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R/V Mirai Cruise Report
MR10-07

November 24, 2010 – December 30, 2010
Tropical Ocean Climate Study (TOCS)

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

Intergovernmental Oceanographic Commission (IOC)
50th Anniversary


TRITON JAMSTEC
KORDI
MR10-07 cruise of R/V MIRAI
Nov. 24 – Dec. 30, 2010
IOC's 50th anniversary
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Table of contents

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 Climatology Study

MR10-07

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 147E and 156E lines in the western equatorial Pacific. Additionally, subsurface Acoustic Doppler Current Profiler (ADCP) buoys at the equator are maintained to obtain time-series data of equatorial ocean current.

We have been observed ocean fine structure in order to understand ocean mixing effect on tropical ocean climate since MR07-07 leg 1. For this purpose, we conducted CTD observations with a LADCP until 500m depth every 30nm along 147E and 156E lines. Additionally, ocean turbulence observation was conducted using a turbulence microstructure profiler, Turbo-Map during this cruise.

Near the New Ireland between 156E and 147E lines, we checked the bottom topography because of future mooring observations, which will be conducted under the SPICE (South West Pacific Ocean Circulation and Climate Experiment) project collaborating with USA and France.

We deployed a prototype of the Southern Ocean buoy, which has been developing for future observation in the rough and cold area of the South Pacific Ocean, near the Cape Erimo of Hokkaido. In the Kuroshio Extension region, we also conducted CTD/XCTD and Radiosonde observations in order to understanding the air-sea interaction in this area. Furthermore, we searched for and found the underwater line of the K-TRITON buoy which drifted on 8 October 2010. We also deployed two Argo floats.

Except for above, automatic continuous oceanic, meteorological and geophysical observations are also conducted along ship track during this cruise as usual. In particular, a cesium magnetometer was towed east of Mariana Islands and west of 147E line.

Finally, this cruise was conducted as the celebration cruise for 50th anniversary of the Intergovernmental Oceanographic Commission (IOC) of UNESCO.

2.2 Overview

1) Ship

R/V Mirai

Captain Yasushi Ishioka

2) Cruise code

MR10-07

3) Project name

Tropical Ocean Climate Study (TOCS)

4) Undertaking institution

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

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

5) Chief scientist

Yuji Kashino (JAMSTEC)

6) Period

November 24, 2010 (Sekinehama, Japan) – November 25, 2010 (Hachinohe, Japan) – December 30, 2010 (Koror, Republic of Palau)

7) Research participants

Two scientists from JAMSTEC

(Three engineers and one administrative staff of JAMSTEC were on board from Sekinehama to Hachinohe.)

One scientist from International Pacific Research Center (USA)

One technician from Korea Ocean Research & Development Institute

Sixteen Marine technicians from Marine works Japan. Ltd. and Global Ocean Development Inc. (Japan)

2.3 Observation summary

TRITON mooring recovery and re-installation: 9 moorings were deployed and recovered

Prototype of the Southern Ocean buoy: It was successfully deployed.

Subsurface ADCP mooring recovery and re-installation: 2 moorings were deployed and recovered

Search of the underwater line of K-TRITON buoy: It was successfully found.

CTD (Conductivity, Temperature and Depth) and water sampling: 55 casts

XCTD:	45 casts
Ocean turbulence observation	51 casts
Launch of Argo floats	2 floats
Radiosonde	23 casts
Rain, water vapor and surface water sampling for isotope analysis	
15 casts for rain, 70 casts for water vapor, and 33 cast for surface water	
Current measurements by shipboard ADCP:	continuous
Sea surface temperature, salinity, dissolved oxygen, and CO2 measurements by intake method:	continuous
Surface meteorology:	continuous
Clouds and aerosol observations	continuous
Underway geophysics observations	continuous
Towing a cesium magnetometer	continuous, two times

We successfully recovered and re-installed nine TRITON buoys at 147E and 156E lines during this cruise without any troubles. We do not find any damages and distortions in the recovered buoys due to vandalism.

Some optional sensors were recovered and re-installed in the TRITON buoys. At first, optional sensors for CO2 measurement by Mutsu Institute of Oceanography (MIO) of JAMSTEC and Central Research Institute of Electric Power Industry (CRIEPI, Japan) were recovered in the TRITON buoys #3 at 2N156E. The former was re-installed in the same buoy. There is no damage in both sensors attached to the recovered buoy. Next, we installed the new conductivity, temperature and depth sensors developed by Marine Technology Center of JAMSTEC at TRITON buoys #1 (8N156E), #2 (5N156E) and #5 (2S156E). One upward ADCP was also installed at TRITON buoy #4 (0N156E) at 175m depth.

We have been maintaining the subsurface ADCP buoys in the western equatorial region since 1996. Two ADCP buoys at 0N147E and 0N156E were recovered and re-installed during this cruise with no trouble. Data from these ADCPs were successfully acquired.

During this cruise, we conducted shallow CTD casts with a LADCP until 500m or 800m depth and ocean turbulence observation using Turbo-Map every 30nm along 156E and 147E lines. We successfully got all CTD and LADCP data.

However, there are some troubles in the ocean turbulence observations. At first, measurement depth of the ocean turbulence observation did not reached 500m depth at the many casts because of strong undercurrents in the equatorial region, We had better discuss its operation considering the case of strong undercurrents. Next, one temperature sensor and one shear probe showed error data during cruise and we exchanged them. Third, the Turbo-Map maker found program bugs in data processing program regarding the equation of conversion from pressure to depth, but they have not been fixed yet. Therefore, we asked the maker to reprocess data using fixed program.

At the equator, 156E, we firstly conducted 24 hours observation using CTD/LADCP/Turbo-Map observation every 3 hours. Although this point locates in the open ocean, we found that signal of ocean tide is not trivial from the moored ADCP data. Interesting data was obtained by this observation and will probably contribute to understanding the mechanism of ocean mixing in this region.

XCTD and radiosonde observations were conducted in the Kuroshio Extension region. Because large air-sea interaction seems to occur in the Kuroshio Extension region as same as the tropics, JAMSTEC and PMEL/NOAA(USA) deployed surface moorings, K-TRITON and KEO buoys, in this region. With regard to the K-TRITON buoy, its float drifted on 8 October 2010 and was recovered on 12 October 2010. Therefore, we searched for its underwater line by acoustic method and successfully found it on 26 November 2010.

In the FY 2012, we have a plan of deployment moorings near the New Ireland in order to observe the New Ireland Coastal Undercurrent, collaborating with USA and France under the SPICE project. Therefore, we searched for suitable points for mooring north of New Ireland on 18 and 19 November conducting XCTD/Shipboard ADCP observations. Then we found some suitable places for mooring near the New Ireland.

With regard to automatic continuous meteorological, oceanographic and geophysical observations, all observations were carried out well. The shipboard ADCP of R/V Mirai did not work well during MR09-04, but its data was good during this cruise.

Thus, we conducted all planed observations on schedule in this cruise.

2.4 Observed oceanic and atmospheric conditions

In 2010 boreal summer, atmosphere and ocean in the tropical Pacific was changed to La Nina condition. Japan Meteorological Agency forecasted this El Nino will continue until 2009/10 boreal winter. Because of the La Nina, low sea surface temperature (SST) anomaly exceeding 2℃ appeared in the eastern Pacific (Figure. 2-1).

Weather during observations along 156E line was good and suitable for buoy maintenance work. However, when R/V Mirai arrived at 147E line, weather was almost rainy.

Sea surface temperature was around 28℃ at 156E (Figure2-2) because cold tongue associating with La Nina reached at this longitude. This SST value was 2 degree lower than that during MR09-04. Because of this relative low SST, air-sea interaction in this region did not seem to be active. In fact we hardly found cumulonimbus with squall during 156E observation. Sea surface salinity south on 2N of 156E line was high exceeding 35PSU. This salinity distribution also largely differs from that during MR09-04.

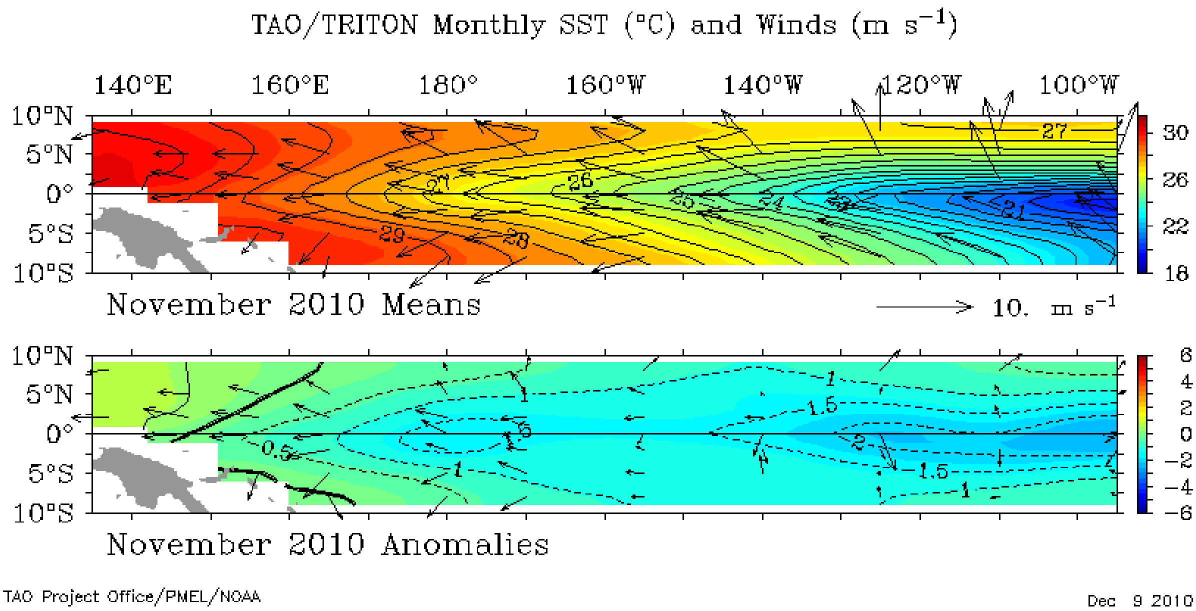

Figure 2-1. Maps of monthly sea surface temperature and winds (upper panel), and their anomaly (lower panel) obtained from TAO/TRITON buoy array in November 2009. (http://www.pmel.noaa.gov/tao/jsdisplay/)

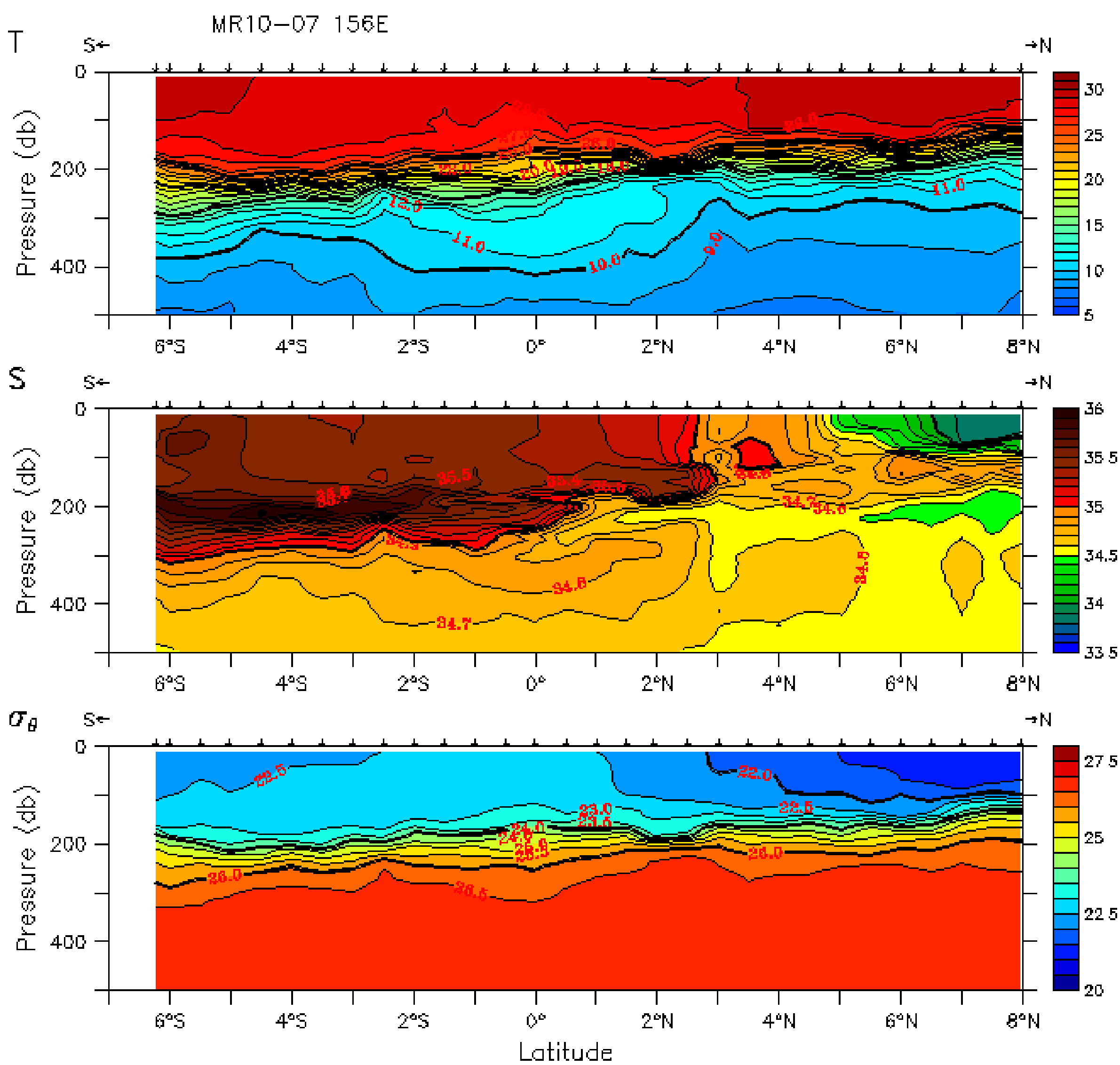

Figure 2-2. Temperature, salinity and potential density sections along 156E line.

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

3.1 Period

23th November 2010 – 30th December 2010

3.2 Ports of call

Sekinehama, Japan (Departure: 23th November 2010)

Hachinohe, Japan (Arrival: 24th November 2010 and Departure: 25th November 2010)

Koror, Palau (Arrival: 30th December 2010)

3.3 Cruise Log

SMT	UTC	Event
Nov. 24th (Wed.) 2010		
07:10	22:10 (-1day)	Departure of Sekinehama
		[Ship Mean Time (SMT)=UTC+9h]
10:30	01:30	Safety guidance
12:10	03:10	XCTD observation X01 (#01)
12:24	03:24	Arrival at St. SOS (41-50N, 142-40E)
13:29 – 14:57	04:29 – 05:57	Deployment of Southern Ocean Surface buoy
		(Fixed Position: 41-50.1522N, 142-39.7641E)
15:48	06:48	Departure of St. SOS
21:07 – 21:34	12:07 – 12:34	Figure-8 turn for Three-components magnetometer calibration
		(41-01N, 142-05E, #1)
Nov. 25th (Thu.) 2010		
08:50	23:50 (-1day)	Arrival of Hachinohe
15:40	06:40	Departure of Hachinohe
16:40	07:40	Surface sea water sampling start
Nov. 26th (Fri.) 2010		
11:12	02:12	Arrival at St. J-KEO (38-02.4N, 146-30.6E)
11:14 – 11:25	02:14 – 02:25	Search for underwater part of K-TRITON buoy
11:56	02:56	Radiosonde observation JKEO (#01)
12:00	03:00	XCTD observation JKEO (#02)
12:06	03:06	Departure of St. J-KEO
13:15	04:15	Emergency drill
14:10	05:10	Radiosonde observation E-01 (#02)
14:14	05:14	XCTD observation E-01 (#03)
15:31	06:31	Radiosonde observation E-02 (#03)
15:36	06:36	XCTD observation E-02 (#04)
16:45	07:45	Konpira ceremony

SMT	UTC	Event
17:09	08:09	Radiosonde observation E-03 (#04)
17:15	08:15	XCTD observation E-03 (#05)
18:39	09:39	Radiosonde observation E-04 (#05)
18:45	09:45	XCTD observation E-04 (#06)
20:05	11:05	Radiosonde observation E-05 (#06)
20:11	11:11	XCTD observation E-05 (#07)
21:35	12:35	Radiosonde observation E-06 (#07)
21:40	12:40	XCTD observation E-06 (#08)
23:06	14:06	Radiosonde observation E-07 (#08)
23:11	14:11	XCTD observation E-07 (#09)
Nov. 27th (Sat.) 2010		
00:36	15:36 (-1day)	Radiosonde observation E-08 (#09)
00:41	15:41	XCTD observation E-08 (#10)
02:15	17:15	Radiosonde observation E-09 (#10)
02:19	17:19	XCTD observation E-09 (#11)
03:43	18:43	Radiosonde observation E-10 (#11)
03:46	18:46	XCTD observation E-10 (#12)
05:15	20:15	Radiosonde observation E-11 (#12)
05:18	20:18	XCTD observation E-11 (#13)
06:54	21:54	Radiosonde observation E-12 (#13)
06:59	21:59	XCTD observation E-12 (#14)
08:27	23:27	Radiosonde observation E-13 (#14)
08:30	23:30	XCTD observation E-13 (#15)
10:01	01:01	Radiosonde observation E-14 (#15)
10:03	01:03	XCTD observation E-14 (#16)
11:29	02:29	Radiosonde observation E-15 (#16)
11:32	02:32	XCTD observation E-15 (#17)
13:05	04:05	Radiosonde observation E-16 (#17)
13:08	04:08	XCTD observation E-16 (#18)
14:45	05:45	Radiosonde observation E-17 (#18)
14:51	05:51	XCTD observation E-17 (#19)
16:28	07:28	Radiosonde observation E-18 (#19)
16:35	07:35	XCTD observation E-18 (#20)
18:16	09:16	Radiosonde observation E-19 (#20)
18:22	09:22	XCTD observation E-19 (#21)
20:15	11:15	Radiosonde observation E-20 (#21)
20:22	11:22	XCTD observation E-20 (#22)
21:47	12:47	Radiosonde observation E-21 (#22)
21:52	12:52	XCTD observation E-21 (#23)

SMT	UTC	Event
22:00	13:00	Time adjustment +1h (SMT=UTC+10h)
Nov. 28th (Sun.) 2010		
01:06	15:06 (-1day)	Radiosonde observation KEO (#23)
01:09	15:09	XCTD observation KEO (#24)
02:00	16:00	Arrival at St. KEO (32-27.8N, 144-28.4E)
05:31 – 05:54	19:31 – 19:54	Figure-8 turn for Three-components magnetometer calibration (32-28N, 144-29E, #2)
06:40 – 07:05	20:40 – 21:05	Check of KEO buoy
08:00 – 08:47	22:00 – 22:47	CTD C00M01 (1000m)
08:48	22:48	Departure of St. KEO
Nov. 29th (Mon.) 2010		
Nov. 30th (Tue.) 2010		
07:33	21:33 (-1day)	Start of Cesium magnetometer observation (#1)
Dec. 01st (Wed.) 2010		
Dec. 02nd (Thu.) 2010		
06:44	20:44 (-1day)	End of Cesium magnetometer observation (#1)
10:12	00:12	Arrival at St.1 (15-00N, 152-00E)
10:15 – 11:27	00:15 – 01:27	CTD C01M01 (2000m)
11:31	01:31	Launch of Argo float (#1)
11:36	01:36	Departure of St.1
Dec. 03rd (Fri.) 2010		
22:00	12:00	Time adjustment +1h (SMT=UTC+11h)
Dec. 04th (Sat.) 2010		
04:48	17:48 (-1day)	Arrival at St.2 (TR#1: 08-00N, 156-00E)
08:16 – 11:02	21:16 – 00:02	Deployment of TRITON buoy TR#1 (#1) (Fixed Position: 07-57.9481N, 156-02.0902E)
13:34 – 14:13	02:34 – 03:13	CTD C02M01 (800m)
15:43 – 16:21	04:43 – 05:21	CTD C02M02 (800m)
18:00 –18:23	07:00 – 07:23	Figure-8 turn for Three-components magnetometer calibration (08-01N, 155-58E, #3)
Dec. 05th (Sun.) 2010		
07:51 – 11:25	20:51 (-1day) – 00:25	Recovery of TRITON buoy TR#1 (#1)
11:30	00:30	Departure of St.2
13:32	02:32	XCTD observation X02 (#25)
15:36	04:36	Arrival at St.3 (07-00N, 156-00E)
15:38 – 16:48	04:38 – 05:48	CTD C03M01 (2000m)
16:53	05:53	Launch of Argo float (#2)
16:54	05:54	Departure of St.3

SMT	UTC	Event
19:19	08:19	XCTD observation X03 (#26)
21:47	10:47	XCTD observation X04 (#27)
Dec. 06th (Mon.) 2010		
00:17	13:17 (-1day)	XCTD observation X05 (#28)
04:00	17:00	Arrival at St.4 (TR#2: 05-00N, 156-00E)
08:15 – 11:22	21:15 – 00:22	Deployment of TRITON buoy TR#2 (#2)
		(Fixed Position: 05-01.2933N, 155-57.7677E)
13:01 – 13:37	02:01 – 02:37	CTD C04M01 (800m)
13:42 – 14:18	02:42 – 03:18	MSP observation (#1)
14:24 – 15:01	03:24 – 04:01	MSP observation (#2)
16:03 – 16:43	05:03 – 05:43	CTD C04M02 (800m)
Dec. 07th (Tue.) 2010		
08:02	21:02 (-1day)	Recovery of TRITON buoy TR#2 (#2)
– 11:36	– 00:36	
11:42	00:42	Departure of St.4
14:00	03:00	Arrival at St.5 (04-30N, 156-00E)
14:00 – 14:28	03:00 – 03:28	CTD C05M01 (500m)
14:32 – 15:07	03:32 – 04:07	MSP observation (#3)
15:12	04:12	Departure of St.5
17:30	06:30	Arrival at St.6 (04-00N, 156-00E)
17:33 – 18:03	06:33 – 07:03	CTD C06M01 (500m)
18:08 – 18:44	07:08 – 07:44	MSP observation (#4)
18:48	07:48	Departure of St. 6
Dec. 08th (Wed.) 2010		
02:30	15:30 (-1day)	Arrival at St.7 (03-30N, 156-00E)
06:02 – 06:31	19:02 – 19:31	CTD C07M01 (500m)
06:35 – 06:57	19:35 – 19:57	MSP observation (#5)
07:34 – 08:07	20:34 – 21:07	MSP observation (#6)
08:12	21:12	Departure of St.7
10:36	23:36	Arrival at St.8 (03-00N, 156-00E)
10:41 – 11:15	23:41 – 00:15	CTD C08M01 (500m)
11:20 – 11:53	00:20 – 00:53	MSP observation (#7)
11:54	00:54	Departure of St.8
14:12	03:12	Arrival at St.9 (02-30N, 156-00E)
14:17 – 14:46	03:17 – 03:46	CTD C09M01 (500m)
14:50 – 15:22	03:50 – 04:22	MSP observation (#8)
15:24	04:24	Departure of St.9
17:30	06:30	Arrival at St.10 (TR#3: 02-00N, 156-00E)

SMT	UTC	Event
Dec. 09th (Thu.) 2010		
08:16	21:16 (-1day)	Deployment of TRITON buoy TR#3 (#3)
– 10:10	– 23:10	(Fixed Position: 01-57.1650N, 156-00.0022E)
10:36	23:36	Departure of St.10
12:36	01:36	Arrival at St.11 (01-30N, 156-00E)
12:37 – 13:05	01:37 – 02:05	CTD C11M01 (500m)
13:07 – 13:38	02:07 – 02:38	MSP observation (#9)
13:42	02:42	Departure of St.11
15:36	04:36	Arrival at St.10 (TR#3: 02-00N, 156-00E)
15:41 – 16:17	04:41 – 05:17	CTD C10M01 (800m)
16:21 – 16:55	05:21 – 05:55	MSP observation (#10)
Dec. 10th (Fri.) 2010		
06:00	19:00 (-1day)	CTD C10M02 (800m)
– 06:42	– 19:42	
08:11 – 11:04	21:11 – 00:04	Recovery of TRITON buoy TR#3 (#3)
11:06	00:06	Departure of St.10
15:12	04:12	Arrival at St.12 (01-00N, 156-00E)
15:15 – 15:45	04:15 – 04:45	CTD C12M01 (500m)
15:48 – 16:19	04:48 – 05:19	MSP observation (#11)
16:24	05:24	Departure of St.12
18:24	07:24	Arrival at St.13 (00-30N, 156-00E)
18:30 – 18:59	07:30 – 07:59	CTD C13M01 (500m)
19:03 – 19:38	08:03 – 08:38	MSP observation (#12)
19:42	08:42	Departure of St.13
Dec. 11th (Sat.) 2010		
01:00	14:00 (-1day)	Arrival at St.14 (TR#4: EQ, 156-00E)
08:11 – 10:06	21:11 – 23:06	Deployment of TRITON buoy TR#4 (#4)
		(Fixed Position: 00-01.0208S, 155-57.3530E)
10:38	23:38	XCTD observation X06 (#29)
13:01 – 14:23	02:01 – 03:23	Recovery of ADCP buoy #1 (EQ, 156E)
15:09 – 15:48	04:09 – 04:48	CTD C14M01 (800m)
Dec. 12th (Sun.) 2010		
08:01	21:01 (-1day)	Recovery of TRITON buoy TR#4 (#4)
– 10:43	– 23:43	
13:01 – 14:01	02:01 – 03:01	Deployment of ADCP buoy #1 (EQ, 156E)
		(Fixed Position: 00-02.2441S, 156-08.0201E)
Dec. 13th (Mon.) 2010		
05:59	18:59 (-1day)	CTD C14M02 (500m)
– 06:30	– 19:30	

SMT	UTC	Event
06:34 – 07:04	19:33 – 20:04	MSP observation (#13)
07:06 – 07:37	20:06 – 20:37	MSP observation (#14)
08:57 – 09:26	21:57 – 22:26	CTD C14M03 (500m)
09:31 – 09:59	22:31 – 22:59	MSP observation (#15)
10:01 – 10:30	23:01 – 23:30	MSP observation (#16)
11:55 – 12:24	00:55 – 01:24	CTD C14M04 (500m)
12:27 – 12:59	01:27 – 01:59	MSP observation (#17)
13:00 – 13:32	02:00 – 02:32	MSP observation (#18)
14:57 – 15:26	03:57 – 04:26	CTD C14M05 (500m)
15:29 – 16:04	04:29 – 05:04	MSP observation (#19)
16:05 – 16:41	05:05 – 05:41	MSP observation (#20)
17:56 – 18:25	06:56 – 07:25	CTD C14M06 (500m)
18:28 – 19:01	07:28 – 08:01	MSP observation (#21)
19:02 – 19:34	08:02 – 08:34	MSP observation (#22)
20:56 – 21:25	09:56 – 10:25	CTD C14M07 (500m)
21:29 – 22:00	10:29 – 11:00	MSP observation (#23)
22:00 – 22:35	11:00 – 11:35	MSP observation (#24)
23:58 –	12:58 –	CTD C14M08 (500m)
Dec. 14th (Tue.) 2010		
– 00:28	– 13:28 (-1day)	CTD C14M08 (500m)
00:32 – 01:07	13:32 – 14:07	MSP observation (#25)
01:08 – 01:41	14:08 – 14:41	MSP observation (#26)
02:56 – 03:26	15:56 – 16:26	CTD C14M09 (500m)
03:30 – 04:02	16:30 – 17:02	MSP observation (#27)
04:03 – 04:37	17:03 – 17:37	MSP observation (#28)
05:56 – 06:28	18:56 – 19:28	CTD C14M10 (500m)
06:31 – 07:05	19:31 – 20:05	MSP observation (#29)
07:06 – 07:39	20:06 – 20:39	MSP observation (#30)
07:42	20:42	Departure of St.14
09:48	22:48	Arrival at St.15 (00-30S, 156-00E)
09:50 – 10:18	22:50 – 23:18	CTD C15M01 (500m)
10:22 – 10:58	23:22 – 23:58	MSP observation (#31)
11:00	00:00	Departure of St.15
13:06	02:06	Arrival at St.16 (01-00S, 156-00E)
13:09 – 13:37	02:09 – 02:37	CTD C16M01 (500m)
13:41 – 14:17	02:41 – 03:17	MSP observation (#32)
14:18	03:18	Departure of St.16
16:30	05:30	Arrival at St.17 (01-30S, 156-00E)
16:50 – 17:18	05:50 – 06:18	CTD C17M01 (500m)

SMT	UTC	Event
17:22 – 17:58	06:22 – 06:58	MSP observation (#33)
18:00	07:00	Departure of St.17
23:12	12:12	Arrival at St.18 (TR#5: 02-00S, 156-00E)
Dec. 15th (Wed.) 2010		
08:06	21:06 (-1day)	Deployment of TRITON buoy TR#5 (#5)
– 10:05	– 23:05	(Fixed Position: 01-58.9661S, 156-01.8436E)
10:42 – 11:20	23:42 – 00:20	CTD C18M01 (500m)
11:24 – 11:55	00:24 – 00:55	MSP observation (#34)
12:56 – 13:35	01:56 – 02:35	CTD C18M02 (800m)
13:36	02:36	Departure of St.18
15:36	04:36	Arrival at St.19 (02-30S, 156-00E)
15:40 – 16:10	04:40 – 05:10	CTD C19M01 (800m)
16:13 – 16:47	05:13 – 05:47	MSP observation (#35)
16:48	05:48	Departure of St.19
19:42	08:42	Arrival at St.18 (TR#5: 02-00S, 156-00E)
Dec. 16th (Thu.) 2010		
08:00	21:00 (-1day)	Recovery of TRITON buoy TR#5 (#5)
– 10:22	– 23:22	
10:24	23:24	Departure of St.18
14:12	03:12	Arrival at St.20 (03-00S, 156-00E)
14:17 – 14:45	03:17 – 03:45	CTD C20M01 (500m)
14:49 – 15:24	03:49 – 04:24	MSP observation (#36)
15:24	04:24	Departure of St.20
17:24	06:24	Arrival at St.21 (03-30S, 156-00E)
17:25 – 17:54	06:25 – 06:54	CTD C21M01 (500m)
17:57 – 18:36	06:57 – 07:36	MSP observation (#37)
18:36	07:36	Departure of St.21
Dec. 17th (Fri.) 2010		
05:48	18:48(-1day)	Arrival at St.24 (TR#6: 05-00S, 156-00E)
05:57 – 06:36	18:57– 19:36	CTD C24M01 (800m)
08:13 – 09:43	21:13 – 22:43	Deployment of TRITON buoy TR#6 (#6)
		(Fixed Position: 04-58.0328S, 156-00.9999E)
10:28 – 11:04	23:28 – 00:04	CTD C24M02 (800m)
11:09 – 11:46	00:09 – 00:46	MSP observation (#38)
12:24	01:24	Departure of St.24
14:36	03:36	Arrival at St.25 (05-30S, 156-00E)
14:39 – 15:06	03:39 – 04:06	CTD C25M01 (500m)
15:11 – 15:44	04:11 – 04:44	MSP observation (#39)
15:48	04:48	Departure of St.25

SMT	UTC	Event
17:48	06:48	Arrival at St.26 (06-00S, 156-00E)
17:50 – 18:18	06:50 – 07:18	CTD C26M01 (500m)
18:23 – 18:54	07:23 – 07:54	MSP observation (#40)
19:00	08:00	Departure of St.26
20:16	09:16	XCTD observation X07 (#30, 06-14S, 156-06E)
21:30 –21:59	10:30 – 10:59	Figure-8 turn for Three-components magnetometer calibration (06-01S, 156-05E, #4)
Dec. 18th (Sat.) 2010		
07:42	20:42 (-1day)	Arrival at St.24 (TR#6: 05-00S, 156-00E)
08:02 – 10:06	21:02 – 23:06	Recovery of TRITON buoy TR#6 (#6)
10:12	23:12	Departure of St.24
12:42	01:42	Arrival at St.23 (04-30S, 156-00E)
12:46 – 13:14	01:46 – 02:14	CTD C23M01 (500m)
13:18 – 13:51	02:18 – 02:51	MSP observation (#41)
13:54	02:54	Departure of St.23
16:06	05:06	Arrival at St.22 (04-00S, 156-00E)
16:08 – 16:37	05:08 – 05:37	CTD C22M01 (500m)
16:40 – 17:13	05:40 – 06:13	MSP observation (#42)
17:18	06:18	Departure of St.22
Dec. 19th (Sun.) 2010		
00:52	13:52 (-1day)	XCTD observation X08 (#31)
00:53	13:53	Start of bathymetric site survey (Papua New Guinea off)
01:56	14:56	XCTD observation X09 (#32)
03:01	16:01	XCTD observation X10 (#33)
04:07	17:07	XCTD observation X11 (#34)
05:13	18:13	XCTD observation X12 (#35)
06:21	19:21	XCTD observation X13 (#36)
07:30	20:30	XCTD observation X14 (#37)
08:43	21:43	XCTD observation X15 (#38)
14:09	03:09	XCTD observation X16 (#39)
15:14	04:14	XCTD observation X17 (#40)
16:20	05:20	XCTD observation X18 (#41)
17:26	06:26	XCTD observation X19 (#42)
Dec. 20th (Mon.) 2010		
00:12	13:12 (-1day)	XCTD observation X20 (#43)
00:18	13:18	End of bathymetric site survey (Papua New Guinea off)
07:37	20:37	XCTD observation X21 (#44)
14:50	03:50	XCTD observation X22 (#45)
22:00	11:00	Time adjustment -1h (SMT=UTC+10h)

SMT	UTC	Event
21:01	11:01	XCTD observation X23 (#46)
Dec. 21th (Tue.) 2010		
06:00	20:00 (-1day)	Arrival at St.27 (TR#9: EQ, 147-00E)
08:09 – 10:33	22:09 – 00:33	Deployment of TRITON buoy TR#9 (#7)
		(Fixed Position: 00-01.4752S, 146-59.9756E)
12:57 – 13:33	02:57 – 03:33	CTD C27M01 (800m)
13:37 – 14:12	03:37 – 04:12	MSP observation (#43)
14:52 – 15:30	04:52 – 05:30	CTD C27M02 (800m)
Dec. 22th (Wed.) 2010		
08:00	22:00 (-1day)	Recovery of TRITON buoy TR#9 (#7)
– 10:56	– 00:56	
13:05 – 15:05	03:05 – 05:05	Recovery of ADCP buoy #2 (EQ, 147E)
15:06	05:06	Departure of St.27
17:24	07:24	Arrival at St.28 (00-30N, 147-00E)
17:29 – 17:56	07:29 – 07:56	CTD C28M01 (500m)
17:59 – 18:34	07:59 – 08:34	MSP observation (#44)
18:36	08:36	Departure of St.28
23:12	13:12	Arrival at St.27 (TR#9: EQ, 147-00E)
Dec. 23th (Thu.) 2010		
08:00	22:00 (-1day)	Deployment of ADCP buoy #2 (EQ, 147E)
– 09:30	– 23:30	(Fixed Position: 00-00.2456S, 147-04.5778E)
10:12	00:12	Departure of St.27
14:36	04:36	Arrival at St.29 (01-00N, 147-00E)
14:38 – 15:05	04:38 – 05:05	CTD C29M01 (500m)
15:08 – 15:45	05:08 – 05:45	MSP observation (#45)
15:48	05:48	Departure of St.29
18:00	08:00	Arrival at St.30 (01-30N, 147-00E)
18:00 – 18:31	08:00 – 08:31	CTD C30M01 (500m)
18:34 – 19:07	08:34 – 09:07	MSP observation (#46)
19:12	09:12	Departure of St.30
Dec. 24th (Fri.) 2010		
02:00	16:00 (-1day)	Arrival at St.31 (TR#8: 02-00N, 147-00E)
08:10 – 10:27	22:10 – 00:27	Deployment of TRITON buoy TR#8 (#8)
		(Fixed Position: 02-04.4708N, 146-57.0191E)
12:56 – 13:32	02:56 – 03:32	CTD C31M01 (800m)
13:36 – 14:10	03:36 – 04:10	MSP observation (#47)
14:53 – 15:32	04:53 – 05:32	CTD C31M02 (800m)
15:36	05:36	Departure of St.31

SMT	UTC	Event
17:42	07:42	Arrival at St.32 (02-30N, 147-00E)
17:43 – 18:11	07:43 – 08:11	CTD C32M01 (500m)
18:14 – 18:49	08:14 – 08:49	MSP observation (#48)
18:54	08:54	Departure of St.32
Dec. 25th (Sat.) 2010		
00:30	14:30 (-1day)	Arrival at St.31 (TR#8: 02-00N, 147-00E)
08:00 – 11:20	22:00 – 00:20	Recovery of TRITON buoy TR#8 (#8)
11:24	01:24	Departure of St.31
15:36	07:42	Arrival at St.33 (03-00N, 147-00E)
15:41 – 16:10	05:41 – 06:10	CTD C33M01 (500m)
16:13 – 16:50	06:13 – 06:50	MSP observation (#49)
16:54	06:54	Departure of St.33
18:54	08:54	Arrival at St.34 (03-30N, 147-00E)
18:56 – 19:25	08:56 – 09:25	CTD C34M01 (500m)
19:28 – 20:06	09:28 – 10:06	MSP observation (#50)
20:06	10:06	Departure of St.34
Dec. 26th (Sun.) 2010		
00:30	14:30 (-1day)	Arrival at St.37 (TR#7: 05-00N, 147-00E)
05:57 – 06:37	19:57 – 20:37	CTD C37M01 (800m)
08:10 – 11:02	22:10 – 01:02	Deployment of TRITON buoy TR#7 (#9)
		(Fixed Position: 05-02.5262N, 146-56.8225E)
11:48	01:48	Departure of St.37
14:12	04:12	Arrival at St.36 (04-30N, 147-00E)
14:15 – 14:44	04:15 – 04:44	CTD C36M01 (500m)
14:47 – 15:26	04:47 – 05:26	MSP observation (#51)
15:30	05:30	Departure of St.36
17:48	07:48	Arrival at St.35 (04-00N, 147-00E)
17:49 – 18:18	07:49 – 08:18	CTD C35M01 (500m)
18:21 – 18:53	08:21 – 08:53	MSP observation (#52)
18:54	08:54	Departure of St.35
20:59 –21:31	10:59 – 11:31	Figure-8 turn for Three-components magnetometer calibration
		(04-27N, 147-00E, #5)
Dec. 27th (Mon.) 2010		
03:00	17:00 (-1day)	Arrival at St.37 (TR#7: 05-00N, 147-00E)
08:02 – 11:04	22:02 – 00:04	Recovery of TRITON buoy TR#7 (#9)
12:56 – 13:36	02:56 – 03:36	CTD C37M02 (800m)
13:40 – 14:20	03:40 – 04:20	MSP observation (#53)
14:24	04:24	Departure of St.37
14:44	04:44	Start of Cesium magnetometer observation (#2)

SMT	UTC	Event
Dec. 28th (Tue.) 2010		
22:00	10:00	Time adjustment -1h (SMT=UTC+9h)
Dec. 29th (Wed.) 2010		
02:10	17:10 (-1day)	End of continuous observation
02:10	17:10	End of Cesium magnetometer observation (#2)
02:10	17:00	Surface sea water sampling stop
Dec. 30th (Thu.) 2010		
10:10	01:10	Arrival of Koror

3.4 Cruise track

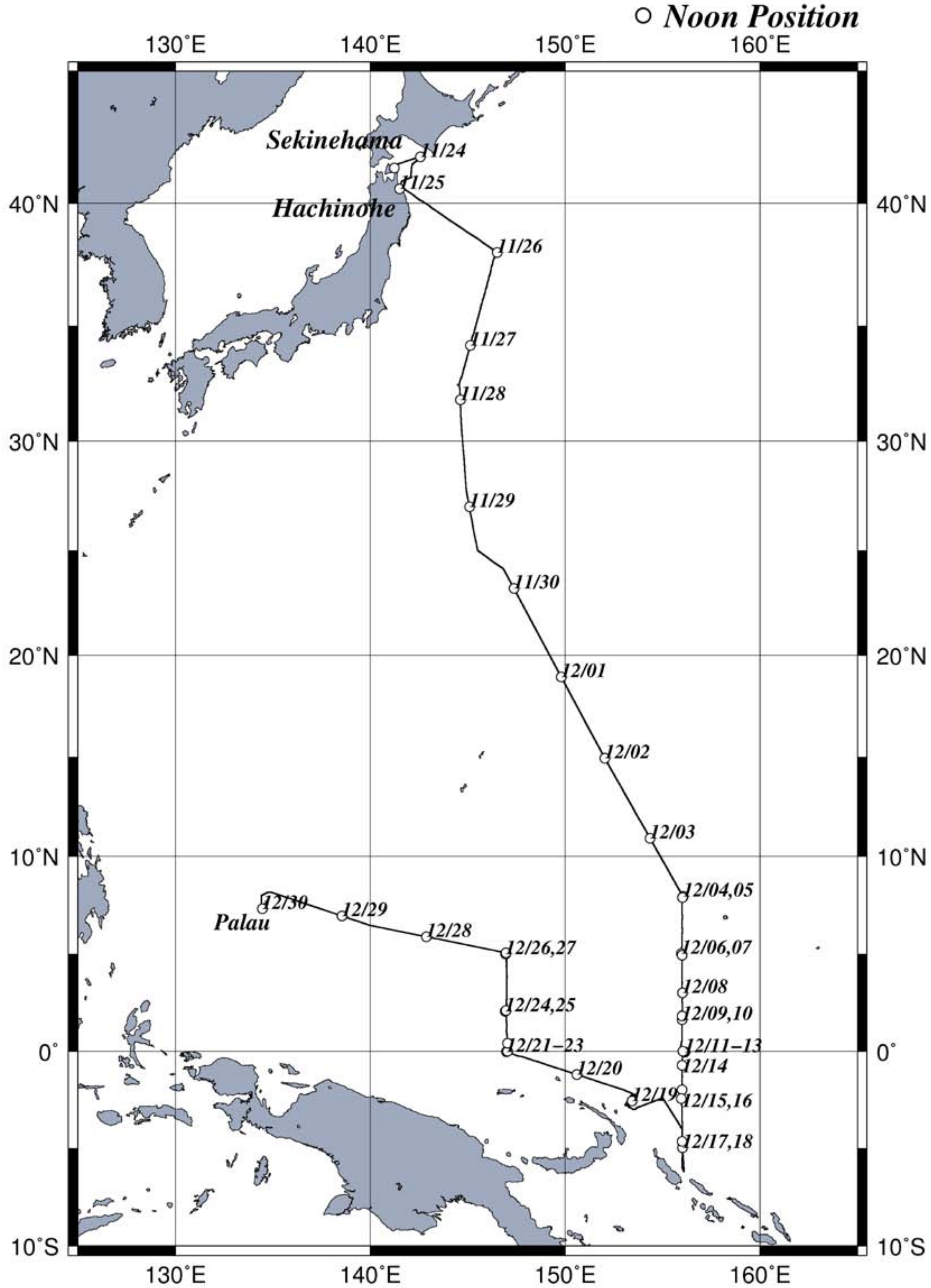

Fig 3.4 MR10-07 Cruise track and noon positions

4. Chief scientist

Chief Scientist

Yuji Kashino

Senior 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
Takuya Hasegawa	JAMSTEC	Scientist
Andrei Natarov [1)]	International Pacific Research Center, University of Hawaii	Scientist
Dong Guk Kim	Korea Ocean Research & Development Institute	Scientist
Hitoshi Nakai [2)]	JAMSTEC	Engineer
Shoichiro Baba [2)]	JAMSTEC	Engineer
Tatsuya Fukuda [2)]	JAMSTEC	Engineer
Mai Funakubo [2)]	JAMSTEC	Administrative Staff
Tomohide Noguchi	Marine Works Japan Ltd	Technical Staff
Keisuke Matsumoto	Marine Works Japan Ltd	Technical Staff
Shinsuke Toyoda	Marine Works Japan Ltd	Technical Staff
Hiroki Ushiromura	Marine Works Japan Ltd	Technical Staff
Akira Watanabe	Marine Works Japan Ltd	Technical Staff
Hirokatsu Uno	Marine Works Japan Ltd	Technical Staff
Yasuhiro Arii	Marine Works Japan Ltd	Technical Staff
Misato Kuwahara	Marine Works Japan Ltd	Technical Staff
Yasushi Hashimoto	Marine Works Japan Ltd	Technical Staff
Makito Yokota	Marine Works Japan Ltd	Technical Staff
Takatoshi Kiyokawa	Marine Works Japan Ltd	Technical Staff
Kai Fukuda	Marine Works Japan Ltd	Technical Staff
Yuki Miyajima	Marine Works Japan Ltd	Technical Staff
Miki Tawata	Marine Works Japan Ltd	Technical Staff
Norio Nagahama	Global Ocean Development Inc	Technical Staff
Ryo Kimura	Global Ocean Development Inc	Technical Staff

1) Participation from Hachinohe to Koror

2) Participation from Sekinehama to Hachinohe

5.2 R/V MIRAI crew members

Name	Rank or rating
Yasushi Ishioka	Master
Haruhiko Inoue	Chief Officer
Takeshi Isohi	1st Officer
Nobuo Fukaura	2nd Officer
Haruka Wakui	3rd Officer
Yoichi Furukawa	Chief Engineer
Katsunori Kajiyama	2nd Engineer
Koji Manako	2nd Engineer
Keisuke Nakamura	3rd Engineer
Ryo Ohyama	Technical Officer
Yosuke Kuwahara	Boatswain
Kazuyoshi Kudo	Able Seaman
Tsuyoshi Sato	Able Seaman
Tsuyoshi Monzawa	Able Seaman
Masashige Okada	Able Seaman
Yoshihiro Hatanaka	Able Seaman
Shuji Komata	Able Seaman
Hideaki Tamotsu	Ordinary Seaman
Hideyuki Okubo	Ordinary Seaman
Hajime Ikawa	Ordinary Seaman
Tomohiro Shimada	Ordinary Seaman
Yoshihiro Sugimoto	Oiler
Nobuo Boshita	Oiler
Kazumi Yamashita	Oiler
Keisuke Yoshida	Ordinary Oiler
Hiromi Ikuta	Ordinary Oiler
Shintaro Abe	Ordinary Oiler
Hitoshi Ota	Chief Steward
Tamotsu Uemura	Cook
Michihiro Mori	Cook
Kozo Uemura	Cook
Shohei Maruyama	Steward

6. General observations

6.1 Meteorological measurements

6.1.1 Surface meteorological observations

Yuji Kashino (JAMSTEC) : Principal Investigator
Norio Nagahama (Global Ocean Development Inc., GODI)
Ryo Kimura (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 MR10-07 cruise. During this cruise, we used three 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 (SMet)
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. SST (Sea Surface Temperature) data was available in the following periods.
07:40UTC 25 Nov. 2010 – 17:10UTC 28 Dec. 2010

ii. SMet optical rain gauge lens clearning
07:12UTC 25 Nov. 2010
22:12UTC 13 Dec. 2010
04:22UTC 24 Dec. 2010

iii. In the following time, SMet rain gauge amount values were increased because of test transmitting for MF/HF radio
03:13UTC 19 Dec. 2010

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-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-200	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

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	61202V	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	

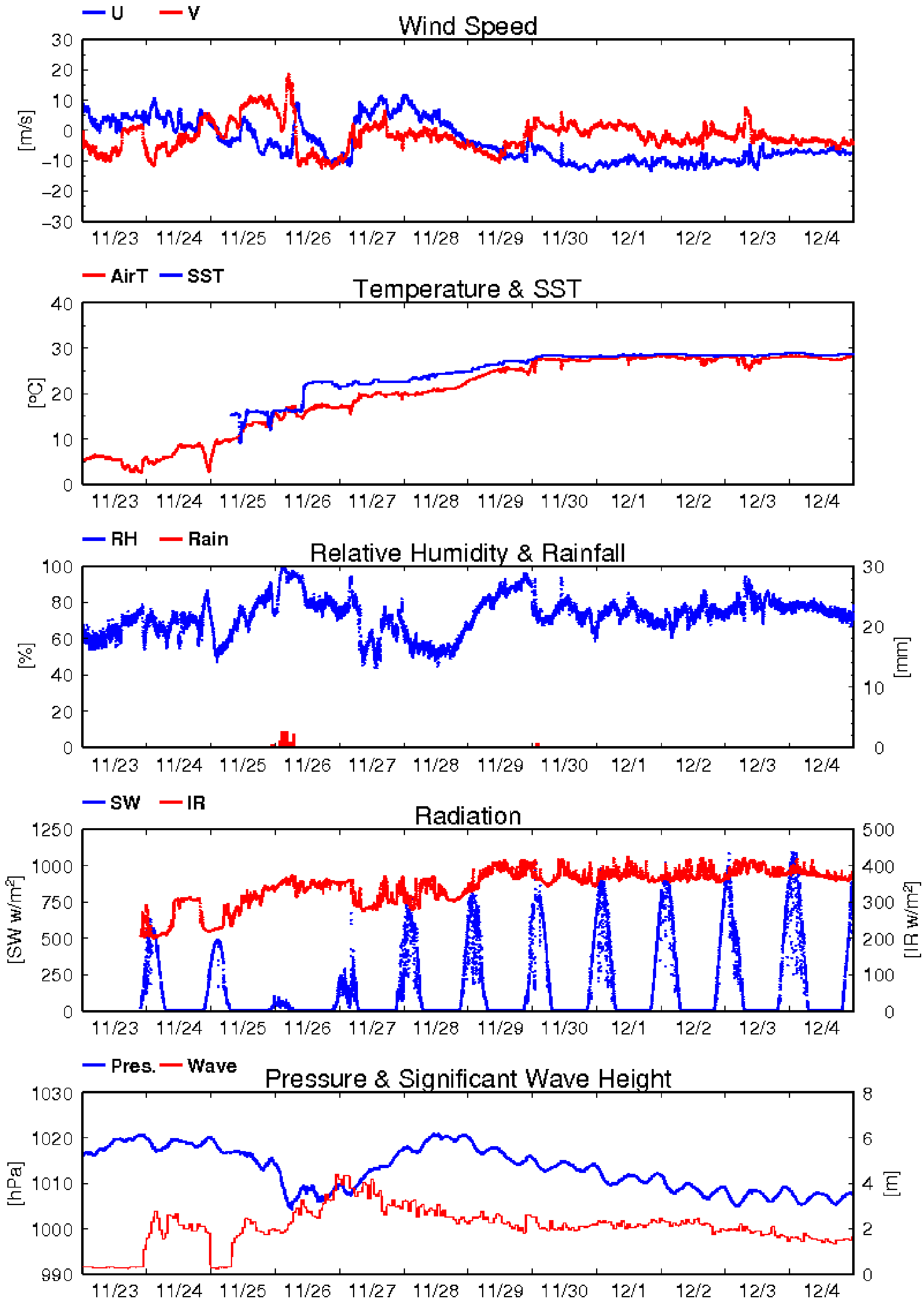


Fig.6.1.1-1 Time series of surface meteorological parameters during the MR10-07 cruise

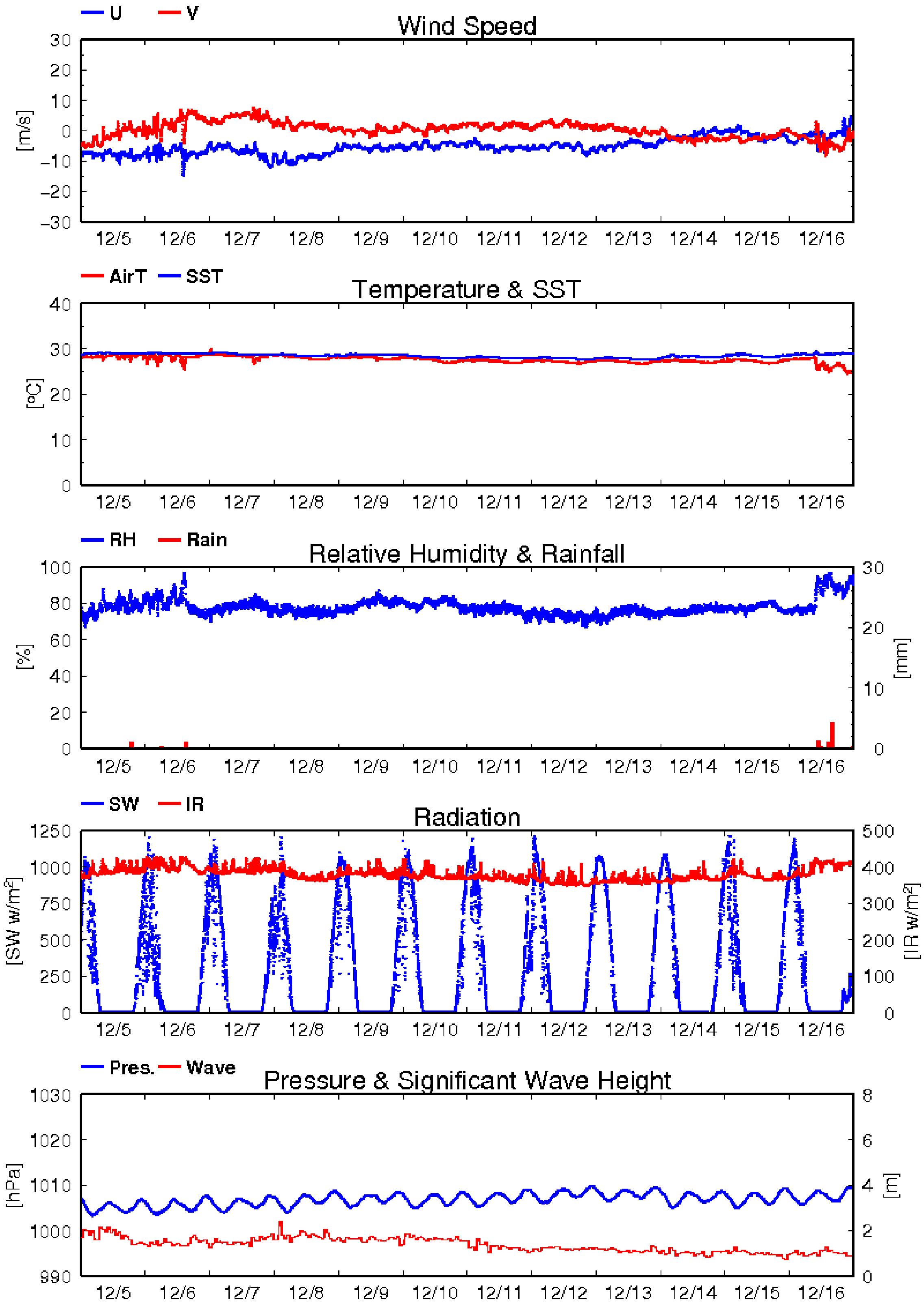


Fig. 6.1.1-1 (Continued)

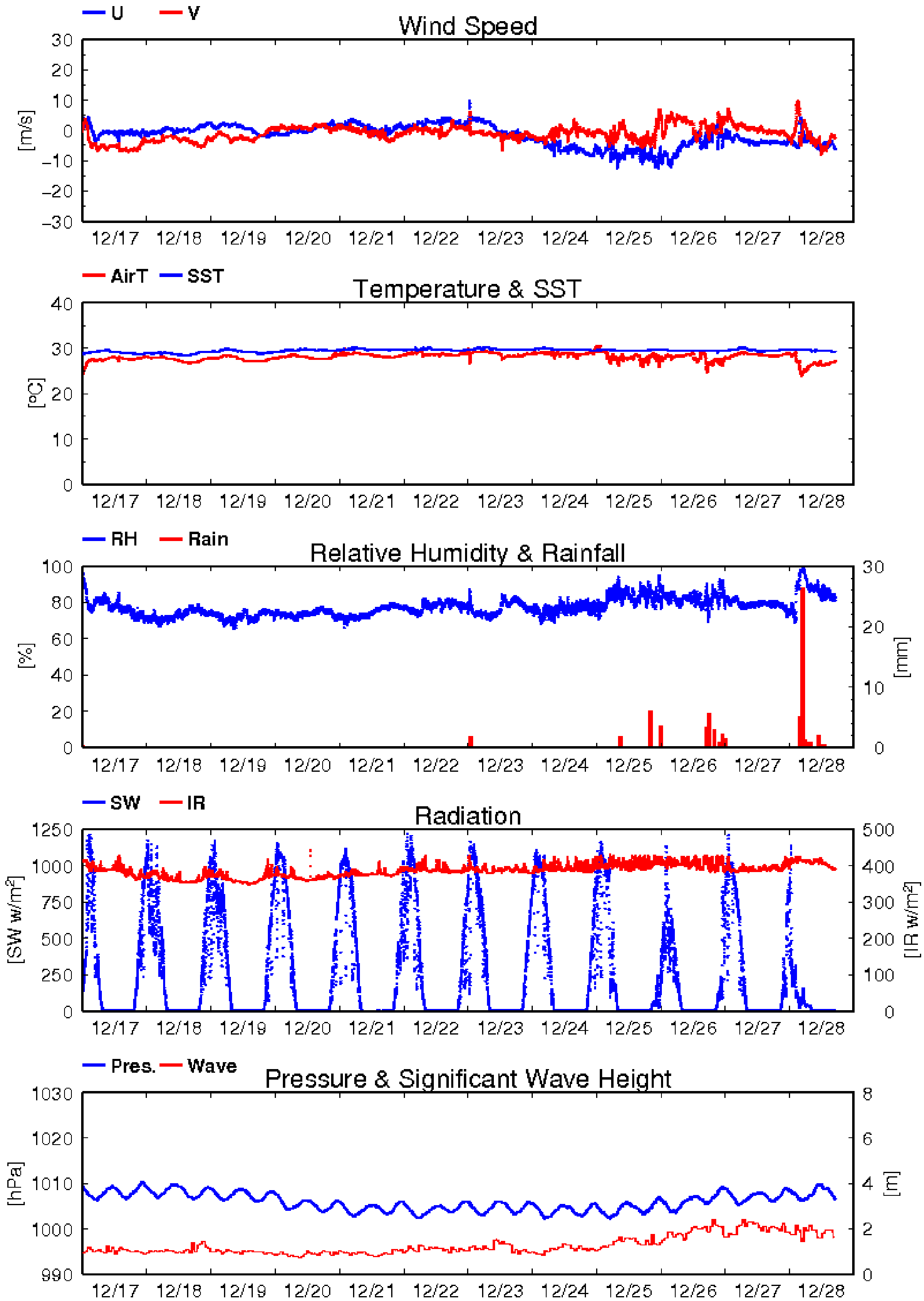


Fig. 6.1.1-1 (Continued)

6.1.2 Ceilometer observation

Yuji Kashino	(JAMSTEC) : Principal Investigator
Norio Nagahama	(Global Ocean Development Inc., GODI)
Ryo Kimura	(GODI)
Ryo Ohyama	(MIRAI Crew)

(1) Objectives

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

(2) Parameters

1. Cloud base height [m].
2. Backscatter profile, sensitivity and range normalized at 30 m resolution.
3. Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm.

(3) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR10-07 cruise.

Major parameters for the measurement configuration are as follows;

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

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

(4) Preliminary results

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

(5) Data archives

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

(7) Remarks

1. Window cleaning;

21:18UTC 23 Nov. 2010, 07:11UTC 25 Nov. 2010, 05:57UTC 10 Dec 2010,
22:10UTC 13 Dec. 2010, 04:21UTC 24 Dec. 2010

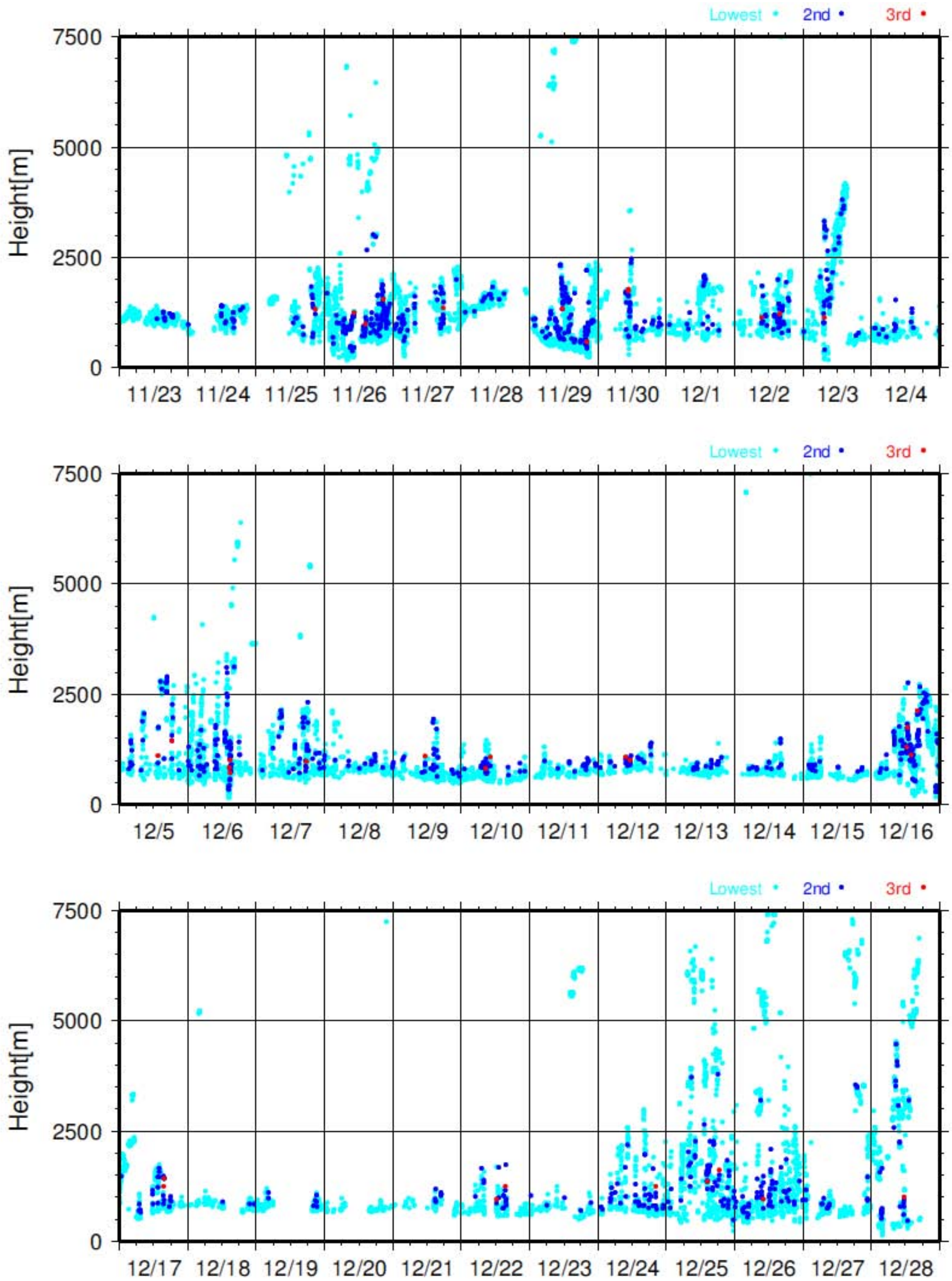


Fig. 6.1.2-1 Lowest, 2nd and 3rd cloud base height during the MR10-07 cruise

6.2 CTD/XCTD

6.2.1 CTD

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal investigator
Shinsuke Toyoda	(MWJ): Operation leader
Hirokatsu Uno	(MWJ)
Tomohide Noguchi	(MWJ)
Hiroki Ushiromura	(MWJ)
Yasushi Hashimoto	(MWJ)
Yasuhiro Arii	(MWJ)
Yuki Miyajima	(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)

(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), and pressure and dissolved oxygen (Primary). 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.7.20g) 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.

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

After Stn.C09, 9plus was changed (S/N 0357 - S/N 0677).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.18d) 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 6 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 dissolved oxygen voltage and decent rate.

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

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.

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: MR1007A.con

Specifications of the sensors are listed below.

CTD: SBE911plus CTD system

Under water unit:

SBE9plus

S/N 09P9833-0357 (Sea-Bird Electronics, Inc.):Stn.C00 - Stn.C09

Pressure sensor: Digiquartz pressure sensor (S/N 42423)

Calibrated Date: 06 Jul. 2010

S/N 09P27443-0677 (Sea-Bird Electronics, Inc.):Stn.C11 - final cast

Pressure sensor: Digiquartz pressure sensor (S/N 79511)

Calibrated Date: 07 Jul. 2010

Temperature sensors:

Primary: SBE03-04/F (S/N 031464, Sea-Bird Electronics, Inc.)

Calibrated Date: 20 Jul. 2010

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

Calibrated Date: 17 Sep. 2010

Conductivity sensors:

Primary: SBE04-04/0 (S/N 042854, Sea-Bird Electronics, Inc.)

Calibrated Date: 09 Jun. 2010

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

Calibrated Date: 28 Jan. 2010

Dissolved Oxygen sensors:

Primary: SBE43 (S/N 430205, Sea-Bird Electronics, Inc.)

Calibrated Date: 08 Sep. 2010

Carousel water sampler:

SBE32 (S/N 3227443-0391, Sea-Bird Electronics, Inc.)

Deck unit: SBE11plus (S/N 11P7030-0272, Sea-Bird Electronics, Inc.)

(5) Preliminary Results

During this cruise, 55 casts 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 - 6.2.1-14.

(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 MR10-07 CTD Casttable

Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire	Max	Max	CTD	Remark
		(mmddyy)	Start	End	Latitude	Longitude		Out	Depth	Pressure	Filename	
C00	1	112710	22:07	22:44	32-25.63N	144-34.39E	5735.0	1002.5	1002.1	1010.7	C00M01	test cast KEO buoy point LADCP
C01	1	120210	00:17	01:25	15-00.11N	151-59.95E	6004.0	2001.4	2000.6	2022.3	C01M01	ARGO
C02	1	120410	02:38	03:10	07-57.80N	156-03.30E	4853.0	800.0	800.1	806.0	C02M01	Deployment point of T01
C02	2	120410	04:48	05:19	08-00.75N	155-58.08E	4863.0	799.5	800.8	806.8	C02M02	Recovery point of T01
C03	1	120510	04:42	05:46	06-59.98N	156-00.00E	4446.0	1998.7	2001.3	2021.6	C03M01	ARGO
C04	1	120610	02:06	02:34	05-01.48N	155-56.12E	3597.0	801.1	800.6	807.2	C04M01	LADCP Deployment point of T02
C04	2	120610	05:07	05:39	04-58.75N	156-00.87E	3599.0	796.7	800.1	805.7	C04M02	Recovery point of T02
C05	1	120710	03:04	03:25	04-30.12N	155-59.97E	3553.0	499.8	500.5	503.9	C05M01	LADCP
C06	1	120710	06:38	07:00	04-00.15N	155-59.87E	3474.0	498.3	500.8	503.7	C06M01	LADCP
C07	1	120710	19:06	19:28	03-30.19N	156-00.13E	3252.0	498.1	501.3	503.5	C07M01	LADCP
C08	1	120710	23:48	00:12	03-00.25N	156-00.28E	2879.0	496.8	501.3	505.4	C08M01	LADCP
C09	1	120810	03:22	03:43	02-30.03N	156-00.21E	2675.0	498.7	501.2	504.9	C09M01	LADCP
C11	1	120910	01:41	02:01	01-29.94N	155-59.89E	2386.0	497.6	500.9	504.2	C11M01	changed SBE9plus (S/N 0357 - S/N0677) LADCP
C10	1	120910	04:46	05:15	01-56.78N	155-58.93E	2560.0	799.1	802.9	808.7	C10M01	LADCP Deployment point of T03
C10	2	120910	19:06	19:38	02-02.08N	156-00.19E	2585.0	798.9	800.0	806.1	C10M02	LADCP Recovery point of T03
C12	1	121010	04:19	04:42	00-59.97N	155-59.88E	2261.0	499.2	500.5	504.4	C12M01	LADCP
C13	1	121010	07:34	07:56	00-29.98N	155-59.86E	2140.0	498.9	501.2	503.9	C13M01	LADCP

C14	1	121110	04:14	04:45	00-00.57S	155-59.92E	1949.0	801.9	801.9	808.0	C14M01	LADCP Recovery point of T04
C14	2	121210	19:04	19:27	00-00.00N	156-02.50E	1953.0	499.6	502.4	506.8	C14M02	LADCP Deployment point of T04
C14	3	121210	22:02	22:24	00-00.00S	156-02.45E	1952.0	497.2	500.2	504.2	C14M03	LADCP
C14	4	121310	01:00	01:21	00-00.00N	156-02.44E	1953.0	498.5	502.6	505.5	C14M04	LADCP
C14	5	121310	04:01	04:23	00-00.00N	156-02.49E	1952.0	498.1	502.4	506.0	C14M05	LADCP
C14	6	121310	07:00	07:22	00-00.09N	156-02.54E	1953.0	498.9	501.4	504.1	C14M06	LADCP
C14	7	121310	10:01	10:22	00-00.00N	156-02.43E	1953.0	498.9	501.0	504.6	C14M07	LADCP
C14	8	121310	13:02	13:25	00-00.00S	156-02.40E	1954.0	499.8	502.0	506.0	C14M08	LADCP
C14	9	121310	16:01	16:23	00-00.01S	156-02.48E	1953.0	499.6	502.0	505.2	C14M09	LADCP
C14	10	121310	19:02	19:25	00-00.03N	156-02.52E	1952.0	499.8	502.1	505.3	C14M10	LADCP
C15	1	121310	22:55	23:16	00-30.02S	155-59.93E	1952.0	499.8	502.4	506.6	C15M01	LADCP
C16	1	121410	02:14	02:34	00-59.98S	155-59.89E	2084.0	500.3	502.8	505.9	C16M01	LADCP
C17	1	121410	05:55	06:16	01-30.21S	155-59.54E	1814.0	500.9	501.8	505.1	C17M01	LADCP
C18	1	121410	23:47	00:17	01-59.34S	156-00.65E	1745.0	800.8	800.4	806.4	C18M01	LADCP Deployment point of T05
C18	2	121510	02:01	02:32	02-01.67S	155-57.18E	1748.0	799.8	800.9	806.4	C18M02	LADCP Recovery point of T05
C19	1	121510	04:45	05:07	02-30.02S	155-59.85E	1744.0	499.4	499.4	502.4	C19M01	LADCP
C20	1	121610	03:21	03:42	03-00.10S	155-59.85E	1814.0	499.0	500.0	502.1	C20M01	LADCP
C21	1	121610	06:30	06:51	03-30.11S	155-59.84E	1895.0	497.0	499.1	500.6	C21M01	LADCP
C24	1	121610	19:02	19:33	05-01.87S	156-00.21E	1532.0	801.3	800.6	806.1	C24M01	LADCP Recovery point of T06
C24	2	121610	23:33	00:03	04-59.26S	156-00.38E	1523.0	801.7	800.5	806.4	C24M02	LADCP Deployment point of T06

C25	1	121710	03:43	04:03	05-30.17S	155-59.85E	2127.0	499.2	500.6	504.0	C25M01	LADCP
C26	1	121710	06:55	07:16	06-00.04S	156-00.01E	2863.0	499.6	501.6	505.1	C26M01	LADCP
C23	1	121810	01:51	02:11	04-30.08S	156-00.01E	1719.0	498.9	500.6	504.1	C23M01	LADCP
C22	1	121810	05:13	05:34	03-59.95S	155-59.85E	1785.0	499.6	501.8	504.6	C22M01	LADCP
C27	1	122110	03:02	03:31	00-02.47S	146-58.54E	4574.0	799.8	798.8	803.2	C27M01	LADCP Deployment point of T09
C27	2	122110	04:56	05:26	00-02.44N	146-59.33E	4396.0	798.4	801.8	808.6	C27M02	LADCP Recovery point of T09
C28	1	122210	07:33	07:53	00-29.93N	146-59.87E	4468.0	500.1	501.1	504.9	C28M01	LADCP
C29	1	122310	04:42	05:02	00-59.95N	146-59.89E	4511.0	498.9	500.4	504.3	C29M01	LADCP
C30	1	122310	08:05	08:27	01-30.06N	146-59.92E	4515.0	499.6	501.3	504.7	C30M01	LADCP
C31	1	122410	03:00	03:29	02-03.93N	146-55.46E	4478.0	801.9	800.1	806.3	C31M01	LADCP Deployment point of T08
C31	2	122410	04:58	05:29	02-00.26N	146-59.76E	4516.0	798.6	801.3	807.0	C31M02	LADCP Recovery point of T08
C32	1	122410	07:48	08:08	02-30.10N	146-59.98E	4431.0	498.9	500.8	504.5	C32M01	LADCP
C33	1	122510	05:46	06:07	03-00.10N	146-59.97E	4431.0	497.8	501.4	505.7	C33M01	LADCP
C34	1	122510	09:00	09:22	03-30.13N	147-00.07E	4309.0	496.3	500.5	503.9	C34M01	LADCP
C37	1	122510	20:02	20:34	04-58.05N	147-00.73E	4293.0	801.3	800.6	806.5	C37M01	LADCP Recovery point of T07
C36	1	122610	04:20	04:40	04-30.20N	146-59.99E	4062.0	498.1	500.0	503.7	C36M01	LADCP
C35	1	122610	07:54	08:15	04-00.14N	147-00.05E	4678.0	500.3	502.2	505.3	C35M01	LADCP
C37	2	122710	03:01	03:33	05-03.88N	146-56.95E	4198.0	801.5	800.9	806.5	C37M02	LADCP Deployment point of T07

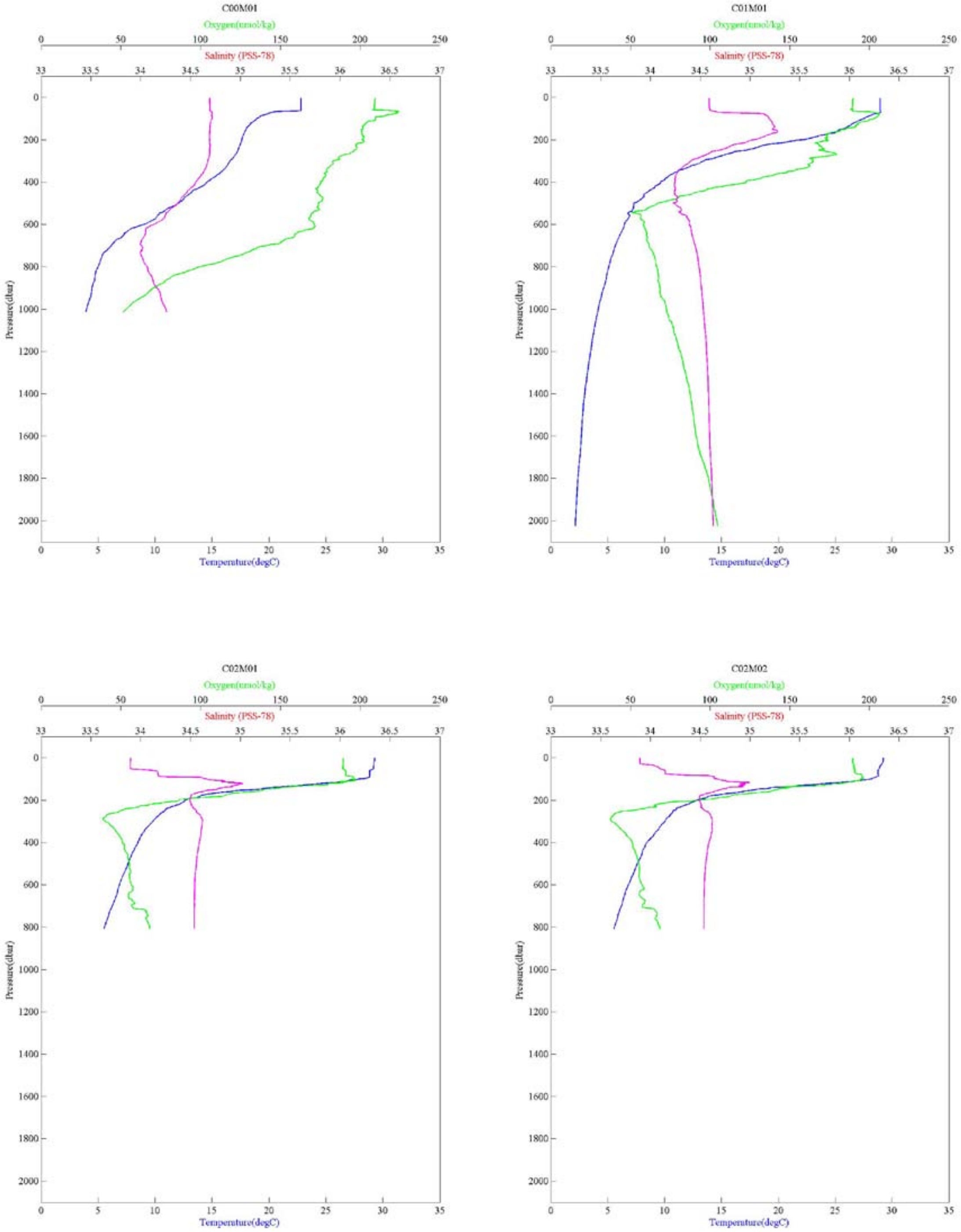


Figure 6.2.1-1 CTD profile (C00M01, C01M01, C02M01 and C02M02)

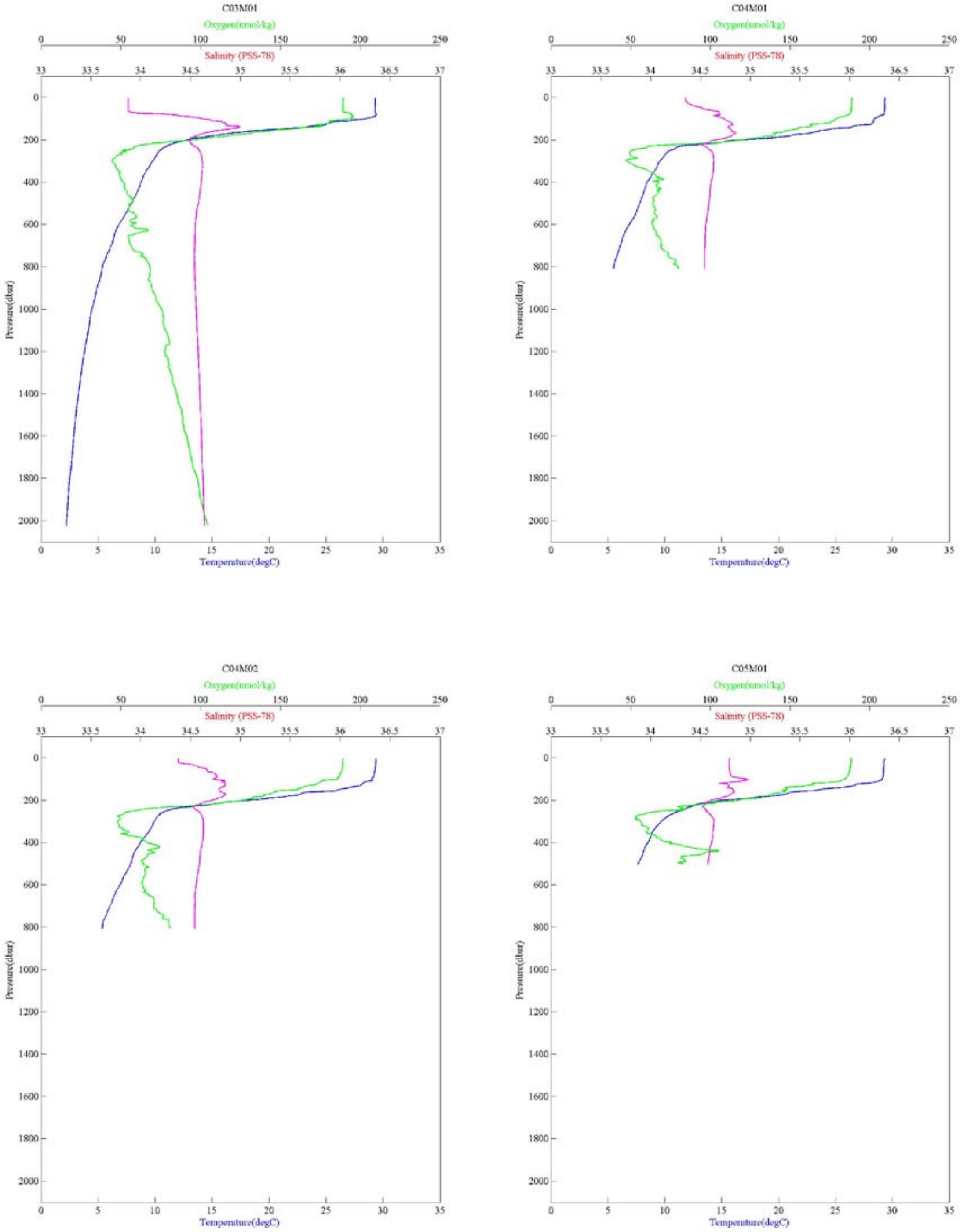


Figure 6.2.1-2 CTD profile (C03M01, C04M01, C04M02 and C05M01)

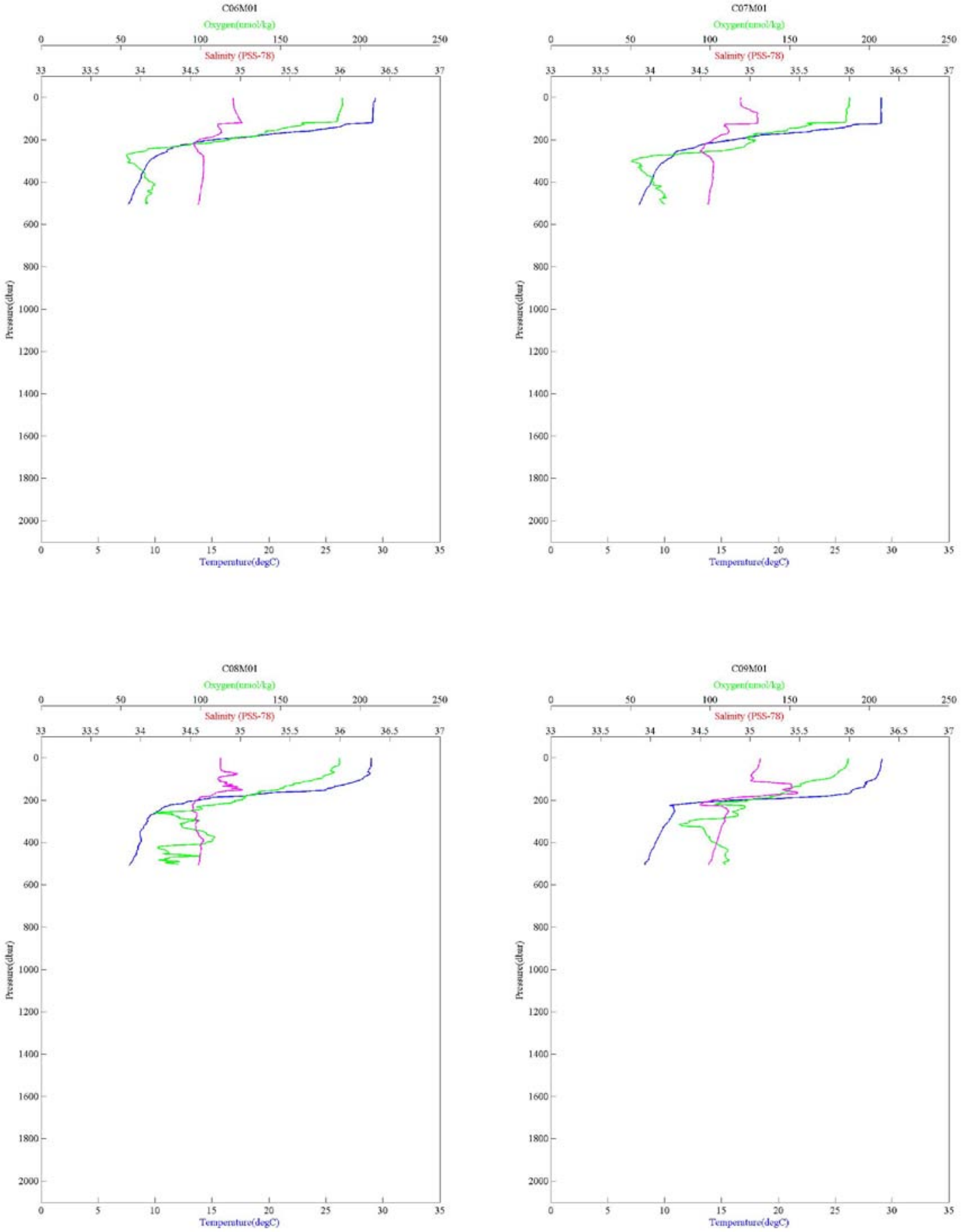
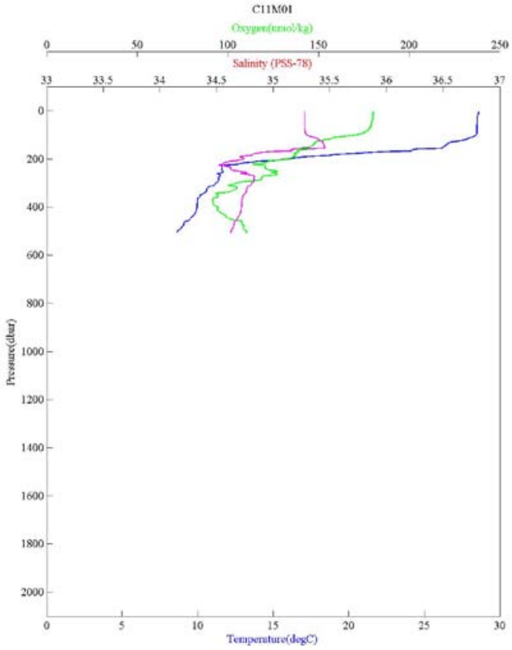
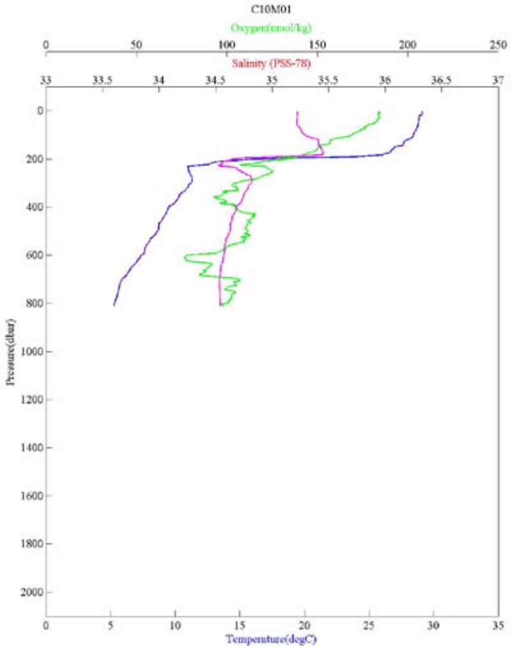
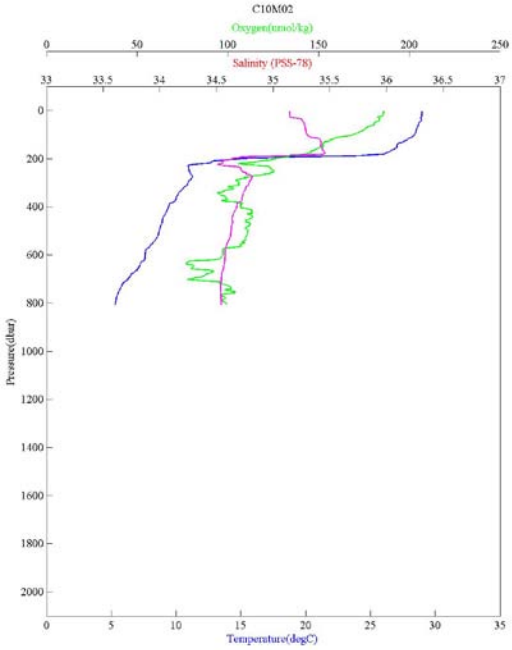


Figure 6.2.1-3 CTD profile (C06M01, C07M01, C08M01 and C09M01)







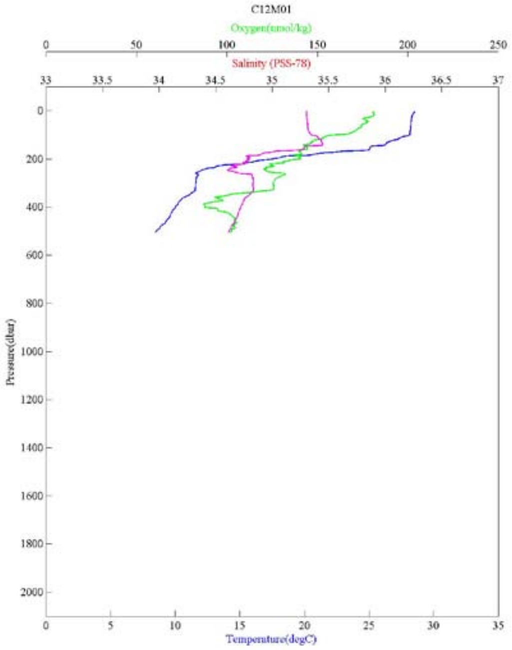


Figure 6.2.1-4 CTD profile (C11M01, C10M01, C10M02 and C12M01)

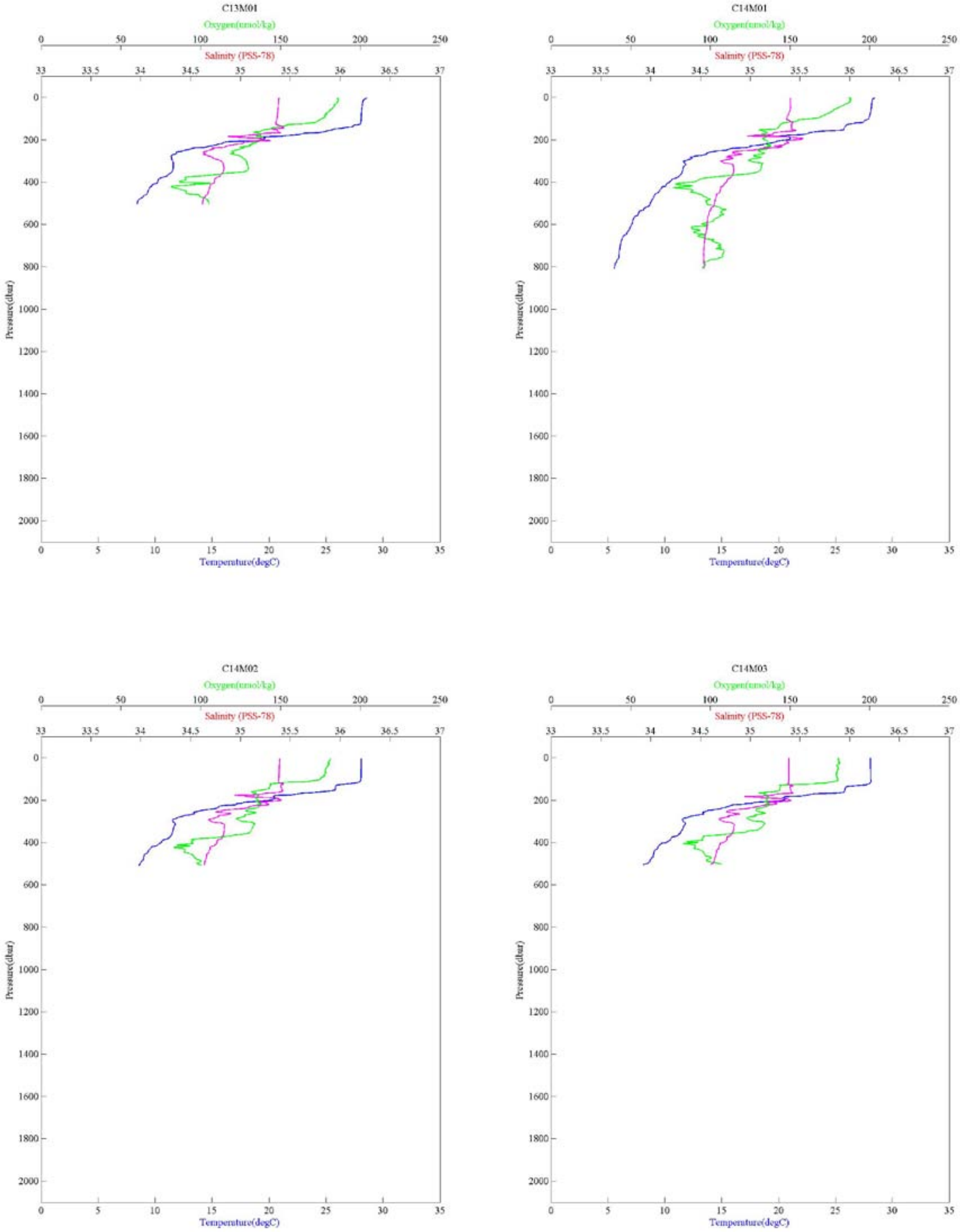


Figure 6.2.1-5 CTD profile (C13M01, C14M01, C14M02 and C14M03)

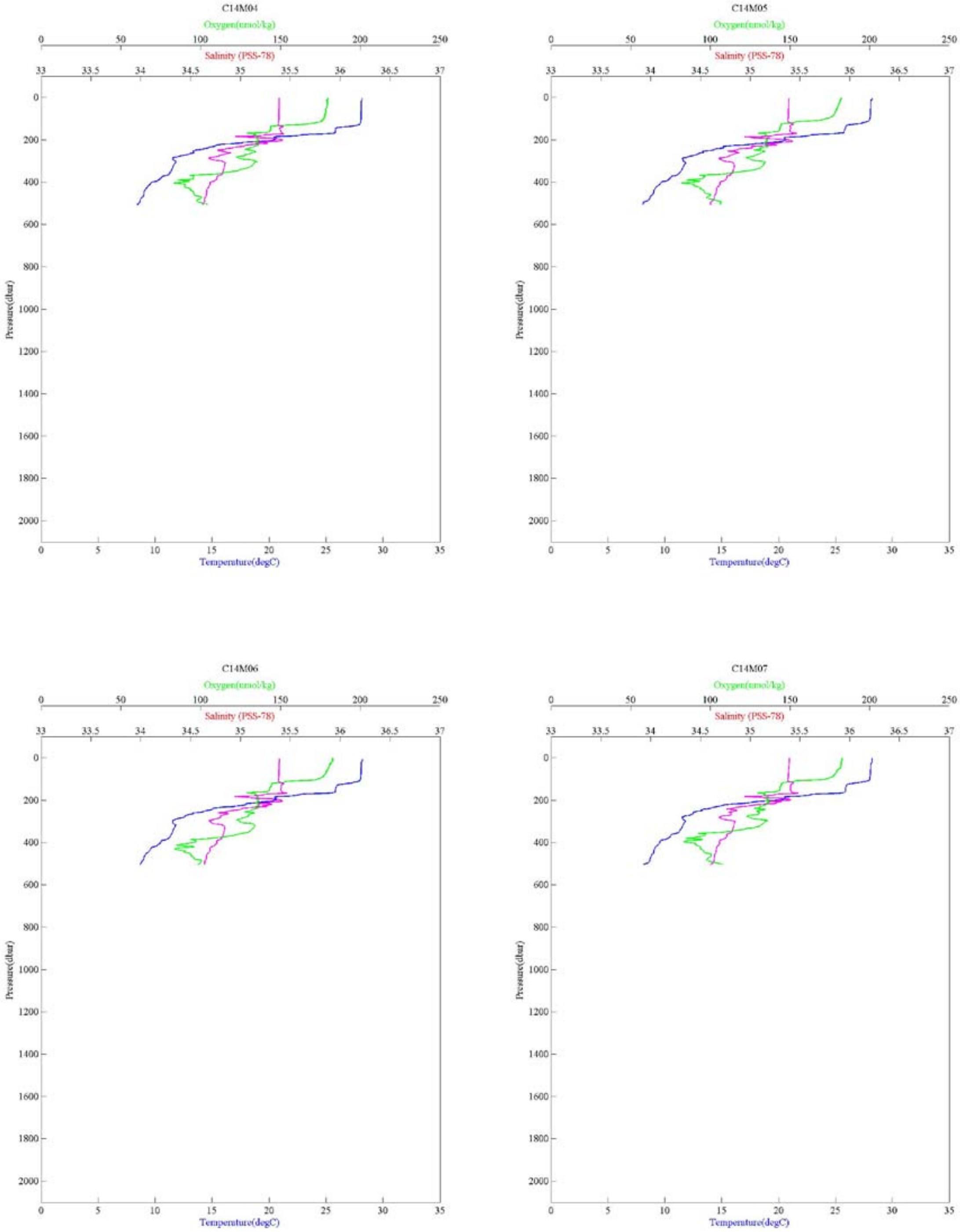


Figure 6.2.1-6 CTD profile (C14M04, C14M05, C14M06 and C14M07)

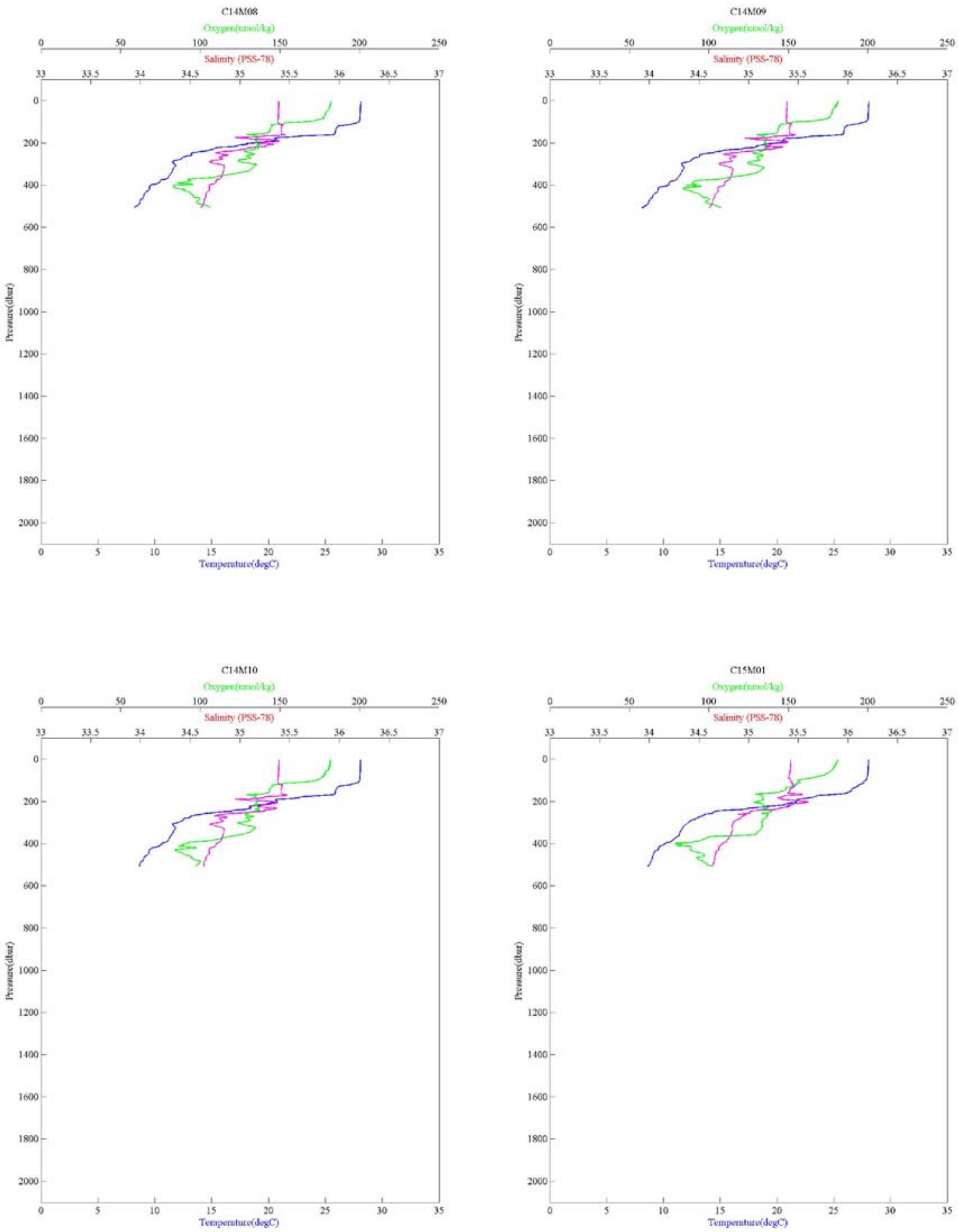


Figure 6.2.1-7 CTD profile (C14M08, C14M09, C14M10 and C15M01)

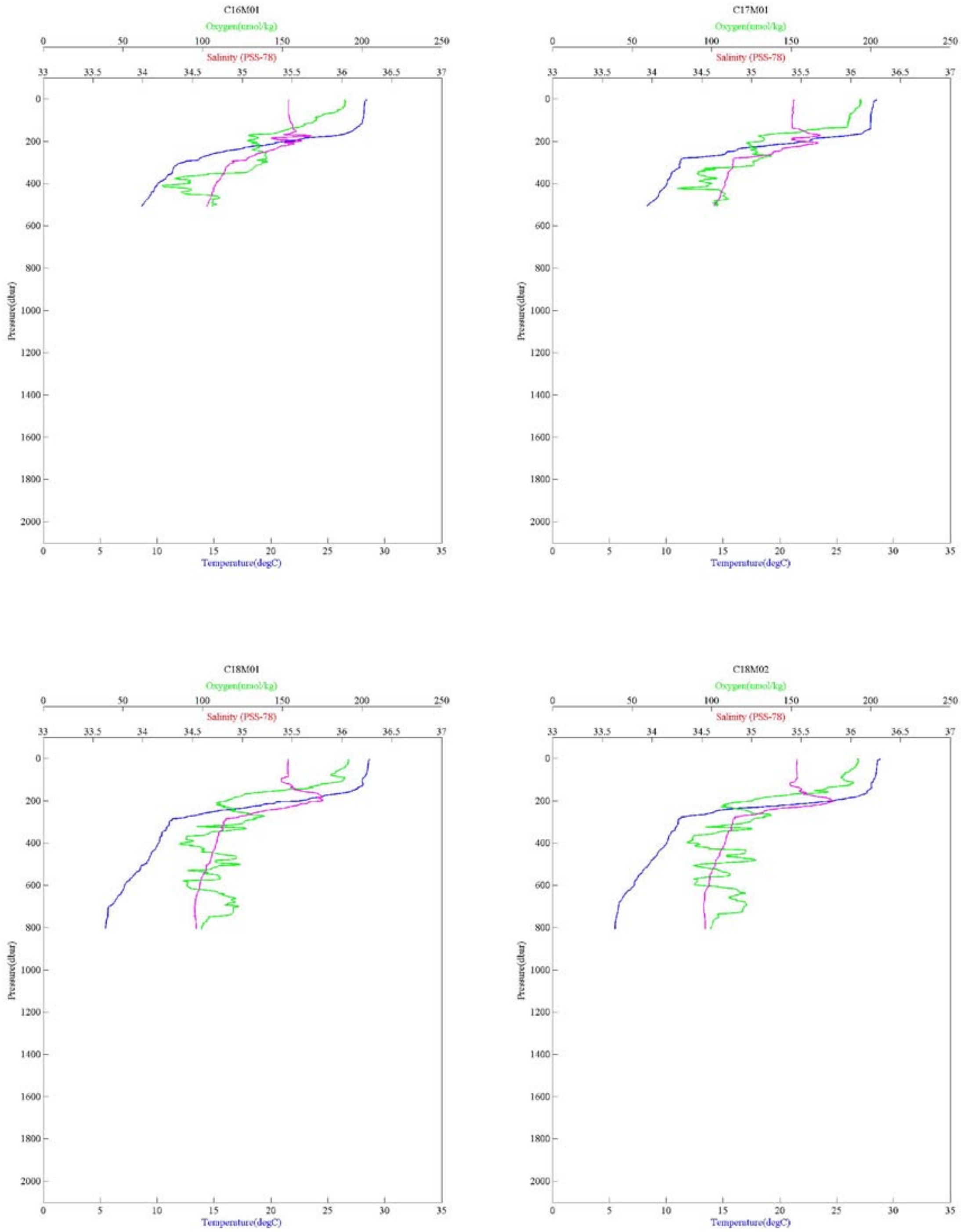


Figure 6.2.1-8 CTD profile (C16M01, C17M01, C18M01 and C18M02)

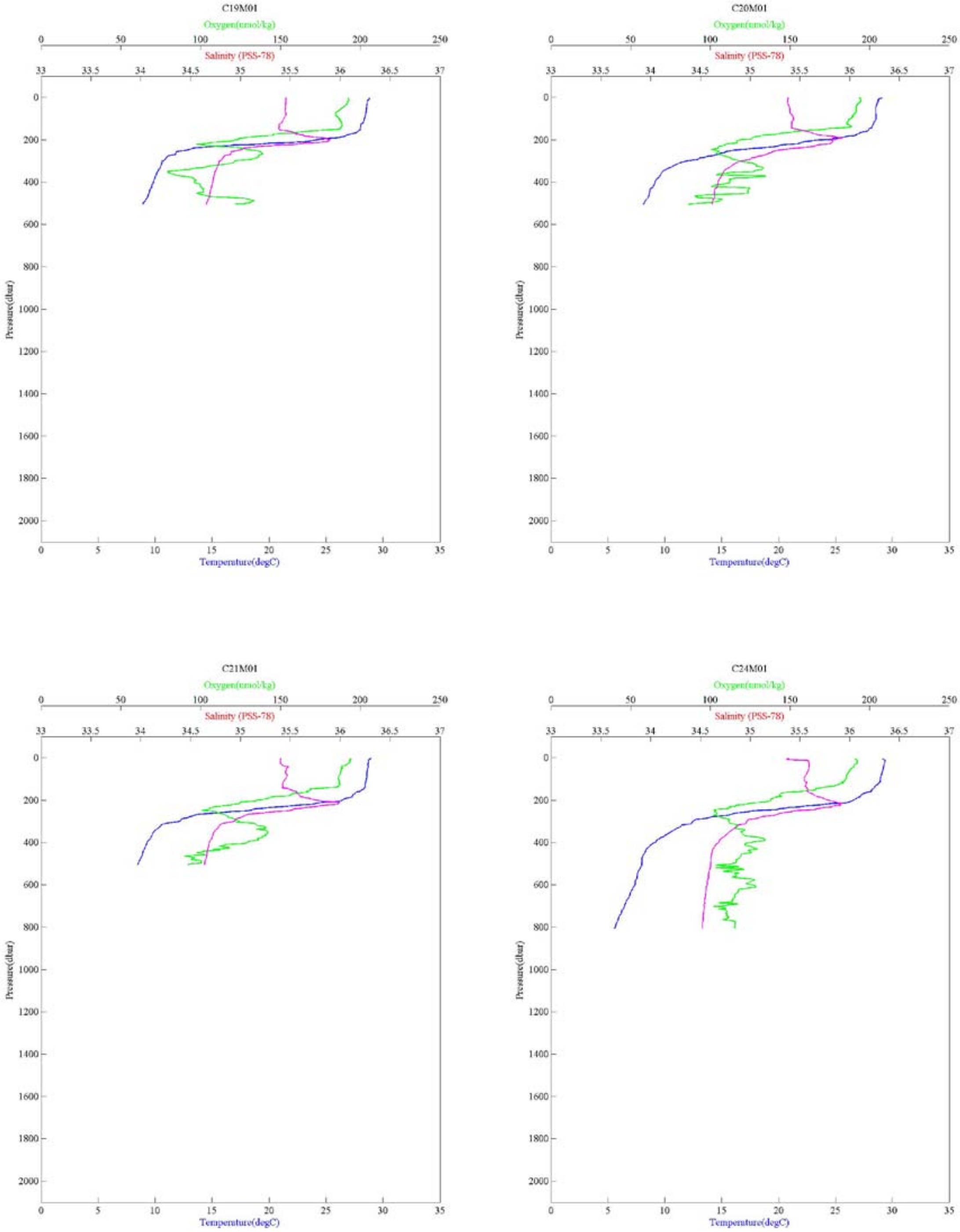


Figure 6.2.1-9 CTD profile (C19M01, C20M01, C21M01 and C24M01)

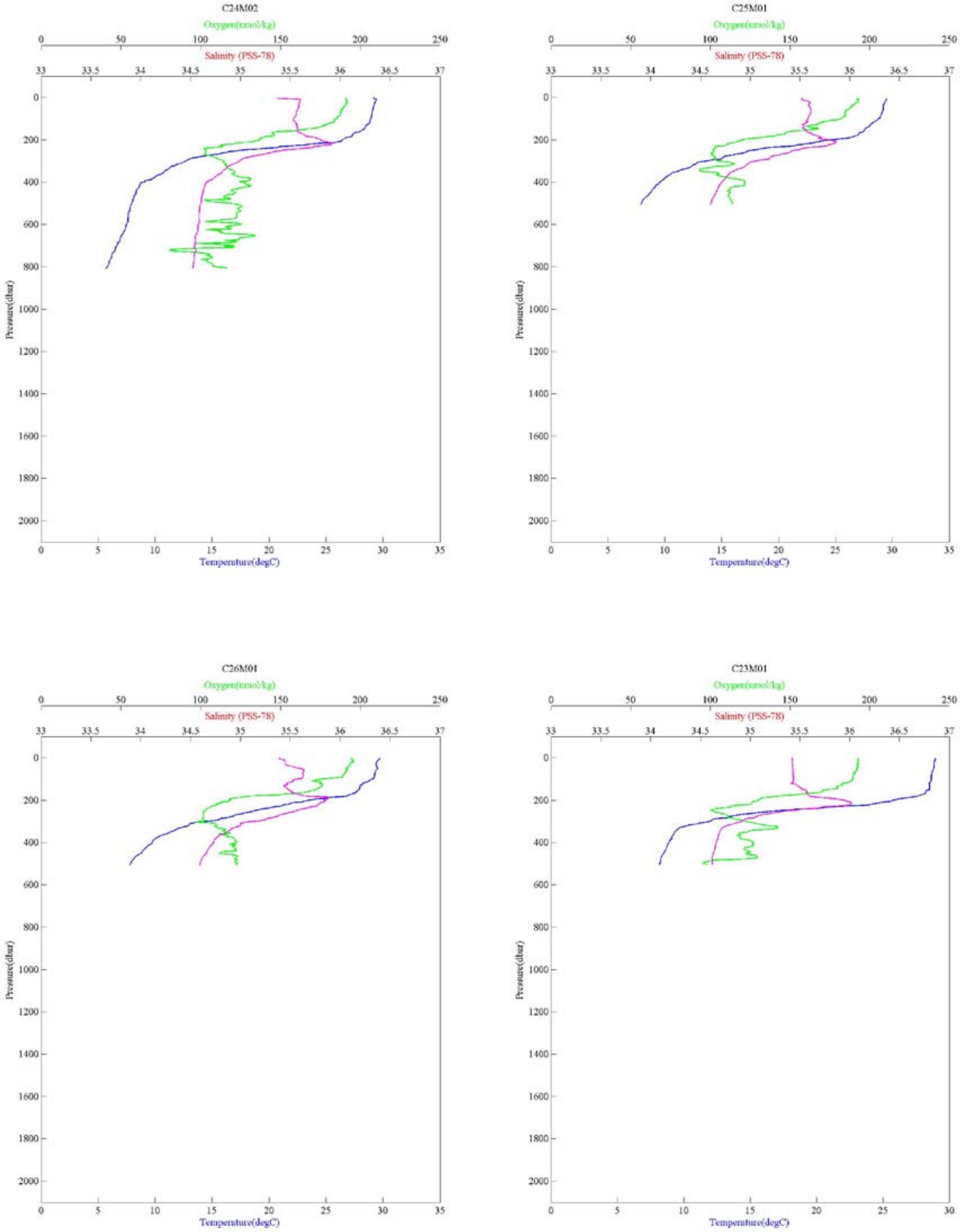


Figure 6.2.1-10 CTD profile (C24M02, C25M01, C26M01 and C23M01)

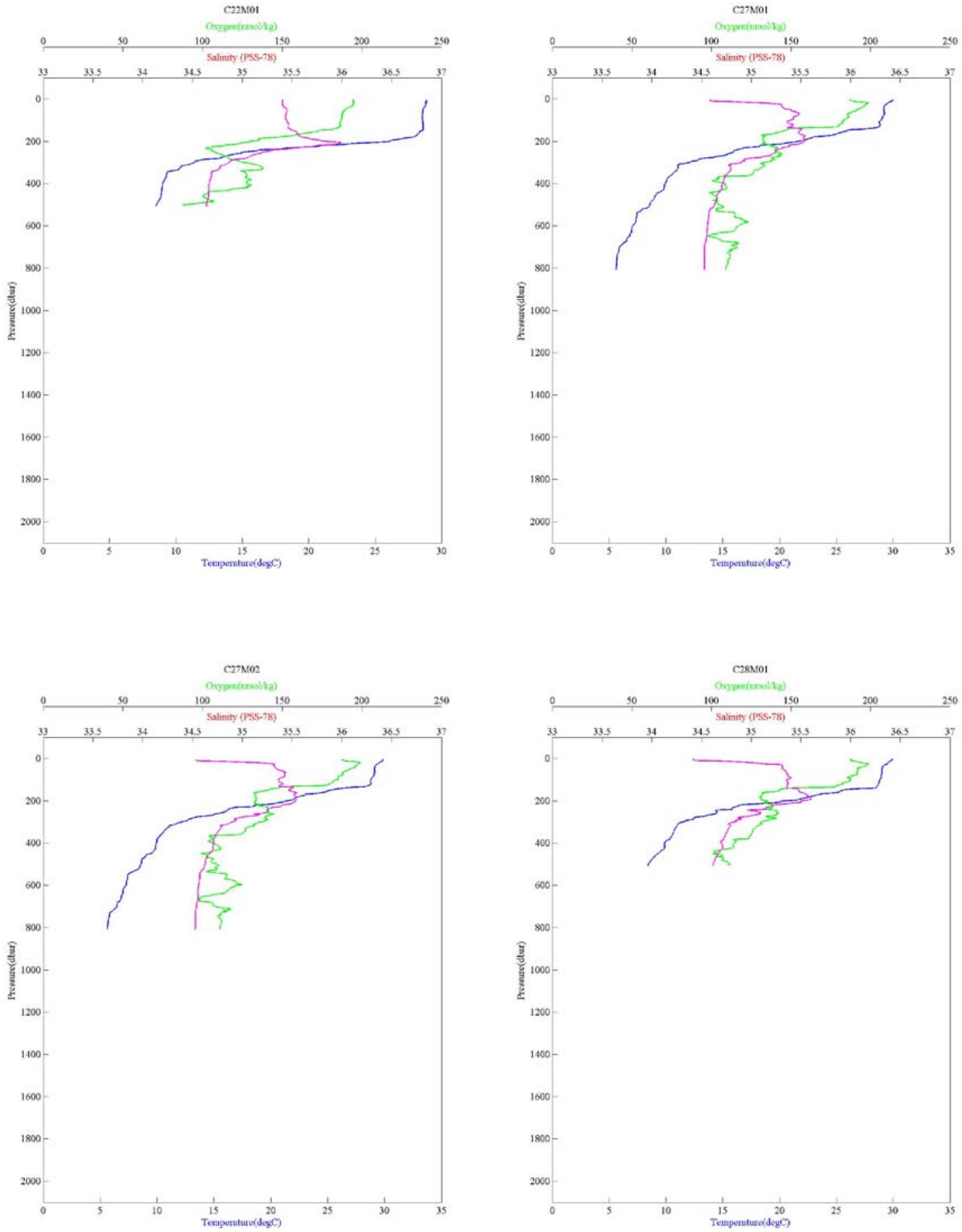


Figure 6.2.1-11 CTD profile (C22M01, C27M01, C27M02 and C28M01)

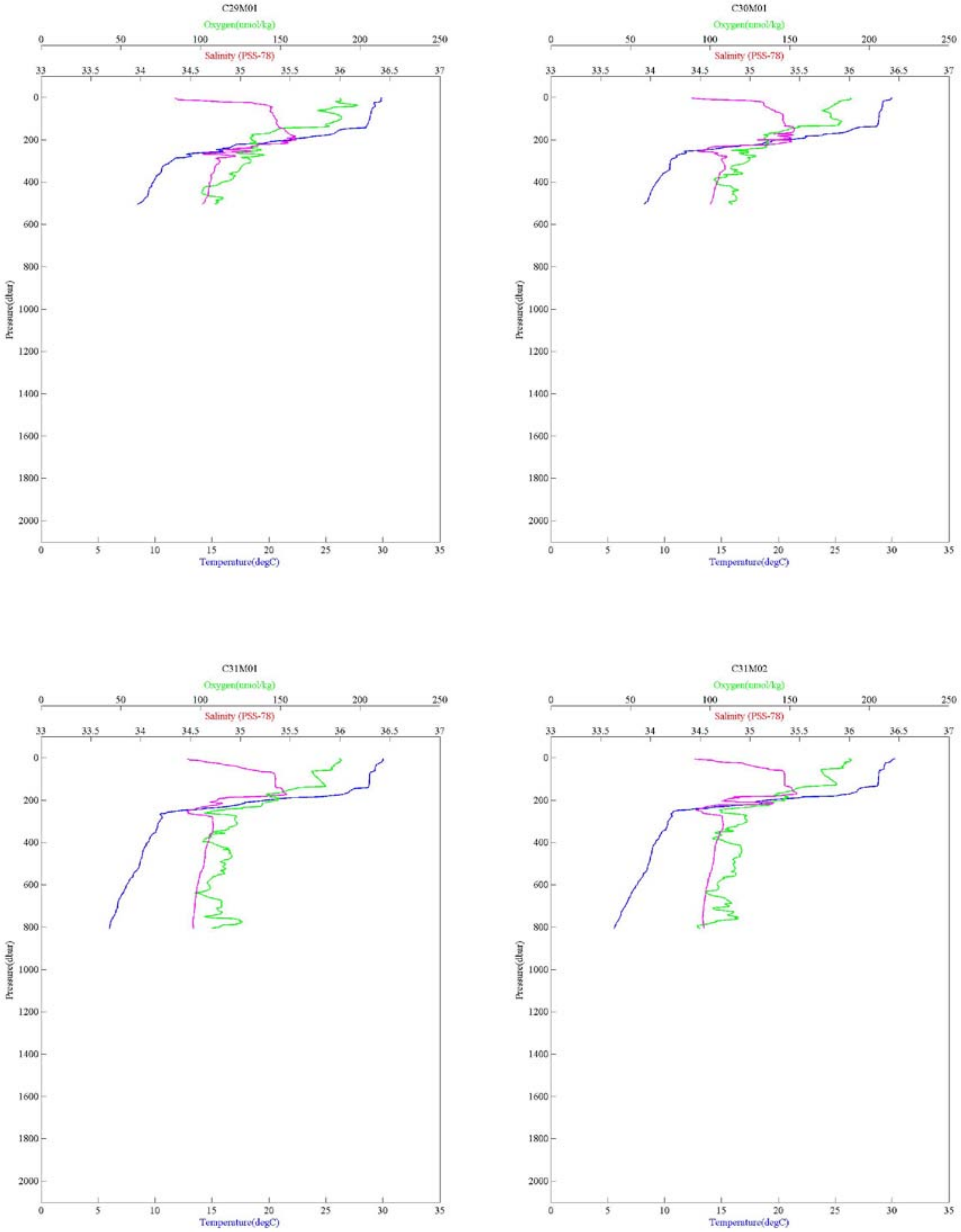


Figure 6.2.1-12 CTD profile (C29M01, C30M01, C31M01 and C31M02)

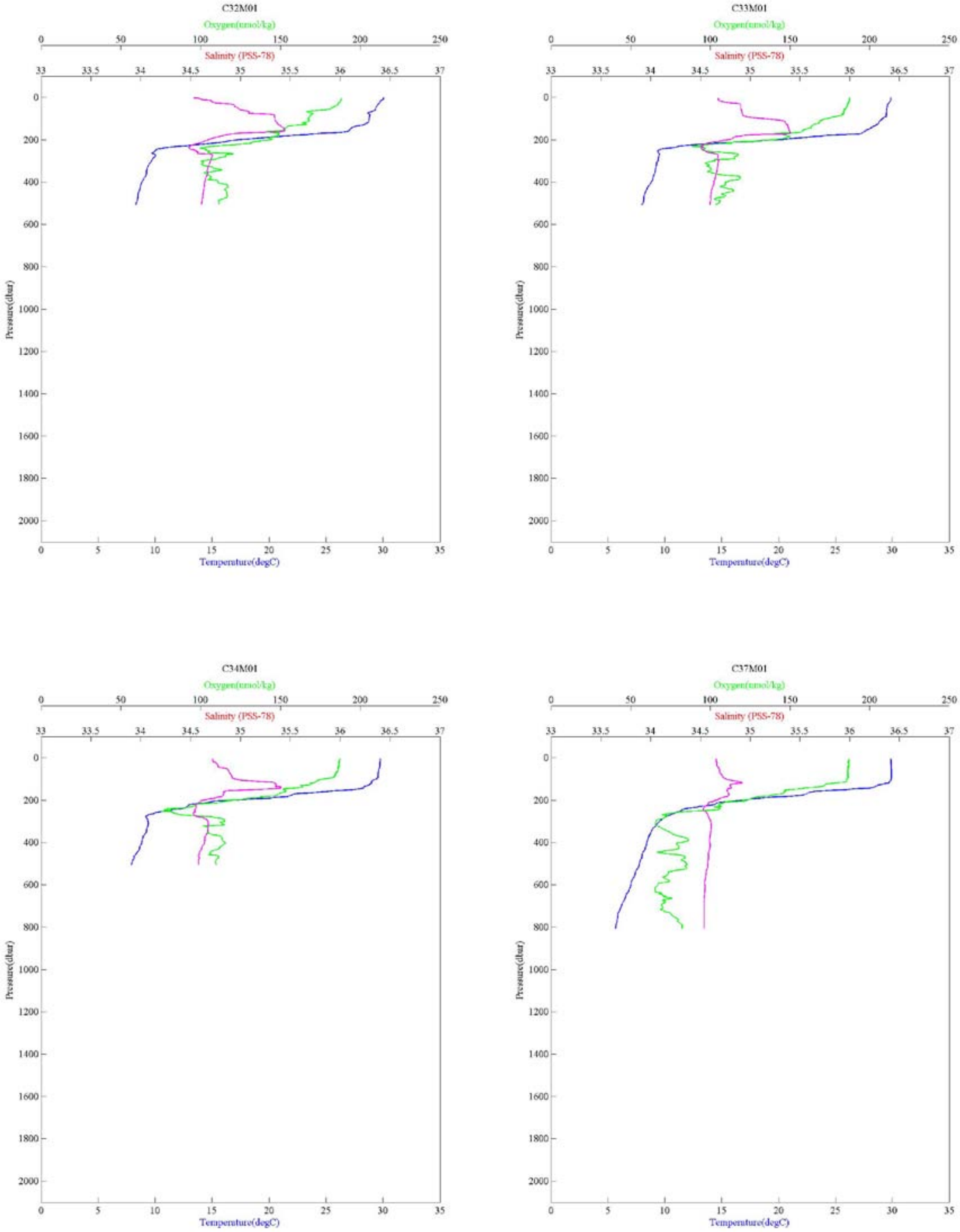
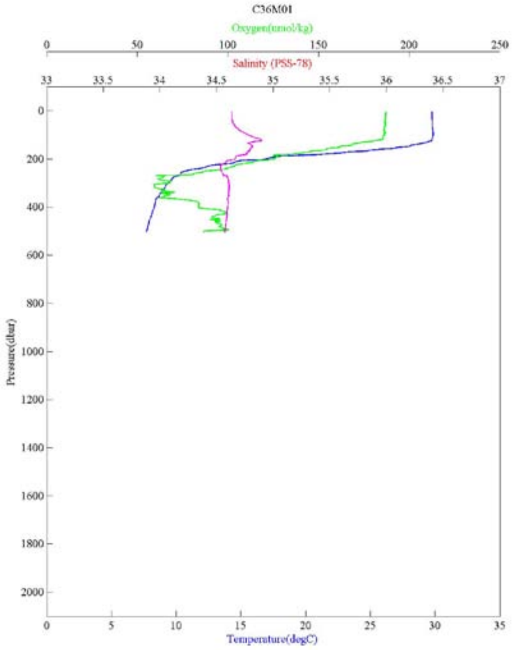
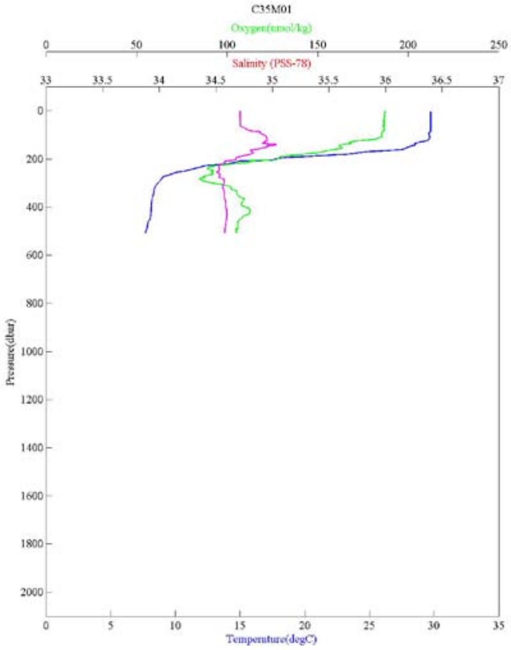


Figure 6.2.1-13 CTD profile (C32M01, C33M01, C34M01 and C37M01)





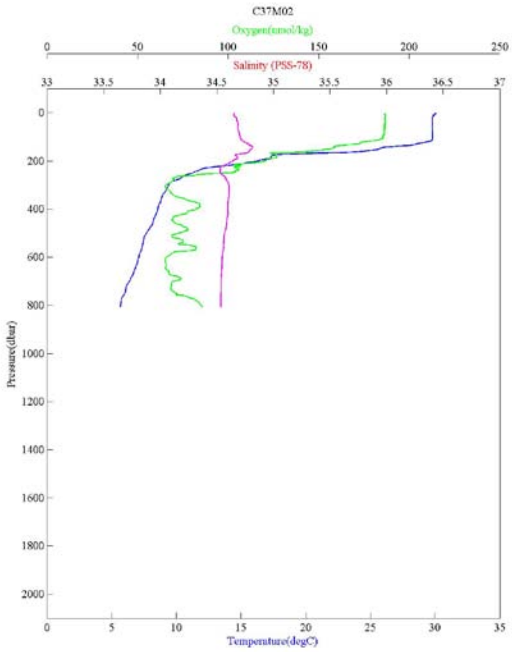


Figure 6.2.1-14 CTD profile (C36M01, C35M01 and C37M02)

6.2.2 XCTD

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Takuya Hasegawa	(JAMSTEC)
Norio Nagahama	(Global Ocean Development Inc.: GODI)
Ryo Kimura	(GODI)
Ryo Ohyama	(MIRAI Crew)
Not on-board	
Yoshimi Kawai	(JAMSTEC) : Principal Investigator
Hiroyuki Tomita	(JAMSTEC)

(2) Objectives

Investigation of oceanic structure.

(3) Parameters

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

Parameter	Range	Accuracy
Conductivity	0 ~ 60 [mS/cm]	+/- 0.03 [mS/cm]
Temperature	-2 ~ 35 [deg-C]	+/- 0.02 [deg-C]
Depth	0 ~ 1000 [m]	5 [m] or 2 [%] (either of them is major)

(4) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-130, Tsurumi-Seiki Co. and was recorded by MK-130 software (Kuroshio region: Ver.3.11, Tropical region: Ver.3.12) provided by Tsurumi-Seiki Co.. We launched 46 probes (X01-X23, E01-E21, JKEO and KEO) by using automatic launcher. The summary of XCTD observations and launching log were shown in Table 6.2.2-1 to 6.2.2-2. SST (Sea Surface Temperature) and SSS (Sea Surface Salinity) in the table were got from EPCS at launching.

(5) Preliminary results

Position map of XCTD observations, Vertical sections of temperature and salinity were shown in Fig. 6.2.2-1 to 6.2.2-3.

(6) 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 "R/V Mirai Data Web Page" in JAMSTEC home page.

Table 6.2.2-1 Summary of XCTD observation and launching log (Kuroshio region)

No.	Station No.	Date	Time	Latitude	Longitude	Depth [m]	SST [deg-C]	SSS [PSU]	Probe S/N
1	X01	2010/11/24	03:10	41-49.29N	142-36.69E	872	-	-	08048292
2	JKEO	2010/11/26	03:00	38-01.99N	146-30.51E	5419	16.441	33.912	10069401
3	E01	2010/11/26	05:14	37-44.73N	146-19.08E	5534	16.429	33.862	10069402
4	E02	2010/11/26	06:36	37-30.26N	146-13.57E	5538	16.314	33.932	10069404
5	E03	2010/11/26	08:15	37-14.18N	146-11.03E	5606	16.548	34.040	10069395
6	E04	2010/11/26	09:45	36-58.90N	146-05.24E	5454	16.328	33.852	10069403
7	E05	2010/11/26	11:11	36-43.76N	146-00.40E	5488	22.067	34.456	10069400
8	E06	2010/11/26	12:40	36-29.48N	145-55.42E	5488	22.514	34.483	10069399
9	E07	2010/11/26	14:11	36-14.32N	145-44.99E	5574	22.697	34.509	10069398
10	E08	2010/11/26	15:41	35-59.46N	145-44.99E	5724	22.812	34.508	10069489
11	E09	2010/11/26	17:19	35-43.95N	145-39.82E	5826	22.707	34.497	10079647
12	E10	2010/11/26	18:46	35-29.25N	145-35.03E	5856	22.744	34.531	10079646
13	E11	2010/11/26	20:18	35-14.66N	145-29.81E	5902	22.889	34.528	10079645
14	E12	2010/11/26	21:59	34-58.95N	145-24.78E	5825	22.457	34.507	10069406
15	E13	2010/11/26	23:30	34-44.71N	145-19.94E	5824	21.712	34.509	10069405
16	E14	2010/11/27	01:03	34-30.01N	145-13.56E	5584	21.826	34.506	10079644
17	E15	2010/11/27	02:32	34-14.87N	145-09.95E	5816	21.951	34.489	10079655
18	E16	2010/11/27	04:08	33-59.76N	145-04.97E	5730	22.172	34.476	10079655
19	E17	2010/11/27	05:51	33-45.15N	144-59.27E	5778	22.954	34.476	10079655
20	E18	2010/11/27	07:35	33-29.83N	144-54.56E	5724	22.363	34.538	10079648
21	E19	2010/11/27	09:22	33-14.93N	144-49.64E	5760	22.381	34.536	10079651
22	E20	2010/11/27	11:22	32-57.87N	144-44.44E	5689	22.453	34.561	10079649
23	E21	2010/11/27	12:52	32-45.38N	144-39.30E	5415	23.239	34.638	10079654
24	KEO	2010/11/27	15:09	32-26.92N	144-33.38E	5764	22.875	34.648	10079652

Table 6.2.2-2 Summary of XCTD observation and launching log (Tropical region)

No.	Station No.	Date	Time	Latitude	Longitude	Depth [m]	SST [deg-C]	SSS [PSU]	Probe S/N
25	X02	2010/12/05	02:32	07-30.01N	156-00.04E	4390	29.226	33.862	10027040
26	X03	2010/12/05	08:19	06-30.00N	155-59.99E	4410	29.238	34.023	10027041
27	X04	2010/12/05	10:47	06-00.00N	156-00.00E	4143	29.329	34.193	09075023
28	X05	2010/12/05	13:17	05-30.00N	155-59.98E	3738	29.300	34.270	09075026
29	X06	2010/12/10	23:38	00-01.30S	155-56.83E	1940	28.325	35.367	10027042
30	X07	2010/12/17	09:16	06-13.73S	156-06.20E	1576	29.968	35.305	10027043
31	X08	2010/12/18	13:52	02-24.86S	154-59.98E	2527	28.772	35.421	10027044
32	X09	2010/12/18	14:56	02-29.97S	154-47.00E	2695	28.741	35.417	10090169
33	X10	2010/12/18	16:01	02-34.94S	154-34.00E	2775	28.759	35.439	10090170
34	X11	2010/12/18	17:07	02-39.99S	154-20.98E	2669	28.992	35.525	10027047
35	X12	2010/12/18	18:13	02-44.99S	154-08.00E	2773	29.083	35.522	10090168
36	X13	2010/12/18	19:37	02-50.00S	153-54.99E	4033	29.317	35.552	10090171
37	X14	2010/12/18	20:30	02-54.97S	153-41.84E	2522	29.478	35.561	10027046
38	X15	2010/12/18	21:43	03-00.00S	153-28.98E	2752	29.453	35.526	10027045
39	X16	2010/12/19	03:09	02-14.32S	153-31.88E	3827	29.537	35.540	10090175
40	X17	2010/12/19	04:14	02-25.00S	153-25.01E	4550	29.762	35.545	10090174
41	X18	2010/12/19	05:25	02-35.99S	153-18.06E	3219	30.129	35.545	10090172
42	X19	2010/12/19	06:26	02-46.99S	153-11.27E	3474	30.111	35.541	10090173
43	X20	2010/12/19	13:12	02-00.00S	153-00.00E	4259	29.523	35.531	10090176
44	X21	2010/12/19	20:37	01-29.99S	151-29.09E	3696	29.203	35.486	10090177
45	X22	2010/12/20	03:50	01-00.71S	149-59.97E	4861	29.722	35.497	10090178
46	X23	2010/12/20	11:01	00-31.04S	148-30.00E	4074	30.121	35.545	10090179

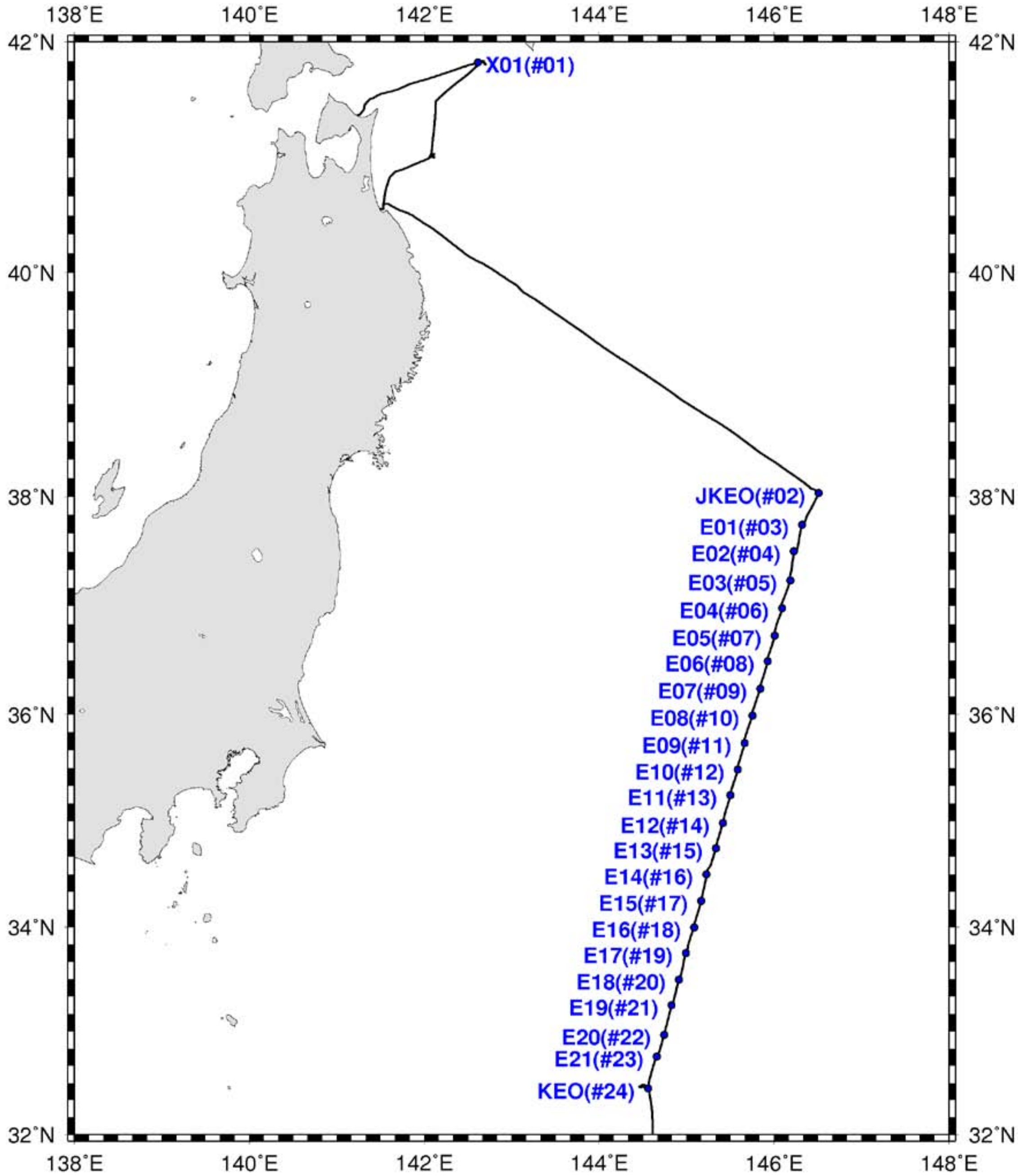


Fig. 6.2.2-1 Position map of XCTD observations (Kuroshio region)

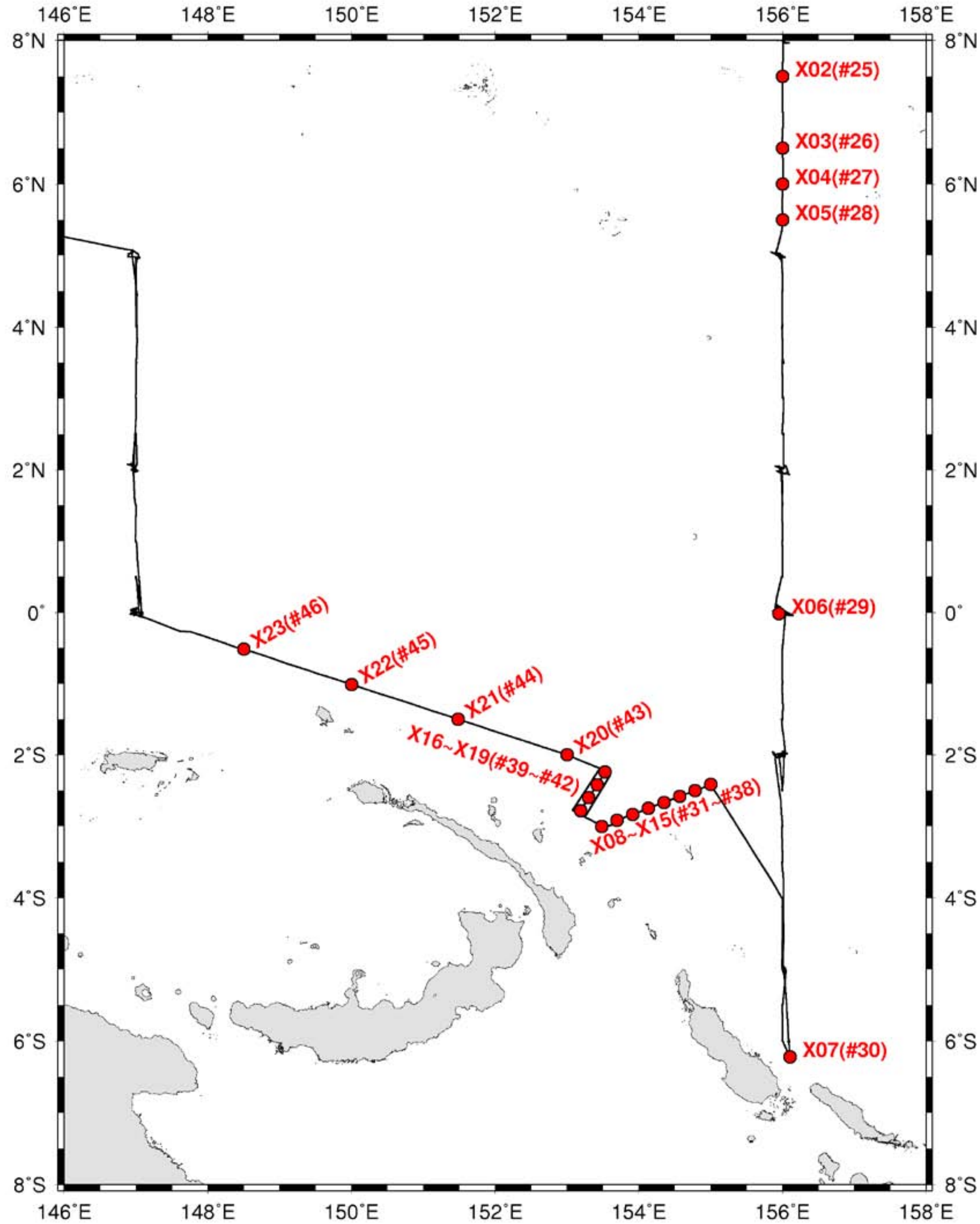


Fig. 6.2.2-2 Position map of XCTD observations (Tropical region).

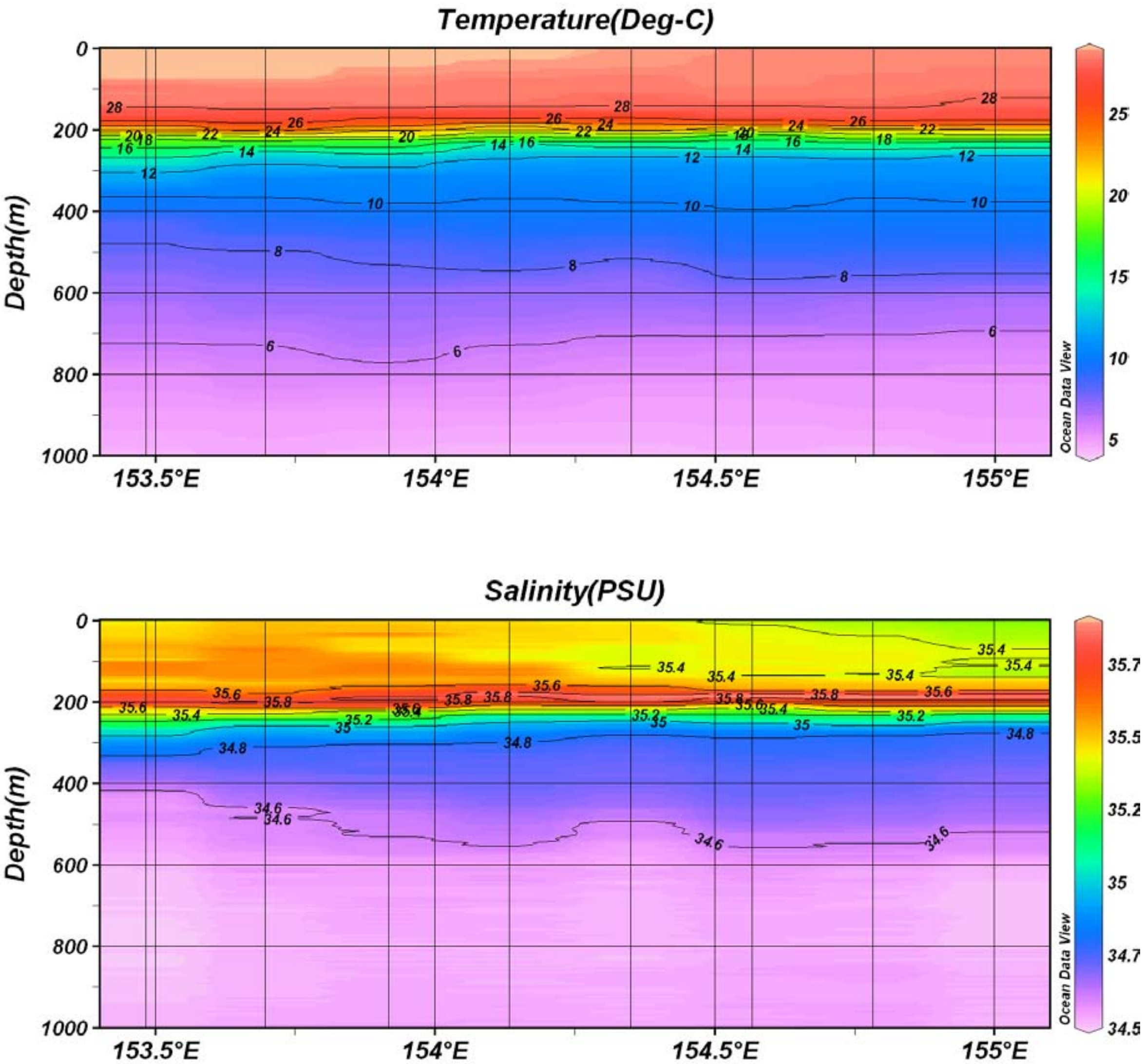


Fig. 6.2.2-3 Vertical section of temperature (upper) and salinity (lower)
along X08 to X15 line (2.5S 155.0E to 3.0S 153.5E)

6.3 Water sampling

6.3.1 Salinity

(1) Personnel

Yuji Kashino	(JAMSTEC)	Principal Investigator
Hiroki Ushiromura	(MWJ)	Operation Leader

(2) Objective

To provide a calibration for the measurement of salinity of bottle water collected on the CTD casts and 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 bottle with screw cap was used for collecting the sample water. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The sample bottle was sealed with a plastic insert thimble and a screw cap. The thimble was thoroughly rinsed with the sample water before use. The bottle was stored for more than 16 hours in the laboratory before the salinity measurement.

The kind and number of samples taken are shown as follows ;

Table 6.3.1-1 Kind and number of samples

Kind of Samples	Number of Samples
Samples for CTD	108
Samples for TSG	39
Total	147

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR10-07 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 62556) with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A pair of precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.) were used. The thermometer monitored the ambient temperature and the other monitored a bath temperature.

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 21.9 deg C to 24.1 deg C, while the bath temperature was very stable and varied within +/- 0.005 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 15 seconds to collect 31 readings by a 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. The measurement was conducted in about 2 - 8 hours per day and the cell was cleaned with soap after the measurement of the day.

(4) Results

a. Standard Seawater

Standardization control of the salinometer was set to 762 and all measurements were done at this setting. The value of STANDBY was 5576 +/- 0001 and that of ZERO was 0.0+0000 or 0.0+0001. The conductivity ratio of IAPSO Standard Seawater batch P152 was 0.99981 (double conductivity ratio was 1.99962) and was used as the standard for salinity. 18 bottles of P152 were measured.

Fig.6.3.1-1 shows the history of the double conductivity ratio of the Standard Seawater batch P152. The average of the double conductivity ratio was 1.99957 and the standard deviation was 0.00003, which is equivalent to 0.0005 in salinity.

Fig.6.3.1-2 shows the history of the double conductivity ratio of the Standard Seawater batch P152 after correction. The average of the double conductivity ratio after correction was 1.99962 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

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

Batch	:	P152
Conductivity Ratio	:	0.99981
Salinity	:	34.993
Use By	:	05th May 2013

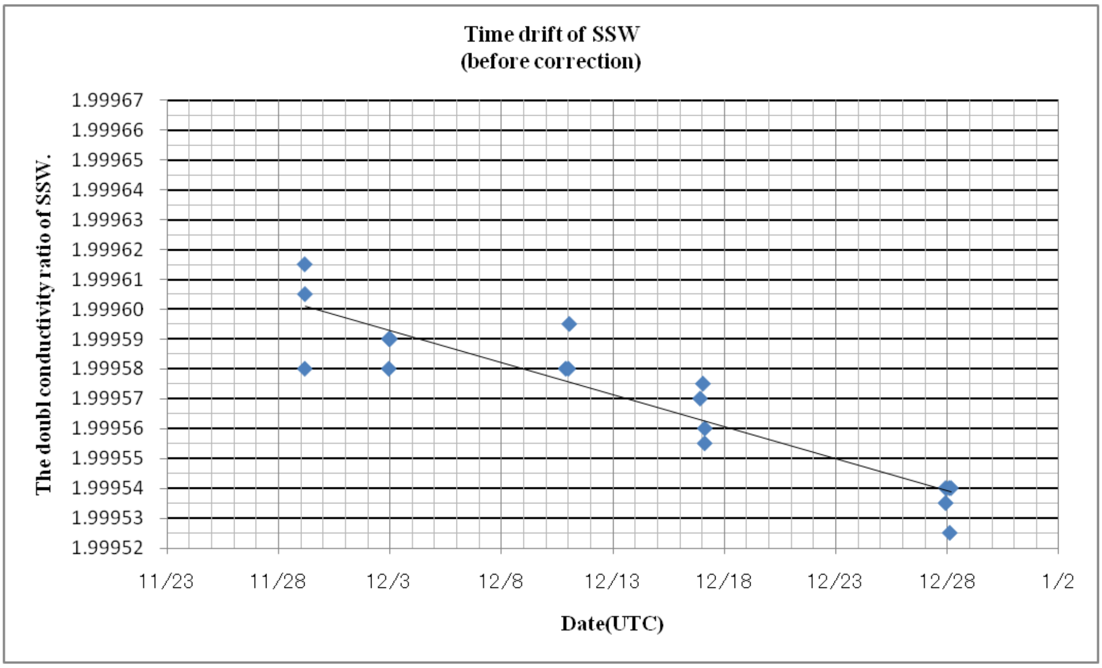


Fig. 6.3.1-1 History of double conductivity ratio for the Standard Seawater batch P152 (before correction)

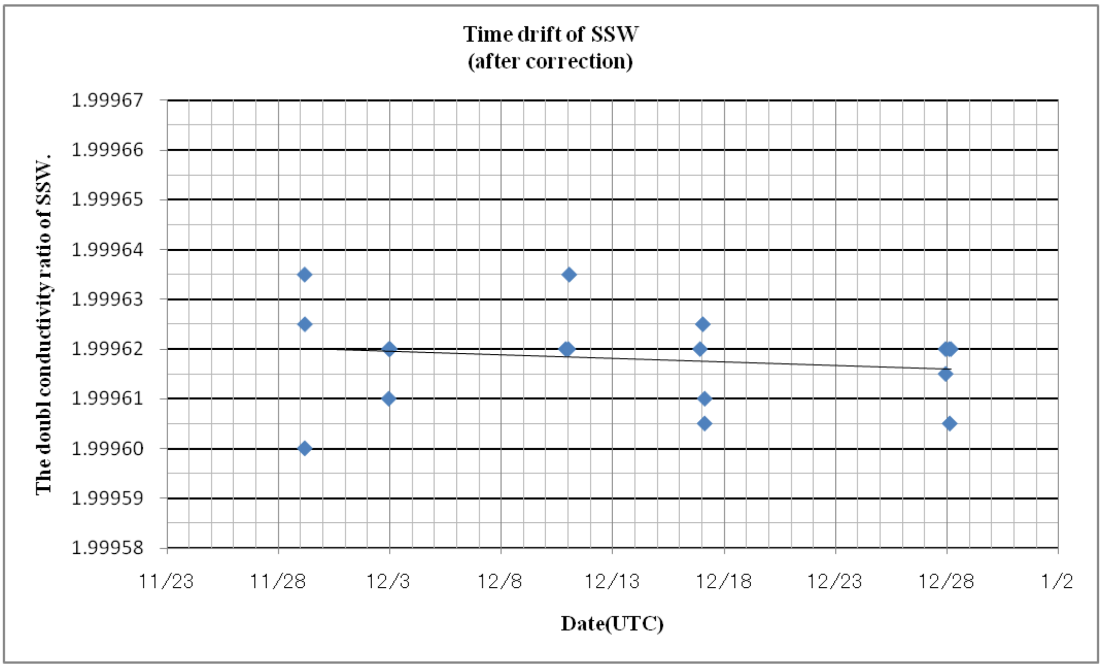


Fig. 6.3.1-2 History of double conductivity ratio for the Standard Seawater batch P152 (after correction)

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 54 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 54 pairs of replicate samples were 0.0002 and 0.0002 in salinity, respectively.

(5) Data archive

These raw datasets will be submitted to JAMSTEC Data Management Office (DMO) and corrected datasets are available from Mirai Web site at http://www.jamstec.go.jp/mirai/.

(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

Misato Kuwahara (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 4 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.1.10

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:	4557820-0319 (2010/11/25～12/13)
	4552788-0264 (2010/12/13～12/28)
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:	3857820-0540
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

4. Measurements

Periods of measurement, maintenance, and problems during MR10-07 are listed in Table 6.4.1-1.

Table 6.4.1-1 Events list of the surface seawater monitoring during MR10-07

System Date [UTC]	System Time [UTC]	Events	Remarks
2010/11/25	9:25	All the measurements started and data was available.	Cruise started.
2010/12/13	4:39	All the measurements stopped. Change SBE45 sensor from S/N:4557820-0319 ƀ S/N:4552788-0264	
2010/12/13	6:23	All of the measurements started and data was available.	

2010/12/28	15:38	Communication of DO sensor was lost.	
2010/12/28	16:02	All the measurements stopped.	Check the DO sensor.
2010/12/28	16:03	T & S measurements started and data was available.	
2010/12/28	16:13	DO measurements started and data was available.	
2010/11/28	17:11	All the measurements stopped.	Cruise finished

5. Preliminary Result

Preliminary data of temperature, salinity, and dissolved oxygen at sea surface are shown in Fig.6.4.1-1. We took the surface water samples once a day to compare sensor data with bottle data of salinity and dissolved oxygen. The results are shown in Fig.6.4.1-2~5. All the salinity samples were analyzed by the Guideline 8400B “AUTOSAL”, and dissolve oxygen samples were analyzed by Winkler method.

The measurement values of salinity were drifted in this cruise (shown in Fig.6.4.1-4). So we changed the SBE45 sensor from S/N: 4557820-0319 to S/N: 4552788-0264 on December 13.

Since 15:38 on December 28, dissolved oxygen sensor didn’t sent measurement value. So we restarted measurement software and sensor.

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.

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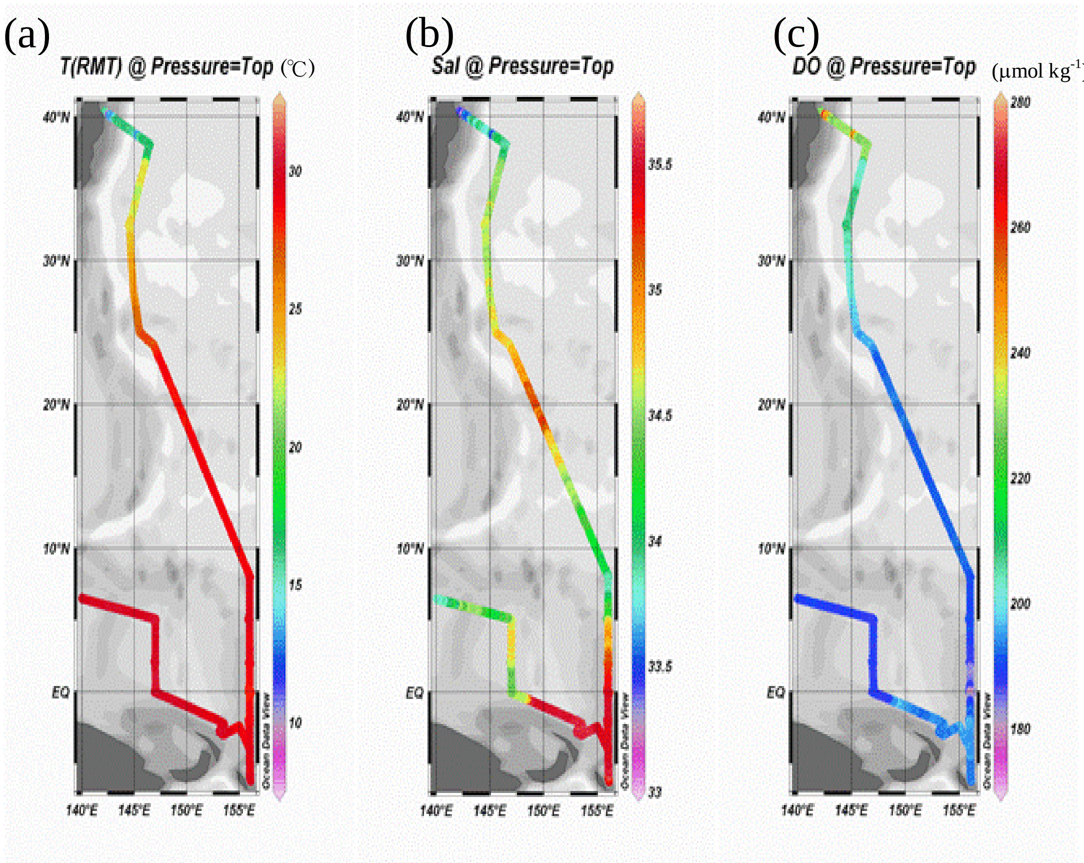


Fig.6.4.1-1 Spatial and temporal distribution of (a) temperature (b) salinity (c) dissolved oxygen in MR10-07 cruise.

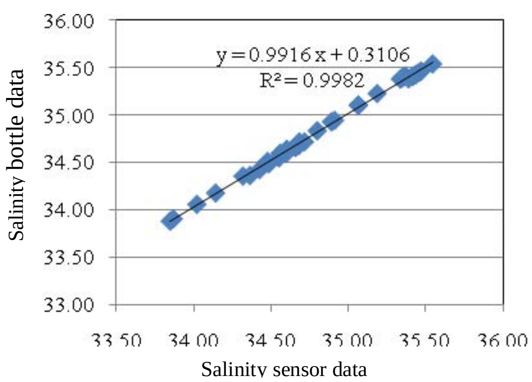


Fig.6.4.1-2 Correlation of salinity between sensor data and bottle data.

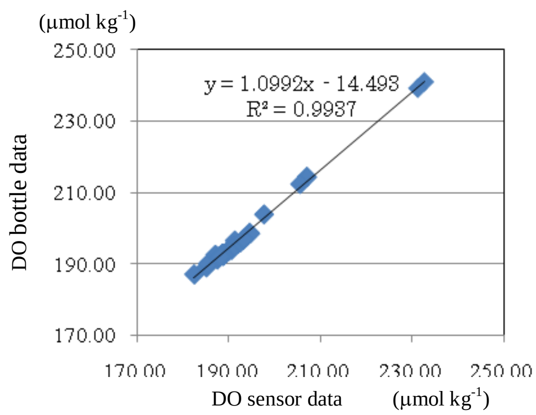


Fig.6.4.1-3 Correlation of dissolved oxygen between sensor data and bottle data.

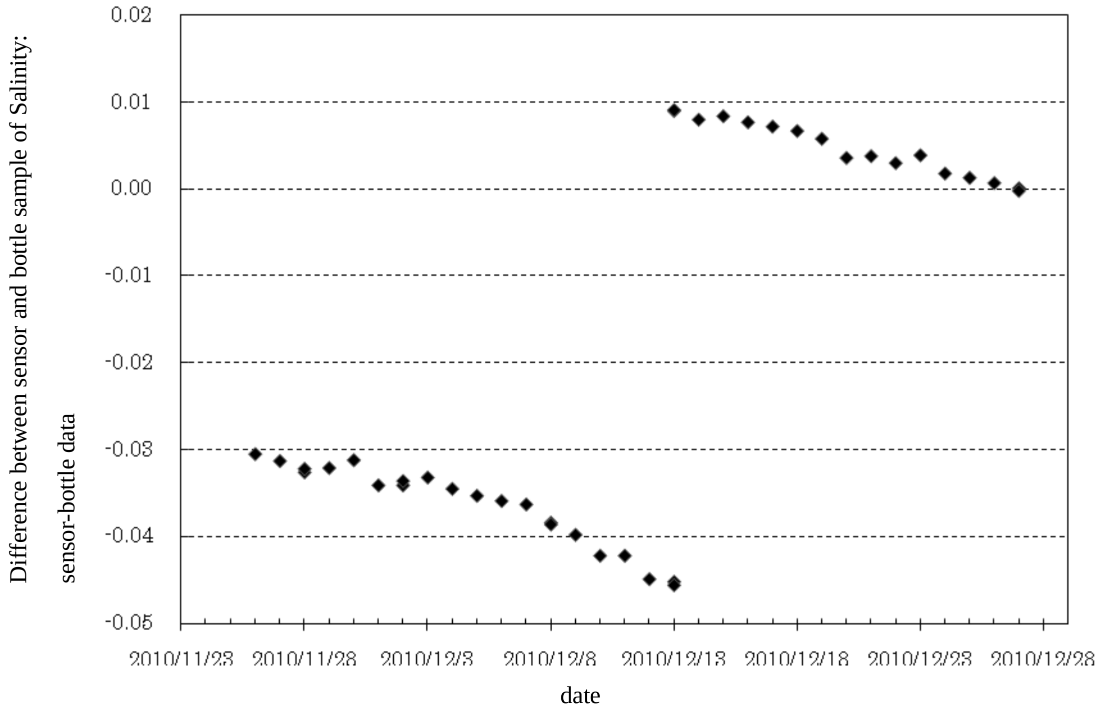


Fig.6.4.1-4 Difference of salinity between sensor data and bottle data.

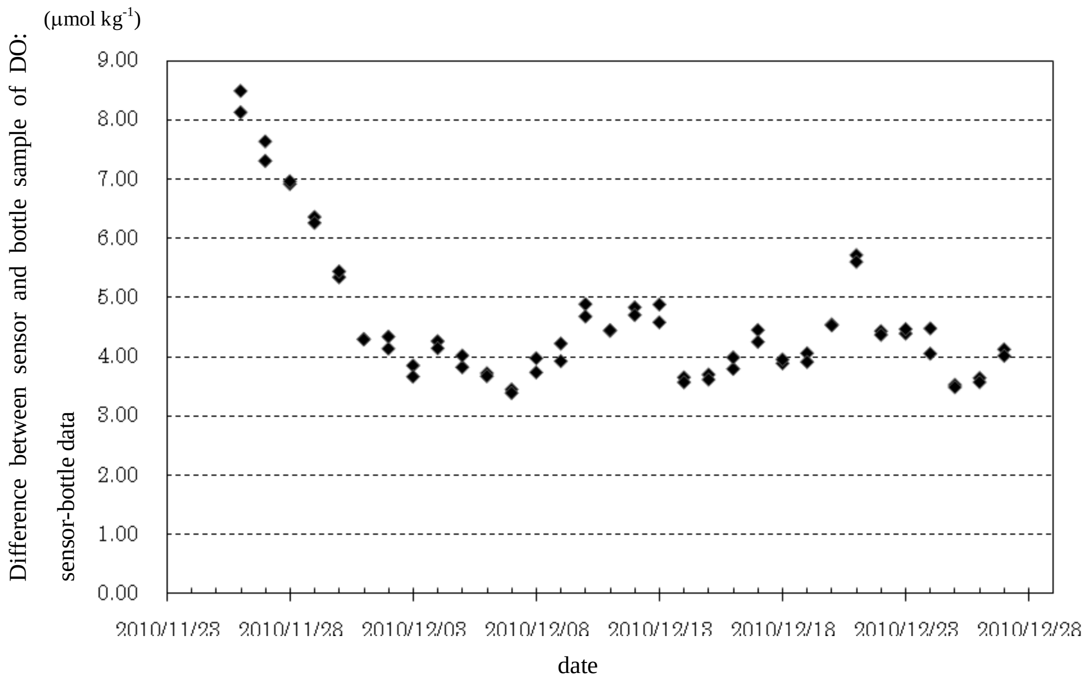


Fig.6.4.1-5 Difference of dissolved oxygen between sensor data and bottle data. The mean difference is 4.58 μmol kg^{-1}.

6.4.2 Underway pCO_2

Shuichi WATANABE (JAMSTEC MIO): Principal Investigator
Yasuhiro ARII (MWJ)

(1) Objectives

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

Since the global warming is becoming an issue world-widely, studies on green house gases such as CO_2 are drawing high attention. Because the ocean plays an important role in buffering the increase of atmospheric CO_2, surveys on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; total alkalinity, total dissolved inorganic carbon, pH and pCO_2. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (Dickson et al., 2007). We here report on board measurements of pCO_2 performed during MR10-07 cruise.

(2) Methods, Apparatus and Performance

Concentrations of CO_2 in the atmosphere and the sea surface were measured continuously during the cruise using an automated system with a non-dispersive infrared gas analyzer (NDIR; Li-7000).

The automated system was operated by on one and a half hour cycle. In one cycle, standard gasses, marine air and equilibrated air with surface seawater within the equilibrator were analyzed subsequently. The concentrations of the standard gas were 300.043, 349.954, 400.326 and 450.078 ppm.

To measure marine air concentrations (mol fraction) of CO_2 in dry air (xCO_2-air), marine air sampled from the bow of the ship (approx.30 m above the sea level) was introduced into the NDIR by passing through a mass flow controller which controls the air flow rate at about 0.5 L min^{-1}, a cooling unit, two perma-pure dryer (GL Sciences Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

To measure surface seawater concentrations of CO_2 in dry air (xCO_2-sea), marine air equilibrated with a stream of seawater within the equilibrator was circulated with a pump at 0.7-0.8 L min^{-1} in a closed loop passing through two cooling units, two perma-pure dryer and a desiccant holder containing $Mg(ClO_4)_2$. The seawater taken by a pump from the intake placed at the approx. 4.5m below the sea surface flowed at a rate of 4-5 L min^{-1} in the equilibrator. After that, the equilibrated air was introduced into the NDIR.

Periods of measurement, maintenance, and problems during MR10-07 are listed in Table 6.4.2-1.

Table 6.4.2-1 Events list of the underway pCO_2 during MR10-07

Date (UTC)	Time (UTC)	Events	Remarks
2010/11/25	08:34	Measurements started.	Start
2010/12/13	04:37	Measurements stopped.	Maintenance
2010/12/13	06:14	Measurements started.	
2010/12/17	06:34	Measurements stopped.	Restart
2010/12/17	06:35	Measurements started.	
2010/12/23	07:42	Measurements stopped.	Maintenance
2010/12/23	10:13	Measurements started.	
2010/12/28	17:16	Measurements stopped.	End

(3) Preliminary results

Concentrations of CO_2 (xCO_2) of marine air and surface seawater are shown in Figure 6.4.2-1.

Figure 6.4.2-1 Temporal variations of atmospheric and oceanic CO_2 concentration (xCO_2). Green dots represent atmosphere xCO_2 variation and blue oceanic xCO_2. SST variation (red) is also shown.

(4) Data Archive

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

(5) Reference

Dickson, A. G., Sabine, C. L. & Christian, J. R. (2007), Guide to best practices for ocean CO_2 measurements; PICES Special Publication 3, 199pp.

6.5 Shipboard ADCP

(1) Personnel

Yuji KASHINO	(JAMSTEC) :Principal Investigator
Norio NAGAHAMA	(Global Ocean Development Inc., GODI)
Ryo KIMURA	(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 in MR10-07 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 75 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 gyro compass (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 1.4.2 (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 intervals starting 23-m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown in Table 6.5-1.

(4) Preliminary results

Fig.6.5-1 and Fig.6.5-2 shows the current profile 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.

Table 6.5-1 Major parameters

Bottom-Track Commands	
BP = 001	Pings per Ensemble (almost less than 1000m 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)

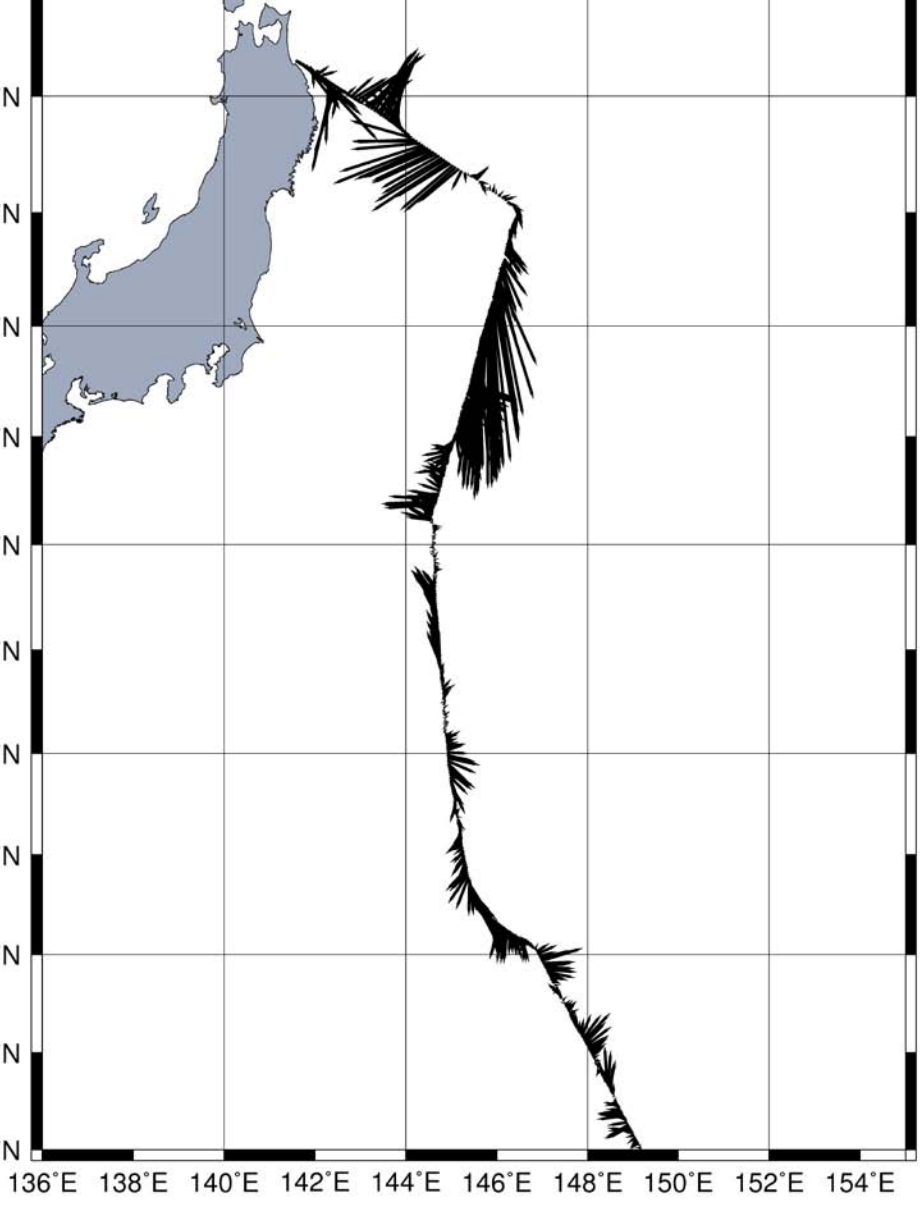


Fig 6.5-1. Current profile along the ship's track.

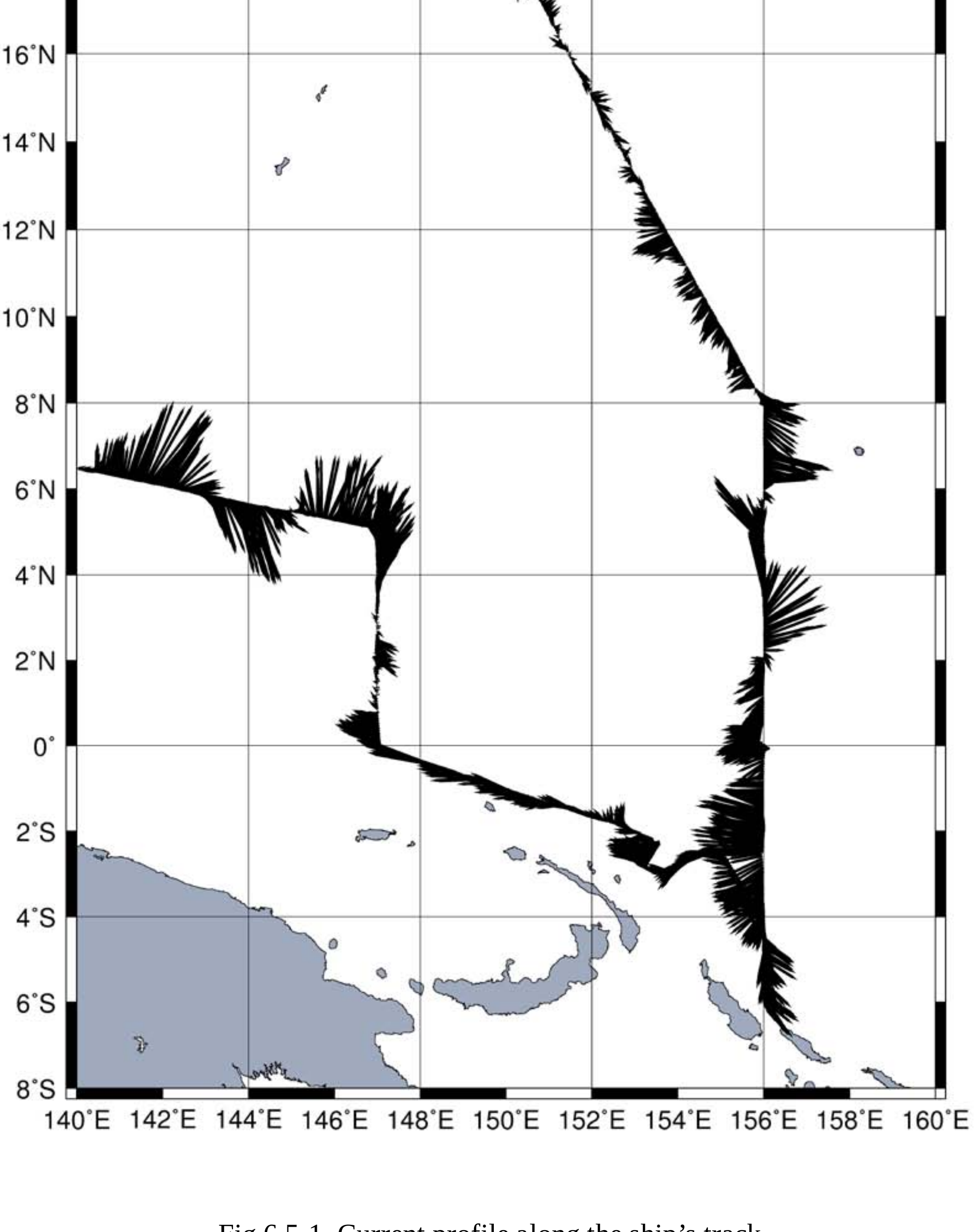


Fig 6.5-1. Current profile along the ship’s track.

6.6 Underway geophysics

6.6.1. Sea surface gravity

(1) Personnel

Takeshi Matsumoto (University of the Ryukyus) : Principal Investigator (Not on-board)
Norio Nagahama (Global Ocean Development Inc., GODI)
Ryo Kimura (GODI)
Ryo Ohyama (MIRAI Crew)

(2) Introduction

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

(3) Parameters

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

(4) Data Acquisition

We measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (Micro-g LaCoste, LLC) during the MR10-07 cruise from 23rd November 2010 to 28th December 2010.

To convert the relative gravity to absolute one, we measured gravity, using portable gravity meter (Scintrex gravity meter CG-3M), at Sekinehama as the reference point.

(5) Preliminary Results

Absolute gravity shown in Tabel 6.6.1-1

(6) Data Archives

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

Table 6.6.1-1

No	Date	UTC	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R*[2] Gravity [mGal]
#1	Nov/23	20:56	Sekinehama	980,371.92	224	630	980,372.66	12654.69
#2	***/**	**:**	*****	***,***.**	***	***	***,***.**	**,***.**

*[1]: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431

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

6.6.2 Sea surface magnetic field

1) Three-component magnetometer

(1) Personnel

Takeshi Matsumoto (University of the Ryukyus): Principal Investigator (Not on-board)
Norio Nagahama (Global Ocean Development Inc., GODI)
Ryo Kimura (GODI)
Ryo Ohyama (MIRAI Crew)

(2) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR10-07 cruise from 23rd November 2010 to 28th December 2010.

(3) Principle of ship-board geomagnetic vector measurement

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

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

where $\widetilde{\mathbf{R}}$, $\widetilde{\mathbf{P}}$ and $\widetilde{\mathbf{Y}}$ are the matrices of rotation due to roll, pitch and heading of a ship, respectively. $\widetilde{\mathbf{A}}$ 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

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

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

(4) Instruments on R/V MIRAI

A shipboard three-component magnetometer system (Tierra Tecnica SFG1214) is equipped on-board R/V MIRAI. Three-axes flux-gate sensors with ring-cored coils are fixed on the fore mast. Outputs 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.

(5) Data Archives

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

(6) Remarks

1) The following periods, data acquisition was stopped due to the PC trouble.

08th Dec. 2010, 14:33:42 – 18:53:12, 20:48:13 – 21:41:48UTC

11th Dec. 2010, 21:53:33 – 12th Dec. 2010, 01:09:02UTC

13th Dec. 2010, 21:22:49 – 21:40:06UTC

14th Dec. 2010, 00:52:25 – 01:37:08, 20:37:57 – 21:21:07UTC

2) The following periods, data acquisition was stopped due to system maintenance.

09th Dec. 2010, 07:46:50 – 09th Dec. 2010, 07:59:28UTC

12th Dec. 2010, 02:09:52 – 12th Dec. 2010, 02:14:25UTC

15th Dec. 2010, 21:54:46 – 15th Dec. 2010, 22:02:09UTC

3) 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.

24th Nov. 2010, 12:05 – 12:34UTC around at 41-01N, 142-05E

28th Nov. 2010, 19:31 – 19:54UTC around at 32-28N, 144-28E

04th Dec. 2010, 07:00 – 07:23UTC around at 08-08N, 155-58E

17th Dec. 2010, 10:29 – 11:00UTC around at 06-01S, 156-05E

2) Cesium magnetometer

(1) Personnel

Takeshi Matsumoto	(University of the Ryukyus)	: Principal investigator / Not on-board
Norio Nagahama	(Global Ocean Development Inc., GODI)	
Ryo Kimura	(GODI)	
Ryo Ohyama	(MIRAI Crew)	

(2) Introduction

Measurement of magnetic force on the sea is required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure.

(3) Data Period

29th Nov. 2010, 20:38 – 01st Dec. 2010, 20:28UTC

27th Dec. 2010, 04:41 – 28th Dec. 2010, 17:10UTC

(4) Specification

We measured total geomagnetic field using a cesium marine magnetometer (Geometrics Inc., G-882) and recorded by G-882 data logger (Clovertech Co., Ver.1.0.0). The G-882 magnetometer uses an optically pumped Cesium-vapor atomic resonance system. The sensor fish towed 500 m behind the vessel to minimize the effects of the ship's magnetic field.

Table 6.6.2-1 shows system configuration of MIRAI cesium magnetometer system.

Table 6.6.2-1 System configuration of MIRAI cesium magnetometer system.

Dynamic operating range:		20,000 to 100,000 nT
Absolute accuracy:		$<\pm 2$ nT throughout range
Setting:	Cycle rate;	0.1 sec
	Sensitivity;	0.001265 nT at a 0.1 second cycle rate
	Sampling rate;	1 sec

(5) Data Archive

Total magnetic force data obtained during this cruise was submitted to the Data Management Group (DMG) of JAMSTEC, and archived there.

6.6.3. Swath Bathymetry

(1) Personnel

Takeshi Matsumoto (University of the Ryukyus): Principal Investigator (Not on-board)
Norio Nagahama (Global Ocean Development Inc., GODI)
Ryo Kimura (GODI)
Ryo Ohyama (MIRAI Crew)

(2) Introduction

R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112 (SeaBeam Instruments Inc.). The objective of MBES is collecting continuous bathymetric data along ship's track to make a contribution to geological and geophysical investigations and global datasets.

(3) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during the MR10-07 cruise from 24th November 2010 to 28th December 2010.

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 (6.2m) sound velocity, and the deeper depth sound velocity profiles were calculated by temperature and salinity profiles from CTD and XCTD data by the equation in Del Grosso (1974) during the cruise.

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

Table 6.6.3-1 System configuration and performance

SEABEAM 2112 (12 kHz system)	
Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max) 120 degree to 4,500 m 100 degree to 6,000 m 90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m, whichever is greater, over the entire swath. (Nadir beam has greater accuracy; typically within < 0.2% of depth or +/-1m, whichever is greater)

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

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

7. Special observations

7.1 TRITON buoys

7.1.1 Operation of the TRITON buoys

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Keisuke Matsumoto	(MWJ): Operation Leader
Akira Watanabe	(MWJ): Technical Staff
Hirokatsu Uno	(MWJ): Technical Staff
Tomohide Noguchi	(MWJ): Technical Staff
Shinsuke Toyoda	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Makito Yokota	(MWJ): Technical Staff
Takatoshi Kiyokawa	(MWJ): Technical Staff
Kai Fukuda	(MWJ): Technical Staff
Yasuhiro Arii	(MWJ): Technical Staff
Misato Kuwahara	(MWJ): Technical Staff
Yasushi Hashimoto	(MWJ): Technical Staff
Yuki Miyajima	(MWJ): Technical Staff
Miki Tawata	(MWJ): Technical Staff

(2) Objectives

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool that affects the global atmosphere and causes El Nino phenomena. The formation mechanism of the warm pool and the air-sea interaction over the warm pool have not been well understood. Therefore, long term data sets of temperature, salinity, currents and meteorological elements have been required at fixed locations. The TRITON program aims to obtain the basic data to improve the predictions of El Nino and variations of Asia-Australian Monsoon system.

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

Nine TRITON buoys have been successfully recovered and deployed during this R/V MIRAI cruise (MR10-07).

(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～+33 deg-C

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

Measurement range, Pressure : 0～full scale range

2) CRN(Current meter)

SonTek Argonaut ADCM

Sensor frequency : 1500kHz

Sampling interval : 1200sec

Average interval : 120sec

3) Meteorological sensors

Precipitation

R.M.YOUNG COMPANY MODEL50202/50203

Atmospheric pressure

PAROPSCIENTIFIC.Inc. DIGIQUARTZ FLOATING BAROMETER 6000SERIES

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

Woods Hole Institution ASIMET

Sampling interval : 60sec

Data analysis : 600sec averaged

(5) Locations of TRITON buoys deployment

Nominal location	8N, 156E
ID number at JAMSTEC	01013
Number on surface float	T01
ARGOS PTT number	29765
ARGOS backup PTT number	24242
Deployed date	04 Dec. 2010
Exact location	07- 57.95N, 156- 02.09E
Depth	4,842 m

Nominal location	5N, 156E
ID number at JAMSTEC	02013
Number on surface float	T04
ARGOS PTT number	27388
ARGOS backup PTT number	29692
Deployed date	06 Dec. 2010
Exact location	05- 01.29N, 155- 57.77E
Depth	3,601 m

Nominal location	2N, 156E
ID number at JAMSTEC	03014
Number on surface float	T07
ARGOS PTT number	27389

ARGOS backup PTT number	29694
Deployed date	08 Dec. 2010
Exact location	01- 57.17N, 156- 00.00E
Depth	2,563 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04014
Number on surface float	T05
ARGOS PTT number	27401
ARGOS backup PTT number	29697
Deployed date	10 Dec. 2010
Exact location	00- 01.02S, 155- 57.35E
Depth	1,940 m

Nominal location	2S, 156E
ID number at JAMSTEC	05012
Number on surface float	T06
ARGOS PTT number	27399
ARGOS backup PTT number	29710
Deployed date	14 Dec. 2010
Exact location	01- 58.97S, 156- 01.84E
Depth	1,752 m

Nominal location	5S, 156E
ID number at JAMSTEC	06012
Number on surface float	T08
ARGOS PTT number	27394
ARGOS backup PTT number	24243
Deployed date	16 Dec. 2010
Exact location	04- 58.03S, 156- 01.00E
Depth	1,508m

Nominal location	5N, 147E
ID number at JAMSTEC	07012
Number on surface float	T15
ARGOS PTT number	29638
ARGOS backup PTT number	24244
Deployed date	26 Dec. 2010
Exact location	05- 02.53N, 146- 56.82E
Depth	4,257 m

Nominal location	2N, 147E
ID number at JAMSTEC	08011
Number on surface float	T16
ARGOS PTT number	29855
ARGOS backup PTT number	24245
Deployed date	24 Dec. 2010

Exact location	02- 04.47N, 146- 57.02E
Depth	4,491m

Nominal location	EQ, 147E
ID number at JAMSTEC	09012
Number on surface float	T20
ARGOS PTT number	29639
ARGOS backup PTT number	29696
Deployed date	21 Dec. 2010
Exact location	00-01.48S, 146- 59.98E
Depth	4,550 m

(6) TRITON recovered

Nominal location	8N, 156E
ID number at JAMSTEC	01012
Number on surface float	T09
ARGOS PTT number	28868
ARGOS backup PTT number	24229
Deployed date	14 Nov. 2009
Recovered date	04 Dec. 2010
Exact location	08- 01.00N, 155- 57.17E
Depth	4,836 m

Nominal location	5N, 156E
ID number at JAMSTEC	02012
Number on surface float	T12
ARGOS PTT number	20374
ARGOS backup PTT number	24230
Deployed date	15 Nov. 2009
Recovered date	06 Dec. 2010
Exact location	04- 58.39N, 156- 02.04E
Depth	3,600 m

Nominal location	2N, 156E
ID number at JAMSTEC	03013
Number on surface float	T17
ARGOS PTT number	3780
ARGOS backup PTT number	24240
Deployed date	17 Nov. 2009
Recovered date	09 Dec. 2010
Exact location	02- 02.26N, 156- 01.29E
Depth	2,573 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04013
Number on surface float	T19

ARGOS PTT number	23470
ARGOS backup PTT number	27409
Deployed date	18 Nov. 2009
Recovered date	11 Dec. 2010
Exact location	00-00.97N, 156- 02.44E
Depth	1,953 m

Nominal location	2S, 156E
ID number at JAMSTEC	05011
Number on surface float	T22
ARGOS PTT number	20439
ARGOS backup PTT number	27410
Deployed date	21 Nov. 2009
Recovered date	15 Dec. 2010
Exact location	02- 01.00S, 155- 57.50E
Depth	1,749 m

Nominal location	5S, 156E
ID number at JAMSTEC	06011
Number on surface float	T24
ARGOS PTT number	20392
ARGOS backup PTT number	13067
Deployed date	22 Nov. 2009
Recovered date	17 Dec. 2010
Exact location	05- 01.73S, 156-01.44E
Depth	1,517m

Nominal location	5N, 147E
ID number at JAMSTEC	07011
Number on surface float	T25
ARGOS PTT number	7898
ARGOS backup PTT number	11592
Deployed date	02 Dec. 2009
Recovered date	26 Dec. 2010
Exact location	04- 57.66N, 147- 01.83E
Depth	4,290 m

Nominal location	2N, 147E
ID number at JAMSTEC	08010
Number on surface float	T27
ARGOS PTT number	9793
ARGOS backup PTT number	29698
Deployed date	30 Nov. 2009
Recovered date	24 Dec. 2010
Exact location	01- 59.51N, 147- 01.24E
Depth	4,519 m

Nominal location	EQ, 147E
ID number at JAMSTEC	09011
Number on surface float	T28
ARGOS PTT number	3779
ARGOS backup PTT number	24715
Deployed date	26 Nov. 2009
Recovered date	21 Dec. 2010
Exact location	00-0 3.59E, 147- 00.64 E
Depth	4,474 m

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

(6) Details of deployed

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

Deployment TRITON buoys

Observation No.	Location	Details
01013	8N156E	Deploy with full spec and 1 optional unit. JES-10C : 25m
02013	5N156E	Deploy with full spec and 1 optional unit. JES-10C : 25m
03014	2N156E	Deploy with full spec and 2 optional sensors. CO2 float type buoy : with TRITON top buoy SBE37 (CT) : 175m
04014	EQ156E	Deploy with full spec and 2 optional unit. SBE37 (CT) : 175m WH-ADCP : 175m
05012	2S156E	Deploy with full spec and 2 optional unit. JES-10TD : 300m JES-10TD : 750m
06012	5S156E	Deploy with full spec.
07012	5N147E	Deploy with full spec.
08011	2N147E	Deploy with full spec and 1 optional unit. SBE37 (CT) : 175m
09012	EQ147E	Deploy with full spec.

(7) Data archive

Hourly averaged data are transmitted through ARGOS satellite data transmission system in almost real time. The real time data are provided to meteorological organizations via Global Telecommunication System and utilized for daily weather forecast. The data will be also distributed world wide through Internet from JAMSTEC and PMEL home pages. All data will be archived at 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
Shinsuke Toyoda	(MWJ): Technical Staff
Akira Watanabe	(MWJ): Technical Staff

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

- Temperature
- Conductivity
- Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We used the same CTD (SBE 9/11Plus) system with general CTD observation (See section 5) on R/V MIRAI for this 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.

Compared site

Observation No.	Latitude	Longitude	Condition
01013	8N	156E	After Deployment
02013	5N	156E	After Deployment
03014	2N	156E	After Deployment
04014	EQ	156E	After Deployment
05012	2S	156E	After Deployment
06012	5S	156E	After Deployment
07012	5N	147E	After Deployment
08011	2N	147E	After Deployment
09012	EQ	147E	After Deployment
01012	8N	156E	Before Recover
02012	5N	156E	Before Recover
03013	2N	156E	Before Recover
04013	EQ	156E	Before Recover
05011	2S	156E	Before Recover
06011	5S	156E	Before Recover
07011	5N	147E	Before Recover

08010	2N	147E	Before Recover
09011	EQ	147E	Before Recover

(5) Results

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

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

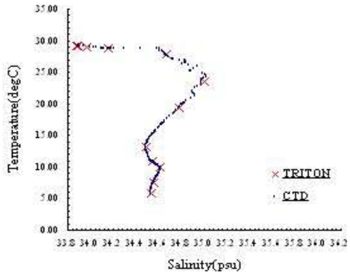
The estimation was calculated as deployed buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.0702 to 0.0635 for all depths. Below 300db, salinity differences are from –0.0133 to 0.0081 (See the Figures 7.1.2-2 (a)). The average of salinity differences was -0.0012 with standard deviation of 0.0184.

The estimation was calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –2.4390 to 0.1061 for all depths. Below 300db, salinity differences are from -2.4390 to 0.0061 (See the Figures 7.1.2-2(b)). The average of salinity differences was -0.0232 with standard deviation of 0.2462.

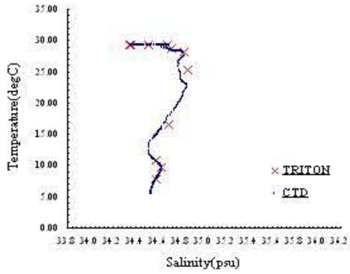
The estimation of time-drift was calculated as recovered buoy data minus deployed buoy data. The salinity changes for 1 year are from –2.4749 to 0.1175, for all depths. Below 300db, salinity changes for 1 year are from -2.4749 to 0.0480 (See the figures 7.1.2-2(c)). The average of salinity differences was -0.0358 with standard deviation of 0.2484.

(6) Data archive

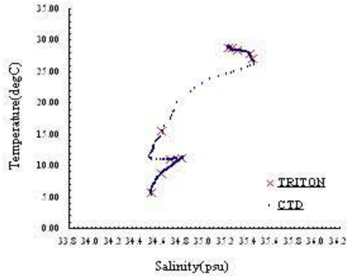
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 7)



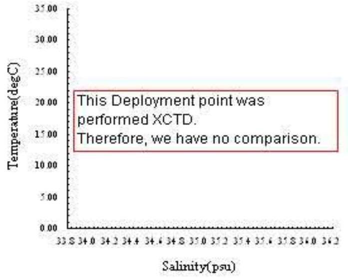
Observation No. 01013 after Deployment



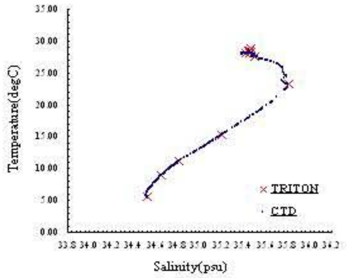
Observation No. 02013 after Deployment



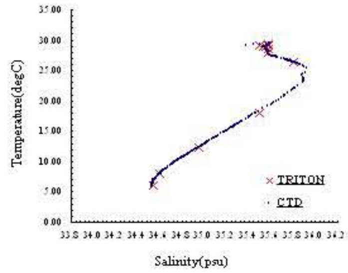
Observation No. 03014 after Deployment



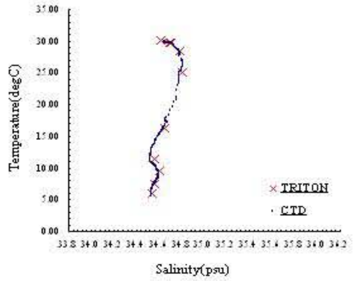
Observation No. 04014 after Deployment



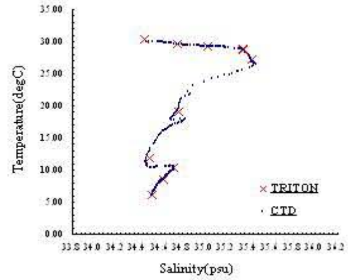
Observation No. 05012 after Deployment



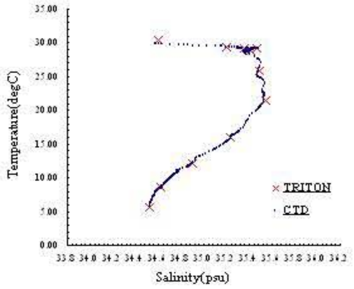
Observation No. 06012 after Deployment



Observation No. 07012 after Deployment

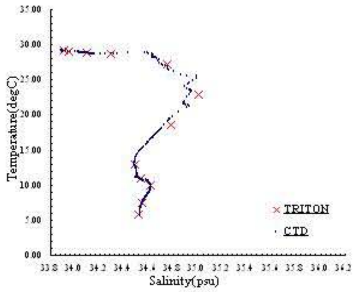


Observation No. 08011 after Deployment

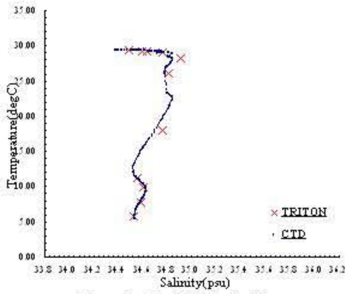


Observation No. 09012 after Deployment

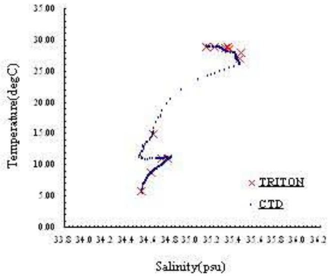
Fig.7.1.2.-1(a) T-S diagram of TRITON buoys data and shipboard CTD data



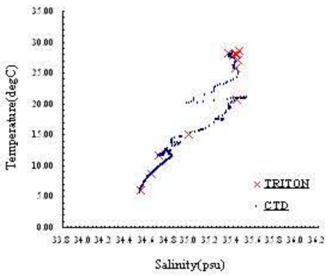
Observation No. 01012 before Recover



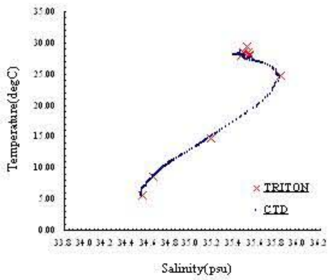
Observation No. 02012 before Recover



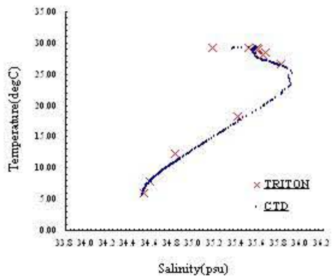
Observation No. 03013 before Recover



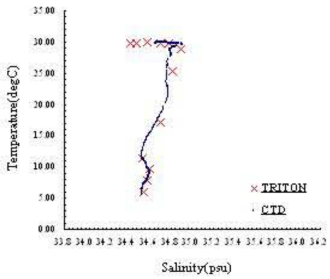
Observation No. 04013 before Recover



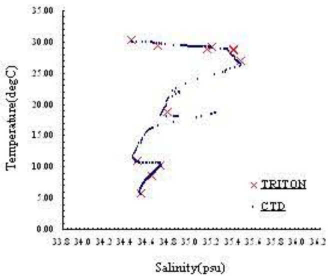
Observation No. 05011 before Recover



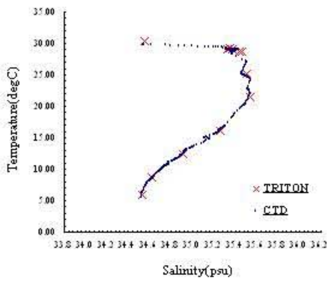
Observation No. 06011 before Recover



Observation No. 07011 before Recover



Observation No. 08010 before Recover



Observation No. 09011 before Recover

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

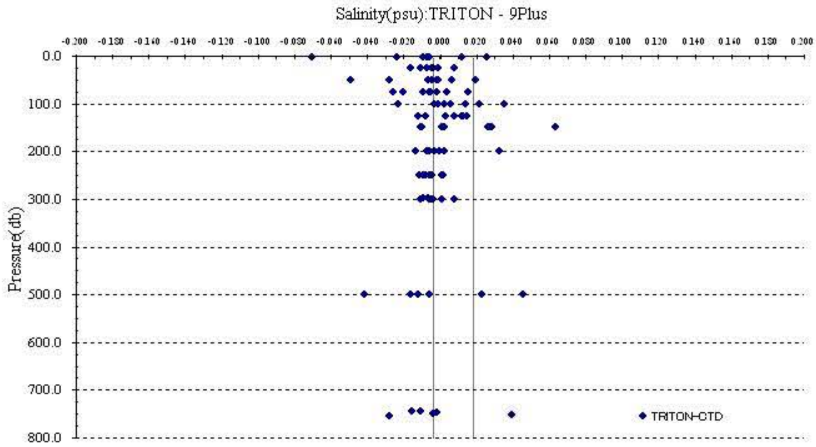


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

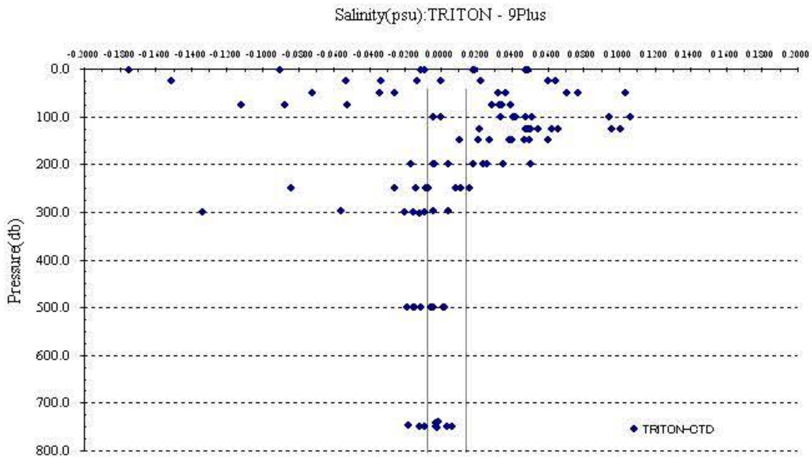


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

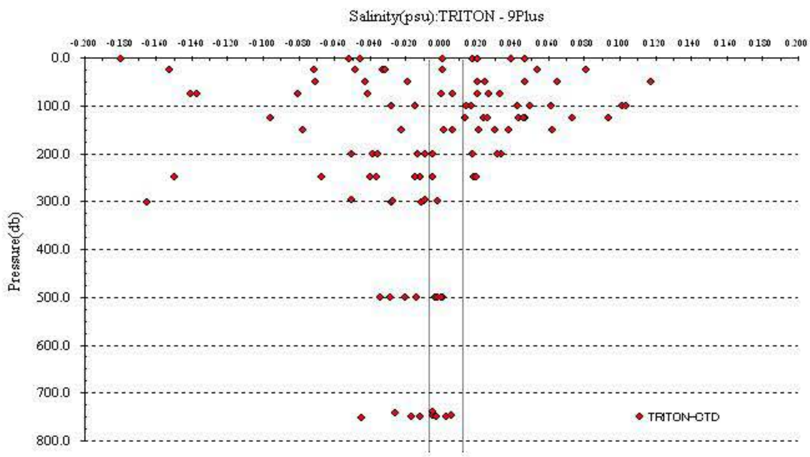


Fig.7.1.2.-2 (c) Salinity differences between deployment data and recovery data for 1year

7.2 Deployment of the Southern Ocean buoy

(1) Personnel

Shoichiro Baba (JAMSTEC): Engineer
Tatsuya Fukuda (JAMSTEC): Engineer
Tomohide Noguchi (MWJ): Technical staff
Keisuke Matsumoto (MWJ): Technical staff
Akira Watanabe (MWJ): Technical staff

(2) Objective

The southern ocean test buoy was deployed in Hokkaido coast to verify the engineering performance in winter real sea for the development of the southern ocean buoy.

(3) Measured parameters

Meteorological parameters: Wind speed/direction, Atmospheric pressure, Air temperature, Relative humidity, Radiation, Precipitation

Oceanic parameters: water temperature at 2m

Engineering parameters: Monitoring camera for the wind direction velocimetry with the ice suppression heater, Monitoring camera for the deck of buoy, Monitoring camera for the dome cover, Iridium camera for the dome cover in real time communication, Overtopping waves measure, Nilometer at 1.4m 3 sets, Tension meter at the end of the center pole, Attitude Measurement, ADCP

(4) Instrument

1) Meteorological sensors

Wind speed/direction, air temperature, relative humidity, atmospheric pressure, precipitation

Vaisala Weather Transmitter (WXT520)
Sampling interval: 600s

Atmospheric pressure
JAMMET type BAR & model DP4000
Sampling interval: 600s

Air temperature, relative humidity
JAMMET type HRH & model MP103A
Sampling interval: 600s

Short Wave Radiation
JAMMET type SWR & model EPSP
Sampling interval: 600s

Precipitation
JAMMET type RAN & model Y50202
Sampling interval: 600s

2) Underwater sensor

Water temperature

JES10 (form JAMSTEC): Sampling interval 600sec

3) Engineering sensors

Monitoring cameras 3 sets

TAMAYA TECHNICS INC. KADEC21-EYE II: Shooting interval: 1 hour

Iridium camera

Nissin-technica inc. UART-camera for outside: Shooting interval: 24h

Overtopping waves measure

KENEK CO., LTD. CHT5-100JAMS: Sampling interval: 600s, Sampling time: 60s

Measurement range: 0-1000mm

Nilometer

RIGO CO., LTD. RMD N5225: Sampling interval: 600s, Sampling time: 60s

Measurement range: 0-5m

Tension meter

Unipulse Corporation LT-50KNG79: Sampling interval: 600s, Sampling time: 60s

Measurement range: 0-50kN

Attitude Measurement

Silicon Sensing Systems Japan, Ltd. AMU-1802-BR

Sampling interval: 7 days, Sampling time: 8hours

Measurement range roll: ±180deg

Measurement range pitch : ±85deg

Measurement range angle velocity: ±180 deg/s

Measurement range accelerated velocity: ±2G

Workhorse ADCP 300kHz

Hydro Systems Development. Inc.

Layer: 8m, Sampling interval: 600s, Maximum measuring range: 154m

Compass

PNI Corporation type TCM3: Sampling interval: 600s

(5) Location of Southern Ocean buoy

Nominal location	41° 50'N,142° 40'E
ARGOS PTT number	96773
Deployed date	24 Nov. 2010
Exact location	41°50.1522N, 142°39.7641'E
Depth	796m

7.3 Search for underwater parts of the K-TRITON buoy

(1) Personnel

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

(2) Objective

The K-TRITON buoy, which was moored in the north of the Kuroshio Extension on 29 August 2009, drifted in the beginning of October 2010 due to the breakage of its mooring wire (Figure 7.3-1). Although the buoy hull was recovered on 12 October, all of its underwater part has been left in the ocean. The underwater part is going to be recovered in February 2011 (MR11-02 cruise). Before that, we confirmed whether the underwater part certainly exists just near the moored site.

(3) Methods

A transponder (Benthos XT-6000-68371) is installed on the mooring chain about 90 m above the sea floor (Figure 7.3-2). We tried to examine its accurate position by using the SSBL system. The specification is shown in Table 7.3-1.

The position of the transponder at 12 JST on 29 August 2009

Latitude:	38° 04.7087' N
Longitude:	146° 25.7551' E
Depth:	5251.2 m

(4) Results

The SSBL calibration was done at 11 JST on 26 November 2010. The transponder worked well, and its position scarcely changed.

The position of the transponder at 11 JST on 26 November 2010

Latitude:	38° 04.8191' N
Longitude:	146° 25.8057' E
Depth:	5268.1 m

(5) 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/index.html).

Table 7.3-1 Specification of the transponder

Manufacturer	Benthos
Model	D-855-84-2
S/N	47654
Receive	13.0 kHz
Transmit	13.5 kHz
Enable code	A
Enable Time	12 hours

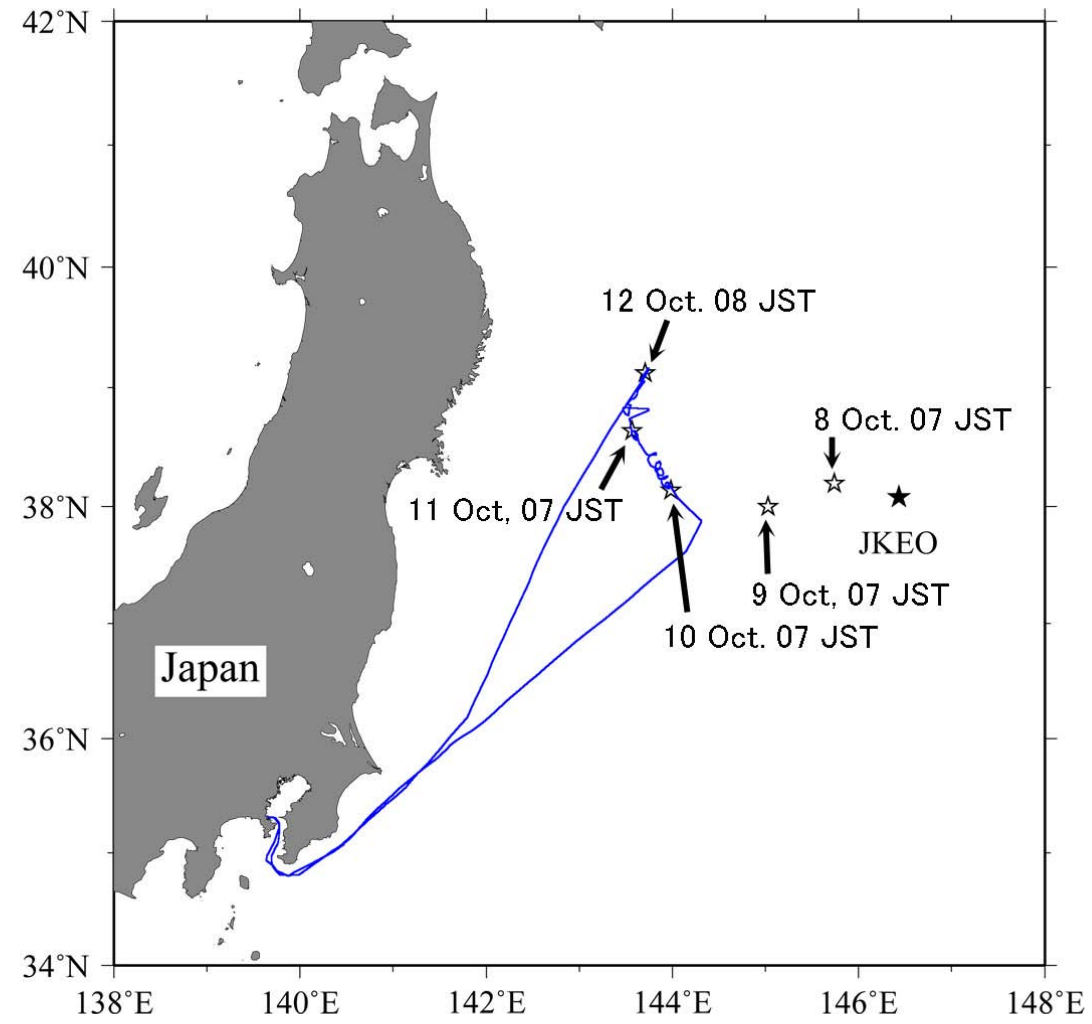


Figure 7.3-1 Track of the drifting K-TRITON buoy (white star) and the moored site (JKEO, black star). Blue line shows the track of R/V KAIREI, which recovered the buoy hull.

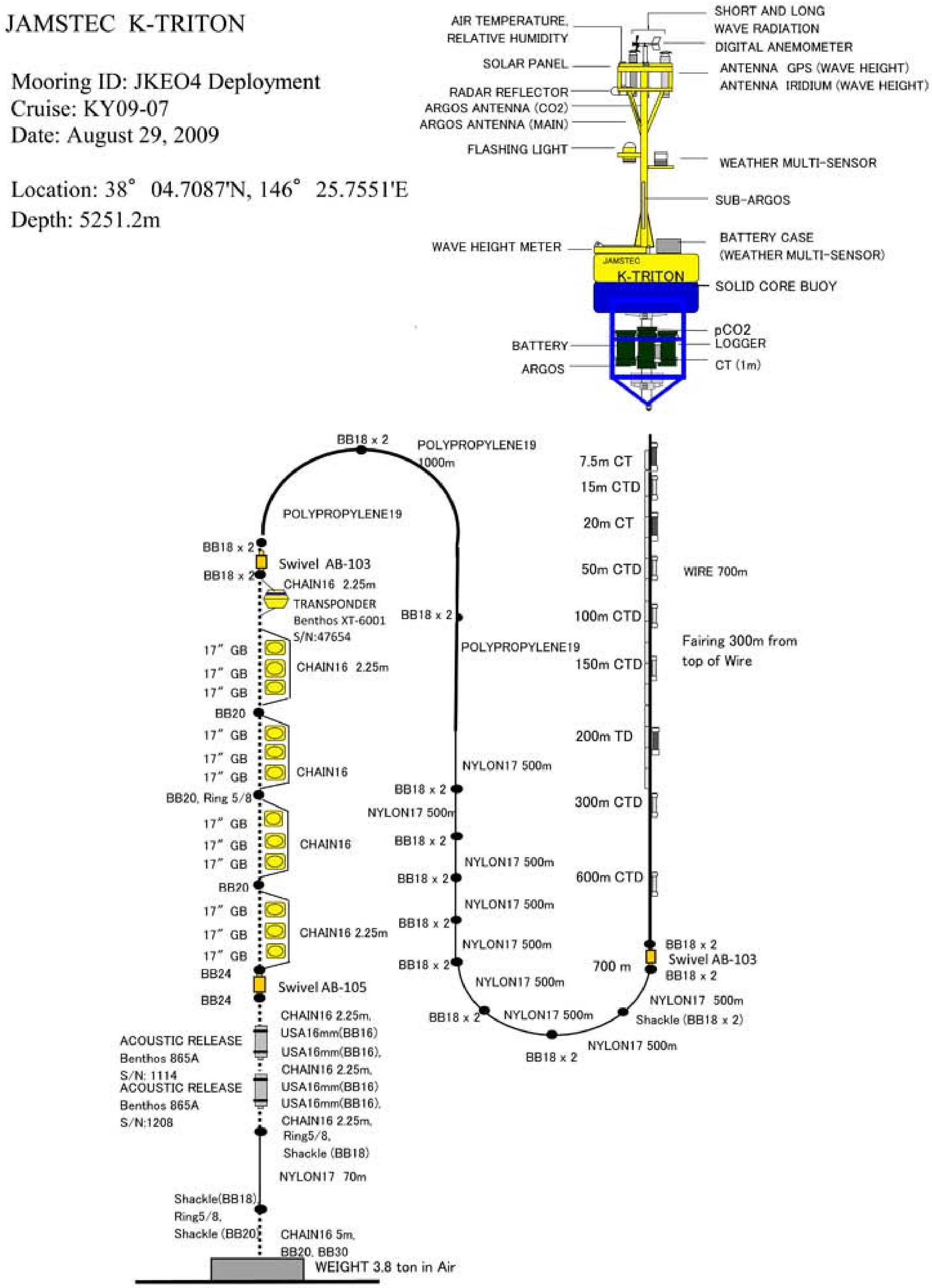


Figure 7.3-2 Schematic picture of the K-TRITON mooring.

7.4 Subsurface ADCP moorings

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Tomohide Noguchi	(MWJ): Operation leader
Akira Watanabe	(MWJ): Technical staff
Yasushi Hashimoto	(MWJ): Technical staff
Yuki Miyajima	(MWJ): Technical staff
Kai Fukuda	(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. In this cruise (MR10-07), we recovered two subsurface ADCP moorings at Eq-147E/Eq-156E and deployed two ADCP moorings at Eq-147E/Eq-156E.

(3) Parameters

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

(4) Methods

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

1) ADCP

Broadband ADCP 150 kHz (Teledyne RD Instruments, Inc.)

Distance to first bin : 8 m

Pings per ensemble : 16

Time per ping : 2.00 seconds

Bin length : 8.00 m

Sampling Interval : 3600 seconds

Recovered ADCP

- Serial Number : 1150 (Mooring No.091127-00147E)
- Serial Number : 1225 (Mooring No.091120-00156E)

Deployed ADCP

- Serial Number : 1220 (Mooring No.101222-00147E)
- Serial Number : 1221 (Mooring No.101212-00156E)

2) CTD

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds

Recovered CTD

- Serial Number : 1283 (Mooring No.091127-00147E)
- Serial Number : 2611 (Mooring No.091120-00156E)

Deployed CTD

- Serial Number : 1286 (Mooring No.101222-00147E)
- Serial Number : 1274 (Mooring No.101212-00156E)

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)

Recovered Acoustic Releaser

- Serial Number : 663 (Mooring No.091127-00147E)
- Serial Number : 694 (Mooring No.091127-00147E)
- Serial Number : 716 (Mooring No.091120-00156E)
- Serial Number : 719 (Mooring No.091120-00156E)

Deployed Acoustic Releaser

- Serial Number : 954 (Mooring No.101222-00147E)
- Serial Number : 636 (Mooring No.101222-00147E)
- Serial Number : 963 (Mooring No.101212-00156E)
- Serial Number : 961 (Mooring No.101212-00156E)

(b) Transponder (BENTHOS,Inc.)

Recovered Transponder

- Serial Number : 57068 (Mooring No.091127-00147E)
- Serial Number : 46472 (Mooring No.091120-00156E)

Deployed Transponder

- Serial Number : 57069 (Mooring No.101222-00147E)
- Serial Number : 67491 (Mooring No.101212-00156E)

(5) Deployment

Deployment of the ADCP mooring at Eq-147E and Eq-156E was planned to mount the ADCP at about 340m depths. During the deployment, we monitored the depth of the acoustic releaser after dropped the anchor.

The position of the mooring No. 101222-00147E

Date: 22 Dec. 2010 Lat: 00-00.25S Long: 147-04.58E Depth: 4,485m

The position of the mooring No. 101212-00156E

Date: 12 Dec. 2010 Lat: 00-02.24S Long: 156-08.02E Depth: 1,950m

(6) Recovery

We recovered two ADCP moorings. One was deployed on 20 Sep.2009 and the other was deployed on 27 Sep. 2009 (MR09-04cruise). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. Figure 7.4 show results from the mooring.

(7) Data archive

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

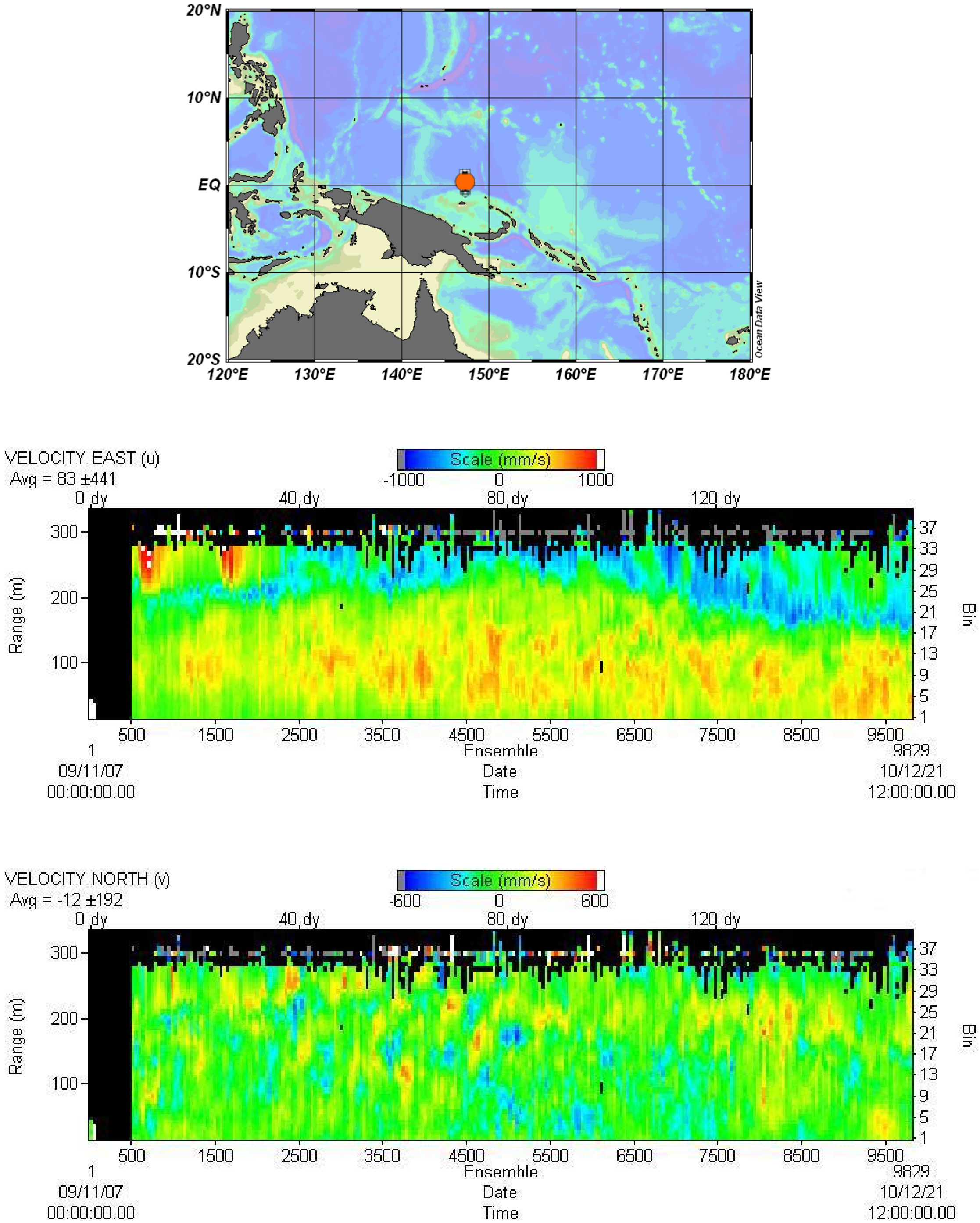


Fig.7.4-1 Time-depth sections of observed zonal (*top panel*) and meridional (*bottom panel*) currents obtained from ADCP mooring at Eq-147E.

(2009/11/19-2010/12/22)

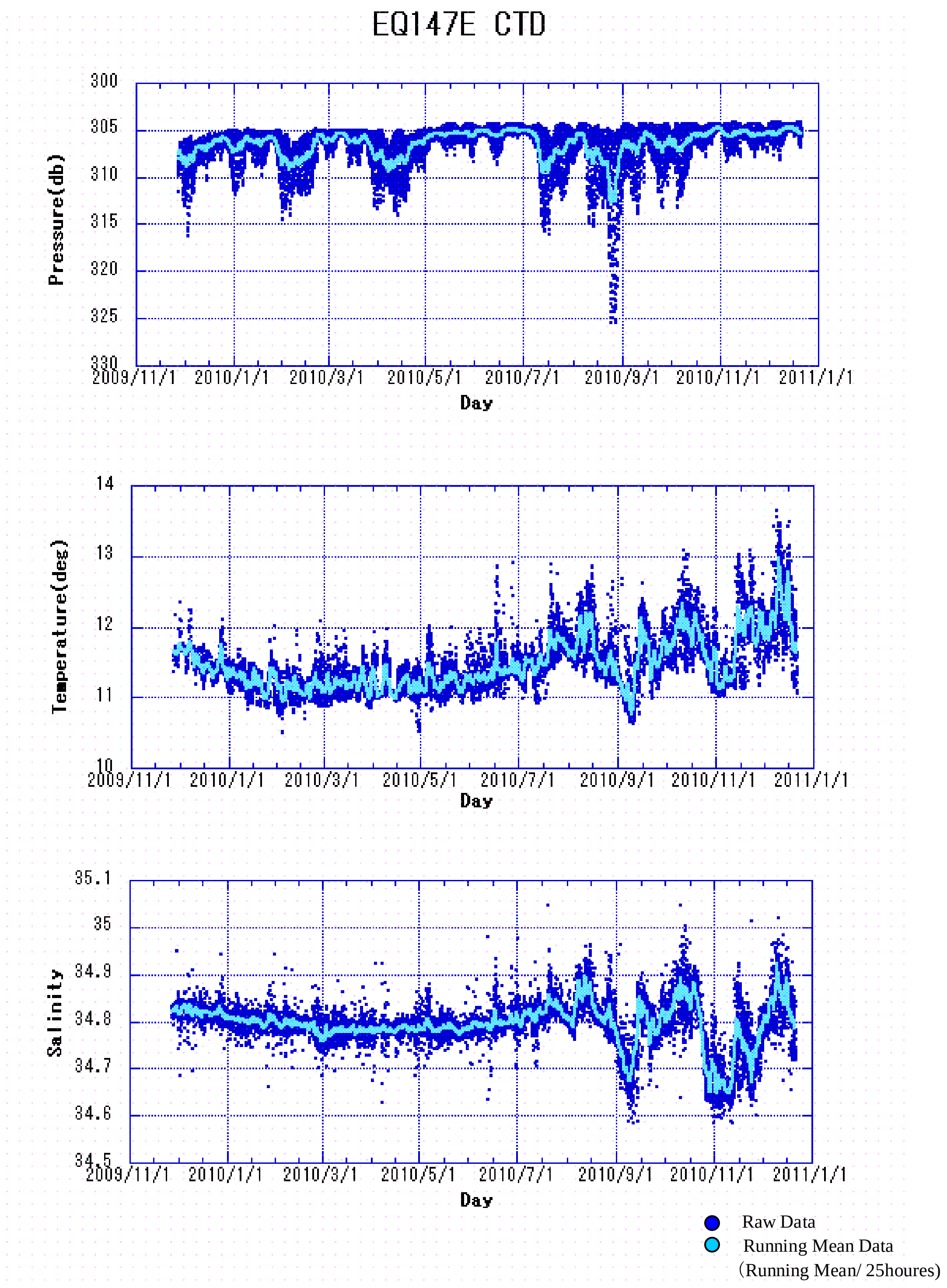


Fig.7.4-2 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at Eq-147E. The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean. (2009/11/19-2010/12/22)

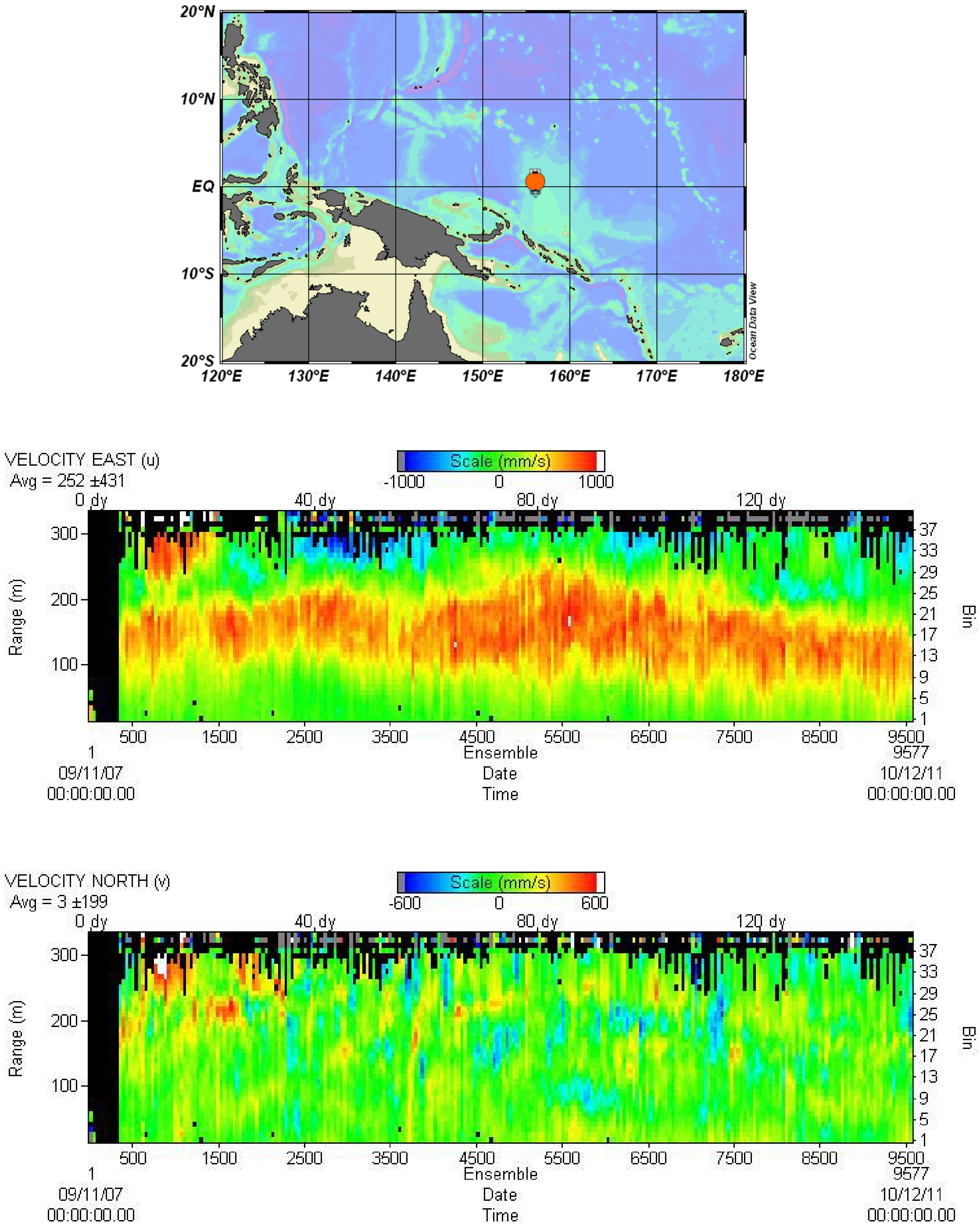


Fig.7.4-3 Time-depth sections of observed zonal (*top panel*) and meridional (*bottom panel*) currents obtained from ADCP mooring at Eq-156E.

(2009/11/20-2010/12/11)

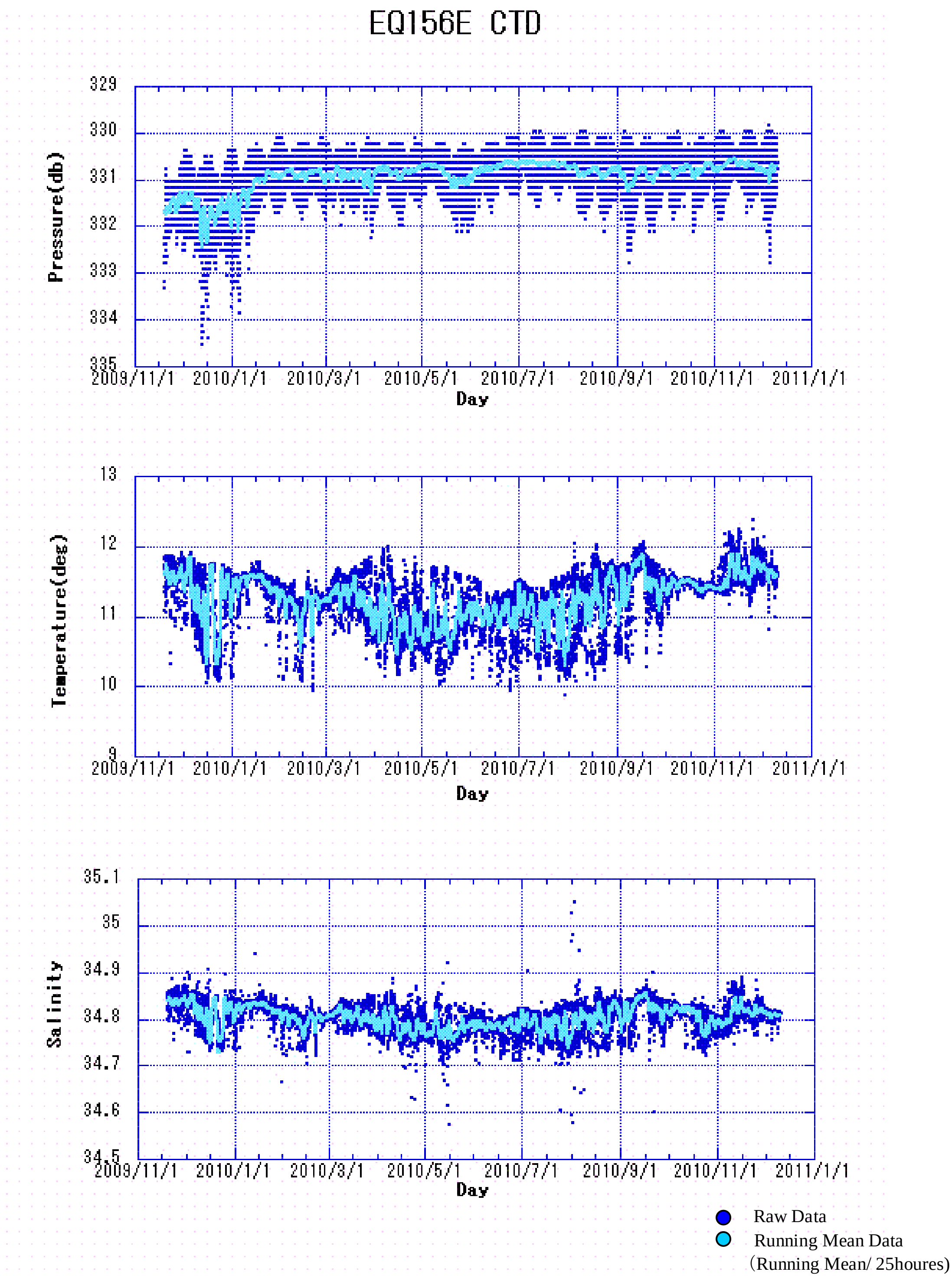


Fig.7.4-4 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at Eq-156E. The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean. (2009/11/20-2010/12/11)

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

Personnel Andrei Natarov (IPRC, University of Hawaii)
Takuya Hasegawa (JAMSTEC)

(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 plastic collar and two retaining bolts. A rope was tied to the top end of the instrument to minimize vertical slippage and for added safety (see Figure X.1). The instrument was tested at 32N (CTD station 00), deployed on CTD stations C04-C37 in the tropics and performed well throughout its use.

Fig 7.5-1 Mounting of LADCP on CTD System (photo: T. Hasegawa)

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. Direct measurements of the battery voltage were taken before and after the deployment and compared to the recorded voltage count:

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	43.50	150	0.29
After	40.45	139	0.29

implying an almost constant relationship of V~=0.29VC. RDI recommend the battery is changed when V gets below 30V.

(3) Setup and Parameter settings

At all stations except the test station 00, the LADCP was controlled at deploy and recover stages by a Linux PC using the python script **ladcp600.py** (written by Eric Firing, University of Hawai`i) 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.)

To add flexibility, during the test cast at the CTD station 00, the instrument was controlled at deploy and recover stages by the RDI software (**BBTalk**) installed on the JAMSTEC Windows PC with the same list of commands as above. BBTalk was also later used several times for downloading the data off the instrument’s recorder, when difficulties occurred in using the Linux software for that purpose.

(4) Data processing

An initial sampling of the data was made using the following scripts to check that the instrument was performing correctly

scanbb	integrity check
plot_PTCV.py	plot pressure, temperature, voltage and current counts
plot_vel.py	plot velocity from all 4 beams

The principal onboard data processing was performed using the Lamont Doherty Earth Observatory (LDEO, Columbia University) LADCP software package version IX_6beta (available at ftp://ftp/ldeo.columbia.edu/pub/ant/LADCP). The package is based on a number of matlab scripts. The package performs an inverse of the LADCP data, incorporating 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 package also calculates U and V from the vertical shear of velocity.

The software is run using the matlab script **process_cast.m** with the configuration file **set_cast_params.m.** Frequent CTD data are required. Files of 1 second averaged CTD data were prepared for each station. Accurate time keeping is also required, particularly between the CTD and GPS data. To ensure this the CTD data records also included the GPS position. The LDEO software allows the ship's ADCP data (SADCP) to be included in the inverse calculation. The SADCP data were not included in this case so as to provide an independent check on the functioning of the LADCP.

On-station SADCP velocity profiles were produced by averaging the five minute averaged profiles (mr1007004_000000.LTA and mr1007006_000000.LTA produced using VmDAS) over the period of the CTD/LADCP cast. Care was taken to ensure the average did not contain any spurious data from periods when the ship was maneuvering.

(5) Preliminary results

An example of the on-board processed data is presented in Figure 7.5-2 and 7.5-3. Figure 7.5-2 compares the full cast inverse, up- and down-cast inverse, and the shear solutions for the zonal (U) and meridional (V) components of the velocity vector with the corresponding SADCP profile for Station C14_04. There is a very good correspondence between the general structure of all velocity profiles. While the large vertical scale flow is in a good agreement with the SADCP data (gray line), the LADCP solutions show a lot of smaller scale structure, not resolved by the SADCP. Especially noticeable are the features in the core of the EUC between the depths of 150 and 250 m visible in both U and V.

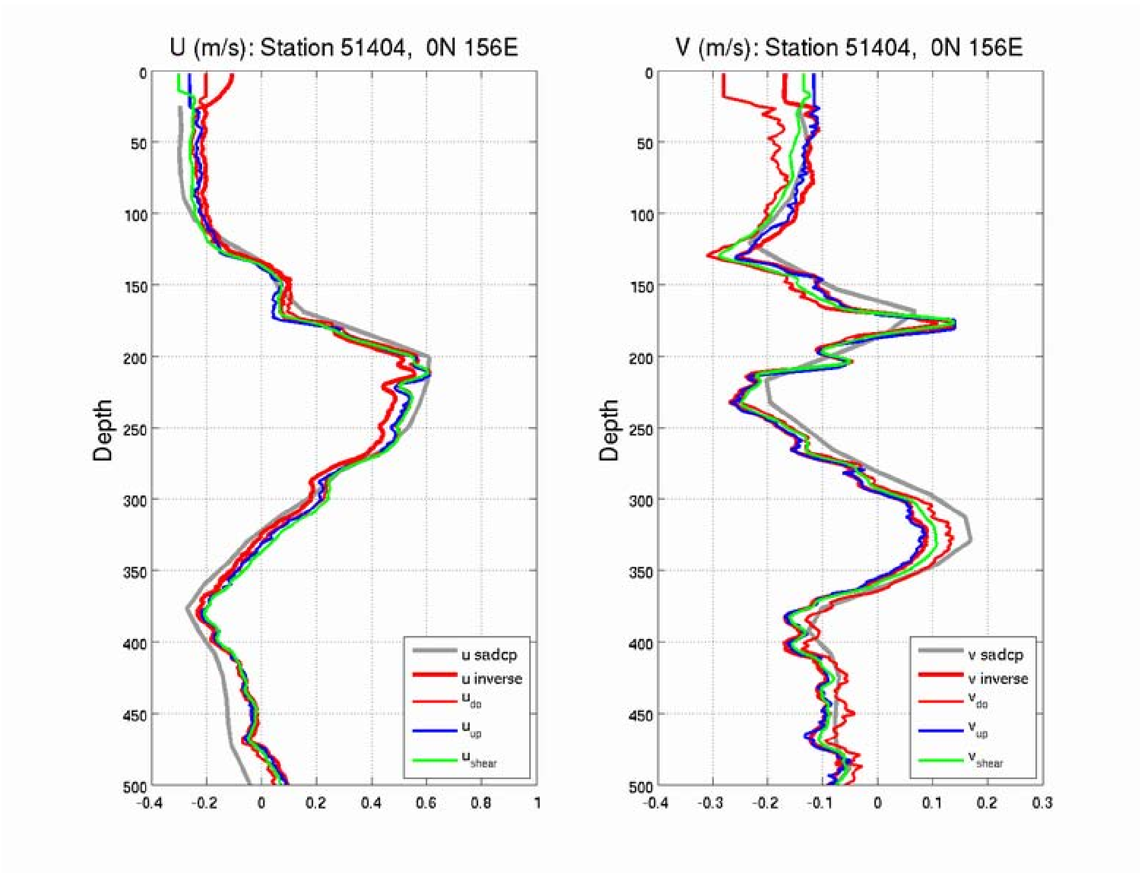


Figure 7.5-2 CTD Station C14M04: Vertical profiles of U and V calculated by a number of methods using LADCP data. Full cast inverse (u inverse), down-cast only inverse (u_do), up-cast only inverse (u_up) and shear solution (u_shear). Also shown are the profiles using SADCP data (u sadcp).

The down- and up-cast inverse solutions for U and V are compared with salinity and temperature over a portion of the same CTD Station (C14_04) profile in Figure 7.5-3. The fact that a number of the same small scale features are evident in both the down- and up- cast profiles of both U and V, confirms the ability of the instrument to measure small vertical scale features in velocity. There is a strong correspondence between the small scale features in V and salinity (e.g., slightly above and below the 200 m depth), although the exact relationship will depend on the time evolution of the fields.

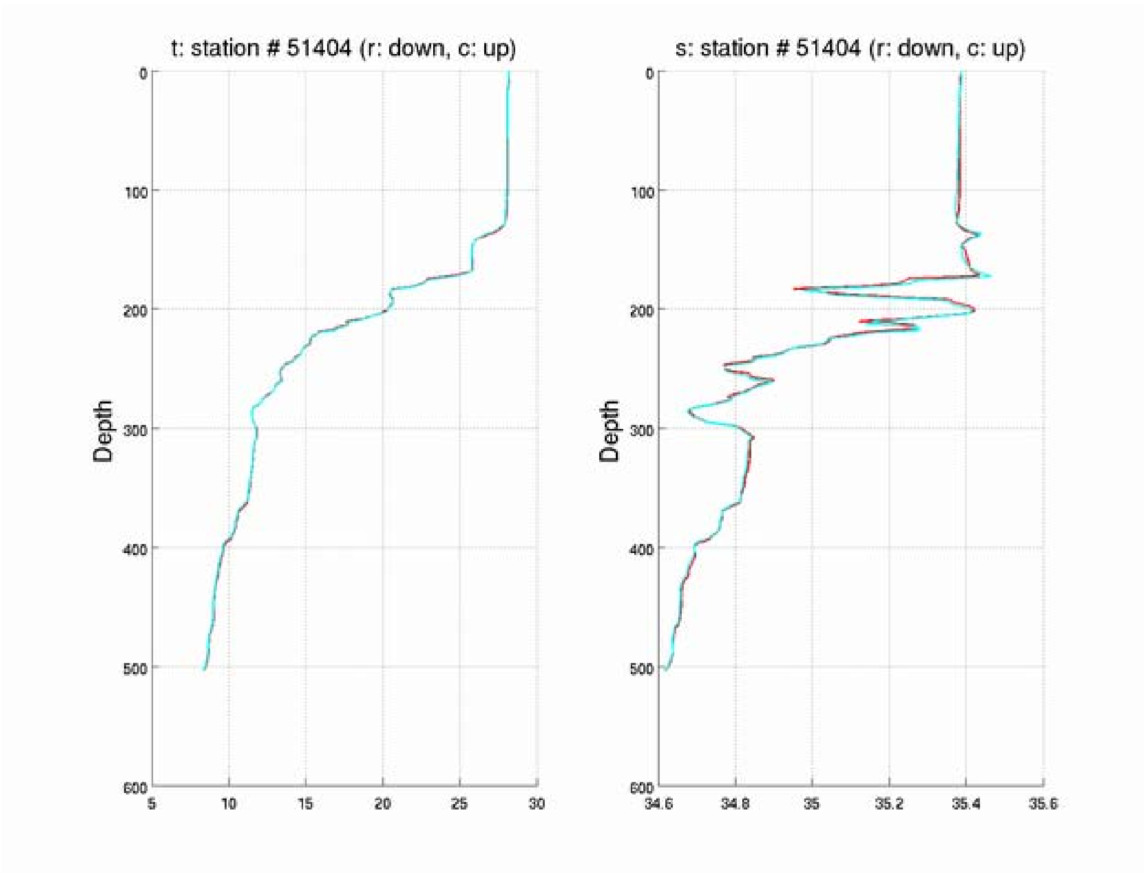


Figure 7.5-3 CTD Station C14M04: Vertical profile of the down-cast (magenta) and up-cast (red) temperature (left panel) and salinity (right panel). Note the correspondence with the small vertical scale meridional velocity features in Figure X.2.

The measurements at individual stations are combined to produce latitudinal sections of the velocity fields. Figures 7.5-4, 7.5-5, 7.5-6 and 7.5-7 show the zonal and meridional components of the velocity vector as a function of latitude and depth at 156E and 147E correspondingly. All plots show the abundance of features with vertical scales 30 – 60 m. The intensity of such features seems to be independent of latitude. Many SVS features clearly extend over several stations. This is particularly evident in the contour plots of the meridional velocity. The origin of these features is the subject of an ongoing observational and theoretical investigation. A comparison with the turbulence energy dissipation rate profiles obtained on this cruise using a microstructure profiles (MSP) suggests that these features may account for a significant fraction of the overall dissipation in the thermocline, but further analysis is necessary to quantify their role.

Finally, the LADCP has been deployed during a 24-hour time series experiment (CTD stations C14M02 through C14M10). The results clearly show a signal with a small vertical scale. The dynamic origin of the signal will be investigated during the post-processing.

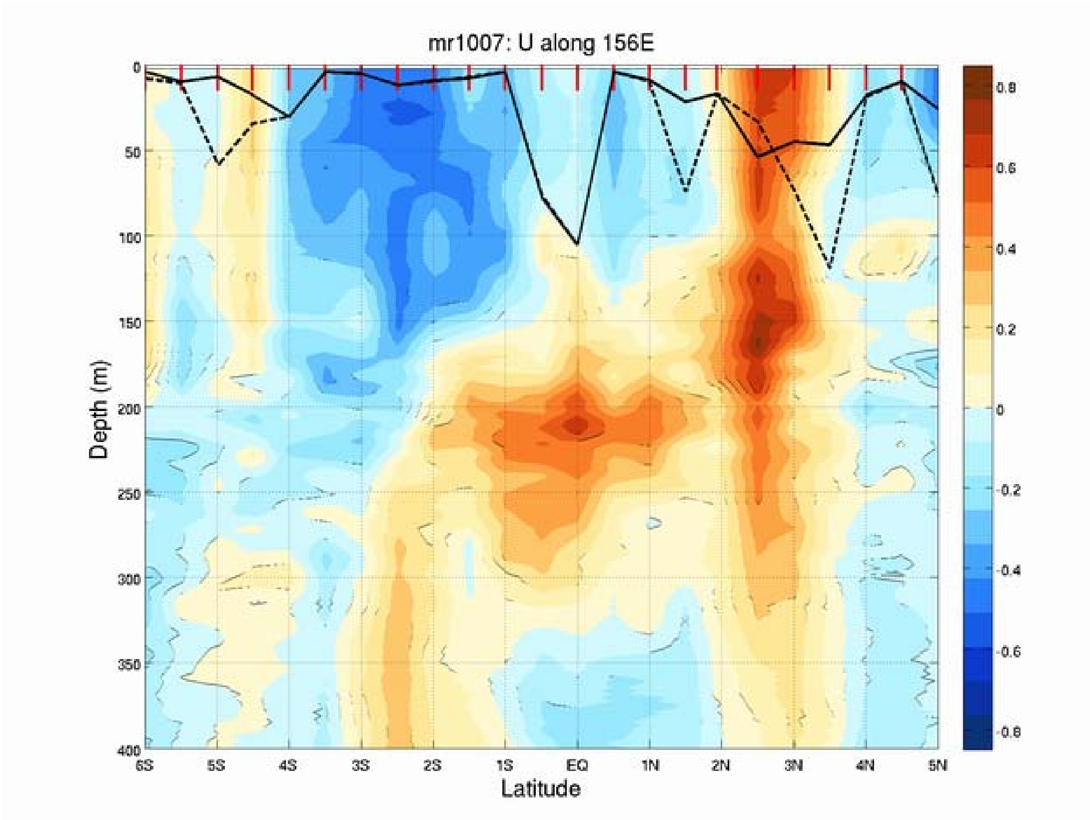


Figure 7.5-4. Latitudinal section of the zonal component of the velocity vector at 156E.

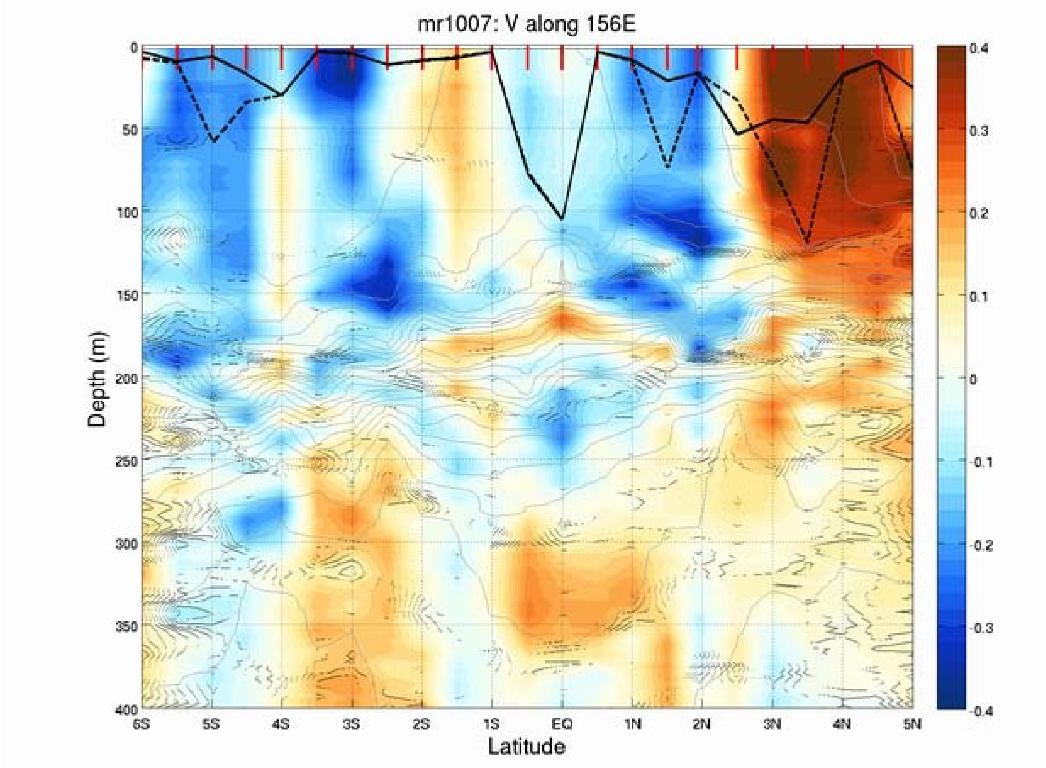


Figure 7.5-5. Latitudinal section of the meridional component of the velocity vector at 156E.

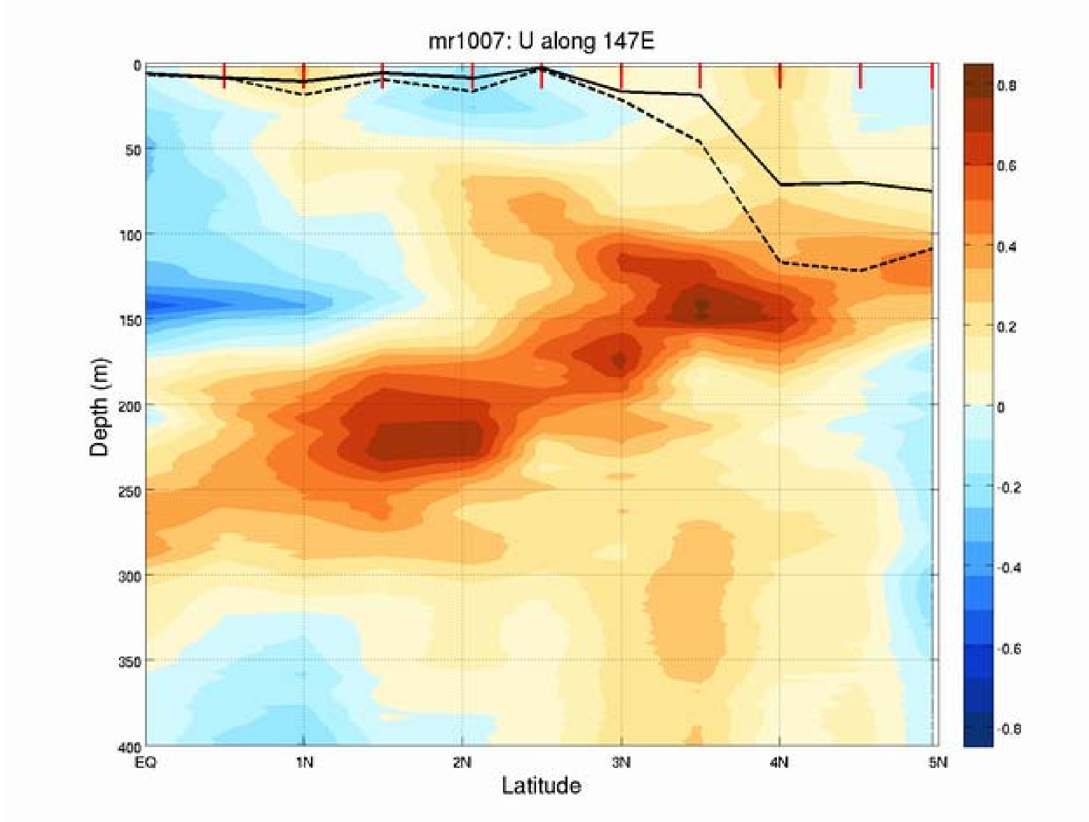


Figure 7.5-6. Latitudinal section of the zonal component of the velocity vector at 147E.

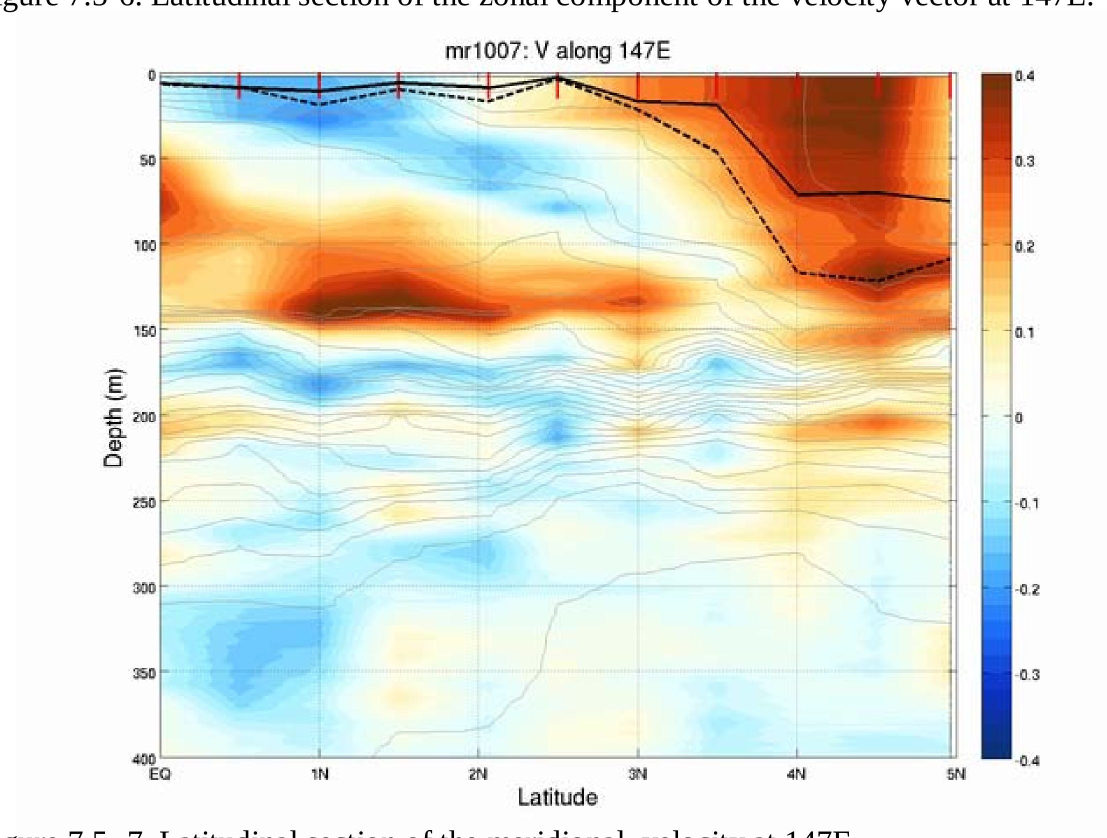


Figure 7.5-.7. Latitudinal section of the meridional velocity at 147E.

7.6 Observation of ocean turbulence

Personnel Yuji Kashino (RIGC, JAMSTEC)
Andrei Natarov (International Pacific Research Center)
Norio Nagahama (Global Ocean Development Inc.)
Ryo Kimura (Global Ocean Development Inc.)
Ryo Ohyama (Crew of R/V Mirai)
Kelvin Richards (International Pacific Research Center, not on board)

(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 IPRC of Univ. of Hawaii since 2007, and observations using lowered acoustic Doppler current profiler (LADCP) with high frequency were carried out during MR07-07 Leg 1, MR08-03 and MR09-04. 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 ocean turbulence observation using Turbo-Map every 30nm along 156E and 147E lines. Additionally, we conducted twice cast of Turbo-Map observations together with a CTD/LADCP cast (500m depth) every 3 hours at the equator, 156E on 13-14 December 2010.

(2) Measurement parameters

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

Parameter	Type	Range	Accuracy	Sample Rate
$\partial u/\partial z$	Shear probe	0～10 /s	5%	512Hz
T+$\partial T/\partial z$	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
$\partial u/\partial z$	Shear probe	0～10 /s	5%	512Hz

We use following sensor and twin shear probes:

FP07 sensor

Cast No. 1- 5 SN:180

Cast No. 6-53 SN:181

Shear Ch1 sensor

Cast No. 1-22 SN:685

Cast No. 23-53 SN:718

Shear Ch2 sensor

All casts: SN:686

Temperature data from FP07 sensor at casts #2, #3, #4 and #5 were not good and we exchanged it at cast #6. We also exchanged shear probe (Ch1) at cast #23 because observed mean shear at cast #21 was almost twice as that from Ch13 (secondary probe).

(3) Observation stations.

Cast No.	Station ID	Date	Observation Start			Max Depth	
			Time	Latitude	Longitude	Time	Depth(m)
1	TR02	2010/12/06	02:42	155-55.99E	05-01.61N	03:03	713
2	TR02	2010/12/06	03:22	155-55.61E	05-02.03N	03:45	753
3	4.5N156E	2010/12/07	03:32	155-59.91E	04-30.23N	03:50	624
4	4.0N156E	2010/12/07	07:09	155-59.73E	04-00.38N	07:28	669
5	3.5N156E	2010/12/07	19:38	156-00.18E	03-30.40N	-	-
6	3.5N156E	2010/12/07	20:35	155-59.91E	03-30.90N	20:49	538
7	3.0N156E	2010/12/08	00:22	156-00.52E	03-00.51N	00:36	520
8	2.5N156E	2010/12/08	03:51	156-00.46E	02-30.13N	04:05	474
9	1.5N156E	2010/12/09	02:09	155-59.81E	01-29.95N	02:23	502
10	2.0N156E	2010/12/09	05:21	155-58.87E	01-56.79N	05:36	543
11	1.0N156E	2010/12/10	04:50	155-59.78E	00-59.96N	05:40	521
12	0.5N156E	2010/12/10	08:03	155-59.73E	00-30.02N	08:18	470
13	EQ156E	2010/12/12	19:35	156-02.46E	00-00.02N	19:50	509
14	EQ156E	2010/12/12	20:05	156-02.39E	00-00.08N	20:20	512
15	EQ156E	2010/12/12	22:32	156-02.39E	00-00.02N	22:46	471
16	EQ156E	2010/12/12	23:00	156-02.18E	00-00.10N	23:14	476
17	EQ156E	2010/12/13	01:28	156-02.38E	00-00.01N	01:43	465
18	EQ156E	2010/12/13	01:58	156-02.15E	00-00.10N	02:13	510
19	EQ156E	2010/12/13	04:30	156-02.44E	00-00.03N	04:46	525
20	EQ156E	2010/12/13	05:05	156-02.27E	00-00.15N	05:21	534
21	EQ156E	2010/12/13	07:29	156-02.52E	00-00.19N	07:44	522
22	EQ156E	2010/12/13	08:02	156-02.42E	00-00.41N	08:16	526

23	EQ156E	2010/12/13	10:30	156-02.37E	00-00.05N	10:45	514
24	EQ156E	2010/12/13	11:18	156-02.12E	00-00.20N	11:18	527
25	EQ156E	2010/12/13	13:33	156-02.35E	00-00.01S	13:48	518
26	EQ156E	2010/12/13	14:09	156-02.17E	00-00.06N	14:22	508
27	EQ156E	2010/12/13	16:31	156-02.44E	00-00.02S	16:46	478
28	EQ156E	2010/12/13	17:02	156-02.23E	00-00.05N	17:17	489
29	EQ156E	2010/12/13	19:32	156-02.48E	00-00.05N	19:47	511
30	EQ156E	2010/12/13	20:06	156-02.36E	00-00.17N	20:21	518
31	0.5S156E	2010/12/13	23:23	155-59.90E	00-30.00S	23:38	530
32	1.0S156E	2010/12/14	02:42	155-59.81E	00-59.91S	02:56	497
33	1.5S156E	2010/12/14	06:22	155-59.37E	01-30.15S	06:37	502
34	2.0S156E	2010/12/15	00:24	156-00.57E	01-59.29S	00:39	514
35	2.5S156E	2010/12/15	05:13	155-59.78E	02-30.04S	05:28	504
36	3.0S156E	2010/12/16	03:50	155-59.71E	03-00.15S	04:06	606
37	3.5S156E	2010/12/16	06:58	155-59.70E	03-30.11S	07:17	699
38	5.0S156E	2010/12/17	00:10	156-00.33E	04-59.35S	00:30	729
39	5.5S156E	2010/12/17	04:12	155-59.76E	05-30.25S	04:28	621
40	6.0S156E	2010/12/17	07:25	155-59.93E	06-00.06S	07:39	541
41	4.5S156E	2010/12/18	02:19	156-00.23E	04-30.21S	02:35	591
42	4.0S156E	2010/12/18	05:41	155-59.71E	03-59.96S	05:56	589
43	EQ147E	2010/12/21	03:38	146-58.44E	00-02.53S	03:53	495
44	0.5N147E	2010/12/22	07:59	146-59.78E	00-29.90N	08:15	498
45	1.0N147E	2010/12/23	05:08	146-59.79E	00-59.92N	05:08	433
46	1.5N147E	2010/12/23	08:35	146-59.84E	01-30.12N	08:49	380
47	2.0N147E	2010/12/24	03:36	146-55.31E	02-04.01N	03:50	401
48	2.5N147E	2010/12/24	08:15	146-59.87E	02-30.14N	08:29	500
49	3.0N147E	2010/12/25	06:14	146-59.91E	03-00.21N	06:27	378
50	3.5N147E	2010/12/25	09:29	147-00.15E	03-30.22N	09:45	556
51	4.5N147E	2010/12/26	04:47	147-00.01E	04-30.37N	05:05	628
52	4.0N147E	2010/12/26	08:22	147-00.11E	04-00.26N	08:36	512
53	5.0N147E	2010/12/27	03:41	146-57.03E	04-04.04N	03:59	670

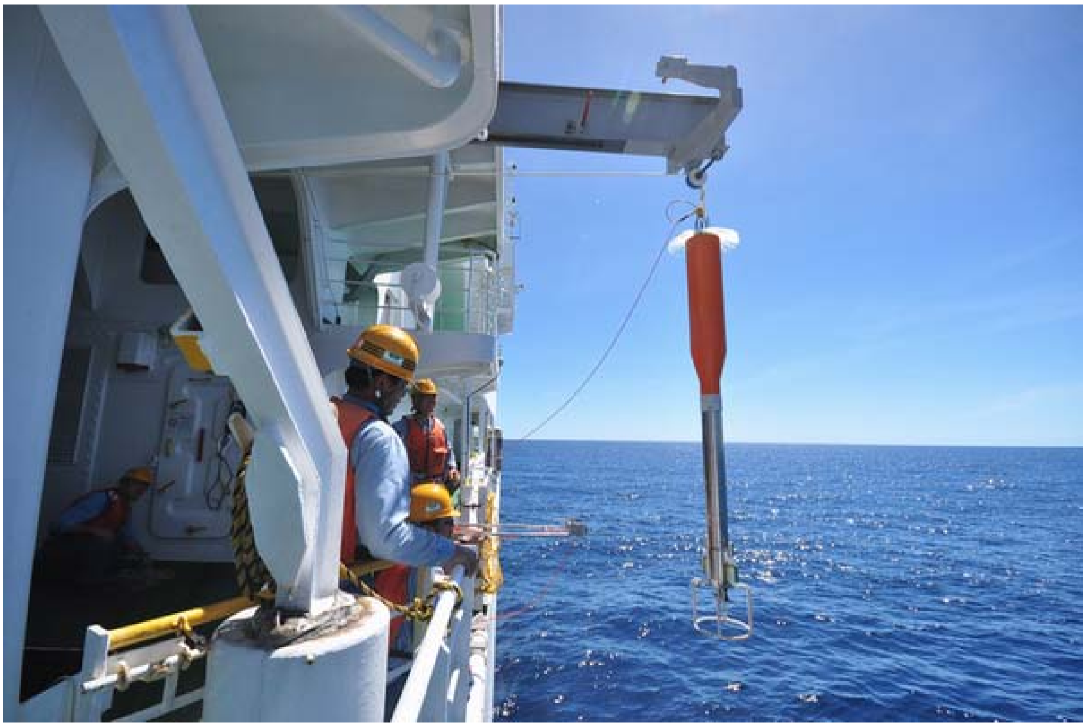
Cast # (nn) coincides with number in file names of mr10-07-nn.bin and others.

Cast #2 observation was carried out because large spike noise which cannot be removed by data processing was observed at cast #1. We do not open data at Casts #1 and #5.

Note that time in the data files from Cast #8 to Cast #53 is Japan Standard Time (not UTC).

(3) 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 (see below).



Measurement depth was 500m because our interest is ocean turbulence around thermocline. However, we could not measure until 500m depth at many casts because Turbo-Map was drifted by strong undercurrents.

Decent rate of the Turbo Map-L was 0.6 – 0.8 m s^{-1}.

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

4) Results

Time-depth plot of logarithm of epsilon during 24 hour observation at the equator, 156E is shown in Figure 7.6-1. It is interesting that strong turbulence was observed not only around the depth of the Equatorial Undercurrent but also around 300-350m depth, which seems to ascend/descend associated with internal tide.

Mean vertical profiles of square of velocity share and logarithm of epsilon at the same observation is shown in Figure 7.6-2. Both profiles are very similar and this result suggests that strong vertical velocity share induces large ocean mixing.

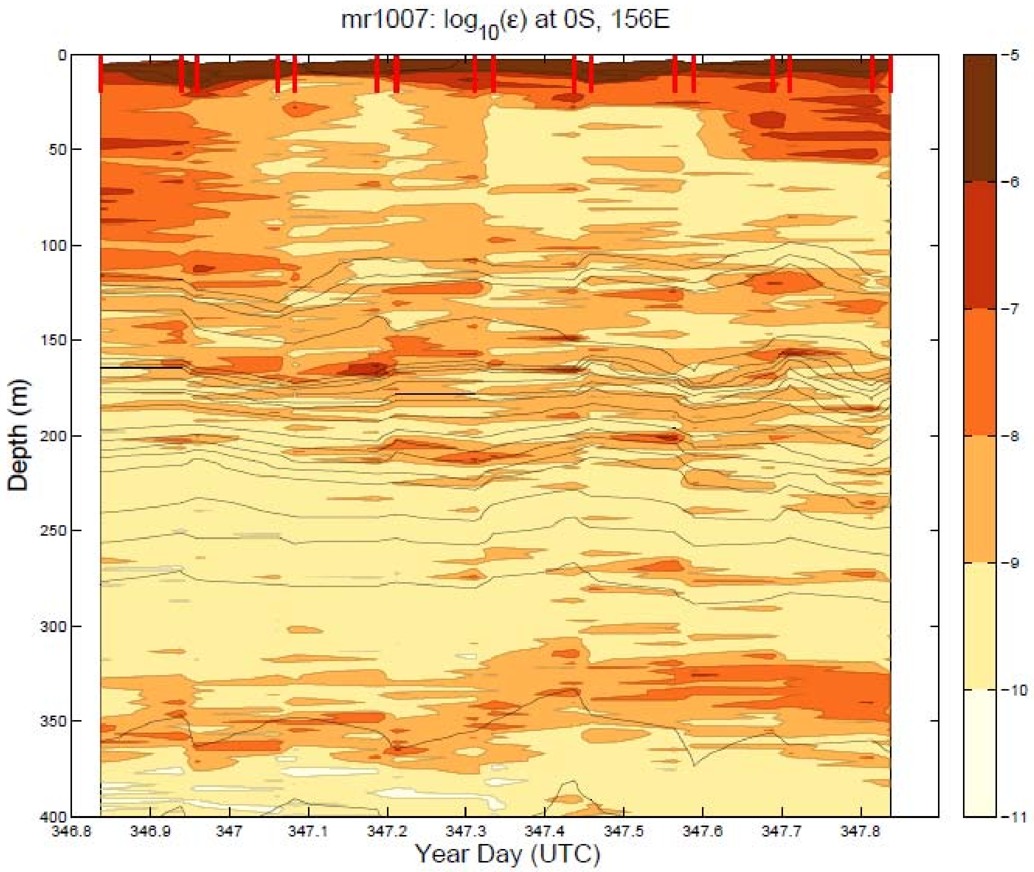


Fig.7.6-1. Time-depth plot of logarithm of epsilon at the equator, 156E on 13-14 December 2010.

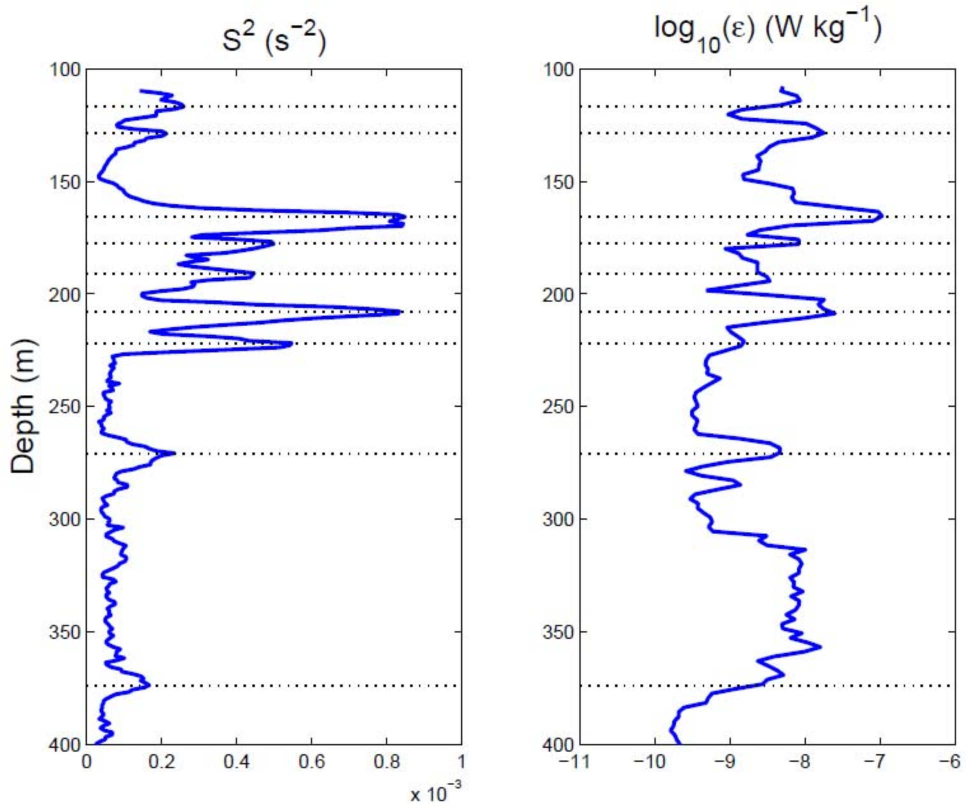


Figure 7.6-2. Mean vertical profiles of square of velocity share and logarithm of epsilon at the same observation as Figure 7.6-1.

7.7 Performance test of pCO_2 sensor

Shuichi Watanabe, Yoshiyuki Nakano and Tetsuichi Fujiki (JAMSTEC)

(1) Objective

A lot of observations to obtain the fate of CO_2 in the atmosphere which is related with long term climate change have been carried in the world. However, the sea surface pCO_2 observations on ships of opportunity and research vessels concentrated in the North Atlantic and North Pacific. To obtain the spatial and temporal variation of surface pCO_2 in the whole ocean, new simplified automated pCO_2 measurement system is needed.

We have been developing newly small and simple *in situ* system for pCO_2 measurement using spectrophotometric technique. In this cruise, we aim at testing the new pCO_2 sensor and recovering prototype pCO_2 sensor deployed by MR09-04 cruise in the open sea. The new pCO_2 sensor is attached with TRITON buoy and start mooring (2°N, 156°E) for about one year.

(2) Method

The pCO_2 sensor for the measurement of pCO_2 is based on the optical absorbance of the pH indicator solution. The CO_2 in the surrounding seawater equilibrates with the pH indicator solution across gas permeable membranes, and the resulting change in optical absorbance, representing the change of pH, is detected by the photo multiplier detector. We calculated the pH in the pH indicator solution from the absorbance ratios. In this cruise I decided to use AF Teflon tube (amorphous fluoropolymer, AF Teflon, AF-2400) as an equilibrium membrane because this material is well suited to pCO_2 measurements due to its high gas permeability. This measuring system was constructed from LED light source, optical fiber, CCD detector, micro pump, and downsized PC. The new simple system is attached in aluminum drifting buoy with satellite communication system, which size is about 300 mm diameter and 500 mm length and weight is about 15 kg (Fig. 7.7-1). A Li-ion battery is occupied about one third of the drifting buoy. This system also has a lead-acid battery with two 5W solar panels. The solar panel unit is attached with the middle of TRITON buoy tower and connected with pCO_2 sensor by cable. In the laboratory experiment, we obtained high response time (less than 10 minutes) and precision within 3 µatm.

(3) Preliminary results

We succeeded in deploying the new pCO_2 sensor with TRITON buoy and recovering the prototype pCO_2 sensor at 2°N, 156°E. We obtained long term (about one year) pCO_2 data from the prototype pCO_2 sensor every three days via satellite system (Fig. 7.7-2).

(4) Data Archive

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

Reference

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

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

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

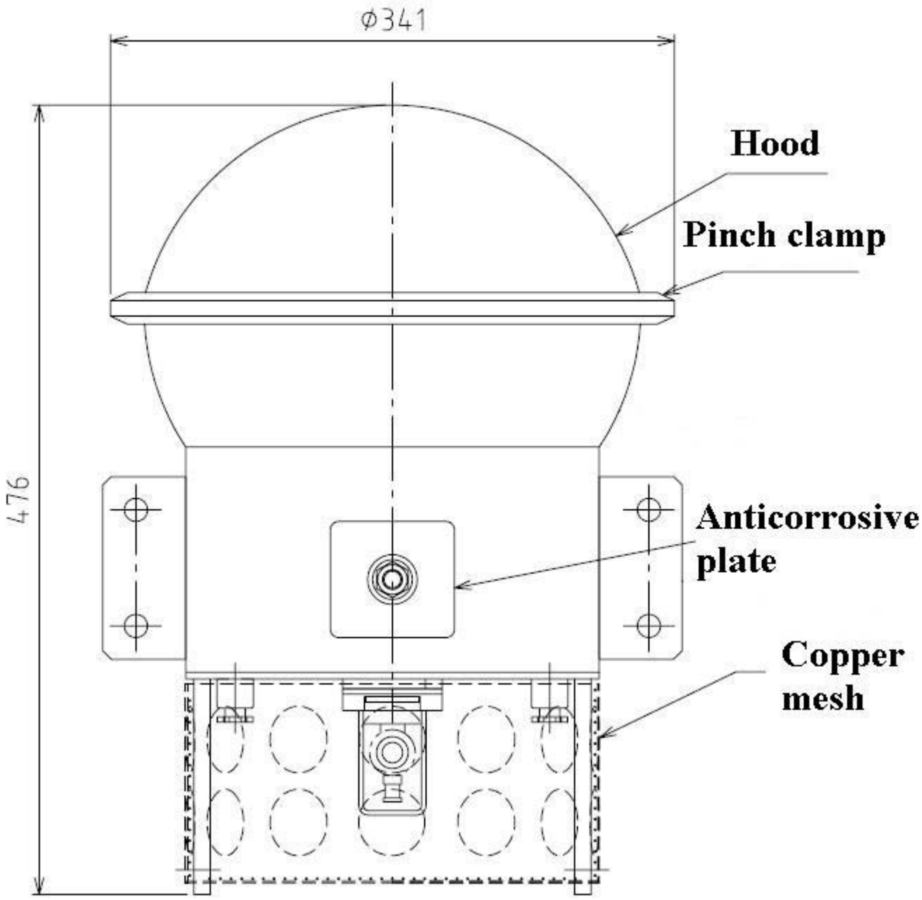


Fig. 7.7-1 Side view of pCO_2 sensor.

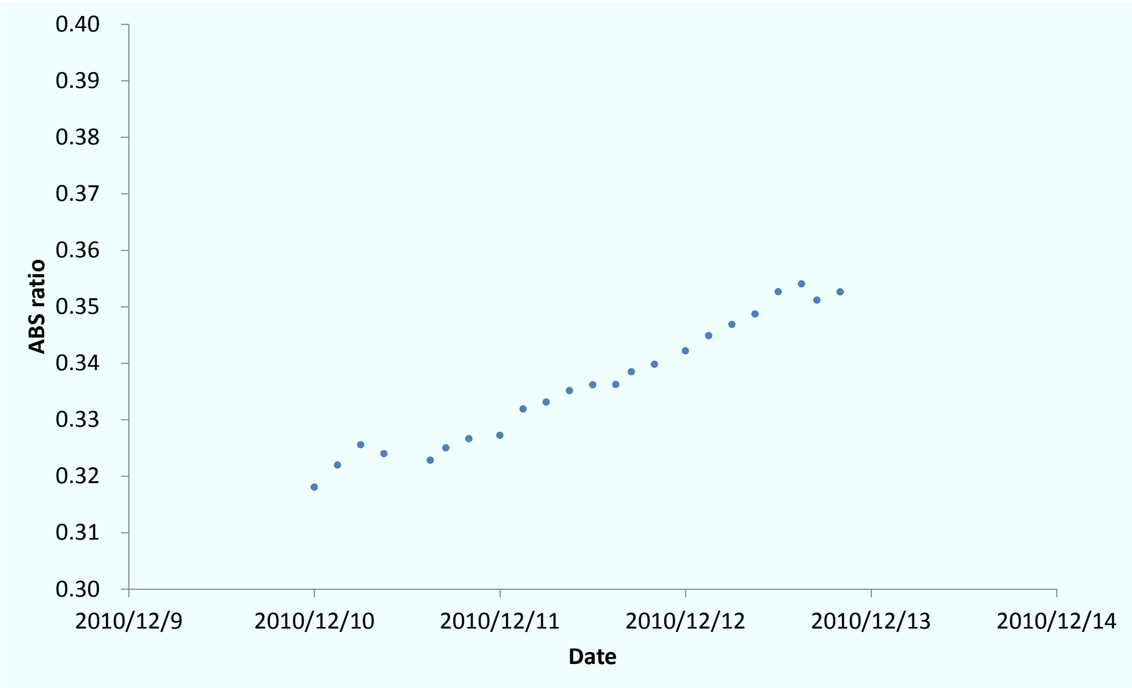


Fig. 7.7-2 Variations of absorbance ratio (ABS, ●: left axis) in the western equatorial Pacific. We calculate pCO_2 from ABS ratio by using on board calibration data after cruise.

7.8Argo floats

(1) Personnel

Toshio Suga	*(JAMSTEC/RIGC): Principal Investigator (not on board)*
Shigeki Hosoda	*(JAMSTEC/RIGC): not on board*
Kanako Sato	*(JAMSTEC/RIGC): not on board*
Mizue Hirano	*(JAMSTEC/RIGC): not on board*
Hiroki Ushiromura	*(MWJ): Technical Staff (Operation Leader)*
Yasushi Hashimoto	*(MWJ): Technical Staff*
Yuki Miyajima	*(MWJ): Technical Staff*

(2) Objectives

The objective of deployment is to clarify the structure and temporal/spatial variability of water masses in the North Pacific such as North Pacific Tropical Water. To achieve the objective, profiling floats are launched in the region with less number of active floats to measure vertical profiles of temperature and salinity automatically every 10 days. The data from the floats as well as other active floats in this area will enable us to understand the variability of water masses.

(3) Parameters

・water temperature, salinity, and pressure

(4) Methods

i. Profiling float deployment

We launched an APEX float manufactured by Webb Research Ltd. These floats equip an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc to measure temperature, salinity and pressure from surface to 1500 dbar. The floats usually drift at a depth of 1000 dbar (called the parking depth), diving to a depth of 1525 dbar. During the ascent to the surface by increasing the volume of the float in order to increase its buoyancy, the float measures sea water temperature, salinity, and pressure. To send the measured data to the Argo data center via the ARGOS transmitting system in real time, the float stays at the sea surface for enough time, approximately 10 hours. Finally, the float returns to the parking depth by decreasing its volume. This cycle of the float moving repeats every 10 days for 3 or 4 years. The status of floats and their launches are shown in Table 7.8-1.

Table 7.8-1 Status of floats and their launches
Float(1525dbar)

Float Type	**APEX floats manufactured by Webb Research Ltd.**
CTD sensor	**SBE41 manufactured by Sea-Bird Electronics Inc.**
Cycle	**10 days (approximately 9 hours at the sea surface)**
ARGOS transmit interval	**30 sec**
Target Parking Pressure	**1000 dbar**
Sampling layers	**105 (1500, 1450, 1400, 1350, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 980, 960, 940, 920, 900, 880, 860, 840, 820, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 490, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220,210, 200, 195, 190, 185, 180, 175, 170, 165, 160, 155, 150, 145, 140, 135, 130,**

	125, 120, 115, 110, 105, 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10, 4 or surface dbar)

Launches

Float S/N	ARGOS ID	Date and Time of Reset (UTC)	Date and Time of Launch(UTC)	Location of Launch	CTD St. No.
5210	70354	2010/12/01 23:51	2010/12/02 01:31	15-00.17N 151-59.95E	C01
5211	70355	2010/12/05 04:54	2010/12/05 05:53	6-59.92 N 156 -00.09E	C03

(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.

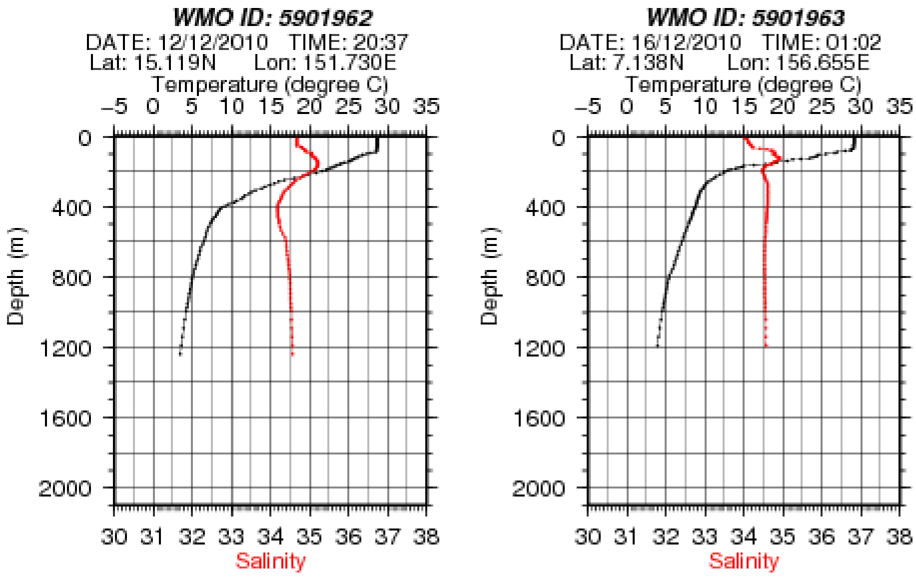


Fig. 7.8-1 The first profile of each float launched during MR10-07.

7.9 Radiosonde observation

(1) Personnel

Norio Nagahama	(GODI)	
Ryo Kimura	(GODI)	
Not on board:		
Yoshimi Kawai	(JAMSTEC)	Principal Investigator
Hiroyuki Tomita	(JAMSTEC)	

(2) Objective

Investigation of atmospheric vertical structure of pressure, temperature, relative humidity, wind direction, and wind speed responding to the ocean temperature front of the Kuroshio Extension.

(3) Parameters

According to the manufacturer, the range and accuracy of parameters measured by the radiosonde sensor (RS92-SGPD) are as follows;

Parameter	Range	Accuracy
Pressure	3~1080 hPa	+/- 1 hPa (1080-100 hPa), +/- 0.6 hPa (100-3 hPa)
Temperature	-90~60 °C	+/- 0.5 °C
Humidity	0~100 %	5 %

(4) Method

Atmospheric sounding by radiosonde was carried out between the JKEO and KEO sites in the northwestern Pacific Ocean. In total, 23 soundings were carried out (Table 7.9-1). The main system consists of processor (Vaisala, DigiCORA III), GPS antenna (GA20), UHF antenna (RB21), ground check kit (GC25), balloon launcher (ASAP), and GPS radiosonde sensor (RS92-SGPD).

(5) Preliminary results

Latitude-height cross sections of air temperature, specific humidity, zonal and meridional wind speeds along the ship track are shown in Figure.7.9-1.

(6) Data archive

Raw data are recorded in ASCII format every 2 seconds during ascent. These raw data will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC just after the cruise.

Table 7.9-1 Radiosonde launch log between the JKEO and KEO sites.

Sounding No.	Station No.	Launching				Maximum	
		Date (UTC)	Time	Lon	Lat	Altitude	hPa
RS001	J-KEO	2010.11.26	2:56:57	146.4720	38.0577	11834	202.0
RS002	E01	2010.11.26	5:10:31	146.3630	37.7960	12893	171.6
RS003	E02	2010.11.26	6:31:57	146.2450	37.5019	15582	112.5
RS004	E03	2010.11.26	8:09:01	146.1890	37.2996	13787	150.3
RS005	E04	2010.11.26	9:39:59	146.0920	37.0356	13756	151.3
RS006	E05	2010.11.26	11:05:41	146.0100	36.7799	15122	122.0
RS007	E06	2010.11.26	12:35:28	145.9380	36.5535	15643	112.3
RS008	E07	2010.11.26	14:06:54	145.8560	36.3034	16622	96.1
RS009	E08	2010.11.26	15:36:37	145.7610	36.0473	15922	107.8
RS010	E09	2010.11.26	17:15:00	145.6710	35.7946	15658	112.5
RS011	E10	2010.11.26	18:43:14	145.5960	35.5511	15989	106.5
RS012	E11	2010.11.26	20:15:26	145.5170	35.3100	13966	147.7
RS013	E12	2010.11.26	21:54:03	145.4280	35.0367	13947	148.4
RS014	E13	2010.11.26	23:27:05	145.3420	34.7835	15191	121.6
RS015	E14	2010.11.27	1:01:33	145.2330	34.5367	14277	140.9
RS016	E15	2010.11.27	2:29:45	145.1770	34.2949	14826	129.0
RS017	E16	2010.11.27	4:05:10	145.0930	34.0455	14717	131.1
RS018	E17	2010.11.27	5:45:42	145.0130	33.8119	14914	126.9
RS019	E18	2010.11.27	7:28:30	144.9290	33.5291	15607	112.9
RS020	E19	2010.11.27	9:16:34	144.8560	33.3090	13665	154.4
RS021	E20	2010.11.27	11:15:16	144.7710	33.0596	13705	153.7
RS022	E21	2010.11.27	12:47:27	144.6860	32.8047	14990	125.2
RS023	KEO	2010.11.27	15:06:53	144.5630	32.4688	19418	60.3

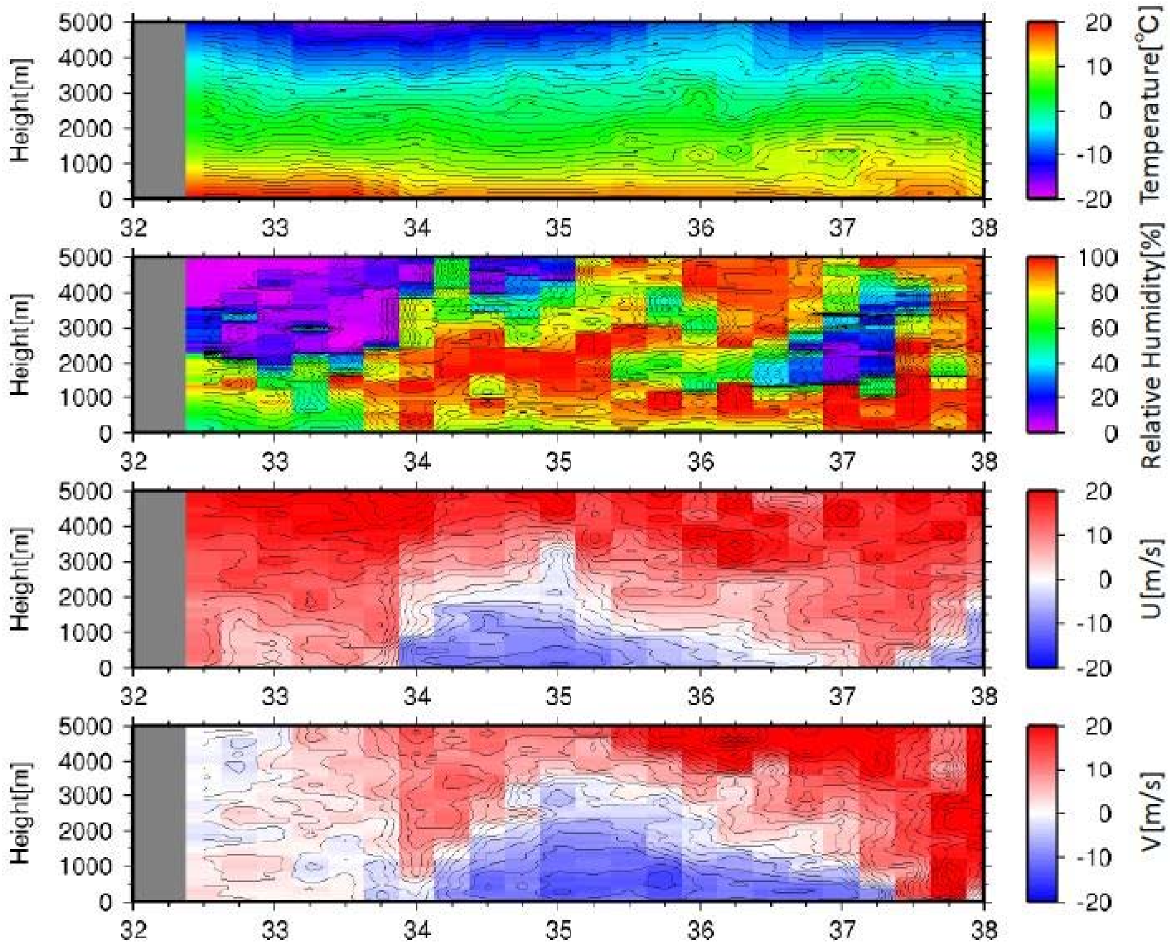


Figure 7.9-1. Latitude-height cross sections of air temperature, specific humidity, zonal and meridional wind speeds along the ship track.

7.10 Surface atmospheric turbulent flux measurement

(1) Personnel

Osamu Tsukamoto	(Okayama University)	Principal Investigator	* not on board
Fumiyoshi Kondo	(University of Tokyo)		* not on board
Hiroshi Ishida	(Kobe University)		* not on board

(2) Objective

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

(3) Instruments and Methods

The surface turbulent flux measurement system (Fig. 7.10-1) consists of turbulence instruments (Kaijo Co., Ltd.) and ship motion sensors (Kanto Aircraft Instrument Co., Ltd.). The turbulence sensors include a three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (LICOR, LI-7500). The sonic anemometer measures three-dimensional wind components relative to the ship. The ship motion sensors include a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI7500 is a CO_2/H_2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously. These signals are sampled at 10 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.). By obtaining the ship speed and heading information through the Mirai network system it yields the absolute wind components relative to the ground. Combining wind data with the turbulence data, turbulent fluxes and statistics are calculated in a real-time basis. These data are also saved in digital files every 0.1 second for raw data and every 1 minute for statistic data.

(4) Observation log

The observation was carried out throughout this cruise.

(5) Data Policy and citation

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

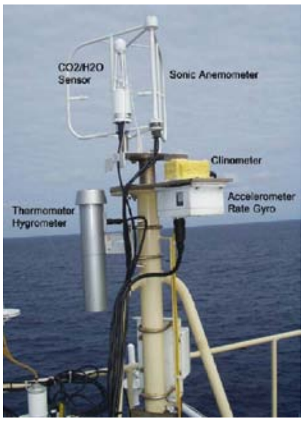


Fig. 7.10-1 Turbulent flux measurement system on the top deck of the foremast.

7.11 Aerosol optical characteristics measured by Shipborne Sky radiometer

Kazuma Aoki (University of Toyama) Principal Investigator / not onboard
Tadahiro Hayasaka (Tohoku University) Co-worker / not onboard

(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 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto, Ichiro Matsui, Atsushi Shimizu, Tomoaki Nishizawa (National Institute for Environmental Studies, not on board)

(2) Objectives

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

(3) Measured parameters

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

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 30 mJ per pulse at both of 1064 and 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a transient recorder and stored on a hard disk with a computer. The lidar system was installed in 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.

(5) Results

As lidar data has not been brought to NIES, a quick-look of lidar observation on December 8 is shown in Figure 7.12-1. Although data duration is one day, multi-layered structure of the atmosphere is clearly depicted. Typical cirrus clouds appeared between 9-12 km, and aerosol layer was apparent below 2 km. It is interesting that optically thin cloud layer is confirmed around 17 km, continuously. This cloud is considered to be sub-visible cirrus whose radiative characteristics is important for the climate in this region.

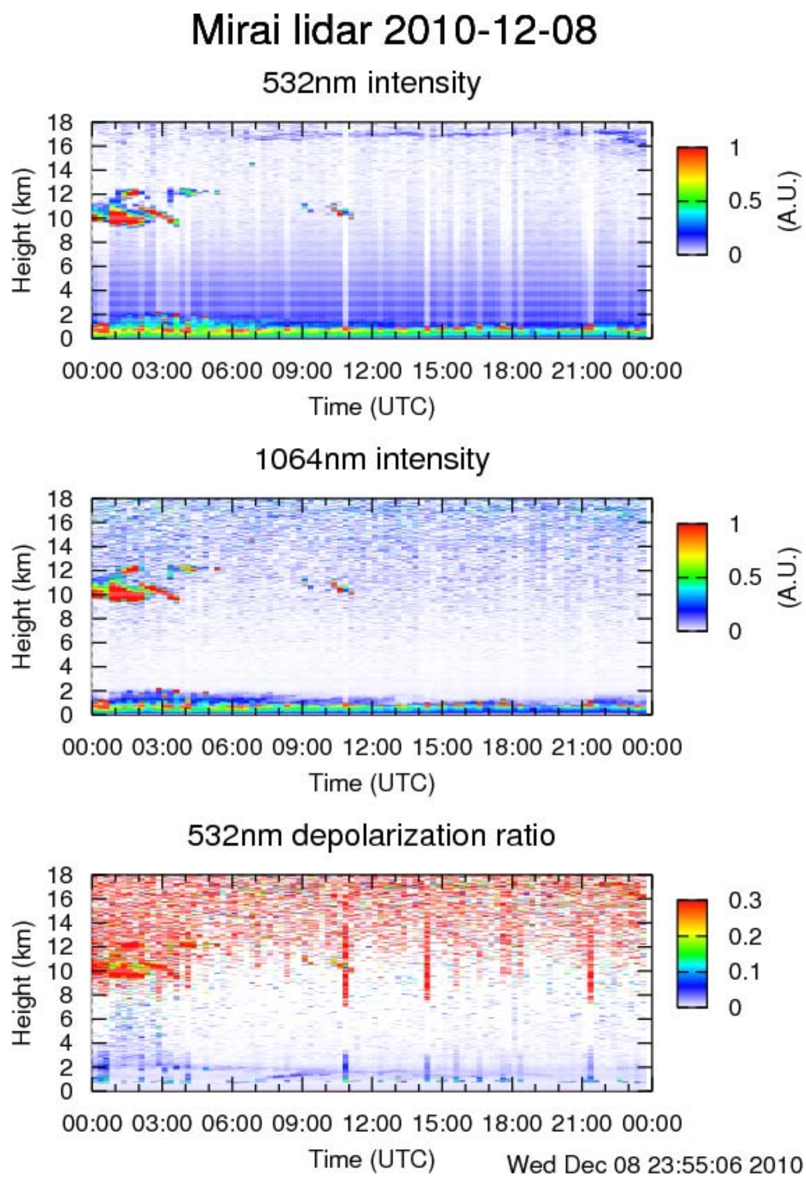


Figure 7.12-1: Time-height sections of (top) backscatter intensity at 532 nm,

(middle) backscatter intensity at 1064 nm, and (bottom) volume depolarization ratio at 532 nm on December 8, 2010.

(6) Data archive

- raw data
  - lidar signal at 532 nm
  - lidar signal at 1064 nm
  - depolarization ratio at 532 nm
  - temporal resolution 10min/ vertical resolution 6 m
  - data period (UTC): November 23 – December 28, 2010
- 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

(7) Data policy and Citation

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

7.13 Rain, water vapor and surface water sampling

(1) Personnel

Naoyuki Kurita (JAMSTEC) Principal Investigator (not on-board)

(2) Objective

It is well known that the variability of stable water isotopes (HDO and $H_2{}^{18}O$) is closely related with the moisture origin and hydrological processes during the transportation from the source region to deposition site. Thus, water isotope tracer is recognized as the powerful tool to study of the hydrological cycles in the 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 MR10-07.

(3) Method

Following observation was carried out throughout this cruise.

- Atmospheric moisture sampling:

  Water vapor was sampled from the height about 20m above the sea level. The air was drawn at rate of 1.2-4.5 L/min through a plastic tube attached to top of the compass deck. The flow rate is regulated according to the water vapor content to collect the sample amount 5-30ml. The water vapor was trapped in a glass trap submerged into an ethanol cooled to 100 degree C by radiator, and then they are collected every 12 hour during the cruise. After collection, water in the trap was subsequently thawed and poured into the 6ml glass bottle.

- 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 depth were collected in glass bottle (6ml) around the noon at the local time.

(4) Results

Sampling of water vapor for isotope analysis is summarized in Table 7.13-1 (70 samples). The detail of rainfall sampling (15 samples) is summarized in Table 7.13-2. 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 7.13-3 (33 samples).

(5) Data archive

Isotopes (HDO, $H_2{}^{18}O$) analysis will be done at RIGC/JAMSTEC, and then analyzed isotopes data will be submitted to JAMSTEC Data Management Group (DMG).

Table 7.13-1 Summary of water vapor sampling for isotope analysis

Sample	Start Date	Start Time (UT)	End Date	End Time (UT)	Lon	Lat	T.M. (m^3)	Sam. (ml)	H2O ppm
V-1	11.23	21:47	11.24	9:00	142-15E	41-34N	1.54	5.0	4040
V-2	11.24	9:04	11.24	21:00	141-35E	40-47N	2.81	12.0	5314
V-3	11.24	21:11	11.25	9:01	142-02E	40-25N	3.19	13.0	5071
V-4	11.25	9:04	11.25	21:00	145-08E	38-46N	3.20	21.3	8283
V-5	11.25	21:04	11.26	9:00	146-08E	37-06N	3.00	30.0	12444
V-6	11.26	9:04	11.26	21:00	145-28E	35-08N	2.56	25.8	12542
V-7	11.26	21:04	11.27	8:56	144-51E	33-17N	1.57	15.0	11890
V-8	11.27	9:00	11.27	20:00	144-29E	32-28N	1.45	11.9	10213
V-9	11.27	20:04	11.28	8:05	144-41E	30-36N	1.58	13.8	10869
V-10	11.28	8:09	11.28	20:00	144-53E	28-16N	1.55	12.0	9634
V-11	11.28	20:03	11.29	8:00	145-20E	25-46N	1.59	20.2	15810
V-12	11.29	8:02	11.29	19:50	146-44E	24-12N	1.55	27.8	22320
V-13	11.29	19:52	11.30	8:00	147-59E	22-09N	1.60	27.0	21000
V-14	11.30	8:04	11.30	20:00	149-12E	20-01N	0.84	14.0	20741
V-15	11.30	20:12	12.1	8:00	150-25E	17-52N	0.85	14.0	20497
V-16	12.1	8:03	12.1	20:00	151-35E	15-46N	0.86	14.0	20258
V-17	12.1	20:04	12.2	8:00	152-37E	13-55N	0.86	13.7	19824
V-18	12.2	8:03	12.2	19:00	153-41E	12-05N	0.79	12.0	18903
V-19	12.2	19:03	12.3	7:01	154-59E	09-49N	0.86	14.0	20258
V-20	12.3	7:04	12.3	19:00	156-02E	07-58N	0.86	14.9	21561
V-21	12.3	19:04	12.4	7:00	155-58E	08-08N	0.86	13.0	18811
V-22	12.4	7:03	12.4	19:00	155-56E	08-00N	0.86	13.7	19824
V-23	12.4	19:04	12.5	7:00	156-00E	06-47N	0.85	14.1	20643
V-24	12.5	7:02	12.5	19:00	155-50E	05-03N	0.86	16.0	23152
V-25	12.5	19:04	12.6	7:00	155-59E	04-58N	0.86	14.4	20837
V-26	12.6	7:03	12.6	19:00	156-00E	04-59N	0.86	14.0	20258
V-27	12.6	19:03	12.7	6:32	156-00E	04-00N	0.87	16.2	23172
V-28	12.7	6:35	12.7	18:30	156-00E	03-31N	0.87	16.2	23172
V-29	12.7	18:33	12.8	7:00	156-03E	02-03N	0.90	14.0	19358
V-30	12.8	7:04	12.8	19:00	155-56E	01-58N	0.86	12.3	17798
V-31	12.8	19:03	12.9	7:00	155-57E	02-02N	0.86	12.8	18522
V-32	12.9	7:03	12.9	19:47	156-00E	02-02N	0.93	17.9	23952
V-33	12.9	19:50	12.10	7:00	156-00E	00-36N	0.81	13.0	19973
V-34	12.10	7:02	12.10	19:00	155-52E	00-00S	0.87	13.7	19596
V-35	12.10	19:03	12.11	7:00	155-58E	00-04N	0.86	14.2	20548
V-36	12.11	7:03	12.11	19:00	155-59E	00-01N	1.08	19.0	21893
V-37	12.12	19:03	12.12	7:02	156-03E	00-00S	1.08	14.0	16132

V-38	12.12	7:04	12.12	18:40	156-02E	00-00S	1.05	16.0	18963
V-39	12.12	18:42	12.13	6:49	156-02E	00-00N	1.09	18.0	20550
V-40	12.13	6:52	12.13	18:49	156-02E	00-00S	1.08	17.0	19588
V-41	12.13	18:52	12.14	7:00	155-59E	01-30S	1.09	18.0	20550
V-42	12.14	7:03	12.14	19:00	156-01E	02-02S	1.08	17.8	20510
V-43	12.14	19:03	12.15	7:00	156-01E	02-16S	1.07	18.0	20935
V-44	12.15	7:02	12.15	19:00	155-56E	02-02S	1.07	16.5	19190
V-45	12.15	19:05	12.16	7:00	156-00E	03-30S	1.07	17.8	20702
V-46	12.16	7:02	12.16	19:00	156-00E	05-02S	1.07	20.0	23261
V-47	12.16	19:03	12.17	7:00	156-00E	06-00S	1.08	16.0	18436
V-48	12.17	7:04	12.17	19:00	156-01E	05-04S	1.07	19.0	22098
V-49	12.17	19:03	12.18	7:00	155-54E	03-51S	1.07	16.0	18609
V-50	12.18	7:02	12.18	19:00	153-58E	02-49S	1.07	17.0	19772
V-51	12.18	19:03	12.18	7:03	153-05E	02-47S	1.08	18.0	20741
V-52	12.19	7:06	12.19	19:00	151-47E	01-36S	1.07	18.0	20935
V-53	12.19	19:05	12.20	7:00	149-20E	00-48S	1.07	19.0	22098
V-54	12.20	7:02	12.20	20:00	146-56E	00-01S	1.16	20.5	21992
V-55	12.20	20:02	12.21	8:00	146-57E	00-01N	1.07	19.0	22098
V-56	12.21	8:02	12.21	20:00	147-01E	00-04N	1.07	20.0	23261
V-57	12.21	20:03	12.22	8:40	147-00E	00-29N	1.13	22.0	24228
V-58	12.22	8:44	12.22	20:00	147-03E	00-02S	0.79	20.0	31505
V-59	12.22	20:03	12.23	8:00	147-00E	01-30N	1.07	22.0	25587
V-60	12.23	8:02	12.23	20:00	146-53E	02-05N	1.07	21.5	25005
V-61	12.23	20:03	12.24	8:00	147-00E	02-30N	1.07	20.0	23261
V-62	12.24	8:03	12.24	20:00	146-59E	01-59N	1.07	22.0	25587
V-63	12.24	20:05	12.25	8:00	147-00E	03-17N	1.07	22.0	25587
V-64	12.25	8:02	12.25	20:00	147-01E	04-58N	1.07	22.0	25587
V-65	12.25	20:02	12.26	7:56	147-00E	04-00N	1.07	22.0	25587
V-66	12.26	7:59	12.26	20:00	147-02E	04-58N	1.08	22.0	25350
V-67	12.26	20:02	12.27	8:00	146-17E	05-12N	1.07	21.0	24424
V-68	12.27	8:03	12.27	20:00	143-59E	05-41N	1.07	21.5	25005
V-69	12.27	20:02	12.28	8:06	141-44E	06-07N	1.08	21.0	24198
V-70	12.28	8:09	12.28	17:00	140-02E	06-28N	1.07	21.5	25005

Table 7.13-2 Summary of precipitation sampling for isotope analysis.

	Date	Time (UT)	Lon	Lat	Date	Time (UT)	Lon	Lat	Rain (mm)
R-1	11.24	00:00	141-39E	41-35N	11.26	07:09	146-13E	37-25N	12.9
R-2	11.26	07:09	146-13E	37-25N	11.30	00:05	147-11E	23-32N	0.7
R-3	11.30	00:05	147-11E	23-32N	11.30	05:31	147-44E	22-35N	1.9

R-4	11.30	05:31	147-44E	22-35N	12.03	20:51	156-05E	07-58N	0.9
R-5	12.03	20:55	156-05E	07-58N	12.05	21:33	155-56E	05-00N	1.0
R-6	12.05	21:33	155-56E	05-00N	12.06	20:31	156-01E	04-59N	3.4
R-7	12.06	20:31	156-01E	04-59N	12.16	19:05	156-00E	05-02S	9.3
R-8	12.16	19:05	156-00E	05-02S	12.23	08:06	147-00E	01-30N	1.7
R-9	12.23	08:06	147-00E	01-30N	12.25	11:25	147-00E	03-44N	3.4
R-10	12.25	11:25	147-00E	03-44N	12.25	20:05	147-01E	04-58N	9.1
R-11	12.25	20:05	147-01E	04-58N	12.25	23:48	146-54E	05-02N	4.2
R-12	12.25	23:48	146-54E	05-02N	12.26	20:27	147-01E	04-58N	11.2
R-13	12.26	20:27	147-01E	04-58N	12.27	08:08	146-16E	05-12N	4.4
R-14	12.27	08:08	146-16E	05-12N	12.28	09:25	141-30E	06-10N	30.9
R-15	12.28	09:25	141-30E	06-10N	12.28	17:00	140-02E	06-28N	3.5

Table 7.13-3 Summary of sea surface water sampling for isotope analysis

Sampling No.		Date	Time	Position	
			(UTC)	LON	LAT
MR10-07 O-	1	11.26	03:13	146-30E	38-00N
MR10-07 O-	2	11.27	03:00	145-08E	34-10N
MR10-07 O-	3	11.28	02:02	144-37E	31-48N
MR10-07 O-	4	11.29	02:01	145-05E	27-00N
MR10-07 O-	5	11.30	02:00	147-22E	23-12N
MR10-07 O-	6	12.1	02:00	149-48E	18-57N
MR10-07 O-	7	12.2	02:00	152-02E	14-56N
MR10-07 O-	8	12.3	01:01	154-21E	10-55N
MR10-07 O-	9	12.4	01:00	156-03E	07-58N
MR10-07 O-	10	12.5	01:01	156-00E	07-53N
MR10-07 O-	11	12.6	01:03	155-57E	05-01N
MR10-07 O-	12	12.7	01:03	155-59E	04-55N
MR10-07 O-	13	12.8	01:04	156-00E	03-00N
MR10-07 O-	14	12.9	01:01	156-00E	01-37N
MR10-07 O-	15	12.10	01:00	155-59E	01-48N
MR10-07 O-	16	12.11	01:01	156-08E	00-03S
MR10-07 O-	17	12.12	01:14	156-06E	00-02S
MR10-07 O-	18	12.13	00:54	156-02E	00-00S
MR10-07 O-	19	12.14	01:00	156-00E	00-44S
MR10-07 O-	20	12.15	01:03	156-00E	02-00S
MR10-07 O-	21	12.16	01:00	155-57E	02-26S
MR10-07 O-	22	12.17	01:00	156-01E	04-59S
MR10-07 O-	23	12.18	01:00	156-00E	04-39S
MR10-07 O-	24	12.19	00:57	153-26E	02-34S

MR10-07 O-	25	12.20	01:00	150-34E	01-12S
MR10-07 O-	26	12.21	02:00	146-59E	00-02S
MR10-07 O-	27	12.22	02:00	147-03E	00-00S
MR10-07 O-	28	12.23	02:01	147-03E	00-24N
MR10-07 O-	29	12.24	02:00	146-55E	02-04N
MR10-07 O-	30	12.25	02:00	146-58E	02:06N
MR10-07 O-	31	12.26	02:08	146-57E	04-58N
MR10-07 O-	32	12.27	02:00	146-57E	05-04N
MR10-07 O-	33	12.28	02:00	142-52E	05-53N

7.14 Observation of atmospheric gas and aerosols by MAX-DOAS methods

(1) Personnel

Hisahiro TAKASHIMA (PI, JAMSTEC/RIGC, not on board)
Hitoshi IRIE (JAMSTEC/RIGC)
Yugo KANAYA (JAMSTEC/RIGC)

(2) Objectives

- To quantify typical background values of atmospheric aerosol and gas over the ocean
- To clarify transport processes from source over Asia to the ocean (and also clarify the gas emission from the ocean (including organic gas))
- To validate satellite measurements (as well as chemical transport model)

(3) Methods

Multi-Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) is a passive remote sensing technique using scattered visible and ultraviolet (UV) solar radiation at several elevation angles. The MAX-DOAS system used in this study records spectra of scattered solar radiation every 0.2-0.4 second. Measurements were made at several elevation angles of 0, 3, 4, 5, 10, 20, 30, 70, 110, 150, 160, 170, 175, 176 and 177 degrees using a movable mirror, which repeated the same sequence of elevation angles every 30-min. The UV/visible spectra range was changed every min (284-423 nm and 391-528 nm). On the roof top of the anti-rolling system of R/V *Mirai*, the telescope unit was installed on a gimbal mount, which compensates for the pitch and roll of the ship. A sensor measuring pitch and roll of the telescope unit (10Hz) is used together to measure an offset of elevation angle due to incomplete compensation by the gimbal. The line of sight was in directions of the starboard and portside of the ship.

After measurements were made, we first selected spectrum data with an elevation angle offset less than ±0.2 degrees. For those spectra, DOAS spectral fitting was performed to quantify the slant column density (SCD), defined as the concentration integrated along the light path, for each elevation angle. In this analysis, SCDs of NO_2 (and other gases) and O_4 (O_2-O_2, collision complex of oxygen) were obtained together. Next, O_4 SCDs were converted to the aerosol optical depth (AOD) and the vertical profile of aerosol extinction coefficient (AEC) at a wavelength of 476 nm using an optimal estimation inversion method with a radiative transfer model. Using derived aerosol information, another inversion is performed to retrieve the tropospheric vertical column/profile of NO_2 and other gases.

(4) Preliminary results

These data for the whole cruise period will be analyzed.

(5) Data archives

The data will be submitted to the Data Management Group (DMG) of JAMSTEC after the full analysis of the raw spectrum data is completed, which will be <2 years after the end of the cruise.

7.15 Long-term measurement by in-situ pH sensors

(1) Personnel

Kiminori Shitashima (CRIEPI)

(2) Objectives

In the view of the problem of the global warming, it is important to know the concentration level of greenhouse effect gases in the ocean. Especially, long-term measurement data of in-situ pH and pCO_2 is very important for monitoring of air-sea CO_2 exchange and oceanic carbon cycle. Purpose of this cruise is to install the in-situ pH sensor at 25m depth on 2N-156E station and recover an in-situ pH sensor (25m depth) set up in MR09-04 cruise.

(3) Parameters

Long-term measurement data of in-situ pH

(4) Methods

The in-situ pH sensor employs an Ion Sensitive Field Effect Transistor (ISFET) as a pH electrode, and the Chloride ion selective electrode (Cl-ISE) as a reference electrode. The ISFET is a semiconductor made of p-type Si coated with SiO_2 and Si_3N_4 that can measure H^+ ion concentration in aqueous phase and has a quick response (within a few second), high accuracy (±0.005pH) and pressure-resistant performance. Before and after observation, the pH prove was calibrated by two different standard solutions (2-aminopyridine (AMP); pH=6.7866 and 2-amino-2-hydroxymethil-1,3-propanediol (TRIS); pH=8.0893) for the proofreading of electrical drift of pH data. The in-situ pH sensor was installed to the mooring wire of TRITON buoy at 2N-156E station and in-situ data were measured every 60 minutes.

(5) Preliminary result

The in-situ pH sensor set up in MR09-04 cruise were recovered from 25m depth. At 25m depth, the pressure housings were covered with biofouling. There is few biofouling on pH electrode because an electric charge exists on the ISFET-pH electrode.

(6) Data archive

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

7.16 Search mooring points for SPICE

(1) Personal

Takuya Hasegawa (JAMSTEC)

Norio Nagahama (GODI)

Ryo Kimura (GODI)

Ryo Ohyama (MIRAI Crew)

Yuji Kashino (JAMSTEC, Principal Investigator)

(2) Introduction

The objective of MBES observation off New Ireland Island (Fig. 7.16-1) is to decide locations for two subsurface ADCP moorings in this area that will be deployed by JAMSTEC in 2012. R/V MIRAI is equipped with a Multi narrow Beam Echo Sounding system (MBES), SEABEAM 2112 (SeaBeam Instruments Inc.). The main purpose of the JAMSTEC's subsurface ADCP is to explore current variations of New Ireland Island Coastal Undercurrent (NICU). The JAMSTEC's future moorings, together with other mooring in the Solomon Sea by USA and French in the CLIVAR-SPICE project, can reveal the western equatorial boundary currents variations and related volume and heat transport in the tropical Pacific that can affect oceanic condition in the western equatorial Pacific and related climate variations. XCTD and SADCP observation were also conducted along the same track for MBES to investigate currents and water property of NICU.

(3) Preliminary Results

Figure 7.16-1 shows the track for the MBES observation from 19 December 2010 to 20 December 2010. From the MBES survey, several good locations for the future JAMSTEC's mooring deployments were found. For example, Fig. 7.16-2 shows very flat bottom geometry around 2.65S-154.40E; the horizontal gradient is ~ 1 %. From SADCP data observed along the same track as MBES survey, relatively strong northwestward currents of 0.5 m/s are found in the NICU depth of ~250 m in consistent with previous SADCP observations. The result indicates that the survey area in this cruise is suitable for subsurface ADCP moorings to explore NICU currents variations. In addition, sixteen XCTD observations were conducted along the same track. Temperature-Salinity (T-S) vertical profiles point out that many salinity peaks appear near at ~200 m depth in the upper part of thermocline layer, in which strong northwestward NICU currents occurred (Fig. 7.16-3).

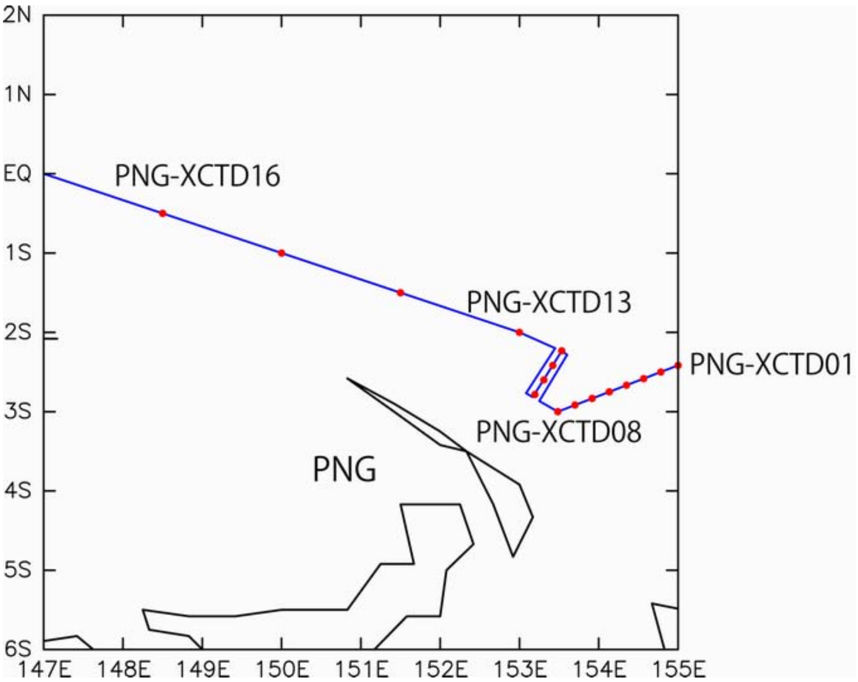


Figure 7.16-1. Map for cruise track During the MBES/SADCP/XCTD observation. Blue line shows the track and red marks indicate the sixteen XCTD observation points.

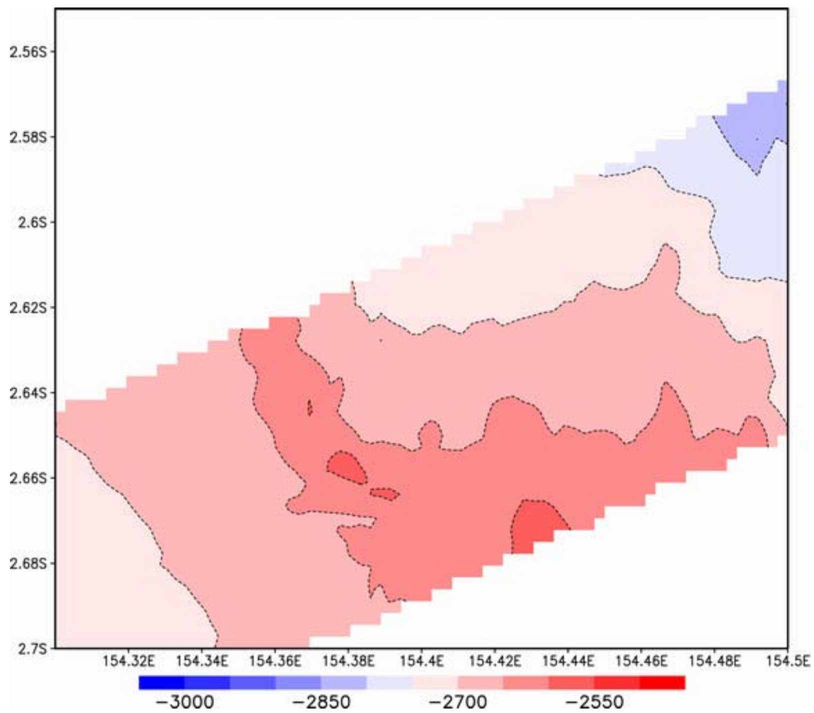


Figure 7.16-2. Map for the MBES-observed depth around 2.65S-154.40E (unit in m).

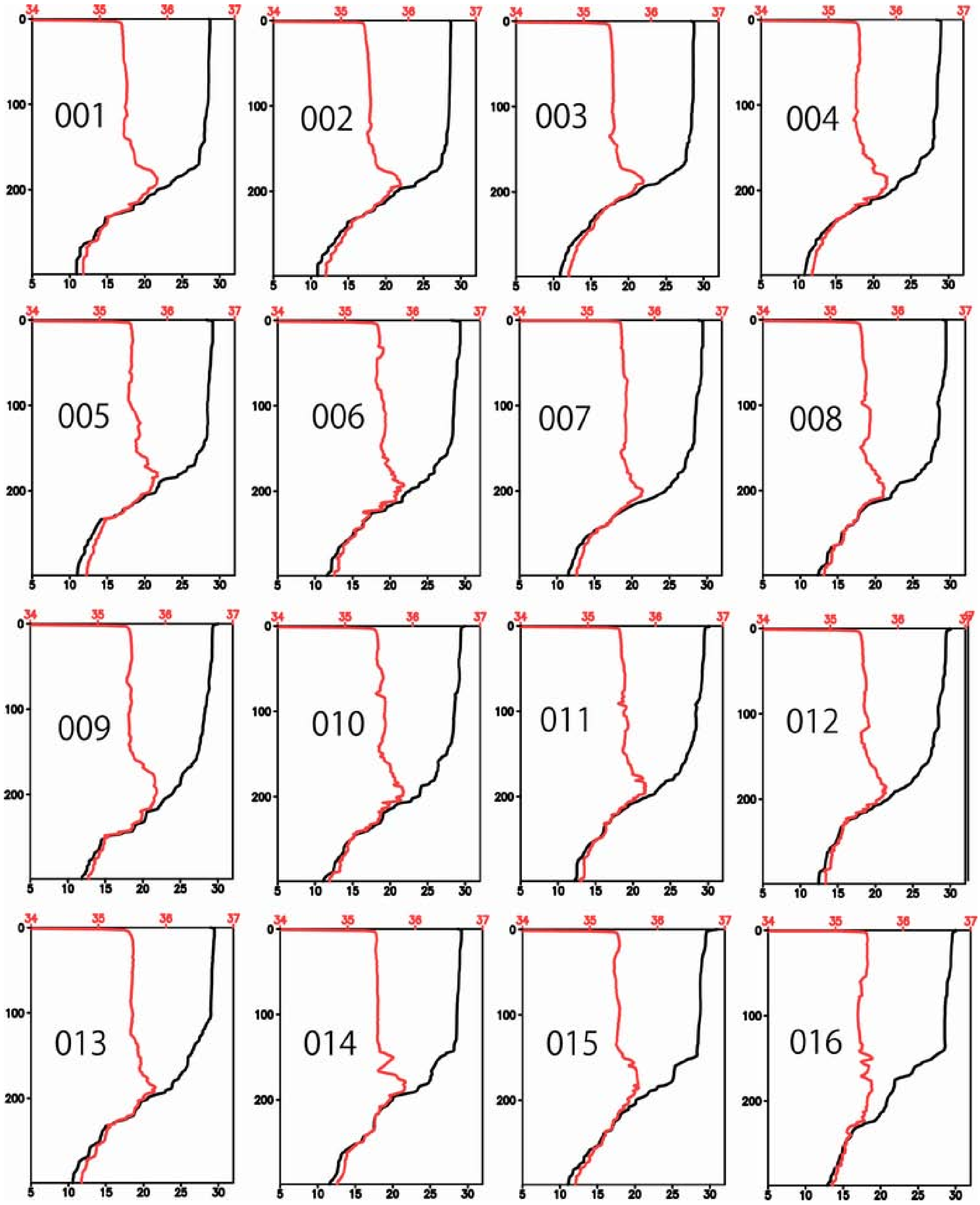


Figure 7-16.3. Vertical profiles of temperature (black line) and salinity (red line) upper 300 m-depth obtained from XCTD observation (from PNG-XCTD #01 to PNG-XCTD #16).