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R/V Mirai Cruise Report MR06-01

February 5 – March 18, 2006
Tropical Ocean Climate Study (TOCS)

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


TRITON
JAMSTEC
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1. Cruise name and code

Tropical Ocean Climatology Study

MR06-01

Ship: R/V Mirai

Captain: Yujiro Kita

2. Introduction and observation summary

2.1. Introduction

The purpose of this cruise is to observe the ocean and atmosphere in the western tropical Pacific Ocean for better understanding of climate variability involving the ENSO (El Nino/Southern Oscillation) phenomena. Particularly, warm water pool (WWP) in the western tropical Pacific is characterized by the highest sea surface temperature in the world, and plays a major role in driving global atmospheric circulation. Zonal migration of the WWP is associated with El Nino and La Nina which causes drastic climate changes in the world such as 1997-98 El Nino and 1999 La Nina. However, this atmospheric and oceanic system is so complicated that we still do not have enough knowledge about it.

In order to understand the mechanism of the atmospheric and oceanic system, its high quality data for long period is needed. Considering this background, we developed the TRITON (TRIangle Trans-Ocean buoy Network) buoys and have deployed them in the western equatorial Pacific and Indian Ocean since 1998 cooperating with USA, Indonesia, and India. The major mission of this cruise is to maintain the network of TRITON buoys along 147E and 156E lines in the western equatorial Pacific. Additionally, subsurface Acoustic Doppler Current Profiler (ADCP) buoys at the equator are maintained to obtain time-series data of equatorial ocean current.

We conducted ocean observations using CTD/XCTDs, Caroucel water sampler, shipboard ADCP, Argo profiling floats in the western tropical Pacific not only for the above purpose but also for research of exchange of greenhouse gasses between ocean and atmosphere. Atmospheric observations were also conducted using meteorological observational instruments of the R/V Mirai (ceilometer, lider system, sky radiometer, and so on) at the same time.

2.2. Overview

2.2.1. Ship

R/V Mirai

Captain Yujiro Kita

2.2.2. Cruise code

MR06-01

2.2.3. Project name

Tropical Ocean Climate Study (TOCS)

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

Yuji Kashino (JAMSTEC)

2.2.6. Period

February 5, 2006 (Sekinehama, Japan) – March 18, 2006 (Sekinehama, Japan)

2.2.7. Research participants

Total 20 scientists and technical staff from 4 institutions and companies.

2.3. Observation summary

TRITON mooring deployment:	9 sites
TRITON mooring recovery:	9 sites
TRITON mooring repair:	1 site
ADCP mooring deployment:	2 sites
ADCP mooring recovery:	3 sites
Argo profiling float launching:	3 floats
CTD (Salinity, Temperature and Depth) and water sampling:	19 casts at 10 sites
XCTD (Salinity, Temperature and Depth):	30 casts
Surface meteorology:	continuous
ADCP measurements:	continuous
Surface temperature and salinity measurements by intake method:	continuous

Other specially designed observations were carried out successfully.

Firstly, we maintained six TRITON buoys along 156E line from Feb. 13 to Feb. 24. Regarding the TRITON #5 at 2S, 156E, which drifted by vandalism, we recovered the mooring line below the recovery buoys because its surface buoy and underwater conductivity/temperature sensors had been already recovered. At the equator, we recovered and deployed the subsurface ADCP buoy. Next, at 147E line, we maintained three TRITON buoys and one ADCP buoy from Feb. 26 to Mar. 5. We also recovered the ADCP buoy at 2.5S, 142E on Mar. 7.

Although we were planning XCTD observations along 142E line after the ADCP buoy recovery at 2.5S, we canceled this observation and instead moved to 5N, 156E to repair the wind speed/direction of TRITON #2, which had failed the data communication since Feb. 28. We arrived at this site and exchanged the sensor on Mar. 10.

We conducted two CTD casts with water sampling at every TRITON sites. XCTDs were deployed between the TRITON sites to supplement of CTD observations. Three Argo profiling floats were launched at 8N, 156E, 5N, 147E and 18N, 150E.

Observed Oceanic and Atmospheric Conditions

According to the information of TAO/TRITON buoy array (Figure 2-1), the equatorial Pacific was under the La Nina condition during this boreal autumn-winter. Southern Oscillation Index by Climate Prediction Center/NOAA reached 1.8 in January 2006. However, as shown in outgoing longwave radiation anomaly picture (Figure 2-2) from CDC/NOAA, Maddan Julian Oscillation passed 150E line at the end of January, and westerly wind was strong west of this longitude after then. Because of this phenomenon, the La Nina condition seems to be weakened after February. Temperature anomaly picture along the equatorial vertical section obtained from TAO/TRITON array (Figure 2-3) also shows that positive temperature anomaly around the thermocline depth appears around 160E and it will propagate eastward as an ocean Kelvin wave, which will weaken the La Nina condition.

However, status of ocean surface during this cruise was still that of La Nina; the South Equatorial Current was strong with velocity exceeding 1.0m/s and SST in this region exceeded 29.5 C.

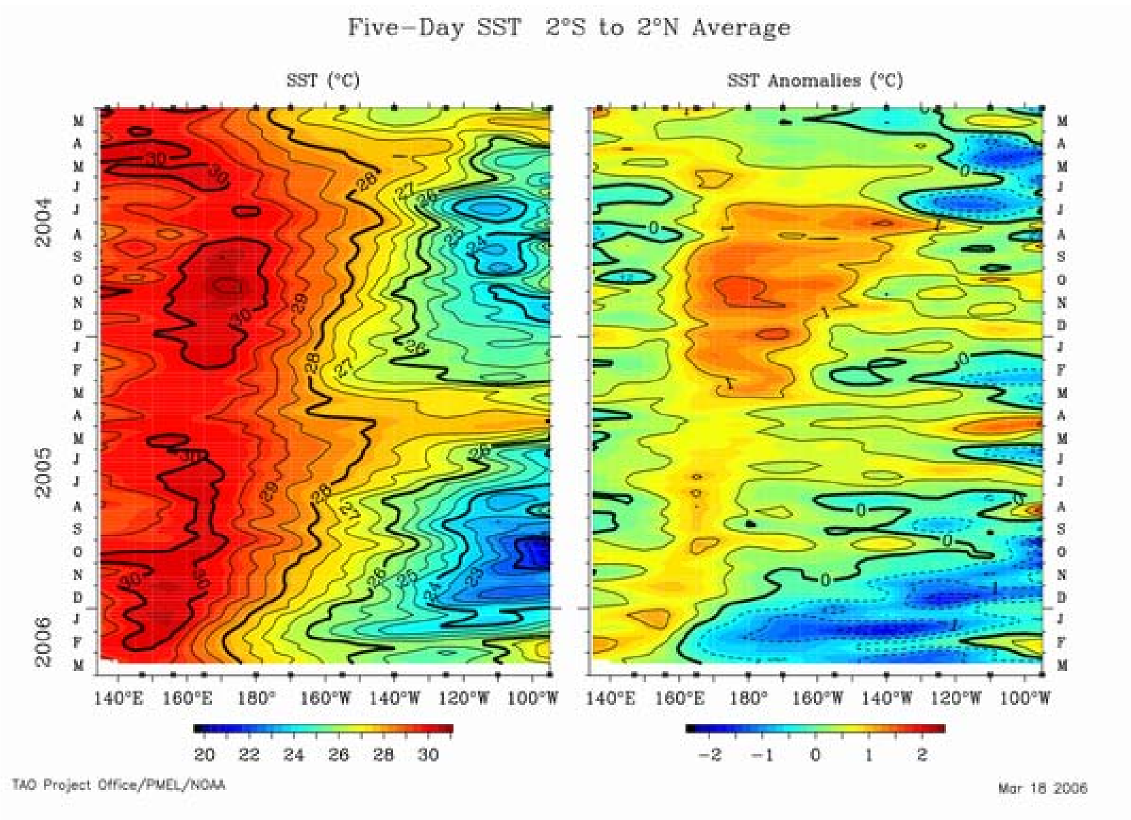

Figure 2-1. Time-longitude plot of sea surface temperature and its anomaly at the equator obtained from TAO/TRITON buoy array from March 2004 to March 2006. (http://www.pmel.noaa.gov/tao/jsdisplay/)

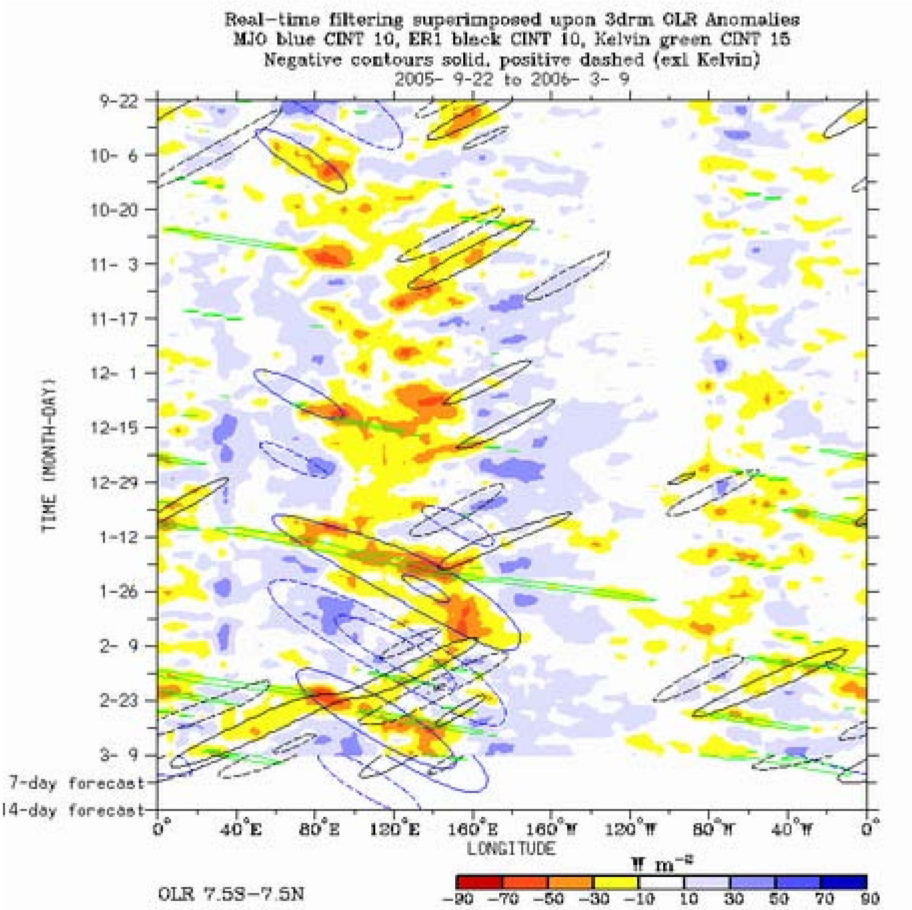

Figure 2-2. Outgoing radiation anomaly averaged over 7.5S-7.5N from the web page of the Climate Diagnostic Center (CDC), National Oceanic and Atmospheric Association (NOAA) (http://www.cdc.noaa.gov/map/clim/olr_modes/).

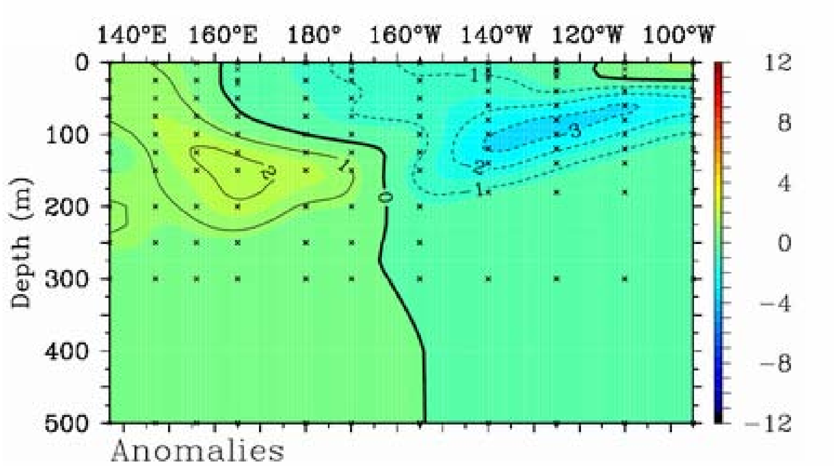

Figure 2-3. Vertical section of temperature anomaly along the equator on February 2006 obtained from TAO/TRITON array.

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

3.1 Period

February 5, 2006 – March 18, 2006

3.2 Port of call

Sekinehama, Japan (Departure; February 5, 2006)
Hachinohe, Japan (February 6, 2006)
Sekinehama, Japan (Arrival; March 18, 2006)

3.3 Cruise log

SMT (Ship mean time)	UTC	Event
Feb. 05 (Sun.)		
15:00	06:00	Departure at Sekinehama, Japan (SMT=UTC+09:00)
Feb. 06 (Mon.)		
08:30	23:30	Arrived at Hachinohe, Japan
12:20	03:20	Departure at Hachinohe, Japan
14:00	05:00	Safety Guidance on the R/V Mirai
16:45	07:45	Konpira Ceremony
Feb. 07 (Tue.)		
11:02	02:02	Start of continuous water observation
13:15	04:15	Boat station drill
Feb. 08 (Wed.)		
		Cruise for 8N 156E
Feb. 09 (Thu.)		
10:30	01:30	Meeting for MR06-01 observation
Feb. 10 (Fri.)		
		Cruise for 8N 156E
Feb. 11 (Sat.)		
		Cruise for 8N 156E
Feb. 12 (Sun.)		
		Cruise for 8N 156E
Feb. 13 (Mon.)		
		Cruise for 8N 156E
Feb. 14 (Tue.)		
06:00 – 06:24	21:00 – 21:24	“Figure eight” turning for calibration of magnetometer
08:21 – 10:39	23:21 – 01:39	Deployment of TRITON buoy at 8N 156E (07-57.64N, 156-01.40E, 4841m)
10:58 – 11:43	01:58 – 02:43	CTD cast, down to 1000m depth (07-57.11N, 156-01.50E, 4831m)
12:59 – 16:34	03:59 – 07:34	CTD cast, down to 4750m depth (07-59.80N, 155-56.19E, 4802m)

Feb. 15 (Wed.)

08:06 – 11:27	23:06 – 02:27	Recovery of TRITON buoy at 8N 156E
11:34	02:34	Launching of Argo float (07-59.04N, 155-51.80E, 4746m)
13:35	04:35	XCTD X-001 (07-29.98N, 155-53.09E, 4131m)
15:40	06:40	XCTD X-002 (06-59.99N, 155-55.52E, 4470m)
17:52	08:52	XCTD X-003 (06-28.53N, 155-57.41E, 4408m)
19:50	10:50	XCTD X-004 (05-59.99N, 155-57.67E, 4131m)
21:52	12:52	XCTD X-005 (05-29.99N, 155-57.88E, 3691m)

Feb. 16 (Thu.)

08:16 – 10:05	23:16 – 01:05	Deployment of TRITON buoy at 5N 156E (05-01.10N, 155-58.13E, 3606m)
10:25 – 11:13	01:25 – 02:13	CTD cast, down to 1000m depth (05-02.36N, 155-57.96E, 3598m)
13:58 – 16:53	04:58 – 07:53	CTD cast, down to 3600m (04-59.30N, 156-01.09E, 3620m)

Feb. 17 (Fri.)

08:18 – 11:05	23:18 – 02:05	Recovery of TRITON buoy at 5N 156E
13:05	04:05	XCTD X-006 (04-29.99N, 156-00.27E, 3557m)
15:05	06:05	XCTD X-007 (03-59.99N, 156-00.11E, 3476m)
17:05	08:05	XCTD X-008 (03-29.99N, 155-59.82E, 3253m)
19:06	10:06	XCTD X-009 (02-59.99N, 155-59.89E, 2870m)
21:08	12:08	XCTD X-010 (02-30.00N, 155-59.92E, 2668m)

Feb. 18 (Sat.)

08:14 – 09:56	23:14 – 00:56	Deployment of TRITON buoy at 2N 156E (01-57.18N, 155-59.84E, 2564m)
10:24 – 11:11	01:24 – 02:11	CTD cast, down to 1000m depth (01-58.04N, 156-01.09E, 2581m)
13:00 – 15:13	04:00 – 06:13	CTD cast, down to 2580m depth (02-01.47N, 156-00.78E, 2580m)

Feb. 19 (Sun.)

08:03 – 10:46	23:03 – 01:46	Recovery of TRITON buoy at 2N 156E
12:51	03:51	XCTD X-011 (01-30.00N, 155-57.93E, 2377m)
14:51	05:51	XCTD X-012 (00-59.99N, 155-58.88E, 2276m)
16:51	07:51	XCTD X-013 (00-30.00N, 155-58.40E, 2150m)

Feb. 20 (Mon.)

08:11 – 10:46	23:11 – 01:46	Deployment of TRITON buoy at EQ 156E (00-01.38S, 155-56.76E, 1941m)
10:25 – 12:10	01:25 – 03:10	CTD cast, down to 1908m depth (00-01.59N, 155-55.98E, 1943m)
13:45 – 15:06	04:45 – 06:06	Recovery of ADCP mooring at EQ 156E
15:51 – 16:35	06:51 – 07:35	Deployment of ADCP mooring at EQ 156E (00- 00.12S, 156-08.47E, 1958m)
17:40 – 18:26	08:40 – 09:26	CTD cast, down to 1000m depth (00-00.94S, 156-02.11E, 1948m)

Feb 21 (Tue.)

08:03 – 10:42	23:03 – 01:42	Recovery of TRITON buoy at EQ 156E
12:31	03:31	XCTD X-014 (00-30.00S, 156-01.91E, 1955m)

14:30	05:30	XCTD X-015 (01-00.00S, 156-01.53E, 2068m)
16:29	07:29	XCTD X-016 (01-30.00S, 156-00.89E, 1809m)
Feb 22 (Wed.)		
08:03 – 09:01	23:03 – 00:01	Recovery of TRITON buoy at 2S 156E
10:27 – 12:13	01:27 – 03:13	CTD cast, down to 1740m depth (01-59.42S, 155-58.03E, 1741m)
Feb. 23 (Thu.)		
08:12 – 09:43	23:12 – 00:43	Deployment of TRITON buoy at 2S 156E (01-58.76S, 156-01.88E, 1752m)
10:26 – 11:11	01:26 – 02:11	CTD cast, down to 1000m depth (01-57.92N, 156-01.55E, 1754m)
13:39	04:39	XCTD X-017 (02-29.99S, 156-01.57E, 1737m)
15:42	06:42	XCTD X-018 (03-00.00S, 156-01.34E, 1806m)
17:44	08:44	XCTD X-019 (03-30.00S, 156-01.13E, 1896m)
19:47	10:47	XCTD X-020 (04-00.01S, 156-01.61E, 1771m)
21:52	12:52	XCTD X-021 (04-30.00S, 156-01.54E, 1708m)
Feb. 24 (Fri.)		
08:09 – 09:34	23:09 – 00:34	Deployment of TRITON buoy at 5S 156E (04-58.76S, 156-00.85E, 1515m)
10:42 – 12:16	01:42 – 03:16	CTD cast, down to 1457m depth (05-01.63S, 156-02.72E, 1505m)
13:28 – 15:34	04:28 – 06:34	Recovery of TRITON buoy at 5S 156E
16:09 – 16:55	07:09 – 07:55	CTD cast, down to 1000m depth (04-59.67S, 156-01.47E, 1502m)
Feb. 25 (Sat.)		
		Cruise for EQ 147E
Feb. 26 (Sun.)		
13:09 – 15:10	04:09 – 06:10	Deployment of TRITON buoy at EQ 147E (00-01.53S, 146-59.84E, 4547m)
16:28 – 17:13	07:28 – 08:13	CTD cast, down to 1000m depth (00-02.21N, 146-59.29E, 4411m)
Feb. 27 (Mon.)		
08:03 – 11:00	23:03 – 02:00	Recovery of TRITON buoy at EQ 147E
13:26 – 16:53	04:26 – 07:53	CTD cast, down to 4542m depth (00-03.24S, 147-00.50E, 4584m)
Feb. 28 (Tue.)		
08:03 – 09:52	23:03 – 00:52	Recovery of ADCP mooring at EQ 147E
13:02 – 14:16	04:02 – 05:16	Deployment of ADCP mooring at EQ 147E (00-00.32S, 147-04.58E, 4477m)
17:06	08:06	XCTD X-022 (00-30.00N, 147-01.70E, 4506m)
19:05	10:05	XCTD X-023 (01-00.00N, 147-00.33E, 4529m)
21:04	12:04	XCTD X-024 (01-30.00N, 146-58.89E, 4515m)
Mar. 01 (Wed.)		
13:55 – 17:03	04:55 – 08:03	CTD cast, down to 4124m depth (04-59.35N, 147-03.24E, 4165m)

Mar. 02 (Thu.)		
08:30 – 11:34	23:30 – 02:34	Recovery of TRITON buoy at 5N 147E
Mar. 03 (Fri.)		
08:12 – 10:12	23:12 – 01:12	Deployment of TRITON buoy at 5N 147E (05-02.34N, 146-57.06E, 4255m)
10:40 – 11:24	01:40 – 02:24	CTD cast, down to 1000m depth (05-01.42N, 146-56.51E, 4258m)
11:27	02:27	Launching of Argo float (05-01.37N, 146-56.71E, 4257m)
15:08	06:08	XCTD X-025 (04-29.03N, 146-58.73E, 4177m)
17:07	08:07	XCTD X-026 (04-00.00N, 146-58.21E, 4583m)
19:08	10:08	XCTD X-027 (03-30.00N, 146-57.34E, 4243m)
21:12	12:12	XCTD X-028 (03-00.01N, 146-57.13E, 4479m)
23:23	14:23	XCTD X-029 (02-30.00N, 146-56.67E, 4477m)
Mar. 04 (Sat.)		
08:11 – 10:13	23:11 – 01:13	Deployment of TRITON buoy at 2N 147E (02-04.67N, 146-56.96E, 4492m)
10:39 – 11:26	01:39 – 02:26	CTD cast, down to 1000m depth (02-05.06N, 146-57.91E, 4490m)
13:52 – 17:10	04:52 – 08:10	CTD cast, down to 4430m depth (02-01.19N, 147-00.56E, 4456m)
Mar. 05 (Sun.)		
08:07 – 11:35	23:07 – 02:35	Recovery of TRITON buoy at 2N 147E
Mar. 06 (Mon.)		
17:37 – 17:53	08:37 – 08:53	“Figure eight” turning for calibration of magnetometer
Mar. 07 (Tue.)		
08:03 – 09:36	23:03 – 00:36	Recovery of ADCP mooring at 2.5S 142E
09:41	00:41	XCTD X-030 (02-27.33S, 141-55.83E, 3190m)
Mar. 08 (Wed.)		
		Cruise for 5N 156E
Mar. 09 (Thu.)		
		Cruise for 5N 156E
Mar. 10 (Fri.)		
08:05 – 08:45	23:05 – 23:45	Repairing of TRITON buoy at 5N 156E
Mar. 11 (Sat.)		
		Cruise for 18N 150E
Mar. 12 (Sun.)		
		Cruise for 18N 150E
Mar. 13 (Mon.)		
08:04 – 09:28	23:04 – 00:28	CTD cast, down to 2000m depth (18-00.26N, 150-00.65E, 5176m)
09:42	00:42	Launching of Argo float (18-00.78N, 150-01.06E, 5175m)

Mar. 14 (Tue.)		
08:50	23:50	Stop of continuous water observation
Mar. 15 (Wed.)		
		Cruise for Sekinehama
Mar. 16 (Thu.)		
		Cruise for Sekinehama
Mar. 17 (Fri.)		
		Cruise for Sekinehama
Mar. 18 (Sat.)		
09:00	00:00	Arrived at Sekinehama, Japan

3.4 Cruise Track

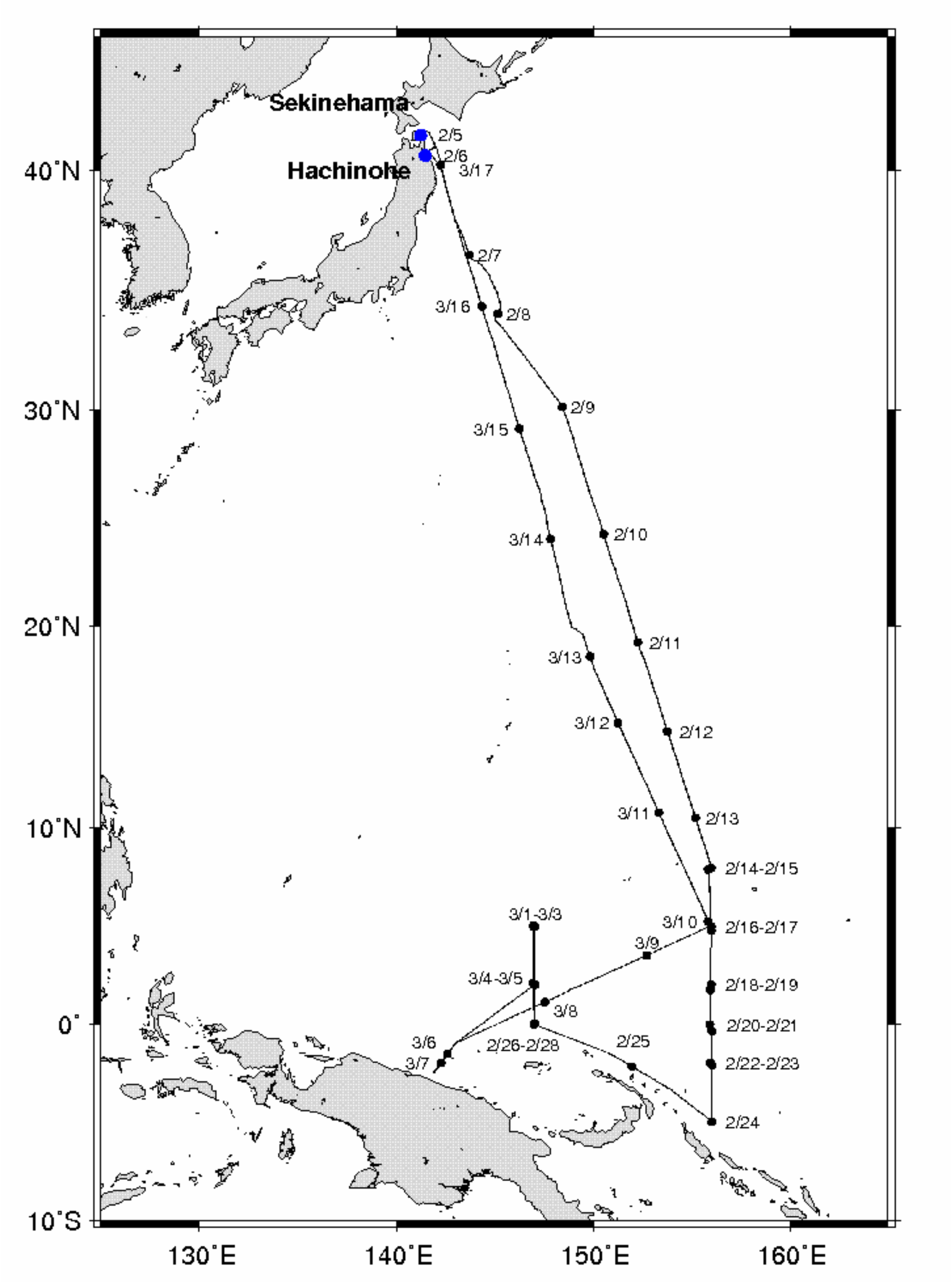

Fig 3.4-1 Cruise Track and Noon Position.

4. Chief scientist

Yuji Kashino
Research Scientist
Institute of Observational Research for Global Change (IORGC),
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima-cho, Yokosuka, 237-0061, Japan

5. Participants list

5.1. R/V MIRAI scientist and technical staff

Yuji Kashino	JAMSTEC
Kiminori Shitashima	CRIEPI
Akinori Fujita	CRIEPI
Masaki Taguchi	MWJ
Hiroshi Matsunaga	MWJ
Keisuke Matsumoto	MWJ
Tomohide Noguchi	MWJ
Akinori Murata	MWJ
Tanaka Tatsuya	MWJ
Hiroki Ushiromura	MWJ
Tetsuharu Iino	MWJ
Ai Yasuda	MWJ
Junji Matsushita	MWJ
Masaki Furuhata	MWJ
Takatoshi Kiyokawa	MWJ
Hiroshi Komura	MWJ
Masayuki Kumagai	MWJ
Ami Iwaki	MWJ
Soichiro Sueyoshi	GODI
Kazuho Yoshida	GODI

JAMSTEC: Japan Agency for Marine-Earth Science and Technology
CRIEPI: Central Research Institute of Electric Power Industry
GODI: Global Ocean Development Inc.
MWJ: Marine Works Japan Ltd.

5.2. R/V MIRAI Crew member

Master	Yujiro Kita
Chief Officer	Haruhiko Inoue
1st Officer	Katsumi Ishimota
2nd Officer	Mitsunobu Asanuma
3rd Officer	Nobuo Fukaura
Jr. 3rd Officer	Ryota Natsuno
Chief Engineer	Toshiyuki Igata
1st Engineer	Koji Masuno
2nd Engineer	Kenji Ishida
Jr. 3rd Engineer	Hiroyuki Tohken
C/R Officer	Naoto Morioka
Boatswain	Kenetsu Ishikawa
Able Seaman	Yasuyuki Yamamoto
Able Seaman	Kunihiko Omote
Able Seaman	Masami Sugami
Able Seaman	Yukiharu Suzuki
Able Seaman	Masaru Hamabe
Able Seaman	Yosuke Kuwahara
Able Seaman	Kazuyoshi Kudo
Able Seaman	Tsuyoshi Sato
Able Seaman	Tsuyoshi Monzawa
Able Seaman	Shuji Komata
No.1 Oiler	Yukitoshi Horiuchi
Oiler	Toshimi Yoshikawa
Oiler	Yoshihiro Sugimoto
Oiler	Nobuo Boshita
Oiler	Shigeo Yamaguchi
Oiler	Kazumi Yamashita
Chief Steward	Hitoshi Ota
Cook	Kitoshi Sugimoto
Cook	Ryoji Takesako
Cook	Tatsuya Hamabe
Cook	Yoshiteru Hiramatsu

6 General Observations

6.1 Meteorological measurement

6.1.1 Surface Meteorological Observations

Personnel

Kunio Yoneyama	(JAMSTEC) Principal Investigator / Not on-board
Souichiro Sueyoshi	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)

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.

Methods

The surface meteorological parameters were observed throughout the MR06-01 cruise from Sekinehama on 5 February 2006 to Sekinehama 18 March 2006. During this cruise, we used two systems for the 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 and measured parameters are listed in Table 6.1-2 Data was collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6-second averaged data.

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 Table6.1-3 and measured parameters are listed in Table 6.1-4.

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

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.

Preliminary results

Figures 6.1-1 and Figures 6.1-2 show the time series of the following parameters;

Wind (SOAR)
Air temperature (SOAR)
Relative humidity (SOAR)
Precipitation (SOAR, ORG)
Short/long wave radiation (SOAR)
Pressure (SOAR)
Sea surface temperature (from EPCS)
Significant wave height (SMET)

Data archives

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

Remarks

1. Sea surface temperature is not acquired from the departure to 00:00 UTC 7 February and from 00:00 UTC 14 March to the arrival, because we stopped pumping up surface water.
2. Data acquisition stopped from 09:51 07 February to 02:22 08 February for logging PC trouble. 6 second averaged dataset in this period was used from SMET 6 second dataset recorded by SOAR, and 10 minute dataset and 1 hour dataset were re-calculated from this 6 second dataset.
3. SOAR PRP system did not work correctly from departure from Sekinehama to 09:21 UTC 05 February, because of decreasing battery power under low temperature environment (below –5degC).

Table 6.1-1 Instruments and installations of MIRAI Surface Meteorological observation system

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

Table 6.1-2 Parameters of MIRAI Surface Meteorological observation system

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

Table 6.1-3 Instrument and installation locations of SOAR system

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

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

Table 6.1-4 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	

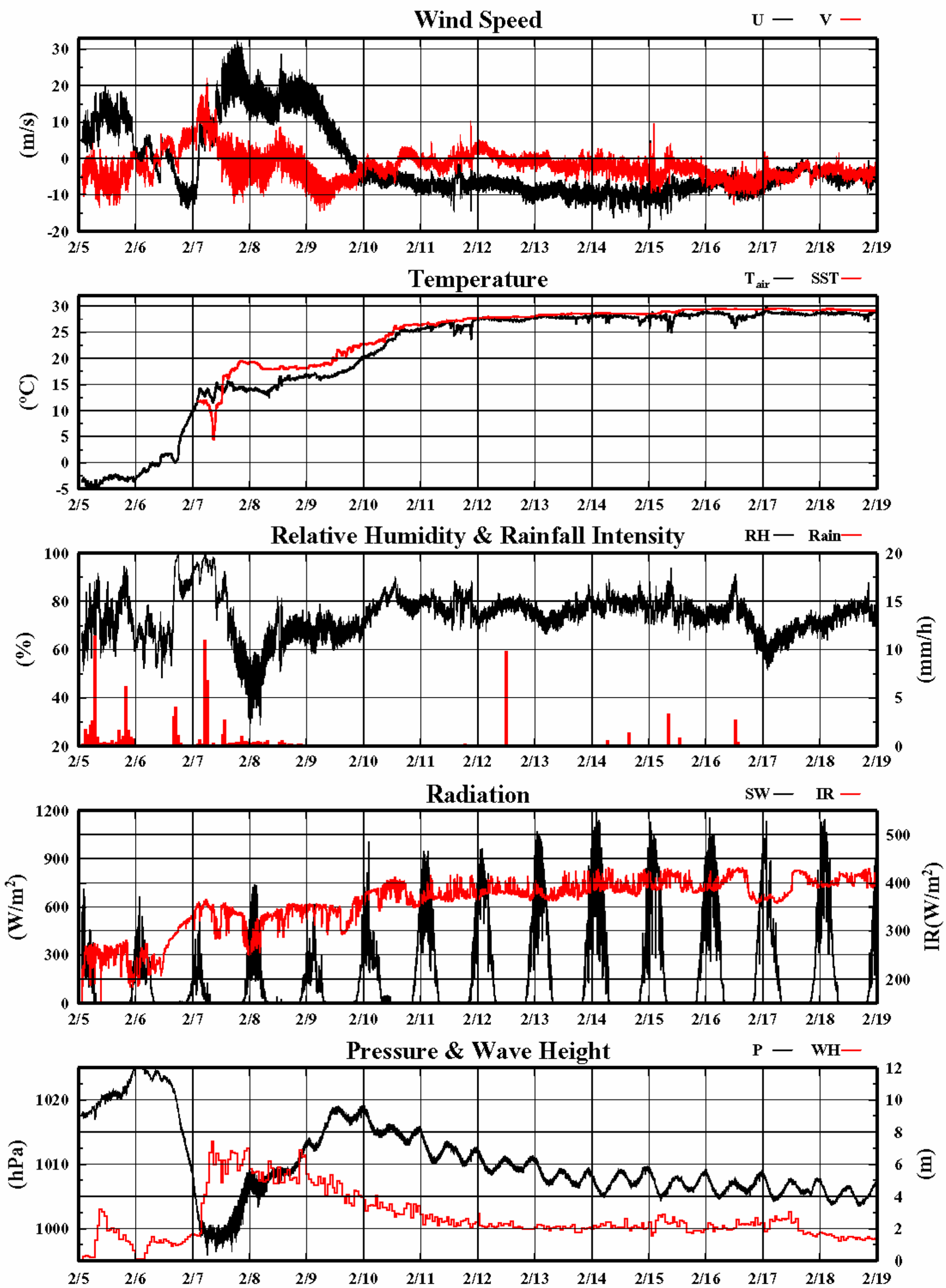

Fig.6.1-1 Time series of surface meteorological parameters during the MR06-01 cruise

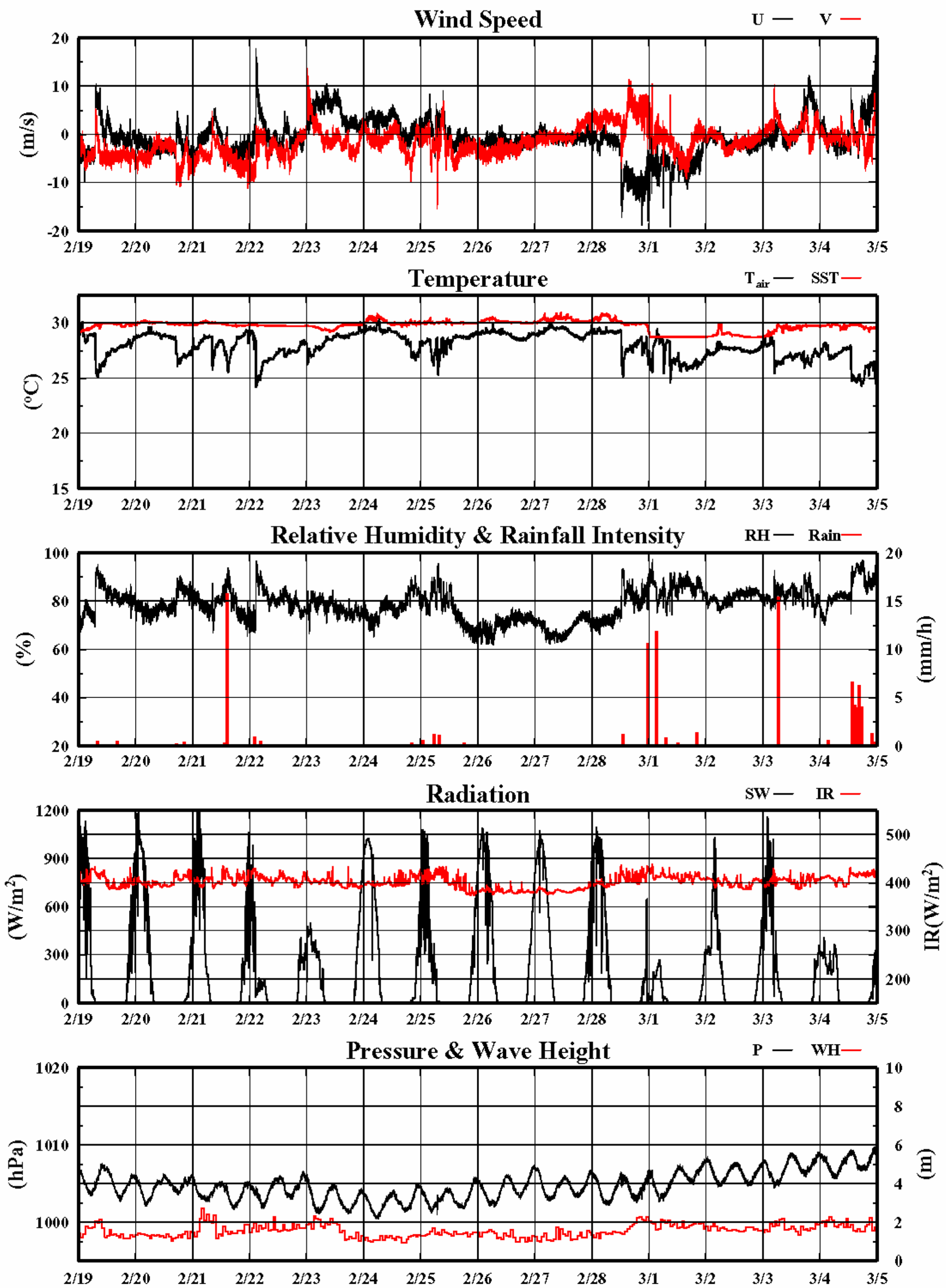

Fig.6.1-1 (continued)

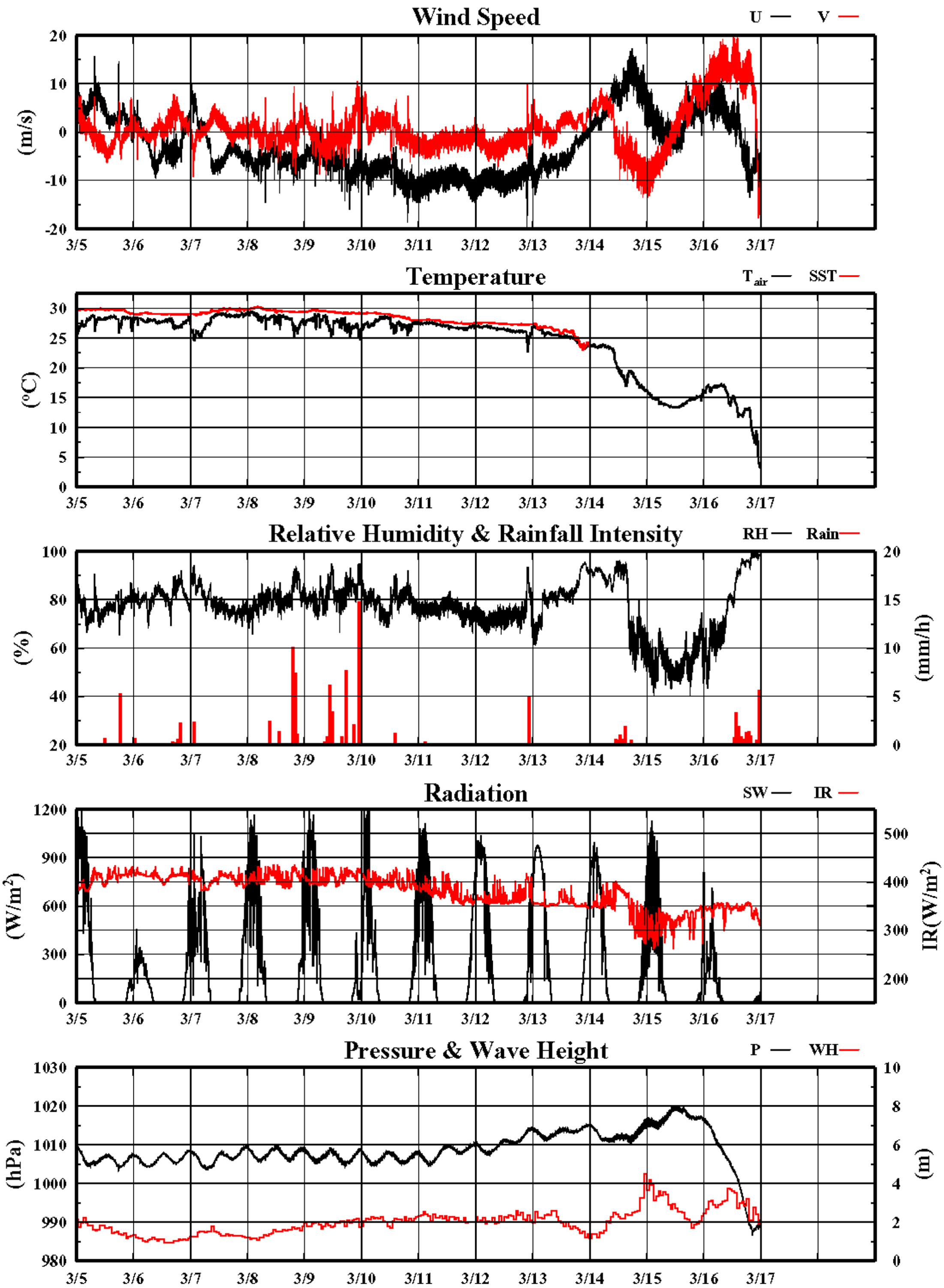

Fig.6.1-1 (continued)

6.1.2 Ceilometer Observation

Personnel

Kunio Yoneyama	(JAMSTEC) Principal Investigator / Not on-board
Souichiro Sueyoshi	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)

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.

Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR06-01 cruise from Sekinehama on 5 February 2006 to Sekinehama 18 March 2006. 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 archive dataset, cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft).

Preliminary results

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

Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division. And also be available from K. Yoneyama of JAMSTEC.

Remarks

Window cleaning (UTC) :	06:17, 06 February 2006
	00:36, 10 February 2006
	03:49, 12 February 2006
	05:45, 16 February 2006
	00:28, 19 February 2006
	01:27, 24 February 2006
	04:33, 26 February 2006
	03:32, 03 March 2006
	06:43, 08 March 2006
	03:29, 12 March 2006

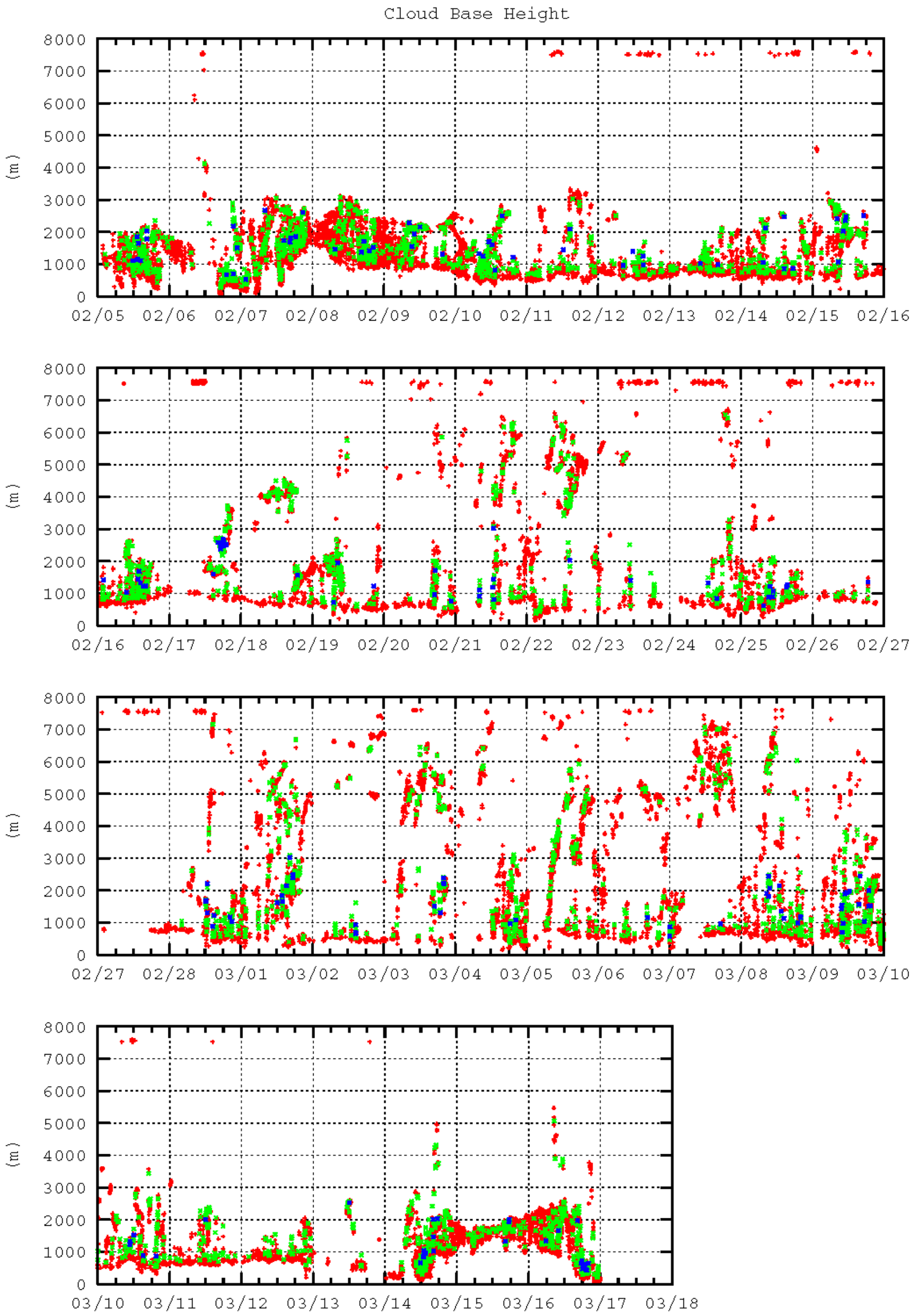

Fig.6.1.2-1 1st (red) 2nd (green) and 3rd (blue) lowest cloud base height during MR06-01 cruise.

6.2 CTD/XCTD

6.2.1. CTD

Personnel	Yuji Kashino	(JAMSTEC):	Principal Investigator
	Akinori Murata	(MWJ)	: Operation leader
	Tetsuharu Iino	(MWJ)	

(1) Objective

Investigation of oceanic structure and water sampling.

(2) Overview of the equipment and observation

CTD/Carousel water sampling system (CTD system), which is a 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. This CTD system was deployed from starboard on working deck. During this cruise.19 CTD cast were carried out (see Table 6.2.1).

(3) List of sensors and equipments

Under water unit:	SBE, Inc., SBE 9plus, S/N 0575
Temperature sensor:	SBE, Inc., SBE 03-04/F, S/N 031524
Conductivity sensor:	SBE, Inc., SBE 04C, S/N 042240
Oxygen sensor:	SBE, Inc., SBE 43, S/N 430330
Pump:	SBE, Inc., SBE 5T, S/N 053118
Altimeter	Benthos, Inc, PSA-916T, S/N 1100
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P9833-0344
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3227443-0391
Water sample bottle:	General Oceanics, Inc., 12-litre Niskin-X

(4) 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, time elapsed, temperature, conductivity, oxygen voltage, altitude, descent rate, modulo error count and pump status. DATCNV also extracted the information when Niskin bottles were closed by 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 file of the bottle data. The bottle position, date, time were output as the first two columns. Oxigen, Salinity, sigma-theta and potential temperature were averaged over 3.0 seconds.

ALIGNCTD converted the time-sequence of oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. 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 S/N 11P9833-0344 was set to advance the primary conductivity for 1.73 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, temperatur, 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 pressures 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.

(5) Preliminary Results

Date, time and locations of the CTD casts are listed in Table 6.2.1. Vertical profile of temperature salinity and oxygen with pressure are shown in Figure 6.2.1-1 – 19.

(6) 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.

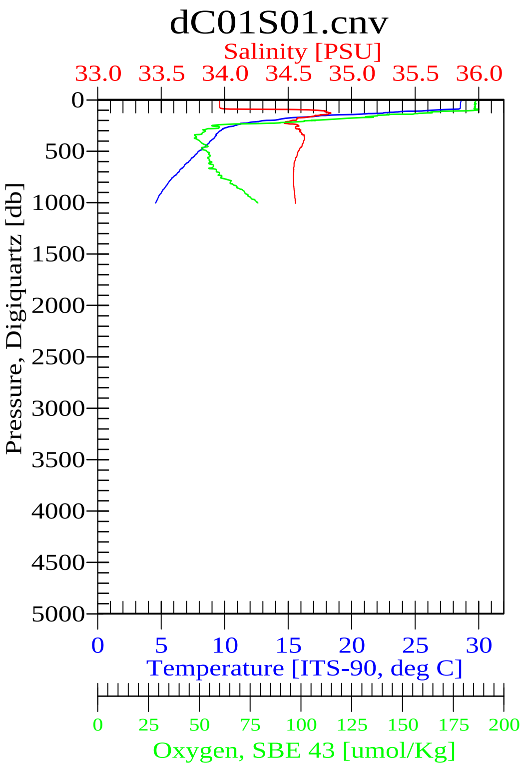

Figure 6.2.1-1.

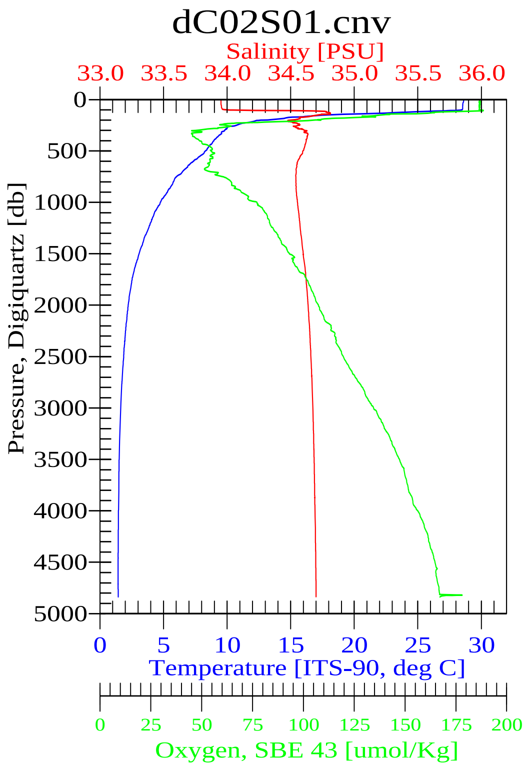

Figure 6.2.1-2.

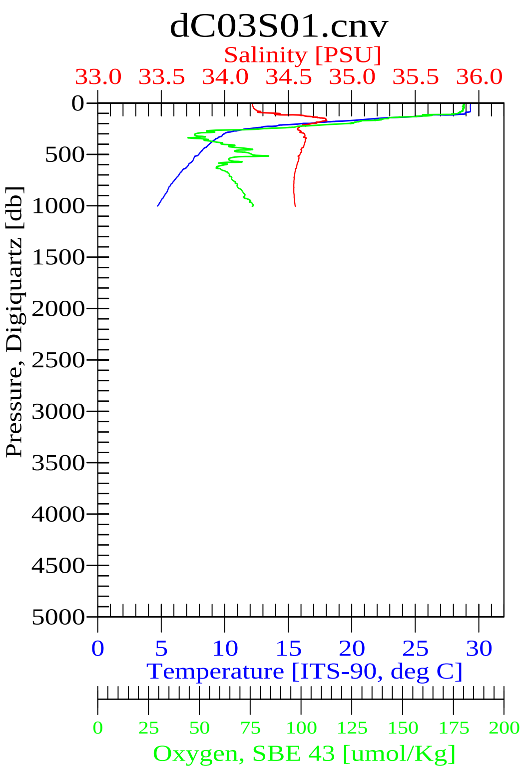

Figure 6.2.1-3.

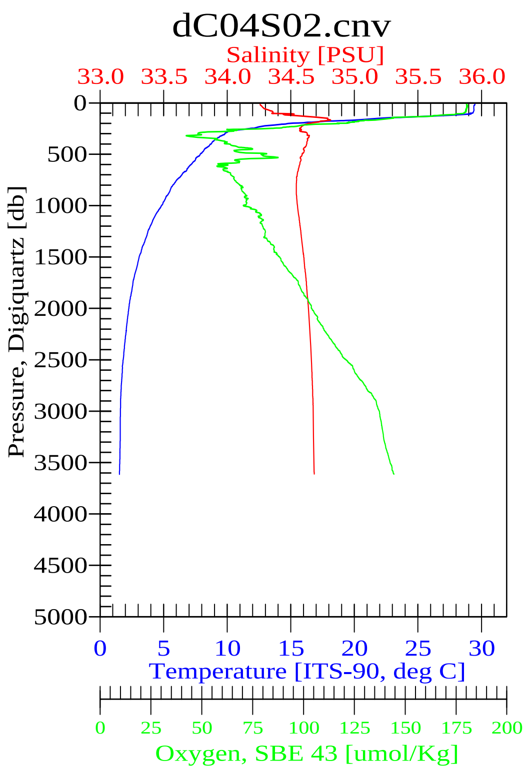

Figure 6.2.1-4.

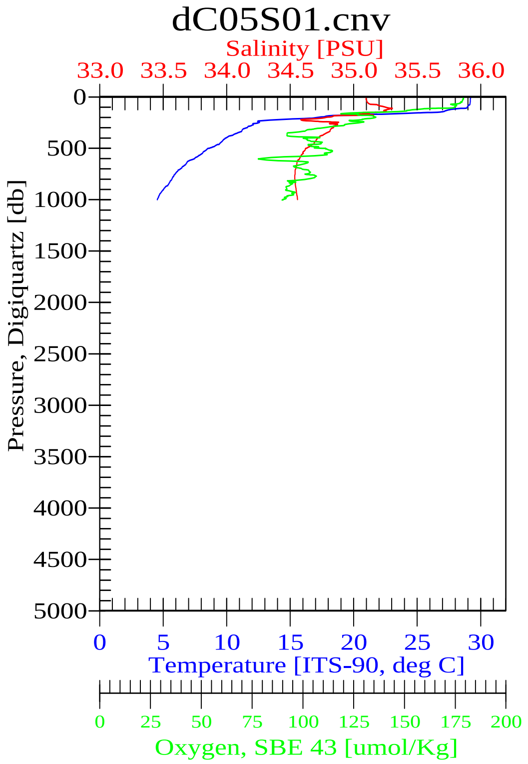

Figure 6.2.1-5.

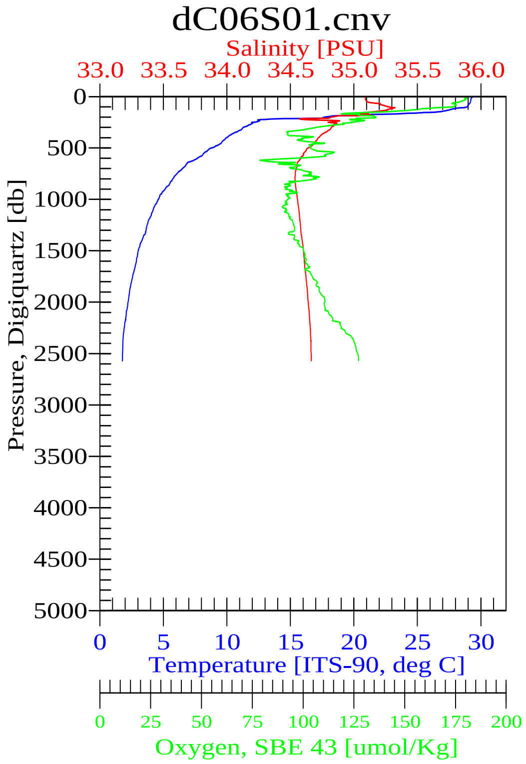

Figure 6.2.1-6.

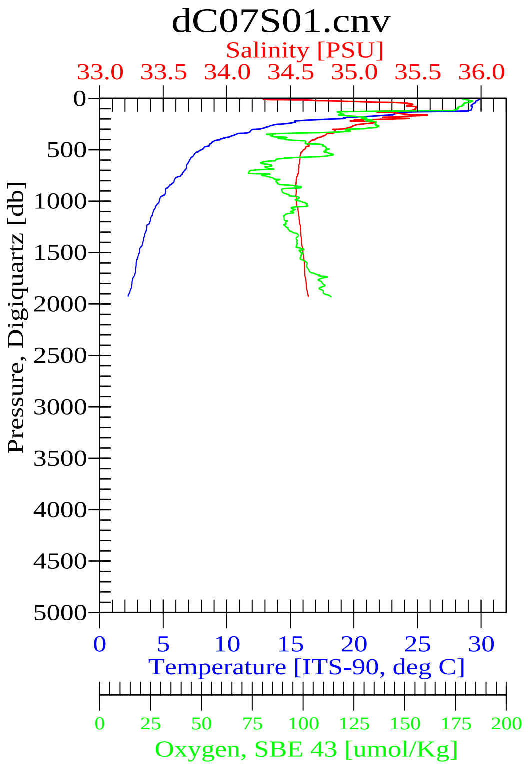

Figure 6.2.1-7.

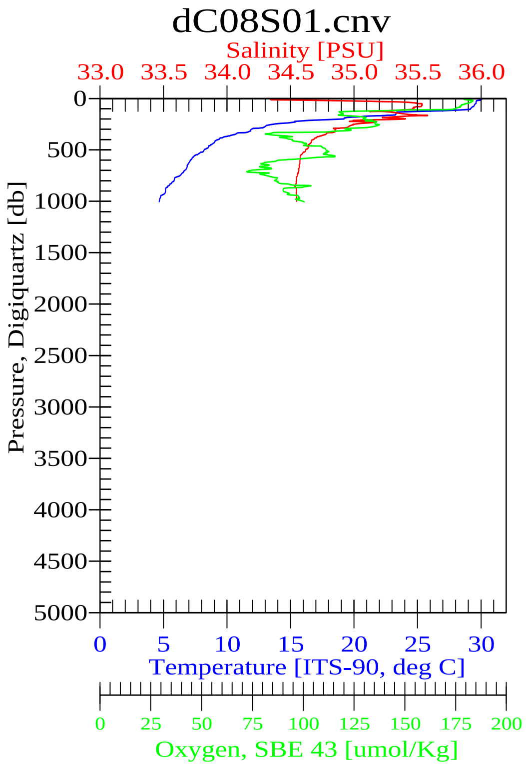

Figure 6.2.1-8.

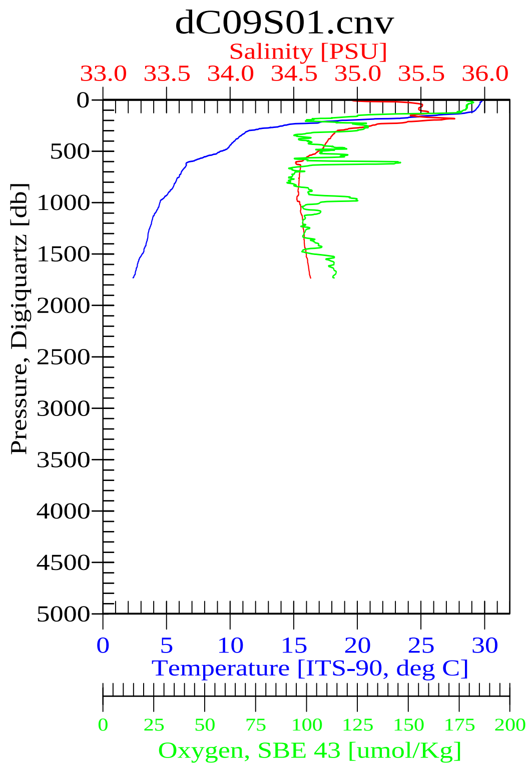

Figure 6.2.1-9.

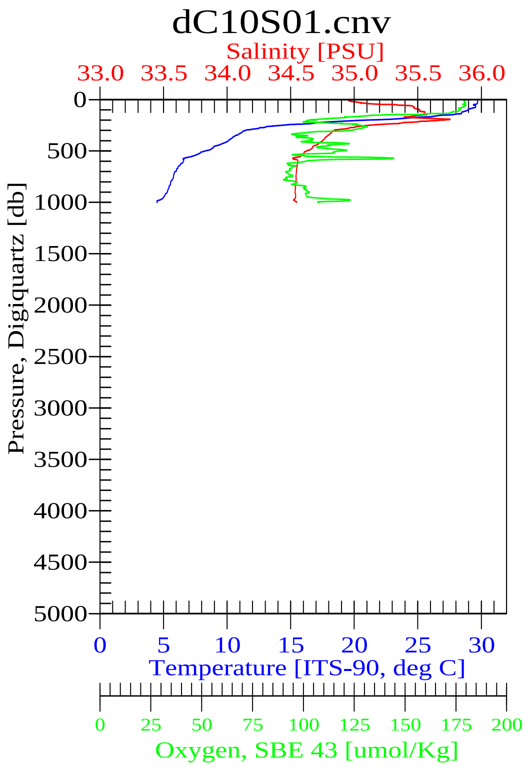

Figure 6.2.1-10.

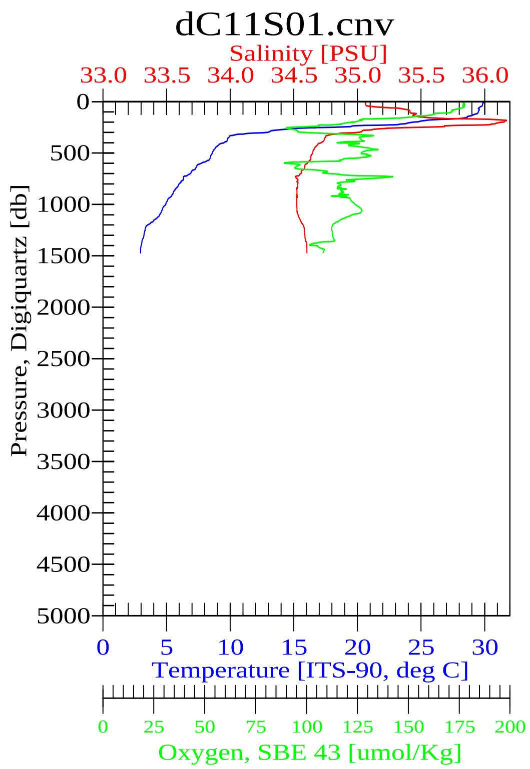

Figure 6.2.1-11.

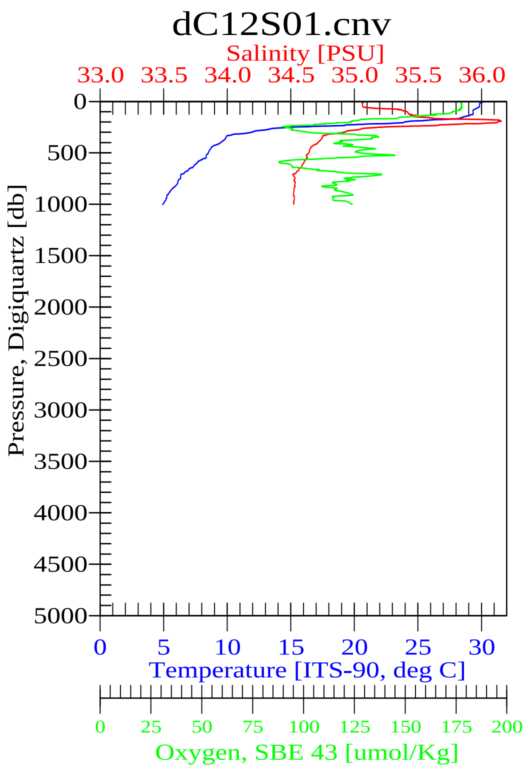

Figure 6.2.1-12.

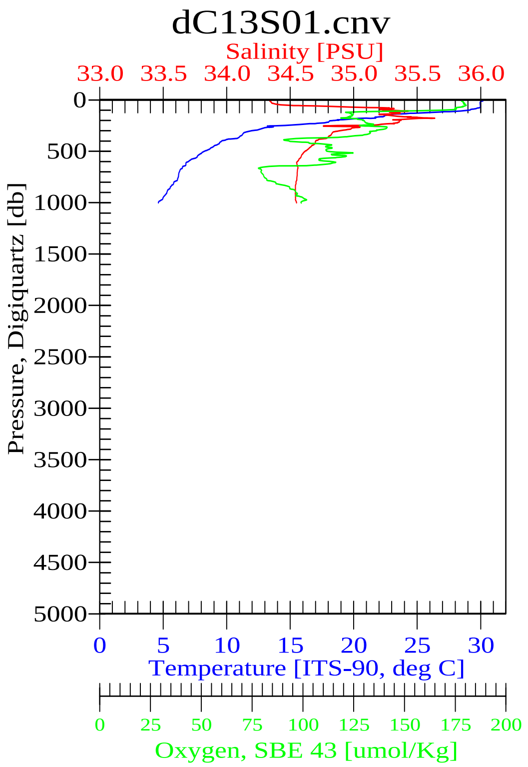

Figure 6.2.1-13.

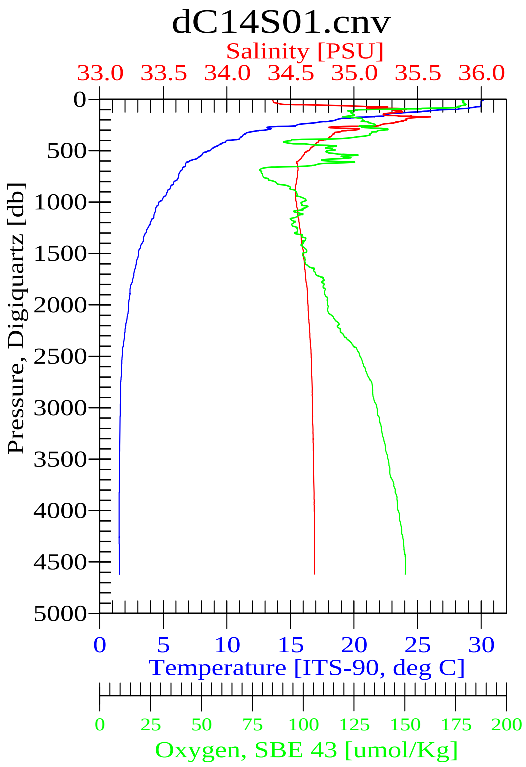

Figure 6.2.1-14.

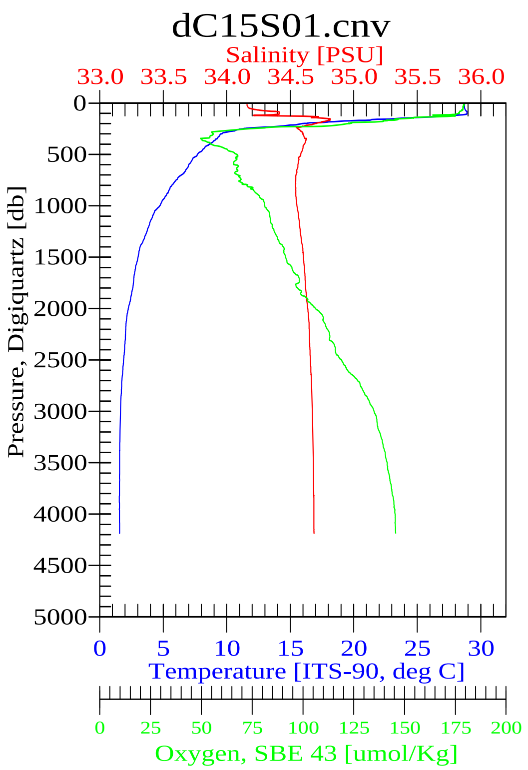

Figure 6.2.1-15.

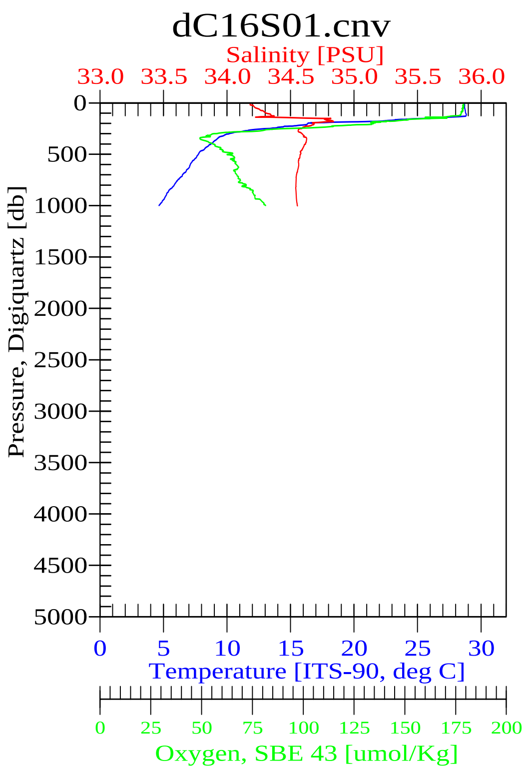

Figure 6.2.1-16.

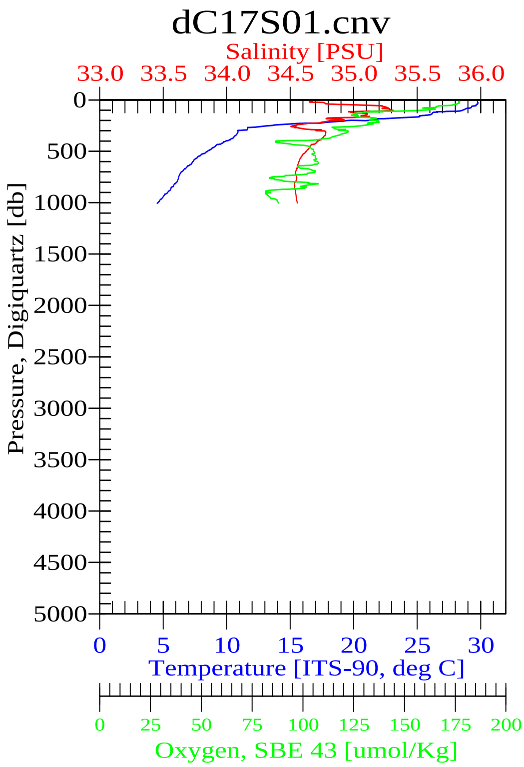

Figure 6.2.1-17.

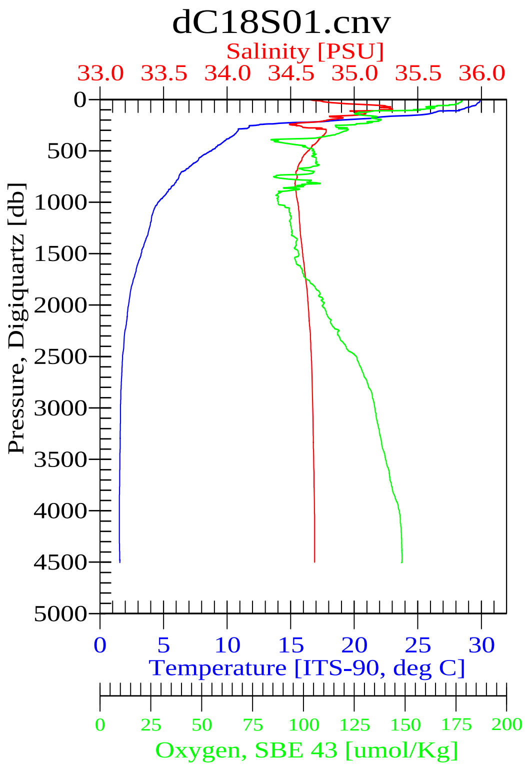

Figure 6.2.1-18.

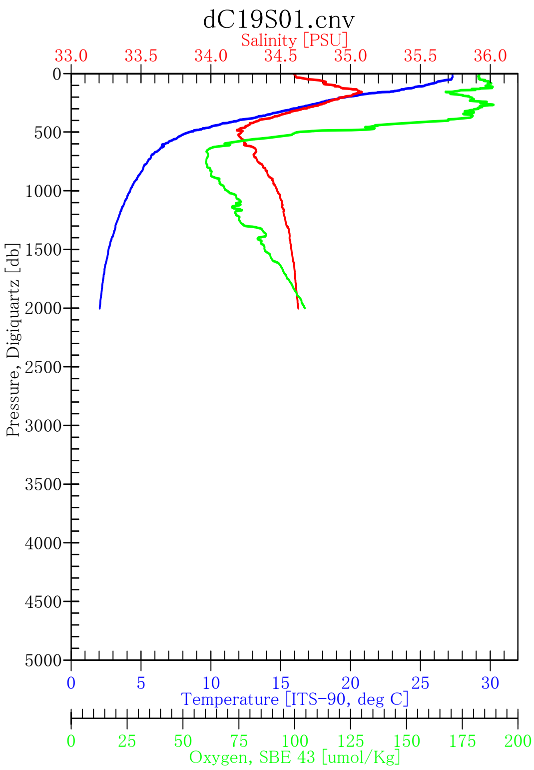

Figure 6.2.1-19.

Table 6.2.1 CTD Cast table

STNNBR	CASTNO	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	HT ABOVE	Max	Max	CTD data	Remarks
		yyyy/mm/dd	Start	End	Latitude	Longitude		OUT	BOTTOM	Depth	Pressure	file name	
C01	1	2/14/2006	2:02	2:40	07-57.46N	156-01.56E	4827.0	997.4	-	993.0	1002.1	C01S01	
C02	1	2/14/2006	4:04	7:31	07-59.55N	155-56.65E	4802.0	4804.1	39.6	4750.0	4837.8	C02S01	*1
C03	1	2/16/2006	1:29	2:09	05-02.34N	155-58.07E	3597.0	1006.0	-	997.0	1005.0	C03S01	
C04	1	2/16/2006	4:01	4:15	04-58.91N	156-01.24E	3596.0	-	-	-	-	C04S01	*2
C04	2	2/16/2006	5:02	7:51	04-59.21N	156-01.20E	3597.0	3575.1	31.3	3561.9	3610.1	C04S02	
C05	1	2/18/2006	1:28	2:09	01-58.07N	155-59.10E	2582.0	1000.9	-	994.2	1002.3	C05S01	
C06	1	2/18/2006	4:04	6:10	02-01.42N	156-00.87E	2583.0	2551.3	40.4	2539.9	2569.5	C06S01	
C07	1	2/20/2006	1:28	3:07	00-01.48S	155-56.05E	1944.0	1918.1	29.7	1908.9	1927.6	C07S01	
C08	1	2/20/2006	8:46	9:24	00-00.82S	156-02.18E	1944.0	1003.8	-	994.4	1001.9	C08S01	
C09	1	2/22/2006	1:31	3:11	01-59.43S	155-58.41E	1741.0	1745.5	29.5	1714.3	1731.1	C09S01	
C10	1	2/23/2006	1:30	2:08	01-57.89S	156-01.55E	1755.0	994.3	-	991.3	999.7	C10S01	
C11	1	2/24/2006	1:46	3:13	05-01.57S	156-02.65E	1505.0	1464.0	49.5	1457.2	1470.1	C11S01	
C12	1	2/24/2006	7:13	7:53	04-59.57S	156-01.48E	1500.0	997.8	-	993.0	1001.1	C12S01	
C13	1	2/26/2006	7:31	8:10	00-02.34N	146-59.47E	4390.0	1003.6	-	994.3	1002.7	C13S01	*3
C14	1	2/27/2006	4:30	7:51	00-02.68S	147-00.78E	4586.0	4587.7	29.3	4542.0	4616.7	C14S01	
C15	1	3/1/2006	4:59	8:01	04-58.84N	147-03.48E	4156.0	4187.0	29.5	4124.0	4187.0	C15S01	
C16	1	3/3/2006	1:44	2:22	05-01.36N	146-56.62E	4261.0	996.7	-	996.4	1000.1	C16S01	
C17	1	3/4/2006	1:43	2:25	02-04.87N	146-57.89E	4488.0	1007.5	-	994.7	1002.1	C17S01	
C18	1	3/4/2006	4:55	8:06	02-01.43N	147-00.87E	4455.0	4447.2	18.0	4430.3	4502.3	C18S01	
C19	1	3/12/2006	23:08	0:26	18-00.07N	150-00.33E	5174.0	1995.0	-	1979.9	2000.7	C19S01	

*1 There are spikes from 4818db to 4835db in Oxygen.

*2 We couldn't carry out the cast, because of trouble.

*3 We made a mistake in writing header information. I entered 00-02.34S in header information, but true latitude is 00-02.34N.

6.2.2 XCTD

Yuji Kashino (JAMSTEC) : Principal Investigator
Souichiro Sueyoshi (Global Ocean Development Inc.,GODI)
Kazuho Yoshida (GODI)

(1) Objectives

Investigation of oceanic structure.

(2) Parameters

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

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

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.08) provided by Tsurumi-Seiki Co.. We launched 30 probes (X001 – X030) by using automatic launcher. The summary of XCTD observation and launching log were shown in Table 6.2.2-1.

(4) Preliminary results

Position of XCTD observation, Vertical temperature and salinity sections were shown in the following Fig. 6.2.2-1 to 6.2.2-5

(5) 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 home page.

Table 6.2.2-1 Summary of XCTD observation and launching log

Station No.	Date	Start time	Finish time	Launched Position Latitude	Longitude	Measured Depth [m]	Water Depth [m]	Surface Temp. [deg-C]	Surface Salinity [PSU]	Probe S/N
X001	2006/2/15	4:35:10	4:40	7-29.9779 N	155-53.0851 E	1035	4131	28.603	34.036	05022105
X002	2/15	6:39:56	6:45	6-59.9942 N	155-55.5162 E	1034	4470	28.924	34.247	05022106
X003	2/15	8:51:56	8:57	6-28.5261 N	155-57.4076 E	1036	4408	28.871	34.223	05022104
X004	2/15	10:49:39	10:55	5-59.9830 N	155-57.6729 E	1035	4131	28.837	34.189	05022103
X005	2/15	12:52:17	12:57	5-29.9889 N	155-57.8843 E	1035	3691	29.139	34.186	05022111
X006	2/17	4:04:36	4:10	4-29.9908 N	156-00.2715 E	1035	3557	29.430	34.549	05022114
X007	2/17	6:05:14	6:10	3-59.9909 N	156-00.1084 E	1033	3476	29.503	34.843	05022117
X008	2/17	8:04:34	8:10	3-29.9897 N	155-59.8204 E	1032	3253	29.549	34.932	05022109
X009	2/17	10:06:06	10:10	2-59.9922 N	155-59.8852 E	1035	2870	29.344	35.070	05022110
X010	2/17	12:08:04	12:13	2-30.0017 N	155-59.9176 E	1036	2668	29.258	35.071	05022108
X011	2/19	3:51:10	3:56	1-29.9968 N	155-57.9280 E	1036	2377	29.412	35.068	05022120
X012	2/19	5:51:26	5:56	0-59.9925 N	155-58.8762 E	1035	2276	29.658	34.652	05022116
X013	2/19	7:50:56	7:56	0-30.0012 N	155-58.4006 E	1033	2150	29.816	34.259	05022113
X014	2/21	3:31:29	3:37	0-30.0050 S	156-01.9104 E	1033	1955	30.044	34.429	05022119
X015	2/21	5:30:26	5:35	1-00.0008 S	156-01.5294 E	1033	2068	30.146	34.399	05022123
X016	2/21	7:29:02	7:34	1-29.9991 S	156-00.8911 E	1025	1809	29.982	34.343	05022122
X017	2/23	4:39:01	4:44	2:29.9923 S	156-01.5685 E	1036	1737	29.570	35.204	05022121
X018	2/23	6:42:10	6:47	3-00.0018 S	156-01.3408 E	1033	1806	29.358	35.060	05022118
X019	2/23	8:43:53	8:49	3-29.9979 S	156-01.1265 E	1033	1896	29.367	35.288	05022115
X020	2/23	10:47:16	10:52	4-00.0125 S	156-01.1161 E	1034	1771	29.241	34.770	05022138
X021	2/23	12:52:12	12:57	4-29.9953 S	156-01.5383 E	1035	1708	29.592	34.944	05022112
X022	2/28	8:06:26	8:11	0-29.9994 N	147-01.6960 E	1033	4506	30.309	34.409	05022147
X023	2/28	10:04:36	10:10	0-59.9977 N	147-00.3342 E	1034	4529	30.297	34.771	05022144
X024	2/28	12:03:47	12:09	1-30.0029 N	146-59.8919 E	1035	4515	30.105	34.797	05022141
X025	3/3	6:07:37	6:13	4-29.0294 N	146-58.7301 E	1035	4177	29.792	34.650	05022140
X026	3/3	8:07:18	8:12	4-00.0047 N	146-58.2138 E	1033	4583	29.333	33.674	05022136
X027	3/3	10:08:35	10:14	3-29.9973 N	146-57.3417 E	1035	4243	29.764	34.830	05022145
X028	3/3	12:12:36	12:18	3-00.0114 N	146-57.1284 E	1033	4479	29.389	34.268	05022137
X029	3/3	14:22:42	14:28	2-30.0031 N	146-56.6737 E	1032	4477	29.664	34.724	05022146
X030	3/7	0:40:43	0:46	2-27.3339 S	141-55.8334 E	1033	3190	29.046	34.313	05022139

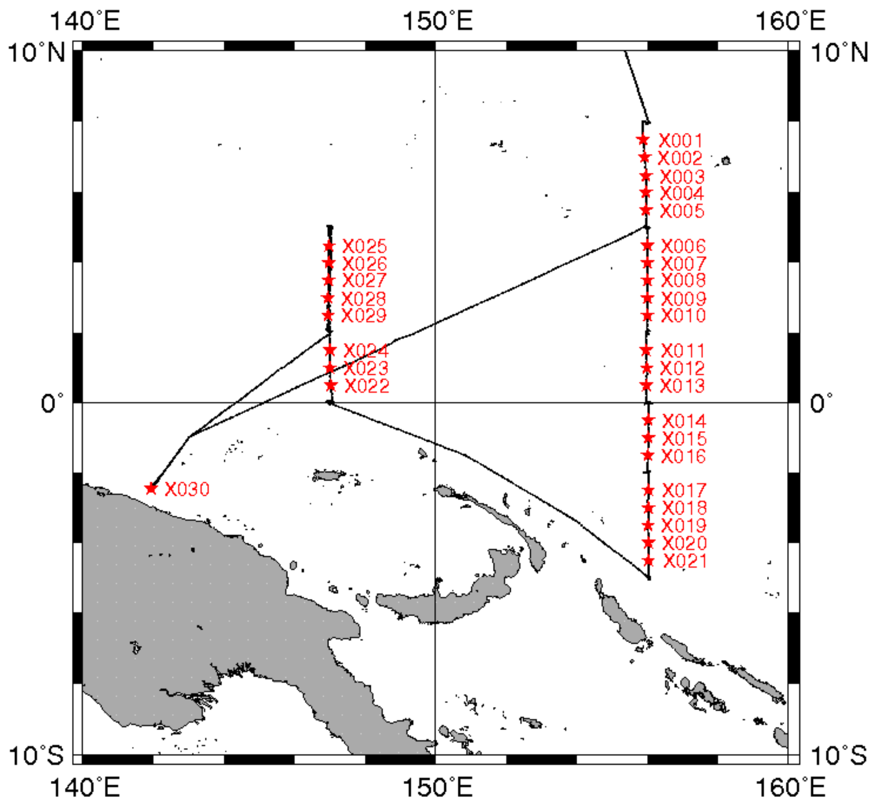

Fig. 6.2.2-1 Position of XCTD observation.

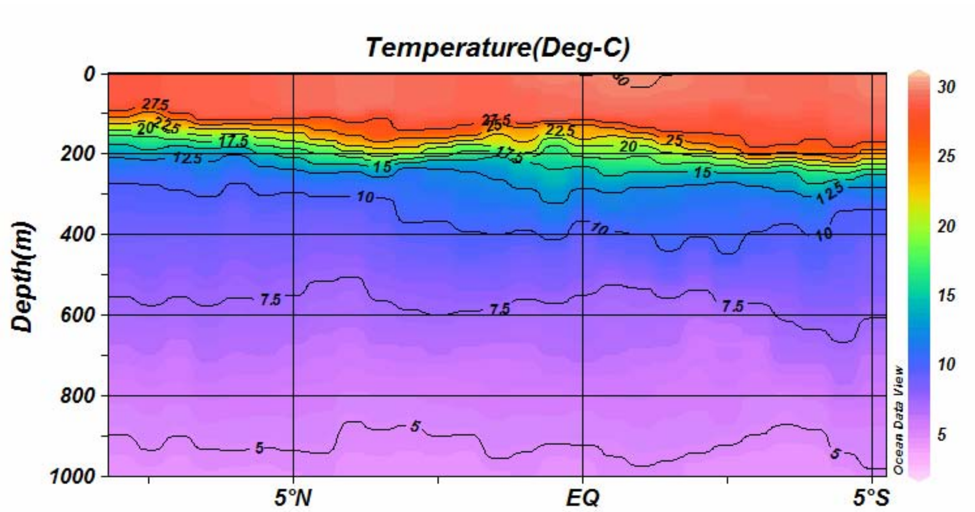

Fig. 6.2.2-2 Vertical section of Temperature along 156E line (X001 – X021)

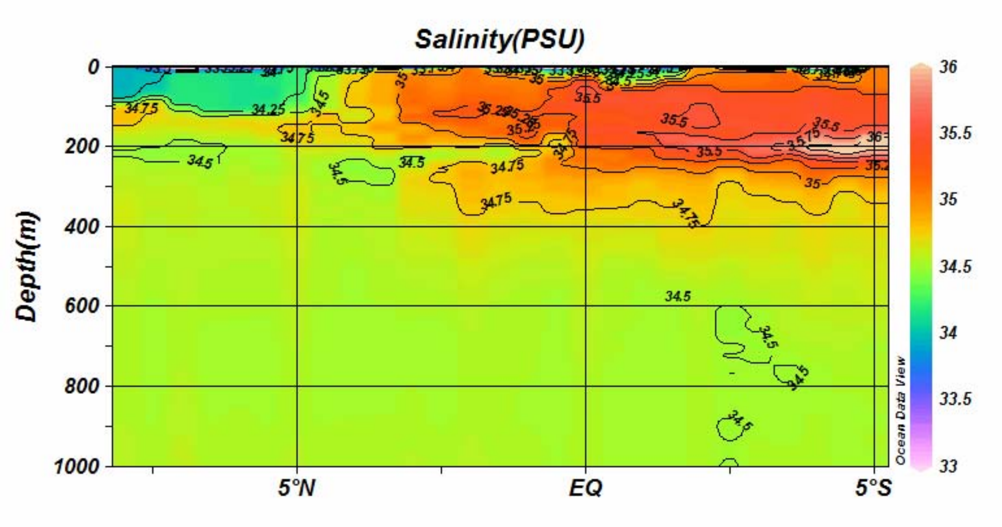

Fig. 6.2.2-3 Vertical section of Salinity along 156E line (X001 – X021)

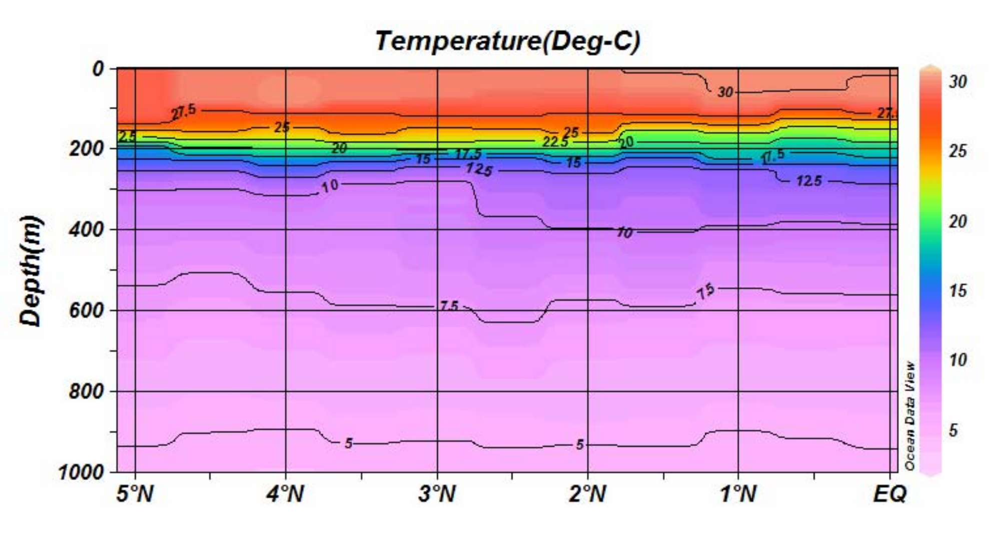

Fig. 6.2.2-4 Vertical section of Temperature along 147E line (X022 – X029)

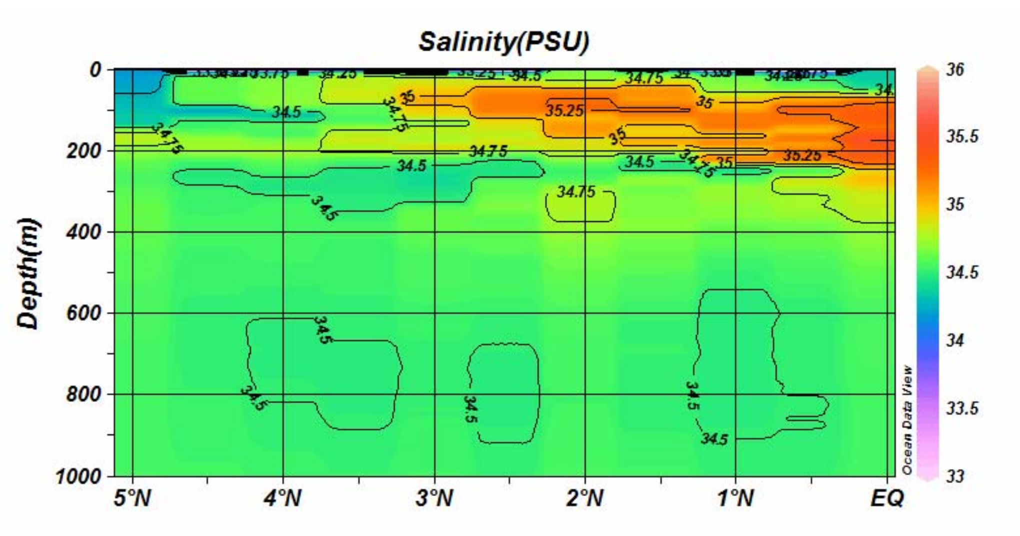

Fig.6.2.2-5 Vertical section of Salinity along 147E line (X022 – X029)

6.3 Water sampling

6.3.1 Salinity

(1) Personnel

Tatsuya Tanaka (MWJ) : Operation Leader

(2) Objective

Bottle salinity was measured in order to compare with CTD salinity.

(3) Instrument and Method

The Salinity analysis was carried out on R/V MIRAI during the cruise of MR06-01 using the Guildline AUTOSAL salinometer model 8400B (S/N 62556), with additional peristaltic-type intake pump, manufactured by Ocean Scientific International, Ltd. We also used two Guildline platinum thermometers model 9450. One thermometer monitored an air temperature and the other monitored a bath temperature.

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

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

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

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

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

The measurement system was almost same as Aoyama *et al.* (2003). The salinometer was operated in the air-conditioned ship's laboratory ‘AUTOSAL ROOM’ 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 is started after 5 seconds from set FUNCTION switch to READ then it takes about 10 seconds to collect 31 readings by a personal computer. If the difference between the double conductivity ratio measured for each sample 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 this condition isn’t satisfied within 5 times in a series of measurement for each sample, we will consider the sample as the bad sample.

(3-1) Standardization

The salinometer was standardized at the beginning of the sequence of measurements using IAPSO standard seawater (SSW). Because of the good stability of the salinometer, standardize of the salinometer was performed only once, the Standardize Dial was adjusted at the time. 10 bottles of SSW were measured in total, and their standard deviation to the catalogue value was 0.0001 (PSU). The value is used for the calibration (linear compensation) of the measured salinity.

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

Standard seawater (SSW)

batch : P145
conductivity ratio : 0.99981
salinity : 34.993
preparation date : 15-Jul.-2004

(3-2) Sub-Standard Seawater

We also used sub-standard seawater (SUB) that was sampled and filtered by Millipore filter (pore size of 0.45μm), which was stored in a 20 liters polyethylene container. It was measured every about 8 samples in order to check the drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

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

Sub standard seawater (SUB)

sampling cruise ID : MR05-04
sampling depth : 2,000m
filtration date : 2-Sep.-2005

(3-3) Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X (Non-coating) bottles and EPCS. The salinity sample bottle of the 250ml brown glass bottle was used to collect the sample water. The sample bottle was sealed with a plastic insert thimble and a screw cap. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. Its cap was also thoroughly rinsed. The bottle was stored more than 24 hours in 'AUTOSAL ROOM' 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	76
Samples for EPCS	35
Total	111

(4) Preliminary Results

Data of all samples were shown in Table 6.3.1-2. We estimated the precision of this method using 20 pairs of duplicate samples taken from the same pressure but different Niskin bottles, 19 pairs of replicate samples taken by the same Niskin bottle, and compared the salinity of all samples to check the salinity data of CTD. The average and standard deviation of duplicate samples and replicate samples were shown in Table 6.3.1-3 and Table 6.3.1-4, respectively.

The average of difference between measurement data and CTD data were 0.0031 (PSU) and the standard deviation was 0.0007 (PSU), and those of duplicate samples were 0.0003 (PSU) and 0.0003 (PSU), and those of replicate samples were 0.0003 (PSU) and 0.0002 (PSU), respectively.

(5) Data Archive

All processed salinity data were submitted to Principal Investigator according to the data management policy of JAMSTEC.

(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 Technical Papers in Marine Science*, 36, 25 pp., 1981

Table 6.3.1-2 Difference between bottle-sampling salinity and CTD salinity

Station	Cast	Sample Bottle	Salinity (PSS-78)	Niskin Bottle No.	CTD Pressure (db)	CTD salinity (PSS-78)	**Salinity Diff. CTD-Salinity**
c01	1	0003	34.5540	18	1003.8	34.5576	**0.0036**
	1	0001	34.5544	1	1003.4	34.5579	**0.0035**
	1	0002	34.5537	1	1003.4	34.5579	**0.0042**
c02	1	0004	33.9728	Bucket	-	-	**-**
	1	0007	34.5975	17	1501.7	34.6011	**0.0036**
	1	0005	34.6980	16	4837.8	34.7003	**0.0023**
	1	0006	34.6976	16	4837.8	34.7003	**0.0027**
	1	0008	34.5979	14	1502.1	34.6011	**0.0032**
c03	1	0011	34.5504	18	1000.9	34.5541	**0.0037**
	1	0009	34.5508	1	1000.8	34.5545	**0.0037**
	1	0010	34.5507	1	1000.8	34.5545	**0.0038**
c04	1	0012	34.2809	Bucket	-	-	**-**
	1	0015	34.5998	17	1499.3	34.6030	**0.0032**
	1	0013	34.6820	16	3611.1	34.6851	**0.0031**
	1	0014	34.6818	16	3611.1	34.6851	**0.0033**
	1	0016	34.5996	11	1499.0	34.6030	**0.0034**
c05	1	0019	34.5540	18	1002.3	34.5582	**0.0042**
	1	0017	34.5545	1	1000.9	34.5583	**0.0038**
	1	0018	34.5542	1	1000.9	34.5583	**0.0041**
c06	1	0020	35.1171	Bucket	-	-	**-**
	1	0024	34.6003	17	1500.5	34.6033	**0.0030**
	1	0021	34.6619	16	2570.1	34.6647	**0.0028**
	1	0022	34.6621	16	2570.1	34.6647	**0.0026**
	1	0023	34.6005	11	1501.2	34.6033	**0.0028**
c07	1	0025	34.3062	Bucket	-	-	**-**
	1	0041	34.5977	17	1501.5	34.6001	**0.0024**
	1	0039	34.6392	16	1928.3	34.6415	**0.0023**
	1	0040	34.6390	16	1928.3	34.6415	**0.0025**
	1	0034	34.5976	11	1501.6	34.6002	**0.0026**
c08	1	0063	34.5447	18	1002.6	34.5479	**0.0032**
	1	0061	34.5449	1	1002.0	34.5482	**0.0033**
	1	0062	34.5447	1	1002.0	34.5482	**0.0035**
c09	1	0064	34.9707	Bucket	-	-	**-**
	1	0067	34.5951	17	1500.7	34.5972	**0.0021**
	1	0065	34.6305	16	1731.8	34.6333	**0.0028**
	1	0066	34.6297	16	1731.8	34.6333	**0.0036**
	1	0068	34.5948	11	1501.5	34.5973	**0.0025**
c10	1	0071	34.5431	18	999.3	34.5470	**0.0039**
	1	0069	34.5424	1	999.0	34.5470	**0.0046**
	1	0070	34.5430	1	999.0	34.5470	**0.0040**

c11	1	0075	35.0806	Bucket	-	-	**-**
	1	0079	34.6010	17	1471.3	34.6034	**0.0025**
	1	0076	34.6009	16	1470.9	34.6035	**0.0026**
	1	0077	34.6013	16	1470.9	34.6035	**0.0022**
	1	0078	34.6011	1	1470.6	34.6034	**0.0023**
c12	1	0074	34.5204	18	1001.7	34.5234	**0.0030**
	1	0072	34.5197	1	1001.5	34.5234	**0.0037**
	1	0073	34.5196	1	1001.5	34.5234	**0.0038**
c13	1	0082	34.5462	18	1003.3	34.5497	**0.0036**
	1	0080	34.5466	1	1003.3	34.5499	**0.0033**
	1	0081	34.5460	1	1003.3	34.5499	**0.0039**
c14	1	0083	34.3766	Bucket	-	-	**-**
	1	0086	34.5994	17	1499.5	34.6026	**0.0032**
	1	0085	34.6873	16	4616.5	34.6904	**0.0031**
	1	0084	34.6875	16	4616.5	34.6904	**0.0029**
	1	0087	34.5993	13	1500.0	34.6026	**0.0033**
c15	1	0088	34.1660	Bucket	-	-	**-**
	1	0092	34.6016	17	1501.7	34.6043	**0.0027**
	1	0090	34.6854	16	4188.8	34.6876	**0.0022**
	1	0091	34.6851	16	4188.8	34.6876	**0.0026**
	1	0089	34.6174	11	1751.9	34.6204	**0.0030**
c16	1	0095	34.5503	18	1001.8	34.5547	**0.0044**
	1	0093	34.5505	1	1001.2	34.5544	**0.0039**
	1	0094	34.5508	1	1001.2	34.5544	**0.0036**
c17	1	0098	34.5534	18	1004.2	34.5577	**0.0043**
	1	0096	34.5531	1	1003.0	34.5565	**0.0034**
	1	0097	34.5532	1	1003.0	34.5565	**0.0033**
c18	1	0099	34.3492	Bucket	-	-	**-**
	1	0103	34.5955	17	1500.5	34.5976	**0.0022**
	1	0101	34.6872	16	4502.0	34.6896	**0.0024**
	1	0102	34.6876	16	4502.0	34.6896	**0.0020**
	1	0100	34.5950	13	1501.6	34.5974	**0.0024**
c19	1	0107	34.5741	34	1501.5	34.5761	**0.0020**
	1	0106	34.5735	17	1501.0	34.5762	**0.0027**
	1	0104	34.6244	16	2001.9	34.6272	**0.0028**
	1	0105	34.6244	16	2001.9	34.6272	**0.0028**

Average	**0.0031**
Stdev	**0.0007**

Table 6.3.1-3 Difference of duplicate samples

Cast	Niskin Bottle	CTD Pressure (db)	CTD Salinity (PSS-78)	Sample Bottle	Salinity (PSS-78)	Salinity Diff. CTD-Salinity	Niskin Bottle	CTD Pressure (db)	CTD Salinity (PSS-78)	Sample Bottle	Salinity1 (PSS-78)	Salinity Diff. CTD-Salinity	**Duplicate DIFF. SAL-SAL1**
1	18	1003.8	34.5576	003	34.5540	0.0036	1	1003.4	34.5579	001	34.5544	0.0035	**0.0001**
1	14	1502.1	34.6011	008	34.5979	0.0032	17	1501.7	34.6011	007	34.5975	0.0036	**0.0004**
1	18	1000.9	34.5541	011	34.5504	0.0037	1	1000.8	34.5545	009	34.5508	0.0037	**0.0000**
1	17	1499.3	34.6030	015	34.5998	0.0032	11	1499.0	34.6030	016	34.5996	0.0034	**0.0002**
1	18	1002.3	34.5582	019	34.5540	0.0042	1	1000.9	34.5583	017	34.5545	0.0038	**0.0004**
1	11	1501.2	34.6033	023	34.6005	0.0028	17	1500.5	34.6033	024	34.6003	0.0030	**0.0002**
1	11	1501.6	34.6002	034	34.5976	0.0026	17	1501.5	34.6001	041	34.5977	0.0024	**0.0002**
1	18	1002.6	34.5479	063	34.5447	0.0032	1	1002.0	34.5482	061	34.5449	0.0033	**0.0001**
1	11	1501.5	34.5973	068	34.5948	0.0025	17	1500.7	34.5972	067	34.5951	0.0021	**0.0004**
1	18	999.3	34.5470	071	34.5431	0.0039	1	999.0	34.5470	069	34.5424	0.0046	**0.0007**
1	17	1471.3	34.6034	079	34.6010	0.0025	16	1470.9	34.6035	076	34.6009	0.0026	**0.0002**
1	16	1470.9	34.6035	076	34.6009	0.0026	1	1470.6	34.6034	078	34.6011	0.0023	**0.0003**
1	1	1470.6	34.6034	078	34.6011	0.0023	17	1471.3	34.6034	079	34.6010	0.0025	**0.0001**
1	18	1001.7	34.5234	074	34.5204	0.0030	1	1001.5	34.5234	072	34.5197	0.0037	**0.0007**
1	1	1003.3	34.5499	080	34.5466	0.0033	18	1003.3	34.5497	082	34.5462	0.0036	**0.0002**
1	13	1500.0	34.6026	087	34.5993	0.0033	17	1499.5	34.6026	086	34.5994	0.0032	**0.0001**
1	18	1001.8	34.5547	095	34.5503	0.0044	1	1001.2	34.5544	093	34.5505	0.0039	**0.0005**
1	18	1004.2	34.5577	098	34.5534	0.0043	1	1003.0	34.5565	096	34.5531	0.0034	**0.0009**
1	13	1501.6	34.5974	100	34.5950	0.0024	17	1500.5	34.5976	103	34.5955	0.0022	**0.0003**
1	34	1501.5	34.5761	107	34.5741	0.0020	17	1501.0	34.5762	106	34.5735	0.0027	**0.0008**

Average	**0.0003**
Stdev.	**0.0003**

Table 6.3.1-4 Difference of replicate samples

Station	Cast	Niskin Bottle	CTDPressure (db)	Sample Bottle	Salinity (PSS-78)	Sample Bottle	Salinity1 (PSS-78)	**Replicate Diff. Sal-Sal1**
c01	1	1	1003.37	0001	34.5544	0002	34.55372	**0.0007**
c02	1	16	4837.79	0005	34.69802	0006	34.69763	**0.0004**
c03	1	1	1000.84	0009	34.55077	0010	34.55067	**0.0001**
c04	1	16	3611.09	0013	34.682	0014	34.68181	**0.0002**
c05	1	1	1000.92	0017	34.5545	0018	34.55421	**0.0003**
c06	1	16	2570.05	0021	34.66186	0022	34.66206	**0.0002**
c07	1	16	1928.3	0039	34.63917	0040	34.63897	**0.0002**
c08	1	1	1001.98	0061	34.54488	0062	34.54468	**0.0002**
c09	1	16	1731.77	0065	34.63052	0066	34.62974	**0.0008**
c10	1	1	999.02	0069	34.54242	0070	34.54301	**0.0006**
c11	1	16	1470.92	0076	34.60086	0077	34.60125	**0.0004**
c12	1	1	1001.49	0072	34.51974	0073	34.51964	**0.0001**
c13	1	1	1003.32	0080	34.54655	0081	34.54596	**0.0006**
c14	1	16	4616.46	0085	34.68731	0084	34.68751	**0.0002**
c15	1	16	4188.79	0090	34.68544	0091	34.68505	**0.0004**
c16	1	1	1001.19	0093	34.55047	0094	34.55077	**0.0003**
c17	1	1	1002.95	0096	34.55313	0097	34.55322	**0.0001**
c18	1	16	4502.02	0101	34.68721	0102	34.6876	**0.0004**
c19	1	16	2001.92	0104	34.62443	0105	34.62443	**0.0000**

Average	**0.0003**
Stdev.	**0.0002**

6.3.2 Dissolved oxygen

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Mar. 15, 2006

Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

Methods

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)

Instruments:

Burette for sodium thiosulfate;

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

Burette for potassium iodate;

APB-410 manufactured by Kyoto Electronic Co. Ltd. / 20 cm^3 of titration vessel

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

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, 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.

Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen concentration using two sets of the titration apparatus (DOT-3 and DOT-4). Dissolved oxygen concentration (μ mol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution without the blank.

Standardization and determination of the blank

Concentration of sodium thiosulfate titrant (ca. 0.025M) was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130^{o}C. 1.7835 g 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. 1 and 2 cm^3 of the standard potassium iodate solution were added to two flasks respectively. 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 two flask in order. The blank was determined by difference between the two times of the first (1 cm^3 of KIO_3) titrated volume of the sodium thiosulfate and the second (2 cm^3 of KIO_3) one. The averaged blank of DOT-3 and DOT-4 were –0.003 and –0.006 cm^3 , respectively. Most of them are negative, implying that there are deoxidizers in the reagents.

Table 6.3.1 shows results of the standardization and the blank determination during this cruise

Table 6.3.1 Results of the standardization and the blank determinations during this cruise.

Date	KIO_3	DOT-03(cm^3)				DOT-04(cm^3)			
(UTC)	Bottle No.	$Na_2S_2O_3$	E.P.	S.D.(E.P.)	Blank	$Na_2S_2O_3$	E.P.	S.D.(E.P.)	Blank
2006/02/13	20050830-10	20060212-1	3.962	0.001	-0.006	20060212-2	3.965	0.004	-0.012
2006/02/14	20050830-9	20060212-1	3.961	0.000	-0.002	20060212-2	3.964	0.002	-0.007
2006/02/15	20050830-08	20060212-1	3.959	0.001	-0.001	20060212-2	3.963	0.002	-0.007
2006/02/16	20050830-07	20060212-1	3.961	0.002	-0.001	20060212-2	3.963	0.004	-0.004
2006/02/19	20050830-06	20060212-1	3.963	0.001	-0.002	20060212-2	3.963	0.002	-0.005
2006/02/21	20050830-05	20060212-5	3.967	0.002	-0.003	20060212-2	3.965	0.001	-0.004
2006/02/23	20050830-04	20060212-5	3.966	0.002	-0.003	20060212-3	3.964	0.001	-0.010
2006/02/26	20050830-03	20060212-5	3.964	0.001	-0.005	20060212-3	3.967	0.001	-0.002
2006/02/28	20050830-02	20060212-5	3.967	0.002	-0.005	20060212-3	3.959	0.001	-0.006
2006/03/03	20050830-01	20060212-4	3.964	0.001	-0.003	20060212-3	3.967	0.002	-0.001

Reproducibility of sample measurement

Replicate samples were taken at every CTD cast; usually these were 10 – 15 % of seawater samples of each cast during this cruise. Results of the replicate samples were shown in Table 6.3.2 and this histogram shown in Fig. 6.3.1. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

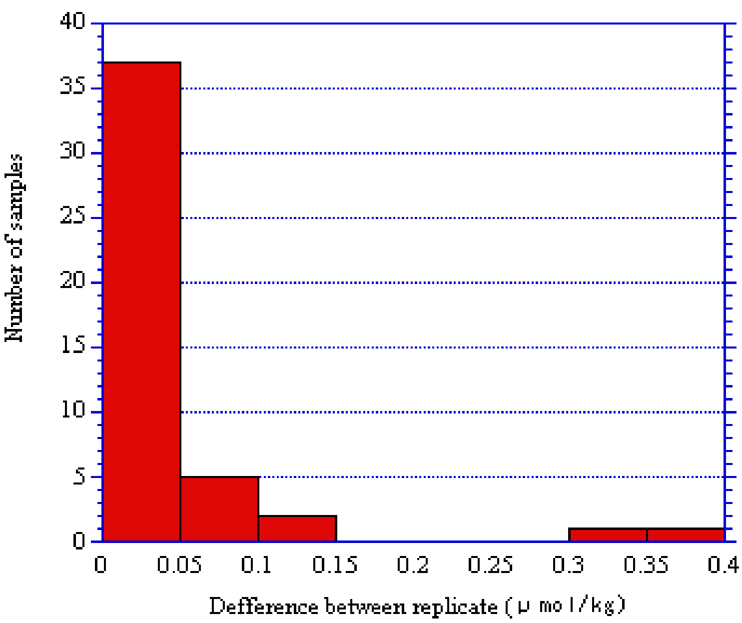


Fig. 6.3.1 Results of the replicate sample measurements

Table 6.3.2 Results of the replicate sample measurements

Number of replicate sample pairs	Oxygen concentration (μ mol/kg)
	Standard Deviation.
46	0.134

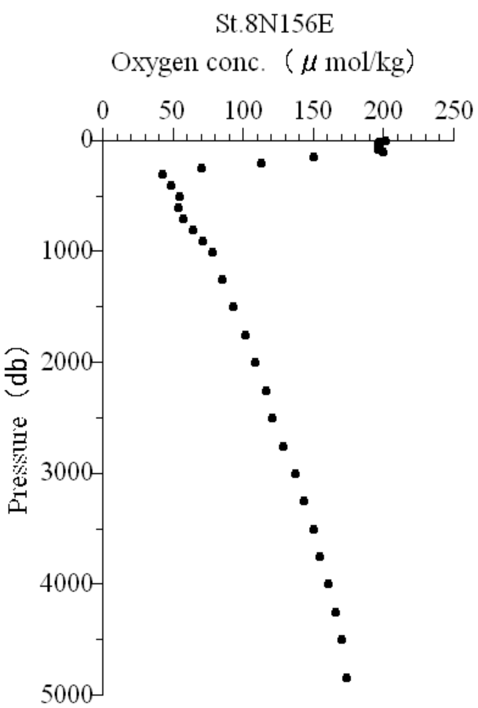
Preliminary results

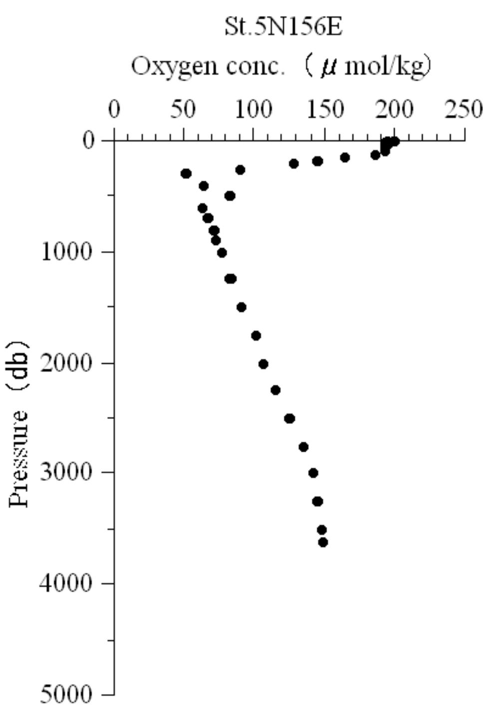
During this cruise we measured oxygen concentration in 348 seawater samples at 9stations. Vertical profiles show Figs 6.3.2 at each cast.

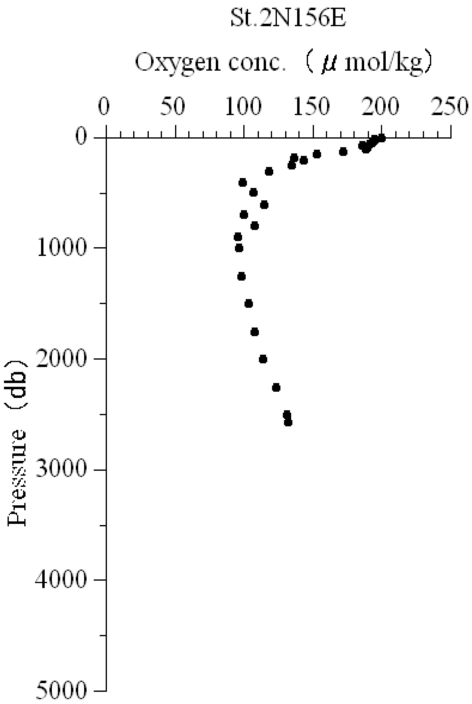
Station number In Figs 6.3.2 refer to Table 6.3.3.

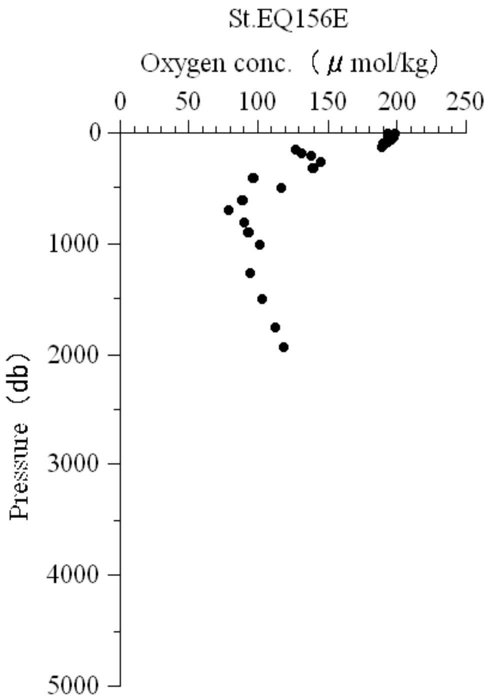
Table 6.3.3　Oxygen sampling Station number

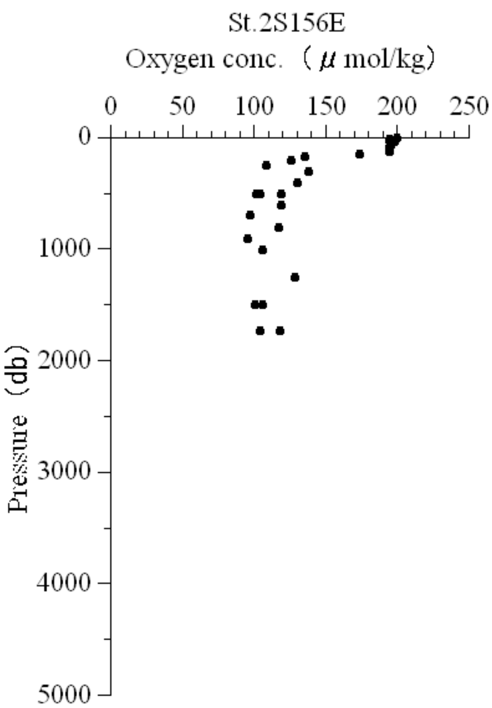
	St.NO. in Figs6.3.2								
	8N156E	5N156E	2N156E	EQ156E	2S156E	5S156E	EQ147E	5N147E	2N147E
CTD St.NO	C02	C04	C06	C07	C09	C11	C14	C15	C18

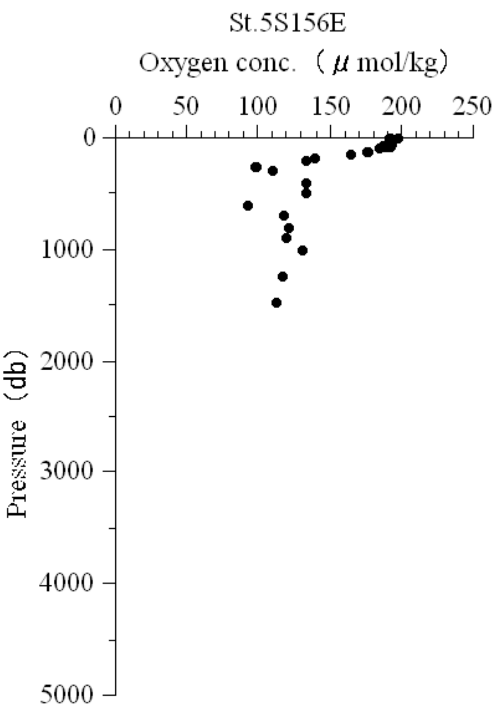


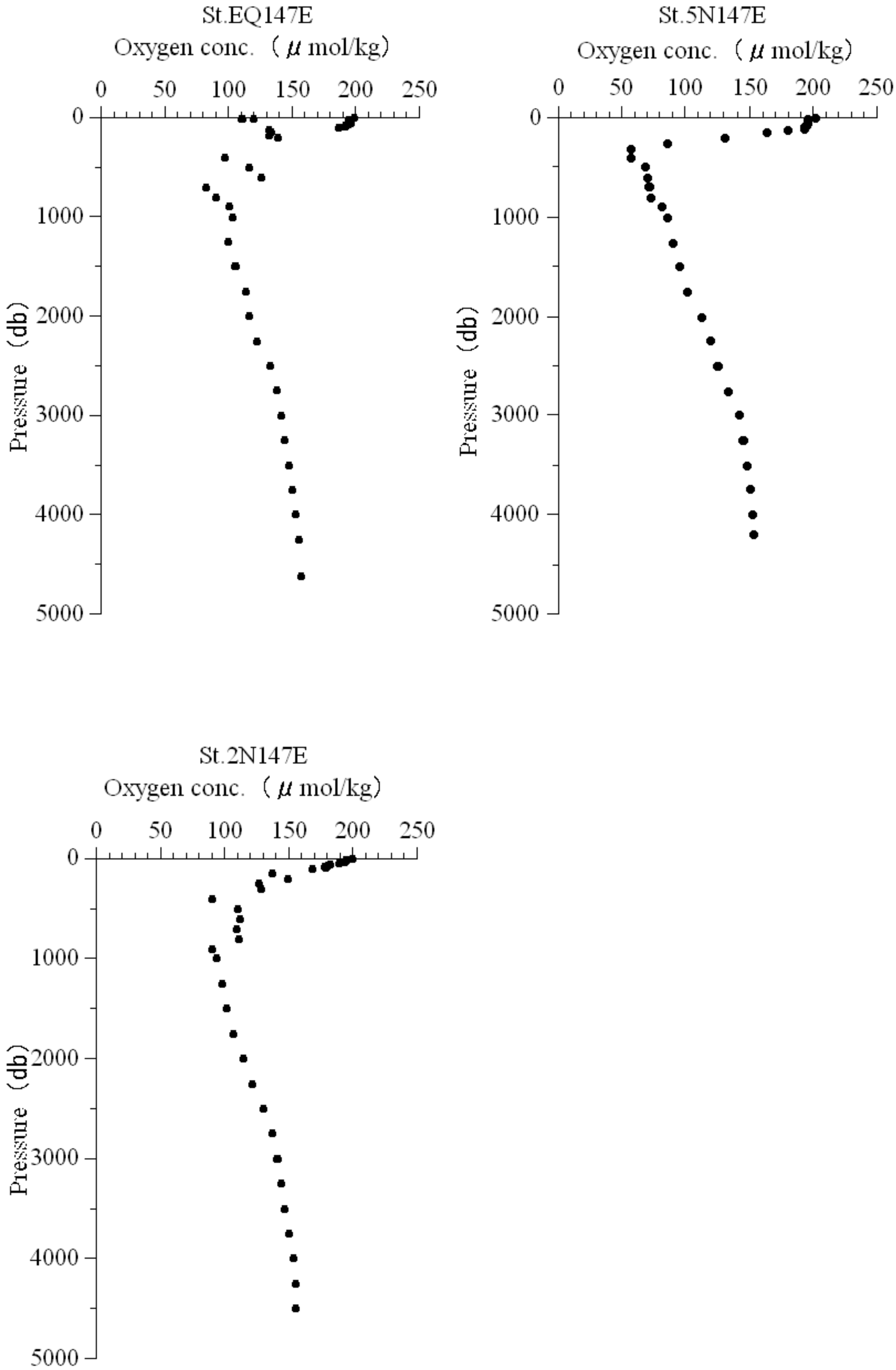



St.2N156E
Oxygen conc. （μ mol/kg）
0 50 100 150 200 250
Pressure （db）
0 1000 2000 3000 4000 5000


St.EQ156E
Oxygen conc. （μ mol/kg）
0 50 100 150 200 250
Pressure （db）
0 1000 2000 3000 4000 5000


St.2S156E
Oxygen conc. （μ mol/kg）
0 50 100 150 200 250
Pressure （db）
0 1000 2000 3000 4000 5000


St.5S156E
Oxygen conc. （μ mol/kg）
0 50 100 150 200 250
Pressure （db）
0 1000 2000 3000 4000 5000



Figs.6.3.2 Vertical profiles at each station

References:

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 Continuous monitoring of surface seawater

6.4.1 EPCS

Ai YASUDA (Marine Works Japan Co. Ltd.) ：Operation Leader
Junji MATSUSHITA(Marine Works Japan Co.Ltd.)

Mar. 16, 2006

Objective

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

Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has four kind of sensors and can automatically measure salinity, temperature, dissolved oxygen and fluorescence in near-sea surface water continuously, every 1-minute. 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 salinity sensors*

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.	
Serial number:	2118859-3126	
Measurement range:	Temperature -5 to +35℃,	Salinity 0 to 6.5 S m^{-1}
Accuracy:	Temperature 0.01 ℃ $6month^{-1}$,	Salinity 0.001 S m^{-1} $month^{-1}$
Resolution:	Temperatures 0.001℃,	Salinity0.0001 S m^{-1}

b) Bottom of ship thermometer

Model:	SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number:	032607
Measurement range:	-5 to +35℃

Resolution: ±0.001℃

Stability: 0.002 ℃ $year^{-1}$

c) Dissolved oxygen sensor

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

Serial number: 47477

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}

Measurments

Periods of measurement, maintenance, and problems during this cruise are listed in Table 6.4-1.

Table 6.4-1 Events list of this cruise

Date [UTC]	Time [UTC]	Event	Remarks
7-Feb.- 06	02:07	All the measurements started.	
9-Mar.-06	23:30～23:42	The fluorescence measurement stopped for cell cleaning.	
13-Mar.-06	23:48	All the measurements stopped.	

Calibrations

We collected the surface seawater samples approximately once a day from the outlet equipped in the middle of water line of the system for salinity sensor calibration. A 250ml brown grass bottle with plastic inner stopper and screw cap was used to collect the samples. The sample bottles were stored in the sea surface monitoring laboratory. The samples were measured using the Guildline 8400B at the end of the legs after all the measurements of hydrocast bottle samples. The measurement technique was almost same as that for bottle salinity measurement. Comparison between the salinity values measured by SBE21of the Sea Surface Monitoring System and Autosal salinometer for 35 samples shown in Fig.6-4-1. The results are shown in Table 6.4-2 .

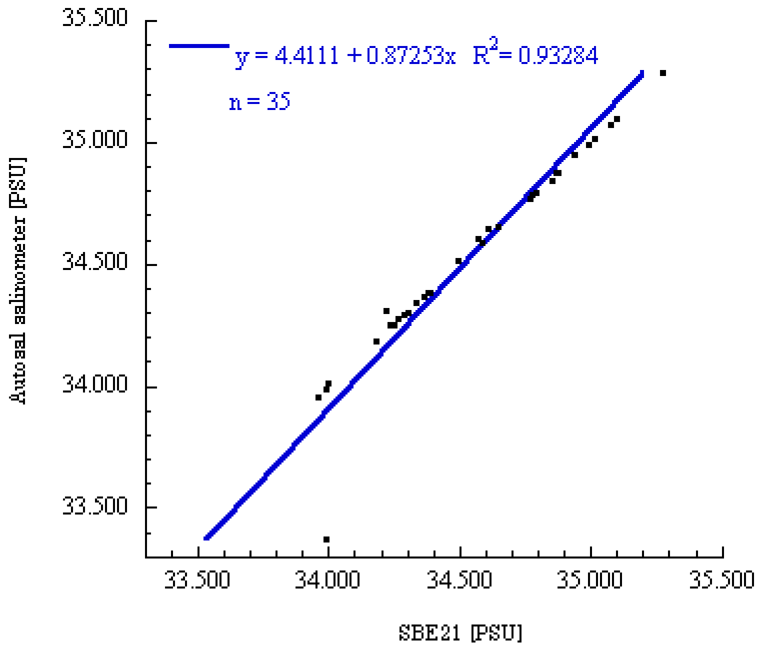


Fig.6-4-1. Comparison between the salinity values measured by SBE21of the Sea Surface Monitoring System and Autosal salinometer for 35 samples.

Table 6-4-2. Comparison of sensor salinity and the bottle salinity.

Date [UTC]	Time [UTC]	Sensor salinity [PSS-78]	Bottle salinity [PSS-78]	Quality Flag for bottle salinity
7-Feb-06	8:42	33.9936	33.3712	3
8-Feb-06	7:53	34.877	34.8805	2
9-Feb-06	7:34	34.8516	34.8426	2
10-Feb-06	7:00	35.0725	35.0702	2
11-Feb-06	7:28	34.7698	34.7716	2
12-Feb-06	2:45	34.5847	34.5874	2
13-Feb-06	4:15	33.9905	33.9882	2
14-Feb-06	5:05	33.9557	33.9541	2
15-Feb-06	5:22	34.2392	34.2501	2
16-Feb-06	11:03	34.2899	34.2923	2

Table 6-4-2. continued.

Date [UTC]	Time [UTC]	Sensor salinity [PSS-78]	Bottle salinity [PSS-78]	Quality Flag for bottle salinity
17-Feb-06	8:42	34.941	34.9510	2
18-Feb-06	4:58	35.0994	35.0981	2
19-Feb-06	11:39	34.3817	34.3819	2
20-Feb-06	10:02	34.3359	34.3384	2
21-Feb-06	12:31	34.8666	34.8744	2
22-Feb-06	5:08	34.9943	34.9943	2
23-Feb-06	8:31	35.2762	35.2871	2
24-Feb-06	8:49	35.0133	35.0188	2
25-Feb-06	2:42	34.4974	34.5128	2
26-Feb-06	12:06	34.3644	34.3673	2
27-Feb-06	11:21	34.386	34.3824	2
28-Feb-06	10:50	34.7743	34.7832	2
1-Mar-06	12:00	34.1832	34.1883	2
2-Mar-06	9:38	34.2642	34.2725	2
3-Mar-06	5:07	34.2215	34.3083	2
4-Mar-06	5:37	34.5698	34.6019	2
5-Mar-06	12:44	34.3041	34.3048	2
6-Mar-06	8:28	34.2864	34.2953	2
7-Mar-06	10:14	34.0006	34.0106	2
8-Mar-06	8:38	34.6056	34.6442	2
9-Mar-06	9:40	34.9885	34.9913	2
10-Mar-06	9:45	34.2495	34.2542	2
11-Mar-06	10:41	34.2371	34.2538	2
12-Mar-06	9:46	34.6447	34.6510	2
13-Mar-06	3:36	34.7905	34.7961	2

Date archive

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

6.5 Shipboard ADCP

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Souichiro Sueyoshi	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)

(2) Parameters

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

(3) Methods

Continuous upper ocean current measurement along ship's track were made using hull-mounted Acoustic Doppler Current Profiler, RD Instruments VM-75 system installed on the centerline and approximately 28 m aft from the bow. The firmware version was 5.59 and the data acquisition software was VmDas Ver.1.3. For most of its operation, the instrument was configured for water-tracking mode recording each ping as the raw data in 16 m (bin size) x 40 bins (bin number) from 24.74 m to 648.74 m. 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. Major parameters are listed in table 6.5.1. Raw data was recorded in beam coordinate, and then converted to earth coordinate using ship's heading data from ship's main gyrocompass, Tokimec TG-6000. The position fix data from ship's navigation system was also recorded in NMEA0183 format and merged with ensemble data in the VmDas.

The system performed well throughout the cruise. The profile range always reached 655 m under calm weather. Also, 60 seconds and 300 seconds average data were recorded as short-term average (STA) and long-term average (LTA) data.

The system consists of following components;

1. a 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating at 75 KHz (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
2. the Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;
3. a GPS navigation receiver (Trimble DS4000) providing position fixes;
4. a personal computer running data acquisition software. The clock of the logging PC is adjusted to GPS time every 10 minutes.

(4) Preliminary results

Horizontal velocity along the ship's track is presented in figure 6.5.1. In vertical direction, the data are averaged at layers bounded on the depths of 31, 75, and every 50m interval to 625m with the center average scheme of CODAS (Common Oceanographic Data Acquisition System) software.

(5) Data archives

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

Table 6.5.1 Major parameters

Bottom-Track Commands

BP000 -------------------- Ping per Ensemble
BP001 -------------------- Ping per Ensemble

Environmental Sensor Commands

EA = +00000 -------------------- Heading Alignment (1/100 deg)
EB = +00000 -------------------- Heading Bias (1/100 deg)
ED = 00065 -------------------- Transducer Depth (0-65535dm)
EF = +0001 -------------------- Pitch/Roll Division/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)

Timing Commands

TE = 00000200 -------------------- Time per Ensemble (hrs; min; sec; sec/100)
TP = 000200 -------------------- 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 = 111000000 -------------------- 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%)
WM = 1 -------------------- Profiling Mode (1-8)
WN = 040 -------------------- Number of Depth Cells (1-128)
WP = 00001 -------------------- Pings per Ensemble
WS = 1600 -------------------- Depth Cell Size (cm)
WV = 999 -------------------- Mode 1 Ambiguity Velocity (cm/s radial)

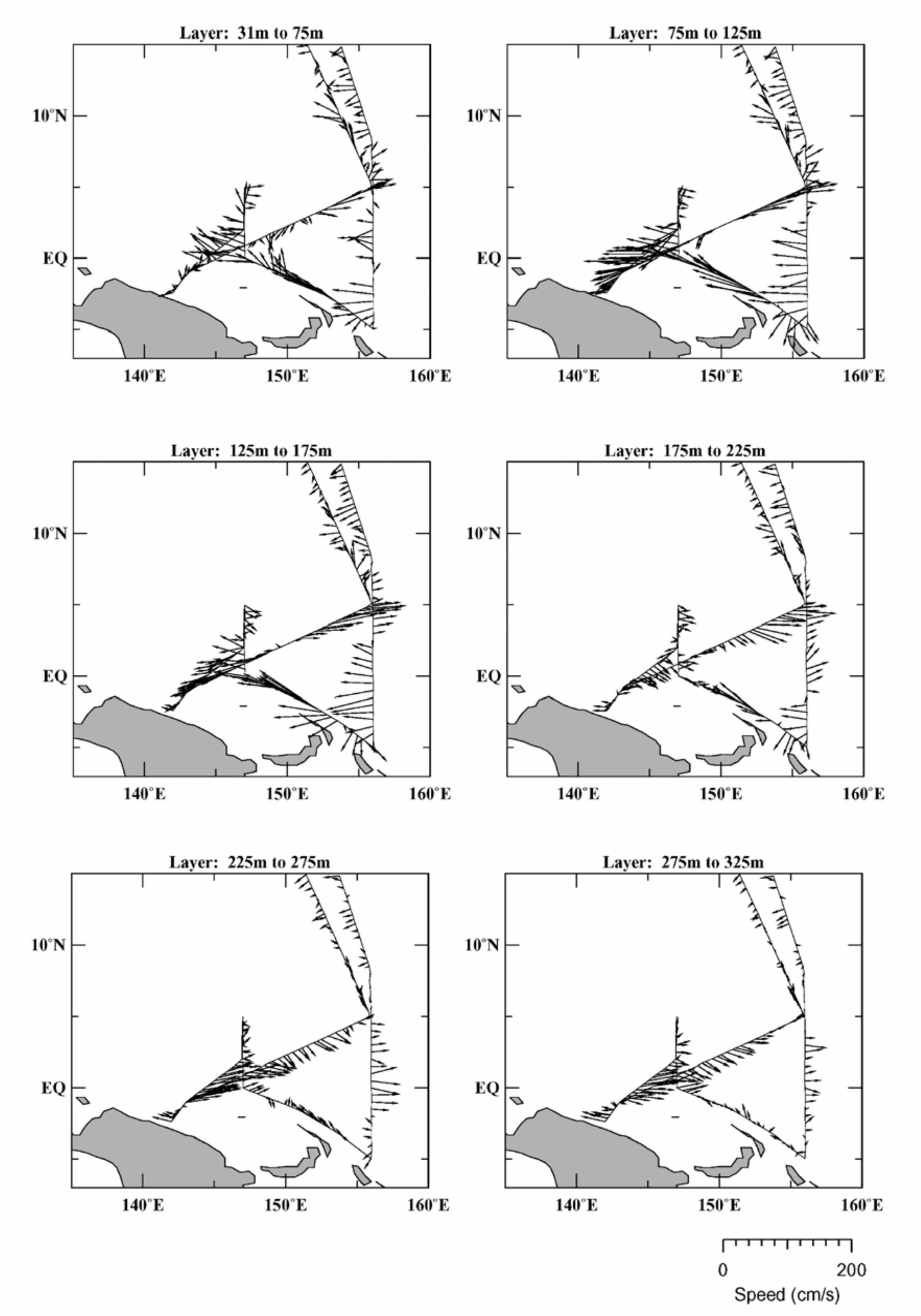


Fig 6.5.1 Horizontal Velocity along Track.

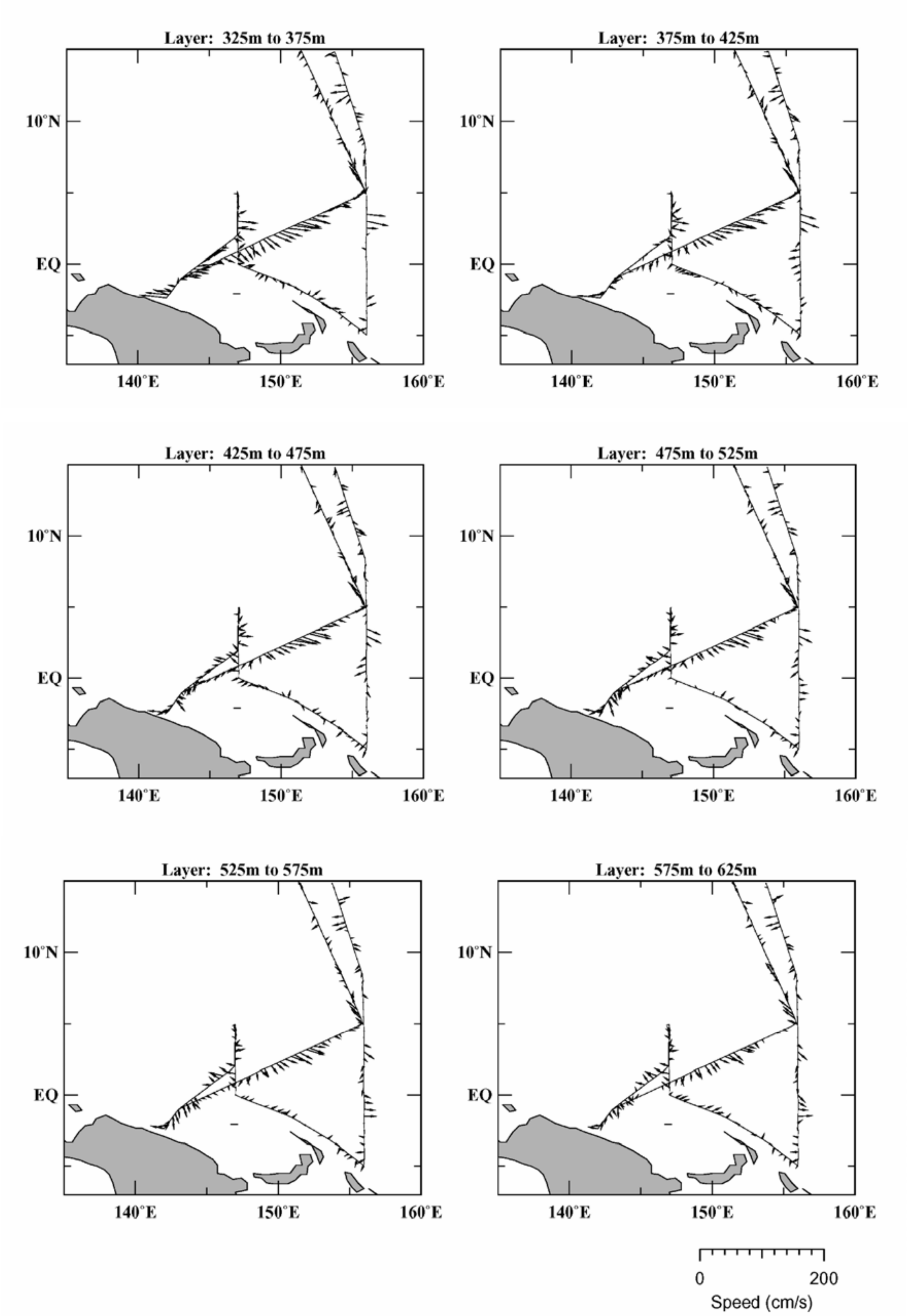


Fig 6.5.1 (continued)

6.6 Underway geophysics

6.6.1 Sea Surface Gravity

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

(1) Introduction

The distribution of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR06-01 cruise from 5 February 2006, departure of Sekinehama, to 18 March, arrival of Sekinehama.

(2) Parameters

Relative Gravity [mGal]

(3) Data Acquisition

We have measured relative gravity by on-board gravity meter (Air-Sea System II; Micro-G LaCoste, USA) during this cruise. Comparative measurement was conducted at the land gravity base near the port of call by the portable gravity meter (CG-5; Scintrex, Canada) to estimate the sensor drift of the on-board meter.

(4) Preliminary Results

Absolute gravity shown in Table 6-6-1

Table 6-6-1

No.	Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	Relative Gravity*[2] [mGal]
#1	03/Feb	04:04	Sekinehama	980371.944	267	637	980372.81	12718.02

*[1]: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431
*[2]: On-board gravity meter Air-Sea System II / S-116

(5) Data Archives

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

(6) Remarks

6.6.2 Sea surface three-component magnetic field

(1) Personnel

Souichiro Sueyoshi (Global Ocean Development Inc.)
Kazuho Yoshida (GODI)
Takeshi Matsumoto (University of the Ryukyus) : Principal investigator (Not on-board)

(2) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR06-01 cruise from 5 February 2006, departure of Sekinehama, to 18 March, arrival of Sekinehama.

(3) Parameters

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

(4) Method of Data Acquisition

A shipboard three-component magnetometer system (SFG1214, Tierra Tecnica, Japan) consists of three axes fluxgate sensors, setting on the top of foremast. Output signal from the sensor is digitized through 20-bit A/D converter (1nT/LSB) and sent to the deckbox. Data sampling is controlled by 1-pps (pulse per second) signal from GPS standard clock. Navigation information, 8 Hz three-component of magnetic force and ship's attitude data from Vertical Reference Unit, a ring-laser gyro installed for controlling attitude of a Doppler radar, are merged and recorded every one-second.

For calibration of the ship's magnetic effect, we made a "figure-eight" turn (a pair of clockwise and anti-clockwise rotation) two times, from 21:00 to 21:24 on 13 February at 7-58N 156-01E and from 8:37 to 8:53 on 6 March at 2-27S 141-57E.

(5) Preliminary Results

The results will be published after primary processing.

(6) Data Archives

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

(7) Remarks

Data logging was stopped due to the PC trouble on 4 March. The data does not exist following periods (times in UTC),

From 00:00:00 to 00:00:01
From 09:03:59 to 12:42:00

6.6.3 Swath Bathymetry

(1) Personnel

Souichiro Sueyoshi	(Global Ocean Development Inc.; GODI)
Kazuho Yoshida	(GODI)
Takeshi Matsumoto	(University of Ryukyus): Principal Investigator: Not on-board

(2) Introduction

R/V MIRAI equipped a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). The main system of “SeaBeam 2100”, 12 kHz system, provides swath bathymetry data. The major objective of MNBES is collecting continuous bathymetry data along ship’s track to make a contribution to geological and geophysical investigations and global datasets. We carried out bathymetric survey during the MR06-01 cruise from 7 February 2006 to 17 March 2006.

(3) Method of Data Acquisition

The “SEABEAM 2100” on R/V MIRAI was used for bathymetry mapping during MR06-01 cruise. For data quality management, applying applicable sound velocity profile is the most important. Sound velocity profile was calculated using formula of Mackenzie (1981), which parameters were water temperature and salinity from CTD and XCTD. Variations of sound velocity at transducer face have a large influence on measurement depth, especially side beams. So that this system has Surface Sound Velocimeter (SSV), which measuring sound velocity in the surface intake (6.2 m) water continuously. Obvious bad data was flagged automatically by real-time data screening function of the system.

System configuration and performance of SEABEAM 2112.004;

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 Archives

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

7 Special Observations

7.1 TRITON moorings

7.1.1 TRITON Mooring Operation

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Masaki Taguchi	(MWJ): Technical Leader
Ai Yasuda	(MWJ): Technical Staff
Hiroshi Matsunaga	(MWJ): Technical Staff
Masaki Furuhata	(MWJ): Technical Staff
Keisuke Matsumoto	(MWJ): Technical Staff
Tomohide Noguchi	(MWJ): Technical Staff
Akinori Murata	(MWJ): Technical Staff
Takatoshi Kiyokawa	(MWJ): Technical Staff
Tetsuharu Iino	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Tatsuya Tanaka	(MWJ): Technical Staff
Junji Matsushita	(MWJ): Technical Staff
Hiroshi Komura	(MWJ): Technical Staff
Masayuki Kumagai	(MWJ): Technical Staff
Ami Iwaki	(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/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).

Nine TRITON buoys have been successfully recovered during this R/V MIRAI cruise (MR06-01), nine buoys deployed and one buoy visited.

(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	01009
Number on surface float	T01
ARGOS PTT number	03595
ARGOS backup PTT number	24239
Deployed date	14 Feb. 2006
Exact location	07 - 57.86N, 156 - 01.46E
Depth	4841 m
Option sensors	Ultrasonic anemometer sensor on the tower

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
Exact location	05 - 01.10Ｎ, 155 - 19.00Ｅ
Depth	3606 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
Exact location	01 - 57.18N, 155 - 59.84E
Depth	2564 m
Option sensors	CT at 175 m : S/N 0601

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
Exact location	00 - 01.38S, 155 - 56.76E
Depth	1941 m
Option sensors	CT at 175m : S/N 1051

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
Exact location	01 - 58.76S, 156 - 01.88E
Depth	1752 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
Exact location	04 - 58.19N, 156 - 00.85E
Depth	1515m

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
Exact location	00 - 01.53S, 146 - 59.84E
Depth	4547 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
Exact location	05 - 02.34N, 146 - 57.06E
Depth	4255 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
Exact location	02 - 04.69N, 146 - 56.96E
Depth	4792 m
Option sensors	CT at 175m : S/N 0647

(6) TRITON recovered

Nominal location	8N, 156E
ID number at JAMSTEC	01008
Number on surface float	T04
ARGOS PTT number	09794
ARGOS backup PTT number	07860,07881
Deployed date	10 Feb. 2005
Recovered date	15 Feb. 2006
Exact location	08 - 01.30N, 155 - 56.11E
Depth	4858 m

Nominal location	5N, 156E
ID number at JAMSTEC	02008
Number on surface float	T05
ARGOS PTT number	03780
ARGOS backup PTT number	24235,07861
Deployed date	08 Feb. 2005
Recovered date	17 Feb. 2006
Exact location	04 - 58.49N, 156 - 02.18E
Depth	3602 m

Nominal location	2N, 156E
ID number at JAMSTEC	03009
Number on surface float	T06
ARGOS PTT number	11826
ARGOS backup PTT number	24237,07864
Deployed date	05 Feb. 2005
Recovered date	19 Feb. 2006
Exact location	02 - 02.23N, 156 - 01.21E
Depth	2572 m
Option sensors	CT at 175 m : S/N 0191

Nominal location	EQ, 156E
ID number at JAMSTEC	04009
Number on surface float	T07
ARGOS PTT number	03594
ARGOS backup PTT number	07871
Deployed date	02 Feb. 2005
Recovered date	21 Feb. 2006
Exact location	00 - 00.73N, 156 - 02.98E
Depth	1949 m
Option sensors	CT at 175m : S/N 0999
	ALEC CT at 1.5m , TSK CT at 500m

Nominal location	2S, 156E
ID number at JAMSTEC	05007
Number on surface float	T14
ARGOS PTT number	07962
ARGOS backup PTT number	11592,11584
Deployed date	31 Jan. 2005
Recovered date	21 Feb. 2006
Exact location	02 - 01.00S, 155 - 57.59E
Depth	1748 m

Nominal location	5S, 156E
ID number at JAMSTEC	06007
Number on surface float	T15
ARGOS PTT number	09770
ARGOS backup PTT number	24245,11593
Deployed date	29 Jan. 2005
Recovered date	24 Feb. 2006
Exact location	05 - 01.93N, 156 - 01.50E
Depth	1521m

Nominal location	EQ, 147E
ID number at JAMSTEC	09007
Number on surface float	T19
ARGOS PTT number	20392
ARGOS backup PTT number	24234
Deployed date	25 Jan. 2005
Recovered date	26 Feb. 2006
Exact location	00 - 03.65N, 147 - 00.70E
Depth	4479 m

Nominal location	5N, 147E
ID number at JAMSTEC	07007
Number on surface float	T16
ARGOS PTT number	09771
ARGOS backup PTT number	24238

Deployed date	21 Jan. 2005
Recovered date	01 Mar. 2006
Exact location	04 - 57.87N, 147 - 01.69E
Depth	4243 m

Nominal location	2N, 147E
ID number at JAMSTEC	08006
Number on surface float	T17
ARGOS PTT number	20374
ARGOS backup PTT number	24236,24229
Deployed date	24 Jan. 2005
Recovered date	04 Mar. 2006
Exact location	01 - 59.54N, 147 - 01.09E
Depth	4516 m
Option sensors	CT at 175m : S/N 1027

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

(6) Details of deployed

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

Deployed TRITON buoys

Observation No.	Location.	Details.
01009	8N156E	Deploy with full spec and one ultrasonic anemometer sensor.
02009	5N156E	Deploy with full spec.
03010	2N156E	Deploy with full spec and one optional CT sensor.
04010	EQ156E	Deploy with full spec and one optional CT sensor.
05008	2S156E	Deploy with full spec.
06008	5S156E	Deploy with full spec.
09008	EQ147E	Deploy with full spec.
07008	5N147E	Deploy with full spec.
08007	2N147E	Deploy with full spec and one optional CT sensor.

(7) 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

Yuji Kashino (JAMSTEC): Principal Investigator
Masaki Taguchi (MWJ): Technical Leader
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
01009	8N	156E	After Deployment
02009	5N	156E	After Deployment
03010	2N	156E	After Deployment
04010	EQ	156E	After Deployment
05008	2S	156E	After Deployment
06008	5S	156E	After Deployment
07008	5N	147E	After Deployment
08007	2N	147E	After Deployment
09008	EQ	147E	After Deployment
01008	8N	156E	Before Recover
02008	5N	156E	Before Recover
03009	2N	156E	Before Recover
04009	EQ	156E	Before Recover
06007	2S	156E	Before Recover
07007	5S	156E	Before Recover
08006	5N	147E	Before Recover
09007	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)(c)(d).

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.

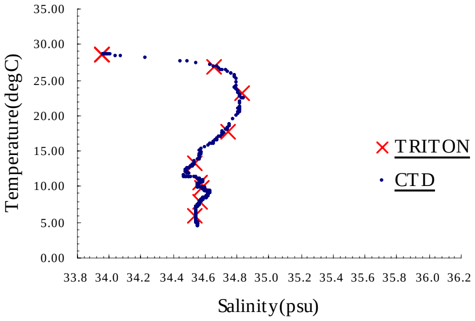
The estimation was calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from –0.4345 to 0.0686 for all depths. Below 300db, salinity differences are from –0.0179 to 0.0097 (See the Figures 7.1.2-2 (a) and Table 7.1.2-1 (a)). The average of salinity differences was -0.0053 with standard deviation of 0.0472.

The estimation was calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.4482 to 0.1388 for all depths. Below 300db, salinity differences are from –0.0219 to 0.0191 (See the Figures 7.1.2-2(b) and Table 7.1.2-1 (b)). The average of salinity differences was –0.0093 with standard deviation of 0.0924.

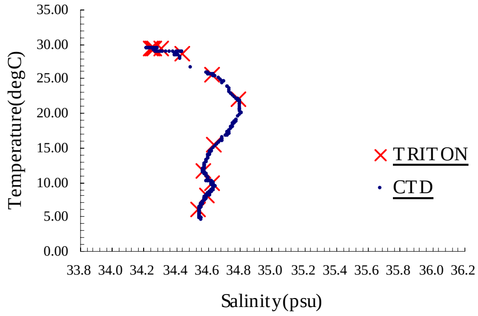
The estimation of time-drift was calculated as recovered buoy data minus deployed buoy data. The salinity changes for 1 year are from –0.4631 to 0.1349, for all depths. Below 300db, salinity changes for 1 year are from -0.0294 to 0.0136 (See the figures 7.1.2-2(c)). The average of salinity differences was -0.0210 with standard deviation of 0.1044.

(6) Data archive

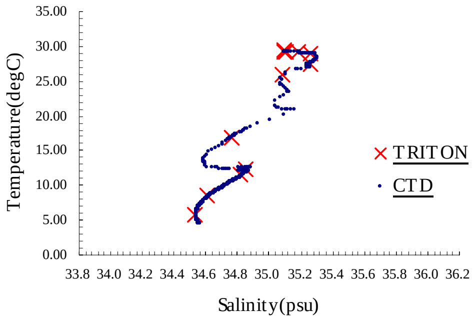
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)



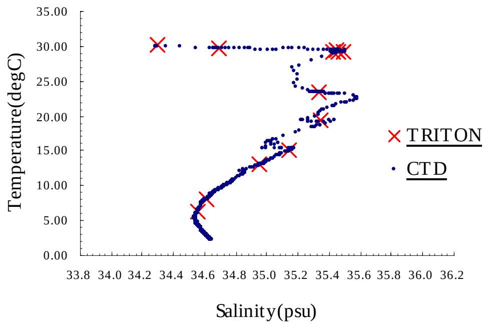
Observation No. 01009 after Deployment



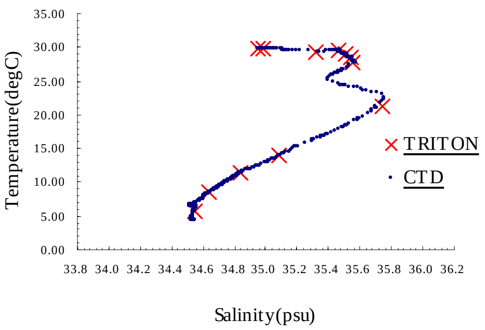
Observation No. 02009 after Deployment



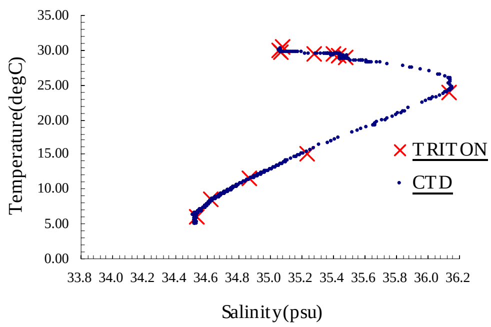
Observation No. 03010 after Deployment



Observation No. 04010 after Deployment

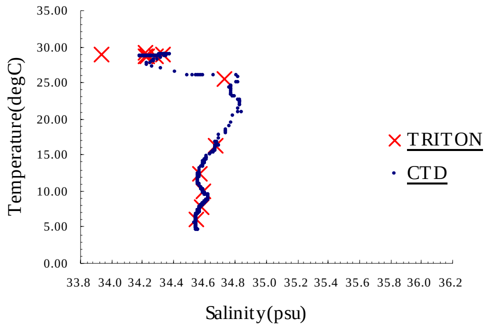


Observation No. 05008 after Deployment

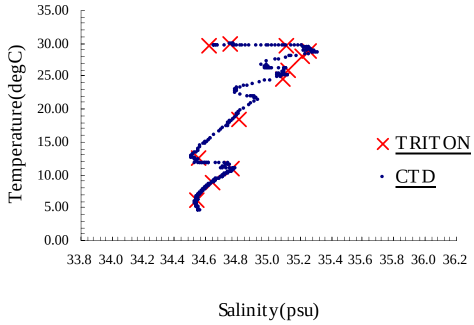


Observation No. 06008 after Deployment

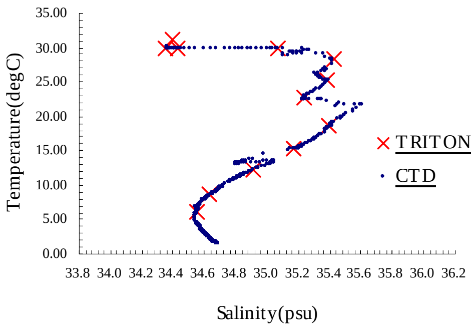
Fig.7.1.2.-1(a) T-S diagram of TRITON buoys data and shipboard CTD data



Observation No. 07008 after Deployment

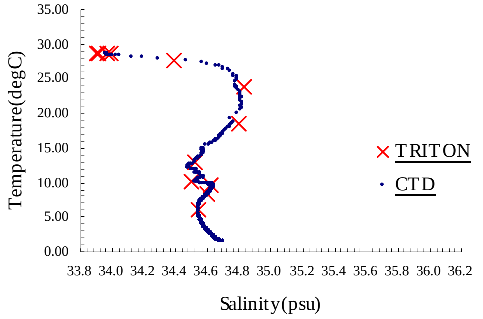


Observation No. 08007 after Deployment

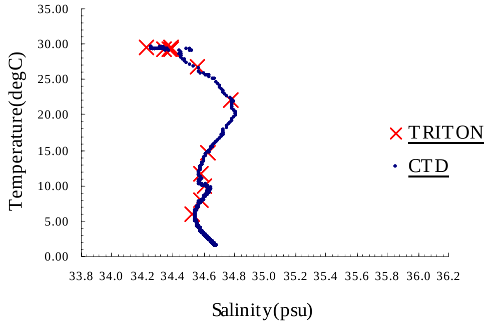


Observation No. 09008 after Deployment

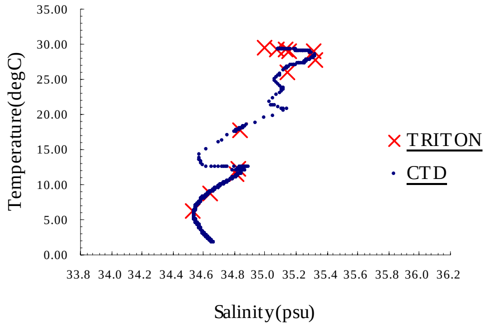
Fig.7.1.2.-1(b) T-S diagram of TRITON buoys data and shipboard CTD



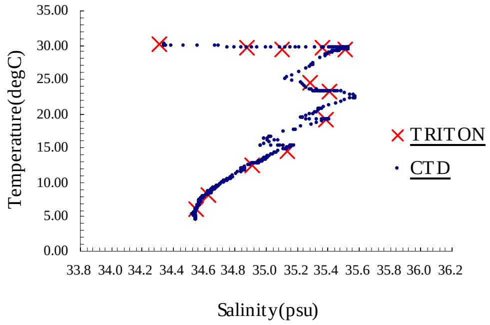
Observation No. 01008 before Recover



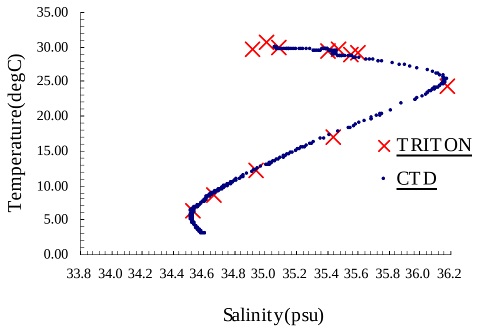
Observation No. 02008 before Recover



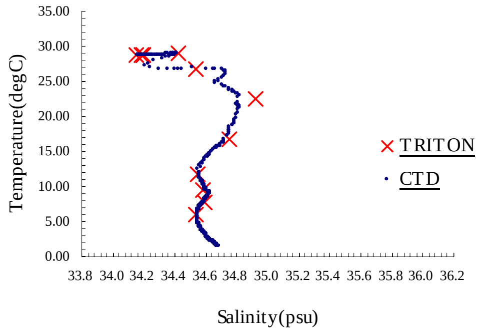
Observation No. 03009 before Recover



Observation No. 04009 before Recover

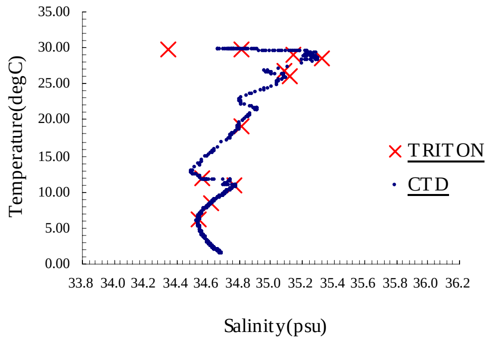


Observation No. 06007 before Recover

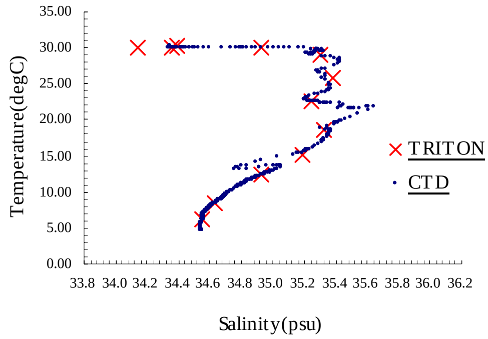


Observation No. 07007 before Recover

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



Observation No. 08006 before Recover



Observation No. 09007 before Recover

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

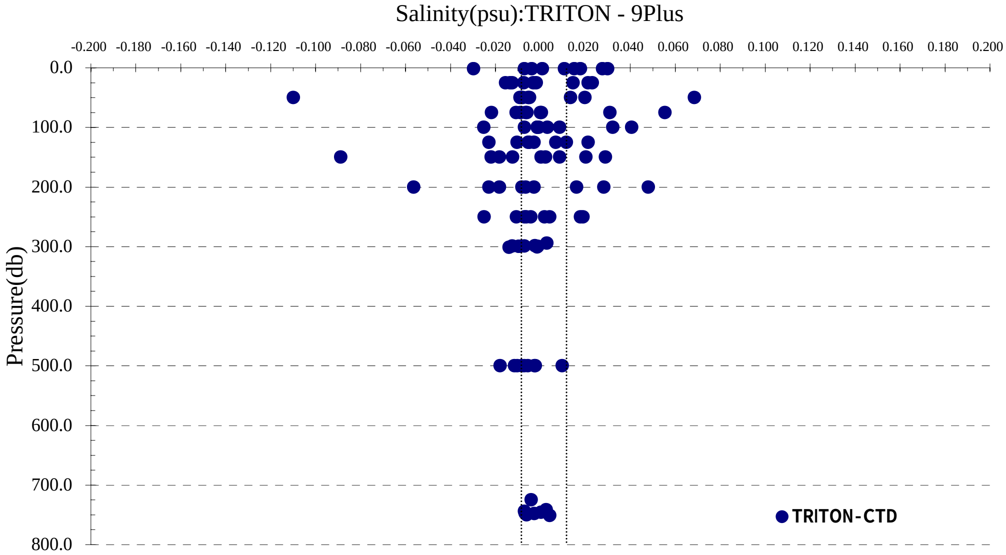


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

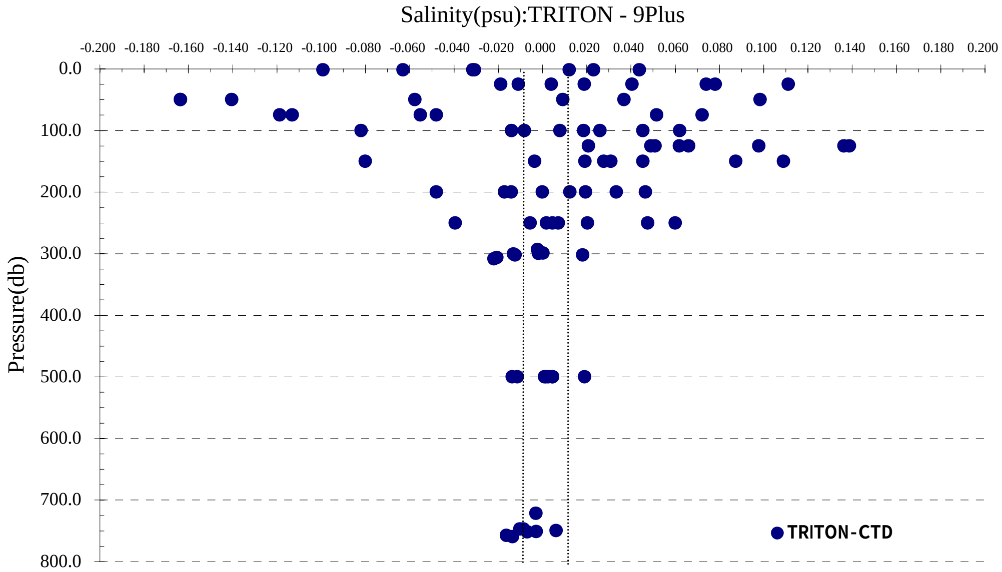


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

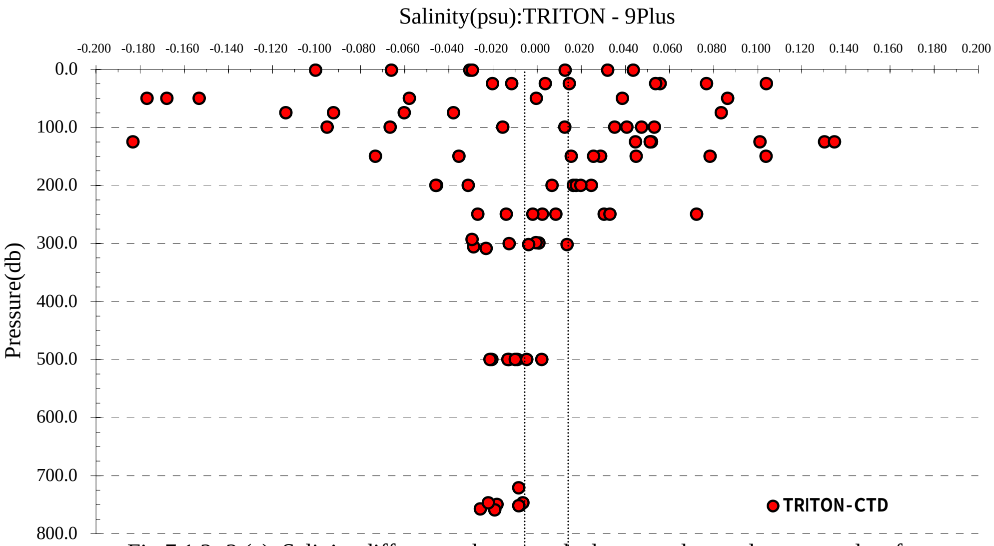


Fig.7.1.2.-2 (c) Salinity differences between deployment data and recovery data for 1year
Observation No.01,02,03,04,05,06,07,08,09

Table 7.1.2.-1(a) Data differences between TRITON buoys data and ship board CTD data after deployment

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
01009	1.5	0.01	0.000	-0.004
01009	25.0	0.00	0.000	-0.002
01009	50.0	-0.01	-0.002	-0.008
01009	75.0	0.00	-0.002	-0.011
01009	100.0	0.01	0.001	-0.001
01009	125.0	0.04	0.007	0.021
01009	150.0	-0.07	-0.006	0.009
01009	200.0	-0.06	-0.006	-0.003
01009	250.0	0.01	0.000	-0.011
01009	299.4	0.00	-0.001	-0.010
01009	500.0	0.00	-0.002	-0.018
01009	744.1	0.00	-0.001	-0.007
02009	1.5	0.04	0.008	0.028
02009	25.0	0.01	0.004	0.021
02009	50.0	0.01	0.003	0.020
02009	75.0	0.03	0.012	0.056
02009	100.0	-0.11	-0.007	0.032
02009	125.0	0.00	-0.001	-0.005
02009	150.0	-0.01	-0.001	0.000
02009	200.0	0.04	0.001	-0.023
02009	250.0	-0.02	-0.002	-0.004
02009	298.8	0.00	-0.001	-0.007
02009	500.0	0.00	-0.001	-0.008
02009	747.5	0.00	-0.001	-0.007
03010	1.5	0.16	0.017	0.001
03010	25.0	0.00	0.000	-0.003
03010	50.0	0.00	-0.001	-0.005
03010	75.0	0.00	0.000	0.000
03010	100.0	0.00	-0.001	-0.007
03010	125.0	0.00	0.001	0.007
03010	150.0	-0.02	-0.005	-0.022
03010	200.0	-0.03	-0.004	-0.008
03010	250.0	-0.01	-0.001	-0.006
03010	299.1	0.00	-0.001	-0.012
03010	500.0	0.00	-0.001	-0.007
03010	747.8	0.00	-0.001	-0.003

Table 7.1.2.-1(a) Data differences between TRITON buoys data and ship board CTD data after deployment

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
04010	1.5	0.24	0.026	0.011
04010	25.0	0.00	0.004	0.023
04010	50.0	0.00	0.002	0.013
04010	75.0	0.00	0.000	-0.006
04010	100.0	0.00	0.000	-0.001
04010	125.0	0.00	0.000	-0.005
04010	150.0	0.01	-0.001	-0.018
04010	200.0	-0.02	-0.008	-0.056
04010	250.0	0.17	0.016	-0.007
04010	298.5	0.12	0.011	-0.002
04010	500.0	0.01	0.001	-0.006
04010	746.0	0.00	0.000	0.000
05008	1.5	-0.02	-0.003	-0.007
05008	25.0	0.00	-0.002	-0.016
05008	50.0	0.01	0.000	-0.008
05008	75.0	-0.01	-0.002	-0.007
05008	100.0	-0.01	0.000	0.003
05008	125.0	-0.01	-0.001	-0.003
05008	150.0	-0.10	-0.013	-0.012
05008	200.0	-0.02	0.004	0.048
05008	250.0	0.02	0.002	0.002
05008	299.8	0.00	-0.001	-0.009
05008	500.0	0.00	0.000	-0.002
05008	741.3	-0.01	-0.002	0.003
06008	1.5	0.36	0.041	0.015
06008	25.0	0.00	-0.001	-0.007
06008	50.0	0.00	-0.001	-0.005
06008	75.0	0.00	-0.004	-0.022
06008	100.0	0.00	-0.004	-0.025
06008	125.0	0.00	-0.003	-0.023
06008	150.0	-0.01	0.003	0.029
06008	200.0	0.00	0.002	0.016
06008	250.0	-0.04	-0.002	0.019
06008	301.2	-0.02	-0.003	-0.014
06008	500.0	0.00	-0.002	-0.010
06008	751.2	-0.04	-0.004	0.004

Table 7.1.2.-1(a) Data differences between TRITON buoys data and ship board CTD data after deployment

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
07008	1.5	0.46	0.049	0.018
07008	25.0	0.00	0.002	0.015
07008	50.0	0.00	-0.002	-0.009
07008	75.0	0.00	-0.002	-0.009
07008	100.0	0.00	-0.001	-0.001
07008	125.0	0.00	-0.063	-0.435
07008	150.0	-0.14	-0.027	-0.089
07008	200.0	0.00	-0.001	-0.007
07008	250.0	0.00	0.000	0.004
07008	299.4	-0.02	-0.002	-0.001
07008	500.0	0.02	0.002	-0.003
07008	743.0	0.00	0.000	0.003
08007	1.5	-0.01	-0.005	-0.030
08007	25.0	0.05	0.003	-0.012
08007	50.0	0.00	0.010	0.069
08007	75.0	0.00	0.004	0.031
08007	100.0	0.05	0.011	0.041
08007	125.0	-0.25	-0.026	0.012
08007	150.0	-0.63	-0.064	0.020
08007	200.0	-0.14	-0.011	0.028
08007	250.0	0.04	0.005	0.018
08007	300.5	-0.01	-0.001	-0.001
08007	500.0	0.22	0.022	0.010
08007	749.9	0.02	0.001	-0.006
09008	1.5	0.95	0.105	0.030
09008	25.0	-0.01	-0.003	-0.014
09008	50.0	0.00	-0.016	-0.110
09008	75.0	-0.01	0.000	0.001
09008	100.0	0.01	0.002	0.009
09008	125.0	0.02	0.001	-0.010
09008	150.0	-0.01	-0.001	0.002
09008	200.0	-0.02	-0.004	-0.018
09008	250.0	0.01	-0.003	-0.025
09008	294.3	-0.01	-0.002	0.003
09008	500.0	0.02	0.001	-0.011
09008	724.9	0.00	0.001	-0.004
(red)	Bad data			

Table 7.1.2.-1(b) Data differences between TRITON buoys data and ship board CTD data before recovery

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
01008	1.5	0.00	0.001	0.012
01008	25.0	0.00	0.006	0.041
01008	50.0	0.00	-0.009	-0.058
01008	75.0	0.00	-0.007	-0.048
01008	100.0	0.00	-0.012	-0.082
01008	125.0	-0.03	0.004	0.051
01008	150.0	-0.04	0.001	0.046
01008	200.0	0.08	0.009	0.013
01008	250.0	0.01	-0.004	-0.039
01008	299.5	-0.01	-0.001	-0.002
01008	500.0	0.00	0.000	0.002
01008	751.4	0.01	0.000	-0.003
02008	1.500	0.000	-0.005	-0.031
02008	25.0	0.00	0.016	0.111
02008	50.000	-0.007	0.014	0.098
02008	75.00	0.00	0.008	0.052
02008	100.0	0.02	0.000	-0.014
02008	125.0	0.07	0.010	0.021
02008	150.0	-0.05	-0.006	-0.004
02008	200.0	0.00	-0.002	-0.014
02008	250.0	-0.03	-0.002	0.007
02008	306.2	0.00	-0.001	-0.021
02008	500.0	0.00	-0.001	-0.014
02008	757.6	0.00	-0.002	-0.016
03009	1.5	0.13	-0.001	-0.099
03009	25.0	0.00	-0.003	-0.019
03009	50.0	0.01	0.007	0.037
03009	75.0	0.00	-0.008	-0.055
03009	100.0	0.00	0.003	0.019
03009	125.0	-0.01	0.006	0.049
03009	150.0	-0.22	-0.020	0.028
03009	200.0	-0.02	-0.002	0.000
03009	250.0	-0.05	-0.004	0.002
03009	300.5	-0.01	-0.002	-0.013
03009	500.0	0.00	0.000	0.001
03009	747.2	0.00	-0.001	-0.009

Table 7.1.2.-1(b) Data differences between TRITON buoys data and ship board CTD data before recovery

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
04009	1.5	0.01	-0.004	-0.031
04009	25.0	-0.01	0.011	0.078
04009	50.0	-0.01	-0.021	-0.140
04009	75.0	0.00	-0.063	-0.432
04009	100.0	0.03	0.010	0.046
04009	125.0	-0.04	0.004	0.062
04009	150.0	-0.01	-0.012	-0.080
04009	200.0	0.00	-0.002	-0.017
04009	250.0	-0.03	0.003	0.048
04009	302.1	0.04	0.007	0.018
04009	500.0	0.00	0.000	0.005
04009	751.9	0.00	-0.001	-0.007
06007	1.5	0.70	0.065	-0.063
06007	25.0	0.00	0.003	0.019
06007	50.0	0.00	-0.024	-0.164
06007	75.0	0.02	0.013	0.072
06007	100.0	0.00	0.000	-0.008
06007	125.0	-0.01	0.019	0.136
06007	150.0	-0.01	0.012	0.087
06007	200.0	0.03	0.010	0.047
06007	250.0	-0.14	-0.011	0.020
06007	299.1	0.02	0.002	0.000
06007	500.0	0.00	0.002	0.019
06007	749.7	-0.02	-0.001	0.006
07007	1.5	-0.02	0.001	0.023
07007	25.0	0.00	-0.002	-0.011
07007	50.0	0.00	0.001	0.009
07007	75.0	0.00	-0.016	-0.113
07007	100.0	0.01	0.002	0.008
07007	125.0	0.01	0.021	0.139
07007	150.0	-0.28	-0.015	0.109
07007	200.0	0.26	0.030	0.034
07007	250.0	0.00	0.000	-0.006
07007	308.6	-0.02	-0.004	-0.022
07007	500.0	0.02	0.003	0.005
07007	759.4	0.00	0.001	-0.013

Table 7.1.2.-1(b) Data differences between TRITON buoys data and ship board CTD data before recovery

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
08006	1.5	-0.12	-0.079	-0.448
08006	25.0	0.00	0.011	0.074
08006	50.0	0.00	-0.024	-0.164
08006	75.0	-0.01	-0.019	-0.119
08006	100.0	0.01	0.005	0.026
08006	125.0	0.23	0.038	0.098
08006	150.0	0.13	0.018	0.031
08006	200.0	-0.03	-0.001	0.020
08006	250.0	0.12	0.012	0.005
08006	301.9	0.00	-0.002	-0.012
08006	500.0	-0.17	-0.018	-0.011
08006	746.8	-0.08	-0.009	-0.010
09007	1.5	0.13	0.020	0.044
09007	25.0	0.00	0.000	0.004
09007	50.0	0.00	-0.037	-0.251
09007	75.0	-0.01	-0.041	-0.272
09007	100.0	0.03	0.012	0.062
09007	125.0	0.08	0.018	0.066
09007	150.0	-0.01	0.002	0.019
09007	200.0	0.01	-0.005	-0.048
09007	250.0	0.05	0.012	0.060
09007	293.4	0.01	0.001	-0.002
09007	500.0	0.01	0.001	0.003
09007	721.4	0.00	-0.001	-0.003
(red)	Bad data			

7.2 ADCP subsurface mooring

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Masaki Taguchi	(MWJ): Operation leader
Hiroshi Matsunaga	(MWJ): Technical staff
Masaki Furuhata	(MWJ): Technical staff
Keisuke Matsumoto	(MWJ): Technical staff
Akinori Murata	(MWJ): Technical staff
Tomohide Noguchi	(MWJ): Technical staff
Tetsuharu Iino	(MWJ): Technical staff
Takatoshi Kiyokawa	(MWJ): Technical staff
Tatsuya Tanaka	(MWJ): Technical staff
Hiroki Ushiromura	(MWJ): Technical staff
Junji Matushita	(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 (MR06-01), we recovered three subsurface ADCP mooring at Eq-156E/ Eq-147E/ 2.5S-142E 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 340m 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 : 1222 (Mooring No.050204-00156E)
- Serial Number : 1221 (Mooring No.050127-00147E)
- Serial Number : 1152 (Mooring No.050118-2.5S142E)

Deployed ADCP

- Serial Number : 1150 (Mooring No.060220-00156E)
- Serial Number : 1154 (Mooring No.060228-00147E)

2) CTD

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Recovered CTD

- Serial Number : 1275 (Mooring No.050204-00156E)
- Serial Number : 1288 (Mooring No.050127-00147E)
- Serial Number : 1274 (Mooring No.050118-2.5S142E)

Deployed CTD

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

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)

Recovered Acoustic Releaser

- Serial Number : 916 (Mooring No.050204-00156E)
- Serial Number : 663 (Mooring No.050204-00156E)
- Serial Number : 667 (Mooring No.050127-00147E)
- Serial Number : 693 (Mooring No.050127-00147E)
- Serial Number : 631 (Mooring No.050118-2.5S142E)
- Serial Number : 634 (Mooring No.050118-2.5S142E)

Deployed 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)

(b) Transponder (BENTHOS,Inc.)

Recovered Transponder

- Serial Number : 67491 (Mooring No.050204-00156E)
- Serial Number : 57068 (Mooring No.050127-00147E)
- Serial Number : 57114 (Mooring No.050118-2.5S142E)

Deployed Transponder

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

(5) Deployment

The ADCP mooring deployed at Eq-156E and Eq-147E was planned to play the ADCP at about 340m depth. After we dropped the anchor, we monitored the depth of the acoustic releaser.

The position of the mooring No. 060220-00156E

Date: 20 Feb. 2006 Lat: 00-00.12S Long: 156-08.47E Depth: 1959m

The position of the mooring No. 060228-00147E

Date: 28 Feb. 2006 Lat: 00-00.32S Long: 147-04.58E Depth: 4477m

(6) Recovery

We recovered three ADCP moorings. One was deployed on 4 Feb.2005 (MR04-08 Leg2), the other was deployed on 27 Jan. 2005 (MR04-08 Leg2) and the other was deployed on 18 Jan. 2005 (MR04-08 Leg2). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. But the ADCP recovered at Eq-147E was not able to upload data because of the communication error.

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 CTD pressure, temperature and salinity data (Eq-142E). Fig.7-2-4 shows the ADCP velocity data (zonal and meridional component / 2.5S-143E). Fig.7-2-5 shows CTD pressure, temperature and salinity data (2.5S-143E).

(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.

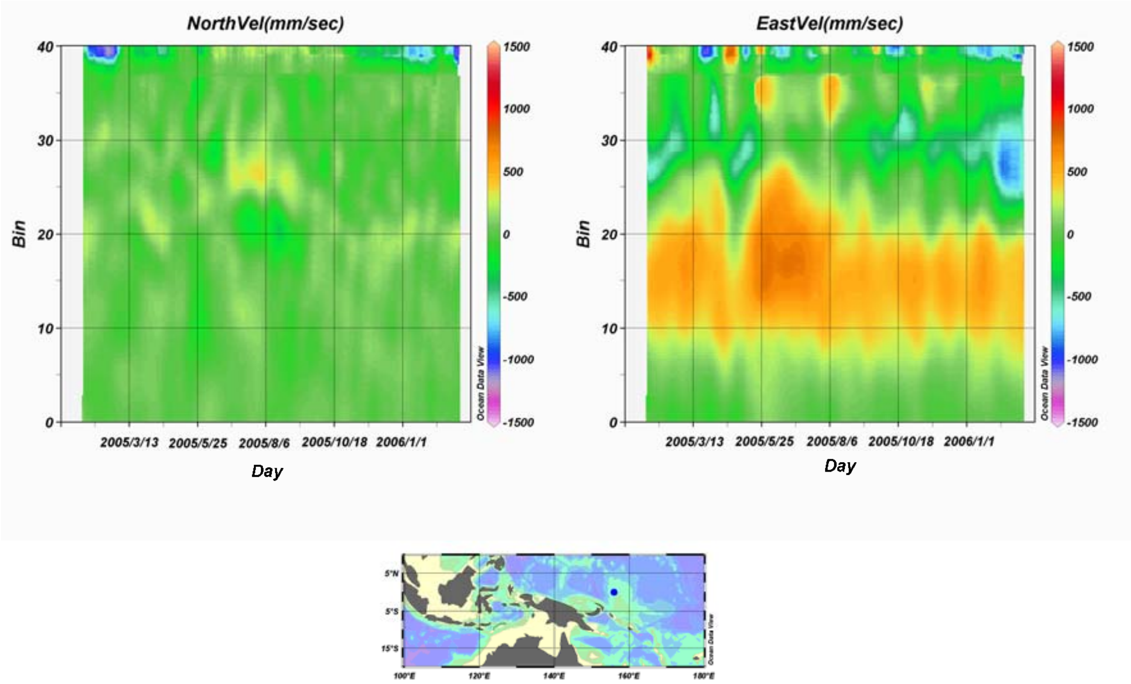


Fig.7-2-1 Time Series of zonal and meridional velocities of EQ-156E mooring (2005/2/4-2006/2/20)

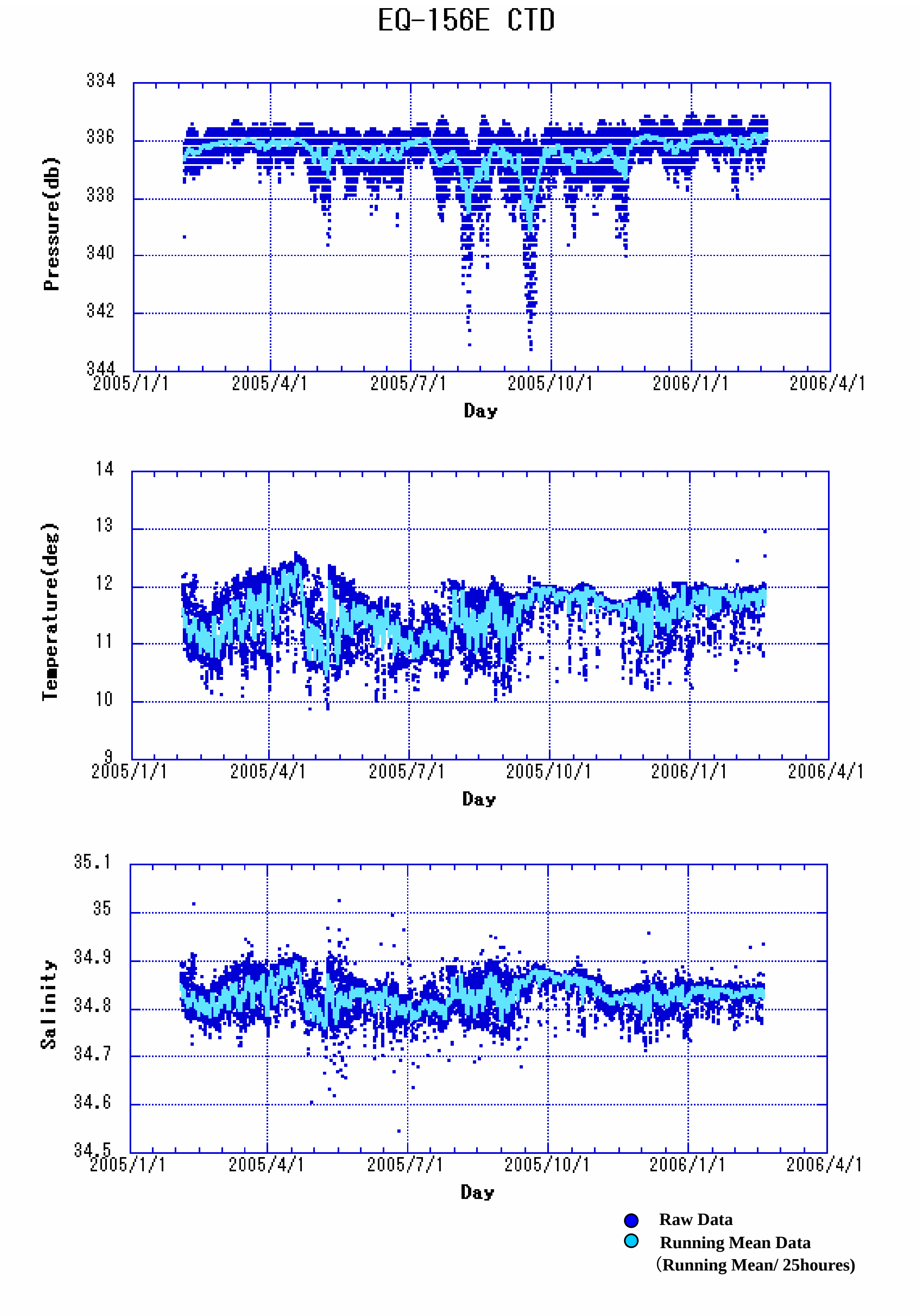


Fig.7-2-2 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-156E mooring (2005/2/4-2006/2/20)

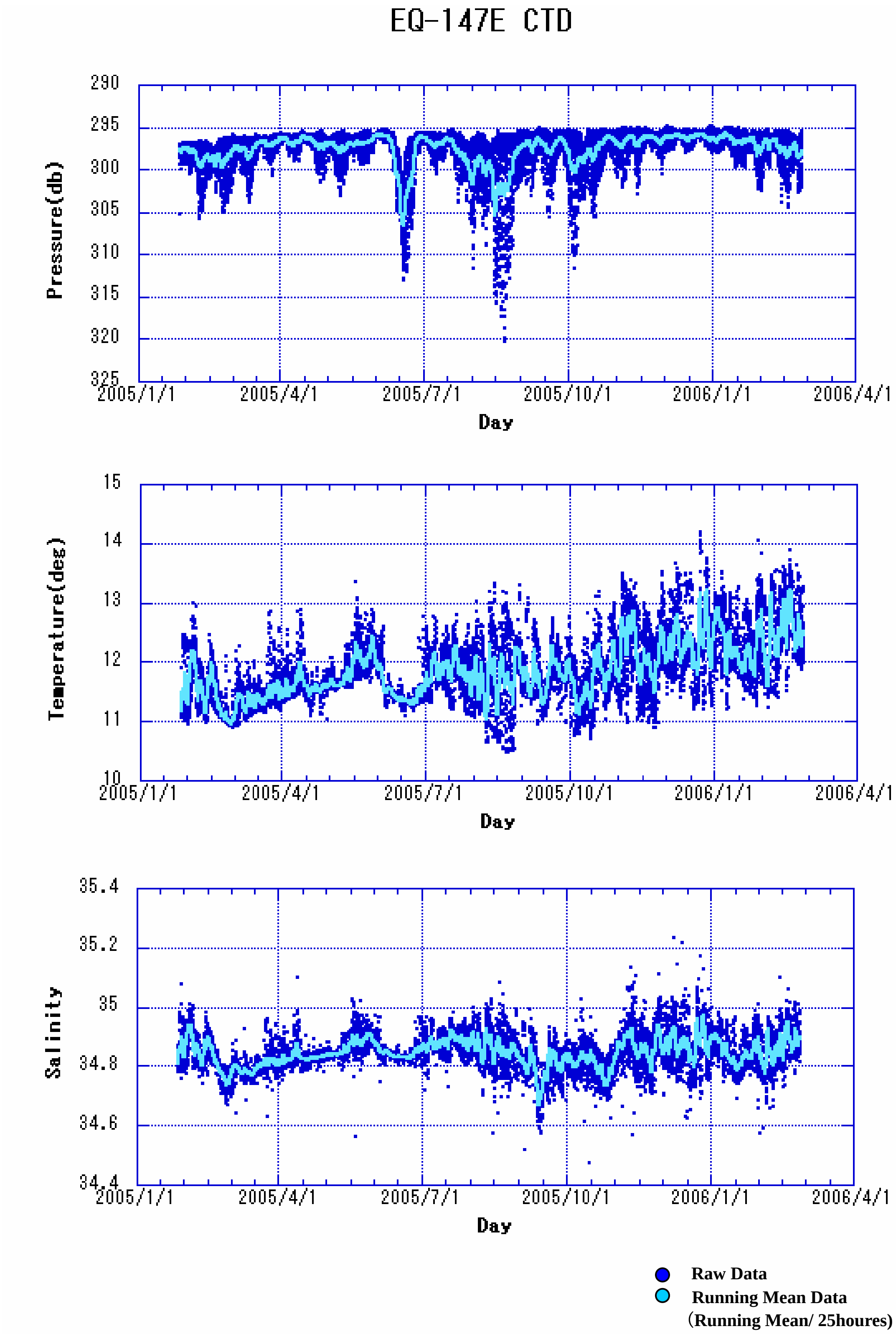


Fig.7-2-3 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-147E mooring (2005/1/27-2006/2/28)

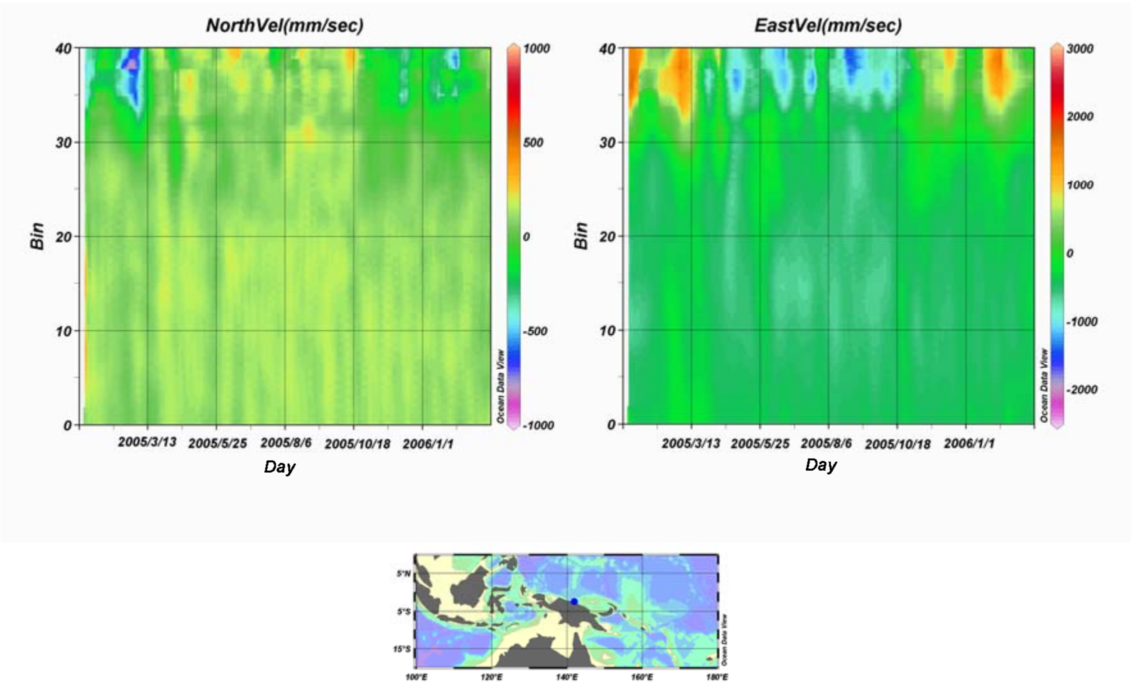


Fig.7-2-4 Time Series of zonal and meridional velocities of 2.5S-142E mooring (2005/1/18-2006/3/7)

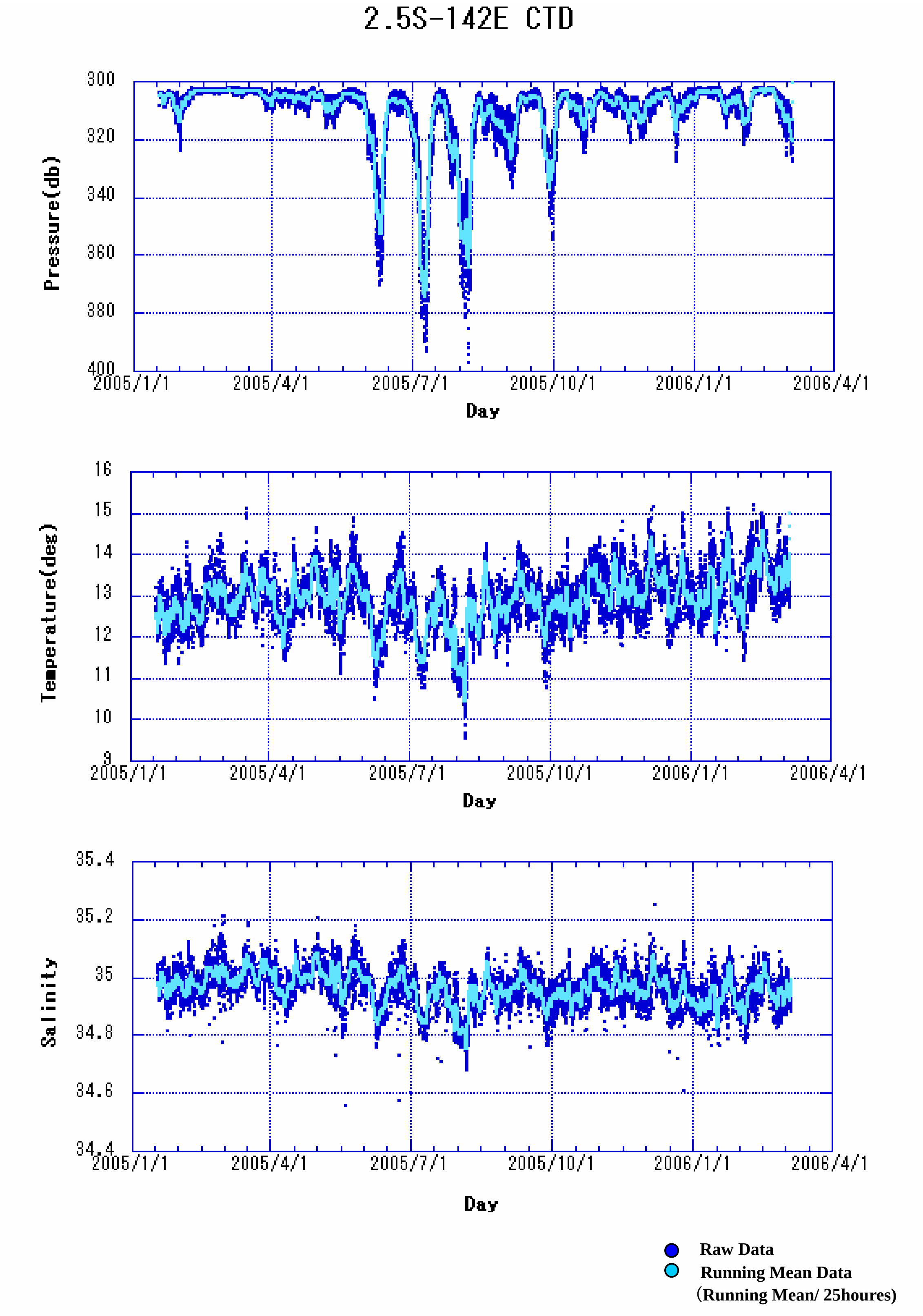


Fig.7-2-5 Time Series of pressure, temperature, salinity of obtained with CTD of 2.5S-142E mooring (2005/1/18-2006/3/7)

7.3 Argo float

(1) Personnel

Nobuyuki Shikama	(JAMSTEC)	Principal Investigator (not on board)
Hiromiti Ueno	(JAMSTEC)	not on board
Mizue Hirano	(JAMSTEC)	not on board
Hiroki Ushiromura	(MWJ)	
Tatsuya Tanaka	(MWJ)	
Tomohide Noguchi	(MWJ)	

(2) Objectives

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

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

(3) Parameters

・water temperature, salinity, and pressure

(4) Methods

1) Profiling float deployment

We launched 2 APEX floats of JAMSTEC and 1 NINJA float of TSK (TSURUMI-SEIKI CO.LTD). These floats equip a SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 1000 m (called the parking depth), rising up to the sea surface every ten days by increasing their volume and thus changing the buoyancy. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting their positions and the CTD data to the land via the ARGOS system, and then return to the parking depth by decreasing volume. The status of floats and their launches are shown in Table 7.3-1.

(5) Data archive

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

Table 7.3-1 Status of floats and their launches

APEX

Float Type	APEX floats manufactured by Webb Research Ltd.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days
ARGOS transmit interval	30 sec
Parking depth	1000 m
Plofiling depth	2000 m

NINJA

Float Type	NINJA floats manufactured by TSURUMI-SEIKI CO. LTD.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days
Parking depth	1000 m
Plofiling depth	2000 m

Launches

Owner	Type	S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch
JAMSTEC	APEX	2406	60136	15.Feb.2006 02:08	15. Feb.2006 02:34	07-59.04N, 155-51.84E
JAMSTEC	APEX	2407	60137	03.Mar.2006 01:39	03.Mar.2006 02:27	05-01.38N, 146-76.71E
TSK	NINJA	1162	22729	13.Mar.2006 00:28	13.Mar.2006 00:42	18-00.78N, 150-01.06E

7.4 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto

(National Institute for Environmental Studies, NIES) Principal Investigator / not onboard

Ichiro Matsui, Atsushi Shimizu, Akihide Kamei (NIES) not onboard

operation was supported by Global Ocean Development Inc. (GODI).

(2) Objective

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

(3) Measured parameters

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

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 100 mJ per pulse at 1064 nm and 50 mJ per pulse at 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a digital oscilloscope and stored on a hard disk with a computer. The lidar system was installed in the radiosonde container on the compass deck. The container has a glass window on the roof, and the lidar was operated continuously regardless of weather.

(5) Results

Data obtained in this cruise will be analyzed at NIES.

(6) Data archive

- raw data

  lidar signal at 532 nm

  lidar signal at 1064 nm

  depolarization ratio at 532 nm

  temporal resolution 15 min.

  vertical resolution 6 m.

  data period : February 6, 2006 – March 17, 2006

- processed data

  cloud base height, apparent cloud top height

  phase of clouds (ice/water)

  cloud fraction

  boundary layer height (aerosol layer upper boundary height)

  backscatter coefficient of aerosols

  particle depolarization ratio of aerosols

7.5 Aerosol observations by Sky Radiometer

Personnel

Principal Investigator – not onboard -

Tatsuo ENDOH (Tottori University of Environmental Studies) Professor

Co-workers - not on board -

Sachio OHTA (Engineering environmental resource laboratory, Graduate school of engineering, Hokkaido University) Professor

Tamio TAKAMURA (Center of environmental remote sensing science, Chiba University) Professor

Teruyuki NAKAJIMA (Center of climate system research, University of Tokyo) Professor

Nobuo SUGIMOTO (National Institute for Environmental Studies, Japan) Chief Research Scientist

Objective theme

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

Introduction

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

Measuring parameters

Atmospheric optical thickness, Ångström coefficient of wave length efficiencies,

Direct irradiating intensity of solar, and forward up to back scattering intensity with scattering angles of 2-140degree and seven different wave lengths

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

Methods

The instruments used in this work are shown as following in Table-1.

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

Results

Information of data and sample obtained are summarized in Table-2. The sky radiometer has been going well owing to more calm and silent condition and circumstances about shivering problems provided by the R/V Mirai whose engines are supported by well-defined cushions. Therefore, measured values will be expected to be considerably stable and provide good calculated parameters in higher quality. However, some noise waves were found to interfere the 16,13 and 12channel marine bands of VHF from sky radiometer. Fortunately the origin and source were identified by using VHF wide band receiver and the interference waves were kept by fairly separating from two VHF antennae and decreased to recovery of 100%.

Data archive

The data of aerosol measurements are not archived so soon and developed, examined, arranged and finally provided as available data after a certain duration. All data will be archived at TUES (Endoh),Tottori University of Environmental Studies, CCSR(Nakajima), University of Tokyo and CEReS (Takamura), Chiba University after the quality check and submitted to JAMSTEC within 3-year.

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Miura, K., S. Nakae, et al.,: Optical properties of aerosol particles over the Western Pacific Ocean, Proc. Int. Sym. Remote Sensing, 275-280, 1997.

Table-1. Information of obtained data inventory (Method)

Item, No.data	Name	Instrument	Site position
Optical thickness, Ångström exponent and Aerosol Size distribution.	Endoh	Sky Radiometer(Prede,POM-01MK2)	roof of stabilizer

Table-2. Data and Sample inventory

Data/Sample	rate	site	object	name	state	remarks
Sun & Sky Light	1/5min (fine& daytime)	roof of stabilizer	optical thickness Ångström expt.	Endoh	land analysis	06/02’06-17/03’06

7.6 Rain sampling for stable isotopes

(1) Personnel

Kimpei Ichiyanagi (JAMSTEC) (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 23 samples in total. Table 7.6-1 lists the date and location of rainfall samples. Analysis will be done after the cruise.

(5) Data archive

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

Table 7.6-1 Dates and locations to show when and where rain water were sampled.

Sample No.	Date (UTC)	Location (lat/lon)	Rain (mm)
001	00:30, February 9	30-36.40N, 148-02.10E	15
002	00:44, February 12	15-14.20N, 153-38.85E	5.7
003	22:00, February 14	08-00.00N, 155-54.43E	0.6
004	21:55, February 16	04-58.30N, 156-01.69E	0.8
005	21:33, February 19	00-01.35S, 155-57.40E	0.2
006	01:05, February 21	00-01.88S, 156-02.33E	0.2
007	20:24, February 21	01-58.62S, 156-00.16E	9.4
008	06:31, February 22	02-00.06S, 155-58.25E	9.8
009	00:30, February 25	02-32.83S, 152-33.00E	0.4
010	08:27, February 25	01-29.48S, 150-48.24E	13.8
011	03:50, March 1	04-57.74N, 147-03.63E	16.8
012	00:23, March 2	04-57.80N, 147-02.01E	0.4
013	06:42, March 3	04-20.79N, 146-58.56E	3.6
014	00:36, March 5	02-00.11N, 147-01.73E	3.6
015	21:13, March 5	00-41.54S, 143-25.13E	2.1
016	23:24, March 6	02-28.30S, 141-56.00E	1.4
017	23:15, March 8	03-07.78N, 151-54.76E	4.8
018	22:18, March 9	05-00.92N, 155-57.32E	1.0
019	03:31, March 10	05-20.86N, 155-48.71E	3.0
020	20:45, March 10	09-17.83N, 154-00.82E	0.6
021	01:41, March 13	18-12.29N, 149-57.42E	1.4
022	23:55, March 14	28-33.30N, 146-28.37E	0.8
023	23:13, March 16	39-24.48N, 142-30.47E	3.2

7.7. Measurement of greenhouse effect gases

(1) Personnel

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(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, alkalinity and pH), nutrients, nitrogen oxide (N_2O) and micro-nutrients (trace metals) at the equatorial area.

(3) Parameters

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

(4) Methods

4.1. pH

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

4.2. Total Alkalinity (At)

Total Alkalinity samples were collected in 250 mL polyethylene bottles with inner caps from Niskin sampler and capped after an overflow of about 150 mL of seawater. All samples were stored at room temperature after sampling and analyzed within a few hours. Samples were transferred into a glass titration cell using a 50 mL transfer pipette and titrated at 20ºC±0.1ºC with 0.1M HCl containing 0.6M NaCl within 10 minutes. The electric potential and temperature of the sample were followed with an Ag/AgCl combined electrode (Radiometer Analytical A/S, GK2401C) and a temperature sensor (Radiometer Analytical A/S, T901) connected to the TitraLab system (Radiometer Analytical A/S). The titration was controlled automatically and the titration curve was analyzed with the inflection point titration method by the system. The precision of the method was determined to be ±0.61 µmol/l (n=8) from replicate analysis of the Certified Reference Solutions (CRMs (batch 72) supplied by Dr. Andrew Dickson of Scripps Institution of Oceanography (SIO)). Standardization of the titrant (0.1M HCl) was accomplished with Na_2CO_3 (99.99% pure; Asahi Grass) standards.

4.3. 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 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 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 CO_2-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.

4.4. 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, flow cell : 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 nitrite 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).

4.5. Nitrogen 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 ^{63}Ni 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.

4.6. 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 *p*CO_2 sensor for in-situ *p*CO_2 measurement in seawater. The principle of *p*CO_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 pCO2 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. The in-situ pH/pCO_2 sensor was installed to CTD and in-situ data were measured every 10 seconds during the operation.

4.7. Trace Metals

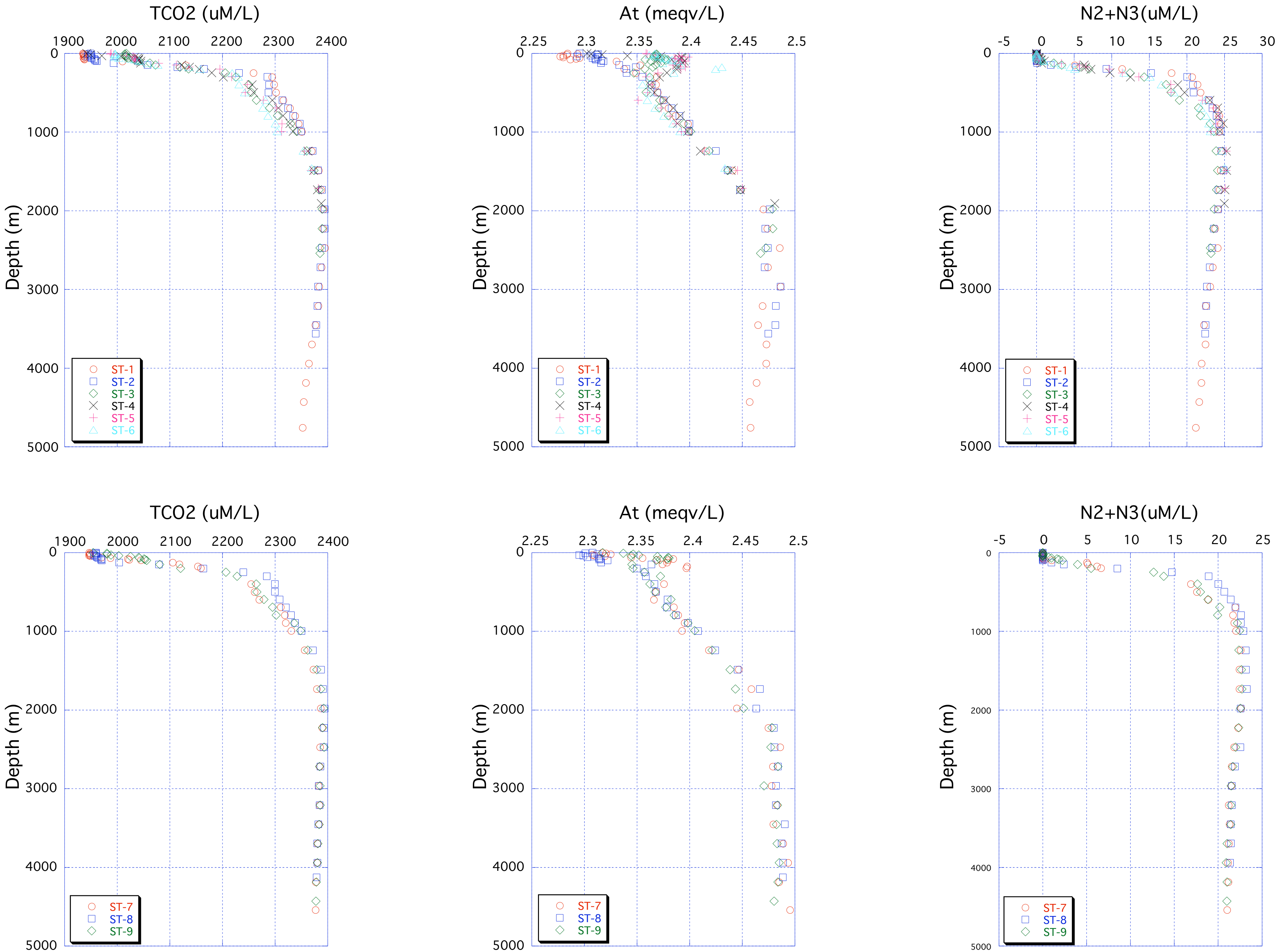
Seawater samples for trace metals analysis, tellurium analysis and suspended particles analysis were collected from several stations. After the collection, samples of seawater for trace metals analysis were stored at deep freezer. On land laboratory, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb were analyzed from the freezing samples. Samples for tellurium were stored at room temperature. Surface seawater samples for suspended particles analysis were filtered with a 0.2-mm filter and a 0.45-mm filter, respectively. In order to desalinate, 250 ml of MQW was passed through each filter. After desalination, each filter was transferred to the Petri dish and stored at refrigerator.

(5) Preliminary result

Vertical profiles of TCO_2, alkalinity and nutrients (NO_3+NO_2-N) at all stations in this cruise are illustrated in Fig. 7.7.1.

(6) Data archive

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


TCO2 (uM/L)
1900 2000 2100 2200 2300 2400
Depth (m)
0 1000 2000 3000 4000 5000
ST-1
ST-2
ST-3
ST-4
ST-5
ST-6
At (meqv/L)
2.25 2.3 2.35 2.4 2.45 2.5
Depth (m)
0 1000 2000 3000 4000 5000
ST-1
ST-2
ST-3
ST-4
ST-5
ST-6
N2+N3(uM/L)
-5 0 5 10 15 20 25 30
Depth (m)
0 1000 2000 3000 4000 5000
ST-1
ST-2
ST-3
ST-4
ST-5
ST-6
TCO2 (uM/L)
1900 2000 2100 2200 2300 2400
Depth (m)
0 1000 2000 3000 4000 5000
ST-7
ST-8
ST-9
At (meqv/L)
2.25 2.3 2.35 2.4 2.45 2.5
Depth (m)
0 1000 2000 3000 4000 5000
ST-7
ST-8
ST-9
N2+N3(uM/L)
-5 0 5 10 15 20 25
Depth (m)
0 1000 2000 3000 4000 5000
ST-7
ST-8
ST-9

7.8 Surface atmospheric turbulent flux measurement

Personnel

Kunio Yoneyama	(JAMSTEC) Principal Investigator / Not-onboard
Osamu Tsukamoto	(Okayama University) Not-onboard
Souichiro Sueyoshi	(Global Ocean Development Inc.) On-board collaborator
Kazuho Yoshida	(Global Ocean Development Inc.) On-board collaborator

Objective

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

Methods

The surface turbulent flux measurement system (Fig. 7.8-1) consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI7500 is a CO2/H2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously.

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

Preliminary results

Data will be processed after the cruise at Okayama University.

Data Archive

All data are archived at Okayama University, and will be open to public after quality checks and corrections by K. Yoneyama and/or O. Tsukamoto. Corrected data will be submitted to JAMSTEC Data Management Division.

Remarks

Since the technical troubles related to wind data frequently occurred during the cruise. it might be possible that most of data would not be available.

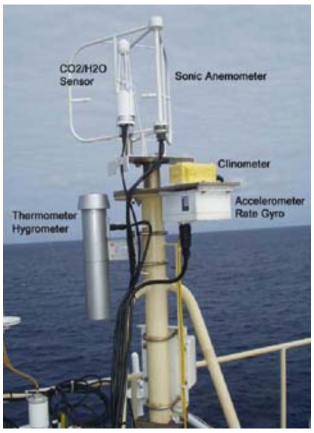


Fig. 7.8-1 Turbulent flux measurement system on the top deck of foremast.