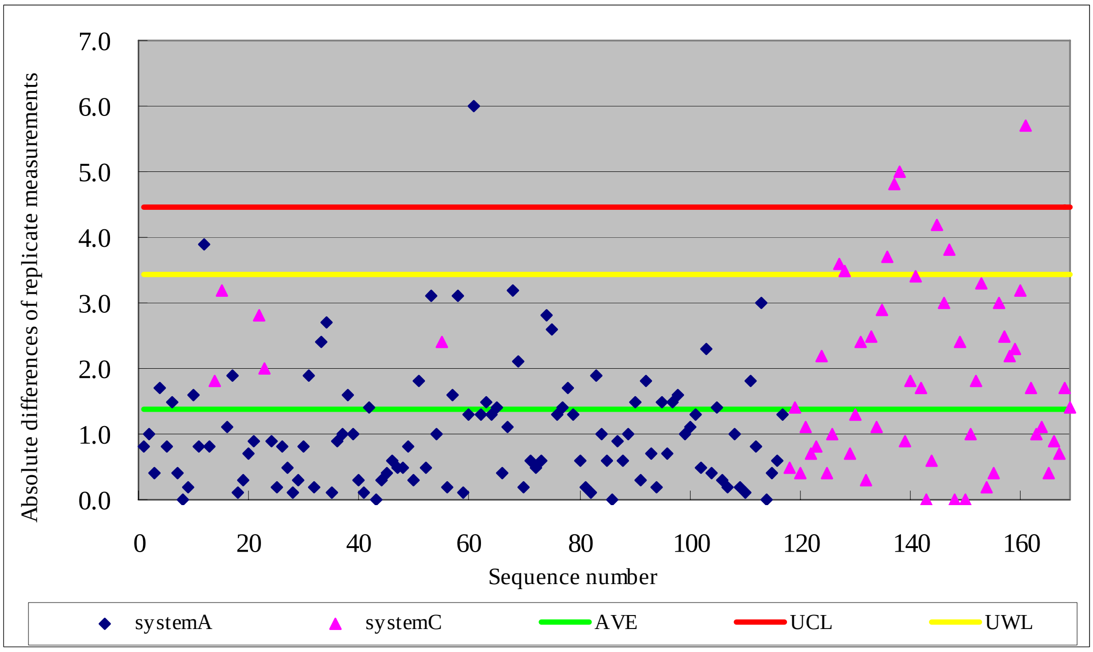


Figure 2.7.-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of DIC during the MR07-01 cruise.

2.8 Total alkalinity

Minoru KAMATA (MWJ)
Ayaka HATSUYAMA (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 MR07-01 cruise.

(2) Methods, Apparatus and Performance

(2)-1 Seawater sampling

Seawater samples were collected with 12L Niskin bottles attached to CTD system at 38 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 was 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.

(2)-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 (Breland and Byrne, 1993).

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 (Breland and Byrne, 1993):

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

, 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:

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

where V_{SW} is the volume of the seawater sample (ml), N_A is the concentration of the added acid (mol/l), V_A is the volume of the added acid, $(H^+)_{ASW}$ is the excess hydrogen ion concentration in the acidified seawater (mol/l), V_{ASW} is the volume of the acidified seawater calculated as V_{SW} + $V_{A,}$, dsw is sample seawater density.

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 0.053455 mol/l.

(3) 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= 125). The standard deviation was 0.6 µmol/kg, which indicates that the analysis was accurate enough according to DOE (1994).

(4) Data Archive

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

Reference

Breland, J.A. and R. H. Byrne (1993), Spectrophotometric procedures for determination of sea water alkalinity using bromocresol green. Deep-Sea Research I Vol 40 No.3 629-641.

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

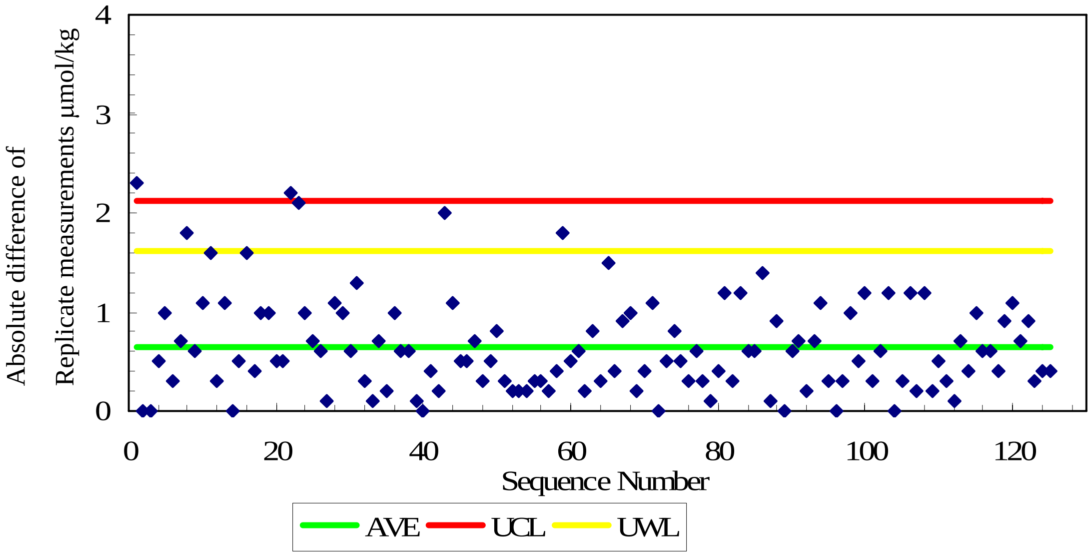


Figure 2.8-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of TA during the MR07-01 cruise.

2.9 Underway pCO_2

Yoshiko ISHIKAWA (MWJ)
Shinichiro YOKOGAWA (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 MR07-01 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 260.03, 310.12, 360.03 and 410.21 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.

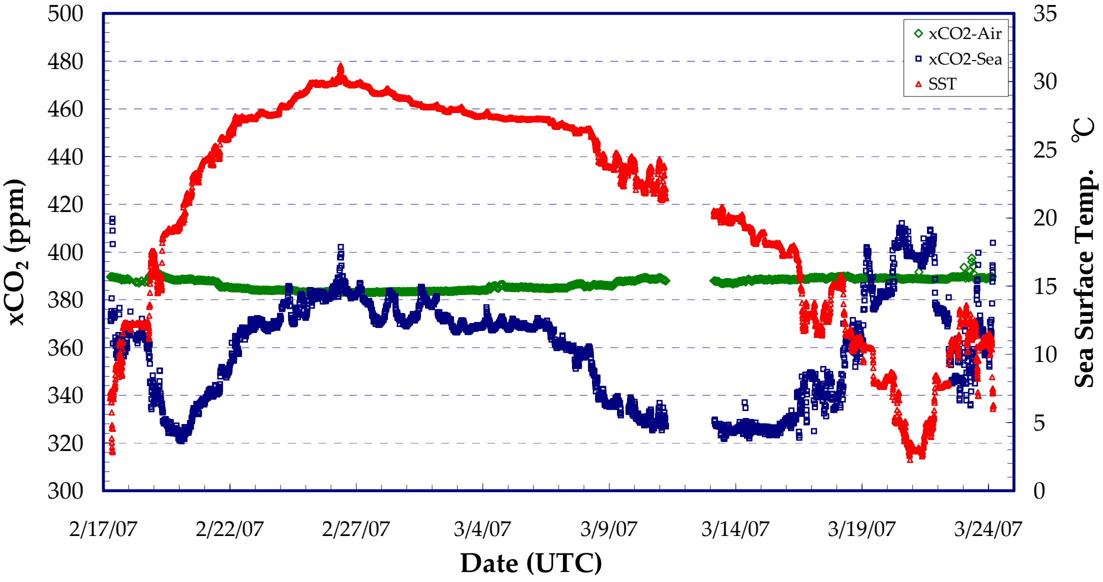


Figure 2.9.-1 Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(4) Data Archive

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

Reference

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

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

3. Special observation

3.1 Chlorofluorocarbons

Ken'ichi SASAKI1), Katsunori Sagishima2)and Hideki YAMAMOTO2)

1) Mutsu Institute for Oceanography, Japan Agency for Marine - Earth Science and Technology

2) Marine Works Japan Co. Ltd

3.1.1 Objectives

Chlorofluorocarbons (hereafter CFCs) have been artificially synthesized at 1930's or later by industrial activities. These compounds are chemically and biologically stable in troposphere and have been accumulated in the atmosphere. 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) and CFC-113 ($C_2Cl_3F_3$), behave conservatively in seawater and have been used as transient tracers for decadal scale circulation of the ocean. In this cruise, we determined these compounds dissolved in seawater on board and obtained vertical sections along 155°E.

We tested to determine carbon tetrachloride (CCl_4) which could be used as another tracer. This compound is also man-made gas and has longer atmospheric accumulation history than these of CFCs. This tracer could give additional knowledge to water circulation and geochemical cycles in the ocean.

3.1.2 Apparatuses

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

Table 3-5-1 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: 8m, thick: 0.25μm]
Main column:	Connected two capillary columns (Pora Bond-Q [i.d.: 0.53mm, length: 13 m, thick: 6.0μm] followed by Silica Plot [i. d.: 0.53mm, length: 30m, thick: 0.25μm])
Purging & trapping:	Automated valve switching system. Trap column are 1/8" SUS packed column (Porapak T)

3.1.3 Procedures

3.1.3.1 Sampling

Seawater sub-samples for CFC measurements were collected from 12 litter Niskin bottles to 300ml glass bottle which was developed by our research group. The bottle is consistent of a 300 ml glass bottle, a 6mm glass tube, SUS unions, and small plastic stop cocks. The bottle was filled by nitrogen gas before sampling. An inlet stop cock was connected to Niskin bottle by rubber tube and any babbles in the tube were removed. Opening inlet and drain cocks, the bottle was filled by seawater sample from the bottom. Two times of the bottle volumes of seawater sample were overflowed from the drain and two cocks were closed immediately from downstream. 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. These procedures were needed in order to minimize contamination from atmospheric CFCs.

Air samples for CFCs measurement were collected to 100ml glass cylinder attached magnesium perchlorate dryer tube at the navigation deck on R/V “MIRAI”.

3.1.3.2 Analysis

The CFCs 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 °C. The CFCs are desorbed by electrically heating the trap column to 140 degree centigrade within 1.5 minutes, and led into the pre-column. CFCs and other compounds are roughly separated in the pre-column and the compounds having earlier retention time than CFC-113 are sent to main analytical column. And then the pre-column is flushed buck by counter flow of pure nitrogen gas (Back flush system). The back flush system is prevent to enter any compounds that have longer 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). Retention time of each CFC is around 1.5, 4.2 and 10.5 minutes for CFC-12, CFC-11 and CFC-113, respectively. The analytical conditions are listed in table 3-5-2.

Table 3-5-2 Analytical conditions of dissolved CFCs in seawater.

Temperature	
Analytical Column:	95 °C
Detector (ECD):	240 °C
Trap column:	-40 °C (at adsorbing) & 140 °C (at desorbing)
Mass flow rate of nitrogen gas (99.9999%)	
Carrier gas:	15 ml min^{-1}
Detector make-up gas:	20 ml min^{-1}

Back flush gas: 15 ml min^{-1}
Sample purge gas: 150 ml min^{-1}

All nitrogen gases through a VICI nitrogen gas purifier tube and Molecular Sieve 13X (MS-13X) gas filters. The MS-13X filters are re-activated by heating to 260 deg C for 24 hr under nitrogen flow every constant interval.

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)

3.1.4 Performances

3.1.4.1 Precisions

The analytical precisions are estimated from replicate sample analyses. The precisions were calculated to be ± 0.007 pmol/kg (n = 134), ± 0.007 pmol/kg (n = 124) and ± 0.007 pmol/kg (n = 136) for CFC-11, -12 and -113, respectively. The precision values could be altered after quality control of data. 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.

3.1.4.2 Analytical blank

Line blanks were almost zero for all CFCs. The analytical blanks (contamination during sampling, sample storage, analytical procedure) are estimated from analyses of deep water samples collected from $\sigma_\theta > 27.75$ (These water masses are expected to be too old to contain any CFCs). The blanks for CFC-11, -12, and -113 were calculated to be 0.018 ± 0.004 , 0.010 ± 0.004, and 0.010 ± 0.008 pmol kg^{-1} (n=200), respectively. These blank values are subtracted from all data.

3.1.5 CCl_4 analysis (Test)

Using one of CFC analytical systems, we tested to determine dissolved CCl4. Several analytical columns and trap columns have been prepared in this cruise. We researched suitable ones from the columns by trial and error and selected 100 m DB624 capillary column for analytical column and Porapak N packed column for cold trap column. Other conditions are as follows: ECD temp. = 90°C; column oven temp. = 50°C; mass flow rate of carrier gas = 10 ml min^{-1}; make-up gas = 5 ml min^{-1}, sample purge gas = 200 ml min^{-1}. We determine dissolved CCl4 concentration at station M07042 by conditions mentioned above. Sampling method was same as that for CFCs. The shape of vertical distribution was close to that expected from CFC profiles but we found some problems in CCl_4 determination which are 1) too higher concentration of surface water than saturation level with respect to background air, 2) thermal decomposition of CCl_4 during trap heating, and 3) considerable high line blank (~0.5 pmol kg^{-1} that corresponds to ~ 8 % with respect to the concentration in surface water).

3.1.6 Data archive

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

3.1.7 References

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.

3.2 Dissolved Organic Carbon

Masahide WAKITA (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 first distribution of DOC during winter at Station KNOT in the northwestern North Pacific Ocean.

(2) Sampling

Seawater samples were collected at Stations KNOT (M07046 cast1 & 3) and brought the total to ~ 40. 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.

3.3 Oxygen Isotope

V. V. S. SARMA (Nagoya University)

3.3.1. Assessment of plankton metabolic processes (gross, net production and respiration) using triple oxygen isotopes of dissolved oxygen and O2/Ar ratios

3.3.1.1. Objective:

Assessment of plankton metabolic processes, such as community gross, net production, and respiration, is very important in order to understand how biological processes influence carbon flux from the sunlit zone. In general, these metabolic rates are measured using incubation techniques involving either geochemical or artificial tracers such as 14C and give rates of a given water mass sampled over time incubated. These methods involve several uncertainties due to bottle effect, tracer recycling, changes of nutrients concentrations in the bottle, continuous exposure to the constant light etc, resulting in ambiguous estimation of metabolic rates. Nevertheless, bottle incubation techniques will not able to capture short-term bloom events. On the other hand, the estimation of metabolic rates based on triple oxygen isotopic composition of dissolved oxygen would alleviate problems involved in the incubation techniques and would give time-integrated rates over residence time of oxygen in the mixed layer. Our aim is to examine spatial variations in the plankton metabolic processes along the ship's cruise track in the western North Pacific to understand how biological pump influences carbon flux to the twilight zone in different regions.

3.3.1.2. Principle and approach

Our technique involves precise measurements of triple oxygen isotopes (^{16}O, ^{17}O and ^{18}O) in dissolved oxygen (O_2) in the surface mixed layer of the ocean, which is controlled by photosynthetic O_2 production, respiration, and exchange with atmosphere. The isotopic composition of O_2 produced during photosynthesis and fractionation during respiration is the primary controls on the ratios of stable oxygen isotopes in atmospheric O_2. These processes fractionate oxygen isotopes in a mass-dependent way such that $\delta^{17}O$ enrichment is about half of $\delta^{18}O$ relative to ^{16}O. On the contrary, mass-independent fractionation occurs in the stratosphere during photochemical reactions involving O_3, O_2 and CO_2 and both $\delta^{17}O$ and $\delta^{18}O$ are equally lowered (Thiemens, 2001). Therefore, $\delta^{18}O$ of O_2, which is produced and consumed by biological processes, there is always an excess of ^{17}O in comparison to that of atmospheric O_2, which is influenced by stratospheric O_2 (Luz et al., 1999). This excess or the ^{17}O anomaly ($^{17}\Delta$) in the dissolved O_2 in the surface mixed layer is determined by the relative contributions of photosynthetically produced "normal" O_2 and "anomalous" O_2 from the atmosphere. If the rate of O2 exchange from the atmosphere is known, the gross oxygen production can be estimated. Since both oxygen and argon have similar solubility, therefore, it is possible to estimate the influence of biological processes on oxygen concentrations using measurements of O2/Ar ratios. By assuming the steady state, the net to gross production ratios can be derived using Hendricks et al. (2004) model. Using gross oxygen production, net to gross production ratios, net community production and respiration rates can be derived.

3.3.1.3. Method

Triple oxygen isotopes of dissolved oxygen are measured using Delta Plus Mass spectrometer following gas separation technique of Sarma et al. (2003). About 150 ml of water sample was collected in the flask while leaving 150 ml headspace. Extreme care was taken to avoid trapping of gas bubbles during sampling. The stopcock is closed and port is refilled with distilled water and then sealed with rubber cap to avoid air contamination. The water and headspace in the sampling flasks were equilibrated for 24 hours at room temperature. After equilibration, the water was sucked out of the flasks by leaving only headspace gases. The flasks were then connected to the preparation system for separation and purification of O_2. The separation system consists of vacuum line connected to the gas chromatographic column of 5A molecular sieve at –90 C. The molecular sieve at –90C retains nitrogen and elutes O2 and Ar and the eluted gases are trapped using 15x molecular sieve at liquid nitrogen temperature. These samples are admitted to the mass spectrometer for isotopic ratios of the 16,17 and 18O and O2/Ar ratios against atmospheric air as a standard.

3.3.1.4. Preliminary Results:

The samples analysis is underway.

3.3.1.5. Data Archive

All the data will be submitted to JAMSTEC Data Management Office (DMO)

3.3.1.6. References:

Luz, B, E. Barkan, M.L. Bender, M.H. Thiemens, K.A. Boering, Triple-isotope composition of atmospheric oxygen as a tracer of biosphere productivity, *Nature, 400*, 547-550, 1999.

Sarma, V.V.S.S., O. Abe, and T. Saino, Chromatographic separation system of nitrogen, argon and oxygen in dissolved air for determination of triple oxygen isotopes by Dual-inlet mass spectrometry, *Anal. Chem., 75*, 4913-4917, 2003.

Thiemens, M.H., Atmospheric science – The mass-independent ozone isotope effect, *Science, 293*, 226-226, 2001.

3.3.2. Estimation of gross oxygen production of the mode waters

3.3.2.1. Objective:

Estimation of phytoplankton gross oxygen production of the mode waters is very important to understand carbon biogeochemistry of these regions. However, time-integrated primary production in these regions is very sparse. The mode waters forms during winter and spreads in the subsurface waters between 200-800 m. The main objective of this work is to explore possibility of estimation of gross oxygen production of the mode waters using triple isotopes of dissolved oxygen and age of water mass derived from CFCs.

3.3.2.2. Principle and approach

The principle of this approach as described in section 3.3.1.2. Once the water mass leave the surface, the oxygen anomaly behaves as a conservative tracer. Though respiration decreases oxygen concentrations however, the anomaly will not be changed as it follows mass dependent fractionation procedure. Therefore, the anomaly measured below the photic zone represents average anomaly of the water mass when it was in the surface. Therefore, it is possible to estimate gross oxygen production based on measured oxygen anomaly, age of the water mass and air-sea exchange at the time of water mass formed.

3.3.2.3. Method:

As described in the section 3.3.1.3.

3.3.2.4. Preliminary Results:

The samples analysis is underway.

3.3.2.5. Data Archive

All the data will be submitted to JAMSTEC Data Management Office (DMO)

3.4. Noble Gas sampling

V. V. S. S. SARMA (Nagoya University)

Samples were collected by V. V. S. S. Sarma for measurement of argon and nitrogen gas concentrations on 5 casts (Stations 12-2, 26-3, 32-2, 46-1 and 46-3). In the first four of these casts 10 samples were taken in duplicate between 5 and 500 meters (5, 10, 100, 150, 200, 250, 300, 400 and 500 meters). At station 46 cast 1 included single samples at the same depths in addition to 800, 1000, 1400, 2000, 2600, and 3000 meters. Cast 3 at Station 46 included duplicate sampling at the same depths between 5 and 500 meters in addition to depths, 800, 1000, 1400, 2000, 2600 and 3000 meters. The total number of samples take was 104.

The samples were sent to the laboratory of Steven Emerson at the University of Washington in Seattle, WA, U.S.A. There the concentrations of argon and nitrogen will be determined by isotope dilution mass spectrometry. The goal of this sampling program is to determine the degree of inert gas supersaturation in the thermocline. It has been shown that the degree of supersaturation is a function of the history of diapycnal mixing in the thermocline since the water subducted from the surface ocean. By determining the degree of saturation of Ar and N_2 in the latitudes between the subarctic-subtropical boundary and into the subtropical thermocline, we seek to determine the rate of diapycnal mixing in the shallow thermocline of the Subtropical Northwestern Pacific.

3.5 Phytoplankton Pigments

3.5.1 Fluorometric determination (Total chl-*a*, Size-fractionated chl-*a*)

1. Personnel

Kazuhiko MATSUMOTO **(JAMSTEC); Principal Investigator**
Masanori ENOKI **(MWJ); Operation Leader**

2. 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 along 155E between the equator and 44N.

3. 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 0.1% of surface irradiance for shallow-cast. Size-fractionated samples were collected at 8 depths (100, 50, 25, 10, 5, 2.5, 1 and 0.25% 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 1. After the samples measurements for the station of M07001 – M07012, a lamp in the fluorometer of “Non-acidification method” was replaced and continued to measure samples for the station of M07013 – M07026, since the sensitivity was slightly downed. We changed the fluorometer to another one and measured samples for the station of M07026 – M07046 because the condition was not improved while we replaced a lamp. Calibrations have been conducted at every station by a working chlorophyll *a* standard.

4. Preliminary Results

The vertical distributions of total-chlorophyll *a* and size fractionated chlorophyll *a* along 155E between the equator and 44N were shown in Figure 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 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

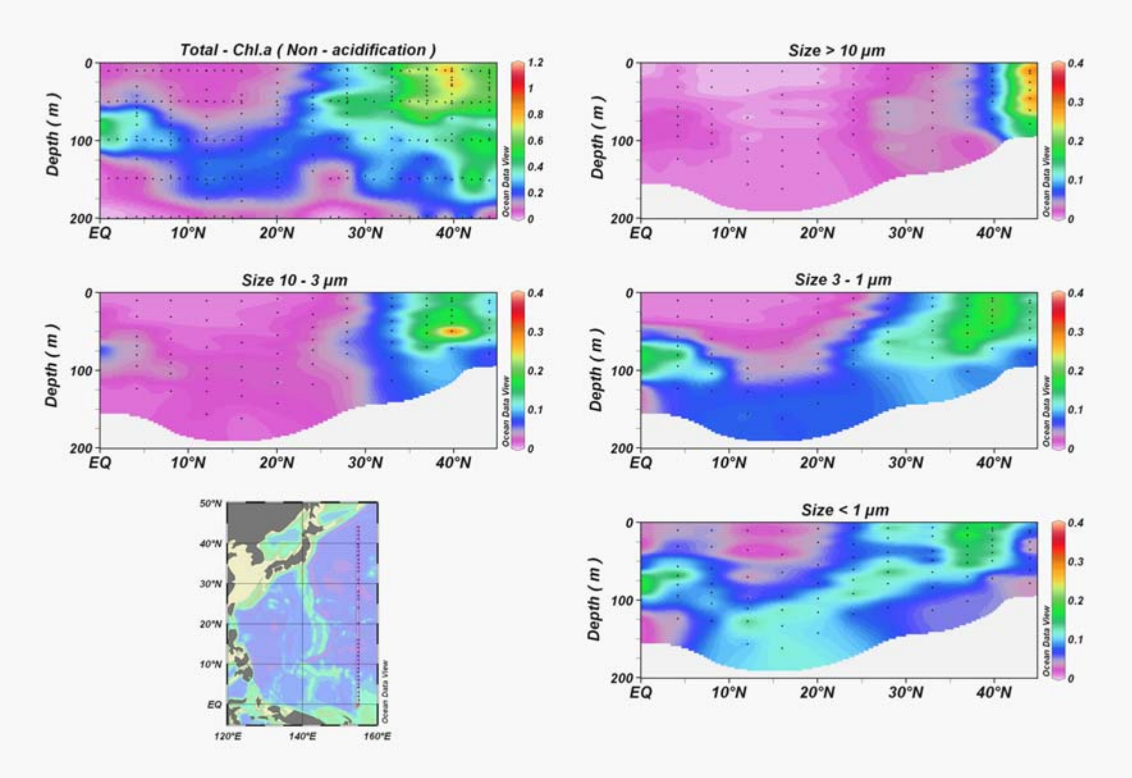


Figure 1. Vertical distributions of chlorophyll *a* concentration (µg/L) along 155E between the equator and 44N.

3.5.2. HPLC measurements of marine phytoplankton pigments

1. Personnel

Kazuhiko MATSUMOTO (JAMSTEC); Principal Investigator
Yuichi SONOYAMA (MWJ); Operation Leader

2. 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 along 155E between the equator and 44N.

3. 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 0.25% 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 (-20 deg C) within 5 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 (420µl), and measured with photodiode array detector. Analytical conditions of HPLC system were modified the method of Zapata *et al*. (2000).

3.1 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).

3.2 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.

3.3 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.

3.4 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 23 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.

3.5 Internal standard

Ethyl-apo-8'-carotenoate 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 164383±4774 (n=159) , the coefficient of variation was 2.9%.

3.6 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.

4. Preliminary results

Vertical distributions of major pigments were shown in Figure 2.

5. 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.

6. 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*	10.143	460
2	Chlorophyllide *a*	12.473	663.9
3	Chlorophyll *c2*	13.975	460
4	Peridinin	17.102	460
5	Pheophorbide *a*	19.368	663.9
6	19'-butanoyloxyfucoxanthin	20.098	460
7	Fucoxanthin	21.207	460
8	Neoxanthin	21.568	460
9	Prasinoxanthin	22.725	460
10	Violaxanthin	23.368	460
11	19'-hexanoyloxyfucoxanthin	23.627	460
12	Diadinoxanthin	25.323	460
13	Antheraxanthin	26.073	460
14	Alloxanthin	26.507	460
15	Diatoxanthin	26.958	460
16	Zeaxanthin	27.302	460
17	Lutein	27.402	460
18	Ethyl-apo-8’-carotenoate	28.827	460
19	Crocoxanthin	30.207	460
20	Chlorophyll *b*	30.722	457.2
21	Divinyl Chlorophyll *a*	31.730	661.4
22	Lycopene	31.782	460
23	Chlorophyll *a*	32.123	661.4
24	Pheophytin a	34.823	663.9
25	Alpha-carotene	35.102	460
26	Beta-carotene	35.577	460

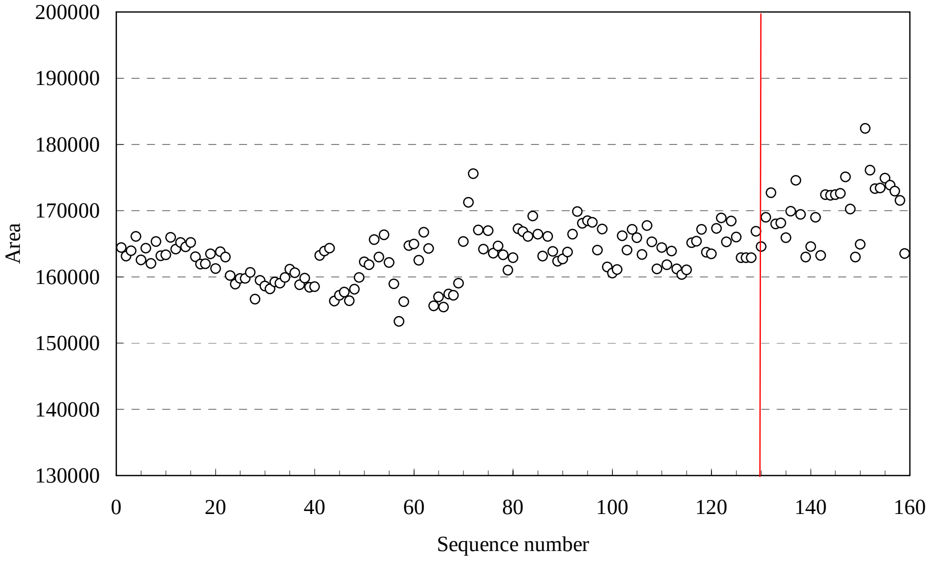


Figure 1. Variabilities of the chromatogram area for the internal standard. After the sequence number of 130 (those are corresponded to the data of 37N, 40N and 44N), the chromatograms of internal standard were overlapped with other pigments due to the tailing, then the area values were slightly increased.

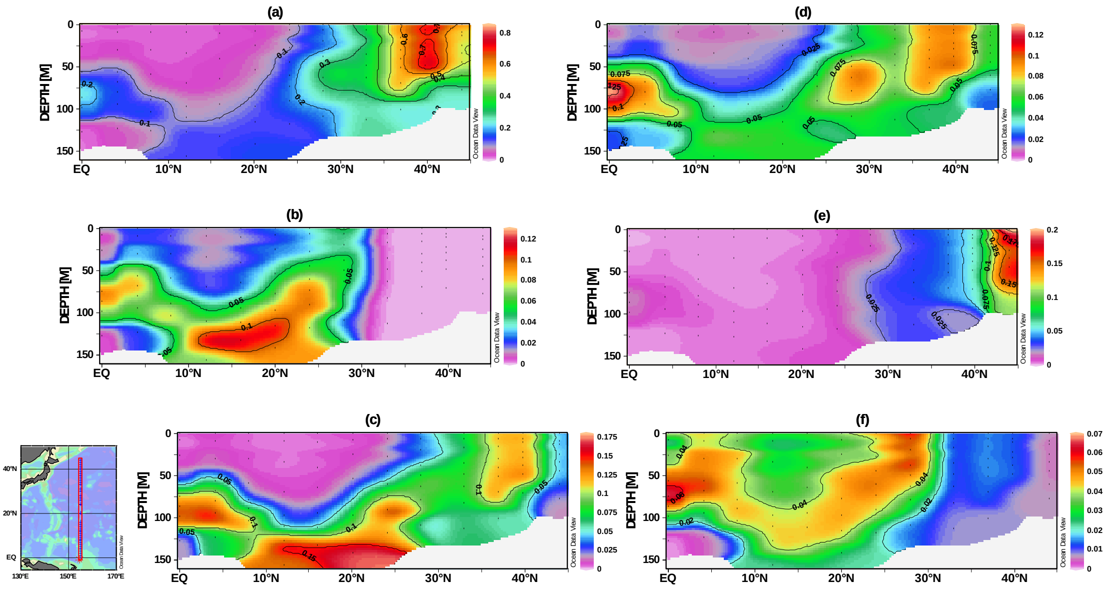


Figure 2. Vertical distributions of phytoplankton pigments (µg/L) along 155E. Chlorophyll *a* (a), Divinyl-chlorophyll *a* (b), Chlorophyll *b* (including Divinyl-chlophyll *b*) (c), 19’-Hexanoyloxy-fucoxanthin (d), Fucoxanthin (e), and Zeaxanthin (f) are roughly represented as the abundance of total phytoplankton, prochlorophytes, prochlorophytes and green algae, diatoms, haptophytes, and cyanobacteria, respectively.

3.6 Primary productivity (P vs E curve)

Ai YASUDA (MWJ)

Fuyuki SHIBATA (MWJ)

(1) Objectives

The objective of this study is to known the mechanism of primary production at the northwest Pacific Ocean.

(2) Methods, Apparatus and Performance

Bottles for incubation and filters

Bottles for incubation (approx. 1 litter) were done to cut off the light on bottle's side, upper and bottom, which did not pass the light from a 500W halogen light (light source). These bottles were numbered from No.1 to 9, near the light. All bottles were shield with a film on light side.

Grass fiber filters (Wattman GF/F 25mm) pre-combusted under 450-degree C of temperature condition for at least 6 hours, were used for a filtration.

Incubation

Photosynthesis and irradiation curve measurement were carried out at St.M07001A, M07002, M07006, M07010, M07014, M07018, M07022, M07026, M07030, M07035, M07039, M07042 and M07046. We took samples form the surface and two predefined depth by a bucket and Niskin bottles at each stations. These depths corresponded to nominal specific optical depths (10%, 10% or 1%). The bottles were spiked with 0.2 mmoles/mL of $NaH^{13}CO_3$ solution, and incubated for 3 hours at temperature- controlled bath in a laboratory. The light intensity was shown in table 3.6. Samples were filtered immediately after the incubation and the filters were kept to freeze till analyze of this cruise. After that, filters were dried on the oven of 45 degree C.

Measurement

During the cruise, all samples will be made to measure by a mass spectrometer ANCA-SL system at MIRAI.

(3) Preliminary results

During in this cruise, we measured isotope δ-POC(mgC/m^3/h) in each incubation filter samples at 13 stations. We collected to compare Light intensity (uE/m^2/sec) and δ-POC(mgC/m^3/h) data. Results of the comparison were shown in Fig. 3.6.1-13.

(4) Data archives

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

Table. 3.6. Light Intensity of P-I measurements

	Light Intensity (uE/cm^2/sec)		
Bottle No.	Bath A (0m)	Bath B（10%）	Bath C（2.5% or 1%）
1	1650	1600	1450
2	800	800	700
3	400	400	340
4	160	160	150
5	70	70	60
6	30	34	30
7	15	20	20
8	4	2.6	3.5
9	0.6	0.6	0.6

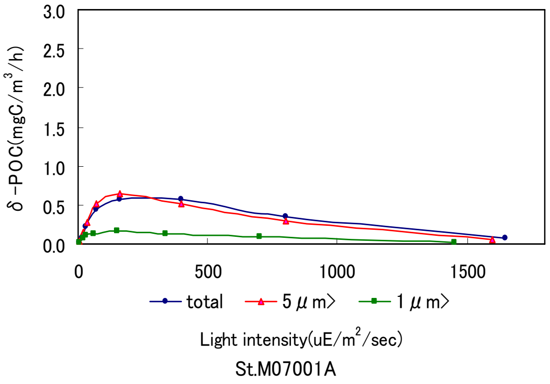


Fig.3.6-1

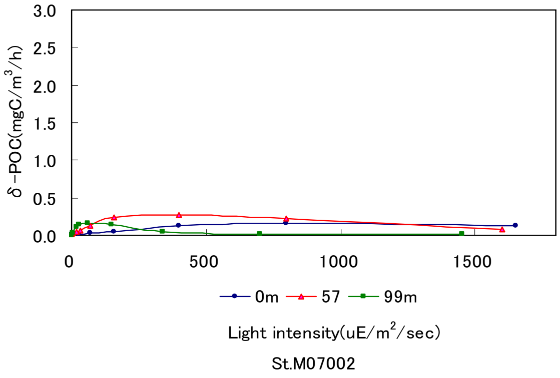


Fig.3.6-2

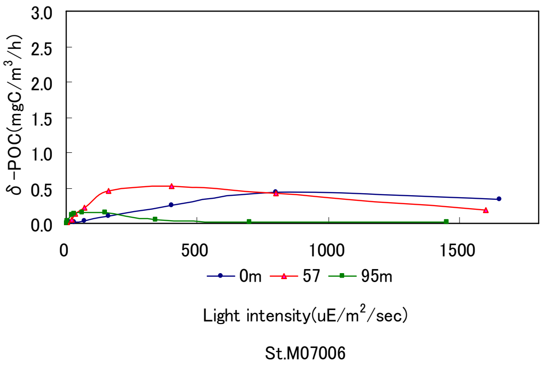


Fig.3.6-3

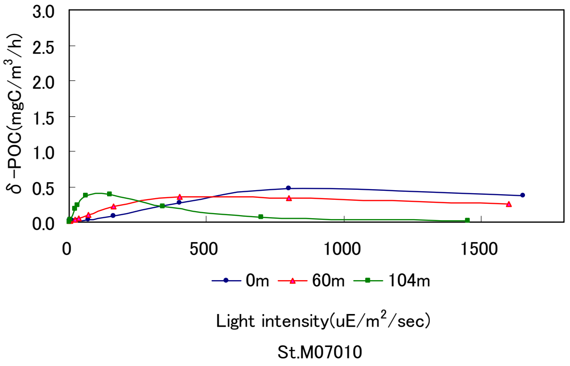


Fig.3.6-4

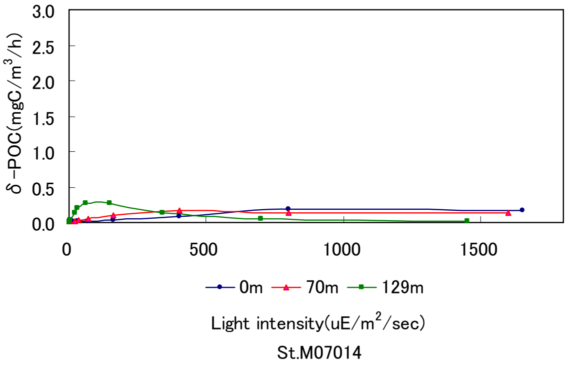


Fig.3.6-5

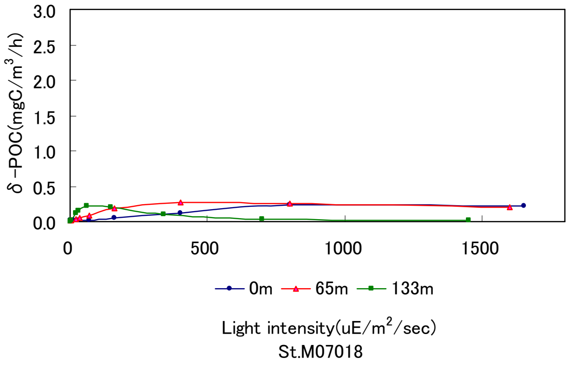


Fig.3.6-6

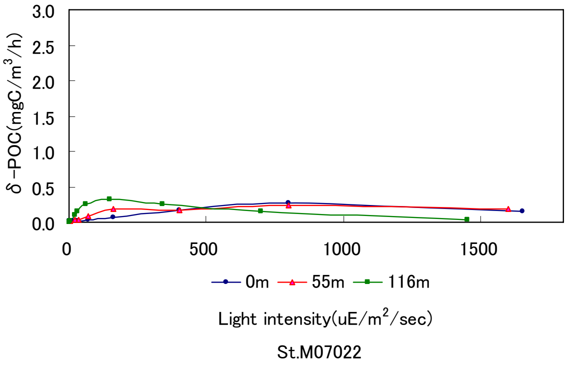


Fig.3.6- 7

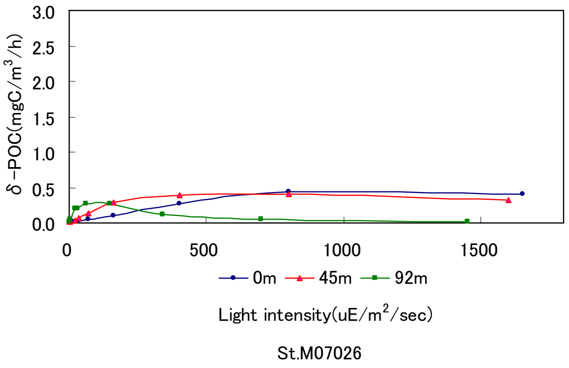


Fig.3.6-8

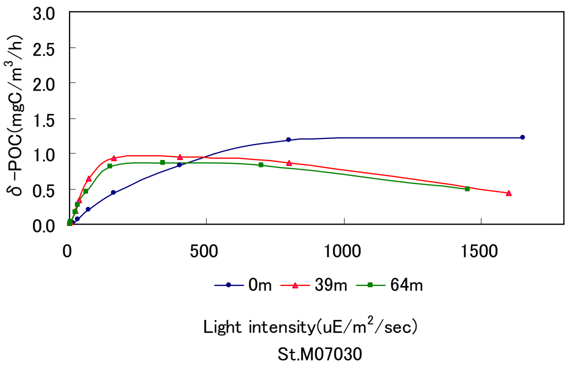


Fig.3.6-9

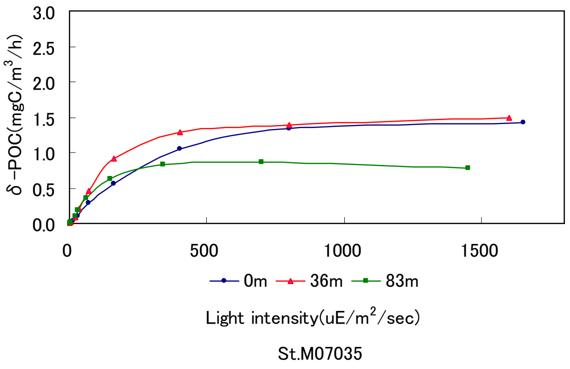


Fig.3.6-10

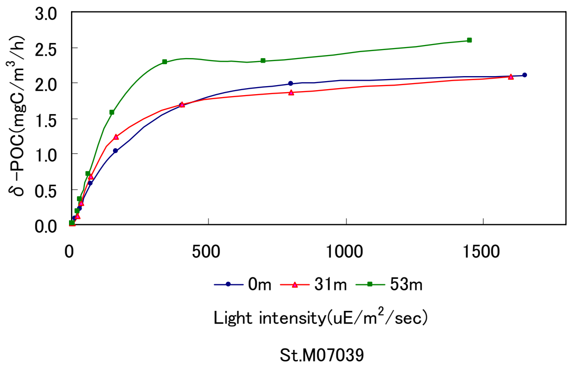


Fig.3.6-11

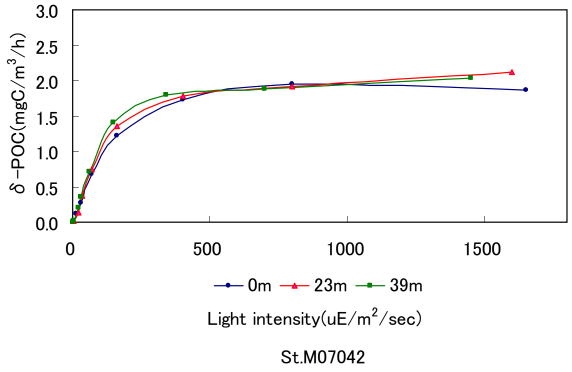


Fig.3.6-12

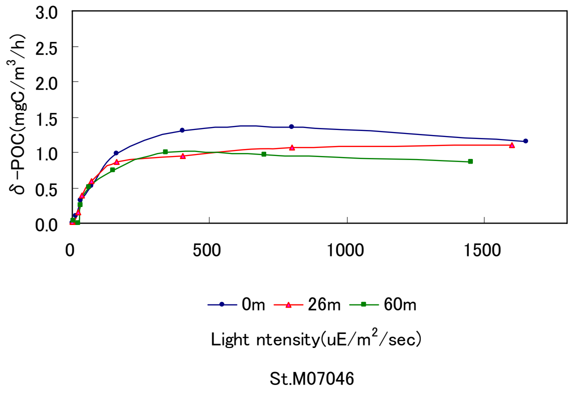


Fig.3.6-13

Fig.3.6-1-13. Comparison between Light intensity (uE/m2/sec) and δ -POC (mgC/m3/h) data

3.7. Optical measurements

1. Personnel

Kazuhiko MATSUMOTO	**(JAMSTEC); Principal Investigator**
Naoko TAKAHASHI	**(MWJ); Supporting Staff**

2. Objective

The objective is to investigate the air and underwater light conditions at respective stations along 155E between the equator and 44N. In addition, it was carried out to determine the sampling depths for shallow cast.

3. Description of instruments deployed

3.1 SPMR/SMSR

The first instrument system deployed was the SeaWiFS Profiling Multichannel Radiometer (SPMR) and SeaWiFS Multichannel Surface Reference (SMSR), (Satlantic Inc.). The SPMR is deployed in a freefall mode through the water column while measuring the following physical and optical parameters. The profiler carries a 13-channel irradiance sensor (Ed) and a 13-channel radiance sensor (Lu), as well as instrument tilt and fluorometry probe. The SMSR or reference sensor has a 13-channel irradiance sensor (Es). Those channels represent in Table 1.

The profiler was deployed twice per station to a depth of 200m. The reference was mounted on the compass deck and was never shadowed by any ship structures. The profiler fell at an average rate of 1m/s with tilts of less than 5 degrees. These measurements provide data to characterize the underwater light field, such as profiles of photosynthetically available radiation (PAR).

Table 1. Center wavelengths 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

3.2 Spectroradiometer

The second instrument system deployed was the PUV-510B (Biospherical Instruments Inc.). This instrument package measures downwelling irradiance (Es). The PUV-510B was set up on the compass deck and started collecting data immediately upon departure from Sekinehama. This instrument package ran 24 hours a day and the data was collected using DASWIN data logging software. However, the records of the acquired data were interrupted due to logging error during the following period; 08:00 – 18:41 on 24 February 2007 (UTC) and since 19 March 2007 (UTC).

3.3 Calibration

SPMR/SMSR were calibrated on January 2007. PUV-510B was calibrated on December 2006, though it was available only PAR channel.

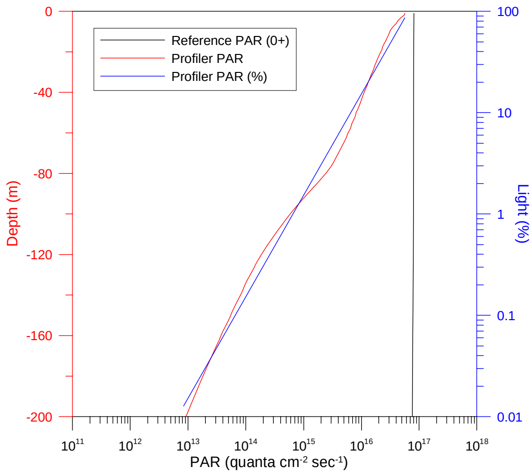
4. Preliminary results

The profiles of PAR irradiance were shown in sample plots.

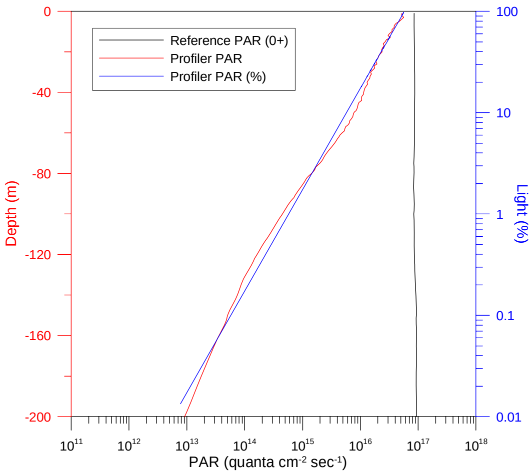
5. Data archives

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

Sample plots



Stn. M07002 (M07002AB)



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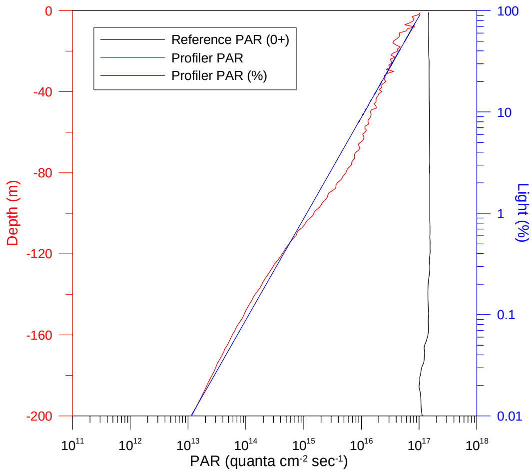

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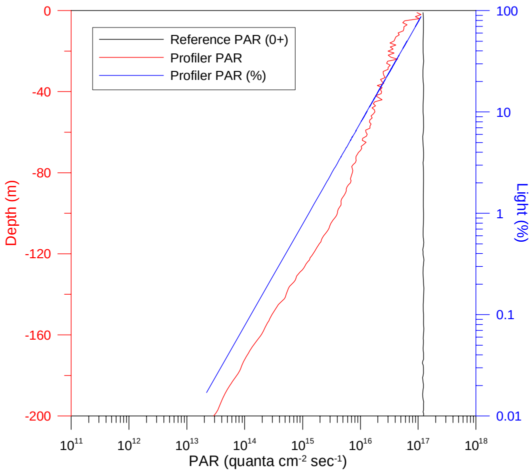

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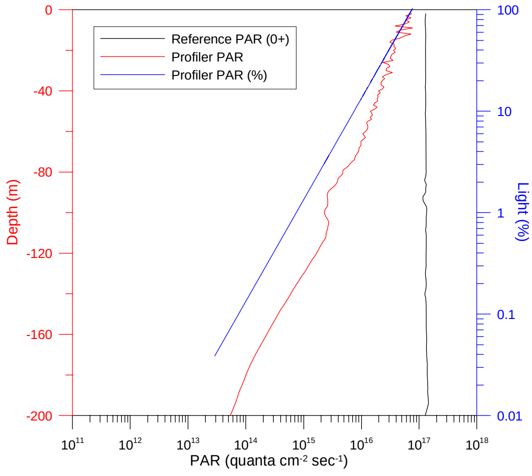

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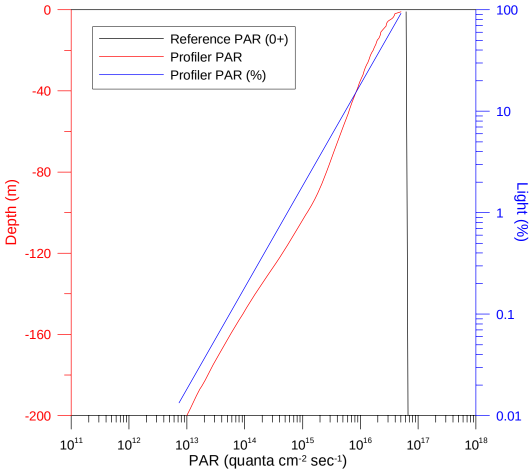

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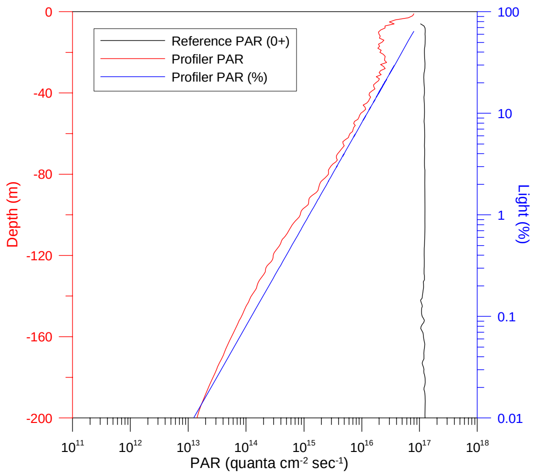

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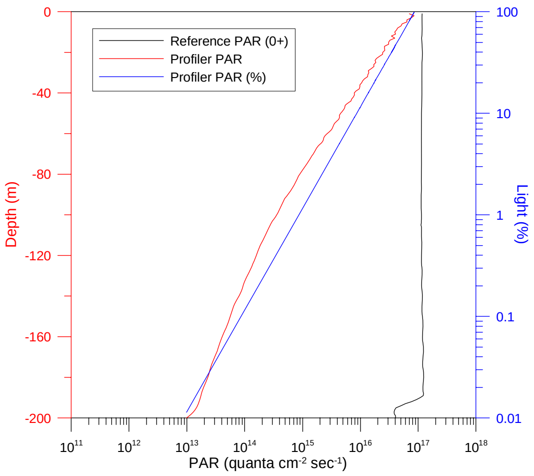

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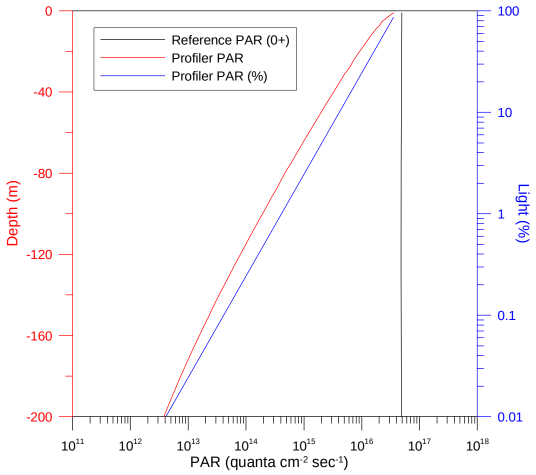

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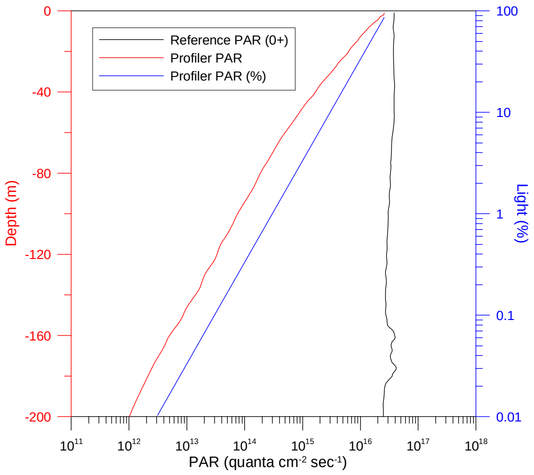

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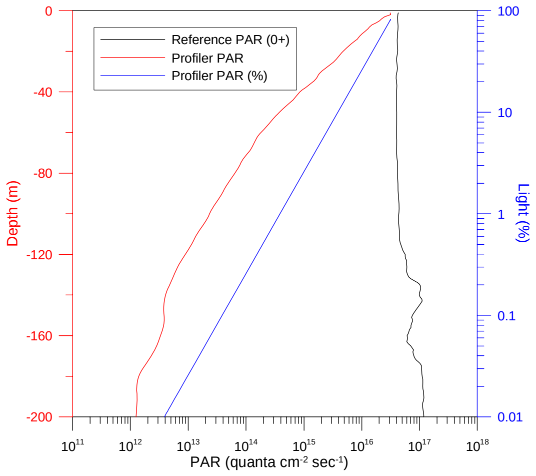

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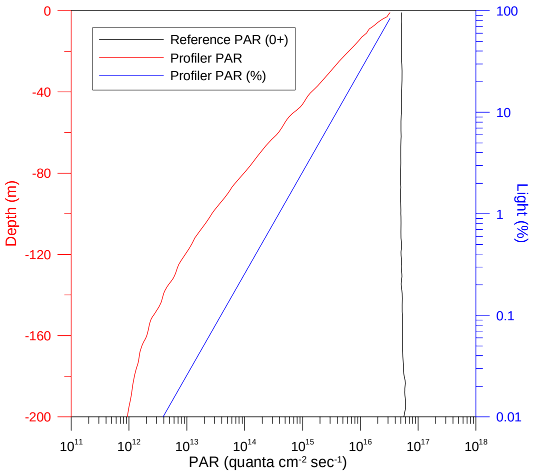

Stn. M07046 (M07046AC)

3.8 FRRF observation

Tetsuichi Fujiki (JAMSTEC)

(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 intervals of about two degrees along 155^oE from 0^o to 44^oN in the Pacific Ocean. The FRR fluorometer was moved up and down between surface and 200 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. The observations of FRR fluorometer were made at *ca* 10:00 a.m. (LST) during the period of investigation.

(3) Preliminary results

The profiles of F_v/F_m, F_m (indicator of chlorophyll *a* biomass) and photosynthetically active radiation (PAR) in the station M07006 (4^o, 155^oE) 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.

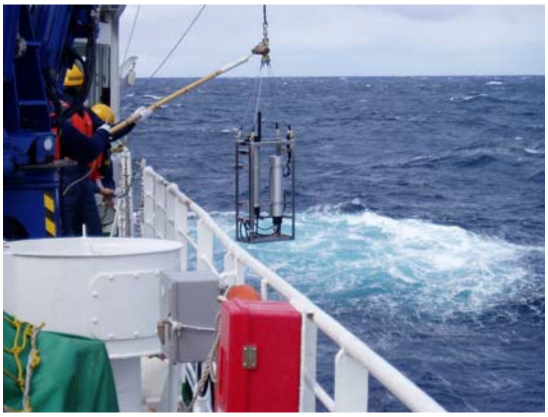

Fig. 1. Observation of phytoplankton productivity with the FRR fluorometer.

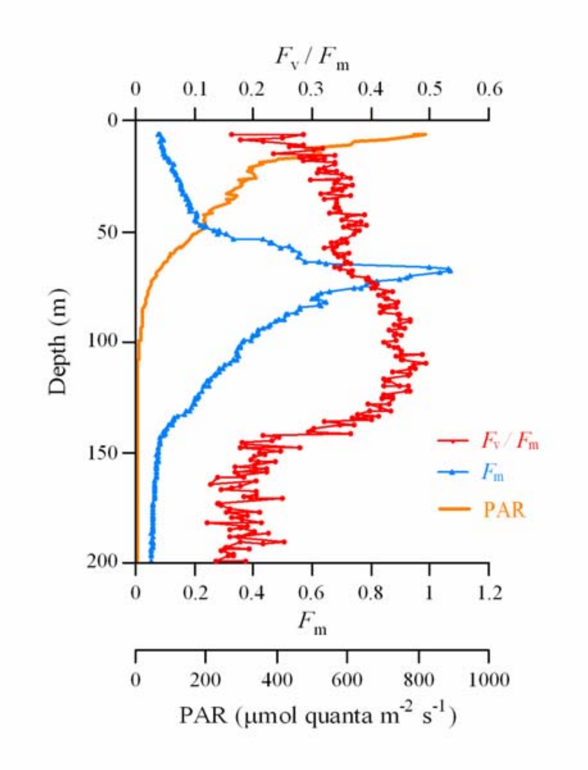

Fig. 2. Vertical profiles of F_v/F_m, F_m (indicator of chlorophyll *a* biomass) and PAR in the equator (0^o, 155^oE).

3.9 N_2 fixation activity and phytoplankton dynamics in the subtropical and tropical western North Pacific

Satoshi Kitajima [1]**, Takuhei Shiozaki** [1]**, Nguyen Van Nguyen** [1]**, Taketoshi Kodama** [1]**, Yasuwo Fukuyo** [2]**, Shigenobu Takeda** [1]**, and Ken Furuya** [1]
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The University of Tokyo
2) Asian Natural Environmental Science Center, The University of Tokyo

Objectives

Importance of nanoplanktonic cyanobacteria in N_2 fixation has become recognized in the subtropical and tropical ocean. This invokes re-evaluation of marine N_2 fixation in these waters. In this cruise, we measured carbon and nitrogen uptakes including N_2 fixation activities with primary production, nutrients concentration, and distribution of phytoplankton to evaluate N_2 fixation in the new production in the subtropical and tropical western North Pacific.

Methods, Apparatus and Performance

Distribution of nutrients, and phytoplankton assemblage on the surface water

Samples were collected using seawater pumped from the bottom of the ship. We took samples for nutrients (N+N, SRP, and ammonium), temperature, salinity, $\delta^{15}N$, *nifH* gene, and phytoplankton abundances, and pigments. Nutrients were determined by a supersensitive colorimetric system (Auto Analyzer II (Technicon) connecting to Liquid Waveguide Capillary Cell (LWCC, WPI)), and temperature and salinity were measured by Ocean Seven 301 (Idronaut). Samples for $\delta^{15}N$, *nifH* gene, and phytoplankton abundance and pigments will be analyzed by mass spectrometer, PCR analyzer, and HPLC, flow cytometry, and microscopy on land.

N_2 fixation, nitrogen uptakes, primary productivity, and abundance of diazotrophs

Samples were collected at the Stn.M07001A and every two or four degree-N of 155 °E by a bucket and Niskin-X samplers from the layers of 100, 50, 25, 10, 5, 2.5, and 1% surface light intensity. The depth profiles of light intensity were obtained by the observation of a freefall SeaWiFS Profiling Multichannel Radiometer system (Satlantic) just before the sampling.

N_2 fixation activities were determined by two methods: acetylene reduction assay and $^{15}N_2$ uptakes. Acetylene reduction assay was carried out for three types of fractionated seawater (whole, <10 µm, and <2 µm) taken at the surface. Each three 560 mL of samples were poured into 1200 mL PET bottle. Samples were spiked with 10% acetylene at dusk and incubated in an on-deck incubator under natural sunlight with running near surface water pumped up from the bottom of the ship. Subsamplings of headspace were done at immediately after acetylene injection, and at dawn and dusk of next day by a gas chromatograph (GC-17A, Shimadzu) to measure ethylene production in daytime and nighttime separately. Produced ethylene during the incubation will be converted to an amount of fixed nitrogen based on the results of $^{15}N_2$ uptakes experiment as below. After the measurement, seawater left in the bottles was fixed for the microscopic observation on land.

$^{15}N_2$ uptakes were measured concomitant with primary production. Seawater samples were poured into four 4 L polycarbonate bottles and spiked with 0.2 mM $H^{13}CO_3^-$ and 2 ml of $^{15}N_2$. After the tracer spiking, samples were placed in on-deck incubators under the light corresponding to the sampling depth. Incubation of each two bottles was terminated 3 or 4 hours and 24 hours after the tracer spiking by the gentle vacuum filtration (<200 mmHg) of seawater samples through a precombusted GF/F filter. They will be measured by a mass spectrometer on land.

$^{15}NO_3^-$ uptakes were measured using a kinetics approach at the stations where ambient nitrate concentrations were under 100 nM. Triplicate samples were poured into 2 L polycarbonate bottles and spiked with 10, 100 and 2000 nM of $^{15}NO_3^-$. At stations M07004, M07008, M07012 and M07017, we measured the uptakes of both $^{15}NO_3^-$ and $^{15}NH_4^+$. Samples were spiked with 10, 20, 100, 200 and 2000 nM of $^{15}NO_3^-$ and $^{15}NH_4^+$. At stations where ambient nitrate concentrations were over 100nM, samples were spiked only with 10 nM of $^{15}NO_3^-$. All the samples were incubated on-deck incubator for 3 or 4 hours and incubation was terminated in the same method as described above.

Morphological and genetic variations of dinophysoid dinoflagellates

Samples were collected by sieving the pumped-up seawater at 6 m depth through a plankton net with mesh size of 20 µm. Single cells of dinophysoids were microscopically isolated and transferred to a 200µl PCR tube for PCR amplification. The first PCR amplified about 5 kilo base pairs of ribosomal DNA, from the small subunit (the 24S region) to the D6 region of the large subunit (the 28S region). The second PCR amplified approximately 700 base pairs of the D1- D2 regions of the large subunit using the first PCR products as templates. The successfully amplified DNA products (checked by electrophoresis) were purified using the Promega purification kit and stored at -20°C for later sequencing when back to land.

3.10 Argo float

(1) Personnel

Nobuyuki Shikama	**(FORSGC): Principal Investigator (not on board)**
Mizue Hirano	**(FORSGC): not on board**
Tomoyuki Takamori	**(MWJ): Technical Staff**
Shinsuke Toyoda	**(MWJ): Technical Staff**

(2) Objectives

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

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.

(3) Parameters

・water temperature, salinity, and pressure

(4) Methods

1) Profiling float deployment

We launched 6 APEX floats manufactured by Webb Research Ltd and 2 NINJA floats manufactured by Tsurumi Ltd. These floats equip an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 1500 and 2000 dbar (called the parking depth), rising up to the sea surface every ten days by increasing their volume and thus changing the buoyancy. 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 3.10-1.

(6) Data archive

The real-time data are provided to meteorological organizations via Global Telecommunication System (GTS) and utilized for analysis and forecasts of sea conditions.

Table 3.10-1 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	2000 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)

Float Type	NINJA floats manufactured by Tsurumi 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	2000 dbar
Sampling layers	72 (2000, 1900, 1800, 1700, 1600, 1500, 1400, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 975, 950, 925, 900, 875, 850, 825, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 480, 460, 440, 420, 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, 5 dbar)

Launches

Float S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch	CTD St. No.
2793	66084	06:48, Feb. 27	08:13, Feb. 27	03-00.47N, 154-59.96 E	M07005
3030	70477	08:00, Feb. 28	09:25, Feb. 28	05-07.59N, 155-00.00 E	M07007
2819	66110	01:27, Mar. 02	02:59, Mar. 02	08-01.42N, 155-00.65 E	M07010
2824	66115	00:47, Mar. 03	02:32, Mar. 03	10-00.34N, 154-57.38 E	M07012
7247	22723	02:45, Mar. 04	03:00, Mar. 04	12-04.85N, 154-55.63 E	M07014
7245	22720	10:18, Mar. 06	10:31, Mar. 06	14-00.86N, 154-59.60 E	M07016
2823	66114	02:28, Mar. 08	04:42, Mar. 08	20-08.01N, 155-01.05 E	M07022
2822	66113	02:17, Mar. 09	04:11, Mar. 09	24-03.14N, 154-58.12 E	M07026

3.11 JKEO Buoy Mooring

(1) Personnel

Hiroyuki Tomita	**(JAMSTEC)**	**Principle Investigator**
Hiroki Tokinaga	**(JAMSTEC)**	
J. Michael Strick	**(NOAA/PMEL)**	
Kristene E. Mctaggart	**(NOAA/PMEL)**	
Hirokatsu Uno	**(MWJ)**	
Shinsuke Toyoda	**(MWJ)**	

(2) Objectives

The Kuroshio Extension region is characterized by intense air-sea interaction that affects both weather and climate. The Kuroshio Extension atmosphere-ocean system represents a major branch of the global heat cycle, whereby the input of excess heat at the top of the atmosphere in the tropics is carried poleward by the combination of the oceanic and atmospheric circulations. The strong current and intense winter storms in this region however have made observations a challenge. As a consequence, many aspects of the heat cycle in this critical region remain uncertain.

Recently PMEL developed a new surface mooring which has withstood extremely harsh conditions in the Kuroshio Extension recirculation gyre, Gulf of Alaska, and on the equator. Engineering designs indicate PMEL slack-line moorings, such as the Kuroshio Extension Observatory (KEO) mooring, could survive in the Kuroshio current.

We plans to develop a methodology that uses satellite data to measure fluxes with high accuracy in the Kuroshio Extension region. For this purpose, by deploying in the north of Kuroshio Extension another surface meteorological and oceanic observation buoy (JKEO buoy) of the same design as that developed by PMEL, we intends to examine the surface heat fluxes at different meteorological and oceanographic condition using the data measure by both of the JKEO and KEO buoys.

(3) Measured Parameters

Meteorological parameters

Wind speed, direction, air temperature, relative humidity, shortwave radiation, longwave radiation and precipitation

Oceanographic parameters

TC:Water temperature and conductivity at 1m, 10m, 30m, 50m and 500m.

Microcat: Water temperature, conductivity and pressure at 5m, 40m, 125m, 175m, 400m and 600m.

TP: Water temperature and pressure at 150m, 250m and 300m.

T: Water temperature at 75m, 100m and 200m.

V: Current at 13.7m

(4) Instruments

1) Meteorological sensors

Wind speed and direction

Gill WindSonic
Air temperature and relative humidity
Rotronics MP-100
Shortwave and longwave radiation
Epply PSP and PIR
Precipitation
R. M. Young Model 50203-34
2) TC, TP and T
PMEL Original
3) CTD
SBE-37SM MicroCat
4) Current meter
SonTek

(5) Details of deployment
Site: 38N, 146.5E
Mooring ID: KE004A
Date (UTC): 2007.02.18
Latitude: 37˚56.58’ N
Longitude: 146˚32.82’ E
Depth: 5441 m
Releaser:
Type: EG & G 8242AA
S/N: 29261
Int. Freq: CH A 11.0
Rep. Freq: CH A 12.0
Release: 234543
Disable: 216551
Enable: 216534

(6) Data display and archive

Hourly and daily averaged data are transmitted through ARGOS satellite data transmission system in near real time. After the initial data processing, surface momentum and turbulent heat fluxes are calculated by COARE 3.0 bulk flux calculation method. The plots of daily mean surface fluxes and related parameters are distributed world wide through Internet from JAMSTEC/IORGC data site* in near real time. Figure 1 shows time series of daily mean surface heat fluxes and related parameters obtained from JKEO. Unfortunately, wind speed data from March 13 are not available because of trouble in the WindSonic. Consequently, surface momentum and turbulent heat flux from March 13 are also not available. The hourly and daily mean data from JKEO will be distributed at same web site in near future.

* http://www.jamstec.go.jp/iorgc/ocorp/ktsfg/data/jkeo/

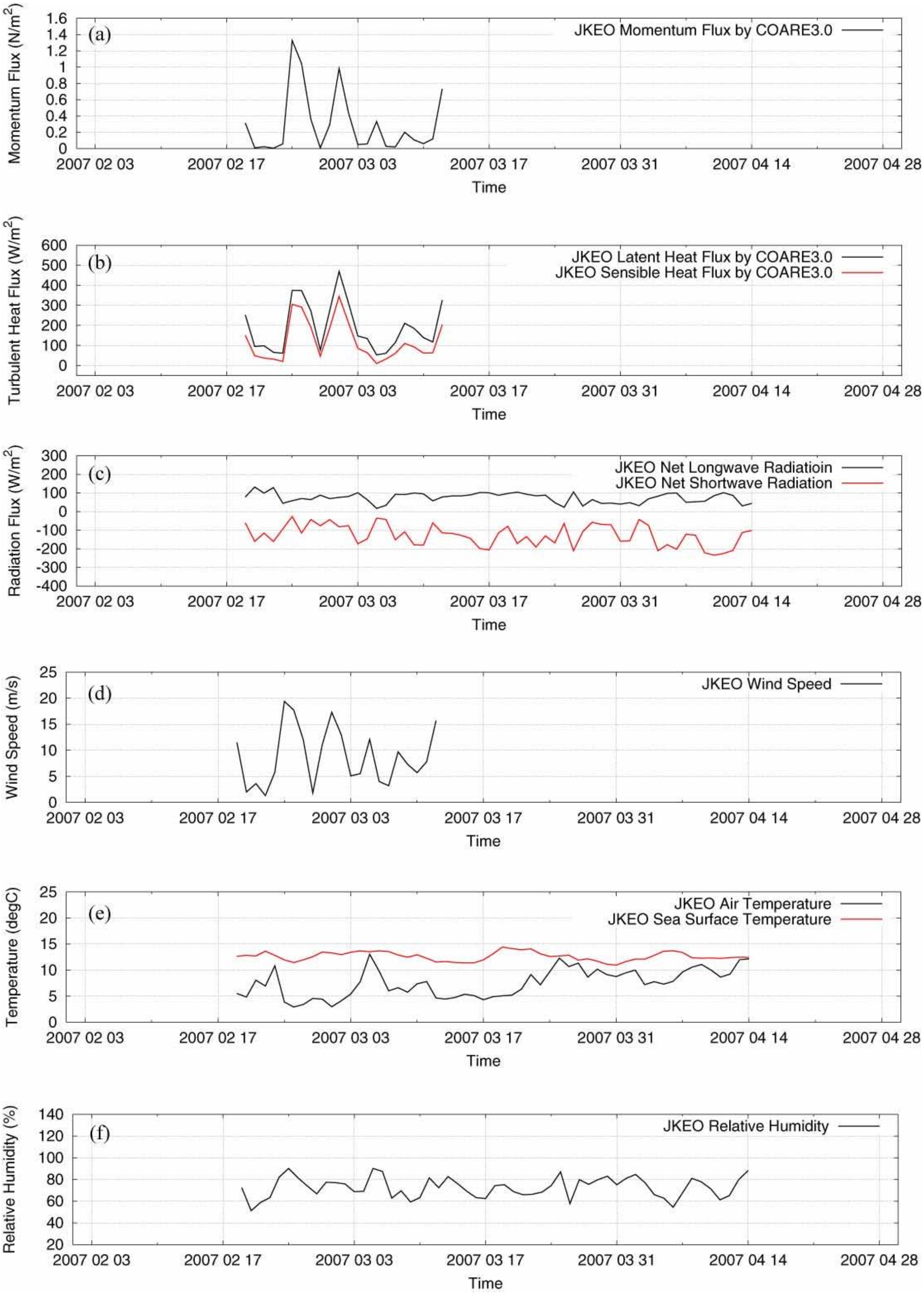


Fig 3.11-1 Time series of daily mean (a) surface momentum flux (N m^{-2}), (b) turbulent heat flux (W m^{-2}), (c) radiation flux (W m^{-2}), (d) wind speed (m s^{-2}), (e) air and sea surface temperature and (f) relative humidity (%) obtained from JKEO buoy.

3.12 Atmospheric sounding by radiosonde

(1) Personnel

Hiroki Tokinaga	**(JAMSTEC)**	**Principal Investigator**
Hiroyuki Tomita	**(JAMSTEC)**	
J. Michael Strick	**(NOAA/PMEL)**	
Kristene E. Mctaggart	**(NOAA/PMEL)**	
Kazuho Yoshida	**(GODI)**	
Ryo Ohyama	**(GODI)**	

(2) Objective

Atmospheric soundings of temperature, humidity, and wind speed/direction.

(3) Method

Atmospheric sounding by radiosonde was carried out at 1˚ latitude interval along 155˚E line from February 18 through March 22, 2007. In total, 33 soundings were carried out (Table 3.12-1). The main system consists of processor (Vaisala, DigiCORA III), GPS antenna (GA20), UHF antenna (RB21), balloon launcher (ASAP), and GPS radiosonde sensor (RS92-SGPW & RS92-SGPD).

(4) Preliminary results

Station-height cross sections of equivalent potential temperature, mixing ratio, zonal and meridional wind components are shown in Fig.3.12-1, respectively. Vertical profiles of air temperature, dew point temperature, and wind are also plotted in Fig. 3.12-2.

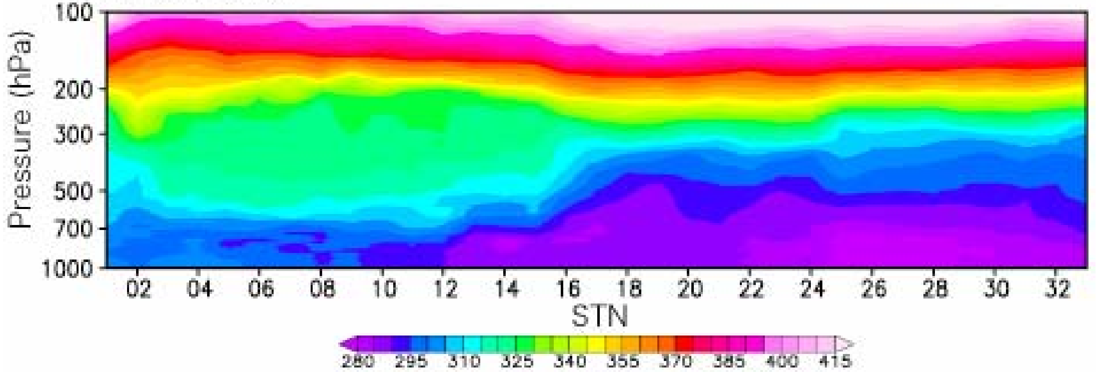
(5) Data archive

Data were sent to the world meteorological community via Global Telecommunication System through the Japan Meteorological Agency, immediately after the each observation. Raw data is recorded as ASCII format every 2 seconds during ascent. These raw datasets will be submitted to JAMSTEC Data Management Office. Corrected and projected onto every 5hPa level datasets are also available from H. Tokinaga of JAMSTEC.

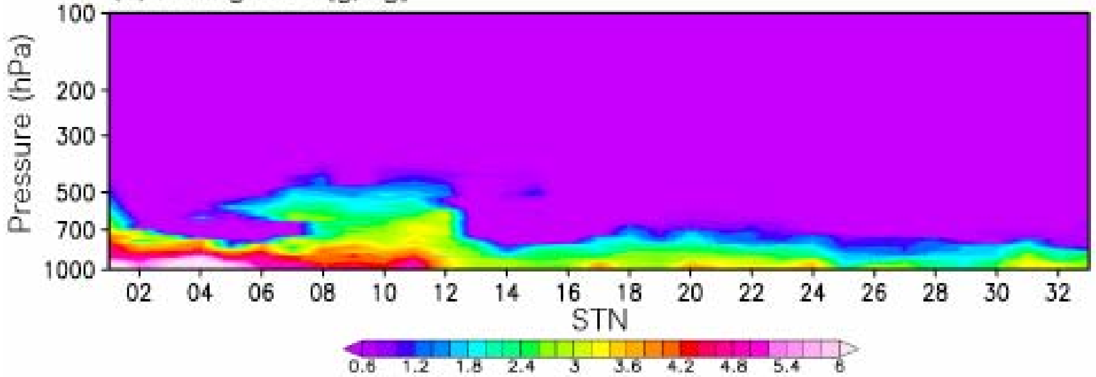
Table 3.12-1 Radiosonde launch log.

No.	DATE &TIME				Position		Surface Data					Maximum Altitude		Cloud Amount & type	
					Lat. N	Lon. E	P	T	RH	WD	WS				
	YY	MM	DD	HH	(deg.)	(deg.)	(hPa)	(℃)	(%)	(deg.)	(m/s)	(gpm)	(hPa)		
1	07	02	18	09	37.921	146.568	998.4	10.8	96	120	7.3	19,465	58.5	－	Unknown
2	07	02	19	13	32.477	144.670	1012.1	13.5	65	22	12.1	22,933	33.7	－	
3	07	03	14	20	29.992	155.052	1012.6	14.3	65	318	10.1	21,693	41.1	－	
4	07	03	15	02	29.996	155.055	1013.1	15.0	71	302	12.0	22,291	37.4	7	Sc, St
5	07	03	15	07	30.952	155.002	1013.5	14.2	64	286	8.5	22,313	37.4	6	Sc, St
6	07	03	15	11	30.976	154.991	1015.3	14.2	67	308	8.6	21,656	41.5	－	
7	07	03	15	16	31.913	154.993	1013.2	13.2	60	298	11.9	24,310	27.2	－	
8	07	03	15	20	32.966	154.996	1014.7	11.0	75	325	6.8	21,187	44.4	10	Cu
9	07	03	16	02	32.999	154.995	1011.8	12.5	57	320	5.9	24,816	25.3	10	St
10	07	03	16	07	33.929	154.999	1012.4	8.7	68	331	6.8	22,596	35.6	10	St
11	07	03	16	12	33.961	155.028	1011.7	8.2	86	28	8.5	19,573	57.5	－	
12	07	03	16	16	34.944	154.985	1007.9	8.8	53	30	7.2	21,525	42.2	－	
13	07	03	16	21	35.987	154.993	1007.4	8.0	56	356	10.4	22,165	38.2	4	Sc, St
14	07	03	17	01	35.984	154.982	1006.0	7.5	50	358	9.3	23,461	31.1	3	Cu, Cs
15	07	03	17	05	35.058	154.992	1003.9	9.0	51	11	9.7	23,997	28.6	8	St
16	07	03	17	14	35.894	154.996	1003.9	7.3	52	306	10.1	23,199	32.4	－	
17	07	03	17	20	36.961	154.991	1002.2	6.1	72	321	10.1	23,490	31.0	8	St, Sc
18	07	03	18	03	36.942	154.948	1000.3	7.4	49	280	8.4	24,405	26.9	9	Cu, Ns
19	07	03	18	08	37.919	154.984	998.2	6.1	58	280	12.7	22,150	38.3	5	Sc
20	07	03	18	21	38.995	154.590	992.4	4.9	80	283	12.0	23,204	32.5	7	Ns, Sc
21	07	03	19	09	39.752	154.931	997.3	4.4	73	305	11.9	23,588	30.7	－	
22	07	03	19	21	40.966	154.996	996.3	3.1	90	309	17.0	20,369	50.3	7	Ns,As
23	07	03	20	06	41.968	154.993	992.9	3.1	84	346	12.6	22,077	38.4	5	St, Sc
24	07	03	20	10	41.978	154.993	1002.0	3.1	88	10	10.0	23,509	31.0	－	
25	07	03	20	21	43.965	154.994	1007.9	0.1	83	348	15.0	22,792	34.6	4	Ns, St, Sc
26	07	03	21	08	44.007	155.022	1011.8	0.4	85	316	10.0	22,882	34.1	－	
27	07	03	21	12	43.054	154.995	1012.9	1.1	76	341	4.5	19,593	56.4	－	
28	07	03	21	16	42.998	154.969	1013.4	0.9	66	321	10.4	20,662	47.8	－	
29	07	03	22	01	41.148	154.993	1016.0	3.0	67	300	8.4	22,401	36.6	5	Ns, At,Cu
30	07	03	22	04	40.979	254.987	1016.0	2.5	66	300	8.8	23,905	29.0	6	Sc, Cu, St
31	07	03	22	13	39.087	154.998	1019.3	4.9	76	323	13.2	21,422	42.5	－	
32	07	03	22	17	38.941	154.990	1018.1	4.6	75	310	5.8	23,939	28.7	－	
33	07	03	22	21	38.095	155.000	1020.0	6.6	49	257	2.5	23,753	29.6	3	St

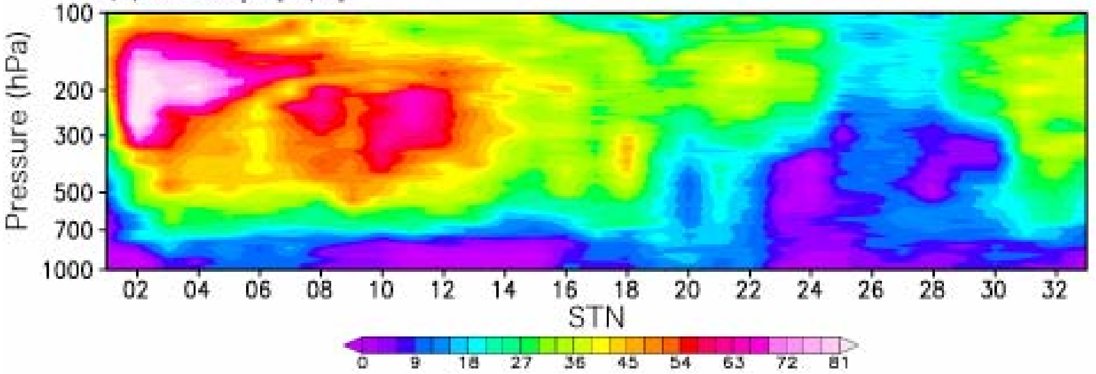
(a) theta-e [K]



(b) mixing ratio [g/kg]



(c) U-comp. [m/s]



(d) V-comp. [m/s]

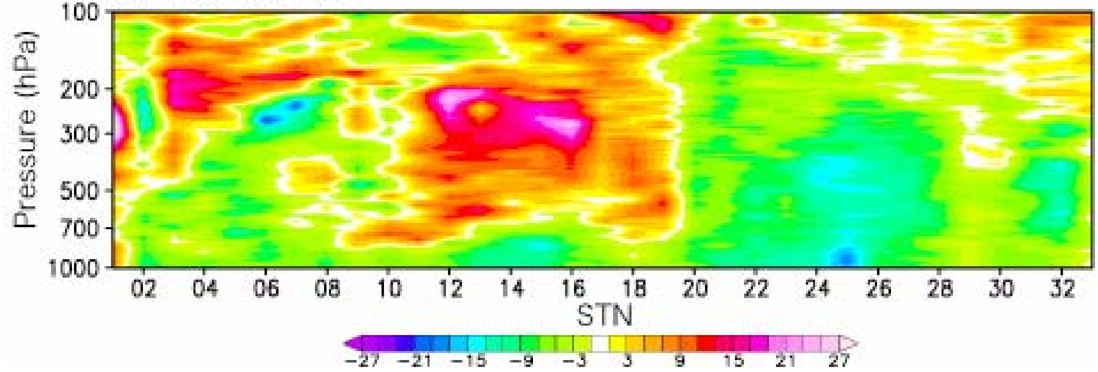
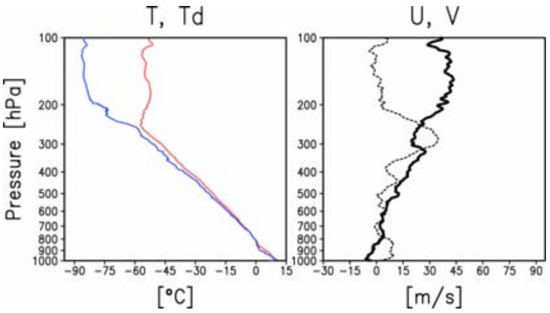
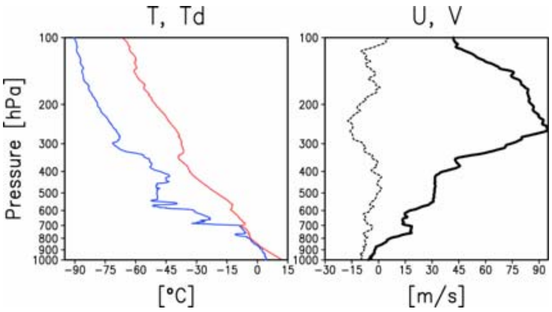


Fig. 3.12-1 Station-height cross sections of (a) equivalent potential temperature (K), (b) mixing ratio (g/kg), (c) zonal wind component (m/s), and (d) meridional wind component (m/s).

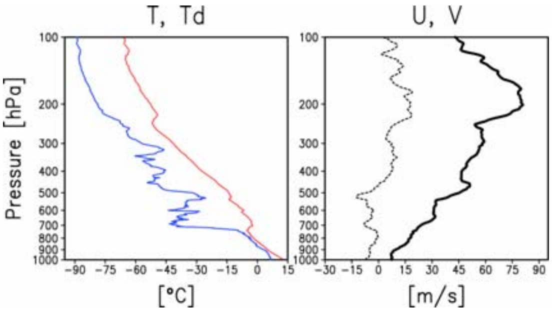
STN01 2007021809 37.921˚N 146.568˚E



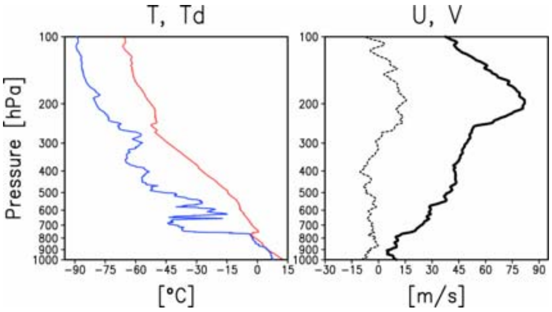
STN02 2007021913 32.477˚N 144.670˚E



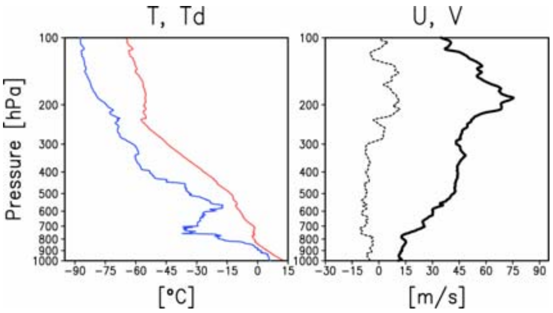
STN03 2007031420 29.992˚N 155.052˚E



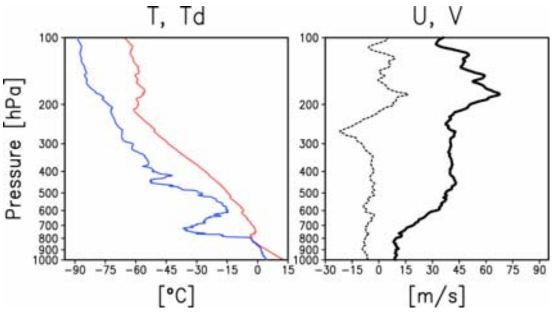
STN04 2007031502 29.996˚N 155.055˚E



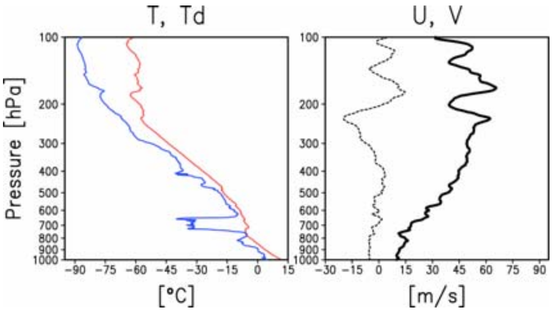
STN05 2007031507 30.952˚N 155.002˚E



STN06 2007031511 30.976˚N 154.991˚E



STN07 2007031516 31.913˚N 154.993˚E



STN08 2007031520 32.966˚N 154.996˚E

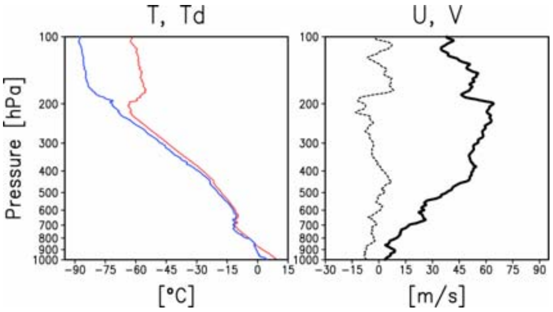
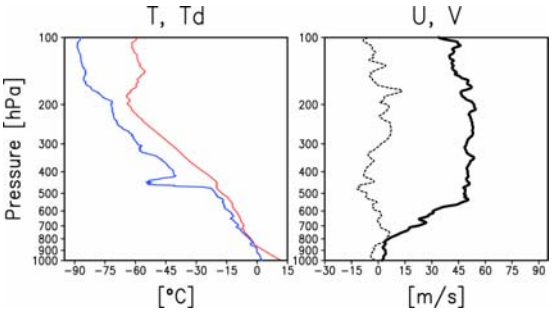
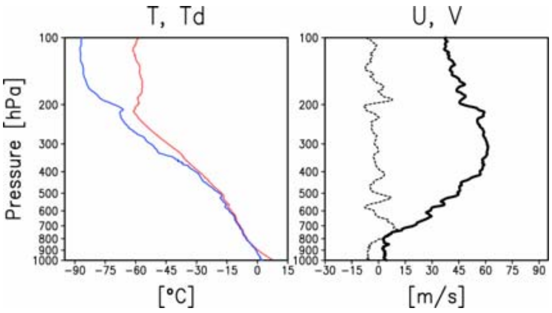


Fig. 3.12-2 Verical profiles of (left) air temperature (red solid line: K) and dew point temperature (blue solid line: K), and (right) zonal (black solid line: m/s) and meridional (black dashed line: m/s) wind components at each radiosonde station (STN01-08).

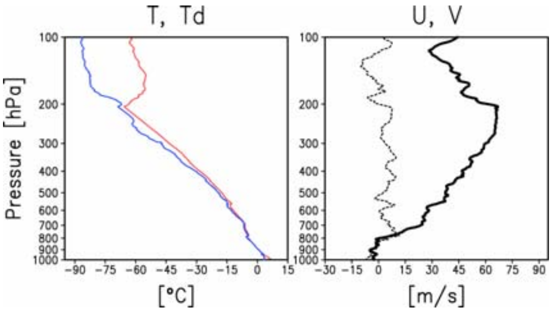
STN09 2007031602 32.999˚N 154.995˚E



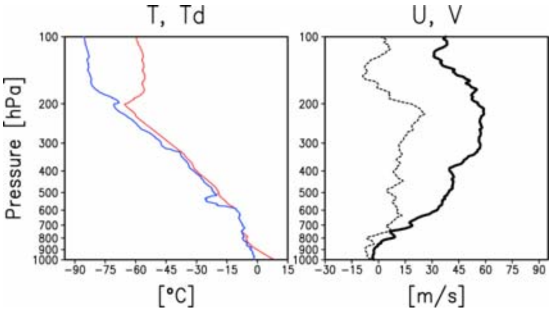
STN10 2007031607 33.929˚N 154.999˚E



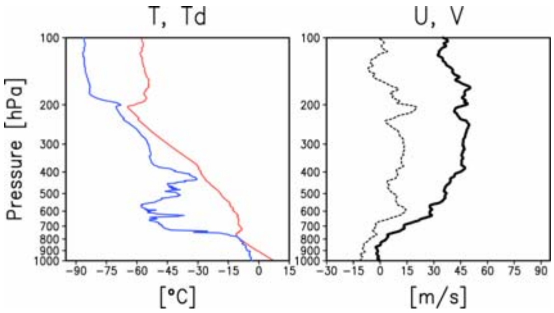
STN11 2007031612 33.961˚N 155.028˚E



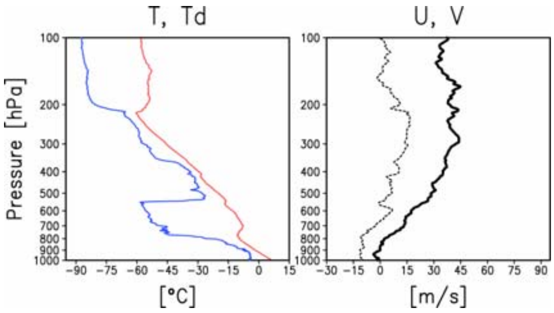
STN12 2007031616 34.944˚N 154.985˚E



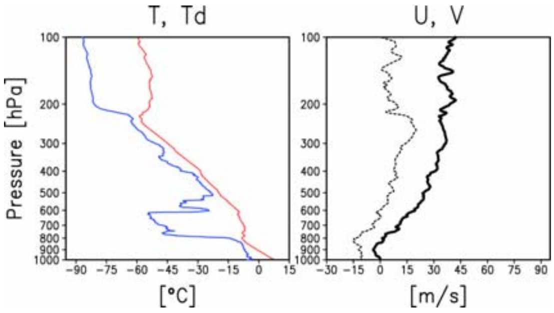
STN13 2007031621 35.987˚N 154.993˚E



STN14 2007031701 35.984˚N 154.982˚E



STN15 2007031705 35.058˚N 154.992˚E



STN16 2007031714 35.894˚N 154.996˚E

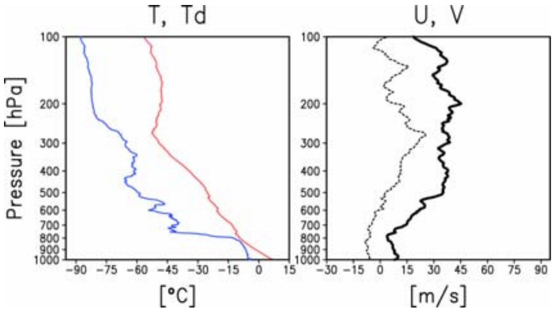
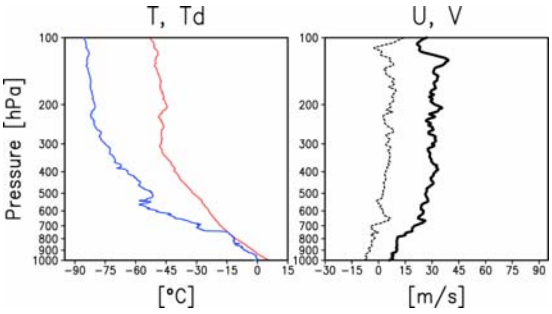
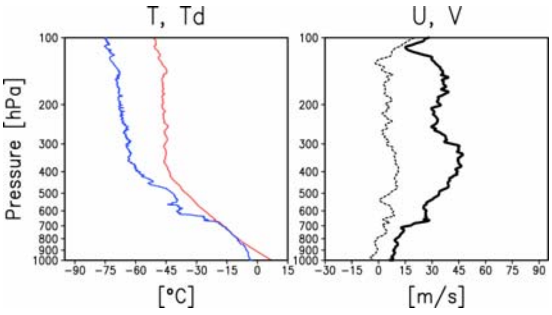


Fig. 3.12-2 (Continued :STN09-16).

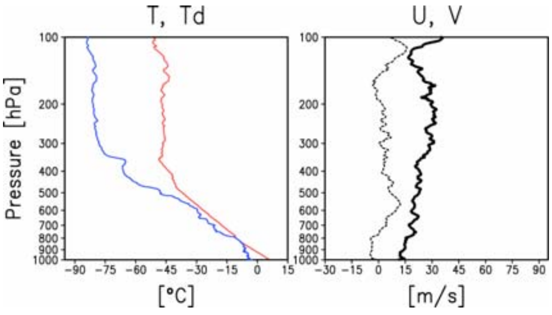
STN17 2007031720 36.961˚N 154.991˚E



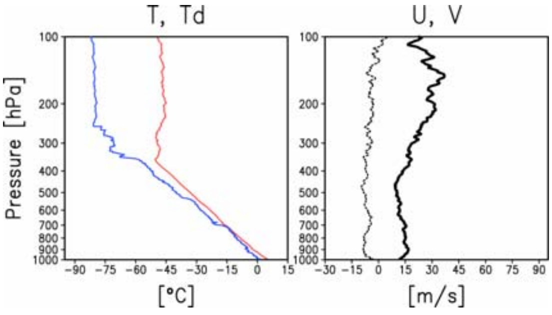
STN18 2007031803 36.942˚N 154.948˚E



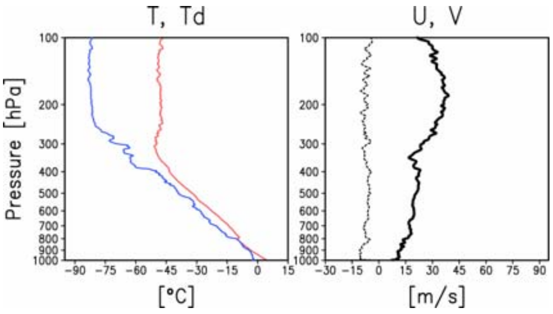
STN19 2007031808 37.919˚N 154.984˚E



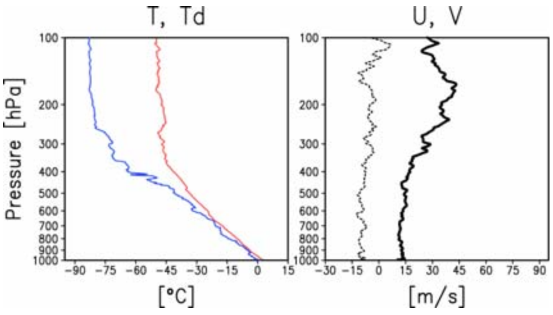
STN20 2007031821 38.995˚N 154.590˚E



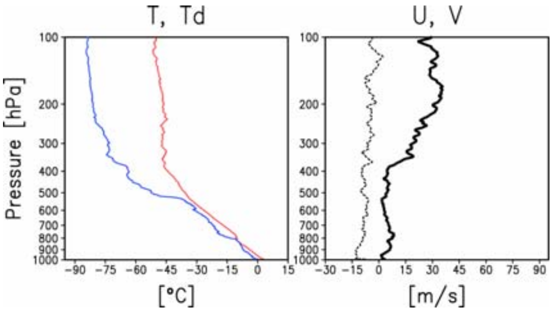
STN21 2007031909 39.752˚N 154.931˚E



STN22 2007031921 40.966˚N 154.996˚E



STN23 2007032006 41.968˚N 154.993˚E



STN24 2007032010 41.978˚N 154.993˚E

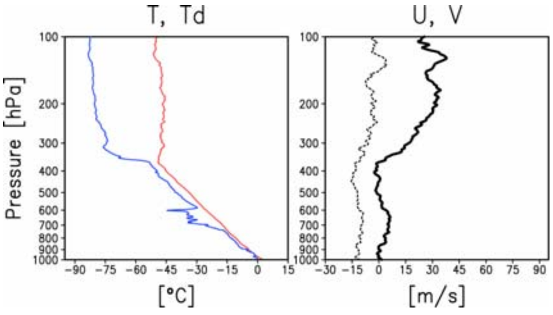
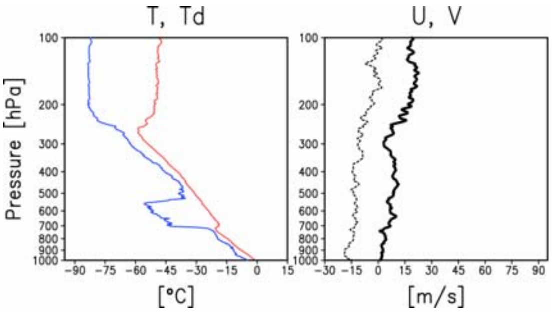
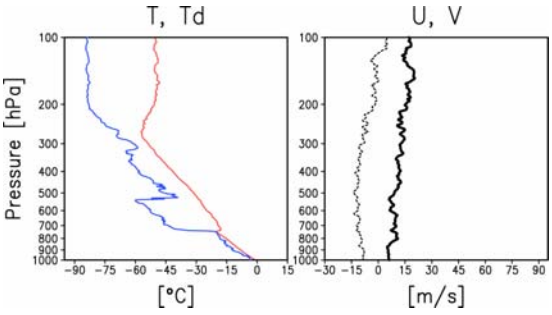


Fig. 3.12-2 (Continued :STN17-24).

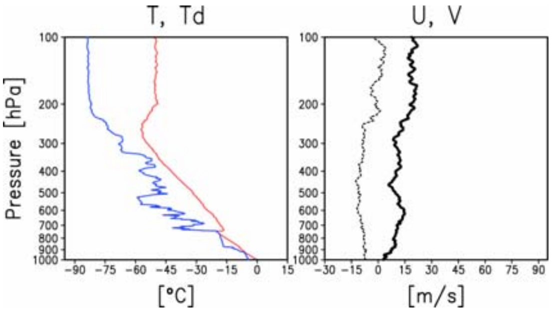
STN25 2007032021 43.965˚N 154.994˚E



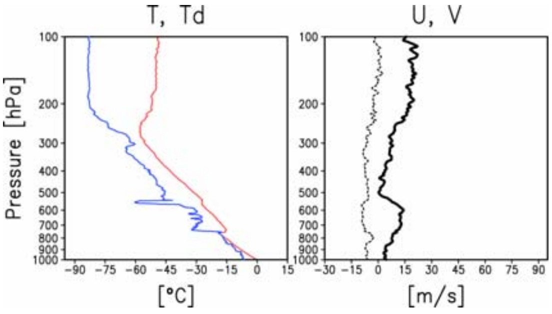
STN26 2007032108 44.007˚N 155.022˚E



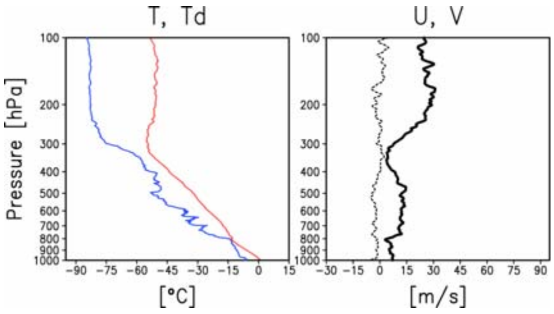
STN27 2007032112 43.054˚N 154.995˚E



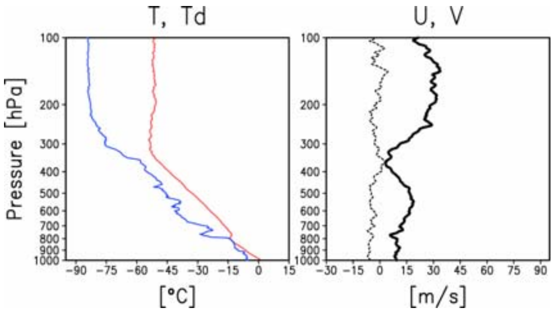
STN28 2007032116 42.998˚N 154.969˚E



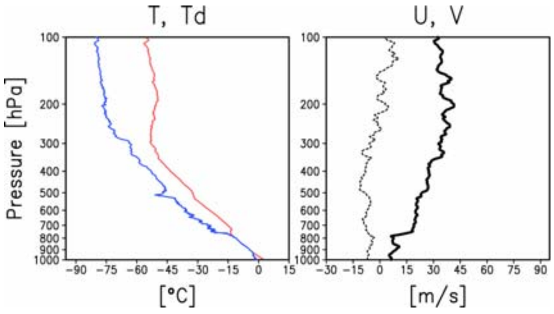
STN29 2007032201 41.148˚N 154.993˚E



STN30 2007032204 40.979˚N 254.987˚E



STN31 2007032213 39.087˚N 154.998˚E



STN32 2007032217 38.941˚N 154.990˚E

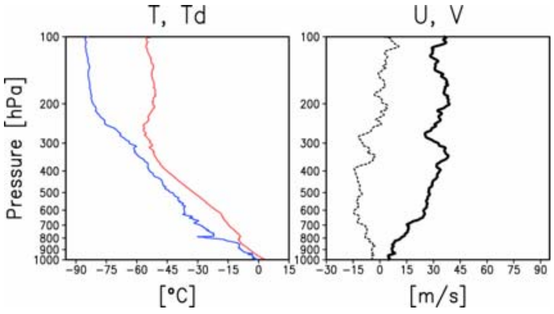


Fig. 3.12-2 (Continued :STN25-32).

STN33 2007032221 38.095˚N 155.000˚E

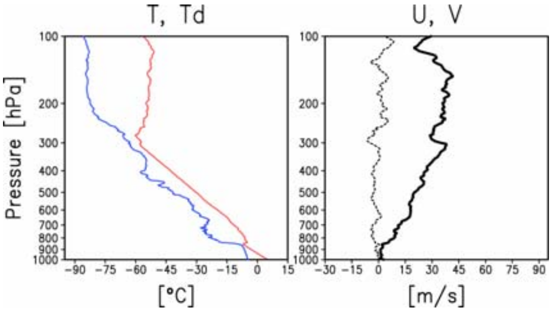


Fig. 3.12-2 (Continued :STN33).

4. Geophysical observation
4.1 Swath Bathymetry

Takeshi Matsumoto	**(University of the Ryukyus)**	**Principal Investigator**
	(Not on-board)	
Kazuho Yoshida	**(Global Ocean Development Inc.: GODI)**	
Ryo Ohyama	**(GODI)**	

(1) Introduction

R/V MIRAI is equipped with a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.).

The objective is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets. In addition, we investigated geographical features to decide J-KEO buoy development point.

(2) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during the MR07-01. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the surface (6.2m) sound velocity, and the others depth sound velocity calculated temperature and salinity profiles from CTD and XCTD data by the equation in Mackenzie (1981) during the cruise.

Table 4.1-1 listed system configuration and performance of SEABEAM 2112.004 system and SBP subsystem.

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)

(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 archived there.

(5) Remark

4.2 Sea Surface Gravity

Takeshi Matsumoto (University of the Ryukyus) Principal Investigator
(Not on-board)
Kazuho Yoshida (Global Ocean Development Inc.: GODI)
Ryo Ohyama (GODI)

(1) Introduction

The distribution of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR07-01 cruise.

(2) Parameters

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

(3) Data Acquisition

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

(4) Preliminary Results

Absolute gravity shown in Table 4.2-1

Table 4.2-1

Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *^{1} [mGal]	L&R *^{2} Gravity [mGal]
Feb./15/07	07:49	Sekinehama	980371.93	269	650	980372.70	12709.10
Mar./26/07	06:59	Sekinehama	980371.95	305	595	980372.92	12708.92

*^{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

(5) Data Archives

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

(6) Remarks

1. 26 Feb. 2007, system trouble occurred.
   - ⅰ) From 8:36UTC 26 Feb. to 1:45UTC 27 Feb., each type of data file include invalid data.
   - ⅱ) From 1:45UTC 27 Feb. to 2:24UTC 27 Feb., data logging was stopped because of system reboot.

4.3 Sea Surface Three-Component Magnetic Field

Takeshi Matsumoto (University of the Ryukyus) Principal Investigator
(Not on-board)
Kazuho Yoshida (Global Ocean Development Inc.: GODI)
Ryo Ohyama (GODI)

(1) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR07-01 cruise.

(2) Parameters

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

(3) Method of Data Acquisition

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

For calibration of the ship's magnetic effect, we made a "figure-eight" turn (a pair of clockwise and anti-clockwise rotation). This calibration carried out below.

22 Feb. 2007, 01:56 to 02:25 around at 20-13N, 150-44E
25 Feb. 2007, 08:53 to 09:19 around at 02-00N, 154-48E
23 Mar. 2007, 01:48 to 02:13 around at 38-01N, 154-59E

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

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

(6) Remarks

5. Satellite image acquisition-MCSST composite (NOAA/HRPT)

Kazuhiko Matsumoto (JAMSTEC): Principal Investigator
Kazuho Yoshida (Global Ocean Development Inc.: GODI)
Ryo Ohyama (GODI)

(1) Objectives

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

(2) Method

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

We received and processed NOAA data throughout MR07-01 cruise.

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

(3) Preliminary results

Fig.5-1 to Fig5-3 shows sea surface temperature about northwest Pacific Ocean. It is daily composite map of MCSST data during the mr07-01 cruise.

(4) Data archives

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

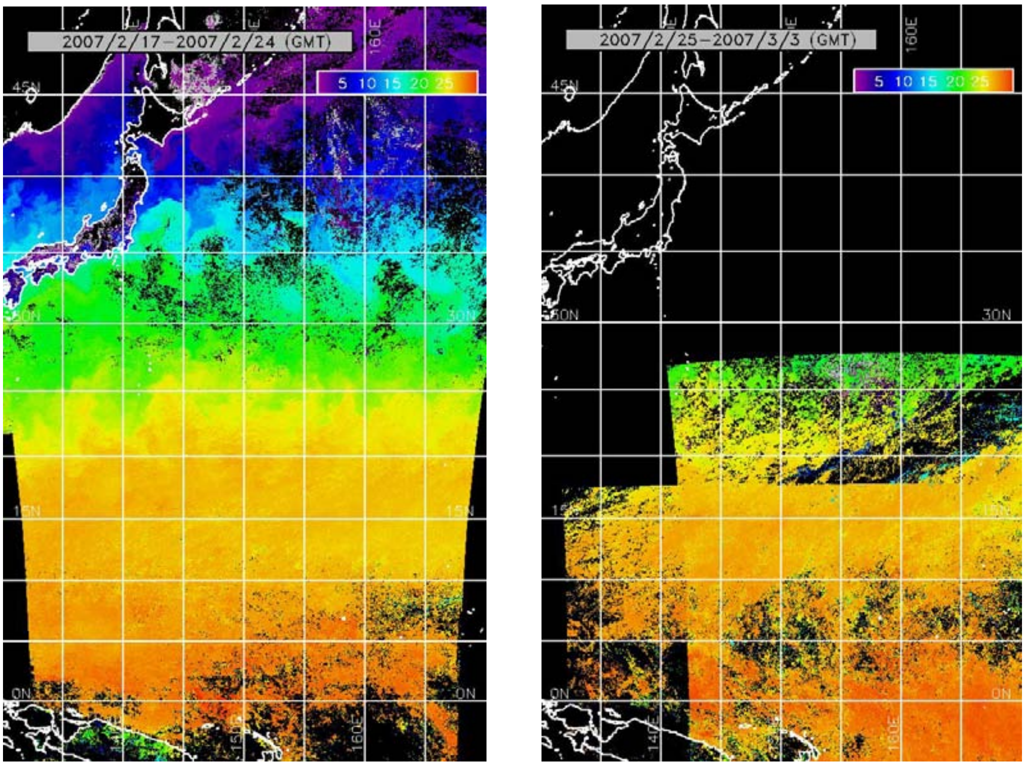


Fig.5-1 The map shows sea surface temperature from 17 February 2007 to 24 February 2007(left) and from 25 February 2007 to 3 March 2007(right)

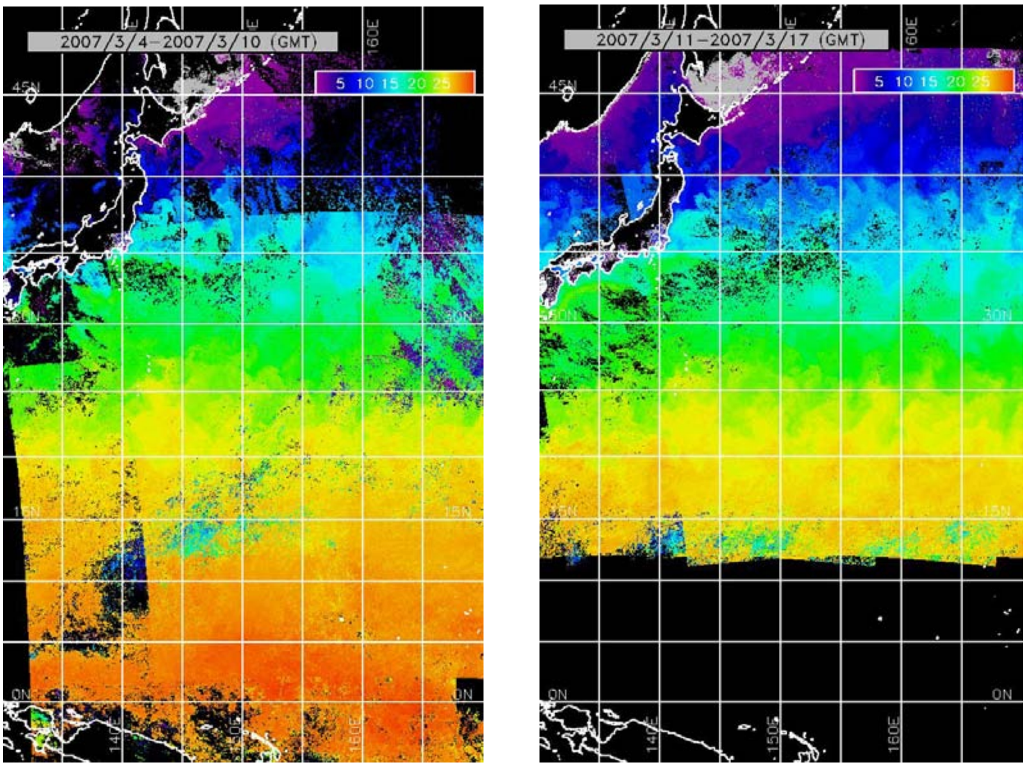


Fig.5-2 The map shows sea surface temperature from 4 March 2007 to 10 March 2007(left) and from 11 March 2007 to 17 March 2007(right)

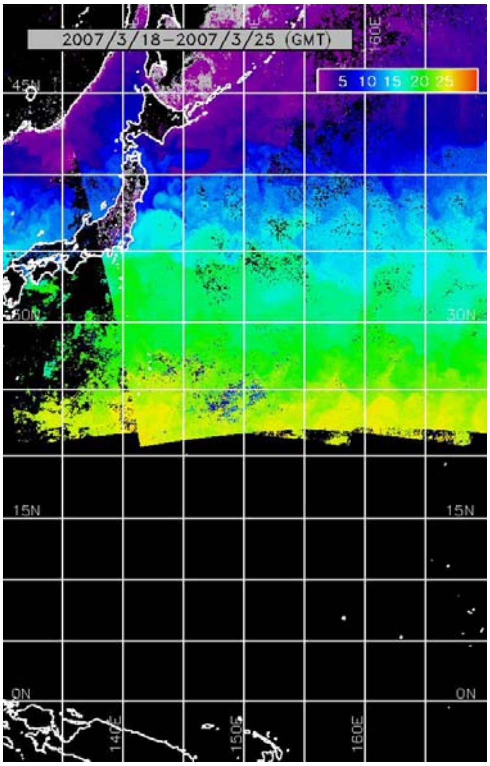


Fig.5-3 The map shows sea surface temperature from 18 March 2007 to 25 March 2007

6. 1 Ship's Handling for Deployment of J-KEO buoy

(1) Personnel

Captain Masaharu Akamine, Master of R/V"MIRAI"
And Ship's Crew

(2) Objectives

- **To deploy it accurately and efficiently to a spot where a mooring is required.**
- **To prevent the damage of each observation equipment and sensor.**

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

(3) Observation parameters

- Ship's position, course and speed
- Directions of the wind and the current, velocities of the wind and the current
- Vectors of drift by the wind and of the current
- Working hours
- Distance for the deployment
- Position of the sinker

(4) Methods

(4.1) Measurement of the actual ship-movement

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

(4.2) Measurement of the wind and the current

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

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

(4.3) Measurement of the releaser-movement in the sea for fixing the sinker position

Acoustic communication from the ship to the releaser is conducted with an acoustic transducer (8242AA) which is made by Edgetech Inc. USA.

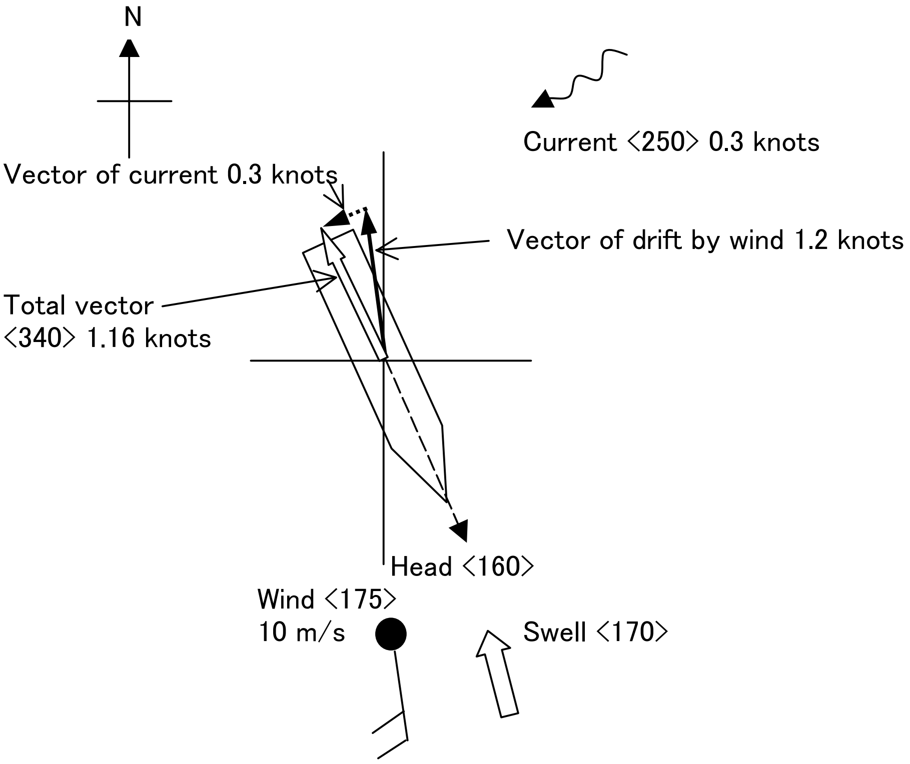
(5) Results

A deployment work of a J-KEO mooring was the first experience for MIRAI.

The deployment of the J-KEO mooring was carried out according to past methods of the m-TRITON and the ATLAS moorings because the J-KEO mooring is a similar system to them.

(5.1) Measurement of the ship-movement before the deployment

A set-drift was executed before deploying the J-KEO mooring in order to decide in advance the ship's course into consideration of the external force and topographical features. Results of the set-drift and the conceptual map are shown in the following.



The ship which stopped the engine is generally moved according to the resultant force (total vector) computed by the vector of the current and the vector of drift by the wind etc. The wind data is converted into the vector of drift with using an approximate formula given by some hydrodynamic tests in past.

As for the movement of the ship under the external force, the result of the calculation and the reality is verified by the set drift.

There were a few influences of the current in the area concerned because originally the J-KEO buoy is moored in the place where the current is not strong.

As the influence of the wind and the swell was big, the ship's course for deploying the buoy was set toward the wind as shown in results of the set-drift.

(5.2) Ship's speed

According to results measured in past, and the instruction from the marine technician of the PMEL, on the deploy of the J-KEO mooring, the ship's speed is made into 2.0 knots by the maximum at ship's through-the-water (Log speed) while the mooring lines are paid out, to keep her speed under 1 knot at ship's Log speed while the various instruments such as sensors, fairings, glass balls /releasers/sinker etc. are attached.

The results are shown in Fig.6.1-1,Table 6.1-1 and 6.1-2.

An approximate Log speed in each work is shown in the following.

	J-KEO	**m-TRITON**
During the setting of the top-buoy & sensors	1.0 (1.0) knots	1.5 (0.6) knots
During the paying out of mooring ropes (Nylon)	1.1 (1.4)	2.4 (1.5)
During the setting of floats	0.4 (0.7)	1.3 (0.4)
During the towing at the final stage	0.5 (0.8)	It isn't done
During the setting of the sinker	1.3 (1.6)	1.4 (0.5)
The average speed during the deployment	1.0 (1.2)	2.0 (1.1)

( ) An average speed at over-the –ground (OG).

As for the m-TRITON mooring, the above shows the average figure of 3 units that were deployed as a practical use.

Fig.6.1-1 shows each longitudinal component of the OG speed and the Log speed. As shown in this figure, during the setting of sensors there is no difference between the OG speed and the Log speed, and the difference is formed by the follow current after the paying out of mooring ropes.

When it is compared with the actual results of the m-TRITON mooring, there is no big difference at the OG average speed. There is a big difference in the average Log speed by the existence of the external force influence due to the current.

The result was shown that the speed of the ship was kept according to standard established by the results in past and the instruction of the marine-technician in the beginning.

As far as the tension of the nylon rope was checked in the stern, the speed of the ship has been able to increase a little more.

(5.3) Ship's course (Fig. 6.1-6, Table 6.1-1 and 6.1-2)

The cables/ropes are paid out right astern to improve safety and efficiency of the deploying work. Therefore it is also important to lessen the angle between the ship's course and the wind direction in order to prevent the ship drifting to the lee. It was also necessary to consider the direction of the swell that influences the shift of the ship. It referred to the direction of the depth contour in the bathymetric map and by the measurement results of the SEA-BEAM as well.

The ship’s course was decided so that the ship proceed to upwind by the above mentioned items to take into consideration and results of the set-drift carried out before the deploying operation of the J-KEO mooring.

The direction of the swell coming was much the same as that of the wind

The course-made-good and the heading of the ship are shown as follows.

Course	CMG	Towing Co.	Sinker Co.	Unit: degrees
<160>	<158>	<140>	<140>	

“Course” is the course set when the development of the mooring started.

“CMG” stands for “course-made-good “. It means the furrow which the ship actually navigated from the deployment start to the sinker drop.

“Towing Co.” means the furrow in navigation from the towing start to the sinker drop.

“Sinker Co.” means the course just before the sinker dropping.

It is clear a big difference isn’t shown between the course and the CMG.

In the towing at a final stage of the deployment, the course was adjusted to make the sinker hit the target point. Therefore the towing Co. and Sinker Co. were kept 140 degrees. Although the sinker which was dropped into the sea was influenced by the fcurrent toward the South, finally it was fixed on the target point on the extension of the course set in the beginning.

(5.4) External force of the wind and the current

Fig.6.1-2 shows that there were few influences of the wind laterally because the course of the ship was set to receive the wind in the bow and moderate head swell and to reduce the lateral force of the flow, though the direction of the wind changed and the force of the wind increased during the deployment. (Fig.6.1-3)

The current which changed to the ESE from the ESW moved the ship to the starboard in the first half of the development, and streamed her forward in the latter half of it as shown in Fig.6.1-4 (X=longitudinal component of current velocity, Y=lateral component of current velocity) and Fig.6.1-5. The lateral force of the current was absorbed easily by using the powerful side thruster and by changing the ship's head variously in response to the change in the external force. However a forward current made the remaining development distance shorten, and as a result, the ship's speed and the speed paying out the rope had to slow down.

(5.4) Working hours for the deployment of the J-KEO mooring (Table 6.1-1)

The time that the ship needs in each section was investigated and recorded referring to the working hours of the same buoys which were deployed by PMEL in the past. Investigation results (Expectations), actual results of the J-KEO mooring and of the m-TRITON mooring are shown in the following.

Work's section	Expectations	Actual results	m-TRITON
Sensor section (paying out a wire cable)	1.5 – 2.0 hrs	2 hrs 11 min	1 hrs 10 min
Nylon section (paying out nylon ropes)	1.5 hrs	2 hrs 24 min	2 hrs 3 min
Releaser & sinker section (setting releasers /a sinker and towing)	1.0 hr	40 min	24 min
Total	4.0 – 4.5 hrs	5 hrs 15 min	3 hrs 37 min

As stated above, there is a difference between the J-KEO mooring and the m-TRITON mooring in the sensor section. The reason why the working hours of the JKEO mooring are long is as the next.

- the length of the wire cable of the J-KEO mooring was long in comparison with the thing of the m-TRITON mooring by 250m,
- the J-KEO mooring was equipped with the fairing system which needs a extra working hour,
- After all the wire cable was paid out continually, the check of the sensor installed on that cable was done. Much time to consult with the staff on the shore about the detailed check on the data of the anemometer installed on the surface buoy is included in this.

The reason why the difference was in the expectations and the actual results at the rope section of the J-KEO mooring was that the speed paying out the rope had to be decreased due to the shortage of the development distance. The shortage of the deployment distance was caused from the changing of the external force such as the current, and from the occurrence of the sensor trouble which isn't expected.

The time spent in paying out nylon ropes of the J-KEO mooring was long because the rope length in total was 1328 meters longer than that of the m-TRITON mooring, and the speed paying out ropes was slow without room enough for the deployment distance of the J-KEO mooring.

The cable and ropes were paid out through the traction winch in case of the J-KEO mooring and they were paid out with using the wind winch instead of the traction winch in case of the m-TRITON mooring. There is no essential difference between the two.

The speed of the ship and revolutions of the winch was adjusted so as not to hang a big stress in the cable/ropes actually paid out from her stern, checking the past data and the cable/ropes tension measurement by skilled hands of marine technicians and chief officer at ship’s stern. The big stress was never applied to the rope and so on because the ship’s speed and the speed paying out them were slow.

A nylon line of the J-KEO mooring is composed of the nylon rope of the length 4500m and the polyolefin rope of the length 2328m. It makes a special mention that this composition is efficient in the work which the line is paid out because the joint of the line is only one.

(5.5) Dropping sinker (Fig.6.1-6)

After the condition that the sinker could be always dropped was taken, the mooring system line was pulled straight behind the ship for about fifteen minutes.

During pulling the line, the return distance after sinker dropping was predicted at about 10% of the depth of water. The 10% referred to the actual results of m-TRITON mooring.

The sinker was dropped at the moment when the above two conditions were satisfied.

As soon as the sinker dropped into the ocean, the ship’s head was turned to the direction where the movement of the top buoy on the surface of the water can be easily watched by the radar.

According to the radar watching, the surface buoy ran on the surface of the sea as follows.

When the sinker was dropped into the sea, the surface buoy was in the position of **Lat.37-5816N, Long.146-32.08E**. (Fig.6.1-7)

	Running direction	Running speed
15 minutes after the sinker dropped	124 degrees	3.4 knots
43 minutes after the sinker dropped	176 degrees	1.9 knots

About 1 hour after the sinker had been dropped, the movement of the surface buoy almost stopped in the position of **Lat.37-56.86N, Long.146-33.03E.**

The movement of the surface buoy between both points was the direction of **150 degrees**, the distance of **2778 meters** in a straight line**.**

And, these radar data are useful to know the catenary curve of the mooring line. The Fig.6.1-7 is a result of measurement with the radar at a moment when a sinker was dropped in the sea, at a moment when it was anchored at the bottom of the sea.

The work to confirm the precise location of the sinker was started here.

(5.6) Decision of the anchored position

The position of the sinker that arrived at the seabed was measured by an acoustic transducer lowered over the stern at 5 places within a radius of 3100 meters of the point that the sinker dropped. Numerical values that were measured by the acoustic transducer include the 79 meters distance between the bridge where is equipped with GPS and the ship's stern where the acoustic transducer is lowered. These numerical values were added, and the calculation was done with using software of the ship.

As a result, the precise position of the J-KEO mooring was decided at **lat.37° 55'.33N, Long. 146° 34'.64E** (Depth **5415** meters).

The position of the surface buoy at that time was lat.37-56.80N and long.146-33.00E. The surface buoy existed in the direction of 319 degrees, the horizontal distance of 3630m from the precise position of the J-KEO mooring. (Fig.6.1-7)

(5.7) Sinker's position (Table 6.1-1)

The difference between the position that **the sinker was dropped (the drop point)** and the position that **the sinker reached the seabed** (**the fixed point**) is shown in the following numerical data.

The drop point to the fixed point: direction 295degrees, distance 574meters

The ship's wake just before the sinker drop: 320 degrees

Above-mentioned numerical value shows that the straight-line distance between the sinker drop point and the fixed point which was obtained in the (5.6).

The difference of 35 degrees between the ship's wake and the return direction of the sinker arose likely with the current toward the South. However the fixed point was located on the development course (160 degrees) set in the beginning.

The proportion of the sinker return distance to the depth was 10.6 %. It is almost the same when that value is compared with the m-TRITON mooring.

(5.7) Required depth

As for the mooring depth of water, the flat bottom of the sea was required, and that difference in ups and downs was confined to the one within 20 meters.

The J-KEO mooring was actually anchored within the same 20 meter-depth contour as shown in Fig 6.1-6. The depth of the anchored position was 5415 meters by measurement of the SEA-BEAM 2000.

(5.8) Distance for Deployment of J-KEO mooring (Table 6.1-1 & 6.1-2)

Results are shown in the following table.

Works	Time-hour	Ship's speed-knot	Distance-mile
Setting the top-buoy	0.08	0.8 (0.8)	0.06
Paying out the wire cable with sensors	2.18	1.0 (1.0)	2.26
Paying out the nylon ropes (6828 m)	2.40	1.4 (1.1)	3.40
Attachment of the various instruments	0.30	0.7 (0.4)	0.19
Towing	0.25	0.8 (0.5)	0.20
Setting the sinker	0.04	1.6 (1.3)	0.06
Total	5.25 hours	OG1.2 knots (Log 1.0 knots)	6.18 miles

As for the speed and the distance, it has the point which the number doesn't add up with a little by rounding off.

The speeds of the ship and of the paying out of the rope had to be decreased after the paying out the nylon rope was started because the current became the following current of about 0.3 knots. If the current had been predicated in the beginning, the extra deployment distance of about 0.8 mile should be added.

(6) Data archive

All data will be archived on board.

(7) Remarks

Because the mooring place (37-56N, 146-30E) where it was designed in the beginning was near the sea mountain, the place was moved to a direction 58 degrees and a distance 4.34 miles from it. It confirmed that the place was very far from the submarine cable as well. The sinker of the J-KEO mooring was anchored at the required depth and place.

However, if it thought about shortening of the working hours, the development distance should be secured much larger than the present condition.

Because a defective sensor which was found was replaced with the new one while preparing working, the ship had to stand by for about 1 hour and brought the result from which the deployment distance planned at the beginning was subtracted sharply.

At final stage of the development work the towing is necessary in order to tow the mooring rope straight from the ship's stern. If that is also taken into consideration, the deployment distance should be set up with some extra distance.
In conclusion it is necessary to keep the deployment distance more than 7 miles (6.17 miles in this time) if the ocean current which is hard to predict, and an unexpected trouble are taken into consideration.

Although the work of the J-KEO mooring was the first time for MIRAI, it finished safely smoothly by referring to the past work of the m-TRITON mooring and the ATLAS mooring.
This precious experience will be very useful for the deployment of the future J-KEO mooring.

Fig.6.1-1 Log/OG Speed in deployment of J-KEO mooring (MR07-01)

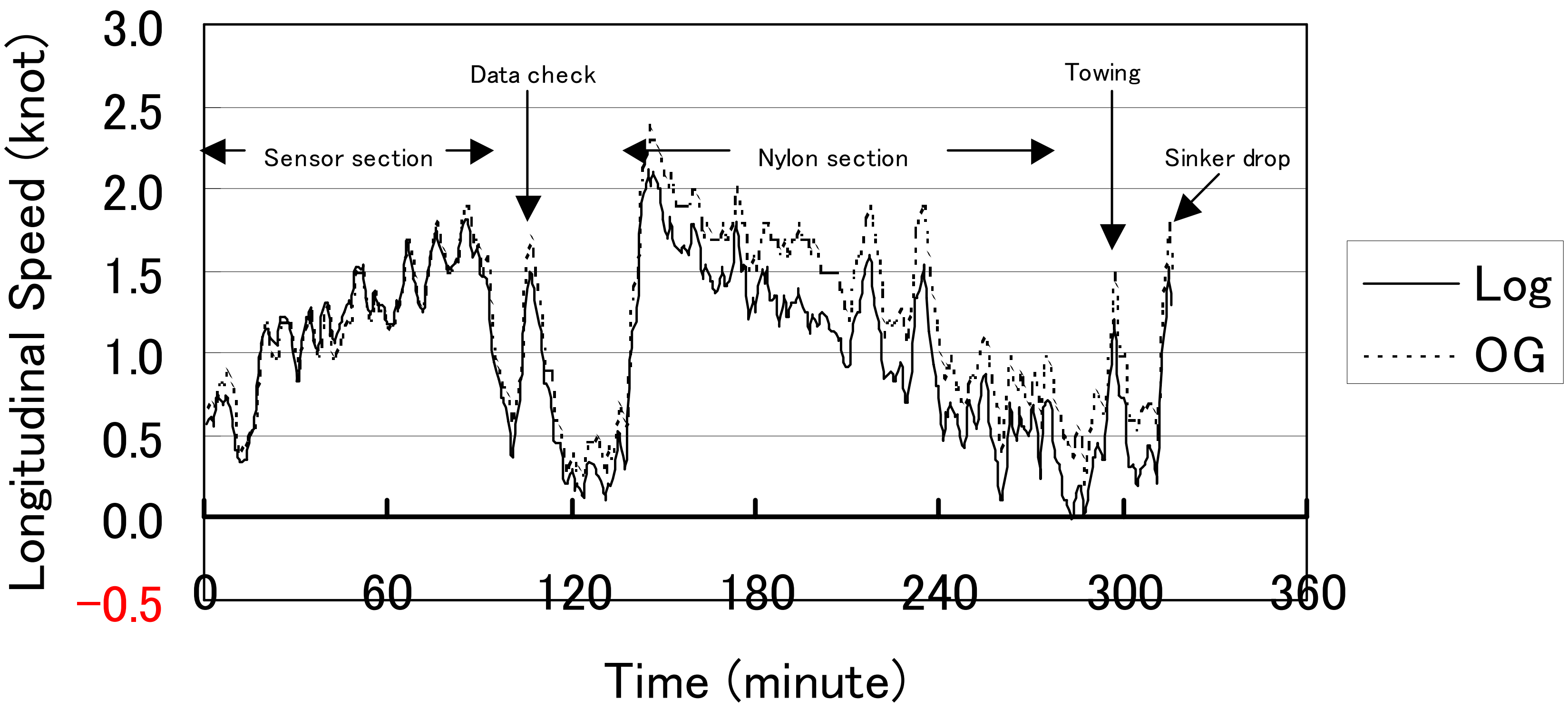


Fig.6.1-4 Current influence in deployment of J-KEO mooring (MR07-01)

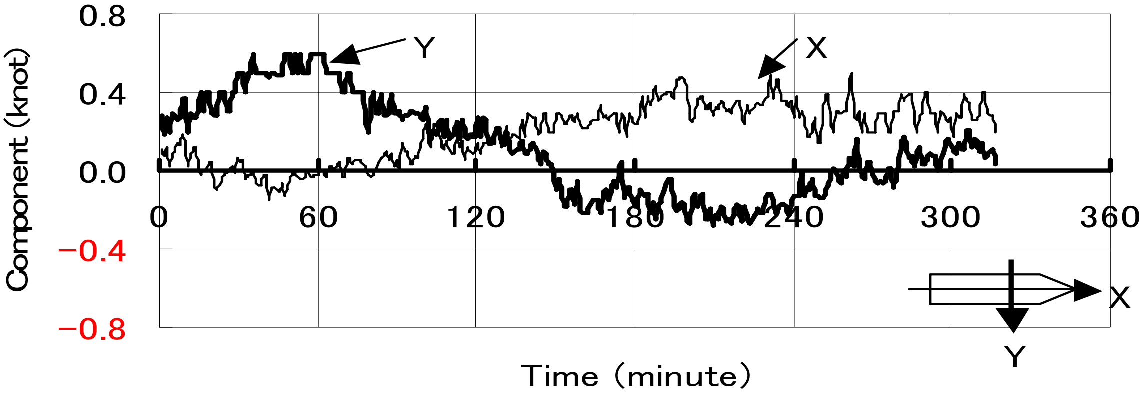


Fig.6.1-5 True current to ship's track in deployment of J-KEO mooring (MR07-01)

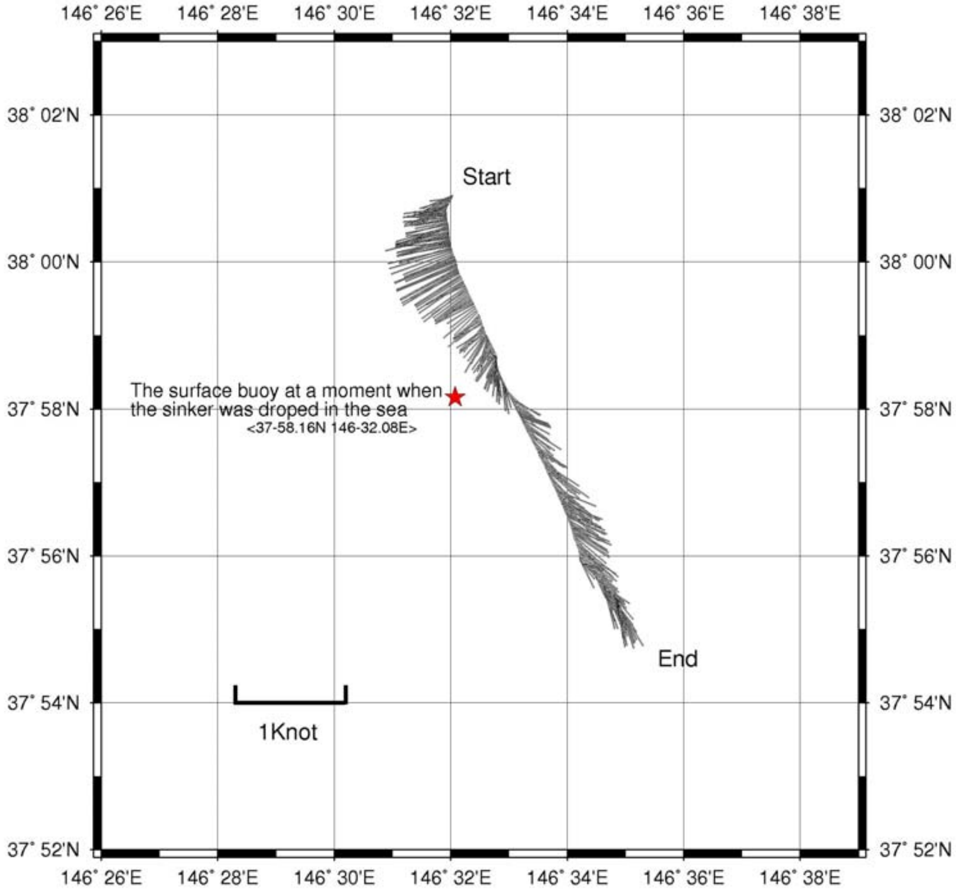


Fig.6.1-6 Terrain of ocean floor in deployment of J-KEO mooring (MR07-01)

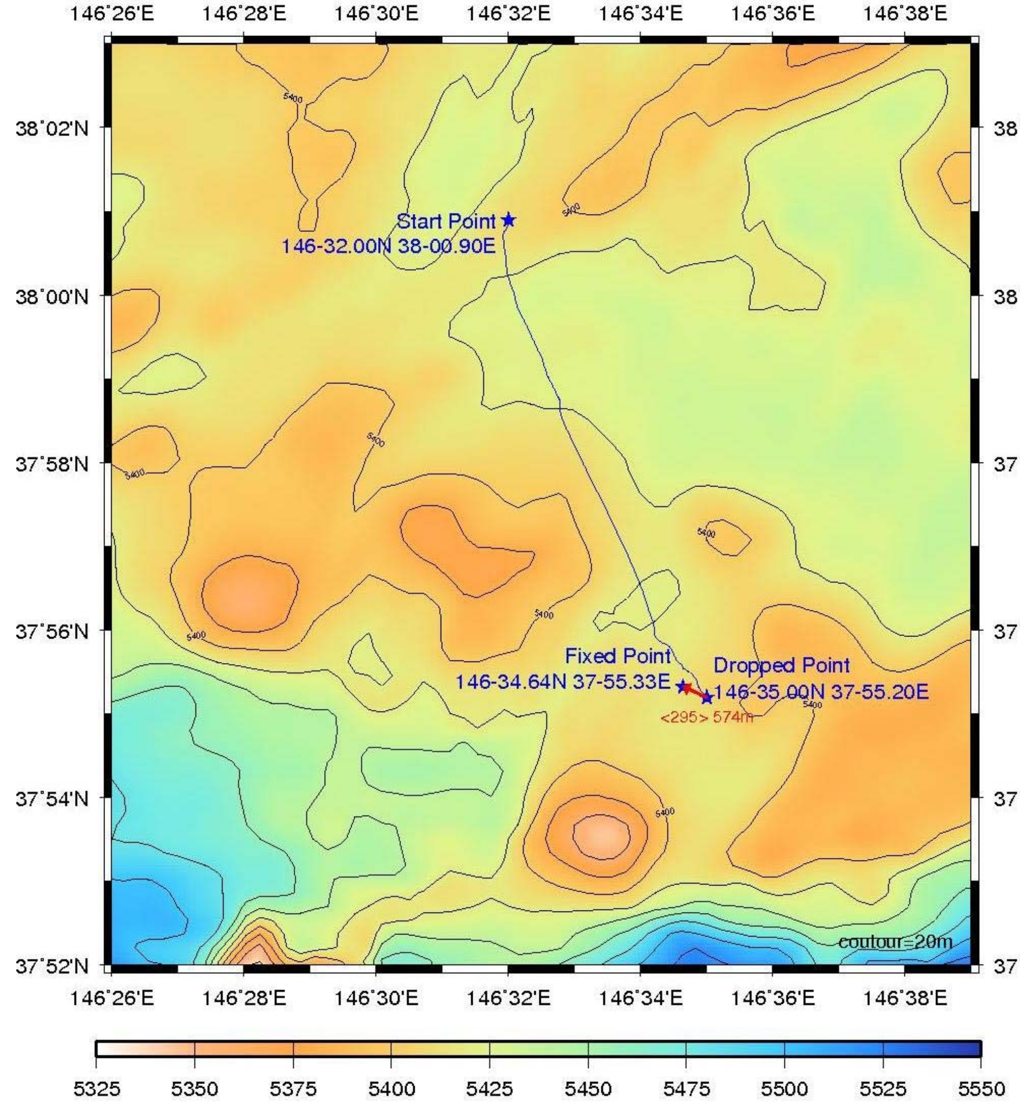


Fig.6.1−7 Movement of the surface buoy by radar measurement in deployment of J−KEO mooring (MR07−01)

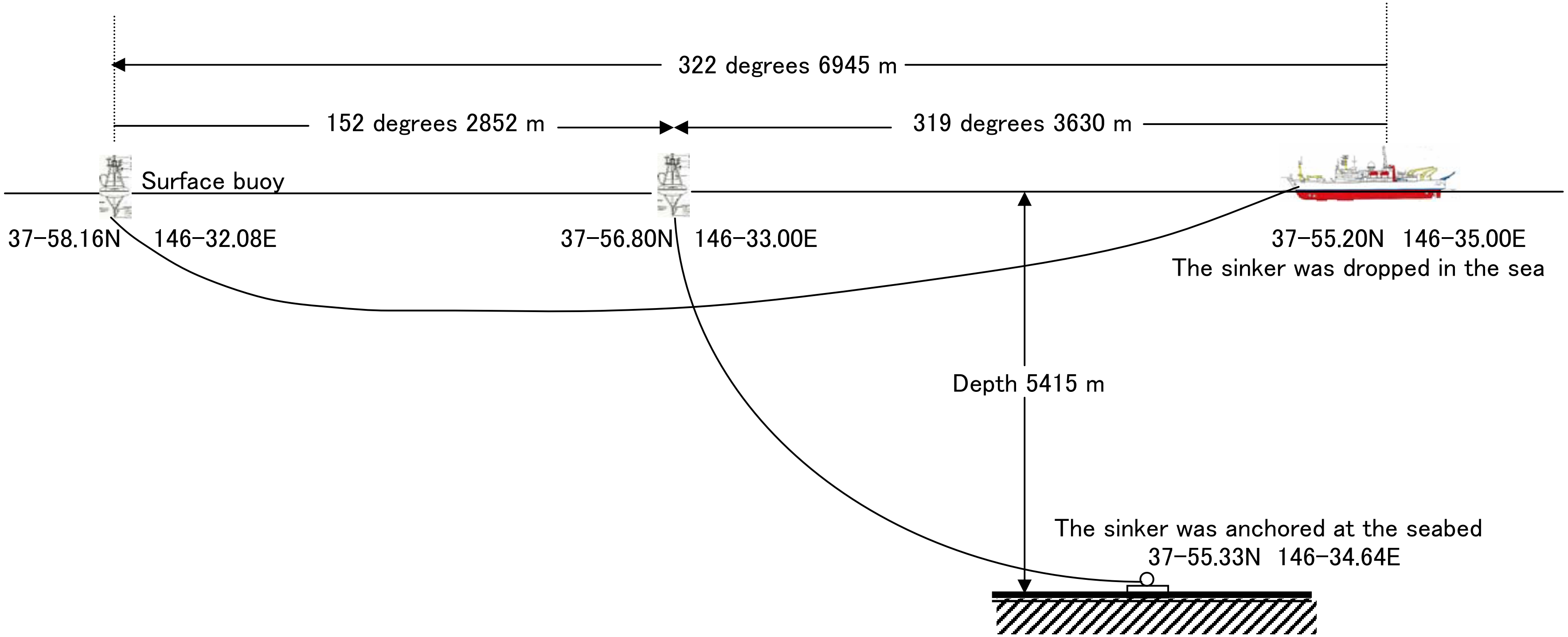


Table 6.1-1 Summary of working time in deployment of J-KEO and m-TRITON moorings (MR07-01)

		J-KEO	m-TRITON				
							m-TRITON from 1 to 3 Average
SITE No.		M07001	Test	1	2	3	
Required depth(m)		5415	2268	4760	4606	4714	
Location		38N,147E	Suruga	0N,79E	0N,82E	0,156E	
Works Date		2/18/07	3/28/06	10/25/06	10/27/06	12/4/06	
Sling buoy		9:12	8:09	7:37	7:40	7:48	
Buoy into sea		9:17	8:24	7:49	7:52	7:55	
Set 200m Sensor		10:00	8:49	8:19	8:22	8:23	
Set 500m Sensor		10:36	9:02	8:40	8:48	8:45	
Set 750m Sensor		10:52	9:21	8:40	8:48	8:45	
Pay out Nylon Rope		11:28	9:28	8:54	9:11	9:00	
Set Recovery Buoy		13:52	10:03	11:05	11:26	10:43	
Set Releaser		13:57	10:07	11:05	11:26	10:52	
S/B sinker		14:10	10:07	11:11	11:38	10:58	
Let go sinker		14:27	10:45	11:13	11:41	11:02	
	for buoy	0:05	0:15	0:12	0:12	0:07	0:10
H	for cable	2:11	1:04	1:05	1:19	1:05	1:09
o	for ropes	2:24	0:35	2:11	2:15	1:43	2:03
u	for recovery B'y	0:18	0:04	0:06	0:12	0:15	0:11
r	for sinker	0:17	0:38	0:02	0:03	0:04	0:03
Total		**5:15**	**2:36**	**3:36**	**4:01**	**3:14**	**3:37**
Length of all ropes(m)		6828	2200	5500	5500	5500	**5,500**
Length of ropes(m/h)		2,845	3,771	2,519	2,444	3,204	2,683
D	for cable (mile)	2.32	1.64	0.47	0.96	0.69	0.71
I	for ropes (mile)	3.37	1.49	3.12	3.2	3.1	3.14
s	for recovery (mile)	0.22	0.05	0.03	0.06	0.13	0.07
t	for sinker (mile)	0.26	1.54	0.02	0.01	0.04	0.02
Total (mile)		**6.17**	**4.72**	**3.64**	**4.23**	**3.96**	**3.94**
S	for cable (knot)	1.0	1.2	0.4	0.6	0.6	0.6
p	for ropes (knot)	1.4	2.6	1.4	1.4	1.8	1.5
ee	for recovery(knot)	0.7	0.8	0.3	0.3	0.5	0.4
d	for sinker (knot)	0.9	2.4	0.6	0.2	0.6	0.5
Av. OG speed (knot)		1.2	1.8	1.0	1.1	1.2	1.1
Av. Log speed(knot)		1.0	2.1	2.2	1.9	1.9	2.0
Deploy course (deg)		<160>	<180>	<120>	<080>	<225>	
Co.Made.Good (deg)		<158>	<179>	<122>	<087>	<224>	
Current direction (deg)		<185>	<045>	<300>	<244>	<048>	
Current speed (knt)		0.3	0.4	1.2	0.9	0.7	
Significant wave (m)		2.0	0.8	1.5	1.4	1.6	
Sinker return (m)		574	315	370	278	537	
Sinker return (deg)		<295>	<014>	<297>	<259>	<069>	
Sinker return/depth		0.106	0.139	0.078	0.060	0.114	

Table6.1-2 Navigational data in deployment of J-KEO mooring (MR07-1)

UTC	Position		Heading	Log	OG		Relative Wind		True Wind		Current	
Feb.18	lat.	Long.	(deg)	Speed (knt)	Course(deg)	Speed(knt)	Direction(deg)	Velocity(m/s)	Direction(deg)	Velocity(m/s)	Direction(deg)	Velocity(knt)
0:12	38-00.90N	146-32.04E	179	0.6	211	0.8	-3	10.6	173	10.3	247	0.3
0:20	38-00.79N	146-31.97E	176	0.6	205	0.9	0	10.1	176	9.8	239	0.4
0:30	38-00.69N	146-31.92E	168	1.1	174	1.1	5	10.2	170	9.6	253	0.4
0:40	38-00.50N	146-31.95E	168	1.1	171	1.1	14	11.5	175	11	259	0.4
0:50	38-00.32N	146-31.97E	163	1.5	172	1.2	8	12.1	167	11.3	262	0.5
1:00	38-00.13N	146-32.03E	155	1.5	161	1.4	15	11.6	162	10.8	250	0.6
1:10	37-59.92N	146-32.12E	150	1.2	169	1.3	0	10.1	150	9.5	242	0.6
1:20	37-59.70N	146-32.24E	150	1.4	152	1.4	16	10.2	158	9.5	241	0.4
1:30	37-59.47N	146-32.38E	151	1.6	154	1.5	0	12	151	11.1	246	0.2
1:40	37-59.21N	146-32.52E	153	1.5	163	1.7	6	12.6	155	11.8	238	0.3
1:50	37-59.03N	146-32.60E	155	0.5	158	0.7	0	10.9	155	10.6	222	0.3
2:00	37-58.85N	146-32.72E	156	1.2	153	1.4	-15	10.9	132	10.2	215	0.3
2:10	37-58.75N	146-32.77E	155	0.3	147	0.3	-5	11.8	147	11.7	220	0.2
2:20	37-58.68N	146-32.78E	155	0.3	175	0.5	-19	14.1	128	13.9	200	0.3
2:30	37-58.59N	146-32.79E	155	1.1	167	1.1	-17	13.4	128	12.8	172	0.3
2:40	37-58.27N	146-32.96E	154	2	157	2.2	-19	13.3	125	12.3	154	0.2
2:50	37-57.98N	146-33.14E	154	1.9	156	2	-13	13.6	134	12.7	145	0.3
3:00	37-57.71N	146-33.30E	155	1.4	154	1.8	-9	15	141	14.3	135	0.3
3:10	37-57.45N	146-33.47E	155	1.4	152	1.6	-11	16	137	15.3	124	0.3
3:20	37-57.20N	146-33.63E	155	1.4	158	1.7	-13	12.9	134	12.3	127	0.4
3:30	37-56.95N	146-33.78E	155	0.9	154	1.7	-11	15.6	138	15.1	135	0.5
3:40	37-56.72N	146-33.90E	155	1.1	157	1.3	-17	14.7	126	14.2	125	0.4
3:50	37-56.47N	146-34.03E	156	1.4	158	1.7	-12	14.5	135	13.9	130	0.4
4:00	37-56.28N	146-34.11E	155	0.9	162	1.1	-11	15.8	138	15.4	131	0.4
4:10	37-56.03N	146-34.21E	155	1.1	169	1.2	-20	12.9	123	12.4	129	0.4
4:20	37-55.89N	146-34.26E	149	0.7	130	0.8	-8	15.9	140	15.4	110	0.2
4:30	37-55.81N	146-34.43E	141	0.3	141	0.6	-14	13.9	120	13.7	140	0.3
4:40	37-55.70N	146-34.51E	141	0.3	151	0.7	-20	12.2	109	12	155	0.2
4:50	37-55.59N	146-34.61E	140	0.4	113	0.7	-14	13.4	122	13.2	146	0.3
5:00	37-55.53N	146-34.67E	141	0.3	94	0.6	-15	11.4	117	11.2	149	0.3
5:10	37-55.43N	146-34.83E	135	0.7	141	1	-10	12.3	120	11.9	168	0.3
5:20	37-55.32N	146-34.88E	140	0.5	148	0.7	-7	11.6	130	11.3	172	0.3
5:27	37-55.21N	146-34.98E	139	1.3	142	1.5	0	10	139	9.4	147	0.2