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R/V Mirai Cruise Report
MR13-01

February 18, 2013 – March 28, 2013
Tropical Ocean Climate Study (TOCS)

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


TRITON
JAMSTEC

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Note:

This cruise report is a preliminary documentation as of the end of the cruise. It may not be revised even if new findings and others are derived from observation results after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the chief scientist for the latest information before using this report. Users of data or results of this cruise are requested to submit their results to Data Integration and Analysis Group (DIAG), JAMSTEC (e-mail: diag-dmd@jamstec.go.jp).

1. Cruise name and code

Tropical Ocean Climate Study

MR13-01

Ship: R/V Mirai

Captain: Yasushi Ishioka

2. Introduction and observation summary

2.1 Introduction

The purpose of this cruise is to observe 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 cause 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 130E and 137-138E lines in the western equatorial Pacific.

Circumstance of TRITON buoy project in JAMSTEC has been severe because of limited budget and ship time of JAMSTEC in these years. In this FY, observations of three TRITON buoy are stopped: 0N138E (#13), 8N130E (#14) and 2N130E (#16). Therefore, we recover the buoy at these locations, but do not deploy the buoy there during this cruise.

Replace for TRITON buoy #13, new Indonesian TRITON buoy (Ina-TRITON buoy) was deployed at 0.5N, 138E since September 2012 by Indonesia. However, data communication from the buoy was not good when it was deployed, and communication was stopped on January 2013. Therefore, we repair this buoy on the deck of R/V Mirai.

During this cruise, we observe the low-latitude western boundary currents of the Pacific collaborating with China under the NPOCE (North Pacific Ocean Circulation and Climate Experiment) project, which was recently endorsed by CLIVAR. For this purpose, two subsurface Acoustic Doppler Current Profiler (ADCP) buoys were deployed east of Mindanao Island of Philippines during MR11-06. We recover these moorings during this cruise. Additionally, CTD observations with a lowered ADCP are conducted in the western boundary region of the equatorial Pacific where is in the Indonesian EEZ and Philippine EEZ/territorial waters. Because of this background, three Indonesians and three Filipinos participate in this cruise. Water will be sampled at the depth of chlorophyll maximum layer and surface in order to get sample of nannoplankton, which was requested by Philippine Government.

We have been observed ocean fine structure in the western equatorial Pacific in order to understand ocean mixing effect on tropical ocean climate since MR07-07 leg 1 collaborating with International Pacific Research Center (IPRC) of USA. For this purpose, we conducted CTD observations with a LADCP along 137E-138E, 2N, 130E, and 7N lines. Additionally, ocean turbulence observation is conducted using a turbulence microstructure profiler, Turbo-Map during this cruise.

. During this cruise, 20 Agro floats and 20 surface drifters are deployed because of contribution to the global observational network. Argo floats and drifters are prepared by University of Hawaii and National Oceanic and Atmospheric Administration (NOAA, USA), respectively.

Except for above, automatic continuous oceanic, meteorological and geophysical observations are also conducted along ship track during this cruise as usual.

2.2 Overview

1) Ship

R/V Mirai

Captain Yasushi Ishioka

2) Cruise code

MR13-01

3) Project name

Tropical Ocean Climate Study (TOCS)

4) Undertaking institution

This cruise was jointly conducted by following two institutes:

Japan: Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima-cho, Yokosuka, 237-0061, Japan

Indonesia: Badan Pengkajian Dan Penerapan Teknologi (BPPT)
Jl.M.H.Thamrin 8, Jakarta, 10340, Indonesia

5) Chief scientist

Chief Scientist (Japan)

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

Co-chief Scientist (Indonesia)

Albertus Sulaiman, Badan Pengkajian Dan Penerapan Teknologi (BPPT)

6) Period

February 18, 2013 (Fremantle, Australia) – March 27, 2013 (Hachinohe, Japan)
– March 28, 2011 (Sekinehama, Japan)

7) Research participants

One scientist, one engineer, and fifteen marine technicians from Japan

One scientist, one engineer and one security officer from Indonesia

Two scientists and one navy officer from Philippines

2.3 Observation summary

TRITON buoy recovery and re-installation:	3 moorings were deployed and
	5 moorings were recovered.
	One mooring could not be recovered.
Ina- TRITON buoy	We could not repair it
	because the surface buoy was not found.
NKEO buoy:	It was successfully recovered.
Subsurface ADCP moorings:	One mooring was recovered.
	One mooring could not be recovered.
CTD (Conductivity, Temperature and Depth) and water sampling:	43 casts
XCTD:	21 casts
Ocean turbulence observation	27 casts
Launch of Argo floats	
SOLO II type (USA)	17 floats
Launch of surface drifters	20 drifters
Rain and surface water sampling for isotope analysis	
	7 casts for rain and 22 casts for surface water
Current measurements by shipboard ADCP:	continuous (*1)
Sea surface temperature, salinity, and dissolved oxygen,	
measurements by intake method:	continuous (*1)
Surface meteorology:	continuous (*1)
Water vapor observation:	continuous (*1)
Underway geophysics observations	continuous (*1)

*1) We started these continuous observations when we left Indonesian territorial water in the Pacific at 07:15 on 26 February (GMT). That is, we did not conduct these observations in the Indian Ocean and Indonesian Seas. We also stopped these observations in the Exclusive Economic Zone and territorial water of Papua New Guinea from 14:36 on 28 February (GMT) to 13:55 on 1 March (GMT).

During this cruise, we met many troubles, in particular, in mooring works. At first, before R/V Mirai left Fremantle on 18 February 2013, TRITON buoy #13 (equator, 138E) started drifting on 9 February. Because drifting speed was slower than 1.0 knot until 23 February, we were planning to recover this buoy after observation along 2N line between 129E and 138E. However, the buoy drifted eastward with speed exceeding 2.0 knot after 27 February. Therefore, we canceled observations along 2N line and chased the buoy with full speed of R/V Mirai. Then, we caught up the buoy on 1 March, however, we found that this buoy drifted ashore at the west coast of Aua Island, Papua New Guinea. (Photo 2-1).

Photo 2-1. TRITON buoy at the coast of Aua Island, Papua New Guinea.
(Photo by Keisuke Matsumoto, Marine Works Japan Co.Ltd.)

Because R/V Mirai could not go near the coast, we gave up recovery of this buoy on 1 March. Fortunately, we found two recovery floats near Aua Island and recovered them.

Next, we started CTD/ocean turbulence observations on 2 March near the New Guinea coast of Indonesian side. Around the coast of New Guinea, strong surface eastward current, which advected the TRITON buoy #13 to the Aua Island, and subsurface westward undercurrent were observed. Because of this current structure, a sensor of Turbo-Map L, which is used for ocean turbulence observation, did not sink until intended measurement depth (500m). There was also a trouble in the Dyacon crane for CTD observation, although it was repaired soon.

After observation near the New Guinea coast, we tried to recover the underwater part of TRTION buoy #13, which was remained around the equator, 138E on 3 March. We sent enable and release commands to both lower and upper acoustic releasers of this buoy. Although the releasers responded to these commands, they did not come up to the surface. Therefore, we gave up recovery of this part.

As described in 2.1, we had a plan of repairing the Ina-TRITON buoy in the afternoon of 3 March. After trying recovery of underwater part of TRITON buoy #13, we moved to the location of the Ina-TRITON buoy at 0.5N, 138E. However, we could not find the surface buoy around there. Therefore, we gave up repair of this buoy. We calibrated its sinker position because we found the acoustic releaser of this buoy.

We successfully recovered five TRITON buoys along 130E and 137-138E lines, and re-install three buoys at 2N, 138E, 5N, 137E, and 8N, 137E during this cruise without any troubles. Although many shellfishes and fishing gears clung to wire of the buoys, we did not find damages and distortions in the recovered buoys. CTD and ocean turbulence observations also successfully were carried out after troubles near the New Guinea Coast. Sensors of Turbo-Map L, which were not good during MR11-06 and MR12-03 cruises, worked well during this cruise.

Because we deployed two subsurface ADCP moorings east of Mindanao during MR11-06 cruise, we tried to recover these moorings during this cruise. The mooring near the coast (7N, 127E) was successfully recovered on 16 March. However, offshore one (7N, 128E) could not be recovered. When we sent release command to the acoustic releaser, ascent of the releaser stopped above 1000m depth from the bottom. It seems that something caught the mooring line at the bottom, or buoyancy was lost because surface and/or ABS floats of the mooring were broken and/or lost. We will try to recover this mooring during the next FY cruise by bottom survey.

We deployed 17 Argo floats between 5N and 18N under the US OKMC (Origins of Kuroshio and Mindanao Currents) project. (We canceled deployment of three floats because of troubles in these floats.) These floats were new SOLO II type developed by Scripps Institute of Oceanography. We also deployed 20 surface drifters collaborating with the NOAA south of 7N along 137-138E and 130E lines.

Finally, we heard that NKEO buoy deployed in the Kuroshio Extension region started drifting on 9 March. R/V Kaiyo tried to recover it at first, however, it failed because of lack of fuel. Therefore, JAMSTEC decided that R/V Mirai goes to Kuroshio Extension region with full speed in order to recover this buoy. We canceled observation of the cesium magnetometer because ship speed should be kept in 14 knot on the way to Kuroshio Extension region. R/V Mirai arrived at the Kuroshio Extension region and successfully recovered the NKEO buoy on 24 March. We found that wire below the current meter at the depth of 10m was cut.

With regard to automatic continuous meteorological, ceilometer did not work well from 22 February. Other oceanographic and geophysical observations, all observations were carried out well except for the ceilometer and cancel of cesium magnetometer observation. As described above, we did not conduct these observations in the Indian Ocean, Indonesian Seas, and EEZ/territorial water of Papua New Guinea.

2.4 Observed oceanic and atmospheric conditions

In 2013 boreal winter, atmosphere and ocean in the tropical Pacific was under normal condition. Japan Meteorological Agency forecasted that this condition will continue until autumn. Because of this condition, sea surface temperature (SST) anomaly was lower than 1℃ in the whole equatorial

Pacific (Figure. 2-1).

Clouds associating with the Maddan Julian Oscillation passed the Maritime Continent at the end of February. Therefore, weather in the western Pacific was generally good during the cruise in March (Figure 2-2).

CTD and Shipboard ADCP section along 130E shows southward shift of the Halmahera Eddy, that center was seen around 4N (Figures 2-3 and 2-4). As described in 2.3, strong surface eastward current and subsurface westward undercurrent were dominant in the southern edge of 138E section during this cruise (Figure 2-4).

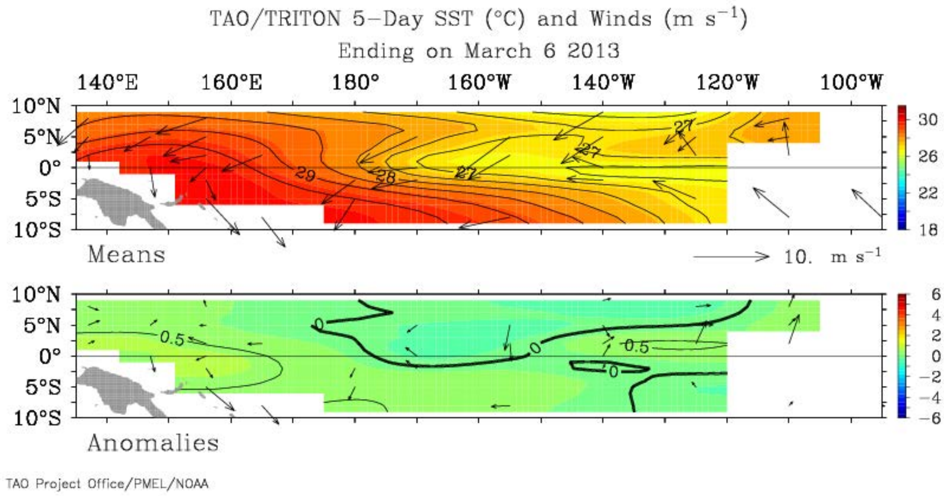

Figure 2-1. Maps of five–day mean sea surface temperature and winds (upper panel), and their anomaly (lower panel) obtained from TAO/TRITON buoy array on 6 March 2013. (http://www.pmel.noaa.gov/tao/jsdisplay/)

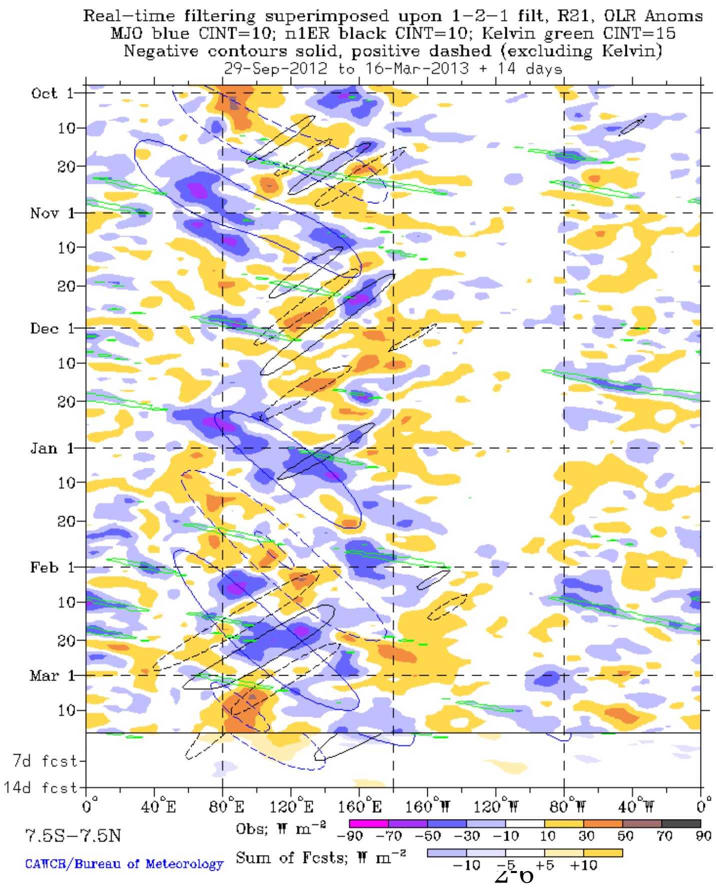

Figure 2-2. Hovmöller diagram of anomaly of outgoing long wave radiation.

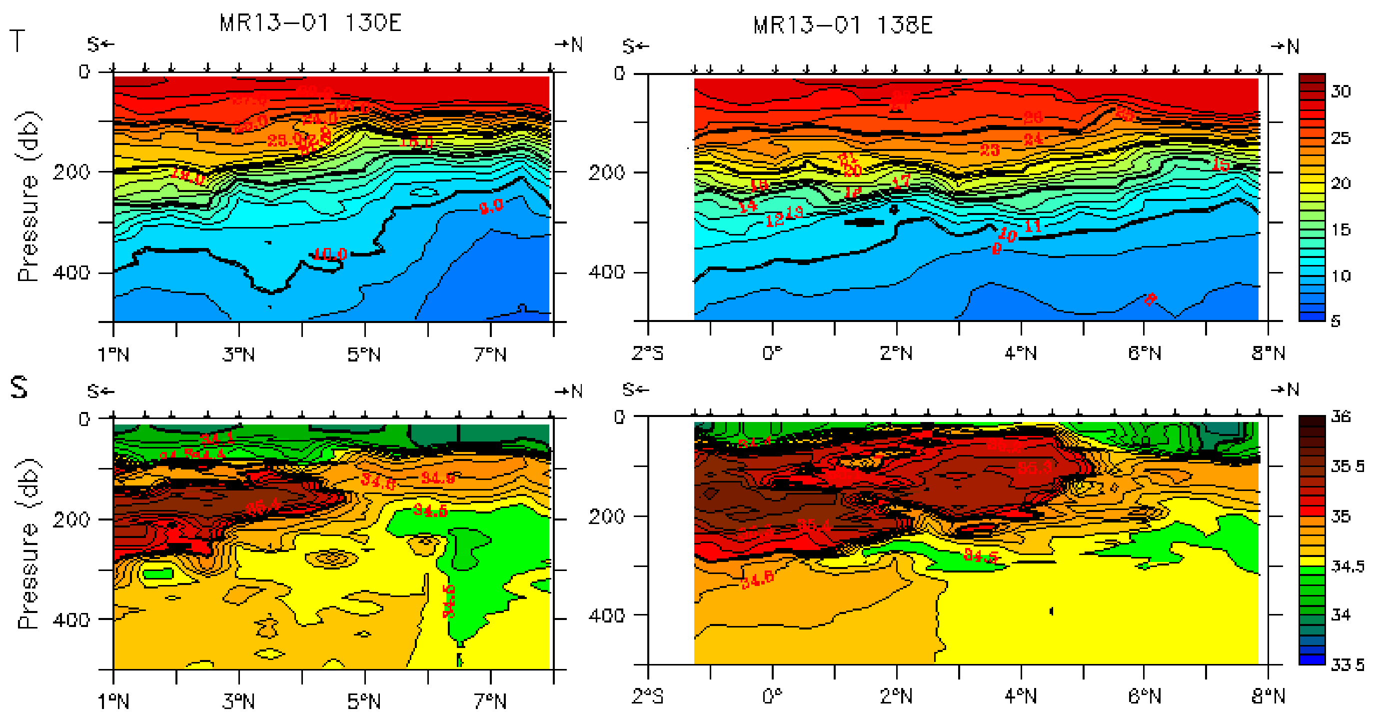

Figure 2-3. Meridional sections of temperature and salinity along 130E (left) and 137-138E (left) lines.

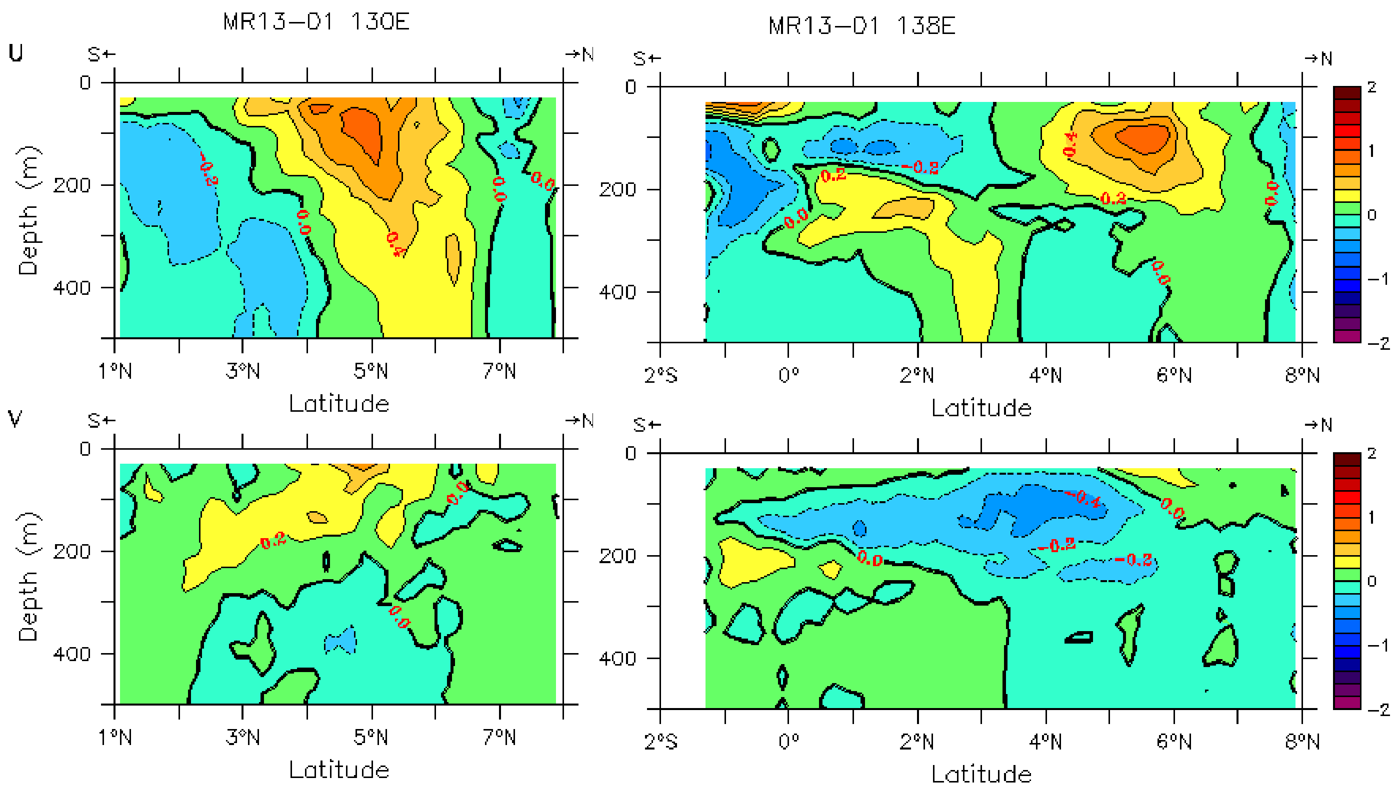

Figure 2-4. Meridional sections of shipboard ADCP velocity along 130E (left) and 137-138E (left) lines.

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

3.1 Period

18 February, 2013 – 28 March, 2013

3.2 Ports of call

Fremantle, Australia (Departure: 18 February)

Hachinohe, Japan (Arrival: 27 March, Departure: 27 March)

Sekinehama, Japan (Arrival: 28 March)

3.3 Cruise Log

SMT	UTC	Event
Feb. 18 (Sun.) 2013		
10:00	02:00	Departure from Fremantle [Ship Mean Time (SMT)=UTC+8h]
Feb. 22 (Fri.) 2013		
22:00	13:00	Time adjustment +1h (SMT=UTC+9h)
Feb. 26 (Tue.) 2013		
14:51	05:51	Start pumping intake surface water
16:15	07:15	Start continuous observations because R/V MIRAI exited from Indonesian territorial waters
Feb. 28 (Thu.) 2013		
23:36	14:36	Stop continuous observations because R/V MIRAI entered into Papua New Guinea EEZ
Mar. 01 (Fri.) 2013		
06:00	21:00	Arrival at TRITON #13 drift recovery buoy area (01-27S, 143-00E)
08:37	23:37	Find float of TRITON buoy #13 aground on Aua Island
10:00-10:36	01:00-01:36	Recover a part of TRITON #13 recovery buoy
13:16-13:42	04:16-04:42	Recover a part of TRITON #13 recovery buoy
13:48	04:48	Departure of TRITON #13 drift recovery buoy area
22:55	13:55	Start continuous observations because R/V MIRAI exited from Papua New Guinea EEZ
Mar. 02 (Sat.) 2013		
14:54	05:54	Arrival at St.1 (01-15S, 138-00E)
15:01-15:44	06:01-06:44	CTD observation 500m (#1)
15:49-16:47	06:49-07:47	MSP observation (#1)
16:48	07:48	Departure of St.1
18:06	09:06	Arrival at St.2 (01-00S, 138-00E)

SMT	UTC	Event
18:10-18:44	09:10-09:44	CTD observation 500m (#2)
18:48-19:23	09:48-10:23	MSP observation (#2)
19:26	10:26	Deployment of drifter buoy (#1)
		Deployment of drifter buoy (#2)
19:30	10:30	Departure of St.2
21:42	12:42	Arrival at St.3 (00-30S, 138-00E)
21:45-22:17	12:45-13:17	CTD observation 500m (#3)
22:22-23:01	13:22-14:01	MSP observation (#3)
23:10-23:35	14:10-14:35	Three-components magnetometer calibration
		(00-30.0N, 130-01.9E, #1)
23:36	14:36	Departure of St.3
Mar. 03 (Sun.) 2013		
05:06	20:06	Arrival at St.4 (TR#13; 04-30.0N, 138-02.9E)
05:27-06:00	20:27-21:00	CTD observation 500m (#4)
06:04-06:37	21:04-21:37	MSP observation (#4)
06:40-08:27	21:40-23:27	Recovery of TRITON buoy #13
		We couldn’t recover it because sensors didn’t float.
08:30	23:30	Deployment of drifter buoy (#3)
08:31	23:31	Deployment of drifter buoy (#4)
08:36	23:36	Departure of St.4
11:00	02:00	Arrival at St.5 (00-30N, 138-02E)
13:48-15:02	04:48-06:02	Calibration of Ina-TRITON buoy sinker position
		(Fixed point: 00-30.7549N, 138-02.4103E)
15:43-16:28	06:43-07:28	CTD observation 800m (#5)
16:30-17:07	07:30-08:07	MSP observation (#5)
18:18	09:18	Start, site survey around Ina-TRITON buoy
Mar. 04 (Mon.) 2013		
05:35	20:35	Finish, site survey around Ina-TRITON buoy
		Departure of St.5
07:48	22:48	Arrival at St.6 (01-00N, 138-00E)
07:56-08:29	22:56-23:29	CTD observation 500m (#6)
08:33-09:16	23:33-00:16	MSP observation (#6)
09:22	00:22	Deployment of drifter buoy (#5)
09:24	00:24	Departure of St.6
11:42	02:42	Arrival at St.7 (01-30N, 138-00E)
11:43-12:16	02:43-03:16	CTD observation 500m (#7)
12:20-12:56	03:20-03:56	MSP observation (#7)
13:00	04:00	Departure of St.7
15:18	06:18	Arrival at St.8 (TR#12, 02-00N, 138-06E)

SMT	UTC	Event
15:32-16:30	06:32-07:30	CTD observation 800m (#8)
16:32-17:06	07:32-08:06	MSP observation (#8)
Mar. 05 (Tue.) 2013		
08:12-11:02	23:12-02:02	Deployment of TRITON buoy #12
11:41-11:45	02:41-02:45	Calibration of TRITON buoy #12 sinker position
		(Fixed point: 02-03.9303N, 138-03.8342E, Depth: 4322m)
13:36	04:36	XCTD observation X-01 (#1)
		Departure of St.8
15:36	06:36	Arrival at St.9 (02-30N, 137-55E)
15:41-16:12	06:41-07:12	CTD observation 800m (#9)
16:16-16:50	07:16-07:50	MSP observation (#9)
16:54	07:54	Departure of St.9
19:12	10:12	Arrival at St.10 (03-00N, 137-45E)
19:14-19:47	10:14-10:47	CTD observation 500m (#10)
19:49-20:21	10:49-11:21	MSP observation (#10)
20:23	11:23	Deployment of drifter buoy (#6)
20:24	11:24	Departure of St.10
Mar. 06 (Wed.) 2013		
06:00	21:00	Arrival at St.8
07:57-11:18	22:57-02:18	Recovery of TRITON buoy #12
11:20	02:20	Deployment of drifter buoy (#7)
11:24	02:24	Departure of St.8
18:18	09:18	Arrival at St.11 (03-30N, 137-35E)
18:31-19:09	09:31-10:09	MSP observation (#11)
19:15-19:48	10:15-10:48	CTD observation 500m (#11)
19:48	10:48	Departure of St.11
Mar. 07 (Thu.) 2013		
05:30	20:30	Arrival at St.14 (TR#11-A; 04-56.5N, 137-18.0E)
08:09-11:07	23:09-02:07	Deployment of TRITON buoy #11
11:30-11:33	02:30-02:33	Calibration of TRITON buoy #11 sinker position
		(Fixed point: 04-56.4274N, 137-18.1001E, Depth: 4131m)
12:58-13:39	03:58-04:39	CTD observation 800m (#12)
13:42	04:42	Departure of St.14
15:30	06:30	Arrival at St.13 (04-30N, 137-15E)
15:38-16:11	06:38-07:11	CTD observation 500m (#13)
16:13-16:45	07:13-07:45	MSP observation (#12)
16:48	07:48	Departure of St.13
19:06	10:06	Arrival at St.12 (04-00N, 137-25E)
19:07-19:39	10:07-10:39	CTD observation 500m (#14)

SMT	UTC	Event
19:42-20:17	10:42-11:17	MSP observation (#13)
20:20	11:20	Deployment of drifter buoy (#8)
20:24	11:24	Departure of St.12
Mar. 08 (Fri.) 2013		
05:12	20:12	Arrival at St.14 (TR#11-B; 04-51.5N, 137-16.0E)
05:30-06:09	20:30-21:09	CTD observation 800m (#15)
06:12-06:50	21:12-21:50	MSP observation (#14)
07:57-11:38	22:57-02:38	Recovery of TRITON buoy #11
11:40	02:40	Deployment of drifter buoy (#9)
11:42	02:42	Departure of St.14
14:42	05:42	XCTD observation X-02 (#2)
16:55	07:55	Deployment of drifter buoy (#10)
16:57	07:57	XCTD observation X-03 (#3)
19:11	10:11	XCTD observation X-04 (#4)
21:23	12:23	Deployment of drifter buoy (#11)
21:24	12:24	XCTD observation X-05 (#5)
23:39	14:39	XCTD observation X-06 (#6)
Mar. 09 (Sat.) 2013		
02:42	17:42	Arrival at St.15 (TR#10; 07-39N, 136-42E)
08:13-10:52	23:13-01:52	Deployment of TRITON buoy #10
11:12-11:15	02:12-02:15	Calibration of TRITON buoy #10 sinker position
		(Fixed point: 07-38.9621N, 136-41.9514E, Depth: 3171m)
12:58-13:39	03:58-04:39	CTD observation 800m (#16)
15:23-16:00	06:23-07:00	CTD observation 800m (#17)
16:04-16:37	07:04-07:37	MSP observation (#15)
Mar. 10 (Sun.) 2013		
08:00-11:05	23:00-02:05	Recovery of TRITON buoy #10
11:06	02:06	Departure of St.15
15:17	06:17	XCTD observation X-07 (#7)
18:32	09:32	XCTD observation X-08 (#8)
21:34	12:34	XCTD observation X-09 (#9)
Mar. 11 (Mon.) 2013		
00:37	15:37	XCTD observation X-10 (#10)
03:26	18:26	XCTD observation X-11 (#11)
06:37	21:37	XCTD observation X-12 (#12)
09:34	00:34	XCTD observation X-13 (#13)
12:25	03:25	XCTD observation X-14 (#14)
16:35	07:35	XCTD observation X-15 (#15)
18:49	09:49	XCTD observation X-16 (#16)

SMT	UTC	Event
21:32	12:32	XCTD observation X-17 (#17)
Mar. 12 (Tue.) 2013		
00:42	15:42	XCTD observation X-18 (#18)
05:00	20:00	Arrival at St.18 (TR#16; 01-57.0N, 130-11.5E)
05:15-06:01	20:15-21:01	CTD observation 1000m (#18)
06:04-06:42	21:04-21:42	MSP observation (#16)
07:59-11:15	22:59-02:15	Recovery of TRITON buoy #16
11:16	02:16	Deployment of drifter buoy (#12)
		Deployment of drifter buoy (#13)
11:18	02:18	Departure of St.18
13:18	04:18	Arrival at St.17 (01-30N, 130-00E)
13:23-14:09	04:23-05:09	CTD observation 1000m (#19)
14:12-14:49	05:12-05:49	MSP observation (#17)
14:54	05:54	Departure of St.17
16:54	07:54	Arrival at St.16 (01-00N, 130-00E)
16:58-17:45	07:58-08:45	CTD observation 1000m (#20)
17:47-18:26	08:47-09:26	MSP observation (#18)
18:28	09:28	Deployment of drifter buoy (#14)
		Deployment of drifter buoy (#15)
18:30	09:30	Departure of St.16
Mar. 13 (Wed.) 2013		
00:58	15:58	XCTD observation X-10 (#19)
03:18	18:18	XCTD observation X-11 (#20)
05:31	20:31	XCTD observation X-12 (#21)
07:54	22:54	Arrival at St.19 (02-30N, 130-00E)
07:59-08:43	22:59-23:43	CTD observation 1000m (#21)
08:47-09:19	23:47-00:19	MSP observation (#19)
09:24	00:24	Departure of St.19
11:48	02:48	Arrival at St.20 (03-00N, 130-00E)
11:50-12:38	02:50-03:38	CTD observation 1000m (#22)
12:41-13:14	03:41-04:14	MSP observation (#20)
13:16	04:16	Deployment of drifter buoy (#16)
13:18	04:18	Departure of St.20
15:30	06:30	Arrival at St.21 (03-30N, 130-00E)
15:36-16:22	06:36-07:22	CTD observation 1000m (#23)
16:25-16:59	07:25-07:59	MSP observation (#21)
17:00	08:00	Departure of St.21
19:12	10:12	Arrival at St.22 (04-00N, 130-00E)
19:17-20:03	10:17-11:03	CTD observation 1000m (#24)

SMT	UTC	Event
20:06-20:42	11:06-11:42	MSP observation (#22)
20:45	11:45	Deployment of drifter buoy (#17)
20:48	11:48	Departure of St.22
22:54	13:50	Arrival at St.23 (04-30N, 130-00E)
22:58-23:42	13:58-14:42	CTD observation 1000m (#25)
23:45-00:23	14:45-15:23	MSP observation (#23)
Mar. 14 (Thu.) 2013		
00:24	15:24	Departure of St.23
02:30	17:30	Arrival at St.24 (05-00N, 130-00E)
02:33-03:22	17:33-18:22	CTD observation 1000m (#26)
03:25-04:03	18:25-19:03	MSP observation (#24)
04:08	19:08	Deployment of Argo float (#1)
04:09	19:09	Deployment of drifter buoy (#18)
04:12	19:12	Departure of St.24
06:18	21:18	Arrival at St.25 (05-30N, 130-00E)
06:20-07:05	21:20-22:05	CTD observation 1000m (#27)
07:09-07:44	22:09-22:44	MSP observation (#25)
07:48	22:48	Departure of St.25
09:54	00:54	Arrival at St.26 (06-00N, 130-00E)
10:00-10:45	01:00-01:45	CTD observation 1000m (#28)
10:49-11:21	01:49-02:21	MSP observation (#26)
11:25	02:25	Deployment of Argo float (#2)
11:26	02:26	Deployment of drifter buoy (#19)
11:30	02:30	Departure of St.26
13:42	04:42	Arrival at St.27 (06-30N, 130-00E)
13:50-14:37	04:50-05:37	CTD observation 1000m (#29)
14:42	05:42	Departure of St.27
16:54	07:54	Arrival at St.28 (07-00N, 130-00E)
16:55-17:40	07:55-08:40	CTD observation 1000m (#30)
17:44	08:44	Deployment of Argo float (#3)
		Deployment of drifter buoy (#20)
17:48	08:48	Departure of St.28
20:06	11:06	Arrival at St.29 (07-30N, 130-00E)
21:19-22:03	12:19-13:03	CTD observation 1000m (#31)
22:06	13:06	Departure of St.29
Mar. 15 (Fri.) 2013		
05:42	20:42	Arrival at St.30 (TR#14; 07-58.81N, 130-02.66E)
06:01-06:48	21:01-21:48	CTD observation 1000m (#32)
08:00-11:43	23:00-02:43	Recovery of TRITON buoy #14

SMT	UTC	Event
11:48	02:48	Departure of St.30
18:06	09:06	Arrival at St.31 (07-00N, 129-30E)
18:10-18:56	09:10-09:56	CTD observation 1000m (#33)
19:00	10:00	Departure of St.31
Mar. 16 (Sat.) 2013		
06:30	21:30	Arrival at ADCP buoy recovery area #1 (07N, 127E)
08:15-11:09	23:15-02:09	Recovery of ADCP buoy #1
11:12	02:42	Departure of ADCP buoy recovery area #1
12:54	03:54	Arrival at St.41 (07-00N, 126-30E)
13:00-13:41	04:00-04:41	CTD observation 800m (#34)
13:42	04:42	Departure of St.41
14:36	05:36	Arrival at St.40 (07-00N, 126-36E)
14:42-15:25	05:42-06:25	CTD observation 1000m (#35)
15:10	06:10	Departure of St.40
16:48	07:48	Arrival at St.39 (07-00N, 126-48E)
16:48-17:34	07:48-08:34	CTD observation 1000m (#36)
17:36	08:36	Departure of St.39
18:42	09:42	Arrival at St.38 (07-00N, 127-00E)
18:45-19:32	09:45-10:32	CTD observation 1000m (#37)
19:35	10:35	Deployment of Argo float (#4)
19:36	10:36	Departure of St.38
20:54	11:54	Arrival at St.37 (07-00N, 127-15E)
20:58-21:44	11:58-12:44	CTD observation 1000m (#38)
21:48	12:48	Departure of St.37
Mar. 17 (Sun.) 2013		
02:00	17:00	Arrival at St.36 (07-00N, 127-30E)
04:57-05:41	19:57-20:41	CTD observation 1000m (#39)
05:42	20:42	Departure of St.36
07:00	22:00	Arrival at ADCP buoy recovery area #2 (07N, 128E)
07:06-08:18	22:06-23:18	Recovery of ADCP buoy #2 We couldn’t recover it because releasers stop floating the depth of 4800m after released.
08:24	23:24	Departure of ADCP buoy recovery area #2
08:30	23:30	Arrival at St.35 (07-00N, 127-45E)
08:34-09:21	23:34-00:21	CTD observation 1000m (#40)
09:24	00:24	Departure of St.35
09:36	00:36	Arrival at ADCP buoy recovery area #2
09:39-12:25	00:39-03:25	Recovery of ADCP buoy #2 We couldn’t recover it

SMT	UTC	Event
12:30	03:30	Departure of ADCP buoy recovery area #2
13:42	04:42	Arrival at St.34 (07-00N, 128-00E)
13:44-14:31	04:44-05:31	CTD observation 1000m (#41)
14:34	05:34	Deployment of Argo float (#5)
14:36	05:36	Departure of St.34
16:54	07:54	Arrival at St.33 (07-00N, 128-30E)
16:59-17:44	07:59-08:44	CTD observation 1000m (#42)
17:48	08:48	Departure of St.33
20:00	11:00	Arrival at St.32 (07-00N, 129-00E)
20:04-20:48	11:04-11:48	CTD observation 1000m (#43)
20:53	11:53	Deployment of Argo float (#6)
21:01-21:31	12:01-12:31	Three-components magnetometer calibration (07-01.2N, 129-00.6E, #2)
21:36	12:36	Departure of St.32
Mar. 18 (Mon.) 2013		
02:23	17:23	Deployment of Argo float (#7)
07:16	22:16	Deployment of Argo float (#8)
12:19	03:19	Deployment of Argo float (#9)
17:18	08:18	Deployment of Argo float (#10)
22:10	13:10	Deployment of Argo float (#11)
Mar. 19 (Tue.) 2013		
02:59	17:59	Deployment of Argo float (#12)
07:52	22:52	Deployment of Argo float (#13)
12:40	03:40	Deployment of Argo float (#14)
17:28	08:28	Deployment of Argo float (#15)
22:19	13:19	Deployment of Argo float (#16)
Mar. 20 (Wed.) 2013		
03:07	18:07	Deployment of Argo float (#17)
Mar. 24 (Sun.) 2013		
01:00	16:00	Arrival at N-KEO buoy recovery area (37N, 149E)
07:58-08:47	22:58-23:47	Recovery of N-KEO buoy
09:00-09:28	00:00-00:28	Three-components magnetometer calibration (36-06.1N, 147-51.8E, #3)
09:30	00:30	Departure of N-KEO buoy recovery area
Mar. 26 (Tue.)		
09:00	00:00	Stop pumping surface water
Mar. 27 (Wed.)		
09:00	00:00	Arrival at Hachinohe
15:50	06:50	Departure from Hachinohe

SMT	UTC	Event
Mar. 28 (Thu.)		
09:10	00:10	Arrival at Sekinehama and finish continuous observations

3.4 Cruise track

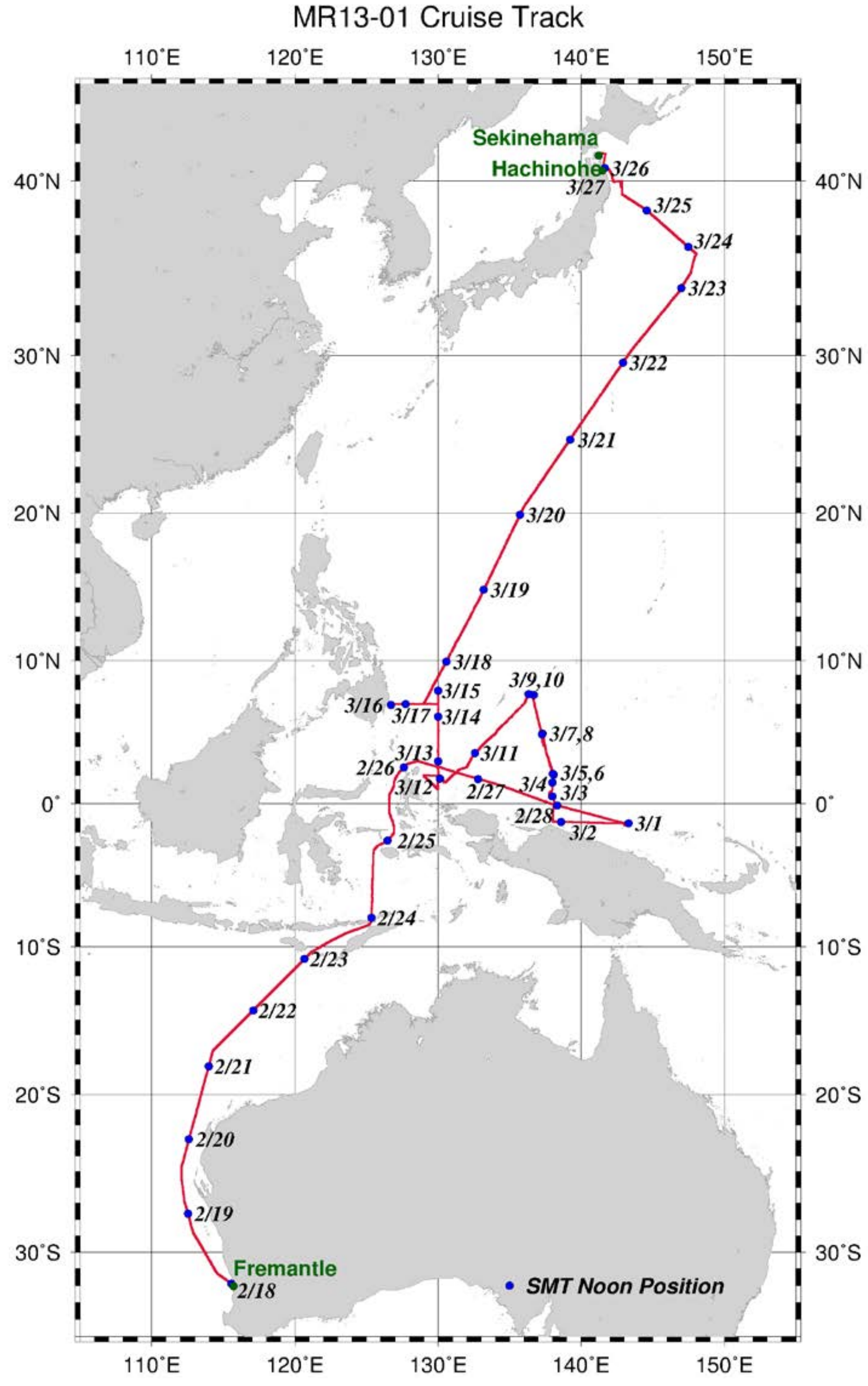

Fig 3.4-1 MR13-01 Cruise track with noon positions

4. Chief scientist

Chief Scientist

Yuji Kashino

Senior Research Scientist

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Co-chief Scientist (Indonesia)

Dr. Albertus Sulaiman

Research Scientist

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5. Participants list

5.1 R/V MIRAI scientists and technical staffs

Name	Affiliation	Occupation
Yuji Kashino	JAMSTEC	Chief Scientist
Yukio Takahashi	JAMSTEC	Engineer
Albertus Sulaiman	BPPT	Researcher
Dwi Haryanto	BPPT	Researcher
Agus Iwan Santoso	Indonesian Navy	Security Officer
Marilou C. Martin	University of Philippine	Researcher
Rhett Simon Tabbada	Philippine Nuclear Research Institute	Researcher
Christopher Q. Cargo	Philippine Navy	Security Officer
Keisuke Matsumoto	MWJ	Technical Staff
Hirokatsu Uno	MWJ	Technical Staff
Kenichi Katayama	MWJ	Technical Staff
Hiroki Ushiromura	MWJ	Technical Staff
Akira Watanabe	MWJ	Technical Staff
Shungo Oshitani	MWJ	Technical Staff
Rei Ito	MWJ	Technical Staff
Keitaro Matsumoto	MWJ	Technical Staff
Takayuki Hashimukai	MWJ	Technical Staff
Makito Yokota	MWJ	Technical Staff
Takatoshi Kiyokawa	MWJ	Technical Staff
Keisuke Tsubata	MWJ	Technical Staff
Shinya Okumura	GODI	Technical Staff
Kazuho Yoshida	GODI	Technical Staff
Toshimitsu Goto	GODI	Technical Staff

JAMSTEC: Japan Agency for Marine-Earth Science and Technology,Japan

BPPT: Badan Pengkajian Dan Penerapan Technology, Indonesia

MWJ: Marine Works Japan Co. Ltd.

GODI: Global Ocean Development Inc.

5.2 R/V MIRAI crew members

Name	Rank or rating
Yasushi Ishioka	Master
Haruhiko Inoue	Chief Officer
Takeshi Isohi	1st Officer
Kan Matsuura	Jr. 1st Officer
Hajime Matsuo	2nd Officer
Hiroki Kobayashi	3rd Officer
Hiroyuki Suzuki	Chief Engineer
Hiroyuki Tohken	1st Engineer
Koji Manako	2nd Engineer
Yusuke Kimoto	3rd Engineer
Ryo Oyama	Chief Radio Officer
Kazuyoshi Kudo	Boatswain
Tsuyoshi Sato	Able Seaman
Takeharu Aisaka	Able Seaman
Tsuyoshi Monzawa	Able Seaman
Hideaki Tamotsu	Sailor
Hideyuki Okubo	Sailor
Masaya Tanikawa	Sailor
Shohei Uehara	Sailor
Kazunari Mitsunaga	Sailor
Tomohiro Shimada	Sailor
Tetsuya Sakamoto	Sailor
Kazumi Yamashita	No.1 Oiler
Masato Shirakura	Oiler
Daisuke Taniguchi	Oiler
Shintaro Abe	Ordinary Oiler
Hiromi Ikuta	Ordinary Oiler
Yuichiro Tani	Ordinary Oiler
Hitoshi Ota	Chief Steward
Ryotaro Baba	Cook
Sakae Hoshikuma	Cook
Tsuneaki Yoshinaga	Cook
Yukio Chiba	Cook

6. General observations

6.1 Meteorological measurements

6.1.1 Surface meteorological observations

Yuji Kashino	(JAMSTEC) : Principal Investigator
Shinya Okumura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Toshimitsu Goto	(GODI)
Ryo Ohyama	(MIRAI Crew)

(1) Objectives

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

(2) Methods

Surface meteorological parameters were observed throughout the MR13-01 cruise. During this cruise, we used two systems for the observation.

i. MIRAI Surface Meteorological observation (SMet) system
ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

i. MIRAI Surface Meteorological observation (SMet) system

Instruments of SMet system are listed in Table.6.1.1-1 and measured parameters are listed in Table.6.1.1-2. Data were collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set consists of 6-second averaged data.

ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) measurement system

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

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

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

For the quality control as post processing, we checked the following sensors, before and after the cruise.

i. Young Rain gauge (SMet and SOAR)

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

ii. Barometer (SMet and SOAR)

Comparison with the portable barometer value, PTB220CASE, VAISALA.

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

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

(3) Preliminary results

Figure 6.1.1-1 shows the time series of the following parameters;

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

(4) Data archives

These meteorological data will be submitted to the Data Management Group (DMG) of JAMSTEC just after the cruise.

(5) Remarks

i. The following period, observation was stopped because we navigated in EEZ of Papua New Guinea.
14:36UTC 28 Feb. 2013 - 13:54UTC 01 Mar. 2013

ii. The following period, SST (Sea Surface Temperature) of SMet data was available.
07:15UTC 26 Feb. 2013 – 14:35UTC 28 Feb. 2013
13:55UTC 01 Mar. 2013 - 00:00UTC 26 Mar. 2013

iii. The following time, SMet rain gauge amount value was increased because of test transmitting for MF/HF radio
05:20UTC 19 Mar. 2013

iv. a) The following period, acquisition of SOAR radiation data (shortwave, longwave and defuse irradiance) was suspended intermittently in daytime, due to error of PRP while FRSR observation was active.
20:45UTC 01 Mar. 2013 – 20:35UTC 07 Mar. 2013

b) The following period, FRSR data acquisition was stopped due to avoid error of PRP.
20:35UTC 07 Mar. 2013 to the end of this cruise

Table.6.1.1-1 Instruments and installations of MIRAI Surface Meteorological observation system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	compass deck (21 m) starboard side and port side
Thermometer: SST	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m)
Barometer	Model-370	Setra System, USA	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-802	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	WM-2	Tsurumi-seiki, Japan	bow (10 m)

Table.6.1.1-2 Parameters of MIRAI Surface Meteorological observation system

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 Ship’s speed	knot	MIRAI log, DS-30 Furuno
4 Ship’s heading	degree	MIRAI gyro, TG-6000, Tokimec
5 Relative wind speed	m/s	6sec./10min. averaged
6 Relative wind direction	degree	6sec./10min. averaged
7 True wind speed	m/s	6sec./10min. averaged
8 True wind direction	degree	6sec./10min. averaged
9 Barometric pressure	hPa	adjusted to sea surface level 6sec. averaged
10 Air temperature (starboard side)	degC	6sec. averaged
11 Air temperature (port side)	degC	6sec. averaged
12 Dewpoint temperature (starboard side)	degC	6sec. averaged
13 Dewpoint temperature (port side)	degC	6sec. averaged
14 Relative humidity (starboard side)	%	6sec. averaged
15 Relative humidity (port side)	%	6sec. averaged
16 Sea surface temperature	degC	6sec. averaged
17 Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18 Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19 Down welling shortwave radiation	W/m2	6sec. averaged
20 Down welling infra-red radiation	W/m2	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.6.1.1-3 Instruments and installation locations of SOAR system

Sensors (Zeno/Met)	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	foremast (23 m)
Barometer	61302V	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (23 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.6.1.1-4 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/m2	
13 Down welling infra-red radiation	W/m2	
14 Defuse irradiance	W/m2	

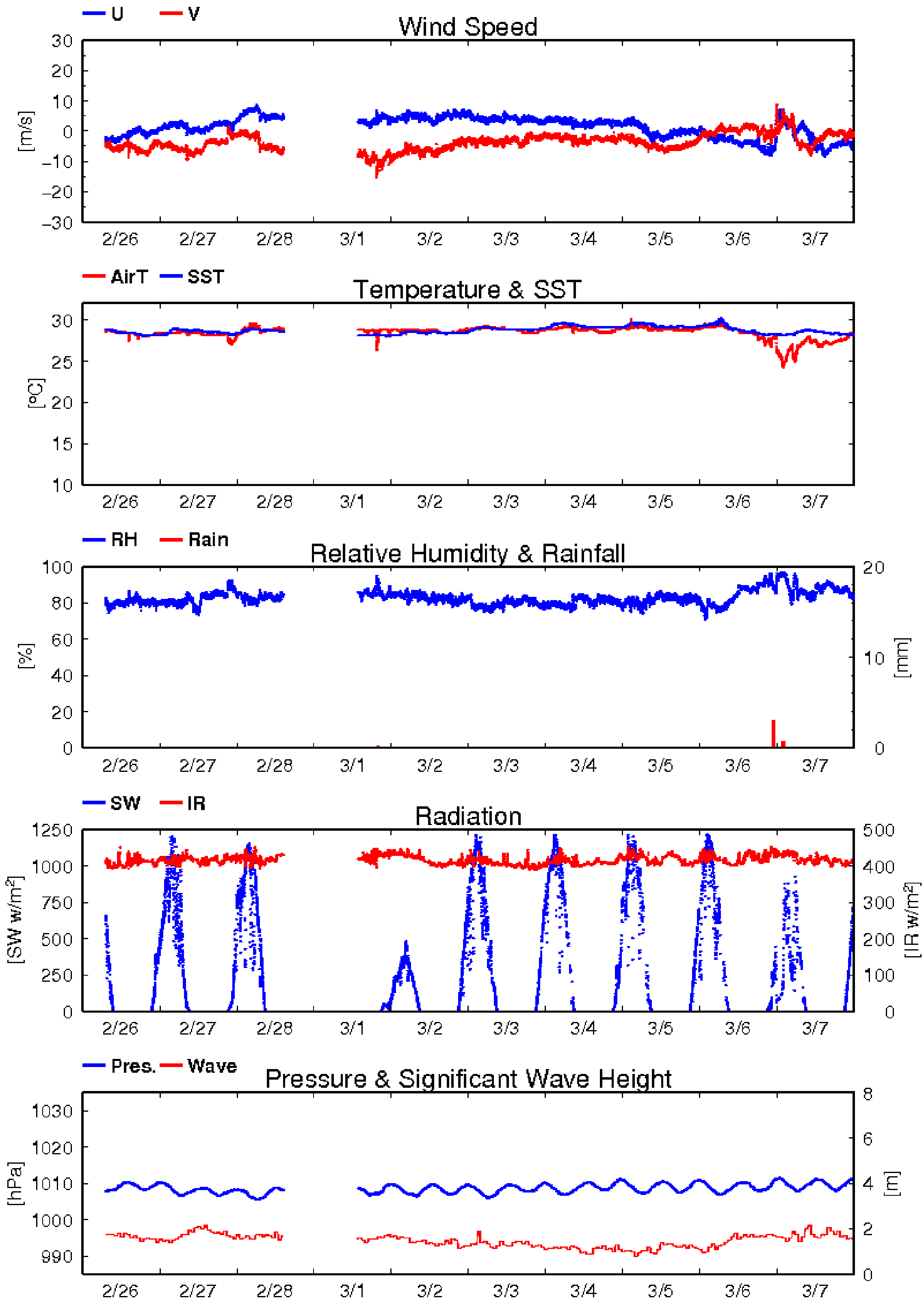


Fig.6.1.1-1 Time series of surface meteorological parameters during the MR13-01 cruise

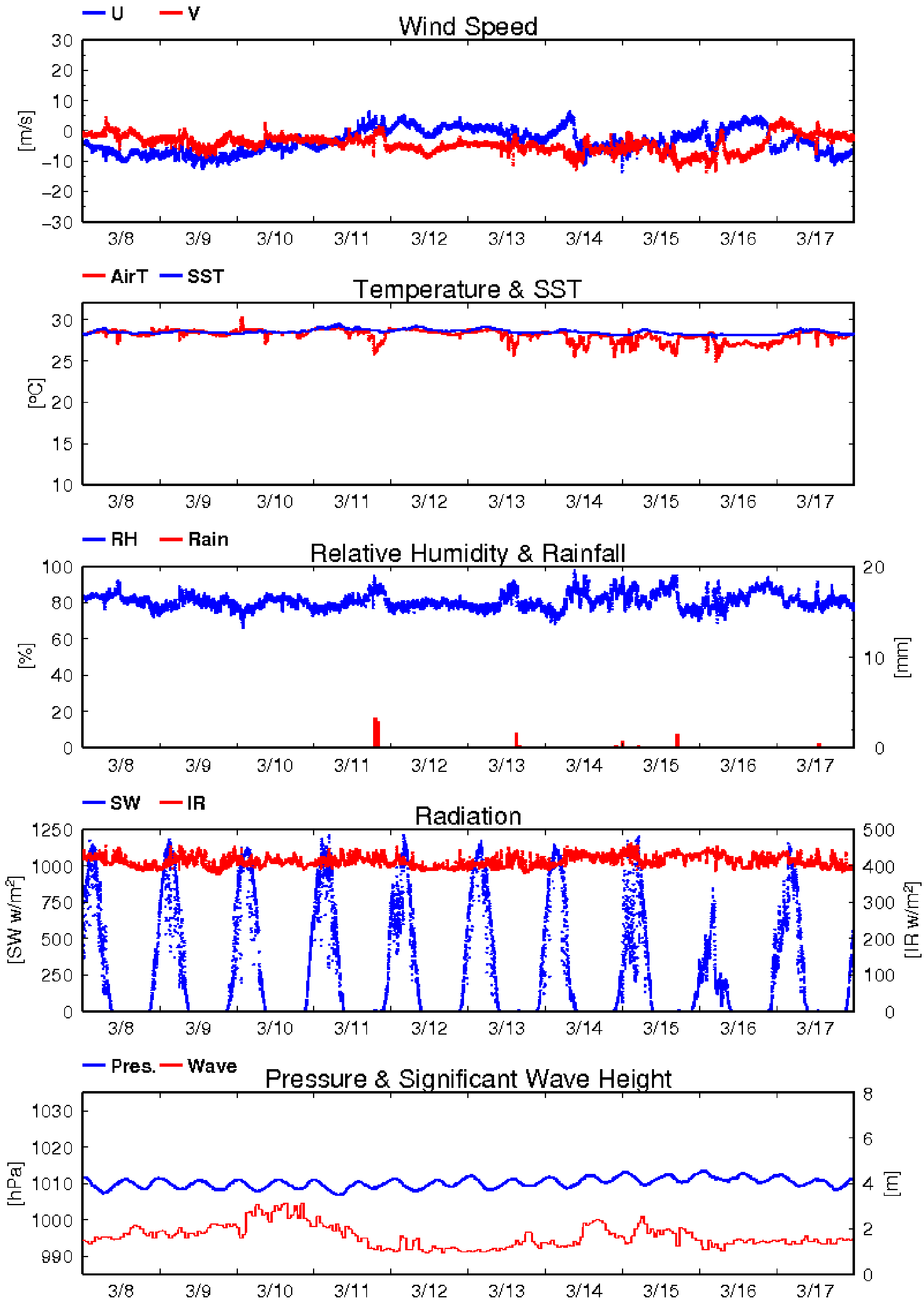


Fig.6.1.1-1 (continued)

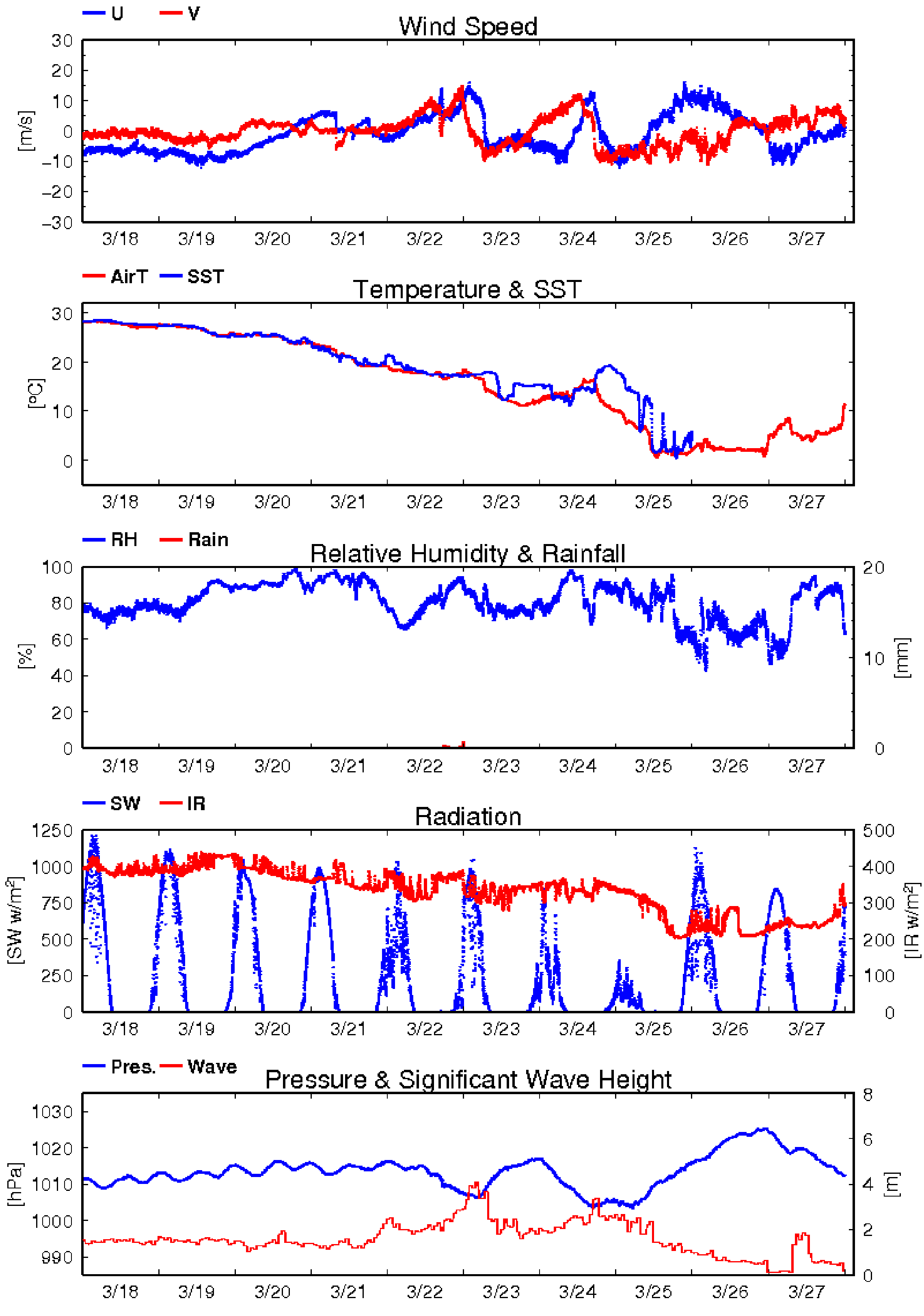


Fig.6.1.1-1 (continued)

6.2 CTD/XCTD

6.2.1 CTD

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal investigator
Rei Ito	(MWJ): Operation leader
Shungo Oshitani	(MWJ)
Kenichi Katayama	(MWJ)
Hiroki Ushiromura	(MWJ)

(2) Objective

Investigation of oceanic structure and water sampling.

(3) Parameters

Temperature (Primary and Secondary)
Conductivity (Primary and Secondary)
Pressure
Dissolved Oxygen (Primary only)
Fluorescence
Altimeter

(4) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 36-position Carousel water sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE9plus), was used during this cruise. 12-litter Niskin Bottles were used for sampling seawater. The sensors attached on the CTD were temperature (Primary and Secondary), conductivity (Primary and Secondary), pressure, dissolved oxygen, fluorescence and altimeter. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.7.22) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of the personal computer. Seawater was sampled during the up cast by sending fire commands from the personal computer. We usually stop for 30 seconds to stabilize then fire.

43 casts of CTD measurements were conducted (Table 6.2.1-1).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.22.0) and SEASOFT were as follows:

(The process in order)

DATCNV: Convert the binary raw data to engineering unit data. DATCNV also extracts bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

BOTTLESUM: Create a summary of the bottle data. The data were averaged over 3.0 seconds.

ALIGNCTD: Convert the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Dissolved oxygen data are systematically delayed with respect to depth mainly because of the long time constant of the dissolved oxygen sensor and of an additional delay from the transit time of water in the pumped pluming line. This delay was compensated by 3 seconds advancing dissolved oxygen sensor output (dissolved oxygen voltage) relative to the temperature data.

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

CELLTM: 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: Perform a low pass filter on pressure with a time constant of 0.15 second. In order to produce zero phase lag (no time shift) the filter runs forward first then backward

WFILTER: Perform a median filter to remove spikes in the fluorescence data. A median value was determined by 49 scans of the window.

SECTIONU (original module of SECTION): Select 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 of was set to be the end time when the package came up from the surface.

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

DERIVE: Compute dissolved oxygen (SBE43).

BINAVG: Average the data into 1-dbar pressure bins.

BOTTOMCUT (original module): Bottom cut deletes discontinuous scan bottom data if it’s created by BINAVG.

DERIVE: Compute salinity, potential temperature, and sigma-theta.

SPLIT: Separate the data from an input .cnv file into down cast and up cast files.

Configuration file: MR1301A.xmlcon

Specifications of the sensors are listed below.

CTD: SBE911plus CTD system

Under water unit:

SBE9plus

S/N 09P38273-0786 (Sea-Bird Electronics, Inc.)

Pressure sensor: Digiquartz pressure sensor (S/N 94766)

Calibrated Date: 30 Jun. 2012

Temperature sensors:

Primary: SBE03Plus (S/N 03P4421, Sea-Bird Electronics, Inc.)

Calibrated Date: 20 Sep. 2012

Secondary: SBE03Plus (S/N 03P2453, Sea-Bird Electronics, Inc.)

Calibrated Date: 22 Jun. 2012

Conductivity sensors:

Primary: SBE04-02/0 (S/N 041088, Sea-Bird Electronics, Inc.)

Calibrated Date: 20 Sep. 2012

Secondary: SBE04C (S/N 042240, Sea-Bird Electronics, Inc.)

Calibrated Date: 26 Jun. 2012

Dissolved Oxygen sensors:

Primary: SBE43 (S/N 430330, Sea-Bird Electronics, Inc.)

Calibrated Date: 01 May. 2012

Fluorescence:

Chlorophyll Fluorometer (S/N 3054, Seapoint Sensors, Inc.)

Altimeter

Benthos PSA-916T (S/N 1100, Teledyne Benthos, Inc.)

Carousel water sampler:

SBE32 (S/N 3221746-0278, Sea-Bird Electronics, Inc.)

Deck unit: SBE11plus (S/N 11P7030-0344, Sea-Bird Electronics, Inc.)

(5) Preliminary Results

During this cruise, 43casts of CTD observation were carried out. Date, time and locations of the CTD casts are listed in Table 6.2.1-1.

Vertical profile (down cast) of primary temperature, salinity and dissolved oxygen with pressure are shown in Figure 6.2.1-1 - 6.2.1-11

(6) Data archive

All raw and processed data files were copied onto HD provided by Data Management Office (DMO); JAMSTEC will be opened to public via “R/V MIRAI Data Web Page” in the JAMSTEC home page.

Table 6.2.1-1 MR13-01 CTD casttable

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire Out	HT Above Bottom	Max Depth	Max Pressure	CTD Filename	Remark
		(mmddyy)	Start	End	Latitude	Longitude							
C01	1	030213	06:06	06:41	01-15.05S	138-00.29E	2005.0	504.1	-	500.6	504.0	C01M01	sampling for Salinity and Particles
C02	1	030213	09:15	09:41	01-00.00S	138-00.03E	4003.0	500.1	-	502.6	506.0	C02M01	sampling for Salinity and Particles
C03	1	030213	12:50	13:14	00-30.10S	138-00.03E	4476.0	498.9	-	503.6	507.0	C03M01	sampling for Salinity and Particles
C04	1	030213	20:32	20:57	00-03.29N	138-07.86E	3788.0	501.2	-	502.6	506.0	C04M01	sampling for Salinity and Particles
C05	1	030313	06:48	07:24	00-33.26N	138-02.16E	3996.0	800.0	-	801.0	807.0	C05M01	Near the Ina-TRITON bouy sampling for Salinity and Particles
C06	1	030313	23:01	23:26	00-59.93N	137-59.88E	4211.0	498.1	-	500.6	504.0	C06M01	sampling for Salinity and Particles
C07	1	030413	02:49	03:13	01-30.04N	137-59.90E	4370.0	501.6	-	502.6	506.0	C07M01	sampling for Salinity and Particles
C08	1	030413	06:36	07:27	01-58.14N	138-05.82E	4295.0	799.1	-	801.0	807.0	C08M01	Recovery point of T12 JES10 cast sampling for Salinity and Particles
C09	1	030513	06:46	07:10	02-30.05N	137-54.87E	4648.0	500.7	-	502.6	506.0	C09M01	sampling for Salinity and Particles

C10	1	030513	10:19	10:43	02-59.99N	137-44.92E	4812.0	499.6	-	500.6	504.0	C10M01	sampling for Salinity and Particles
C11	1	030613	10:20	10:45	03-30.06N	137-34.72E	4663.0	500.7	-	501.6	505.0	C11M01	sampling for Salinity and Particles
C14	1	030713	04:02	04:35	04-56.17N	137-19.69E	4158.0	801.5	-	803.0	809.0	C14M01	Deployment point of T11 sampling for Salinity and Particles
C13	1	030713	06:43	07:07	04-30.04N	137-15.09E	4913.0	500.0	-	501.6	505.0	C13M01	sampling for Salinity and Particles
C12	1	030713	10:12	10:36	03-59.99N	137-24.79E	4656.0	500.5	-	502.6	506.0	C12M01	sampling for Salinity and Particles
C14	2	030713	20:35	21:06	04-50.22N	137-15.86E	4118.0	799.7	-	802.0	808.0	C14M02	Recovery point of T11 sampling for salinity
C15	1	030913	04:03	04:36	07-38.64N	136-40.19E	3173.0	802.4	-	801.9	808.0	C15M01	Deployment point of T10 sampling for Salinity and Particles
C15	2	030913	06:28	06:57	07-50.73N	136-28.33E	3356.0	799.8	-	801.9	808.0	C15M02	Recovery point of T10 sampling for salinity
C18	1	031113	20:20	20:58	01-55.82N	130-10.59E	4379.0	999.2	-	1000.0	1008.0	C18M01	Recovery point of T16 sampling for Salinity and Particles
C17	1	031213	04:28	05:06	01-29.91N	129-59.54E	4123.0	1003.6	-	1002.0	1010.0	C17M01	sampling for Salinity and Particles
C16	1	031213	08:03	08:41	00-59.99N	130-00.03E	3021.0	999.0	-	1000.0	1008.0	C16M01	sampling for Salinity and Particles
C19	1	031213	23:04	23:41	02-30.03N	129-59.99E	4023.0	1000.5	-	1001.0	1009.0	C19M01	sampling for Salinity and Particles

C20	1	031313	02:55	03:35	02-59.87N	129-59.90E	3091.0	1001.1	-	1001.0	1009.0	C20M01	sampling for Salinity and Particles
C21	1	031313	06:41	07:19	03-29.95N	129-59.99E	4507.0	1000.7	-	1001.0	1009.0	C21M01	sampling for Salinity and Particles
C22	1	031313	10:23	11:00	04-00.11N	129-59.98E	4723.0	999.4	-	1001.0	1009.0	C22M01	sampling for Salinity and Particles
C23	1	031313	14:03	14:40	04-30.21N	130-00.27E	4785.0	1006.4	-	1001.0	1009.0	C23M01	sampling for Salinity and Particles
C24	1	031313	17:39	18:19	05-00.27N	130-00.54E	5049.0	1006.2	-	1001.0	1009.0	C24M01	sampling for Salinity and Particles
C25	1	031313	21:25	22:02	05-29.99N	130-00.15E	5485.0	999.8	-	1001.0	1009.0	C25M01	sampling for Salinity and Particles
C26	1	031413	01:05	01:43	05-59.90N	130-00.07E	5490.0	1000.5	-	1002.0	1010.0	C26M01	sampling for Salinity and Particles
C27	1	031413	04:55	05:34	06-29.93N	129-59.81E	5564.0	1012.5	-	1001.0	1009.0	C27M01	sampling for Salinity and Particles
C28	1	031413	08:00	08:37	06-59.85N	129-59.84E	5558.0	999.6	-	1001.0	1009.0	C28M01	sampling for Salinity and Particles
C29	1	031413	12:24	13:01	07-30.12N	129-59.87E	5557.0	998.9	-	1000.9	1009.0	C29M01	sampling for Salinity and Particles
C30	1	031413	21:06	21:45	07-57.70N	130-01.84E	5719.0	1001.4	-	1001.9	1010.0	C30M01	Recovery point of T14 sampling for Salinity and Particles
C31	1	031513	09:15	09:53	07-00.19N	129-29.94E	5349.0	998.1	-	1001.0	1009.0	C31M01	sampling for Salinity and Particles
C41	1	031613	04:04	04:38	07-00.19N	126-30.10E	796.0	797.1	6.3	798.0	804.0	C41M01	sampling for Salinity and Particles

C40	1	031613	05:46	06:23	06-59.48N	126-35.53E	2277.0	1013.2	-	1001.0	1009.0	C40M01	sampling for Salinity and Particles
C39	1	031613	07:53	08:31	06-59.46N	126-47.69E	4265.0	1012.1	-	1000.9	1009.0	C39M01	sampling for Salinity and Particles
C38	1	031613	09:50	10:28	06-59.52N	126-59.76E	5569.0	1008.2	-	1000.9	1009.0	C38M01	sampling for Salinity and Particles
C37	1	031613	12:03	12:42	06-59.64N	127-14.79E	8169.0	1008.0	-	1000.0	1008.0	C37M01	sampling for Salinity and Particles
C36	1	031613	20:02	20:38	06-59.67N	127-29.96E	7248.0	1001.8	-	1001.0	1009.0	C36M01	sampling for Salinity and Particles
C35	1	031613	23:39	00:18	06-59.76N	127-44.75E	5818.0	1002.7	-	1002.9	1011.0	C35M01	sampling for Salinity and Particles
C34	1	031713	04:49	05:27	06-58.77N	127-59.87E	4615.0	1000.0	-	1000.9	1009.0	C34M01	sampling for Salinity and Particles
C33	1	031713	08:04	08:41	07-00.13N	128-29.93E	5644.0	998.7	-	1001.9	1010.0	C33M01	sampling for Salinity and Particles
C32	1	031713	11:09	11:46	07-00.08N	129-00.05E	5052.0	999.4	-	1000.0	1008.0	C32M01	sampling for Salinity and Particles

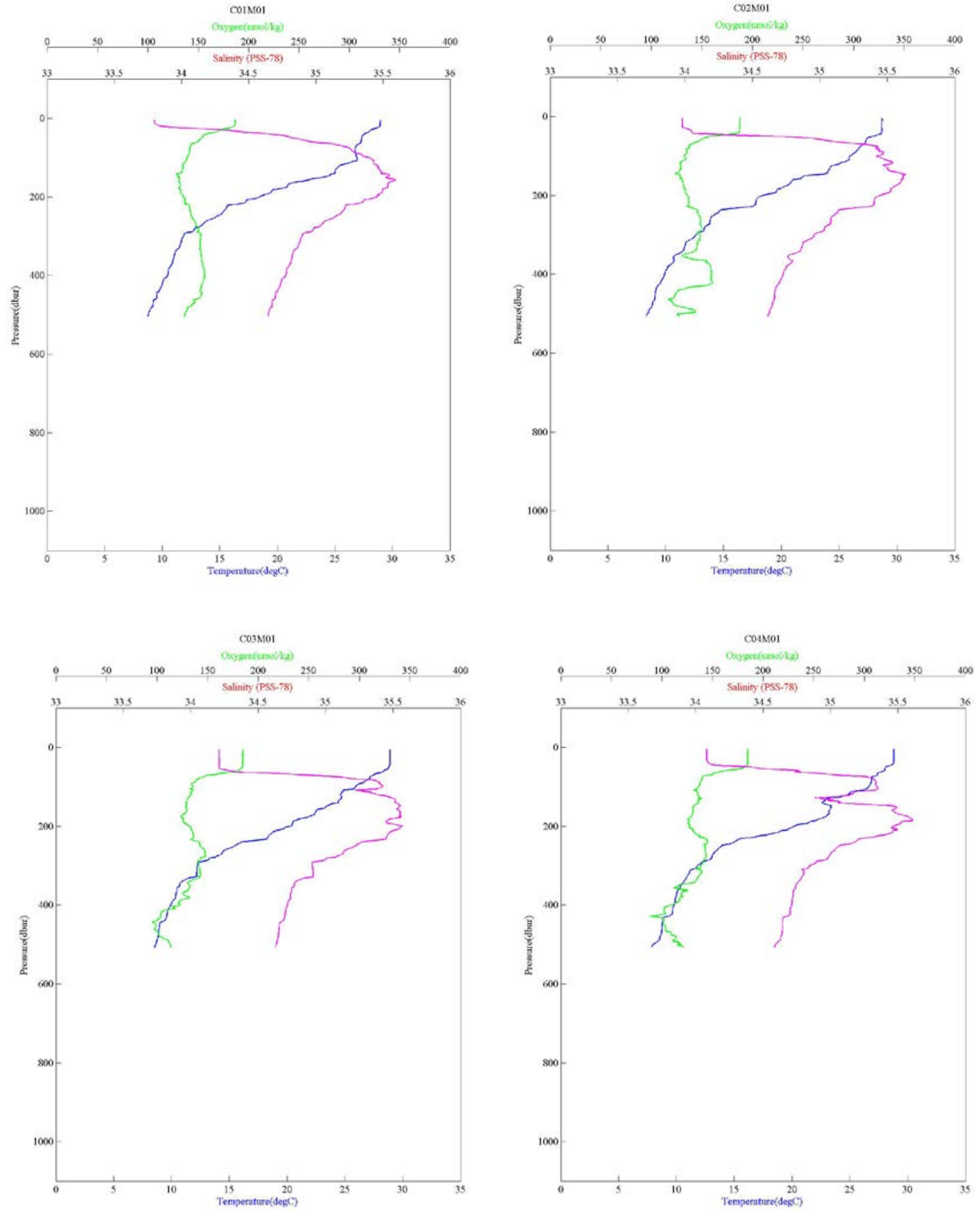


Figure 6.2.1-1 CTD profile (C01M01, C02M01, C03M01 and C04M01)

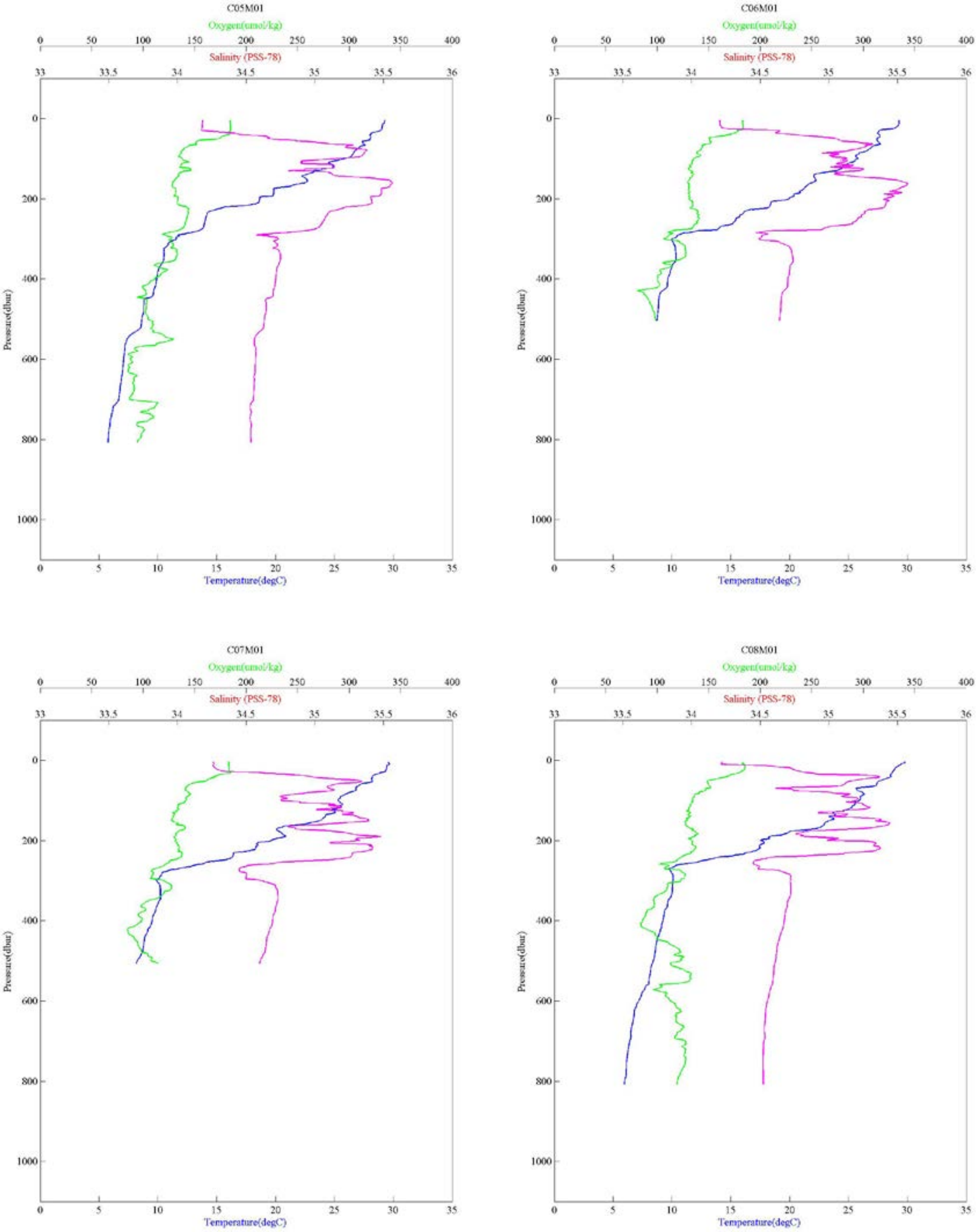


Figure 6.2.1-2 CTD profile (C05M01, C06M01, C07M01 and C08M01)

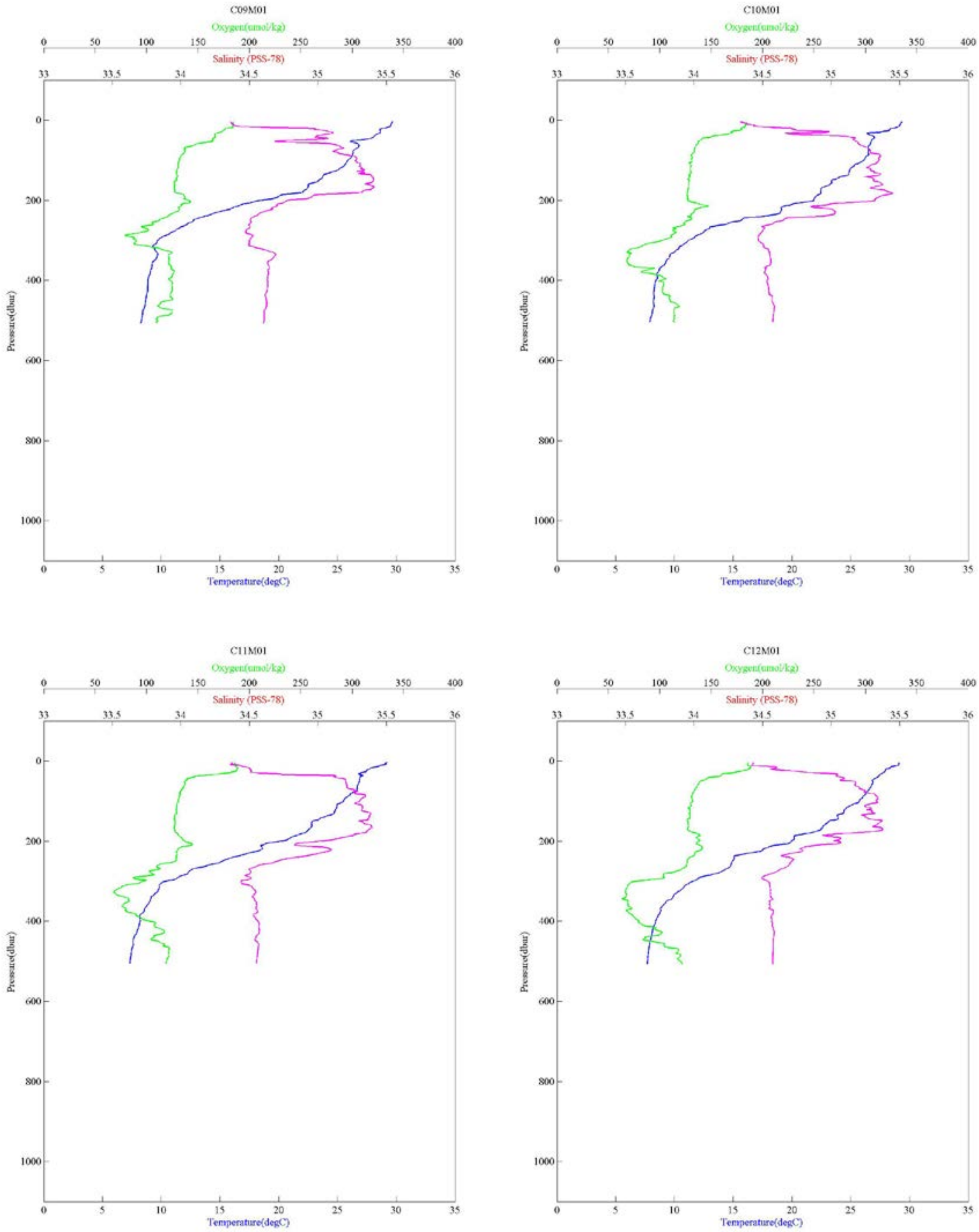


Figure 6.2.1-3 CTD profile (C09M01, C10M01, C11M01 and C12M01)

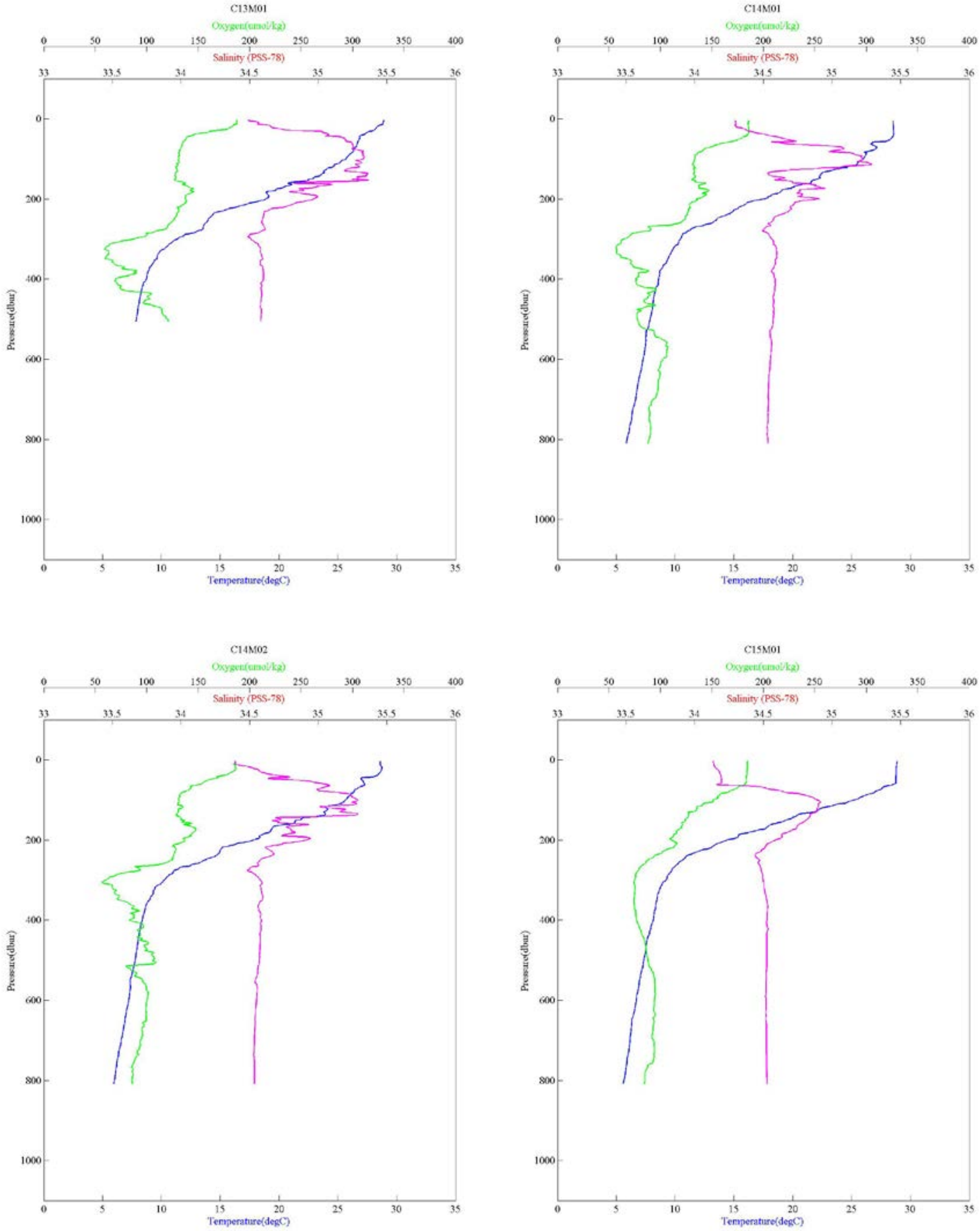


Figure 6.2.1-4 CTD profile (C13M01, C14M01, C14M02 and C15M01)

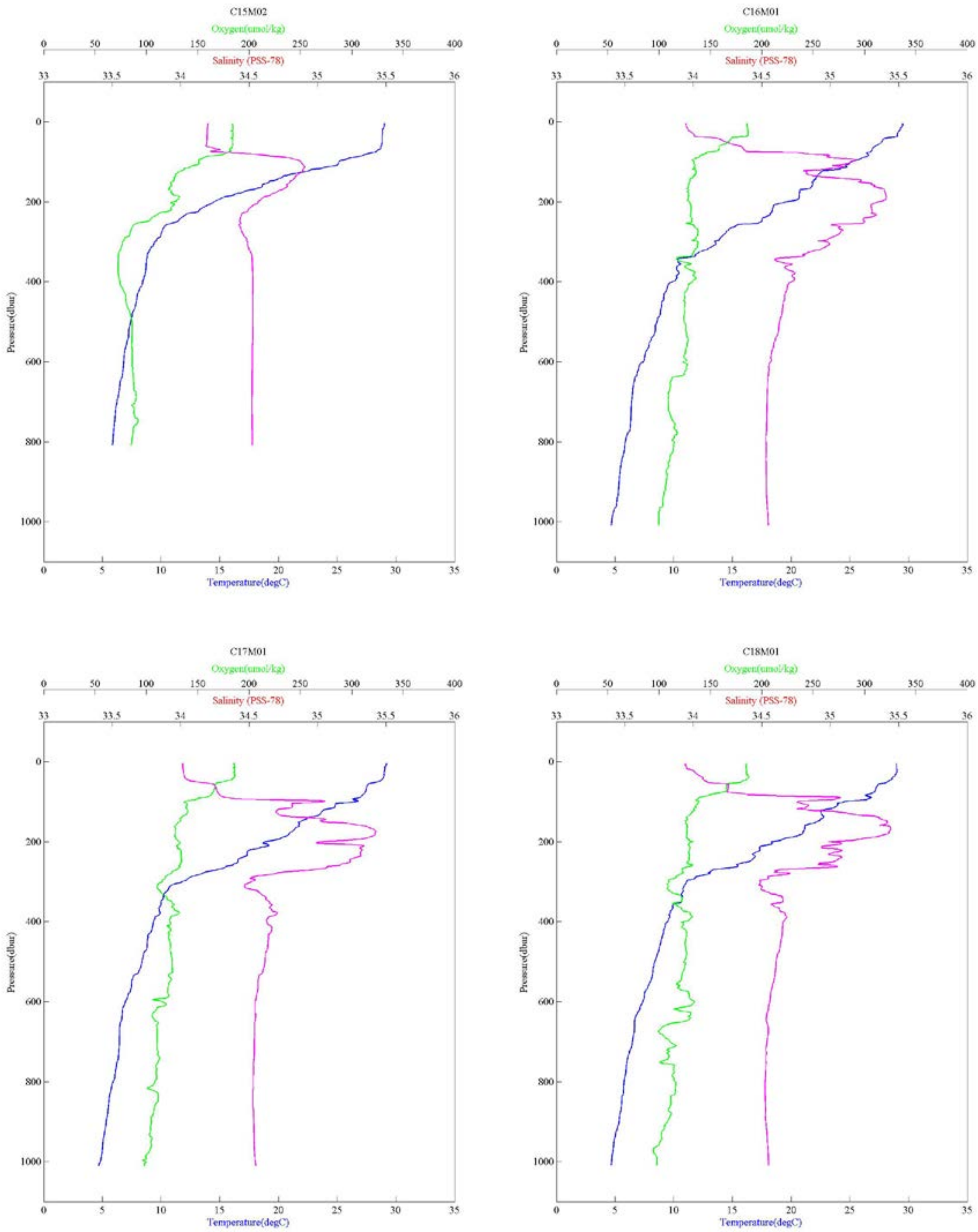


Figure 6.2.1-5 CTD profile (C15M02, C16M01, C17M01 and C18M01)

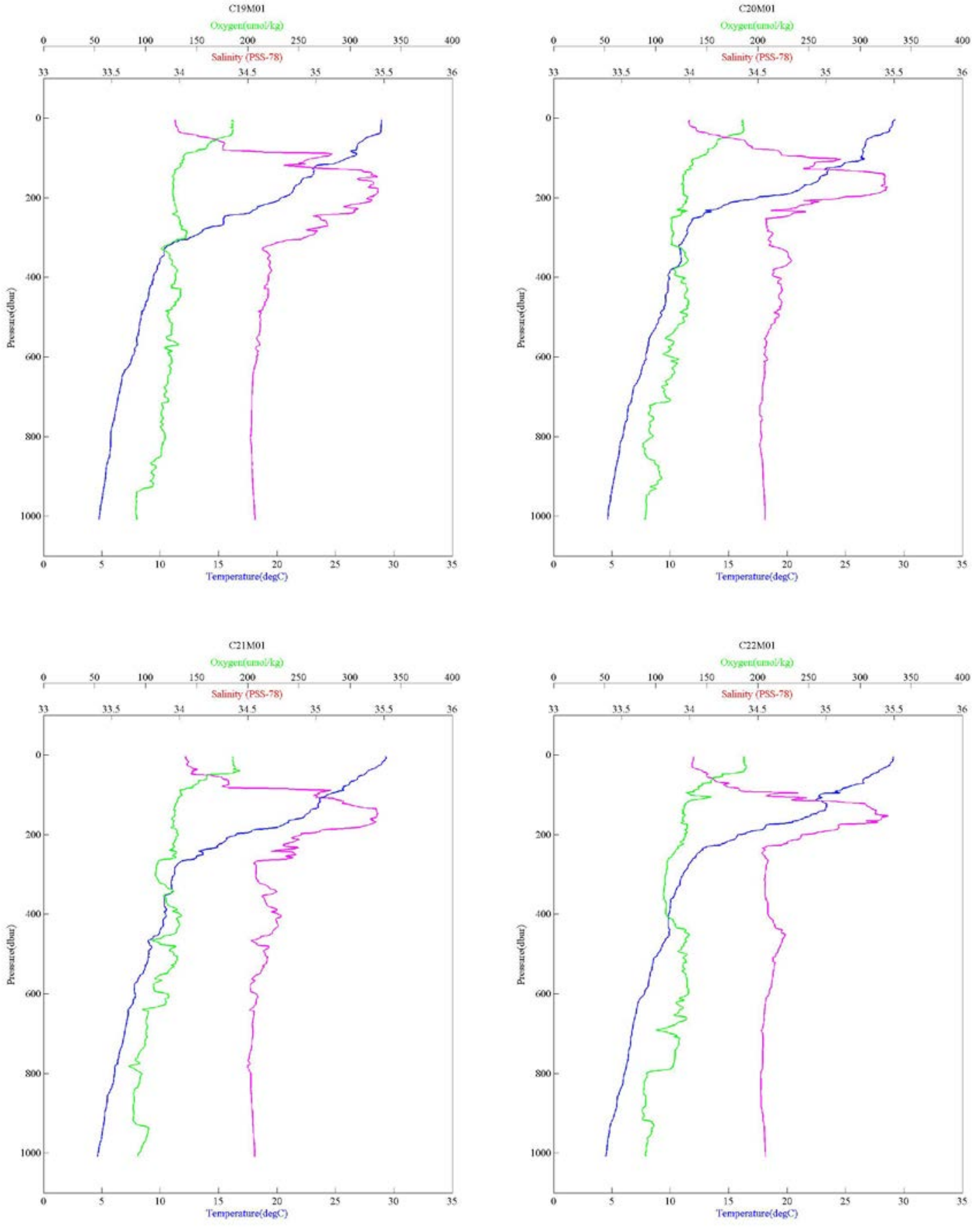


Figure 6.2.1-6 CTD profile (C19M01, C20M01, C21M01 and C22M01)

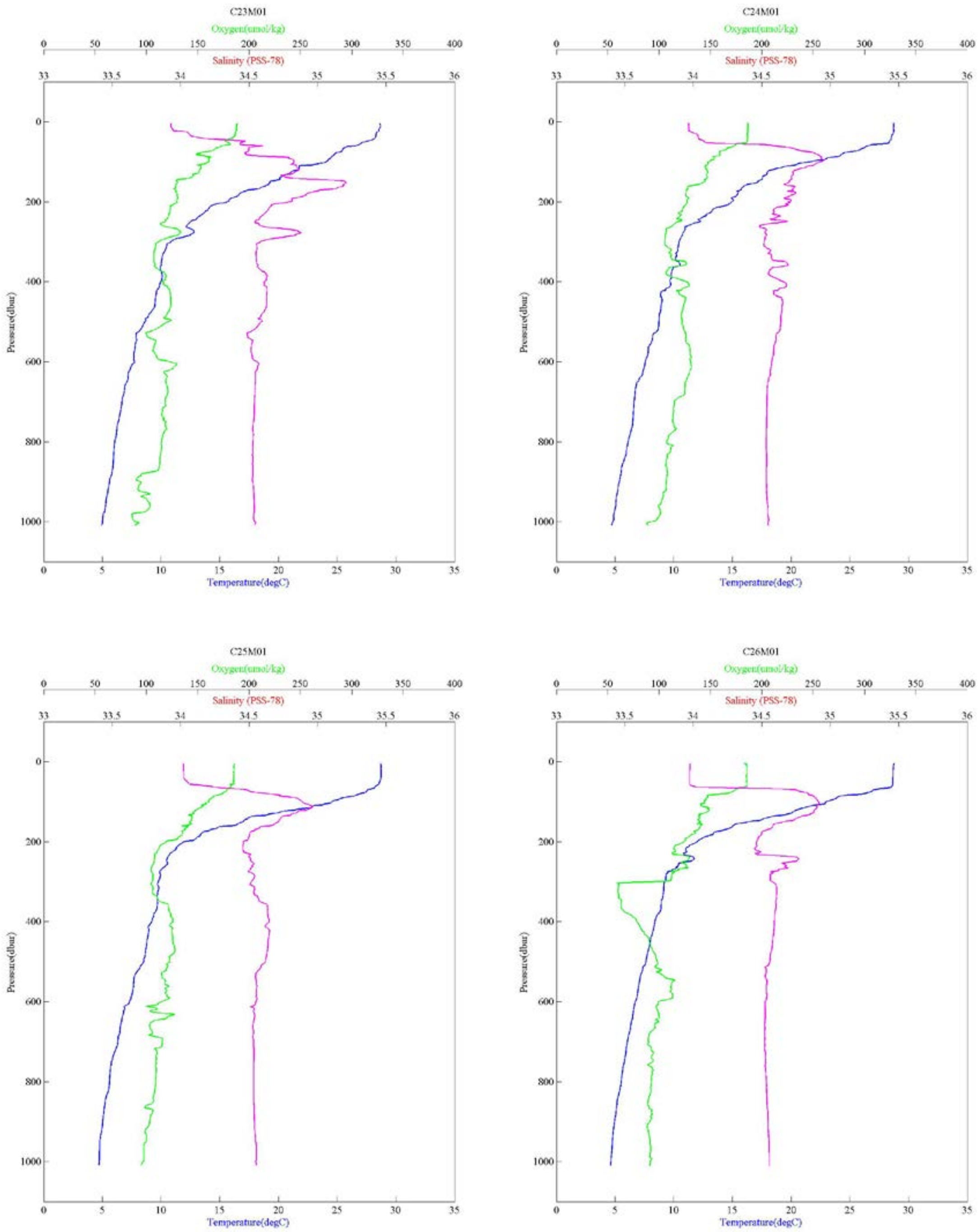


Figure 6.2.1-7 CTD profile (C23M01, C24M01, C25M01 and C26M01)

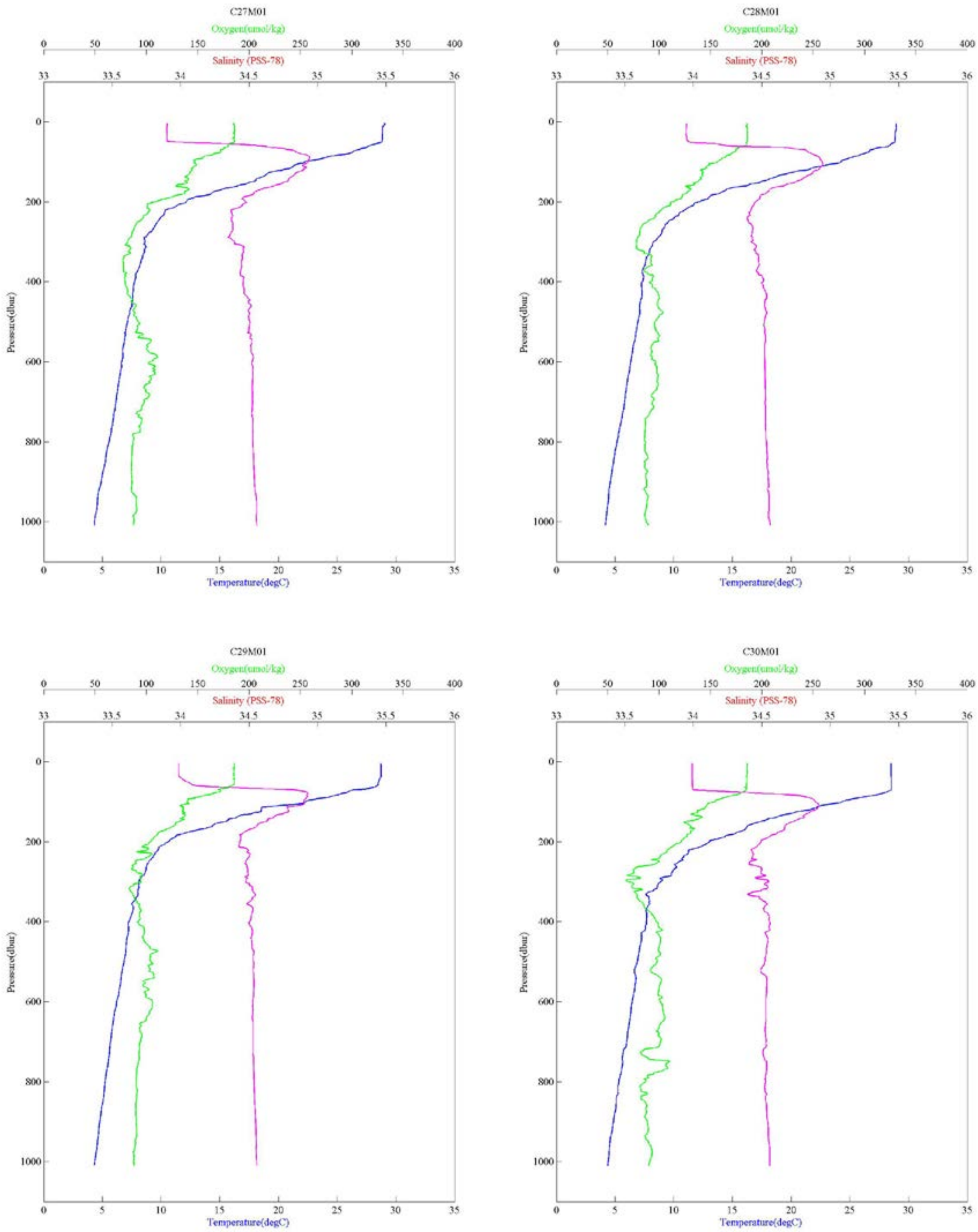


Figure 6.2.1-8 CTD profile (C27M01, C28M01, C29M01 and C30M01)

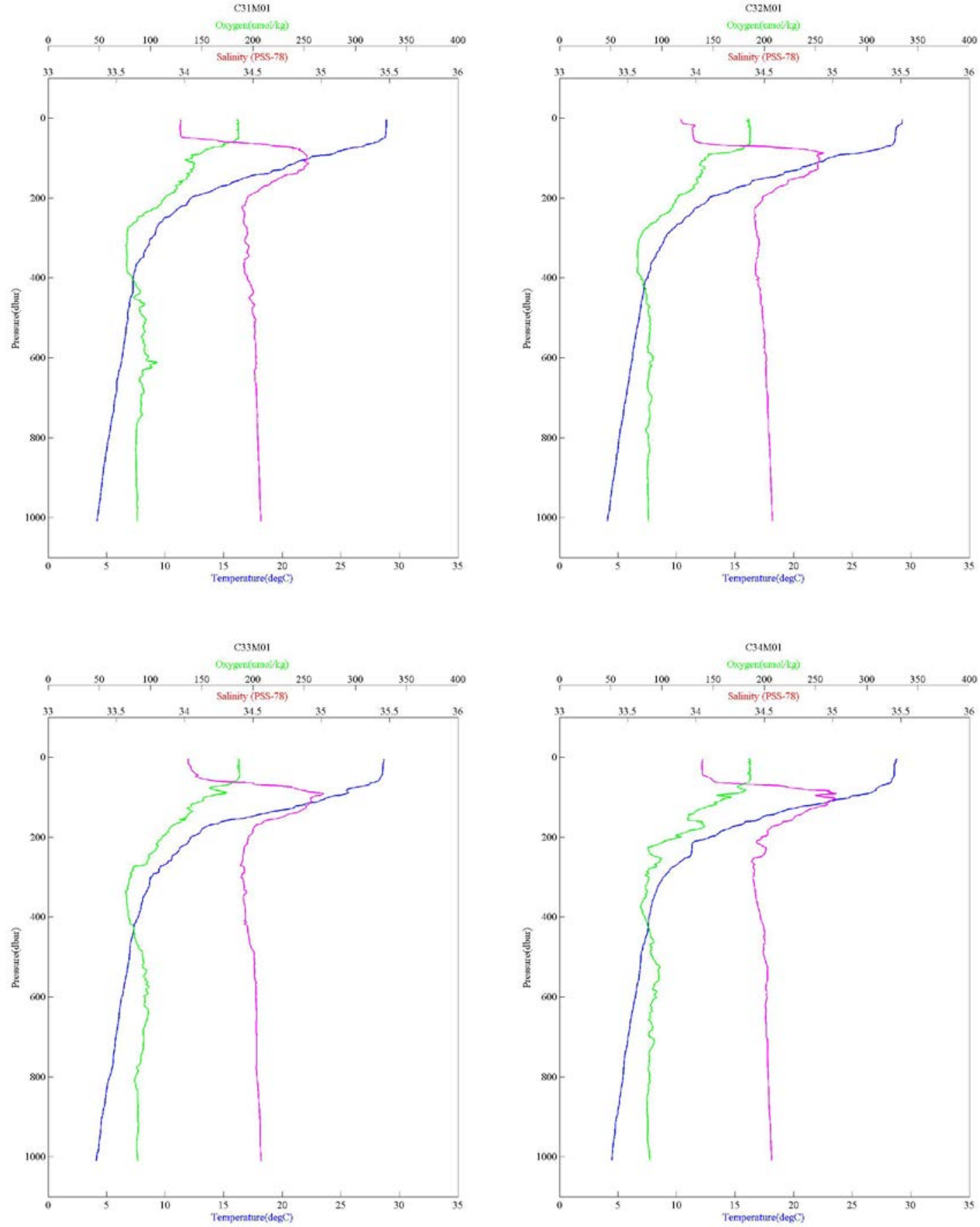


Figure 6.2.1-9 CTD profile (C31M01, C32M01, C33M01 and C34M01)

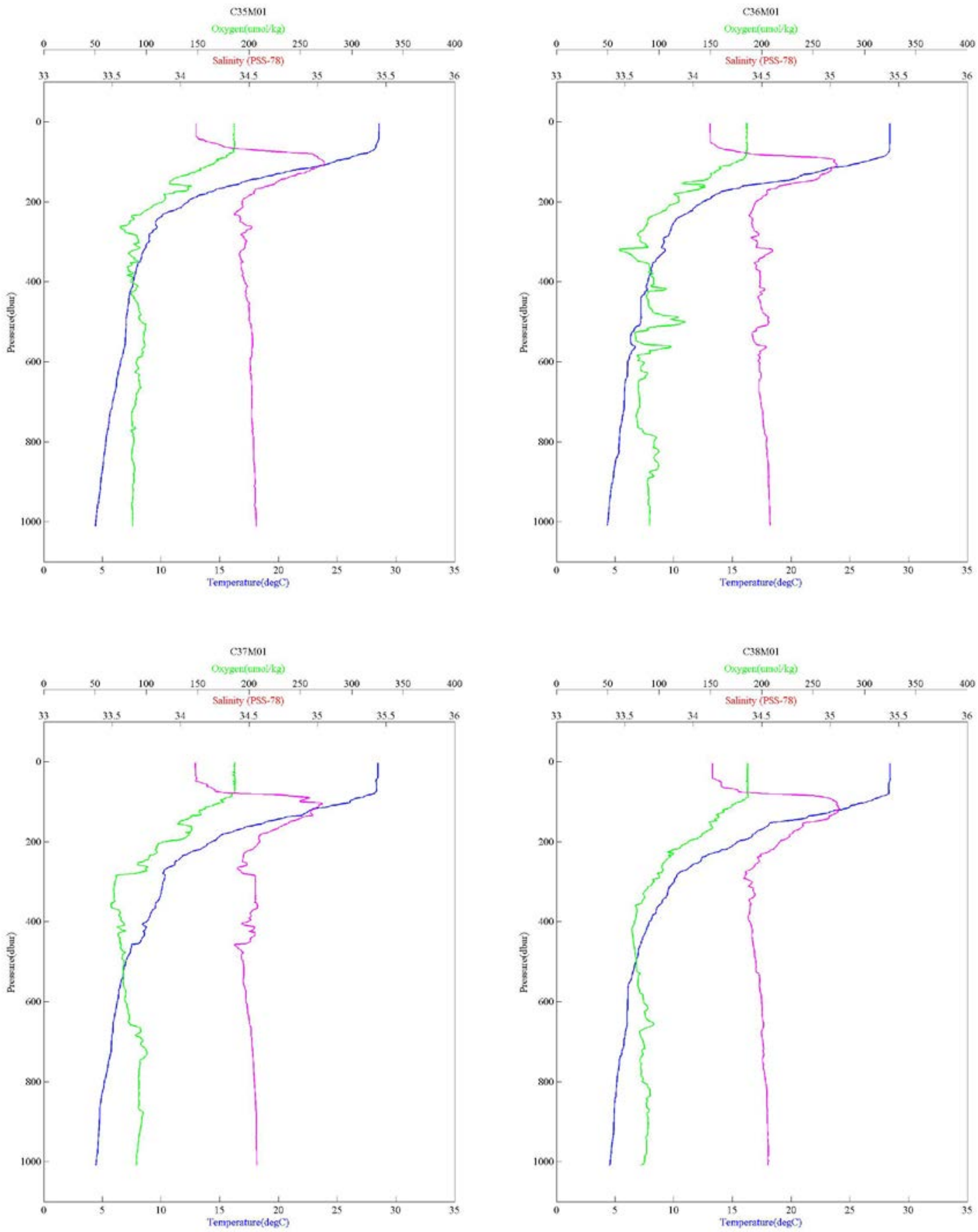


Figure 6.2.1-10 CTD profile (C35M01, C36M01, C37M01 and C38M01)

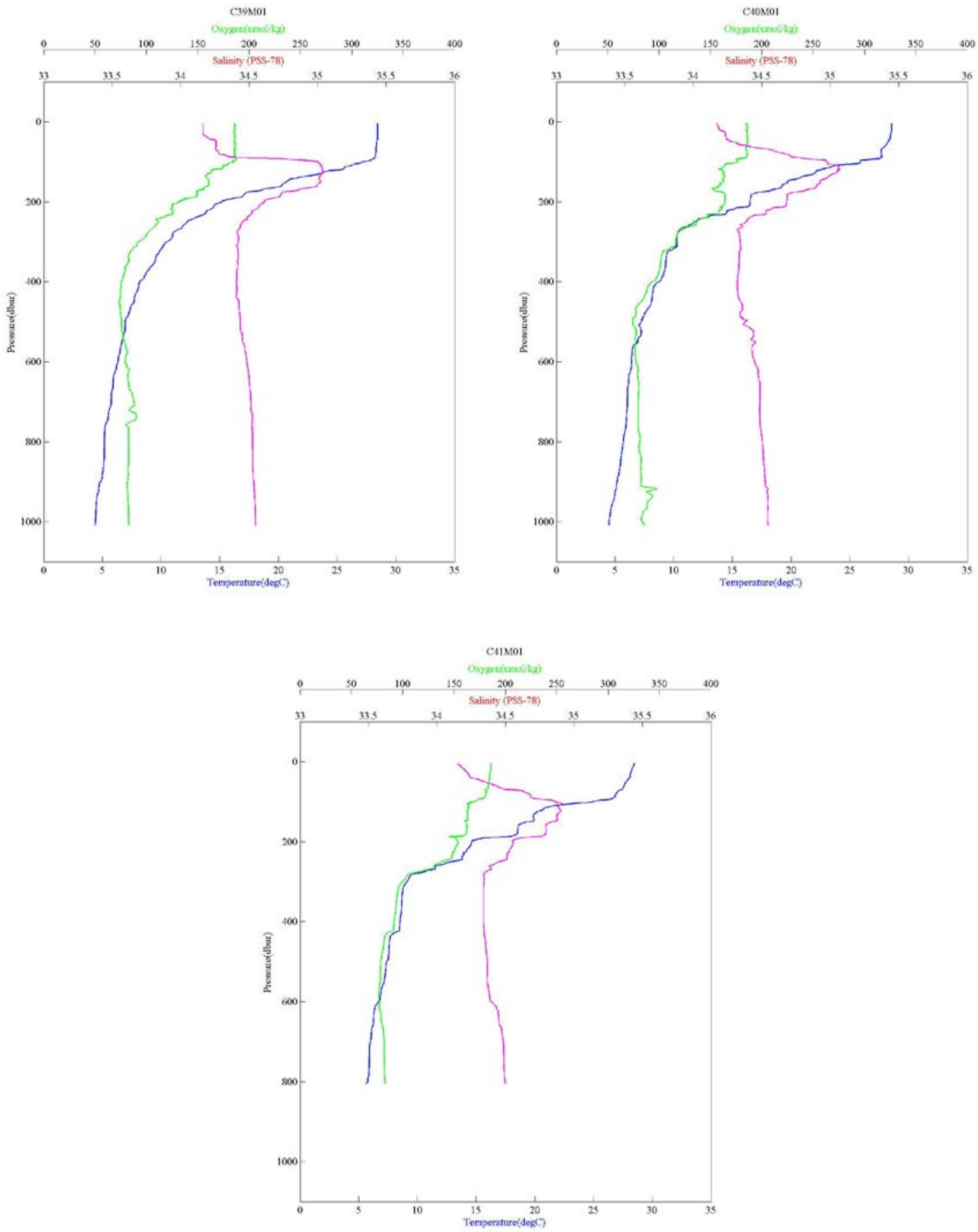


Figure 6.2.1-11 CTD profile (C39M01, C40M01, and C41M01)

6.2.2 XCTD

(1) Personnel

Yuji Kashino	(JAMSTEC) : Principal Investigator
Shinya Okumura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Toshimitsu Goto	(GODI)
Ryo Ohyama	(MIRAI Crew)

(2) Objectives

Investigation of oceanic structure.

(3) Parameters

Parameters of XCTD (eXpendable Conductivity, Temperature & Depth profiler; Tsurumi-Seiki Co..) are as follows;

Parameter	Range	Accuracy
Conductivity	0 ~ 60 mS/cm	+/- 0.03 mS/cm
Temperature	-2 ~ 35deg-C	+/- 0.02 deg-C
Depth	0 ~ 1000 m (XCTD-1)	5 m or 2 % at depth , whichever is greater

(4) Methods

We observed the vertical profiles of the sea water temperature and salinity by XCTD. The signal was converted by MK-150N digital converter (Tsurumi-Seiki Co.) and recorded by AL-12B software (Ver.1.1.4; Tsurumi-Seiki Co.). We launched 21 XCTD-1 probes by automatic launcher or hand launcher. The summary of XCTD observation is shown in Table 6.2.2.

(5) Preliminary results

Position map of XCTD observations was shown in Fig. 6.2.2-1. Vertical section of temperature and salinity were shown in Fig.6.2.2-2 .

(6) Data archive

These data obtained in this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC.

Table 6.2.2 Summary of XCTD observation and launching log

Station No.	Date (UTC)	Time (UTC)	Latitude [deg-minN]	Longitude [deg-minE]	Depth [m]	SST [deg-C]	SSS [PSU]	Probe S/N
Cast01	2013/03/05	04:35	02-04.07	138-03.98	4327	29.808	34.232	12089059
Cast03	2013/03/08	05:42	05-30.01	137-04.99	4624	29.178	34.297	12099297
Cast04	2013/03/08	07:56	06-00.19	136-57.99	4425	28.965	34.172	12099298
Cast05	2013/03/08	10:11	06-29.99	136-51.01	4581	28.907	34.061	12089062
Cast06	2013/03/08	12:23	07-00.07	136-43.99	4916	28.789	33.859	12089060
Cast07	2013/03/08	14:39	07-29.95	136-36.98	2470	28.681	33.906	12089061
Cast09	2013/03/10	06:16	06-59.43	135-59.44	4269	28.813	33.918	12099303
Cast10	2013/03/10	09:32	06-28.00	135-27.98	4627	28.874	33.981	12099306
Cast11	2013/03/10	12:34	05-59.50	134-59.50	4655	28.788	33.869	12099300
Cast12	2013/03/10	15:37	05-30.02	134-30.02	4724	28.827	34.028	12099299
Cast13	2013/03/10	18:32	05-00.05	134-04.07	4794	28.810	33.908	12099305
Cast14	2013/03/10	21:36	04-30.01	133-30.08	3111	28.933	33.974	12099301
Cast15	2013/03/11	00:33	03-59.97	132-59.95	3682	29.135	33.891	12099307
Cast16	2013/03/11	03:25	03-29.98	132-29.98	3708	29.299	33.877	12099310
Cast17	2013/03/11	07:35	02-35.09	132-00.01	3955	29.719	33.890	12099311
Cast18	2013/03/11	09:48	02-24.95	131-29.89	2983	29.253	33.857	12099312
Cast19	2013/03/11	12:32	02-00.00	131-00.02	3954	29.083	33.889	12099309
Cast20	2013/03/11	15:42	01-30.00	130-27.22	3657	29.153	34.016	12099308
Cast21	2013/03/12	15:57	02-00.00	128-59.98	1777	28.955	33.977	12099313
Cast22	2013/03/12	18:18	01-59.99	129-30.00	4019	28.929	34.037	12099314
Cast23	2013/03/12	20:31	02-00.00	130-00.02	4417	29.042	34.003	12099315

Acronyms in Table XCTD observation log are as follows;

Depth: The depth of water [m]

SST: Sea Surface Temperature [deg-C] measured by TSG (ThermoSalinoGraph).

SSS: Sea Surface Salinity [PSU] measured by TSG.

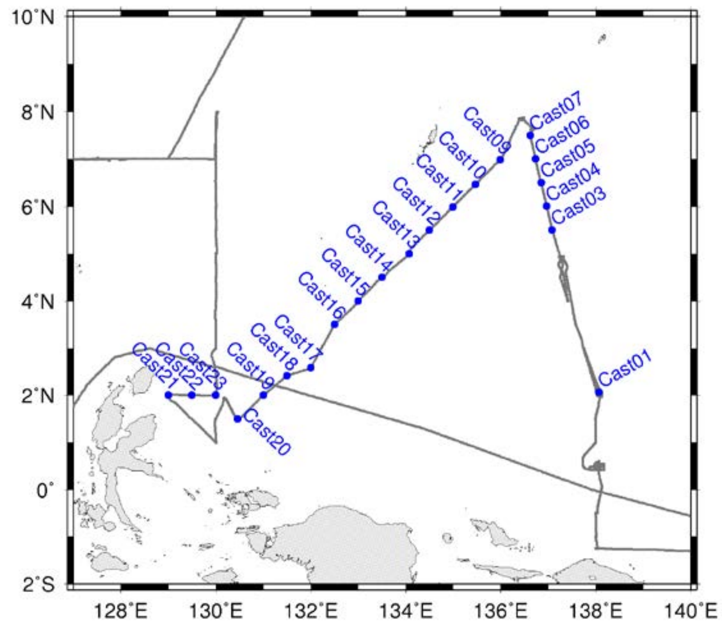


Fig. 6.2.2-1 Position of XCTD observation.

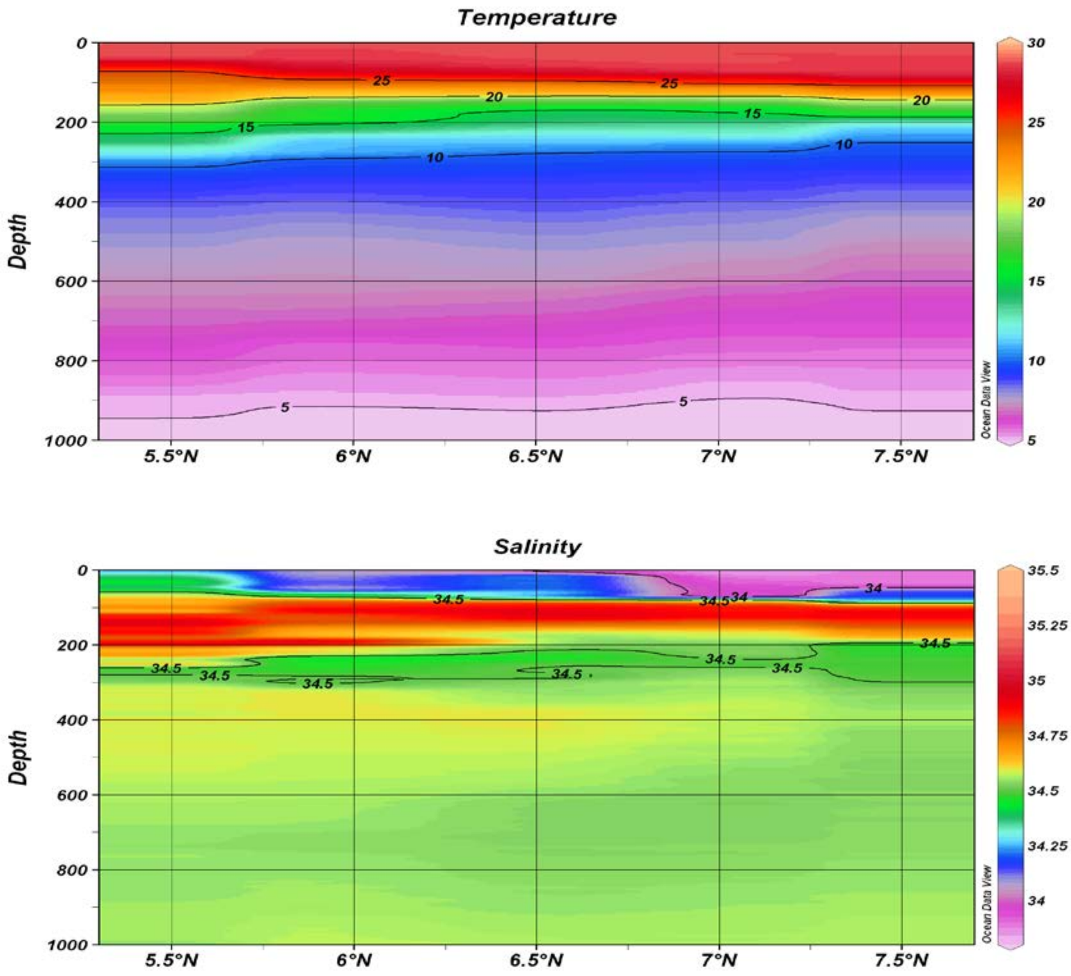
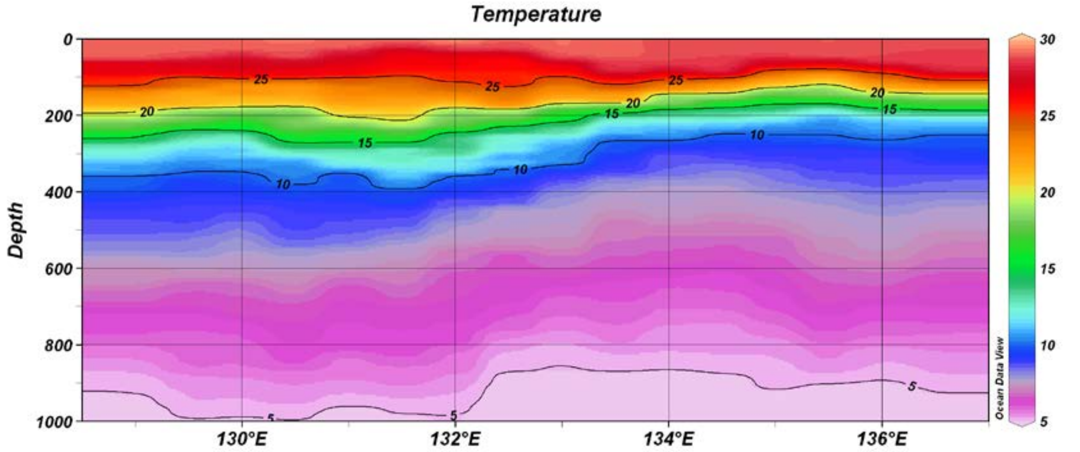


Fig. 6.2.2-2 Vertical section from Cast 01 to 07 (upper: temperature, lower: salinity).



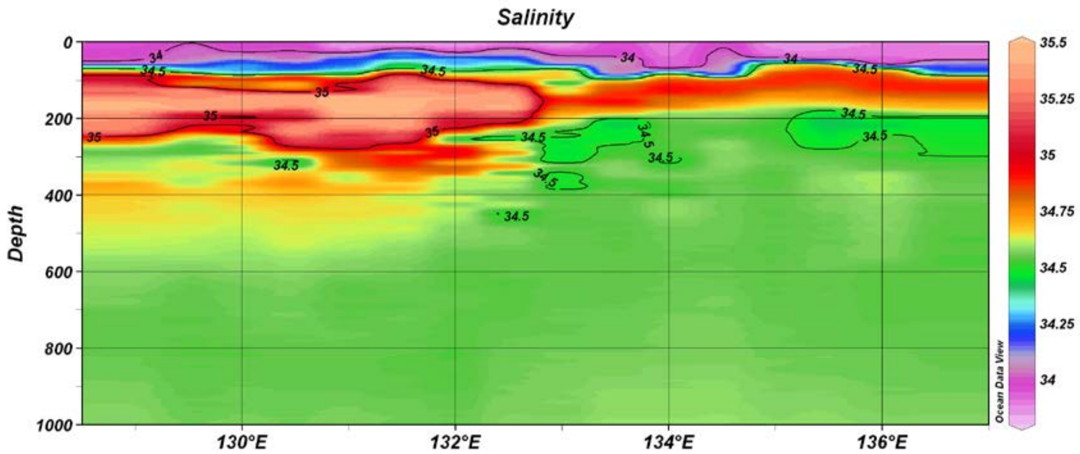


Fig. 6.2.2-3 Vertical section from Cast 07 to Cast 23
(upper: temperature, lower: salinity).

6.3 Water sampling

6.3.1 Salinity

(1) Personnel

Yuji Kashino (JAMSTEC) : Principal Investigator

Kenichi Katayama (MWJ) : Technical Staff (Operation Leader)

Hiroki Ushiromura (MWJ) : Technical Staff

(2) Objective

To measure bottle salinity obtained by CTD casts and the continuous sea surface water monitoring system (TSG).

(3) Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles and TSG. The salinity sample bottle of the 250ml brown glass with GL32 screw cap was used for collecting the sample seawater. Each bottle was rinsed 3 times with the sample seawater, and was filled with sample seawater to the bottle shoulder. All of sample bottles were sealed with a plastic cone and a screw cap because we took into consideration the possibility of storage for about a month. The cone was rinsed 3 times with the sample seawater before its use. Each bottle was stored for more than 12 hours in the laboratory before the salinity measurement.

Types and numbers (n) of samples are shown in Table 6.3.1-1.

Table 6.3.1-1 Types and numbers (n) of samples

Types	N
Samples for CTD	86
Samples for TSG	27
Total	113

b. Instruments and Method

The salinity measurement was carried out on R/V MIRAI during the cruise of MR13-01 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62556) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.).

One pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. One thermometer monitored the ambient temperature and the other monitored the bath temperature of the salinometer.

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

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

Measurement Range : 0.005 to 42 (PSU)

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

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

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

The measurement system was almost the same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. The ambient temperature varied from approximately 21 deg C to 24 deg C, while the bath temperature was very stable and varied within +/- 0.002 deg C on rare occasion.

The measurement for each sample was done with a double conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection was started 10 seconds after filling the cell with the sample and it took about 10 seconds to collect 31 readings by the personal computer. Data were taken for the sixth and seventh filling of the cell. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity with the algorithm for the practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, an eighth filling of the cell was done. In the case of the difference between the double conductivity ratio of these two fillings being smaller than 0.00002, the average value of the double conductivity ratio was used to calculate the bottle salinity. In the case of the double conductivity ratio of eighth filling did not satisfy the criteria above, we measured a ninth filling of the cell and calculated the bottle salinity. The conductivity cell was cleaned with detergent after the measurement of the day.

(4) Results

a. Standard Seawater (SSW)

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

Batch	:	P154
Conductivity Ratio	:	0.99990
Salinity	:	34.996
Use By	:	20th October 2014

Standardization control of the salinometer S/N 62556 was set to 692 at 9th March and all measurements were carried out at this setting. The value of STANDBY was 24+5199~5200 and that of ZERO was 0.0-0001~0000. 11 bottles of SSW were measured.

Fig.6.3.1-1 shows the time series of the double conductivity ratio of SSW batch P154 before correction. The average of the double conductivity ratio was 1.99979 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

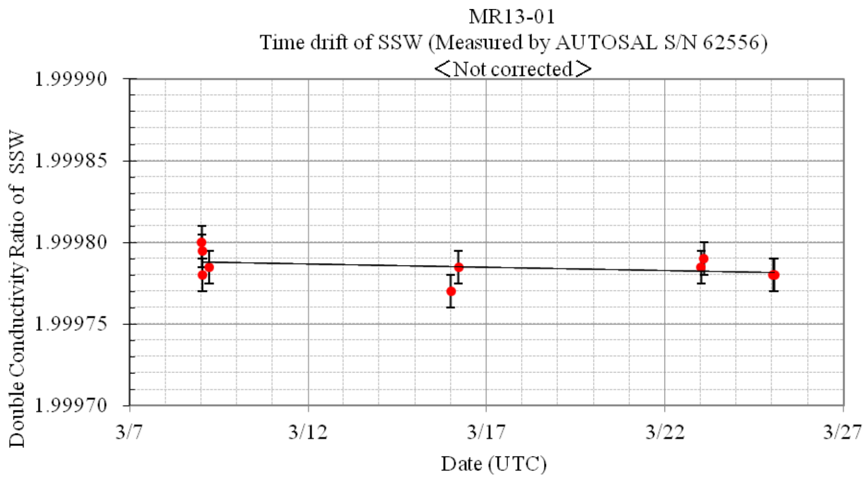


Fig. 6.3.1-1 Time series of double conductivity ratio for the Standard Seawater batch P154 (before correction)

Fig.6.3.1-2 shows the time series of the double conductivity ratio of SSW batch P154 after correction. The average of the double conductivity ratio was 1.99980 and the standard deviation was 0.000005, which is equivalent to 0.0001 in salinity.

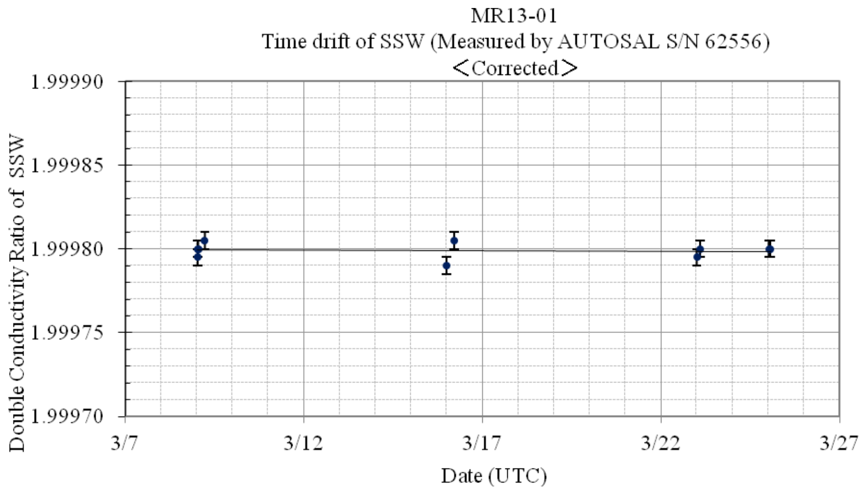


Fig.6.3.1-2 Time series of double conductivity ratio for the Standard Seawater batch P154 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by a pore size of 0.45 micrometer and stored in a 20 liter container made of polyethylene and stirred for at least 24 hours before measuring. It was measured about every 6 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

We estimated the precision of this method using 43 pairs of replicate samples taken from the same Niskin bottle. Fig.6.3.2 shows the histogram of the absolute difference between each pair of the replicate samples. The average and the standard deviation of absolute difference among 43 pairs of replicate samples were 0.0001 and 0.00008 in salinity, respectively.

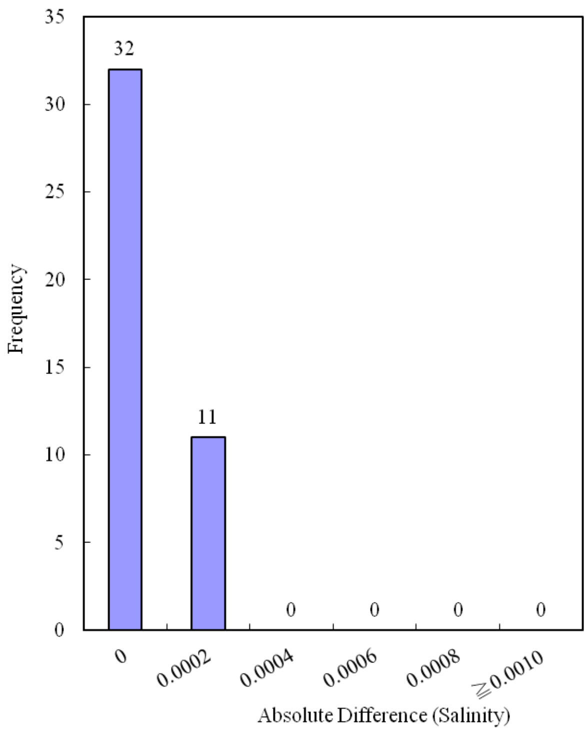


Fig.6.3.2 Histogram of the absolute difference between replicate samples

(5) Data archive

These raw datasets will be submitted to JAMSTEC Data Management Office (DMO).

(6) Reference

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

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

6.4 Continuous monitoring of surface seawater

6.4.1 Temperature, salinity, dissolved oxygen

1. Personnel

Yuji Kashino (JAMSTEC): Principal Investigator
Keitaro Matsumoto (MWJ)

2. Objective

Our purpose is to obtain salinity, temperature and dissolved oxygen data continuously in near-sea surface water.

3. Instruments and Methods

The Continuous Sea Surface Water Monitoring System (Marine Works Japan Co. Ltd.) has four sensors and automatically measures salinity, temperature and dissolved oxygen in near-sea surface water every one minute. This system is located in the "*sea surface monitoring laboratory*" and connected to shipboard LAN-system. Measured data, time, and location of the ship were stored in a data management PC. The near-surface water was continuously pumped up to the laboratory from about 5 m water depth and flowed into the system through a vinyl-chloride pipe. The flow rate of the surface seawater was adjusted to be 3 dm^3 min^{-1}. Specifications of the each sensor in this system are listed below.

a. Instruments

Software

Seamoni-kun Ver.1.30

Sensors

Specifications of the each sensor in this system are listed below.

Temperature and Conductivity sensor

Model:	SBE-45, SEA-BIRD ELECTRONICS, INC.
Serial number:	4552788-0264
Measurement range:	Temperature -5 to +35 ^{o}C
	Conductivity 0 to 7 S m^{-1}
Initial accuracy:	Temperature 0.002 ^{o}C
	Conductivity 0.0003 S m^{-1}

Typical stability (per month):	Temperature 0.0002 ^{o}C
	Conductivity 0.0003 S m^{-1}
Resolution:	Temperatures 0.0001 ^{o}C
	Conductivity 0.00001 S m^{-1}

Bottom of ship thermometer

Model:	SBE 38, SEA-BIRD ELECTRONICS, INC.
Serial number:	3852788-0457
Measurement range:	-5 to +35 ^{o}C
Initial accuracy:	±0.001 ^{o}C
Typical stability (per 6 month):	0.001 ^{o}C
Resolution:	0.00025 ^{o}C

Dissolved oxygen sensor

Model:	OPTODE 3835, AANDERAA Instruments.
Serial number:	1233
Measuring range:	0 - 500 μmol dm^{-3}
Resolution:	<1 μmol dm^{-3}
Accuracy:	<8 μmol dm^{-3} or 5% whichever is greater
Settling time:	<25 s

Dissolved oxygen sensor

Model:	RINKO II, ARO-CAR/CAD
Serial number:	13
Measuring range:	0 - 540 μmol dm^{-3}
Resolution:	< 0.1 μmol dm^{-3}
	or 0.1 % of reading whichever is greater
Accuracy:	< 1 μmol dm^{-3}
	or 5 % of reading whichever is greater

4. Measurements

Periods of measurement, maintenance, and problems during MR13-01 are listed in Table 6.4.1-1.

Table 6.4.1-1 Events list of the surface seawater monitoring during MR13-01

System Date [UTC]	System Time [UTC]	Events	Remarks
2013/02/26	7:15	All the measurements started and data was available.	Leaving from Indonesian territorial seas
2013/03/01	14:36	All the measurements stopped.	Entry to Papua New Guinean EEZ
2013/03/02	13:55	All the measurements started.	Leaving from Papua New Guinean EEZ
2013/03/12	07:54	OPTODE correspondence stopped	
2013/03/12	08:39	All the measurements stopped.	Restart the system at CTD station.
2013/03/12	08:42	The measurements except OPTODE started.	
2013/03/13	02:51	All the measurements stopped.	Change OPTODE sensor to spare. Cleaning the filter.
2013/03/13	03:32	All the measurements started.	OPTODE data from spare sensor.
2013/03/25	09:00	All the measurements stopped.	Cruise end.

5. Preliminary Result

We took the surface water samples to compare sensor data with bottle data of salinity. The results are shown in Fig.6.4.1-1. All the salinity samples were analyzed by the Guideline 8400B "AUTOSAL". Preliminary data of temperature, salinity, and dissolved oxygen at sea surface are shown in Fig.6.4.1-2.

We checked the data of spare OPTODE sensor that started from 2013/03/13 03:32 to 2013/03/26 09:00 (UTC). Then we found strong drift of this sensor. After this cruise, we will correct the date using interrelation between OPTODE and RINKO from the data of resent cruise. Then we will reintroduce these data.

6. Data archive

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

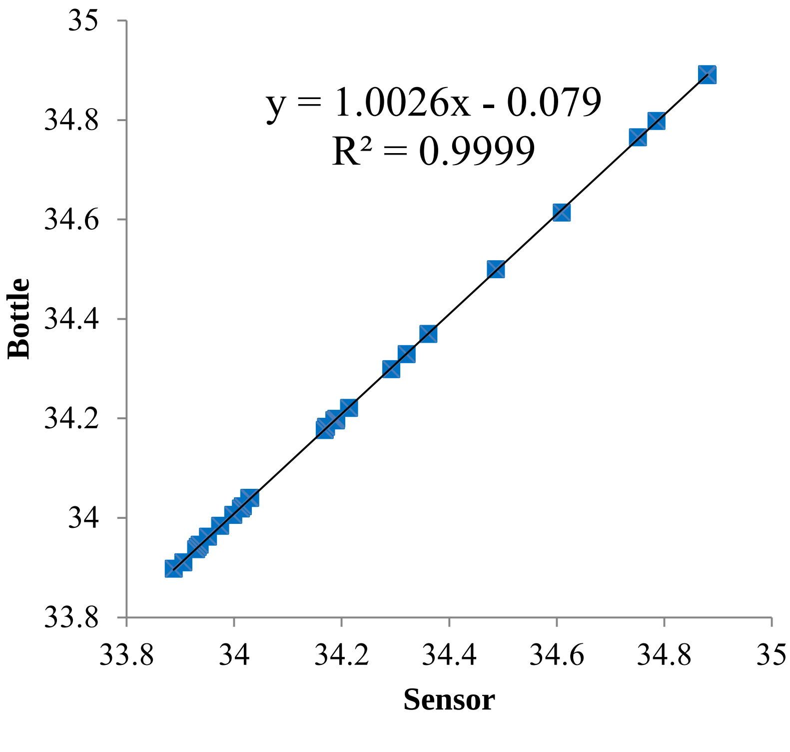
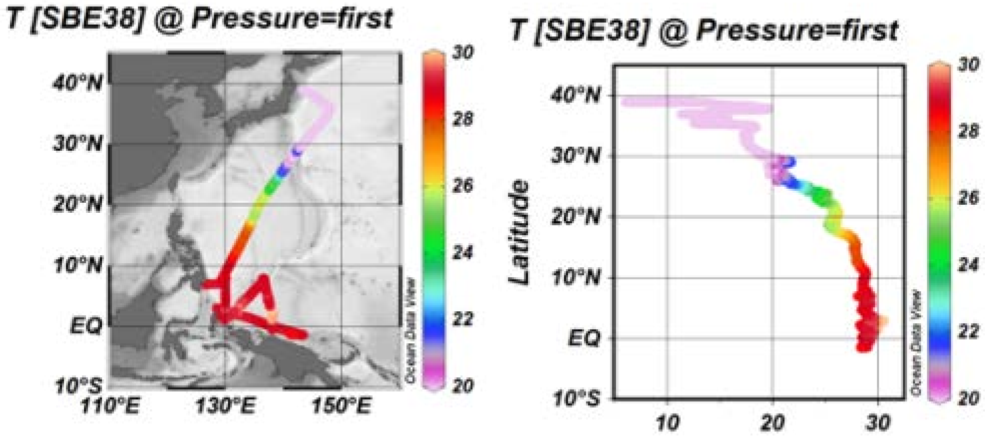
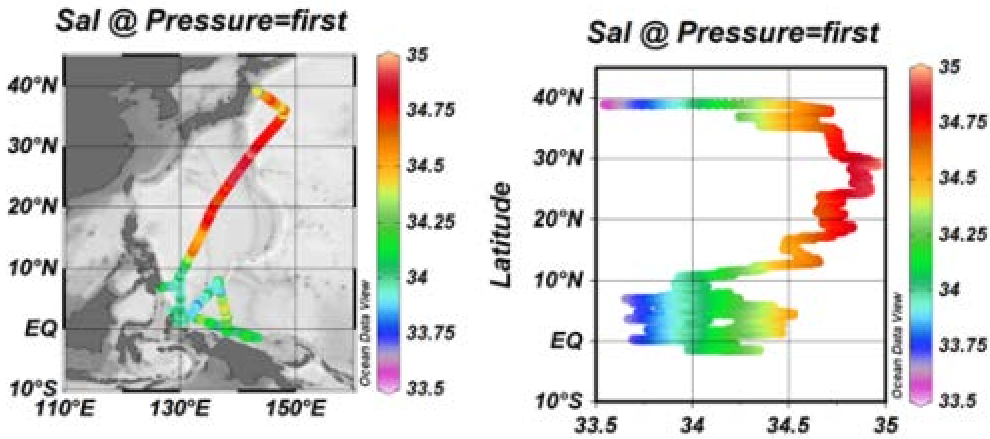


Fig.6.4.1-1 Correlation of salinity between sensor data and bottle data.

(a) Temperature



(b) Salinity



(c) Dissolved oxygen

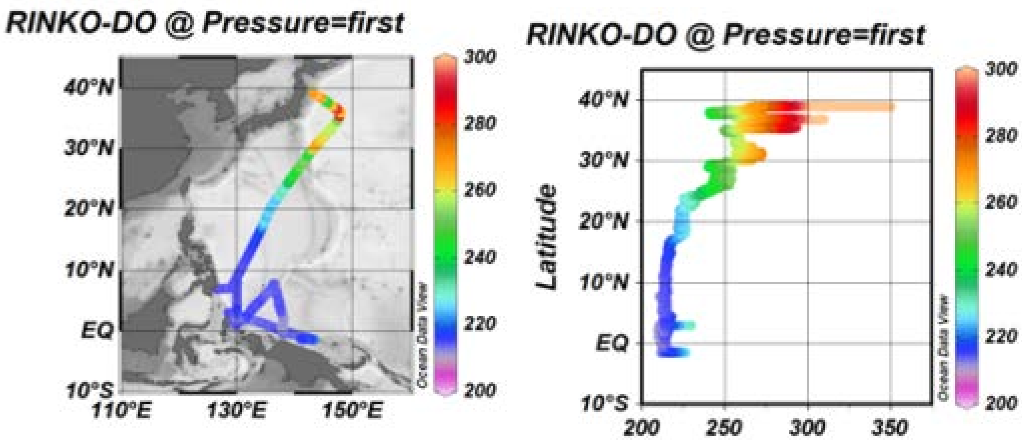


Fig.6.4.1-2 Spatial and temporal distribution of (a) temperature by SBE38 (b) salinity (c) dissolved oxygen by RINKO in MR13-01 cruise.

6.5 Shipboard ADCP

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Shinya Okumura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Toshimitsu Goto	(GODI)
Ryo Ohyama	(MIRAI Crew)

(2) Objective

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

(3) Methods

Upper ocean current measurements were made through MR13-01 cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system. For most of its operation the instrument was configured for water-tracking mode. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made to get the calibration data for evaluating transducer misalignment angle. The system consists of following components;

1) R/V MIRAI has installed the Ocean Surveyor for vessel-mount (acoustic frequency 76.8 kHz; Teledyne RD Instruments). It has a phased-array transducer with single ceramic assembly and creates 4 acoustic beams electronically. We mounted the transducer head rotated to a ship-relative angle of 45 degrees azimuth from the keel
2) For heading source, we use ship's gyrocompass (Tokimec, Japan), continuously providing heading to the ADCP system directory. Additionally, we have Inertial Navigation System (INS) which provide high-precision heading, attitude information, pitch and roll, are stored in ".N2R" data files with a time stamp.
3) DGPS system (Trimble SPS751 & StarFixXP) providing position fixes.
4) We used VmDas version 1.46.5 (TRD Instruments) for data acquisition.
5) To synchronize time stamp of ping with GPS time, the clock of the logging computer is adjusted to GPS time every 1 minute
6) We have placed ethylene glycol into the fresh water to prevent freezing in the sea chest.
7) The sound speed at the transducer does affect the vertical bin mapping and vertical velocity measurement, is calculated from temperature, salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by equation in Medwin (1975).

Data was configured for 16 m processing bin, 40 m intervals and starting 24 m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short-term average (.STA) and long-term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown in Table 6.5-1.

(4) Preliminary results

Fig.6.5-1 shows the surface current vector along the ship's track.

(5) Data archive

These data obtained in this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC, and will be opened to the public via JAMSTEC home page.

(6) Remarks

The following period, observation was stopped, because we navigated in EEZ of Papua New Guinea.

14:30 UTC 28 Feb 2013 - 13:59 UTC 01 Mar 2013

Table 6.5-1 Major parameters

Bottom-Track Commands			
BP	=	001	Pings per Ensemble (almost less than 1300m depth)
BP	=	000	Disable bottom-track ping (almost over 1300m depth)
Environmental Sensor Commands			
EA	=	+04500	Heading Alignment (1/100 deg)
EB	=	+00000	Heading Bias (1/100 deg)
ED	=	00065	Transducer Depth (0 - 65535 dm)
EF	=	+001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH	=	00000	Heading (1/100 deg)
ES	=	35	Salinity (0-40 pp thousand)
EX	=	00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ	=	10200010	Sensor Source (C; D; H; P; R; S; T; U)
			C (1): Sound velocity calculates using ED, ES, ET (temp.)
			D (0): Manual ED
			H (2): External synchro
			P (0), R (0): Manual EP, ER (0 degree)
			S (0): Manual ES
			T (1): Internal transducer sensor
			U (0): Manual EU
Timing Commands			
TE	=	00:00:02.00	Time per Ensemble (hrs:min:sec.sec/100)
TP	=	00:02.00	Time per Ping (min:sec.sec/100)
Water-Track Commands			

WA	=	255	False Target Threshold (Max) (0-255 count)
WB	=	1	Mode 1 Bandwidth Control (0=Wid, 1=Med, 2=Nar)
WC	=	120	Low Correlation Threshold (0-255)
WD	=	111 100 000	Data Out (V; C; A; PG; St; Vsum; Vsum^2;#G;P0)
WE	=	1000	Error Velocity Threshold (0-5000 mm/s)
WF	=	0800	Blank After Transmit (cm)
WG	=	001	Percent Good Minimum (0-100%)
WI	=	0	Clip Data Past Bottom (0 = OFF, 1 = ON)
WJ	=	1	Rcvr Gain Select (0 = Low, 1 = High)
WM	=	1	Profiling Mode (1-8)
WN	=	40	Number of depth cells (1-128)
WP	=	00001	Pings per Ensemble (0-16384)
WS	=	1600	Depth Cell Size (cm)
WT	=	000	Transmit Length (cm) [0 = Bin Length]
WV	=	0390	Mode 1 Ambiguity Velocity (cm/s radial)

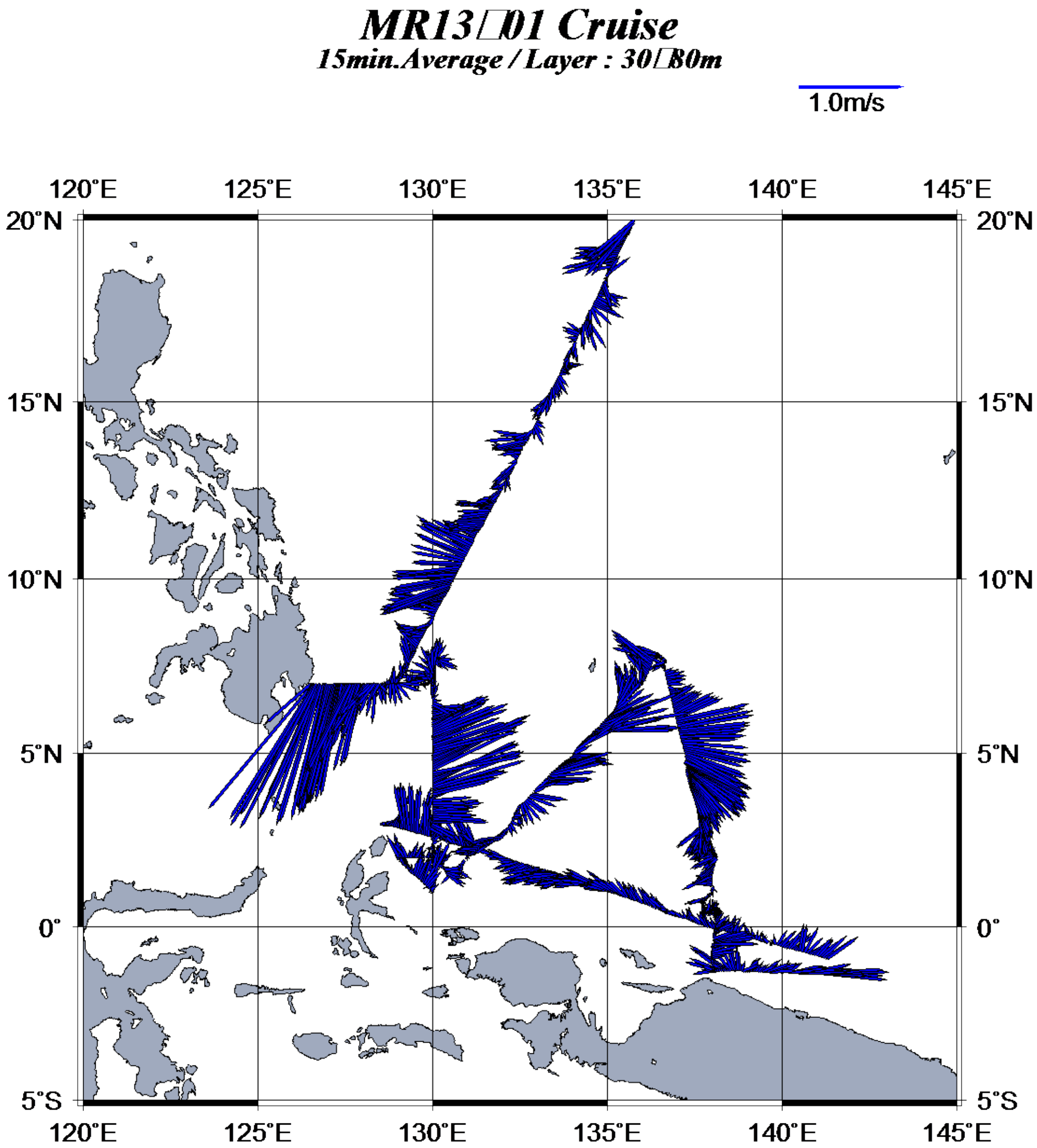


Fig 6.5-1. Current vector along the ship's track.

6.6 Underway geophysics

Personnel

Yuji Kashino	(JAMSTEC) : Principal Investigator
Takeshi Matsumoto	(University of the Ryukyus) : Principal Investigator (Not on-board)
Shinya Okumura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Toshimitsu Goto	(GODI)
Ryo Ohyama	(MIRAI Crew)

6.6.1. Sea surface gravity

(1) Introduction

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

(2) Parameters

Relative Gravity [CU: Counter Unit]

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

(3) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during the MR13-01 cruise.

To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (Scintrex gravity meter CG-5), at Sekinehama as the reference point.

(4) Preliminary Results

Absolute gravity shown in Tabel 6.6.1-1

(5) Data Archives

Surface gravity data obtained during this cruise will be submitted to the Data Management Group (DMG) of JAMSTEC, and will be archived there.

(6) Remarks

The following period, observation was stopped, because we navigated in EEZ of Papua New Guinea.

14:30 UTC 28 Feb 2013 - 13:59 UTC 01 Mar 2013

Table 6.6.1-1 Absolute gravity table

No	Date	UTC	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R*[2] Gravity [mGal]
#1	4-Nov-12	01:13	Sekinehama	980,371.93	261	625	980,372.95	12,611.57
#2	29-Mar-13	02:33	Sekinehama	980,371.93	323	575	980,373.03	12,610.35

*[1]: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.2222

*[2]: LaCoste and Romberg air-sea gravity meter S-116

6.6.2 Sea surface magnetic field

1) Three-component magnetometer

(1) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR13-01 cruise.

(2) Principle of shipboard geomagnetic vector measurement

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

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

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

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

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

(3) Instruments on R/V MIRAI

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

(4) Data Archives

These data obtained in this cruise will be submitted to the Data Management Group (DMG) in JAMSTEC.

(5) Remarks

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

   02 Mar 2013, 14:10 – 14:35 UTC around 00-29.59S / 138-02.25E.

   17 Mar 2013, 12:01 – 12:31 UTC around 07-01.49N / 129-00.68E.

   24 Mar 2013, 00:00 – 00:28 UTC around 36-06.06N / 147-51.78E.

2) The following period, observation was stopped, because we navigated in EEZ of Papua New Guinea.

   14:30 UTC 28 Feb 2013 - 13:59 UTC 01 Mar 2013

2) Cesium magnetometer

(1) Introduction

Measurement of total magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. But observation was canceled in this cruise; due to we had to recovered drift buoy (N-KEO BUOY) immediately.

6.6.3. Swath Bathymetry

1) Multi beam echo sounding system

(1) Introduction

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 3012 Upgrade Model (L3 Communications ELAC Nautik). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

(2) Data Acquisition

The "SEABEAM 3012 Upgrade Model" on R/V MIRAI was used for bathymetry mapping during the MR13-01 cruise.

To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data to get the sea surface (6.62m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD, XCTD and Argo float data by the equation in Del Grosso (1974) during the cruise. Table 6.6.3-1 shows system configuration and performance of SEABEAM 3012 system.

Table 6.6.3-1 SEABEAM 3012 System configuration and performance

Frequency:	12 kHz
Transmit beam width:	1.6 degree
Transmit power:	20 kW
Transmit pulse length:	2 to 20 msec.
Receive beam width:	1.8 degree
Depth range:	100 to 11,000 m
Beam spacing:	0.5 degree athwart ship
Swath width:	150 degree (max) 120 degree to 4,500 m 100 degree to 6,000 m 90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or ±1m, Whichever is greater, over the entire swath. (Nadir beam has greater accuracy; typically within < 0.2% of depth or ±1m, whichever is greater)

(3) Preliminary Results

The results will be published after primary processing.

(4) Data Archives

Bathymetric data obtained during this cruise will be submitted to the Data Management Group (DMG) in JAMSTEC, and will be archived there.

(5) Remark

The following period, observation was stopped, because we navigated in EEZ of Papua New Guinea.

14:30 UTC 28 Feb 2013 - 13:59 UTC 01 Mar 2013

7 Special Observations

7.1 TRITON buoys

7.1.1 Operation of TRITON buoys

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Keisuke Matsumoto	(MWJ): Operation Leader
Akira Watanabe	(MWJ): Technical Leader
Takayuki Hashimukai	(MWJ): Technical Staff
Makito Yokota	(MWJ): Technical Staff
Takatoshi Kiyokawa	(MWJ): Technical Staff
Hirokatsu Uno	(MWJ): Technical Staff
Kenichi Katayama	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Shungo Oshitani	(MWJ): Technical Staff
Rei Ito	(MWJ): Technical Staff
Keitaro Matsumoto	(MWJ): Technical Staff
Keisuke Tsubata	(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).

Five TRITON buoys have been successfully recovered and three TRITON buoys deployed during this R/V MIRAI cruise (MR13-01).

(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, 137E
ID number at JAMSTEC	10011
Number on surface float	T06
ARGOS PTT number	27961
ARGOS backup PTT number	27411
Deployed date	9 Mar. 2013
Exact location	07-38.96N, 136-41.95E
Depth	3,171 m

Nominal location	5N, 137E
ID number at JAMSTEC	11011
Number on surface float	T07
ARGOS PTT number	27401
ARGOS backup PTT number	29692
Deployed date	7 Mar. 2013
Exact location	04-56.43Ｎ, 137-18.10Ｅ
Depth	4,131 m

Nominal location	2N, 138E
ID number at JAMSTEC	12013
Number on surface float	T14
ARGOS PTT number	27389

ARGOS backup PTT number	29694
Deployed date	5 Mar. 2013
Exact location	02-03.93N, 138-03.83E
Depth	4,322m

(6) TRITON recovered

Nominal location	8N, 137E
ID number at JAMSTEC	10010
Number on surface float	T24
ARGOS PTT number	28151
ARGOS backup PTT number	7860
Deployed date	24 Aug. 2011
Recovered date	9 Mar. 2013
Exact location	07-52.00N, 136-29.59E
Depth	3,355 m

Nominal location	5N, 137E
ID number at JAMSTEC	11010
Number on surface float	T25
ARGOS PTT number	27958
ARGOS backup PTT number	24234
Deployed date	25 Aug. 2011
Recovered date	7 Mar. 2013
Exact location	04-51.57N, 137-16.03E
Depth	4,110 m

Nominal location	2N, 138E
ID number at JAMSTEC	12012
Number on surface float	T27
ARGOS PTT number	28149
ARGOS backup PTT number	24238
Deployed date	28 Aug. 2011
Recovered date	5 Mar. 2013
Exact location	01-59.98N, 138-05.98E
Depth	4,320m

Nominal location	EQ, 138E
ID number at JAMSTEC	13012
Number on surface float	T12
ARGOS PTT number	29768
ARGOS backup PTT number	7881
Deployed date	30 Aug. 2011
Recovered date	This buoy wasn’t recovered. Table. 7.1.1-1 show operation record.
Exact location	00-04.31N, 138-02.84E
Depth	4,206m

Nominal location	8N, 130E
ID number at JAMSTEC	14009
Number on surface float	T28
ARGOS PTT number	29874
ARGOS backup PTT number	27410
Deployed date	7 Sep. 2011
Recovered date	14 Mar. 2013
Exact location	07-58.86N, 130-02.69Ｅ
Depth	5,726m

Nominal location	2N, 130E
ID number at JAMSTEC	16010
Number on surface float	T13
ARGOS PTT number	None
ARGOS backup PTT number	27406, 27409
Deployed date	4 Sep. 2011
Recovered date	11 Mar. 2013
Exact location	01-57.17N, 130-11.38Ｅ
Depth	4,371m

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

Table. 7.1.1-1 Operation record of recovery, No.13012 TRITON buoy.

Date(UTC)	Time(UTC)	Action	Remark
10 Feb. 2013	-	-	**No. 13012 TRITON buoy drifted from deploymed position.**
28 Feb.2013	20:50	Confirm top buoy drifted ashore to Aua Island(Papua New Guinea)	
	23:00～	Visual check for top buoy by workboat	
	23:40～	Visual confirmation for Aua Islands circumference	
1 Mar. 2013	00:54～01:28	Discover and recover a drifting recovery buoy(No. 719)	Position of discovered recovery buoy: 01-25.16620S 143-07.21230E
	01:30～	Search for other recovery buoys	
	03:54～04:32	Discover and recover a drifting recovery buoy(No. 805)	Position of discovered recovery buoy: 01-22.09110S 143-06.80610E
2 Mar. 2013	21:49	Send enable command to lower A/R(Acoustic Releaser)	
	23:00	Send release command to lower A/R	A/R's floatation wasn't confirmed.
	23:15	Send enable command to upper A/R	
	23:16	Send release command to upper A/R	A/R's floatation wasn't confirmed.

(7) Details of deployed

We had deployed three TRITON buoys. Table. 7.1.1-2 show them details.

Table. 7.1.1-2 Deployment TRITON buoys details

Observation No.	Location	Details
10011	8N137E	Deploy with full spec and 1 optional unit. JES10-CTIM : 751m
11011	5N137E	Deploy with full spec and 2 optional units. SBE37 (CT) : 175m JES10-aC: 751m
12013	2N138E	Deploy with full spec and 1 optional unit. SBE37 (CT): 175m

(8) Data archive

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

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

7.1.2 Inter-comparison between shipboard CTD and TRITON transmitted data

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Keisuke Matsumoto	(MWJ): Technical Staff
Akira Watanabe	(MWJ): Technical Staff
Rei Ito	(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 6.2.1) on R/V MIRAI for this intercomparison. We conducted 1 CTD cast at each TRITON buoy site before recovery, conducted 1 CTD or XCTD 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 (X)CTD data on R/V MIRAI and the TRITON buoy data for each deployment and recovery of buoys.

XCTD has large differences from TRITON data, therefore we did not compare the each data. Some recovered TRITON buoys couldn't compare the data, because No.14, 16 buoys didn't transmit ARGOS satellite data , and No.13 buoy couldn't recover during this cruise.

Compared site

Observation No.	Latitude	Longitude	Condition
10011	8N	137E	After Deployment
11011	5N	137E	After Deployment
10010	8N	137E	Before Recover
11010	5N	137E	Before Recover
12012	2N	138E	Before Recover

(5) Results

Most of temperature, conductivity and salinity data from TRITON buoy showed good agreement with CTD cast data in T-S diagrams. See the Figures 7.1.2-1(a) (b).

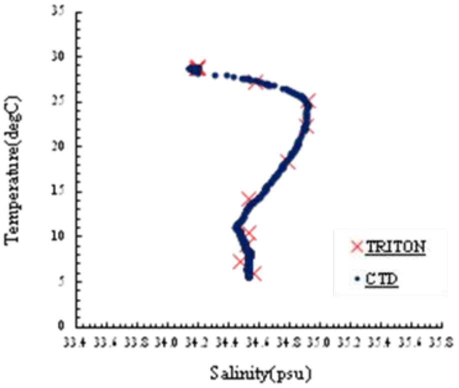
To evaluate the performance of the conductivity sensors on TRITON buoy, the data from had deployed buoy and shipboard CTD data at the same location were analyzed.

The estimation was calculated as deployed buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.0686 to 0.2113 for all depths. Below 300db, salinity differences are from –0.0579 to 0.0292 (See the Figures 7.1.2-2 (a)). The average of salinity differences was 0.0020 with standard deviation of 0.0576.

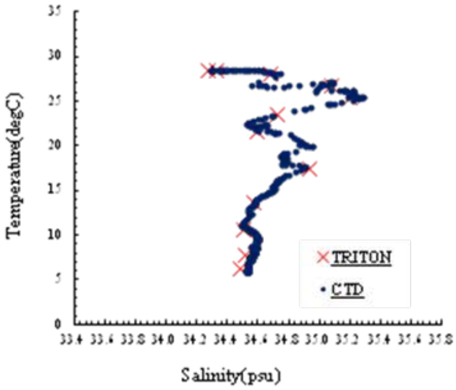
The estimation was calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.7097 to 0.1539 for all depths. Below 300db, salinity differences are from -0.0735 to 0.0598 (See the Figures 7.1.2-2(b)). The average of salinity differences was -0.0217 with standard deviation of 0.1439.

(6) Data archive

All raw and processed CTD data files were submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch.

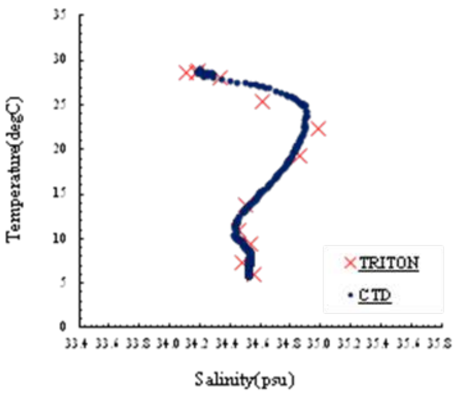


Observation No. 10011 after deployment

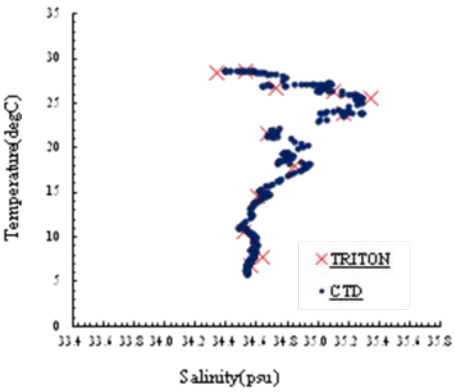


Observation No. 11011 after deployment

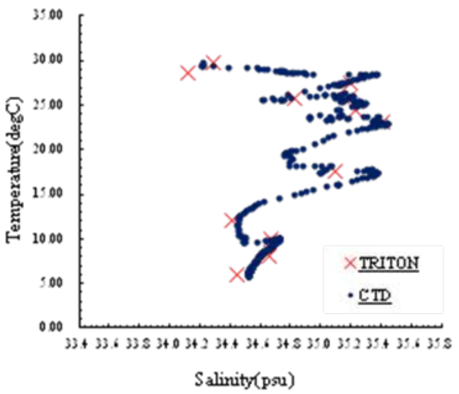
Fig.7.1.2.-1(a) T-S diagram of TRITON buoys data and shipboard CTD data



Observation No. 10010 before recovery



Observation No. 11010 before recovery



Observation No. 12012 before recovery

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

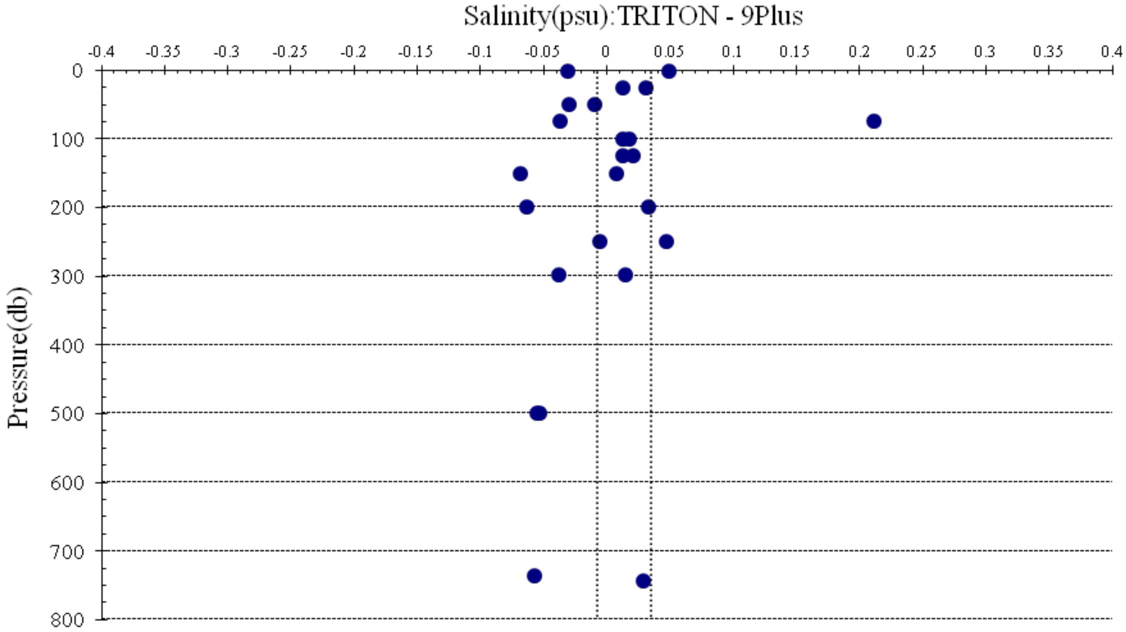


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

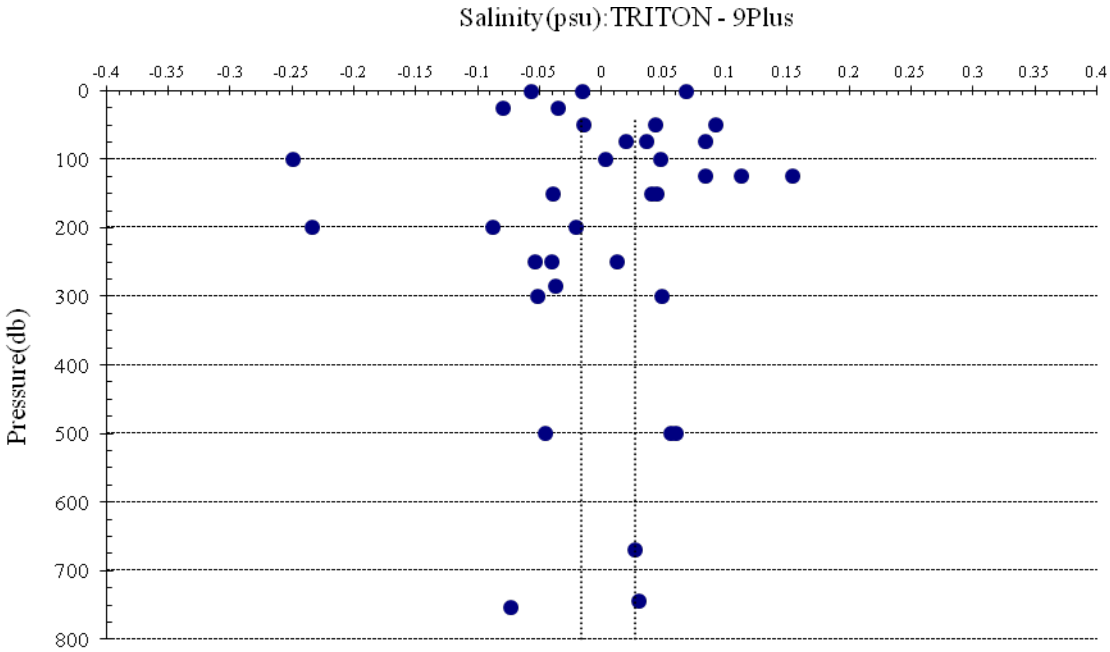


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

7.1.3 JAMSTEC original CTD sensor for TRITON buoy

1) Personnel

Yukio Takahashi (JAMSTEC): Engineer

2) Objectives

(1) The evaluation of long-term drift and the effect of preventing marine bio-fouling properties of the CTD sensors developed by JAMSTEC.

(2) Sensors newly have developed by JAMSTEC, in order to evaluate the conductivity drift. These were deployed in this cruise.

(a) CT sensor equipped with a conductivity cell that was developed in JAMSTEC.

(b) C sensor aimed at ultra-low drift of conductivity

3) Evaluation of log-term drift

In MR11-06 cruise, CTD sensors (JES10-CTDIM SN003, JES10-CTDIM SN002) were deployed in TRITON buoys. Locations are 8N, 130E and 2N, 138E. Both the installation depth is 750m. These two sensors were recovered in this cruise.

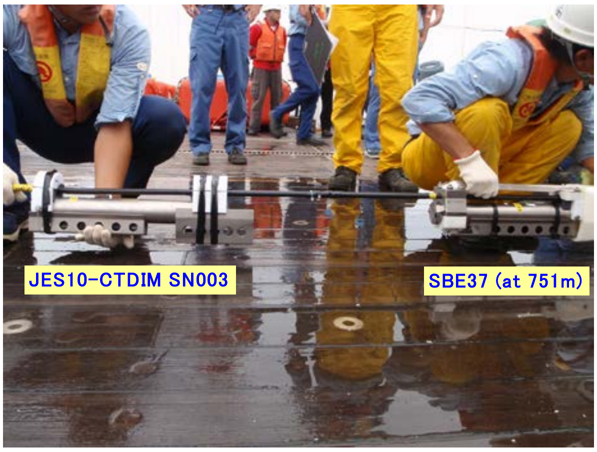


Photo 7.1.4-1 JES10-CTDIM SN003.

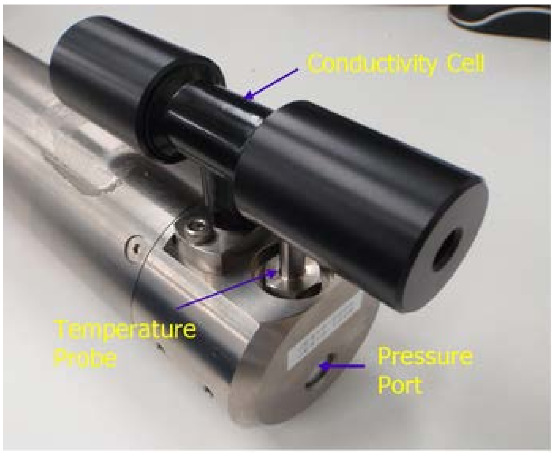


Photo 7.1.4-2 Sensor head

Figure 7.1.4-1 and 7.1.4-2 show the measurement results of the mooring period together with SBE37 that was attached in the vicinity of these sensors. Amount of drift of the sensor in mooring period, it is planned to be evaluated at the Post-calibration-.

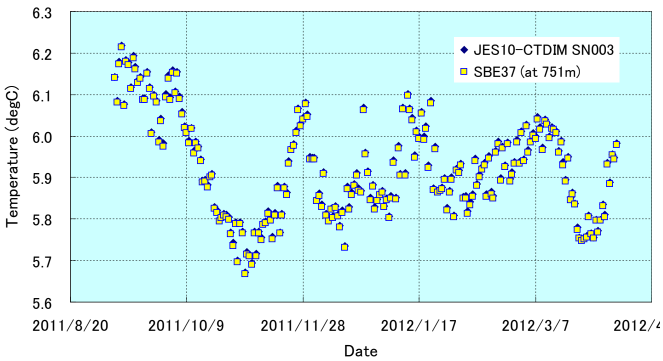


Figure 7.1.4-1 Temperature

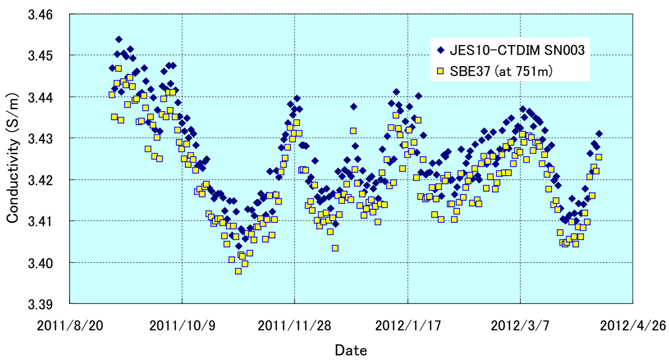


Figure 7.1.4-2 Conductivity

4) Evaluation of marine bio-fouling prevention

On MR11-06 cruise, CT sensor (JES10-CTIM SN001) with a new anti-foulant device was deployed on TRIOTN buoy at the location of 8N137E, and depth of 26m. On behalf of TBTO, the mesh of BeCu has been attached on each end of the conductivity cell. In addition, we also have applied a silicon-based antifouling paint mixed with marine derived anti-fouling, at the outer wall of the conductivity cell (Photo 7.1.4-3).

Photo 7.1.4-4 and 7.1.4-5 show the state of bio-fouling. Some small shellfishes were observed in the inner wall of the cell. The mesh of BeCu was dissolved entirely in sea water. Therefore, the ability of anti-foulant was lost on the way. I think that a thick plate of BeCu would be better for a long-term mooring.

Figure 7.1.4-3 shows the measurement results of the mooring period together with SBE37 that was attached in the vicinity of this sensor. Amount of drift of the sensor in mooring period, it is planned to be evaluated at the Post-calibration.

Photo 7.1.4-3 CT sensor attached BeCu on each end of the conductivity cell

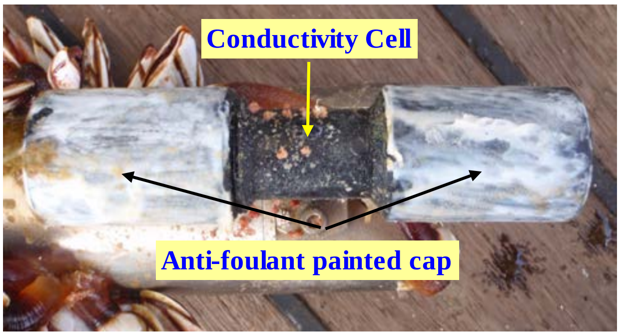


Photo 7.1.4-4 Recovered the sensor head

Photo 7.1.4-5 State of bio-fouling at the conductivity cell interior

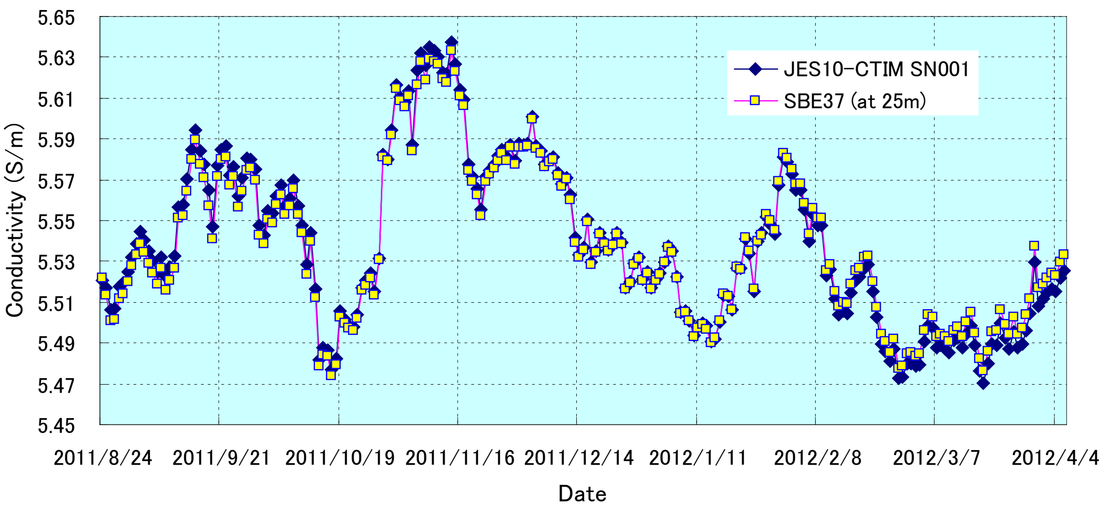


Fig. 7.1.4-3 Day average conductivity of JES10 and SBE37

5) CT sensor newly developed

The CT sensor newly developed, has deployed in TRITON buoy on this cruise. We are planning post-calibration to evaluate the drift characteristics after buoy recovery.

(1) JES10-CTIM SN004 (deployed on TRTION buoy of location 8N137E, at 750m depth)

This sensor is a CT sensor equipped with a platinized electrode conductivity cells developed in JAMSTEC. By this sensor, other than the inductive modem module was domestically produced. The photo 7.1.4-6 shows the glass cell of the conductivity. Photo 7.1.4-7 shows the CT sensor equipped with this cell. Using SUS316 housing of 62mm/φ, is reduced cost of the housing.

Photo 7.1.4-6 Glass cell of conductivity cell

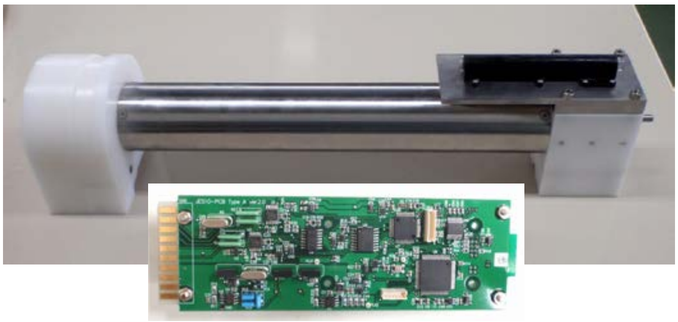


Photo 7.1.4-7 JES10-CTIM SN004

(2) JES10-aC (deployed on TRTION buoy of location 5N137E, 750m depth)

Aimed at the ultra-low drift of conductivity, we have developed a conductivity process using an analog-digital (AD) conversion system. In the conventional method, the conductivity process has an internal RC oscillator circuit, and the oscillation frequency is variable by the resistance of the conductivity cell. This method has been counted the oscillation frequency by a frequency counter. In this scheme, the circuit drift of the conductivity is determined by the drift characteristics of the fixed resistor and capacitor, these determine the frequency of the oscillation circuit RC. On the other hand, in the AD conversion system, a low-frequency constant current drives the conductivity cell and the reference resistor. The AD converted signal is applied to both devices, the resistance of the conductivity cell is calculated by the reference resistor and the amplitude ratio of the two signals. In this scheme, a circuit drift of the conductivity is determined solely by the drift characteristics of the reference resistor. Photo 7 is C sensor equipped with the AD conversion system. The conductivity cell and the housing is to reuse the SBE37.

Photo 7.1.4-8 JES10-aC SN001 and the circuit board

6) CTD casting

CTD casting of the CT sensor newly developed (JES10-CTIM SN004), was conducted. Table 7.1.4-1 shows a comparison of the results of the two measurements (JES10 & SBE 9plus). The difference between the conductivity results is about 0.0006 S/m. Figure 7.1.4-4 shows the response of conductivities around depth of 300m.

Table 7.1.4-1 CTD casting

(S/m)

Depth	JES10-CTIM	9Plus	Residual
800m	3.42650	3.42709	−0.00058
	0.000258	0.000038	−
500m	3.62904	3.62958	−0.00055
	0.000324	0.000300	−
300m	3.80027	3.80083	−0.00056
	0.000334	0.000446	−

(upper: average, lower: std.)

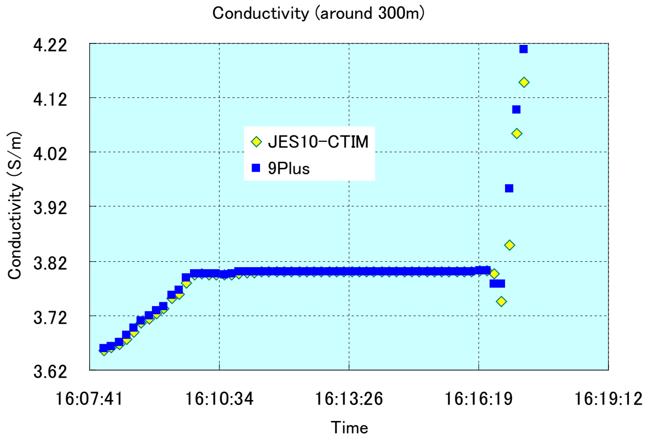


Figure 7.1.4-4 Response of conductivities

7.2 The maintenance of the Ina-TRITON buoy

1) Personnel

Yasuhisa Ishihara (Not onboard) (JAMSTEC): Engineer

2) Objectives

Ina-TRITON buoy was deployed at the position of 00-30'N, 138-02'E in 12th of September 2012 by Indonesia BPPT R/V "BARUNA JAYA III (BJ3)". After the deployment, BPPT confirmed that Iridium satellite data transmission did not work and they could not calculate the exact deployment position. They tried on deck repair to fix this problem, but they could not fix during their cruise. And because of multi narrow echo sounding system trouble of R/V "BJ3" , BPPT could not survey the bottom for No.2 Ina-TRITON buoy deployment area. In 9th January 2013, Satellite position beacon system stopped suddenly. BPPT could not monitor the position of buoy. To solve these problem, according to the IA between JAMSTEC and BPPT, BPPT requested as below during the R/V "MIRAI" MR13-01 cruise.

(1) Repair a iridium satellite data transmission system of the buoy.

(2) Repair a satellite position beacon system of the buoy.

(3) Calibrate the exact position of the underwater acoustic releaser of the mooring system.

(4) Bottom survey for the No.2 Ina-TRITON buoy deployment area.

3) Result

R/V MIRAI searched the surface buoy around the estimated deployment position of 00-30'N, 138-02'E from 1:50 until 5:00 in the 3rd of March. But the surface buoy has disappeared.

After that R/V MIRAI tried the position calibration of the underwater acoustic releaser of the mooring and succeeded. The exact position of the underwater acoustic releaser was 00-30.755'N, 138-02.410'E

R/V "MIRAI" surveyed the bottom for the No.2 Ina-TRITON buoy deployment area.

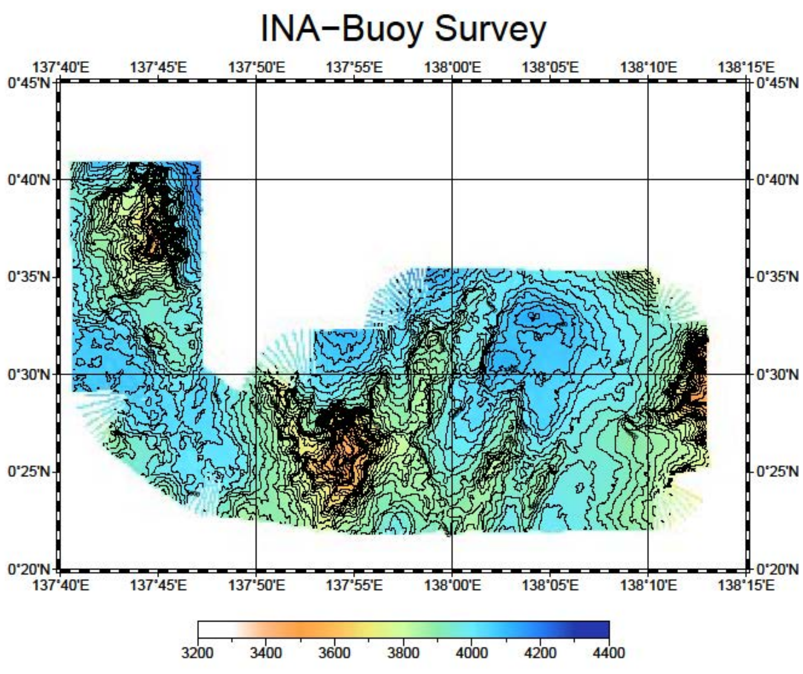


Fig 7.2 Result for bottom survey of No.2 Ina-TRITON buoy deployment area.

7.3 Emergent recovery of K-TRITON buoy

(1) Personnel

Yuji Kashino	(JAMSTEC)	
Keisuke Matsumoto	(MWJ)	
Hirokatsu Uno	(MWJ)	
Not on board:		
Yoshimi Kawai	(JAMSTEC)	Principal Investigator

(2) Objective

JAMSTEC deployed one of K-TRITON buoys at NKEO site in the Kuroshio Extension region on 22 June 2012 in the MR12-02 cruise. The objective of the moored-buoy observation was to investigate the air-sea interaction around the Kuroshio Extension, where a large amount of heat is released from the ocean. In addition, a GPS wave gauge was attached on the K-TRITON buoy for freak wave research and wave prediction. We planned to recover the K-TRITON buoy at NKEO site in the summer of 2013 (one year only).

In the morning on 9 March 2013, Argos position data showed that the K-TRITON buoy was fast drifting eastward. We inferred from the Argos data that the mooring wire or rope was cut around 18:00 on 8 March (UT). JAMSTEC decided to emergently recover the drifting K-TRITON buoy in the MR13-01 cruise because there was not any other ship that could recover the buoy in this region.

(3) Results

The drifting K-TRITON buoy was found around 16:00 on 23 March by R/V Mirai. The recovery operations started at 22:58 and ended at 23:47 on 23 March (Table 7-3-1). The drift track of the K-TRITON buoy is shown in Fig.7-3-1. The top buoy (buoy hull) was not damaged at all (Fig.7-3-2). However, the mooring wire was broken at the point of 11.415 m from the top of the wire, which was at about 14 m depth. We could not recover the instruments that were deployed deeper than 14m. There were several other scratches on the wire (at 7.65, 7.67, 7.93, 7.96, 9.05, 10.455, 10.725, 10.76, and 11.10 m from the top of the wire), and the wire coat peeled off at 10.725, 10.76, and 11.10 m. The broken part looked quite sharp (Fig.7-3-3).

We will attempt to recover the rest of the mooring in the cruise of R/V Kaiyo in the summer of 2013.

[Positions]

Mooring point (anchor position):	33°50.6977'N,	144°54.1396'E
Found the buoy:	35°57'N,	148°03'E
Recovered the buoy:	36°05.29'N,	147°53.00'E

[Recovered instruments]

K-TRITON buoy	1	JAMSTEC
Anemometer	1	JAMMET (WND11015u)
Thermometer/hygrometer	1	JAMMET (HRH11029)
Thermometer/hygrometer	1	HOBO CO-U23-001 (10033610)
Shortwave radiometer	1	ASIMET (SWR228)
Longwave radiometer	1	ASIMET (LWR237)
Barometer	1	JAMMET (BAR11011)
Rain gauge	1	JAMMET (RAN11039)
Weather transmitter	1	WXT520 (F4830016)
Wave gauge	1	Zeni lite buoy
CT sensor	1	SBE 37-IMP (8330)
Current meter	1	Nortek Aquadopp (70001111)

[Not recovered instruments]

CT sensor	1	SBE 37-IM (8903)
CTD sensor	2	SBE 37-IM (8905, 8906)
DO sensor	3	RINKO-I (0075, 0076, 0077)
Transponder	1	Benthos XT6000 (47654)
Glass ball	18	Benthos
Acoustic releaser	2	Bnthos 865A (1084, 1121)

(4) Data archives

The meteorological and oceanic data obtained at the K-TRITON buoy are released through the Internet (http://www.jamstec.go.jp/iorgc/ocorp/ktsfg/data/jkeo/JKEOdata.htm).

Table 7-3-1. Operation log.

Date	Time		Event
	(JST)	(UTC)	
			Japan Standard Time is (UTC+9h)
22 Jun. 2012	13:03	04:03	K-TRITON buoy was deployed at NKEO site
9 Mar. 2013	03:00	18:00 (-1d)	The mooring wire was cut
24 Mar.	01:00	16:00 (-1d)	Found the K-TRITON buoy
	07:58	22:58 (-1d)	Started the recovery operations. Boat down.
	08:39	23:39 (-1d)	Raised the buoy hull.
	08:47	23:47 (-1d)	Buoy on deck. Finished the recovery operations.

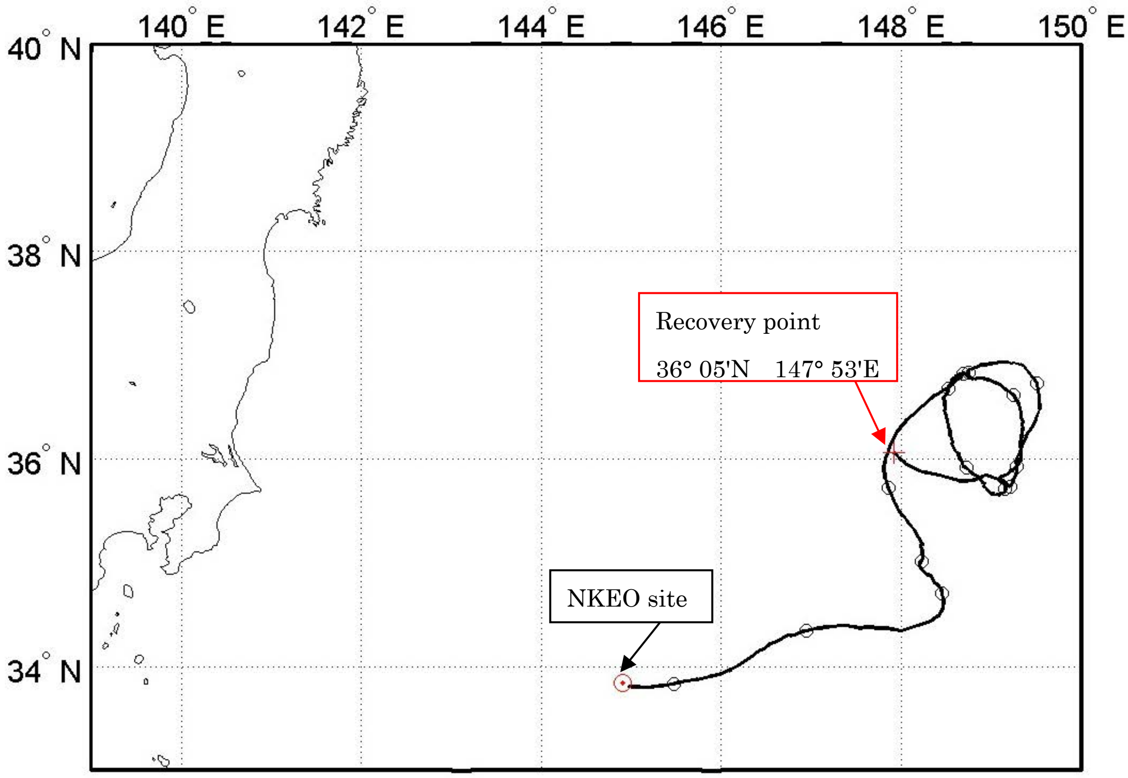
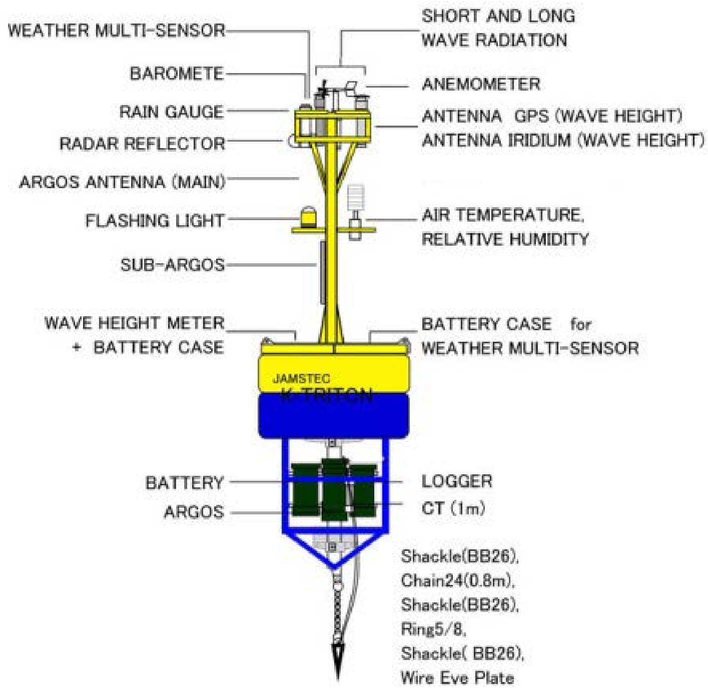


Figure 7-3-1. Drift track of the K-TRITON buoy.

TOP BUOY



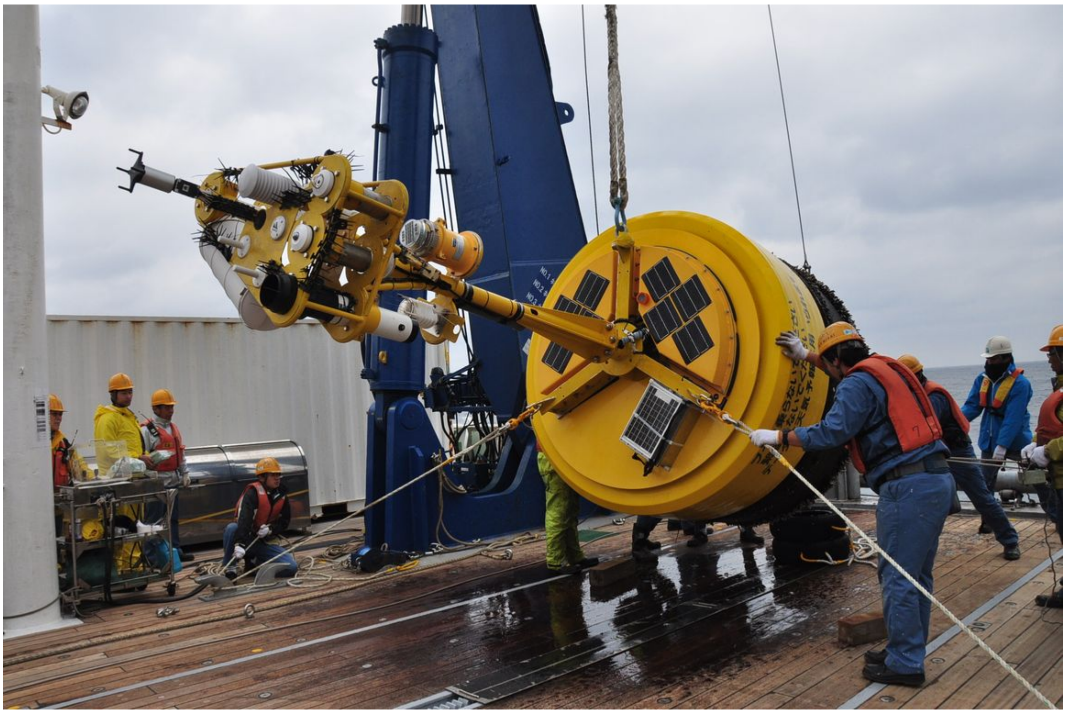


Figure 7-3-2. Recovered K-TRITON buoy.

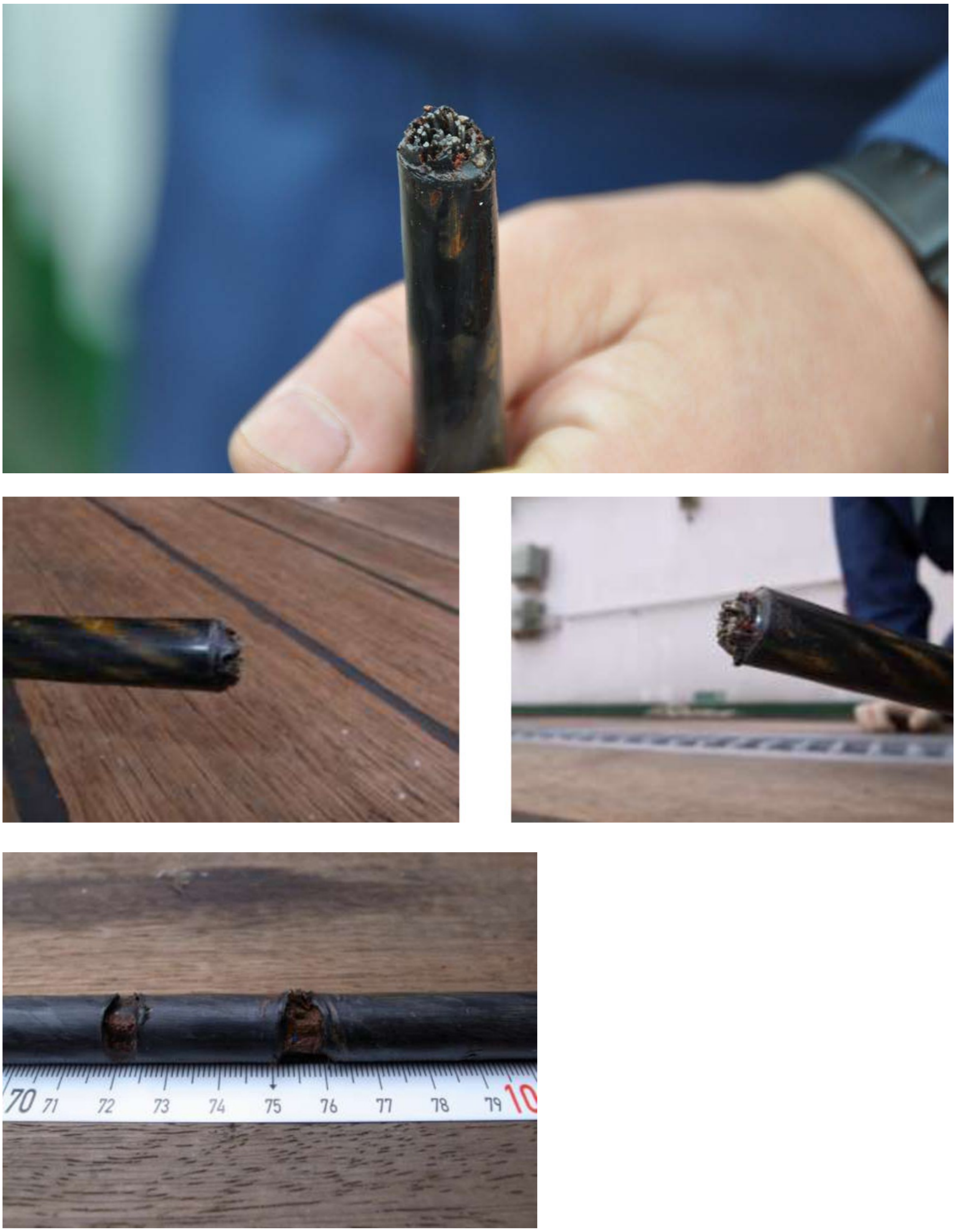


Figure 7-3-3. Photos of broken parts of the wire.

7.4 Subsurface ADCP moorings

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Akira Watanabe	(MWJ): Operation leader
Hirokatsu Uno	(MWJ): Technical staff
Keisuke Matsumoto	(MWJ): Technical staff
Hiroki Ushiromura	(MWJ): Technical staff
Rei Ito	(MWJ): Technical staff
Takayuki Hashimukai	(MWJ): Technical staff
Makito Yokota	(MWJ): Technical staff
Takatoshi Kiyokawa	(MWJ): Technical staff
Keitaro Mastumoto	(MWJ): Technical staff
Keisuke Tsubata	(MWJ): Technical staff

(2) Objectives

The purpose of this ADCP observation is to get knowledge of physical process underlying the dynamics of oceanic circulation in the western equatorial Pacific Ocean. We have been observing subsurface currents using ADCP moorings along the equator region. In this cruise (MR13-01), we recovered two subsurface ADCP moorings at 7N-127E and 7N-128E.

(3) Parameters

- Current profiles
- Echo intensity
- Pressure, Temperature and Conductivity

(4) Instruments

1) Current meters

WorkHorse ADCP 75kHz (Teledyne RD Instruments, Inc.)

Distance to first bin : 7.04 m

Pings per ensemble : 27

Time per ping : 6.66 seconds

Number of depth cells: 60

Bin length : 8.00 m

Sampling Interval : 3600 seconds

RCM9(AANDERAA INSTRUMENTS)

Temperature Range : Low

Sampling Interval : 3600 seconds

3-D Acoustic Current Meter(Falmouth Scientific Inc.)

Sampling Interval : 3600 seconds

Average Interval : 30 seconds

On time : 30 seconds

AQUADOPP Deep Water Current Meter(NORTEC AS)

Sampling Interval : 3600 seconds

Average Interval : 30 seconds

2) CTD

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

3) Other instrument

Acoustic Releaser (BENTHOS,Inc.)

Transponder (BENTHOS,Inc.)

(5) Recovery

We recovered ADCP moorings at 7N-127E. This ADCP moorings was deployed on 11 Sep.2011 (MR11-06cruise). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. Figure 7.3 show results from the mooring.

However, we failed recovery of ADCP moorings at 7N-128E. This ADCP moorings was deployed on 10 Sep.2011(MR11-06cruise).Table 7.3 show the operation record of recovery .

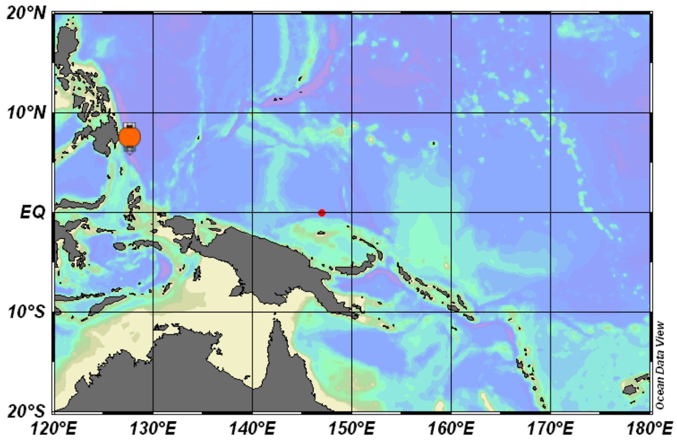
Table.7.3 Operation record of recovery, ADCP moorings at 7N-128E.

Date(UTC)	Time(UTC)	Action	Remark
16 Mar.2013	22:09	Send enable command to lower A/R(Acoustic Releaser)	Lower A/R depth was about 5,700m.*
	22:13	Send release command to lower A/R	Lower A/R was confirmed floatation.
	22:13～23:17	Search for top float	Top float wasn't discovered. A/R's floatation stoped about 4,800m.
17 Mar.2013	0:42	Send enable code to upper A/R	Upper A/R depth was about 4,800m.
	0:46	Confirm A/R depth	Lower A/R depth was about 4,800m.
	01:20～02:40	Search for toransponder under the top float	Response from toransponder wasn't confirmed.
	2:57	Confirm A/R depth	Upper A/R depth was about 4,800m. Lower A/R depth was about 4,800m.
	03:08～03:20	Calibration of A/R position and depth	Position and depth of upper A/R(reference value): **7-00.1233 N** **127-46.1061 E** **4,839m**
			Position and depth of lower A/R(reference value): **7-00.1158 N** **127-46.0966 E** **4,854m**

*All depth was by SSBL.

(6) Data archive

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



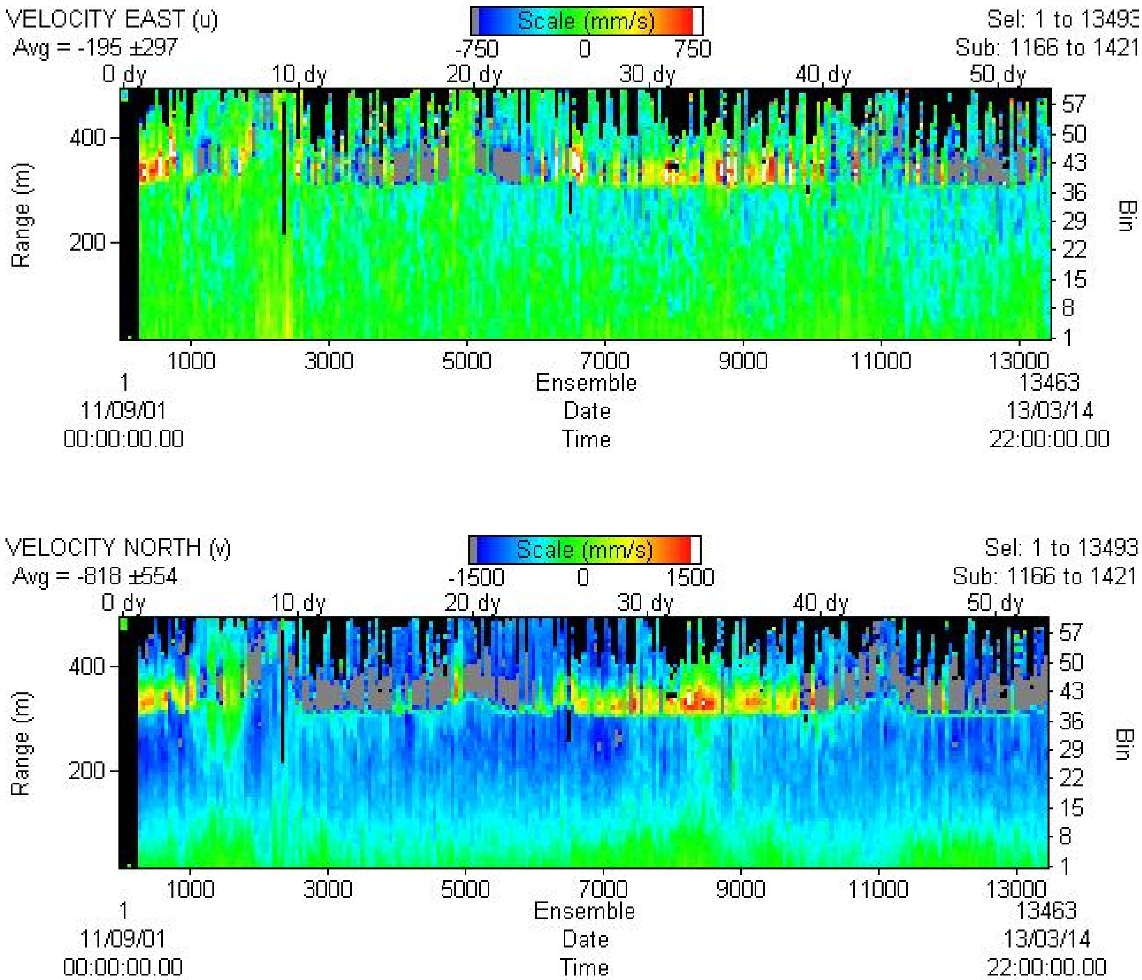


Fig.7.3-1 Time-depth sections of observed zonal (*top panel*) and meridional (*bottom panel*) currents obtained from ADCP mooring at 7N-127E.

(2011/9/11-2013/3/16)

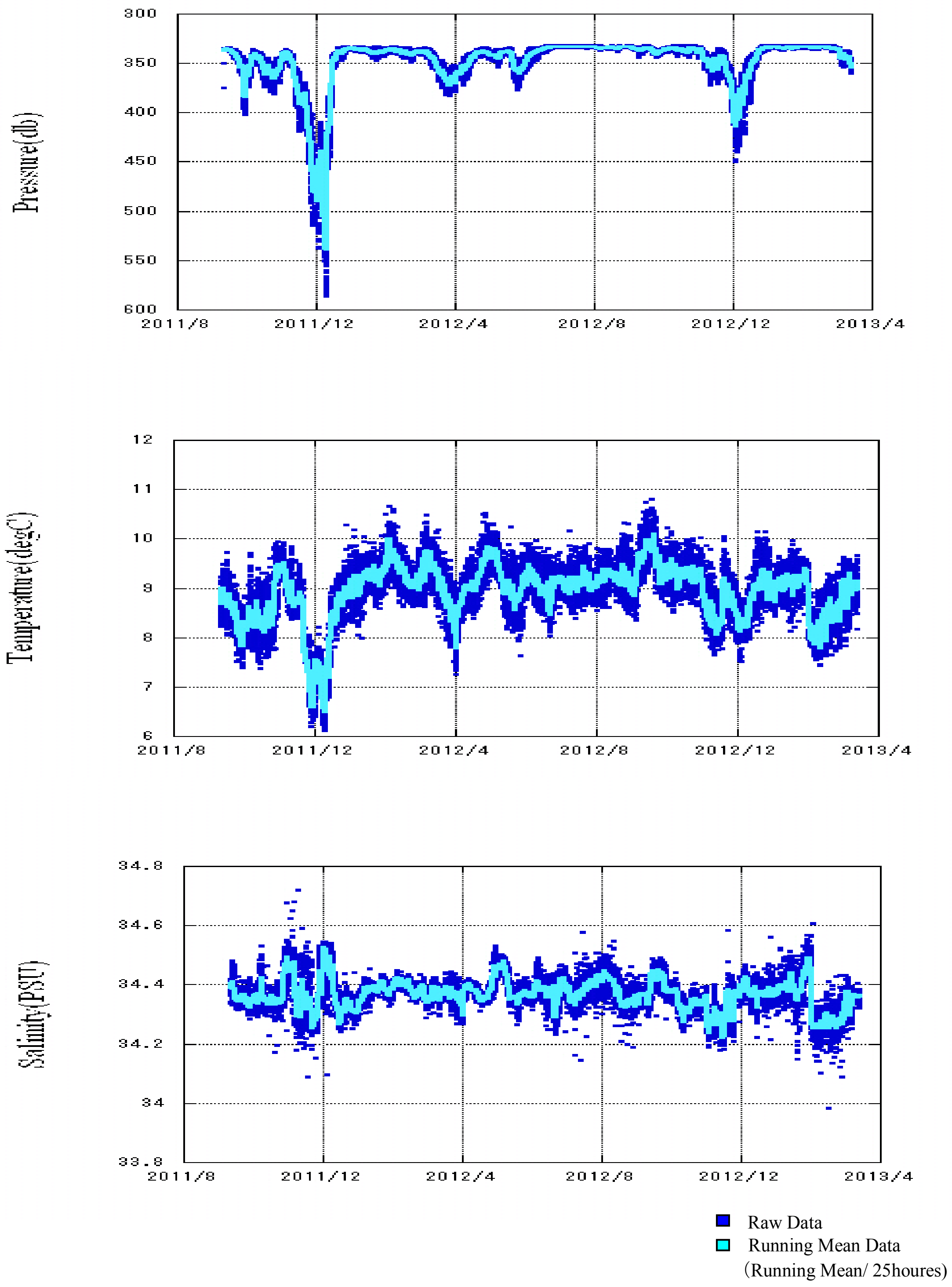


Fig.7.3-2 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at 7N127E. The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean. (2011/9/11-2013/3/16)

7.5 Current profile observations using a high frequency lowered acoustic Doppler current profiler

Personnel Yuji Kashino (JAMSTEC)
Kelvin Richards (IPRC, not on board)
Andrei Natarov (IPRC, not on board)
Shogo Oshitani (MWJ)
Rei Ito (MWJ)

(1) Objective

To measure the small vertical scale (SVS) velocity structure in the tropics.

(2) Overview of instrument and operation

In order to measure the velocity structure at fine vertical scales a high frequency ADCP was used in lowered mode (LADCP). The instrument was a Teledyne RDI Workhorse Sentinel 600kHz ADCP rated for 1000m depth. The instrument was attached to the frame of the CTD system using a steel collar sealed around the instrument by three bolts on each side, with the collar attached to the rosette frame by two u-bolts on two mounting points. A rope was tied to the top end of the instrument to minimize vertical slippage and for added safety (see Figure 7.5-1). The instrument was deployed on CTD stations C01-C34 in the tropics, performing well throughout its use.

Fig 7.5-1 Mounting of LADCP on CTD System

The instrument is self-contained with an internal battery pack. The health of the battery is monitored by the recorded voltage count. The relationship between the actual battery voltage and the recorded voltage count is obscure and appears to vary with the instrument and environmental conditions. Taking a direct measurement of the state of the battery requires opening up the instrument. Battery voltages before and after the deployment were 44.3 V and 40.4 V, respectively.

RDI recommends the battery be changed when V gets below 30V.

(3) Setup and Parameter settings

At all stations the LADCP was controlled at deploy and recover stages by a Windows XP PC using BBtalk manufactured by TRD Instruments. The commands sent to the instrument at setup were contained in **ladcp600.cmd**. The instrument was set up to have a relatively small bin depth (2m) and a fast ping rate (every 0.25 sec). The full list of commands sent to the instrument were:

CR1	# Retrieve parameter (default)
TC2	# Ensemble per burst
WP1	# Pings per ensemble
TE 00:00:00.00	# Time per ensemble (time between data collection cycles)
TP 00:00.25	# Time between pings in mm:ss
WN25	# Number of Depth cells
WS0200	# Depth cell size (in cms)
WF0088	# Blank after transit (recommended setting for 600kHz)
WB0	# Mode 1 bandwidth control (default - wide)
WV250	# Ambiguity velocity (in cm/s)
EZ0111101	# Sensor source (speed of sound excluded)
EX00000	# Beam coordinates
CF11101	# Data flow control parameters

(see the RDI Workhorse "Commands and Data Output Format" document for details.)

(4) Data processing

Data were processed using UHDAS+CODAS ADCP processing software developed by Eric Firing's "currents" group at the University of Hawai`i (available at http://currents.soest.hawaii.edu). The package consists of a number of python scripts and supporting low-level functions written in C. It performs an inverse of the LADCP data using the shear method. Processing step incorporates CTD (for depth) and GPS data, to provide a vertical profile of the horizontal components of velocity, U and V (eastward and northward, respectively), that is a best fit to specified constraints. The down- and up-casts are solved separately, as well as the full cast inverse.

The software is run using the python script **shearcalc.py** which processes all LADCP data files within a specified directory**.** Frequent CTD data are required. Files of 1 second averaged CTD data were prepared for each station. Accurate time keeping is essential,, particularly between the CTD and GPS data. To ensure this, the CTD data records also included the GPS position. The SADCP data were not included in this case so as to provide an independent check on the functioning of the LADCP.

(5) Preliminary results

An example of the processed data is presented in Figure 7.5-2 which compares the full cast, up- and down-cast solutions for the zonal (U) and meridional (V) components of the velocity vector for Station C01M01.

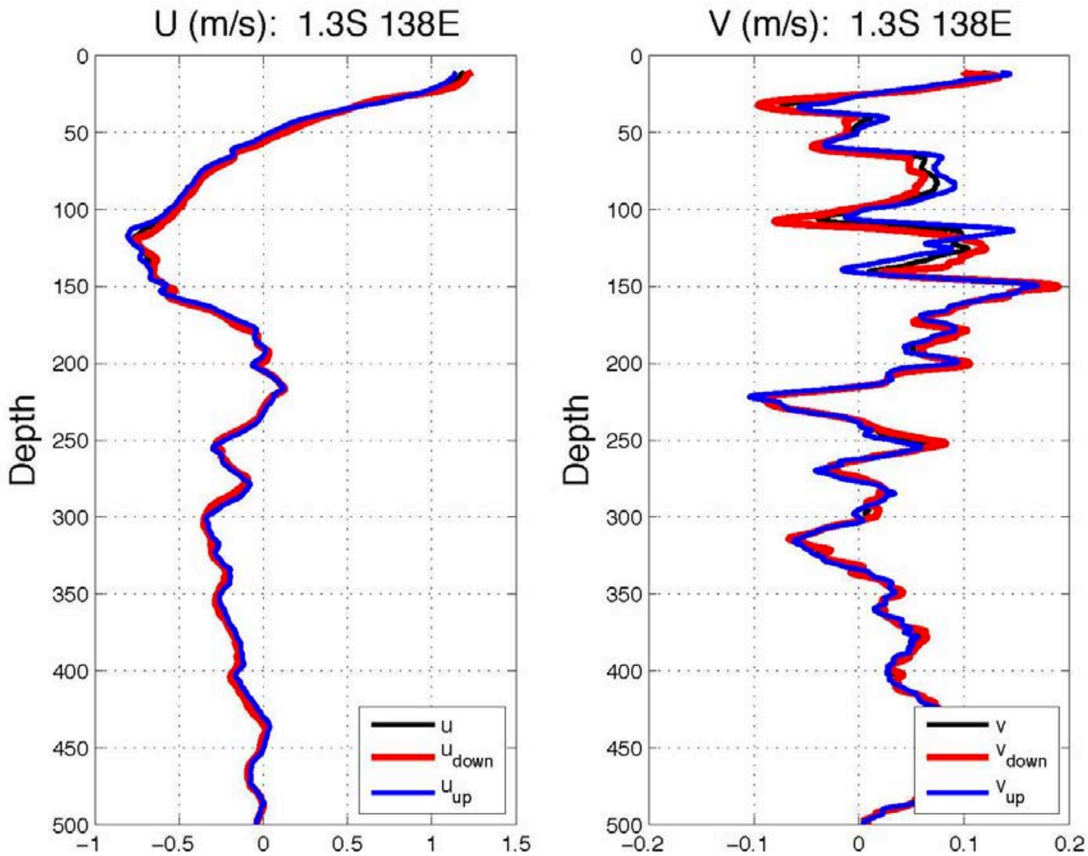


Figure 7.5-2 CTD Station C01M01: Vertical profiles of U and V calculated using LADCP data. Full cast (u), downcast only (u_down), and up-cast only (u_up).

7.6 Observation of ocean turbulence

Personnel Yuji Kashino (RIGC, JAMSTEC)
Albertus Sulaiman (BPPT)
Shinya Okumura (Global Ocean Development Inc.)
Kazuho Yoshida (Global Ocean Development Inc.)
Toshimitsu Goto(Global Ocean Development Inc.)
Ryo Ohyama (Mirai crew, Global Ocean Development Inc.)

(1) Introduction

The western equatorial Pacific is called "Water Mass Crossroad" (Fine et al., 1994) because of complicated ocean structure due to various water masses from the northern and southern Pacific oceans. Small structure associated with ocean mixing such as interleaving was sometimes observed. Because this mixing effect is not fully implemented in the ocean general circulation model presently, it should be evaluated by in-situ observation. Considering this background, JAMSTEC started collaboration research with International Pacific Research Center (IPRC) of Univ. of Hawaii since 2007, and observations using lowered acoustic Doppler current profiler (LADCP) with high frequency were carried out since MR07-07 Leg 1. These observations revealed interesting fine structures with vertical scale of order 10m and horizontal scale of order 100km. For better understanding of ocean fine structures involving this phenomenon, we observe ocean turbulence using a Turbulence Ocean Microstructure Acquisition Profiles, Turbo Map-L, developed by JFE Advantech Co Ltd. during this cruise. During this cruise, we conducted observations along 138 and 130E lines.

(2) Measurement parameters

Using the Turbo Map-L, we measured following parameters:

Parameter	Type	Range	Accuracy	Sample Rate
∂u/∂z	Shear probe	0～10 /s	5%	512Hz
T+∂T/∂z	EPO-7 thermistor	−5～45℃	±0.01℃	512Hz
T	Platinum wire thermometer	−5～45℃	±0.01℃	64Hz
Conductivity	Inductive Cell	0～70mS	±0.01mS	64Hz
Depth	Semiconductor strain gauge	0～1000m	±0.2%	64Hz
x- acceleration	Solid-state fixed mass	±2G	±1%	256Hz
y- acceleration	Solid-state fixed mass	±2G	±1%	256Hz
z- acceleration	Solid-state fixed mass	±2G	±1%	64Hz
Chlorophyll	Fluorescence	0～100 μg/Lm	0.5 μg/L or ±1%	256Hz
Turbidity	Backscatter	0～100ppm	1ppm or ±2%	256Hz
∂u/∂z	Shear probe	0～10 /s	5%	512Hz

We use following sensor and twin shear probes:

FP07 sensor SN:220

Shear Ch1 sensor SN:718

Shear Ch2 sensor SN:876

(3) Observation stations.

No.	Date	Longitude	Latitude	Logging Time		Observation Depth	File name	Remark
				Start	Stop			
01	2013/03/02	138-00.64E	01-15.05S	6:49	7:01	245	MR1301-1.BIN	
02	2013/03/02	138-01.63E	01-15.31S	7:24	7:32	163	MR1301-2.BIN	*1
03	2013/03/02	138-00.24E	01-00.09S	9:47	10:01	305	MR1301-3.BIN	
04	2013/03/02	138-00.31E	00-30.29S	13:21	13:35	242	MR1301-4.BIN	
05	2013/03/02	138-07.88E	00-03.18N	21:03	21:19	531	MR1301-5.BIN	
06	2013/03/03	138-02.11E	00-33.13N	7:30	7:46	550	MR1301-6.BIN	
07	2013/03/03	137-59.83E	00-59.79N	23:32	23:58	623	MR1301-7.BIN	
08	2013/03/04	137-59.80E	01-29.96N	3:20	3:36	567	MR1301-8.BIN	
09	2013/03/04	138-05.89E	01-58.11N	7:32	7:49	562	MR1301-9.BIN	
10	2013/03/05	137-54.77E	02-30.01N	7:14	7:33	606	MR1301-10.BIN	
11	2013/03/05	137-44.81E	02-59.99N	10:48	11:05	539	MR1301-11.BIN	
12	2013/03/06	137-34.93E	03-30.02N	9:32	9:48	544	MR1301-12.BIN	
13	2013/03/07	137-15.12E	04-30.08N	7:13	7:28	517	MR1301-13.BIN	
14	2013/03/07	137-24.73E	03-59.99N	10:42	10:58	566	MR1301-14.BIN	
15	2013/03/07	137-15.85E	04-50.27N	21:12	21:27	474	MR1301-15.BIN	
16	2013/03/09	136-28.21E	07-50.77N	7:02	7:21	610	MR1301-16.BIN	
17	2013/03/11	130-10.43E	01-55.75N	21:05	21:21	552	MR1301-17.BIN	
18	2013/03/12	129-59.52E	01-29.68N	5:12	5:28	528	MR1301-18.BIN	
19	2013/03/12	130-00.04E	00-59.88N	8:47	9:02	521	MR1301-19.BIN	
20	2013/03/12	129-59.89E	02-29.99N	23:47	3/13 0:01	546	MR1301-20.BIN	
21	2013/03/13	129-59.81E	02-59.81N	3:40	3:56	523	MR1301-21.BIN	
22	2013/03/13	129-59.95E	03-29.89N	7:24	7:41	530	MR1301-22.BIN	
23	2013/03/13	130-00.05E	04-00.17N	11:05	11:21	477	MR1301-23.BIN	
24	2013/03/13	130-00.42E	04-30.34N	14:50	15:03	485	MR1301-24.BIN	
25	2013/03/13	130-00.95E	05-00.46N	18:25	18:39	460	MR1301-25.BIN	
26	2013/03/13	130-00.27E	05-29.97N	22:08	22:25	560	MR1301-26.BIN	
27	2013/03/14	130-00.12E	05-59.78N	1:49	2:05	587	MR1301-27.BIN	

*1) This cast was carried out because measurement depth of cast #1 did not reach 250m depth. However, lowering speed of the sensor was slow and measurement depth was expected to be as same as that of cast #1, we stopped observation of this cast halfway.

(4) Operation and data processing

We operated the Turbo Map-L by a crane which is usually used for foods supply and installed in the middle of ship. We lowered it at the starboard of R/V Mirai (Photo 7-6-1).

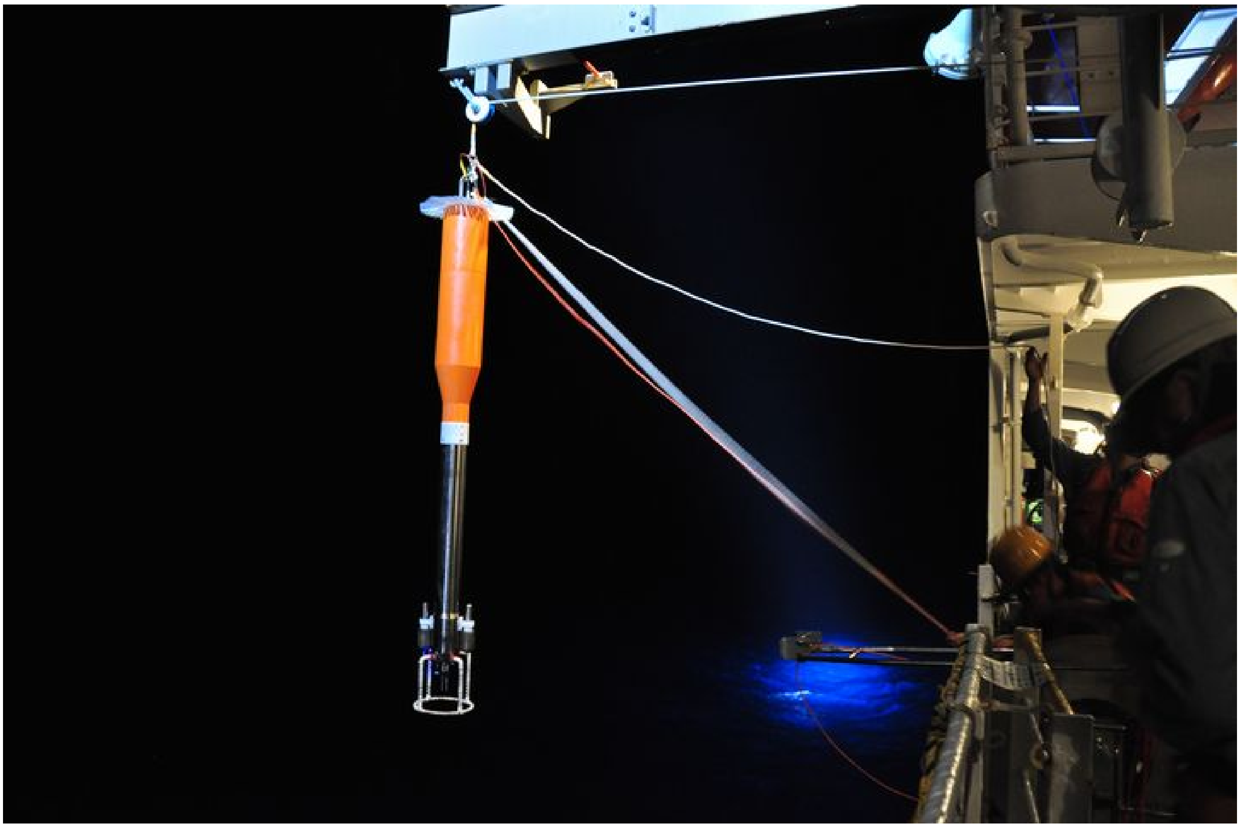


Photo 7-6-1. Observation using Turbo Map-L.

Measurement depth was 500m because our interest is ocean turbulence around thermocline. Descent rate of the Turbo Map-L was 0.5 – 0.7 m s^{-1}. However, strong current region south of the equator at 138E, the decent rate was sometimes slower than 0.5m/s.

Data acquisition and processing were carried out using a PC in the Atmospheric Gas Observation Room of R/V Mirai (Photo 7-6-2). Data processing software was TM-Tool ver 3.04D provided by JFE Advantech Co Ltd.

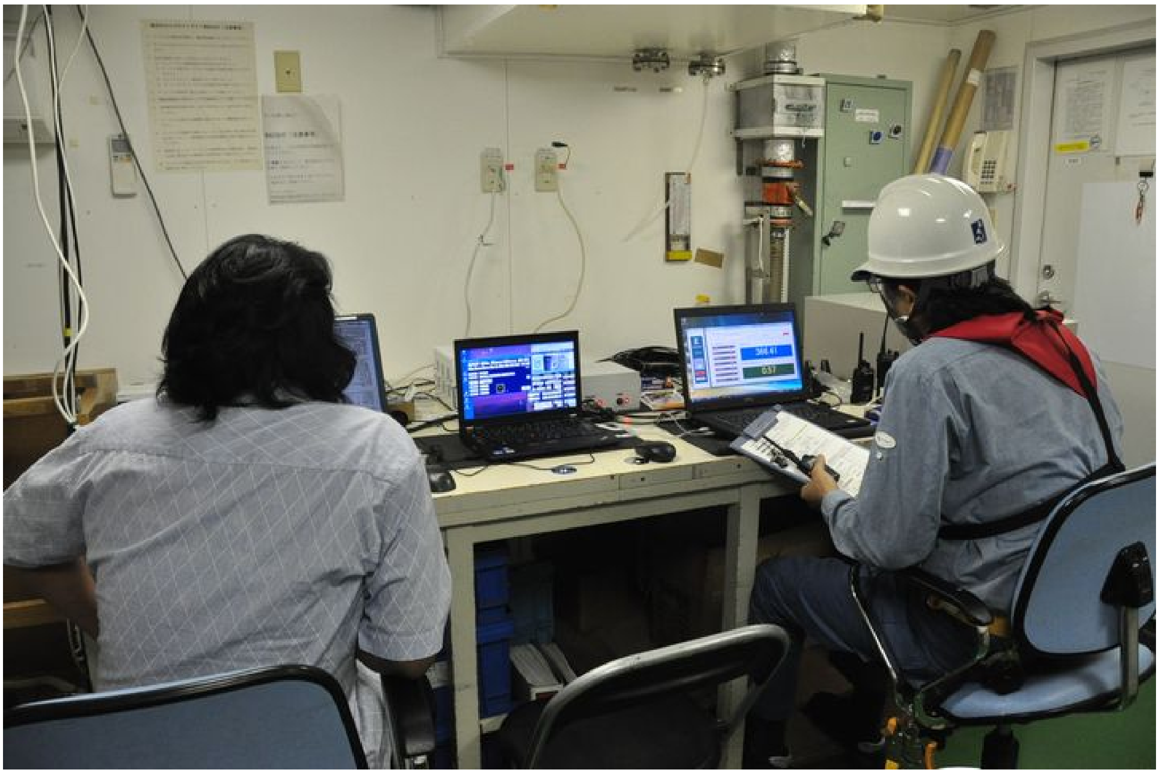
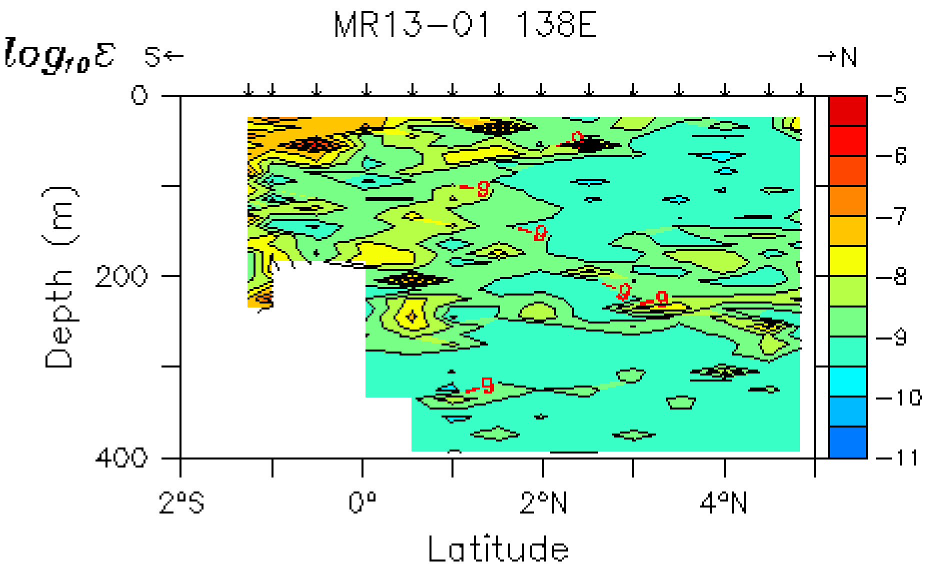


Photo 7-6-2. Data acquisition and processing in the Atmospheric Gas Observation Room.

(5) Results

Figure 7-6-1 shows the sections of logarithm of energy dissipation rate (epsilon) along 138E, and 130E. High epsilon was generally seen in the strong current region of the New Guinea Coastal Current and North Equatorial Countercurrent.

a)



b)

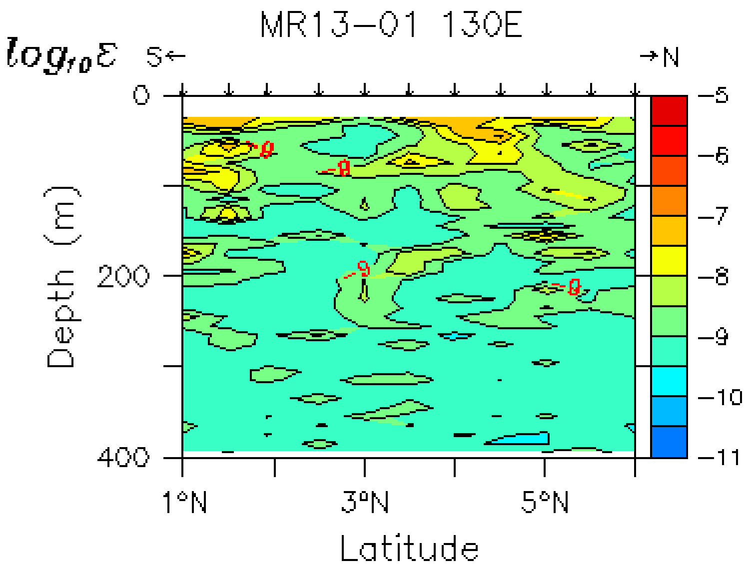


Figure 7-6-1. Vertical section of logarithm of energy dissipation rate along a) 138E and b) 130E during MR13-01 cruise.

7.7 OKMC SOLO-II profiling floats

(1) Personnel

Dan Rudnick	*(Scripps Institution of Oceanography): Principal Investigator of OKMC (not on board)*
Bo Qiu	*(University of Hawaii): co-PI of OKMC (not on board)*
Derek Vana	*(Scripps Institution of Oceanography): Technical staff (not on board)*

(2) Objectives

The objective of deploying the 17 SOLO-II is to clarify the structure and temporal/spatial variability of water masses in the Philippine Seas in the western North Pacific Ocean. The float deployment complements other on-going, in-situ measurements in the region as part of the US Origins of the Kuroshio and Mindanao Currents (OKMC) project funded by the Office of Naval Research. The SOLO-II profiling float data will be combined with other available measurements from the OKMC project and other sources to synergetically determine the circulation pattern and variability in the western North Pacific Ocean.

(3) Parameters

Water temperature, salinity, and pressure from surface down to 2,000 dbar.

(4) Methods

i. Profiling float deployment

We launched seventeen (17) SOLO-II floats manufactured by Scripps Institution of Oceanography. These floats are equipped with SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc to measure the temperature, salinity and pressure from surface to 2,000 dbar. The floats drift at the depth of 1,000 dbar (known as the parking depth), diving to the depth of 2,000 dbar before their profiling ascending. The measured T/S/p data are sent to the Argo data center via the Iridium transmitting system in real time; for data transmission, the floats stay at the sea surface for only a few minutes. The repeat cycle of the float measurements is every 5 days and the floats are expected to take a total of about 300 profiles for ~4 years. The status of floats and their launches are shown in Table 7.7.1.

Table 7.7.1 Status of floats and their launches

Float Type	**SOLO-II floats manufactured by Scripps Institution of Oceanography**
CTD sensor	**SBE41-cp manufactured by Sea-Bird Electronics Inc.**
Repeat Cycle	**5 days (a few minutes at the sea surface)**
Target Parking Pressure	**1,000 dbar**
Sampling layers	**1-dbar between surface and 10-dbar, 2-dbar from 10 to 2,000 dbar**

Launches

Float S/N	Date and Time of Launch(UTC)	Location of Launch	CTD St. No.
8139	2013/03/13 19:08	05-00.94N; 130-00.24E	
8123	2013/03/14 02:25	05-59.88N; 130-00.24E	
8128	2013/03/14 08:44	06-59.91N; 129.59.60E	
8135	2013/03/16 10:35	06-59.00N; 126-59.56E	
8126	2013/03/17 05:34	06-58.77N; 127-59.83E	
8034	2013/03/17 11:53	07-00.17N: 129-00.15E	
8030	2013/03/17 17:33	08-00.05N; 129-31.97E	
8027	2013/03/17 22:16	08-59.98N; 130-03.99E	
8025	2013/03/18 03:19	09-59.99N; 130-36.16E	
8031	2013/03/18 08:13	10-59.99N; 131-08.32E	
8000	2013/03/18 13:10	12-00.00N; 131-40.65E	
8000	2013/03/18 17:58	13-00.03N; 132-13.22E	
8000	2013/03/18 22:51	13-59.98N; 132-45.81E	
8000	2013/03/19 03:40	14-59.98N; 133-15.49E	
8000	2013/03/19 08:27	16-00.00N; 133-45.69E	
8000	2013/03/19 13:19	16-59.97N; 134-15.53E	
8000	2013/03/19 18:06	18-00.03N; 134-45.51E	

(5) Data archive

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

7.8 Global Drifter Program – SVP Drifting Buoys

(1) Personnel

Rick Lumpkin (National Oceanographic Atmospheric Administration / Global Drifter Program): Principal Investigator of GDP (not on board)
Shaun Dolk (National Oceanographic Atmospheric Administration / Global Drifter Program): (not on board)

(2) Objectives

The objective of deploying the 20 drifting buoys is to compliment the current global array of drifting buoys. The western equatorial region is of great value, as there are few deployment opportunities in this region. As a result, the data collected from these instruments will significantly affect the current dataset of historical drifters in the area.

(3) Parameters

Sea surface temperature and ocean current velocities.

(4) Methods

i. Profiling float deployment

We launched twenty (20) drifting buoys manufactured by Data Buoy Instrumentation (DBi). These drifters are equipped with thermistor sensors to measure the temperature at the surface of the ocean. The drifters float at the surface, following upper ocean surface currents. The measured temperature and location data are sent to the Drifter Data Assembly Center via the ARGOS transmitting system for data processing and quality control procedures. The drifters are expected to transmit for 450 days, while maintaining a drogue presence for 300 days. The status of drifters and their launches are shown in Table 7.8.1.

Table 7.8.1 Status of drifters and their launches

Drifter Type	Surface Velocity Profiler (SVP) Type drifter Manufactured by Clearwater and DBi.

Launches

Drifter S/N	Date	Time (UTC)	Latitude	Longitude
122562	2 Mar, 2013	10:25 AM	01 00.26 S	138 00.89 E
122575	2 Mar, 2013	10:26 AM	01 00.25 S	138 00.89 E
118474	2 Mar, 2013	11:29 PM	00 03.37 N	138 08.17 E
122564	2 Mar, 2013	11:30 PM	00 03.40 N	138 08.16 E
122576	4 Mar, 2013	12:22 AM	01 00.01 N	137 59.62 E
122558	5 Mar, 2013	11:23 AM	02 59.97 N	137 44.65 E
122559	6 Mar, 2013	2:20 AM	01 58.73 N	138 02.87 E
122560	7 Mar, 2013	11:20 AM	04 00.04 N	137 24.66 E
122561	8 Mar, 2013	2:40 AM	04 51.25 N	137 14.68 E
122565	8 Mar, 2013	7:55 AM	06 00.01 N	136 58.04 E
122563	8 Mar, 2013	12:23 AM	07 00.00 N	136 44.01 E
118471	12 Mar, 2013	2:16 AM	01 55.32 N	130 10.01 E
118472	12 Mar, 2013	2:16 AM	01 55.32 N	130 10.01 E
122574	12 Mar, 2013	9:28 AM	00 59.31 N	130 00.29 E
118473	12 Mar, 2013	9:28 AM	00 59.32 N	130 00.27 E
122581	13 Mar, 2013	4:16 AM	02 59.79 N	129 59.74 E
122580	13 Mar, 2013	1:45 AM	04 00.27 N	130 00.25 E
122578	13 Mar, 2013	7:09 PM	05 00.97 N	130 01.46 E
122579	14 Mar, 2013	2:26 AM	05 59.90 N	130 00.25 E
122577	14 Mar, 2013	8:44 AM	06 59.94 N	129 59.59 E

(5) Data archive

The real time data are provided via DAC Data Products, which you can access at (http://www.aoml.noaa.gov/phod/dac/meds.html). The quality controlled data are provided to oceanographic organizations, research institutes, and universities via Drifter Data Assembly Center (http://www.aoml.noaa.gov/phod/dac/dirall.html) and Global Telecommunication System (GTS), and utilized for analysis and forecasts of the ocean conditions and the climates.

7.9 Calcareous Nannoplankton Sampling

Alyssa PELEO-ALAMPAY (National Institute of Geological Sciences, University of the Philippines, Diliman, UP NIGS)
Marilou MARTIN (Marine Science Institute, University of the Philippines, Diliman)
Rhett Simon TABBADA (Philippine Nuclear Research Institute)

(1) Objective

To collect sewater samples for calcareous nannoplankton analysis

(2) Parameter

Calcareous nannoplankton filtered from seawater

(3) Instruments and Methods

a. Instruments

Niskin sampler
Filtering glassware/apparatus
Filtering pump

b. Materials

Millipore filters

c. Sampling

Seawater samples were collected with Niskin bottle attached to the CTD system. Sampling stations were don in a transect from 1º 15.03'S, 138º00.21'E to 7º 00.07'S, 138º00.21'E at water depths ranging from 500 to 1010m (Table 7-9-1).

Samples were taken at the surface and at the deep chlorophyll maximum (DCM) of each station. Thiry two (32) stations were sampled from March 2-17, 2013 for a total of sixty four (64) seawater samples (Table 7-9-2). Two (2) liters of seawater were used for filtering. No reagents were added to seawater. Filtering of the seawater was done soon after collection to avoid possible nannoplankton dissolution. The investigators on board noted down sample numbers, and collection and filtering information such as time and date of collection and filtering in a prepared collection and filtering worksheet for later reference.

d. Filtering

Two (2) liters of seawater for each sampling depth at each station were filtered using a vacuum pump onboard the RV Mirai. Vacuum pressure was set at 5-10 kpa (37.5 - 75 mmHg) during the filtering. The seawater sample was pre-sieved using a 125 µm mesh sieve prior to filtering to remove the coarser/larger particles. The seawater sample was filtered onto a Millipore filter (0.45 µm pore size, 47 mm diameter) and air dried in the ship laboratory. Once the filter is dry, the sample number is written on the edge of the filter and stored.

e. Sample Analysis

These filtered sewater samples will be analyzed for alcareous nannoplankton at the National Institute of Geological Sciences, University of the Philippines using microscopy (phase contrast research microscope and/or scanning electron microscope (SEM)) at minimum 1000X magnification. Calcareous nannoplankton abundance will be correlated with onboard measurements of temperature, salinity and chlorophyll at the sampling stations.

(4) Data archive

All data will be submitted to Chief Scientist.

(5) References

Not applicable

Table 7-9-1. Sampling station list

No.	Station ID	Sample Category	Sampling Method	Preservation	Date Collected YYYY	MM	DD	hh:mm	Latitude Deg.	Min.		Longitude Deg.	Min.		Depth [m]
1	C01	particle	niskin sampler	air drying	2013	3	2	5:57	1	15.03	S	138	0.21	E	500.0
2	C02	particle	niskin sampler	air drying	2013	3	2	9:15	0	59.98	S	138	0.01	E	503.9
3	C03	particle	niskin sampler	air drying	2013	3	2	12:50	0	30.06	S	138	0.01	E	506.7
4	C04	particle	niskin sampler	air drying	2013	3	2	20:32	0	3.36	N	138	7.88	E	502.9
5	C05	particle	niskin sampler	air drying	2013	3	3	6:48	0	33.37	N	138	2.20	E	807.3
6	C06	particle	niskin sampler	air drying	2013	3	3	23:01	0	59.99	N	137	59.90	E	502.4
7	C07	particle	niskin sampler	air drying	2013	3	4	2:49	1	30.06	N	137	59.97	E	504.7
8	C08	particle	niskin sampler	air drying	2013	3	4	6:36	1	58.15	N	138	5.89	E	806.6
9	C09	particle	niskin sampler	air drying	2013	3	5	6:46	2	30.06	N	137	54.92	E	505.1
10	C10	particle	niskin sampler	air drying	2013	3	5	10:19	3	0.02	N	137	44.97	E	502.5
11	C11	particle	niskin sampler	air drying	2013	3	6	10:20	3	30.05	N	137	34.75	E	504.2
12	C14	particle	niskin sampler	air drying	2013	3	7	4:02	4	56.20	N	137	19.62	E	808.7
13	C13	particle	niskin sampler	air drying	2013	3	7	6:43	4	30.04	N	137	15.07	E	504.5
14	C12	particle	niskin sampler	air drying	2013	3	7	10:12	3	59.99	N	137	24.86	E	505.7
15	C15	particle	niskin sampler	air drying	2013	3	9	4:03	7	38.56	N	136	40.24	E	807.2
16	C18	particle	niskin sampler	air drying	2013	3	11	20:20	1	55.87	N	130	10.72	E	1,007.7
17	C17	particle	niskin sampler	air drying	2013	3	12	4:28	1	30.00	N	129	59.64	E	1,010.4
18	C16	particle	niskin sampler	air drying	2013	3	12	8:03	1	0.03	N	130	0.07	E	1,007.6

19	C19	particle	niskin sampler	air drying	2013	3	12	23:04	2	30.07	N	130	0.04	E	1,008.7
20	C20	particle	niskin sampler	air drying	2013	3	13	2:55	2	59.94	N	130	0.01	E	1,000.0
21	C21	particle	niskin sampler	air drying	2013	3	13	6:41	3	29.99	N	130	0.02	E	1,009.2
22	C22	particle	niskin sampler	air drying	2013	3	13	10:23	4	0.06	N	129	59.96	E	1,008.2
23	C23	particle	niskin sampler	air drying	2013	3	13	14:03	4	30.10	N	130	0.10	E	1,009.9
24	C24	particle	niskin sampler	air drying	2013	3	13	17:39	5	0.12	N	130	0.24	E	1,008.3
25	C25	particle	niskin sampler	air drying	2013	3	13	21:25	5	30.04	N	130	0.03	E	1,009.0
26	C26	particle	niskin sampler	air drying	2013	3	14	1:05	5	59.98	N	129	59.99	E	1,009.0
27	C27	particle	niskin sampler	air drying	2013	3	14	4:55	6	30.00	N	129	59.94	E	1,009.3
28	C28	particle	niskin sampler	air drying	2013	3	14	8:00	6	59.89	N	129	59.96	E	1,008.7
29	C29	particle	niskin sampler	air drying	2013	3	14	12:24	7	30.10	N	129	59.90	E	1,008.8
30	C30	particle	niskin sampler	air drying	2013	3	14	21:06	7	57.63	N	130	1.86	E	1,009.8
31	C31	particle	niskin sampler	air drying	2013	3	15	9:15	7	0.16	N	129	29.96	E	1,009.0
32	C41	particle	niskin sampler	air drying	2013	3	16	4:04	7	0.08	N	126	30.19	E	1,000.0
33	C40	particle	niskin sampler	air drying	2013	3	16	5:46	6	59.94	N	126	35.82	E	1,008.2
34	C39	particle	niskin sampler	air drying	2013	3	16	7:53	6	59.91	N	126	47.88	E	1,008.4
35	C38	particle	niskin sampler	air drying	2013	3	16	9:50	6	59.91	N	126	59.87	E	1,008.2
36	C37	particle	niskin sampler	air drying	2013	3	16	12:03	6	59.98	N	127	14.92	E	1,008.2
37	C36	particle	niskin sampler	air drying	2013	3	16	20:18	6	59.88	N	127	30.03	E	1,008.9
38	C35	particle	niskin sampler	air drying	2013	3	16	23:39	6	59.88	N	127	44.88	E	1,009.9
39	C34	particle	niskin sampler	air drying	2013	3	17	4:49	6	58.80	N	127	59.93	E	1,008.9
40	C33	particle	niskin sampler	air drying	2013	3	17	8:04	7	0.11	N	128	29.98	E	1,009.5
41	C32	particle	niskin sampler	air drying	2013	3	17	11:09	7	0.07	N	129	0.05	E	1,008.7

Table 7-9-2. Sampling list

Station No.	Sample No.	Water Depth (m)	Date of Collection (JST)	Time of Collection (JST)	Date of Filtering (JST)	Start Time of Filtering (JST)	Volume of Water Filtered	Pre-sieving?	Sieve Mesh	Remarks	Filtering Done by
C01	C01_S	surface	2-Mar-13	1530	2-Mar-13	1610	2L	yes	125 µm		Simon
	C01_D	40	2-Mar-13	1530	2-Mar-13	1610	2L	yes	125 µm		Malou
C02	C02_S	surface	2-Mar-13	1830	2-Mar-13	1900	2L	yes	125 µm		Simon
	C02_D	52	2-Mar-13	1830	2-Mar-13	1900	2L	yes	125 µm		Malou
C03	C03_S	surface	2-Mar-13	2200	2-Mar-13	2232	2L	yes	125 µm		Simon
	C03_D	64	2-Mar-13	2200	2-Mar-13	2232	2L	yes	125 µm		Malou
C04	C04_S	surface	3-Mar-13	600	3-Mar-13	610	2L	yes	125 µm		Simon
	C04_D	56	3-Mar-13	600	3-Mar-13	610	2L	yes	125 µm		Malou
C05	C05_S	surface	3-Mar-13	1615	3-Mar-13	1645	2L	yes	125 µm		Simon
	C05_D	49	3-Mar-13	1615	3-Mar-13	1645	2L	yes	125 µm		Malou
C06	C06_S	surface	4-Mar-13	935	4-Mar-13	945	2L	yes	125 µm		Simon
	C06_D	40	4-Mar-13	935	4-Mar-13	945	2L	yes	125 µm		Malou
C07	C07_S	surface	4-Mar-13	1220	4-Mar-13	1225	2L	yes	125 µm		Simon
	C07_D	55	4-Mar-13	1220	4-Mar-13	1225	2L	yes	125 µm		Malou
C08	C08_S	surface	4-Mar-13	1600	4-Mar-13	1640	2L	yes	125 µm		Simon
	C08_D	50	4-Mar-13	1600	4-Mar-13	1640	2L	yes	125 µm		Malou
C09	C09_S	surface	5-Mar-13	420	5-Mar-13	425	2L	yes	125 µm		Simon
	C09_D	51	5-Mar-13	420	5-Mar-13	425	2L	yes	125 µm		Malou

C10	C10_S	surface	5-Mar-13	1945	5-Mar-13	1958	2L	yes	125 µm		Simon
	C10_D	50	5-Mar-13	1945	5-Mar-13	1958	2L	yes	125 µm		Malou
C11	C11_S	surface	6-Mar-13	1955	6-Mar-13	2000	2L	yes	125 µm		Simon
	C11_D	40	6-Mar-13	1955	6-Mar-13	2000	2L	yes	125 µm		Malou
C14	C14_S	surface	7-Mar-13	1343	7-Mar-13	1346	2L	yes	125 µm		Simon
	C14_D	63	7-Mar-13	1343	7-Mar-13	1346	2L	yes	125 µm		Malou
C13	C13_S	surface	7-Mar-13	1615	7-Mar-13	1624	2L	yes	125 µm		Simon
	C13_D	30	7-Mar-13	1615	7-Mar-13	1624	2L	yes	125 µm		Malou
C12	C12_S	surface	7-Mar-13	1947	7-Mar-13	1950	2L	yes	125 µm		Simon
	C12_D	39	7-Mar-13	1947	7-Mar-13	1950	2L	yes	125 µm		Malou
C15	C15_S	surface	9-Mar-13	1350	9-Mar-13	1355	2L	yes	125 µm		Simon
	C15_D	85	9-Mar-13	1350	9-Mar-13	1355	2L	yes	125 µm		Malou
C18	C18_S	surface	12-Mar-13	610	12-Mar-13	617	2L	yes	125 µm		Simon
	C18_D	53	12-Mar-13	610	12-Mar-13	617	2L	yes	125 µm		Malou
C17	C17_S	surface	12-Mar-13	1418	12-Mar-13	1425	2L	yes	125 µm		Simon
	C17_D	53	12-Mar-13	1418	12-Mar-13	1425	1670 ml	yes	125 µm	sample accidentally spilled	Malou
C16	C16_S	surface	12-Mar-13	1753	12-Mar-13	1755	2L	yes	125 µm	funnel was removed while there was still small amt of sample/water in it	Simon
	C16_D	44	12-Mar-13	1753	12-Mar-13	1755	2L	yes	125 µm		Malou

C19	C19_S	surface	13-Mar-13	857	13-Mar-13	901	2L	yes	125 µm	Simon
	C19_D	55	13-Mar-13	857	13-Mar-13	901	2L	yes	125 µm	Malou
C20	C20_S	surface	13-Mar-13	1347	13-Mar-13	1350	2L	yes	125 µm	Simon
	C20_D	50	13-Mar-13	1347	13-Mar-13	1350	2L	yes	125 µm	Malou
C21	C21_S	surface	13-Mar-13	1633	13-Mar-13	1638	2L	yes	125 µm	Simon
	C21_D	46	13-Mar-13	1633	13-Mar-13	1638	2L	yes	125 µm	Malou
C22	C22_S	surface	13-Mar-13	2018	13-Mar-13	2020	2L	yes	125 µm	Simon
	C22_D	48	13-Mar-13	2018	13-Mar-13	2020	2L	yes	125 µm	Malou
C23	C23_S	surface	13-Mar-13	2355	13-Mar-13	2359	2L	yes	125 µm	Simon
	C23_D	63	13-Mar-13	2355	13-Mar-13	2359	2L	yes	125 µm	Malou
C24	C24_S	surface	14-Mar-13	325	14-Mar-13	335	2L	yes	125 µm	Simon
	C24_D	64	14-Mar-13	325	14-Mar-13	335	2L	yes	125 µm	Simon
C25	C25_S	surface	14-Mar-13	720	14-Mar-13	725	2L	yes	125 µm	Malou
	C25_D	90	14-Mar-13	720	14-Mar-13	725	2L	yes	125 µm	Malou
C26	C26_S	surface	14-Mar-13	1057	14-Mar-13	1200	2L	yes	125 µm	Simon
	C26_D	90	14-Mar-13	1057	14-Mar-13	1200	2L	yes	125 µm	Malou
C27	C27_S	surface	14-Mar-13	1450	14-Mar-13	1455	2L	yes	125 µm	Simon
	C27_D	85	14-Mar-13	1450	14-Mar-13	1455	2L	yes	125 µm	Malou
C28	C28_S	surface	14-Mar-13	1850	14-Mar-13	1855	2L	yes	125 µm	Simon
	C28_D	94	14-Mar-13	1850	14-Mar-13	1855	2L	yes	125 µm	Malou
C29	C29_S	surface	14-Mar-13	2218	14-Mar-13	2220	2L	yes	125 µm	Simon
	C29_D	83	14-Mar-13	2218	14-Mar-13	2220	2L	yes	125 µm	Malou
C30	C30_S	surface	15-Mar-13	659	15-Mar-13	703	2L	yes	125 µm	Simon

	C30_D	96	15-Mar-13	659	15-Mar-13	703	2L	yes	125 µm	Malou
C31	C31_S	surface	15-Mar-13	1913	15-Mar-13	1915	2L	yes	125 µm	Simon
	C31_D	79	15-Mar-13	1913	15-Mar-13	1915	2L	yes	125 µm	Malou
C41	C41_S	surface	16-Mar-13	1355	16-Mar-13	1400	2L	yes	125 µm	Simon
	C41_D	85	16-Mar-13	1355	16-Mar-13	1400	2L	yes	125 µm	Malou
C40	C40_S	surface	16-Mar-13	1538	16-Mar-13	1542	2L	yes	125 µm	Simon
	C40_D	100	16-Mar-13	1538	16-Mar-13	1542	2L	yes	125 µm	Malou
C39	C39_S	surface	16-Mar-13	1743	16-Mar-13	1747	2L	yes	125 µm	Simon
	C39_D	115	16-Mar-13	1743	16-Mar-13	1747	2L	yes	125 µm	Malou
C38	C38_S	surface	16-Mar-13	1940	16-Mar-13	1942	2L	yes	125 µm	Simon
	C38_D	107	16-Mar-13	1940	16-Mar-13	1942	2L	yes	125 µm	Malou
C37	C37_S	surface	16-Mar-13	2152	16-Mar-13	2155	2L	yes	125 µm	Simon
	C37_D	100	16-Mar-13	2152	16-Mar-13	2155	2L	yes	125 µm	Malou
C36	C36_S	surface	17-Mar-13	558	17-Mar-13	557	2L	yes	125 µm	Simon
	C36_D	109	17-Mar-13	558	17-Mar-13	557	2L	yes	125 µm	Malou
C34	C34_S	surface	17-Mar-13	1440	17-Mar-13	1445	2L	yes	125 µm	Simon
	C34_D	95	17-Mar-13	1440	17-Mar-13	1445	2L	yes	125 µm	Malou
C33	C33_S	surface	17-Mar-13	1853	17-Mar-13	1857	2L	yes	125 µm	Simon
	C33_D	90	17-Mar-13	1857	17-Mar-13	1857	2L	yes	125 µm	Malou
C32	C32_S	surface	17-Mar-13	2058	17-Mar-13	2101	2L	yes	125 µm	Simon
	C32_D	90	17-Mar-13	2058	17-Mar-13	2101	2L	yes	125 µm	Malou

7.10 Lidar observations of clouds and aerosols

Nobuo SUGIMOTO (NIES)
Ichiro MATSUI (NIES)
Atsushi SHIMIZU (NIES)
Tomoaki NISHIZAWA (NIES)
(Lidar operation was supported by Global Ocean Development Inc. (GODI).)

(1) Objectives

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

(2) Description of instruments deployed

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

(3) Preliminary results

The Mie lidar did not work well in the MR13-01 observation period due to problem of the laser, especially in the beginning (from Feb. 26 to Mar. 2) and the end (from Mar. 22). Examples of the measured data are depicted in Fig. 7-10-1. The figure indicates that the lidar detects aerosols in the planetary boundary layer (PBL) formed below 1km, water clouds formed at the top of the PBL, ice clouds in the upper layer over 12km, but the quality of the observed data is worse due to laser issue than that measured in the other cruises. We will change the laser after the MR13-01 cruise finishes.

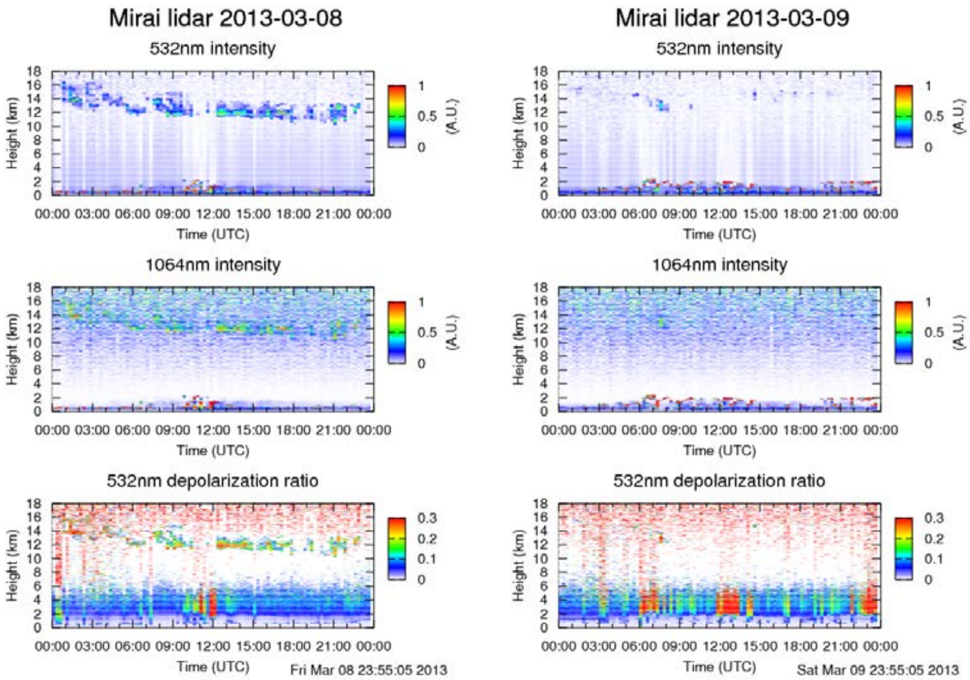


Figure 7-10-1: Time-height sections of backscatter intensities at 532nm and 1064nm and total depolarization ratios at 532nm measured on Mar. 8 and Mar. 9, 2013.

(4) Data archive

- Raw data

temporal resolution 10min / vertical resolution 6 m

data period (UTC): Feb. 26-28, 2013; Mar. 1-28, 2013

lidar signal at 532 nm, lidar signal at 1064 nm, depolarization ratio at 532 nm

- Processed data (plan)

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

* Data policy and Citation

Contact NIES lidar team (nsugimot/i-matsui/shimizua/nisizawa@nies.go.jp) to utilize lidar data for productive use.

7.11 Aerosol optical characteristics measured by Ship-borne Sky radiometer

Kazuma Aoki (University of Toyama) Principal Investigator / not onboard
Tadahiro Hayasaka (Tohoku University) Co-worker / not onboard
Sky radiometer operation was supported by Global Ocean Development Inc.

(1) Objective

Objective of the observations in this aerosol is to study distribution and optical characteristics of marine aerosols by using a ship-borne sky radiometer (POM-01 MKII: PREDE Co. Ltd., Japan). Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously.

(2) Methods and Instruments

Sky radiometer is measuring the direct solar irradiance and the solar aureole radiance distribution, has seven interference filters (0.34, 0.4, 0.5, 0.675, 0.87, 0.94, and 1.02 μm). Analysis of these data is performed by SKYRAD.pack version 4.2 developed by Nakajima *et al.* 1996.

@ Measured parameters

- Aerosol optical thickness at five wavelengths (400, 500, 675, 870 and 1020 nm)
- Ångström exponent
- Single scattering albedo at five wavelengths
- Size distribution of volume (0.01 μm – 20 μm)

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.

(3) Preliminary results

This study is not onboard. Data obtained in this cruise will be analyzed at University of Toyama.

(4) Data archives

Measurements of aerosol optical data are not archived so soon and developed, examined, arranged and finally provided as available data after certain duration. All data will archived at University of Toyama (K.Aoki, SKYNET/SKY: http://skyrad.sci.u-toyama.ac.jp/) after the quality check and submitted to JAMSTEC.

7.12 Rain and sea water sampling for stable water isotope analysis

(1) Personnel

Yasushi Fujiyoshi **(Hokkaido Univ./JAMSTEC)**
Principal Investigator（not on-board）
Naoyuki Kurita ***(JAMSTEC)***
Operator
Shinya Okumura ***(Global Ocean Development Inc.: GODI)***

(2) Objective

It is well known that the variability of stable water isotopes (HDO and $H_2{}^{18}O$) reflects the integrated history of water mass exchange that occurs during transportation from the upstream region. Thus, water isotope tracer is recognized as the powerful tool to study of the hydrological cycles in the marine atmosphere. However, oceanic region is one of sparse region of the isotope data, it is necessary to fill the data to identify the moisture sources by using the isotope tracer. In this study, to fill this sparse observation area, intense water isotopes observation was conducted along the cruise track of MR13-01.

(3) Method

Following observation was carried out throughout this cruise.

- Rainwater sampling

  Rainwater samples gathered in rain/snow collector were collected just after precipitation events have ended. The collected sample was then transferred into glass bottle (6ml) immediately after the measurement of precipitation amount.

- Surface seawater sampling

  Seawater sample taken by the pump from 4m depths were collected in glass bottle (6ml) around the noon at the local time.

(4) Water samples for isotope analysis

Sampling of rainfall for isotope analysis is summarized in Table 7.11-1 (7 samples). Described rainfall amount is calculated from the collected amount of precipitation. Sampling of surface seawater taken by pump from 4m depths is summarized in Table 7.11-2 (22 samples).

(5) Data archive

The isotope analysis of collected water samples will be done at Nagoya University, and then analyzed isotopes data will be submitted to JAMSTEC DIAG.

Table 7.11-1 Summary of precipitation sampling for isotope analysis.

	Date	Time (UT)	Lon	Lat	Date	Time (UT)	Lon	Lat	Rain (mm)	R/S
R−01	3.1	13:55	141−16.32E	01−20.12S	3.4	23:06	138−02.20E	02−01.40N	0.4	R
R−02	3.4	23:06	138−02.20E	02−01.40N	3.7	05:31	137−17.93E	04−44.45N	11.4	R
R−03	3.7	05:31	137−17.93E	04−44.45N	3.11	22:17	130−10.50E	01−56.33N	7.8	R
R−04	3.11	22:17	130−10.50E	01−56.33N	3.13	16:11	130−00.26E	04−41.50N	4.3	R
R−05	3.13	16:11	130−00.26E	04−41.50N	3.15	04:55	129−59.97E	07−28.65N	7.8	R
R−06	3.15	04:55	129−59.97E	07−28.65N	3.15	23:21	129−53.96E	06−58.14N	4.3	R
R−07	3.15	23:21	129−53.96E	06−58.14N	3.17	21:07	129−56.92E	08−46.38N	4.7	R

Table 7.11-2 Summary of sea surface water sampling for isotope analysis

Sampling No.		Date	Time (UTC)	Position LON	LAT
O−	1	2.26	10:18	129−08.58E	01−49.21N
O−	2	2.27	02:01	132−34.75E	01−49.21N
O−	3	2.28	02:27	138−11.17E	00−04.55S
O−	4	3.1	22:48	139−26.54E	01−17.31S
O−	5	3.2	02:30	138−40.67E	01−15.96S
O−	6	3.3	02:24	138−04.67E	00−36.38N
O−	7	3.4	02:09	138−00.01E	01−23.77N
O−	8	3.5	03:08	138−04.72E	02−03.65N
O−	9	3.6	02:06	138−03.11E	01−58.80N
O−	10	3.7	05:30	137−17.96E	04−44.59N
O−	11	3.8	01:50	137−15.22E	04−51.15N
O−	12	3.9	02:38	136−41.29E	07−38.29N
O−	13	3.10	01:55	136−24.89E	07−51.41N
O−	14	3.11	02:26	132−40.80E	03−40.05N
O−	15	3.12	01:56	130−10.01E	01−55.45N
O−	16	3.13	02:06	129−54.95E	02−53.18N
O−	17	3.14	01:54	130−00.12E	05−59.77N
O−	18	3.15	02:26	130−01.19E	07−58.65N
O−	19	3.16	02:09	126−52.40E	06−52.81N
O−	20	3.17	02:26	127−45.18E	06−58.78N
O−	21	3.18	02:07	130−29.08E	09−46.70N
O−	22	3.19	02:13	133−06.84E	14−42.65N