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R/V Mirai Cruise Report
MR02-K06
(Leg 2)

December 17, 2002 – January 12, 2003

Joint Research Cruise of

TOCS (Tropical Ocean Climate Study)

and

the Primary Production Project in the Pacific

Edited by
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Japan Marine Science and Technology Center
(JAMSTEC)

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8.2 Ship’s handling for recovery TRITON buoy/Sediment-traps

1. Cruise name and code

Tropical Ocean Climate Study

MR02-K06-Leg-2

Ship: R/V MIRAI

Captain: Masaharu Akamine

2. Introduction and observation summary

2.1 Introduction

The purpose of this cruise is to observe physical oceanographic conditions in the western tropical Pacific Ocean to achieve a better understanding of air-sea interaction affecting on the ENSO (El Nino/Southern Oscillation) phenomena and its related climate change. The surface layer in the western tropical Pacific Ocean is characterized by high sea surface temperature area, which plays major role in driving global atmospheric circulation. Especially, El Nino occurs when warm water migrates eastward, and causes short-term climate changes in the world dramatically. For example, the western Pacific area has very few rainfalls when the "El Nino" occurred, as in 1997-98. This atmospheric and oceanic system is so complicated, and we still do not have enough knowledge about it. This climate system also has the long time scale. To investigate the mechanism, precise and detailed data are needed for the long period continuously. Therefore, ocean and atmosphere observing mooring array is effective to obtain such data. The major mission of this cruise is to deploy and recover TRITON buoys developed at JAMSTEC for the long term measurements of ocean and atmosphere in the western tropical Pacific Ocean. In this crises, we have successfully deployed 8 TRITON buoys and recovered 7 TRITON buoys with R/V Mirai.

The other purposes of this cruise are,

1) The measurement of the primary production in the tropical Pacific,

1) The pCO2 measurements in the boundary layer by Meteorological Research Institute of Japan,

2) The recovery of Sediment trap mooring by National Institute of advanced Industrial Science and Technology,

3) The aerosol measurement in the atmospheric boundary layer by Hokkaido University,

4) The Mie-scattering Lidar aerosol measurement by National Institute for Environmental Studies,

5) The Surface Turbulent measurement by JAMSTEC and Okayama University,

6) The measurements of carbonalte and its related materials by Central Research Insitutute of Electric Power Industry,

7) The underway geophysical measurement by JAMSTEC, and

8) The launching of ARGO floats by Frontier Observation Research System for Global change,

9) the measurement for validation of ADEOS-2 satellite measurement by NASDA and

10) the satellite data receive from Seawifs by NASDA,

These measurements are also made successfully during this cruise.

2.2 Observation summary

TRITON buoy deployment:	8 sites
TRITON buoy recovery:	7 sites
TRITON buoy visit:	1 site
CTD(Salinity, Temperature, Depth) with water sampling:	10 sites
XCTD (Salinity, Temperature, Depth):	30 profiles down to 1000m
Surface meteorology:	continuous
ADCP measurements:	continuous
Surface temperature, salinity measurements by intake method:	continuous

Other specially designed observations have been carried out successfully.

Observed oceanic and atmospheric conditions :

This MR02-K06-Leg-2 cruise was carried out under the mature stage of the 2002 El Nino. The data from TAO/TRITON buoy array indicates that since December 2001 the strong westerly wind burst (WWB) events continuously occurred in the western Pacific, and after May 2002, the Sea Surface temperature (SST) in the central and eastern pacific increased. The SST fields in November- December 2002 indicate the mature stage of El Nino with high SST anomaly more than 3 degree-C. The TRITON buoy data will provide the precise information on the 2002 El Nino with the TAO buoy data.

During this cruise, the sea surface temperature (SST) along 156E, the SST was higher than 29 degree-C, and the temperature and salinity vertical section along 156E showed no indication of equatorial upwelling. The depth of thermocline is shallower (50 meters) than normal, indicating the loss of heat storage resulted from the eastward displacement of warm water pool. The surface current measured by shipboard ADCP indicated the weak eastward current from 2N to 2S along 156E, and the surface wind observed on the R/V Mirai indicated the weak westerly wind near the Equator. Such conditions were associated with the El Nino. Since January 6th 2003, due to the sever weather condition more than 3 meters wave height and more than 12m/s wind speed, the TRITON buoy at 5N156E was not be able to recover. This sever weather was caused by the enhancement of the atmospheric convection east of 160E generated by the eastward movement of warm water pool located at the same area. The convection continued for more than 1 week since January 6, the maintenance works of

TRITON buoys (recovery of the old 5N156E buoy, deployment of the new 8N156E buoy and recovery of the old 8N156E buoy) were unable to finish.

3. Period, ports of call, cruise log and cruise track
3.1 Period

December 17,2002 - January 12,2003

3.2 Ports of call

Guam, U.S.A.	(December 16 - 17, 2002)
Chuuk, F.S.M	(January 12-13, 2003)

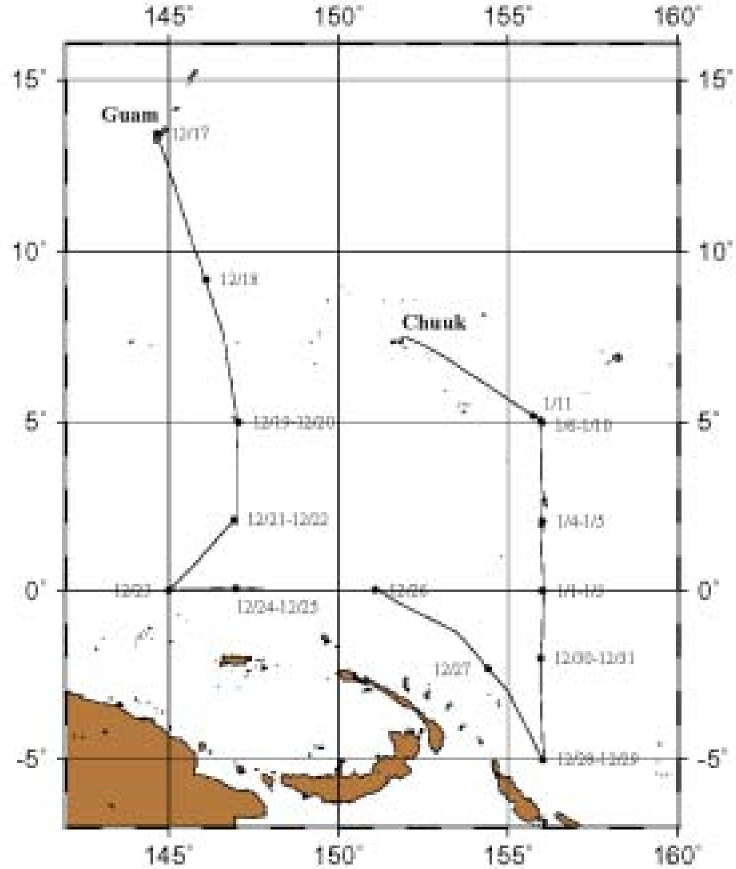
3.3 Cruise log

SMT (Ship Mean Time)	UTC	Event
Dec. 17 (Tue.)		
13:30-	03:30-	Safety guidance on the R/V Miral
14:00	04:00	Departure from Guam, USA (SMT=UTC+10)
15:00-	05:00-	Boat station drill
19:33-	09:33-	Start of continuous shipboard observations and surface seawater monitoring
21:54	11:54	XCTD-01 (12-00.00N, 145-08.66E)
Dec. 18 (Wed.)		
01:58	15:58	XCTD-02 (11-00.01N, 145-27.98E)
06:11	20:11	XCTD-03 (10-00.09N, 145-47.78E)
10:00-	00:00-	Meeting for observation
10:56	00:56	XCTD-04 (9-00.00N, 146-28.01E)
15:17	05:17	XCTD-05 (7-59.99N, 146-28.01E)
19:35	09:35	XCTD-06 (7-00.07N, 146-42.18E)
23:48	13:48	XCTD-07 (5-59.57N, 146-51.04E)
Dec. 19 (Thu.)		
08:28-11:21	22:28-01:21	Deployment of TRITON buoy (5N147E)
12:08-12:38	02:08-02:38	CTD01-1 (300m, 5-01.08N, 146-58.08E)
13:58-16:24	03:58-06:24	CTD01-2 (4,188m, 5-01.92N, 146-57.65E)
Dec. 20 (Fri.)		
07:58-11:34	21:58-01:34	Recovery of TRITON buoy (5N147E)
11:38	01:38	Argo float launched (5-03.54N, 147-00.87E)
12:14	02:14	XCTD08 (4-58.05N, 147-01.93E)
16:22	06:22	XCTD09 (4-00.01N, 146-59.96E)
20:34	10:34	XCTD10 (3-00.02N, 147-00.12E)
Dec. 21 (Sat.)		
08:21-11:03	22:21-01:03	Deployment of TRITON buoy (2N147E)
12:08-12:41	02:08-02:41	CTD02-1 (300m, 2-00.92N, 146-59.69E)
13:43-16:26	03:43-06:26	CTD02-2 (4,480m, 2-01.06N, 146-59.65E)
Dec.22 (Sun.)		
07:55-11:35	21:55-01:35	Recovery of TRITON buoy (2N147E)
11:41	01:41	Argo float launched (2-01.59N, 146-57.25E)
11:59	01:59	XCTD11 (2-04.47N, 146-56.72E)

17:53	07:53	XCTD12 (0-59.98N, 145-58.08E)
Dec. 23 (Mon.)		
03:57-04:23	17:57-18:23	CTD03-1 (200m, 0-01.41N, 144-59.52E)
05:28-05:43	19:28-19:43	Launching of in-situ incubation drifting buoy
06:57-09:28	20:57-23:28	Recovery of Sediment-trap mooring
10:59-11:31	00:59-01:31	CTD03-2 (200m, 0-00.03N, 144-59.62E)
11:35-11:46	01:35-01:46	Free-fall radiation measurement (50m, 130m)
18:03-18:23	08:03-08:23	Recovery of in-situ incubation drifting buoy
18:45	08:45	XCTD13 (0-01.59N, 144-58.21E)
22:48	12:48	XCTD14 (0-02.12N, 146-00.04E)
Dec. 24 (Tue.)		
08:24-10:50	22:24-00:50	Deployment of TRITON buoy (0-147E)
11:54-12:23	01:54-02:23	CTD04-1 (200m, 00-00.19S, 147-00.43E)
13:22-16:11	03-22-06:11	CTD04-2 (4,455m, 0-00.42S, 147-00.49E)
Dec. 25 (Wed.)		
07:50-11:15	21:50-01:15	Recovery of TRITON (0-147E)
11:56	01:56	XCTD15 (0-03.21N, 147-00.64E)
15:50	05:50	XCTD16 (0-00.10N, 148-00.01E)
19:38	09:38	XCTD17 (0-00.02S, 148-59.14E)
23:30	13:30	XCTD18 (0-00.00N, 150-00.02E)
Dec. 26 (Thu.)		
03:15	17:15	XCTD19 (0-00.01N, 150-59.99E)
03:53-04:20	17:30-18:20	CTD05-1 (200m, 0-00.15N, 151-03.08E)
05:10-05:18	19:10-19:18	Launching of in-situ incubation drifting buoy
06:54-08:10	20:54-22:10	CTD05-2 (1,800m, 0-00.96N, 151-05.14E)
08:17-09:52	22:17-23:52	Plankton net (1,800m)
09:58-10:47	23:52-00:47	Plankton net (1,000m)
10:59-11:31	00:59-01:31	CTD05-3 (200m, 0-00.42N, 151-06.06E)
11:32-11:42	01:32-01:42	Free fall radiation measurement (50m, 130m)
17:42-18:00	07:42-08:00	Recovery of in-situ incubation drifting buoy
Dec. 27 (Fri.)		Cruising to 5S156E TRITON buoy site
Dec. 28 (Sat.)		
08:20-10:02	22:20-00:02	Deployment of TRITON buoy (5S156E)
10:59-11:33	00:59-01:33	CTD06-1 (300m, 4-59.64S, 156-00.57E)
11:40-12:08	01:40-02:08	Calibration of geo-magnetmeter
12:57-14:29	02:57-04:29	CTD06-2 (1,476m, 4-59.56S, 156-00.33E)
Dec. 29 (Sun.)		
07:45-10:20	21:45-00:20	Recovery of TRITON buoy (5S156E)
10:56-12:13	00:56-02:13	Repair of deployed TRITON buoy (5S156E)
13:57-15:25	03:57-05:25	Repair of deployed TRITON buoy (5S156E)
17:25	07:25	XCTD20 (5-01.87S, 156-02.58E)
21:22	11:22	XCTD21 (3-59.99S, 155-59.97E)
Dec. 30 (Mon.)		
01:17	15:17	XCTD22 (3-00.04S, 155-58.10E)
08:19-10:05	22:19-00:05	Deployment of TRITON buoy (2S156E)

10:56-11:29	00:56-01:29	CTD07-1 (300m, 1-59.29N, 156-00.21E)
12:55-14:31	02:55-04:31	CTD07-2 (1,718m, 1-59.47N, 156-00.14E)
Dec. 31 (Tue.)		
07:58-10:41	21:58-00:41	Recovery of TRITON buoy (2S156E)
11:15	01:15	XCTD23 (2-01.14S, 155-57.81E)
15:31	05:31	XCTD24 (1-00.00S, 156-01.15E)
Jan. 1, 2003 (Wed.) Happy New Year Holiday		
Jan. 2 (Thu.)		
08:46-11:26	22:46-01:26	Deployment of TRITON buoy (0-156E)
12:24-12:55	02:24-02:55	CTD08-1 (300m, 0-01.13N, 155-56.90E)
13:57-15:22	03:57-05:22	CTD08-2 (1,800m, 0-01.09N, 155-56.95E)
15:52-17:25	05:52-07:25	CTD08-3 (1,904m, 0-01.10N, 155-56.46E)
Jan. 3 (Fri.)		
07:54-11:03	21:54-01:03	Recovery of TRITON buoy (0-156E)
12:54-14:13	02:54-04:13	Plankton net (1,800m)
14:18-15:05	04:18-05:05	Plankton net (1,000m)
15:43	05:43	XCTD25 (0-00.44N, 156-02.11E)
19:34	09:34	XCTD26 (1-00.03N, 155-59.94E)
Jan. 4 (Sat.)		
08:34-10:24	22:34-00:24	Deployment of TRITON buoy (2N156E)
11:24-11:55	01:24-01:55	CTD09-1 (300m, 1-57.03N, 156-01.08E)
12:32	02:32	XCTD27 (2-02.27N, 156-01.16E)
13:10-15:02	03:10-05:02	CTD09-2 (2,606m, 1-56.87N, 156-01.39E)
Jan. 5 (Sun.)		
08:40-11:38	22:40-01:38	Recovery of TRITON buoy (2N156E)
11:44	01:44	Argo float launched (1-56.29N, 155-57.89E)
18:34	08:34	XCTD28 (3-00.05N, 156-00.13E)
22:18	12:18	XCTD29 (4-00.02N, 155-59.26E)
Jan. 6 (Mon.)		
08:23-10:33	22:23-00:33	Deployment of TRITON buoy (5N156E)
11:09-12:29	01:09-02:29	CTD10-1 (1,800m, 5-02.99N, 155-57.39E)
12:50	02:50	XCTD30 (5-01.50N, 155-58.10E)
13:24-15:48	03:24-05:48	CTD10-2 (3,628m, 4-59.75N, 156-00.42E)
Jan. 7 (Tue.)		
03:54-04:22	17:54-18:22	CTD10-3 (200m, 4-58.42N, 155-59.60E)
05:05-05:17	19:05-19:17	Launching of in-situ incubation drifting buoy
10:53-11:19	00:53-01:19	CTD10-4 (200m, 5-00.09N, 155-54.63E)
11:25-11:35	01:25-01:35	Free fall radiation measurement (50m, 130m)
17:23-17:43	07:23-07:43	Recovery of in-situ incubation drifting buoy
Jan. 8 (Wed.)		No observation work due to rough sea condition
Jan. 9 (Thu.)		No observation work due to rough sea condition
Jan. 10 (Fri.)		No observation work due to rough sea condition
Jan. 11 (Sat.)		No observation work due to rough sea condition
Jan. 12 (sun.)		
10:30	00:30	Arrival to Chuuk, Micronesia

3.4 Cruise Track



4. Chief scientist

Kentaro Ando, Dr.
Associate Scientist, Ocean Observation and Research Department, JAMSTEC

5. Participants list

5.1 R/V Mirai Scientists and Technical Staff

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Michimasa Magi	Research Institute of Innovative Technology for the Earth(RITE) 9-2,Kizugawadai,Kizu-cho,Soraku-gun,Kyoto,619-0292,Japan
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Wataru Tokunaga	GODI
Shinya Okumura	GODI
Kouichi Takao	Marine Works Japan LTD. (MWJ) Live Pier Kanagawahakkei 3F 1-1-7, Mutuura, Kanazawa-ku, Yokohama, Kanagawa, 236-0031, Japan
Masayuki Fujisaki	MWJ
Takeo Matsumoto	MWJ
Ai Yasuda	MWJ
Kenichiro Sato	MWJ
Keisuke Wataki	MWJ
Kei Suminaga	MWJ
Masaki Furuhata	MWJ
Miki Yoshiike	MWJ

Tomoyuki Takamori	MWJ
Yu Sasaki	MWJ
Yo Yasuda	MWJ
Shinji Rakuma	MWJ
Maiko Kimino	MWJ
Saiko Sugisaki	MWJ
Akira Shimizu	MWJ
Keisuke Ohnishi	MWJ

5.2 R/V MIRAI Crew member

Master	Masaharu Akamine
Chief Officer	Takaaki Hashimoto
1st. Officer	Haruhiko Inoue
2nd. Officer	Shingo Fujita
3rd. Officer	Nobuo Fukaura
Chief Engineer	Akiteru Ono
1st. Engineer	Nobuya Araki
2nd. Engineer	Koji Masuno
3rd. Engineer	Takahiro Machino
Chief Radio Officer	Keiichirou Shishido
2nd. Radio Officer	Naoto Morioka
Boatswain	Kenetsu Ishikawa
Able Seaman	Hisashi Naruo
Able Seaman	Keiji Yamauchi
Able Seaman	Kunihiko Omote
Able Seaman	Hisao Oguni
Able Seaman	Toshiyuki Oikawa
Able Seaman	Masaru Suzuki
Able Seaman	Yosuke Kuwahara
Able Seaman	Kazuyoshi Kudo
Able Seaman	Tsuyoshi Sato
Able Seaman	Tsuyoshi Monzawa
Able Seaman	Masashige Okada
Able Seaman	Shuji Komata
No.1 Oiler	Sadayoshi Honda
Oiler	Kiyoharu Emoto
Oiler	Yoshihiro Sugimoto
Oiler	Takashi Miyazaki
Oiler	Toshio Matsuo
Oiler	Daisuke Taniguchi
Chief Steward	Yasuaki Koga
Cook	Yasutaka Kurita
Cook	Hitoshi Ota
Cook	Tatsuya Hamabe
Cook	Wataru Sasaki

6. General Observations
6.1 Meteorological Measurement
6.1.1 Surface meteorological observation

(1) Personnel

Kunio Yoneyama (JAMSTEC): Principal Investigator - Shore-side participant -
Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Objective

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

(3) Methods

The surface meteorological parameters were observed throughout MR02-K06 Leg2 cruise from the departure of Guam, USA on 17 December 2002 to the arrival of Chuuk, Federated stats of Micronesia on 12 January 2003.

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

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

(3-1) Mirai meteorological observation system

Instruments of Mirai met system are listed in Table 6.1.1-1 and measured parameters are listed in Table 6.1.1-2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin Denki, Japan. The data set has 6-second averaged every 6-second record and 10-minute averaged every 10-minute record.

Table 6.1.1-1 Instruments and their installation locations of Mirai met system

sensors	type	manufacturer	location (altitude from surface)
anemometer	KE-500	Koshin Denki, Japan	foremast (24m)
thermometer	FT	Koshin Denki, Japan	compass deck (21m) AT
SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet –5m)
dewpoint meter	DW-1	Koshin Denki, Japan	compass deck (21m)
barometer	F-451	Yokogawa, Japan	captain deck (13m)
rain gauge	50202	R. M. Young, USA	compass deck (19m)
optical rain gauge	ORG-115DR	ScTi, USA	compass deck (19m)
radiometer (SW)	MS-801	Eiko Seiki, Japan	radar mast (28m)
radiometer (IR)	MS-202	Eiko Seiki, Japan	radar mast (28m)
wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10m)

Table 6.1.1-2 Parameters of Mirai meteorological observation system

parmeters	units	remarks
1. latitude	degree	
2. longitude	degree	
3. ship's speed	knot	Mirai log, DS-30 Furuno
4. ship's heading	degree	Mirai gyro,TG-6000,Tokimec
5. relative wind speed	m/s	6sec/10min averaged
6. relative wind direction	degree	6sec/10min averaged
7. true wind speed	m/s	conducted by 3/4/5/6 6sec/10min averaged
8. true wind direction	degree	conducted by 3/4/5/6 6sec/10min averaged
9. barometric pressure	hPa	adjusted to sea surface level 6sec/10min averaged
10. air temperature (starboard side)	degC	6sec/10min averaged
11. air temperature (port side)	degC	6sec/10min averaged
12. dewpoint temperature (starboard side)	degC	6sec/10min averaged
13. dewpoint temperature (port side)	degC	6sec/10min averaged
14. relative humidity (starboard side)	%	conducted by 9/10/12 6sec/10min averaged
15. relative humidity (port side)	%	conducted by 9/11/13 6sec/10min averaged
16. sea surface temperature	degC	6sec/10min 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/10min averaged
20. down welling infra-red radiation	W/m^2	6sec/10min averaged
21. significant wave height	m	hourly
22. significant wave period	second	hourly

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

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

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

SCS recorded PRP data every 6.5 seconds, Zeno/met data every 10 seconds. Instruments and their locations are listed in Table 6.1.1-3 and measured parameters are listed in Table 6.1.1-4

Table 6.1.1-3 Instrument installation locations of SOAR system

sensors	type	manufacturer	location (altitude from surface)
Zeno/Met			
anemometer	05106	R. M. Young, USA	foremast (25m)
T/RH	HMP45A	Vaisala, USA	foremast (24m)
		with 43408 Gill aspirated radiation shield (R. M. Young)	
barometer	61201	R. M. Young, USA	foremast (24m)
		with 61002 Gill pressure port (R. M. Young)	
rain gauge	50202	R. M. Young, USA	foremast (24m)
optical rain gauge	ORG-815DA	Optical Science Inc., USA	foremast (24m)
PRP			
radiometer (SW)	PSP	Eppley labs, USA	foremast (25m)
radiometer (IR)	PIR	Eppley labs, USA	foremast (25m)
fast rotating shadowband radiometer		Yankee Environmental Sys	foremast (25m)

Table 6.1.1-4 Parameters of SOAR System

parmeters	units	remarks
1. latitude	degree	
2. longitude	degree	
3. ship's speed	knot	Mirai log, DS-30 Furuno
4. ship's heading	degree	Mirai gyro, TG-6000, Tokimec
5. relative wind speed	m/s	
6. relative wind direction	degree	
7. true wind speed	m/s	conducted by 3/4/5/6
8. true wind direction	degree	conducted by 3/4/5/6
9. barometric pressure	hPa	
10. air temperature	degC	
11. relative humidity	%	
12. rain rate (optical rain gauge)	mm/hr	
13. precipitation (capacitive rain gauge)	mm	reset at 50mm
14. down welling shortwave radiation	W/m^2	
15. down welling infra-red radiation	W/m^2	
16. defused radiation	W/m^2	

(4) Preliminary results

Wind (converted to U, V component, from SOAR), T-air (from SOAR) / SST (from EPCS), RH (from SOAR) / precipitation (from SOAR), solar radiation (from SOAR), pressure (from SOAR) and hourly significant wave height observed during the cruise are shown in Figure 6.1.1-1, Figure 6.1.1-2, and Figure 6.1.1-3 respectively. In the figures, accumulated precipitation data from SOAR capacitive rain gauge was converted to the precipitation amount in every minute and obvious noises were eliminated but not calibrated. Other figures are showing uncorrected data.

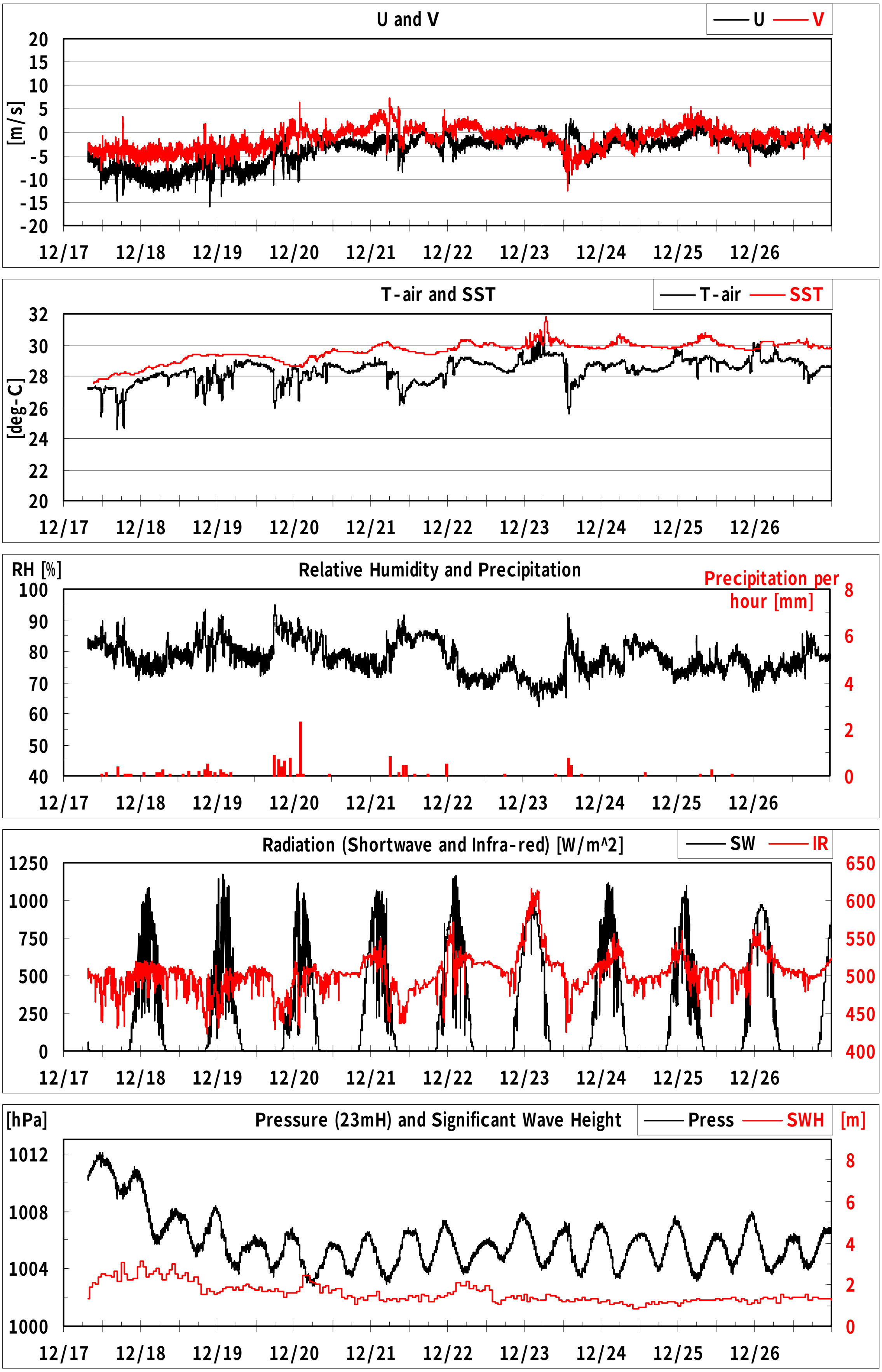
(5) Data archives

1. We did not sample the data within the territorial waters of Guam, USA and Chuuk, Federated states of Micronesia.
   Data acquisition term; 07:30(UTC) 17 December 2002 to 16:29(UTC) 11 January 2003

2. SST (Sea Surface Temperature) data was available from 09:24(UTC) 17 December 2002 to 16:27(UTC) 11 January 2003.

(6) Data archives

These raw data will be submitted to the JAMSTEC DMD (Data Management Division) just after the cruise and archived there.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28
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24
22
20
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70
60
50
40
8
6
4
2
0
Radiation (Shortwave and Infra-red) [W/m^2]
SW
IR
1250
1000
750
500
250
0
650
600
550
500
450
400
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1012
1008
1004
1000
8
6
4
2
0

Figure 6.1.1-1

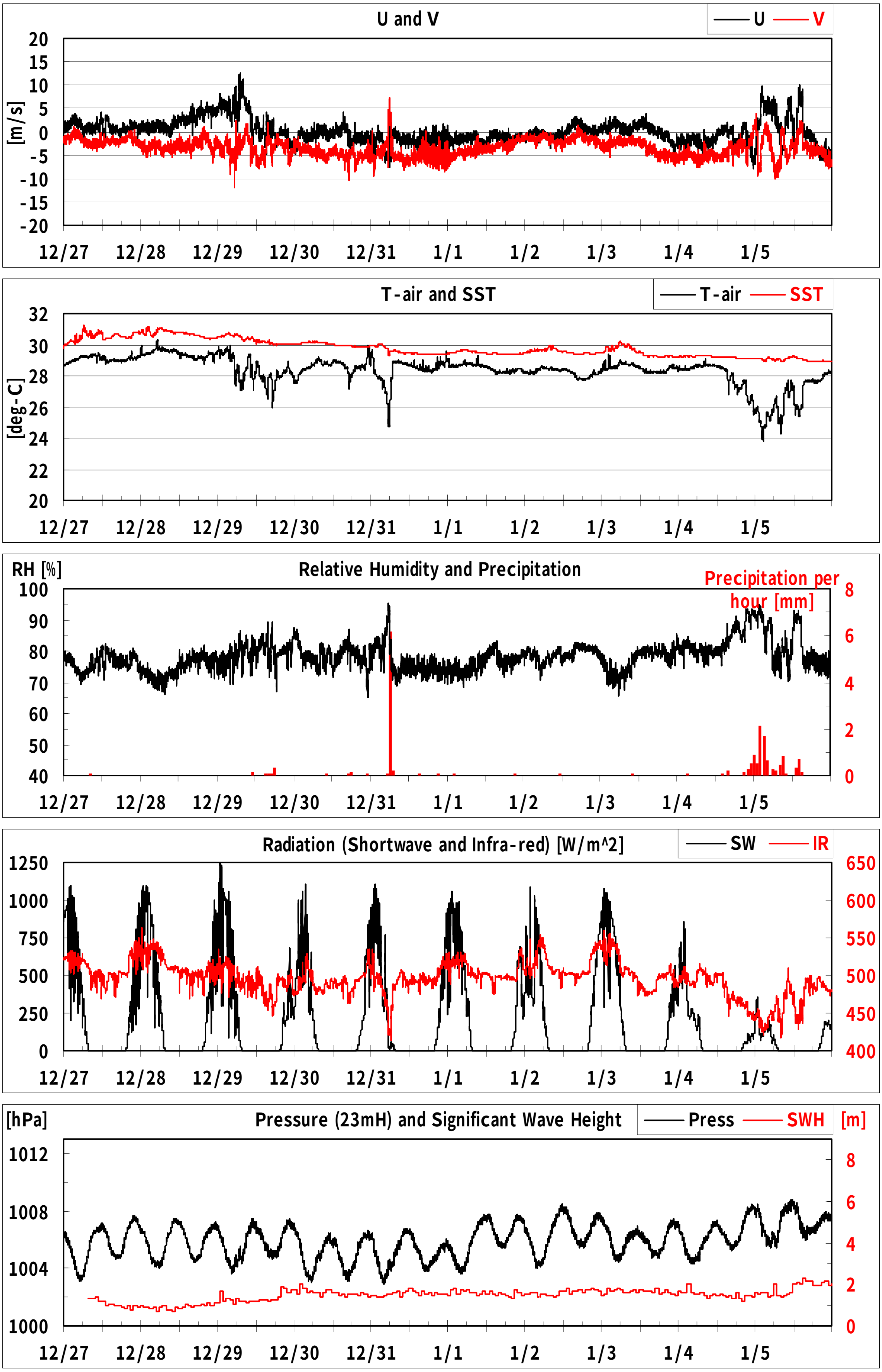
U and V
U
V
[m/s]
20
15
10
5
0
-5
-10
-15
-20
12/27
12/28
12/29
12/30
12/31
1/1
1/2
1/3
1/4
1/5
T-air and SST
T-air
SST
[deg-C]
32
30
28
26
24
22
20
RH [%]
Relative Humidity and Precipitation
Precipitation per hour [mm]
100
90
80
70
60
50
40
8
6
4
2
0
Radiation (Shortwave and Infra-red) [W/m^2]
SW
IR
1250
1000
750
500
250
0
650
600
550
500
450
400
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1012
1008
1004
1000

Figure 6.1.1-2

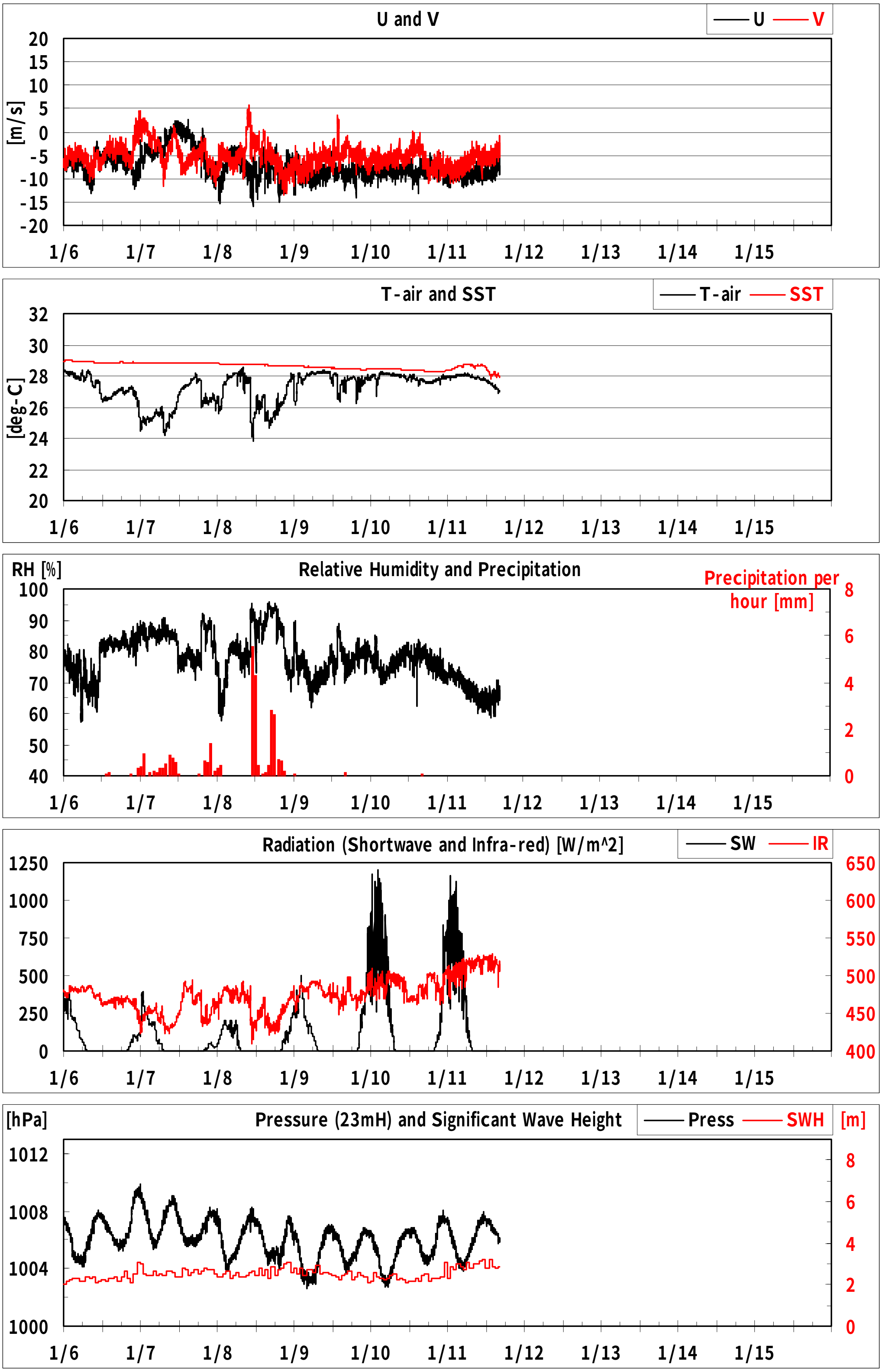
U and V
U
V
[m/s]
T-air and SST
T-air
SST
[deg-C]
RH [%]
Relative Humidity and Precipitation
Precipitation per hour [mm]
Radiation (Shortwave and Infra-red) [W/m^2]
SW
IR
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1/6
1/7
1/8
1/9
1/10
1/11
1/12
1/13
1/14
1/15

Figure 6.1.1-3

6.1.2 Ceilometer Observation

(1) Personnel

Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Objectives

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

(3) Parameters

(3-1) Cloud base height [m]
(3-2) Backscatter profile, sensitivity and range normalized at 100ft resolution.
(3-3) Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm

(4) Methods

We measured cloud base height, backscatter profiles and Sky Condition (cloud amount) using CT-25K ceilometer (Ver. 2.01) made by VAISALA, Finland and recorded by CT-VIEW software (Ver. 2.1) made by VAISALA, Finland throughout MR02-K06 Leg2 cruise from the departure of Guam, USA on 17 December 2002 to the arrival of Chuuk, Federated stats of Micronesia on 12 January 2003.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode Laser
Transmitting wavelength:	905 +/- 5 nm at 25 deg-C
Transmitting average power:	8.9 mW
Repetition rate:	5.57 kHz
Detector:	Silicon Avalanche Photodiode (APD)
Responsively at 905 nm:	65 A/W
Measurement range:	0 ~ 7.5 (0 ~ 25,000 ft)
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)

(5) Preliminary results

Fig. 6.1.2-1 shows the detected cloud base height during this cruise. The “C1” is the lowest cloud base height, and “C2” is the second lowest cloud base height. And Fig. 6.1.2-2 shows every 30-minutes of the estimated cloud amount (Sky Condition) during this cruise.

(6) Remarks

1. We did not sample the data in the territorial waters of Guam, USA and Chuuk, Federated states of Micronesia.
   Data acquisitions term; 07:30(UTC) 17 December 2002 to 16:29(UTC) 11 January 2003
2. Following data were missed.
   2002/12/30, 12:10 UTC
   2003/01/01, 22:23 UTC

(7) Data archives

Ceilometer data obtained in this cruise will be submitted to the JAMSTEC DMD (Data Management Division) and will be available via “R/V Mirai Data Web Page” in JAMSTEC home page.

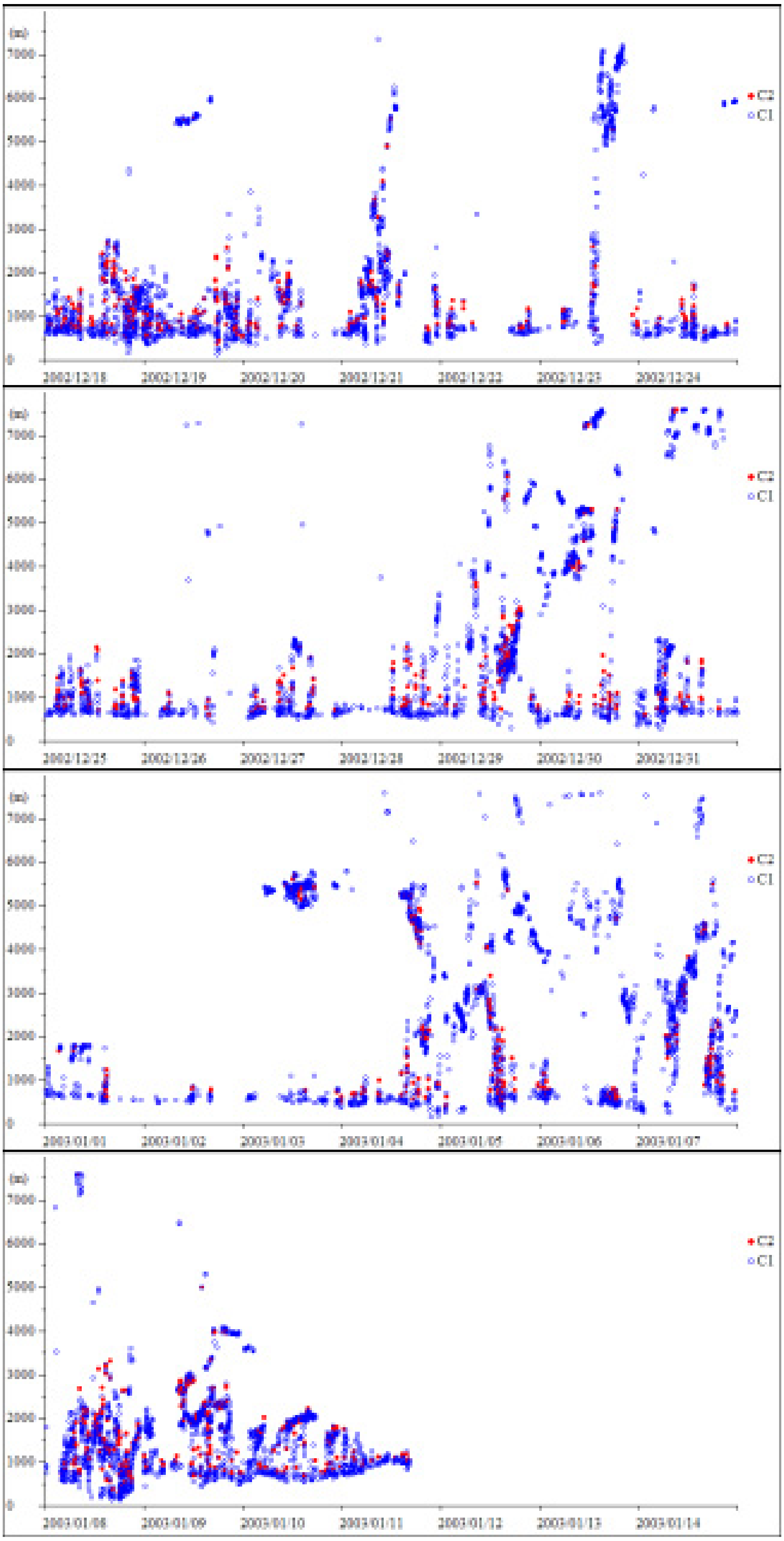

Fig. 6.1.2-1 Every minutes of Cloud base height (m)

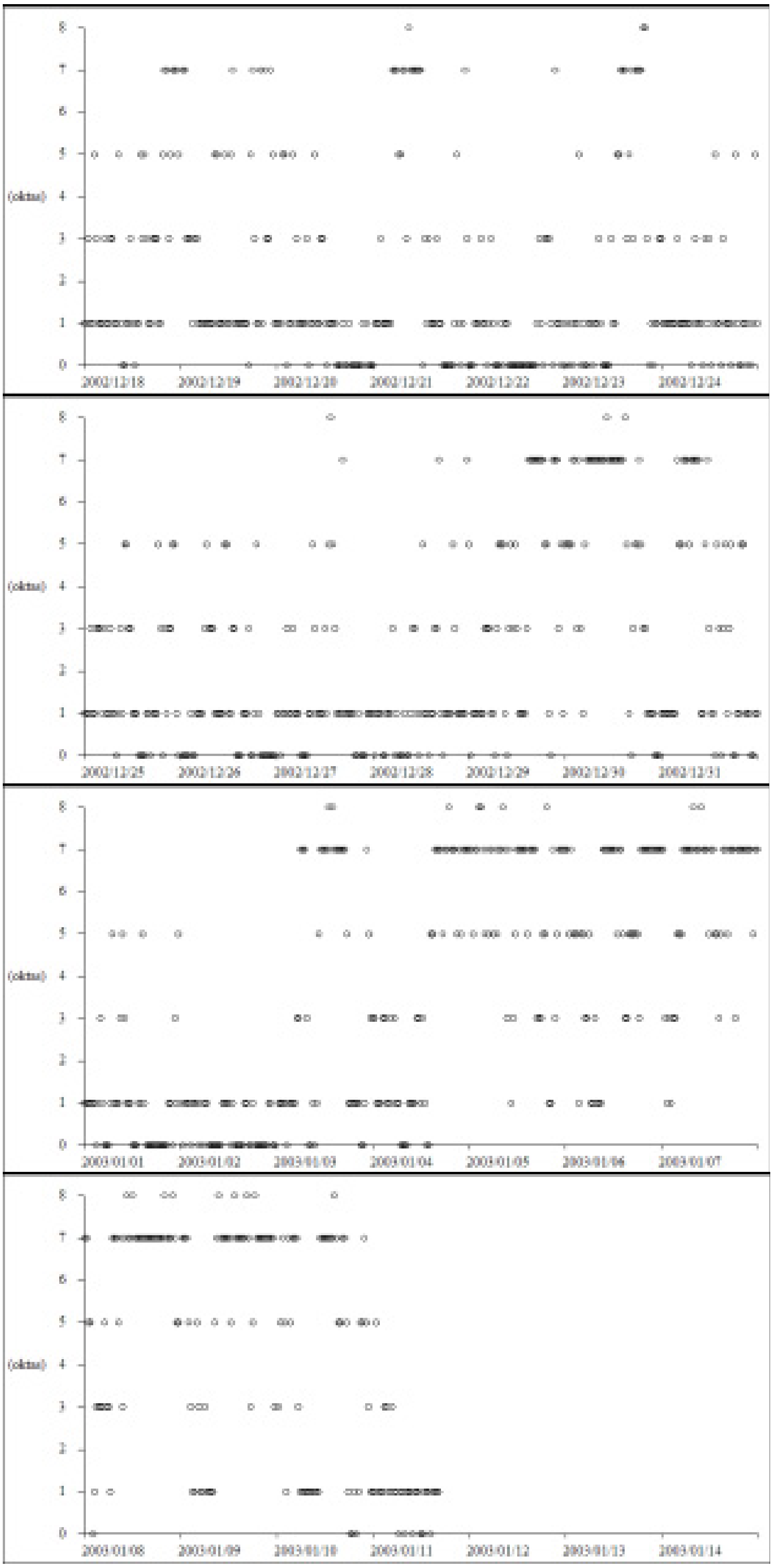

Fig. 6.1.2-2 Every half an hour of calculated cloud amount of Sky Condition (oktas)

6.2 CTD/XCTD
6.2.1 CTD

(1) Personnel

Masayuki Fujisaki (MWJ) : Operation Leader
Takeo Matsumoto (MWJ)
Miki Yoshiike (MWJ)
Tomoyuki Takamori (MWJ)

(2) Objective

Investigation of oceanic structure.

(3) Parameters

Temperature (Primary and Secondary)
Conductivity (Primary and Secondary)
Pressure
Fluorescence

(4) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 12-position Carousel water sampler with Sea-Bird Electronics Inc. CTD (SBE9plus), was used during this cruise. 12-litter Niskin Bottles were used for sampling seawater. The sensors attached on the CTD were temperature (Primary and Secondary), conductivity (Primary and Secondary), pressure and fluorometer, altimeter sensors. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.5.27b) provided by Sea-Bird Electronics,Inc. and stored on the hard disk of the personal computer. Seawater was sampled during up-cast by sending fire commands from the personal computer. We sampled seawater to calibrate salinity data.

Total 24 casts of CTD measurements have been carried out. (See table 6.2.1-1)

The CTD raw data was processed using SBE Data Processing-Win32 (ver.5.27b). Data processing procedures and used utilities SBE Data Processing-Win32 of were as follows:

DATCNV : Convert the binary raw data to output on physical units.
This utility selects the CTD data when bottles closed to output on another file.

SECTION : Remove the unnecessary data.

ALIGNCTD : ALIGNCTD aligns parameter data in time, relative to pressure.
Secondary Conductivity sensor relative to pressure = 0.073 seconds

WILDEDIT : Obtain an accurate estimate of the true standard deviation of the data.
Std deviation for pass 1= 10
Std deviation for pass 2= 20
Scan per block= 1000
Keep data within this distance of mean= 1
Exclude Scan Marked Bad = Check

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

Primary　　Alpha = 0.03, 1/beta = 7.0
Secondary　Alpha = 0.03, 1/beta = 7.0

FILTER：　Filter the high frequency noise on the data
Filter A = 0.15sec
Variable to Filter: Pressure: Low Pass Filter A

LOOPEDIT：　Mark scan with ‘badflag’, if the CTD velocity is less than 0 m/s.
Minimum Velocity Type = Fixed Minimum Velocity
Minimum CTD Velocity [m/sec] = 0.0
Exclude Scan Marked Bad = Check

BINAVG：　Calculate the averaged data in every 1 db.

DERIVE：　Calculate oceanographic parameters.

SPLIT：　Splits the data made in CNV files into up-cast and down-cast files.

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

Configuration file
MR02K062.con

Specifications of the sensors are listed below.

CTD：　SBE911plus CTD system

Under water unit：
SBE9plus (S/N 09P27443-0677, Sea-bird Electronics, Inc.)
Pressure sensor：　Digiquartz pressure sensor (S/N 79511)
Calibrated Date:　07 Feb.2002

Temperature sensors：
Primary：　SBE03plus (S/N 03P2730, Sea-bird Electronics, Inc.)
Calibrated Date:　02 Nov. 2002
Secondary：SBE03-4/F (S/N 031524, Sea-bird Electronics, Inc.)
Calibrated Date:　06 Sep. 2002

Conductivity sensors：
Primary：　SBE04-02/0 (S/N 041088, Sea-bird Electronics, Inc.)
Calibrated Date:　01 Nov. 2002
Secondary：SBE04-04/0 (S/N 041202, Sea-bird Electronics, Inc.)
Calibrated Date:　12 Nov. 2002

Altimeter：　Datasonics PSA-900 (S/N 396, Datasonics, Inc.)

Fluorometer：　(S/N 2148, Seapoint Sensors, Inc.)

Deck unit：　SBE11plus (S/N 11P9833-0344, Sea-bird Electronics, Inc.).

Carousel water sampler：　SBE32 (S/N 3227443-0389, Sea-bird Electronics, Inc.).

(5) Results

Temperature, salinity and fluorescence downcasting profiles are shown in Fig.6.2.1-1 – Fig.6.2.1-6. Note that in these figures, the correction of salinity data by sampled water is not applied.

(6) Data archives

All raw and processed CTD data files were copied onto CD-ROMs. The data will be submitted to the Data Management Office (DMO), JAMSTEC, and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC home page.

Table.6.2.1-1 CTD casttable

Station	File name	Date (UTC)	Start time	End time	Latitude (N)	Longitude (E)	Wire Out (m)	Depth (MNB)	Max.Press (db)
C01	C01s01	2002/12/19	2:12	2:36	05-01.04N	146-58.12E	302.6	4263	301.63
	C01s02	2002/12/19	4:02	6:21	05-01.50N	146-58.06E	4188.1	4259	4244.64
C02	C02s01	2002/12/21	2:12	2:38	02-00.92N	146-59.71E	299.1	4496	301.00
	C02s02	2002/12/21	3:47	6:24	02-01.09N	146-59.61E	4430.1	4488	4488.77
C03	C03s01	2002/12/22	18:02	18:21	00-01.41N	144-59.52E	201	3576	199.74
	C03s02	2002/12/23	1:00	1:32	00-00.02S	144-59.65E	-	3680	200.23
C04	C04s01	2002/12/24	1:58	2:21	00-00.19S	147-00.35E	299.7	4504	300.52
	C04s02	2002/12/24	3:26	6:08	00-00.43S	147-00.47E	4455.1	4514	4516.98
C05	C05s01	2002/12/25	17:58	18:17	00-00.08N	151-03.88E	199.1	4886	200.82
	C05s02	2002/12/25	20:58	22:08	00-01.08N	151-05.06E	1790.7	4477	1799.99
	C05s03	2002/12/26	1:01	1:29	00-00.44N	151-06.03E	200.1	4549	200.92
C06	C06s01	2002/12/28	1:02	1:32	04-59.70S	156-00.64E	302.4	1516	299.98
	C06s02	2002/12/28	3:01	4:27	04-59.58S	156-00.31E	1476.4	1523	1483.24
C07	C07s01	2002/12/30	1:00	1:27	01-59.24S	156-00.26E	301.7	1743	301.02
	C07s02	2002/12/30	2:59	4:29	01-59.53S	156-00.08E	1718	1747	1717.18
C08	C08s01	2003/1/2	2:28	2:53	00-01.13N	155-56.86E	302.6	1951	303.20
	C08s02	2003/1/2	4:02	5:19	00-01.10N	155-56.95E	1789.2	1951	1801.82
	C08s03	2003/1/2	5:56	7:22	00-01.12N	155-56.43E	1904.4	1950	1915.36
C09	C09s01	2003/1/4	1:28	1:52	01-56.96N	156-01.19E	305.9	2550	300.58
	C09s02	2003/1/4	3:13	4:59	01-56.93N	156-01.32E	2605.8	2550	2526.10
C10	C10s01	2003/1/6	1:13	2:26	05-02.92N	155-57.41E	1816.2	3597	1800.11
	C10s02	2003/1/6	3:29	5:45	04-59.76N	156-00.40E	3628.4	3607	3600.00
	C10s03	2003/1/6	17:58	18:20	04-58.41N	155-59.56E	199.1	3606	200.19
	C10s04	2003/1/7	0:56	1:17	05-00.19N	155-54.60E	203.6	3582	200.20

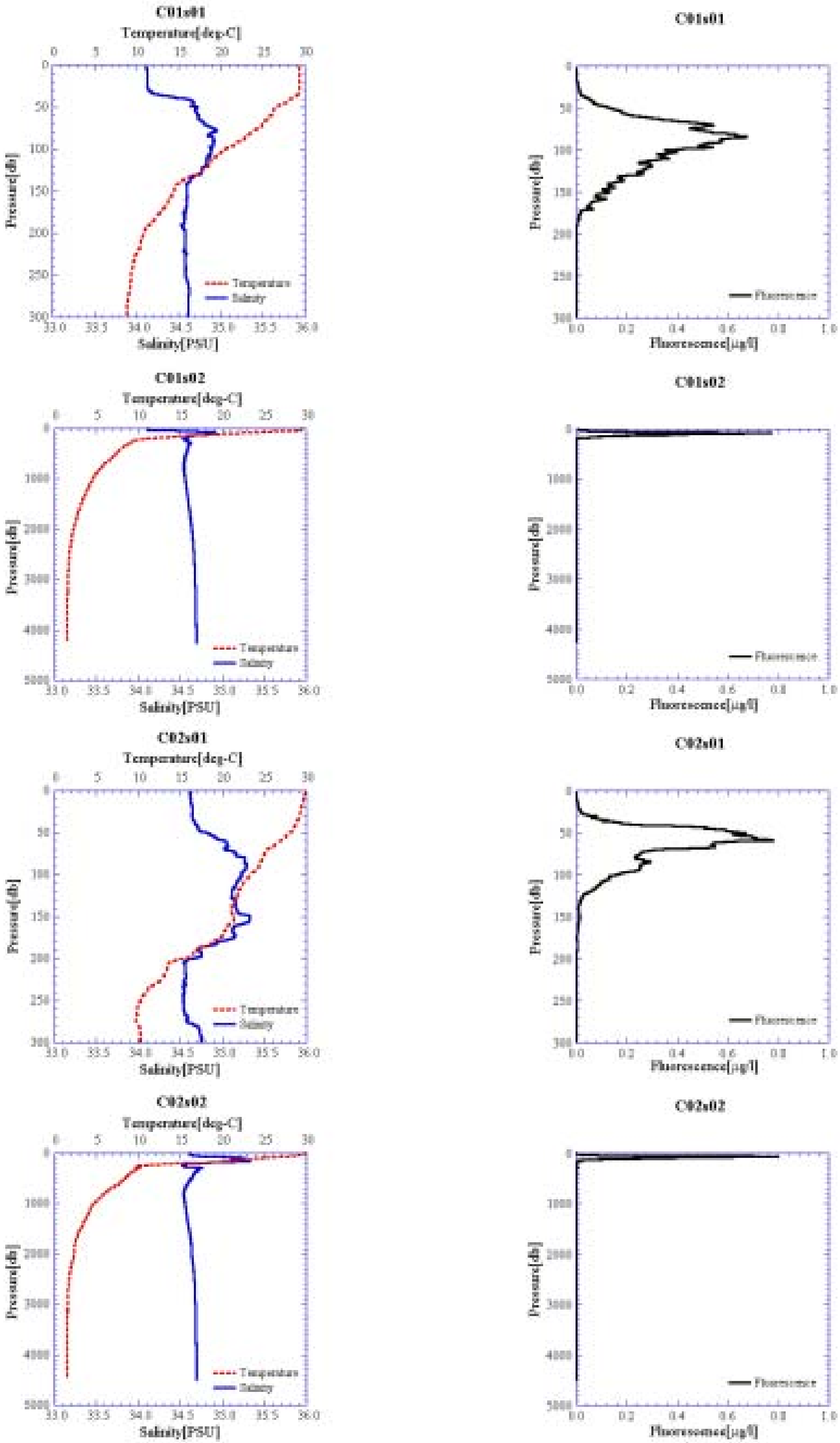
C01s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C01s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C01s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C01s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C02s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C02s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C02s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C02s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-1

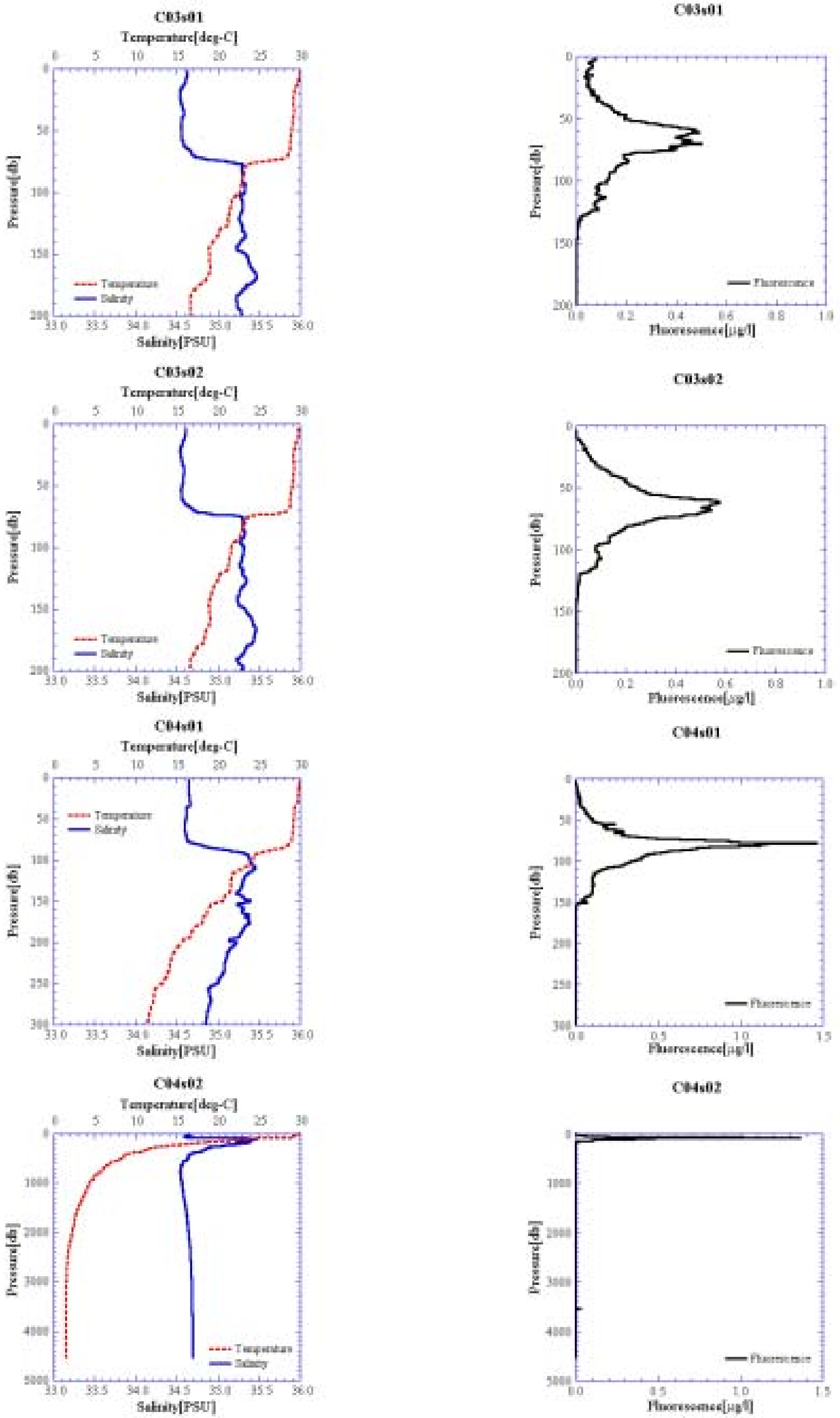
C03s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C03s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C03s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C03s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C04s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C04s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C04s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C04s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-2

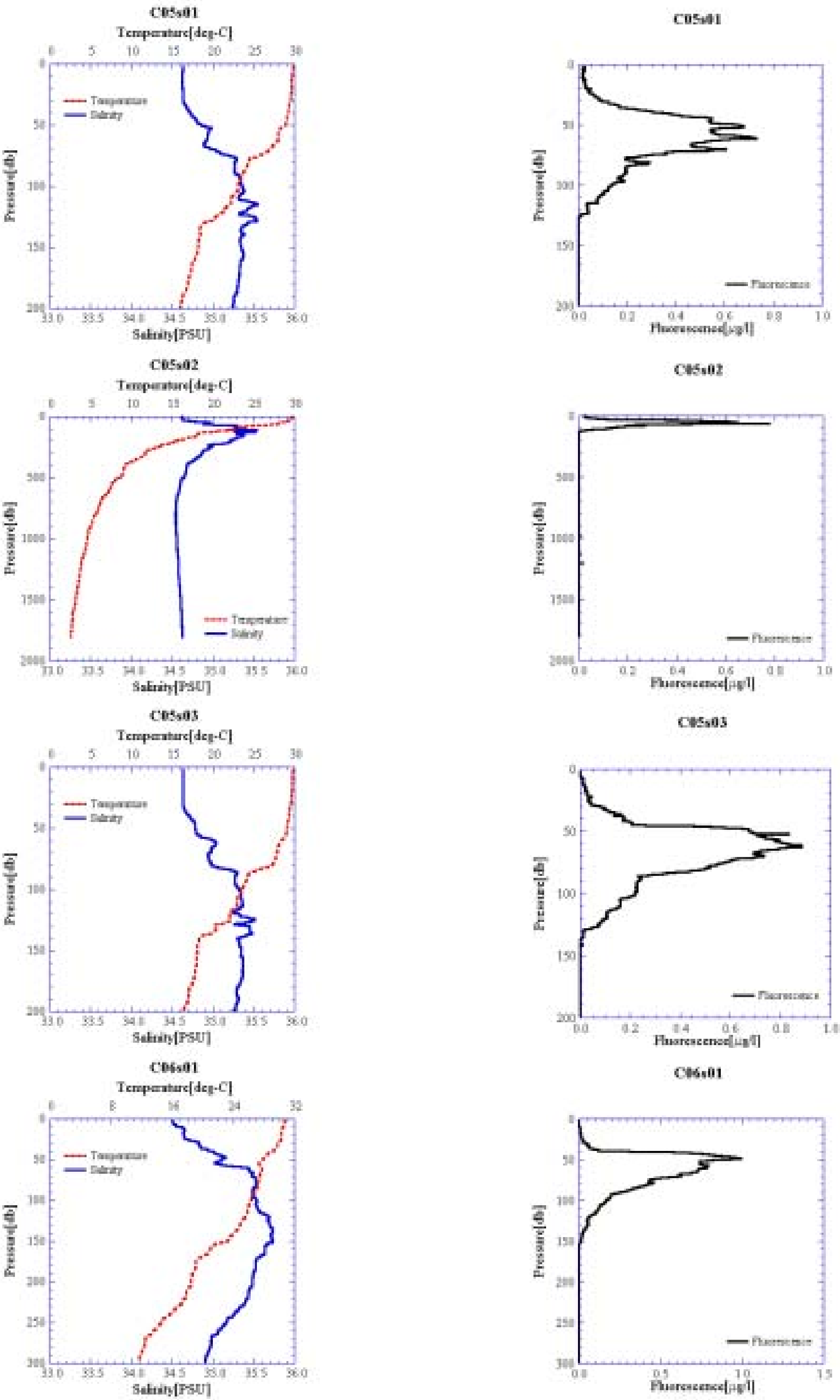
C05s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C05s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C05s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C05s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C05s03
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C05s03
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C06s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C06s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-3

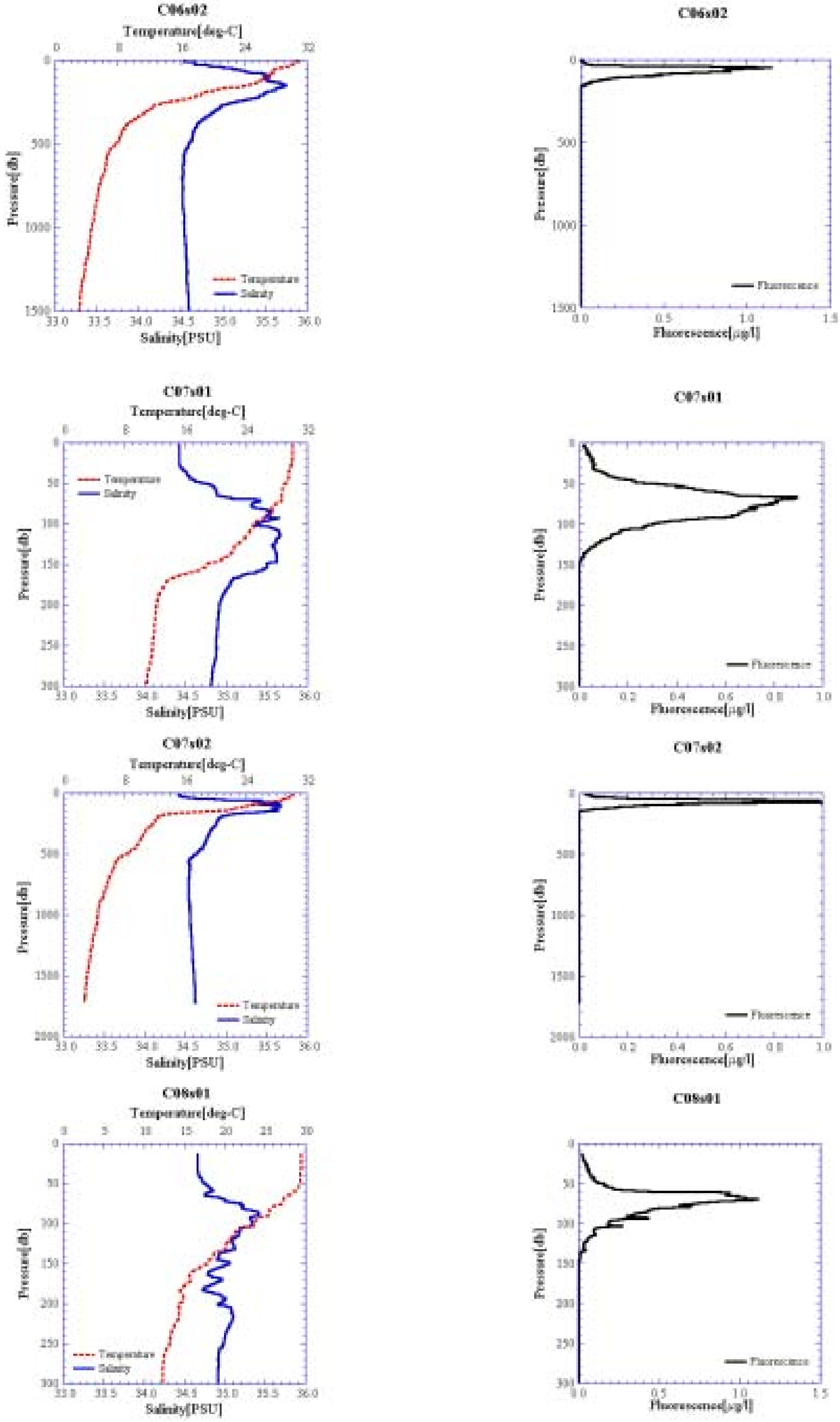
C06s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C06s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C07s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C07s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C07s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C07s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C08s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C08s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-4

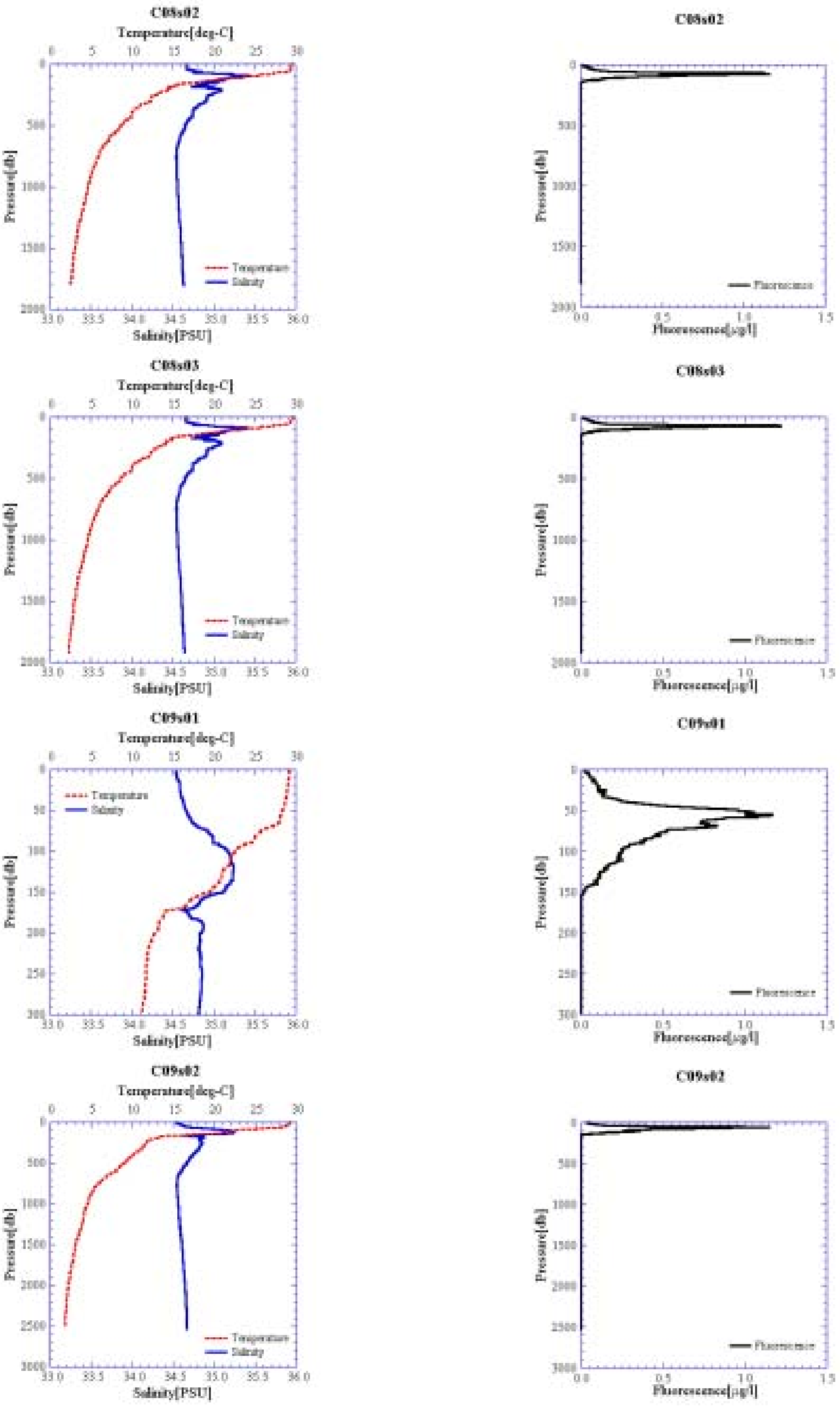
C08s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C08s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C08s03
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C08s03
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C09s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C09s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C09s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C09s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-5

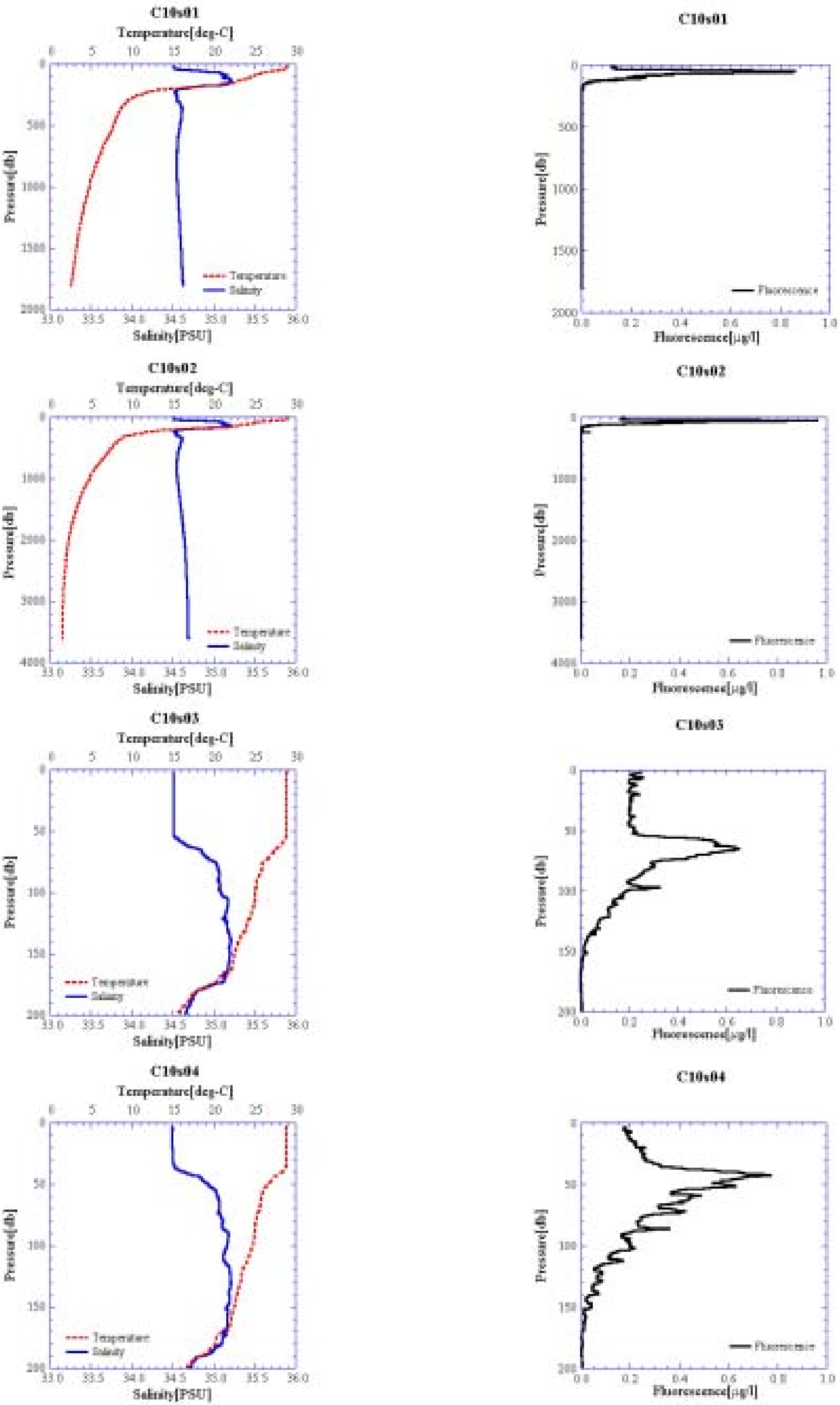
C10s01
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C10s01
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C10s02
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C10s02
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C10s03
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C10s03
Pressure[db]
Fluorescence[μg/l]
Fluorescence
C10s04
Temperature[deg-C]
Pressure[db]
Salinity[PSU]
Temperature
Salinity
C10s04
Pressure[db]
Fluorescence[μg/l]
Fluorescence

Fig.6.2.1-6

6.2.2 XCTD

(1) Personnel
Kentaro Ando (JAMSTEC): Principal Investigator
Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)
Naoto Morioka (MIRAI Crew)

(2) Objectives
Investigation of oceanic structure.

(3) Parameters
According to the manufacturer's information, 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]	+/- 0.03 [mS/cm]
Temperature	-2~35 [deg-C]	+/- 0.02 [deg-C]
Depth	0~1000 [m]	5 [m] or 2% at depth, whichever is greater

(4) Methods
We observed the vertical profiles of the sea water temperature and salinity measured by the XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.06) made by Tsurumi-Seiki Co.. We dropped 30 probes (X01-X30) by using automatic launcher.

Table 6.2.2-1 Summary of XCTD observation log

Station	Date [yyyy/mm/dd]	Start time [hh:mm:ss]	End time [hh:mm]	Latitude	Longitude	Measured Depth [m]	Water Depth [m]	Surface Temp [deg-C]	Surfece Salinity [PSU]	Probe S/N
X01	2002/12/17	11:53:55	11:59	12-00.00 N	145-08.66 E	1035	7743	27.80	34.475	02090733
X02	2002/12/17	15:58:26	16:03	11-00.01 N	145-27.98 E	1033	4666	28.20	34.322	02090735
X03	2002/12/17	20:11:06	20:16	10-00.07 N	145-47.78 E	1035	3343	28.20	34.268	02090736
X04	2002/12/18	00:56:53	01:02	09-00.01 N	146-08.31 E	1035	2990	28.30	34.077	02090734
X05	2002/12/18	05:17:12	05:22	07-59.99 N	146-28.01 E	1033	1819	28.66	34.066	02090730
X06	2002/12/18	09:34:35	09:40	07-00.07 N	146-42.18 E	1034	2351	28.82	34.011	02090732
X07	2002/12/18	13:47:59	13:53	05-59.57 N	146-51.04 E	1033	4151	29.15	34.090	02090731
X08	2002/12/20	02:14:54	02:19	04-58.05 N	147-01.93 E	790	4269	28.66	34.408	02090725
X09	2002/12/20	06:22:19	06:27	04-00.01 N	146-59.96 E	1035	4666	29.25	34.653	02090728
X10	2002/12/20	10:33:52	10:39	03-00.02 N	147-00.12 E	1035	4426	29.55	34.657	02090726
X11	2002/12/22	01:59:03	02:04	02-04.47 N	146-56.72 E	1034	4490	29.80	34.539	02090727
X12	2002/12/22	07:53:09	07:58	00-59.98 N	145-58.08 E	920	4391	30.12	34.647	02090737
X13	2002/12/23	08:35:39	08:41	00-01.57 N	144-58.21 E	1034	3630	30.27	34.631	02090739
X14	2002/12/23	12:47:50	12:53	00-02.12 N	146-00.04 E	1033	3526	30.05	34.688	02090738
X15	2002/12/25	01:55:46	02:01	00-03.21 N	147-00.64 E	1034	4473	29.97	34.629	02090741
X16	2002/12/25	05:50:30	05:55	00-00.10 N	148-00.01 E	1035	4493	30.22	34.611	02090743
X17	2002/12/25	09:38:04	09:43	00-00.02 S	148-59.94 E	1033	5827	30.63	34.605	02090744
X18	2002/12/25	13:30:14	13:35	00-00.00 N	150-00.02 E	1034	5279	30.00	34.635	02090740
X19	2002/12/25	17:14:54	17:20	00-00.01 N	150-59.99 E	1032	4946	29.85	34.633	02090745
X20	2002/12/29	07:24:00	07:30	05-01.87 S	156-02.60 E	1034	1500	30.51	34.642	02090746
X21	2002/12/29	11:21:34	11:27	03-59.99 S	155-59.97 E	1035	1781	30.29	34.626	02090748
X22	2002/12/29	15:16:44	15:22	03-00.04 S	155-58.01 E	1035	1818	30.16	34.333	02090747
X23	2002/12/31	01:14:35	01:20	02-01.14 S	155-57.81 E	1034	1747	29.93	34.222	02090749
X24	2002/12/31	05:30:53	05:36	00-60.00 S	156-01.15 E	1034	2071	29.41	36.064	02090715

Table 6.2.2-1 (continued)

Station	Date [yyyy/mm/dd]	Start time [hh:mm:ss]	End time [hh:mm]	Latitude	Longitude	Measured Depth [m]	Water Depth [m]	Surface Temp [deg-C]	Surfece Salinity [PSU]	Probe S/N
X25	2003/01/03	05:43:06	05:48	00-00.44 N	156-02.11 E	1035	1956	30.19	34.714	02090718
X26	2003/01/03	09:34:25	09:39	01-00.03 N	155-59.94 E	1034	2263	29.70	34.690	02090721
X27	2003/01/04	02:31:47	02:37	02-02.26 N	156-01.16 E	1035	2579	29.31	34.511	02090724
X28	2003/01/05	08:33:52	08:39	03-00.05 N	156-00.13 E	1035	2870	28.93	34.022	02090713
X29	2003/01/05	12:18:18	12:23	04-00.23 N	155-59.26 E	1034	3473	29.25	34.434	02090714
X30	2003/01/06	02:50:12	02:55	05-01.50 N	155-58.10 E	1035	3602	28.98	34.501	02090717

(5) Preliminary results

XCTD stations, vertical temperature and salinity sections are shown in the following figures. Fig. 6.2.2-1, Fig. 6.2.2-2 and Fig. 6.2.2-3 are along the ship track southward. Fig. 6.2.2-4, Fig. 6.2.2-5 and Fig. 6.2.2-6 are along the Equator eastward. Fig. 6.2.2-7, Fig. 6.2.2-8 and Fig. 6.2.9 are along the156E northward.

(6) Data archives

XCTD data obtained in this cruise will be submitted to the JAMSTEC DMD (Data Management Division) and will be available via “R/V Mirai Data Web Page” in JAMSTEC home page.

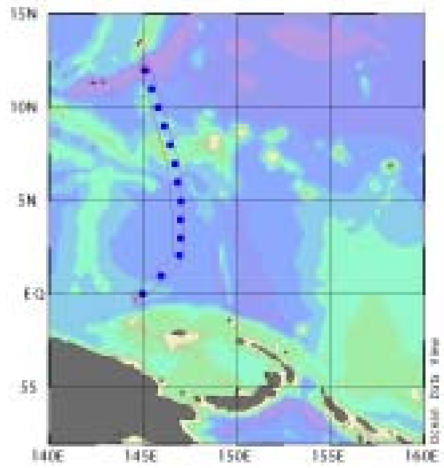

Fig. 6.2.2-1 XCTD stations

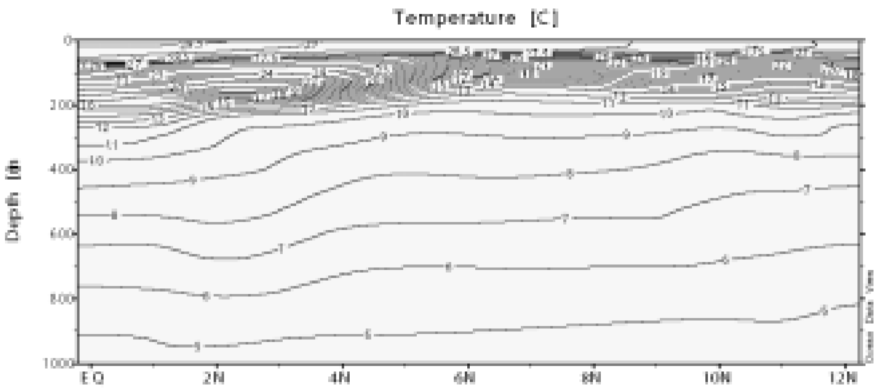

Fig. 6.2.2-2 Temperature along the ship track southward

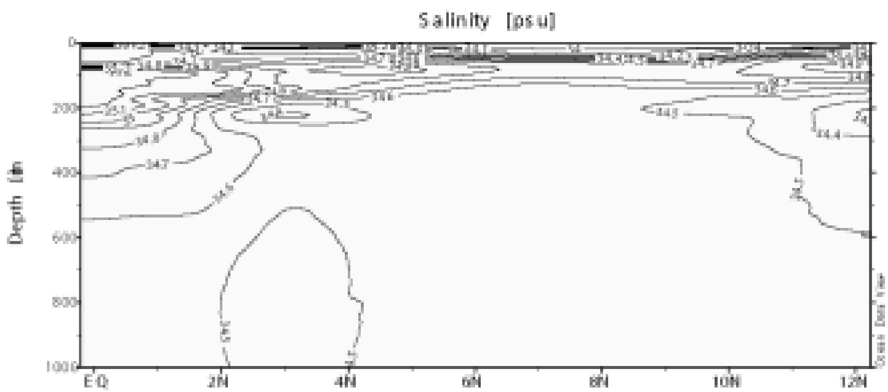

Fig. 6.2.2-3 Salinity along the ship track southward

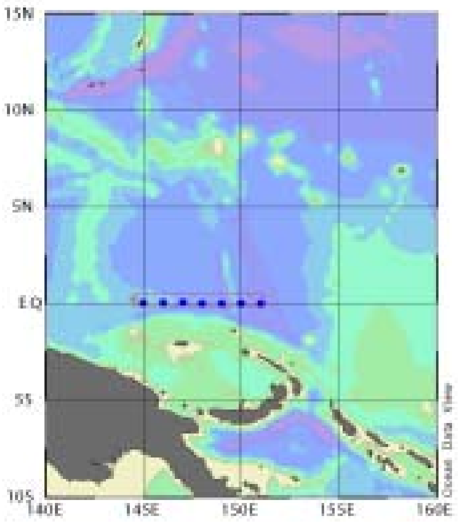

Fig. 6.2.2-4　XCTD stations

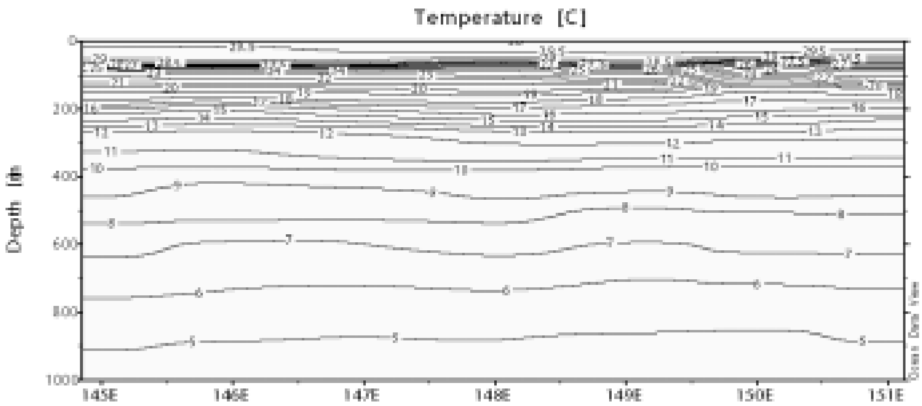

Fig. 6.2.2-5　Temperature along the Equator eastward

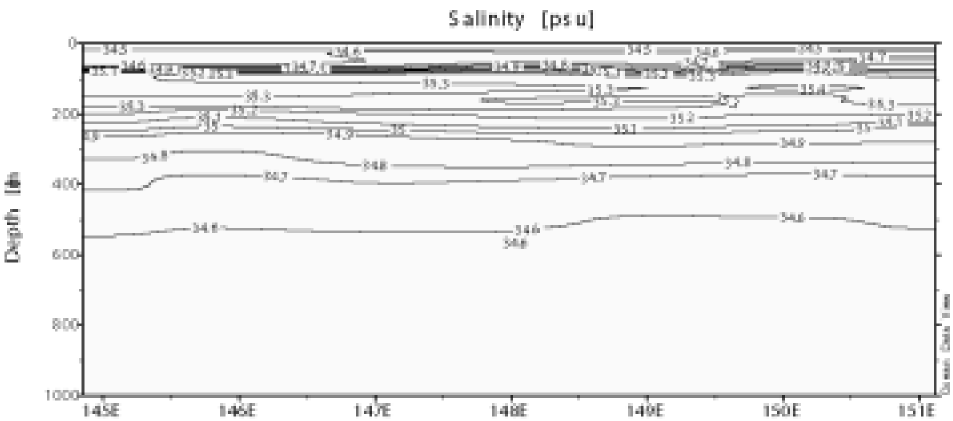

Fig. 6.2.2-6　Salinity along the Equator eastward

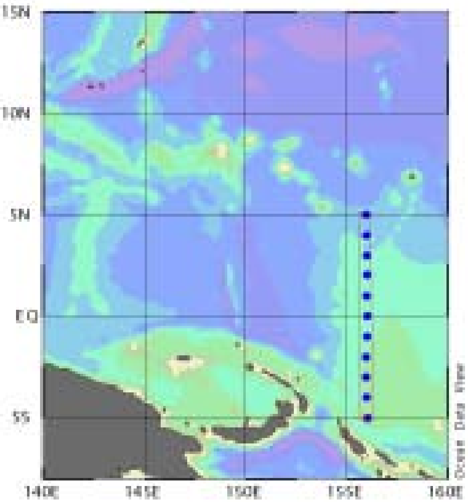

Fig. 6.2.2-7 XCTD stations

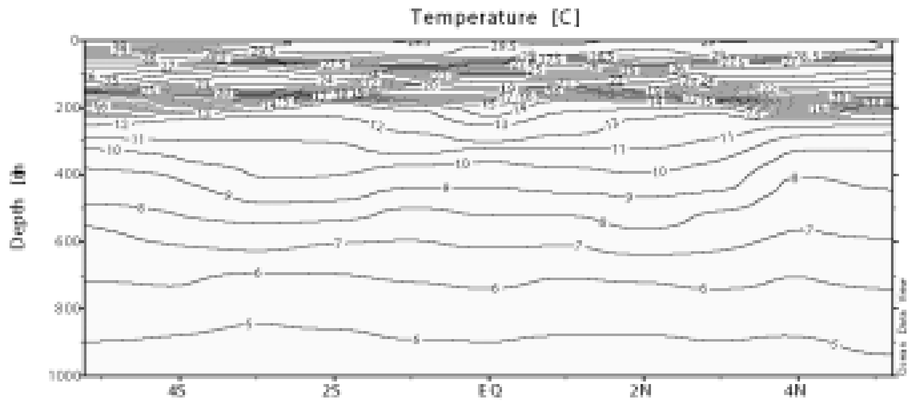

Fig. 6.2.2-8 Temperature along 156E (5N-5S)

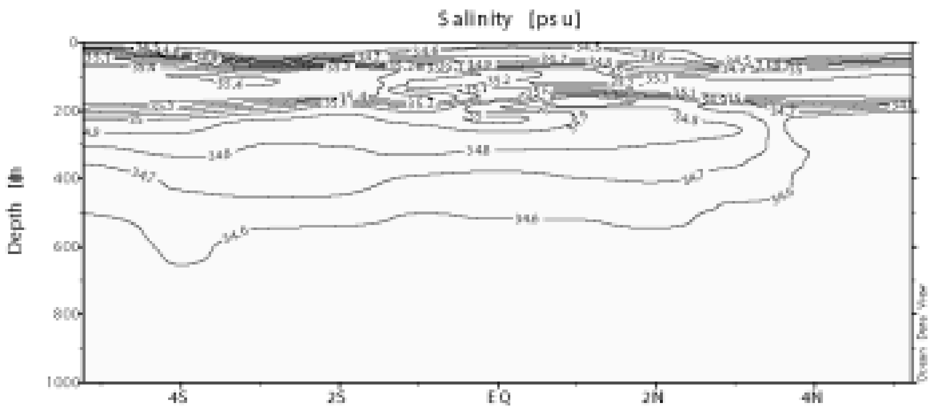

Fig. 6.2.2-9 Salinity along 156E (5N-5S)

6.2.3 Salinity measurements of sampled seawater for validation of CTD cast data

(1) Peronnel

Kentaro Ando	(JAMSTEC):on board Leg2 Principal Investigator
Takeo Matsumoto	(MWJ): on board Leg2 Operation Leader

(2) Objectives

To check the quality of CTD salinity.

(3) Parameters

Salinity of sampled water

(4) Method

Seawater samples were collected with a bucket for the surface, 12-liter Niskin bottles for the deepest layer(2020db) and the other layers. They were stored in 250ml Phoenix brown glass bottles. The salinity analysis of samples were carried out using “Guildline Autosal 8400B Salinometer” on cruise MR02-K06 Leg.2 , which was modified by addition of an Ocean Scientific International peristaltic-type sample intake pump. The instrument was operated “Autosal Room” of R/V Mirai constant temperature laboratory at a bath temperature of 24 deg-C with the laboratory set under 24 deg-C. A double conductivity ratio was defined as a median of 31 readings of the salinometer. Data collection was started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer. The salinometer standardzations were made with IAPSO Standard Seawater batch P142, of which 10 ampoules were consumed. The conductivity ratio was 0.99991 (2K 1.99982, salinity 34.996). Sub-standard seawater was used to check the drift of the Autosal.

(5) Results

Analysis data of all samples were shown in table.6.2.3.1 and 2. Ten pairs of duplicate samples taken by the same Niskin bottle and bucket were analyzed to estimate the precision of this method. To check the salinity data of CTD, we compared the salinity of all samples except for the surface samples.

The mean standardization drift was not accepted. There were 2 pairs of duplicate samples drawn. The standard deviations and mean of sample pairs were shown in table.6.2.3.3.

(6) Data archive

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

Table.6.2.3.1. Salinity of all samples. Comparison Autosal and CTD

Station	Bottle	Smeasure	Niskin Bottle No.	Pressure	CTD Sal.	Sal Difference
C01	1	34.6333	6	2000.967	34.6375	-0.0042
	2	34.6334	6	2000.967	34.6375	-0.0041
	3	34.5954	7	1500.096	34.5994	-0.0040
C02	4	34.6319	6	2000.322	34.6367	-0.0048
	5	34.6322	6	2000.322	34.6367	-0.0045
	6	34.6008	7	1499.965	34.6049	-0.0041
C04	7	34.6358	6	2000.159	34.6406	-0.0048
	8	34.6350	6	2000.159	34.6406	-0.0056
	9	34.6026	7	1500.598	34.6038	-0.0012
	10	34.5535	8	1000.876	34.5586	-0.0051
C06	11	34.5858	1	1482.960	34.5913	-0.0055
	12	34.5650	2	1248.917	34.5701	-0.0051
	13	34.5267	3	999.963	34.5334	-0.0067
	14	34.5280	3	999.963	34.5334	-0.0054
C07	15	34.6141	1	1717.902	34.6206	-0.0065
	16	34.6014	2	1500.786	34.6077	-0.0063
	17	34.5491	4	999.352	34.5549	-0.0058
	18	34.5484	4	999.352	34.5549	-0.0065
C08	19	34.6352	1	1915.133	34.6411	-0.0059
	20	34.6015	3	1500.122	34.6074	-0.0059
	21	34.5520	5	1000.089	34.5573	-0.0053
	22	34.5520	5	1000.089	34.5573	-0.0053
C09	23	34.6401	3	2000.526	34.6462	-0.0061
	24	34.6397	3	2000.526	34.6462	-0.0065
	25	34.6000	5	1501.334	34.6062	-0.0062
	26	34.5548	7	1001.557	34.5614	-0.0066
C10	27	34.6351	5	2000.712	34.6412	-0.0061
	28	34.6354	5	2000.712	34.6412	-0.0058
	29	34.5944	6	1501.135	34.5991	-0.0047
	30	34.5496	7	999.152	34.5556	-0.0060

Table 6.2.3.2. Salinity sampled from EPCS for comparison

Bottle No.	Salinity	Date and time of sampled
264	34.0118	2002/12/18 10:51
263	34.1355	2002/12/19 10:37
262	34.6581	2002/12/20 10:39
261	34.6193	2002/12/21 10:33
260	34.6440	2002/12/22 10:40
259	34.6415	2002/12/23 10:27
258	34.6495	2002/12/24 10:39
257	34.6000	2002/12/25 10:31
256	34.6290	2002/12/26 10:39
255	34.4585	2002/12/27 10:50
254	34.5668	2002/12/28 10:36
253	34.5345	2002/12/29 10:35
252	34.4172	2002/12/30 10:45
251	34.6229	2002/12/31 10:30
250	34.6531	2003/ 1/ 2 10:37
249	34.6434	2003/ 1/ 3 10:38
248	34.5368	2003/ 1/ 4 10:36
247	34.3780	2003/ 1/ 5 10:40
246	34.4970	2003/ 1/ 6 10:36
245	34.4844	2003/ 1/ 7 10:39
244	34.4817	2003/ 1/ 8 10:23
243	34.5191	2003/ 1/ 9 10:35
242	34.5407	2003/ 1/10 11:50
241	34.5456	2003/ 1/11 00:04

Table.6.2.3.3. There were 2 pairs of duplicate samples drawn.

Station	Sample1 Bottle No.	Sample2 Bottle No.	Sample 1 Sal mes	Sample2 Sal mes	Dupri Sal dif.
C01	1	2	34.6333	34.6334	0.0001
C02	4	5	34.6319	34.6322	0.0003
C04	7	8	34.6358	34.6350	0.0008
C06	13	14	34.5267	34.5280	0.0013
C07	17	18	34.5491	34.5484	0.0007
C08	21	22	34.5520	34.5520	0.0000
C09	23	24	34.6401	34.6397	0.0004
C10	27	28	34.6351	34.6354	0.0003
				Average	0.0004
				STD dev.	0.0003

6.3 Continuous monitoring of surface seawater (EPCS)

(1) Personnel

Kentaro ANDO (JAMSTEC)   Principal Investigator
Keisuke WATAKI (Marine Works Japan Ltd.)
Saeko SUGISAKI (Marine Works Japan Ltd.)
Akira SHIMIZU (Marine Works Japan Ltd.)

(2) Objective

Measurement of temperature, salinity, dissolved oxygen and fluorescence in the sea surface water.

(3) Methods

EPCS (Nippon Kaiyo co.,Ltd.) has five kinds of sensors and fluorescence photometer, and can automatically measure temperature, salinity, dissolved oxygen, fluorescence and particle size of plankton in near-sea surface water continuously every 1-minute. This system is located in the "*sea surface monitoring laboratory*" of R/V Mirai, and connected to the shipboard LAN-system. Measured data are stored in a hard disk of PC machine every 1-minute with time and position of ship, and displayed on a data management PC machine.

Near-sea surface water is continuously pumped up to the laboratory and flows into the *EPCS* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves to be 12L/min except the fluorometer (about 0.3L/min). The flow rate is measured with two flow meters and each values are checked by marine technicians everyday.

Specification of the each sensor in this system are 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℃,	Salinity0 to 6.5 S m-1
Accuracy:	Temperature 0.01 ℃ 6month-1,	Salinity0.001 S m-1 month-1
Resolution:	Temperature 0.001℃,	Salinity0.0001 S m-1

b) Bottom of ship thermometer

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

c) Dissolved oxygen sensor

Model:	2127A, Orbisphere Laboratories Japan INC.
Serial number:	44733
Measurement range:	0 to 14 ppm
Accuracy:	±1% at 5 ℃ of correction range
Stability:	1% month-1

d) Fluorometer

Model:	10-AU-005, TURNER DESIGNS
Serial number:	5562 FRXX
Detection limit:	5 ppt or less for chlorophyll a

Stability: 0.5% month-1 of full scale

e) Particle size sensor

Model: P-05, Nippon Kaiyo LTD.
Serial number: P5024
Measurement range: 0.02681 mmt to 6.666 mm
Accuracy: ±10% of range
Reproducibility: ±5%
Stability: 5% week-1

f) Flow meter

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

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

9:24-17/Dec./2002 to 21:00-11/Jan./2003.

(4) Preliminary Result

The figures of time series of the salinity, temperature, dissolved oxygen and fluorescence were shown in Fig.6.3-1 to 4.

The figures of the correlation between salinity [sensor] and salinity analysis result were shown in Fig.6.3-5.

The figures of the correlation between D.O.[sensor] and D.O. analysis result were shown in Fig.6.3-6.

(5) Date archive

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

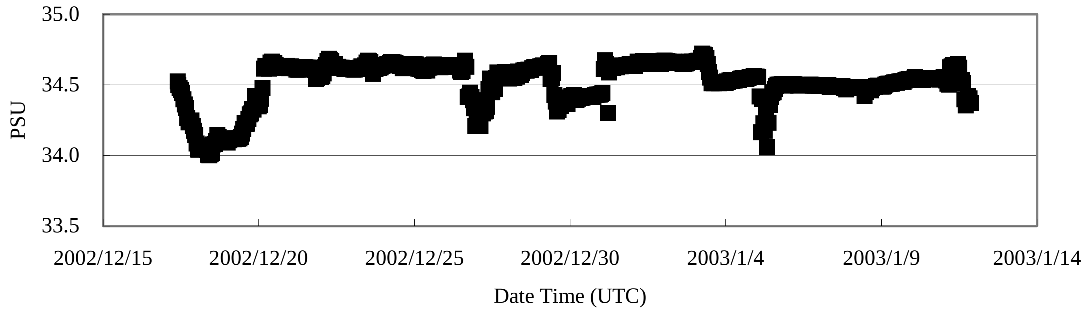

Fig. 6.3-1 Time series of salinity in the sea surface water.

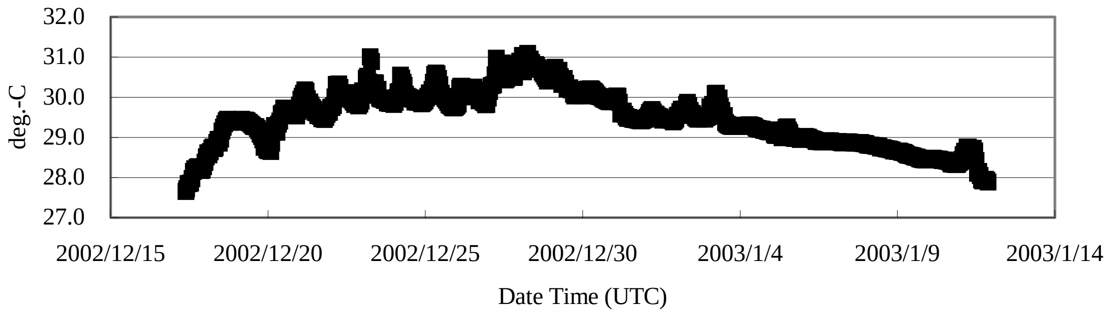

Fig. 6.3-2 Time series of temperature in the sea surface water.

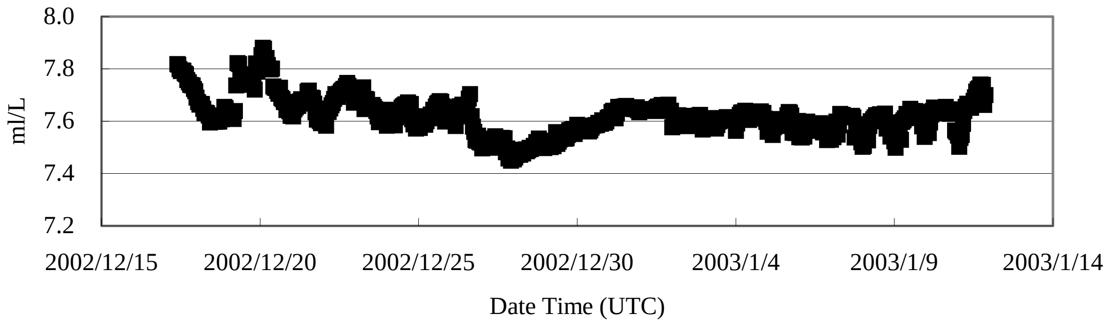

Fig. 6.3-3 Time series of dissolved oxygen in the sea surface water.

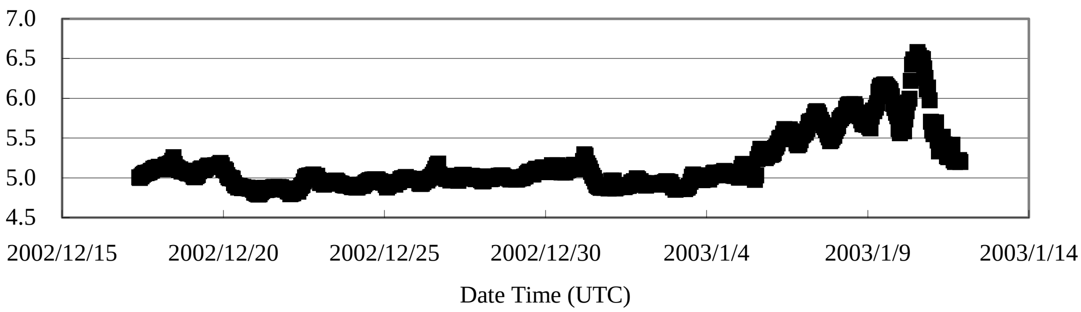

Fig. 6.3-4 Time series of fluorescence in the sea surface water.

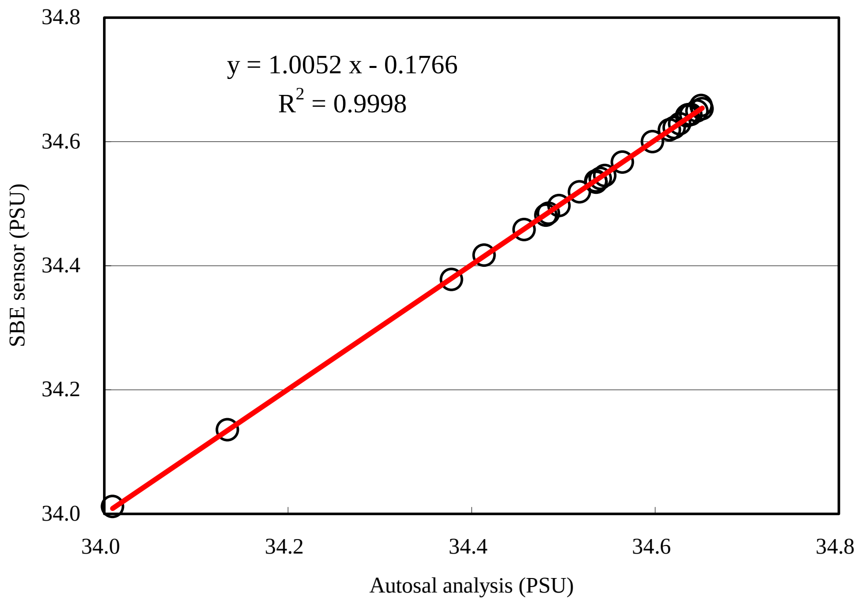

Fig. 6.3-5 The correlation between salinity [sensor] and salinity analysis result.

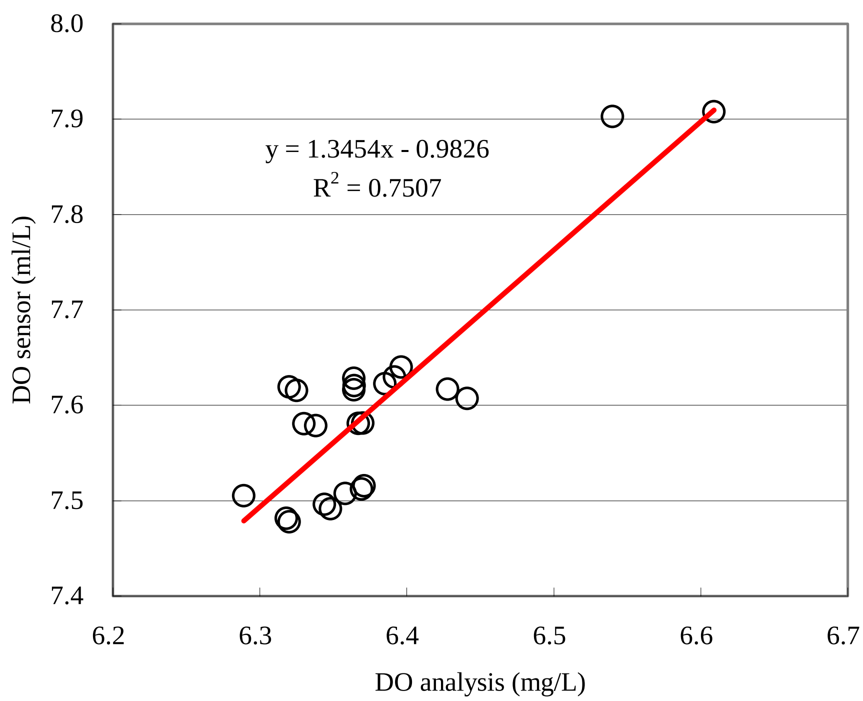

Fig. 6.3-6 The correlation between D.O.[sensor] and D.O. analysis result.

6.4 Shipboard ADCP

(1) Personnel

Kentaro Ando (JAMSTEC) : Principal Investigator
Satoshi Okumura (GODI) : Operation Leader
Wataru Tokunaga（GODI）
Shinya Okumura（GODI）

(2) Parameters

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

(3) Methods

Upper ocean current measurements were made throughout MR02-K06(Leg2) cruise from 17 December 2002 (Guam, USA) to 12 January 2003 (Chuuk, Federated states of Micronesia) using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V Mirai. The system consists of following components;

1) a 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating at 78.5 KHz (VM-75; RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
2) the Ship's main gyro compass (TG-6000; Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;
3) a GPS navigation receiver (Leica MX9400) providing position fixes;
4) an IBM-compatible personal computer running data acquisition software (VmDas version 1.3 ; RD Instruments, USA).

The ADCP was configured for 16-m processing bin, a 8-m blanking interval. The sound speed is calculated from temperature at the transducer head. The transducer depth was 6.5 m; 40 velocity measurements were made at 16-m intervals starting 31.18 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 in the appendix-6.

(4) Preliminary result

Fig. 6.4-1 show 1-hourly averaged current vectors along cruise track. The data was processed using CODAS, Common Oceanographic Data Access System, developed at the University of Hawaii.

(5) Data archive

These data obtained during this cruise will be submitted to the JAMSTEC DMD (Data Management Division), and will be opened to the public via "R/V Mirai Data Web Page" in JAMSTEC home page.

MR02-K06 Leg2

R/V Mirai

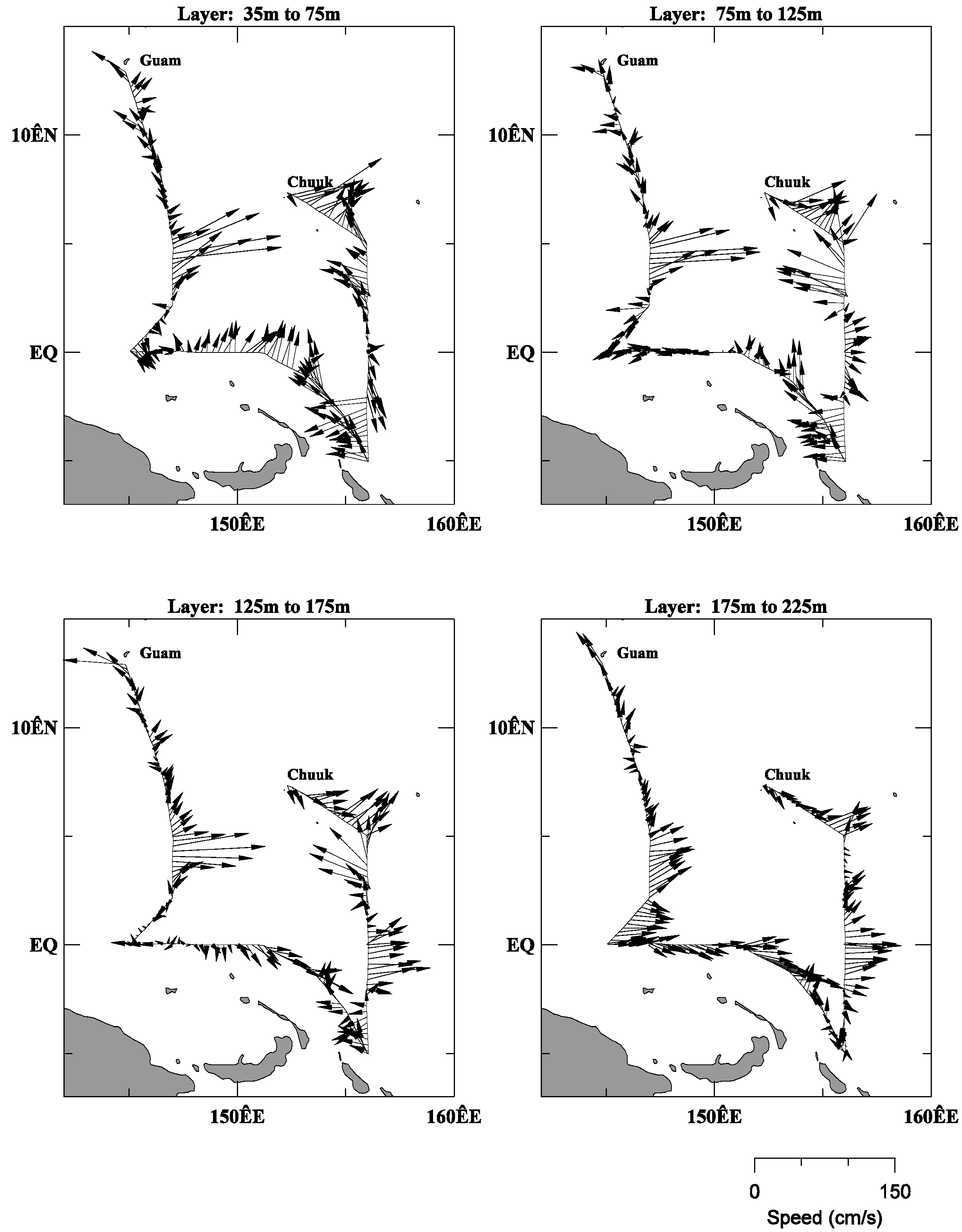

Fig6.4-1(a)

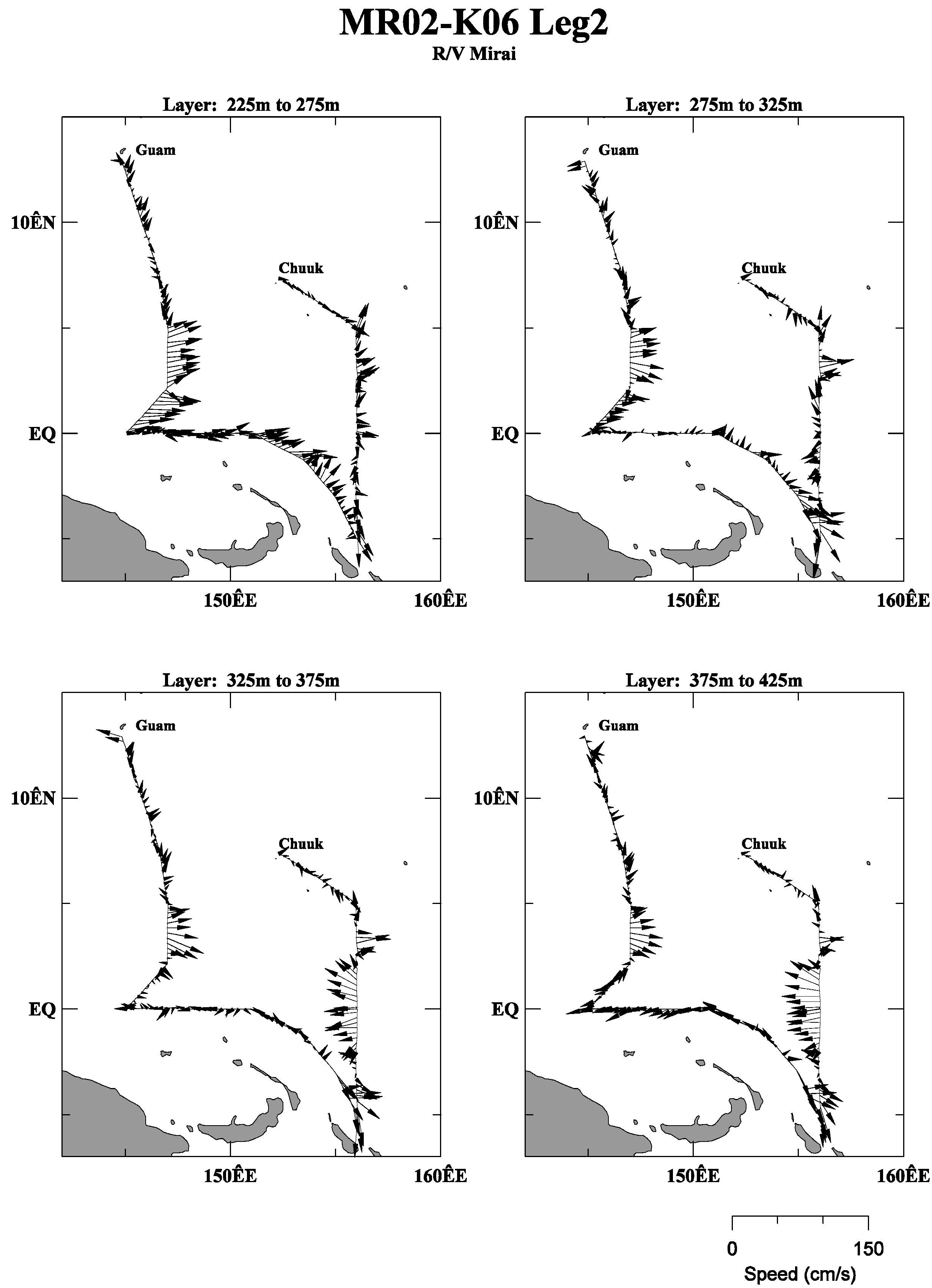
MR02-K06 Leg2
R/V Mirai
Layer: 225m to 275m
Layer: 275m to 325m
Layer: 325m to 375m
Layer: 375m to 425m
Guam
Chuuk
10ÊN
EQ
150ÊE
160ÊE
0
150
Speed (cm/s)

Fig6.4-1(b)

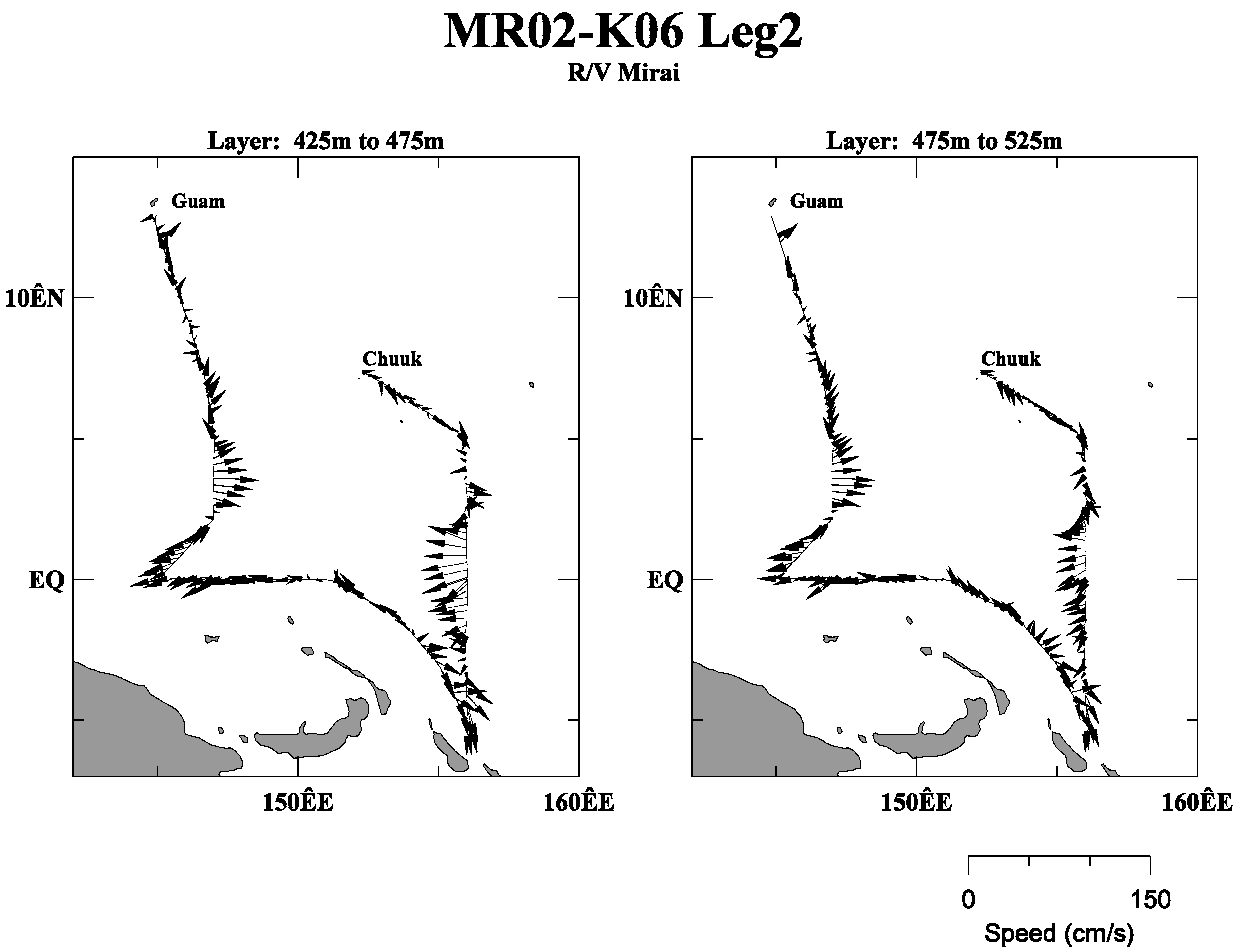
MR02-K06 Leg2
R/V Mirai
Layer: 425m to 475m
Layer: 475m to 525m
Guam
Chuuk
10ÊN
EQ
150ÊE
160ÊE
0
150
Speed (cm/s)

Fig.6.4-1(c)

6.5 Underway geophysics

6.5.1 Sea surface gravity

(1) Personnel

Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Objectives

To obtain the continuous gravity data for contribution of geophysical investigation.

(3) Parameters

Gravity [mgal]

(4) Methods

We measured relative gravity values by LaCoste-Romberg (L&R) onboard gravity meter S-116 throughout MR02-K06 Leg2 cruise from the departure of Guam, USA on 17 December 2002 to the arrival of Chuuk, Federated stats of Micronesia on 12 January 2003.

To obtain absolute gravity value, we usually measure relative value by portable gravity meter (Scintrex gravity meter CG-3M) at comparable points, MIO gravity base, already known absolute gravity values. Moreover, measured values are corrected based on the bathymetry and ship movement. Consequently, the corrected gravity data should involve the information of crustal and upper mantle structures how they compensate the discrepancy from isostatic balance.

(5) Remarks

The absolute gravity values calculated in comparison with absolute values of reference point at Sekinehama Ports, to estimate mechanical drift of gravity meter during the MR02-K06 cruise. Future results as follows,

No.	Data	UTC	Port	Absolute Gravity (mGal)	Sea Level (cm)	Draft (cm)	Gravity at sensor (mGal)*	L&R (mGal)
1	Nov/13	03:31	Sekinehama	980371.85	225	625	980372.59	12660.6
2	Dec/15	08:36	Guam	-	217	612	-	10802.5
3	Jan/12	05:32	Chuuk	-	249	620	-	10629.7
4	-	-	Honolulu	-	-	-	-	-
5	-	-	Sekinehama	980371.85	-	-	-	-

*: Gravity values at sensor positon of onboard gravity meter are calculated the follows;

[Gravity at sensor value]
= [Absolute Gravity] + Sea Level*0.3086/100 + [Draft-530]/100*0.0431

(6) Remarks

1. Data recoding was stopped from 23:44:00UTC 31 Dec. 2002 to 01:19:00UTC 1 Jan. 2003, because of logging PC trouble.
2. We did not sample the data in the territorial waters of Guam, USA and Chuuk, Federated states of Micronesia.
   Data acquisitions term; 07:30(UTC) 17 December 2002 to 16:29(UTC) 11 January 2003

(7) Data archives

Gravity data obtained in this cruise will be submitted to the JAMSTEC DMD (Data

Management Division) and will be archived there.

6.5.2 Surface three-component magnetometer

(1) Personnel

Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Objectives

In order to continuously obtain the geomagnetic field vectors on the sea surface, a three-component magnetometer is very useful equipment. The magnetic force on the sea is affected by induction of magnetized body beneath the subbottom in addition to the earth dipole magnetic field. The magnetic measurement on the sea is, therefore, one of utilities for geophysical reconstruction of crustal structure and so on. The geomagnetic field can be divided into three components, i.e., two horizontal (x & y) and one vertical (z) moments. Three-component observation instead of total force includes much information of magnetic structure of magnetized bodies.

(3) Parameters

Three-component magnetic force	[nT]
Ship's attitude (Pitch, Roll and Heading)	[1/100 deg]

(4) Methods

The sensor is a three axes fluxgate magnetometer on the top of foremast and sampling period is 8 Hz. The timing of navigation information data sampling is controlled by the 1pps standard clock of GPS signal. Every one second data set which consists of 310 bytes; navigation information, 8 Hz three component of magnetic forces and Vertical Reference Unit (VRU) data were recorded in the hard disk. The navigation information data set is simultaneously fed to the R/V Mirai network server through ethernet LAN system.

(5) Preliminary results

During MR02-K06 Leg2 cruise, the magnetic force is continuously measured from the departure of Guam, USA on 17 December 2002 to the arrival of Chuuk, Federated stats of Micronesia on 12 January 2003. Data obtained on the sea will be analyzed in near future. The procedure of quality control is mainly to eliminate the effect of ship's magnetized vector condition.

(6) Remarks

1. We acquired calibration data at 01:40UTC to 02:08UTC 28 December 2002, at 04-59S, 156-00E.
2. We did not sample the data in the territorial waters of Guam, USA and Chuuk, Federated states of Micronesia.

   Data acquisition term; 07:30(UTC) 17 December 2002 to 16:27(UTC) 11 January 2003

(7) Data archives

Magnetic force data obtained in this cruise will be submitted to the JAMSTEC DMD (Data Management Division) and will be archived there.

6.5.3 Multi narrow beam echo sounding system

(1) Personnel
Satoshi Okumura (Grobal Ocean Development Inc.): Operation Leader
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Objectives
To obtain the bathymetry data for the contribution of geophysical investigation.

(3) System configurations and performance

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)

(4) Methods
R/V Mirai has installed a Multi Narrow Beam Echo Sounding system (MNBES), SeaBeam 2112.004 (SeaBeam Inc., USA).
We surveyed MR02-K06 Leg2 cruise from the departure of Guam, USA on 17 December 2002 to the arrival of Chuuk, Federated stats of Micronesia on 12 January 2003. Additional we measured depth of fixed TRITON buoy anchor position at TRITON buoy deployment sites.
To get accurate sound velocity of water column, we used temperature and salinity profiles from CTD (deep casts) or XCTD data and calculated sound velocity by equation in Mackenzie (1981).

(5) Remarks
We did not survey in the territorial waters of Guam, USA and Chuuk, Federated states of Micronesia.
Data acquisition term; 07:30(UTC) 17 December 2002 to 16:29(UTC) 11 January 2003

(6) Data archives
Bathymetry data obtained in this cruise will be submitted to the JAMSTEC DMD (Data Management Division) and will be archived there.

7 Special Observation

7.1 TRITON moorings

7.1.1 TRITON Mooring Operation

(1) Personnel

Kentaro Ando	(JAMSTEC): Principal Investigator (on board Leg2)
Masayuki Fujisaki	(MWJ): Operation leader (on board Leg2)
Koichi Takao	(MWJ): Technical staff (on board Leg2)
Takeo Matumoto	(MWJ): Technical staff (on board Leg2)
Miki Yoshiike	(MWJ): Technical staff (on board Leg2)
Tomoyuki Takamori	(MWJ): Technical staff (on board Leg2)
Kei Suminaga	(MWJ): Technical staff (on board Leg2)
Masaki Furuhata	(MWJ): Technical staff (on board Leg2)
Yu Sasaki	(MWJ): Technical staff (on board Leg2)
You Yasuda	(MWJ): Technical staff (on board Leg2)
Keisuke Onishi	(MWJ): Technical staff (on board Leg2)
Sinji Rakuma	(MWJ): Technical staff (on board Leg2)
Maiko Kimino	(MWJ): Technical staff (on board Leg2)

(2) Objectives

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool affects the global atmosphere and causes El Nino phenomena. The formation mechanism of the warm pool and the air-sea interaction over the warm pool have not been well understood. Long term data sets of temperature, salinity, currents, so on have been required at fixed locations. In particular, the oceanic change due to the surface winds over the western tropical Pacific is important to study the relation with El Nino and rain fall over the ocean is also important parameter to study El Nino and Asia-Australian Monsoon. The TRITON program aims to obtain the basic data to improve the predictions of El Nino and variations of Asia-Australian Monsoon system.

TRITON buoy array is integrated with the existing TAO(Tropical Atmosphere Ocean) array, which is presently operated by the Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration of the United States. TRITON is a component of international research program of CLIVAR (Climate Variability and Predictability), which is a major component of World Climate Research Program sponsored by the World Meteorological Organization, the International Council of Scientific Unions, and the Intergovernmental Oceanographic Commission of UNESCO. TRITON will also contribute to the development of GOOS (Global Ocean Observing System) and GCOS (Global Climate Observing System).

The seven TRITON buoys have been successfully recovered during this R/V Mirai cruise (MR02-K06-leg2), deployed eight TRITON buoys.

(3) Measured parameters

Meteorological parameters:	wind speed, direction, atmospheric pressure, air temperature, relative humidity, radiation, precipitation.
Oceanic parameters:	water temperature and conductivity at 1.5m, 25m, 50m, 75m, 100m, 125m, 150m, 200m, 300m, 500m 750m, depth at 300m and 750m, currents at 10m.

(4) Instrument

1) CTD and CT

SBE-37 IM MicroCAT

A/D cycles to average :	4
Sampling interval :	600sec
Measurement range Temperature :	-5～+35
Measurement range Conductivity :	0～+7
Measurement range Pressure :	0～full scale range

2) CRN(Current meter)

SonTek　Argonaut ADCM

Sensor frequency :	1500kHz
Sampling interval :	1200sec
Average interval :	120sec

3) Meteorological sensors

Precipitation

SCTI　ORG-115DX

Atmospheric pressure

PARPSCIENTIFIC. Inc.　DIGIQUARTZ FLOATING BAROMETER 6000SERIES

Relative humidity/air temperature, Shortwave radiation, Wind speed/direction

Woods Hole Institution　ASIMET

Sampling interval :	60sec
Data analysis :	600sec averaged

(5) Locations of TRITON Buoys Deployment

Nominal location	5N, 156E
ID number at JAMSTEC	02006
Number on surface float	T05
ARGOS PTT number	01132
ARGOS backup PTT number	24243
Deployed date	06 Jan. 2003
Exact location	05 - 01.62N, 155 - 58.05E
Depth	3599 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	2N, 156E
ID number at JAMSTEC	03007
Number on surface float	T06
ARGOS PTT number	09794
ARGOS backup PTT number	24244
Deployed date	04 Jan. 2003
Exact location	02 - 02.38N, 156 - 01.12E
Depth	2577 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04007
Number on surface float	T07

ARGOS PTT number	03594
ARGOS backup PTT number	13065
Deployed date	02 Jan. 2003
Exact location	00 - 00.38N, 156 - 02.49E
Depth	1952 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	2S, 156E
ID number at JAMSTEC	05005
Number on surface float	T08
ARGOS PTT number	09426
ARGOS backup PTT number	13066
Deployed date	30 Dec. 2002
Exact location	02 - 01.06S, 155 - 57.49E
Depth	1748 m

Nominal location	5S, 156E
ID number at JAMSTEC	06005
Number on surface float	T09
ARGOS PTT number	03779
ARGOS backup PTT number	13067
Deployed date	28 Dec. 2002
Exact location	05 - 01.93S, 156 - 01.50E
Depth	1522 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	5N, 147E
ID number at JAMSTEC	07005
Number on surface float	T10
ARGOS PTT number	09792
ARGOS backup PTT number	24241
Deployed date	19 Dec. 2002
Exact location	04 - 57.88N, 147 - 01.75E
Depth	4282 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	2N, 147E
ID number at JAMSTEC	08004
Number on surface float	T11
ARGOS PTT number	03781
ARGOS backup PTT number	24245
Deployed date	21 Dec. 2002
Exact location	02 - 04.50N, 146 - 57.07E
Depth	4490m
Option sensors	CT at 175 m : S/N 0639

Nominal location	EQ, 147E

ID number at JAMSTEC	09005
Number on surface float	T12
ARGOS PTT number	07960
ARGOS backup PTT number	24246
Deployed date	24 Dec. 2002
Exact location	00 - 03.45N, 147 - 00.63E
Depth	4475m

(2) TRITON recovered

Nominal location	2N, 156E
ID number at JAMSTEC	03006
Number on surface float	T15
ARGOS PTT number	09770
ARGOS backup PTT number	07861
Deployed date	05 Mar. 2002
Recovered date	05 Jan. 2003
Exact location	01 - 56.27N, 155 - 58.21E
Depth	2565 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04006
Number on surface float	T16
ARGOS PTT number	09771
ARGOS backup PTT number	07864
Deployed date	09 Mar. 2002
Recovered date	03 Jan 2003
Exact location	00 - 03.06S, 155 - 54.98E
Depth	1942 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	2S, 156E
ID number at JAMSTEC	05004
Number on surface float	T17
ARGOS PTT number	03593
ARGOS backup PTT number	07871
Deployed date	11 Mar. 2002
Recovered date	31 Dec. 2002
Exact location	02 - 02.50S, 156 - 01.80E
Depth	1762 m

Nominal location	5S, 156E
ID number at JAMSTEC	06004
Number on surface float	T18
ARGOS PTT number	09425
ARGOS backup PTT number	07878
Deployed date	13 Mar. 2002
Recovered date	29 Dec. 2002

Exact location	04 - 57.66S, 156 - 00.05 E
Depth	1508 m

Nominal location	5N, 147E
ID number at JAMSTEC	07004
Number on surface float	T19
ARGOS PTT number	11827
ARGOS backup PTT number	07881
Deployed date	20 Mar. 2002
Recovered date	20 Dec. 2002
Exact location	05 - 03.51N, 147 - 00.71 E
Depth	4247 m
Option sensors	Precipitation sensor (capacitive type) at Tower

Nominal location	2N, 147E
ID number at JAMSTEC	08003
Number on surface float	T20
ARGOS PTT number	09427
ARGOS backup PTT number	24238
Deployed date	18 Mar. 2002
Recovered date	22 Dec. 2002
Exact location	02 - 01.38N, 146 - 57.75 E
Depth	4523 m
Option sensors	CT sensor at 175 m : S/N 1029

Nominal location	EQ, 147E
ID number at JAMSTEC	09004
Number on surface float	T02
ARGOS PTT number	09793
ARGOS backup PTT number	11592
Deployed date	19 Dec. 2001
Recovered date	25 Dec. 2002
Exact location	00 - 01.90S, 146 - 57.96 E
Depth	4552 m

*: Dates are UTC and represent anchor drop times for deployments and release time for recoveries, respectively.

(6) Details of deployed

We had deployed nine TRITON buoys, described them details in the list.

Deployed and Repaired TRITON buoys

Observation No.	Location.	Details.
02006	5N 156E	Deploy with full spec with one optional precipitation sensor.
03007	2N 156E	Deploy with full spec.
04007	EQ 156E	Deploy with full spec with one optional precipitation sensor.
05005	2S 156E	Deploy with full spec.
06005	5S 156E	Deploy with full spec with one optional precipitation sensor.
07005	5N 147E	Deploy with full spec with one optional precipitation sensor.
08004	2N 147E	Deploy with full spec with one optional CT sensor.
09005	EQ 147E	Deploy with full spec.

(7) Data archive

Hourly averaged data transmitted are through ARGOS satellite data transmission system in near real time. The real time data are provided to meteorological organizations via Global Telecommunication System and utilized for daily weather forecast. The data will be also distributed world wide through Internet from JAMSTEC and PMEL home pages. All data will be archived at JAMSTEC Mutsu Institute.

TRITON Homepage: http://www.jamstec.go.jp/jamstec/triton

7.1.2 Inter-comparison between shipboard CTD and TRITON data

(1) Personnel

Kentaro Ando	(JAMSTEC):	on board Leg2
Takeo Matsumoto	(MWJ):	on board Leg2
Tomoyuki Takamori	(MWJ):	on board Leg 2
Tetsuya Nagahama	(MWJ):	not on board

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We used the same CTD (SBE 9/11Plus) system with general CTD/XCTD observation (See section 6.2.1) on R/V MIRAI for this intercomparision. We conducted 1 CTD cast at each TRITON buoy site of before recovery, conducted 1 XCTD cast at each TRITON buoy site of after deployment. The cast was performed immediately after the deployment and before recovery. R/V MIRAI was kept the distance from the TRITON buoy within 2 nm.

TRITON buoy data was sampled every 1 hour except for transmition to the ship. We compared CTD/XCTD observation by R/V MIRAI data with TRITON buoy data using the 1 hour averaged value.

As our temperature sensors are expected to be more stable than conductivity sensors, conductivity data and salinity data are selected at the samevalue of temperature data. Then, we calculate difference of salinity from conductivity between the shipboard CTD/XCTD data on R/V MIRAI and the TRITON buoy data for each deployment and recovery of buoys.

(5) Results

Most of temperature, conductivity and salinity data from TRITON buoy showed good agreement with CTD cast data in T-S diagrams. See the figures 7.1.2-1(a), (b). To evaluate the performance of the conductivity sensors on TRITON buoy, the data from had deployed buoy and shipboard CTD or XCTD data at the same location were analysed. The estimation were calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.354 to 0.218 psu for all depths. Below 300db, salinity differences are from –0.007 to 0.010 psu (See the figures 7.1.2-2(a) and table 7.1.2-1(a)). The average of salinity differences was 0.002 psu with standard deviation of 0.066 psu. The estimation were calculated as deployed buoy data minus shipboard XCTD data. The salinity differences are from –2.396 to 0.242 psu for all depths. Below 300db, salinity differences are from –0.005 to 0.006 psu (See the figures 7.1.2-2(b) and table 7.1.2-1(b)). The average of salinity differences was 0.023 psu with standard deviation of 0.059 psu.

(6) Data archive

All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC Data Management Office. All original data will be stored at JAMSTEC Mutsu brunch.

Table 7.1.2(a) Data differences between TRITON buoys data and ship board CTD(9Plus) data after 10 month (9004: 1 year)

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
2005	1.5	-0.02	-0.004	-0.009
2005	25	-0.01	-0.003	-0.010
2005	50	0.00	-0.032	-0.213
2005	75	0.00	-0.002	-0.015
2005	100	0.00	0.005	0.039
2005	125	-0.05	-0.003	0.019
2005	150	0.01	0.003	0.025
2005	200	-0.05	-0.003	0.018
2005	250	0.00	0.001	0.013
2005	300	-0.01	0.000	0.008
2005	500	0.00	-0.002	-0.012
2005	750	0.00	0.000	-0.001
3006	1.5	0.02	-0.010	-0.077
3006	25	0.00	-0.019	-0.127
3006	50	-0.02	-0.039	-0.252
3006	75	-0.04	-0.012	-0.055
3006	100	-0.02	0.004	0.053
3006	125	0.02	0.006	0.034
3006	150	0.04	0.016	0.097
3006	200	0.06	0.007	0.013
3006	250	0.00	0.000	0.002
3006	300	0.00	-0.002	-0.007
3006	500	0.00	0.000	0.004
3006	750	0.01	0.001	-0.005
4006	1.5	0.58	0.048	-0.084
4006	25	0.01	-0.002	-0.014
4006	50	-0.01	-0.011	-0.062
4006	75	0.00	0.000	0.004
4006	100	-0.01	0.003	0.036
4006	150	-0.13	-0.009	0.037
4006	200	0.00	-0.002	-0.016
4006	250	-0.01	-0.003	-0.010
4006	300	0.00	-0.002	-0.014
4006	500	0.00	0.001	0.011
4006	750	0.00	-0.001	-0.002
5004	1.5	0.12	0.018	0.048
5004	25	-0.06	-0.020	-0.091
5004	50	-0.02	0.008	0.077
5004	75	-0.10	-0.006	0.043
5004	100	0.01	-0.005	-0.038
5004	125	-0.01	0.005	0.049
5004	150	0.53	0.059	0.046
5004	200	0.01	0.000	-0.006
5004	250	0.00	0.001	0.016
5004	300	0.00	-0.001	-0.003
5004	500	0.03	0.003	0.010
5004	750	0.01	0.000	-0.002
6004	1.5	0.36	0.039	0.005

Table 7.1.2(a) Data differences between TRITON buoys data and ship board CTD(9Plus) data after 10 month (9004: 1 year)

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
6004	25	0.00	-0.053	-0.354
6004	50	0.03	-0.004	-0.043
6004	75	0.02	0.031	0.209
6004	100	-0.02	0.006	0.067
6004	125	0.04	0.015	0.079
6004	150	0.01	0.006	0.040
6004	200	0.01	0.001	0.002
6004	250	0.01	0.003	0.023
6004	300	0.02	0.003	0.008
6004	500	-0.02	-0.003	-0.004
6004	750	0.00	-0.001	-0.014
7004	1.5	-0.01	0.002	0.026
7004	25	0.00	-0.004	-0.025
7004	50	-0.16	-0.016	0.009
7004	75	-0.03	-0.011	-0.060
7004	100	-0.03	0.003	0.051
7004	125	0.08	0.014	0.051
7004	150	-0.01	0.000	0.017
7004	200	0.02	0.000	-0.009
7004	250	0.00	-0.001	-0.007
7004	300	-0.01	-0.002	-0.006
7004	500	0.00	-0.002	-0.013
7004	750	0.00	0.000	-0.003
8003	1.5	0.13	0.014	0.011
8003	25	0.00	0.000	0.007
8003	50	-0.01	-0.006	-0.026
8003	75	-0.03	-0.005	-0.006
8003	100	-1.00	-0.104	0.005
8003	125	-0.08	-0.002	0.058
8003	150	0.03	0.024	0.163
8003	200	-0.07	-0.001	0.054
8003	250	0.02	0.003	0.006
8003	300	-0.01	0.023	0.218
8003	500	0.00	-0.001	-0.006
8003	750	0.00	0.000	-0.002
9004	1.5	0.16	-0.013	-0.197
9004	25	0.00	0.000	0.005
9004	50	0.00	-0.035	-0.233
9004	75	0.00	-0.023	-0.156
9004	100	0.01	0.010	0.064
9004	125	0.01	0.006	0.036
9004	150	-0.07	-0.015	-0.060
9004	200	0.00	0.002	0.023
9004	250	-0.09	-0.010	-0.006
9004	300	0.00	-0.002	-0.011
9004	500	0.00	0.000	-0.006
9004	750	0.00	-0.001	-0.011

Table 7.1.2(b) Data differences between TRITON buoys data and ship board XCTD(TSK1000) data after deploy

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
2006	1.5	-0.01	0.015	0.115
2006	25	-0.01	0.004	0.020
2006	50	0.00	0.004	0.012
2006	75	-0.04	0.001	0.026
2006	100	-0.02	0.002	0.018
2006	125	0.02	0.008	0.025
2006	150	0.00	0.004	0.018
2006	200	-0.04	0.008	0.090
2006	250	0.04	0.005	0.002
2006	300	-0.01	0.000	-0.003
2006	500	0.00	0.002	-0.003
2006	750	0.00	0.001	-0.002
3007	1.5	0.01	0.011	0.051
3007	25	-0.01	0.002	0.009
3007	50	0.02	0.006	0.012
3007	75	-0.06	-0.001	0.024
3007	100	-0.09	-0.006	0.017
3007	125	-0.14	-0.011	0.026
3007	150	0.03	0.006	0.000
3007	200	-0.01	0.002	0.006
3007	250	-0.01	0.000	0.003
3007	300	0.00	0.002	0.006
3007	500	0.00	0.001	0.002
3007	750	0.00	0.001	0.002
4007	1.5	0.08	0.035	0.242
4007	25	-0.01	0.002	0.003
4007	50	0.03	0.007	0.003
4007	75	0.00	-0.007	-0.099
4007	100	0.00	0.005	0.021
4007	150	0.04	0.010	0.043
4007	200	0.01	0.030	0.254
4007	250	0.01	0.005	0.018
4007	300	0.00	0.004	0.017
4007	500	-0.04	0.002	0.026
4007	750	0.00	0.001	0.004
5005	1.5	0.00	0.006	0.030
5005	25	-0.01	0.004	0.010
5005	50	0.02	0.012	0.042
5005	75	-0.02	0.004	0.029
5005	100	-0.04	0.000	0.018
5005	125	0.02	0.006	0.020
5005	150	0.02	0.009	0.034
5005	200	0.00	***	***
5005	250	0.00	0.002	0.002
5005	300	0.00	0.003	0.016
5005	500	-0.01	0.000	0.000
5005	750	0.00	0.003	0.003
6005	1.5	0.07	0.010	0.001

Table 7.1.2(b) Data differences between TRITON buoys data and ship board XCTD(TSK1000) data after deploy

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
6005	25	-0.05	-0.003	0.001
6005	50	-0.03	0.008	0.06
6005	75	0.01	0.005	0.015
6005	100	0.00	0.004	0.007
6005	125	-0.01	0.007	0.045
6005	150	0.06	0.012	0.031
6005	200	-0.02	0.003	0.042
6005	250	0.01	0.004	0.005
6005	300	0.02	0.005	0.002
6005	500	0.00	0.002	0.002
6005	750	0.00	0.001	-0.005
7005	1.5	0.74	0.065	-0.085
7005	25	0.72	0.054	-0.161
7005	50	0.01	0.001	-0.004
7005	75	0.04	0.000	-0.053
7005	100	0.02	0.012	0.076
7005	300	0.01	0.003	0.003
7005	750	-0.01	0.000	0.001
8004	125	-0.02	0.000	0.000
8004	150	0.00	0.004	0.020
8004	200	0.03	0.003	-0.027
8004	250	0.00	0.003	0.001
8004	500	0.00	-0.226	-2.396
9005	1.5	0.00	***	***
9005	25	0.00	0.004	0.011
9005	50	0.00	0.006	0.022
9005	75	0.03	0.005	0.002
9005	100	0.13	0.015	-0.002
9005	125	-0.09	-0.005	0.011
9005	150	-0.02	0.003	0.023
9005	200	-0.06	-0.003	0.004
9005	250	0.02	0.018	0.114
9005	300	-0.05	0.020	0.214
9005	500	-0.01	0.016	0.126
9005	750	0.02	0.018	0.143

***:no data

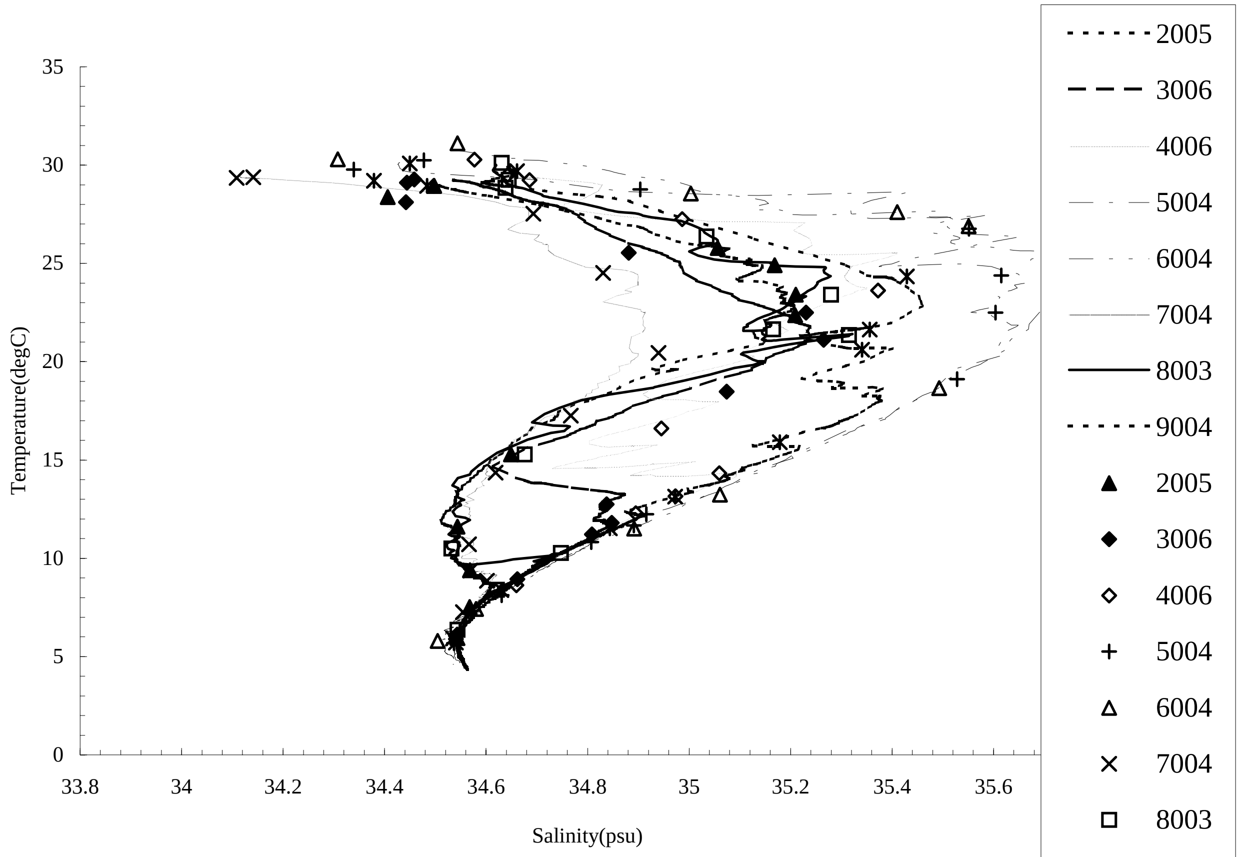

fig.7.1.2-1(a) T-S diagram (TRITON buoys data and ship board CTD(9Plus) data after 10 month (09004: 1 ye

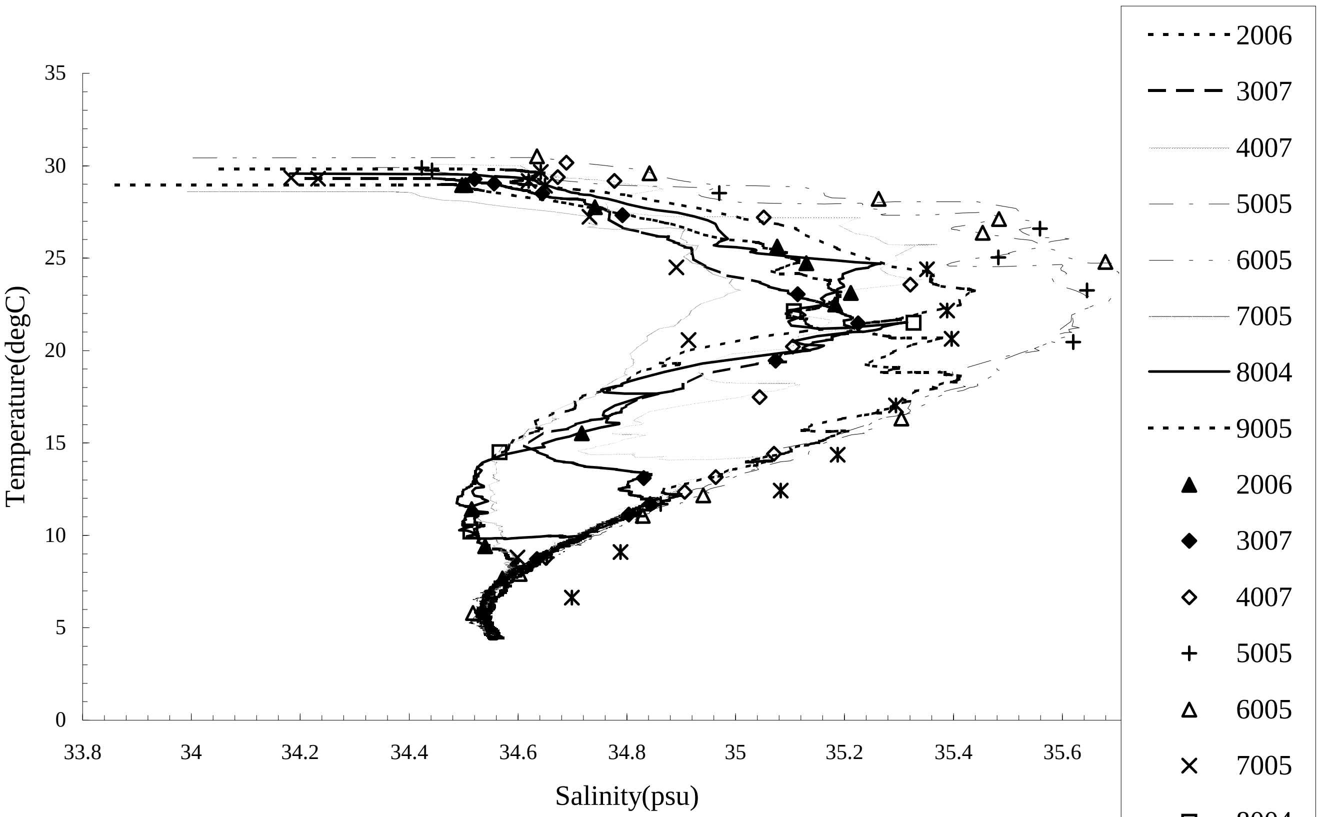

fig.7.1.2-1(b) T-S diagram (TRITON buoys data and ship board XCTD(TSK1000) data aft
Deploy)

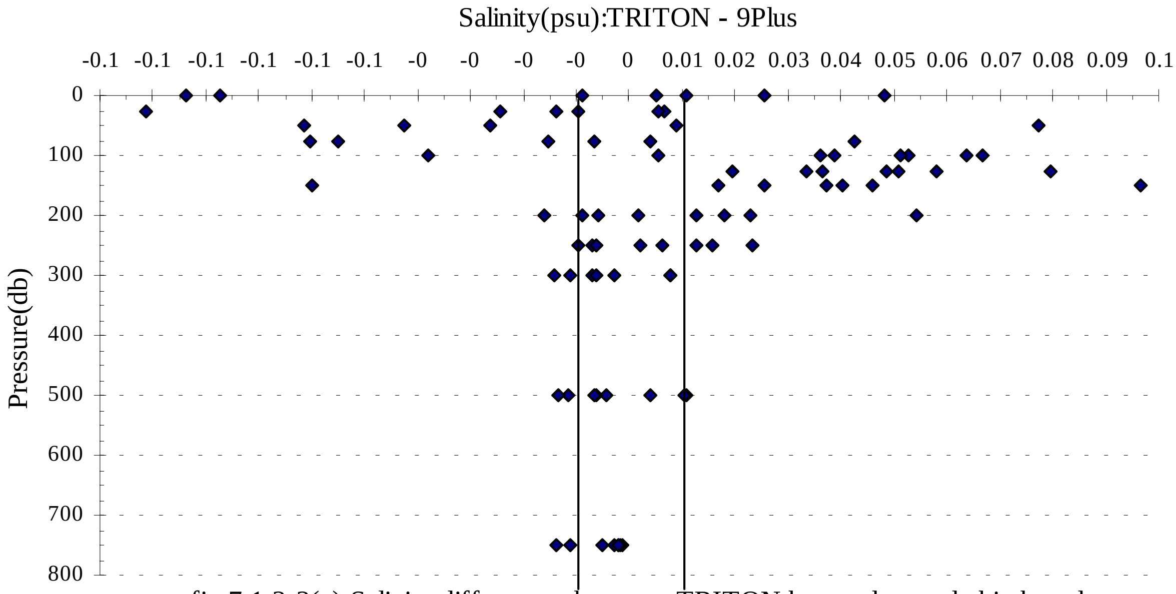

fig.7.1.2-2(a) Salinity differences between TRITON buoys data and ship board CTD(9Plus) data after 10 month (09004:1year)

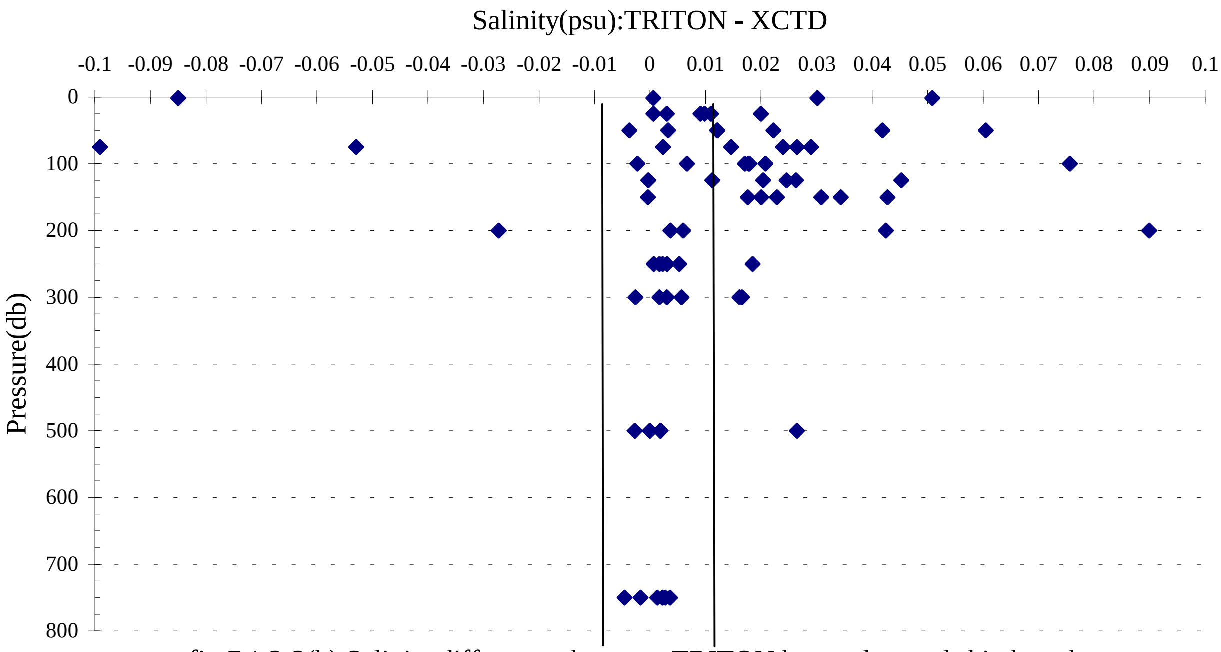

fig.7.1.2-2(b) Salinity differences between TRITON buoys data and ship board XCTD(TSK1000) data after Deploy

7.2 Argo float launch

(1) Personnel

Kensuke Takeuchi	(FORSGC): Principal Investigator (not on board)	
Kentaro Ando	(JAMSTEC)	
Nobie Shikama	(FORSGC)	not on board
Eitarou Oka	(FORSGC)	not on board

(2) Objectives

The objective of deployment is to clarify variations of temperature and salinity in association with interannual variations such as ENSO events and intra-seasonal variations.

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 variations mentioned above with time scales much smaller than those in the previous studies.

(3) Parameters

・water temperature, salinity, and pressure

(4) Methods

1) Profiling float deployment

We launched 3 APEX floats manufactured by Webb Research Ltd. Each float equips SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

These floats usually drift at a depth of 1500 dbar (called the parking depth), and rise up to the sea surface every ten days by increasing their volume and changing the buoyancy. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting their positions and 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 7.2-1

2) CTD observation

A CTD cast to a depth of 2000 m was made just before the launch of each float for calibration of the float sensor (see 6.2.1)

(6) Data archive

All data acquired through the ARGOS system is stored at FORSGC. The real-time data are provided to meteorological organizations via Global Telecommunication System (GTS) and utilized for analysis and forecasts of sea conditions.

Table 7.2-1 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	1500 dbar
Sampling layers	66 (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 [dbar])

Launches

Float S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch
727	16357	00:10, Dec 20	01:38, Dec 20	5-03.54 N, 147-00.87 E
726	16356	23:55, Dec 21	01:41, Dec 22	2-01.59 N, 146-57.25 E
728	16358	23:00, Jan 04	01:44, Jan 05	1-56.29 N, 155-57.89 E

7.3. Nutrients
7.3.1.Water column nutrients

Kenichiro SATO (Marine Works Japan Ltd.: MWJ)
Kazuhiro MATSUMOTO (JAMSTEC)

(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) Instruments and Methods

Nutrient analysis was performed on two BRAN+LUEBBE TRAACS 800 systems that have 4-channel analyzing systems for nitrate, nitrite, silicate and phosphate. The methods used were proposed for nutrients of seawater by BRAN+LUEBBE. The laboratory temperature was maintained between 23 - 26 deg C.

a. Measured Parameters

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

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

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

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

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

b. Nutrients Standard

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

c. Sampling Procedures

Samples were drawn into 10 ml acrylic screw-capped tubes that were rinsed three times before filling. Each sample was analyzed two times as soon as possible. Sets of 5 different concentrations of shipboard standards were analyzed at beginning, halfway and end of each group of analysis.

d. Low Nutrients Sea Water (LNSW)

Twelve containers (20L) of low nutrients seawater were collected in January 2002 at equatorial Pacific and filtered with 0.45um pore size membrane filter (Millipore HA). They are used as preparing the working standard solution.

(3) Results

212 nutrient analysis from the rosette stations were performed including surface seawaters collected by bucket. Duplicate samples were collected from all bottles of each casting. Average of difference between duplicate samples for nitrate, nitrite, silicate and phosphate is 0.03, 0.00, 0.16 and 0.01, respectively. Figure 7.3.1. show the vertical sections of nutrients along lines with CTD observations.

(4) Data Archive

These data are stored in MO disk in Ocean Research Department in JAMSTEC.

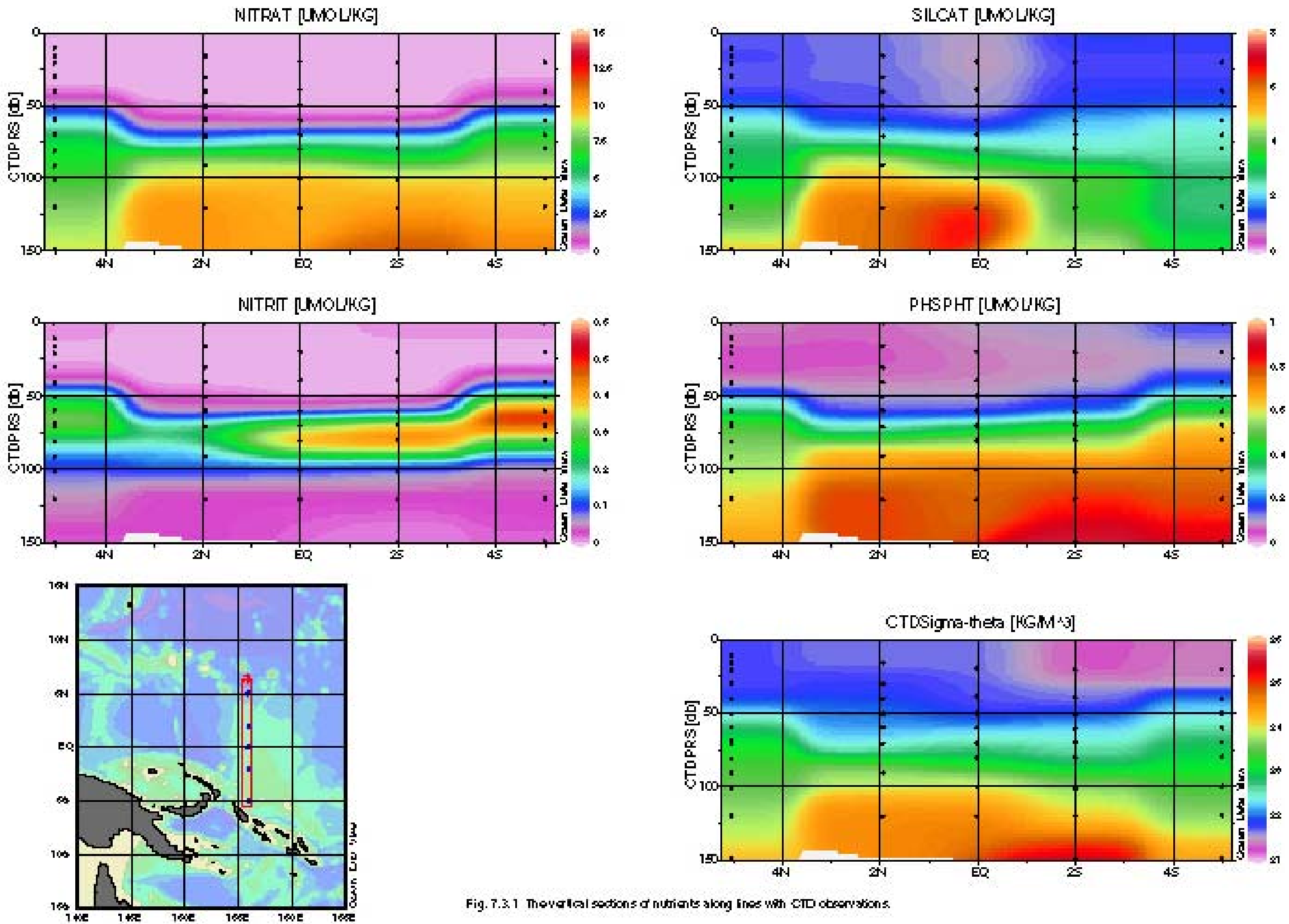

Fig. 7.3.1 The vertical sections of nutrients along lines with CTD observations.

7.3.3

7.3.2. Sea surface nutrients

Kenichiro SATO (Marine Works Japan Ltd.: MWJ)
Kazuhiro MATSUMOTO (JAMSTEC)

(1) Objective

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

(2) Sampling elements

Nitrate+ Nitrite, Nitrite, Phosphate, Silicate

(3) Inventory information for the sampling

Date: December 20, 2002 to January 9, 2003

(4) Instruments (including setting parameters if required), and methods

The nutrients monitoring system was performed on BRAN+LUEBBE continuous monitoring system Model TRAACS 800 (4 channels). This system was located at the surface seawater laboratory for monitoring in R/V Mirai. Seawater at depth of 4.5 m was continuously pumped up to the laboratory and introduced direct to monitoring system with narrow tube. The methods are as follows.

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

Nitrite: Nitrite was determined by diazotizing with sulfanilamide by coupling with N-1-naphthyl-ethylendiamine (NED) to form a colored azo compound, and by being measured the absorbance of 550 nm using 3 cm length flow cell in the system.

Phosphate: Phosphate was determined by complexion with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 800 nm using 5 cm length flow cell in the system.

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

(5) Results (Expected/preliminary results)

We are now arranging the method of data revision.

(6) Data archives

All raw and revised data files will be copied onto CD-ROM and submitted to Chief Scientist and JAMSTEC Data Management Office (DMO) according to the data management policy of JAMSTEC.

7.4 Phytoplankton abundances

Kazuhiko Matsumoto (JAMSTEC)

Objectives

The main objective of our study is to clarify the relations with distribution, abundance and primary productivity of phytoplankton in the equatorial Pacific. The equatorial Pacific was distinguished spatially with hydrological condition to two major regions, where are the regions of the warm pool and the upwelling. Primary productivity is greatly different in each region, in addition, phytoplankton dominant species and the abundances are also different in each region. Primary productivity is cell-specific, phytoplankton abundance and distribution of each cell is very useful and important information to clarify the mechanism of primary productivity. We measured phytoplankton abundances with two kinds of methods: microscopy for large size phytoplankton and flowcytometry for picophytoplankton.

Methods

1. Microscopy

Water samples were placed in 5000 ml plastic bottle and fixed with neutral buffered formalin solution (3% final concentration). The measurements will be scheduled at Marine biological research institute of Japan co.,ltd.

2. Flowcytometry

Equipment

The flowcytometry system used in this research was BRYTE HS system Bio-Rad Laboratories Inc.

System specification were follows:

Light source: 75W Xenon arc lamp

Excitation wavelength: 350-650 nm

Detector: high-performance PMT

Analyzed volume: 75 µl

Flow rate: 10 µl min^{-1}

Sheath fluid: Milli-Q water

Filter block: B2 as excitation filter block, OR1 as fluorescence separator block

B2 and OR1 have ability as follows:

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

Sampling

Water samples were immediately filtered with 10 μm filter which mounted with filter holder, and placed in 50 ml poly-carbonate bottle.

Measurements

Before 30 min of measurement, the power of flowcytometer was turned on (for warm up). Internal standard beads were added before measurement. Water sample (75 μl) was run on the flowcytometer. After the measurement, the sample was fixed with glutaraldehyde (1% final concentration) for 10 min, then measured again. The analysis will be scheduled at JAMSTEC, Yokosuka.

7.5 Phytoplankton pigments

(1) Personnel

Kazuhiko MATSUMOTO (JAMSTEC)
Keisuke WATAKI (Marine Works Japan Ltd.)
Saeko SUGISAKI (Marine Works Japan Ltd.)
Akira SHIMIZU (Marine Works Japan Ltd.)

(2) Objectives

The purpose of this study is to estimate the distributions of chlorophyll-*a* in the equatorial Pacific Ocean by fluorometric analysis. Chlorophyll-*a* measurements are carried out with two differrent type fluorometers (broadband filter type and narrowband filter type). Broadband filter type fluorometer is used in common, but it is recognized the errors related to the acidification technique when chlorophyll-*b* is present. The new non-acidification method was developed by Welschmeyer (1994) with narrowband filter type fluorometer to eliminate the effect of acidification error. Narrowband filter type fluorometer is the same equipment as broadband filter type fluorometer, just changed excitation-emission filters and lamp. A new non-acidification method is not need to consider the acidification error, but the new method yields some overestimate of the true chlorophyll-*a* concentration, especially when chlorophyll-*b* is present.

High performance liquid chromatography (HPLC) analysis has been shown to be a conclusive method for separating and quantifying pigments in natural seawater. In this cruise, the marine phytoplankton pigments were analyzed, in order to compare the marine phytoplankton community structure.

(3) Method

a) Chlorophyll-a

Seawater samples were collected from upper 200m using Niskin bottles, except for the surface water, which was taken by the bucket. The samples (0.5L) were filtered separately through Nuclepore filters (diameter 47mm) with pore sizes of 0.4μm. It was applied to vacuum less than 10cmHg. It was extracted in a glass vial with 7ml N-N,dimethylformamide (DMF), stored at –20℃ under a dark condition for extraction of chl-a. Over 24 hours, fluorescence was measured with a Turner Design fluorometer (10-AU-005), which was previously calibrated against a pure chl-a (Sigma chemical Co.). It was done two methods of Acidification and non-acidification. Analytical conditions of methods indicate in Table 7.5-1. The vertical section of chlorophyll-a concentrations is shown in Figure 7.5-1 to 3.

b) Chlorophyll-a,b and carotenoids pigments

Seawater samples were filtered through a 47 mm diameter Whatman GF/F filters (nominal size 0.7 μm). It was the remaining seawater in filters to remove by vacuum dry in freezer. Samples were extracted with DMF over 24 hours in freezer (-20 deg C). Extracts were then filtered through 25 mm diameter polypropylene syringe filters (0.2 µm pore size) to remove cell and filter debris. They are measured by the two way of HPLC method. As a role of ion-pair reagent, ultra pure water. It was, Canthaxanthin, as the internal standard was added to all samples, it was quickly to inject. It is showed as the following solvents and column system, which is modified the method of Zapata *et al* (2000).

Solvent Amethanol : acetonitrile : 0.25M pyridine solution = 50 : 25 : 25
Solvent B acetonitrile : acetone = 80:20
Column C-8 (Pro C8; YMC,Inc.) 4.6 x 150 mm I.D.

HPLC system is consisted as follows.

Detector Waters 996 Photodiode Array
Pump Waters 616
Auto Sampler Waters 717plus
Column temperature 25degC

The HPLC system is calibrated with the following commercially pigment standards.

Chlorophyll a,b,c_2,c_3 Diadinoxanthin Lutein Fucoxanthin Alpha-carotene Beta-carotene Neoxanthin Peridinin Prasinoxanthin Alloxanthin Violaxanthin 19’hexanoyloxyfucoxanthin 19’butanoyloxyfucoxanthin Canthaxanthin Zeaxanthin Diatoxanthin Divinyl-chlorophyll-a Chlorophyllide-a Lycopene Crocoxanthin Pheophytin-a,b Antheraxanthin Canthaxanthin (Chlorophyll-a,b and Pheophytin-a,b are made by Sigma Chem.Co.. Others are made by VKI.)

Concentrations of pigment standards are determined using a spectrophotometer. Chlorophyll-a and Chlorophyll–b are quantitatively evaluated by drawing the calibration curve using the amount of the standards and their respective chromatogram peak areas. Other pigments are quantitatively evaluated using the formula of JGOFS Protocols (1994). Chlorophyll-a and Chlorophyll–b, Divinyl-chlorophyll-a peak areas are measured by Photodiode Array Detector at each blue maximum wavelength. Others are measured at 440nm.

Samples will be analyzed Leg.3.

Table 7.5-1. Analytical conditions of acidification method and non-acidification method for chlorophyll-a with Turner fluorometer.

	Acidification method	Non-acidification method
Excitation filter (nm)	340-540	436
Emission filter (nm)	>665	680
Lamp	Daylight white F4T5D	Blue F4T5, B2/BP

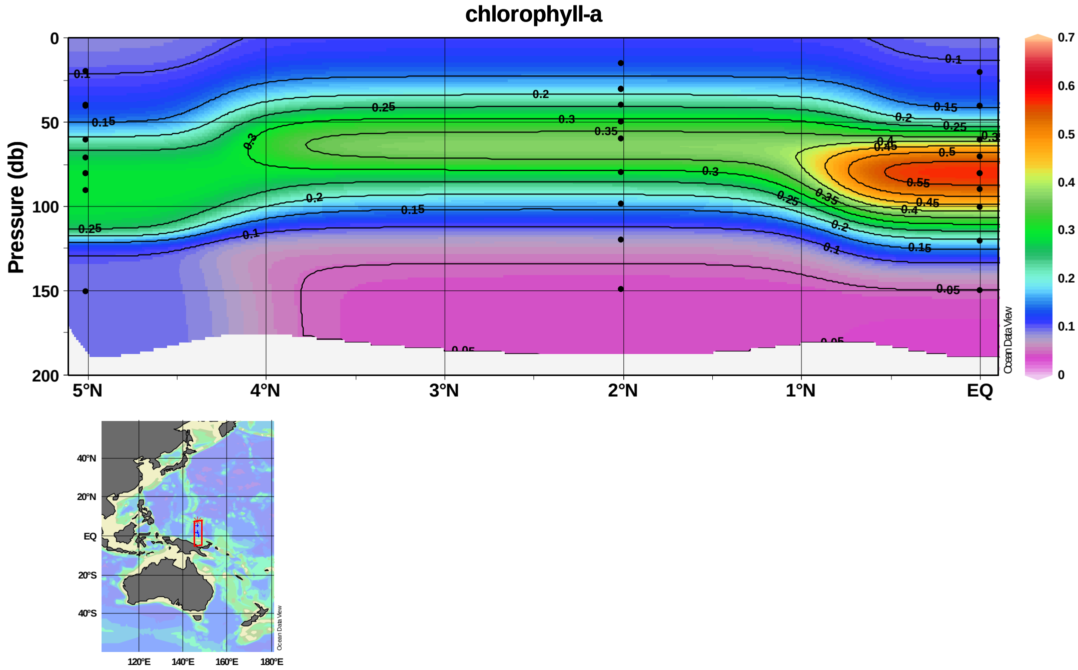

Figure 7.5-1 Distributions of chlorophyll-*a* concentrations (μg/L) at Station.C01,02,04.
(on 147 degree-East)

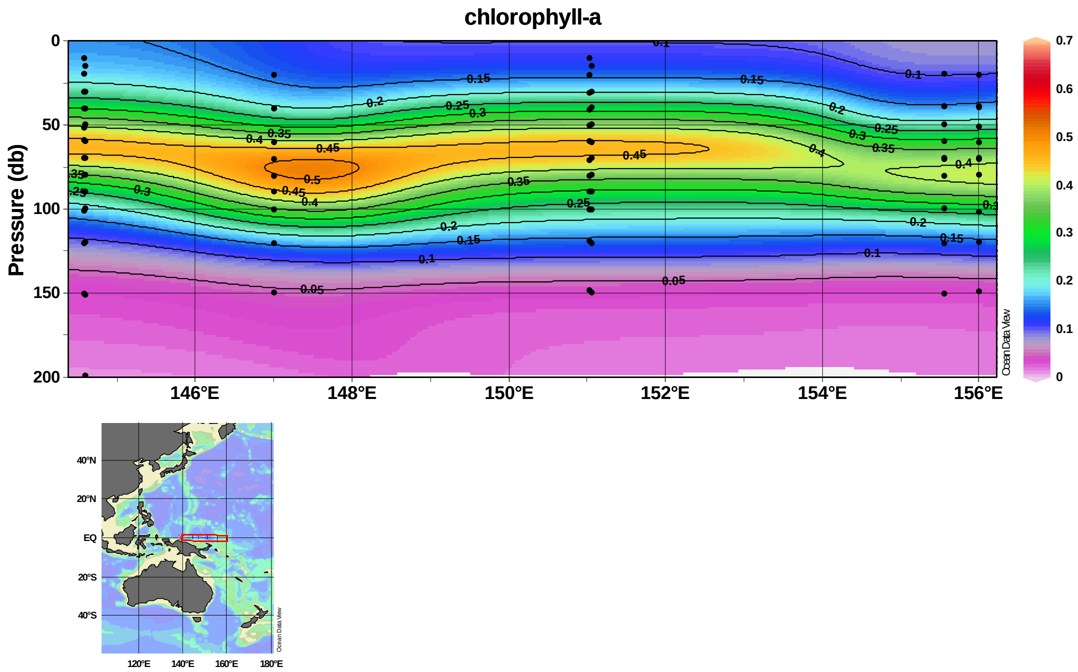

Figure 7.5-2 Distributions of chlorophyll-*a* concentrations (μg/L) at Station.C03,04,05,08.
(on Equator.)

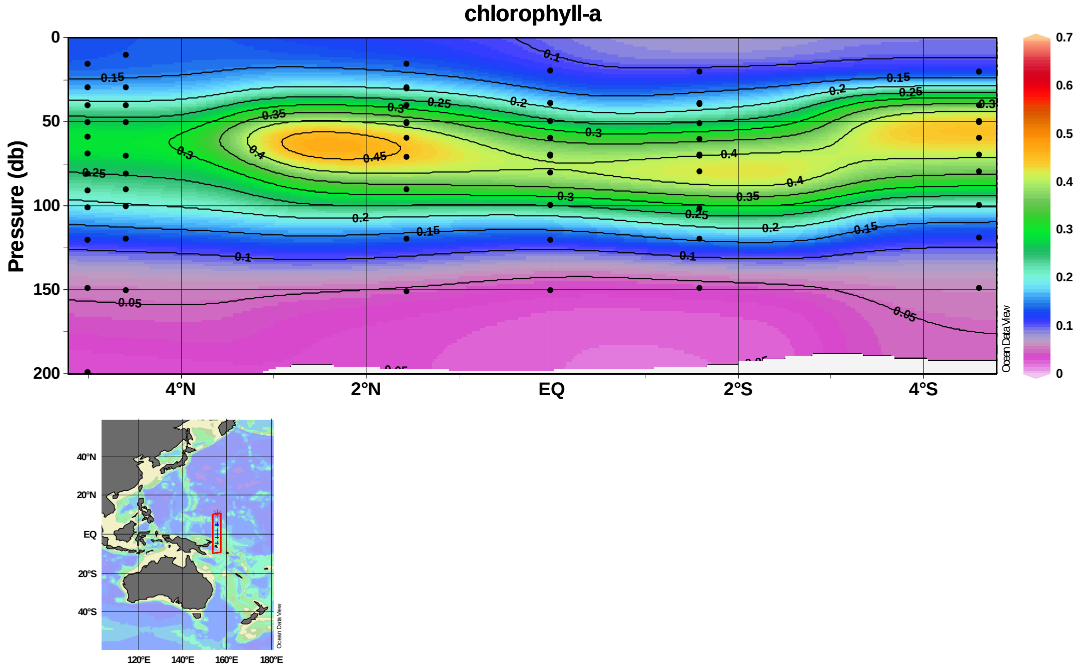

Figure 7.5-3 Distributions of chlorophyll-*a* concentrations (μg/L) at Station.C06,07,08,09,10.
(on 156 degree-East)

7.6 Primary and new productivity

Ai YASUDA 1), Keisuke Wataki 1), Kenichiro Sato 1), Saiko Sugisaki 1),
Akira Shimizu 1)
1) Marine Works Japan LTD

Objectives

The objective of this study is to known the mechanism of primary production at the open sea on the equator.

(1) In-situ Incubation

Bottles for incubation and filters

Bottles for incubation are ca. 1 liter Nalgen polycarbonate bottles with screw caps. Grass fiber filters (Wattman GF/F 25mm) pre-combusted under 450 degree C of temperature for at least 6 hours, were used for a filtration.

Incubation

In-situ incubation for 12 hours were executed at station before incubated St. C01,C03,C05 and C010. We took two transparent bottles samples from 13 layers took from 150m depth (every 10m from surface to 100m, 120m and 150m depth and morred these samples at each depth for 12 houres, after morring all samples incubated in bath on deck 12 hours). All the samples were spiked with 0.2 mmoles/ mL of $NaH^{13}CO_3$ solution just before mooring. Samples were filtered immediately after the incubation and the filters were kept frozen 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 and JAMSTEC.

(2) Simulated in-situ incubation

Bottles for incubation and filters

Bottles for incubation are ca. 1 liter Nalgen polycarbonate bottles with screw caps. Grass fiber filters (Wattman GF/F 25mm) pre-combusted with temperature of 450 degree C for at least 6 hours, were used for a filtration.

Simulated in-situ incubation

We took four samples form the surface and one predefined depth by a bucket and Niskin bottles at St. C02, C04, C06, C07, C08, and C09. The depth corresponded to nominal specific optical
All samples were spiked with 0.2 mmoles/mL of $NaH^{13}CO_3$ solution. After spike, bottles were placed into incubators by neutral density filters corresponding to nominal light levels at the depth at which samples were taken. Samples were incubated in a bath on the deck for 3 hours.
Samples were filtered through the 47mm-diameter 10.0 μm mesh filter and Nuclepore filters (pore size of 3.0 μm and 1.0 μm) , all samples were filtered through Grass fiber filters (Wattman GF/F 25mm) immediately after the incubation. Phytoplankton pigments on the filters were

immediately extracted in 7ml of N,N-dimethyl formamide after filtration and GF/F filters were kept to freeze till analyse 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 and JAMSTEC.

(3) Optical parameters

The first instrument system deployed was the SeaWiFS Profiling Multichannel Radiometer (SPMR) and SeaWiFS Multichannel Surface Reference (SMSR). 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, fluorometry, conductivity and an external temperature probe. The SMSR or reference sensor has a 13-channel irradiance sensor (Es), tilt meter and an internal temperature sensor. This instrument suite is used for the determination of the vertical distribution of apparent optical properties. The profiler was deployed to a depth of 130m.

7.7 CO_2 analyses in air and in seawater

(1) Personnel

Takashi HARIMOTO (KANSO): Operation Leader
Masao ISHII (MRI): Principal Investigator
Shu SAITO (MRI)
Hisayuki Yoshikawa. INOUE (Hokkaido University)

(2) Objective

Carbon dioxide (CO_2), known as a major greenhouse gas, has been increasing in the atmosphere as a result of the anthropogenic emission. Its current concentration is approximately 30% higher than that in the pre-industrial era (280ppm). In order to predict the future atmospheric CO_2 variation due to anthropogenic emission and the potential alteration of the carbon cycle as a result of the climate change, it is necessary to understand the processes controlling CO_2 fluxes among the global carbon reservoirs, the atmosphere, the terrestrial biosphere and the ocean, as well as to estimate the present CO_2 inventory in these reservoirs.

The eastern and the central equatorial Pacific is now known to act as a significant source of the CO_2 to the atmosphere due primarily to the equatorial upwelling. The western equatorial Pacific, where warm water prevails in the surface layer, also occasionally exhibits a large CO_2 emission from the sea to the atmosphere. Flux of CO_2 from the equatorial Pacific has been reported to show a significant interannual variability that is associated with the ENSO event. However, the temporal and spatial variation in the whole CO_2 system in seawater enough to elucidate its controlling mechanism has not been well documented.

In this cruise, we made concurrent underway measurements of CO_2 concentration in the atmosphere and in surface seawater and total inorganic carbon (TCO_2) in surface seawater. The purpose of these observations is to describe the oceanic CO_2 system in the western equatorial Pacific and to clarify the controlling factors that are responsible for its variation in space and time as well as to investigate the air-sea CO_2 flux in this region.

(3) Parameters

a) CO_2 concentration (xCO_2) in marine boundary air and in the air equilibrated with surface seawater.
b) Total inorganic carbon (TCO_2) in surface seawater.
c) TCO_2 and pH in the top 200m of water columns.

(4) Methods

a) Underway measurements of CO_2 concentration in marine boundary air and in the air equilibrated with surface seawater :

We made measurements of the CO_2 concentration (mole fraction of CO_2 in air; xCO_2) in marine boundary air twice every 1.5 hour and that in air equilibrated with the great excess of surface seawater four times every 1.5 hour using the automated CO_2 measuring system (Nippon ANS Co.). Measurements were temporally stopped in the EEZ of the Republic of Palau and the Republic of Indonesia.

Marine boundary air was taken continuously from the foremast. Seawater was taken continuously from the bottom of ship located ca.5m below the sea level and introduced into the

MRI-shower-type equilibrator. Non-dispersive infrared (NDIR) gas analyzer (BINOS 4) was used as a detector. It was calibrated with four CO_2 reference gases (299.40, 349.11, 399.02, 449.11 ppm in air, Nippon Sanso Co., Ltd.) once every 1.5 hour. Concentration of CO_2 will be reported on the MRI87 scale that is traceable to the WMO X85 mole fraction scale. Corrections for the temperature-rise within the inner piping from the bottom of ship to the equilibrator and the drift of CO_2 concentration in reference gases, if any, are also to be made. Partial pressure of CO_2 will be calculated from xCO_2 by taking the water vapor pressure and the atmospheric pressure into account.

b) Underway measurements of total inorganic carbon (TCO_2) in surface seawater

We made underway measurement of TCO_2 in surface seawater using the automated TCO_2 analyzer (Nippon ANS Co., Ltd.) equipped with carbon coulometer 5012 (UIC Co., Ltd.). Seawater was taken continuously from the bottom of the ship and a portion of the seawater (～ 22cm^3) was introduced into the water-jacketed pipette of the analyzer twice every 1.5 hours for analysis. We also analyzed TCO_2 in reference seawaters prepared in MRI that is traceable to the CRM provided by Dr. A. Dickson in Scripps Institution of Oceanography. The analysis of the reference seawater was made at least once during the each run of the coulometric cathode- and anode-solution.

c) TCO_2 and pH in the top 200m of water columns.

We took discrete samples TCO_2 and pH (total hydrogen ion scale) in seawater from Niskin bottles on carousel sampling system at each station (from shallow-cast) and from surface seawater taken by a bucket (Table 1). These samples were stored in 250 cm^3 boro-silicate grass bottle with ground -grass stopcock lubricated with Apiezon-L grease, and were poisoned with 0.2 cm^3 of saturated $HgCl_2$ solution. TCO_2 and will be measured on board in the subsequent leg of this cruise.

Table 1; seawater sampling layer

Station #	C-03	C-05
Date and Start time	2002/12/23 11:02(LST)	2002/12/26 10:59(LST)
Latitude	0 ° 00S	0 ° 00N
Longitude	144 ° 59E	151 ° 06E
Bucket	Surface	Surface
Niskin #1	15db	15db
Niskin #2	30db	30db
Niskin #3	40db	40db
Niskin #4	50bd	50db
Niskin #5	60db	60db
Niskin #6	70db	70db
Niskin #7	80db	80db
Niskin #8	90db	90db
Niskin #9	100db	100db
Niskin #10	120db	120db
Niskin #11	150db	150db
Niskin #12	200db	200db

(5) Results

Data analysis will be made soon.

(6) Data Archive

The original data will be archived at Geochemical Research Department, Meteorological Research Institute. Data will be also submitted to Data Management Office of JAMSTEC within 3 years.

7.8 Sediment trap

(1) <u>Participants</u>

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Yuichiro TANAKA
National Institute of Advanced Industrial Science and Technology.
AIST Tsukuba Central 7, 1-1-1 Higashi, Tsukuba, Ibaraki, Japan

(2) Objective

We are planning next items about how to use collected settling particles.

A) Total mass flux and main component
To analyze total mass flux and main component (Opal, Carbonate, Organic carbon, Organic nitrogen).

B) Carbonate flux by calcareous nannoplankton.
To analyze seasonal varieties of the coccolith species, and annual and vertical changes of the coccolith flux.

C) Planktonic foraminifera flux.
To analyze planktonic foraminifera flux, and the dissolution process of settling foraminiferal shell in the water column.

D) Flux of silicoplankton (1.Diatom, 2.Radiolaria, 3.Silicofragellate, 4.Silicodinofragellate)
To estimate vertical flux of the carbon and silica based on that analyzing each species flux of the time-series settling particles.

E) Radio-nuclide (U-238, Th-230, Pa-231, Pu-239+240, Pb-210, Po-210, etc.)
To consider that settling particle flux, and horizontal and vertical transport process.

(3) Recovery

We've recovered the sediment trap mooring arrays in St.C03. It was deployed in March 2002 (MR02-K02). It seemed that almost sediment traps carried out completely. But the #19sampling bottles (C02M03S19 and C02M03D19) were yet to finished. The several ropes got foul with floating grass buoy. The working record on deck is followed as next table (Table-1). The event schedule of collected samples is followed as next table (Table-2).

Table-1 Recovered mooring array data

Released time (LST) and point	2002/12/23 07:01 (JST +1h) 00-00.92S 145-00.98E
Recovery start time	07:58
Recovery end time	09:27
Collecting layer	852m 1,962m
Total depth	3,684m
Event start time (JST)	2002/03/18 01:00
Event stop time (JST)	2002/12/23 07:30
Interval	c.a. 15days (see next time table)
Preservative	Seawater and formalin neutralized with sodium tetraborate

Table-2 Sampling schedule (JST)

Sample#	Start time	End time
C02M03S01,C02M03D01	2002.3.18.1:00	2002.4.1.1:00
C02M03S02,C02M03D02	2002.4.1.1:00	2002.4.16.1:00
C02M03S03,C02M03D03	2002.4.16.1:00	2002.5.1.1:00
C02M03S04,C02M03D04	2002.5.1.1:00	2002.5.16.1:00
C02M03S05,C02M03D05	2002.5.16.1:00	2002.6.1.1:00
C02M03S06,C02M03D06	2002.6.1.1:00	2002.6.16.1:00
C02M03S07,C02M03D07	2002.6.16.1:00	2002.7.1.1:00
C02M03S08,C02M03D08	2002.7.1.1:00	2002.7.16.1:00
C02M03S09,C02M03D09	2002.7.16.1:00	2002.8.1.1:00
C02M03S10,C02M03D10	2002.8.1.1:00	2002.8.16.1:00
C02M03S11,C02M03D11	2002.8.16.1:00	2002.9.1.1:00
C02M03S12,C02M03D12	2002.9.1.1:00	2002.9.16.1:00
C02M03S13,C02M03D13	2002.9.16.1:00	2002.10.1.1:00
C02M03S14,C02M03D14	2002.10.1.1:00	2002.10.16.1:00
C02M03S15,C02M03D15	2002.10.16.1:00	2002.11.1.1:00
C02M03S16,C02M03D16	2002.11.1.1:00	2002.11.16.1:00
C02M03S17,C02M03D17	2002.11.16.1:00	2002.12.1.1:00
C02M03S18,C02M03D18	2002.12.1.1:00	2002.12.16.1:00
C02M03S19,C02M03D19	2002.12.16.1:00	2002.12.23.7:30

7.9 Volatile organic compounds

(1) Personnel

Kiminori Shitashima [1)], Michimasa Magi[*2)], Shinya Hashimoto [3)], Atsuhiro Tsuchiya [3)] and Michiko Kinoshita [3)]

1) CRIEPI : Central Research Institute of Electric Power Industry

2) RITE : Research Institute of Innovative Technology for the Earth

3) Laboratory of Ecological Chemistry, Graduate School of Nutritional and Environmental Sciences

University of Shizuoka

(* indicates on board personnel)

(2) Objective and method

Volatile organic compounds (VOCs) produced in the marine environment are thought to play a key role in atmospheric reactions, particularly those involved in the global radiation budget and the destruction of tropospheric and stratospheric ozone. Volatile organic compounds, including halogens and halocarbons that are produced by marine algae and phytoplankton, may cause ozone depletion in the troposphere and stratosphere. The assessment of numerous naturally produced VOCs in the atmosphere and in seawater is considered to be important for the estimation of the seawater/atmosphere exchange of these gases in the ocean.

The sampling was carried out during December 24, 2002 and January 2, 2003. The sampling sites were 2 stations between 147°E and 156° E. Water samples were collected from 20 depths at each station with a CTD-rosette sampler fitted with 24 Niskin sample bottles of 20 l volume (General Oceanics). The water sample was collected in 40 ml brown colored glass bottle (I-CHEM Certified 200, Nalge Company) for the measurement of halocarbons. After overflow of more than 100 ml of water, 0.1 ml of $HgCl_2$ was added to inhibit microbial activity, and the sample bottle was immediately sealed with a two layer septa (silicone/PTFE) with care to exclude air bubbles, and stored in the box (in the dark) and kept at 5 °C in refrigerator. Samples containing air bubbles were discarded. The final concentration of $HgCl_2$ in sample bottles was about 180 mg/l. Analysis of VOCs will be done through selected ion monitoring using purge and trap-GC-MS in the lab. Distribution of halocarbon concentrations of the equatorial zone in the Pacific Ocean will be examined to evaluate this oceanic area as a natural halocarbon source.

7.10 Determination of Carbonate, sulfur hexafluoride and nitrogen oxide in seawater, and Plankton and POM in middle layer.

(1) Personnel

Kiminori Shitashima [1], Masahiro Imamura [1] and Michimasa Magi[*2]
1) CRIEPI : Central Research Institute of Electric Power Industry
2) RITE : Research Institute of Innovative Technology for the Earth
(* indicates on board personnel)

(2) Objectives

・Determination of Carbonate, sulfur hexafluoride and nitrogen oxide in seawater

In the view of the problem of the global warming, it is important to know the concentration level of greenhouse effect gases in the ocean and the penetration rate of these gases trough air-sea surface interface. Our purpose of this cruise is to collect the data of carbonate (total carbon dioxide, alkalinity and pH), nitrous oxide (N2O), sulfur hexafluoride (SF6) and Nutrients at the equatorial Pacific. We will make clear the penetration and return processes of antholopogenic carbon dioxide in this area using the SF6 data as a tracer.

・POM and zooplankton sampling

In the view of the problem of the global warming, it is important to know the carbon cycles in ocean. Our purpose of this cruise is to collect basic information of the biological transport of organic material from surface waters into the deep sea using multiple stable isotopes.

(3) Parameters

Oceanic parameters for vertical profile; pH, alkalinity, total carbon dioxide (TCO2), nitrogen oxide (N2O), sulfur hexafluoride (SF6), Particulate organic matter (POM) and zooplankton

(4) Description of Methods

pH:

Seawater samples were collected in 100 mL polyethylene bottles with inner caps from Niskin sampler. The sample bottles were capped after an overflow of about 100 mL seawater. All samples were stored at room temperature after sampling and analyzed within a few hours. Samples were transferred into a closed and jacketed glass measurement cell with a volume of ~30 mL. The cell temperature was maintained at a constant temperature of 20°C±0.1°C. The electric potential and temperature of the sample were measured for 15 minutes with an Ag/AgCl combined electrode (Radiometer Analytical A/S, GK2401C) and a temperature sensor (Radiometer Analytical A/S, T901) connected to a high precision pH meter (Radiometer Analytical A/S, model PHM93). Tris and 2-Aminopyridine buffers were employed to calibrate pH electrodes. Calibrations were made at the beginning and the end of set of measurements for every station.

Total Alkalinity (At):
Total Alkalinity samples were collected in 250 mL polyethylene bottles with inner caps from Niskin sampler and capped after an overflow of about 150 mL of seawater. Samples were transferred into a glass titration cell using a 50 mL transfer pipette and titrated at 20ºC±0.1ºC with 0.1M HCl containing 0.6M NaCl within 10 minutes. The electric potential and temperature of the sample were followed with an Ag/AgCl combined electrode (Radiometer Analytical A/S, GK2401C) and a temperature sensor (Radiometer Analytical A/S, T901) connected to the Titra Lab system (Radiometer Analytical A/S). The titration was controlled automatically and the titration curve was analyzed with the inflection point titration method by the system. The precision of the method was determined to be ±0.61 μmol/l (n=8) from replicate analysis of the Certified Reference Solutions (CRMs (batch 44) supplied by Dr. Andrew Dickson of Scripps Institution of Oceanography (SIO)). Standardization of the titrant (0.1M HCl) was accomplished with Na2C3 (99.99% pure; AsahiGrass) standards.

Total dissolved inorganic carbon (TCO2):
The TCO2 concentration in seawater samples was determined by using the coulometric titration system (UIC Inc., Carbon Coulometer model 5011). Samples for TCO2 analysis were drawn from the Niskin sampler into 125 mL glass vial bottles after an overflow of about 100 mL of the seawater. The samples were immediately poisoned with 50 μl of 50% saturated HgCl2 in order to restrict biological alteration prior to sealing the bottles. All samples were stored at room temperature after sampling and analyzed within a few hours. Seawater was introduced manually into the thermo stated (20ºC±0.1ºC) measuring pipette with a volume of ~30 mL by a pressurized headspace CO2-free air that had been passed through the KOH scrubber. The measured volume was then transferred to the extraction vessel. The seawater sample in the extraction vessel was acidified with1.5 mL of 3.8% phosphoric acid and the CO2 was extracted from the sample for 5 minutes by bubbling with the CO2-free air. After passing through the Ag2SO4 scrubber, polywool and Mg(ClO4)2 scrubber to remove sea salts and water vapor, the evolved CO2 gas was continuously induced to the coulometric titration cell by the stream of the CO2-free air. All reagents were renewed every day. The TCO2 concentration in seawater was calculated using a calibration curve constructed by measuring six different concentrations (0, 500, 1000, 1500, 2000 and 2500 μML) of dissolved Na2CO3 (99.99% pure; Asahi Grass) used as a standard solutions. The precision of the TCO2 measurements was tested by analysis of the CRMs (batch 44) at the beginning of the measurement of samples every day. Our shipboard measurements yielded a mean value of 2030.90±0.97 μmol/kg (n=6), which

compares with 2030.66±0.60 μmol/kg (n=11) certified by SIO. We also prepared and analyzed sub-standards that were bottled into 125 mL glass vial bottles from a 20L bottle of filtered and poisoned offshore surface water in order to check the condition of the system and the stability of measurements every day. The resulting standard deviation form replicate analysis of 8 sub-standards was ±1.00 μmol/l.

Nitrous Oxide (N2O):
Samples for N2O analysis were drawn from the Niskin sampler into 125 mL glass vial bottles after an overflow of about 100 mL of the seawater. The samples were immediately poisoned with 50 μl of 50% saturated HgCl2 in order to restrict biological alteration prior to sealing the bottles. All samples were stored in a refrigerator before measurement, and were analyzed within 12 hours of collection. The concentration of N2O in seawater was determined using the Shimadzu GC14B gas chromatograph (carrier gas; pure N2 gas 40-50 mL/min., column: Molecular Sieve 5A 60/80 2m x 3ø) with 63 Ni electron capture detector on board. A purge-and-trap method and a headspace method were employed to concentrate N2O from seawater.

Purge-and-trap method:
Seawater was introduced into a measuring pipette with a volume of 100 mL by a pressurized headspace pure N2 gas (99.9998%). The measured volume was then transferred to the extraction vessel and N2O was extracted from the sample for 10 minutes by bubbling with the pure N2 gas (flow rate: 100 mL/min). After passing through the calcium chloride scrubber to remove water vapor, the evolved N2O gas was continuously induced to the Porapak Q (80-100 μm, 0.21 m) column and trapped onto the cooled (-80°C) column. After bubbling for 10 minutes, the column was heated at 120°C to desorb the N2O by the stream of the carrier gas (pureN2) and the desorbed N2O was introduced to the gas chromatograph.

Headspace method:
About 15 mL of headspace gas (N2) was introduced into a glass vial bottle by removing seawater with syringe. Subsequently, the bottle was stood in thermo stated water bath (40±0.5°C) for 3 hours in order to make an equilibration between gas phase and liquid phase. The N2O was taken from the headspace gas into a gas tight syringe and injected to the gas chromatograph.

Sulfur hexafluoride (SF6):
A sample for SF6 analysis was drawn from the Niskin sampler into 500 mL SCOTT DURAN glass bottle after an overflow of about 250 mL of the seawater. The bottle was sealed tightly and stored in a refrigerator before measurement. Samples were analyzed on board or land laboratory. SF6 in seawater was concentrated by using a

purge-and-trap method and determined by the HP 5890 series II gas chromatograph (column: RESTEK Molecular Sieve 5A (80-100 μm) 30 m x 0.53 mm) with non-radioactive electron capture detector (VICI, Pulsed discharge Detector (ECD mode)). Seawater was introduced into a measuring pipette with a volume of 480 mL by a pressurized headspace SF6-free N2 gas. The measured volume was then transferred to the extraction vessel and SF6 was extracted from the sample for 5 minutes by bubbling with the SF6-free N2 gas (flow rate: 350 mL/min). After passing through the calcium chloride scrubber to remove water vapor, the evolved SF6 gas was continuously induced to the Porapak Q (80-100 μm) column and trapped onto the cooled (-80ºC) column. After bubbling for 5 minutes, the column was heated at 80ºC to desorb the SF6 by the stream of the carrier gas (SF6-free pure N2) and the desorbed SF6 was introduced to the gas chromatograph. Nutrients The Bran+Luebbe continuous flow analytical system (Model TRAACS2000) was employed for nutrients analysis. The samples were draw into 50 mL polyethylene bottles from the Niskin sampler and stored in a refrigerator before measurement.

Nitrite (NO2-N):
Nitrite was determined by diazotizing with sulfanilamide and coupling with N-1 naphthyl-ethylenediamine (NED) to form a colored azo compound (wavelength : 550 nm, flow cell : 5 cm) Nitrate + Nitrite (NO3+NO2-N) : Nitrate in seawater was reduced to nitrite using a reduction tube (Cd-Cu tube). The reduced nitrate and nitrite were determined by same method as nitrite described above (wavelength: 550 nm, flow cell : 3 cm).

Silicate (SiO2-Si):
Silicate was determined by the molybdenum-yellow (wavelength :630nm, flow cell : 3 cm). Phosphate (PO4-P) : Phosphate was determined by the blue-blue method (wavelength : 880 nm, flow cell : 5 cm).

Ammonia(NH4-N):
Ammonia in seawater was determined by the indophenol method (wavelength : 630 nm, flow cell : 3 cm).

PH monitoring sensor:
High accuracy deep-sea pH sensor (RIITE pH sensor) is composed from pH sensor prove, pH data collect section, endurance pressure case, underwater cable and Lithium buttery. The size of pH sensor is 200mm in height and 85mm in diameter. PH sensor proves is composed from ISFET pH electrode and Chloride-Ion sensitive electrode for reference electrode. PH data collect section is data control base. It can accumulate on memory pH data changed from electrical signal to pH count by pH sensor prove with

temperature and time data. It can save upper 40,000 data. Endurance pressure case is made by titanium. PH electrode is used ISFET (Ion sensitive field effect transistor). ISFET is semiconductor made of p-type Silicone coated with SiO2 and Si3N4. Through this isolated coats, gate voltage Vg is impressed against reference electrode of Chloride-Ion sensitive electrode. Carrier density in the channel of semi-conductor layer changes of Vg. As impressed source-drain voltage Vd, higher carrier density causes higher current. Then, in proportion to H+ ion activity of the solution, interface voltage is caused to determine the current between source and drain. Before and after measurement, pH prove is calibrated by standard solution (2-aminopyridine: AMP: pH=6.7866, 2-amino-2-hydroxymethil-1,3-propanediol: TRIS: pH=8.0893) for proof of pH data. PH sensors are attached the flame of CTD carousel sampler, so measured pH value every 10 seconds during operation.

Particulate organic matter (POM):
POM was obtained from discrete depths using a rosette sampler with an attached CTD meter to take water samples (St.C05, C08 and C10). These were then filtered through a Whatman GF/F filters pretreated at 500°C for 5 hours. All samples were frozen at -60°C pending analysis.

Plankton:
Samples were collected by horizontal tows of meteorological observatory C net, 51 cm in diameter and with meshes of 335 μm (NGG52) (Stn.C05 and C08). Volume of water filtered through the net was determined with flow meter (Rigosha and Co., Ltd), mounted off-center in the mouth of the net. All samples were frozen at -60°C pending analysis.

Stable isotope analysis:
Samples will be thawed and rinsed quickly with distilled water. Organisms will be desiccated in a dry oven at 60°C until dry weight stabilized and be then ground to a fine powder. To avoid variance in $\delta^{13}C$ due to lipid content levels the solvent-extractable lipid fraction will be removed from a subsample by regrinding with a mixture of chloroform:methanol (2:1), filtration onto a Whatman GF/C glass fiber filter, rinsing with the chloroform/methanol sokution several times and subsequent redrying at 60°C over night for$\delta^{13}C$ analysis. The carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) ratios will be analyzed by IsoPrime stable isotope mass spectrometer, after sample combustion in an on-line Elemental Analyzer (Euro EA3024).

7.11 Mie scattering Lidar

(1) Personnel

Atsushi Shimizu (National Institute for Environmental Studies) On board personnel
Ichiro Matsui (National Institute for Environmental Studies)
Nobuo Sugimoto (National Institute for Environmental Studies)

(2) Objectives

Objectives of the observations and experiments during this cruise are to study distribution and optical characteristics of aerosols and clouds using a two-wavelength dual polarization lidar.

(3) Measured parameters

- Vertical profiles of backscattering coefficient at 532 nm and 1064 nm.
- Vertical profile of depolarization ratio at 532 nm.

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength dual polarization 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 100 mJ per pulse at 1064 nm and 50 mJ per pulse at 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 25 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 digital oscilloscope and stored on a hard disk with a computer. The lidar system was installed in a 20-ft container with the cloud profiling radar (CPR) of the Communications Research Laboratory (CRL). The container has a glass window on the roof, and the lidar was operated continuously regardless of weather.

(5) Results

Figure 7.11-1 shows the quick-look time-height indications of the range-corrected signal intensity at 532 nm during this cruise. The lower clouds at 600 m were continuously observed over western Pacific Ocean. Cirrus clouds were also frequently observed in an altitude range of 10 to 18 km. Aerosols were thin in the first half of the cruise corresponding to the weak surface wind. In the second half, a lot of rain drops from middle clouds were detected, and some of them evaporated before reaching the surface.

(6) Data archive

- Raw data

lidar signal at 532 nm (parallel polarization), lidar signal at 532 nm (perpendicular polarization)

lidar signal at 1064 nm, temporal resolution 10 sec., vertical resolution 6 m

- Processed data

cloud base height, apparent cloud top height, cloud phase, cloud fraction

boundary layer height (aerosol layer upper boundary height)

backscatter coefficient of aerosols, depolarization ratio

All data will be archived at National Institute for Environmental Studies, and submitted to JAMSTEC within 3-years.

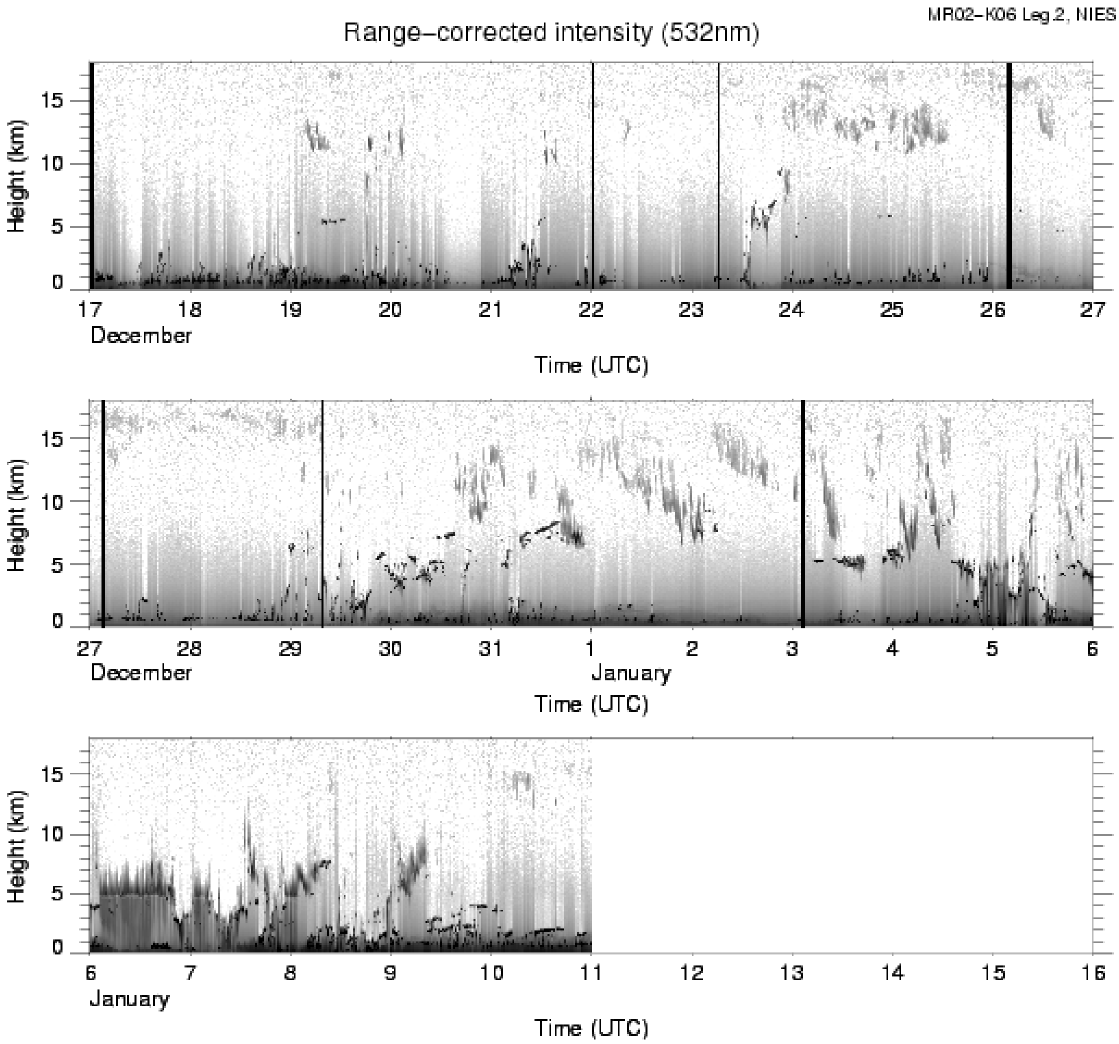

Fig. 7.11-1 Range-corrected signal at 532 nm

7.12 Surface Atmospheric Turbulent Flux

(1) Personnel

Wataru Tokunaga (GODI) : On-board collaborator

On-shore scientists:

Osamu Tsukamoto (Okayama University): Principal Investigator

Hiroshi Ishida (Maritime University of Kobe / Frontier Observational Research System for Global Change)

Kunio Yoneyama (JAMSTEC)

(2) Objective

For the understanding of 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.

(3) Methods

The surface turbulent flux measurement system consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI7500 is a CO2/H2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously. Photo 7.12-1 shows the installation of the instruments at the top of the foremast.

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

(4) Results

Data will be processed after the cruise at Okayama University.

(5) Data Archive

All data are archived at Okayama University, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Data Management Office.

Photo 7.12-1 Turbulent flux measurement systyem on the top deck of tforemast.

7.13 On-board observation for the ADEOS- II (AMSR) satellite data validation

(1) Personnel

Masayuki Sasaki	(NASDA/EORC*): Principle Investigator (not on board)
Yozo Takayama	(JMA/MRI**)

(2) Objectives

The satellite-borne microwave radiometers are the powerful device to obtain the spatial and temporal variation of the water vapor, cloud liquid water, etc, especially over the ocean where the ground-based observation is poor. To validate the products of AMSR (Advanced Mircowave Radiometer) / ADEOS-II, brand-new satellite-borne microwave radiometer, the ground-based vertically-pointed rain radar is installed on the vessel and continuous observation is carried out.

(3) Methods

The micro rain radar MRR-2 (METEK GmbH) and the microwave radiometer WVR26 (Radiometrics Co.) are used for this observation.

The radar is a compact 24 GHz FM-CW-radar for the measurement of profiles of drip size distribution and rain rates, liquid water content and characteristic falling velocity of the raindrops. The transmitter power is 50 mW. In this observation, the data is obtained every 60 seconds, at every 200-m range gate to 6000-m height.

The radiometer obtained brightness temperature data for the two frequency, 23GHz and 31GHz. The brightness temperature data is converted to the vertically integrated water vapor amount and cloud liquid water amount.

The observation is performed continuously from 17 December 2002 to, 12 January 2003.

(4) Preliminary Results

The observed data will be checked and analyzed after the cruise.

(5) Data Archive

The original data will be archived at NASDA/EORC, and will be submitted to JAMSTEC.

*NASDA/EORC: National Space Development Agency of JAPAN / Earth Observation Research Center.

**JMA/MRI : Japan Meteorological Agency / Meteorological Research Institute

7.14 Satellite observation with SeaWiFS for primary productivity research

(1) personnel

Ichio Asanuma[1], Souichiro Sueyoshi[2]

1: Earth Observation Research Center/NASDA

2: Global Ocean Development Inc.

(2) Objectives

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

(3) Methods

The High Resolution Picture Transmission (HRPT) receiving station on the R/V Mirai was operated to capture the HRPT signal from the OrbView-2 satellite automatically. The HRPT signal was decrypted following to the reception on the receiving system by a decryption key, which is assigned by the Goddard Space Flight Center (GSFC) of NASA for this research. The level-1A data were generated on the R/V. The higher product, chlorophyll-a distribution, will be generated at the laboratory using the SeaWiFS Data Analysis System (SEADAS) with the algorithms dedicated for the SeaWiFS. The MSL12 in the SeaDAS is the basic function to generate a chlorophyll-a distribution as a level-2 data. The chlorophyll-a distribution data will be applied for the time and depth resolved primary productivity model.

(4) Data

SeaWiFS data covers a period from Dec.16, 2002 to Jan.11, 2003

(5) Schedule

1) Level-1A reconstruction: by the end of January, 2003
2) Level-1A transfer to GSFC/NASA: by the end of January, 2003 (Duty of the receiving station)
3) Level-2 production: by the second week of February, 2003
4) Level-3 mapped data production: by the end of February, 2003.
5) Primary productivity trial: by the end of March, 2003.

(6) Data availability

A distribution activity of SeaWiFS data is regulated by the agreement between the NASA and JAMSTEC in 1993.

(7) Data list:

Following data list indicates the file name of level-1a data with the rule of notation;

Syyyydddhhmmss.L1A_HMIR.hdf.Z, where yyyy is a year, ddd is a Julian day of the year, hhmmss is a hour, minute and second when data started.

S2002351030820.L1A_HMIR.hdf.Z
S2002352021244.L1A_HMIR.hdf.Z
S2002352035408.L1A_HMIR.hdf.Z
S2002353025458.L1A_HMIR.hdf.Z
S2002354015755.L1A_HMIR.hdf.Z
S2002354033803.L1A_HMIR.hdf.Z
S2002355023840.L1A_HMIR.hdf.Z
S2002356014250.L1A_HMIR.hdf.Z
S2002356032102.L1A_HMIR.hdf.Z
S2002357022310.L1A_HMIR.hdf.Z
S2002358030526.L1A_HMIR.hdf.Z
S2002359020701.L1A_HMIR.hdf.Z
S2002360024822.L1A_HMIR.hdf.Z
S2002361015110.L1A_HMIR.hdf.Z
S2002362005544.L1A_HMIR.hdf.Z
S2002362023433.L1A_HMIR.hdf.Z
S2003002010253.L1A_HMIR.hdf.Z
S2003002024122.L1A_HMIR.hdf.Z
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S2003007024832.L1A_HMIR.hdf.Z
S2003009005445.L1A_HMIR.hdf.Z
S2003010013417.L1A_HMIR.hdf.Z
S2003011003930.L1A_HMIR.hdf.Z
S2003011021451.L1A_HMIR.hdf.Z

7.15 Aerosol Measurements

(1) Personnel

Co-workers not on board

Yuji Fujitani (Graduate school of Engineering, Hokkaido University) Graduate student
Tatsuo Endoh (Institute of Low Temperature Science, Hokkaido University): Associate Professor
Sachio Ohta (Graduate school of Engineering, Hokkaido University): Professor
Tamio Takamura (Center for Environmental Remote Sensing, Chiba University): Professor
Teruyuki Nakajima (Center for Climate System Research, University of Tokyo): Professor

(2) Objectives

Anthropogenic aerosols affect on climate by perturbing radiation budget through scattering and absorbing solar radiation, which is called the direct effect of aerosol. At present, uncertainty of radiative forcing due to greenhouse gases is 15%, whereas it lies in a factor of 2 of the direct aerosol forcing. As in The Third Assessment Report of IPCC in 2001, a chapter was spared about aerosols effect on climate, this problem had been regarded as important. The larger uncertainty of aerosol forcing comes from little available information about aerosol distribution of optical properties. It is most important to reduce the uncertainty is a knowledge of the areal distribution of the single scattering albedo and aerosol optical thickness.

There are few measurements, in particular, of aerosol optical properties over the Pacific Ocean, whereas this region is very important. Anthropogenic materials are increasingly emitted from Asian countries, and more amounts of aerosols may be transported to the Pacific Ocean. Thus, it is important to monitor the atmospheric environment in the East Asia and western Pacific Ocean. Satellite remote sensing is hoped for monitoring global aerosol distribution. For atmospheric correction of the remote sensing, surface measurements are indispensable.

During this cruise, we measured spatial distribution of aerosol optical properties to estimate radiative forcing by aerosol accurately and to do ground truth for satellite remote sensing.

(3) Methods

Sky Radiometer (POM-01MKⅡ; PREDE), equipped on deck, measures direct and aureole sun light intensity every 5min. The sensor provides optical thickness, Åangstrom exponent and size distribution of atmospheric aerosols.

(4) Results

Measurements were mainly conducted in fine day, the data are well acquired on Dec. 18, 21, 23, 24, 25, 27, 28, 29 in 2002, and Jan. 10, 11 in 2003. In the analysis, we must exclude the effect of cloud.

(5) Data archive

The data of skyradiometer are archived at Hokkaido University (Endoh and Ohta), University of Tokyo (Nakajima) and Chiba University (Takamura), and submitted to JAMSTEC within 3-years.

8.1 Ship’s Handling for Deployment TRITON buoy

(1) Personnel

Captain Masaharu Akamine, Master of R/V “ MIRAI ”
And Ship’s Crew

(2) Objectives

- **Deploy it surely and efficiently in the site of which a TRITON buoy is required**
- **Do not cause a kink in the mooring cable or ropes**

Results are analyzed from the standpoint of ship’s maneuvering to achieve two purposes that mentioned above, and the reference in the future is made.

(3) Observation parameters

- Ship’s position, course, speed
- Directions of the wind and the current, velocities of the wind and the current
- Vectors of the wind and the current, the resultant force
- Working hours
- Position of sinker

(4) Methods

(4.1) Measurement of the actual ship-movement

Measurement of the ship-movement at engine stopped is executed by a set-drift that is measured before deploying the TRITON buoy in order to know the appearance to which the receiving ship actually drifts in the external force influence beforehand. A direction and a velocity of the ship-movement in the external force influence is measured by a radio navigation device “ Sains” assembled by Sena Co., Ltd. Japan and a Doppler sonar “DS-30” assembled by FURUNO Electric Co., Ltd. Japan.

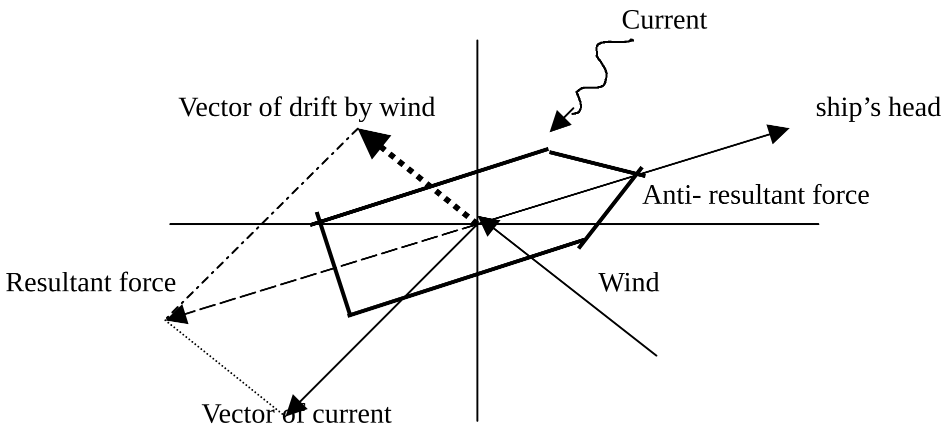
(4.2) Measurement of the wind and the current

The wind, the current, the wave, and the swell are mainly thought as an influence of the external force. Here, the wind and the current that can be quantitatively measured are investigated.

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

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

The vector resultant force is calculated by the wind and the current data in real-time according to the following vector diagram. The wind is transformed into the vector of the drift using an approximate formula given by some hydrodynamic tests.



(4.3) Ship's speed

According to the results measured in past voyages, on the deploy of the TRITON buoy, the ship's speed is set up so as to keep her speed on 2.5 ~ 4.5 knots at ship's through-the-water while the nylon ropes been has let out, to keep her speed on 1.5 ~ 2.5 knots at ship's through-the-water while the cable has been paid out, while the recovery buoys/releasers/sinker have been attached. In order to avoid their kink accident and to maintain a safety of the works, an average speed through all the works around 2.0 –3.0 knots at ship's through-the-water becomes one aim.

(4.4) Ship's course

The ship's course is expected by the vector calculation of the wind-drift and the current as indicated in (4.2), making reference to the data of the set-drift carried out before the deploying operation of the TRITON buoy.

If there is a great difference between the direction of the wind and of the current, the selection of her course shall be attached importance to a bigger one of the vector value and shall be in need of the direction of depth contour in the bathymetric map.

The cable/ropes are paid out right astern to improve safety and efficiency of the 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.

Because the ship is moved in opposite to the direction of the swell, it is necessary to consider the direction of the swell though it is difficult to calculate quantitatively.

The course to face the stream should be taken to avoid a long deploying distance, to handle the ship easily.

(4.4) Working hours for the deployment TRITON buoy

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

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

The distance between the TRITON buoy and the ship's stern is continuously measured with her RADAR installed in the center of the ship (about 80 meters from her stern).

The tension of the cable/the ropes streamed astern may be secondarily checked as compared the distance of radar with the length of the cable/ropes actually paid out from her stern.

The speed of the ship is adjusted so as not to increase much the difference in length between the two, checking the above-mentioned data and the cable/ropes tension measurement by the stern that is a primary means.

(4.5) Decision of the anchored position

The position of the sinker arrived at the seabed is fixed by a radio navigation device, the acoustic navigation device and the ship's radars.

The radio navigation device: "Sains" assembled by Sena Co., Ltd. Japan.

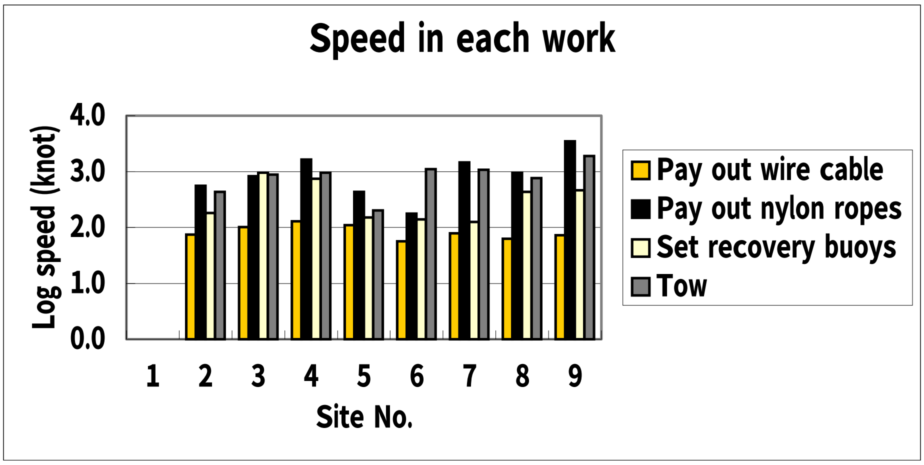
The acoustic navigation device: "SSBL processor (13kHz)" assembled by Oki Electric Co. Ltd. Japan.

The ship's radar: "JMA9000 X band" and "JMA 9000 S band " assembled by JRC Ltd.
"MM950 X & S band" assembled by Consilium Selesmar, Italy.

(5) Results

(5.1) Ship's speed

The results are shown in Table 8.1-1 and the following figure.



The TRITON buoy at site No.1 was not deployed due to rough sea.

The ship's speed is roughly divided into thee kinds of groups according to the result.

The first is the speed when paying out a wire cable, the second is the speed when setting the recovery-buoy, the releaser, etc. and the third is the speed when paying out the nylon rope except 40 meters of the sinker-rope and 240 meters of the rope between the recovery-buoys. If the tow work is executed, it is added to the third.

The shallower depth of the buoy deployment is, the smaller the speed difference of three groups is.

On her through-the-water basis, the first was from 1.8 knots to 2.1 knots, the second was from 2.1 knots to 3.0 knots and the third was from 2.2 knots to 3.5 knots. And in case of the tow, the ship’s speed was from 2.3 knots to 3.3 knots. The numerical value is not greatly different from the past one.

When the ship received the wind or the stream from her back, the ship’s speed showed the tendency to become fast in each.

On the past voyages, the experiment that finds out the optimum cable/ropes tension was conducted using the CTD sensor that were attached on the cable at 300 meters depth and 750 meters depth from the surface float. The depth of CTD sensor were measured and the catenary curve was found. The experiment result at this time becomes one standard as follows.

Events	The difference of the radar-distance and the actual length of the cable/ropes streamed astern
While paying out cable	Within 200 m
When setting releaser	Within 650 m

Timing of the measurement of the cable is time when connected part of the wire cable and nylon ropes just passed the ship’s stern. Since the length from the bottom of the sinker to the lower side of the releasers is about 50 meters, “length to releaser” is excluded from length of whole mooring system by 50 meters.

The radar-distance excludes the distance 80 meters from the stern to the radar position.

The measured values on this voyage are within the limits of the standard as shown in the table below.

Unit: meter

TRITON SITE NO.	01	02	03	04	05	06	07	08	09	Standard
Length of cable	750	750	750	750	750	750	750	750	750	
Radar's distance	-	698	698	698	679	679	679	698	698	
Difference		52	52	52	71	71	71	52	52	200
Length to releaser	4710	3480	2530	1935	1720	1430	4180	4350	4500	
Radar's distance	-	3272	2476	1846	1550	1383	4105	4198	4290	
Difference		208	54	89	170	47	75	152	210	650

The TRITON buoy at site No.1 was not deployed due to rough sea.

The tension condition of the paying out cable/ropes had been checked before the sinker was dropped, and the towing work had been carried out if necessary.

The tension condition of the cable and ropes were numerical values in the standard.

(5.2) Ship's course

The results are shown in Table 8.1-2.

The ship was handled so that the cable/ropes which are paid out lead right aft.

To make the ship's handling easy, the angle between the ship's course and the wind direction was made as small as possible so that the ship does not drift downwind steeply.

By the results of this time, about the course of the ship, a big difference is not recognized between the expectation and the reality**.**

(5.3) External force influence

To explain the external force of the wind and the current, the ship's course/speed when the TRITON buoy at site No.7 (TRITON "7") was deployed are shown in Fig. 8.1-1 and Fig. 8.1-2 as an example of temporal variation.

It can know the speed change of the ship in each work from this figure. Other TRITON buoy deployments show the same tendency in this.

About the course, at the stage of the start, the ship was too further off from her course. After having corrected the deviating with the thrusters, the deflection of the course became small.

X (longitudinal force) of the external force influences the speed of the ship. The current component of **X** is a difference between the OG speed and the log speed. It is proven by the data of TRITON "7" shown in Fig. 8.1-3. **Y** (lateral force) of the external force relates to the course of the ship. **Y** is a deviation from the course of the ship. This relation is proven by the data of TRITON "7" shown in Fig. 8.1-4. Actually, a numerical value of Fig. 8.1-4 is a reference level because a deviation from the course corrects by thrusters.

(5.4) Working hours

The results are shown in Table 8.1-1, Fig.8.1-5.

Except time paying out the nylon ropes, the times that the ship needs in each work show to be fixed nearly.

The mean time spent in each work is as follows;

The time that spent in paying out a wire cable 1 hour 09 minutes

The time that spent in setting recovery buoys, releasers and a sinker 15 minutes

(Excluding the time spent excessively for towing a sinker) Total 1 hour 24 minutes

The numerical value that divided the length of total nylon ropes by Y of the following formula is the time that spent in paying out nylon ropes

Y = 0.61 x X + 1600 m (by recurrence type to lead from the results shown in Fig. 8.1-5)

H = X/Y

Where, X: Length of total nylon ropes except 40 meters of the sinker-rope and 240 meters of the rope between recovery-buoys (unit: meter)

H: The time spent in paying out nylon ropes (unit: hour)

The numerical value in this formula is almost the same one at the time of last MR02-K02. For example, in case of site No.7, it is substituted for X because the length of total nylon ropes is 3200 meters, the answer of 0.9 hours is obtained.

(5.5) Sinker's position

What is necessary is just to maneuver as one standard, so that the ship may come to the buoy mooring site point when attaching the releaser exactly. Namely a sailing distance to the sinker dropped position from the mooring point is the distance to which the sinker returns.

The difference between the position of **the sinker dropped** and the position of **the sinker reached the seabed** is shown in Table 8.1-3.

An approximate formula is given with these records. The distance obtained by this formula shall be added to the necessary distance for the deployment of the TRITON buoy in order to bring the sinker up on the site in the required depth.

Table 8.1-3 shows that the direction from the position of **the sinker dropped** to the position of **the sinker reached the seabed** is almost the same as the course sailed before the ship drops the sinker.

(5.6) Required depth

The depth of water of the position in which the TRITON buoy was actually moored with demanded depth of water is shown below.

Site No.	Actual	Demanded	Difference (%)
1	Cancel	4840 m	
2	3600 m	3600	0 m (Nil)
3	2577	2575	2 m (0.1)
4	1952	1950	2 m (0.1)
5	1748	1750	2 m (0.1)
6	1522	1510	12 m (0.8)
7	4282	4275	7 m (0.2)
8	4490	4490	0 m (Nil)
9	4475	4480	5 m (0.1)

a ratio to actual

The TRITON buoy at site No.1 was not deployed due to rough sea.

The depth of water was measured by a SEA-BEAM 2000 with depth accuracy within 0.5%. About all other than TRITON buoy at site No.6, the difference between the actual depth and the demanded depth was within the 0.5 % depth accuracy.

It is said it is quite no problem because the depth-difference is within 15 meters, and it is deeper than the demanded depth for the TRITON buoy at site No.6.

The draft checks of all buoys were performed by the appearance inspection after the mooring system had been anchored to the seabed, and it was confirmed that they are in good state.

(5.7) Distance for Deployment TRITON buoy

Results are shown in Table 8.1-1,8.1-2 and Table 8.1-3.

The following procedure was adopted before deploying the TRITON buoy to decide the deploy distance of it.

A. The deploy speed in the ship's through-the-water is obtained referring to the data investigated last time.

B. Among the external force influences, the current velocity which greatly influences the speed in the ship's over the ground is calculated.

The cosine of the angle between the ship's course and the current direction multiplied by the current velocity is the amount of the current influence.

The current data is investigated deliberately before the buoy deploys, and obtained according to the forecast value.

C. A – B = the deploy speed in the ship's over the ground.

D. The forecast of the deploying hours that referred to past data is multiplied by the speed shown in C.

E. The amount that the sinker regresses is obtained by the latest approximation formula shown in (5.5) of this report.

F. The numerical value of E is added to the numerical value calculated by D, the deploy distance is found.

The deploying work was carried out according to the deploying distance mentioned above. The result is shown in Table 8.1-2.

There is no a big difference between the realities and the expectation.

(7) Data archive

All data will be archived on board. Following raw data is recorded as a constant format and will be submitted to the DMO of JAMSTEC.

Date	JST(+9h)	Latitude	Longitude	Through the water		Over the ground	
				Course	Speed	Course	Speed
				degree	knot	degree	knot
2002/12/19	7:25:00	05-00.80270N	147-05.56010E	229	1	252	0.2
2002/12/19	7:26:00	05-00.80190N	147-05.55360E	230	1.2	262	0.4
2002/12/19	7:27:00	05-00.79800N	147-05.54270E	229	1.4	251	0.7

Relative wind		External force		Wind		Current	
Direction	Velocity	Direction	Speed	Direction	Velocity	Direction	Velocity
Degree	knot	Degree	KnAot	Degree	m/s	degree	knot
-163	21.6	303	0.1	57	11.4	51	0.9
-164	13	42	0.1	57	7.3	55	0.7
-157	16.7	283	0.1	60	9.2	52	0.7

About the relative wind, the sign minus means the case where the wind is received to the portside.

(8) Remarks

This time, the points in which it had a hard time on the standpoint of the ship's handling were the current and the wind to have changed suddenly, and the external force by the swell to have influenced, while deploying TRITON buoys. These measures are to have enough room in the deployment distance of the buoy, to reduce the angle between the direction of the swell and the course of the ship, and to adjust the speed of the ship carefully.

Fig.8.1-1 An example of temporal variation of External Force Influence (Site No.7)

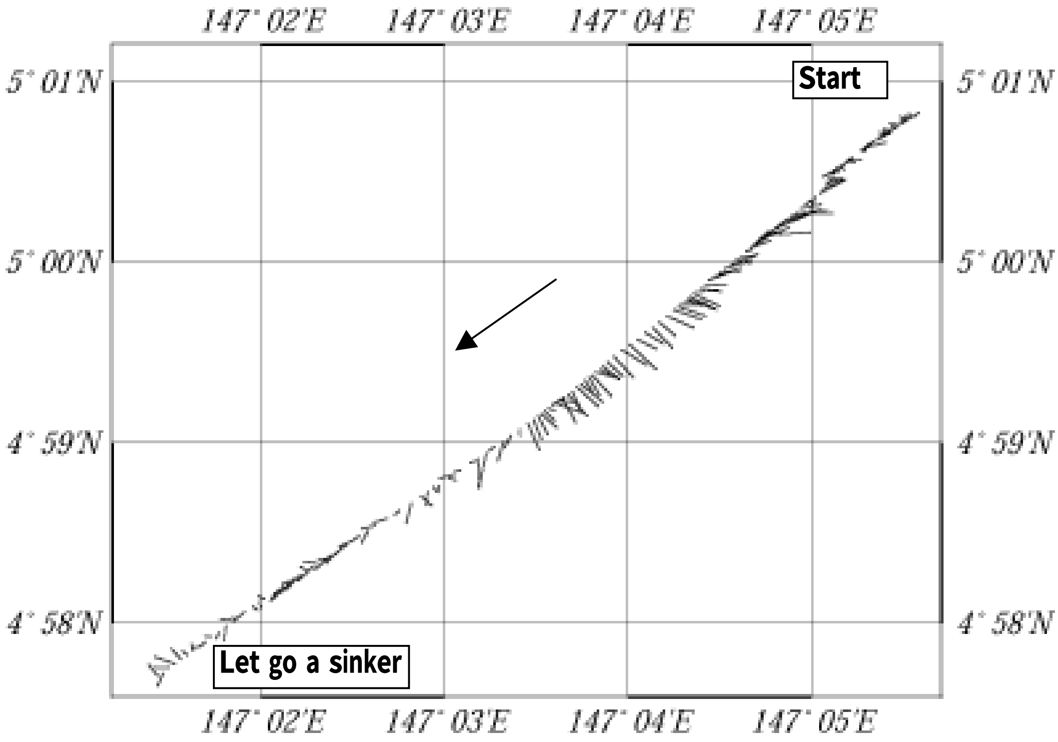


Fig. 8.1-2 An example of temporal variation of Comparison between Log & OG (Site No.7)

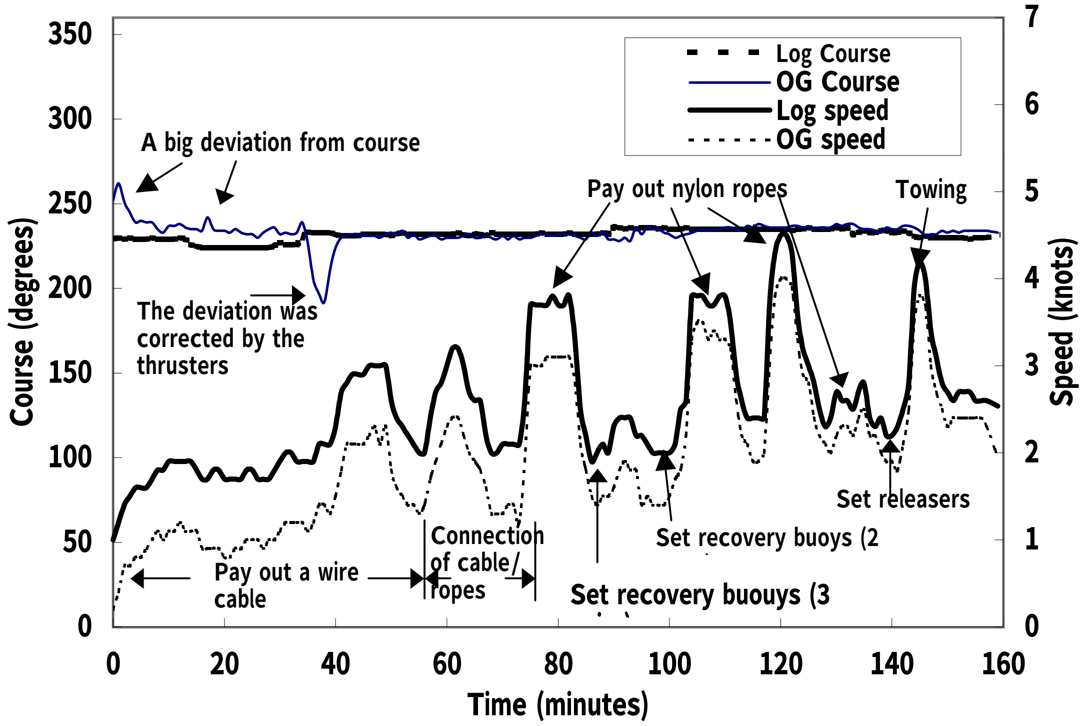


Fig. 8.1-3 An example of temporal variation of difference between Log speed/OG speed (Site No.7)

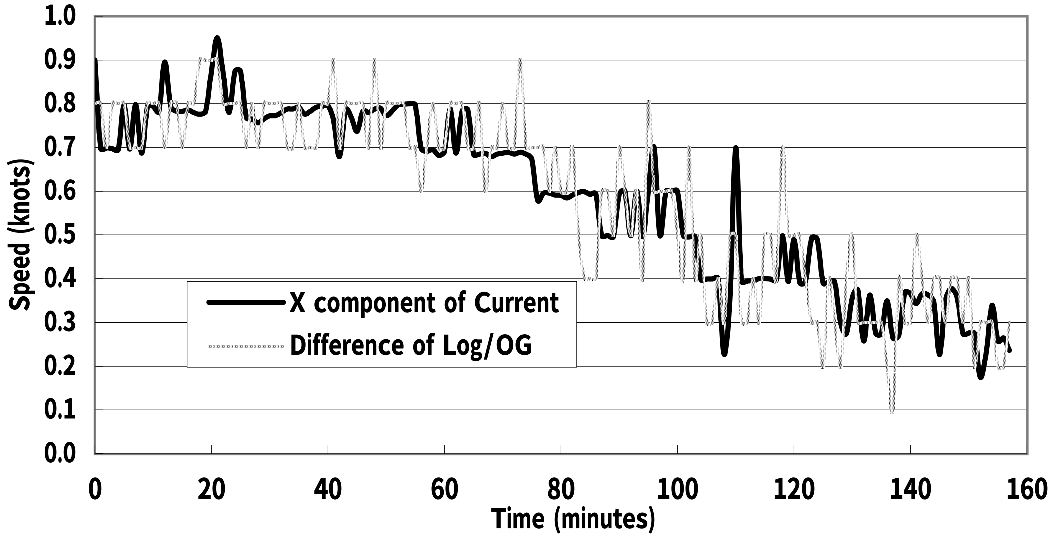


Fig. 8.1-4 An example of temporal variation of difference bet. Log Course/OG Course (Site No.7)

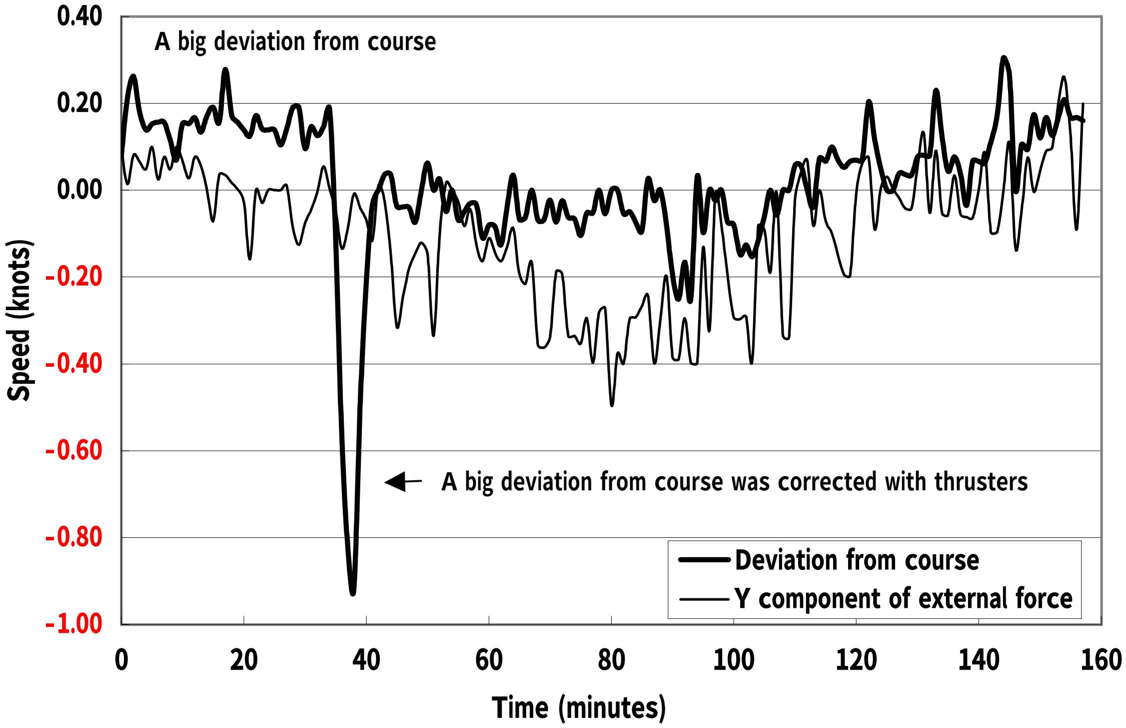
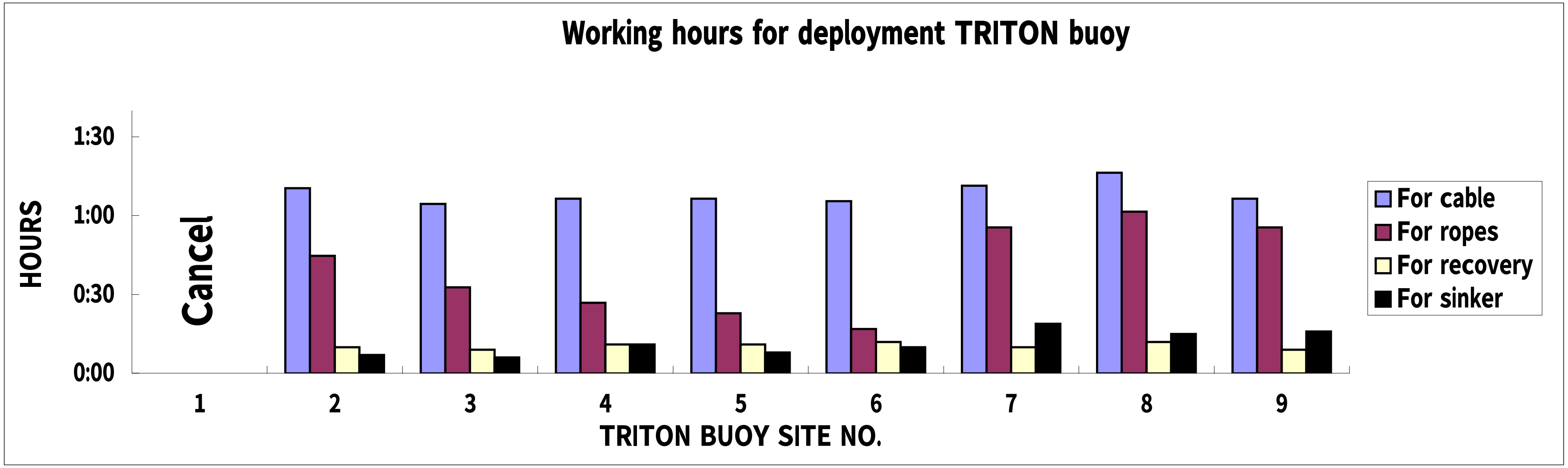
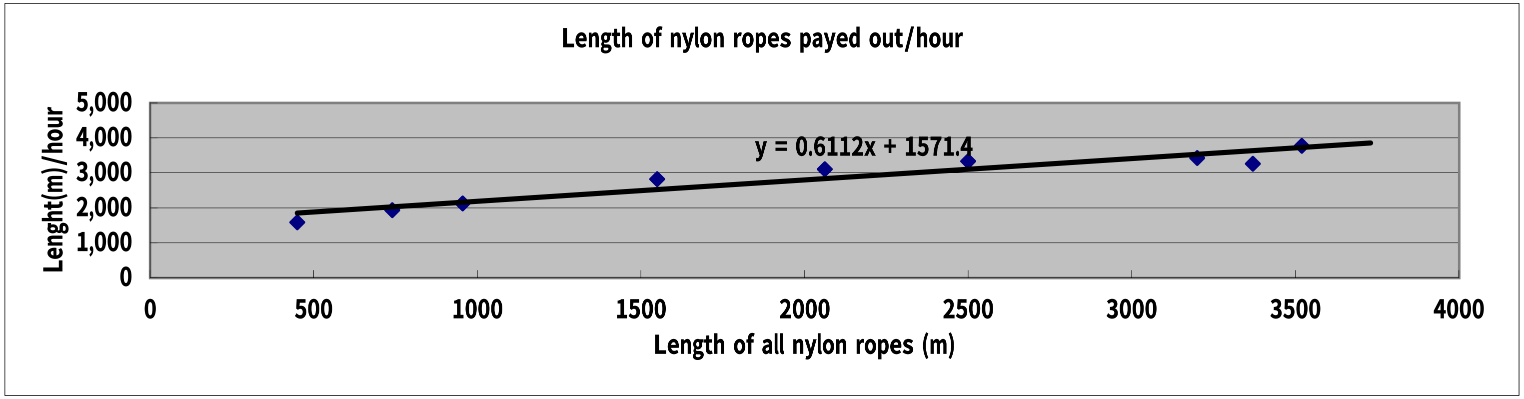


Fig. 8.1-5 SUMMARY OF WORKING TIME FOR DEPLOYMENT TRITON BUOY ON MR02-K06 leg 2



Remarks; 1) Time spent for recovery buoy includes time for pay out a nylon rope between recovery buoys.
2) As for "4, "Hours for cable" excludes 48 minutes consumed in surplus for installing the fairing (300 m).
3) Length of the nylon ropes was different depending on the site depth.
4) TRITON buoy at site No.1 was not deployed due to rough sea..

As for the work for the nylon ropes with which working hours are different in proportion to the length, a following regression formula is derived from the lenghth of the nylon ropes paid out per hour.



Y (meter/hour) = 0.61 x X + 1600 meters, H (hour) = X / Y

Where, Y : Length of the nylon ropes sent out/hour
X : The"length of all the nylon ropes" means the one except the 40 m sinker rope and the 240 m rope between recovery-buoys
H : Working time needed to pay out the nylon ropes (unit:hour)

Table 8.1-1 SUMMARY OF WORKING TIME FOR DEPLOYMENT TRITON BUOY ON MR02-K06 leg 2

SITE No.	1	2	3	4	5	6	7	8	9	
Required depth(m)	4840	3600	2575	1950	1750	1510	4275	4490	4480	
Location	8N,156E	5N,156E	2N,156E	0,156E	2S,156E	5S,156E	5N,147E	2N,147E	0,147E	
Works Date		6-Jan	4-Dec	2-Jan	30-Dec	28-Dec	19-Dec	21-Dec	24-Dec	
Com'ced		8:20	8:31	8:42	8:16	8:17	8:25	8:17	8:22	
Buoy into sea		8:30	8:42	8:52	8:26	8:27	8:28	8:28	8:31	
Set 250m Sensor	C	8:50	9:02	9:46	8:45	8:47	9:01	8:50	8:49	
Set 500m Sensor	A	9:01	9:11	10:07	8:56	8:58	9:10	9:02	9:00	
Set 750m Sensor	N	9:10	9:20	10:19	9:06	9:07	9:21	9:20	9:11	
Pay out Nylon Rope	C	9:31	9:36	10:37	9:23	9:23	9:37	9:34	9:29	
Set Recovery Buoy	E	9:46	10:03	10:59	9:41	9:37	9:57	9:52	9:43	
Set Recovery Buoy	L	9:56	10:12	11:10	9:52	9:49	10:07	10:04	9:52	
Pay out Nylon Rope		9:56	10:12	11:10	9:52	9:49	10:07	10:04	9:52	
Set Releaser		10:26	10:18	11:15	9:57	9:52	10:43	10:48	10:34	
S/B sinker		10:32	10:23	11:20	10:02	9:58	10:48	10:52	10:39	
Let go sinker		10:33	10:24	11:26	10:05	10:02	11:02	11:03	10:50	Average
for fairing etc.				0:48						
H for cable		1:11	1:05	1:07	1:07	1:06	1:12	1:17	1:07	1:09
o for ropes		0:45	0:33	0:27	0:23	0:17	0:56	1:02	0:56	0:39
u for recovery B'y		0:10	0:09	0:11	0:11	0:12	0:10	0:12	0:09	0:10
r for sinker		0:07	0:06	0:11	0:08	0:10	0:19	0:15	0:16	0:11
Total		2:13	1:53	2:44	1:49	1:45	2:37	2:46	2:28	2:10
Length of all ropes(m	3730	2500	1550	955	740	450	3200	3370	3520	2,062
Length of ropes(m/h)		3,333	2,818	2,122	1,930	1,588	3,429	3,261	3,771	3,103
D for cable (mile)		1.71	0.61	3.04	2.22	2.21	1.63	1.69	1.56	1.83
I for ropes (mile)		1.84	0.81	1.21	0.99	0.71	2.45	2.58	2.87	1.68
s for recovery (mile)		0.28	0.23	0.43	0.39	0.48	0.26	0.43	0.33	0.35
t for sinker (mile)		0.24	0.15	0.45	0.3	0.55	0.79	0.6	0.75	0.48
Total (mile)		4.07	1.8	5.13	3.9	3.95	5.13	5.3	5.51	4.35
S for cable (knot)		1.4	0.6	1.6	2.0	2.0	1.4	1.3	1.4	1.6
p for ropes (knot)		2.5	1.5	2.7	2.6	2.5	2.6	2.5	3.1	2.5
ee for recovery(knot)		1.7	1.5	2.3	2.1	2.4	1.6	2.2	2.2	2.0
d for sinker (knot)		2.1	1.5	2.5	2.2	3.3	2.5	2.4	2.8	2.5
Av. OG speed (knot)		1.8	1.0	1.9	2.1	2.3	2.0	1.9	2.2	2.0
Av. Log speed(knot)		2.4	2.4	2.4	2.2	2	2.5	2.4	2.7	2.4

Remarks; 1) Time spent for recovery buoy includes time for pay out a nylon rope between recovery buoys.
2) As for "4, "Hours for cable" excludes 48 minutes consumed in surplus for installing the fairing (300 m).
3) Length of the nylon ropes was different depending on the site depth.
4) TRITON buoy at site No.1 was not deployed due to rough sea..

Table 8.1-2 SUMMARY OF SHIP'S HANDLING FOR DEPLOYING TRITON BUOY ON MR02-K06 leg 2

Site			Course			Speed			Deploy dist			Wind		Current		Vector				Depth	Work- Hours	
No.	Location	Date	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Direct.	Velocity	Direct.	Velocity	Direct.	speed	C.Co.	X.C.F.	(Actual)	Exp.	Act.
1	8N,156E					TRITON buoy at site No.1 was not deployed due to rough sea																
2	5N,156E	6-Jan	175	175	0	1.7	1.8	-0.1	4.2	4	0.1	30	8	355	0.6	42	0.3	55	-0.6	3600(3600)	2:28	2:12
3	2N,156E	4-Jan	140	142	-2	0.9	0.9	-0.1	2.2	1.8	0.4	20	6.5	320	1.4	-64	0.9	110	-1.4	2565(2565)	2:10	1:52
4	0,156E	2-Jan	0	0	0	1.9	1.8	0.1	4.8	4.8	0.0	25	1.7	185	0.5	-6	0.6	7	-0.5	1950(1952)	2:58	2:38
5	2S,156E	30-Dec	135	135	0	1.9	2.1	-0.2	3.7	3.8	-0.1	10	5.0	35	0.3	-31	0.4	314	-0.1	1750(1748)	1:49	1:46
6	5S,156E	28-Dec	0	1	-1	2.3	2.2	0.1	3.8	3.7	0.1	0	3	0	0.3	0	0.1	180	0.3	1510(1522)	1:36	1:41
7	5N,147E	19-Dec	235	233	2	2.1	2.0	0.1	4.9	4.8	0.0	50	7.5	60	0.5	-60	0.1	348	-0.5	4275(4282)	2:10	2:23
8	2N,147E	21-Dec	120	119	1	1.9	1.9	0.1	4.7	4.9	-0.1	110	4.7	320	0.5	21	0.8	125	-0.5	4490(4490)	2:16	2:35
9	0,147E	24-Dec	80	80	0	2.0	2.2	-0.2	4.8	4.9	-0.1	25	6.0	260	0.5	32	0.9	33	-0.5	4480(4475)	2:15	2:17
Unit			deg.	deg.	deg.	knot	knot	knot	mile	mile	mile	deg.	m/s	deg.	Knot	deg.	knot	deg.	knot	meter	Hours	Hours

Remarks: Vector means the resultant force of the wind-drift and the current. Exp.=Expectation, Act.=Actual, Diff.=difference, The working hours means the actual hours for all the work excluding the work for towing the sinker, Dist.=Distance, Direct.=Direction, C.CO=Calculation Course, deg.=degree. X.C.F.=X Component of the current force against ship's course.The course is shown on the course made good basis and the speed is on her over the ground basis. Both of "Speed"&"Deploy dist" are figures except the work for towing the sinker.

Each external force shows the direction of the wind and the current that have prevailed in the site over a period of the buoy deployment, the velocity of them that is the average at the period. The expectation other than the course referred to the last numerical vale.

1) As for TRITON "4", it took the excessive time for 48 minutes to install fairings in the range of 300 meters of the wire cable so that the ship needed to run 1.0 miles extra compared with the usual distance.

2) The ship towed the sinker to each dropped position. Time and the distance towed respectively are as follows;

Site No.	No.2	No.3	N0.4	No.5	No.6	No.7	No.8	No.9
Minute	1	1	6	3	4	14	11	11
Miles	0.03	0.03	0.33	0.13	0.25	0.29	0.45	0.6

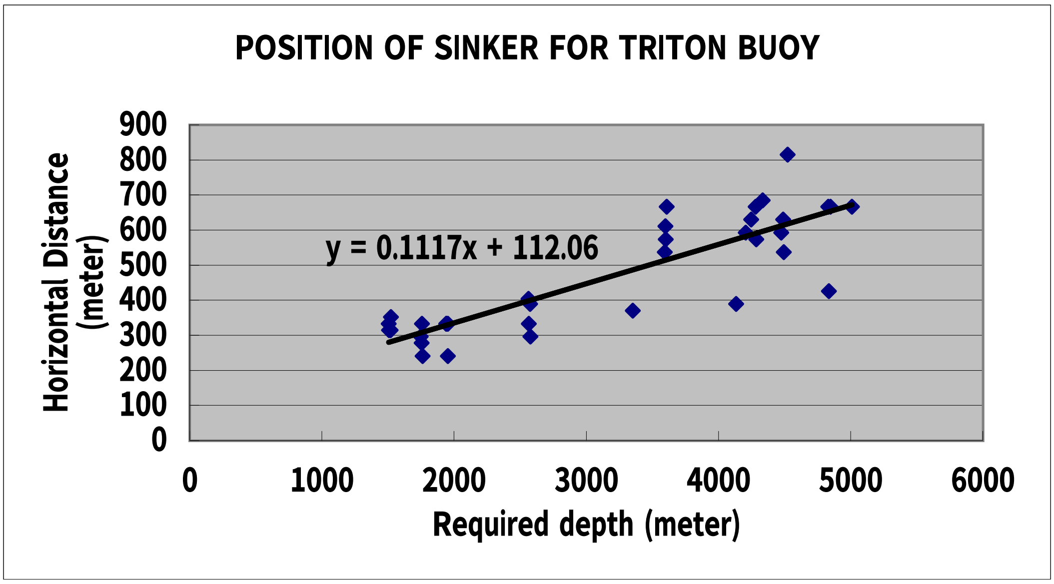
3) As for site No.3, the deployment distance between "act." and "exp." is larger than other one. The reason is that the work ended earlier than the first expectation.

Table 8.1-3 HORIZONTAL DISTANCE OF DROPPED POSITION AND ANCHORED POSITION DURING MR02-K06 leg 2

Site No.	position		Depth (meter)	Distance (meter)	Direction (degree)	Ratio to depth
	Let go sinker	Fixed				
1	TRITON buoy at site No.1 was not deployed due to rough sea					
2	5-01.30N 155-57.98E	5-01.62N 155-58.06E	3600	611	14 <185>	17%
3	2-02.22N 156-01.25E	2-02.38N 156-01.12E	2575	389	321 <140>	15%
4	0-00.52N 156-02.46E	0-0039N 156-02.49E	1952	241	167 <352>	12%
5	2-01.18S 155-57.59E	2-01.06S 155-57.49E	1748	296	320 <135>	17%
6	5-01.75SS 156-01.51E	5-01.94S 156-01.51	1522	352	180 <000>	23%
7	4-57.71N 147-01.45E	4-57.91N 147-01.75E	4282	667	57 <232>	16%
8	2-04.31N 146-57.35E	2-04.51N 146-57.07E	4490	630	306 <123>	14%
9	0-03.46N 147-00.95E	0-03.45N 147-00.63E	4475	593	268 <085>	13%

<>final course

According to the following chart, a horizontal distance between a position of the sinker dropped and a position of the sinker arrived at the seabed is approximated.
X = the required depth, Y = the distance in which the sinker regresses.



The above mentioned graphic chart includes data at past voyages.

8.2 Ship's Handling for recovery TRITON buoy / Sediment-traps

(1) Personnel

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

(2) Objectives

It aims at investigating the recovery work of the mooring systems such as the TRITON buoy etc. from the standpoint of the ship's handling.

(3) Observation parameters

- Movements of the recovery buoy/float and the sediment trap released from the seabed
- Ship's position, course, speed
- Directions of the wind/the current/the swell, velocities of the wind/the current

(4) Methods

(4.1) Measurement of the actual ship-movement

Measurement of the ship-movement at coming close to the buoy and float 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.

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

The releaser is operated with an acoustic navigation device (with elevator for transmission and reception device) which is made by Oki Electric Co., Ltd. Japan.

In case of the sediment trap mooring system, the releaser is operated with a transducer made by Nichiyu-Giken Co. Ltd.

(5) Results

(5.1) Movement of the mooring systems released from the seabed

The results are shown in Fig.8.2-1 ~ Fig.8.2-8 and these are characterized as follows.

(a) The ship was located downwind or downstream on a distance of 250 - 500 meters from the TRITON buoy or the mooring point of the sediment trap.

The "Enable" signal was sent with the acoustic navigation device or the transducer and the signal reception was confirmed.

(b) After recovery buoys of the TRITON mooring or a top buoy/glass balls for the sediment trap were released from the seabed by the acoustic navigation device or the transducer, the recovery buoys of the TRITON mooring rose to the sea surface in the point measured with the acoustic navigation device.

The top buoy for the sediment traps has surfaced from the moored point to the point of 870 meters in the horizontal distance by 308 degrees. This bearing is unrelated in the direction of the wind and the current at this time. This position is near the point where the sinker was dropped when this sediment traps was deployed on 17th March 2002.

It seems that there was a difference between the position of the sinker dropped and the moored position that was decided by the transducer's measuring after the sediment traps had been deployed.

In the sediment-trap mooring system, generally though the position of **the sinker dropped** is almost same as the position of **the sinker reached the seabed**, last time, since the cross bearing for the position fix by the transducer was poor, the difference was among two.

(c) A top-buoy of each mooring-system was drifted with the wind, the current and the swell. When the direction of the wind, the current and the swell conflicted, it drifted according to strong one.

(d) It makes a special mention that the direction of the swell greatly influenced the drift of each mooring-system when the wind and the current are little.

(5.2) How to approach the buoy/the float

The results are illustrated in Fig.8.2-1 ~ Fig.8.2-8 and the following matters are pointed out.

(e) When the ship approached buoys etc, the prow faced to the wind in order to lessen the external force influence of the wind. In addition the ship was maneuvered so as to be located in the lee of buoys/floats.

The influence of the current after the buoy etc. surfaced needs not to be considered too much because the ship drifts with the buoy etc.

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

(g) The work to catch a surface buoy or a top buoy was done with the working boat.

(h) When the working boat was lowered, and the working boat was drawn up, the ship made the lee to keep calm water, an ample berth for it.

(i) While recovering mooring ropes/cables, the ship was steered so that they might be led right astern regardless of the direction of the wind and the current.

(5.2) Working hours for recovery the buoy/Sediment-trap mooring systems

The result is shown in Fig.8.2-9, Table 8.2-1, and the following matters are pointed out.

(a) It is not great difference in the time required each to work in the recovery of each TRITON buoy.

The following matter is recorded as a topic.

① About the TRITON buoy at site No.9, the working boat lowered 10 minutes earlier to remove the rope unlawfully installed in the tower of the buoy. This extra time was absorbed by the other work, and there was no delay finally. In addition a short rope was unlawfully connected with TRITON buoys at site No.3, 4 and 5 respectively. There is no time loss respectively.

② Fishing lines got entangled in the wire cables/nylon ropes of TRITON buoys at site No.4, 7 and 8. It did not cause the delay of working hours.

③ Nylon ropes of TRITON buoys at site No.4, 5 and 6 were twined around the recovery buoys of themselves. There is no big delay about all.

④ About the TRITON buoy at site No.4, in order to remove the fairing installed the wire cable (300 meters in length), the excessive time for about 24 minutes was needed

⑤ As for the working time for the recovery of the nylon ropes that have different lengths, proper time consumption was performed according to each length.

(b) About the working hours of the recovery sediment-trap, it compared with the actual result in MR02-K02 that performed recovery work using the working boat. The time consumed to each work was roughly same.

As for the recovery working hours of Sediment-traps in this site, 2 hours and about 30 minutes are expected if there are neither a big external force influence nor a trouble.

(6) Data archive

All data will be archived on board.

(7) Remarks

It makes a special mention the external force influence of the swell was large while recovering the TRITON buoy system. Because an abnormal tension is not given to the wire cable and the nylon ropes that have been recovered, it is necessary to adjust the speed of the ship carefully.

TRITON buoys at site No.1 and No.2 were not able to be recovered due to rough sea.

Fig. 8.2-1 FIGURE OF RECOVERY BUOY

Triton buoy Site number: 7 (5N, 147E)

Date: 20th Dec. 2002

Wind: <095> 6.7 m/s, Current: <045> 1.2 knot

Swell: NE, Wave height: 1.9m, Weather: c

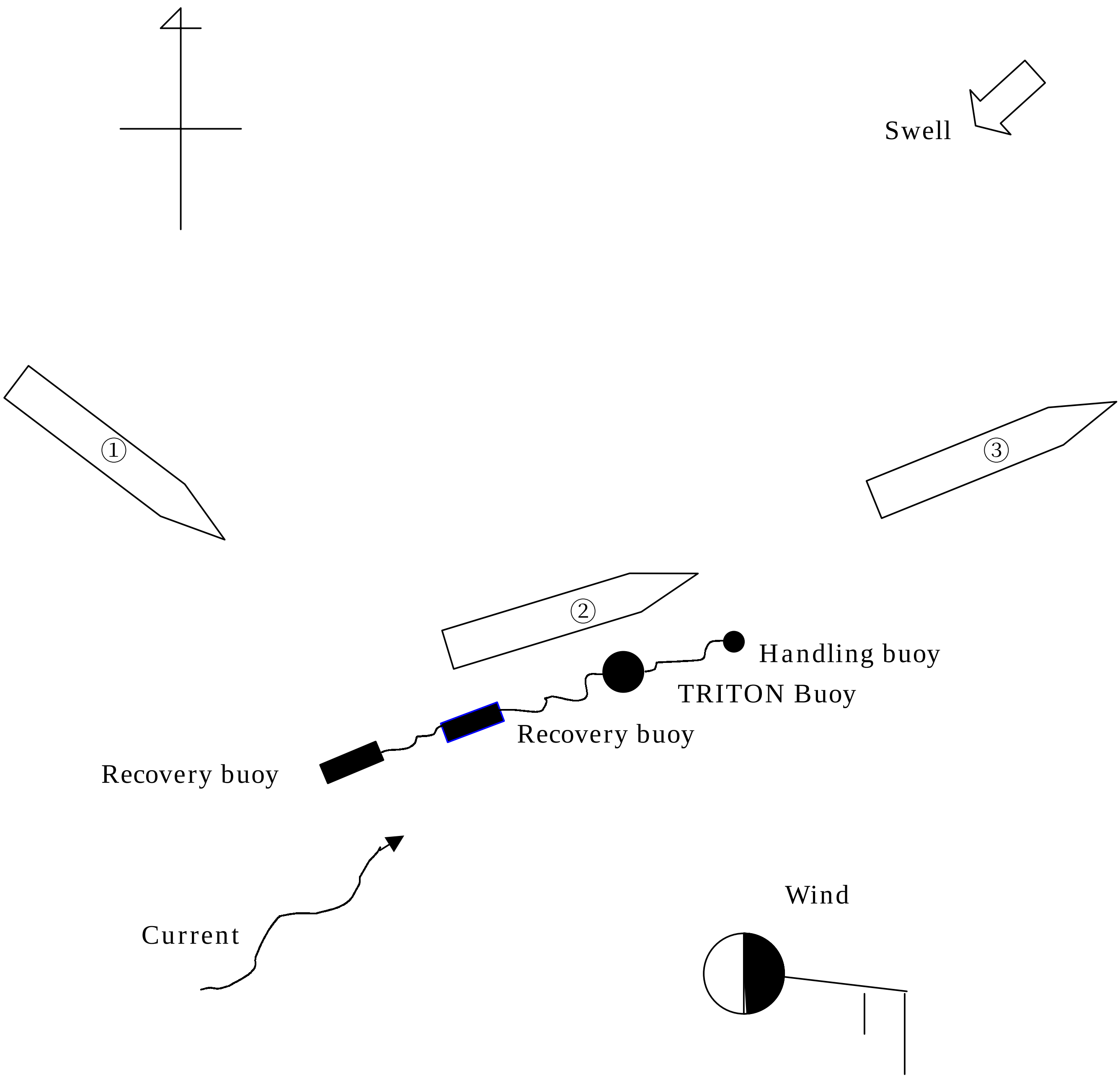


Fig. 8.2-2 FIGURE OF RECOVERY BUOY

Triton buoy Site number: 8 (2N, 147E)

Date: 22nd Dec. 2002

Wind: <070> 4.5 m/s, Current: <310> 0.5 knot

Swell: NNE, Wave height: 1.6 m, Weather: bc

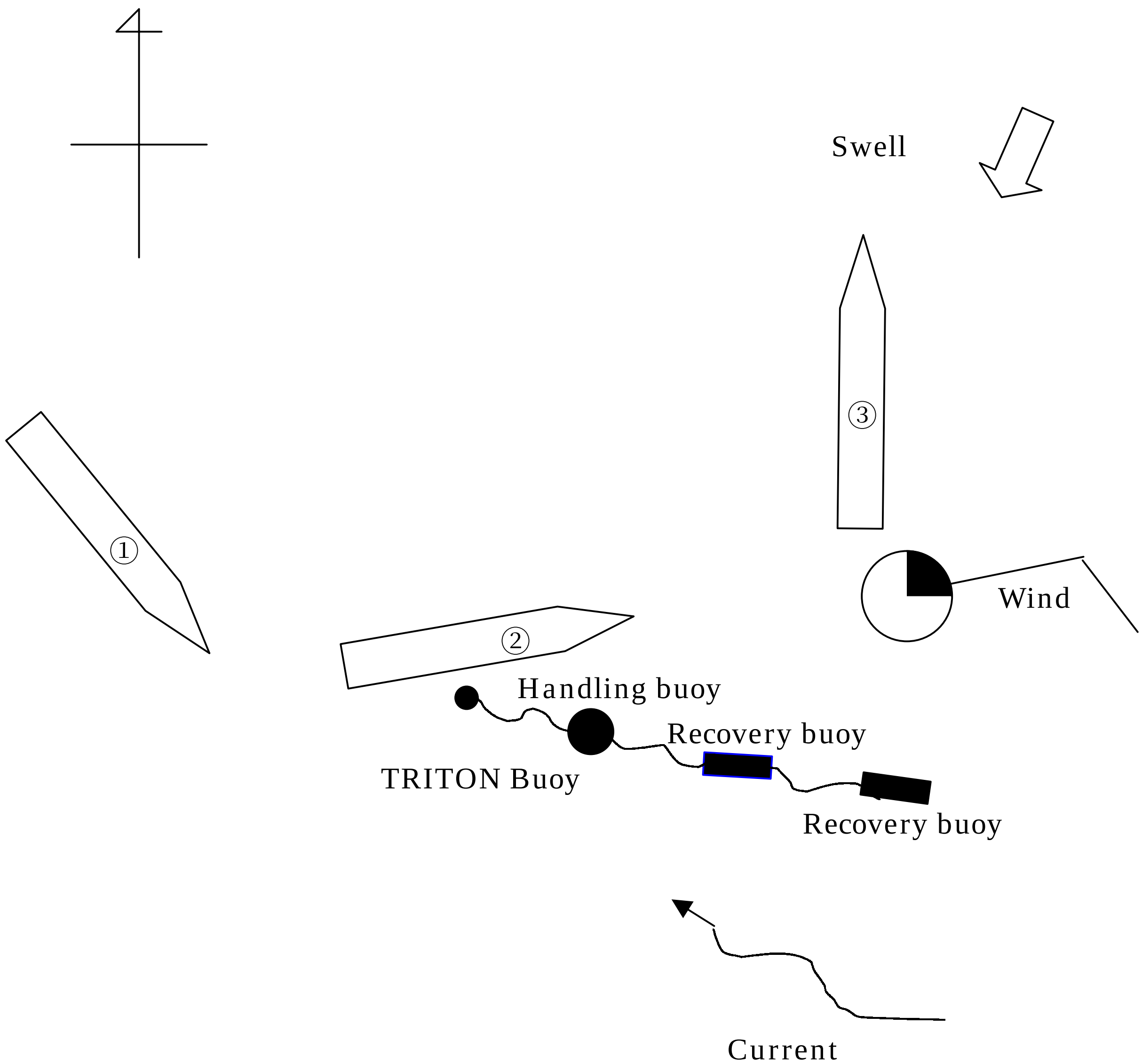


Fig. 8.2-3 FIGURE OF RECOVERY BUOY

Triton buoy Site number: 9 (0, 147E)

Date: 25th Dec. 2002

Wind: <090> 2.3 m/s, Current: <300> 0.4 knot

Swell: NNE, Wave height: 1.3 m, Weather: bc

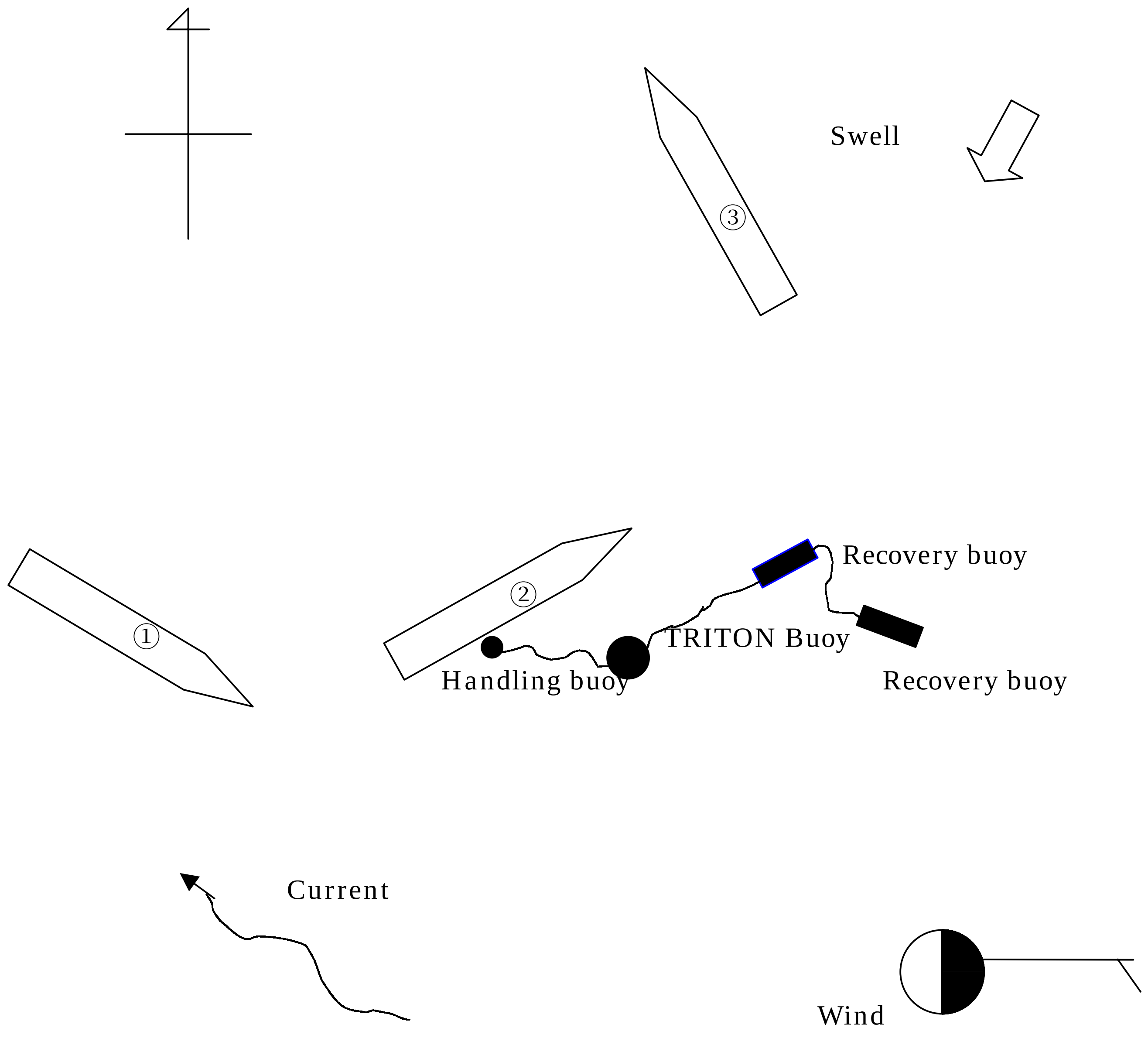


Fig. 8.2-4 FIGURE OF RECOVERY BUOY

Triton buoy Site number: 6 (5S, 156E)

Date: 29th Dec. 2002

Wind: <300> 5.2 m/s, Current: <350>0.8 knot

Swell: North, Wave height: 1.3 m, Weather: bc

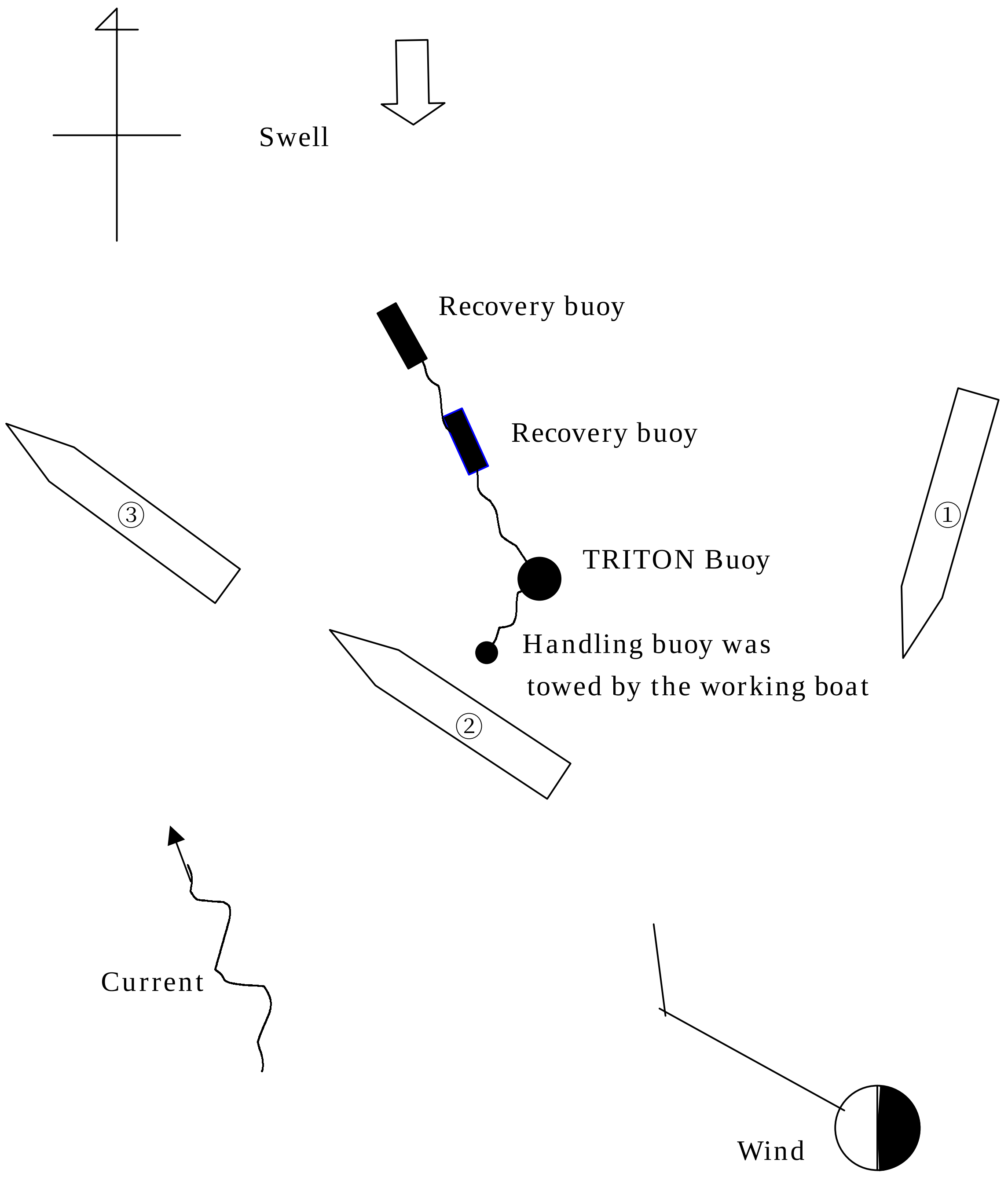


Fig. 8.2-5　　FIGURE OF RECOVERY BUOY

Triton buoy Site number: 5　(2S, 156E)

Date: 31st　Dec.　2002

Wind: <010> 5.8 m/s, Current: <160>0.8 knots

Swell: NNE, Wave height: 1.8m, Weather: c

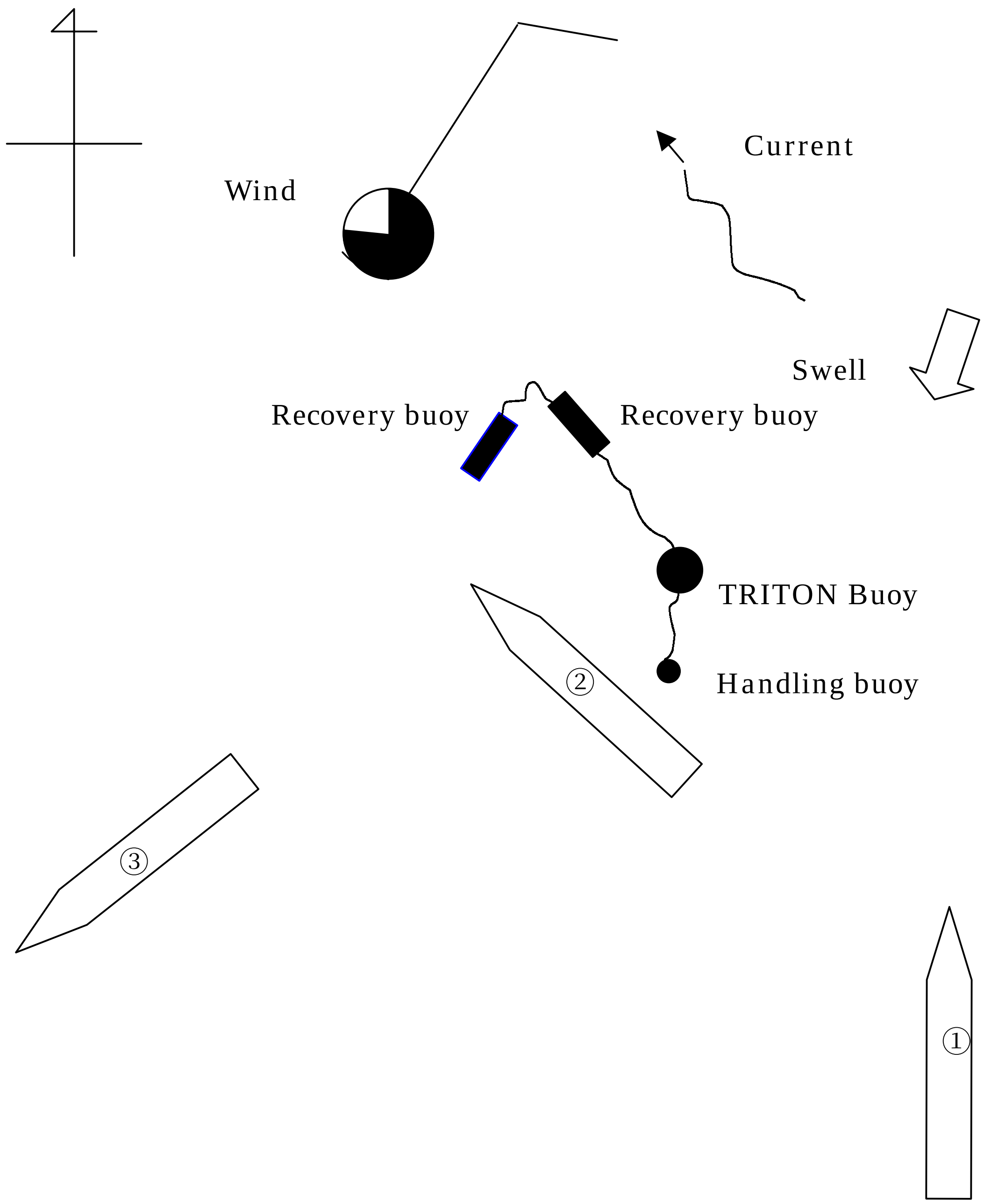


Fig. 8.2-6 FIGURE OF RECOVERY BUOY

Triton buoy Site number: 4 (0, 156E)

Date: 3rd January 2003

Wind: <000> 2.0 m/s, Current: <200>0.5 knots

Swell: NE, Wave height: 2.0 m, Weather: bc

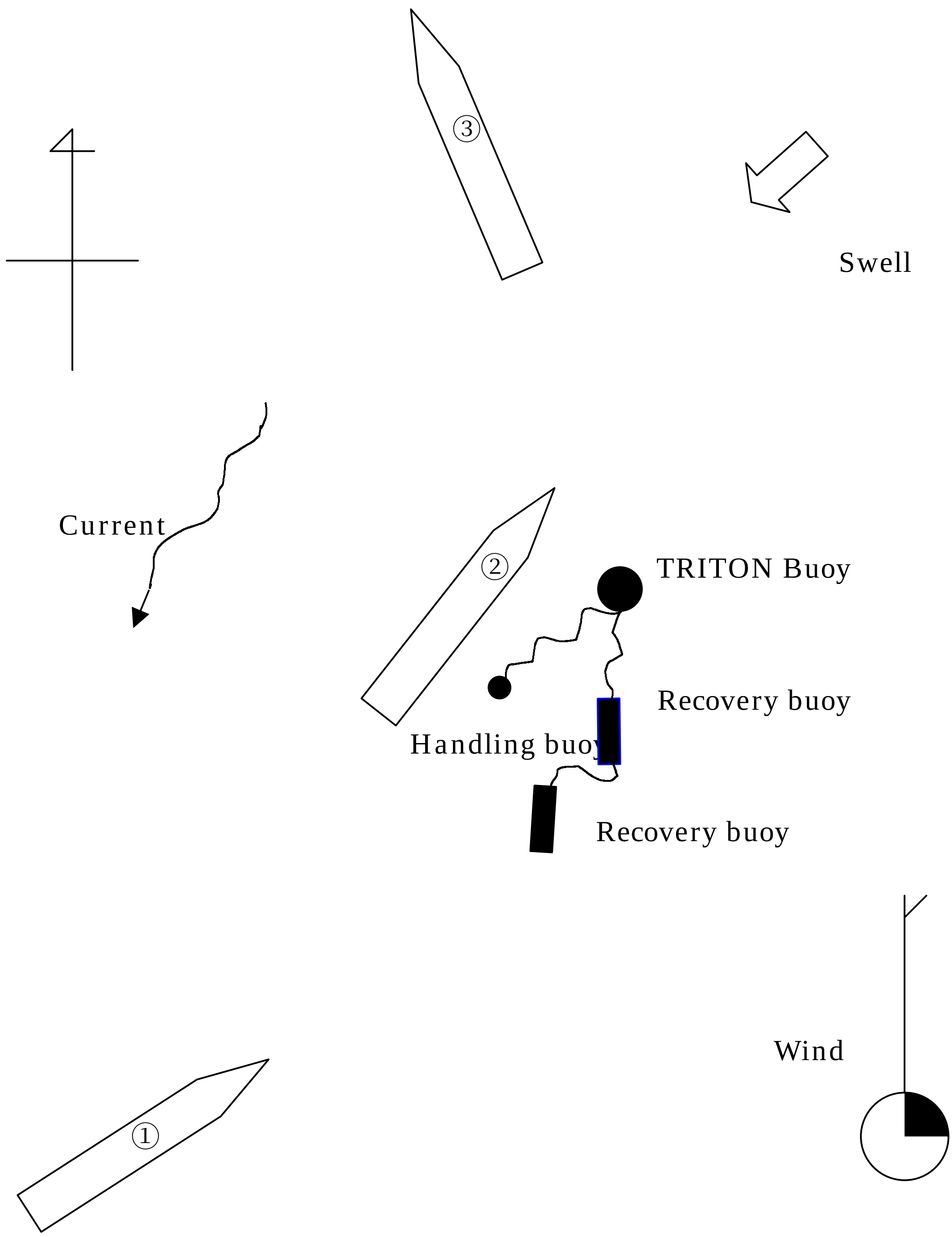


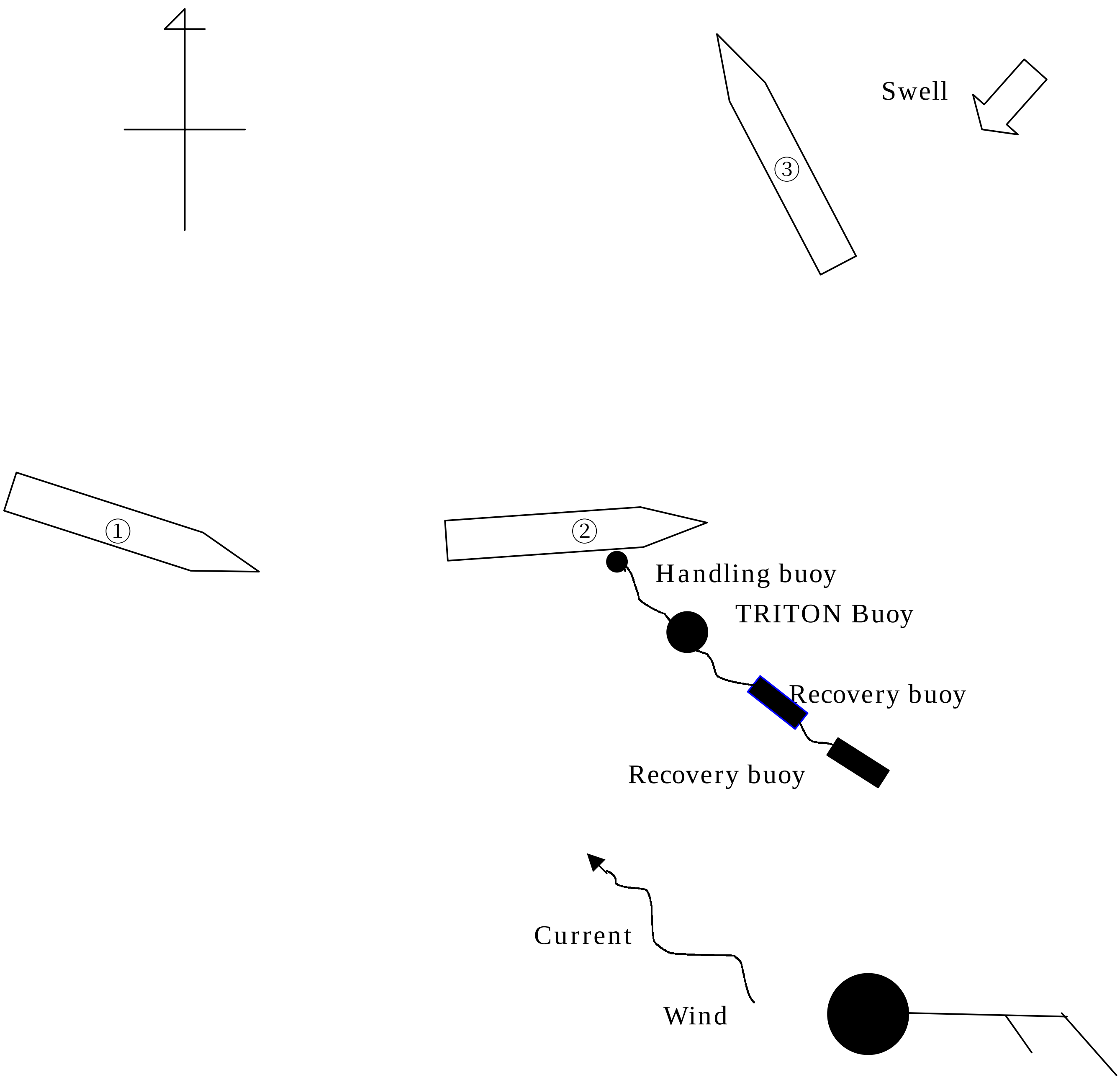
Fig. 8.2-7　　FIGURE OF RECOVERY BUOY

Triton buoy Site number: 3　(2N, 156E)

Date: 5th January 2003

Wind: <090> 6.0 m/s, Current: <320> 1.0 knots

Swell: NE, Wave height: 1.7m, Weather: r



The TRITON buoy has been moved to the position of direction 180 degrees distance 5.14 miles from a first mooed point.

Fig.8.2-8 FIGURE OF RECOVERY ADCP

Location: 0, 145E

Date: 23rd Dec. 2002

Wind: <085> 1 m/s, Current: <200> 0.2 knot

Swell: NE, Wave height: 1.4 m, Weather: bc

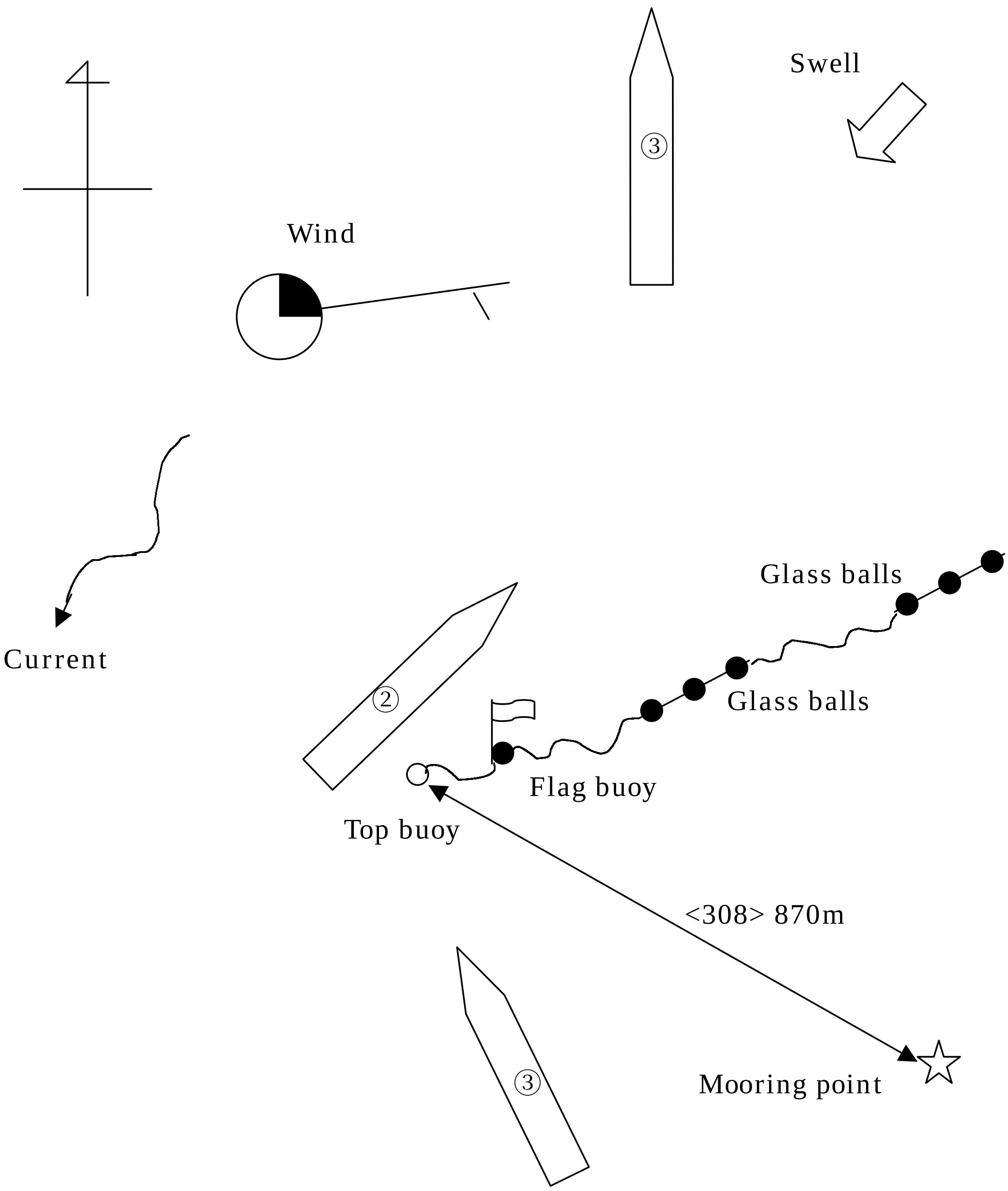
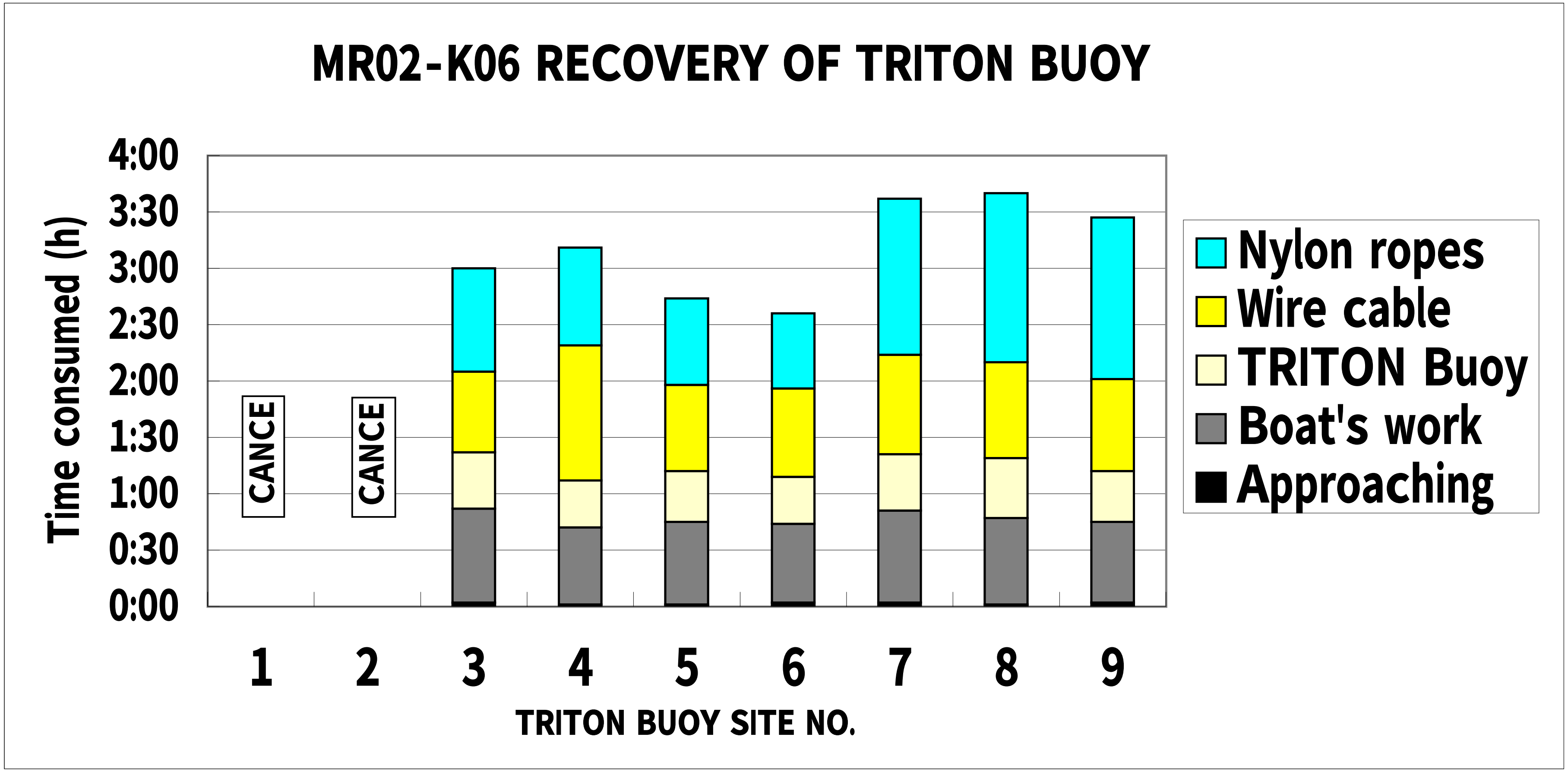


Fig 8.2-9 WORKING TIME OF RECOVERY TRITON BUOY ON MR02-K06 leg 2



Remarks: 1) As for sediment trap, time spent in rising of top buoy includes time in approaching buoy.
2) The fairings had been attached to the wire cable of "4" (300 meters in length) Excessive time for 24 minutes was required to remove it.
3) The ropes of 3 - 7 meters in lenghth were unlawfully set to the buoy of TRITON "9",""5","4" & "3".
4)The fishing string got twisted to the cable/ropes of TRITON "8","7" & "4".
5) The nylon ropes of TRITON "6","5" & "4" were twined around the recovery buoys of themselves.
6) The length of the nylon rope is different depending on the deploy depth.
7) TRITON buoys at site No.1 & No.2 were not able to be recovered due to rough sea.

Table 8.2-1 RECOVERY OF TRITON BUOY/SEDIMENT TRAP DURING VOYAGE MR02-K06 leg 2

TRITON SITE NUMBER	1	2	3	4	5	6	7	8	9	Average		Sediment trap	
Location	8N, 156E	5N, 156E	2N, 156E	0, 156E	2S, 156E	5S, 156E	5N, 147E	2N,147E	0,147E			0,145E	0,145E
Date			5-Jan	3-Jan	31-Dec	28-Dec	20-Dec	22-Dec	24-Dec			23-Dec	17-Mar
LENGTH OF SYSTEM (m)	4766	3530	2565	1994	1770	1485	4215	4460	4620			about2790	3060
SITE DEPTH (m)	4840	3600	2565	1950	1750	1510	4260	4530	4550			3700	3684
Com'ced work			8:38	7:52	7:57	7:44	7:57	7:56	7:48			6:55	7:29
Sent working-boat			8:40	7:53	7:58	7:46	7:59	7:57	7:50			7:38	8:06
Released from sinker			8:51	8:01	8:12	7:53	8:08	8:07	8:03			7:02	7:33
Recovery buoy surfaced	C	C	9:09	8:13	8:28	8:02	8:22	8:20	8:17			7:15	7:50
Pull-rope connected with buoy	A	A	9:24	8:27	8:36	8:22	8:40	8:35	8:27			7:52	8:18
Picked up the boat	N	N	9:30	8:34	8:42	8:28	8:48	8:43	8:33			7:54	8:21
Winded up buoy	C	C	9:43	8:44	8:54	8:38	9:01	8:55	8:45			7:59	8:27
Recovery of wire cable	E	E	10:00	8:59	9:09	8:53	9:18	9:15	9:00		Sediment trap1	8:19	8:52
Recovery of nylon ropes	L	L	10:43	10:11	9:55	9:40	10:11	10:06	9:49		Sediment trap2	8:51	9:18
Recovery of releaser			11:37	11:02	10:40	10:19	11:32	11:35	11:14			9:28	9:47
Finished the work			11:38	11:03	10:41	10:20	11:34	11:36	11:15			9:28	9:47
Total working hours			3:00	3:11	2:44	2:36	3:37	3:40	3:27			2:33	2:18
Time consumed										Average			
* in rising of recovery buoy			0:18	0:12	0:16	0:09	0:14	0:13	0:14	0:13		0:13	0:17
in approaching buoys			0:02	0:01	0:01	0:02	0:02	0:01	0:02	0:01		0:43	0:37
in working of boat (included *)			0:50	0:41	0:44	0:42	0:49	0:46	0:43	0:45		0:16	0:15
in recovery of TRITON buoy			0:30	0:25	0:27	0:25	0:30	0:32	0:27	0:28		0:25	0:31
in recovery of wire cable			0:43	1:12	0:46	0:47	0:53	0:51	0:49	0:51		0:32	0:26
in recovery of nylon ropes			0:55	0:52	0:46	0:40	1:23	1:30	1:26	1:04		0:37	0:29
Total working hours			3:00	3:11	2:44	2:36	3:37	3:40	3:27	3:10		2:33	2:18

Remarks: 1) As for sediment trap, time spent in rising of top buoy includes time in approaching buoy.
2) The fairings had been attached to the wire cable of "4" (300 meters in length). Excessive time for 24 minutes was required to remove it.
3) The ropes of 3 - 7 meters in lenghth were unlawfully set to the buoy of TRITON "9",""5","4" & "3".
4) The fishing string got twisted to the cable/ropes of TRITON "8","7" & "4".
5) The nylon ropes of TRITON "6","5" & "4" were twined around the recovery buoys of themselves.
6) The length of the nylon rope is different depending on the deploy depth.
7) TRITON "1" & "2" were not able to be recovered due to rough sea.

TRITON SITE NUMBER	1	2	3	4	5	6	7	8	9	23-Dec	17-Mar
Approaching course (deg)			130	190	0	205	130	130	130	350	320
Course of recovery (deg)	C	C	80	180	340	300	70	70	50	40	290
Wind direction (deg)	A	A	90	190	10	300	95	70	90	85	300
Wind velocity (m/s)	N	N	6	8.1	5.8	5.2	6.7	4.5	2.3	1	5
Current direction (deg)	C	C	320	130	160	350	45	310	300	200	60
Current velocity (knot)	E	E	1	0.5	0.8	0.8	1.2	0.5	0.4	0.2	0.2
Swell direction	L	L	NE	NNW	NNE	North	NE	NNE	NNE	NE	NNE
Wave height (m)			1.7	1.7	1.8	1.3	1.9	1.6	1.3	1.4	1