doi : 10.17596/0003509

R/V Mirai Cruise Report
MR07-03

June 01 – July 14, 2007
Tropical Ocean Climate Study (TOCS)

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

Contents

1. Cruise name and code

Tropical Ocean Climate Study

MR07-03

Ship: R/V MIRAI

Captain: Masaharu Akamine

2. Introduction and observation summary

2.1. Introduction

The warm water pool located at the western equatorial Pacific and eastern Indian Ocean has the highest sea surface temperature in the ocean all over the world. Therefore interaction between the ocean and atmosphere in that region becomes important for climate change such as ENSO (El Niño/Southern Oscillation) in the Pacific Ocean and Dipole mode in the Indian Ocean. This cruise is conducted for understanding the process of warm water convergence and divergence, and interaction processes in that region. For that purpose, we carried out deployment and recovery of the TRITON (TRIangle Trans Ocean buoy Network) buoys as the main mission. The TRITON buoys have advantage of analysis for long- term variability in the warm water pool. We also carried out other observations, such as ADCP moorings, CTD measurements and meteorological observation, for understanding the Ocean and atmospheric conditions.

We also carried out emergency recovery of drifting TRITON buoys moored at EQ 156˚E and 2˚N130˚E in this cruise.

2.2. Overview

2.2.1. Ship

R/V MIRAI

Captain Masaharu Akamine

2.2.2. Cruise code

MR07-03

2.2.3. Project name

Tropical Ocean Climate Study

2.2.4. Undertaking institution

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

2-15, Natsushima-cho, Yokosuka 237-0061, Japan

2.2.5. Chief Scientist

Iwao Ueki (JAMSTEC)

2.2.6. Period

June 1st, 2004 (Sekinehama) – July 14, 2007 (Sekinehama)

2.2.7. Research Participants

Total 22 scientists and technical staffs participated from 6 different institutions and companies.

2.3. Observation summary

TRITON buoy deployment:	9 sites.
TRITON buoy recovery:	10 sites
ADCP buoy deployment:	2 sites
ADCP buoy recovery:	2 sites
ADV-ADCP buoy deployment:	1 site
ADV-ADCP buoy recovery:	1 site
CTD including water sampling:	18 casts
XCTD:	19 launches
Surface meteorology:	continuous
Shipboard ADCP measurement:	continuous
Geophysics measurement:	continuous
Surface temperature and salinity measurements by intake method	continuous
pCO_2 measurements	continuous

*** Other specially designed observations have been carried out successfully.

Observed oceanic and atmospheric conditions

Oceanic and atmospheric conditions in the tropical Pacific region showed developing stage of La Niña. The TAO (Tropical Atmosphere/Ocean)/TRITON array data showed slightly warmer sea surface temperature in the warm pool region. According to this high sea surface temperature distribution easterly winds dominate eastern end of the warm pool in the Pacific Ocean during June. Whereas, there was westerly winds domination at the same region during July. An OLR (Outgoing Long-wave Radiation) analysis by NOAA(National Oceanic and Atmospheric Administration)/CPC(Climate Prediction Center) suggests that this winds shift is caused by eastward propagating MJO (Madden-Julian Oscillation).

3. Period, port of call, cruise log and cruise track

3.1. Period

June 1, 2007 – July 14, 2007

3.2. Ports of call

Sekinehama, Japan	(Departure; June 1, 2007)
Hachinohe, Japan	(June 1, 2007)
Sekinehama, Japan	(July 14, 2007)

3.3. Cruise log

LST (Local Ship Time)	**UTC**	**Event**
Jun. 01 (Fri.)	May 31	
06:00	21:00	Departure at Sekinehama, Japan (SMT=UTC+9)
10:00	01:00	Safety guidance for participants
12:00	03:00	Arrival at Hachinohe, Japan
17:20	08:20	Departure at Hachinohe
19:20	10:20	Start of shipboard observations
Jun. 02 (Sat.)		
10:30	01:30	Fire and abandon ship drill
11:20	09:40	Start of continuous surface monitoring of surface seawater, and shipboard observations
13:00	04:00	Meeting for observations in this cruise
16:45	07:45	Konpira-san ceremony
22:00	12:00	Local ship time adjustment (LST = UTC + 10)
Jun. 03 (Sun.) - Jun. 08 (Fri.)		Cruise to drifting TRITON buoy (1˚30”N, 154˚00”E)
Jun. 09 (Sat.)	Jun. 08	
06:15 – 09:13	20:15 – 23:13	emergency recovery of TRITON buoy (1˚34.8S, 154˚08.7E)

Jun. 10 (Sun.)		
		Cruise to 8˚N, 156˚E
Jun. 11 (Mon.)	Jun. 10	
06:00 – 06:45	20:00 – 20:45	C01-1 (07˚57.7"N, 156˚00.5"E) CTD cast with 2 water sampling down to 1,000 m depth
08:09 – 11:49	22:09 – 01:49	Recovery of TRITON buoy (07˚57.8"N, 156˚01.4"E)
12:57 – 16:05	02:57 – 06:05	C01-2 (07˚58.0"N, 156˚00.5"E) CTD cast with 36 water sampling down to 4,810 m depth
13:20 – 15:55	03:20 – 05:55	CO_2 profile observation (stopping)
16:15 –	06:15 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun.12 (Tue.)	Jun. 11	
– 04:05	– 18:05	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:20 – 10:55	22:20 – 00:55	Deployment of TRITON buoy (07˚58.0"N, 156˚02.0"E)
13:00 – 13:45	03:00 – 03:45	C01-3 (07˚58.2"N, 156˚00.6"E) CTD cast with 2 water sampling down to 1,000 m depth
13:40 – 14:20	03:40 – 04:20	CO_2 profile observation (drifting)
		Cruise to 5˚N, 156˚E
18:55	08:55	XCTD001 (07˚00.0"N, 156˚00.8"E)
23:55	13:55	XCTD002 (06˚00.0"N, 155˚57.4"E)
Jun. 13 (Wed)	Jun. 12	
06:01 – 06:49	20:01 – 20:49	C02-1 (05˚01.3"N, 155˚56.1"E) CTD cast with 2 water sampling down to 1,000 m depth
08:08 – 11:04	22:08 – 01:04	Recovery of TRITON buoy (05˚01.2"N, 155˚58.0"E)
13:04 – 15:51	03:04 – 05:51	C02-2 (05˚01.6"N, 155˚57.4"E) CTD cast with 36 water sampling down to 3,560 m depth
13:30 – 16:25	03:30 – 06:25	CO_2 profile observation (stopping)
16:40 –	06:40 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile

Jun. 14 (Thu.)	Jun. 13	
– 04:00	– 18:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:17 – 10:37	22:17 – 00:37	Deployment of TRITON buoy (05˚00.0"N, 155˚58.0"E)
13:00 – 13:51	03:00 – 03:51	C02-3 (05˚00.1"N, 155˚57.1"E) CTD cast with 2 water sampling down to 1,000 m depth
13:10 – 14:20	03:10 – 04:20	CO_2 profile observation (drifting)
		Cruise to 2˚N, 156˚E
20:01	10:01	XCTD003 (03˚58.3"N, 155˚59.5"E)
Jun. 15 (Fri.)	Jun. 14	
01:15	15:15	XCTD004 (03˚00.0"N, 156˚00.2"E)
08:13 – 10:13	22:13 – 00:13	Deployment of TRITON buoy (02˚02.3"N, 156˚01.2"E)
12:04 – 14:04	02:04 – 04:04	C03-1 (02˚01.4"N, 156˚01.7"E) CTD cast with 36 water sampling down to 2,530 m depth
12:12 – 14:15	02:12 – 04:15	CO_2 profile observation (stopping)
15:19 – 16:14	05:19 – 06:14	C03-2 (01˚58.3"N, 155˚59.5"E) CTD cast with 2 water sampling down to 1,000 m depth
16:20 –	06:20 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 16 (Sat.)	Jun. 15	
– 04:00	– 18:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:43 – 11:32	22:43 – 01:32	Recovery of TRITON buoy (01˚57.4"N, 155˚59.4"E)
13:02 – 14:20	03:02 – 04:20	CO_2 profile observation (drifting)
		Cruise to EQ, 156˚E
18:35	08:35	XCTD005 (01˚28.9"N, 156˚00.0"E)
22:38	12:38	XCTD006 (01˚00.0"N, 156˚00.9"E)
Jun. 17 (Sun.)	Jun. 17	
02:41	16:41	XCTD007 (00˚30.0"N, 156˚01.8"E)
08:15 – 10:09	22:15 – 00:09	Deployment of TRITON buoy (00˚01.0"N, 156˚02.5"E)

13:00 – 14:40	03:00 – 04:40	C04-1 (00˚00.5”N, 156˚00.6”E) CTD cast with 36 water sampling down to 1,910 m depth
13:05 – 16:15	03:05 – 04:15	CO_2 profile observation (stopping)
16:28 –	06:28 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 18 (Mon.)	Jun. 17	
– 06:00	– 20:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:07 – 09:41	22:07 – 23:41	Recovery of ADCP buoy (00˚00.1”N, 156˚08.5”E)
10:28 – 11:24	00:28 – 01:24	Deployment of ADCP buoy (00˚00.1”N, 156˚08.0”E)
14:42 – 14:52	04:42 – 04:52	Calibration of TRITON position (00˚01.3”N, 156˚00.6”E)
15:10 –	05:10 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 19 (Tue.)	Jun. 18	
– 06:00	– 20:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:21 – 10:36	22:21 – 00:36	Recovery of TRITON buoy (00˚01.3”N, 156˚00.6”E)
13:10 – 16:18	03:10 – 06:18	CO_2 profile observation (stopping)
16:28 –	06:28 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 20 (Wed.)		
– 13:00	– 03:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
13:05 – 16:21	03:05 – 06:21	C04-2 (00˚19.2”N, 155˚57.5”E) CTD cast with 12 CT sensors installed TRITON buoy down to 1,000 m depth
13:10 – 14:27	03:10 – 04:27	CO_2 profile observation (stopping)
		Cruise to 2˚S, 156˚E
22:30	12:30	XCTD008 (01˚00.0”N, 155˚59.9”E)

Jun. 21 (Thu.)	Jun. 20	
08:14 – 10:06	22:14 – 00:06	Deployment of TRITON buoy (02˚01.0”S, 155˚57.5”E)
10:41	00:41	XCTD009 (02˚01.2”S, 155˚57.4”E)
13:00 – 14:08	03:00 – 04:08	C05-1 (02˚00.7”S, 155˚59.4”E) CTD cast with 36 water sampling down to 1,000 m depth
13:12 – 13:25	03:12 – 03:25	CO_2 profile observation (stopping)
16:15 –	06:15 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 22 (Fri.)	Jun. 21	
– 06:00	– 20:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:10 – 10:36	22:10 – 00:36	Recovery of TRITON buoy (01˚58.8”S, 156˚01.9”E)
13:12 – 16:18	03:12 – 06:18	CO_2 profile observation (stopping)
		Cruise to 5˚S, 156˚E
20:54	10:54	XCTD010 (03˚02.0”S, 155˚59.9”E)
Jun. 23 (Sat.)	Jun. 22	
01:09	15:09	XCTD011 (04˚00.0”S, 156˚00.4”E)
10:33 – 11:56	00:33 – 01:56	Deployment of TRITON buoy (05˚02.0”S, 156˚01.5”E)
12:19	02:19	XCTD012 (05˚01.8”S, 156˚01.4”E)
12:53	02:53	XCTD013 (04˚58.7”S, 156˚01.0”E)
13:33 – 15:50	03:33 – 05:50	Recovery of TRITON buoy (04˚58.7”S, 156˚00.5”E)
		Cruise to EQ, 147˚E
16:30	06:30	Stop of continuous surface monitoring of surface seawater, and shipboard observations
17:00	07:00	Stop of shipboard observations
Jun. 24 (Sun.)		
		Cruise to EQ, 147˚E
Jun. 25 (Mon.)	Jun. 24	
06:00	20:00	Restart of shipboard observations

09:00	23:00	Restart of continuous surface monitoring of surface seawater, and shipboard observations
09:25 – 10:43	23:25 – 00:43	Deployment of ADV-ADCP buoy (00˚02.0”N, 146˚57.0”E)
17:52 –	07:52 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 26 (Tue.)	Jun. 25	
– 06:00	– 20:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:12 – 10:25	22:12 – 00:25	Deployment of TRITON buoy (00˚03.6”S, 147˚00.7”E)
11:11	01:11	XCTD014 (00˚03.7”S, 147˚00.3”E)
13:01 – 14:12	03:01 – 04:12	C07-1 (00˚01.0”S, 147˚00.3”E) CTD cast with 36 water sampling down to 1,000 m depth
13:10 – 16:15	03:10 – 06:15	CO_2 profile observation (stopping)
16:32 –	06:32 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun.27 (Wed.)	Jun. 26	
– 06:00	– 20:00	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:10 – 11:08	22:10 – 01:08	Recovery of TRITON buoy (00˚01.7”S, 147˚01.3”E)
13:06 – 16:30	03:06 – 06:30	CTD freefall (00˚10.1”S, 146˚59.8”E) down to 5050 m
13:10 – 16:26	03:10 – 06:26	CO_2 profile observation (stopping)
16:45 –	06:45 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 28 (Thu.)	Jun. 27	
– 06:45	– 20:45	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:15 – 10:27	22:15 – 00:27	Recovery of ADCP buoy (00˚00.3”S, 147˚04.6”E)
13:01 – 14:07	03:01 – 04:07	Deployment of ADCP buoy (00˚00.3”N, 147˚04.6”E)

15:40 –	05:40 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jun. 29 (Fri.)	Jun. 28	
– 05:55	– 19:55	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:10 – 10:14	22:10 – 00:14	Recovery of ADV-ADCP buoy (00˚02.1”N, 146˚57.0”E)
13:00 – 16:09	03:00 – 06:09	C07-2 (00˚05.6”N, 147˚00.1”E) CTD cast with 13 CT sensors installed TRITON buoy down to 1,000 m depth
13:12 – 16:25	03:12 – 06:25	CO_2 profile observation (stopping)
		Cruise to 2˚N, 147˚E
19:14	09:14	XCTD015 (00˚30.0”N, 146˚59.6”E)
22:19	12:19	XCTD016 (01˚00.0”N, 147˚00.2”E)
Jun. 30 (Sat.)	Jun. 29	
01:30	15:30	XCTD017 (01˚30.0”N, 146˚59.9”E)
05:58 – 06:46	19:58 – 20:46	C08-1 (02˚05.2”S, 146˚58.3”E) CTD cast with 2 water sampling down to 1,000 m depth
08:08 – 11:17	22:08 – 01:17	Recovery of TRITON buoy (02˚04.8”N, 146˚57.4”E)
13:02 – 16:02	03:02 – 06:02	C08-2 (02˚04.6”S, 146˚58.0”E) CTD cast with 36 water sampling down to 4,455 m depth
13:08 – 16:25	03:08 – 06:25	CO_2 profile observation (stopping)
16:40 –	06:40 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jul. 01 (Sun.)	Jun. 30	
– 06:50	– 20:50	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:12 – 10:38	22:12 – 00:38	Deployment of TRITON buoy (02˚04.5”S, 146˚57.0”E)
12:58 – 13:45	02:58 – 03:45	C08-3 (02˚05.8”S, 146˚58.1”E) CTD cast with 2 water sampling down to 1,000 m depth

13:12 – 16:19	03:12 – 06:19	CO_2 profile observation (stopping)
		Cruise to 5˚N, 147˚E
20:38	10:38	XCTD018 (03˚00.6”N, 147˚01.4”E)
Jul. 02 (Mon.)	Jul. 01	
01:50	15:50	XCTD019 (04˚00.0”N, 147˚00.3”E)
09:03 – 11:54	23:03 – 01:54	C09-1 (05˚01.6”S, 146˚56.9”E) CTD cast with 36 water sampling down to 4,220 m depth
09:05 – 11:50	23:05 – 01:50	CO_2 profile observation (stopping)
13:17 – 15:22	03:17 – 05:22	Deployment of TRITON buoy (04˚57.8”S, 147˚01.6”E)
16:13 – 16:56	23:03 – 01:54	C09-2 (04˚58.2”S, 147˚00.3”E) CTD cast with 2 water sampling down to 1,000 m depth
18:20 –	08:20 –	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
Jul. 03 (Tue.)	Jul. 02	
– 06:30	– 20:30	Special maneuver for observation of air-sea turbulent CO_2 flux with that of CO_2 profile
08:08 – 11:26	22:08 – 01:26	Recovery of TRITON buoy (05˚02.6”N, 146˚57.2”E)
		Cruise to 2˚N, 130˚E
		for emergency recovery of TRITON buoy
22:00	13:00	Local ship time adjustment (LST = UTC + 9)
Jul. 04 (Wed.)	Jul. 03	
07:30	22:30	Stop of continuous surface monitoring of surface seawater, and shipboard observations
09:00	00:00	Stop of shipboard observations
		Cruise to 2˚N, 130˚E
Jul. 05 (Thu.)		
		Cruise to 2˚N, 130˚E

Jul. 06 (Fri.)		
09:13 – 12:55	00:13 – 03:55	Emergency recovery of TRITON buoy
		(02˚08.1”N, 129˚39.7”E)
		Cruise to Sekinehama
Jul. 07 (Sat.)		
		Cruise to Sekinehama
Jul. 08 (Sun.)		
09:00	00:00	Restart of continuous surface monitoring of surface seawater, and shipboard observations
		Restart of shipboard observations
		Cruise to Sekinehama
Jul. 09 (Mon.)		
		Cruise to Sekinehama
Jul. 10 (Tue.)		
		Cruise to Sekinehama
Jul. 11 (Wed.)		
12:10 – 16:50	03:10 – 07:50	CTD freefall (30˚33.2”N, 142˚06.7”E) down to 6000 m
		Cruise to Sekinehama
Jul. 12 (Thu.)		
		Cruise to Darwin
Jul. 13 (Fri.)		
		Cruise to Darwin
Jul. 14 (Sat.)		
09:00	00:00	Arrival at Sekinehama, Japan

3.4. Cruise Track

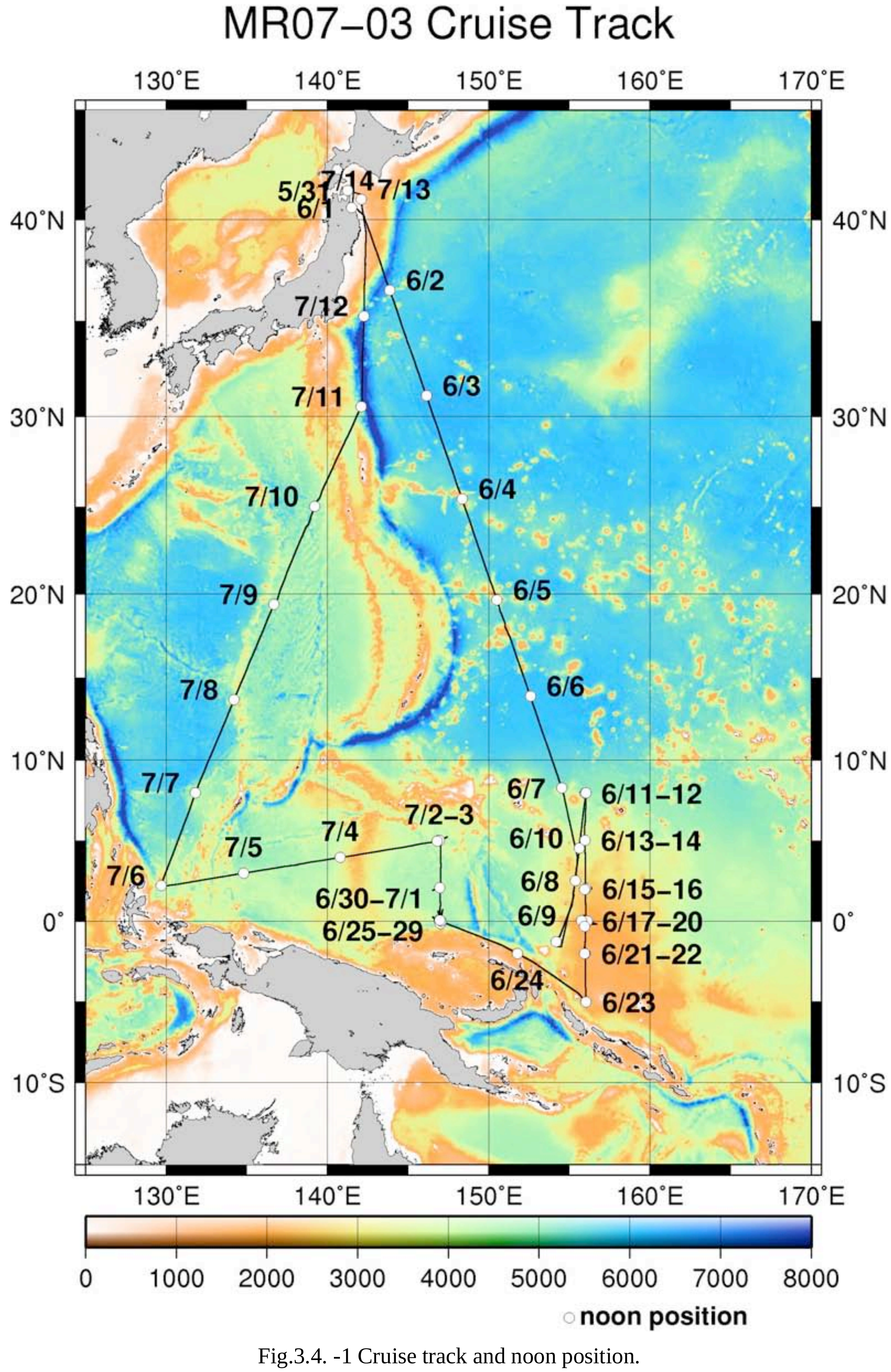

Fig.3.4. -1 Cruise track and noon position.

4. Chief scientist

Iwao Ueki

Researcher

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5. Participants list

5.1. R/V Mirai scientists and technical staffs

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5.2. R/V MIRAI crew member

Masaharu Akamine	Master
Yasushi Ishioka	Chief Officer
Takeshi Isohi	1st Officer
Tomoo Hikichi	2nd Officer
Nobuo Hukaura	3rd Officer
Hiroyuki Doi	Chief Engineer
Koji Masuno	1st Engineer
Kosaku Monji	2nd Engineer
Hiroyuki Tohken	3rd Engineer
Minoru Uchiyama	Jr. 3rd Engineer
Kazuo Sagawa	Chief Radio Officer
Hisao Oguni	Boatswain
Keiji Yamauchi	Able seaman
Masami Sugami	Able seaman
Akito Hodai	Able seaman
Yukiharu Suzuki	Able seaman
Susumu Kanzaki	Able seaman
Kazuyoshi Kudo	Able seaman
Tsuyoshi Monzawa	Able seaman
Masashige Okada	Able seaman
Norimichi Aosaki	Sailor
Kazuya Yamada	Sailor
Sadanori Honda	No. 1 Oiler
Yukitoshi Horiuchi	Oiler
Toshimi Yoshikawa	Oiler
Shigeaki Kinoshita	Oiler
Nobuo Boushita	Oiler
Daisuke Taniguchi	Oiler
Hitoshi Ota	Chief Steward
Hatsuji Hiraishi	Cook
Tatsuya Hamabe	Cook
Kozo Uemura	Cook
Hiroyuki Yoshizawa	Cook

6.1. Meteorological observations

6.1.1. Surface Meteorological Observation

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Kunio Yoneyama	(JAMSTEC): Principal Investigator (Not on-board)
Wataru Tokunaga	(Global Ocean Development Inc., GODI)
Ryo Kimura	(GODI)
Harumi Ota	(GODI)

(2) Objectives

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

(3) Methods

The surface meteorological parameters were observed throughout the MR07-03 cruise from the departure of Sekinehama on 1 June 2007 to arrival of Sekinehama on 14 July 2007, and called at port Hachinohe on 1 June 2007.

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

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

1) MIRAI Surface Meteorological observation (SMet) system

Instruments of SMet system are listed in Table 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.

2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

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

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

SCS recorded PRP data every 6 seconds, Zeno/Met data every 10 seconds. Instruments and their locations are listed in Table6.1.1.-3 and measured parameters are listed in Table 6.1.1.-4.

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

a) Young Rain gauge (SMet and SOAR)

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

b) Barometer (SMet and SOAR)

Comparing with the portable barometer value, PTB220CASE, VAISALA.

c) Thermometer (air temperature and relative humidity) (SMet and SOAR)

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

(4) Preliminary results

Figures 6.1.1.-1 shows the time series of the following parameters;

Wind Speed U and V components (SOAR)

Air temperature (SOAR) and Sea surface temperature (EPCS and SMet)
SMet SST data; 00:00 UTC, 2 June - 06:46 UTC, 2 June
06:14 UTC, 23 June - 23:10 UTC, 24 June
23:20 UTC, 3 July - 00:05 UTC, 8 July
Relative humidity (SOAR) and Rainfall amount (SOAR, Capacitive rain gauge)
Short wave and Long wave radiation (SMet)
Pressure (SMet) and Significant wave height (SMet)

(5) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC. Corrected data sets will also be available from K. Yoneyama of JAMSTEC.

(6) Remarks

1) Following period, SMet Long wave radiation data were no effective because of sensor cable was wrong.
18:00 UTC, 31 May - 05:20 UTC, 23 June
2) Following period, SMet Sea Surface Temperature data were effective.
00:00 UTC, 2 June - 04:00 UTC, 12 July
3) SOAR ORG noises were appeared because of blew the whistle at the foremast, as follows;
02:00 UTC, 02:54UTC, 05 June
02:00 UTC, 07 June
02:00 UTC, 09 June
02:00 UTC, 10 June
02:00 UTC, 12 June
02:00 UTC, 14 June
02:00 UTC, 15 June
02:00 UTC, 17 June
02:00 UTC, 19 June
02:00 UTC, 22 June
02:00 UTC, 24 June
02:00 UTC, 26 June
21:03 UTC, 29 June
02:00 UTC, 3 July
03:00 UTC, 5 July

4) SOAR PRP checking and cleaning, as follows;
05:35 UTC, 13 June
04:20 UTC – 05:00 UTC, 11 July
5) SOAR ORG checking and cleaning, as follows;
05:35 UTC, 13 June

Table 6.2.1.-1 Instruments and installations of MIRAI Surface Meteorological system (SMet)

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair / RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	Model-370	Setra System, USA	captain deck (14 m) weather observation room
Capacitive rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-200	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m) Aft (8 m)

Table 6.2.1.-2 Parameters of MIRAI Surface Meteorological observation system

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

Table 6.2.1.-3 Instruments and installation locations of SOAR system

Sensors (*Zeno/Met*)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	foremast (23 m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (22 m)
Capacitive rain gauge	50202	R. M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-115DA	Osi, USA	foremast (24 m)

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

Table 6.2.1.-4 Parameters of SOAR system

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

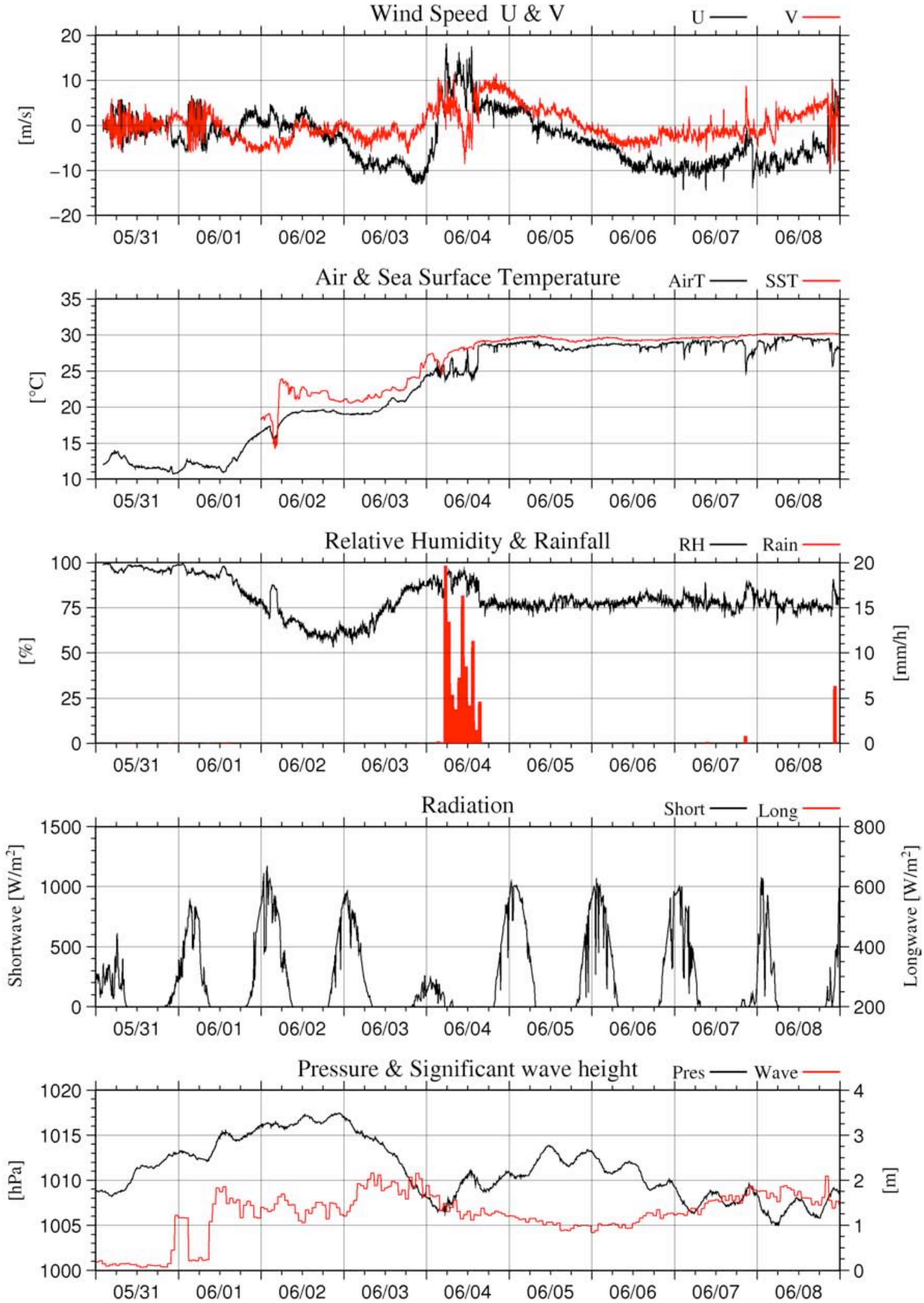


Fig.6.1.1. Time series of surface meteorological parameters during the cruise

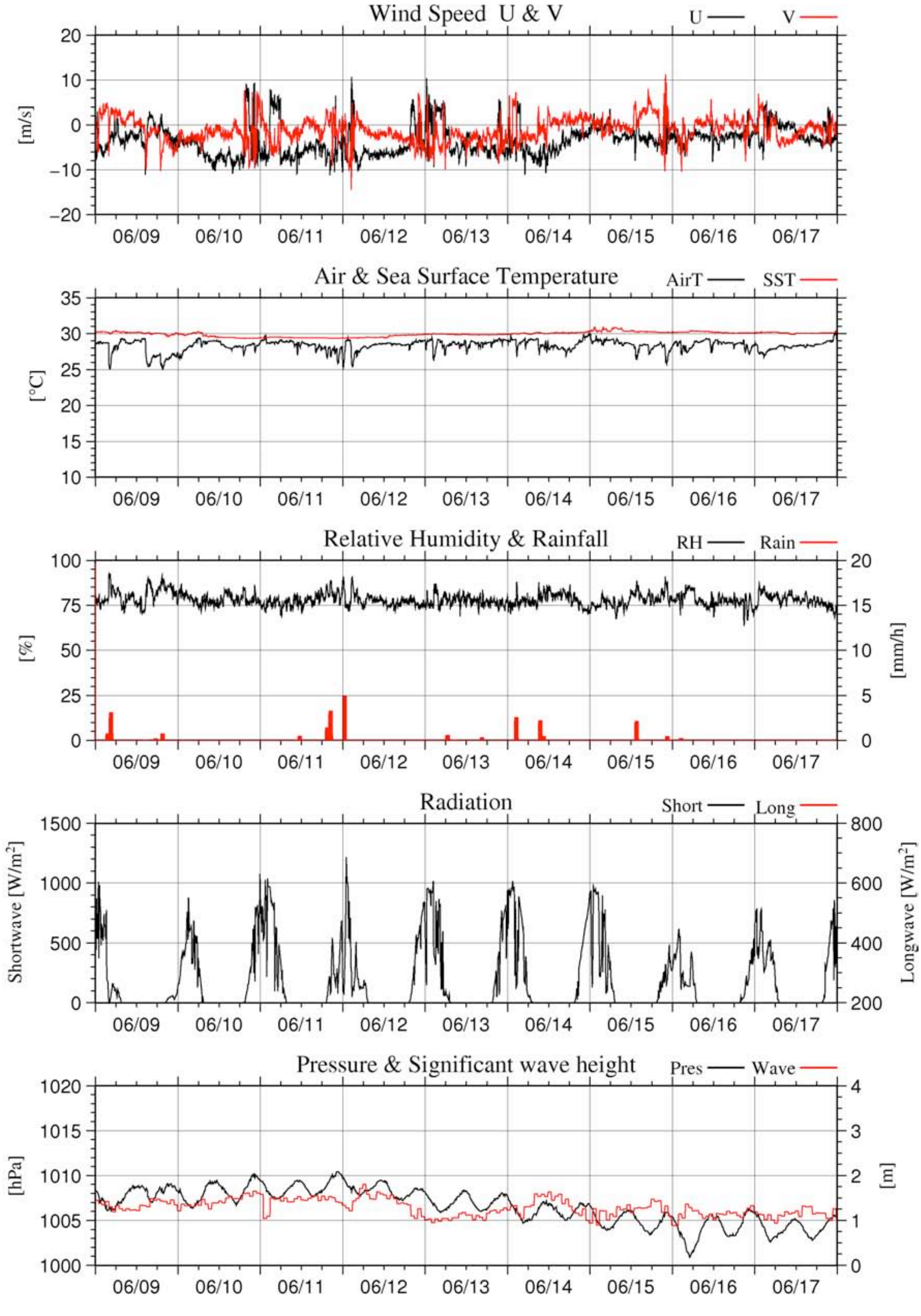
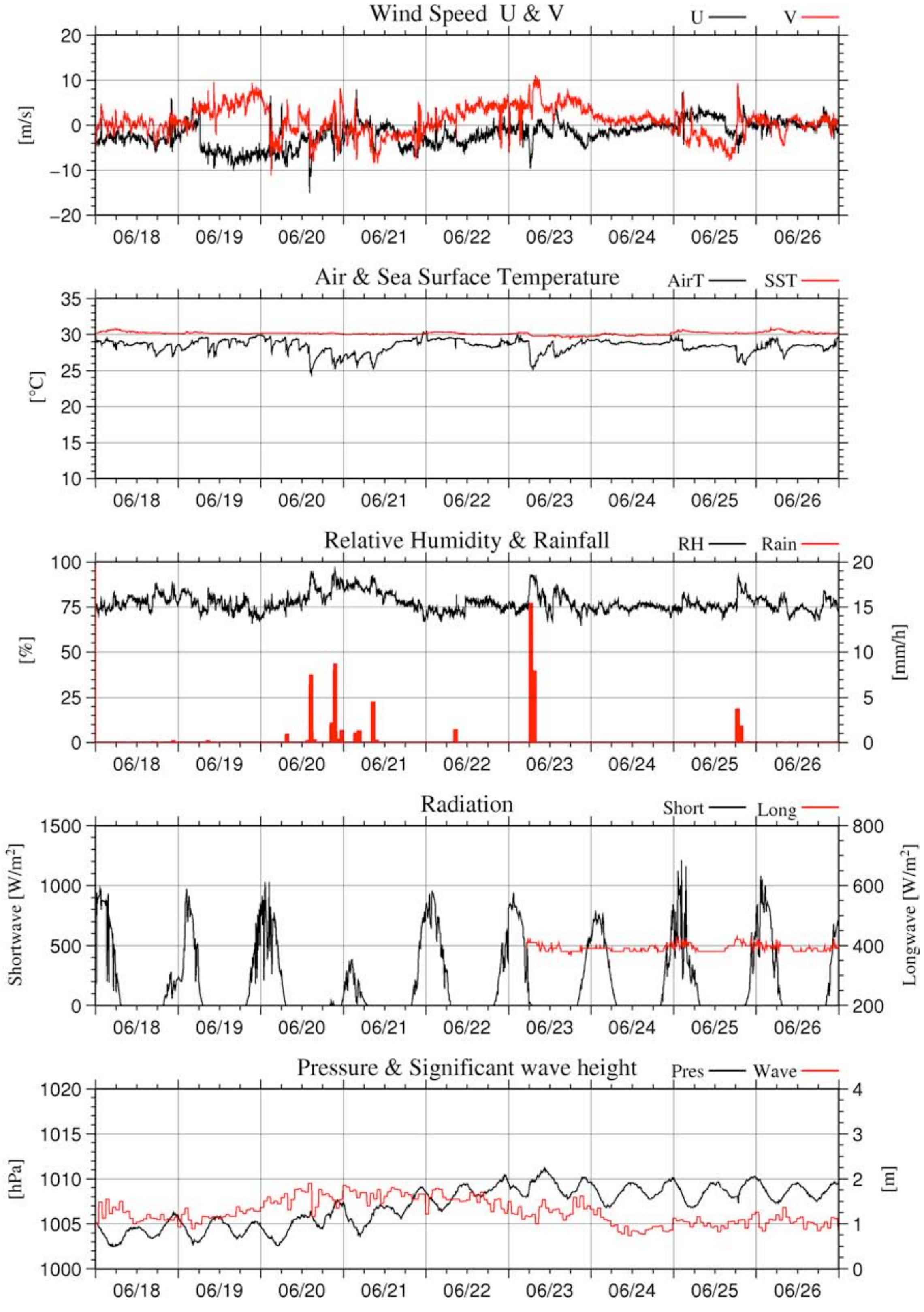


Fig.6.1.1. Continue



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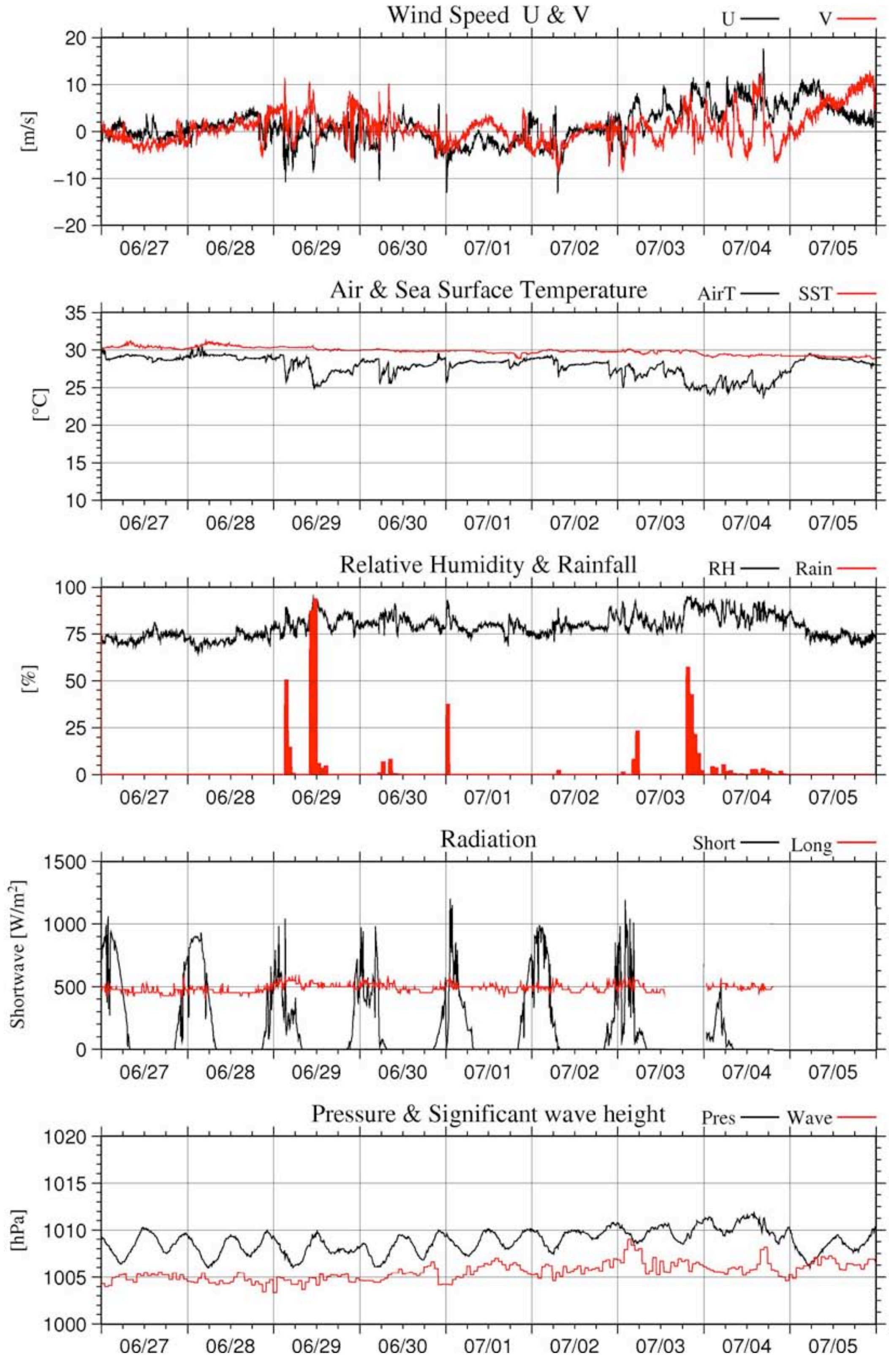

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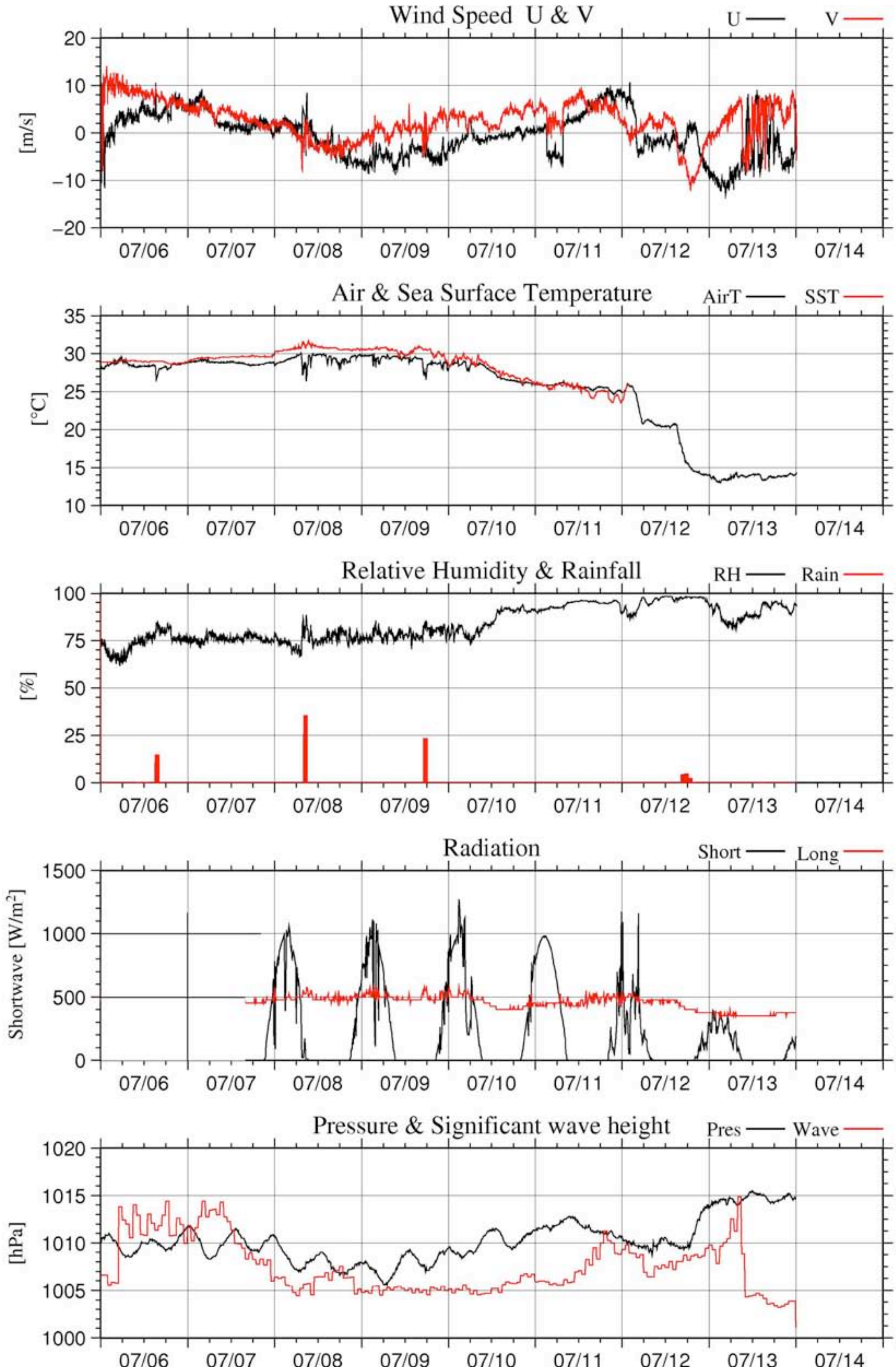


Fig.6.1.1. Continue

6.1.2. Ceilometer Observation

(1) Personnel

Iwao Ueki	(JAMSTEC) : Principal Investigator
Wataru Tokunaga	(Global Ocean Development Inc.: GODI)
Ryo Kimura	(GODI)
Harumi Ohta	(GODI)
Not on-board:	
Kunio Yoneyama	(JAMSTEC)

(2) Objectives

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

(3) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR07-03 cruise, except for the territorial waters of the Papua New Guinea and the EEZ of the Republic of Indonesia and the Republic of Palau islands. Major parameters to be measured are 1) cloud base height in meters, 2) backscatter profiles, and 3) estimated cloud amount in octas.

Specifications of the system are as follows.

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

On the archived dataset, three cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft.). If the apparent cloud base height could not be determined, vertical visibility and the height of detected highest signal are calculated instead of the cloud base height.

(4) Preliminary results

Figure 6.1.2.-1 shows the time series of the first, second and third lowest cloud base height during the cruise.

(5) Data archives

Ceilometer data obtained during this cruise will be submitted to and archived by the Marine-Earth Data and Information Department (MEDID) of JAMSTEC.

(6) Remarks

1) Data acquisition stopped in the territorial waters of Papua New Guinea, non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ. The periods are follows;

07:00, 23 June - 20:00, 24 June	(the Papua New Guinea, territorial waters)
19:44, 04 July - 23:59, 13 July	(non-application area in Federated States of Micronesian EEZ, Indonesian EEZ and Republic of Palau islands' EEZ)

2) Period of data lost is as follow.

01:59, 05 June

3) Window cleaning.

02:05, 05 June
21:55, 15 June
04:10, 24 June
01:00, 30 June

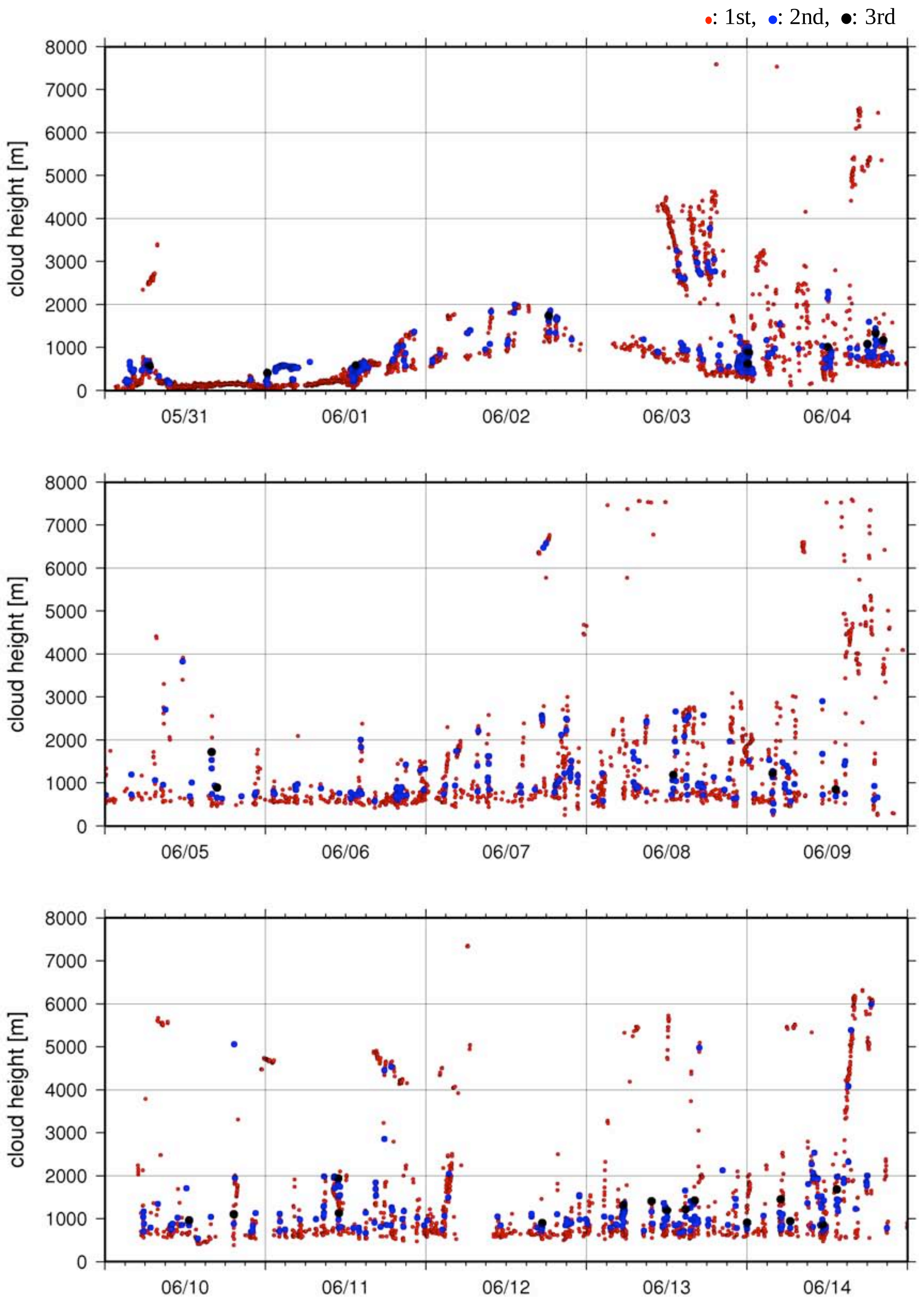


Fig.6.1.2.-1: 1st (red), 2nd (blue) and 3rd (black) lowest cloud base height.

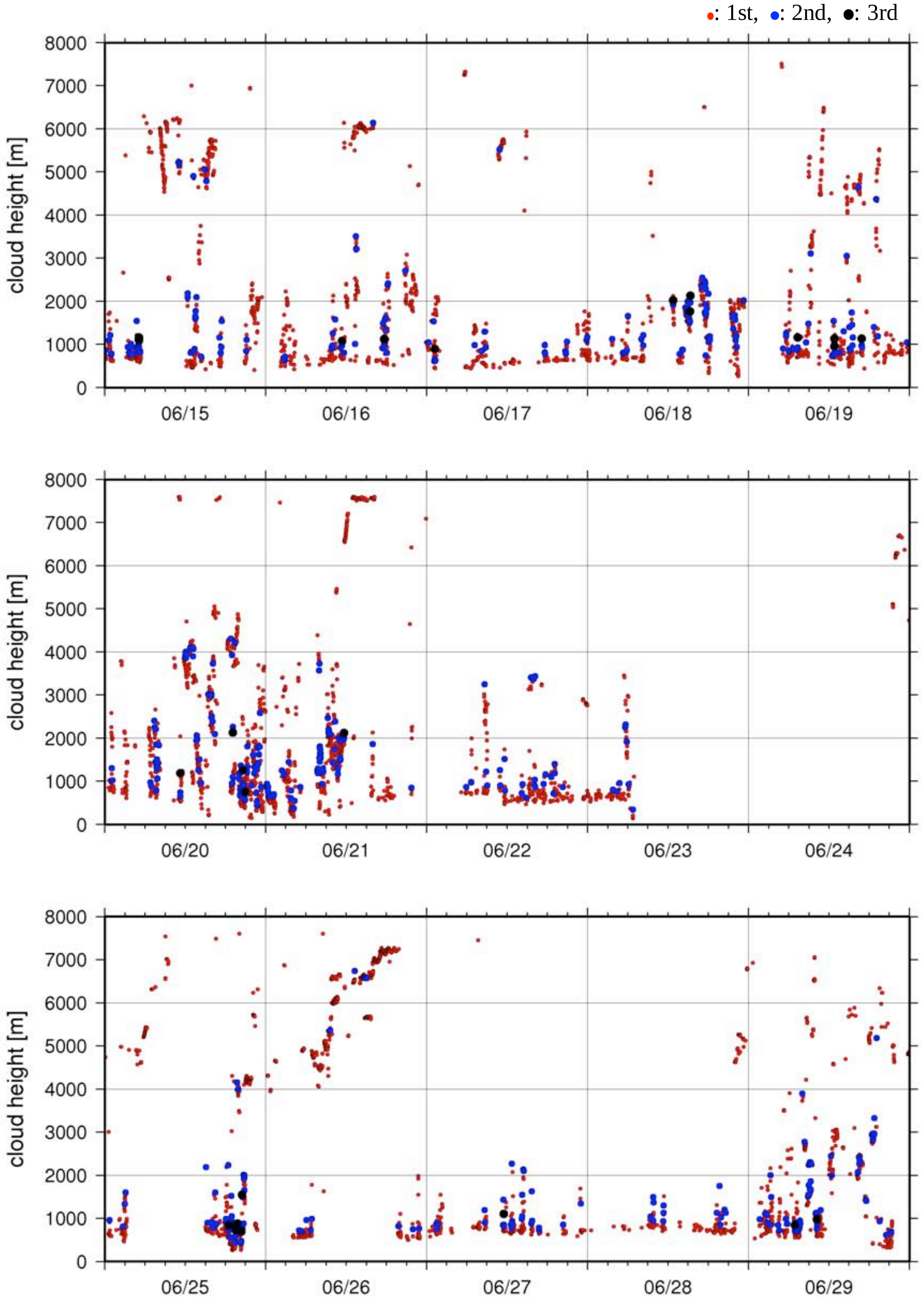


Fig.6.1.2.-1: continue

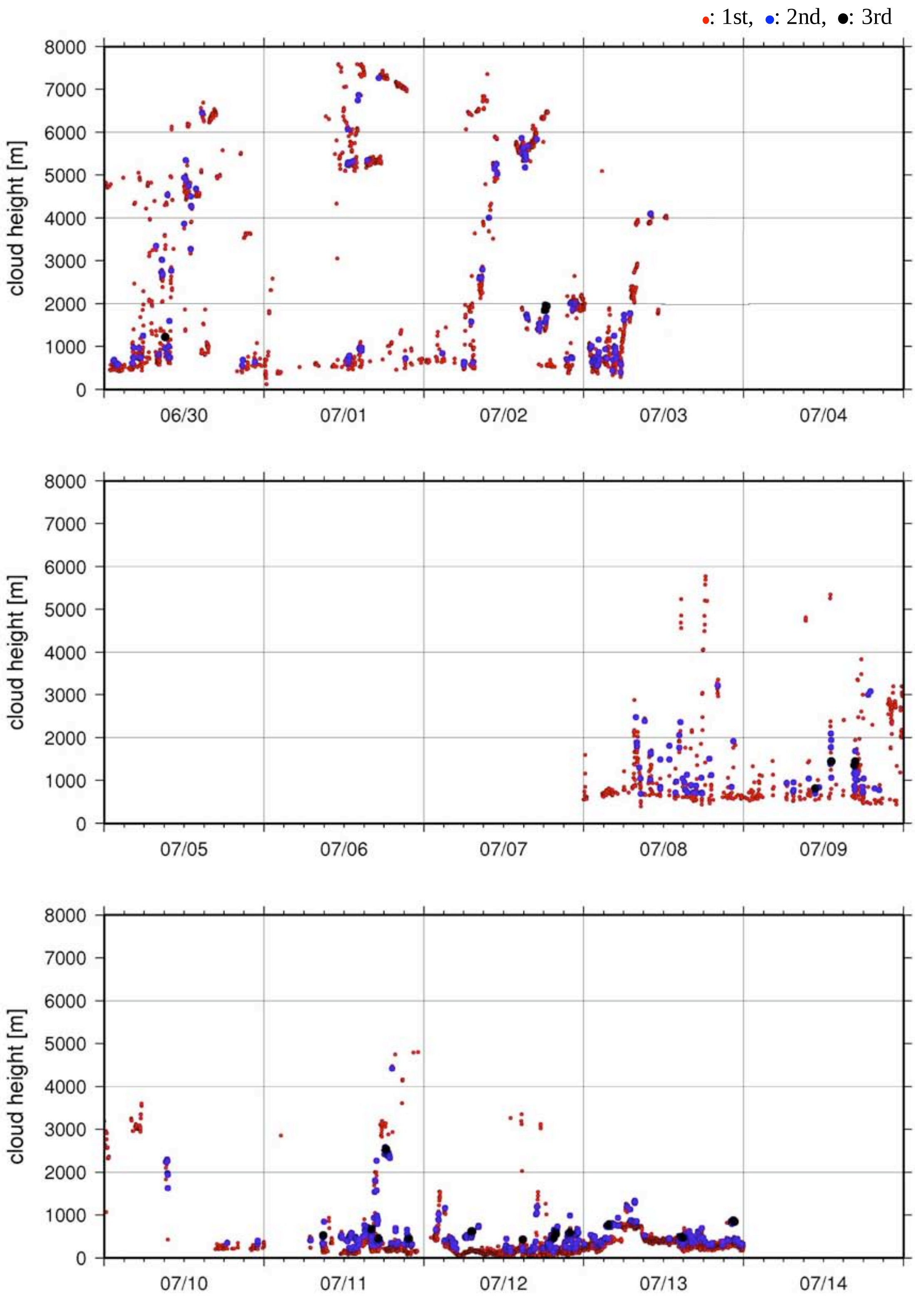


Fig.6.1.2.-1: continue

6.2.1. CTD

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal investigator
Shinsuke Toyoda	(Marine Works Japan Ltd., MWJ): Operation leader
Fujio Kobayashi	(MWJ)
Tsutomu Fujii	(MWJ)

(2) Objective

Investigation of oceanic structure and water property.

(3) Overview of the equipment and observation

CTD/Carousel water sampling system (CTD system), which is 36-position Carousel Water Sampler (SBE 32) with SBE 9plus (Sea-Bird Electronics Inc) attached with sensors, was used during this cruise. 12-litter Niskin bottles were used for sampling seawater. The CTD system was deployed from starboard on working deck. During this cruise, 18 CTD observations were carried out (see Table 6.2.1-1). Sampling layers were shown in Table 6.2.1-2.

(4) List of sensors and equipments

Under water unit:	SBE, Inc., SBE 9plus, S/N 0280
Temperature sensor:	SBE, Inc., SBE 03plus, S/N 03P2730
Conductivity sensor:	SBE, Inc., SBE 04C, S/N 042854
Oxygen sensor:	SBE, Inc., SBE 43, S/N 430205, S/N 430330
Pump:	SBE, Inc., SBE 5T, S/N 053293, S/N 052627
Altimeter:	Benthos, Inc., PSA-916T, S/N 1100
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P7030-0272
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3227443-0391
Water sample bottle:	General Oceanics, Inc., 12-litre Niskin-X

(5) Data processing

The SEASOFT-Win32 (Ver. 5.27b) was used for processing the CTD data. Descriptions and settings of the parameters for the SEASOFT were written as follows.

DATCNV converted the raw data to scan number, pressure, depth, temperature, conductivity, oxygen voltage, altitude, descent rate, pump status and modulo error count. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperature, conductivity, oxygen voltage, altimeter and descent rate were computed over 3.0 seconds. And oxygen, salinity, sigma-theta and potential temperature were computed.

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

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

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

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

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

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

DERIVE was used to compute oxygen.

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

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

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

(6) Preliminary Results

Date, time and locations of the CTD casts are listed in Table 6.2.1-1. Vertical profile of temperature, salinity and oxygen with pressure are shown in Figure 6.2.1.-1, 6.2.1.-2, 6.2.1.-3, 6.2.1.-4 and 6.2.1.-5.

(7) Data archive

All raw and processed data files will be submitted to the Data Management Office (DMO) and will be opened to public via "R/V MIRAI Data Web Page" in the JAMSTEC web site.

Table 6.2.1.-1 CTD Casttable

Stnnbr	Castno	Date(UTC) (mmddyy)	Time(UTC) Start	Time(UTC) End	Start Position Latitude	Start Position Longitude	Depth	Wire Out	HT Above Bottom	Max Depth	Max Pressure	CTD Filename	TRITON	Remarks
C01	1	061007	20:07	20:42	07-57.69N	156-00.55E	4869	997.2	-	994.5	1002.5	C01M01	recovery	Not sampling.
C01	2	061107	3:03	6:02	07-57.74N	156-00.81E	4857	4836	28.2	4811.8	4894.4	C01M02	-	After this cast, D.O. sensor was cleaned.
C01	3	061207	3:05	3:40	07-58.09N	156-00.66E	4836	997.9	-	993.3	1001.9	C01M03	deployment	
C02	1	061207	20:08	20:45	05-01.11N	155-56.22E	3594	1007.8	-	994.8	1002.7	C02M01	recovery	D.O. sensor (sec.) was added. Not sampling.
C02	2	061307	3:08	5:48	05-01.25N	155-57.88E	3599	3639.4	31.3	3565.2	3615.9	C02M02	-	Pri. D.O. sensor and sec. D.O. sensor were exchanged.
C02	3	061407	3:05	3:49	05-00.85N	155-57.26E	3597	1008	-	992.6	1001.5	C02M03	deployment	After this cast, secondary D.O. sensor was cleaned
C03	1	061507	2:09	4:02	02-01.20N	156-01.54E	2574	2549.4	34.7	2537.7	2567.5	C03M01	deployment	After this cast, secondary D.O. sensor was cleaned
C03	2	061507	5:28	6:10	01-58.13N	155-59.51E	2575	999	-	992.7	1000.6	C03M02	recovery	After this cast, T, C sensor was cleaned.
C04	1	061707	3:06	4:37	00-00.44N	156-00.59E	1953	1923.9	34.9	1917.1	1936.7	C04M01	deployment	Sec. D.O. sensor was removed.
C04	2	062007	3:12	6:19	00-19.39S	155-57.47E	1926	998.9	-	994.7	1002.8	C04M02	recovery	
C05	1	062107	3:04	4:05	02-00.90S	155-59.34E	1756	1010.4	-	995.0	1002.8	C05M01	deployment	
C07	1	062607	3:06	4:09	00-01.11S	147-00.14E	4545	1002.3	-	995.1	1002.8	C07M01	recovery	
C07	2	062907	3:07	6:06	00-04.51N	146-59.98E	4459	994.3	-	992.3	999.4	C07M02	deployment	
C08	1	062907	20:04	20:41	02-05.28N	146-58.05E	4490	1007.5	-	992.8	1002.5	C08M01	recovery	Not sampling.
C08	2	063007	3:07	5:59	02-04.47N	146-57.20E	4492	4572	25.9	4454.0	4526.8	C08M02	-	After this cast, T, C,D.O. sensor was cleane
C08	3	070107	3:04	3:43	02-05.50N	146-57.98E	4494	1038.8	-	996.2	1001.7	C08M03	deployment	
C09	1	070107	23:08	1:51	05-01.63N	146-57.55E	4244	4329.2	10.5	4218.7	4286.2	C09M01	recovery	
C09	2	070207	6:17	6:53	04-58.23N	147-00.63E	4286	1026.5	-	991.7	1000.0	C09M02	deployment	

Table 6.2.1.-2 Sampling layer

Stn. C01			Stn. C02			Stn. C03		Stn. C04		Stn. C05	Stn. C07		Stn. C08			Stn. C09	
cast1	cast2	cast3	cast1	cast2	cast3	cast1	cast2	cast1	cast2	cast1	cast1	cast2	cast1	cast2	cast3	cast1	cast2
sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)	sampling depth(dbar)
－	10	－	－	10	－	10	－	10	－	10	10	－	－	10	－	10	－
－	50	－	－	50	－	50	－	50	－	50	50	－	－	50	－	50	－
－	100	－	－	100	－	100	－	100	－	100	100	－	－	100	－	100	－
－	150	－	－	150	－	150	－	150	－	150	150	－	－	150	－	150	－
－	200	－	－	200	－	200	－	200	－	200	200	－	－	200	－	200	－
－	250	－	－	250	－	250	－	250	－	250	250	－	－	250	－	250	－
－	300	－	－	300	－	300	－	300	－	300	300	－	－	300	－	300	－
－	400	－	－	400	－	400	－	400	－	400	400	－	－	400	－	400	－
－	500	－	－	500	－	500	－	500	－	500	500	－	－	500	－	500	－
－	600	－	－	600	－	600	－	600	－	600	600	－	－	600	－	600	－
－	800	－	－	800	－	800	－	800	－	800	800	－	－	800	－	800	－
－	1000	1000	－	1000	1000	1000	1000	1000	1000	1000	1000	1000	－	1000	1000	1000	1000
－	1400	－	－	1400	－	1400	－	1400	－	－	－	－	－	1400	－	1400	－
－	2000	－	－	2000	－	2000	－	bottom	－	－	－	－	－	2000	－	2000	－
－	3000	－	－	3000	－	bottom	－	－	－	－	－	－	－	3000	－	3000	－
－	4000	－	－	bottom	－	－	－	－	－	－	－	－	－	4000	－	4000	－
－	bottom	－	－	－	－	－	－	－	－	－	－	－	－	bottom	－	bottom	－

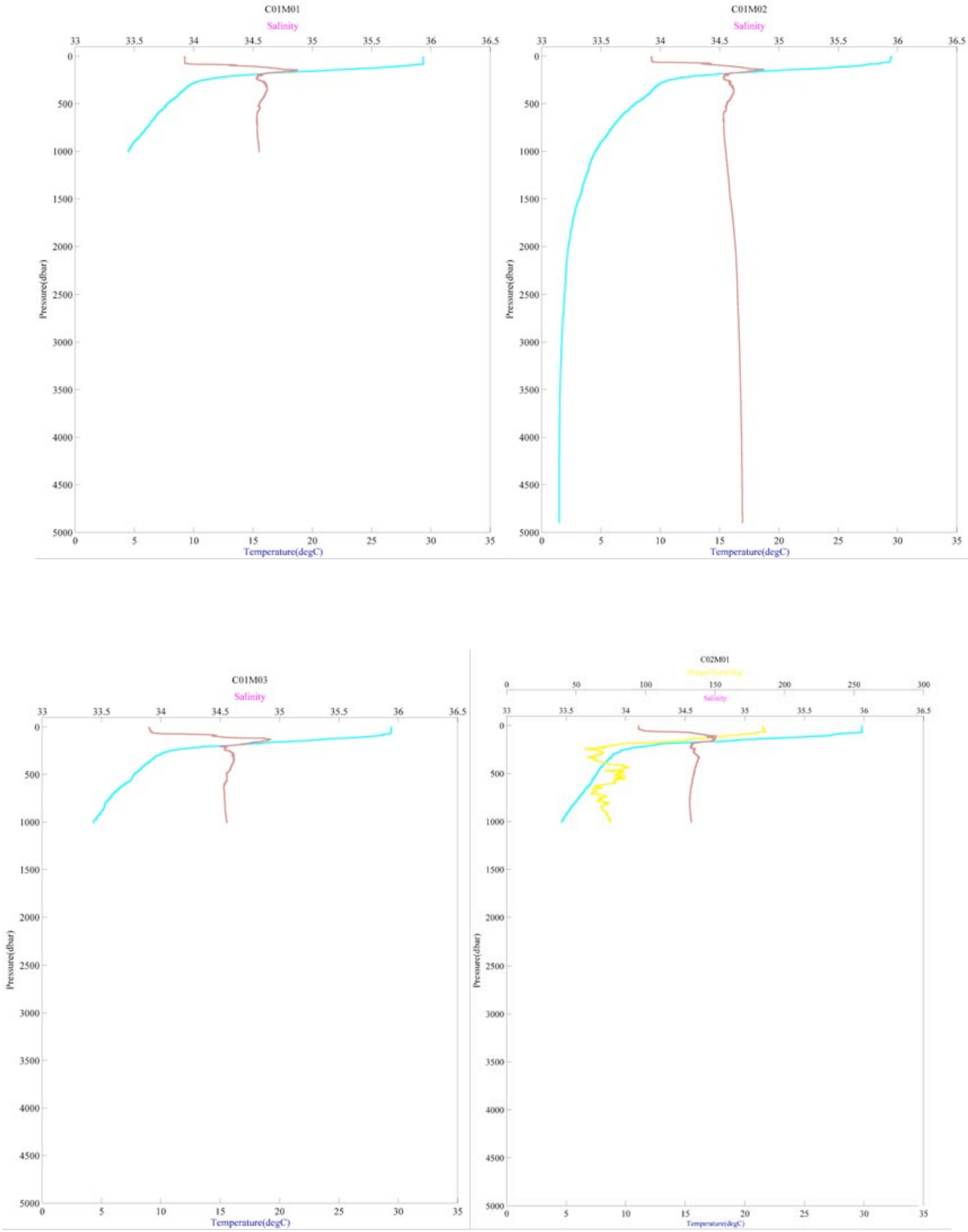


Figure 6.2.1.-1 CTD profile (C01-C02 cast1)

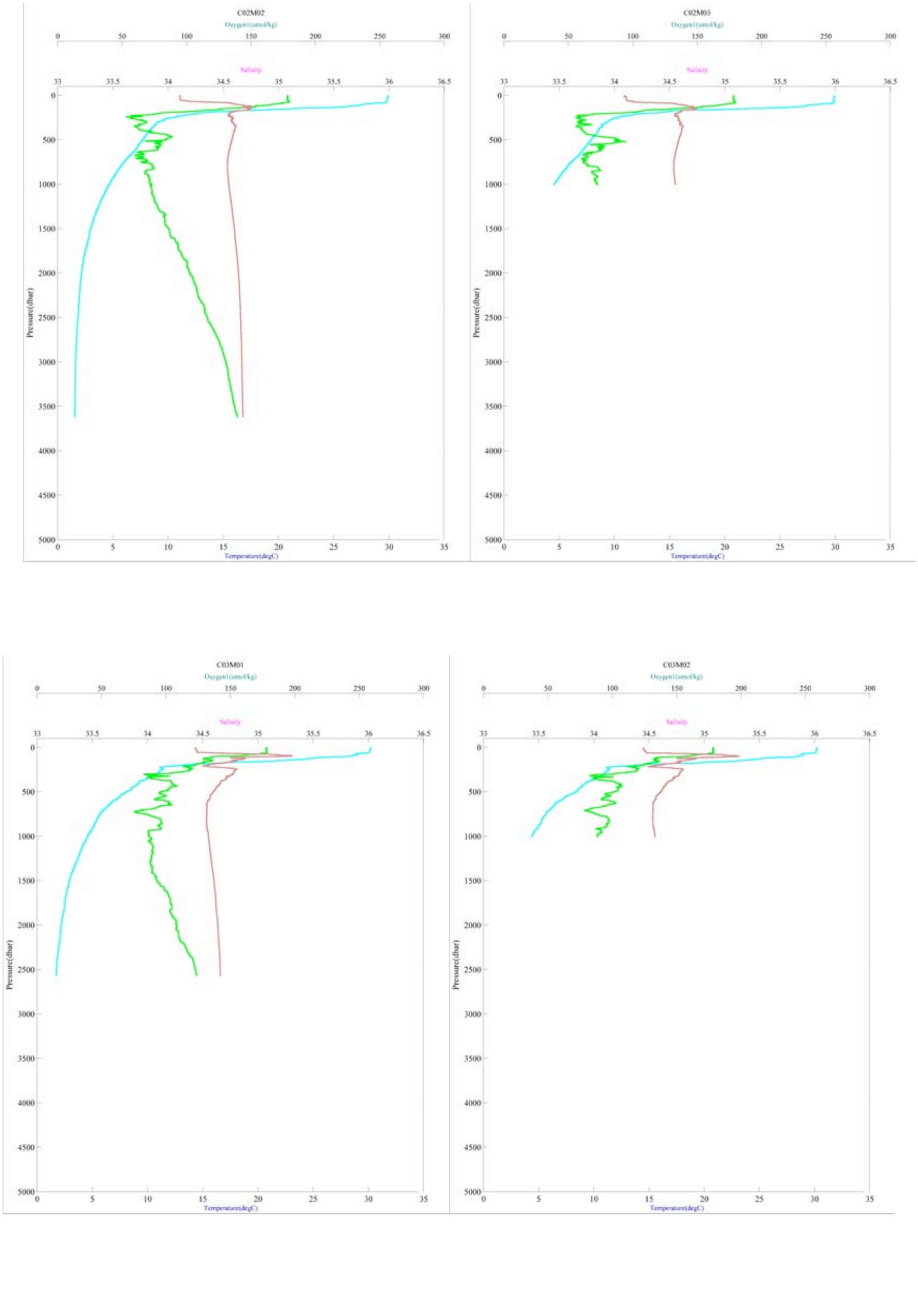


Figure 6.2.1.-2 CTD profile (C02 cast2-C03)

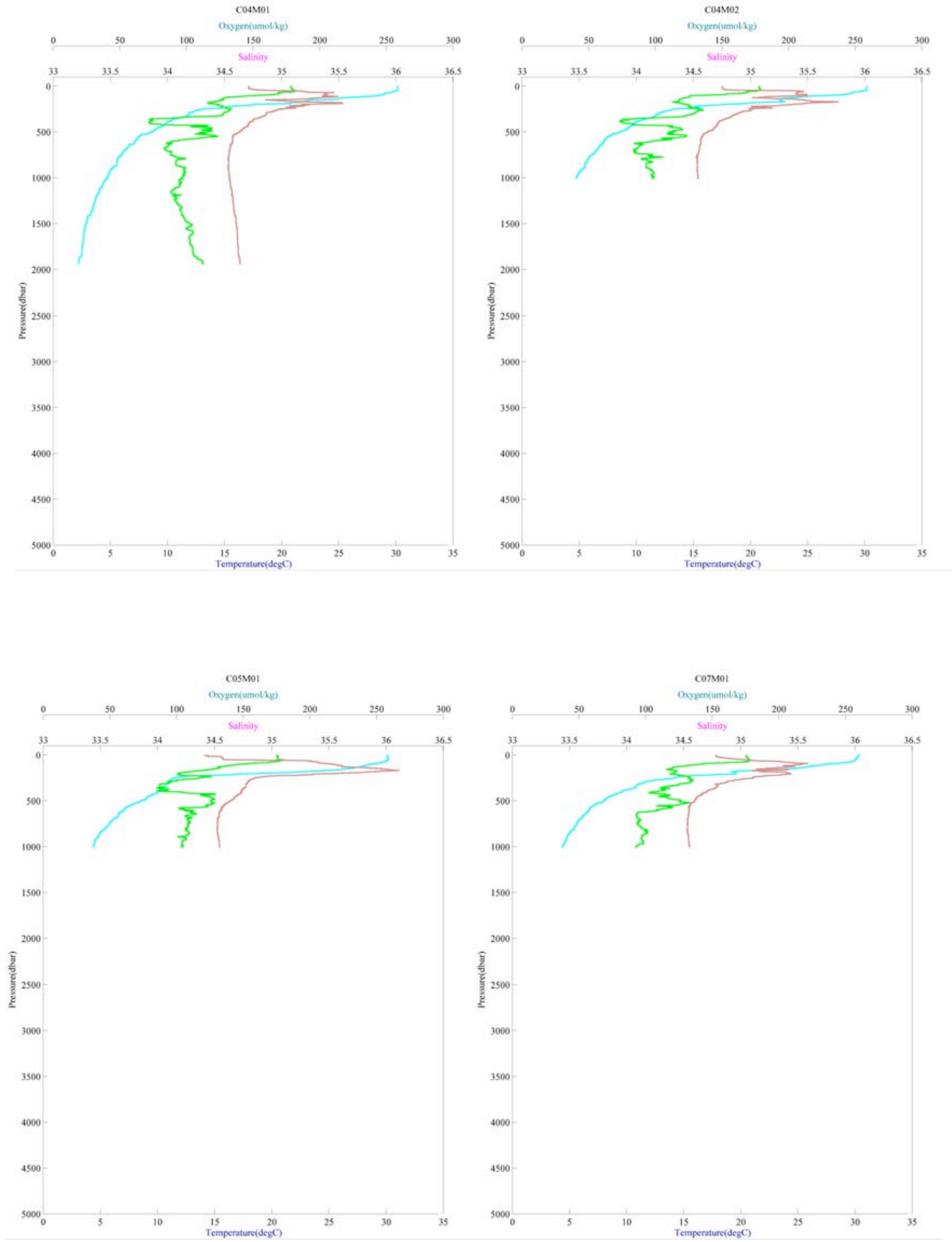


Figure 6.2.1.-3 CTD profile (C04-C07cast1)

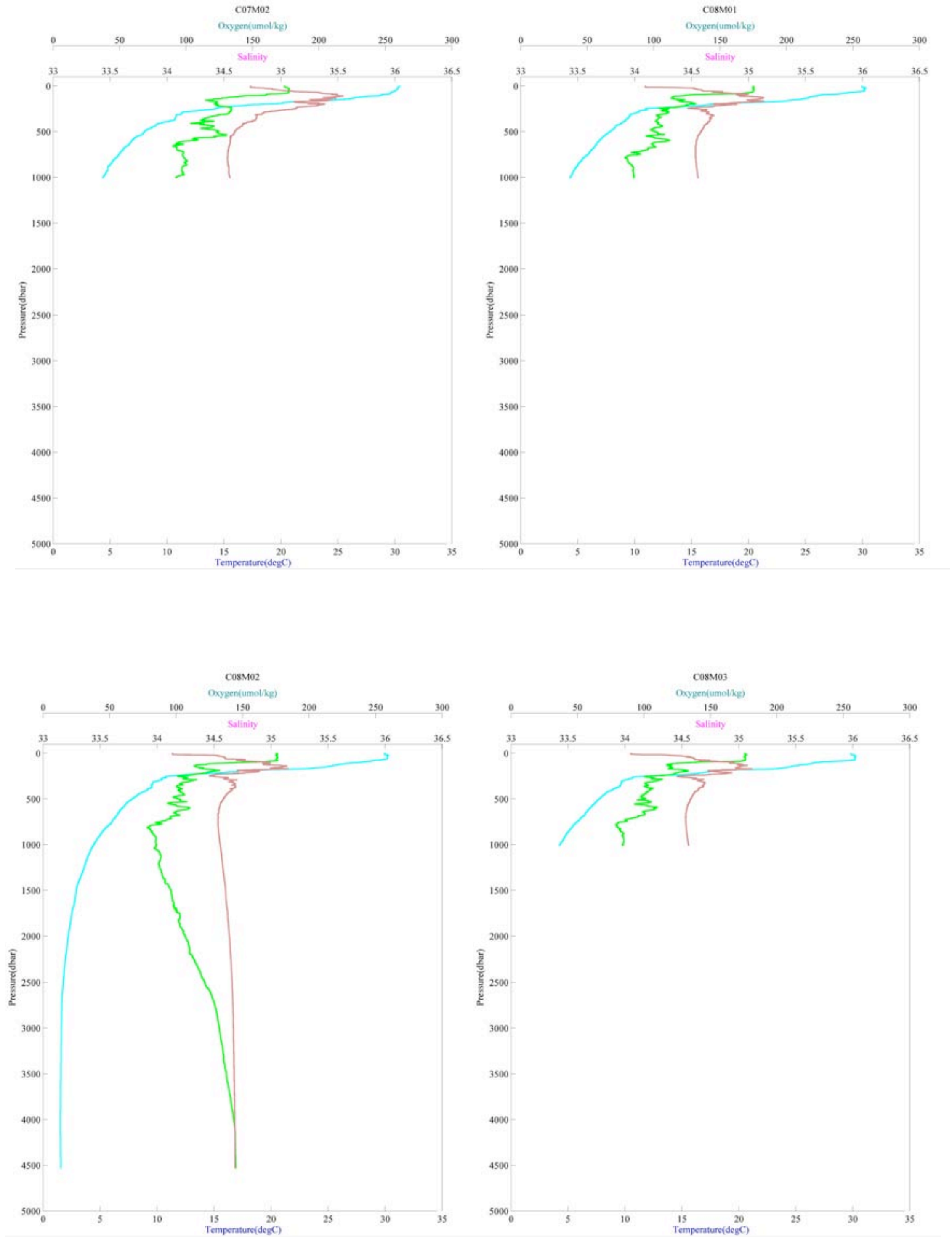


Figure 6.2.1.-4 CTD profile (C07cast2-C08)

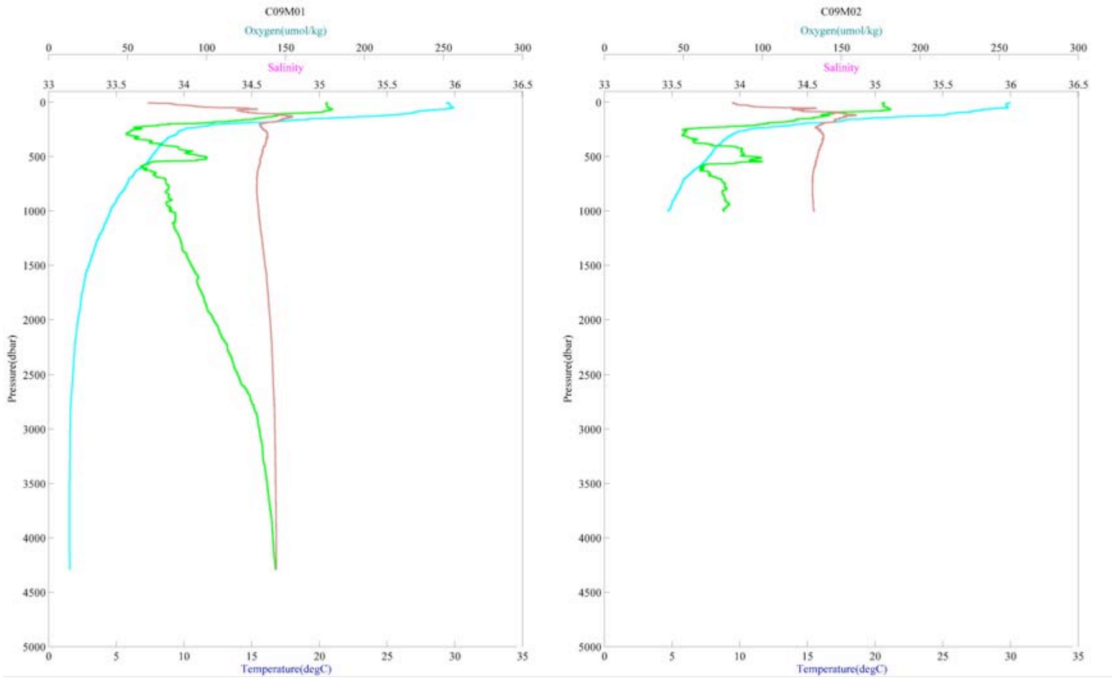


Figure 6.2.1.-5 CTD profile (C09)

6.2.2. XCTD

(1) Personnel

Iwao Ueki (JAMSTEC): Principal Investigator
Wataru Tokunaga (Global Ocean Development Inc.: GODI)
Ryo Kimura (GODI)
Harumi Ota (GODI)

(2) Objectives

Investigation of oceanic structure.

(3) Parameters

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

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

(4) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.08) provided by Tsurumi-Seiki Co.. We launched 18 probes (X001-X009, X011-X019) by using automatic launcher, and 1 probe (X010) by using hand launcher from upper deck. The summary of XCTD observations and launching log were shown in Table 6.2.2-1.

(5) Preliminary results

Position of XCTD observations, Vertical section of temperature and salinity with CTD data were shown in Fig. 6.2.2.-1 to 6.2.2.-3

(6) Data archive

XCTD data obtained during this cruise will be submitted to the JAMSTEC and will be available via "R/V Mirai Data Web Page" in JAMSTEC.

Table 6.2.2.-1 Summary of XCTD observation and launching log

Station No.	Date	Start time	Finish time	Launched position		Measured depth	Water depth	Surface temp	Surface salinity	Probe S/N	Remarks
				Latitude	Longitude						
X001	2007/6/12	8:55:05	9:00	07-00.0064N	156-00.7646E	1035	4443	29.454	33.834	07033413	
X002	2007/6/12	13:54:31	14:00	06-00.0198N	155-57.4065E	1035	4133	29.712	34.114	07033412	
X003	2007/6/14	10:01:24	10:06	03-58.3129N	155-59.4734E	1034	3473	30.066	34.297	07033416	
X004	2007/6/14	15:15:45	15:21	03-00.0210N	156-00.1906E	1035	2870	30.085	34.369	07033415	
X005	2007/6/16	8:34:57	8:40	01-28.9231N	156-00.0283E	1035	2393	30.325	34.507	07033417	
X006	2007/6/16	12:37:37	12:43	01-00.0066N	156-00.9041E	1035	2242	30.173	34.56	07033401	
X007	2007/6/16	16:41:19	16:46	00-30.0101N	156-01.7712E	1035	2144	30.099	34.712	07033400	
X008	2007/6/20	12:29:50	12:35	01-00.0030S	155-59.9173E	1035	2084	30.169	34.608	07033420	
X009	2007/6/21	0:40:40	0:46	02-01.2313S	155-57.3498E	1035	1754	29.984	34.27	07033402	
X010	2007/6/22	10:54:23	11:00	03-01.9519S	155-59.9408E	1100	1816	30.113	34.646	07033405	Hand launcher
X011	2007/6/22	15:09:48	15:15	03-59.9905S	156-00.4269E	1035	1779	30.032	34.666	07033403	
X012	2007/6/23	2:19:25	2:24	05-01.7974S	156-01.3797E	1035	1519	30.173	34.469	07033406	Tr#06 Dep Pos.
X013	2007/6/23	2:53:44	2:59	04-58.6598S	156-00.9840E	1034	1507	30.211	34.478	07033407	Tr#06 Rec Pos.
X014	2007/6/26	1:11:13	1:16	00-03.6750N	147-00.3229E	1035	4465	30.301	34.809	07033408	Tr#09 Dep Pos.
X015	2007/6/29	9:14:25	9:19	00-30.0018N	146-59.5814E	1035	4466	30.298	34.756	07033411	
X016	2007/6/29	12:19:00	12:24	01-00.0057N	147-00.2205E	1049	4507	30.024	34.194	07033409	
X017	2007/6/29	15:30:17	15:35	01-30.0077N	146-59.9373E	1035	4518	30.036	34.397	07033410	
X018	2007/7/1	10:38:27	10:43	03-00.6153N	147-01.3999E	1035	4419	29.819	34.098	07033388	
X019	2007/7/1	15:50:05	15:55	04-00.0114N	147-00.3273E	1035	4685	29.636	34.042	07033389	

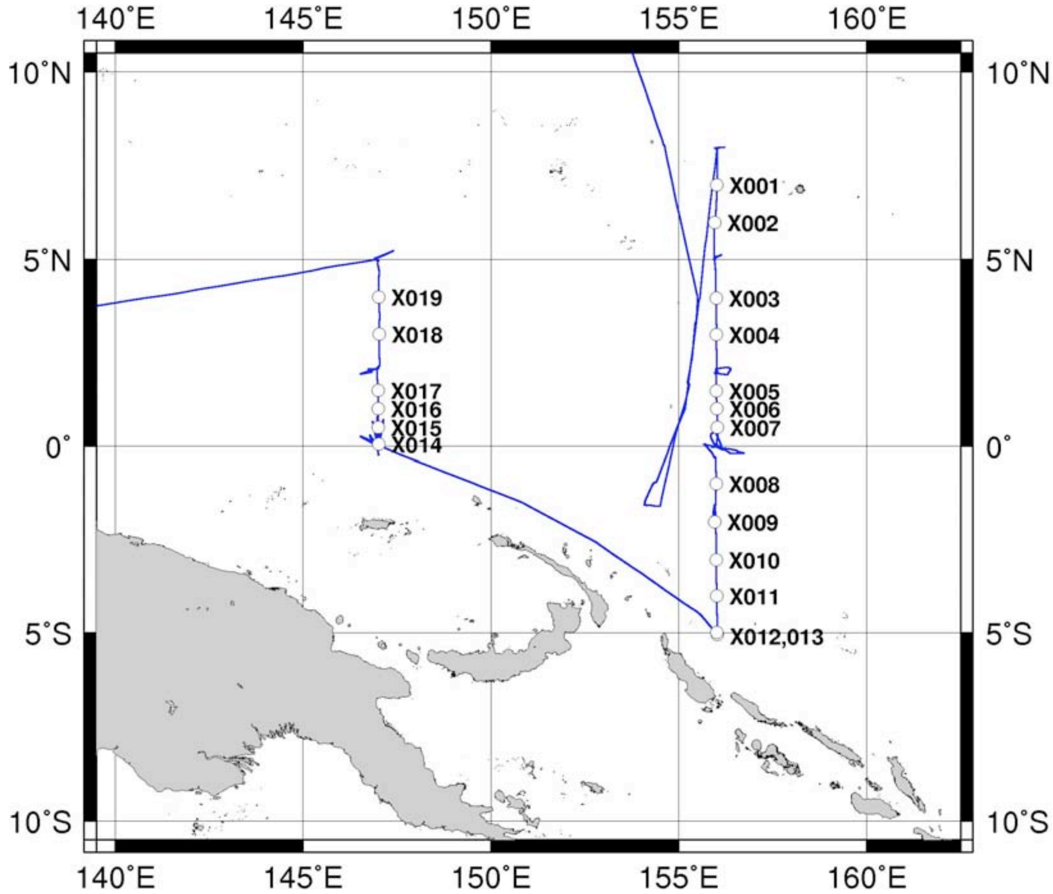


Fig. 6.2.2-1 Position of XCTD observation.

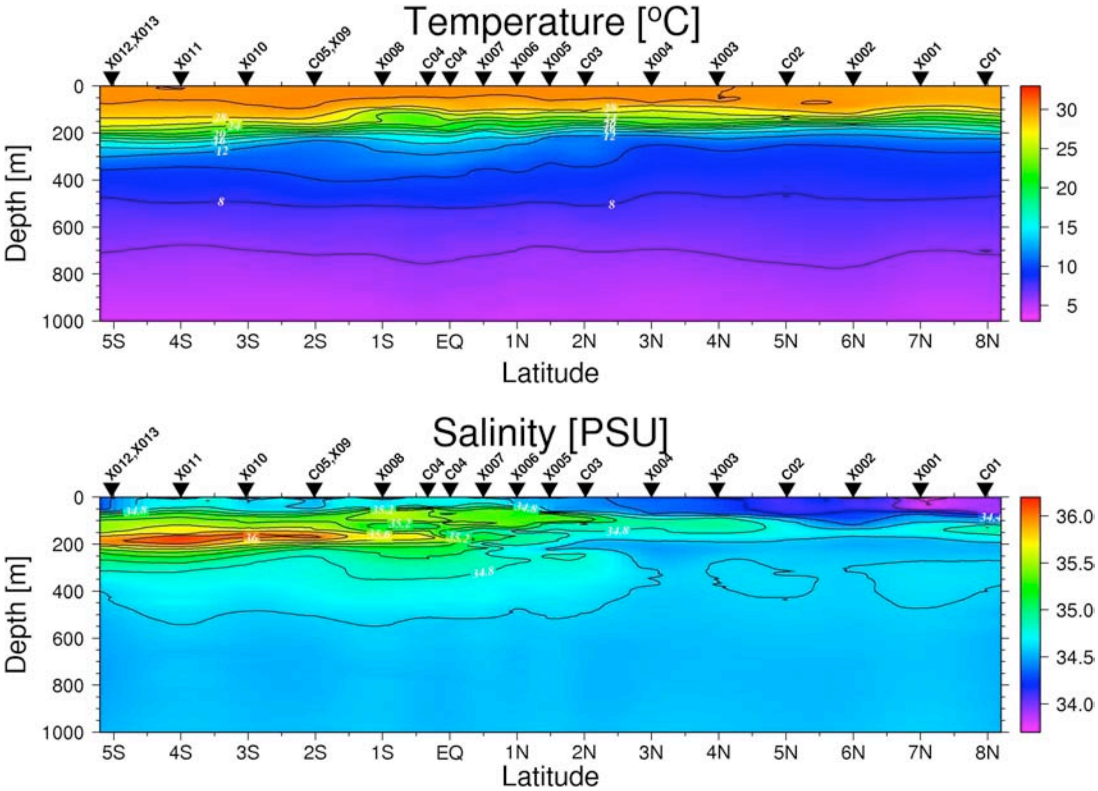


Fig. 6.2.2-2 Vertical section of temperature(upper) and salinity(lower) along 156E line.

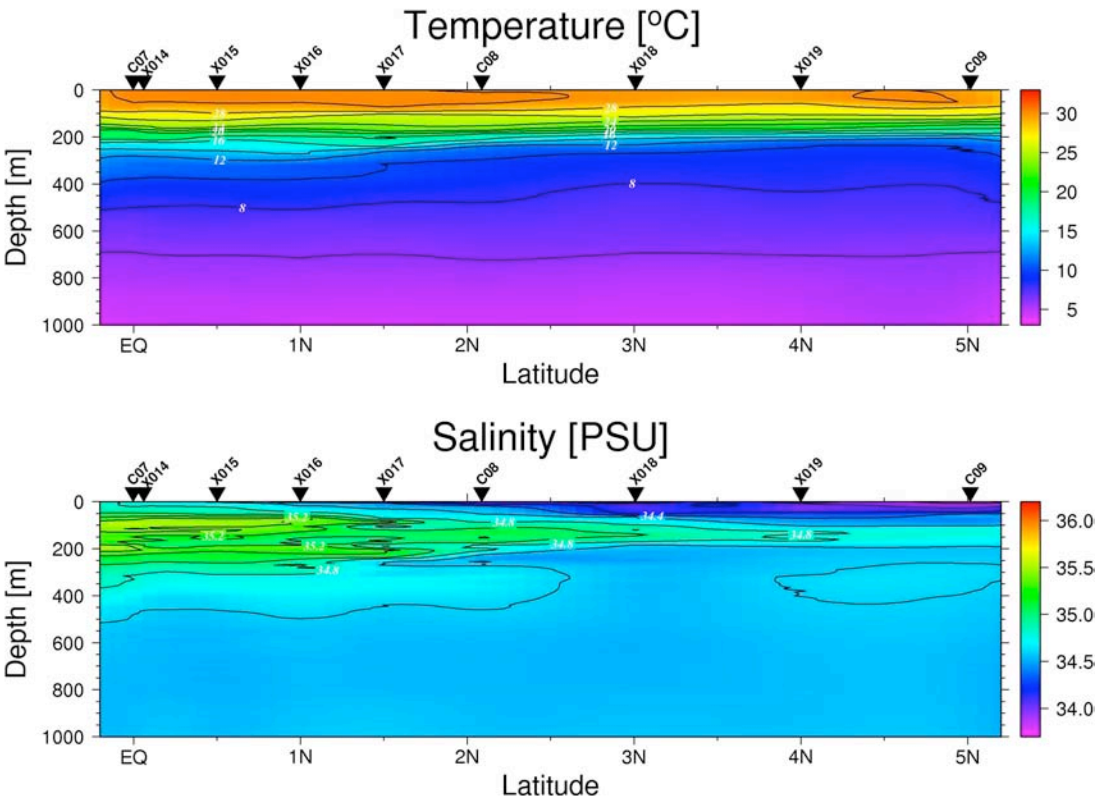


Fig. 6.2.2.-3 Vertical section of temperature(upper) and salinity(lower) along 147˚E line.

6.3.1. Salinity

(1) Personnel

Iwao Ueki (JAMSTEC): Principal Investigator

Fujio Kobayashi (Marine Works Japan Ltd., MWJ): Operation reader

(2) Objectives

Bottle salinities obtained by CTD casts, bucket sampling and EPCS were measured.

(3) Instrument and Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles, bucket, and EPCS. The salinity sample bottle of the 250ml brown grass bottle with screw cap was used to collect the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The sample bottle was sealed with a plastic insert thimble and a screw cap. Its thimble was also thoroughly rinsed. The bottle was stored more than 24 hours in the laboratory before the salinity measurement.

The kind and number of samples are shown as follows ;

Table 6.3.1-1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD and Bucket	163
Samples for EPCS	30
Total	193

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR07-03 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62556) with additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. One thermometer monitored an ambient temperature and the other monitored a bath temperature.

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

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

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

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

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

The measurement system was almost same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. An ambient temperature varied from approximately 21 deg C to 24 deg C, while a bath temperature is very stable and varied within +/- 0.002 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio that is defined as median of 31 times reading of the salinometer. Data collection was started in 5 seconds after filling sample to the cell and it took about 15 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell. In case the difference between the double conductivity ratio of these two fillings is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.0003, eighth filling of the cell was done. In case the difference between the double conductivity ratio of these two fillings is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity.

The measurement was conducted about 8 hours per day and the cell was cleaned with soap and thin-ethanol after the measurement of the day.

(4) Preliminary Result

a. Standard Seawater

Standardization control of the salinometer was set to 832 and all measurements were done in this setting. The value of STANDBY was 5525 +/- 0001 and that of ZERO was 0.0+0001 or 0.0+0002. IAPSO Standard Seawater batch P148 and P147 which both of their conductivity ratio were 0.99982 (double conductivity ratio is 1.99964) were used as the standard for salinity. 18 bottles of P148 and 7 bottles of P147 were measured.

Note: The Standard Seawater batch P147 was used for the drift check of AUTOSAL as the complement of batch P148 in the measurement on July 7.

Fig.6.3.1-1 shows the history of double conductivity ratio of the Standard Seawater batch P148. The average of double conductivity ratio was 1.99963 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity.

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

Fig.6.3.1-2 shows the history of double conductivity ratio of the Standard Seawater batch P148 after correction. The average of double conductivity ratio For after correction was 1.99964 and the standard deviation was 0.00001, which is equivalent to 0.0001 in salinity.

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

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

batch	:	P147
conductivity ratio	:	0.99982
salinity	:	34.993
preparation date	:	06-June-2006

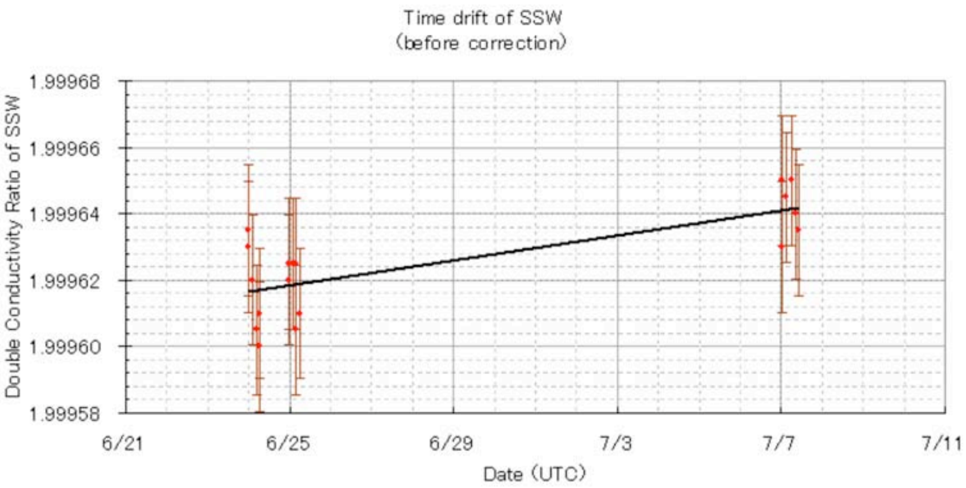


Fig. 6.3.1-1 History of double conductivity ratio for the Standard Seawater batch P148 (before correction)

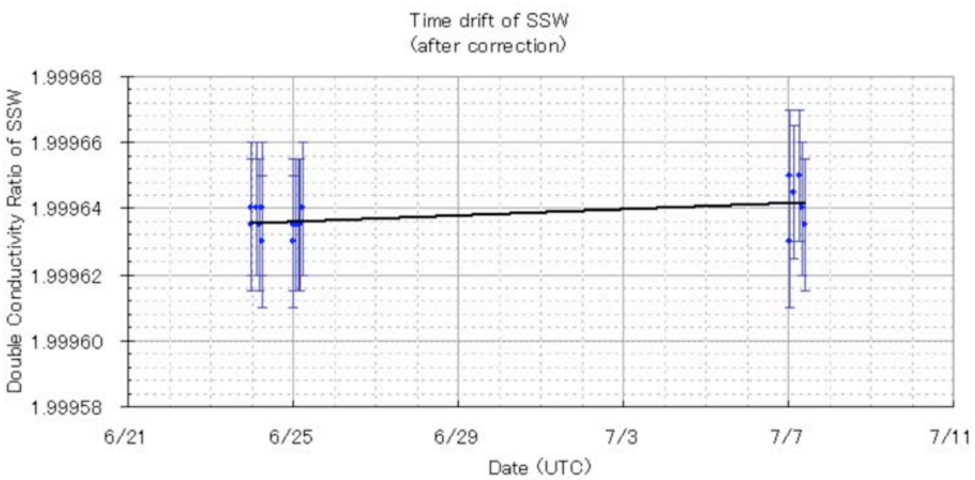


Fig. 6.3.1-2 History of double conductivity ratio for the Standard Seawater batch P148 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 5 samples in order to check the possible sudden drift of the salinometer.

c. Replicate Samples

29 pairs of replicate samples were taken. The standard deviation of the absolute deference of replicate samples was 0.0004 in salinity.

(5) Data archive

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

(6) Reference

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

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

6.3.2. Dissolved oxygen measurement

(1) Personnel

Iwao Ueki (JAMSTEC): Principal Investigator

Masanori Enoki (Marine Works Japan Co. Ltd., MWJ): Operation reader

(2) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(3) Measured parameters

Dissolved oxygen of sampled seawater

(4) Instruments and Methods

a. Reagents

Pickling Reagent I: Manganous chloride solution (3M)

Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)

Sulfuric acid solution (5M)

Sodium thiosulfate (0.025M)

Potassium iodate (0.001667M)

b. Instruments:

Burette for both sodium thiosulfate and potassium iodate;

APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel

Detector and Software; Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

c. Sampling

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

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

d. Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen concentration using of the titration apparatus (DOT-03). Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of CTD-data , and titrated volume of sodium thiosulfate solution without the blank.

e. Standardization and determination of the blank

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

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

Table 6.3.2-1 shows results of the standardization and the blank determination during this cruise.

Table 6.3.2-1 Results of the standardization and the blank determinations during this cruise.

Date	KIO_3		DOT-03 (cm^3)			Samples
(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	(Stations)
2007/06/10	1	20070424-1-7	20070531-2	3.962	-0.007	C01, C02, C03,C04, C05
2007/06/25	2	20070425-1-1	20070531-3	3.964	-0.005	C07, C08, C09

Batch number of the KIO_3 standard solution.

f. Reproducibility of sample measurement

Replicate samples were taken at every CTD cast; usually these were 5 - 10 % of seawater samples of each cast during this cruise. Results of the replicate samples were shown in Table 6.3.2-2 and this histogram shown in Fig.6.3.2-1. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

Table 6.3.2-2 Results of the replicate sample measurements

Number of replicate sample pairs	Oxygen concentration (μmol/kg)
	Standard Deviation.
46	0.07

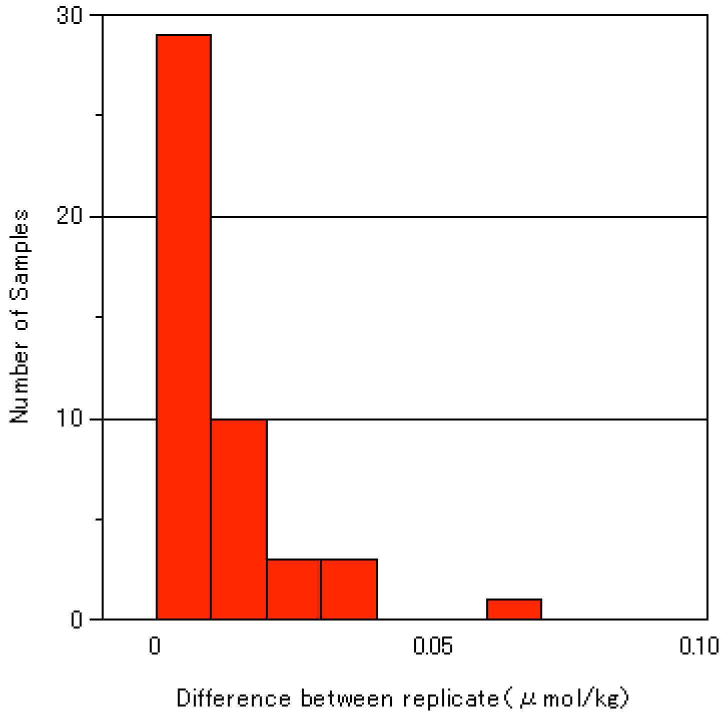


Fig 6.3.2-1 Results of the replicate sample measurements

(5) Preliminary Result

During this cruise, we measured oxygen concentration in 173 seawater samples at 8 stations.

(6) Data archive

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

(7) Reference

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

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

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

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

6.4.1. EPCS

(1) Personnel

Iwao Ueki (JAMSTEC): Principal Investigator

Masanori Enoki (Marine Works Japan Co. Ltd., MWJ): Operation reader

(2) Objectives

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

(3) Instruments and Methods

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

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

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

a) Temperature and Conductivity sensor

SEACAT THERMOSALINOGRAPH

Model: SBE-21, SEA-BIRD ELECTRONICS, INC.

Serial number: 2126391-3126

Measurement range: Temperature -5 to +35℃, Conductivity 0 to 6.5 S m-1

Accuracy: Temperature 0.01℃ 6month-1,Conductivity 0.001 S m-1 month-1

Resolution: Temperatures 0.001℃, Conductivity 0.0001 S m-1

b) Bottom of ship thermometer

Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.

Serial number: 032175

Measurement range: -5 to +35℃

Resolution: ±0.001℃

Stability: 0.002℃ year-1

c) Dissolved oxygen sensor

Model: 2127A, HACH ULTRA ANALYTICS JAPAN, INC.

Serial number: 44733

Measurement range: 0 to 14 ppm

Accuracy: ±1% at 5℃ of correction range

Stability: 1% month-1

d) Fluorometer

Model: 10-AU-005, TURNER DESIGNS

Serial number: 5562 FRXX

Detection limit: 5 ppt or less for chlorophyll a

Stability: 0.5% month-1 of full scale

e) Flow meter

Model: EMARG2W, Aichi Watch Electronics LTD.

Serial number: 8672

Measurement range: 0 to 30 l min-1

Accuracy: ±1%

Stability: ±1% day-1

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

Start : 2007/6/2	02:46	Stop : 2007/6/23	06:05
Start : 2007/6/24	23:35	Stop : 2007/7/3	13:15
Start : 2007/7/8	00:32	Stop : 2007/07/12	00:00

(4) Preliminary Result

Preliminary data of temperature (thermometer of ship bottom), salinity, dissolved oxygen, fluorescence at sea surface during this cruise are shown in Fig.6.4.1-1. We collected samples to compare a bottle data with a sensor value of salinity, dissolved oxygen and fluorescence once a day. They are shown in Fig.6.4.1-2~4. All salinity samples were analyzed by the Guildline AUTOSAL 8400B, dissolve oxygen samples were analyzed by the KIMOTO DOT-01, fluorescence samples were analyzed by Non-acidification method, using 10-AU-005,TURNER DESIGNS.

(5) Data archive

The data were stored on a magnetic optical disk, which will be submitted to the Data Management

Office (DMO) JAMSTEC, and will be opened to public via "R/V MIRAI Data Web Page" in JAMSTEC homepage.

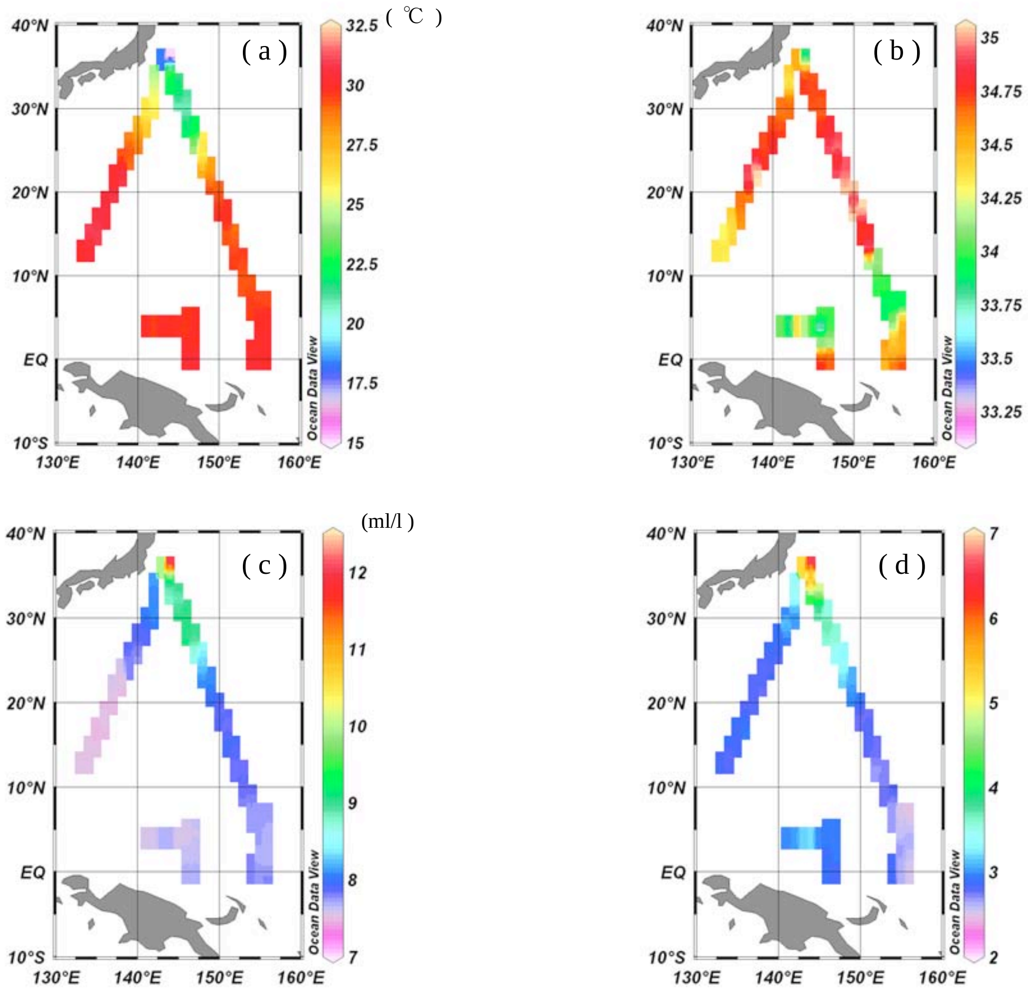


Fig. 6.4.1-1 Contour line of temperature(a), salinity(b), dissolved oxygen(c), fluorescence(d) of the sea surface water during this cruise.

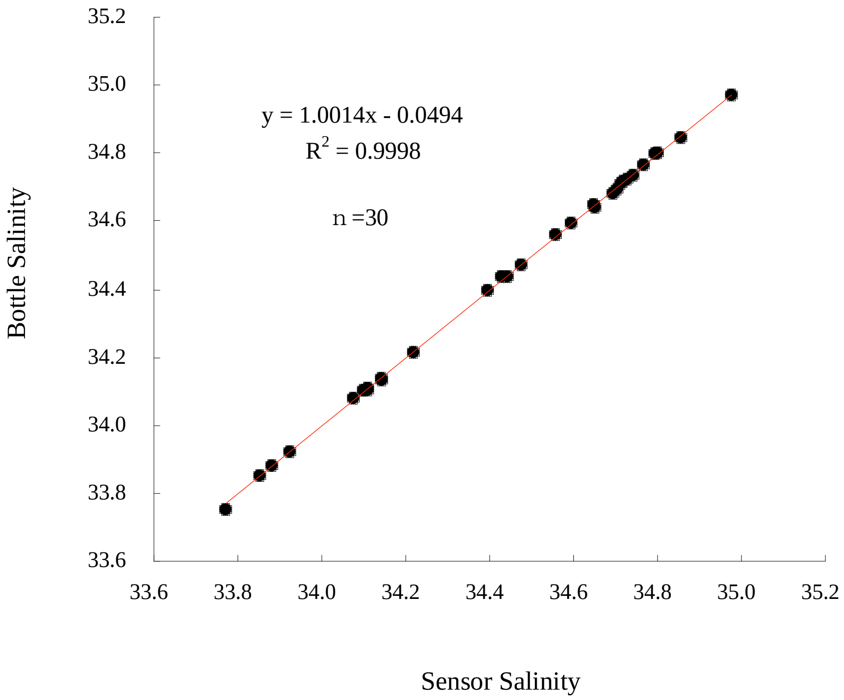


Fig.6.4.1-2 Comparison between salinity sensor and bottle data.

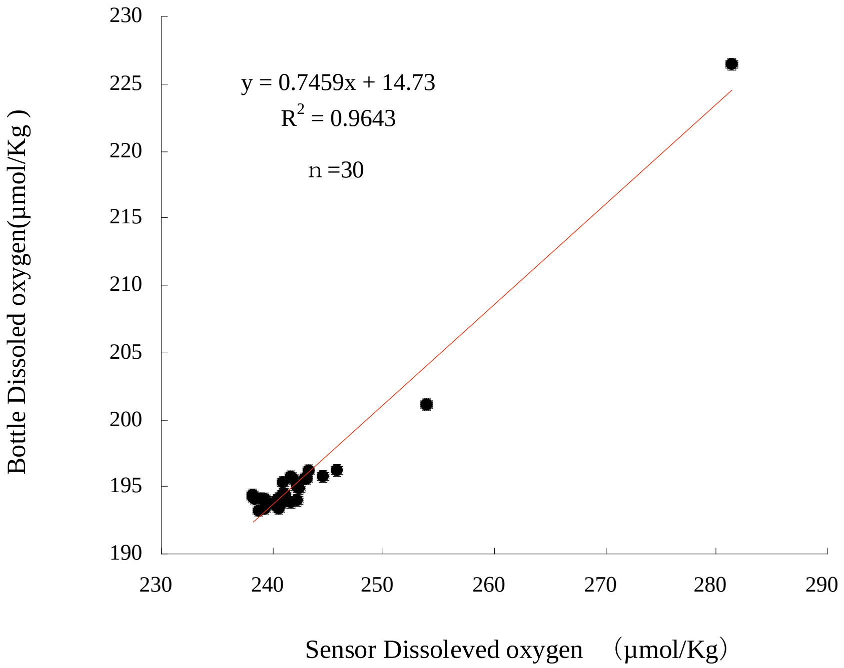


Fig.6.4.1-3 Comparison between dissolved oxygen sensor and bottle data.

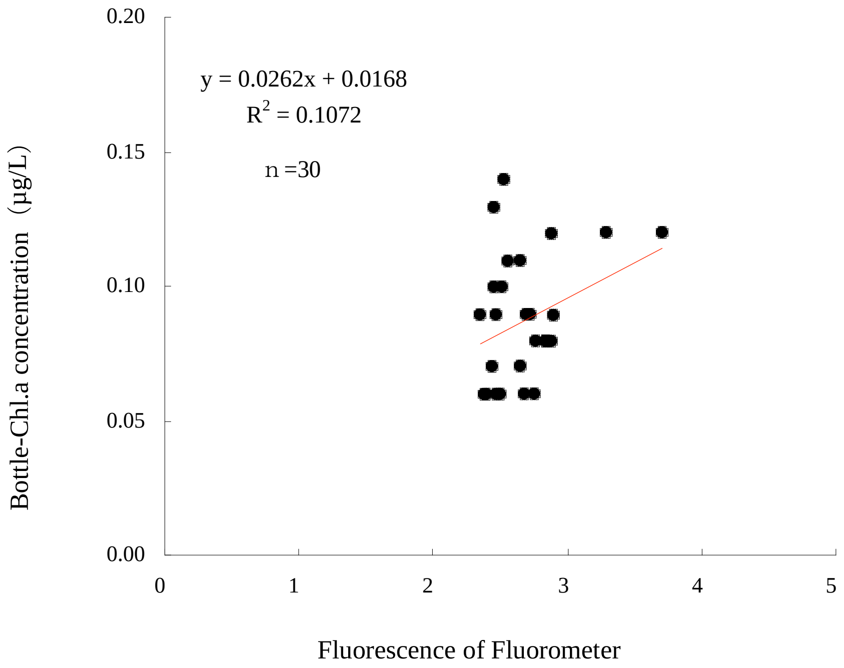


Fig.6.4.1-4 Comparison between Fluorometer sensor and bottle data.

6.4.2. pCO_2 measurement

(1) Prsonnel

Iwao Ueki (JAMSTEC): Principal Investigator

Shinichiro Yokogawa (Marine Works Japan Co. Ltd., MWJ): Operation reader

(2) Objectives

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

When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1997). We here report on board measurements of pCO_2 during MR07-03 cruise.

(3) Method

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

The automated system was operated by on one and a half hour cycle. In one cycle, standard gasses, marine air and equilibrated air with surface seawater within the equilibrator were analyzed subsequently. The concentrations of the standard gas were 299.90, 349.99, 399.94 and 449.99 ppm.

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

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

(4) Preliminary results

Figure 6.4.2-1 is showing the results of measuring the CO_2 concentration (xCO_2) of ambient air samples and the seawater samples.

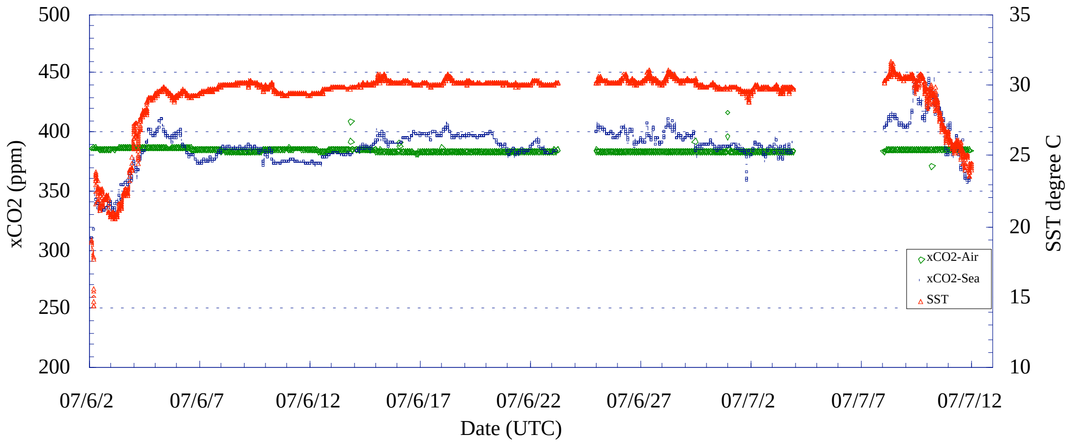


Figure 6.2.4-1 Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(5) Notification

The observation was stopped from 05:58-2007/06/23 to 23:07-2007/06/24 in the territorial waters of Papua New Guinea and from 13:15-2007/07/03 to 00:13-2007/07/08 in the non-application area in Federated States of Micronesian EEZ, Indonesian EEZ and the Republic of Palau islands' EEZ.

(6) Data archive

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

(7) Reference

DOE (1997), Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74.

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

6.5. Shipboard ADCP

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Wataru Tokunaga	(Global Ocean Development Inc., GODI)
Ryo Kimura	(GODI)
Harumi Ota	(GODI)

(2) Objective

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

(3) Methods

Upper ocean current measurements were made throughout MR07-03 cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. For most of its operation, the instrument was configured for water-tracking mode recording. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made in shallower water region to get the calibration data for evaluating transducer misalignment angle. The system consists of following components;

i) 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
ii) The Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements to the ADCP.
iii) A GPS navigation receiver (Trimble 4000DS) providing position fixes.
iv) A personal computer running data acquisition software (VmDas version 1.4.0, RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 3 minutes.
v) High-precision attitude information, heading, pitch and roll, are also stored in N2R data files with a time stamp.

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

(4) Preliminary results

Fig. 6.5-1 was showed an hour averaged surface (30 – 100m) current vector along the ship track. Fig. 6.5-2 and Fig. 6.5-3 were showed water current profiles (eastward and northward) of along 156E and 147E. These data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

(5) Data archive

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

(6) Remarks

1) Deck unit replaced form "S/N 090" to "SN/ 136" on 11 June.
   i) S/N 090; 20:14 UTC, 31 May - 05:38 UTC, 11 June.
   ii) S/N 136; 05:51 UTC, 11 June - 00:00 UTC, 14 July.
2) Data acquisition stopped in the territorial waters of Papua New Guinea, non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ.
   i) Territorial waters of the Papua New Guinea; 07:00, 23 June - 20:00, 24 June
   ii) non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ; 03:15, 03 July - 00:00, 08 July

Table 6.5-1 Major parameters

Bottom-Track Commands	
BP = 001	Pings per Ensemble (almost less than 1000m depth) 18:00 UTC, 31 May - 13:57 UTC, 1 June UTC, July - 00:00 UTC, 14 July
BP = 000	Disable bottom-track ping (almost over 1000m depth) 14:00 UTC, 1 June – UTC, July
Environmental Sensor Commands	
EA = +00000	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +0001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001	Sensor Source (C; D; H; P; R; S; T) C (1): Sound velocity calculates using ED, ES, ET (temp.) D (0): Manual ED H (2): External synchro P (0), R (0): Manual EP, ER (0 degree) S (0): Manual ES T (1): Internal transducer sensor
Timing Commands	
TE = 00:00:02.00	Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:02.00	Time per Ping (min:sec.sec/100)
Water-Track Commands	
WA = 255	False Target Threshold (Max) (0-255 counts)
WB = 1	Mode 1 Bandwidth Control (0=Wid, 1=Med, 2=Nar)
WC = 064	Low Correlation Threshold (0-255)
WD = 111 111 111	Data Out (V; C; A PG; St; Vsum; Vsum^2;#G;P0)
WE = 5000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WG = 001	Percent Good Minimum (0-100%)
WI = 0	Clip Data Past Bottom (0 = OFF, 1 = ON)
WJ = 1	Rcvr Gain Select (0 = Low, 1 = High)
WM = 1	Profiling Mode (1-8)
WN = 040	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 1600	Depth Cell Size (cm)
WT = 000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)

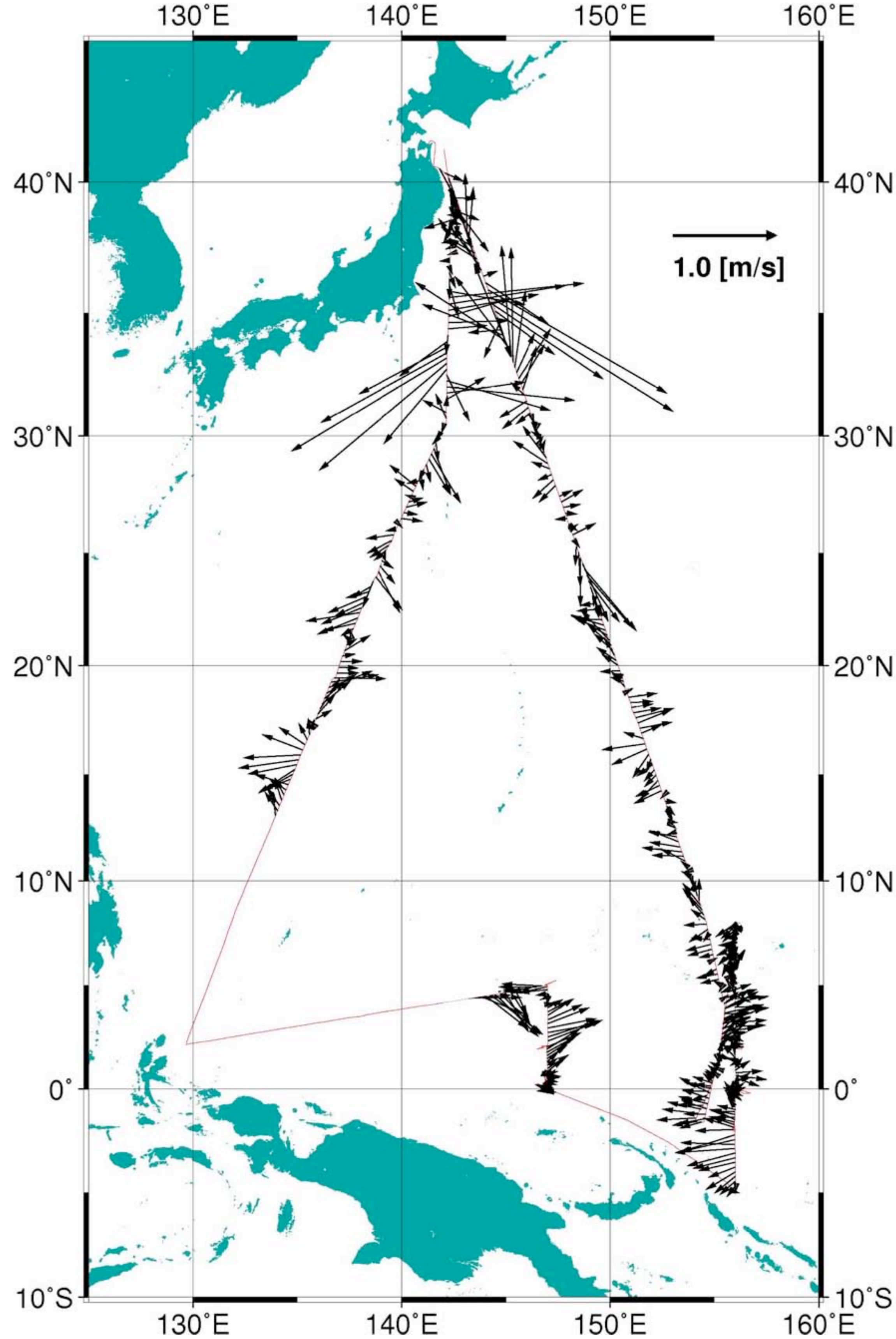


Fig. 6.5-1 An hour averaged surface (40 - 100 m) current vector along the ship track.

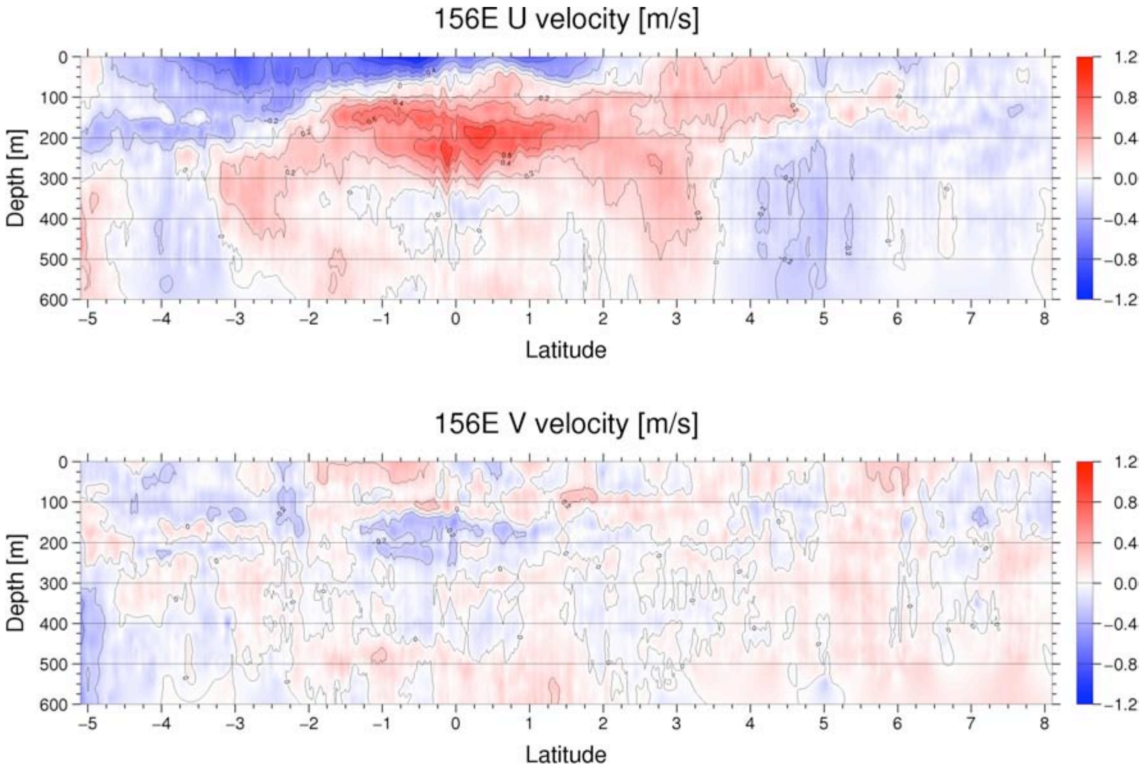


Fig. 6.5-2 Water current profiles of 156E.

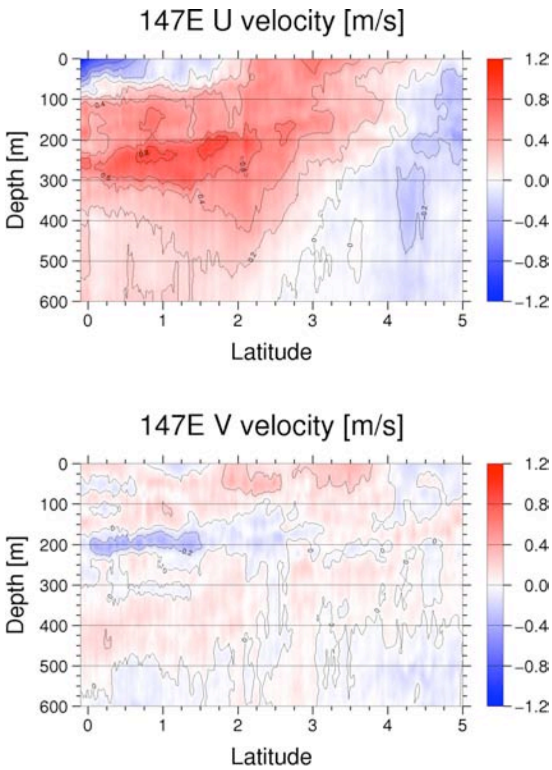


Fig. 6.5-3 Water current profiles of 147E.

6.6. Underway geophysics

6.6.1. Sea surface gravity

(1) Personnel

Takeshi Matsumoto	(University of the Ryukyus): Principal investigator / Not on-board
Wataru Tokunaga	(Global Ocean Development Inc.: GODI)
Ryo Kimura	(GODI)
Harumi Ohta	(GODI)

(2) Introduction

The difference of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR07-03 cruise from 31 May 2007 to 14 July 2007, except for the territorial waters of the Papua New Guinea and the EEZ of the Republic of Indonesia and the Republic of Palau islands.

(3) Parameters

Relative Gravity [CU: Counter Unit]

[mGal] = (coef1: 0.9946) * [CU]

(4) Data Acquisition

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

(5) Preliminary Results

Absolute gravity shown in Tabel 6.6.1-1

Table 6.6.1-1

No.	Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R *[2] Gravity [mGal]
#1	June/31	04:04	Sekinehama	980371.93	264	612	980372.78	12642.22
#2	July/14	03:56	Sekinehama	980371.93	300	615	980372.90	12641.78

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

Differential	G at sensor	L&R value
No.2 - No.1	0.12 mGal ---(a)	-0.79 mGal ---(b)
L&R drift value (b)-(a)	-0.914 mGal	44.98 days
Daily drift ratio	**-0.020 mGal/day**	

(6) Data archives

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

(7) Remarks

1) Data acquisition stopped in the territorial waters of Papua New Guinea, non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ.

23 June, 07:00 - 24 June, 20:00	(the Papua New Guinea, territorial waters)
04 July, 19:44 - 08 July, 00:00	((non-application area in Federated States of Micronesian EEZ, Indonesian EEZ and Republic of Palau islands' EEZ)

2) ETOVOS correction value error beacause of GPS (SOG or COG) error.

02 June, 12:49:46, 16:57:34
03 June, 18:33:34
06 June, 22:06:00
11 June, 11:05:00, 22:19:02
13 June, 12:35:13
15 June, 08:59:37
17 June, 02:00:46, 10:58:15
18 June, 06:26:27, 10:52:19
21 June, 17:59:20, 17:59:21
25 June, 10:56:38, 20:29:36, 20:29:37
27 June, 19:36:27
28 June, 01:40:00, 01:40:01, 02:53:04, 21:24:36
29 June, 07:12:56
30 June, 03:04:45, 11:00:27, 11:55:19, 23:15:04, 23:15:05, 23:24:43
01 July, 00:13:45, 15:38:43, 22:39:26, 23:07:34
02 July, 19:02:41
03 July, 11:31:39
08 July, 08:47:15, 09:56:50
09 July, 04:05:58
11 July, 23:45:42
12 July, 17:21:10

6.6.2. Sea Surface three-component magnetic field

(1) Personnel

Takeshi Matsumoto	(University of the Ryukyus): Principal investigator/Not on-board
Wataru Tokunaga	(Global Ocean Development Inc., GODI)
Ryo Kimura	(GODI)
Harumi Ohta	(GODI)

(2) Introduction

Measurements of magnetic force on the sea are required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR07-03 cruise from 31 May 2007 to 14 July 2007, except for the territorial waters of the Papua New Guinea and the EEZ of the Republic of Indonesia and the Republic of Palau islands.

(3) Principle of ship-board geomagnetic vector measurement

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

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

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

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

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

(4) Instruments on R/V Mirai

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

(5) Data archive

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

(6) Remarks

1) For calibration of the ship's magnetic effect, we made a running like a "Figure of 8" (a pair of clockwise and anti-clockwise rotation). The periods are follows;

04:25, June 16 - 04:45, June 16	(01-56.3N, 155-59.4E)
06:27, June 20 - 06:46, June 20	(00-18.2N, 155-58.6E)
19:31, June 22 - 19:51, June 22	(04-52.3S, 156-01.9E)
00:25, June 29 - 00:49, June 29	(00-03.5N, 146-55.5E)
05:00, July 13 - 05:36, July 13	(41-23.0N, 141-59.0E)

2) Data acquisition stopped in the territorial waters of Papua New Guinea, non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ.

23 June, 07:00 - 24 June, 20:00	(the Papua New Guinea, territorial waters)
04 July, 19:44 - 08 July, 00:00	((non-application area in Federated States of Micronesian EEZ, Indonesian EEZ and Republic of Palau islands' EEZ)

3) Data acquisition suspended, because we changed the VRU. The periods are follows;

02:02:19, June 22 - 02:02:32, June 22	(We have converted from PHINS to NAV)
02:52:04, June 22 - 02:52:14, June 22	(We have converted from NAV to PHINS)
06:35:01, June 29 - 06:35:06, June 29	(We have converted from PHINS to NAV)
07:21:01, June 29 - 07:21:05, June 29	(We have converted from NAV to PHINS)

6.6.3. Swath Bathymetry

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Wataru Tokunaga	(Global Ocean Development Inc., GODI)
Ryo Kimura	(GODI)
Harumi Ohta	(GODI)
Takeshi Matsumoto	(University of the Ryukyus): Not on-board

(2) Introduction

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets. In addition, we need to estimate the depth at the location of deployment of TRITON buoys in order to design these mooring systems.

(3) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during the MR07-03 cruise from 1 June 2007 to 12 July 2007, except for the territorial waters of the Papua New Guinea and the EEZ of the Republic of Indonesia and the Republic of Palau islands. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the sea surface (6.2m) sound velocity, and the others depth sound velocity calculated temperature and salinity profiles from CTD and XCTD data by the equation in Mackenzie (1981) during the cruise.

Table 6.6.3-1 listed system configuration and performance of SEABEAM 2112.004 system.

Table 6.6.3-1 System configuration and performance

SEABEAM 2112.004 (12 kHz system)

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

(4) Preliminary Results

The results will be published after primary processing.

(5) Data archive

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

(6) Remark

Data acquisition stopped in the territorial waters of Papua New Guinea, non-application area in Federated States of Micronesian EEZ and Indonesian EEZ and the Republic of Palau islands' EEZ.

23 June, 07:00 - 24 June, 20:00	(the Papua New Guinea, territorial waters)
04 July, 19:44 - 08 July, 00:00	(non-application area in Federated States of Micronesian EEZ, Indonesian EEZ and Republic of Palau islands' EEZ)

7. Special Observation

7.1. TRITON moorings

7.1.1. TRITON Mooring Operation

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Naomi Ueyama	(JAMSTEC): Technical Staff
Tomohide Noguchi	(MWJ): Operation Leader
Hiroshi Matsunaga	(MWJ): Technical Leader
Masayuki Fujisaki	(MWJ): Technical Staff
Fujio Kobayashi	(MWJ): Technical Staff
Keisuke Matsumoto	(MWJ): Technical Staff
Shinsuke Toyoda	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Tetsuya Nagahama	(MWJ): Technical Staff
Makito Yokota	(MWJ): Technical Staff
Shinichiro Yokogawa	(MWJ): Technical Staff
Masanori Enoki	(MWJ): Technical Staff
Tsutomu Fujii	(MWJ): Technical Staff

(2) Objectives

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool that 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. Therefore, long term data sets of temperature, salinity, currents and meteorological elements have been required at fixed locations. 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 and National Oceanic Data Center/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).

Ten TRITON buoys have been successfully recovered and nine TRITON buoys deployed during this R/V MIRAI cruise (MR07-03).

(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 deg-C

Measurement range, Conductivity : 0～+7 S/m

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

R.M.YOUNG COMPANY MODEL50202/50203

Atmospheric pressure

PAROPSCIENTIFIC.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	8N, 156E
ID number at JAMSTEC	01010
Number on surface float	T02
ARGOS PTT number	20392
ARGOS backup PTT number	24240
Deployed date	12 Jun. 2007
Exact location	07_57.78N, 156_01.74E
Depth	4,843 m

Nominal location	5N, 156E
ID number at JAMSTEC	02010
Number on surface float	T03
ARGOS PTT number	28868
ARGOS backup PTT number	29710
Deployed date	14 Jun. 2007
Exact location	05_01.16N, 155_58.25E
Depth	3,605 m

Nominal location	2N, 156E
ID number at JAMSTEC	03011
Number on surface float	T13
ARGOS PTT number	03780
ARGOS backup PTT number	29697
Deployed date	15 Jun. 2007
Exact location	02_02.14N, 156_01.34E
Depth	2,573 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04011
Number on surface float	T17
ARGOS PTT number	09794
ARGOS backup PTT number	29698
Deployed date	17 Jun. 2007
Exact location	00_01.01S, 156_02.46E
Depth	1,956 m

Nominal location	2S, 156E
ID number at JAMSTEC	05009
Number on surface float	T19
ARGOS PTT number	11823
ARGOS backup PTT number	29695
Deployed date	21 Jun. 2007
Exact location	02_00.89S, 155_57.34E
Depth	1,751 m

Nominal location	5S, 156E
ID number at JAMSTEC	06009
Number on surface float	T21
ARGOS PTT number	07898
ARGOS backup PTT number	29694
Deployed date	23 Jun. 2007
Exact location	05_01.98S, 156_01.39E
Depth	1,523m

Nominal location	EQ, 147E
ID number at JAMSTEC	09009
Number on surface float	T25
ARGOS PTT number	20439
ARGOS backup PTT number	24229
Deployed date	26 Jun. 2007
Exact location	00_03.68N, 147_00.49E
Depth	4,472 m

Nominal location	2N, 147E
ID number at JAMSTEC	08008
Number on surface float	T24
ARGOS PTT number	20384
ARGOS backup PTT number	24230
Deployed date	01 Jul. 2007
Exact location	02_04.55N, 146_57.29E
Depth	4,493 m

Nominal location	5N, 147E
ID number at JAMSTEC	07009
Number on surface float	T22
ARGOS PTT number	23470
ARGOS backup PTT number	29692
Deployed date	02 Jul. 2007
Exact location	04_57.83N, 147_01.40E
Depth	4,297 m

(6) Location of TRITON buoys recovery

Nominal location	8N, 156E
ID number at JAMSTEC	01009
Number on surface float	T01
ARGOS PTT number	03595
ARGOS backup PTT number	24239
Deployed date	14 Feb. 2006
Recovered date	10 Jun . 2007
Exact location	07_57.86N, 156_01.46E
Depth	4,841 m

Nominal location	5N, 156E
ID number at JAMSTEC	02009
Number on surface float	T09
ARGOS PTT number	03779
ARGOS backup PTT number	24241
Deployed date	16 Feb. 2006
Recovered date	12 Jun . 2007
Exact location	05_01.10N, 155_19.00E
Depth	3,606 m

Nominal location	2N, 156E
ID number at JAMSTEC	03010
Number on surface float	T10
ARGOS PTT number	09792
ARGOS backup PTT number	24242
Deployed date	18 Feb. 2006
Recovered date	15 Jun . 2007
Exact location	01_57.18N, 155_59.84E
Depth	2,564 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04010
Number on surface float	T11
ARGOS PTT number	23511
ARGOS backup PTT number	24243
Deployed date	20 Feb. 2006
Recovered date	08 Jun . 2007 (Recovered Top buoy)
	19 Jun . 2007 (Recovered from wire to acoustic releaser)

*This TRITON was broken at wire (in the vicinity 10m), hence the top buoy was drifting.

Exact location	00_01.38S, 155_56.76E
Depth	1,941 m

Nominal location	2S, 156E
ID number at JAMSTEC	05008
Number on surface float	T12
ARGOS PTT number	07960
ARGOS backup PTT number	24244
Deployed date	23 Feb. 2006
Recovered date	21 Jun . 2007
Exact location	01_58.76S, 156_01.88E
Depth	1,752 m

Nominal location	5S, 156E
ID number at JAMSTEC	06008
Number on surface float	T18
ARGOS PTT number	03593
ARGOS backup PTT number	24246
Deployed date	24 Feb. 2006
Recovered date	23 Jun . 2007
Exact location	04_58.19N, 156_00.85E
Depth	1,515m

Nominal location	EQ, 147E
ID number at JAMSTEC	09008
Number on surface float	T28
ARGOS PTT number	03781
ARGOS backup PTT number	29700
Deployed date	26 Feb. 2006
Recovered date	27 Jun . 2007
Exact location	00_01.53S, 146_59.84E
Depth	4,547 m

Nominal location	2N, 147E
ID number at JAMSTEC	08007
Number on surface float	T27
ARGOS PTT number	23719
ARGOS backup PTT number	07878
Deployed date	04 Mar. 2006
Recovered date	29 Jun . 2007
Exact location	02_04.69N, 146_56.96E
Depth	4,792 m

Nominal location	5N, 147E
ID number at JAMSTEC	07008
Number on surface float	T26
ARGOS PTT number	20417
ARGOS backup PTT number	24235
Deployed date	03 Mar. 2006
Recovered date	02 Jul . 2007
Exact location	05_02.34N, 146_57.06E
Depth	4,255 m

Nominal location	2N, 130E
ID number at JAMSTEC	16006
Number on surface float	T16
ARGOS PTT number	None
ARGOS backup PTT number	11593
Deployed date	30 Dec. 2006
Recovered date	06 Jul . 2007
Exact location	01_56.38N, 129_56.12E
Depth	4,428 m

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

(7) Details of deployment

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

Deployed TRITON buoys

Observation No.	Location.	Details.
01010	8N156E	Deploy with full spec.
02010	5N156E	Deploy with full spec.
03011	2N156E	Deploy with full spec, and six optional CT sensor. CO2 float buoy : with TRITON top buoy SBE37(CT) : 175m CO_2, pH : 25m, 750m
04011	EQ156E	Deploy with full spec and 21 optional CT sensor. SBE37(CT) : 12m, 37m, 62m, 175m SBE39(T) : 6m, 18m, 87m ALEC-MarkV(T) : 4m, 9m, 15m, 21m, 31m, 43m, 56m, 68m, 81m, 93m ALEC(Light Q) : 2.5m, 5m, 8m, 15m
05009	2S156E	Deploy with full spec.
06009	5S156E	Deploy with full spec.
09009	EQ147E	Deploy with full spec.
08008	2N147E	Deploy with full spec and one optional CT sensor. SBE37(CT) : 175m
07009	5N147E	Deploy with full spec.

(8) Data archive

Hourly averaged data are transmitted through ARGOS satellite data transmission system in almost 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 The 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

Iwao Ueki	(JAMSTEC): Principal Investigator
Hiroshi Matsunaga	(MWJ): Technical Staff
Keisuke Matsumoto	(MWJ): Technical Staff

(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 observation (See section 5) on R/V MIRAI for this intercomparision. We conducted 1 CTD cast at each TRITON buoy site before recovery, conducted 1 CTD cast at each TRITON buoy site 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 transmission to the ship. We compared CTD 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 same value of temperature data. Then, we calculate difference of salinity from conductivity between the shipboard CTD data on R/V MIRAI and the TRITON buoy data for each deployment and recovery of buoys.

Compared site

Observation No.	Latitude	Longtitude	Condition
01010	8N	156E	After Deployment
02010	5N	156E	After Deployment
03011	2N	156E	After Deployment
04011	EQ	156E	After Deployment
07009	5N	147E	After Deployment
08008	2N	147E	After Deployment
09009	EQ	147E	After Deployment
01009	8N	156E	Before Recover
02009	5N	156E	Before Recover
03010	2N	156E	Before Recover
05008	2S	156E	Before Recover
08007	2N	147E	Before Recover
09008	EQ	147E	Before Recover

(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 data at the same location were analysed.

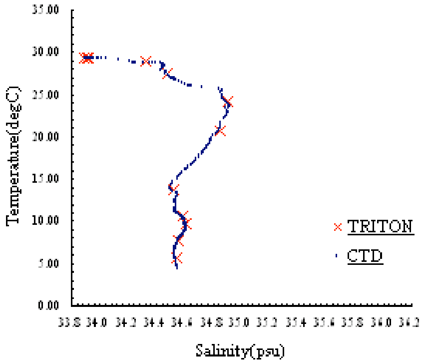
The estimation was calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from –0.1218 to 0.1019 for all depths. Below 300db, salinity differences are from –0.0098 to 0.0131 (See the Figures 7.1.2-2 (a)). The average of salinity differences was -0.0061 with standard deviation of 0.0272.

The estimation was calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.5641 to 0.2128 for all depths. Below 300db, salinity differences are from –0.0117 to 0.0125 (See the Figures 7.1.2-2(b)). The average of salinity differences was –0.0133 with standard deviation of 0.1245.

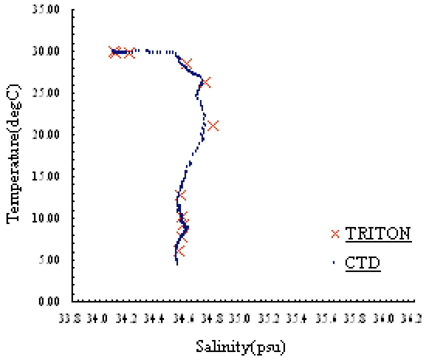
The estimation of time-drift was calculated as recovered buoy data minus deployed buoy data. The salinity changes for 1 year are from –0.5558 to 0.2156, for all depths. Below 300db, salinity changes for 1 year are from -0.0146 to 0.0178 (See the figures 7.1.2-2(c)). The average of salinity differences was -0.0127 with standard deviation of 0.1430.

(6) Data archive

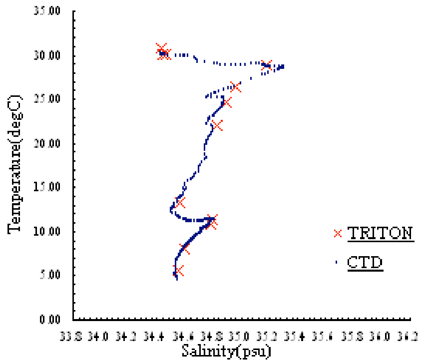
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)



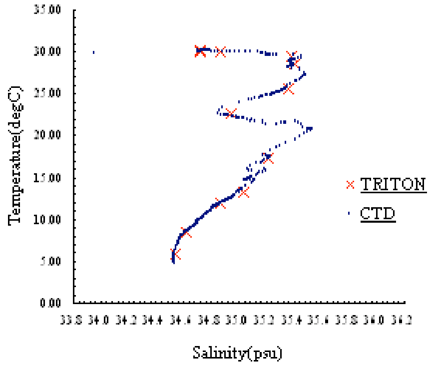
Observation No. 01010 after Deployment



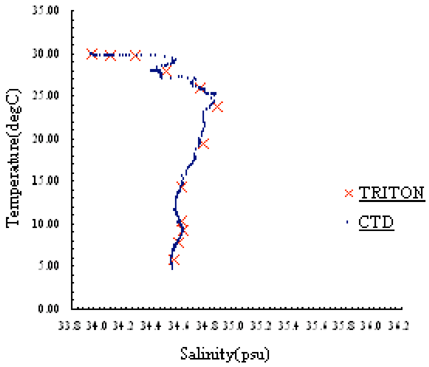
Observation No. 02010 after Deployment



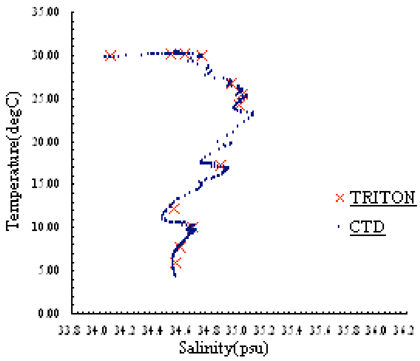
Observation No. 03011 after Deployment



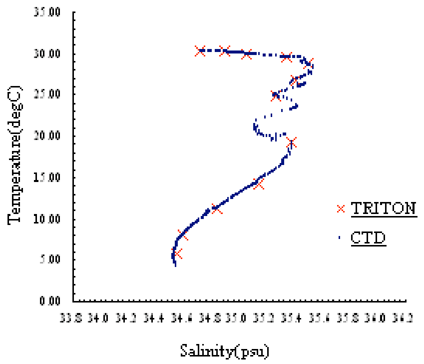
Observation No. 04011 after Deployment



Observation No. 07008 after Deployment

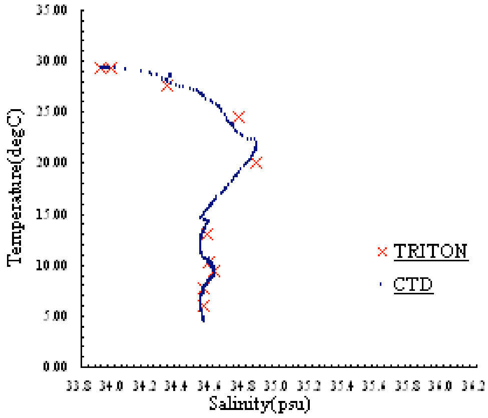


Observation No. 08007 after Deployment

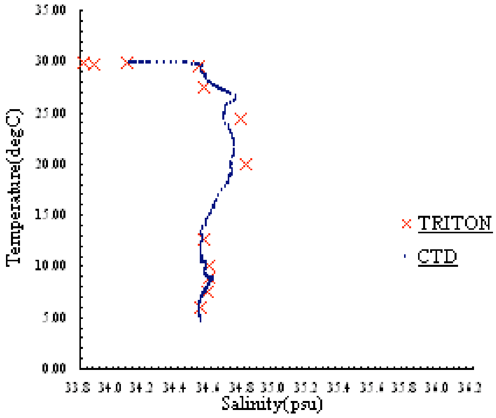


Observation No. 09008 after Deployment

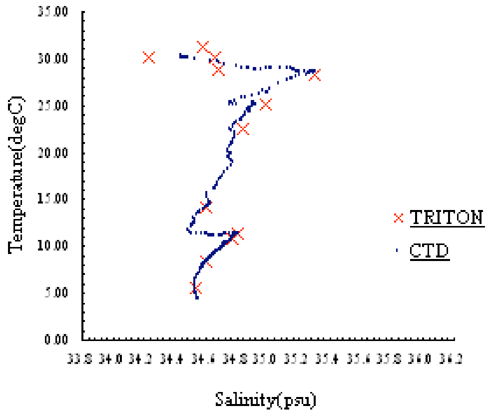
Fig.7.1.2.-1(a) T-S diagram of TRITON buoys data and shipboard CTD data



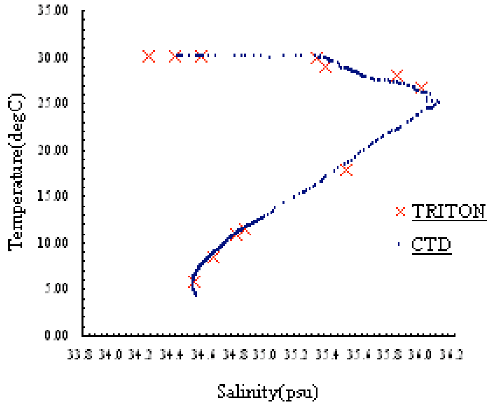
Observation No. 01009 before Recover



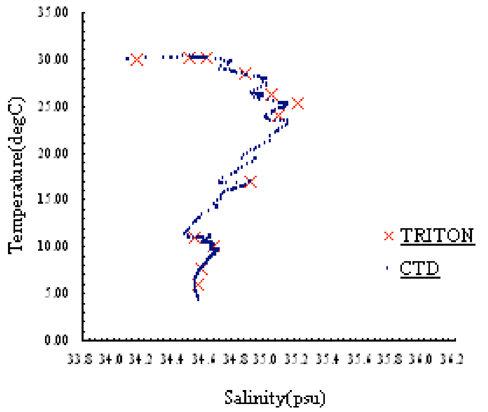
Observation No. 02009 before Recover



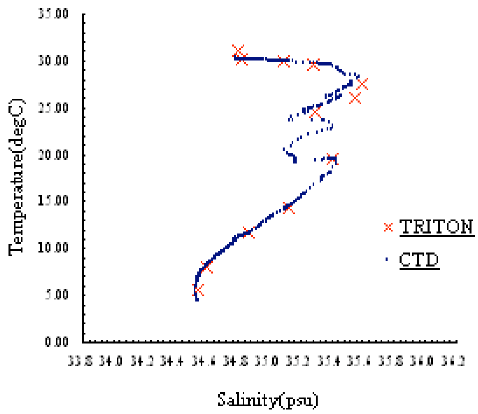
Observation No. 03010 before Recover



Observation No. 05008 before Recover



Observation No. 08007 before Recover



Observation No. 09008 before Recover

Fig.7.1.2.-1(b) T-S diagram of TRITON buoys data and shipboard CTD data

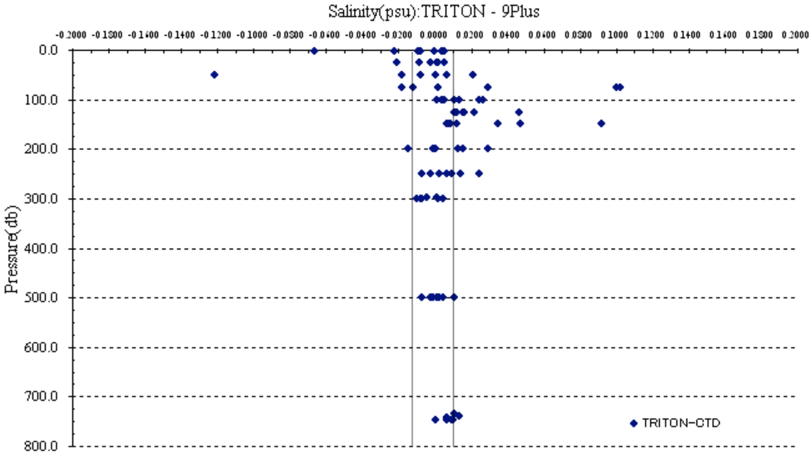


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

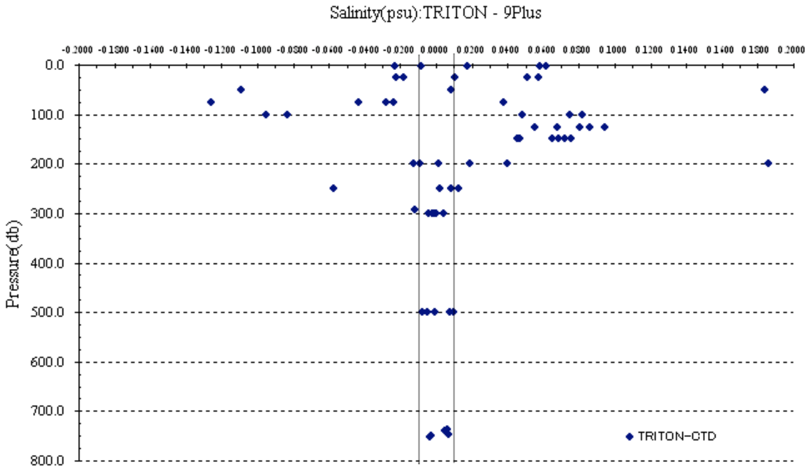


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

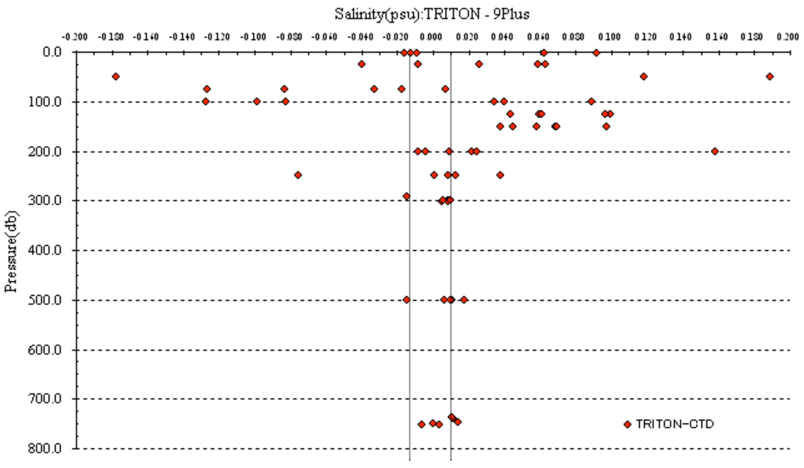


Fig.7.1.2.-2 (c) Salinity differences between deployment data and recovery data for 1year Observation No.01,02,03,05,08,09

7.1.3. Comparison recovered TRITON CT sensors with shipboard CTD

(1) Personnel

Iwao Ueki (JAMSTEC): Principal Investigator
Hiroshi Matsunaga (MWJ): Technical Staff
Shinsuke Toyoda (MWJ): Technical Staff

(2) Objectives

To evaluate property change of moored TRITON CT sensors in situ

(3) Measured parameters

Temperature
Conductivity

(4) Methods

Recovered CT sensors (SBE37) installed in TRITON buoy moored at 8N156E and 5S156E were calibrated in situ against sensors of SBE9/11plus system. The in situ calibration was accomplished by attaching 12 or 13 SBE37 sensors at a time to CTD frame (Photo 7.1.3.1). The sampling interval of SBE37 sensors was set to 30sec. On the other hand, SBE9plus data was processed as 30 second mean value.

The in situ calibration was carried out in up cast. Due to the equilibration time of SBE37 sensors and relatively low sampling rate, CTD stopped time has been decided as 10minutes at each designated depth; 1000, 750, 500, 300, 250, 200, 175, 150, 125, 100, 75, 50 and 25m.

The SBE37 sensors used in this experiment were listed in the table 7.1.3.1.

Photo 7.1.3.1 CTD cast for comparison

Table7.1.3.1 SBE37 sensor list

8n156e		5s156e	
1.5m	S/N:0560	1.5m	S/N:0518
25m	S/N:0566	25m	S/N:0551
50m	S/N:0572	50m	S/N:0177
75m	S/N:0587	75m	S/N:0547
100m	S/N:0628	100m	S/N:0985
125m	S/N:0639	125m	S/N:0634
150m	S/N:0640	150m	S/N:0785
200m	S/N:0644	200m	S/N:0995
250m	S/N:0170	250m	S/N:0648
500m	S/N:0172	500m	S/N:0646
300m	S/N:0163	300m	S/N:0501
750m	S/N:0314	750m	S/N:0502

(5) Results

The in situ calibration of recovered CT sensors was carried out by 2 CTD casts (Table 7.1.3.2). In this report we show a preliminary result for a sensor installed on 25m depth at 8N156E (S/N 0566).

Difference between SBE37 and SBE9plus in the deeper layer (1000 and 750m), in the middle layer (500, 300, 250, and 200m), in the shallower layer (175m, 150m, 125m, and100m) and in the uppermost layer (75, 50 and 25m) are shown in Fig.7.1.3-1~Fig.7.1.3-4, respectively. In these figures we can recognize that the equilibration time of SBE37 sensor is up to 4minutes from CTD stop. This property does not depend on the depth of CTD stop. We, therefore, calculate the 3minutes' mean value from 5 to 8 minutes after CTD stop and define that value as comparable data of SBE37.

Fig.7.1.3.5~Fig.7.1.3.6 and Table7.1.3.3-Table7.1.3.4 show the result of in situ calibration. Regarding to conductivity sensor, difference of conductivity between SBE9plus and SBE37, namely property change of the sensor result of mooring, was from 0.005S/m to 0.010S/m in the conductivity range of 3-6S/m.

Table 7.1.3.2 CTD cast information

Station	Cast	Date (UTC)	Time (UTC)		Start Position		CTD	Comparison Sensors
		mmddyy	Start	End	Latitude	Longtitude	Filename	
C04	2	062007	3:12	6:19	00-19.39S	155-57.47E	C04M02	8N156E Recovry Sensors
C07	2	062907	3:07	6:06	00-04.51N	146-59.98E	C07M02	5S156E Recovry Sensors

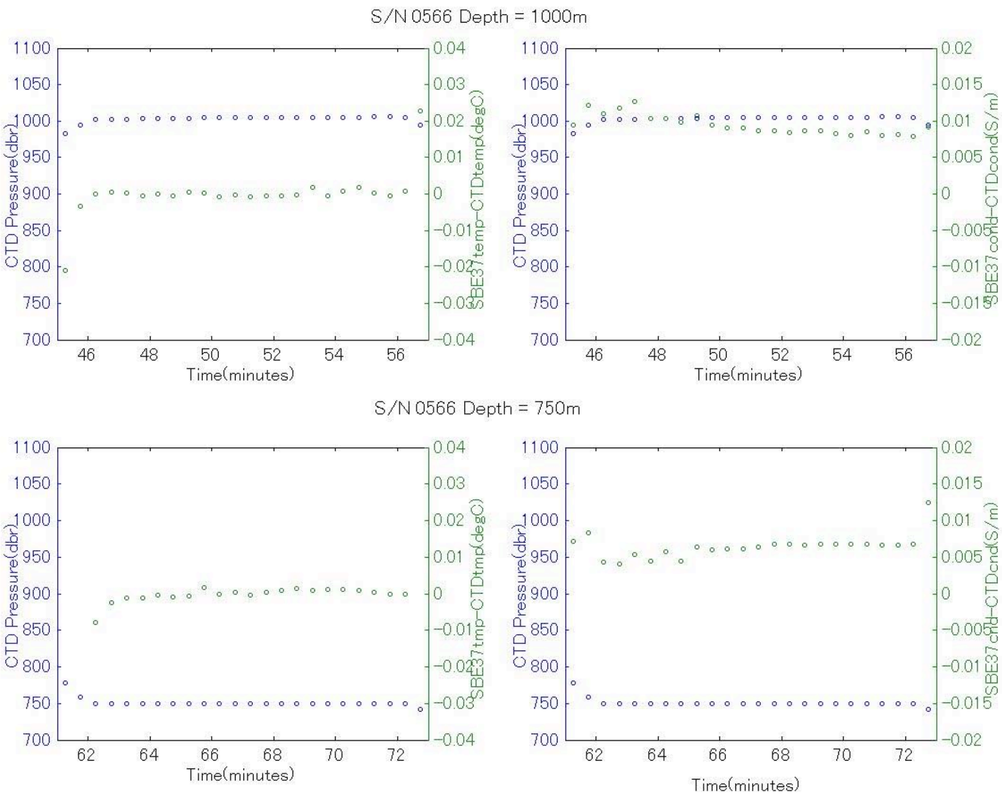


Fig.7.1.3-1 Time series of pressure observed with SBE9plus, and difference of temperature and conductivity between SBE9plus and SBE37 during CTD stops at 1000m, 750m.

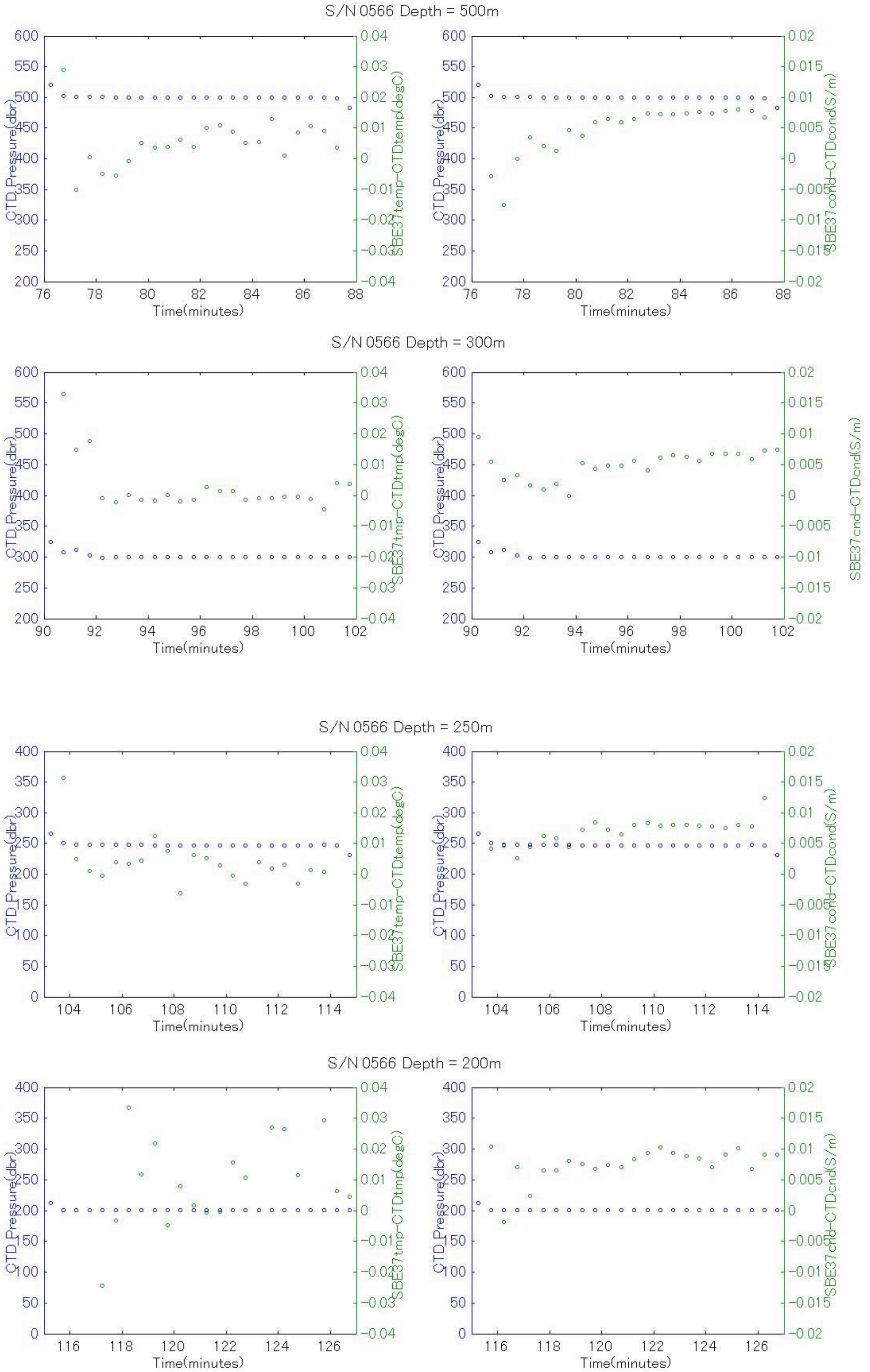


Fig.7.1.3-2 Time series of pressure observed with SBE9plus, and difference of temperature and conductivity between SBE9plus and SBE37 during CTD stops at 500m, 300m, 250m, 200m.

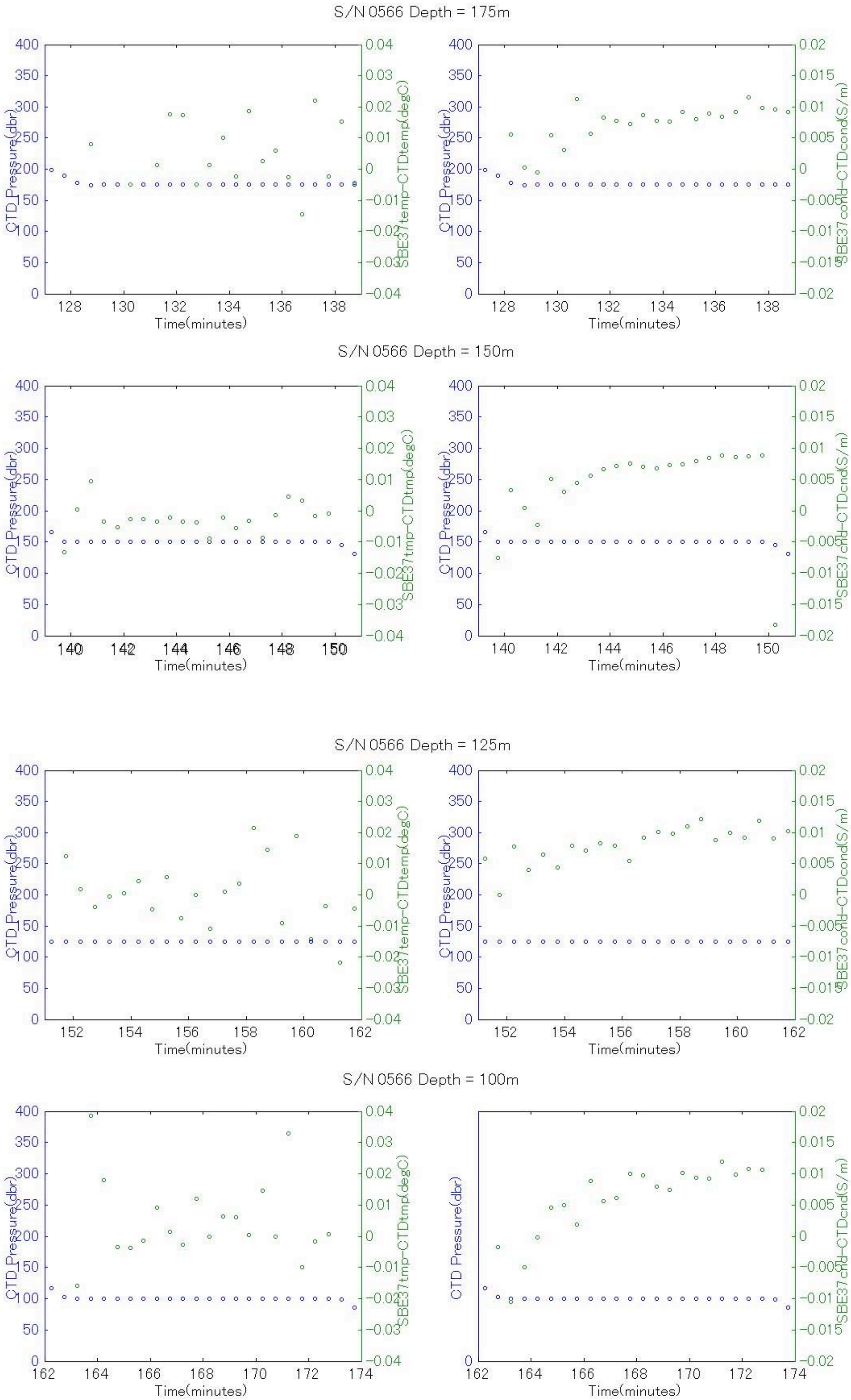


Fig.7.1.3-3 Time series of pressure observed with SBE9plus, and difference of temperature and conductivity between SBE9plus and SBE37 during CTD stops at 175m, 150m, 125m, 100m.

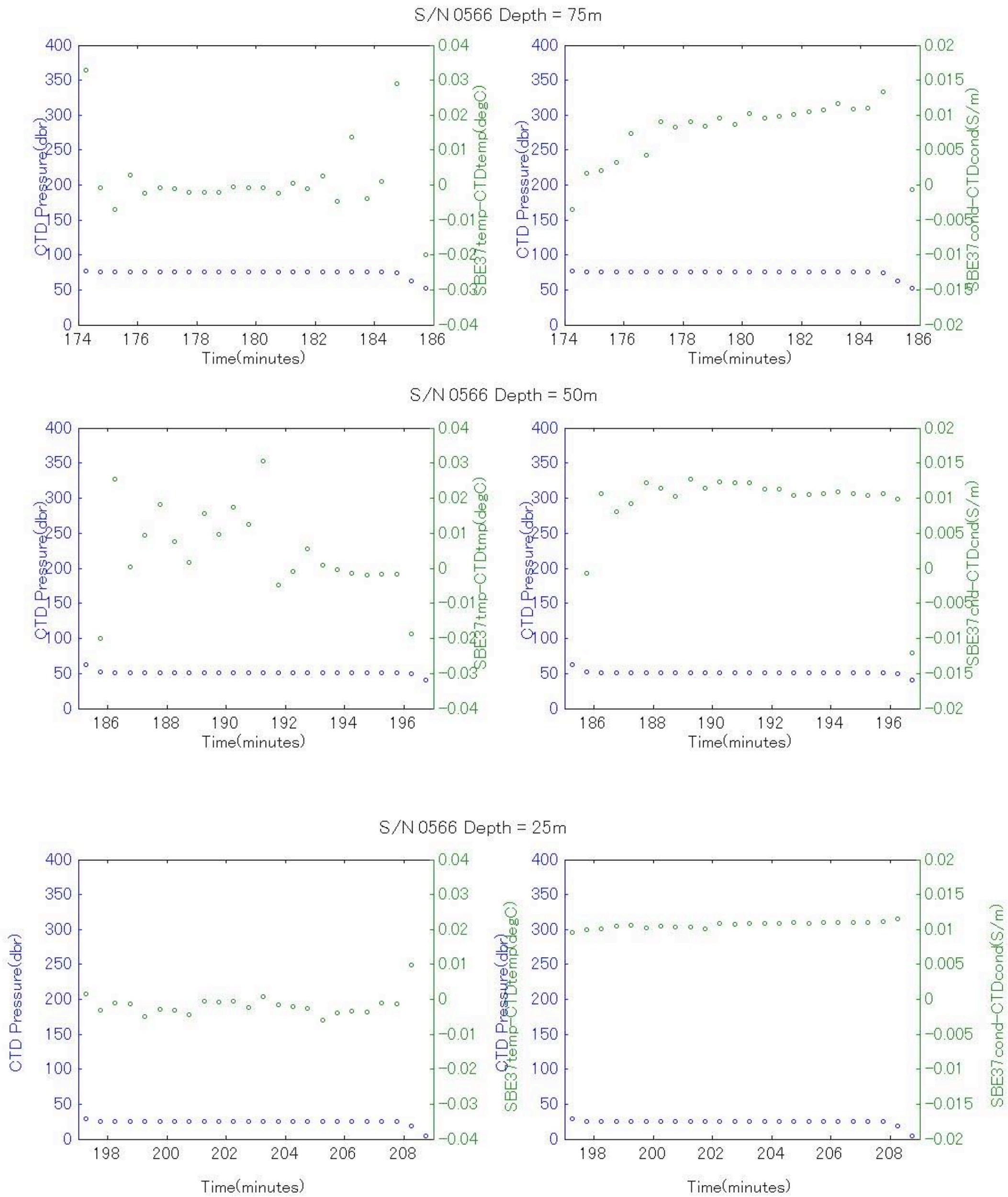


Fig.7.1.3-4 Time series of pressure observed with SBE9plus, and difference of temperature and conductivity between SBE9plus and SBE37 during CTD stops at 75m, 50m and 25m.

Table 7.1.3.3 Difference of temperature at each depth (S/N 0566)

Depth	Temperature Residual Ave. (SBE37temp - SBE9plustemp)	Temperature Residual Std. (SBE37temp-SBE9plustemp)	SBE9plus temperature	Sampling start time	Sampling fnish time	Samples
1000	0.0000	0.0009	4.7498	51.2	54.2	7
750	0.0007	0.0006	6.0839	66.7	69.7	7
500	0.0082	0.0034	8.5213	81.7	84.7	7
300	-0.0001	0.0011	11.8664	96.7	99.7	7
250	0.0023	0.0033	13.0601	108.7	111.7	7
200	0.0137	0.0160	16.3588	120.7	123.7	7
175	0.0048	0.0076	20.2845	133.2	136.2	7
150	-0.0048	0.0030	22.4686	144.7	147.7	7
125	0.0030	0.0117	23.6566	156.2	159.2	7
100	0.0056	0.0060	26.7021	167.7	170.7	7
75	-0.0004	0.0015	28.8987	179.2	182.2	7
50	0.0062	0.0121	29.6617	190.7	193.7	7
25	-0.0025	0.0021	30.1726	202.7	205.7	7

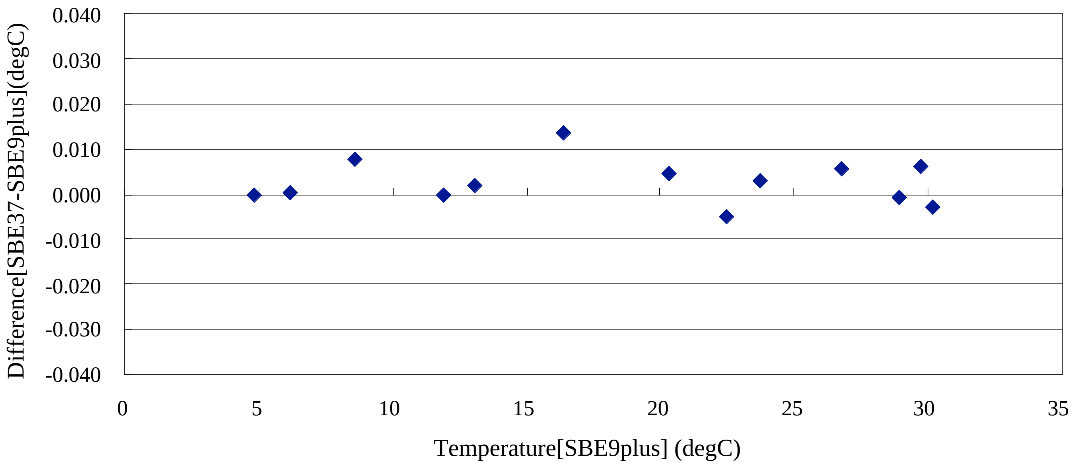


Fig.7.1.3-5 Difference of temperature at each depth (S/N 0566)

Table 7.1.3.3 Difference of conductivity at each depth (S/N 0566)

Depth	Conductivity Residual Ave. (SBE37cnd - SBE9pluscnd)	Conductivity Residual Std. (SBE37cnd-SBE9pluscnd)	SBE9plus Conductivity	Sampling start time	Sampling fnish time	Samples
1000	0.00850	0.00024	3.32802	51.2	54.2	7
750	0.00661	0.00023	3.43629	66.7	69.7	7
500	0.00705	0.00059	3.65618	81.7	84.7	7
300	0.00603	0.00094	3.98698	96.7	99.7	7
250	0.00781	0.00060	4.11342	108.7	111.7	7
200	0.00883	0.00102	4.46573	120.7	123.7	7
175	0.00837	0.00062	4.89876	133.2	136.2	7
150	0.00749	0.00058	5.10630	144.7	147.7	7
125	0.00949	0.00211	5.17744	156.2	159.2	7
100	0.00912	0.00101	5.55709	167.7	170.7	7
75	0.00978	0.00061	5.77917	179.2	182.2	7
50	0.01123	0.00075	5.86324	190.7	193.7	7
25	0.01087	0.00008	5.82186	202.7	205.7	7

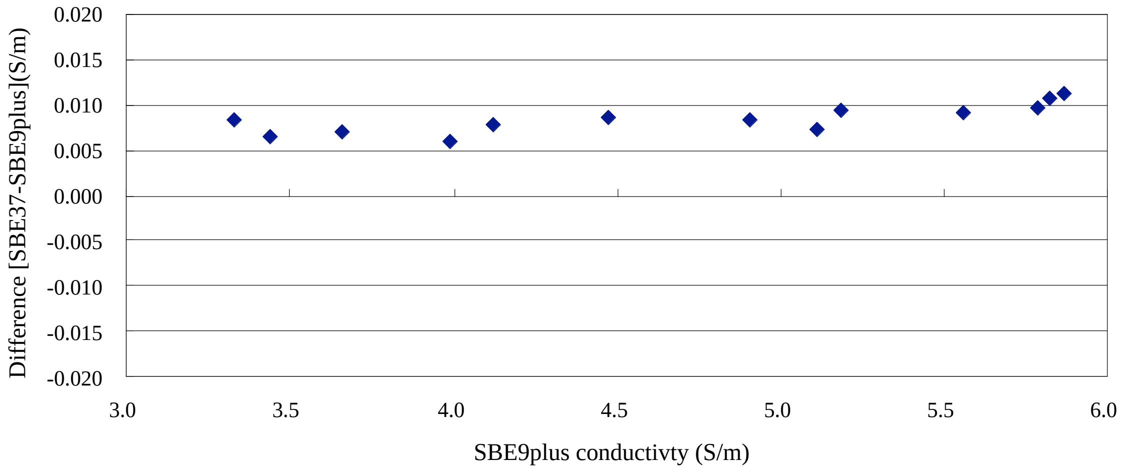


Fig.7.1.3-6 Difference of conductivity in each depth (S/N 0566)

7.1.4. TRITON option sensors for measurement of detailed profile in the mixed layer

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Kentaro Ando	(JAMSTEC) Not on board
Yoshimi Kawai	(JAMSTEC) Not on board
Naomi Ueyama	(JAMSTEC): Technical staff

(2) Objectives

To measure detailed profile in the mixed layer

(3) Parameters

Temperature
Conductivity
Photon

(4) Methods

The optional sensors were installed at wire and surface float of TRITON buoy deployed at EQ 156˚E. The depths of 19 sensors installed at wire were listed Table 7.1.4-1. The other sensors were installed at the surface float to measure temperature profile from the surface to 1.5 m depth. These sensors were installed at three part of the surface float; at front side, right side and left side. The installed depth of these sensors are listed Table 7.1.4-2, 7.1.4-3 and 7.1.4-4.

Details of the instruments and their measurement parameters are listed below.

1) SBE-37 SM MicroCAT

A/D cycles to average:	4
Sampling interval:	600 sec
Measurement range Temperature:	-5～+35 degC
Measurement range Conductivity:	0～7 S/m

2) SBE-39 IM

A/D cycles to average:	4
Sampling interval:	600 sec
Measurement range Temperature:	-5～+35 degC

3) ALEC-MarkV

Sampling interval:	600 sec
Measurement range Temperature:	-4～+40 degC

4) ALW-CMP

Mode:	Burst Mode
Burst Time:	1800 sec
Interval Time:	2 sec
Sample Number:	10
Measurement range Photon:	0～5000 μ mol/s/m^2

5) HOBO U12 Stainless Temp Data Logger

Sampling interval:	600 sec
Measurement range Temperature:	-40～+125 degC

6) 100K6A Thermistor

Sampling interval:	600 sec
Measurement range Temperature:	-35～+50 degC

Table7.1.4-1 Measurement parameter and serial number of sensors installed at TRITON wire

Depth(m)	Parameters	Instrument	Serial Number
4	Temperature, Pressure	SBE-39	3322
5	Photon	ALW-CMP	60
6	Temperature	ALEC-MarkV	101977
8	Photon	ALW-CMP	61
9	Temperature	ALEC-MarkV	101978
12	Temperature, Conductivity, Pressure	SBE-37	5033
15	Photon	ALW-CMP	62
15	Temperature	ALEC-MarkV	101979
18	Temperature, Pressure	SBE-39	3323
21	Temperature	ALEC-MarkV	101980
31	Temperature	ALEC-MarkV	101981
37	Temperature, Conductivity, Pressure	SBE-37	5034
43	Temperature	ALEC-MarkV	101982
56	Temperature	ALEC-MarkV	101983
62	Temperature, Conductivity, Pressure	SBE-37	5035
68	Temperature	ALEC-MarkV	101984
81	Temperature	ALEC-MarkV	101985
87	Temperature, Pressure	SBE-39	3324
93	Temperature	ALEC-MarkV	101986

Table7.1.4-2 Measurement parameter and serial number of sensors installed at the right side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number
0.25	Temperature	ALEC-MarkV	101629
1.0	Temperature	HOBO U12 Stainless Temp Data Logger	956240
1.5	Temperature	HOBO U12 Stainless Temp Data Logger	774312

Table7.1.4-3 Measurement parameter and serial number of sensors installed at the front side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number
0.25	Temperature	ALEC-MarkV	101630
1.0	Temperature	HOBO U12 Stainless Temp Data Logger	956243
1.5	Temperature	HOBO U12 Stainless Temp Data Logger	956273

Table7.1.4-4 Measurement parameter and serial number of sensors installed at the left side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number
0	Temperature	100K6A Thermistor	1
0.25	Temperature	100K6A Thermistor	2
0.5	Temperature	100K6A Thermistor	3
1.0	Temperature	100K6A Thermistor	4
1.5	Temperature	100K6A Thermistor	5

7.2 ADCP subsurface mooring

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator
Naomi Ueyama	(JAMSTEC): Technical staff
Tomohide Noguchi	(MWJ): Operation leader
Masayuki Fuzisaki	(MWJ): Technical staff
Hiroshi Matsunaga	(MWJ): Technical staff
Fujio Kobayashi	(MWJ): Technical staff
Keisuke Matsumoto	(MWJ): Technical staff
Shinsuke Toyoda	(MWJ): Technical staff
Hiroki Ushiromura	(MWJ): Technical staff
Tetsuya Nagahama	(MWJ): Technical staff
Makito Yokota	(MWJ): Technical staff
Shinichiro Yokogawa	(MWJ): Technical staff
Masanori Enoki	(MWJ): Technical staff
Tsutomu Fujii	(MWJ): Technical staff

(2) Objectives

The purpose is to get the knowledge of physical process in the western equatorial Pacific Ocean. We have been observing subsurface currents using ADCP moorings along the equator. In this cruise (MR070-03), we recovered two subsurface ADCP mooring at Eq-156E/ Eq-147E and deployed two ADCP moorings at Eq-156E/ Eq-147E.

(3) Parameters

Current profiles
Echo intensity
Pressure, Temperature and Conductivity

(4) Methods

Two instruments are mounted at the top float of the mooring. One is ADCP(Acoustic Doppler Current Profiler) to observe upper ocean layer currents from subsurface to 300m depth. The other is CTD to observe pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are as follows:

1) ADCP

Self-Contained Broadband ADCP 150 kHz (RD Instruments)
Distance to first bin : 8 m
Pings per ensemble : 16
Time per ping : 2.00 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds

Recovered ADCP

- Serial Number : 1150 (Mooring No.060220-00156E)
  The planned S/N 1220 was canceled because of temperature sensor trouble.
- Serial Number : 1154 (Mooring No.060228-00147E)

Deployed ADCP

- Serial Number : 1152 (Mooring No.070618-00156E)
- Serial Number : 1155 (Mooring No.070628-00147E)

2) CTD

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Recovered CTD

- Serial Number : 1283 (Mooring No.060220-00156E)
- Serial Number : 2611 (Mooring No.060228-00147E)

Deployed CTD

- Serial Number : 1276 (Mooring No.070618-00156E)
- Serial Number : 1288 (Mooring No.070628-00147E)

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)

Recovered Acoustic Releaser

- Serial Number : 963 (Mooring No.060220-00156E)
- Serial Number : 636 (Mooring No.060220-00156E)
- Serial Number : 1104 (Mooring No.060228-00147E)
- Serial Number : 937 (Mooring No.060228-00147E)

Deployed Acoustic Releaser

- Serial Number : 956 (Mooring No.070618-00156E)
- Serial Number : 716 (Mooring No.070618-00156E)
- Serial Number : 664 (Mooring No.070628-00147E)
- Serial Number : 712 (Mooring No.070628-00147E)

(b) Transponder (BENTHOS,Inc.)

Recovered Transponder

- Serial Number : 67489 (Mooring No.060220-00156E)
- Serial Number : 57069 (Mooring No.060228-00147E)

Deployed Transponder

- Serial Number : 57068 (Mooring No.070618-00156E)
- Serial Number : 57114 (Mooring No.070628-00147E)

(5) Deployment

The ADCP mooring deployed at Eq-156E and Eq-147E was planned to play the ADCP at about 300m depths. After we dropped the anchor, we monitored the depth of the acoustic releaser.

The position of the mooring No. 070618-00156E

Date: 18 Jun. 2007 Lat: 00-00.05S Long: 156-08.10E Depth: 1,956m

The position of the mooring No. 070628-00147E

Date: 28 Jun. 2007 Lat: 00-00.29S Long: 147-04.59E Depth: 4,485m

(6) Recovery

We recovered two ADCP moorings. One was deployed on 20 Feb.2006 and the other was deployed on 28 Feb. 2006 (MR06-01cruise). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code.

Results were shown in the figures in the following pages. Fig.7-2-1 shows the ADCP velocity data (zonal and meridional component / Eq-156E). Fig.7-2-2 shows CTD pressure, temperature and salinity data (Eq-156E). Fig.7-2-3 shows the ADCP velocity data (zonal and meridional component / Eq-147E). Fig.7-2-4 shows CTD pressure, temperature and salinity data (Eq-147E).

(7) Data archive

The velocity data will be reconstructed using CTD depth data. The all data will be archived by the member of TOCS project at JAMSTEC.

All data will be submitted to DMO at JAMSTEC within 3 years after each recovery.

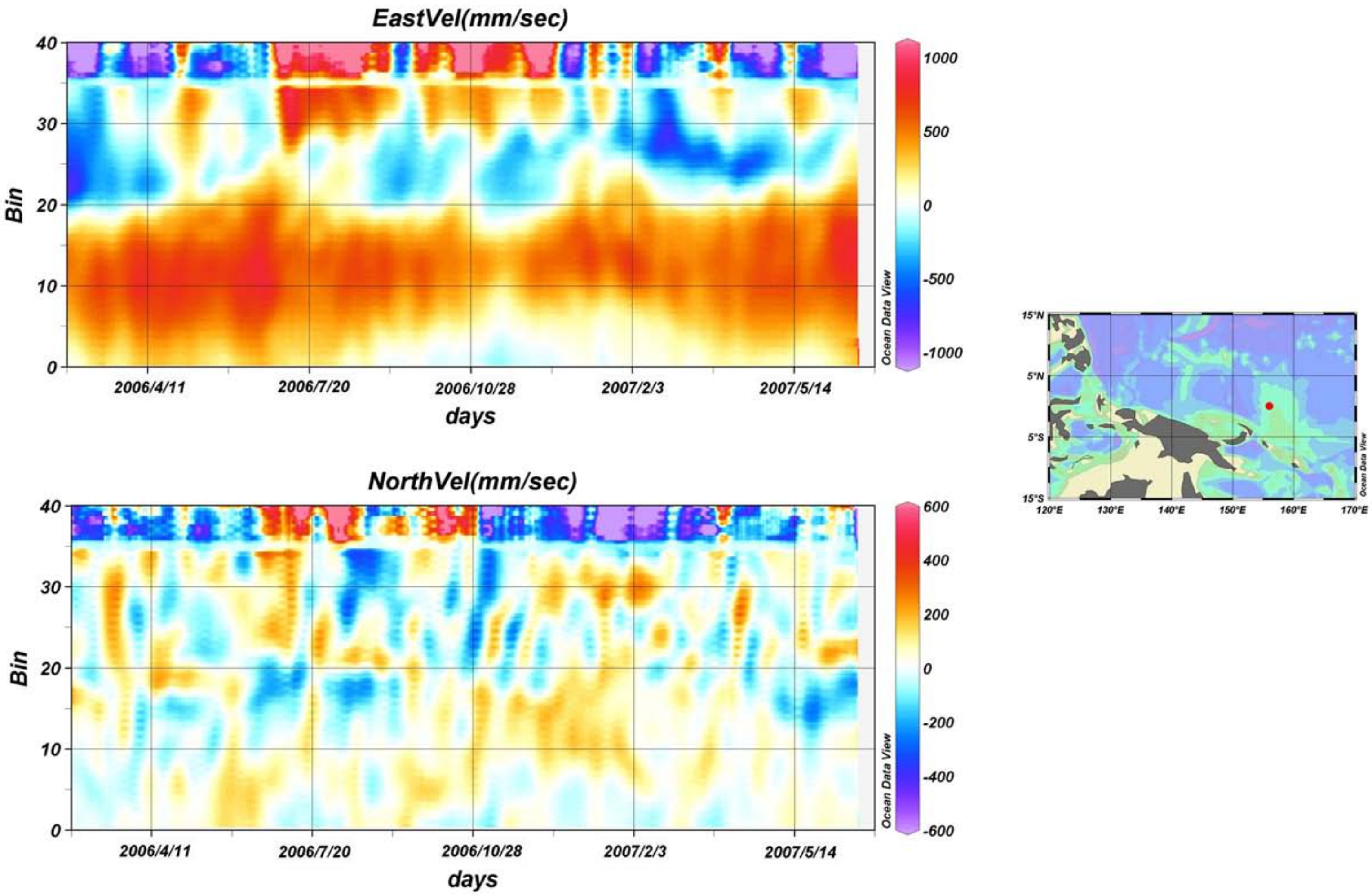


Fig.7-2-1 Time Series of zonal and meridional velocities of EQ-156E mooring (2006/2/20-2007/6/18)

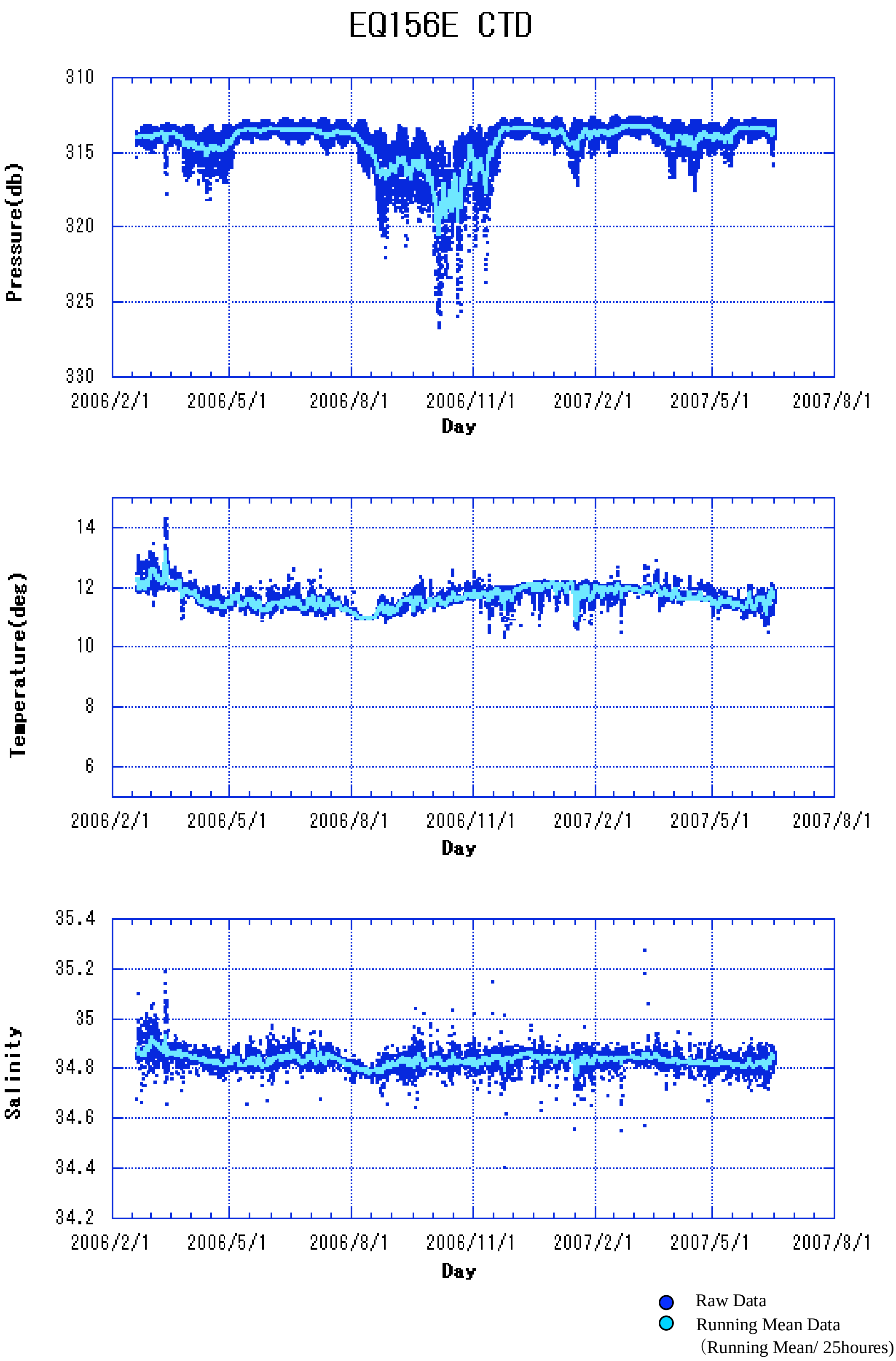


Fig.7-2-2 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-156E mooring (2006/2/20-2007/6/18)

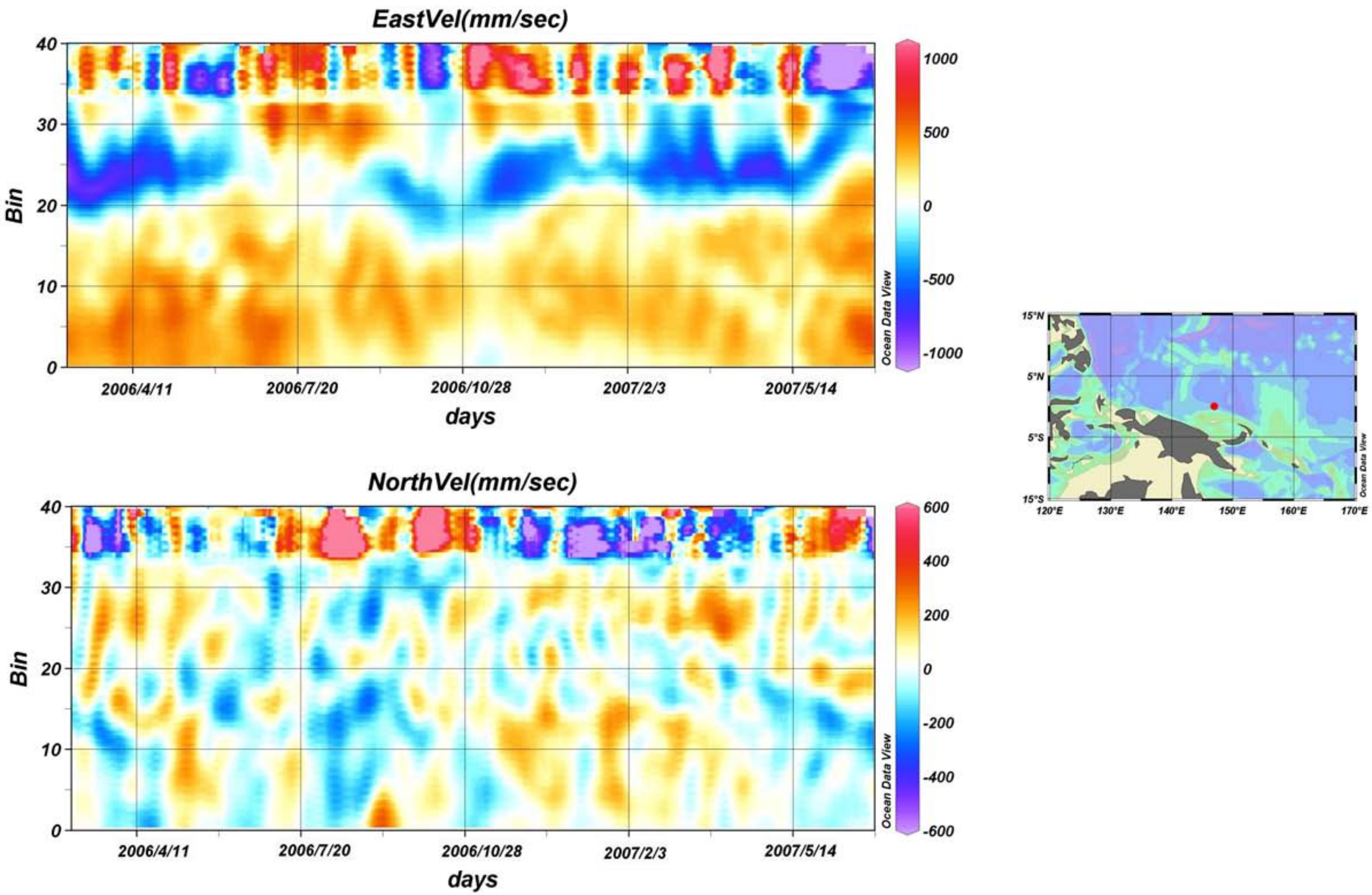


Fig.7-2-3 Time Series of zonal and meridional velocities of EQ-147E mooring (2006/2/28-2007/6/28)

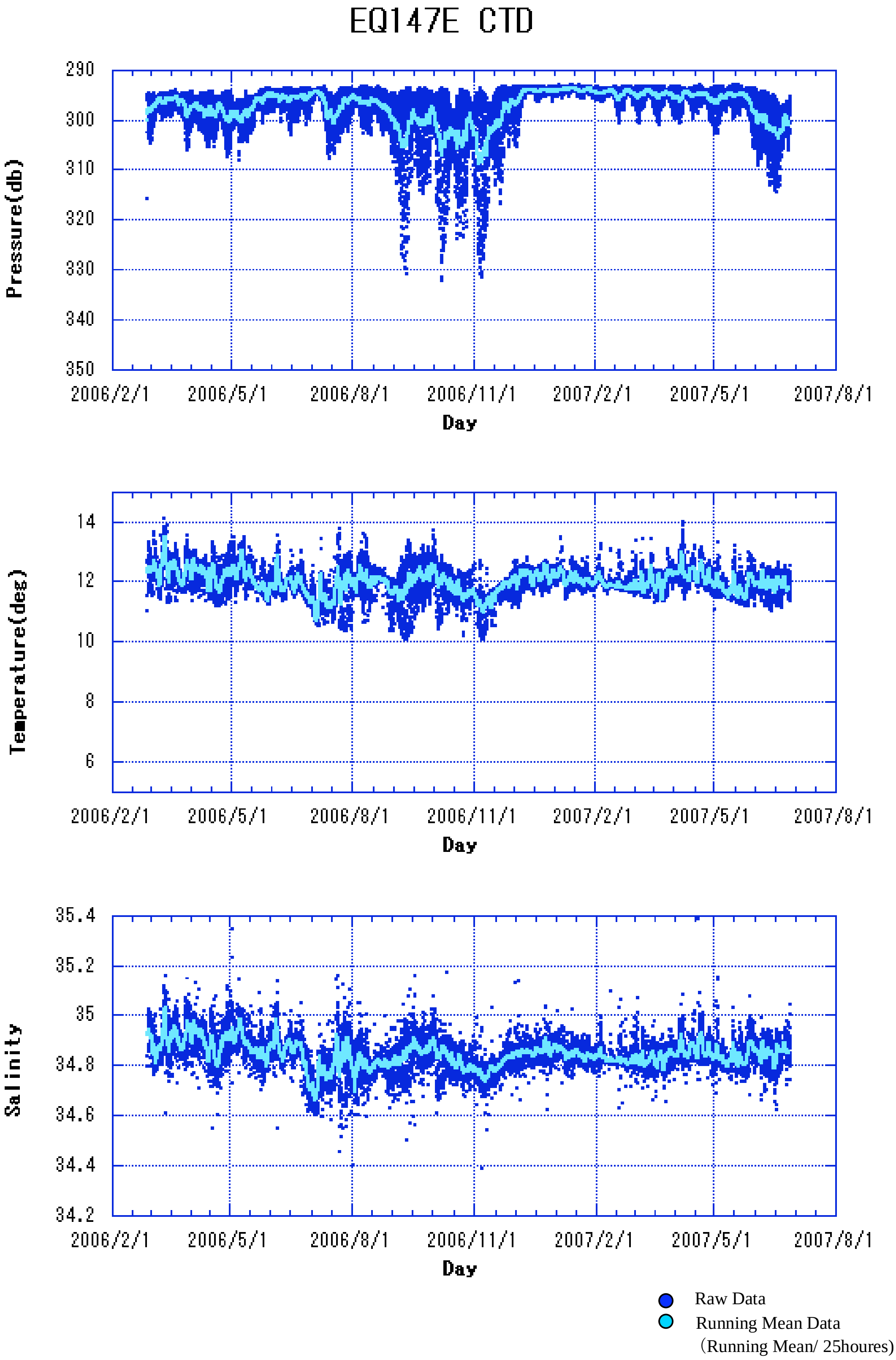


Fig.7-2-2 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-147E mooring (2006/2/28-2007/6/28)

7.3. Measurement of flow fields by ADV-ADCP mooring in the deep ocean

(1) Personnel

Toru Sato	(Prof., University of Tokyo): Principal Investigator, Not on board
Shinichiro Hirabayashi	(Doctoral course student, University of Tokyo)
Makoto Furukawa	(Master course student, University of Tokyo)

(2) Objectives

Simultaneous measurement of velocity at four points is carried out in order to estimate the spatial characteristics of transient flow field in the deep ocean. The result will be used in the forcing term in the numerical simulation to reproduce small-scale turbulence field. Additional measurement is conducted by using an ADCP for verifying the reproduced flow field.

(3) Methodology of measurement

1) Mooring system and measurement devices

The schematic diagram of the mooring system is shown in Fig.1. The total length of the system was 2220 m, and the tension was 480 kg in the still water. The mooring system contained four ADVs (FSI 3D-ACM) and an ADCP (RDI Workhorse Sentinel 300kHz), and two CTDs (SBE SBE37-SM). All the measurement devices were moored at the depth about 2000 m. Unfortunately, one of the four ADVs did not work and it was excluded from the system. Each ADV was allocated so that it comes to the vertex of a tetrahedron, the edge length of which is 2.5 m, being fixed to a stainless frame. The ADCP was moored 70 m upper of the ADVs, facing downwards to obtain vertical velocity profile in the range about 100 m. Two CTDs were located 70 m upper and 20 m lower of the ADVs, respectively, for acquiring the stratification during the measurement. All the devices were set to store the measured data at the period of 15 s as the temporal mean.

2) Deployment and recovery

The mooring system was deployed at 0° 2.115 N, 146° 56.964 E on June 25, 2007, and recovered on June 29, 2007 after 4 days of measurement. The water depth of the deployment position was 4290 m.

(4) Preliminary results

Figure 2 shows the time series of pressure, temperature, and salinity obtained by two CTDs. It was found that the ADVs were moored at the depth of 1950 m. The amplitude of pressure fluctuation is small (O(1m)), and the rigid body approximation of the mooring ropes indicates that the horizontal movement of the ADVs by tidal current was less than 100 m. The mean vertical gradient of temperature, dT/dz, and the buoyancy frequency were $1.1\text{x}10^{-3}$ deg.C/m, and $1.0\text{x}10^{-3}$ 1/s, respectively.

Figure 3 is the raw velocity (will be corrected) in north, east, and up direction, extracted by one of the ADVs. The amplitude of the flow velocity is found to be about 4 cm/s in horizontal direction, and even less in vertical direction. Figure 4 shows the magnitude of velocity as the raw result by the ADCP. Although the vertical range of the ADCP was set 100 m, its practical range was limited to 15 m due to the lack of scattering particles in the deep ocean at this site.

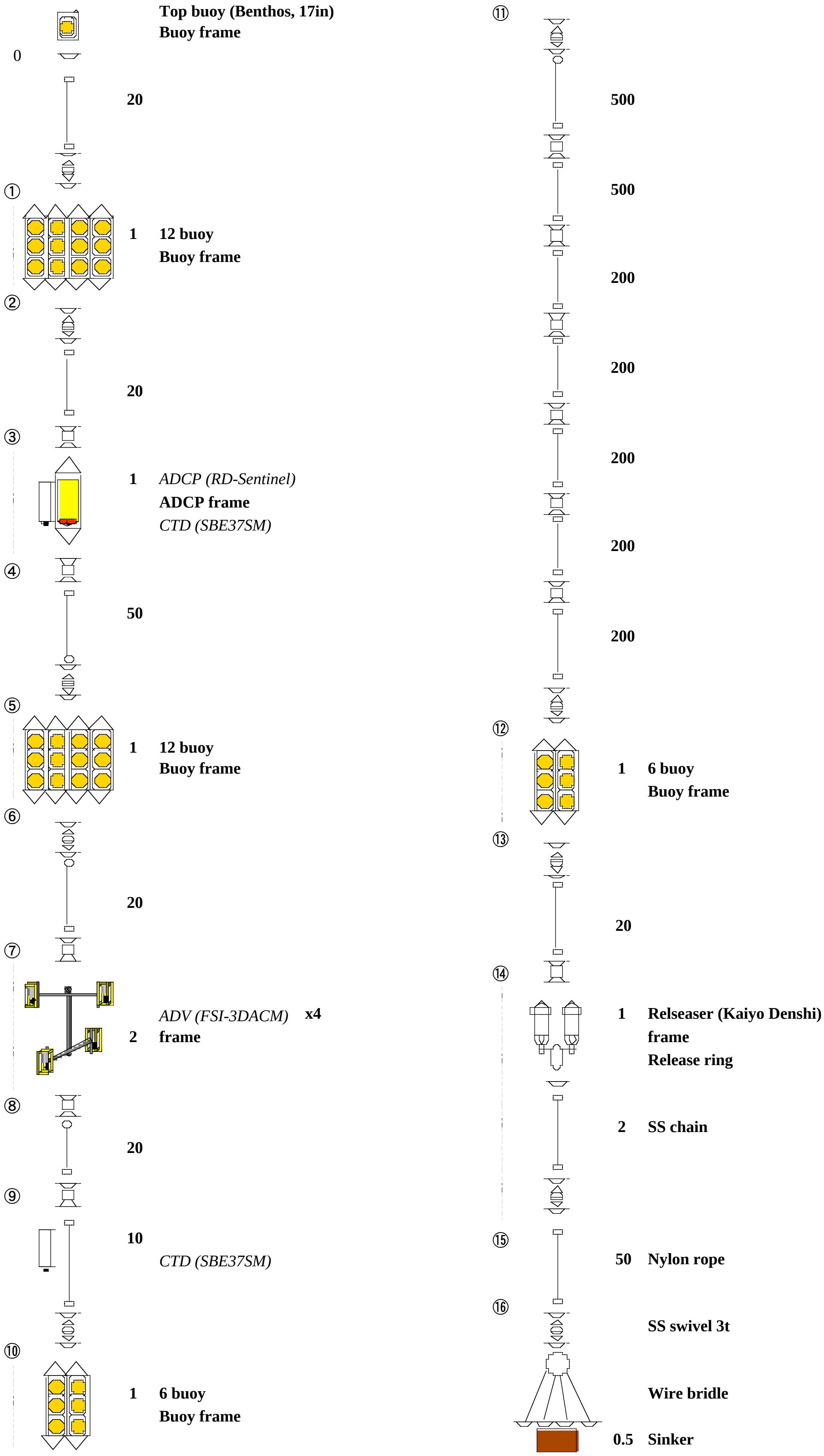


Fig.1 ADV-ADCP mooring system

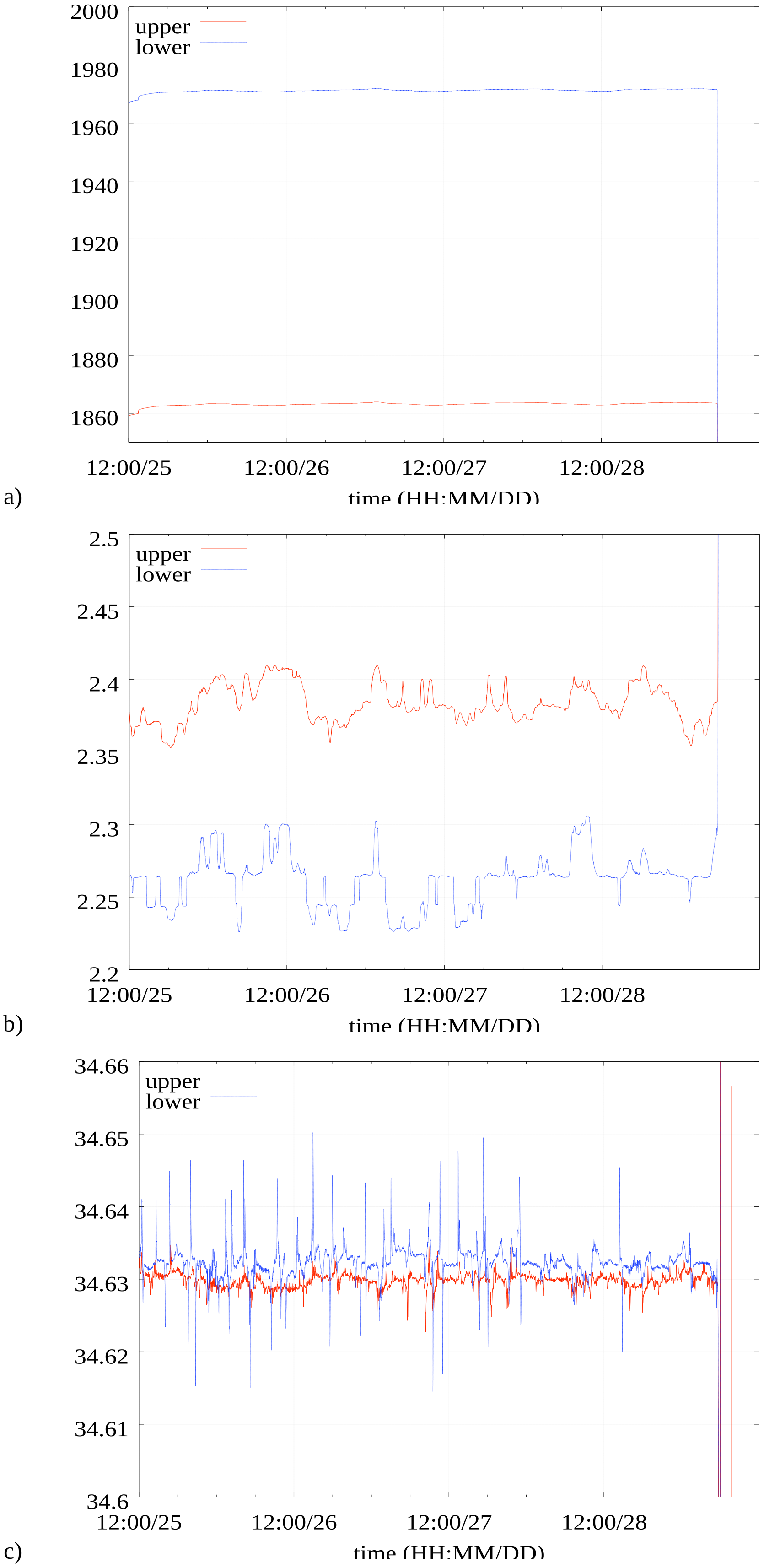


Fig.2 Time series obtained by two CTDs, (a) pressure, (b) temperature, and (c) salinity

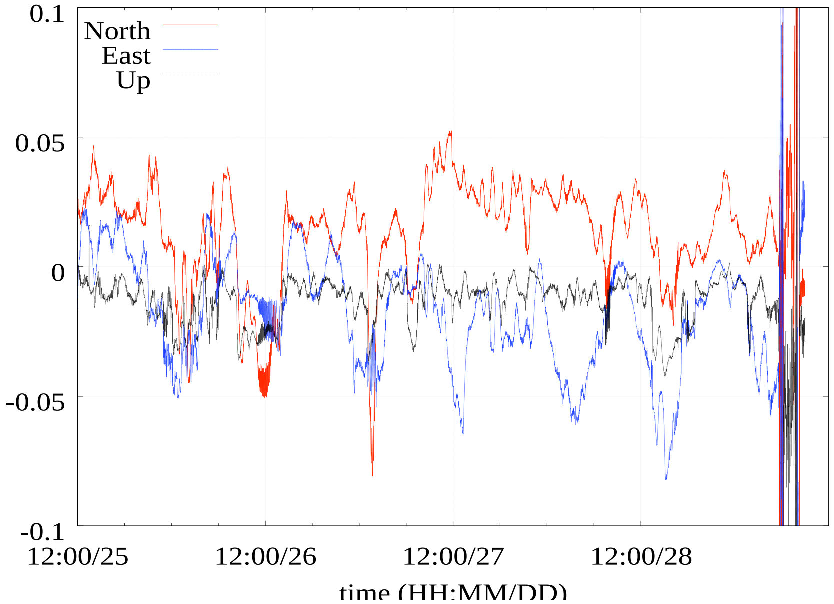


Fig.3　Raw velocity measured by one of the ADVs

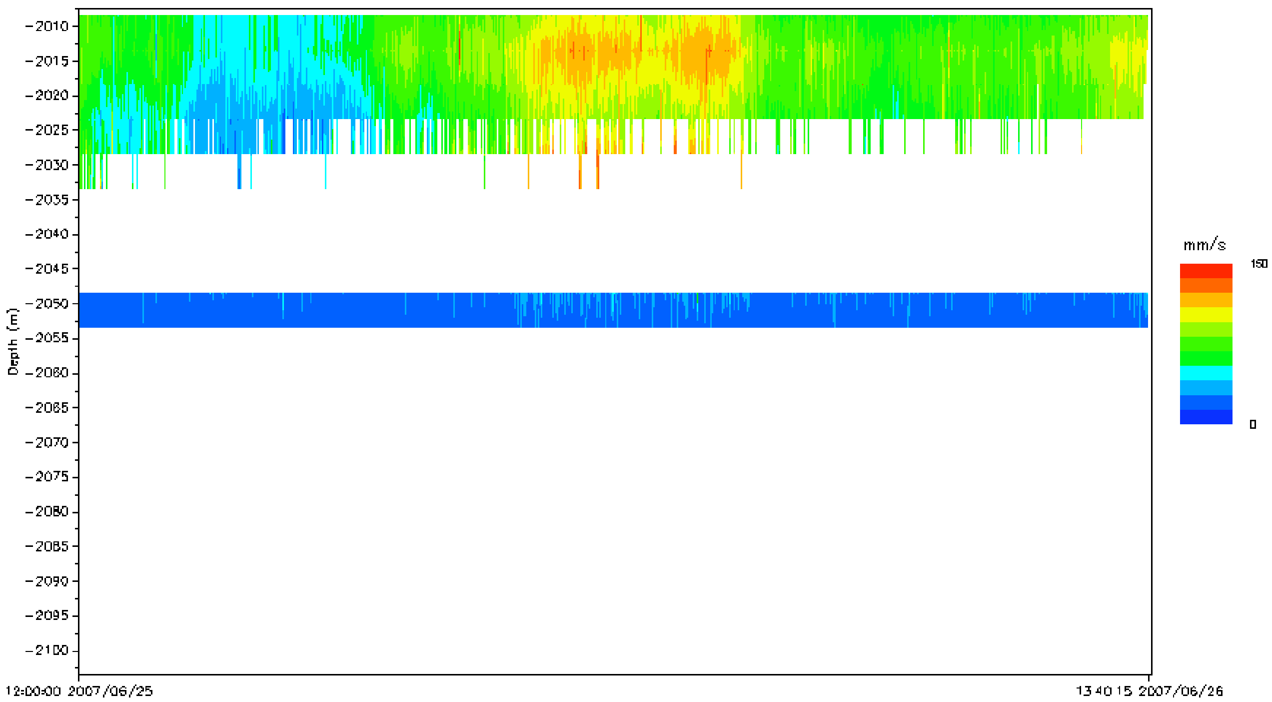


Fig.4 Vertical profile of velocity magnitude

7.4. Atmospheric turbulent flux measurement

7.4.1. Air-Sea Turbulent CO_2 Flux by Eddy Covariance Technique

(1) Personnel

Fumiyoshi Kondo	(Okayama University)
Koji Shimoju	(Okayama University)
Osamu Tsukamoto	(Okayama University): Principal Investigator, Not onboard
Hiroshi Ishida	(Kobe University): Not onboard
Kunio Yoneyama	(JAMSTEC): Not onboard

(2) Objective

The ocean is one of the main sinks of anthropogenic CO_2. Precise measurements of the CO_2 gas flux across the air-sea interface provide a better understanding of the global carbon cycle. Eddy covariance technique is the only direct measurement of air-sea CO_2 flux. This technique has little assumption (constant flux layer and steady state), and may evaluate small spatial and temporal CO_2 flux as compared with mass balance technique. For these reasons, we hope that the eddy covariance technique investigates uncertain processes that control the air-sea CO_2 flux.

(3) Method

We installed the turbulent flux and ship motion correction systems on the top of the foremast (Fig. 1). The turbulent flux system consisted of a sonic anemometer-thermometer (KAIJO, DA-600-3TV) and an infrared CO_2/H_2O gas analyzer (LI-COR, LI-7500). LI-7500 is an open-path analyzer that measures directly turbulent fluctuations of carbon dioxide and water vapor densities in the air. In this cruise, a closed-path CO_2/H_2O gas analyzer (LI-COR, LI-7000) is installed at the top of the foremast. The sample air is drawn into a sample cell in this closed-path analyzer through a sampling tube and a diaphragm air pump.

The sonic anemometer measures three-dimensional wind components relative to the ship including apparent wind velocity due to the ship motion. Then, the ship motion correction system measures the ship motions. This ship motion correction system consisted of a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signals, QA-700-020), and a three-axis rate gyro (Systron Donner, QRS11-0050-100).

Analog output signals from these both systems are sampled at 100 Hz by a PC-based data logging system (National Instruments Co., Ltd., LabVIEW8). This system is connected to the Mirai network system to obtain ship speed and heading data that are used to derive absolute wind components relative to the ground. Combining these data, turbulent fluxes and statistics are calculated in a real-time basis and displayed on the PC (Fig. 2).

(4) Data archive

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. The corrected data and inventory information will be submitted to JAMSTEC Data Management Office.

Fig.1. Installation of the turbulent flux and ship motion correction systems on the top of the foremast.

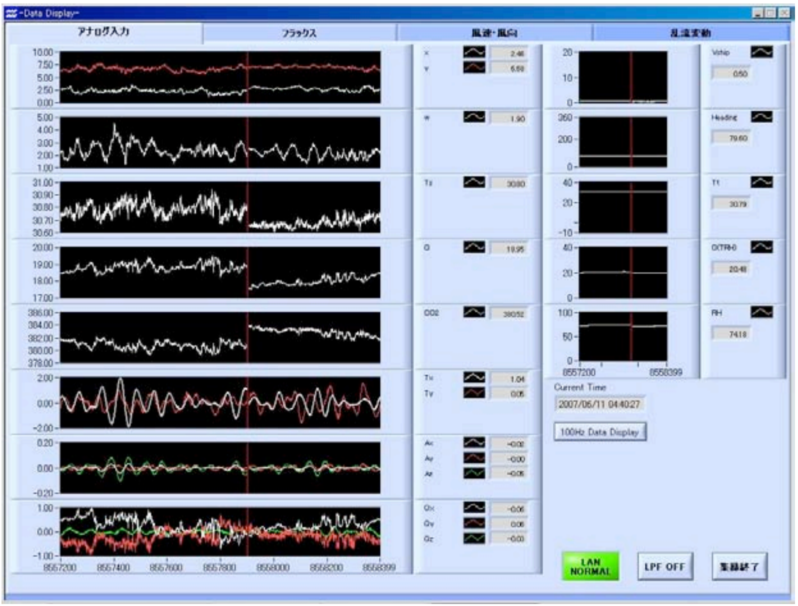


Fig.2. PC-based real time logging and monitoring system using LabVIEW8 software.

7.4.2. CO_2 profile measurement

(1) Personnel

Koji Shimoju	(Okayama University)
Fumiyosi Kondo	(Okayama University)
Toru Iwata	(Okayama University) Not on board
Osamu Tsukamoto	(Okayama University): Principal Investigator, Not on board

(2) Objective

The aerodynamic gradient technique has been used to estimate CO_2 fluxes over the various land surfaces by some micrometeorologists. In order to estimate CO_2 flux between air-sea by this technique, the profile of CO_2 concentration in the surface boundary layer must be measured and the eddy diffusivity should be correctly evaluated.

(3) Methods

We installed the unit of aerodynamic gradient technique systems on lower deck of foremast. The CO_2 content at four levels in the surface atmosphere was measured with a non-dispersive infrared (NDIR) gas analyzer (Licor Co., Li6252) to estimate CO_2 fluxes. Air samples drawn from four levels were alternately introduced into the measuring cell of the NDIR every 60 seconds by the solenoid valve at the rate of 0.8-0.9 L/min (Fig.1). Sample air was pre-dried by passing cooling drier and fiber drier. The calibration of NDIR was made twice a day using different gases with standard concentrations (350 and 410 ppm) of CO_2. Data was sampled at 1 Hz by a logging system (Campbell Scientific Inc., LoggerNet).

Sample airs are introduced to the unit with 4x6 polypropylene hose (24m). Air was sampled two ways by using “Albedo boom” at the top of the ship. The one is to use profiling buoy attached with 6x9 vinyl hose (21m) (Fig.2). A water-repellent filter was attached to the end of hoses. Airs are sampled four levels (0.1, 0.3, 0.7, and 7.1m above the sea surface). Additionally, we tested three type of profiling buoy for underway at three stations. (8N156E, 5N156E, 2N156E). The other is to hang rope attached 6x9 vinyl hose (15m). A water-repellent filter was attached to the end of hoses. Airs are sampled four levels (about 0.5, 1.5, 2.5, and 7.1m, or, 0.5, 1.5, 3.5, and 7.1 m above the sea surface). CO_2 profile observations is summarized in Table.1.

(4) Results

Figure 3 shows an example of the CO_2 profile measured on June 15th, 2007. The profile may present semilogarithmic fit and the difference of CO_2 concentration between surface and 7.1m height is about 0.08 ppm.

(5) Data archives

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. Interested scientists should contact Dr. Toru Iwata at Okayama University. The corrected data and inventory information will be submitted to JAMSTEC Data Management Office.

Table.1 List of surface CO_2 profile observation

Date	DOY	Location	Time(LST)	Mode	Data
June-11	162	8N156E	13:33-15:55	Static	
June-11	162	8N156E	16:15-4:05	Run	
June-12	163	8N156E	13:05-13:20	Run (buoy)	(No data)
June-13	164	5N156E	13:30-16:25	Static	
June-13	164	5N156E	16:40-4:00	Run	
June-14	165	5N156E	13:10-13:55	Run (buoy)	(No data)
June-15	166	2N156E	12:12-14:10	Static	
June-15	166	2N156E	16:20-4:00	Run	
June-16	167	2N156E	13:10-14:12	Run (buoy)	(No data)
June-17	168	EQ156E	13:05-13:35	Static	(No data)
June-17	168	EQ156E	16:28-6:00	Run	
June-18	169	EQ156E	13:33-800	Run	
June-19	170	EQ156E	13:10-16:18	Static	
June-19	170	EQ156E	16:28-	Run	
June-20	171	EQ156E	13:10-14:27	Static	(No data)
June-21	172	2S156E	13:12-13:25	Static	(No data)
June-21	172	2S156E	16:15-2:05	Run	
June-22	173	2S156E	13:12-16:18	Static	
June-25	176	EQ147E	17:52-1:05	Run	
June-26	177	EQ147E	13:10-16:15	Static	
June-26	177	EQ147E	16:32-5:55	Run	
June-27	178	EQ147E	13:10-16:26	Static	
June-27	178	EQ147E	16:45-6:45	Run	
June-28	179	EQ147E	15:40-5:55	Run	
June-29	180	EQ147E	13:12-16:25	Static	
June-30	181	2N147E	13:08-16:25	Static	
June-30	181	2N147E	16:40-6:50	Run	
July-01	182	2N147E	13:12-16:19	Static	
July-02	183	5N147E	9:05-11:50	Static	
July-02	183	5N147E	18:20-6:30	Run	

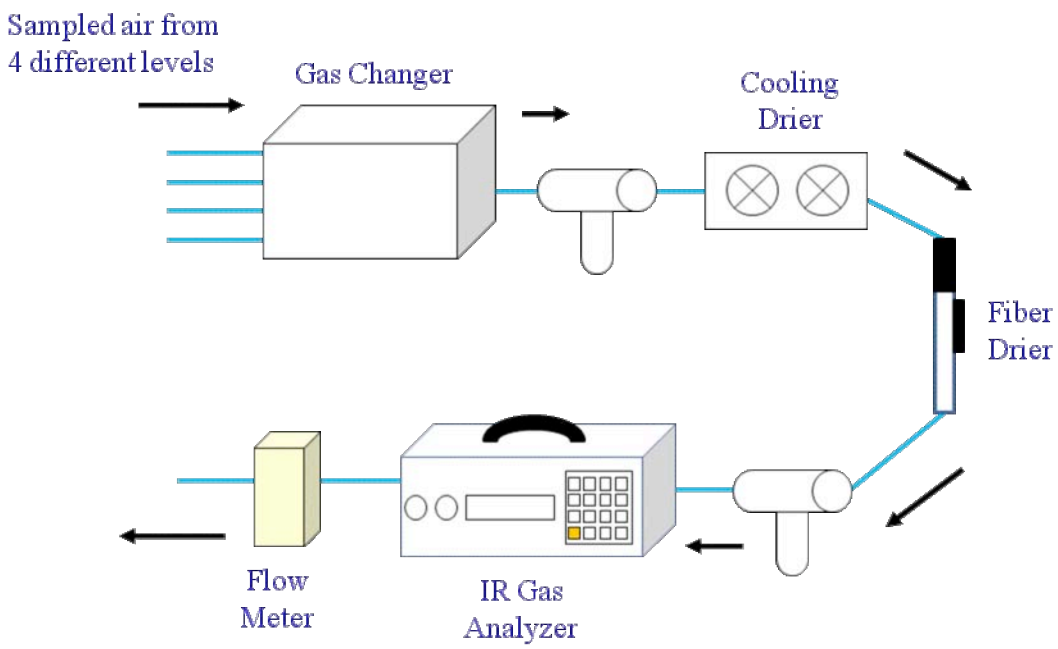


Fig.1 CO_2 profile measurement system

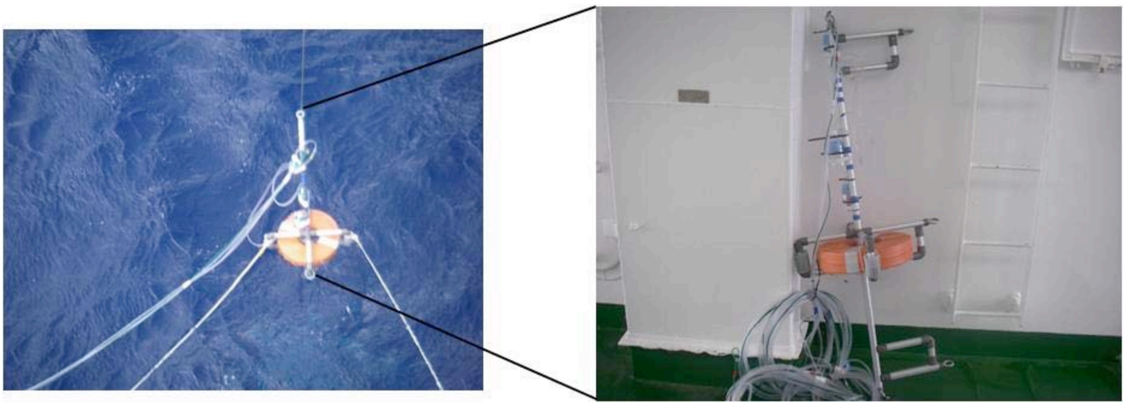


Fig.2 Example of using profiling buoy (left panel), profiling buoy (right panel)

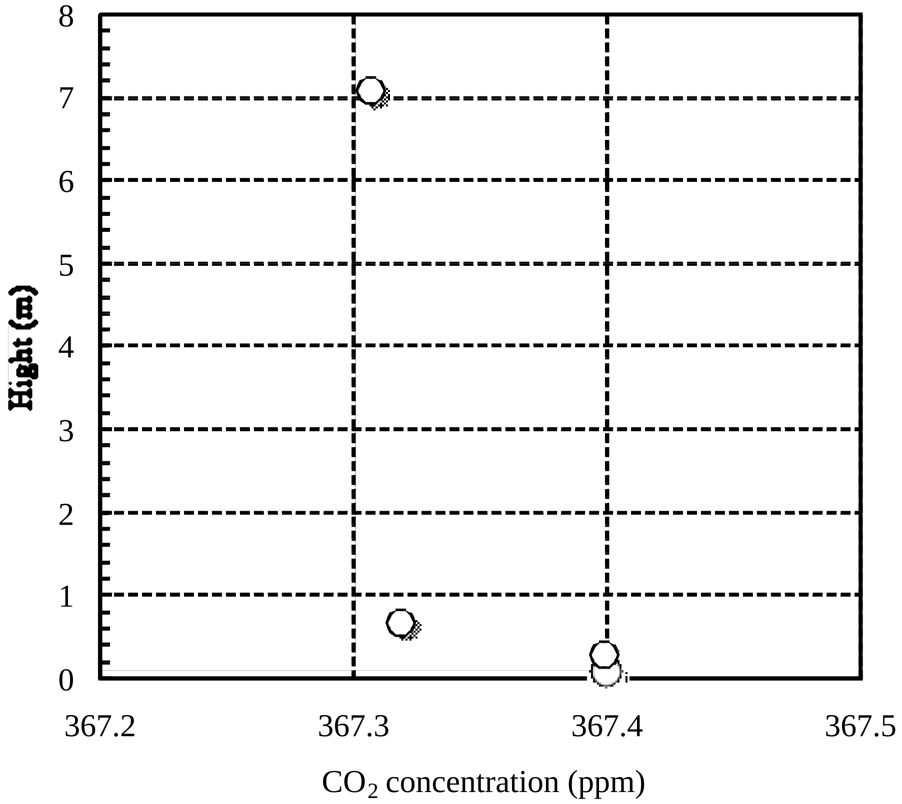


Fig.3 An example of vertical profile of CO_2 during concentration

7.5. Measurement of greenhouse effect gases and CO_2-related microflora at the equatorial area

(1) Personnel

Kiminori Shitashima	(CRIEPI): Principal Investigator, Not on board
Masahiro Imamura	(CRIEPI): Not on board
Yasurou Kurusu	(CRIEPI/Ibaraki Univ.): Not on board
Makoto Ochou	(CRIEPI/Ibaraki Univ.): Not on board
Yosuke Nikkuni	(CRIEPI/Ibaraki Univ.)

(2) Objectives

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 a change of over the years for carbonate (total carbon dioxide), nutrients, nitrogen oxide (N_2O) and microflora at the equatorial area.

(3) Parameters

Oceanic parameters for vertical profile: total carbon dioxide (TCO_2), nutrients (NO_3+NO_2-N, NO_2-N, PO_4-P, SiO_2-Si), nitrogen oxide (N_2O), microflora.

(4) Methods

a) Total dissolved inorganic carbon (TCO_2)

The TCO_2 concentration in seawater samples was determined by using the coulometric titration system (UIC Inc., Carbon Coulometer model 5011). Samples for TCO_2 analysis were drawn from the Niskin sampler into 125 mL glass vial bottles after an overflow of about 100 m of the seawater. The samples were immediately poisoned with 50 µL of 50% saturated $HgCl_2$ 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 thermostated (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 with 1.5 mL of 3.8% phosphoric acid and the CO_2 was extracted from the sample for 5 minutes by bubbling with the CO_2-free air. After passing through the Ag_2SO_4 scrubber, polywool and $Mg(ClO_4)_2$ scrubber to remove sea salts and water vapor, the evolved CO_2 gas was continuously induced to the coulometric titration cell by the stream of the CO_2-free air. All reagents were renewed every day. The precision of the TCO_2 measurement was tested by analyzing CRMs (batch 72) at the beginning of the measurement of samples every day. 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.

b) 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. The analysis of PO_4-P and SiO_2-Si will be carried out on land laboratory.

Nitrite (NO_2-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, flowcell: 5 cm)

Nitrate + Nitrite (NO_3+NO_2-N): Nitrate in seawater was reduced to nitrite using a reduction tube (Cd-Cu tube). The reduced nitrare and nitrite were determined by same method as nitrit described above (wavelength: 550 nm, flow cell: 3 cm). Silicate (SiO_2-Si) : Silicate was determined by the molybden-yellow (wavelength : 630nm, flow cell : 3 cm). Phosphate (PO_4-P): Phosphate was determined by the molybden-blue method (wavelength: 880 nm, flow cell: 5 cm).

c) Nitrous Oxide (N_2O)

Samples for N_2O 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 $HgCl_2$ in order to restrict biological alteration prior to sealing the bottles. All samples were stored in a refrigerator before measurement. The concentration of N_2O in seawater was determined using the Shimadzu GC14A gaschromatograph (carrier gas; pure N_2 gas 40-50 mL/min., column: Molecular Sieve 5A 60/80 2m x 3ø) with 63Ni electron capture detector. A purge-and-trap method was employed to concentrate N_2O from seawater.

Seawater was introduced into a measuring pipette with a volume of 100 mL by a pressurized headspace pure N_2 gas (99.9998%). The measured volume was then transferred to the extraction vessel and N_2O was extracted from the sample for 10 minutes by bubbling with the pure N_2 gas (flow rate: 100 mL/min). After passing through the calcium chloride scrubber to remove water vapor, the evolved N_2O gas was continuously induced to the a molecularsieve 13X column (60-80 µm, 0.5 m) column and trapped onto the cooled (-80ºC) column. After bubbling for 10 minutes, the column was heated at 80ºC to desorb the N_2O by the stream of the carrier gas (pure N_2) and the desorbed N_2O was introduced to the gaschromatograph.

d) In-situ pH/pCO_2 sensor

The in-situ pH sensor employs an Ion Sensitive Field Effect Transistor (ISFET) as a pH electrode, and the Chloride ion selective electrode (Cl-ISE) as a reference electrode. The ISFET is a semiconductor made of p-type Si coated with SiO_2 and Si_3N_4 that can measure H+ ion concentration in aqueous phase and has a quick response (within a few second), high accuracy (±0.005pH) and pressure-resistant performance. Before and after observation, the pH prove was calibrated by two different standard solutions (2-aminopyridine (AMP); pH=6.7866 and 2-amino-2-hydroxymethil-1,3-propanediol (TRIS); pH=8.0893) for the proofreading of electrical drift of pH data. The newly developed pH sensor was then applied to development of the pCO$_2$ sensor for in-situ pCO$_2$ measurement in seawater.

The principle of pCO$_2$ measurement is as follows: the pH electrode and the Cl-ISE of the pH sensor are sealed with a gas permeable membrane filled with the inner solution. The pH sensor can detect the pCO_2 change as the inner solution pH changes which is caused by penetration of carbon dioxide through the membrane. An amorphous Teflon membrane manufactured by U.S. DuPont (Teflon AF™) was used as the gas permeable membrane for this pCO$_2$ sensor. Two sets of in-situ pH/pCO_2 sensors were attached to depth of 25m and 750m of No.13 TRITON Buy mooring and in-situ data will be measured every 10 minutes for one year.

e) Microflora

Seawater samples for microflora analysis were collected in 10 L EVA cases from Niskin sampler. After the collection, samples of seawater for microflora analysis were filtered with 0.22-μm filter (Diameter=47mm; MILLIPORE, DURAPORE® MEMBRANE FILTERS), and filters were stored at 10°C. On land laboratory, DNA (deoxyribonucleic acid) extraction from accumulated microorganisms was performed. Seawater microfrola analyses were performed based on extracted DNA samples.

(5) Data archive

All data will be archived at CRIEPI and Ibaraki University after checking of data quality and submitted to the DMO at JAMSTEC within 3 years.

7.6. Rain Sampling for Stable Isotopes

(1) Personnel

Kimpei Ichiyanagi (JAMSTEC): Principal Investigator, Not on board

(2) Objective

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

(3) Method

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

(4) Preliminary results

During this cruise, we collected 40 samples in total. Table 1 lists the date and location of rainfall samples. Analysis will be done after the cruise.

(5) Data archive

Original samples will be analyzed by Institute of Observational Research for Global Change (IORGC). Inventory and analyzed digital data will be submitted to JAMSTEC Data Management Office.

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

Sample No.	Date (UTC)		Location (lat/lon)		Rain (mm)
1	2007/06/04	06:25	24-16N	148-48E	30.7
2	2007/06/04	22:35	20-25N	150-13E	90.2
3	2007/06/07	22:18	03-25N	155-28E	2.3
4	2007/06/08	22:58	01-34S	154-06E	7.8
5	2007/06/09	04:35	00-45S	154-29E	4.9
6	2007/06/09	22:20	03-37N	155-30E	0.7
7	2007/06/11	20:35	07-59N	156-00E	3.1
8	2007/06/11	23:51	07-59N	156-00E	4.4
9	2007/06/12	01:50	07-58N	156-01E	5.5
10	2007/06/13	06:18	05-03N	155-56E	2.5
11	2007/06/13	20:26	05-03N	155-58E	0.7
12	2007/06/14	03:32	05-01N	155-57E	3.8
13	2007/06/14	20:33	02-06N	155-58E	8.0
14	2007/06/15	20:35	01-56N	155-59E	4.0
15	2007/06/16	00:42	01-58N	155-58E	0.3
16	2007/06/16	05:07	01-54N	156-00E	0.6
17	2007/06/18	20:25	00-02S	156-03E	0.8
18	2007/06/18	23:02	00-01S	156-00E	0.5
19	2007/06/19	22:22	00-15S	155-55E	1.3
20	2007/06/20	20:27	01-58S	155-56E	13.5
21	2007/06/21	00:57	02-01S	155-58E	17.1
22	2007/06/21	05:40	01-58S	155-59E	3.5
23	2007/06/21	20:43	02-01S	156-01E	7.4
24	2007/06/22	20:04	04-54S	156-02E	1.4
25	2007/06/23	06:58	04-53S	155-54E	22.0
26	2007/06/25	23:15	00-04N	146-59E	6.1
27	2007/06/26	12:05	00-35N	147-06E	0.0
28	2007/06/29	05:17	00-05N	147-00E	18.4
29	2007/06/29	08:25	00-22N	147-00E	0.6
30	2007/06/29	12:37	01-03N	147-00E	47.9
31	2007/06/29	20:31	02-05N	146-58E	0.6
32	2007/06/30	09:15	02-04N	146-47E	5.8
33	2007/07/01	08:08	02-29N	147-02E	28.3
34	2007/07/02	07:53	05-01N	146-58E	1.1
35	2007/07/03	03:33	04-55N	146-23E	1.0
36	2007/07/03	06:56	04-46N	145-32E	14.1
37	2007/07/03	23:57	04-04N	141-29E	
38	2007/07/07	09:22	15-12N	134-52E	6.2
39	2007/07/10	00:44	24-29N	138-59E	8.1
40	2007/07/12	23:10	40-06N	142-15E	3.5

7.7. pCO_2 Mooring

(1) Personnel

Yoshiyuki Nakano (JAMSTEC): Not on board
Tetsuichi Fujiki (JAMSTEC): Not on board
Shuichi Watanabe (JAMSTEC): Principal Investigator, Not on board

(2) Objective

We have been developing newly small and simple *in situ* system for pCO_2 measurement using spectrophotometric technique. In this cruise, we aim at testing the new pCO_2 sensor in open sea. The pCO_2 sensor is attached with TRITON buoy and start mooring (2_N, 156_E) for about one year.

(3) Method

The pCO_2 sensor for the measurement of pCO_2 is based on the optical absorbance of the pH indicator solution. The CO_2 in the surrounding seawater equilibrates with the pH indicator solution across gas permeable membranes, and the resulting change in optical absorbance, representing the change of pH, is detected by the photo multiplier detector. We calculated the pH in the pH indicator solution from the absorbance ratios. In this cruise I decided to use AF Teflon tube (amorphous fluoropolymer, AF Teflon, AF-2400, Biogeneral Inc.) as an equilibrium membrane because this material is well suited to pCO_2 measurements due to its high gas permeability. This measuring system was constructed from LED light source, optical fiber, CCD detector, micro pump, and downsized PC. The new simple system is attached in aluminum drifting buoy with satellite communication system, which size is about 300 mm diameter and 500 mm length and weight is about 15 kg (Fig. 1). A Li-ion battery is occupied about one third of the drifting buoy. In the laboratory experiment, we obtained high response time (less than 2 minutes) and precision within 3 μatm.

(4) Preliminary results

We obtained two days pCO_2 data from sensor via satellite system in June. These values are consistent with Mirai data and past data in this area (Fig. 2).

(5) Data archive

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

(6) Reference

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

Nakano, Y., H. Kimoto, S. Watanabe, K. Harada and Y. W. Watanabe (2006): Simultaneous Vertical Measurements of In situ pH and CO_2 in the Sea Using Spectrophotometric Profilers. *J. Oceanogr.*, 62, 71-81.

Yao, W. and R. H. Byrne (2001): Spectrophotometric determination of freshwater pH using bromocresol purple and phenol red, *Environ. Sci. Technol.*, 35, 1197-1201.

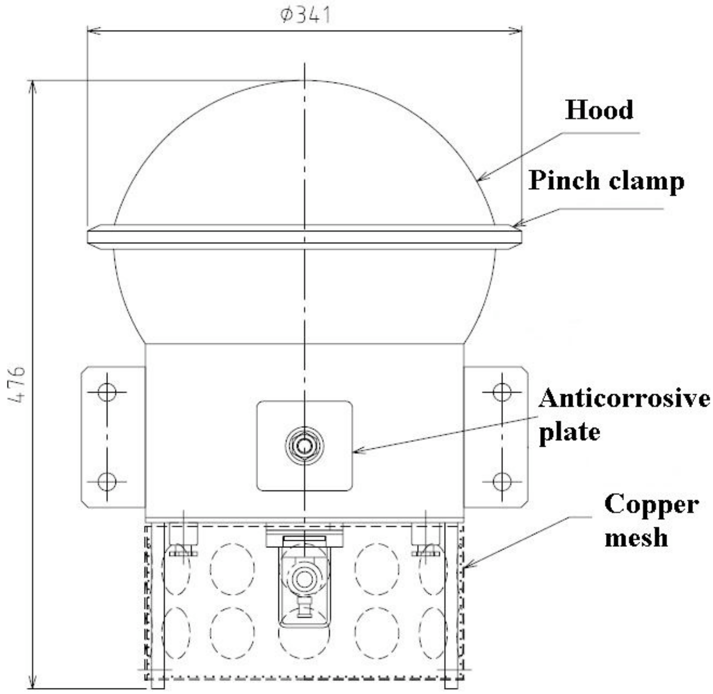


Fig. 1. Side view of pCO_2 sensor.

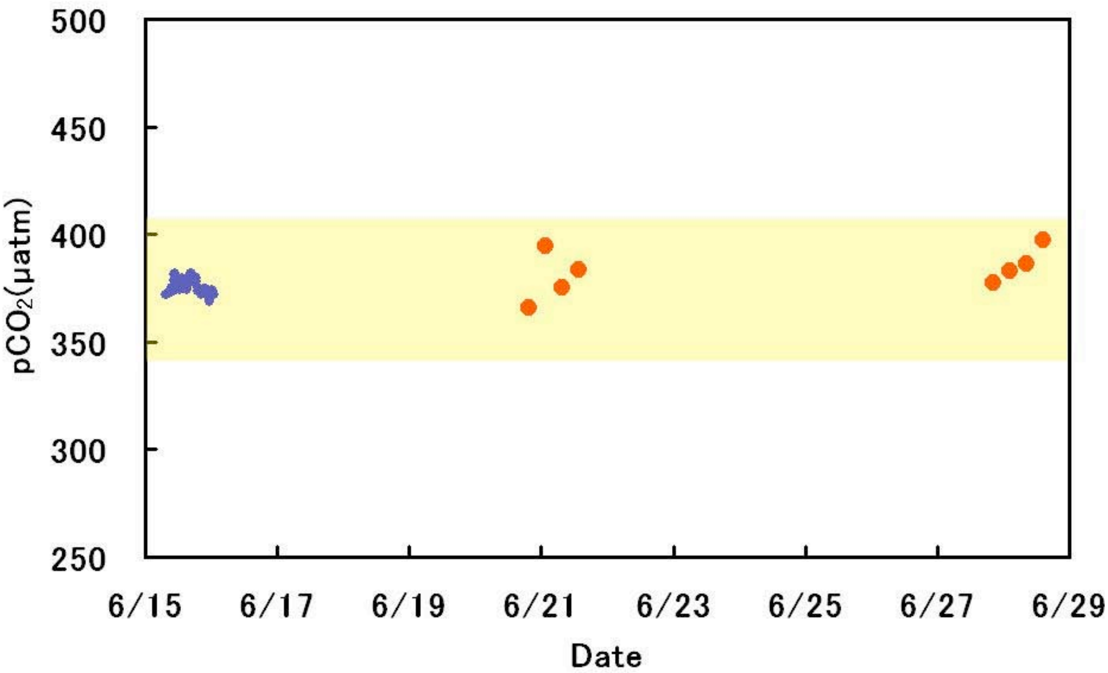


Fig. 2. Surface pCO_2 at mooring station. Blue circles are Mirai data and red circles are pCO_2 sensor data. Yellow band represents pCO_2 distribution range in this area (0-5_N, 152-160_E) over the past 40 years.