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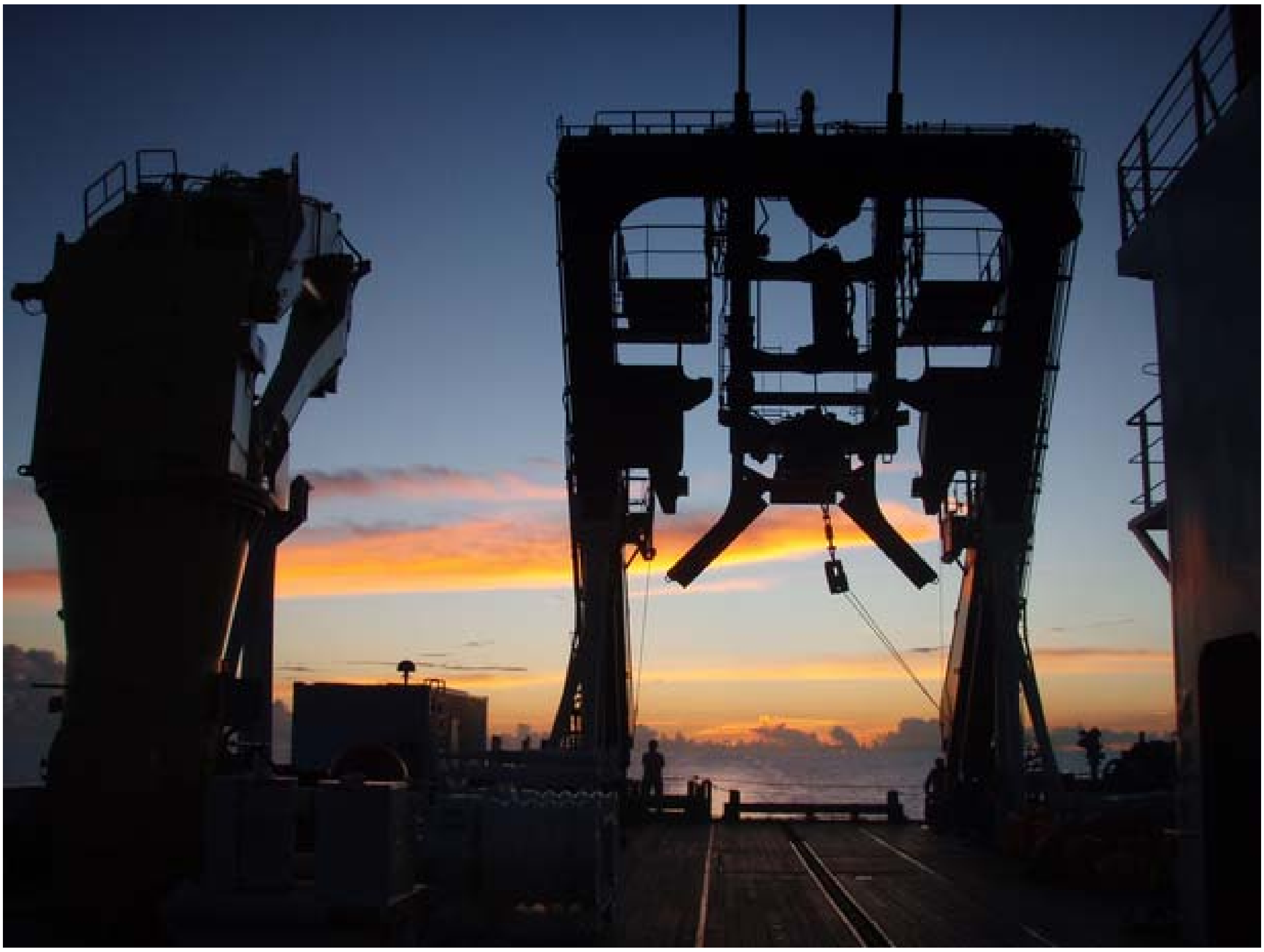
R/V Mirai Cruise Report
MR08-03

July 3, 2008 – August 6, 2008
Tropical Ocean Climate Study (TOCS)



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

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

MR08-03

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.

Second, we observe profiles of temperature, salinity, current, and chemical parameters along 147E and 156E lines using CTD system for following purposes: 1) to observe ocean conditions during the cruise, 2) to check performance of underwater sensors of the TRITON buoys, 3) to investigate ocean fine structure (interleaving) above ocean intermediate layer 4) to observe distribution and daily variability of chlorophyll near the sea surface.

Third, two special meteorological observations are conducted during the cruise: measurement of water vapor on the sea using radiosonde and GPS system, and turbulent flux observations for better understanding of air-sea interaction.

Except for above, automatic continuous oceanic, meteorological and geophysical observations are also conducted along ship track during this cruise as usual. In particular, the shipboard ADCP of R/V Mirai was renewed in this April/May and we pay attention to its performance during this cruise. Finally, we conduct XCTD observations in the region of the Kuroshio Extension on the way to Hachinohe and Sekinehama from the tropical region.

2.2 Overview

1) Ship

R/V Mirai

Captain Yasushi Ishioka

2) Cruise code

MR08-03

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

July 3, 2008 (Guam, USA) – August 6, 2008 (Sekinehama, Japan)

7) Research participants

Eight scientists and thirteen technical staffs from three Japanese institutions and companies

Two scientists from USA

2.3 Observation summary

TRITON mooring recovery and re-installation:	9 moorings were deployed and recovered
Subsurface ADCP mooring recovery and re-installation:	2 moorings were deployed and recovered
CTD (Conductivity, Temperature and Depth) and water sampling:	79 casts
XCTD:	48 casts (including 16 casts for XCTD performance test)
Radiosondes:	68 casts
Turbulent flux observations:	continuous (Cruising to the windward: 15 nights)
Rain sampling	26 casts
Current measurements by shipboard ADCP:	continuous
Sea surface temperature, salinity, dissolved oxygen, and chlorophyll measurements by intake method:	continuous
Surface meteorology:	continuous
Lidar observations of clouds and aerosol	continuous
Doppler radar observation:	continuous
Water vapor observation:	continuous
Underway geophysics observations	continuous

Regarding TRITON buoy maintenance work, we recovered and re-installed nine buoys at 147E and 156 lines during this cruise. Although there were small damages and distortions in some recovered buoys, we did not found large damages in them. All buoy works were successful without troubles.

Some optional sensors were recovered and installed in the TRITON buoys maintained during this cruise. 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 and re-installed in the TRITON buoys at 2N156E (#3). The former was attached to the float at the sea surface, and the latter was underwater sensors installed at the depth of 25m (both recovered and deployed buoys) and 750m (recovered buoy). When we recovered TRITON buoy #3, we found that attachment of the recovered sensor of the MIO was broken and underwater sensor of CRIEPI at 25m was damaged. Second, many temperature, conductivity and light-photon sensors were installed above 100m depth on the TRITON buoy at 0N156E (#4) for observation of near-surface ocean variability when the buoy was deployed in the MR07-03 cruise. We successfully recovered all these sensors, however, we found that many underwater sensors attached to the wire shifted downward few meters. Finally, two ADCPs were newly installed at 175m and 300m depths in the buoy #4.

We have been also 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. Its data was successfully acquired.

During this cruise, we conducted 79 CTD casts for multi-purposes which are shown in 2.1. For TRTION sensor check, CTD casts were conducted until 800m depth near the recovered buoy because the deepest underwater conductivity/temperature sensor is installed at the depth of 750m. (We also conducted CTD observations after deployment at some locations.) Observations of interleaving using a lowered ADCP (LADCP) with CTD system were conducted with half-degree spacing along 147E and 156E lines. Measurement depth for these casts was 500m depth except at TRITON buoy positions. For measurements of near-surface chlorophyll, we conducted shallow CTD casts with a depth of 200m as follows;

1) three casts a day at 6:00 A.M.,1:00 P.M. (or 11:00 A.M.) and 6:00 P.M. near the TRITON buoy,
2) one cast at the midpoints between TRITON buoy locations (e.g., 3.5N147E),
3) eight casts every 3 hours at 2S156E on 18-19 July.

Fluorescence and light photon sensors were installed for these shallow casts. Water was sampled for salinity measurement on 500m and 800m casts, and for nutrient measurement on 200m cast at 1:00 P.M. Sampled water analysis for salinity using AUTOSAL showed negative bias of 0.01 PSU in salinity values derived from CTD primary sensors. (We used twin-sensor system in this cruise.) Therefore, data from secondary sensors is recommended for data analysis until post cruise calibration of sensors will be done.

XCTD observations were conducted at the northern part of 156E line, after TRITON buoy deployment work, and 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, J-KEO and KEO buoys, in this region. Therefore, these XCTD observations were conducted on the way to Hachinohe/Sekinehama although main purpose of this cruise is to observe the tropical ocean and atmosphere.

Regarding XCTD data, we found large negative salinity bias (0.05-0.1 PSU) in the data during MR06-05 leg3, MR07-07 leg 1 and other TOCS cruises. Therefore, we conducted XCTD performance test on 27 July near the TRITON buoy #1 (8N156E). Unfortunately, we did not find the cause of the large XCTD salinity bias from this test. XCTD Data obtained in this test will not be opened through the JAMSTEC data site because of test data.

After we left from the territorial water of USA (Guam), we conducted radiosonde observations every 12 hours from 3 July, 12:00 (UTC) to 4 August, 0:00 for observing water vapor distribution together with GPS system and Doppler radar measurements. In the Kuroshio Extension region, observation interval was 6 hours.

For accurate measurement of air-sea flux, the turbulent flux and ship motion correction systems were installed on the top of the foremast of R/V Mirai. Although this system worked continuously along the ship track, we conducted cruising to the windward fifteen times at the night in order to avoid turbulence by the ship body. Note that ship track near the TRITON buoy was irregular because of this cruising.

Other oceanographical, meteorological and geophysical continuous observations were also successfully carried out during this cruise. New shipboard ADCP of R/V Mirai worked well during this cruise until 600m depth except near the surface along 147E line.

Weather condition was very good and we conducted all observations on schedule. Thus, MR08-03 cruise ended in success.

2.4 Observed Oceanic and Atmospheric Conditions

2007/08 La Nina terminated and the equatorial Pacific was under the normal condition during this boreal summer, although sea surface temperature in the eastern Pacific a little high (Figure 2-1). During this cruise, MJO events did not occur (Figure 2-2) and weather in the observation area was almost clear.

Temperature, salinity and potential density sections along 147E and 156E are shown in Figure 2-3. Sea surface temperature along these lines exceeded 29℃ except north of 5N at 156E. There was a clear salinity front near the surface around 2-3N in these lines. North of this salinity front, low salinity water (fresh water lens) was found and it made barrier layer above 50-100m depth. Sea surface salinity south of this front was high exceeding 35.3 psu. Density structure near the surface well agreed with this salinity structure, which means that salinity is very important factor for determination of ocean structure near the surface.

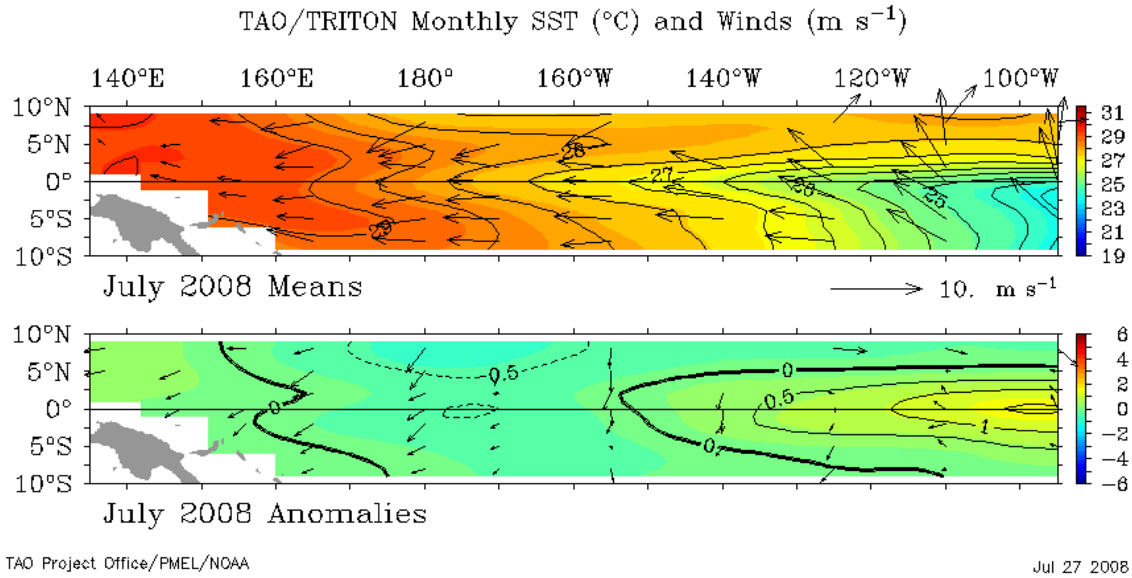


Figure 2-1. Maps of monthly sea surface temperature and winds (upper panel), and their anomaly (lower panel) obtained from TAO/TRITON buoy array in July 2008. (http://www.pmel.noaa.gov/tao/jsdisplay/)

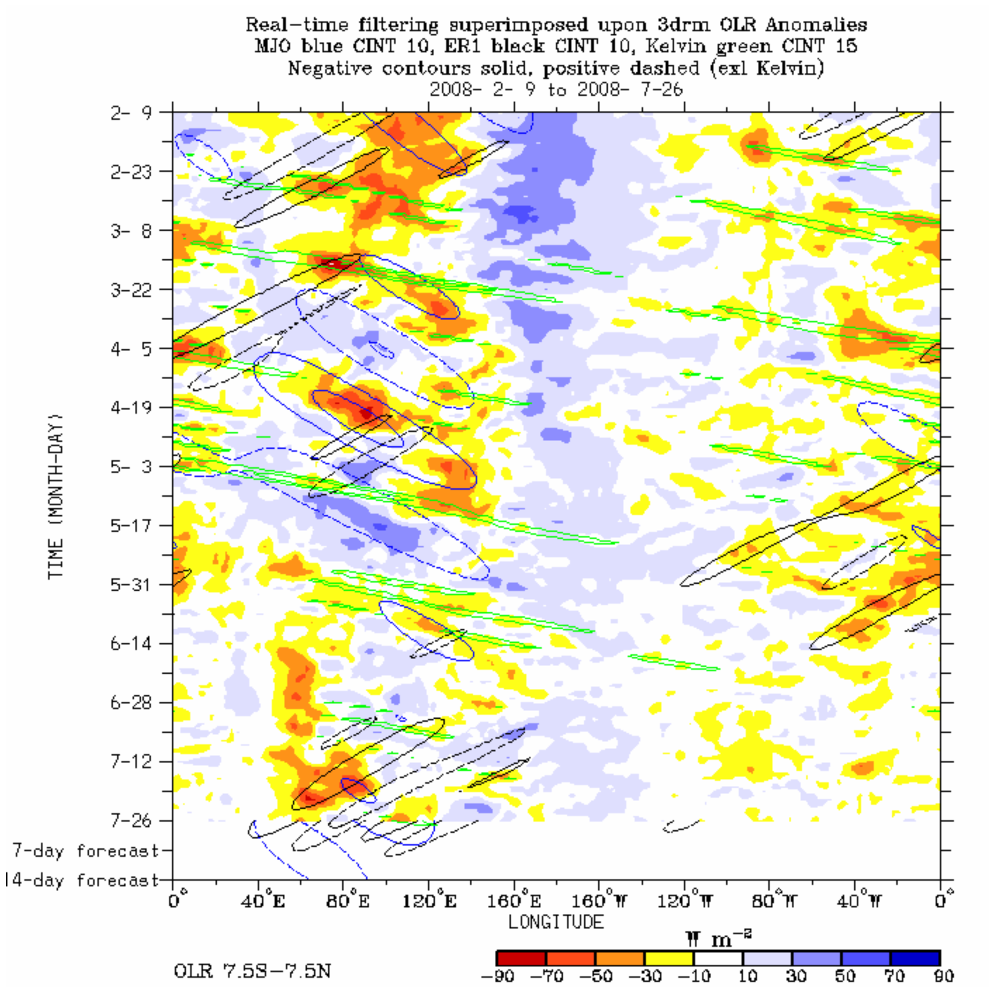


Figure 2-2. Outgoing radiation anomaly averaged over 7.5S-7.5N from the web page of the Climate Diagnostic Center (CDC), National Oceanic and Atmospheric Association (NOAA) (http://www.cdc.noaa.gov/map/clim/olr_modes/).

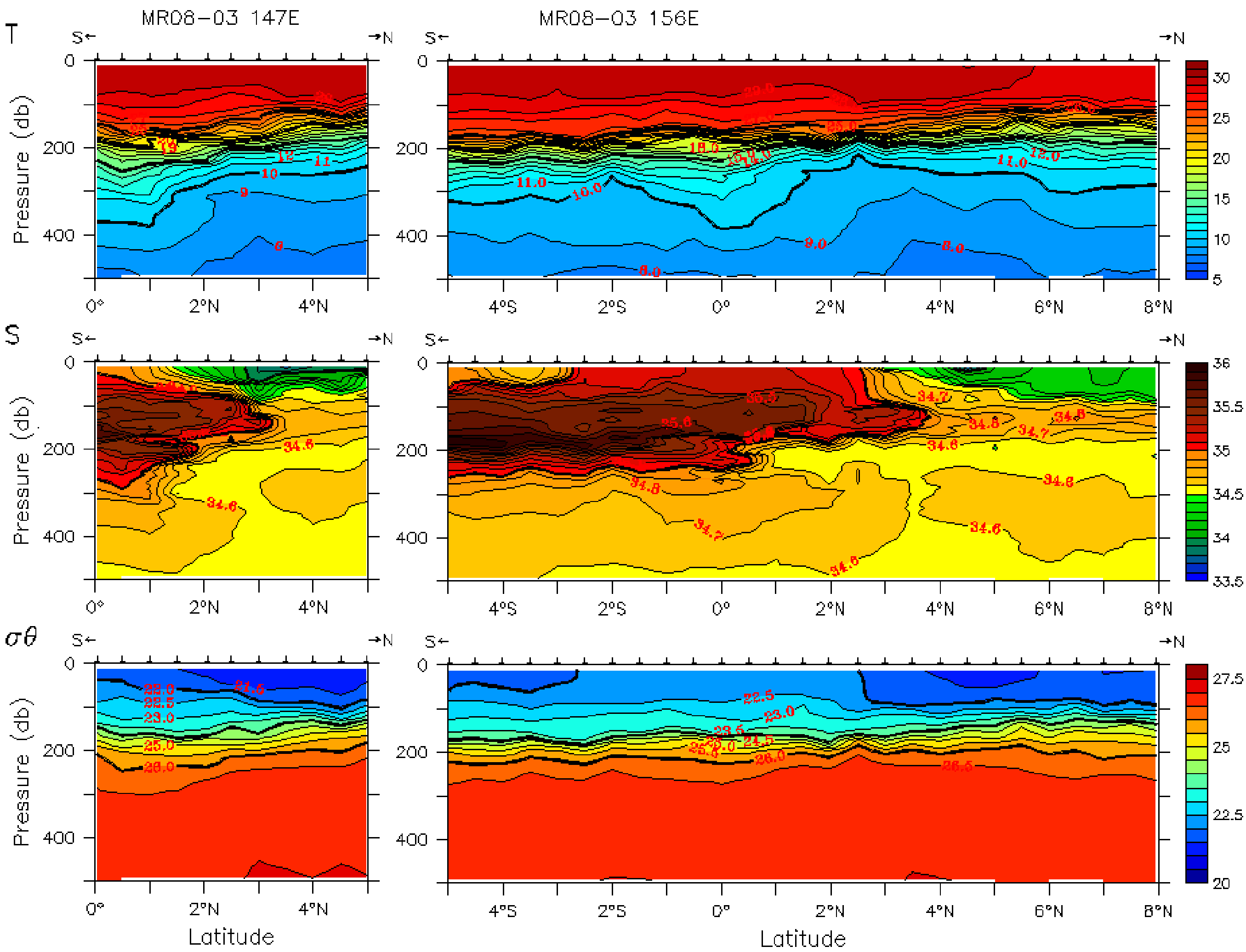


Figure 2-3. Temperature, salinity and potential density sections along 147E (left) and 156E (right) lines.

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

3.1 Period

July 03, 2008 – August 06, 2008

3.2 Ports of call

Guam, USA (Departure: July 03, 2008)

Hachinohe, Japan (Arrival and Departure: August 05, 2008)

Sekinehama, Japan (Arrival: August 06, 2008)

3.3 Cruise Log

SMT	UTC	Event
Jul. 03 (Thu.) 2008		
08:00	22:00 (-1day)	Departure of Guam
		[Ship Mean Time (SMT)=UTC+10h]
10:30	00:30	Safety Guidance
11:00	01:00	Continuous observation start
13:15	03:15	Boat station drill
13:40	03:40	Surface Sea water sampling start
16:45	06:45	Konpira Ceremony
20:29	10:29	Doppler radar observation start
21:29	11:29	Radiosonde observation #RS-01
Jul. 04 (Fri.) 2008		
09:00	23:00	Meeting for MR08-03 observation
09:29	23:29	Radiosonde observation #RS-02
21:29	11:29	Radiosonde observation #RS-03
Jul. 05 (Sat.) 2008		
06:01 – 06:23	20:01 – 20:23	CTD/Fluorescence/Light Photon #C01-1 (200m)
08:08 – 10:44	22:08 – 00:44	Deployment of TRITON #07 (5N, 147E)
		(Fixed Position: 05-02.5077N, 146-56.9864E)
09:30	23:30	Radiosonde observation #RS-04
11:39	01:39	XCTD observation #X-01
13:00 – 13:29	03:00 – 03:29	CTD/Fluorescence/Light Photon #C01-2 (200m)
14:13 – 14:54	04:13 – 04:54	CTD/LADCP #C01-3 (800m)
17:55 – 18:17	07:55 – 08:17	CTD/Fluorescence/Light Photon #C01-4 (200m)
18:30 – 05:50	08:30 – 19:50	Turbulent Flux running #01
21:29	11:29	Radiosonde observation #RS-05
Jul. 06 (Sun.) 2008		
07:57 – 11:38	21:57 – 01:38	Recovery of TRITON #07 (5N, 147E)

09:30	23:30	Radiosonde observation #RS-06
13:34 – 14:00	03:34 – 04:00	CTD/LADCP #C02-1 (500m)
16:15 – 16:45	06:15 – 06:45	CTD/LADCP #C03-1 (500m)
19:04 – 19:26	09:04 – 09:26	CTD/Fluorescence #C04-1 (200m)
19:40 – 05:23	09:40 – 19:23	Turbulent Flux running #02
21:28	11:28	Radiosonde observation #RS-07
Jul. 07 (Mon) 2008		
05:56 – 06:25	19:56 – 20:25	CTD/LADCP #C04-2 (500m)
08:48 – 09:20	22:48 – 23:20	CTD/LADCP #C05-1 (500m)
09:26	23:26	Radiosonde observation #RS-08
11:44 – 12:14	01:44 – 02:14	CTD/LADCP #C06-1 (500m)
17:10 – 17:39	07:10 – 07:39	CTD/LADCP #C08-1 (500m)
20:20 – 05:40	10:20 – 19:40	Turbulent Flux running #03
21:30	11:30	Radiosonde observation #RS-09
Jul. 08 (Tue.) 2008		
05:56 – 06:19	19:56 – 20:19	CTD/Fluorescence/Light Photon #C07-1 (200m)
08:38 – 11:12	22:38 – 01:12	Deployment of TRITON #08 (2N, 147E)
		(Fixed Position: 01-59.5980N, 147-01.3406E)
09:29	23:29	Radiosonde observation #RS-10
12:22	02:22	XCTD observation #X-02
13:00 – 13:28	03:00 – 03:28	CTD/Fluorescence/Light Photon #C07-2 (200m)
14:13 – 14:55	04:13 – 04:55	CTD/LADCP #C07-3 (800m)
17:55 – 18:16	07:55 – 08:16	CTD/Fluorescence/Light Photon #C07-4 (200m)
18:20 – 06:00	08:20 – 20:00	Turbulent Flux running #04
21:31	11:31	Radiosonde observation #RS-11
Jul. 09 (Wed.) 2008		
07:53 –11:14	21:53 – 01:14	Recovery of TRITON #08 (2N, 147E)
09:31	23:31	Radiosonde observation #RS-12
15:48 – 16:17	06:48 – 06:17	CTD/LADCP #C09-1 (500m)
16:35 – 16:56	06:35 – 06:56	CTD/Fluorescence/Light Photon #C09-2 (200m)
19:11 – 19:40	09:11 – 09:40	CTD/LADCP #C10-1 (500m)
21:29	11:29	Radiosonde observation #RS-13
22:00 – 06:15	12:00 – 20:15	Turbulent Flux running #05
Jul. 10 (Thu.) 2008		
08:02 – 10:32	22:02 – 00:32	Deployment of TRITON #09 (EQ, 147E)
		(Fixed Position: 00-01.4850S, 147-00.0394E)
09:26	23:26	Radiosonde observation #RS-14
12:32	02:32	XCTD observation #X-03
13:02 – 13:43	03:02 – 03:43	CTD/LADCP #C11-1 (800m)
14:15 – 05:15	04:15 – 19:15	Turbulent Flux running #06

21:29	11:29	Radiosonde observation #RS-15
Jul. 11 (Fri.) 2008		
05:56 – 06:16	19:56 – 20:16	CTD/Fluorescence/Light Photon #C11-2 (200m)
07:54 – 10:18	21:54 – 00:18	Recovery of ADCP buoy (EQ, 147E)
09:28	23:28	Radiosonde observation #RS-16
12:59 – 13:28	02:59 – 03:28	CTD/Fluorescence/Light Photon #C11-3 (200m)
13:54 – 15:32	03:54 – 05:32	Deployment of ADCP buoy (EQ, 147E)
		(Fixed Position: 00-00.2803S, 147-05.0961E)
17:57 – 18:16	07:57 – 08:16	CTD/Fluorescence/Light Photon #C11-4 (200m)
18:30 – 06:25	08:30 – 20:25	Turbulent Flux running #07
21:29	11:29	Radiosonde observation #RS-17
Jul. 12 (Sat.) 2008		
07:56 –11:42	21:56 – 01:42	Recovery of TRITON #09 (EQ, 147E)
09:24	23:24	Radiosonde observation #RS-18
21:30	11:30	Radiosonde observation #RS-19
22:00	12:00	Time adjustment +1h (SMT=UTC+11h)
Jul. 13 (Sun.) 2008		
10:26	23:26	Radiosonde observation #RS-20
22:29	11:29	Radiosonde observation #RS-21
Jul. 14 (Mon.) 2008		
05:57- 06:18	18:57 – 19:18	CTD/Fluorescence/Light Photon #C18-1 (200m)
08:03 – 09:48	21:03 – 22:48	Deployment of TRITON #05 (2S, 156E)
		(Fixed Position: 01-59.0397S, 156-01.9044E)
10:36	23:36	Radiosonde observation #RS-22
10:37 – 11:22	23:37 – 00:22	CTD/LADCP #C18-2 (800m)
13:00 – 13:32	02:00 – 02:32	CTD/Fluorescence/Light Photon #C18-3 (200m)
14:38 – 15:21	03:38 – 04:21	CTD/LADCP #C18-4 (800m)
17:57 – 18:17	06:38 – 07:17	CTD/Fluorescence/Light Photon #C18-4 (200m)
18:30 – 06:30	07:30 – 19:30	Turbulent Flux running #08
22:22	11:22	Radiosonde observation #RS-23
Jul. 15 (Tue.) 2008		
07:56 –10:34	20:56 – 23:34	Recovery of TRITON #05 (2S, 156E)
10:26	23:26	Radiosonde observation #RS-24
13:19 – 13:48	02:19 – 02:48	CTD/LADCP/ Fluorescence #C17-1 (500m)
16:00 – 16:28	05:00 – 05:28	CTD/LADCP/ Fluorescence #C16-1 (500m)
18:40 – 19:00	07:40 – 08:00	CTD/Fluorescence/Light Photon #C15-1 (200m)
19:08 – 19:36	08:08 – 08:36	CTD/LADCP #C15-2 (500m)
22:29	11:29	Radiosonde observation #RS-25
Jul. 16 (Wed.) 2008		
05:55 – 06:16	18:55 – 19:16	CTD/Fluorescence/Light Photon #C12-1 (200m)

08:04 – 09:51	21:04 – 22:51	Deployment of TRITON #06 (5S, 156E) (Fixed Position: 04-58.0290S, 156-00.9428E)
10:27	23:27	Radiosonde observation #RS-26
10:28 – 11:13	23:28 – 00:13	CTD/LADCP #C12-2 (800m)
12:59 – 13:25	01:59 – 02:25	CTD/Fluorescence/Light Photon #C12-3 (200m)
14:12 – 14:53	03:12 – 03:53	CTD/LADCP #C12-4 (800m)
15:03 – 15:28	04:03 – 04:28	8-figure running for magnetometer calibration
17:55 – 18:15	06:55 – 07:15	CTD/Fluorescence/Light Photon #C12-5 (200m)
18:30 – 06:30	07:30 – 19:30	Turbulent Flux running #09
22:29	11:29	Radiosonde observation #RS-27
Jul. 17 (Thu.) 2008		
07:55 –10:32	20:55 – 23:32	Recovery of TRITON #06 (5S, 156E)
10:33	23:33	Radiosonde observation #RS-28
13:03 – 13:33	02:03 – 02:33	CTD/LADCP/Fluorescence #C13-1 (500m)
16:04 – 16:33	05:04 – 05:33	CTD/LADCP /Fluorescence #C14-1 (500m)
22:30	11:30	Radiosonde observation #RS-29
Jul. 18 (Fri.) 2008		
05:57 – 06:18	18:57 – 19:18	CTD/LADCP/Fluorescence/Light Photon #C18-6 (200m)
08:57 – 09:20	21:57 – 22:18	CTD/LADCP/Fluorescence/Light Photon #C18-7 (200m)
10:01 – 10:29	23:01 – 23:29	Recovery of video camera on TRITON #06
10:21	23:21	Radiosonde observation #RS-30
12:00 – 12:26	01:00 – 01:26	CTD/LADCP/Fluorescence/Light Photon #C18-8 (200m)
14:00 – 15:17	03:00 – 04:17	CTD/LADCP/Fluorescence/Light Photon #C18-9 (200m)
17:57 – 18:17	06:57 – 07:17	CTD/LADCP/Fluorescence/Light Photon #C18-10 (200m)
20:56 – 21:17	09:56 – 10:17	CTD/LADCP/Fluorescence/Light Photon #C18-11 (200m)
22:28	11:28	Radiosonde observation #RS-31
23:57 – 00:25	11:57 – 12:25	CTD/LADCP/Fluorescence/Light Photon #C18-12 (200m)
Jul. 19 (Sat.) 2008		
02:55 – 03:15	15:55 – 16:15	CTD/LADCP/Fluorescence/Light Photon #C18-13 (200m)
05:54 – 06:22	18:54 – 19:22	CTD/LADCP/Fluorescence #C19-1 (500m)
08:54 – 09:15	21:54 – 22:15	CTD/Fluorescence/Light Photon #C20-1 (200m)
09:41 – 10:10	22:41 – 23:10	CTD/LADCP #C20-2 (500m)

10:26	23:26	Radiosonde observation #RS-32
12:57 – 13:24	01:57 – 02:24	CTD/LADCP/Fluorescence #C21-1 (500m)
15:56 – 16:36	04:56 – 05:36	CTD/LADCP #C22-1 (800m)
18:54 – 19:31	07:54 – 08:31	CTD/LADCP/Fluorescence #C23-1 (500m)
22:28	11:28	Radiosonde observation #RS-33
22:36 – 05:50	11:36 – 18:50	Turbulent Flux running #10
Jul. 20 (Sun.) 2008		
05:57 – 06:17	18:57 – 19:17	CTD/Fluorescence/Light Photon #C22-2 (200m)
08:03 – 10:08	21:03 – 23:08	Deployment of TRITON #04 (EQ, 156E)
		(Fixed Position: 00-01.0168S, 155-57.4243E)
10:24	23:24	Radiosonde observation #RS-34
10:43	23:43	XCTD observation #X-04
11:00 – 11:28	00:00 – 00:28	CTD/Fluorescence/Light Photon #C22-4 (200m)
12:59 – 14:25	01:59 – 03:25	Recovery of ADCP buoy (EQ, 156E)
15:13 – 16:05	04:13 – 06:05	Deployment of ADCP buoy (EQ, 156E)
		(Fixed Position: 00-02.1674S, 156-07.8711E)
17:55 – 18:15	06:55 – 07:15	CTD/Fluorescence/Light Photon #C22-5 (200m)
18:30 – 06:30	07:30 – 19:30	Turbulent Flux running #11
22:29	11:29	Radiosonde observation #RS-35
Jul. 21 (Mon.) 2008		
07:56 – 10:53	20:56 – 23:53	Recovery of TRITON #04 (EQ, 156E)
10:27	23:27	Radiosonde observation #RS-36
15:19 – 15:40	04:19 – 04:40	CTD/Fluorescence/Light Photon #C24-1 (200m)
15:52 – 16:21	04:52 – 05:21	CTD/LADCP #C24-2 (500m)
18:44 – 19:13	07:44 – 08:13	CTD/LADCP/Fluorescence #C25-1 (500m)
21:25 – 05:45	10:25 – 18:45	Turbulent Flux running #12
22:29	11:29	Radiosonde observation #RS-37
Jul. 22 (Tue.) 2008		
05:55 – 06:17	18:55 – 19:17	CTD/Fluorescence/Light Photon #C26-1 (200m)
08:05 – 10:20	21:05 – 23:20	Deployment of TRITON #03 (2N, 156E)
		(Fixed Position: 01-57.3595N, 155-59.9811E)
10:28	21:28	Radiosonde observation #RS-38
11:08 – 11:50	00:08 – 00:50	CTD/LADCP #C26-2 (800m)
13:01 – 13:30	02:01 – 02:30	CTD/Fluorescence/Light Photon #C26-3 (200m)
14:16 – 14:59	03:16 – 03:59	CTD/LADCP #C26-4 (800m)
17:55 – 18:16	06:55 – 07:16	CTD/Fluorescence/Light Photon #C26-5 (200m)
18:30 – 06:30	07:30 – 19:30	Turbulent Flux running #13
22:29	11:29	Radiosonde observation #RS-39
Jul. 23 (Wed.) 2008		
07:55 – 11:05	20:55 – 00:05	Recovery of TRITON #03 (2N, 156E)

10:30	23:30	Radiosonde observation #RS-40
14:31 – 14:59	03:31 – 03:59	CTD/LADCP/Fluorescence #C27-1 (500m)
17:00 – 17:30	06:00 – 06:30	CTD/LADCP/Fluorescence #C28-1 (500m)
19:32 – 20:01	08:32 – 09:01	CTD/LADCP #C29-2 (500m)
22:26	11:26	Radiosonde observation #RS-41
Jul. 24 (Thu.) 2008		
08:24 – 10:23	21:24 – 23:23	Deployment of TRITON #02 (5N, 156E)
		(Fixed Position: 04-58.3465N, 156-02.0057E)
10:20	23:20	Radiosonde observation #RS-42
12:42	01:42	XCTD observation #X-05
13:02 – 13:43	02:02 – 02:43	CTD/LADCP #C32-1 (800m)
16:02 – 16:31	05:02 – 05:31	CTD/LADCP/Fluorescence #C31-1 (500m)
18:47 – 19:16	07:47 – 08:16	CTD/LADCP/Fluorescence #C30-1 (500m)
19:30 – 05:48	08:30 – 18:48	Turbulent Flux running #14
22:30	11:30	Radiosonde observation #RS-43
Jul. 25 (Fri.) 2008		
05:56 – 06:18	18:56 – 19:18	CTD/Fluorescence/Light Photon #C32-2 (200m)
07:57 – 11:03	20:57 – 00:05	Recovery of TRITON #02 (5N, 156E)
10:27	23:27	Radiosonde observation #RS-44
13:00 – 13:30	02:00 – 02:30	CTD/Fluorescence/Light Photon #C32-3 (200m)
18:05 – 18:26	07:05 – 07:26	CTD/Fluorescence/Light Photon #C32-4 (200m)
20:51	09:51	XCTD observation #X-06
22:29	11:29	Radiosonde observation #RS-45
23:33	12:33	XCTD observation #X-07
Jul. 26 (Sat.) 2008		
05:26 – 05:56	18:26 – 18:56	CTD/LADCP/Fluorescence #C33-1(500m)
05:33	18:33	XCTD observation #X-08
07:56	20:56	XCTD observation #X-09
09:56	22:56	XCTD observation #X-10
10:13	23:13	Radiosonde observation #RS-46
13:01 – 15:27	02:01 – 04:27	Deployment of TRITON #01 (8N, 156E)
		(Fixed Position: 08-00.9366N, 155-57.0774E)
17:24	06:24	XCTD observation #X-11
17:57 – 18:38	06:57 – 07:38	CTD/LADCP #C34-1(800m)
18:45 – 05:45	07:45 – 18:45	Turbulent Flux running #15
22:29	11:29	Radiosonde observation #RS-47
Jul. 27 (Sun.) 2008		
05:56 – 06:18	18:56 – 19:18	CTD/Fluorescence/Light Photon #C34-2 (200m)
07:58 – 12:02	20:58 – 01:02	Recovery of TRITON #01 (8N, 156E)
10:30	23:30	Radiosonde observation #RS-48

13:00 – 13:28	02:00 – 02:28	CTD/Fluorescence/Light Photon #C34-3 (200m)
13:58 – 14:45	02:58 – 03:45	CTD/LADCP #C34-4 (1,000m)
14:05 – 14:37	03:05 – 03:37	XCTD performance test #01
15:08 – 15:59	04:08 – 04:59	CTD/LADCP #C34-5 (1,000m)
15:16 – 15:45	04:16 – 04:45	XCTD performance test #02
18:19 – 18:41	07:19 – 07:41	CTD/Fluorescence/Light Photon #C34-6 (200m)
22:23	11:23	Radiosonde observation #RS-49
Jul. 28 (Mon.) 2008		
10:27	23:27	Radiosonde observation #RS-50
22:29	11:29	Radiosonde observation #RS-51
Jul. 29 (Tue.) 2008		
10:28	23:28	Radiosonde observation #RS-52
22:00	11:00	Time adjustment -1h (SMT=UTC+10h)
21:30	11:30	Radiosonde observation #RS-53
Jul. 30 (Wed.) 2008		
09:27	23:27	Radiosonde observation #RS-54
21:29	11:29	Radiosonde observation #RS-55
22:00	12:00	Time adjustment -1h (SMT=UTC+9h)
Jul. 31 (Thu.) 2008		
08:28	23:28	Radiosonde observation #RS-56
20:29	11:29	Radiosonde observation #RS-57
Aug. 01 (Fri.) 2008		
08:29	23:29	Radiosonde observation #RS-58
20:28	11:28	Radiosonde observation #RS-59
Aug. 02 (Sat.) 2008		
03:08	18:08	XCTD observation #X-12
04:55	19:55	XCTD observation #X-13
08:28	23:28	Radiosonde observation #RS-60
09:04	00:04	XCTD observation #X-14
11:50	02:50	XCTD observation #X-15
14:24	05:24	Radiosonde observation #RS-61
15:02	06:02	XCTD observation #X-16
16:40	07:40	XCTD observation #X-17
18:14	09:14	XCTD observation #X-18
19:38	10:38	XCTD observation #X-19
20:29	11:29	Radiosonde observation #RS-62
21:07	12:07	XCTD observation #X-20
22:26	13:26	XCTD observation #X-21
23:43	14:43	XCTD observation #X-22
Aug. 03 (Sun.) 2008		

00:55	15:55	XCTD observation #X-23
02:05	17:05	XCTD observation #X-24
02:27	17:27	Radiosonde observation #RS-63
03:51	18:51	XCTD observation #X-25
05:05	20:05	XCTD observation #X-26
06:20	21:20	XCTD observation #X-27
07:40	22:40	XCTD observation #X-28
08:27	23:27	Radiosonde observation #RS-64
10:24	01:24	XCTD observation #X-29
13:36	04:36	XCTD observation #X-30
14:00	05:00	Surface Sea water sampling stop
14:27	05:27	Radiosonde observation #RS-65
16:41	07:41	XCTD observation #X-31
19:20	10:20	XCTD observation #X-32
19:33 – 22:05	10:33 – 13:05	Free fall for CTD cable
20:23	20:23	Radiosonde observation #RS-66
Aug. 04 (Mon.) 2008		
02:27	17:27	Radiosonde observation #RS-67
08:32	08:32	Radiosonde observation #RS-68
11:00	02:00	Doppler Radar observation stop
Aug. 05 (Tue.) 2008		
08:30	23:30	Arrival of Hachinohe
14:50	05:50	Departure of Hachinohe
17:36 – 17:52	08:36 – 08:52	8-figure running for magnetometer calibration
Aug. 06 (Wed.) 2008		
09:00	00:00	Arrival of Sekinehama

3.4 Cruise track

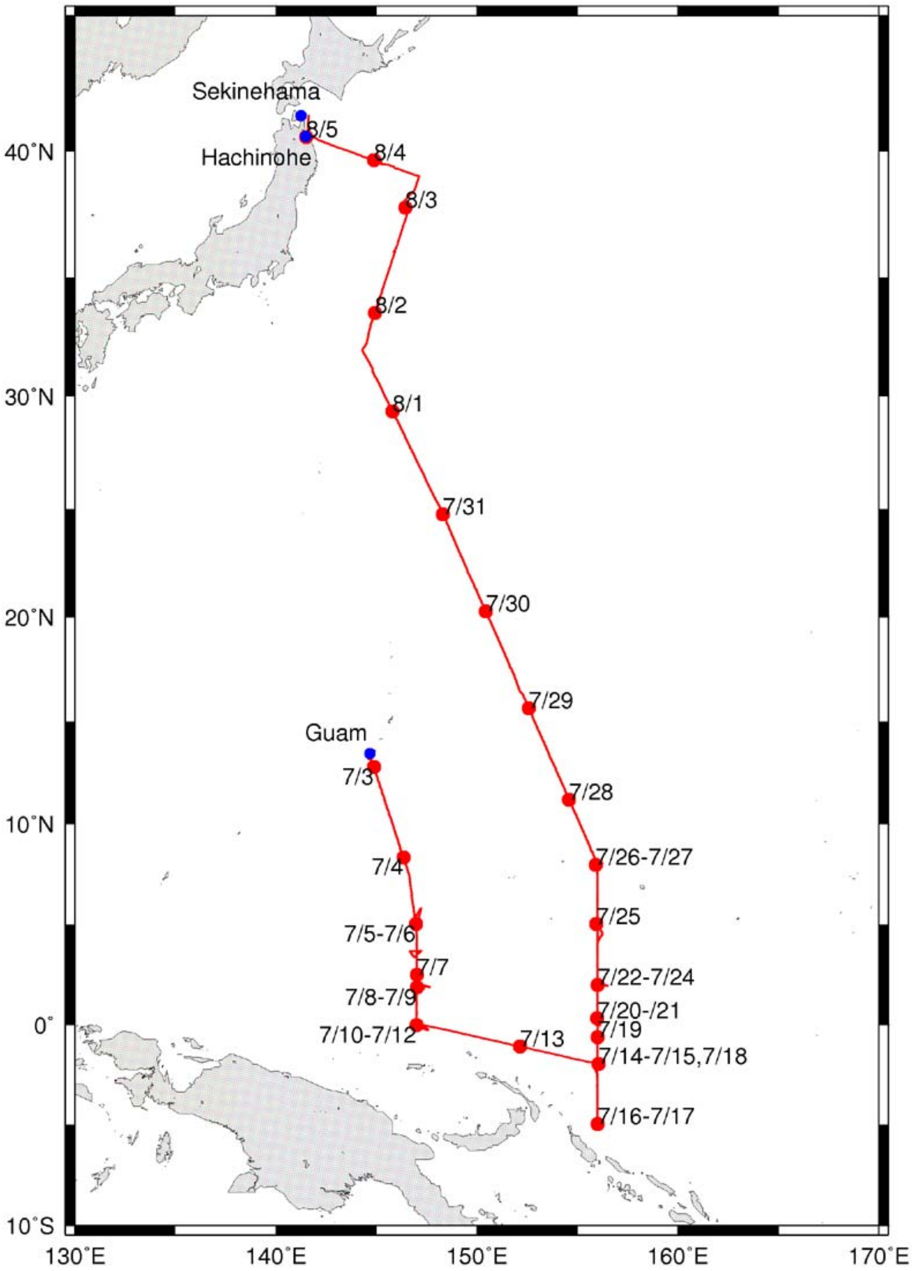


Fig 3-4.1 MR08-03 Cruise track and noon positions

4. Chief scientist

Chief Scientist

Yuji Kashino

Research Scientist

Institute of Observational Research for Global Change (IORGC),

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC) 2-15, Natsushima-cho, Yokosuka, 237-0061, Japan

5. Participants list

5.1 R/V MIRAI scientist and technical staff

Yuji Kashino	JAMSTEC
Mikiko Fujita	JAMSTEC
Yoshiyuki Nakano	JAMSTEC
Kelvin Richards	IPRC
Andrei Natarov	IPRC
Naoki Nakatani	Osaka prefecture university
Koji Tada	Osaka prefecture university
Taichi Nishiyama	Osaka prefecture university
Fumiyoshi Kondo	Okayama university
Yohei Suzuki	Chiba University
Tomohide Noguchi	MWJ
Hiroshi Matsunaga	MWJ
Keisuke Matsumoto	MWJ
Tatsuya Tanaka	MWJ
Shinsuke Toyoda	MWJ
Tetsuharu Iino	MWJ
Fuyuki Shibata	MWJ
Ayumi Takeuchi	MWJ
Kimiko Nishijima	MWJ
Shunsuke Tanaka	MWJ
Masaki Yamada	MWJ
Ryo Kimura	GODI
Kazuho Yoshida	GODI

JAMSTEC: Japan Agency for Marine-Earth Science and Technology
IPRC: International Pacific Research Center (University of Hwaii)
GODI: Global Ocean Development Inc.
MWJ: Marine Works Japan Ltd.

5.2. R/V MIRAI Crew member

Yasushi Ishioka	Master
Haruhiko Inoue	Chief Officer
Takeshi Isohi	1st Officer
Yoshimichi Nagai	2nd Officer
Noriyuki Hatachi	3rd Officer
Hiroyuki Suzuki	Chief Engineer
Hiroyuki Doi	1st Engineer
Kaoru Minami	2nd Engineer
Hiroyuki Tohken	3rd Engineer
Shuji Nakabayashi	C/R Officer
Hisao Oguni	Boatswain
Masami Sugami	Able Seaman
Yosuke Kuwahara	Able Seaman
Tsuyoshi Sato	Able Seaman
Tsuyoshi Monzawa	Able Seaman
Masashige Okada	Able Seaman
Keita Nishimura	Ordinary Seaman
Hideyuki Okubo	Ordinary Seaman
Yusuke Asano	Ordinary Seaman
Ginta Ogaki	Ordinary Seaman
Masaya Tanikawa	Ordinary Seaman
Sadanori Honda	No.1 Oiler
Yukitoshi Horiuchi	Oiler
Toshimi Yoshikawa	Oiler
Hiroki Sato	Oiler
Daisuke Taniguchi	Oiler
Yasuhiro Kitahara	Oiler
Keisuke Yoshida	Oiler
Hitoshi Ota	Chief Steward
Kitoshi Sugimoto	Cook
Hatsuji Hiraishi	Cook
Tamotsu Uemura	Cook
Kozo Uemura	Cook

6. General Observations

6.1 Meteorological measurement

6.1.1 Surface Meteorological Observation

(1) Personnel

Ryo Kimura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Not on-board :	
Kunio Yoneyama	(JAMSTEC) : Principal Investigator

(2) 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.

(3) Methods

Surface meteorological parameters were observed throughout the MR08-03 cruise. During this cruise, we used two systems for the observation.

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

i. MIRAI Surface Meteorological observation (SMET) system

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

ii. Shipboard Oceanographic and Atmospheric Radiation (SOAR) 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) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

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

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

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.

(4) Preliminary results

Figures 6.1.1 shows the time series of the following parameters;

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

(5) Data archives

These meteorological data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC just after the cruise. Corrected data sets will be available from K. Yoneyama of JAMSTEC.

(6) Remarks

i. We did not collect data in the territorial waters of USA during the following periods.
22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

ii. FRSR data was not collected in this cruise.

iii. Noises on SMet Rain gauge data were appeared due to test of shipboard emergency shortwave radio, as follows;
22:02UTC 16 Jul. 2008 – 22:03UTC 16 Jul. 2008
00:19UTC 18 Jul. 2008 – 00:20UTC 18 Jul. 2008
04:12UTC 28 Jul. 2008 – 04:17UTC 28 Jul. 2008
06:05UTC 30 Jul. 2008 – 06:06UTC 30 Jul. 2008

iv. SST (Sea Surface Temperature) data were available in the following periods.
04:30UTC 03 Jul. 2008 – 04:07UTC 03 Aug. 2008

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	AP370	Koshin Denki, Japan	captain deck (13 m) weather observation room
Rain gauge	50202	R. M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-115DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

Table.6.1.1-2 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	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	foremast (22 m)
Rain gauge	50202	R.M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-115DA	Osi, USA	foremast (24 m)

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

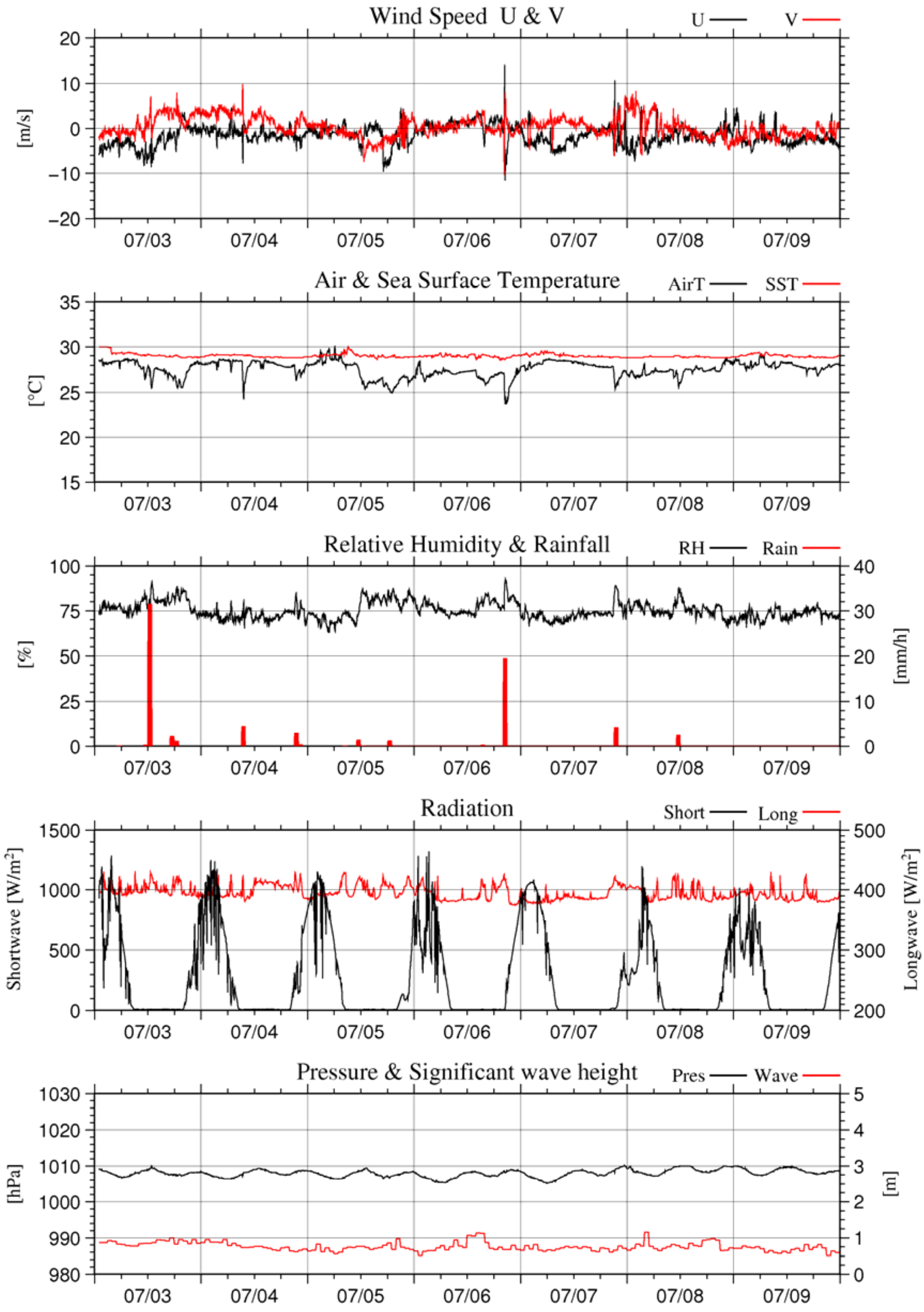


Fig.6.1.1 Time series of surface meteorological parameters during the MR07-07 Leg.1 cruise

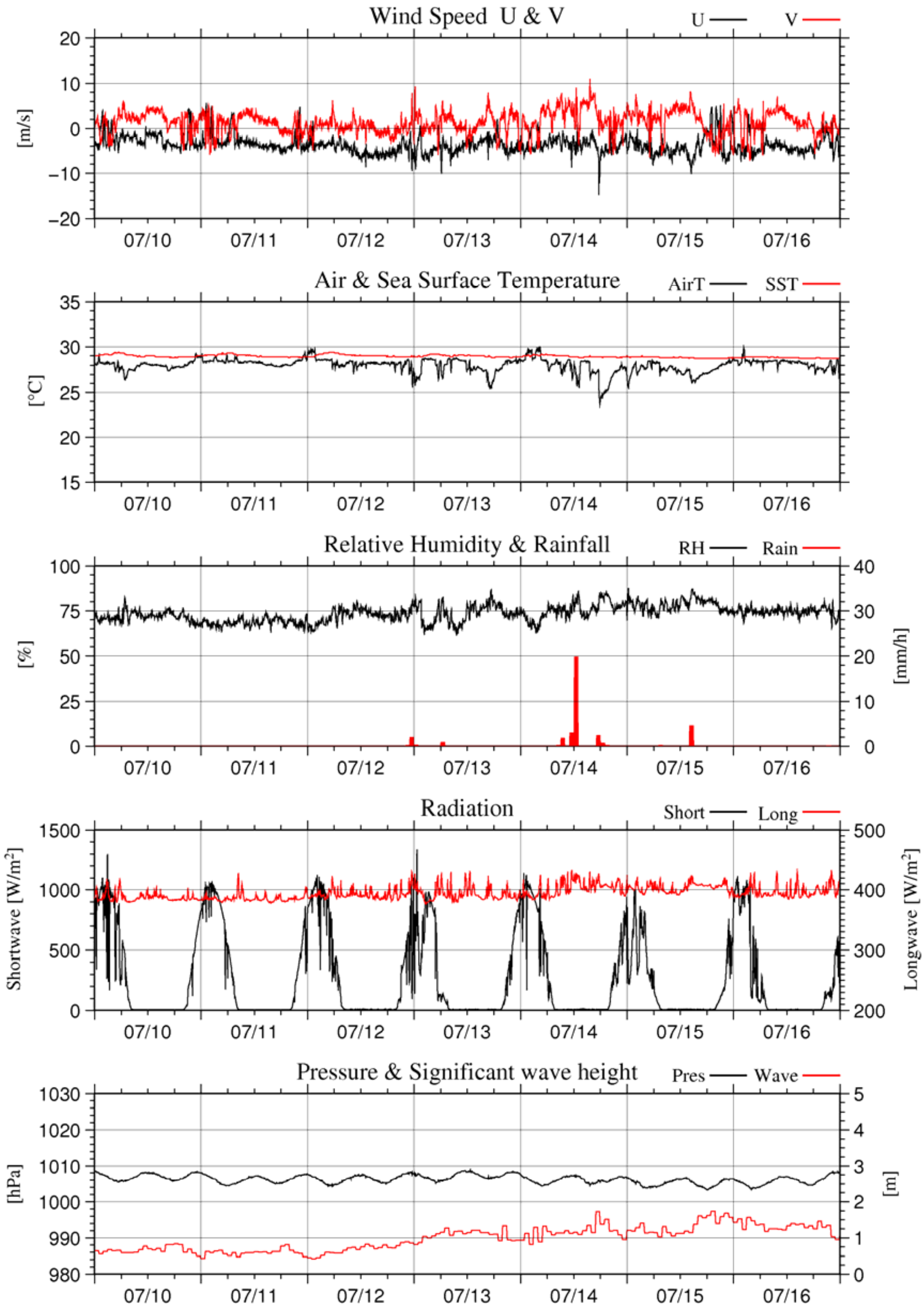


Fig.6.1.1 (Continued)

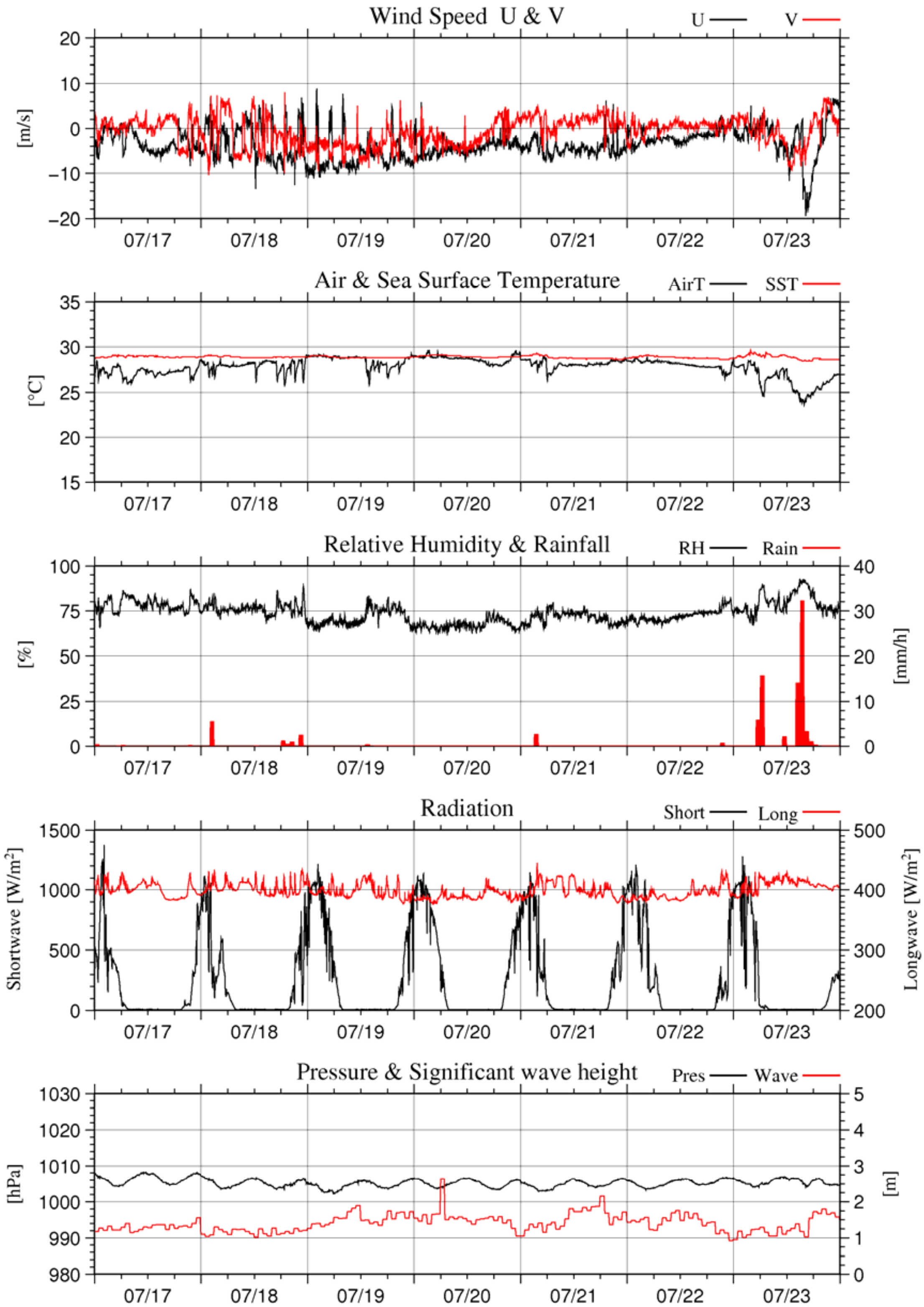


Fig.6.1.1 (Continued)

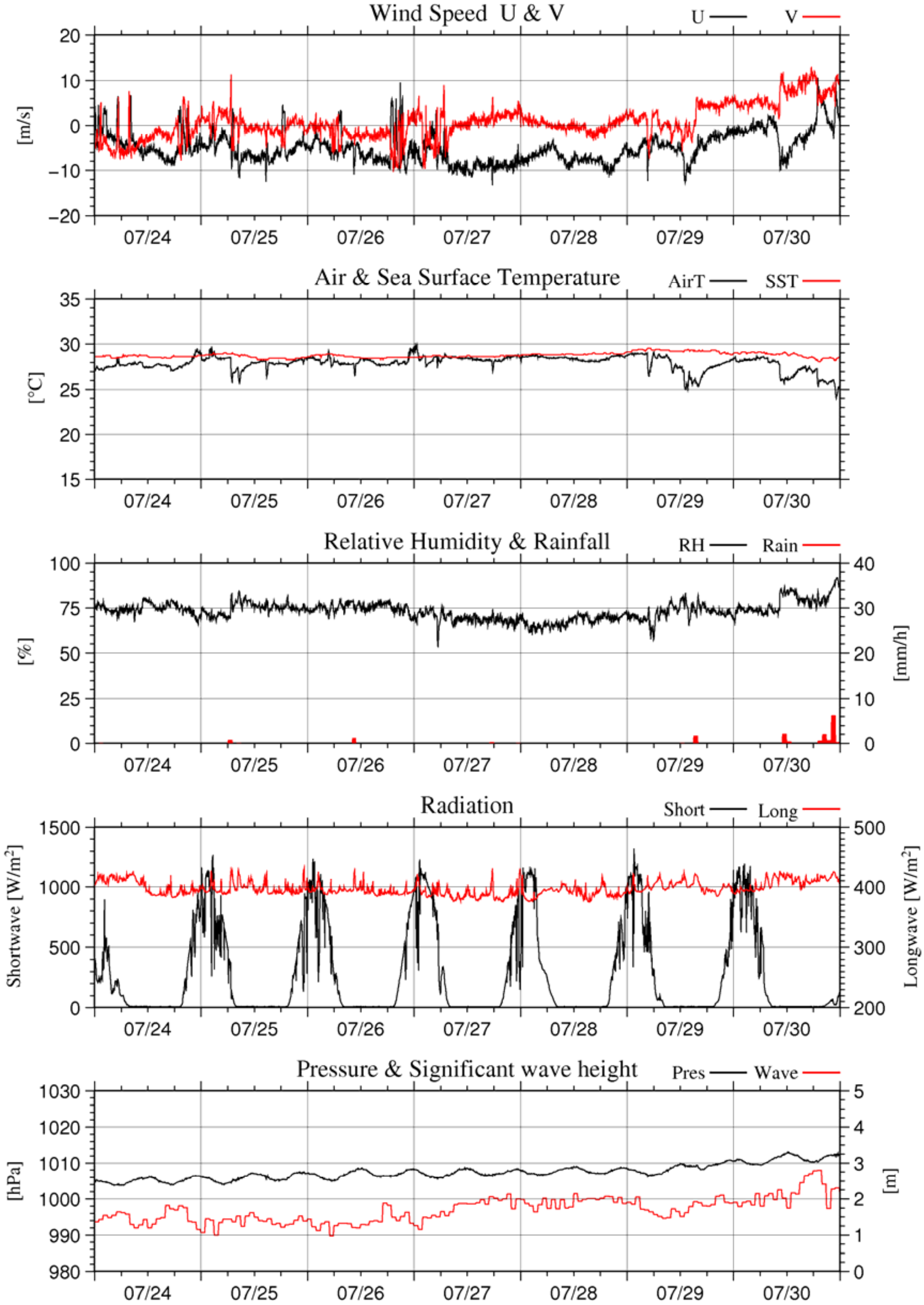


Fig.6.1.1 (Continued)

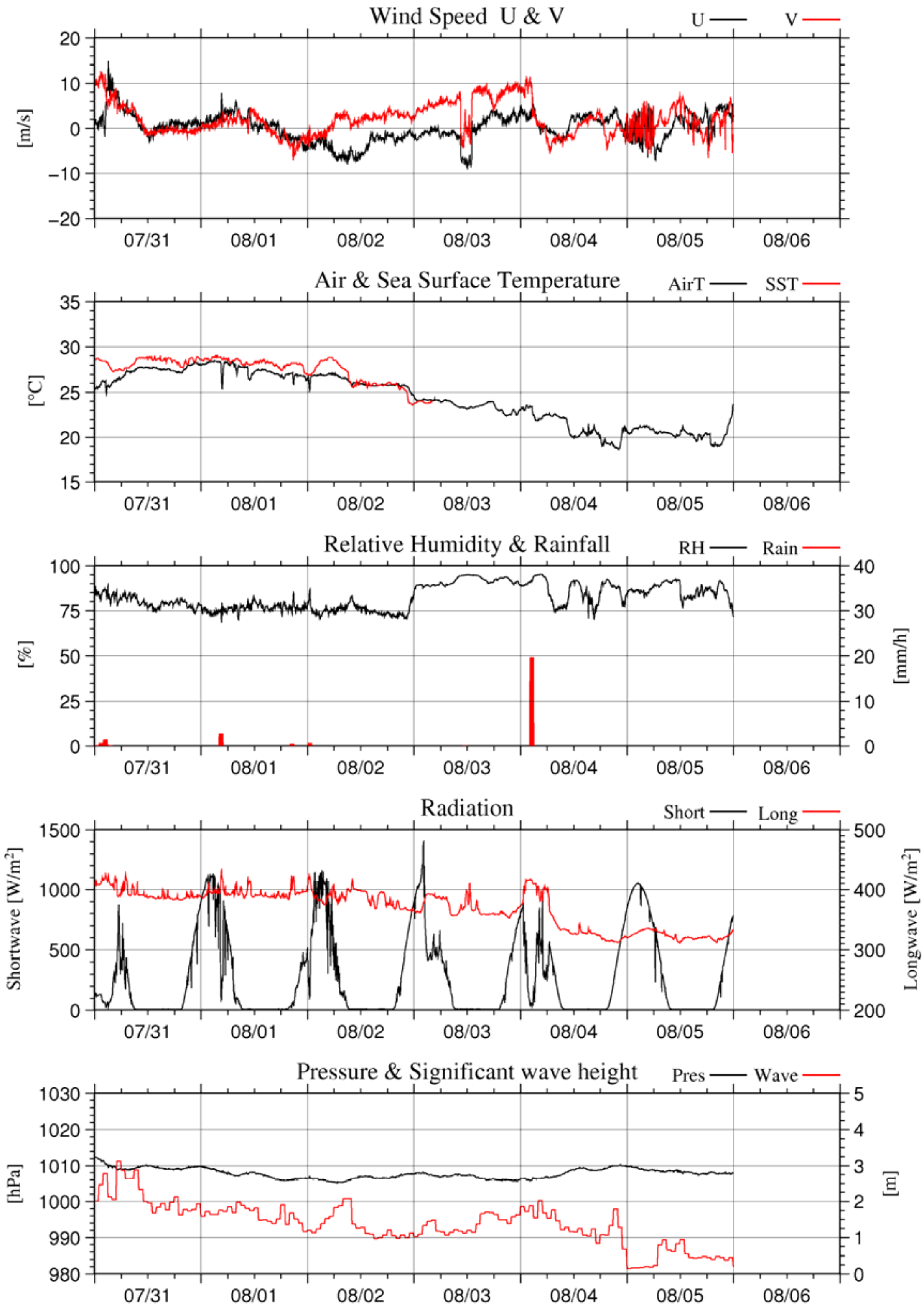


Fig.6.1.1 (Continued)

6.1.2 Ceilometer Observation

(1) Personnel

Ryo Kimura	(Global Ocean Development Inc., GODI)
Kazuho Yoshida	(GODI)
Not on-board:	
Kunio Yoneyama	(JAMSTEC) : Principal Investigator

(2) Objectives

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

(3) 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.

(4) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR08-03 cruise from the departure of Guam on 2 July 2008 to arrival of Sekinehama on 6 August 2008.

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).

(5) Preliminary results

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

(6) Data archives

The raw data obtained during this cruise will be submitted to the Marine-Earth Data and Information Department (MEDID) in JAMSTEC.

(7) Remarks

1. We did not collect data in the territorial waters of USA during the following periods.
   22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

2. Window cleaning;
   05:42UTC 03 Jul. 2008
   03:05UTC 09 Jul. 2008
   02:05UTC 21 Jul. 2008
   03:12UTC 26 Jul. 2008

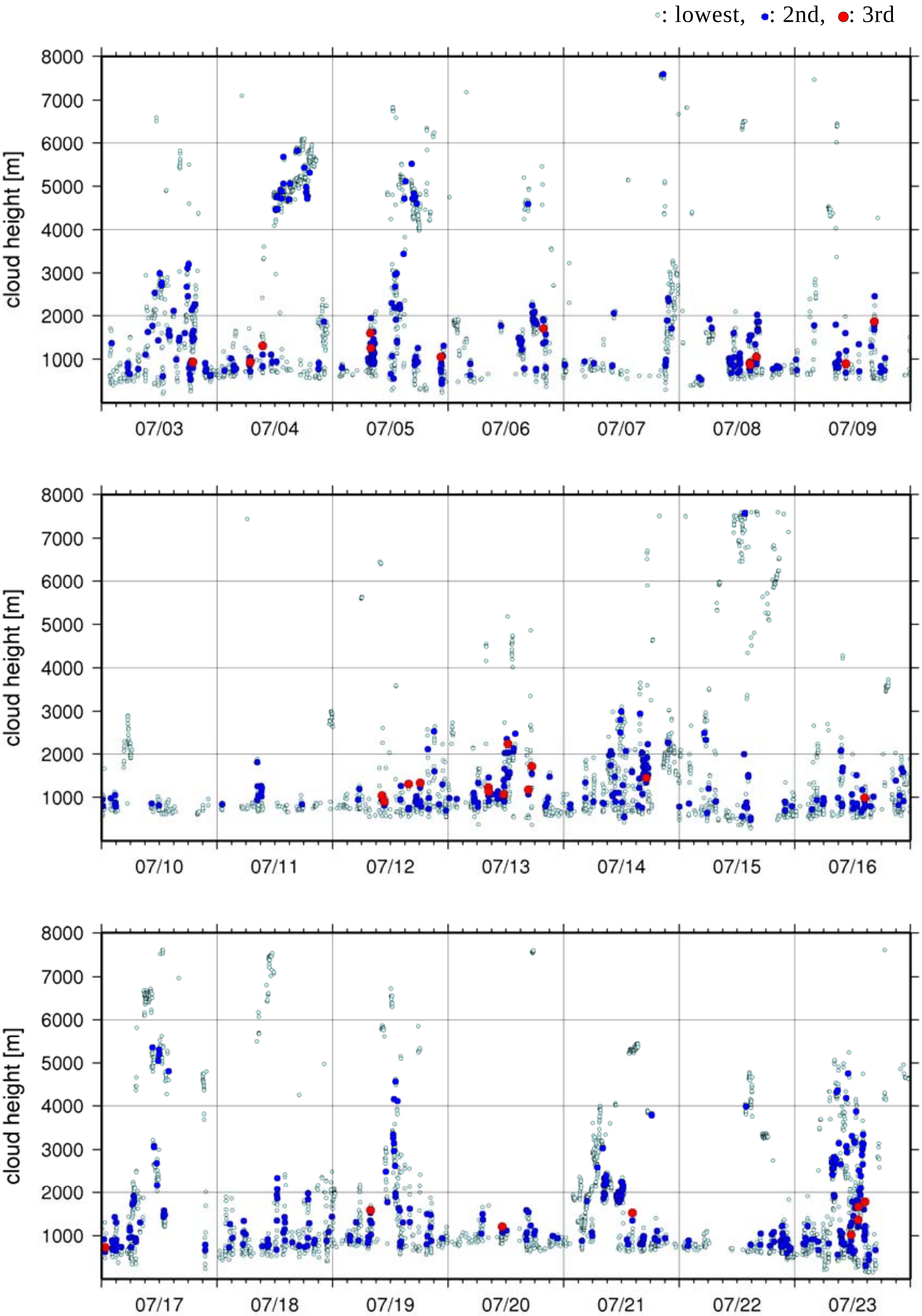


Fig.6.1.2 Lowest, 2nd and 3rd cloud base height during the cruise.

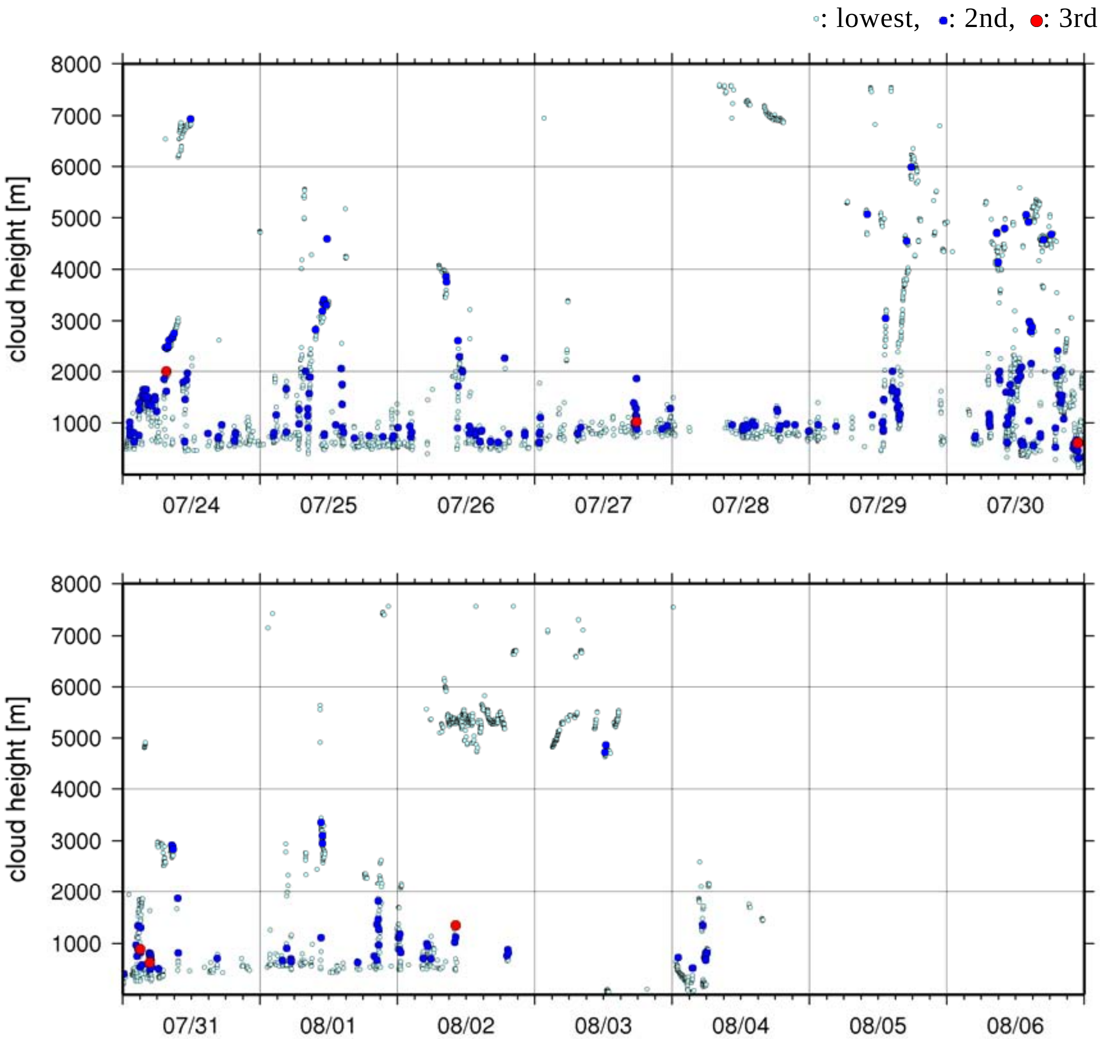


Fig.6.1.2 (Continued)

6.2 CTD/XCTD

6.2.1. CTD

Personnel	Yuji Kashino	(JAMSTEC): Principal investigator
	Shinsuke Toyoda	(MWJ): Operation leader
	Tatsuya Tanaka	(MWJ)

(1) Objective

Investigation of oceanic structure and water sampling.

(2) Overview of the equipment and observation

CTD/Carousel water sampling system (CTD system), which is 36-position Carousel Water Sampler (SBE 32) with SBE 9plus (Sea-Bird Electronics Inc) attached with sensors, was used during this cruise. 12-litter Niskin bottles were used for sampling seawater. The CTD system was deployed from starboard on working deck. During this cruise, 79 casts of CTD observation were carried out (see Table 6.2.1-1).

Primary salinity values had difference from analysis values of the sampling seawater, the difference were about 0.01. We used data of secondary temperature, conductivity sensors at all stations. But we drew oxygen profiles by dissolved oxygen values of primary sensor in Figures.

Stn.C22 cast3 (C22M03) and Stn.29 cast1 (C29M01) were cancelled.

(3) List of sensors and equipments

Under water unit:	SBE, Inc., SBE 9plus, S/N 0677
Temperature sensor:	SBE, Inc., SBE 03-04/F, S/N 031359 (Primary)
Temperature sensor:	SBE, Inc., SBE 03plus S/N 03P4421 (Secondary)
Conductivity sensor:	SBE, Inc., SBE 04C, S/N 043036 (Primary)
Conductivity sensor:	SBE, Inc., SBE 04-04/O, S/N 041206 (Secondary)
Oxygen sensor:	SBE, Inc., SBE 43, S/N 430394 (Primary)
Oxygen sensor:	SBE, Inc., SBE 43, S/N 430949 (Secondary)
Pump:	SBE, Inc., SBE 5T, S/N 054595 (Primary)
Pump:	SBE, Inc., SBE 5T, S/N 054598 (Secondary)
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P7030-0272
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3227443-0391
Water sample bottle:	General Oceanics, Inc., 12-litre Niskin-X

(4) Data processing

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

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

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

ALIGNCTD converted the time-sequence of oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. For a SBE 9plus CTD with the ducted temperature and conductivity sensors and a 3000 rpm pump, the typical net advance of the conductivity relative to the temperature is 0.073 seconds. So, the SBE 11plus deck unit was set to advance the primary conductivity for 1.73 scans (1.75/24 = 0.073 seconds). Oxygen data are also systematically delayed with respect to depth mainly because of the long time constant of the oxygen sensor and of an additional delay from the transit time of water in the pumped plumbing line. This delay was compensated by 6 seconds advancing oxygen sensor output (oxygen voltage) relative to the pressure.

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

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

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

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

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

DERIVE was used to compute oxygen.

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

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

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

(5) Preliminary Results

Date, time and locations of the CTD casts are listed in Table 6.2.1-1. Vertical profile (down cast) of secondary temperature, secondary salinity and primary dissolved oxygen with pressure are shown in Figure 6.2.1-1 - 6.2.1-20.

(6) Data archive

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

Table 6.2.1-1 MR08-03 CTD Cast table

Stn.	Cast	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire	Max	Max	CTD	Remark
		(mmddyy)	Start	End	Latitude	Longitude		Out	Depth	Pressure	Filename	
C01	1	070408	20:06	20:20	05-01.96N	146-57.82E	4255.0	198.0	199.3	200.5	C01M01	Fluorescence / light photon meters no water sample
C01	2	070508	03:06	03:26	05-01.82N	146-57.90E	4257.0	197.6	199.0	200.3	C01M02	Fluorescence / light photon meters
C01	3	070508	04:18	04:51	04-58.76N	147-01.45E	4270.0	799.1	796.3	802.4	C01M03	LADCP / Recovery point of TRITON
C01	4	070508	08:00	08:13	05-01.77N	146-57.86E	4253.0	197.3	199.3	200.5	C01M04	Fluorescence / light photon meters no water sample
C02	1	070608	03:39	03:58	04-29.85N	146-59.96E	3960.0	499.4	496.6	500.5	C02M01	LADCP
C03	1	070608	06:20	06:41	03-59.80N	147-00.20E	4676.0	500.7	496.8	500.1	C03M01	LADCP
C04	1	070608	09:09	09:22	03-29.94N	147-00.19E	4284.0	196.5	198.8	200.2	C04M01	Fluorescence no water sample
C04	2	070608	20:01	20:21	03-29.79N	147-00.22E	4264.0	499.4	496.7	500.0	C04M02	LADCP
C05	1	070608	22:53	23:16	02-59.98N	147-00.27E	4427.0	501.1	497.9	501.3	C05M01	LADCP
C06	1	070708	01:49	02:10	02-30.01N	147-00.36E	4416.0	498.9	496.7	500.1	C06M01	LADCP
C08	1	070708	07:16	07:35	01-30.27N	147-00.43E	4513.0	498.7	497.2	500.6	C08M01	LADCP
C07	1	070708	20:02	20:15	02-00.31N	147-00.48E	4509.0	198.2	199.0	200.0	C07M01	Fluorescence / light photon meters no water sample
C07	2	070808	03:06	03:25	02-00.39N	147-00.40E	4506.0	198.6	199.1	200.3	C07M02	Fluorescence / light photon meters
C07	3	070808	04:18	04:52	02-03.97N	146-58.92E	4485.0	802.3	792.3	798.4	C07M03	LADCP / Recovery point of TRITON
C07	4	070808	08:00	08:13	02-00.42N	147-00.59E	4505.0	199.3	199.2	200.4	C07M04	Fluorescence / light photon meters no water sample
C09	1	070908	05:53	06:13	01-00.01N	146-59.94E	4499.0	499.0	496.7	499.9	C09M01	LADCP
C09	2	070908	06:40	06:52	01-00.01N	146-59.95E	4510.0	196.7	198.8	200.0	C09M02	Fluorescence / light photon meters no water sample
C10	1	070908	09:16	09:37	00-30.09N	146-59.95E	4464.0	504.2	497.7	501.0	C10M01	LADCP

C11	1	071008	03:07	03:40	00-02.79N	146-58.84E	4369.0	800.8	796.7	802.5	C11M01	LADCP / Recovery point of TRITON
C11	2	071008	20:00	20:13	00-00.18S	147-02.34E	4446.0	197.1	198.9	200.1	C11M02	Fluorescence / light photon meters no water sample
C11	3	071108	03:04	03:25	00-00.29S	147-02.23E	4447.0	199.3	199.1	200.3	C11M03	Fluorescence / light photon meters
C11	4	071108	08:00	08:12	00-00.45S	147-02.14E	4472.0	198.0	198.7	199.9	C11M04	Fluorescence / light photon meters no water sample
C18	1	071308	19:02	19:14	01-58.29S	155-58.93E	1741.0	196.7	199.3	200.5	C18M01	Fluorescence / light photon meters no water sample corrected raw data filename
C18	2	071308	23:43	00:17	01-59.45S	156-01.03E	1751.0	799.9	795.1	800.8	C18M02	LADCP / Deployment point of TRITON corrected raw data filename
C18	3	071408	02:06	02:28	01-58.47S	155-58.81E	1741.0	197.1	198.5	199.9	C18M03	Fluorescence / light photon meters
C18	4	071408	03:43	04:18	01-56.32S	155-48.60E	1811.0	799.9	794.9	800.5	C18M04	LADCP / Recovery point of TRITON
C18	5	071408	07:01	07:14	01-58.46S	155-58.77E	1741.0	197.3	199.0	200.2	C18M05	Fluorescence / light photon meters no water sample
C17	1	071508	02:25	02:45	02-30.09S	156-00.11E	1738.0	498.9	497.0	500.6	C17M01	LADCP / Fluorescence
C16	1	071508	05:05	05:25	03-00.01S	155-59.98E	1813.0	498.3	497.3	500.6	C16M01	LADCP / Fluorescence
C15	1	071508	07:44	07:56	03-30.01S	156-00.05E	1892.0	197.1	198.7	200.2	C15M01	Fluorescence / light photon meters no water sample
C15	2	071508	08:12	08:32	03-29.80S	156-00.04E	1892.0	498.5	496.9	500.3	C15M02	LADCP
C12	1	071508	19:00	19:12	04-59.79S	155-59.80E	1530.0	197.1	199.8	201.0	C12M01	Fluorescence / light photon meters no water sample
C12	2	071508	23:34	00:09	04-57.88S	156-00.17E	1518.0	803.9	794.5	801.3	C12M02	LADCP / Deployment point of TRITON
C12	3	071608	02:03	02:22	05-00.01S	155-59.80E	1534.0	196.7	198.5	199.8	C12M03	Fluorescence / light photon meters
C12	4	071608	03:17	03:50	05-02.40S	156-00.11E	1539.0	798.6	792.4	796.6	C12M04	LADCP / Recovery point of TRITON
C12	5	071608	06:59	07:11	04-59.98S	156-00.36E	1522.0	197.5	199.5	200.7	C12M05	Fluorescence / light photon meters no water sample

C13	1	071708	02:09	02:29	04-29.99S	155-59.93E	1717.0	498.1	497.1	500.5	C13M01	LADCP / Fluorescence
C14	1	071708	05:08	05:30	03-59.98S	155-59.93E	1781.0	498.3	497.3	500.6	C14M01	LADCP / Fluorescence
C18	6	071708	19:02	19:14	01-58.29S	155-58.88E	1739.0	196.0	198.8	199.8	C18M06	Fluorescence / light photon meters / LADCP no water sample
C18	7	071708	22:03	22:16	01-58.32S	155-58.79E	1742.0	198.6	198.9	200.1	C18M07	Fluorescence / light photon meters / LADCP no water sample
C18	8	071808	01:01	01:23	01-58.50S	155-58.68E	1742.0	198.6	198.8	200.3	C18M08	Fluorescence / light photon meters / LADCP
C18	9	071808	04:02	04:14	01-58.54S	155-58.79E	1741.0	197.3	199.0	200.5	C18M09	Fluorescence / light photon meters / LADCP no water sample
C18	10	071808	07:02	07:14	01-58.54S	155-58.84E	1740.0	198.4	199.6	200.8	C18M10	Fluorescence / light photon meters / LADCP no water sample
C18	11	071808	10:01	10:14	01-58.45S	155-58.84E	1739.0	197.5	198.9	200.1	C18M11	Fluorescence / LADCP no water sample
C18	12	071808	13:01	13:22	01-58.41S	155-58.79E	1741.0	198.2	198.9	200.1	C18M12	Fluorescence / LADCP
C18	13	071808	16:00	16:11	01-58.40S	155-58.89E	1740.0	198.6	199.1	200.3	C18M13	Fluorescence / LADCP no water sample
C19	1	071808	18:59	19:18	01-29.94S	155-59.71E	1820.0	500.5	497.4	500.9	C19M01	LADCP / Fluorescence
C20	1	071808	21:59	22:12	00-59.89S	155-59.82E	2082.0	200.4	199.0	200.1	C20M01	Fluorescence / LADCP no water sample
C20	2	071808	22:46	23:06	00-59.80S	155-59.76E	2082.0	502.3	497.4	500.2	C20M02	LADCP
C21	1	071908	02:01	02:22	00-29.91S	155-59.89E	1951.0	500.7	497.4	500.8	C21M01	LADCP / Fluorescence
C22	1	071908	05:00	05:33	00-00.63N	156-01.38E	1952.0	800.4	795.0	800.6	C22M01	LADCP / Recovery point of TRITON
C23	1	071908	07:58	08:28	00-30.20N	155-59.92E	2144.0	500.1	497.4	500.2	C23M01	LADCP / Fluorescence
C22	2	071908	19:01	19:14	00-00.82S	155-59.83E	1947.0	200.8	198.5	200.1	C22M02	Fluorescence / light photon meters no water sample
C22	4	072008	00:05	00:25	00-00.15S	155-58.75E	1946.0	209.6	199.4	200.8	C22M04	Fluorescence / light photon meters

C22	5	072008	06:59	07:12	00-00.71S	155-58.66E	1941.0	200.6	198.6	199.9	C22M05	Fluorescence / light photon meters no water sample
C24	1	072108	04:24	04:37	01-00.15N	155-59.81E	2263.0	199.5	199.3	200.4	C24M01	Fluorescence / light photon meters no water sample
C24	2	072108	04:56	05:17	01-00.21N	155-59.60E	2267.0	500.7	496.8	500.1	C24M02	LADCP
C25	1	072108	07:49	08:09	01-30.25N	155-59.76E	2384.0	499.6	497.8	500.8	C25M01	LADCP / Fluorescence
C26	1	072108	19:00	19:13	01-59.18N	156-00.04E	2578.0	197.5	199.4	200.6	C26M01	Fluorescence / light photon meters no water sample
C26	2	072208	00:13	00:46	01-58.48N	156-00.00E	2575.0	799.1	793.1	799.6	C26M02	LADCP / Deployment point of TRITON
C26	3	072208	02:07	02:27	01-59.31N	155-59.80E	2579.0	200.0	199.7	200.9	C26M03	Fluorescence / light photon meters
C26	4	072208	03:21	03:55	02-03.02N	156-01.67E	2577.0	801.7	794.3	800.2	C26M04	LADCP / Recovery point of TRITON
C26	5	072208	07:00	07:13	01-59.32N	156-00.16E	2579.0	198.2	199.3	200.5	C26M05	Fluorescence / light photon meters no water sample
C27	1	072308	03:36	03:56	02-30.76N	156-00.25E	2677.0	499.2	496.8	500.2	C27M01	LADCP / Fluorescence
C28	1	072308	06:05	06:25	03-00.12N	156-00.28E	2869.0	498.3	496.7	500.2	C28M01	LADCP / Fluorescence
C29	2	072308	08:37	08:57	03-29.92N	156-00.06E	3247.0	502.0	497.3	500.6	C29M02	LADCP / Fluorescence
C32	1	072408	02:07	02:40	05-00.85N	155-59.80E	3607.0	799.5	794.4	801.0	C32M01	LADCP / Recovery point of TRITON
C31	1	072408	05:07	05:27	04-30.24N	156-00.10E	3555.0	497.8	497.1	500.1	C31M01	LADCP / Fluorescence
C30	1	072408	07:52	08:12	04-00.46N	155-59.91E	3474.0	500.5	497.0	500.3	C30M01	LADCP / Fluorescence
C32	2	072408	19:01	19:14	05-01.44N	155-57.29E	3596.0	195.6	199.0	200.2	C32M02	Fluorescence / light photon meters no water sample
C32	3	072508	02:07	02:26	05-01.33N	155-57.11E	3596.0	198.0	199.2	200.4	C32M03	Fluorescence / light photon meters
C32	4	072508	07:10	07:23	05-01.55N	155-57.48E	3596.0	196.5	199.3	200.4	C32M04	Fluorescence / light photon meters no water sample
C33	1	072508	18:31	18:52	06-30.30N	155-59.87E	4412.0	499.0	497.8	501.1	C33M01	LADCP / Fluorescence
C34	1	072608	07:02	07:35	07-58.47N	156-00.44E	4835.0	799.7	794.3	800.3	C34M01	LADCP / Recovery point of TRITON

C34	2	072608	19:01	19:14	07-57.46N	156-00.67E	4851.0	196.4	199.1	200.4	C34M02	Fluorescence / light photon meters no water sample
C34	3	072708	02:05	02:25	07-57.41N	156-00.51E	4860.0	198.0	199.8	200.5	C34M03	Fluorescence / light photon meters
C34	4	072708	03:03	03:42	07-57.66N	156-00.47E	4865.0	996.8	992.3	1000.3	C34M04	XCTD / LADCP
C34	5	072708	04:15	04:56	07-58.06N	156-00.61E	4839.0	999.6	994.0	1002.0	C34M05	XCTD / LADCP
C34	6	072708	07:25	07:37	07-57.26N	156-00.16E	4827.0	195.8	198.8	199.9	C34M06	Fluorescence / LADCP no water sample

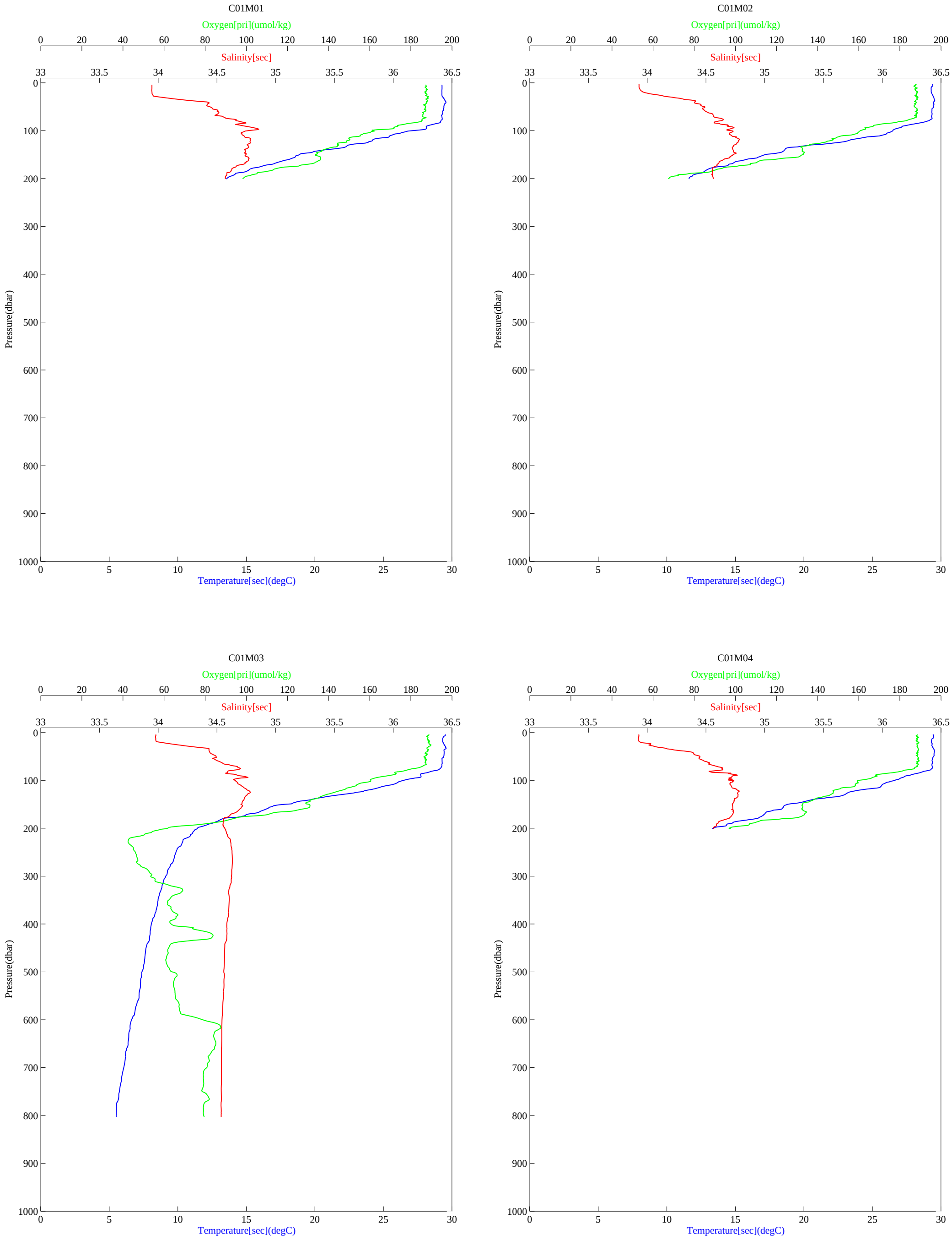


Figure 6.2.1-1 CTD profile (C01M01, C01M02, C01M03 and C01M04)

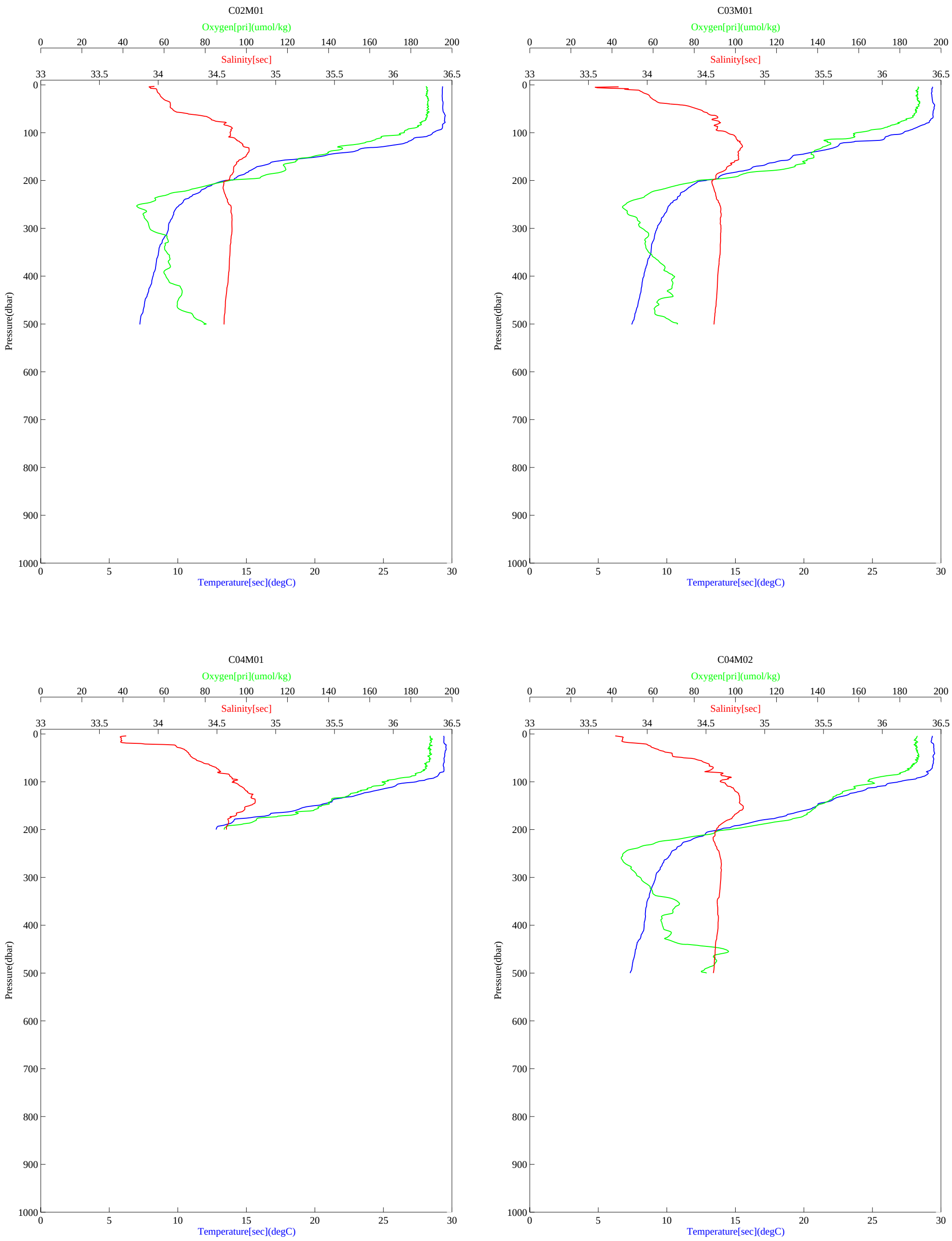


Figure 6.2.1-2 CTD profile (C02M01, C03M01, C04M01 and C04M02)

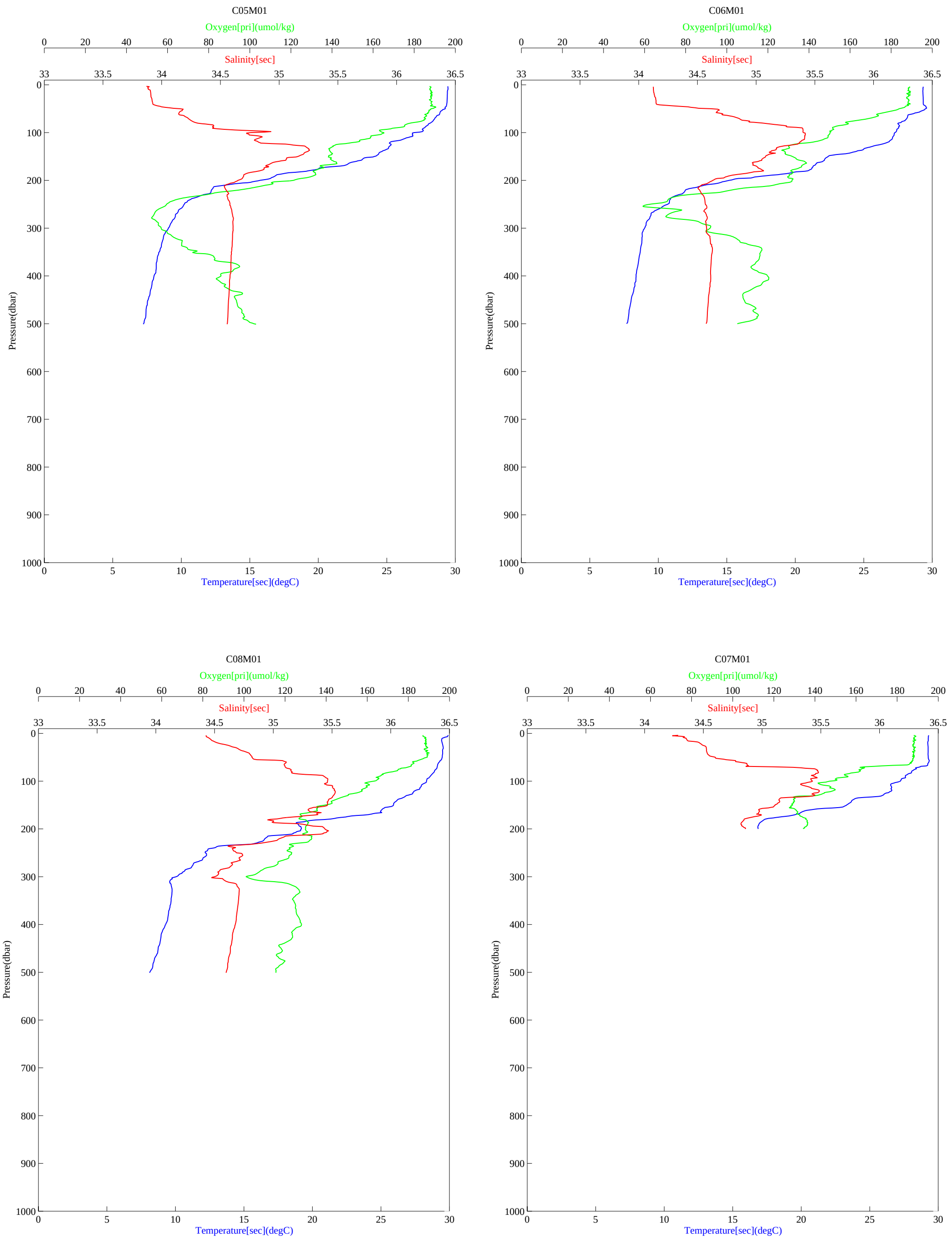


Figure 6.2.1-3 CTD profile (C05M01, C06M01, C08M01 and C07M01)

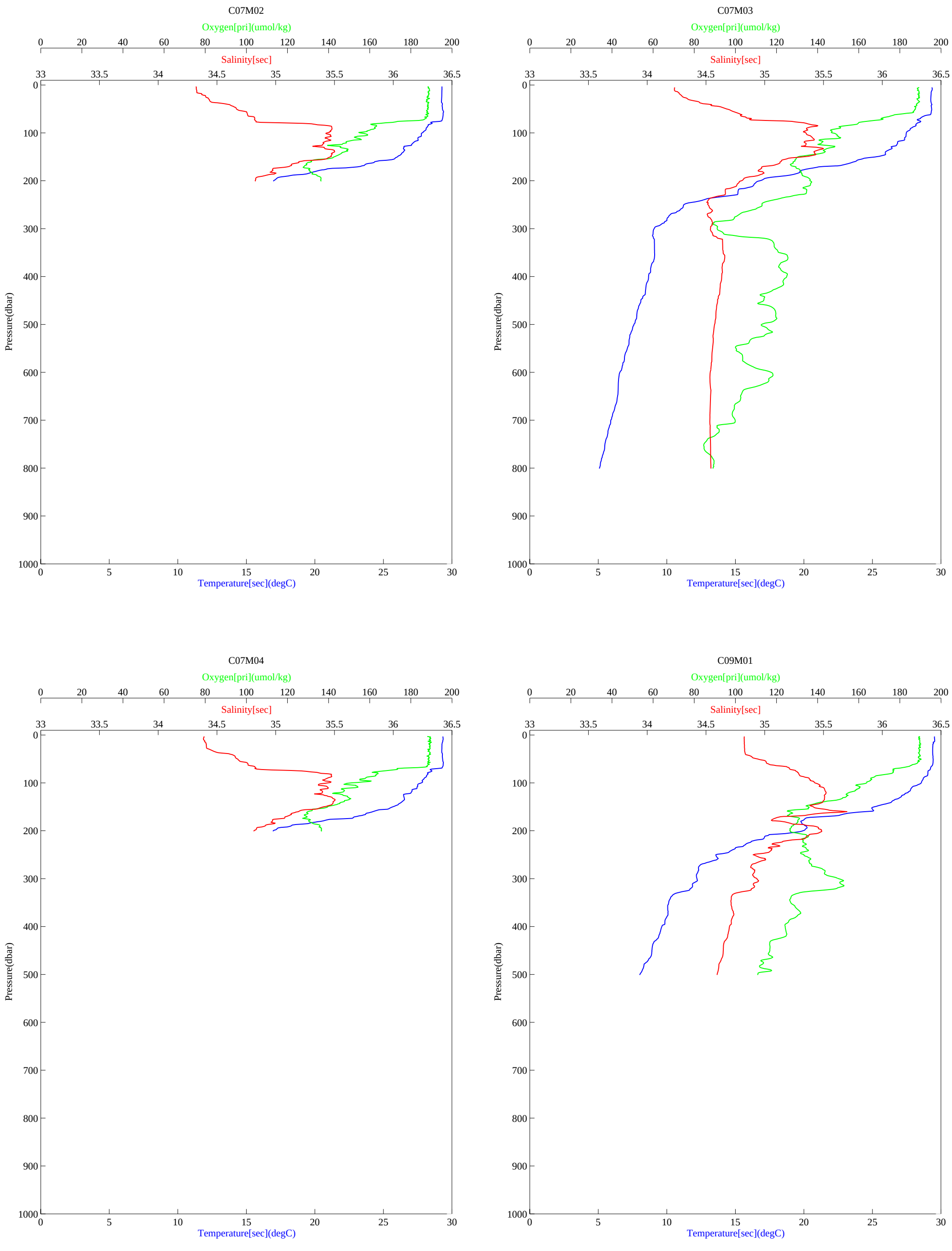


Figure 6.2.1-4 CTD profile (C07M02, C07M03, C07M04 and C09M01)

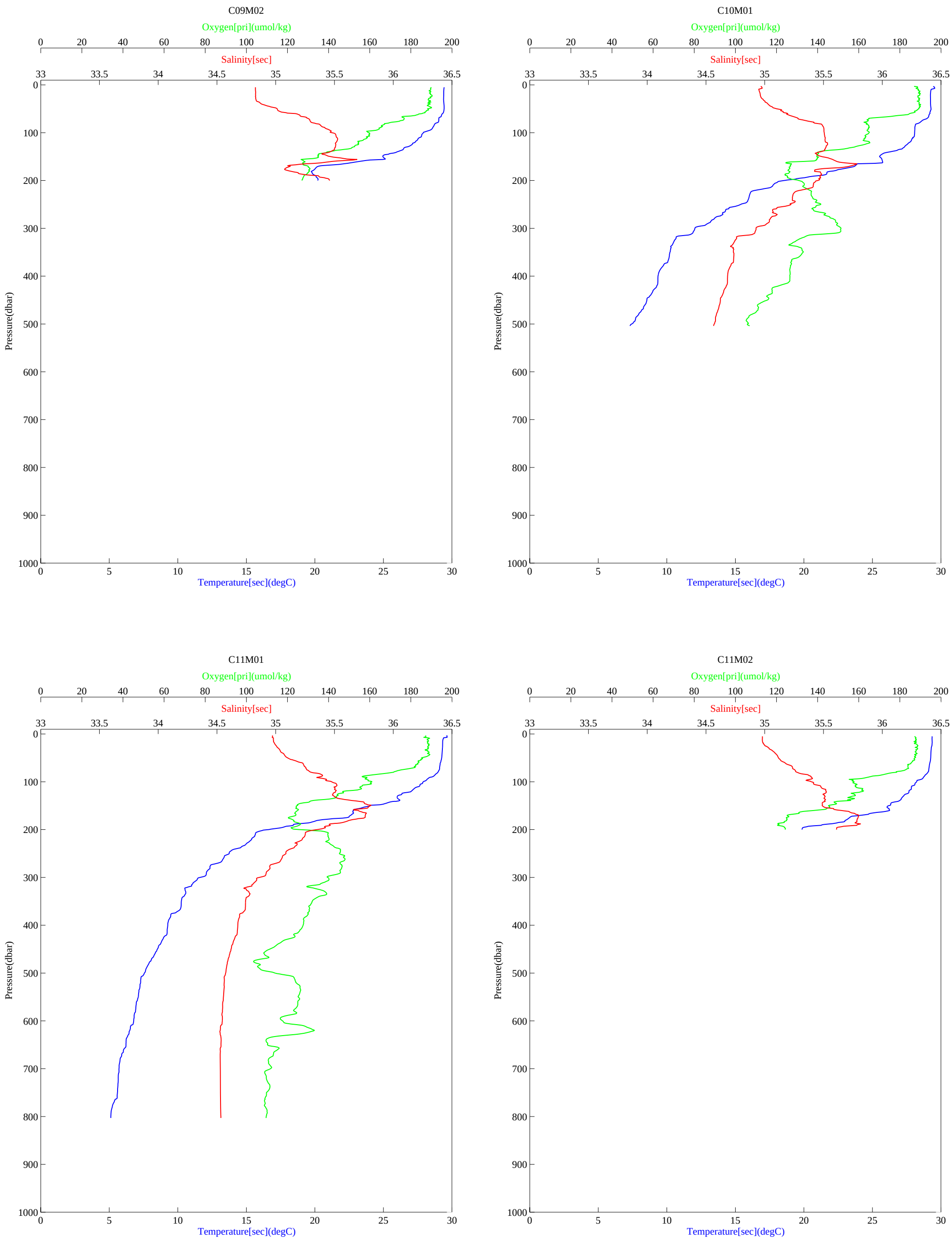


Figure 6.2.1-5 CTD profile (C09M02, C10M01, C11M01 and C11M02)

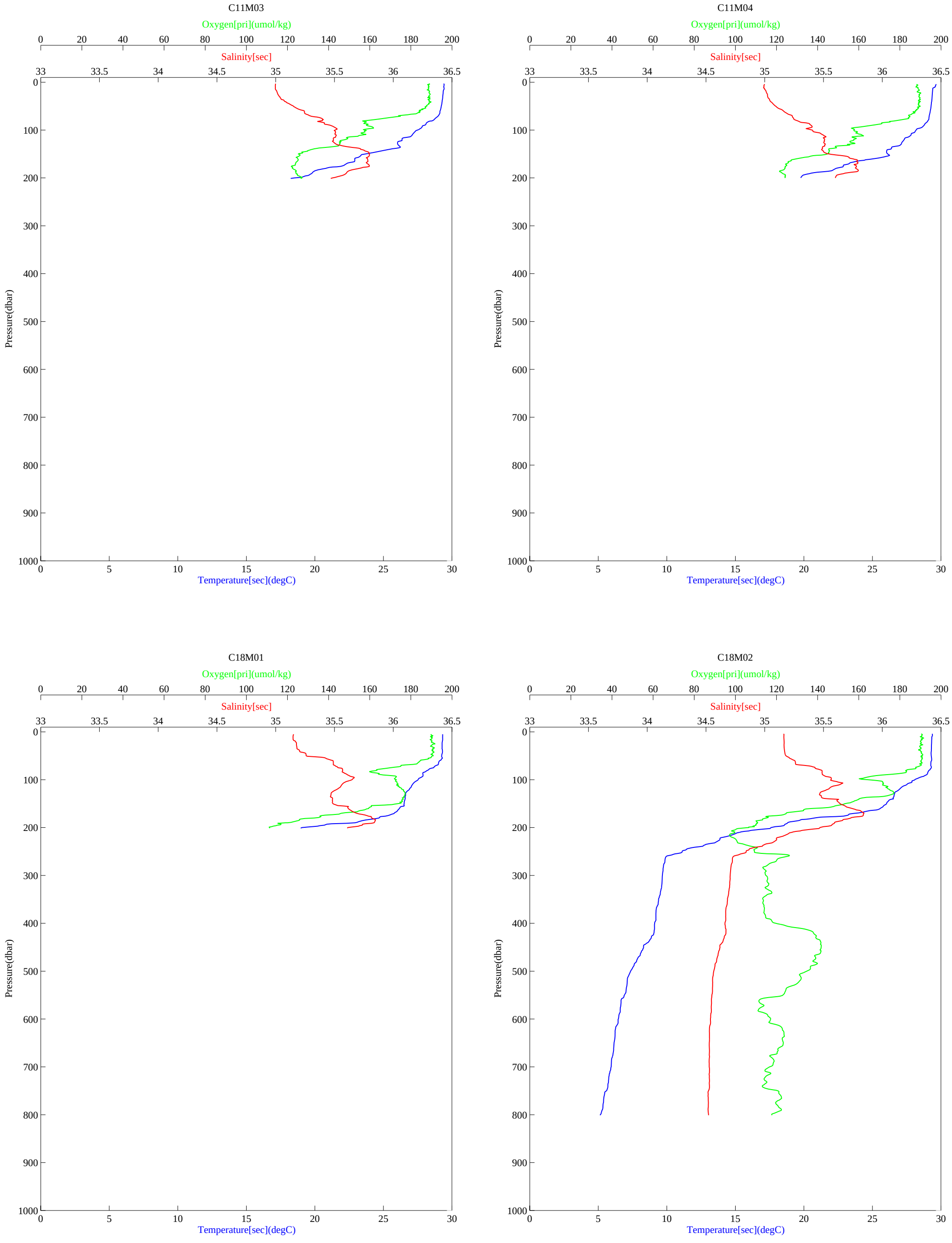


Figure 6.2.1-6 CTD profile (C11M03, C11M04, C18M01 and C18M02)

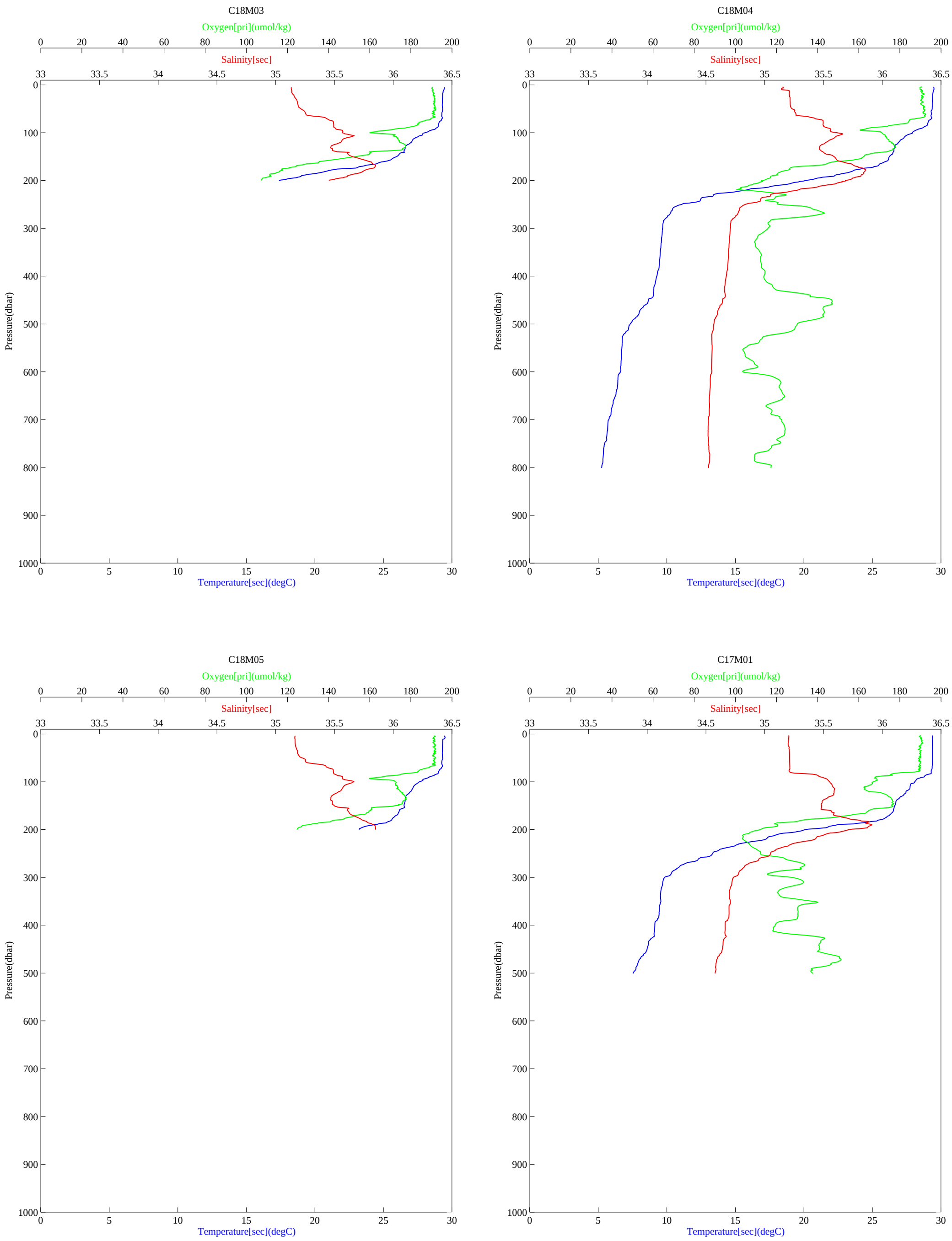


Figure 6.2.1-7 CTD profile (C18M03, C18M04, C18M05 and C17M01)

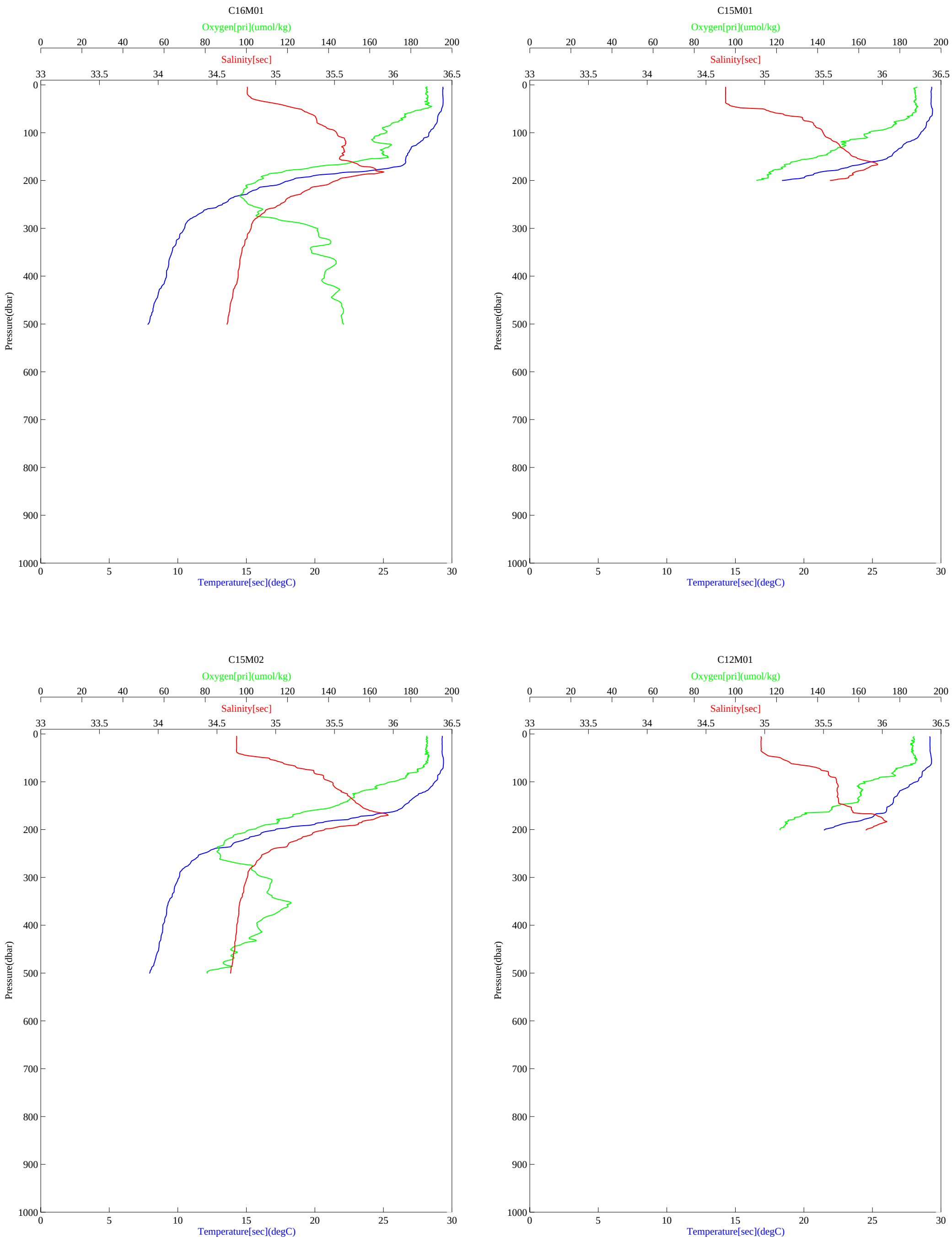


Figure 6.2.1-8 CTD profile (C16M01, C15M01, C15M02 and C12M01)

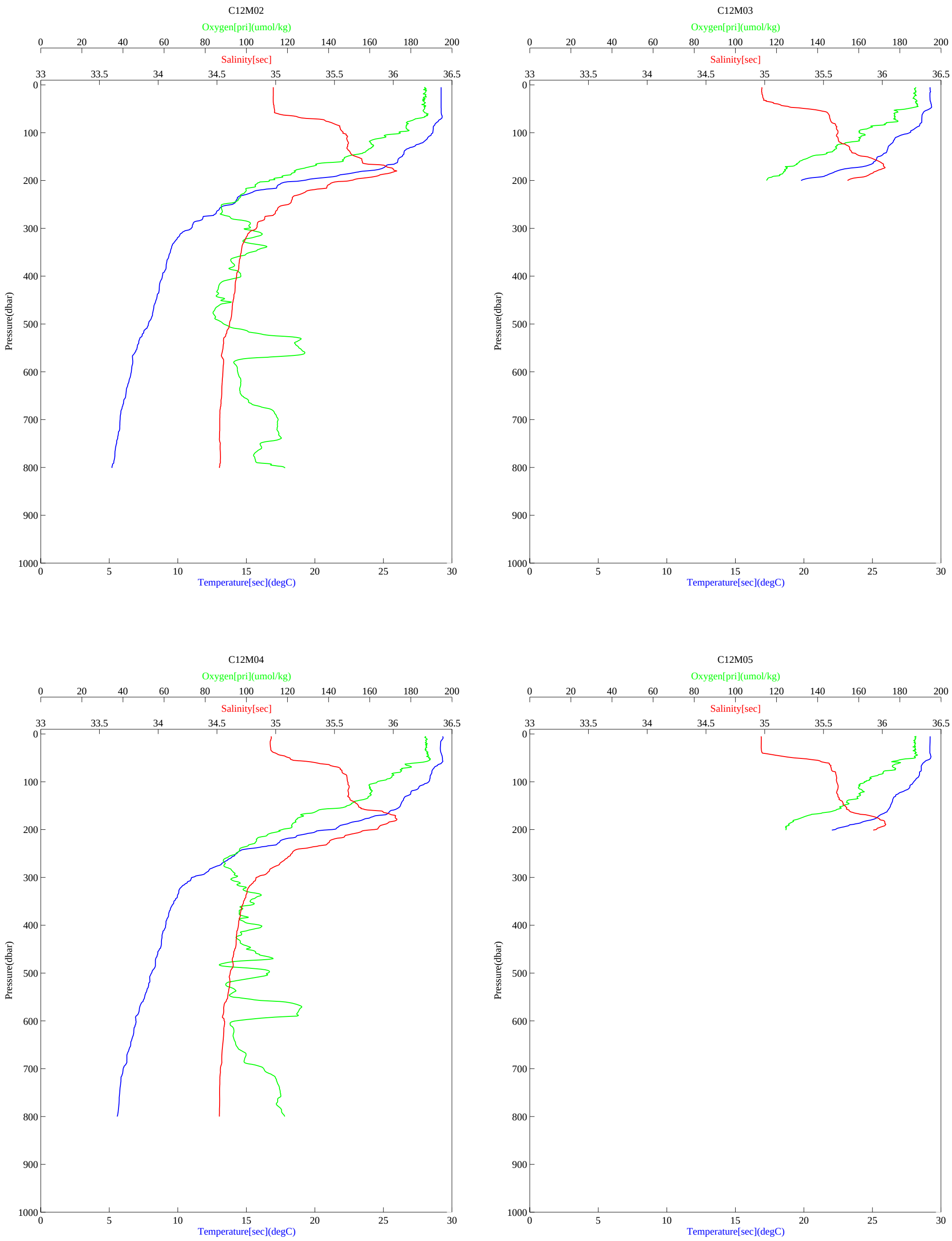


Figure 6.2.1-9 CTD profile (C12M02, C12M03, C12M04 and C12M05)

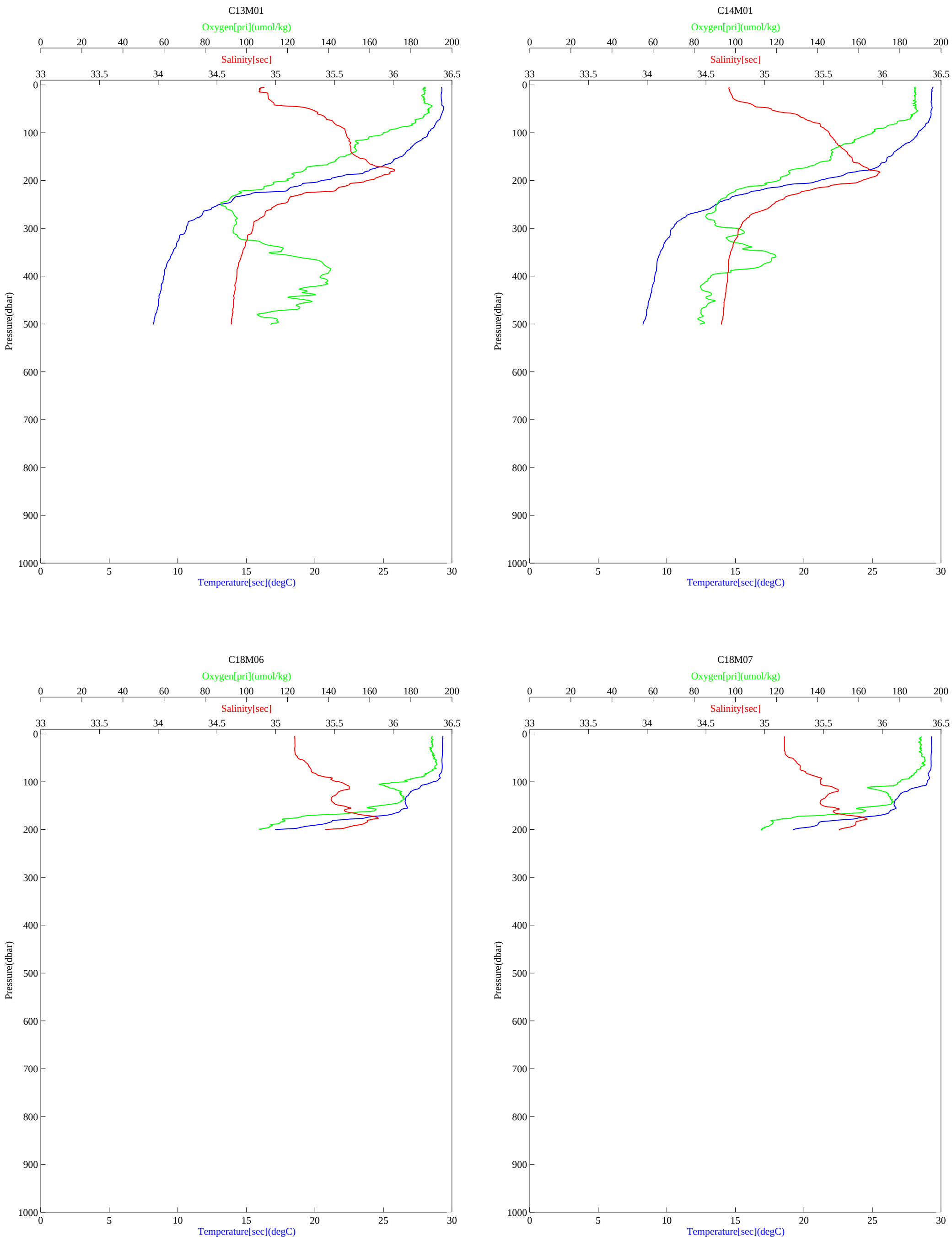


Figure 6.2.1-10 CTD profile (C13M01, C14M01, C18M06 and C18M07)

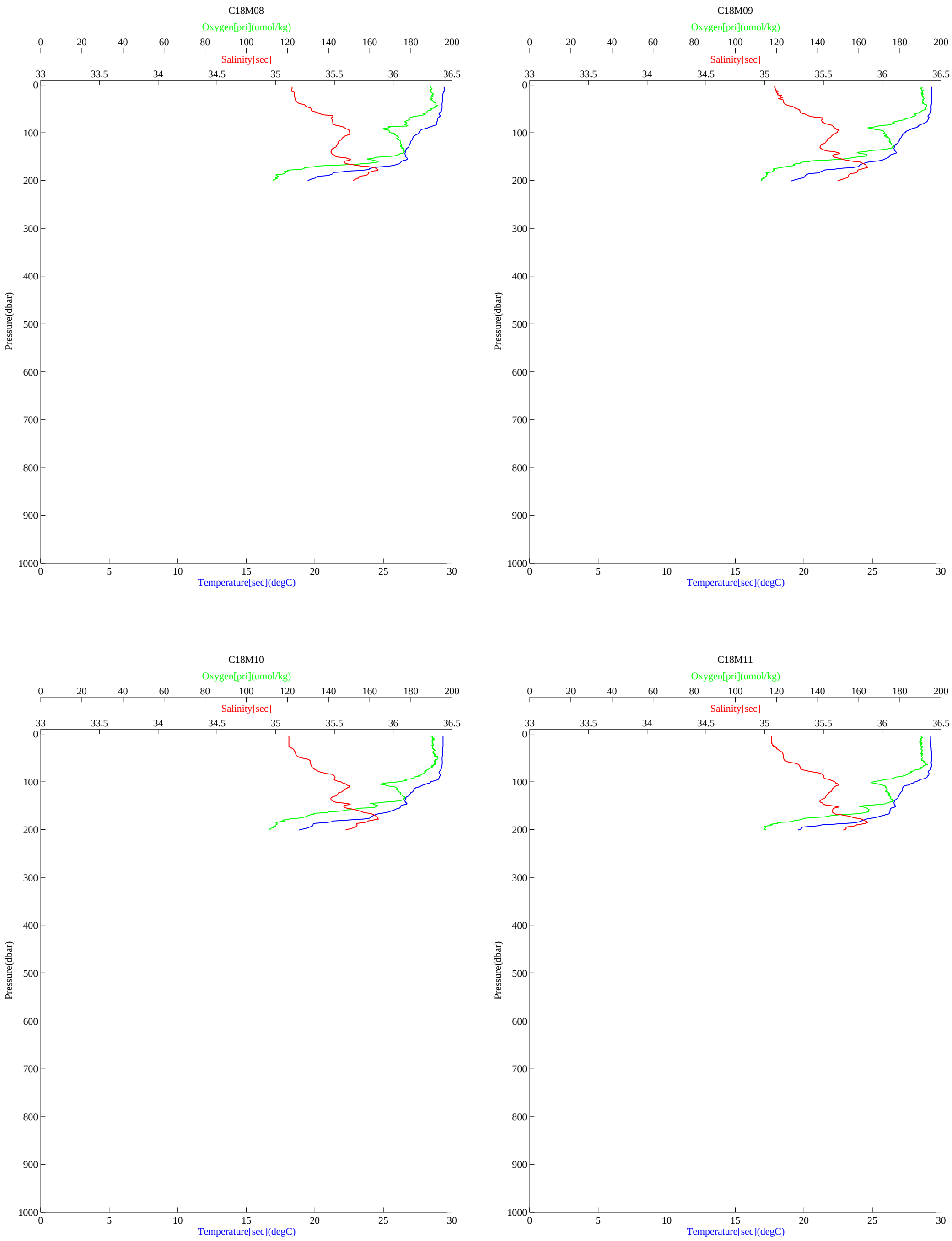


Figure 6.2.1-11 CTD profile (C18M08, C18M09, C18M10 and C18M11)

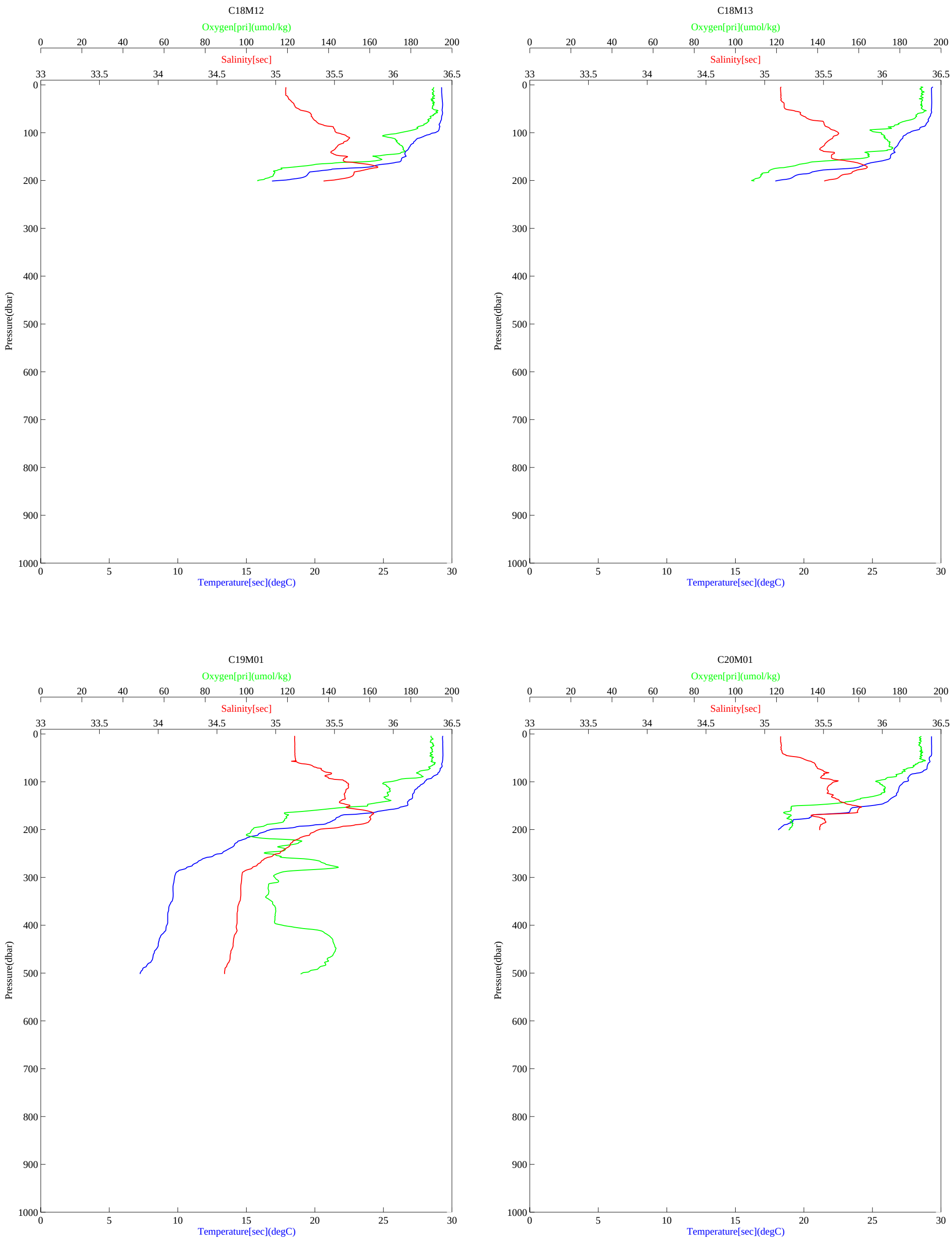


Figure 6.2.1-12 CTD profile (C18M12, C18M13, C19M01 and C20M01)

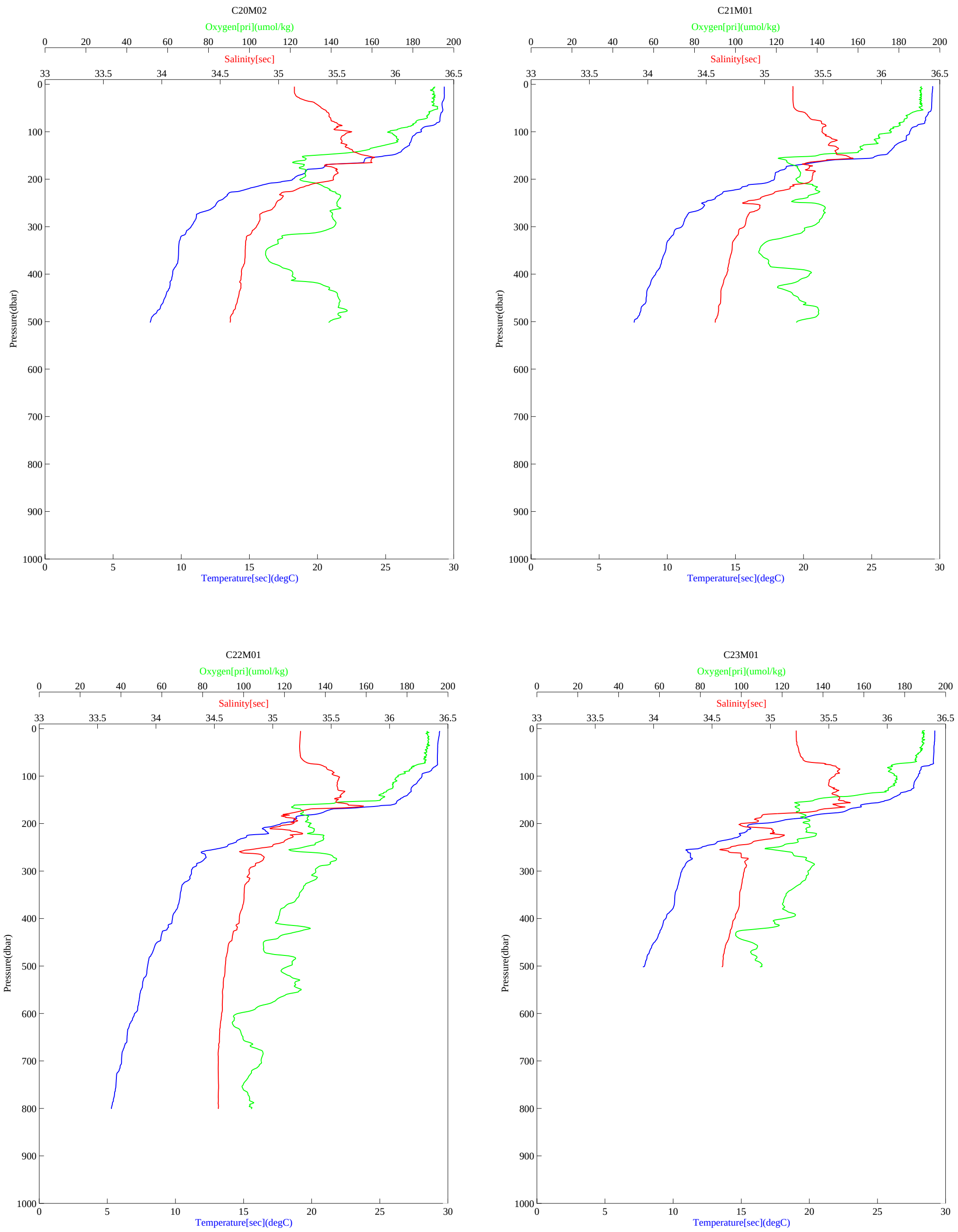


Figure 6.2.1-13 CTD profile (C20M02, C21M01, C22M01 and C23M01)

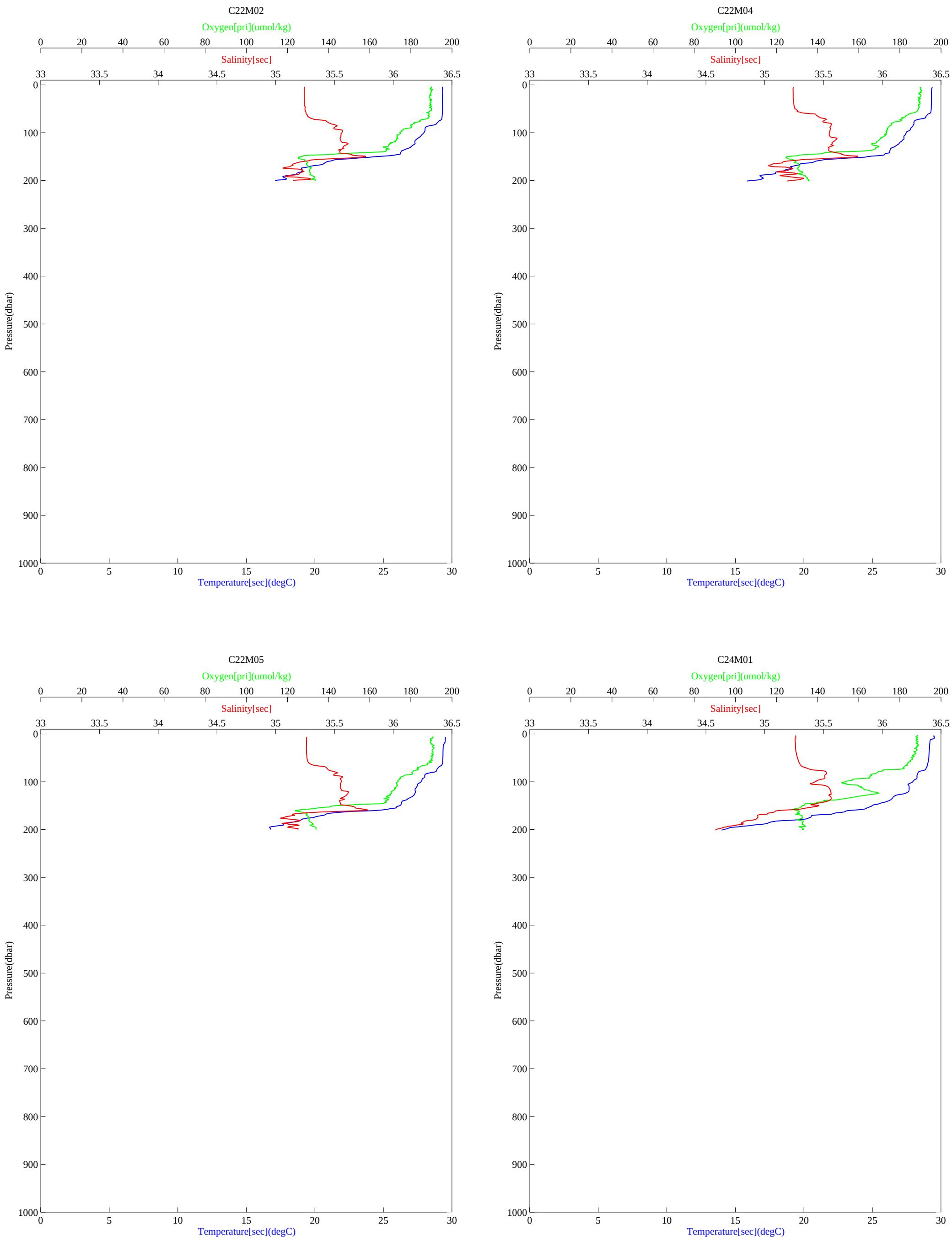


Figure 6.2.1-14 CTD profile (C22M02, C22M04, C22M05 and C24M01)

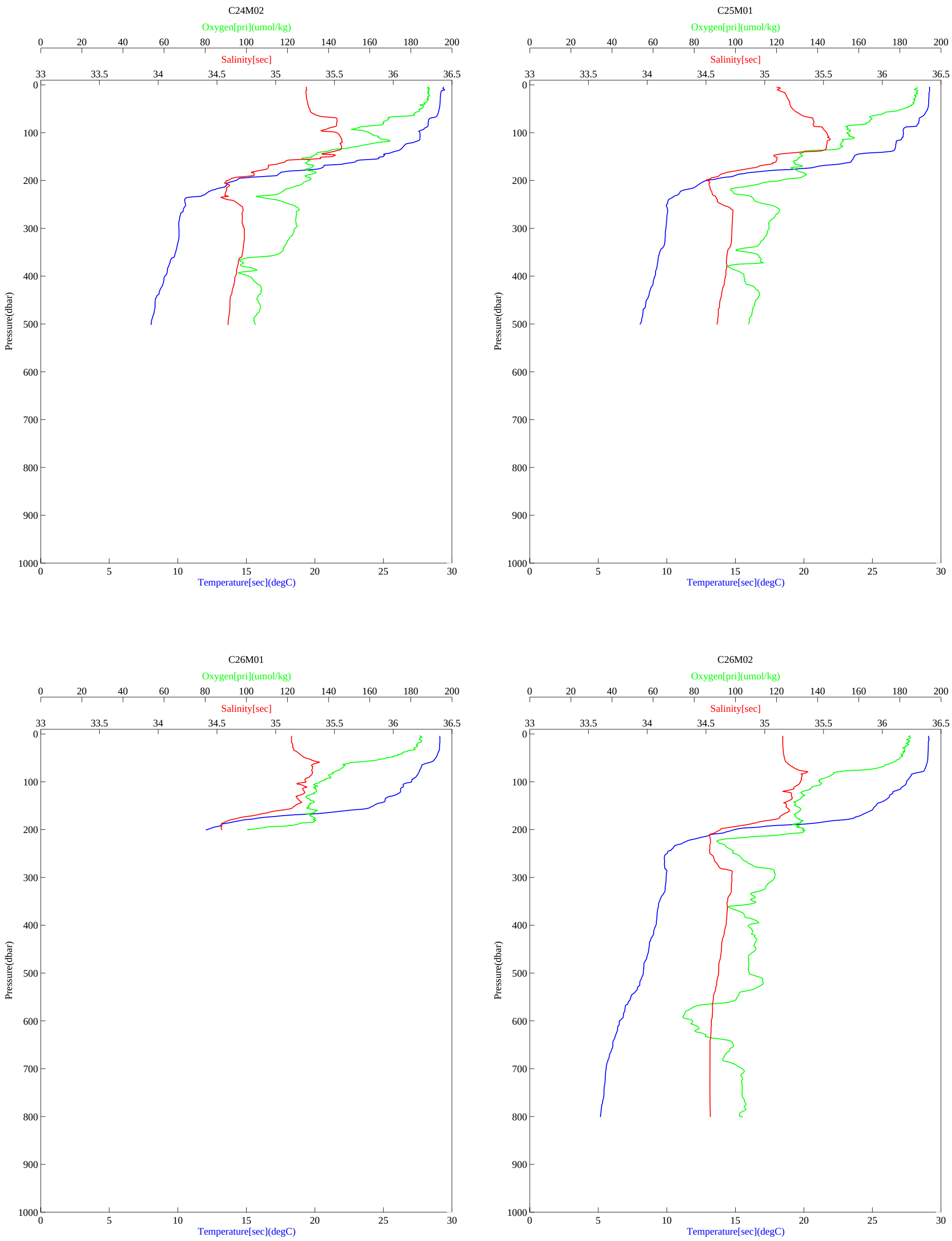


Figure 6.2.1-15 CTD profile (C24M02, C25M01, C26M01 and C26M02)

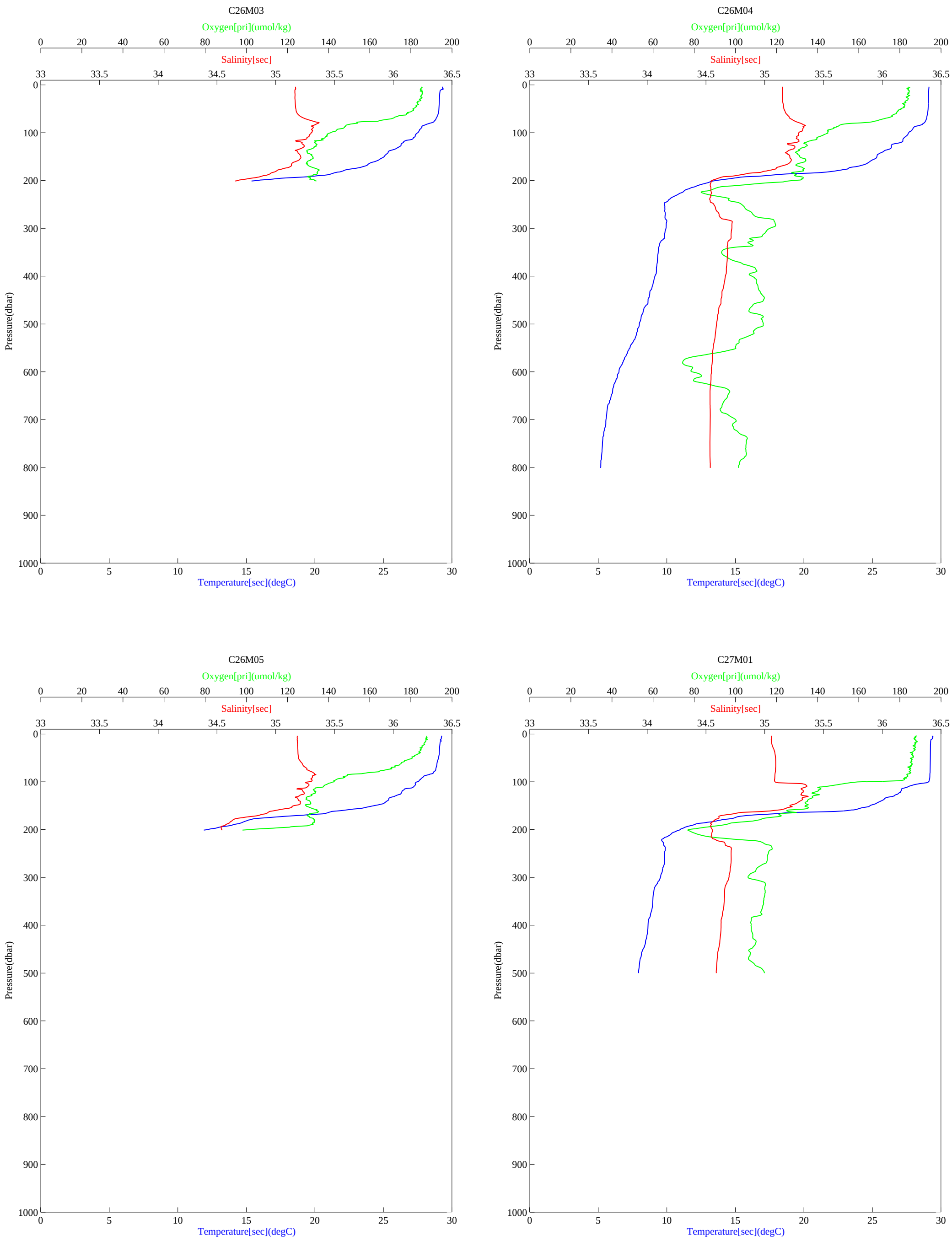


Figure 6.2.1-16 CTD profile (C26M03, C26M04, C26M05 and C27M01)

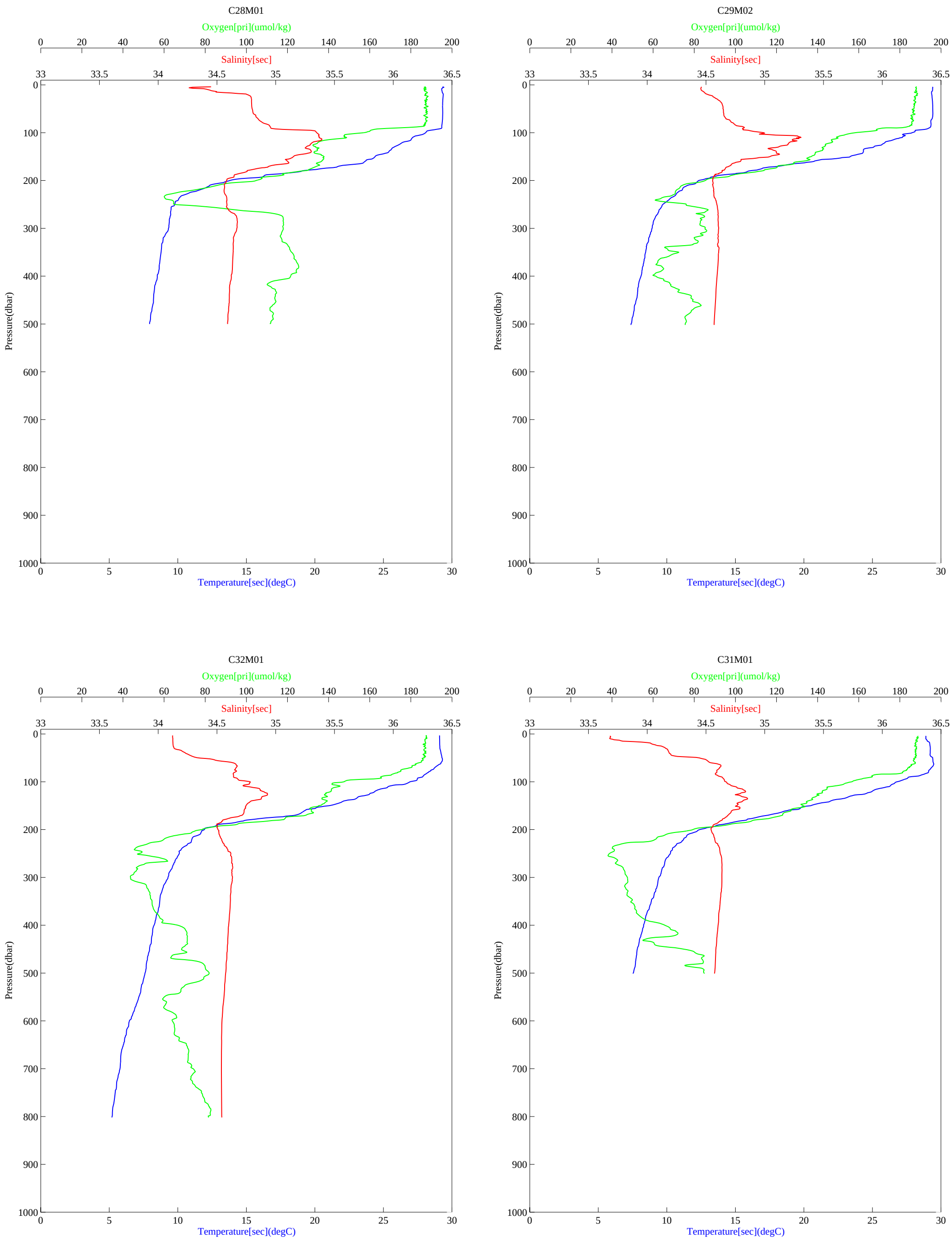


Figure 6.2.1-17 CTD profile (C28M01, C29M02, C32M01 and C31M01)

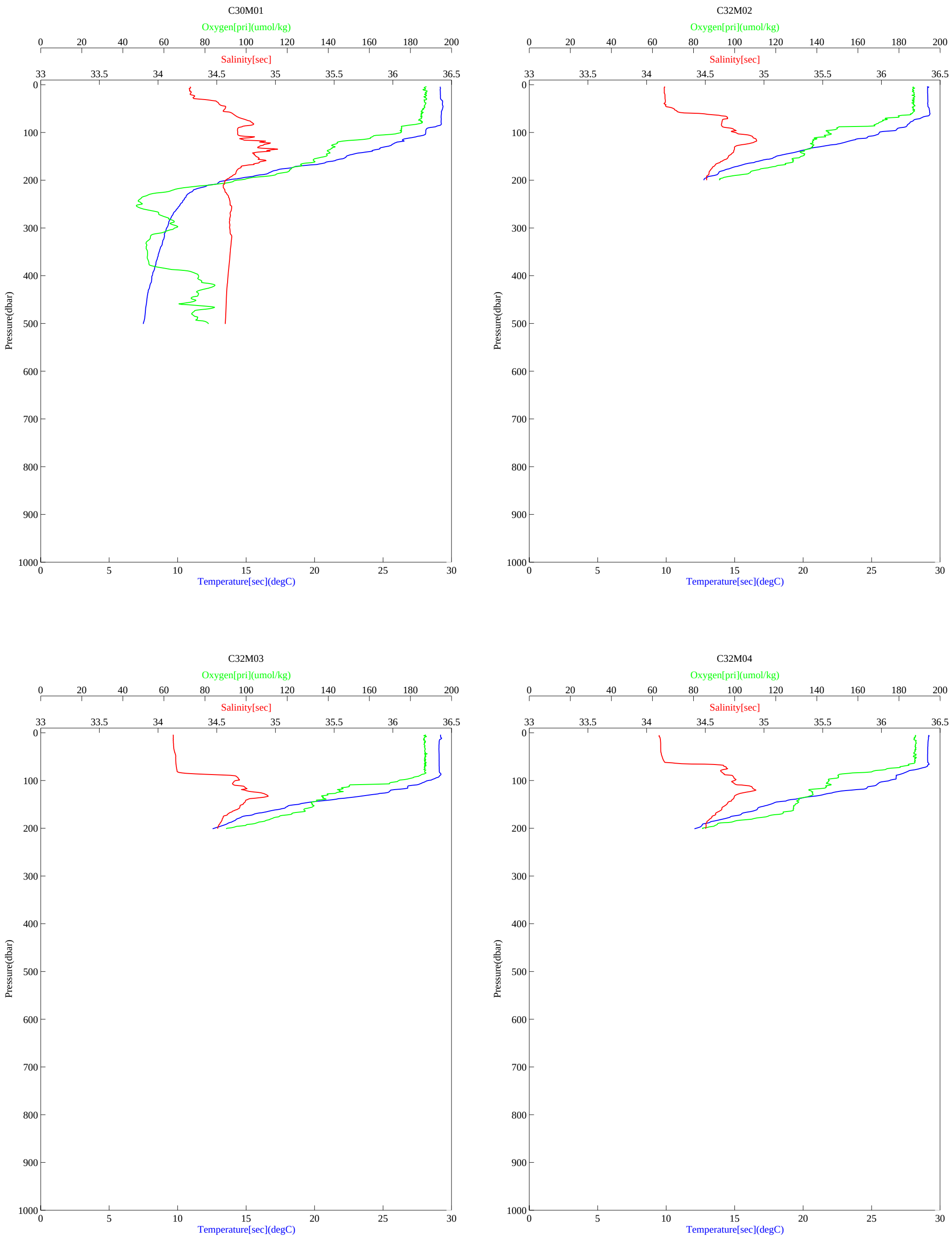


Figure 6.2.1-18 CTD profile (C30M01, C32M02, C32M03 and C32M04)

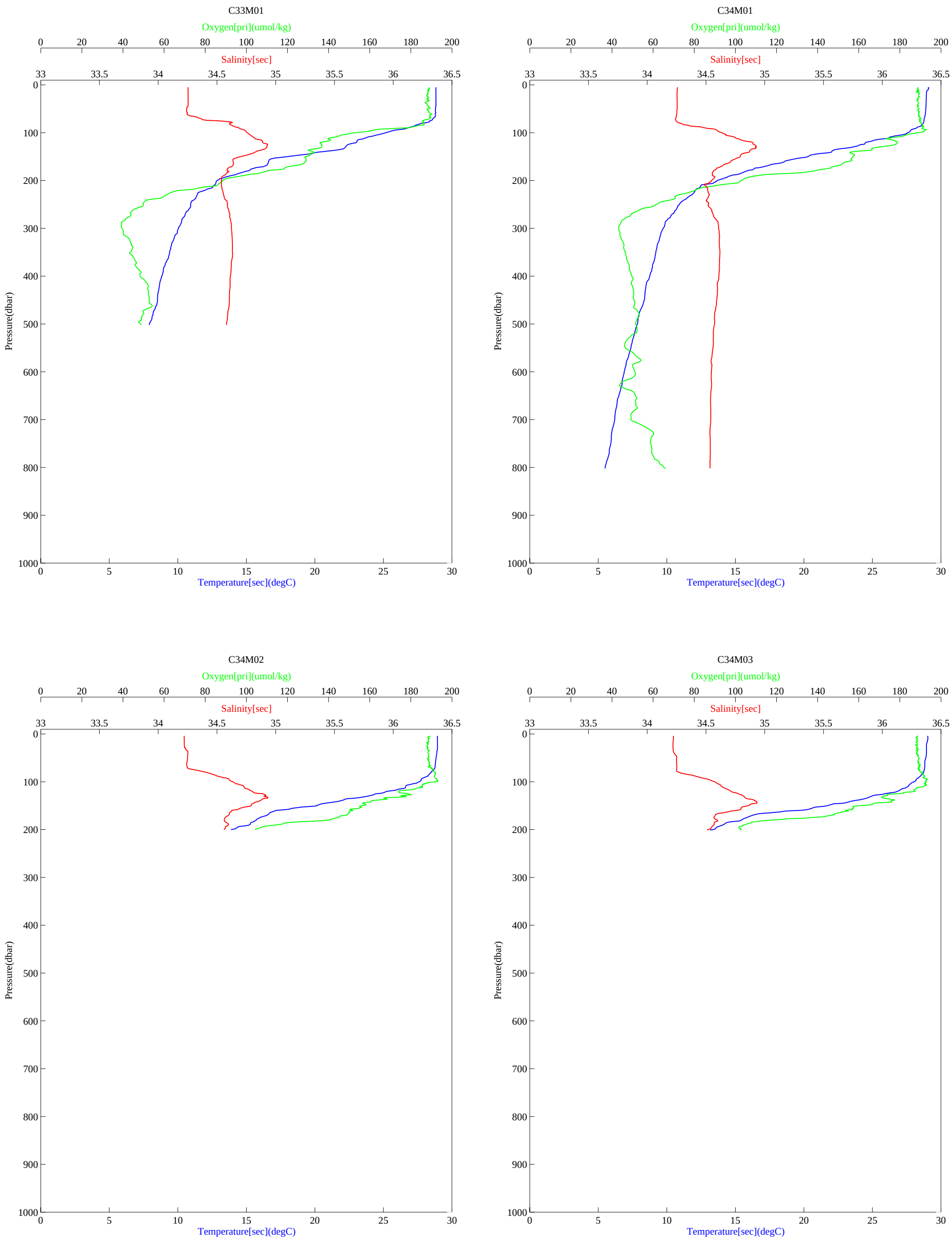


Figure 6.2.1-19 CTD profile (C33M01, C34M01, C34M02 and C34M03)

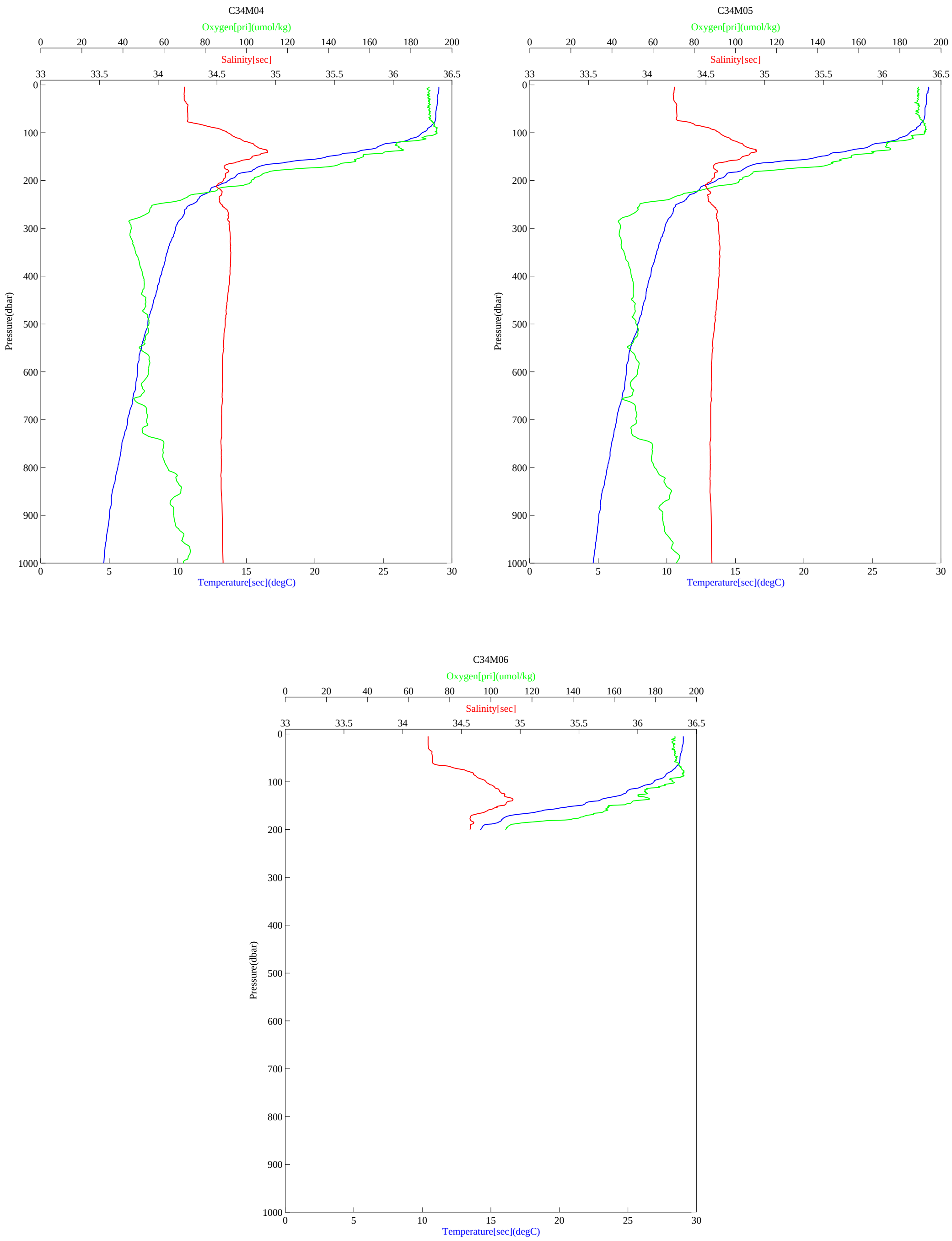


Figure 6.2.1-20 CTD profile (C34M04, C34M05 and C34M06)

6.2.2 XCTD

(1) Personnel

Yuji Kashino (JAMSTEC): Principal Investigator
Ryo Kimura (Global Ocean Development Inc.: GODI)
Kazuho Yoshida (GODI)
Not on-board
Hiroshi Ichikawa (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	

(4) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.08) provided by Tsurumi-Seiki Co.. We launched 32 probes (X01-X32) by using automatic launcher. The summary of XCTD observations and launching log were shown in Table 6.2.2-1. 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 6.2.2-4

(6) Data archive

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

Table 6.2.2-1 Summary of XCTD observation and launching log

Stn. No.	Date [yyyy/mm/dd]	Time [hh:mm:ss]	Latitude	Longitude	Depth [m]	SST [deg-C]	SSS [PSU]	Probe S/N
X01	2008/07/05	01:39:20	05-01.9795N	146-56.8501E	4243	29.610	33.940	07064653
X02	2008/07/08	02:08:22	01-59.9794N	147-01.7672E	4515	29.163	34.318	07064656
X03	2008/07/10	02:32:41	00-01.0447S	146-58.9037E	4528	29.628	35.006	07064655
X04	2008/07/19	23:42:59	00-00.3906S	155-57.3984E	1940	29.320	35.266	07064654
X05	2008/07/24	01:42:04	04-58.6222N	156-00.9976E	3598	29.090	34.152	07064657
X06	2008/07/25	09:51:26	05-30.0102N	155-59.9963E	3733	29.215	34.209	08048282
X07	2008/07/25	12:33:27	06-00.0043N	155-59.9986E	4144	28.869	34.303	08048281
X08	2008/07/25	18:32:57	06-30.2219N	155-59.9186E	4412	28.836	34.276	08048283
X09	2008/07/25	20:56:09	07-00.0105N	156-00.0049E	4447	28.795	34.175	08048285
X10	2008/07/25	22:56:24	07-30.0123N	156-00.0017E	4398	28.966	34.245	08048284
X11	2008/07/26	06:23:52	08-01.8315N	155-57.3379E	4878	29.139	34.276	08048286
X12	2008/08/01	18:08:06	32-00.0106N	144-18.0170E	5683	27.894	34.033	06079373
X13	2008/08/01	19:55:23	32-16.1909N	144-30.6473E	5742	28.459	34.086	06079371
X14	2008/08/02	00:04:20	33-00.0079N	144-42.0032E	5678	27.443	34.113	06079372
X15	2008/08/02	02:49:33	33-30.0031N	144-54.0175E	5717	28.829	34.102	06079370
X16	2008/08/02	06:02:50	33-59.9806N	145-05.9861E	5722	28.998	34.151	06079374
X17	2008/08/02	07:39:31	34-14.9825N	145-12.0047E	5821	28.211	34.116	06079382
X18	2008/08/02	09:14:29	34-29.9912N	145-17.9957E	5875	27.270	34.115	06079383
X19	2008/08/02	10:38:16	34-45.0039N	145-23.9973E	5860	26.068	33.832	06079379
X20	2008/08/02	12:07:00	34-59.9951N	145-29.9950E	5849	26.832	33.965	06079384
X21	2008/08/02	13:26:04	35-14.9999N	145-35.9967E	4830	26.046	33.584	06079375
X22	2008/08/02	14:43:08	35-30.0053N	145-41.9946E	5854	26.323	33.803	06079380
X23	2008/08/02	15:55:30	35-45.0010N	145-48.0075E	5851	26.196	33.378	06079376
X24	2008/08/02	17:05:49	36-00.0000N	145-53.9836E	5740	26.198	33.435	06079381
X25	2008/08/02	18:51:18	36-14.9975N	146-00.0054E	5561	26.333	33.873	06079388
X26	2008/08/02	20:04:35	36-30.0009N	146-05.9983E	5524	26.362	33.827	06079385
X27	2008/08/02	21:20:04	36-44.9981N	146-11.9928E	5570	26.069	33.846	07054047
X28	2008/08/02	22:39:59	36-59.9988N	146-18.0016E	5511	24.511	34.132	06079386
X29	2008/08/03	01:24:18	37-29.9974N	146-30.0001E	5632	24.472	34.147	06079389
X30	2008/08/03	04:36:59	38-03.9344N	146-23.0491E	5396	-	-	06079387
X31	2008/08/03	07:40:54	38-30.0055N	146-54.0019E	5417	-	-	06079390
X32	2008/08/03	10:14:41	39-00.0078N	147-06.0093E	5434	-	-	07054046

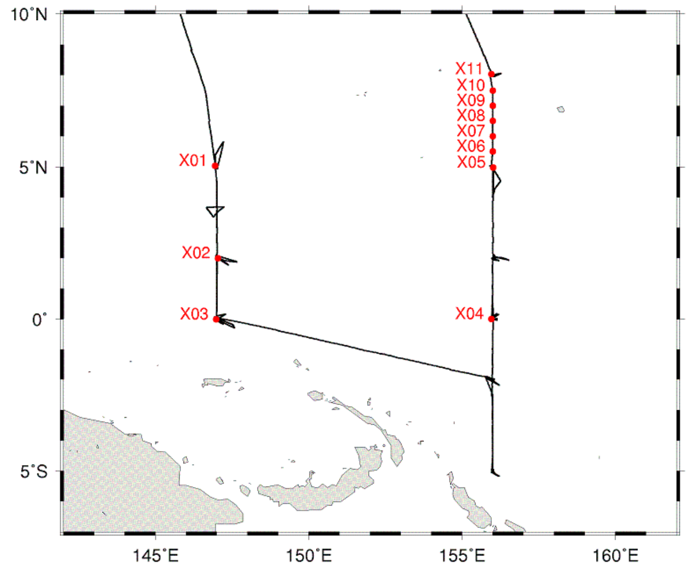


Fig. 6.2.2-1 Position map of XCTD observations (Tropical region).

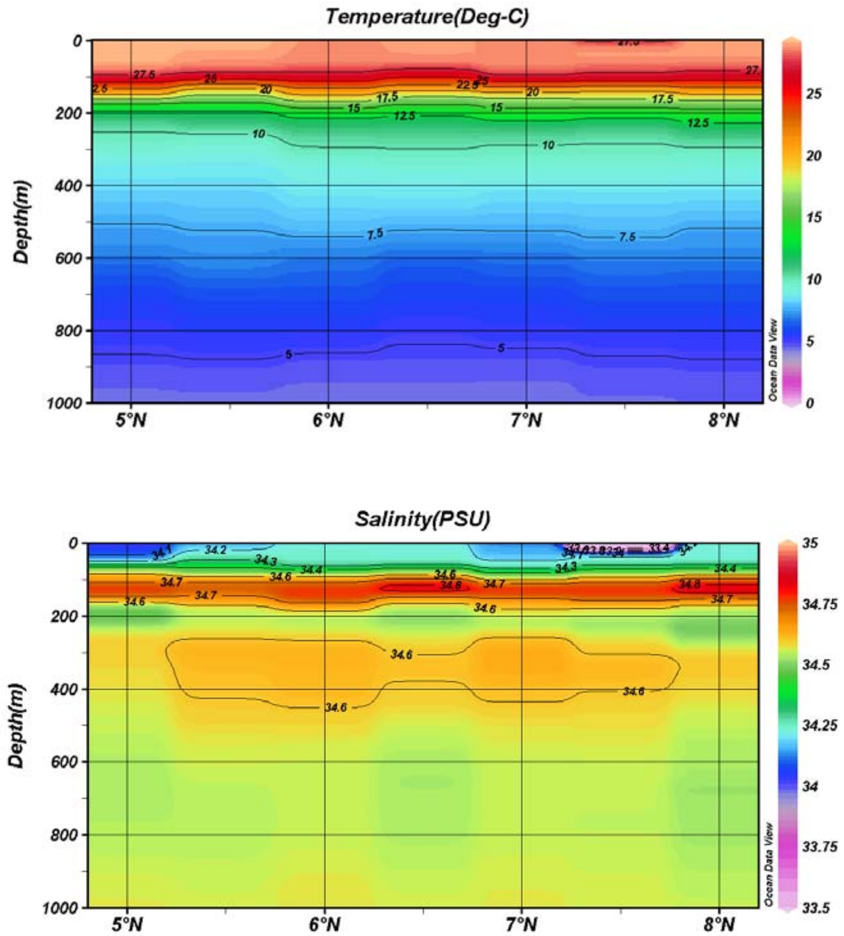


Fig. 6.2.2-2 Vertical section of temperature (upper) and salinity (lower) along 156E line (5N to 8N)

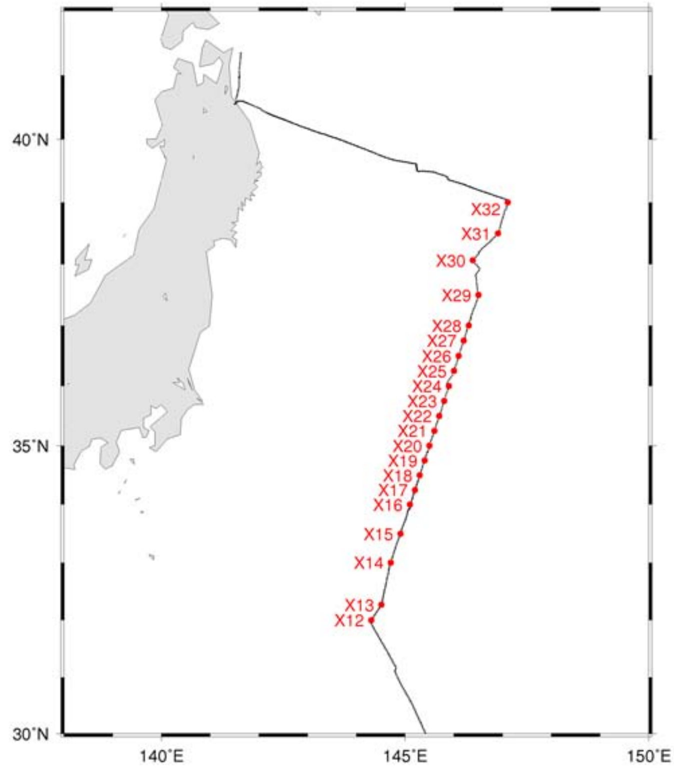


Fig. 6.2.2-3 Position map of XCTD observations (Kuroshio region)

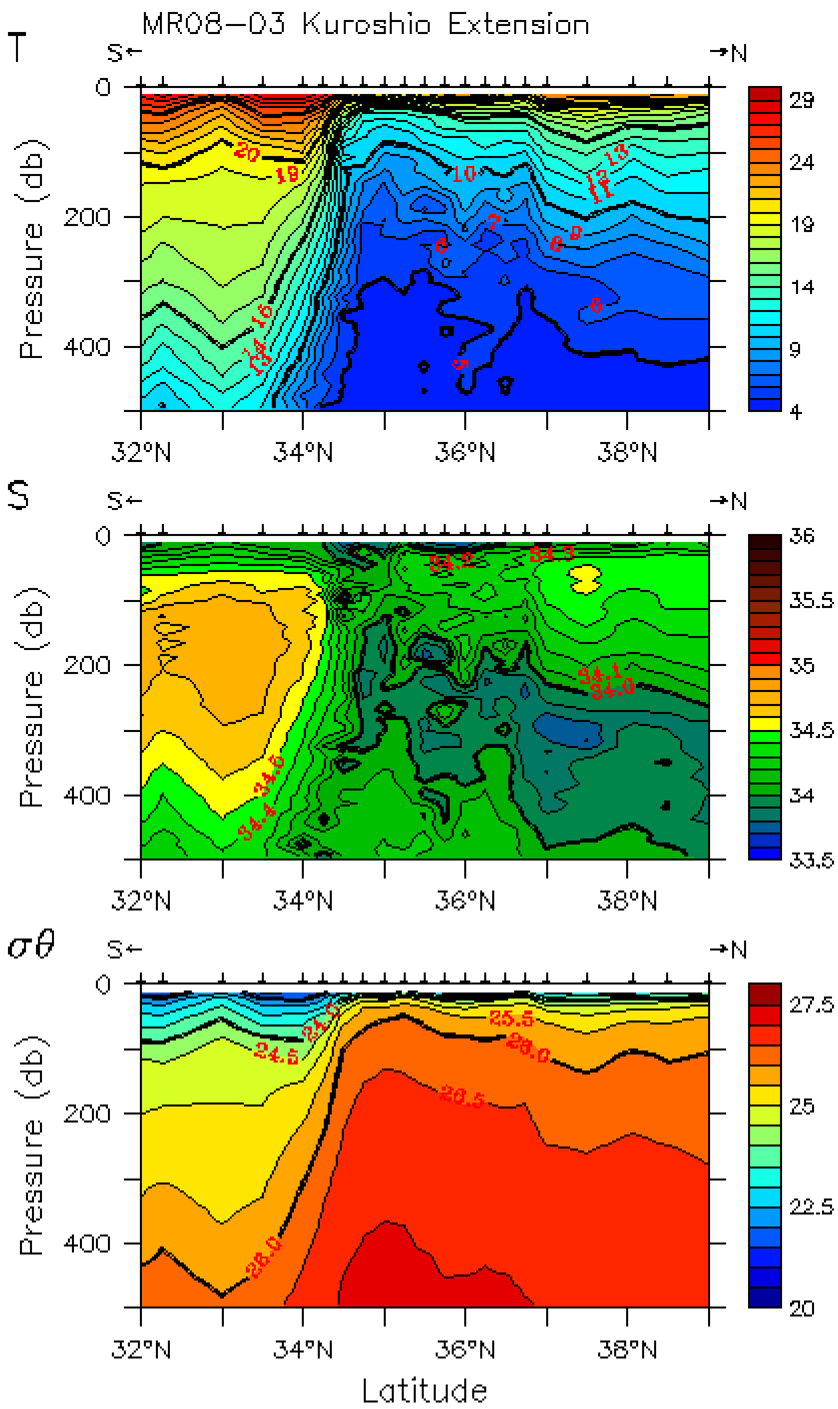


Fig. 6.2.2-4 Vertical section of temperature (top), salinity (middle) and Sigma-theta (bottom) along Kuroshio observation line.

6.3 Water sampling

6.3.1 Salinity

(1) Personnel

Tatsuya Tanaka (MWJ) :Operation Leader

(2) Objective

To provide a calibration for the measurement of salinity of bottle water collected on the CTD casts and EPCS

(3) Method

a. Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X bottles and EPCS. 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 being thoroughly rinsed 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	78
Samples for EPCS	40
Total	118

b. Instruments and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR08-03 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 deg C to 24 deg C, while the bath temperature was very stable and varied within +/- 0.002 deg C on rare occasion. The measurement for each sample was done with a double conductivity ratio and defined as the median of 31 readings of the salinometer. Data collection was started 10 seconds after filling the cell with the sample and it took about 10 seconds to collect 31 readings by 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. In the case of the double conductivity ratio of eighth filling did not satisfy the criteria above, I measured a ninth filling of the cell and calculated the bottle salinity above. The measurement was conducted in about 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 676 and measurements were done at this setting before July 27. The value of STANDBY was 5511 +/- 0001 and that of ZERO was 0.0-0000 +/- 0001. As the high ambient temperature caused by the suddenly broken air conditioner occurred the drift of salinometer, standardization control was changed to 656 on July 27 and measurements were done at this setting after July 27. The value of STANDBY was 5496 +/- 0001 and that of ZERO was 0.0-0000 +/- 0001. The conductivity ratio of IAPSO Standard Seawater batch P148 was 0.99982 (double conductivity ratio was 1.99964) and was used as the standard for salinity. I measured 10 bottles of P148 before July 27 and 6 bottles after July 27, except 2 Bad bottles. Data of these 2 bottles are not taken into consideration hereafter.

Fig.6.3.1-1 shows the history of the double conductivity ratio of the Standard Seawater batch P148. The average of the double conductivity ratio before July 27 was 1.99964 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity. The average of the double conductivity ratio after July 27 was 1.99965 and the standard deviation was smaller than 0.00001, which is equivalent to 0.0001 in salinity.

Fig.6.3.1-2 shows the history of the double conductivity ratio of the Standard Seawater batch P148 after correction. The average of the double conductivity ratio after correction before July 27 was 1.99964 and the standard deviation was 0.00001, which is equivalent to 0.0001 in salinity. The average of the double conductivity ratio after correction after July 27 was 1.99964 and the standard deviation was smaller than 0.00001, which is equivalent to 0.0001 in salinity.

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

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

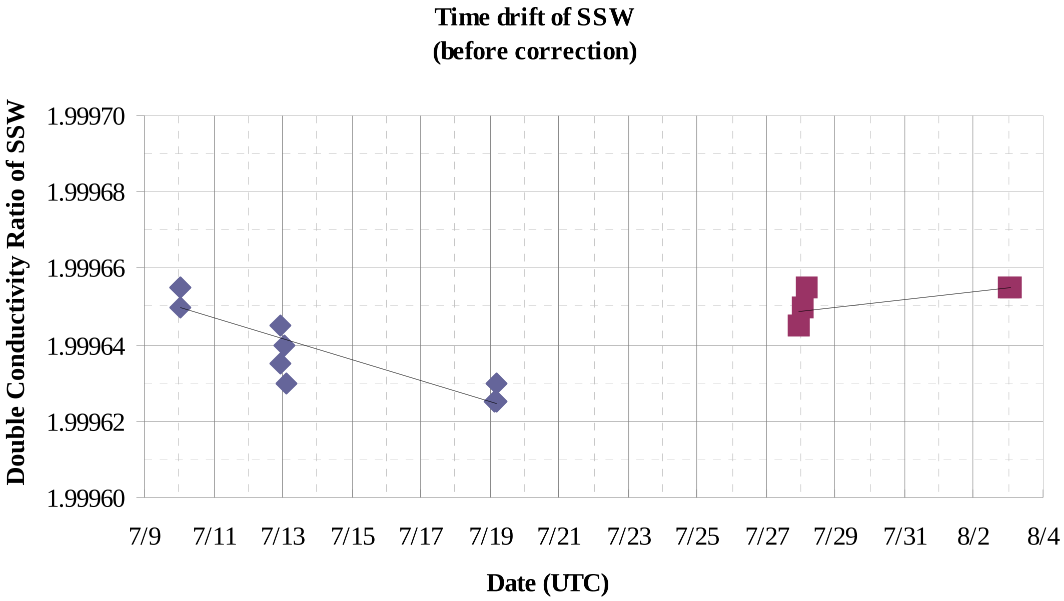


Fig. 6.3.1-1 History of double conductivity ratio for the Standard Seawater batch P148 (before correction)

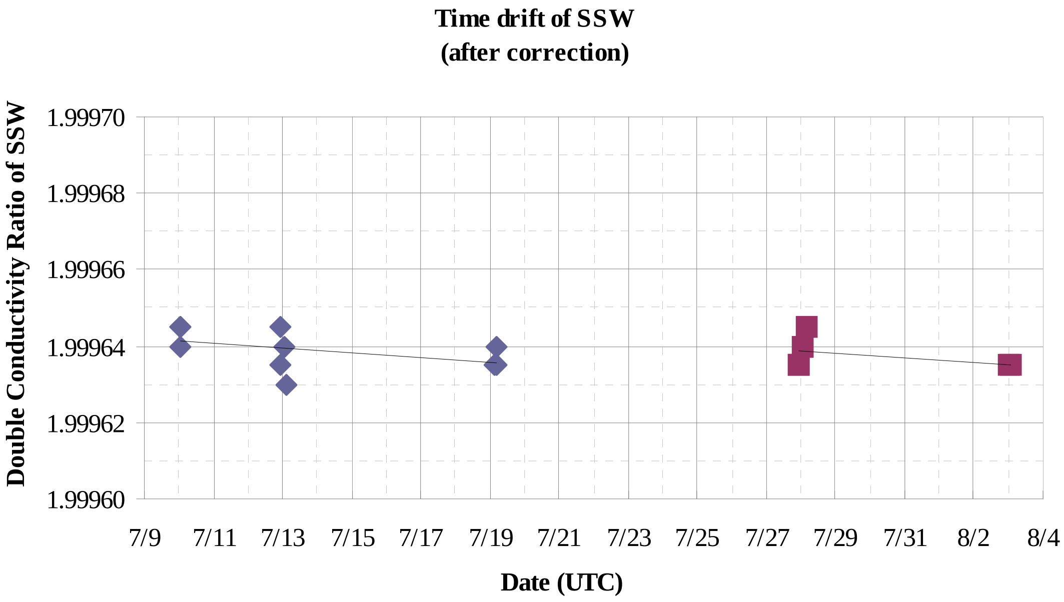


Fig. 6.3.1-2 History of double conductivity ratio for the Standard Seawater batch P148 (after correction)

b. Sub-Standard Seawater

Sub-standard seawater was made from deep-sea water filtered by 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

I estimated the precision of this method using 39 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 39 pairs of replicate samples were 0.0002 and 0.0002 in salinity, respectively.

(5) Data archive

These raw datasets will be submitted to JAMSTEC Marine-Earth Data and Information Department 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

6.3.2 Nutrient

(1) Personnel

Naoki Nakatani (Osaka prefecture university) Principal Investigator
Ayumi Takeuchi (MWJ)
Shunsuke Tanaka (MWJ)

(2) Objectives

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. During this cruise nutrient measurements will give us the important information on the mechanism of the primary production or seawater circulation.

(3) Methods

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system. The laboratory temperature was maintained between 24-25 deg C.

a. Measured Parameters

Nitrate + nitrite and nitrite are analyzed according to the modification method of Grasshoff (1970). The sample nitrate is reduced to nitrite in a cadmium tube inside of which is coated with metallic copper. The sample stream with its equivalent nitrite is treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid, which reacts with the sulfanilamide to produce a diazonium ion. N1-Naphthylethylene-diamine added to the sample stream then couples with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

Absorbance of 550 nm by azo dye in analysis is measured using a 3 cm length cell for Nitrate and 5 cm length cell for Nitrite.

The silicate (Although silicic acid is correct, we use silicate because a term of silicate is widely used in oceanographic community) method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid is first formed from the silicic acid in the sample and added molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using L-ascorbic acid as the reductant.

Absorbance of 630 nm by silicomolybdous acid in analysis is measured using a 3 cm length cell.

The phosphate analysis is a modification of the procedure of Murphy and Riley (1962). Molybdic acid is added to the seawater sample to form phosphomolybdic acid, which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant.

Absorbance of 880 nm by phosphomolybdous acid in analysis is measured using a 5 cm length cell.

b. Nutrients Standard

Silicate standard solution, the silicate primary standard, was obtained from Merck, Ltd.. This standard solution, traceable to SRM from NIST was 1000 mg per litter. Since this solution is alkaline solution of 0.5 M NaOH, an aliquot of 20ml solution were diluted to 500 ml together with an aliquot of 10 ml of 1M HCl. Primary standard for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Merck, Ltd. and nitrite ($NaNO_2$) was obtained from Wako Pure Chemical Industries, Ltd..

c. Sampling Procedures

Samples were drawn into virgin 10 ml polyacrylate vials that were rinsed 3 times before sampling without sample drawing tubes. Sets of 4 different concentrations for nitrate, nitrite, silicate, phosphate of the shipboard standards were analyzed at beginning and end of each group of analysis. The standard solutions of highest concentration were measured every 5 samples and were used to evaluate precision of nutrients analysis during the cruise. We also used reference material for nutrients in seawater, RMNS (KANSO Co., Ltd., lots AX), for every runs to secure comparability on nutrient analysis throughout the cruise.

d. Low Nutrients Sea Water (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.45 μm pore size membrane filter. This water is stored in 20-liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in April 2007.

(4) Results

Analytical precisions were 0.06% (45 μM) for nitrate, 0.07% (0.9 μM) for nitrite, 0.07% (71 μM) for silicate, 0.08% (3.0 μM) for phosphate in terms of median of precision, respectively.

Results of RMNS analysis are shown in Tables 6.3.2_1 for the each cast comparability.

(5) Data Archive

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

(6) Reference

Grasshoff, K. (1970), Technicon paper, 691-57.

Grasshoff, K., Ehrhardt, M., Kremling K. et al. (1983), Methods of seawater analysis. 2nd rev. Weinheim: Verlag Chemie, Germany, West.

Murphy, J., and Riley, J.P. (1962), Analytica chim. Acta 27, 31-36.

Table 6.3.2_1 Results of RMNS Lot. AX analysis in this cruise.

μmol/kg

	serial	Cast	NO_3	NO_2	SiO_2	PO_4
RM-AX	1380	C01M02	21.46	0.35	58.10	1.614
RM-AX	1051	C07M02	21.47	0.35	58.09	1.629
RM-AX	1726	C11M03	21.48	0.35	58.05	1.614
RM-AX	1076	C18M03	21.46	0.34	58.07	1.622
RM-AX	222	C12M03	21.45	0.34	58.07	1.623
RM-AX	1378	C18M08 & M12	21.47	0.34	57.99	1.619
RM-AX	212	C22M04	21.51	0.35	58.05	1.622
RM-AX	339	C26M03	21.49	0.35	58.07	1.624
RM-AX	1828	C32M03	21.45	0.35	58.13	1.625
RM-AX	117	C34M03	21.48	0.34	58.08	1.624

6.3.3 Chlorophyll *a*

1. Personnel

Naoki Nakatani	(Osaka prefecture university) Principal Investigator
Fuyuki Shibata	(MWJ)
Kimiko Nishijima	(MWJ)

2. Objective

Chlorophyll *a* is one of the most convenient indicators of phytoplankton stock, and has been used extensively for the estimation of phytoplankton abundance in various aquatic environments. The object of this study is to investigate the vertical distribution of phytoplankton in various light intensity depth.

3. Instruments and Methods

Seawater samples were collected 0.5 liter at 6 depths in the euphotic zone at Fixed-Station using Niskin bottles. The samples were gently filtrated by low vaccum pressuer(<15cmHg) through Whatman GF/F filter(diameter 25mm) in the dark room. Phytoplankton pigments were immediately extracted in 7ml of N,N-dimethylformamide(DMF) after filtration and then, the samples were stored in the freezer(-20℃) until the analysis of fluorometric determination(over 24 hours).The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005,TURNER DESIGNS) with a 340-500nm bound excitation filter and a >665nm bound emission filter(Table 6.3.3-1), before and after acidification. We had the measurements twice. At first, we measured the fluororescence of samples, after that we dropped 1N HCL to the samaple and measured(Holm-Hansen *et al*., 1965).

The amount of chlorophyll *a* is calculated using the formula the following equation;

$$\text{Chlorophyll } a\ (\mu g/L) = Fm/(Fm-1) \times (Fo-Fa) \times Kx \times vol_{ex}/vol_{filt}$$

Fo:fluorenscenece before acidfication　　Fa: fluorenscenece after acidfication

vol_{ex}:DMF extract volume　　vol_{filt}:filtrated volume

Kx:correction coefficiebt

Fm:acid factor

4. Results

The temporal and spatial distributions of chlorophyll *a* were shown in Figure 6.3.3-1.

5. Data archives

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

6. Reference

Holm-Hansen, O., Lorenzen, C. J., Holmes, R.W., J. D. H. Strickland 1965.Fluorometric determination of chlorophyll. *J. Cons. Cons. Int. Explor. Mer* :30,3-15.

Table 6.3.3-1. Analytical conditions of “Acidification method” for chlorophyll *a* with Turner Designs fluorometer (10-AU-005).

	Acidification method
Excitation filter (nm)	340-500nm
Emission filter (nm)	>665nm
Lamp	Daylight white F4T5D

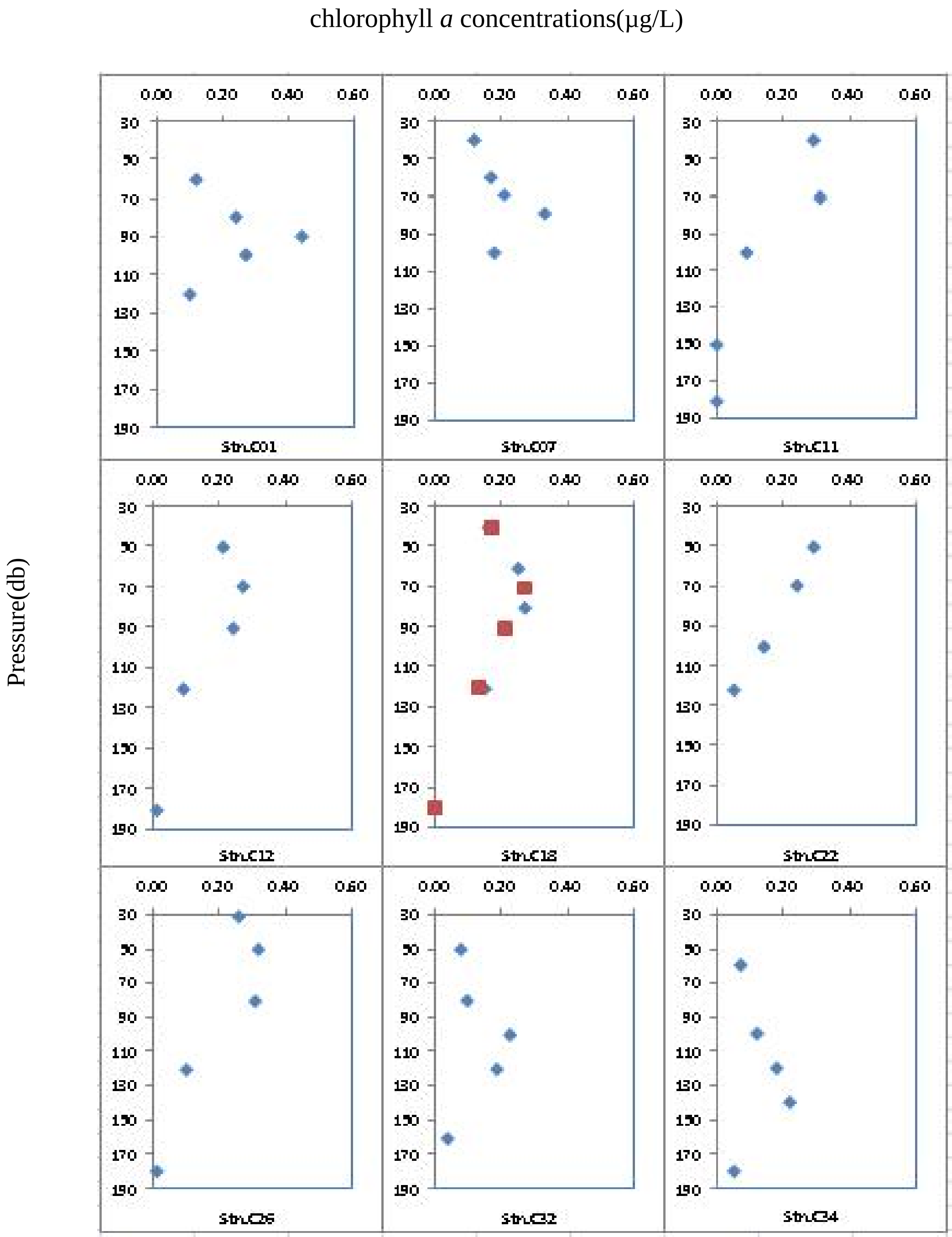


Figure 6.3.3-1. Vertical profiles at each Station.

6.3.4. Trace metals

(1) Personnel

Kiminori Shitashima (CRIEPI)

(2) Objectives

Purpose of this cruise is to collect the water samples for micro-nutrients (trace metals) at the equatorial area in order to have inter-comparison of trace metals data between MR06-01 and MR08-03.

(3) Parameters

Inter-comparison data of micro-nutrients (trace metals)

(4) Methods

Seawater samples for trace metals analysis and suspended particles analysis were collected from 3 layers (0m, 100m, 1000m) at 8N-156E station. After the collection, the samples were stored in a refrigerator. The samples were divided to two aliquots on land laboratory, Mn, Fe, Co, Ni, Cu, Zn, Cd and Pb were analyzed from one aliquot. Another aliquot for suspended particles analysis was filtered with a 0.2-mm filter and a 0.45-mm filter, respectively. In order to desalinate, 250 ml of MQW was passed through each filter. After desalination, each filter was transferred to the Petri dish and stored in a refrigerator.

(5) Data archive

All data will be archived at CRIEPI after checking of data quality and submitted to the DMO at JAMSTEC within 2 years.

6.4 Continuous monitoring of surface seawater

6.4.1 Temperature, salinity, dissolved oxygen and fluorescence

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Fuyuki SHIBATA	(MWJ)
Kimiko Nishijima	(MWJ)

(2) Objective

Measurements of temperature, salinity, dissolved oxygen and fluorescence of the sea surface water in the western tropical Pacific Ocean.

(3) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) that equips five sensors of 1) salinity, 2) temperatures (two sensors), 3) dissolved oxygen and 4) fluorescence can continuously measure their values in near-sea surface water. Salinity is calculated by conductivity on the basis of PSS78. Specifications of these sensors are listed below.

This system is settled in the "*sea surface monitoring laboratory*" on R/V MIRAI, and near-surface water was continuously pumped up to the system through a vinyl-chloride pipe. The flow rate for the system is manually controlled by several valves with its value of 12 L min^{-1} except for the fluorometer (about 0.5 L min^{-1}). Each flow rate is monitored with respective flow meter. The system is connected to shipboard LAN-system, and measured data is stored in a hard disk of PC every 1-minute together with time (UTC) and position of the ship.

a) Temperature and Conductivity sensor

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number:	2118859-2641
Measurement range:	Temperature -5 to +35℃, Conductivity 0 to 7 S m^{-1}
Resolution:	Temperatures 0.001℃, Conductivity 0.0001 S m^{-1}
Stability:	Temperature 0.01℃ 6 months^{-1}, Conductivity 0.001 S m^{-1} month^{-1}

b) Bottom of ship thermometer

Model:	SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number:	032175
Measurement range:	-5 to +35℃
Resolution:	±0.001℃
Stability:	0.002℃ year^{-1}

c) Dissolved oxygen sensor

Model:	2127A, Hach Ultara Analytics Japan, INC.
Serial number:	61230
Measurement range:	0 to 14 ppm
Accuracy:	±1% in ±5℃ of correction temperature
Stability:	5% month^{-1}

d) Fluorometer

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

Stability: 0.5% month^{-1} of full scale

e) Flow meter

Model:	EMARG2W, Aichi Watch Electronics LTD.
Serial number:	8672
Measurement range:	0 to 30 L min^{-1}
Accuracy:	<= ±1%
Stability:	<= ±1% day^{-1}

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

Start : 2008/07/03 04:30 Stop : 2008/08/03 04:08

(4) Preliminary Result

Preliminary data of temperature, salinity, dissolved oxygen, fluorescence at sea surface are shown in Fig.6.4-1. We took the surface water samples once a day to compare sensor data with bottle data of salinity and dissolved oxygen and fluorescence. The results are shown in Fig.6.4-2 ~ 4. All the salinity samples were analyzed by the Guildline 8400B "AUTOSAL", and dissolve oxygen samples by Winkler method and Chlorophyll *a* samples by Holm-Hansen method.

(5) Date archive

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

(6) Remarks

None

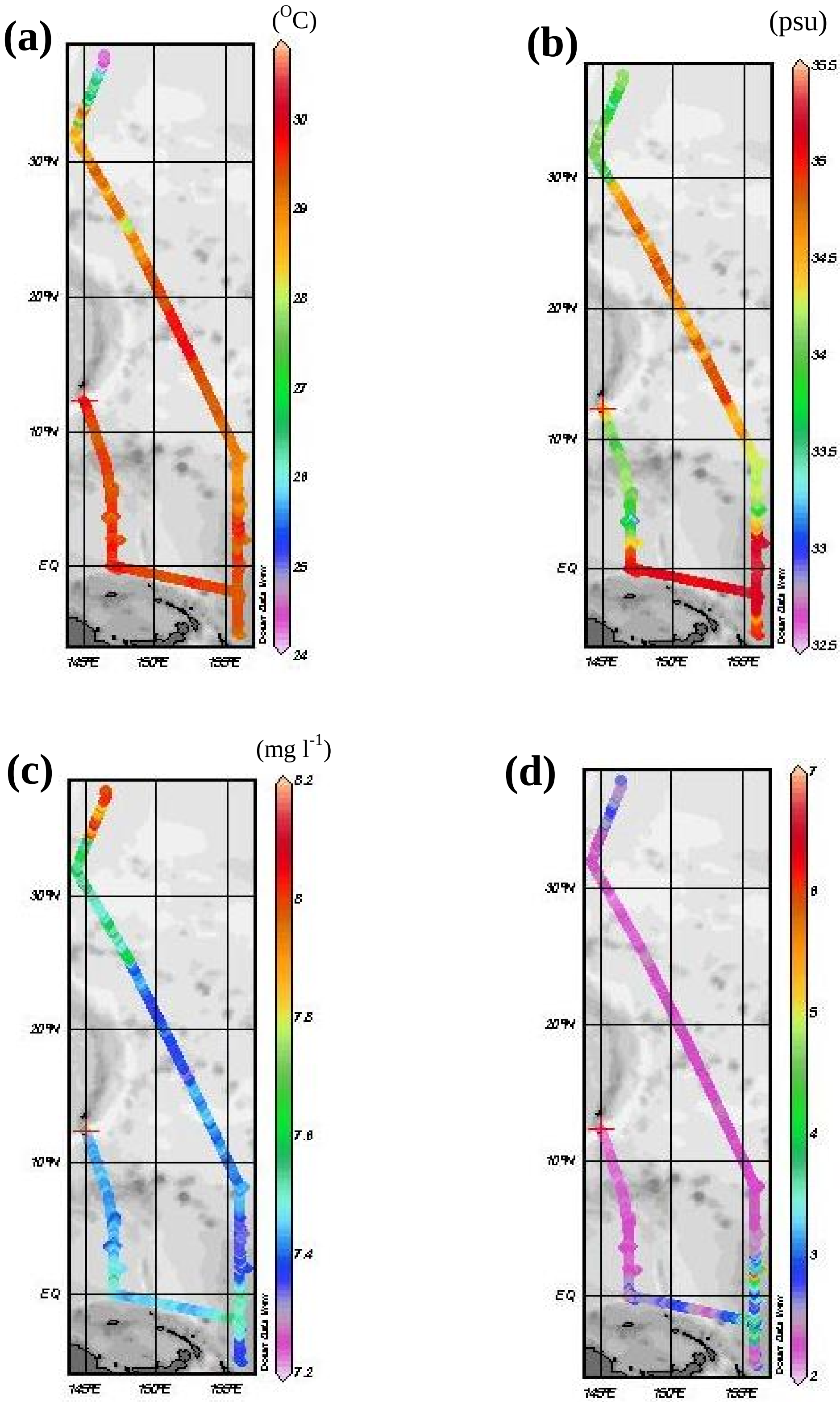


Fig.6.4.1-1 Spatial and temporal distribution of (a) temperature, (b) salinity, (c) dissolved oxygen and (d) fluorescence. Fluorescence is relative value.

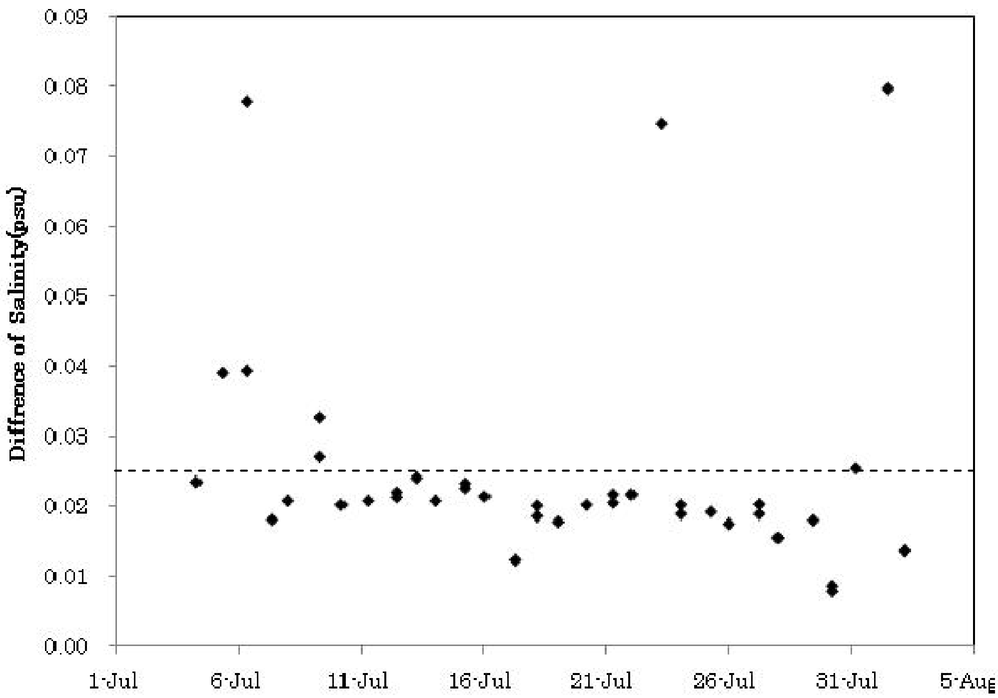


Fig.6.4.1-2 Difference of salinity between sensor data and bottle data. The mean difference is 0.0249psu.

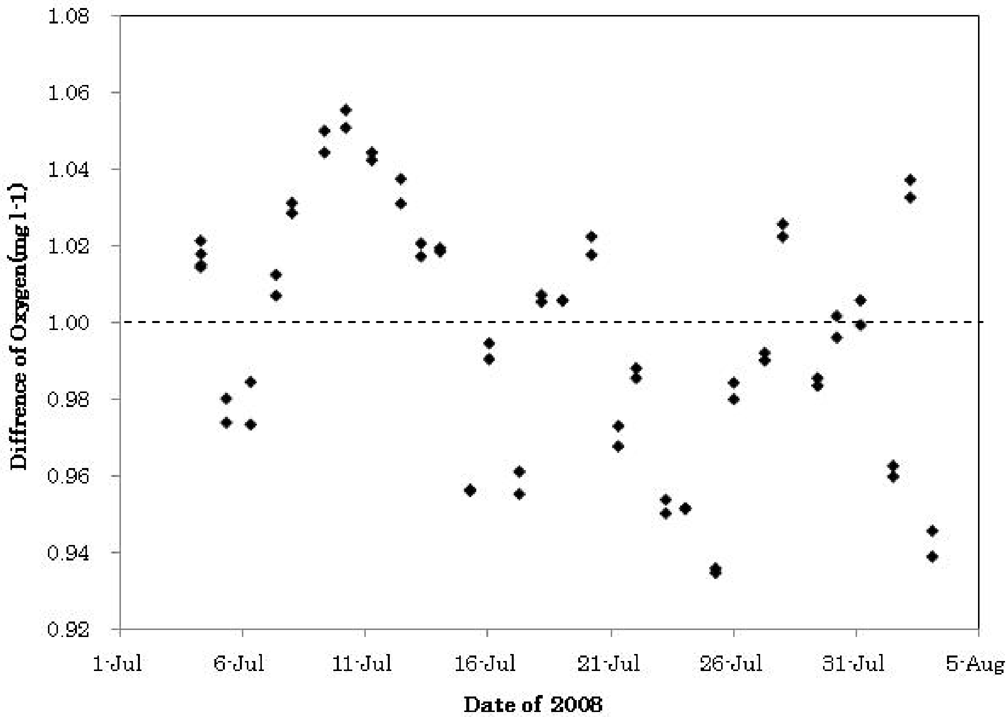


Fig.6.4.1-3 Difference of dissolved oxygen between sensor data and bottle data. The mean difference is 0.9968 mg l^{-1}.

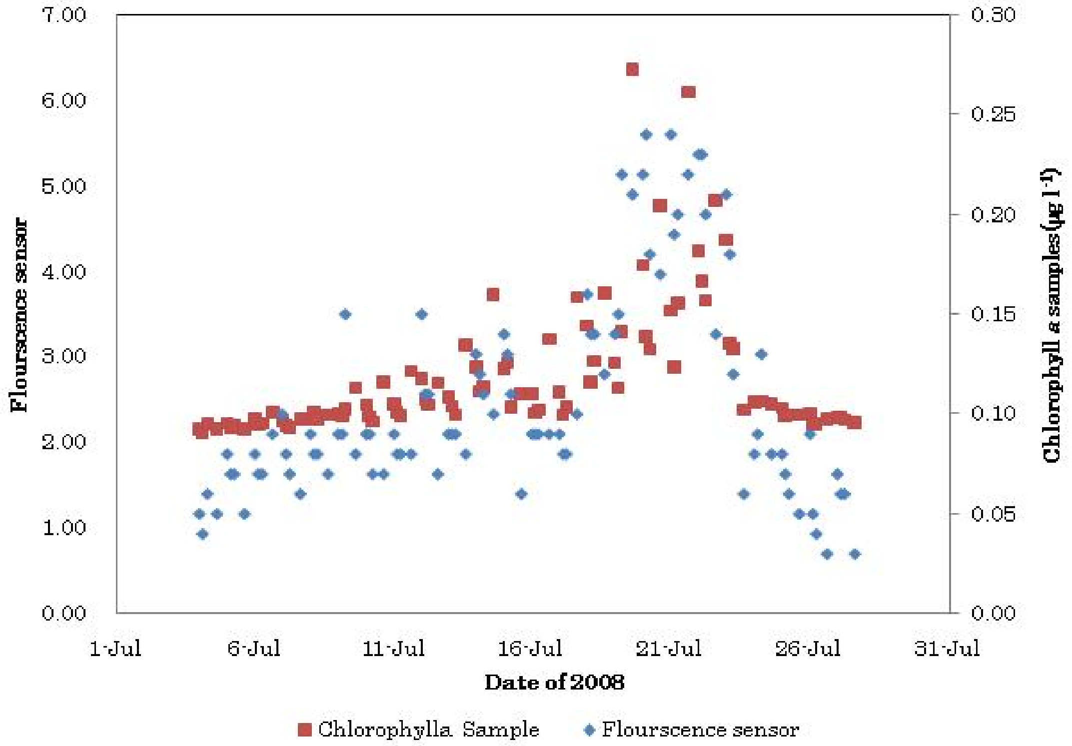


Fig.6.4.1-4 Data of fluorescence sensor and Chlorophyll *a* samples (μg l^{-1}) . Fluorescence is relative value.

6.4.2 Underway pCO_2

Yoshiyuki Nakano (JAMSTEC MIO)
Fuyuki Shibata (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. We here report on board measurements of pCO_2 during MR08-03 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; BINOS^{TM}).

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

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

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

(3) Preliminary results

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

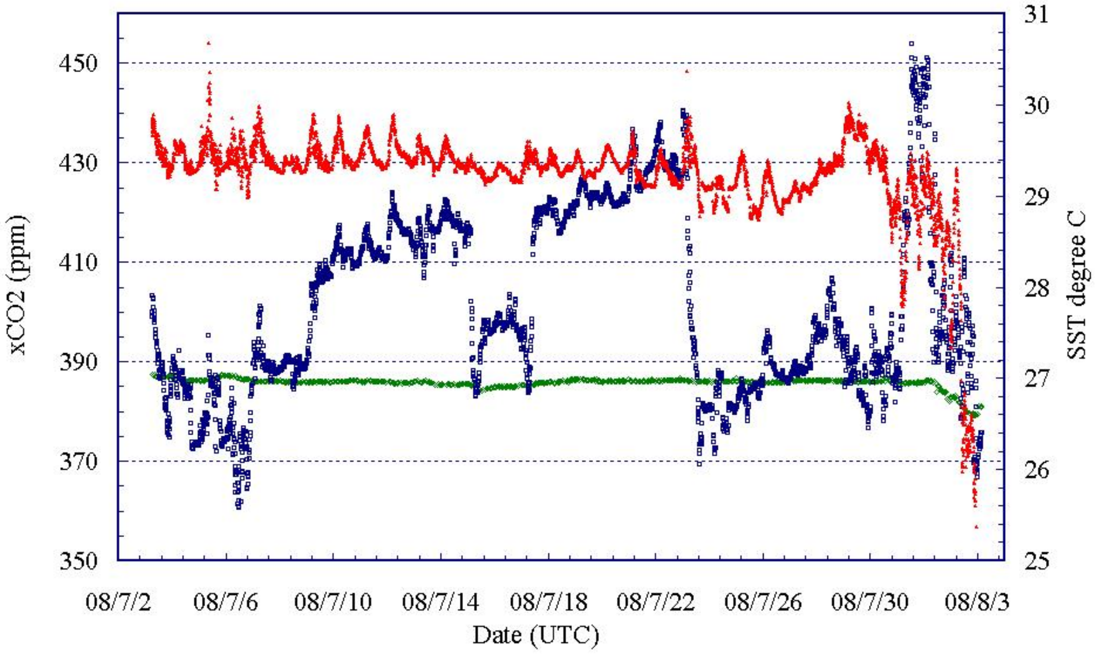


Figure 6.4.2-1 Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(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

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

6.5 Shipboard ADCP

(1) Personnel

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

(2) Objective

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

(3) Methods

Upper ocean current measurements were made throughout MR08-03 cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. For most of its operation, the instrument was configured for water-tracking mode recording. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made in shallower water region to get the calibration data for evaluating transducer misalignment angle. The system consists of following components;

i) R/V MIRAI has installed the Ocean Surveyor (acoustic frequency 75 kHz) for vessel-mount made by 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.

ii) For heading source, we use Inertial Navigation System (INS) for Doppler Rader. Additionally high-precision attitude information from INS, pitch and roll, are stored in N2R data files with a time stamp. And we use also a ship's main gyro compass (Tokimec, Japan) to provide continuously ship's heading to the ADCP.

iii) A GPS navigation receiver (Trimble 4000DS) provides position fixes.

iv) For data acquisition software, VmDas version 1.4.2 (RD Instruments, USA) is used.

v) The clock of the logging PC is adjusted to GPS time every 1-minute.

vi) We have placed ethylene glycol into the fresh water well to prevent freezing in the sea chest.

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

(4) Preliminary results

Fig. 6.5-1 were shown 65 – 130m, 130m – 200m, 200 – 300m and 300 – 400m averaged current vector along the ship track. These data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

As a whole, condition of data acquisition was good. But along 147E line, quality of data near sea surface was not so good.

(5) Data archive

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

(6) Remarks

We did not collect data in the territorial waters of USA during the following periods.

22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

Table 6.5-1 Major parameters

Bottom-Track Commands	
BP = 000	Disable bottom-track ping (almost over 1000m depth) 03 Jul. 2008 01:00 UTC – 04 Aug. 2008 16:23 UTC
BP = 001	Pings per Ensemble (almost less than 1000m depth) 04 Aug. 2008 16:25 UTC – 06 Aug. 2008 00:00 UTC
Environmental Sensor Commands	
EA = +00000	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +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 = 1020001	Sensor Source (C; D; H; P; R; S; T) C (1): Sound velocity calculates using ED, ES, ET (temp.) D (0): Manual ED H (2): External synchro P (0), R (0): Manual EP, ER (0 degree) S (0): Manual ES T (1): Internal transducer sensor
Timing Commands	
TE = 00:00:02.00	Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:02.00	Time per Ping (min:sec.sec/100)
Water-Track Commands	
WA = 255	False Target Threshold (Max) (0-255 count)
WB = 1	Mode 1 Bandwidth Control (0=Wid, 1=Med, 2=Nar)
WC = 120	Low Correlation Threshold (0-255)
WD = 111 110 111	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 = 040	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 1600	Depth Cell Size (cm)
WT = 000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)

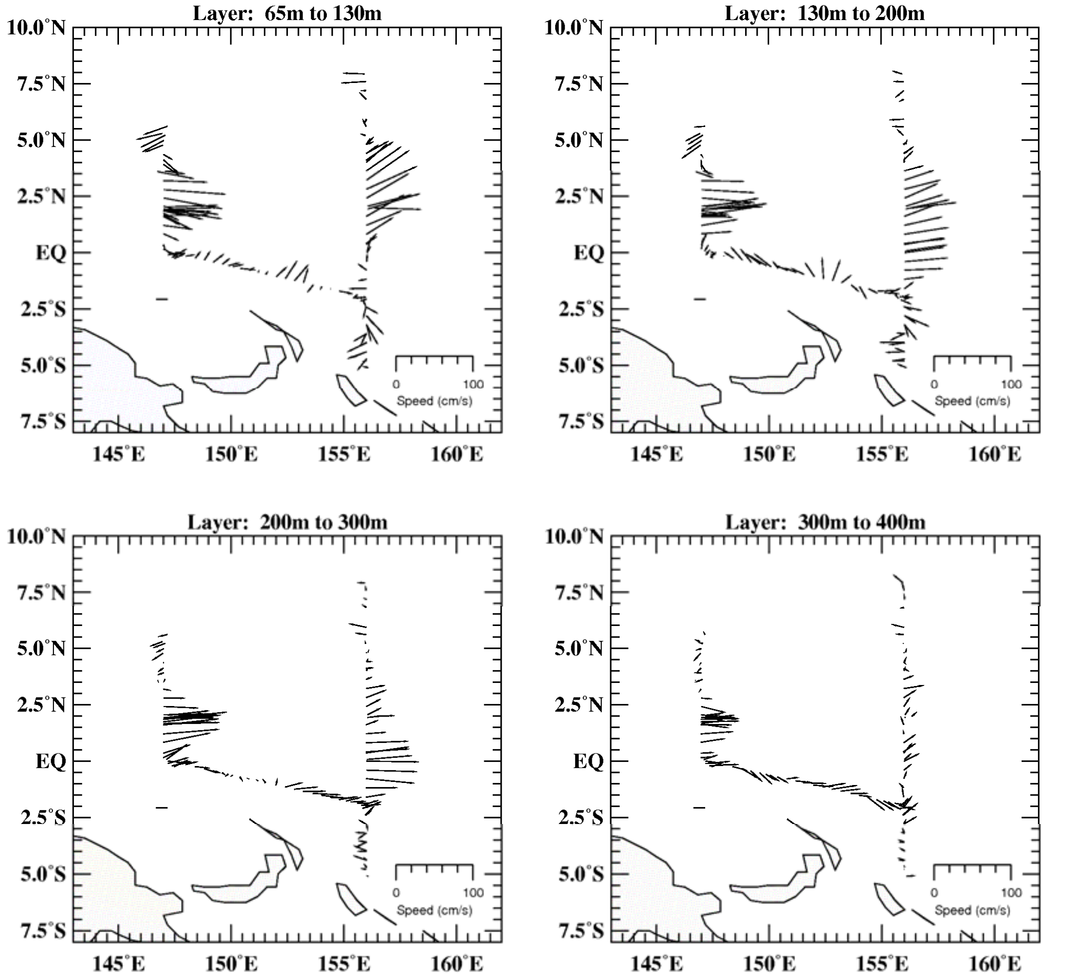


Fig. 6.5-1: Averaged current vector along the ship track (65–130m, 130–200m, 200–300m, 300–400m).

6.6 Underway geophysics

6.6.1 Sea surface gravity

(1) Personnel

Ryo Kimura	(Global Ocean Development Inc.: GODI)
Kazuho Yoshida	(GODI)
Not on-board :	
Takeshi Matsumoto	(University of the Ryukyus) : Principal Investigator
Masao Nakanishi	(University of the Chiba)

(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 MR08-03 cruise from 2nd July 2008 to 6th August 2008, except for the territorial waters of U.S.A.

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

Table 6.6.1

No.	Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Ship Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R *[2] Gravity [mGal]
#1	26 May	06:16	Sekinehama	980371.94	261	615	980372.78	12642.60
#2	06 August	02:33	Sekinehama	980371.94	276	615	980372.83	12641.59

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

Differential	G at sensor	L&R value
#1 - #2	0.05 mGal ---(a)	-1.01 mGal ---(b)
L&R drift value (b) - (a)	-1.062 mGal	73.85 days
Daily drift ratio	-0.0144 mGal/day	

(6) Data Archives

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

(7) Remark

We did not collect data in the territorial waters of USA during the following periods.

22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

6.6.2 Sea surface three-component magnetic field

(1) Personnel

Ryo Kimura	(Global Ocean Development Inc.: GODI)
Kazuho Yoshida	(GODI)
Not on-board :	
Takeshi Matsumoto	(University of the Ryukyus) : Principal Investigator
Masao Nakanishi	(University of the Chiba)

(2) Introduction

Measurements of magnetic force on the sea are required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR08-03 cruise from 2nd July 2008 to 6th August 2008, except for the territorial waters of U.S.A.

(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:

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

where **R**, **P** and **Y** are the matrices of rotation due to roll, pitch and heading of a ship, respectively. **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

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

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

(4) Instruments on *R/V MIRAI*

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

(5) Data Archives

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

(6) Remarks

i. We did not collect data in the territorial waters of USA during the following periods.
   22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

ii. For calibration of the ship’s magnetic effect, we made a running like a “Figure eight” turn (a pair of clockwise and anti-clockwise rotation). The periods were follows;
   04:03UTC 16 Jul. 2008 – 04:28UTC 16 Jul.2008, about at 05-01.2S, 155-59.9E
   08:36UTC 05 Aug. 2008 – 08:52UTC 05 Aug.2008, about at 40-58.5N, 141-35.8E

6.6.3. Swath Bathymetry

(1) Personnel

Ryo Kimura	(Global Ocean Development Inc.: GODI)
Kazuho Yoshida	(GODI)
Not on-board :	
Takeshi Matsumoto	(University of the Ryukyus) : Principal Investigator
Masao Nakanishi	(University of the Chiba)

(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 MR08-03 cruise from 02 July 2008 to 06 August 2008, except for the territorial waters of U.S.A.

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 Mackenzie (1981) during the cruise.

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

Table 6.6.3 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 Marine-Earth Data and Information Department (MEDID) in JAMSTEC, and will be archived there.

(6) Remark

i. We did not collect data in the territorial waters of USA during the following periods.
22:00UTC 02 Jul. 2008 – 01:00UTC 03 Jul. 2008

7 Special Observations

7.1 TRITON buoys

7.1.1 Operation of the TRITON buoys

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Tomohide Noguchi	(MWJ): Operation Leader
Hiroshi Matsunaga	(MWJ): Technical Leader
Keisuke Matsumoto	(MWJ): Technical Staff
Masaki Yamada	(MWJ): Technical Staff
Tetsuharu Iino	(MWJ): Technical Staff
Shinsuke Toyoda	(MWJ): Technical Staff
Tatsuya Tanaka	(MWJ): Technical Staff
Fuyuki Shibata	(MWJ): Technical Staff
Ayumi Takeuchi	(MWJ): Technical Staff
Kimiko Nishijima	(MWJ): Technical Staff
Shunsuke Tanaka	(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 (MR08-03).

(3) Measured parameters

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

(4) Instrument

1) CTD and CT

SBE-37 IM MicroCAT

A/D cycles to average : 4

Sampling interval : 600sec

Measurement range, Temperature : -5～+35 deg-C

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

Measurement range, Pressure : 0～full scale range

2) CRN(Current meter)

SonTek Argonaut ADCM

Sensor frequency : 1500kHz

Sampling interval : 1200sec

Average interval : 120sec

3) Meteorological sensors

Precipitation

R.M.YOUNG COMPANY MODEL50202/50203

Atmospheric pressure

PAROPSCIENTIFIC.Inc. DIGIQUARTZ FLOATING BAROMETER 6000SERIES

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

Woods Hole Institution ASIMET

Sampling interval : 60sec

Data analysis : 600sec averaged

(5) Locations of TRITON buoys deployment

Nominal location	8N, 156E
ID number at JAMSTEC	01011
Number on surface float	T01
ARGOS PTT number	23511
ARGOS backup PTT number	29738
Deployed date	26 Jul. 2008
Exact location	08°00.94N, 155°57.08E
Depth	4,834 m

Nominal location	5N, 156E
ID number at JAMSTEC	02011
Number on surface float	T06
ARGOS PTT number	3595
ARGOS backup PTT number	29708
Deployed date	23 Jul. 2008
Exact location	04°58.35Ｎ, 156°02.01Ｅ
Depth	3,599 m

Nominal location	2N, 156E
ID number at JAMSTEC	03012
Number on surface float	T07
ARGOS PTT number	9426
ARGOS backup PTT number	24243
Deployed date	21 Jul. 2008
Exact location	01°57.36N, 155°59.98Ｅ

Depth	2,565 m
Nominal location	EQ, 156E
ID number at JAMSTEC	04012
Number on surface float	T10
ARGOS PTT number	7883
ARGOS backup PTT number	24244
Deployed date	19 Jul. 2008
Exact location	00°01.02S, 155°57.42E
Depth	1,940 m
Nominal location	2S, 156E
ID number at JAMSTEC	05010
Number on surface float	T11
ARGOS PTT number	9771
ARGOS backup PTT number	7861
Deployed date	13 Jul. 2008
Exact location	01°59.04S, 156°01.90E
Depth	1,756 m
Nominal location	5S, 156E
ID number at JAMSTEC	06010
Number on surface float	T14
ARGOS PTT number	3593
ARGOS backup PTT number	7864
Deployed date	15 Jul. 2008
Exact location	04°58.03S, 156°00.94E
Depth	1,510m
Nominal location	5N, 147E
ID number at JAMSTEC	07010
Number on surface float	T18
ARGOS PTT number	23510
ARGOS backup PTT number	7871
Deployed date	05 Jul. 2008
Exact location	05°02.51N, 146°56.99E
Depth	4,255 m
Nominal location	2N, 147E
ID number at JAMSTEC	08009
Number on surface float	T23
ARGOS PTT number	23719
ARGOS backup PTT number	7878
Deployed date	08 Jul. 2008
Exact location	01°59.60N, 147°01.34E
Depth	4,521 m

Nominal location	EQ, 147E
ID number at JAMSTEC	09010
Number on surface float	T26
ARGOS PTT number	3781
ARGOS backup PTT number	7881
Deployed date	10 Jul. 2008
Exact location	00°01.49S, 147°00.04Ｅ
Depth	4,567 m

(6) TRITON recovered

Nominal location	8N, 156E
ID number at JAMSTEC	01010
Number on surface float	T02
ARGOS PTT number	20392
ARGOS backup PTT number	24240
Deployed date	12 Jun. 2007
Recovered date	27 Jul . 2008
Exact location	07°57.78N, 156°01.74E
Depth	4,843 m

Nominal location	5N, 156E
ID number at JAMSTEC	02010
Number on surface float	T03
ARGOS PTT number	28868
ARGOS backup PTT number	29710
Deployed date	14 Jun. 2007
Recovered date	25 Jul . 2008
Exact location	05°01.16Ｎ, 155°58.25Ｅ
Depth	3,605 m

Nominal location	2N, 156E
ID number at JAMSTEC	03011
Number on surface float	T13
ARGOS PTT number	03780
ARGOS backup PTT number	29697
Deployed date	15 Jun. 2007
Recovered date	23 Jul . 2008
Exact location	02°02.14N, 156°01.34Ｅ
Depth	2,573 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04011
Number on surface float	T17
ARGOS PTT number	09794
ARGOS backup PTT number	29698

Deployed date	17 Jun. 2007
Recovered date	20 Jul . 2008
Exact location	00°01.01S, 156°02.46Ｅ
Depth	1,954 m

Nominal location	2S, 156E
ID number at JAMSTEC	05009
Number on surface float	T19
ARGOS PTT number	11823
ARGOS backup PTT number	29695
Deployed date	21 Jun. 2007
Recovered date	14 Jul . 2008
Exact location	02°00.89S, 155°57.34Ｅ
Depth	1,751 m

Nominal location	5S, 156E
ID number at JAMSTEC	06009
Number on surface float	T21
ARGOS PTT number	07898
ARGOS backup PTT number	29694
Deployed date	23 Jun. 2007
Recovered date	16 Jul . 2008
Exact location	05°01.98S, 156°01.39Ｅ
Depth	1,523m

Nominal location	5N, 147E
ID number at JAMSTEC	07009
Number on surface float	T22
ARGOS PTT number	23470
ARGOS backup PTT number	29692
Deployed date	02 Jul. 2007
Recovered date	06 Jul . 2008
Exact location	04°57.83N, 147°01.40Ｅ
Depth	4,297 m

Nominal location	2N, 147E
ID number at JAMSTEC	08008
Number on surface float	T24
ARGOS PTT number	20384
ARGOS backup PTT number	24230
Deployed date	01 Jul. 2007
Recovered date	09 Jul . 2008
Exact location	02°04.55N, 146°57.29Ｅ
Depth	4,493 m

Nominal location	EQ, 147E
ID number at JAMSTEC	09009

Number on surface float	T25
ARGOS PTT number	20439
ARGOS backup PTT number	24229
Deployed date	26 Jun. 2007
Recovered date	12 Jul . 2008
Exact location	00°03.68N, 147°00.49Ｅ
Depth	4,472 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
01011	8N156E	Deploy with full spec.
02011	5N156E	Deploy with full spec.
03012	2N156E	Deploy with full spec and 4 optional sensors. CO_2 float type buoy : with TRITON top buoy SBE37 (CT) : 175m CO_2, pH : 25m
04012	EQ156E	Deploy with full spec. SBE37 (CT) : 175m WHADCP : 175m, 300m
05010	2S156E	Deploy with full spec and 1 optional unit. Security camera (pilot unit) : with TRITON tower. **
06010	5S156E	Deploy with full spec.
07010	5N147E	Deploy with full spec.
08009	2N147E	Deploy with full spec. SBE37 (CT) : 175m
09010	EQ147E	Deploy with full spec.

**This security camera was recovered by work boat after 4 days.

(7) Data archive

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

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

7.1.2 Inter-comparison between shipboard CTD and TRITON transmitted data

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Hiroshi Matsunaga	(MWJ): Technical Staff
Keisuke Matsumoto	(MWJ): Technical Staff

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We used the same CTD (SBE 9/11Plus) system with general CTD observation (See section 5) on R/V MIRAI for this intercomparision. We conducted 1 CTD cast at each TRITON buoy site before recovery, conducted 1 CTD 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 CTD data on R/V MIRAI and the TRITON buoy data for each deployment and recovery of buoys.

Compared site

Observation No.	Latitude	Longtitude	Condition
01011	8N	156E	After Deployment
02011	5N	156E	After Deployment
03012	2N	156E	After Deployment
04012	EQ	156E	After Deployment
05010	2S	156E	After Deployment
06010	5S	156E	After Deployment
07010	5N	147E	After Deployment
08009	2N	147E	After Deployment
09010	EQ	147E	After Deployment
01010	8N	156E	Before Recover
02010	5N	156E	Before Recover
03011	2N	156E	Before Recover
04011	EQ	156E	Before Recover
05009	2S	156E	Before Recover
06009	5S	156E	Before Recover
07009	5N	147E	Before Recover
08008	2N	147E	Before Recover
09009	EQ	147E	Before Recover

(5) Results

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

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

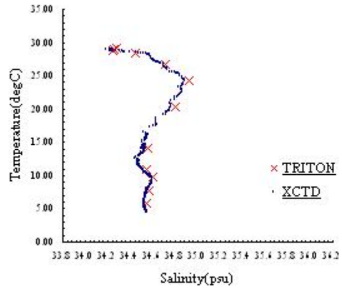
The estimation was calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from –0.1268 to 0.0781 for all depths. Below 300db, salinity differences are from –0.1268 to 0.0593 (See the Figures 7.1.2-2 (a)). The average of salinity differences was -0.0212 with standard deviation of 0.0251.

The estimation was calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.1538 to 0.1607 for all depths. Below 300db, salinity differences are from –0.00037 to 0.0204 (See the Figures 7.1.2-2(b)). The average of salinity differences was 0.0413 with standard deviation of 0.0447.

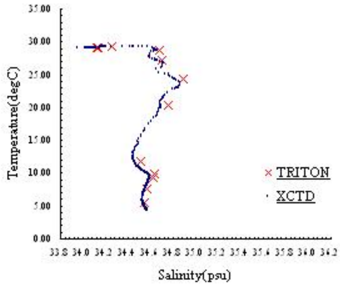
The estimation of time-drift was calculated as recovered buoy data minus deployed buoy data. The salinity changes for 1 year are from –0.1452 to 0.1695, for all depths. Below 300db, salinity changes for 1 year are from -0.0750 to 0.1110 (See the figures 7.1.2-2(c)). The average of salinity differences was -0.0303 with standard deviation of 0.0494.

(6) Data archive

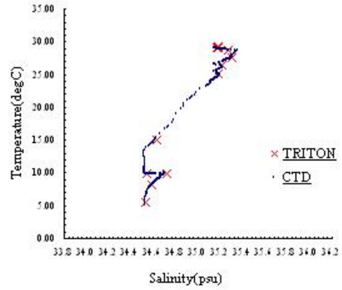
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)



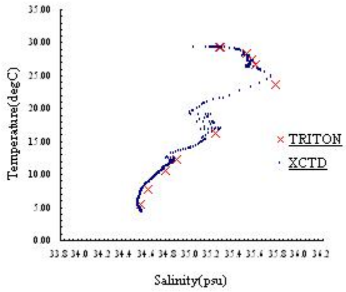
Observation No. 01011 after Deployment



Observation No. 02011 after Deployment



Observation No. 03012 after Deployment



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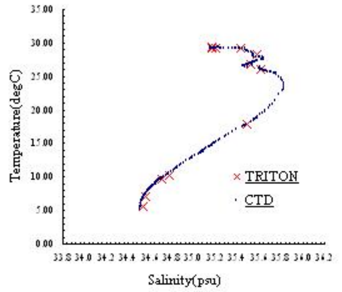

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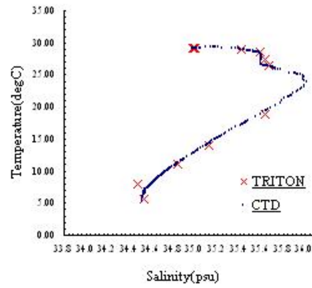

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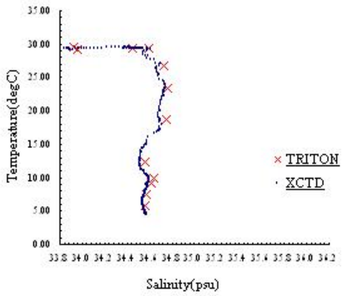
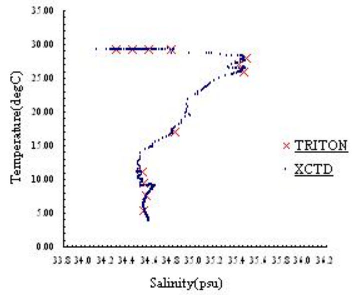
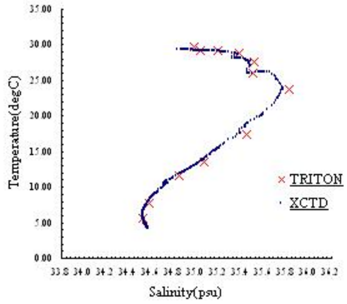


Observation No. 07010 after Deployment

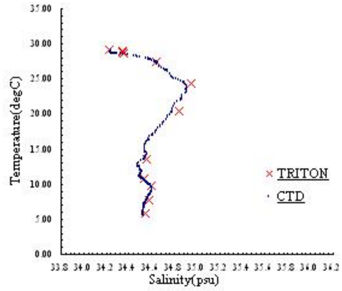


Observation No. 08009 after Deployment

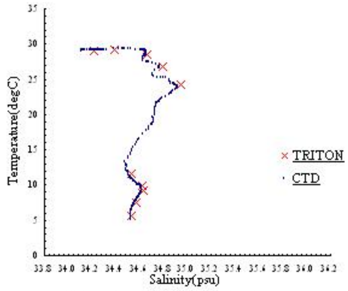


Observation No. 09009 after Deployment

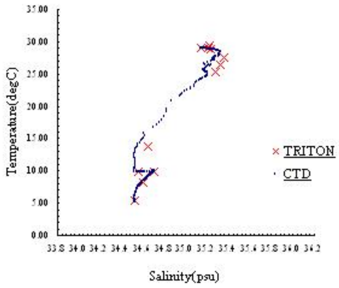
Fig.7.1.2.-1(a) T-S diagram of TRITON buoys data and shipboard CTD data



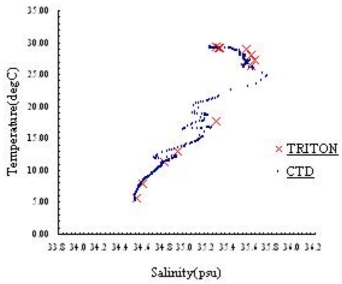
Observation No. 01010 before Recover



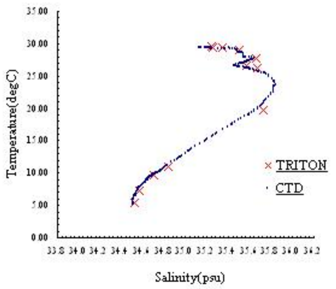
Observation No. 02010 before Recover



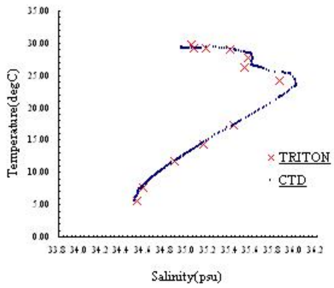
Observation No. 03011 before Recover



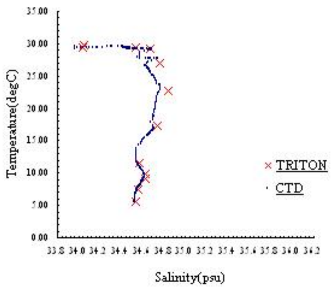
Observation No. 04011 before Recover



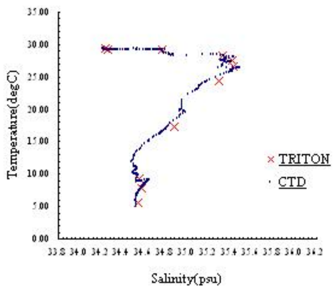
Observation No. 05009 before Recover



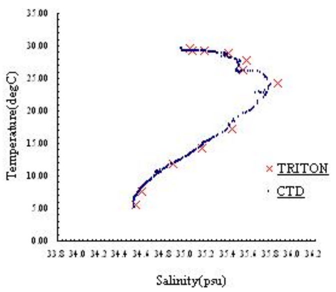
Observation No. 006009 before Recover



Observation No. 07009 before Recover



Observation No. 08008 before Recover



Observation No. 09009 before Recover

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

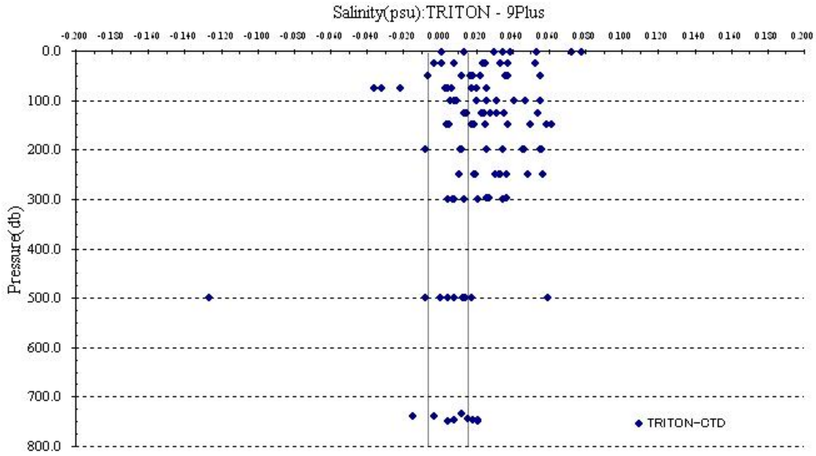


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

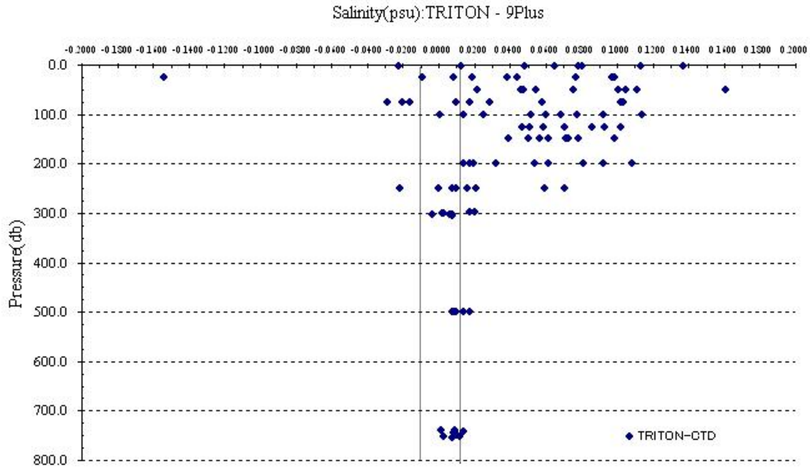


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

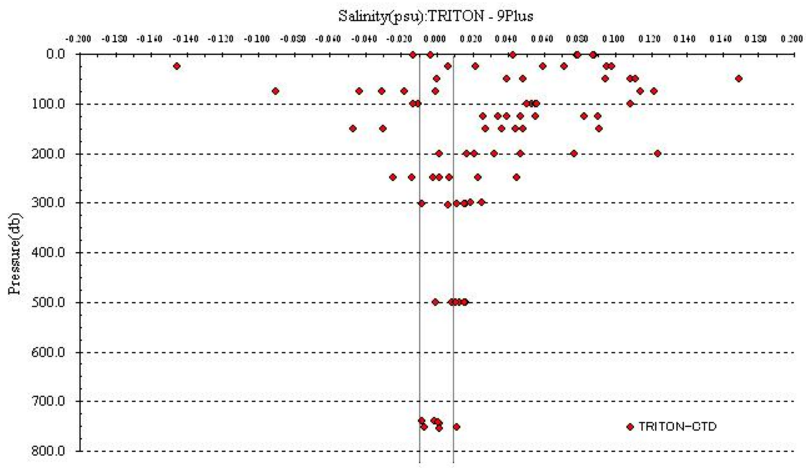


Fig.7.1.2.-2 (c) Salinity differences between deployment data and recovery data for 1year

7.1.3 Time series measurement of detailed temperature and salinity profiles in the mixed layer

(1) Personnel

Kentaro Ando (PI) (JAMSTEC) Not on board
Iwao Ueki (JAMSTEC): Not on board
Yuji Kashino (JAMSTEC): On-board investigator
Yoshimi Kawai (JAMSTEC) Not on board

(2) Objectives

The objective of this project is to measure time series of detailed temperature and salinity profiles in the ocean mixed layer in the Pacific by installing more than 10 sensors along the wire cable of TRITON buoy system for one year long.

During this MR08-03 cruise, all sensors could be recovered; however, several sensors have seemed to be damaged probably due to vandalism by fishing boats. The status at recovery were listed in Table 7.1.3.1-4.

(3) Parameters

Temperature
Conductivity
Photon

(4) Methods

The optional sensors were installed along wire cable and surface float of TRITON buoy deployed at EQ 156˚E. The depths of 19 sensors installed at wire were listed Table 7.1.4-1. The other sensors were installed at the surface float to measure temperature profile from the surface to 1.5 m depth. These sensors were installed at three parts of the surface float; at front side, right side and left side. The installed depth of these sensors are listed Table 7.1.3.

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

1) SBE-37 SM MicroCAT

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

2) SBE-39 IM

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

3) ALEC-MarkV

Sampling interval: 600 sec

Measurement range Temperature: -4～+40 degC

4) ALW-CMP

Mode: Burst Mode

Burst Time: 1800 sec

Interval Time: 2 sec

Sample Number: 10

Measurement range Photon: 0～5000 μ mol/s/m^2

5) HOBO U12 Stainless Temp Data Logger

Sampling interval: 600 sec

Measurement range Temperature: -40～+125 degC

6) 100K6A Thermistor

Sampling interval: 600 sec

Measurement range Temperature: -35～+50 degC

Table7.1.3.1 Measurement parameter and serial number of sensors installed at TRITON wire

Depth(m)	Parameters	Instrument	Serial Number	Status at recovery
4	Temperature, Pressure	SBE-39	3322	Temperature sensor was damaged, inst was moved down several meters
5	Photon	ALW-CMP	60	Sensor wiper was lost, inst was moved down several meters
6	Temperature	ALEC-MarkV	101977	Located at one place with 4m and 5 m sensors
8	Photon	ALW-CMP	61	Possible up-down movement during measurement
9	Temperature	ALEC-MarkV	101978	Inst. Was moved downward several meters
12	Temperature, Conductivity, Pressure	SBE-37	5033	N/A
15	Photon	ALW-CMP	62	Inst. Was moved downward several meters
15	Temperature	ALEC-MarkV	101979	Inst. Was moved downward several meters

18	Temperature, Pressure	SBE-39	3323	Inst. Was moved downward several meters
21	Temperature	ALEC-MarkV	101980	Inst. Was moved downward several meters
31	Temperature	ALEC-MarkV	101981	Inst. Was moved downward several meters
37	Temperature, Conductivity, Pressure	SBE-37	5034	N/A
43	Temperature	ALEC-MarkV	101982	Inst. Was moved downward several meters
56	Temperature	ALEC-MarkV	101983	Inst. Was moved downward several meters
62	Temperature, Conductivity, Pressure	SBE-37	5035	N/A
68	Temperature	ALEC-MarkV	101984	Inst. Was moved downward several meters
81	Temperature	ALEC-MarkV	101985	Inst. Was moved downward several meters
87	Temperature, Pressure	SBE-39	3324	Inst. Was moved downward several meters
93	Temperature	ALEC-MarkV	101986	Inst. Was moved downward several meters

Table7.1.3.2 Measurement parameter and serial number of sensors installed at the right side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number	Status at recovery
0.25	Temperature	ALEC-MarkV	101629	No damage after deployment
1.0	Temperature	HOBO U12 Temp Data Logger	956240	No damage after deployment
1.5	Temperature	HOBO U12 Temp Data Logger	774312	No damage after deployment

Table7.1.3.3 Measurement parameter and serial number of sensors installed at the front side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number	Status at recovery
0.25	Temperature	ALEC-MarkV	101630	No damage after deployment
1.0	Temperature	HOBO U12 Temp Data Logger	956243	No damage after deployment
1.5	Temperature	HOBO U12 Temp Data Logger	956273	No damage after deployment

Table7.1.3.4 Measurement parameter and serial number of sensors installed at the left side of TRITON surface float

Depth(m)	Parameters	Instrument	Serial Number	Status at recovery
0	Temperature	100K6A Thermistor	1	No damage to sensor, chain was not fixed
0.25	Temperature	100K6A Thermistor	2	No damage to sensor, chain was not fixed
0.5	Temperature	100K6A Thermistor	3	No damage to sensor, chain was not fixed
1.0	Temperature	100K6A Thermistor	4	No damage to sensor, chain was not fixed
1.5	Temperature	100K6A Thermistor	5	No damage to sensor, chain was not fixed, sensor cap was lost

7.2 Subsurface ADCP moorings

(1) Personnel

Yuji Kashino	(JAMSTEC): Principal Investigator
Tomohide Noguchi	(MWJ): Operation leader
Hiroshi Matsunaga	(MWJ): Technical staff
Keisuke Matsumoto	(MWJ): Technical staff
Shinsuke Toyoda	(MWJ): Technical staff
Tatsuya Tanaka	(MWJ): Technical staff
Tetsuharu Iino	(MWJ): Technical staff
Fuyuki Shibata	(MWJ): Technical staff
Kimiko Nishijima	(MWJ): Technical staff

(2) Objectives

The purpose is to get the knowledge of physical process in the western equatorial Pacific Ocean. We have been observing subsurface currents using ADCP moorings along the equator. In this cruise (MR08-03), 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 layer currents from subsurface to 300m depths. The other is CTD to observe pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are as follows:

1) ADCP

Self-Contained Broadband ADCP 150 kHz (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 : 1155 (Mooring No.070628-00147E)
- Serial Number : 1152 (Mooring No.070618-00156E)

Deployed ADCP

- Serial Number : 1222 (Mooring No.080711-00147E)
- Serial Number : 1154 (Mooring No.080720-00156E)

2) CTD

SBE-16 (Sea Bird Electronics Inc.)
Sampling Interval : 1800 seconds

Recovered CTD

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

Deployed CTD

- Serial Number : 1278 (Mooring No.080711-00147E)

- Serial Number : 1274 (Mooring No.080720-00156E)

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)

Recovered Acoustic Releaser

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

Deployed Acoustic Releaser

- Serial Number : 632 (Mooring No.080711-00147E)
- Serial Number : 693 (Mooring No.080711-00147E)
- Serial Number : 667 (Mooring No.080720-00156E)
- Serial Number : 634 (Mooring No.080720-00156E)

(b) Transponder (BENTHOS,Inc.)

Recovered Transponder

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

Deployed Transponder

- Serial Number : 57069 (Mooring No.080711-00147E)
- Serial Number : 57491 (Mooring No.080720-00156E)

(5) Deployment

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

The position of the mooring No. 080711-00147E

Date: 11 Jul. 2008 Lat: 00-00.28S Long: 147-05.10E Depth: 4,473m

The position of the mooring No. 080720-00156E

Date: 20 Jul. 2008 Lat: 00-02.17S Long: 156-07.87E Depth: 1,945m

(6) Recovery

We recovered two ADCP moorings. One was deployed on 18 Jun.2007 and the other was deployed on 28 Jun. 2007 (MR07-03cruise). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code.

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

(7) Data archive

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

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

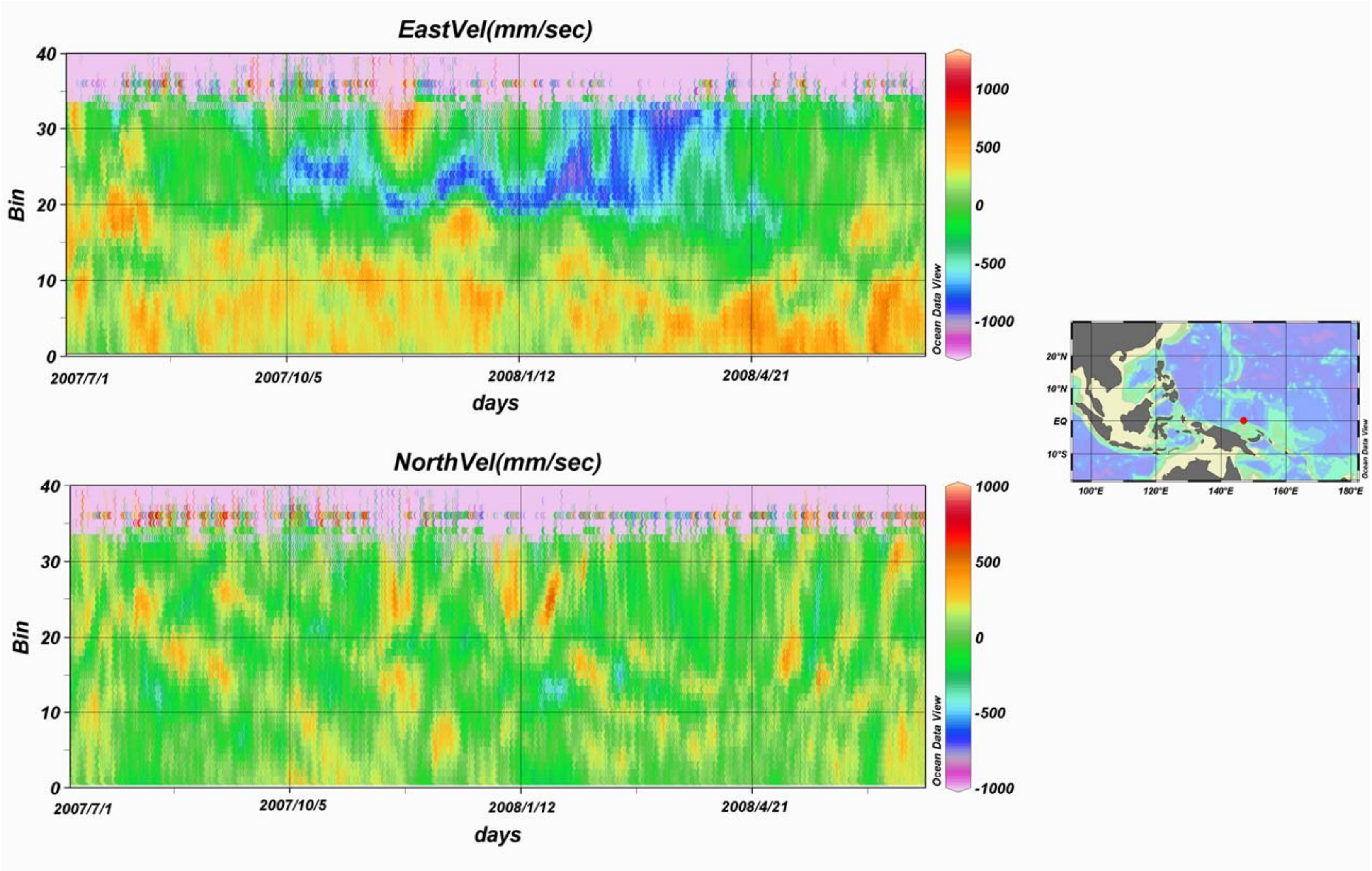


Fig.7-2-1 Time Series of zonal and meridional velocities of EQ-147E mooring (2007/6/28-2008/7/11)

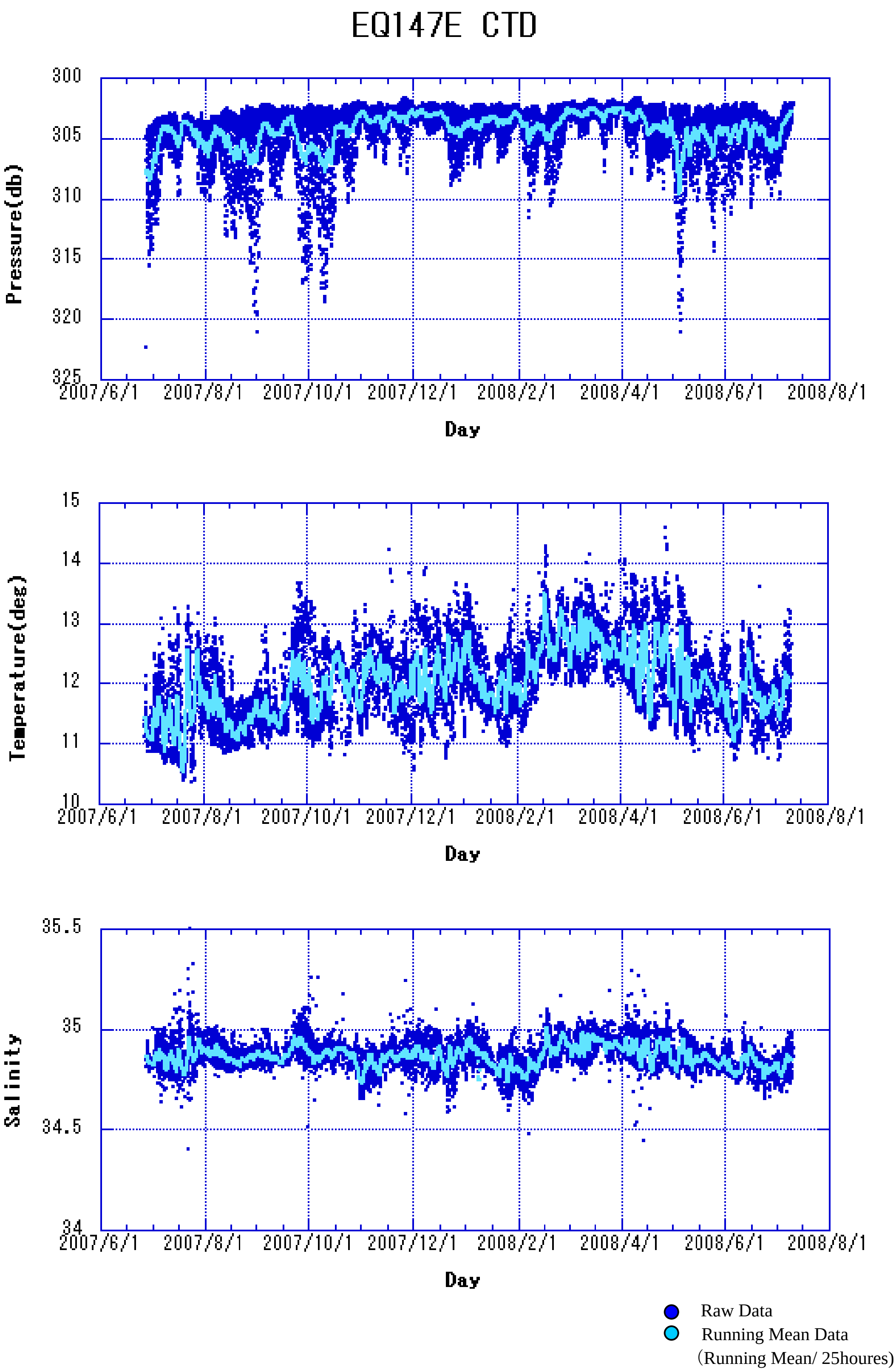


Fig.7-2-2 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-147E mooring (2007/6/28-2008/7/11)

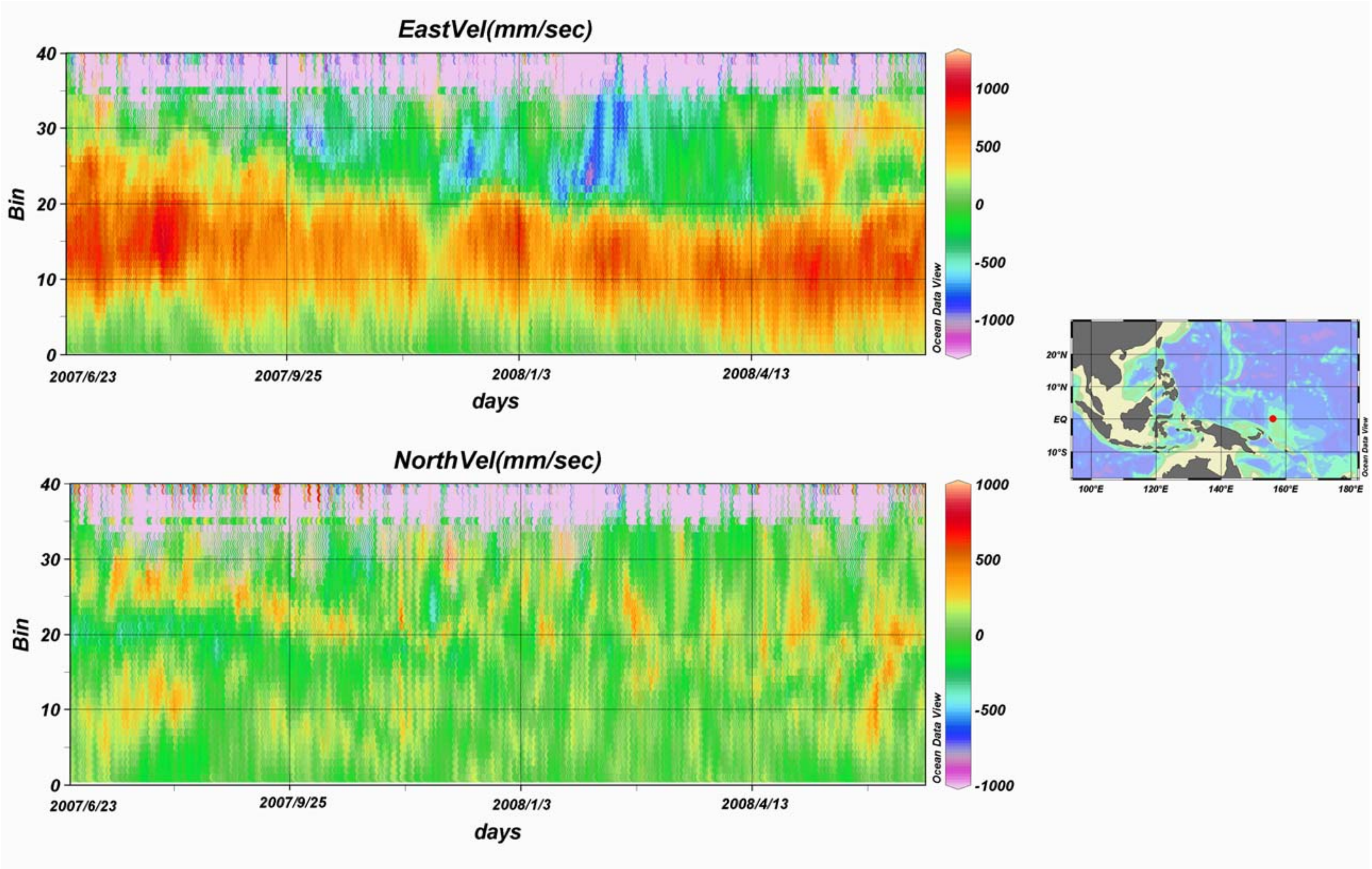


Fig.7-2-3 Time Series of zonal and meridional velocities of EQ-156E mooring (2007/6/18-2008/7/20)

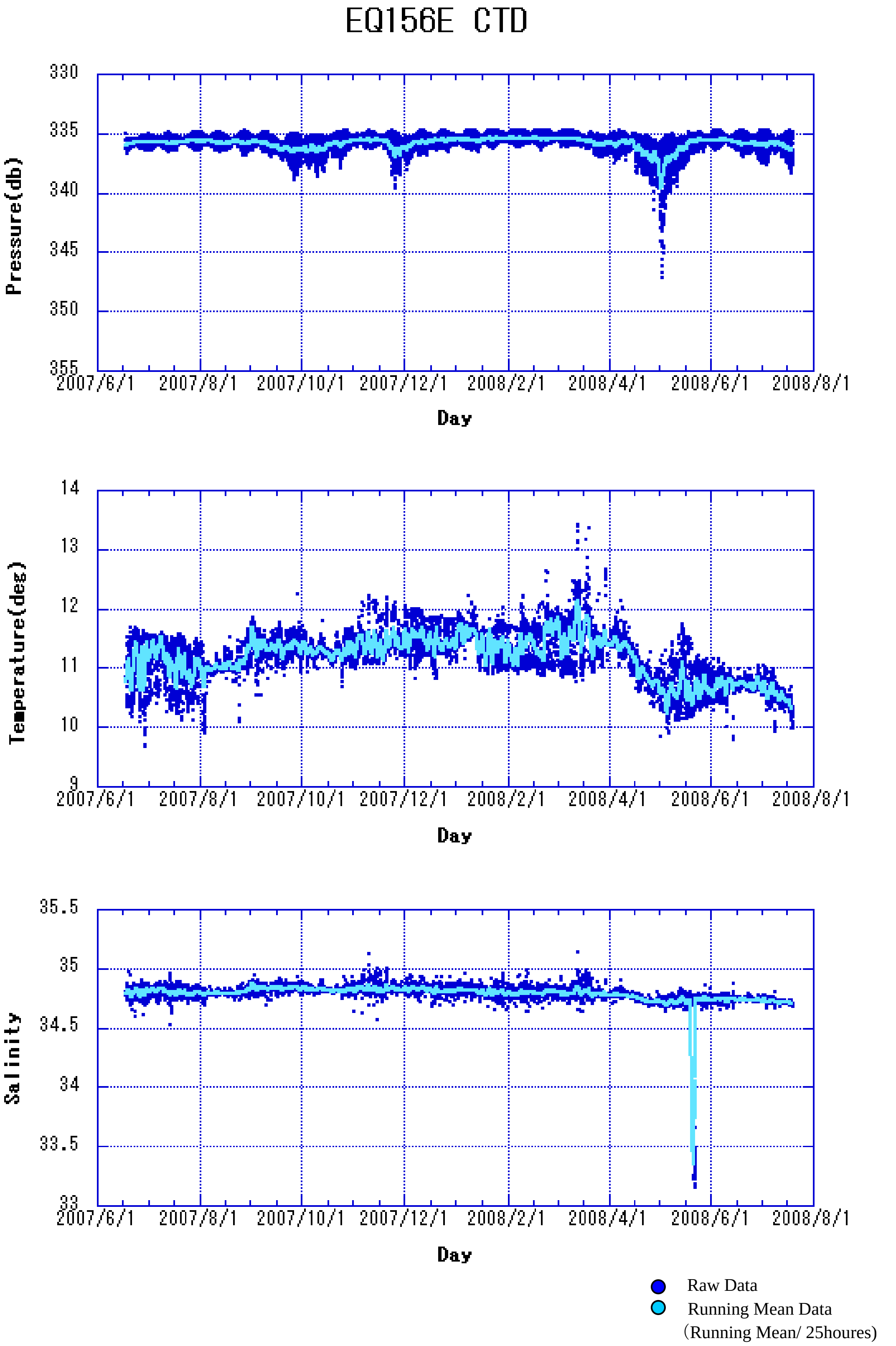


Fig.7-2-2 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-156E mooring (2007/6/18-2008/7/20)

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

Personnel Kelvin Richards (IPRC, University of Hawaii)
Andrei Natarov (IPRC, University of Hawaii)

(1) Objective

To measure small vertical scale (SVS) velocity structures in the upper ocean.

(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 deployed on all 500m, 800m and 1000m casts at CTD stations C1-C34. In addition the instrument was deployed on the 200m casts 06-13 at CTD station C18 (the 21 hour time series at 2S 156E). The instrument performed well throughout its use.

Figure 7-3-1. Mounting of LADCP on the CTD System

The instrument is self-contained with an internal battery pack. The health of the battery is monitored by the recorded voltage count. Direct measurements of the battery voltage were taken before the first and after the last deployments and compared to the recorded voltage count:

	Battery Voltage (V)	Voltage Count (VC)	ratio (V/VC)
Before	45.0	148	0.304
After	40.3	133	0.303

implying an almost constant relationship of V~=0.30VC. RDI recommend the battery is changed when V gets below 30V.

(3) Setup and Parameter settings

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**. For most of the casts the instrument was setup 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.)

During the last two casts the parameters were changed to WS0100 (CTD stations C34_05 and C34_06) and WN50 (CTD station C34_06) to test the instrument at bin depth of 1m. Initial analysis suggests that reducing the bin size to 1 m introduces noise in the data and that 2m should be the preferred bin depth.

(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_4 (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.

Because of the short range of the 600 kHz instrument (20-40m in this case) the analysis is very sensitive to the presence of the wake of the CTD system on up-casts. Individual beams can be affected; indicated by a reduced velocity over the top few bins shown in the velocity plot produced by plot_vel.py. In most cases only one out of the four beams was severely affected. Calculating a 3-beam solution, by ignoring the affected beam, produced much better results than the full 4 beam solution.

On-station SADCP velocity profiles were produced by averaging the five minute averaged profiles (mr080300x_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 7-3-2. Figure 7-3-2 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 C21_01. 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 at about 200 m depth visible in both U and V.

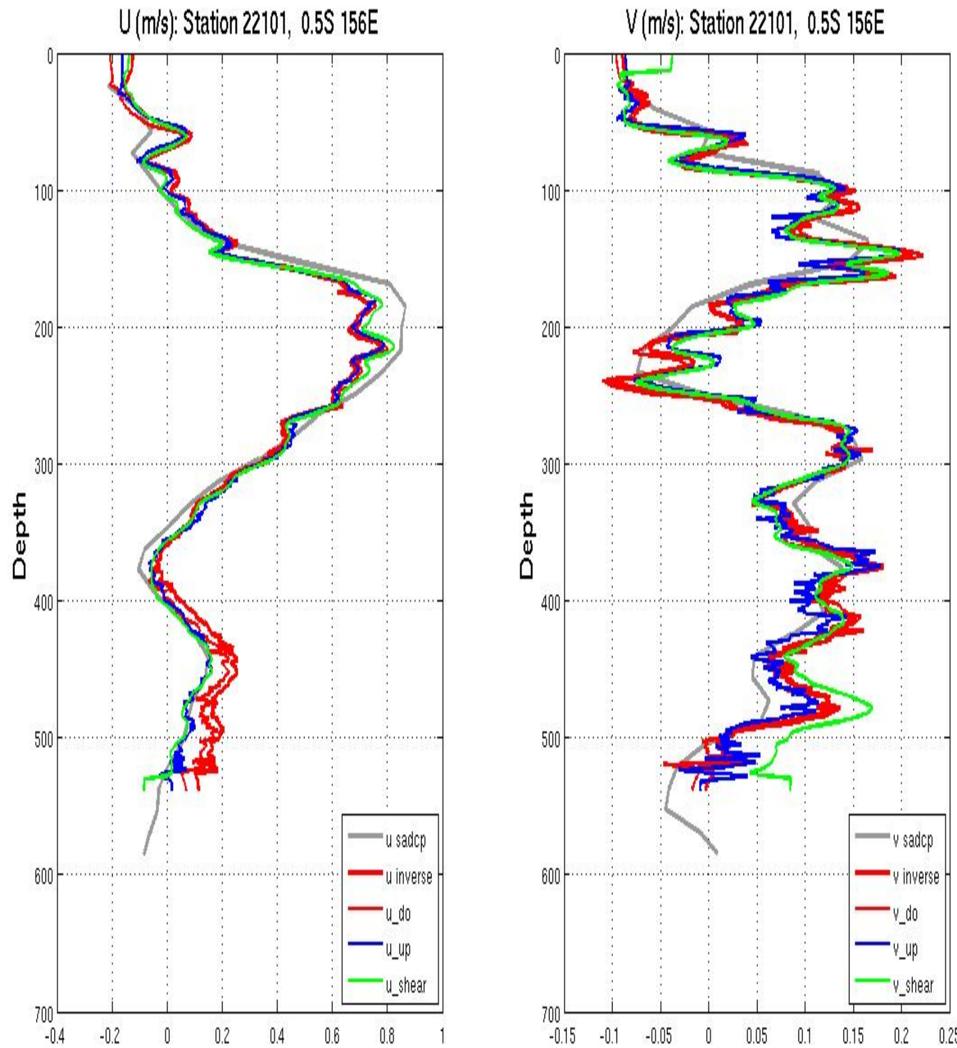


Figure 7-3-2 CTD Station C21_01: Vertical profiles of U and V calculated by a number of methods using LADCP data. Full cast inverse (u inverse), down-cast only inverse (u_do), up-cast only inverse (u_up) and shear solution (u_shear). Also shown are the profiles using SADCP data (u sadcp).

The measurements at individual stations are combined to produce latitudinal sections of the velocity fields. Figures 7-3-3 and 7-3-4 show the zonal component of the velocity as a function of latitude and depth along 147E and 156E, respectively. Both plots show an abundance of features with vertical scales 30 – 60 m. Smaller scale features, not evident in the plots shown, are present and resolved by the LADCP.

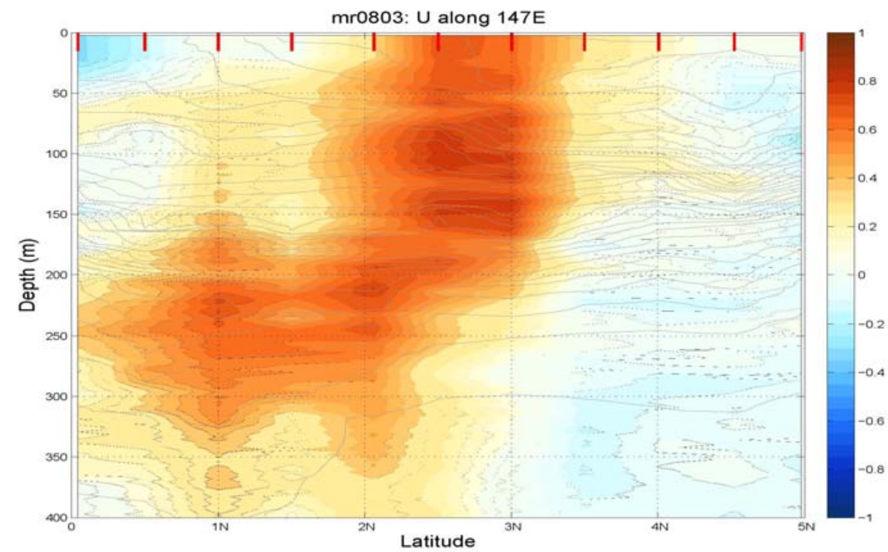


Figure 7-3-3. Latitudinal section of the zonal component of the velocity at 147E. Potential density is also shown as gray contour lines (contour interval: 0.2 kg m^{-3})

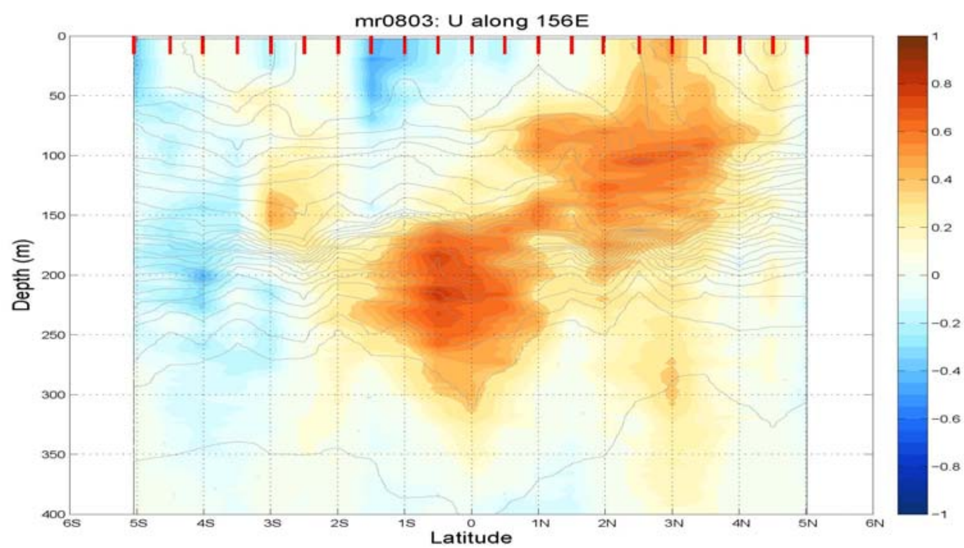


Figure 7-3-4. Latitudinal section of the zonal component of the velocity along 156E. Potential density is also shown as gray contour lines (contour interval: 0.2 kg m^{-3})

7.4 Shallow Water CTD and Fluorescence Observation

(1) Personnel

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(2) Objective

In order to clarify the primary production in the ocean, it is very important to know a vertical concentration of phytoplankton. We carried out the shallow water observation to understand the temporal and spatial variations of environment with biological production in the euphotic layer.

(3) Method

We observed vertical profiles of temperature, conductivity, fluorescence, turbidity, and light intensity by sensor units from surface to 200 or 500 m depth every 0.1 sec. The Conductivity Temperature Depth profiler with fluorescence sensor (Compact-CTD ASTD687, S/N 33, Alec Electronics Co. Ltd.) and the light intensity sensor (Compact-LW ALW-CMP, S/N 33, Alec Electronics Co. Ltd.) were attached to CTD/water sampler which is equipped on board of the vessel. Descending rate was kept about 0.5 m/s when the light intensity sensor was attached. Salinity was calculated from observed pressure, conductivity and temperature. The log data is shown in Table 7.4.1. Light intensity was observed at noon cast. The water samplings at five layers were carried out at the noon cast because of calibration for fluorescence. The fixed point observation was performed at 2.0S 156E in July 18. The CTD cast was measured eight times in the interval for 3 hours from 6 am to 3 am. Fluorescence was recorded as the raw data (N value: 0 to 65520), and we will calibrate the fluorescence data using the chlorophyll-a pigment data which was analyzed by MWJ.

Accuracy of the sensors is as follows;

Depth : ±0.3 %FS

Temperature :±0.02 ℃

Conductivity : ±0.05 mS/cm

Fluorescence : ±1.0 %FS

Light intensity : ±4.0 %FS

Turbidity : ±2.0 %FS

(4) Preliminary Results

Figure 7.4.1-5 show the oceanic profiles at several positions on observation line at 147E. The three times observations during daytime were carried out at 5.0N, 2.0N and EQ which are deployment or recovery point for TRITON buoys. And depth-latitude Cross Section of fluorescence on 147E is shown by Fig. 7.4.6 besides. These results suggest that the maximum layers of fluorescence have deeper position about 80-100 dB at 3.5N and 5.0N but it be became shallower about 60-80 dB as the latitude of the observation point is southern. The vertical distribution of fluorescence has needle shape at 2N because the clear barrier of density at 80 dB hinders the supply of the nutrient to the upper layer. But the vertical distribution of fluorescence become nearly the shape of the normal distribution at EQ which have very gradual gradient of density profile and the concentration of fluorescence in upper layer is higher than other observed point. Therefore the value of fluorescence clearly increases owing to the photosynthesis.

Figure 7.4.7-19 show the oceanic profiles at several positions on observation line at 156E. We measured every 0.5 degrees from 5.0S to 5.0N on this observation line. In the same way at 147E, the observation was carried out three times during daytime in where TRITON buoys were developed or recovered. Figure 7.4.20 shows the depth-latitude Cross Section of fluorescence on this observation line. The depths of the maximum layer for fluorescence have very different at each measured position on 156E. Between 0.5N and 1.5N, where mixing layer depth have 60m deep and the large gradient of density can be confirmed on 60m depth, the maximum layer for fluorescence is existed in 40-60m depth. It is very shallow in equatorial zone. However, at 8N, where mixing layer depth is around 70m depth similar to above zones, the maximum layer of fluorescence is located very deep in 120m depth.

Figure 7.4.21 shows the profiles at 2.0S 156E during the fixed point observation. Depth-Time cross sections of fluorescence, and light intensity (PAR) are shown in Fig.7.4.22. The light intensity is calculated using sown welling shortwave radiation from SOJ and the equation as follow.

$$I(z) = I(0) \cdot \exp\left(a \cdot z^{b}\right)$$

$I(z)$ is light intensity at depth z. $I(0)$ is light intensity at surface layer which is provide from shortwave radiation. *a* and *b* were the attenuated coefficient which are calibrated by observed data of profiles of light intensity. The discontinuity layer moved up and down due to internal wave. The phytoplankton formed the maximum layer on a little of the position of discontinuity layer. The light reaches this layer sufficiently. The value of fluorescence increases at evening because the stoked photosynthesis energy during daytime causes to breeding of phytoplankton late.

(5) Data archive

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

Table 7.4.1 Compact-CTD Cast Table

CAST No.	File name *.csv	Lat.	Long.	Date[LST]	Start Time	End Time	UTC	Depth	Water Sampling	Light intensity ◎: observed
C01M01	C01M01CTD C01M01Li	05-01.99N	146-57.91E	05.Jul.2008	6:04	6:25	-10 hour	200m	none	◎
C01M02	C01M02CTD C01M02Li	05-01.85N	146-57.91E	05.Jul.2008	13:04	13:26	-10 hour	200m	120,100,90,80,60m	◎
C01M04	C01M04CTD C01M04Li	05-01.90N	146-57.88E	05.Jul.2008	17:53	18:13	-10 hour	200m	none	◎
C04M01	C04M01CTD	03-29.96N	147-00.02E	06.Jul.2008	19:07	19:22	-10 hour	200m	none	
C07M01	C07M01CTD C07M01Li	02-00.31N	147-00.33E	08.Jul.2008	5:59	6:15	-10 hour	200m	none	◎
C07M02	C07M02CTD C07M02Li	02-00.42N	147-00.29E	08.Jul.2008	13:03	13:26	-10 hour	200m	100,80,70,60,40m	◎
C07M04	C07M04CTD C07M04Li	02-00.28N	147-00.48E	08.Jul.2008	17:56	18:13	-10 hour	200m	none	◎
C09M02	C09M02CTD C09M02Li	01-00.03N	146-59.95E	09.Jul.2008	16:38	16:53	-10 hour	200m	none	◎
C11M02	C11M02CTD C11M02Li	00-00.23S	147-02.51E	11.Jul.2008	5:58	6:13	-10 hour	200m	none	◎
C11M03	C11M03CTD C11M03Li	00-00.28S	147-02.40E	11.Jul.2008	13:02	13:25	-10 hour	200m	180,150,100,70,40m	◎
C11M04	C11M04CTD C11M04Li	00-00.38S	147-02.25E	11.Jul.2008	17:58	18:12	-10 hour	200m	none	◎
C12M01	C12M01CTD C12M01Li	04-59.87S	155-59.94E	16.Jul.2008	5:58	6:12	-11 hour	200m	none	◎
C12M03	C12M03CTD C12M03Li	04-59.96S	155-59.89E	16.Jul.2008	13:01	13:23	-11 hour	200m	180,120,90,70,50m	◎
C12M05	C12M05CTD C12M05Li	04-59.92S	156-00.49E	16.Jul.2008	17:57	18:12	-11 hour	200m	none	◎
C13M01	C13M01CTD	04-29.98S	155-59.99E	17.Jul.2008	13:07	13:29	-11 hour	500m	none	
C14M01	C14M01CTD	03-59.99S	155-59.99E	17.Jul.2008	16:06	16:30	-11 hour	500m	none	
C15M01	C15M01CTD C15M01Li	03-30.07S	156-00.06E	15.Jul.2008	18:47	18:57	-11 hour	200m	none	◎
C16M01	C16M01CTD	03-00.02S	155-59.97E	15.Jul.2008	16:03	16:25	-11 hour	500m	none	
C17M01	C17M01CTD	02-30.09S	156-00.03E	15.Jul.2008	13:22	13:46	-11 hour	500m	none	
C18M01	C18M01CTD C18M01Li	01-58.33S	155-59.01E	14.Jul.2008	5:59	6:14	-11 hour	200m	none	◎
C18M03	C18M03CTD C18M03Li	01-58.39S	155-58.86E	14.Jul.2008	13:03	13:29	-11 hour	200m	180,120,80,60,40m	◎
C18M05	C18M05CTD C18M05Li	01-58.43S	155-58.86E	14.Jul.2008	17:59	18:14	-11 hour	200m	none	◎
C18M06	C18M06CTD C18M06Li	01-58.34S	155-59.97E	18.Jul.2008	5:59	6:15	-11 hour	200m	none	◎
C18M07	C18M07CTD C18M07Li	01-58.37S	155-58.97E	18.Jul.2008	9:00	9:16	-11 hour	200m	none	◎
C18M08	C18M08CTD C18M08Li	01-58.43S	155-58.83E	18.Jul.2008	11:59	12:23	-11 hour	200m	180,120,90,60,40m	◎
C18M09	C18M09CTD C18M09Li	01-58.50S	155-58.89E	18.Jul.2008	15:00	15:15	-11 hour	200m	none	◎
C18M10	C18M10CTD C18M10Li	01-58.50S	155-58.96E	18.Jul.2008	18:00	18:15	-11 hour	200m	none	◎
C18M11	C18M11CTD	01-58.47S	155-59.01E	18.Jul.2008	20:58	21:14	-11 hour	200m	none	
C18M12	C18M12CTD	01-58.44S	155-58.95E	18-19.Jul.2008	23:59	0:22	-11 hour	200m	180,120,90,70,40m	
C18M13	C18M13CTD	01-58.45S	155-58.98E	19.Jul.2008	2:58	3:12	-11 hour	200m	none	

Table 7.4.1 Compact-CTD Cast Table (continue)

CAST No.	File name *.csv	Lat.	Long.	Date[LST]	Start Time	End Time	UTC	Depth	Water Sampling	Light intensity ◎: observed
C19M01	C19M01CTD	01-29.97S	155-58.88E	19.Jul.2008	5:57	6:19	-11 hour	500m	none	
C20M01	C20M01CTD C20M01Li	00-59.96S	155-59.98E	19.Jul.2008	8:57	9:12	-11 hour	200m	none	◎
C21M01	C21M01CTD	00-29.94S	155-59.96E	19.Jul.2008	13:00	13:23	-11 hour	500m	none	
C22M02	C22M02CTD C22M02Li	00-00.90S	155-59.94E	20.Jul.2008	5:59	6:14	-11 hour	200m	none	◎
C22M04	C22M04CTD C22M04Li	00-00.33S	155-58.95E	20.Jul.2008	11:03	11:25	-11 hour	200m	120,100,70,50,20m	◎
C22M05	C22M05CTD C22M05Li	00-00.69S	155-58.78E	20.Jul.2008	17:58	18:13	-11 hour	200m	none	◎
C23M01	C23M01CTD	00-30.09N	155-59.98E	19.Jul.2008	18:56	19:28	-11 hour	500m	none	
C24M01	C24M01CTD C24M01Li	01-00.12N	155-59.88E	21.Jul.2008	15:21	15:38	-11 hour	200m	none	◎
C25M01	C25M01CTD	01-30.16N	155-59.90E	21.Jul.2008	18:46	19:09	-11 hour	500m	none	
C26M01	C26M01CTD C26M01Li	01-59.01N	155-59.99E	22.Jul.2008	5:58	6:13	-11 hour	200m	none	◎
C26M03	C26M03CTD C26M03Li	01-59.23N	155-59.86E	22.Jul.2008	13:05	13:27	-11 hour	200m	180,120,80,50,30m	◎
C26M05	C26M05CTD C26M05Li	01-59.16N	156-00.13E	22.Jul.2008	17:57	18:13	-11 hour	200m	none	◎
C27M01	C27M01CTD	02-30.60N	156-00.13E	23.Jul.2008	14:34	14:56	-11 hour	500m	none	
C28M01	C28M01CTD	03-00.03N	156-00.12E	23.Jul.2008	17:03	17:26	-11 hour	500m	none	
C29M02	C29M02CTD	03-29.75N	156-00.05E	23.Jul.2008	19:35	19:57	-11 hour	500m	none	
C30M01	C30M01CTD	04-00.39N	155-59.93E	24.Jul.2008	18:49	19:12	-11 hour	500m	none	
C31M01	C31M01CTD	04-30.25N	156-00.03E	24.Jul.2008	16:05	16:27	-11 hour	500m	none	
C32M02	C32M02CTD C32M02Li	05-01.37N	155-57.34E	25.Jul.2008	5:58	6:14	-11 hour	200m	none	◎
C32M03	C32M03CTD C32M03Li	05-01.34N	155-57.19E	25.Jul.2008	13:05	13:27	-11 hour	200m	160,120,100,80,50m	◎
C32M04	C32M04CTD C32M04Li	05-01.48N	155-57.51E	25.Jul.2008	18:08	18:23	-11 hour	200m	none	◎
C33M01	C33M01CTD	06-30.16N	155-59.95E	26.Jul.2008	5:29	5:52	-11 hour	500m	none	
C34M02	C34M02CTD C34M02Li	07-57.38N	156-00.76E	27.Jul.2008	5:59	6:14	-11 hour	200m	none	◎
C34M03	C34M03CTD C34M03Li	07-57.47N	156-00.59E	27.Jul.2008	13:04	13:25	-11 hour	200m	160,120,100,80,50m	◎
C34M06	C34M06CTD C34M06Li	07-57.30N	156-00.25E	27.Jul.2008	18:22	18:38	-11 hour	200m	none	◎

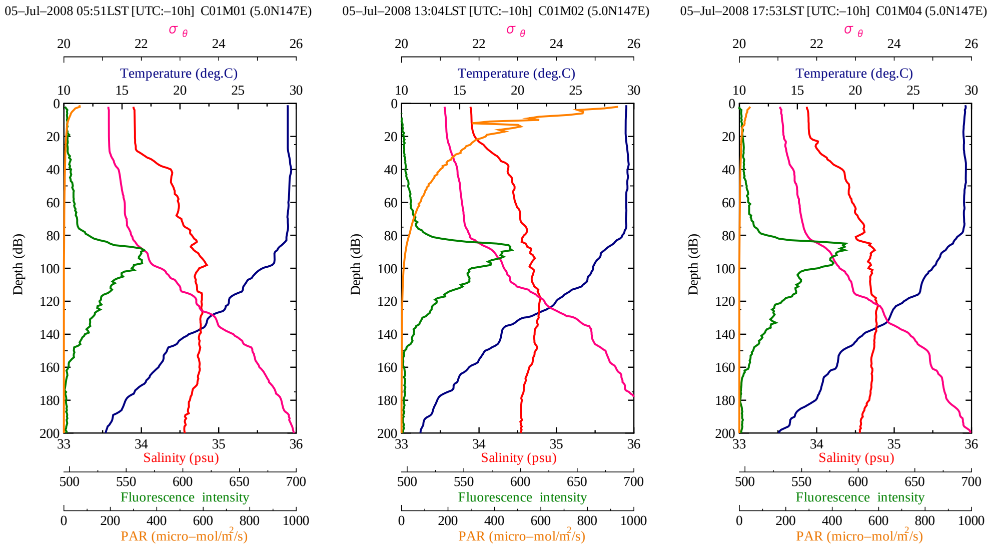


Fig.7.4.1 Oceanic profiles at (5-00N, 147E)

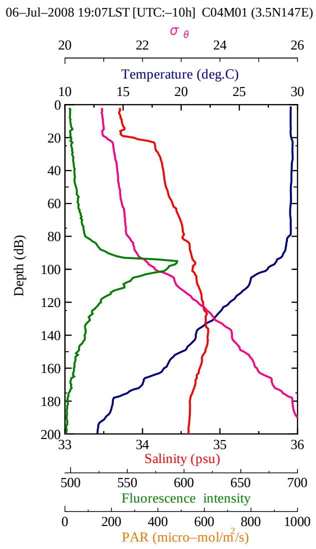


Fig.7.4.2 Oceanic profiles at (3-30N, 147E)

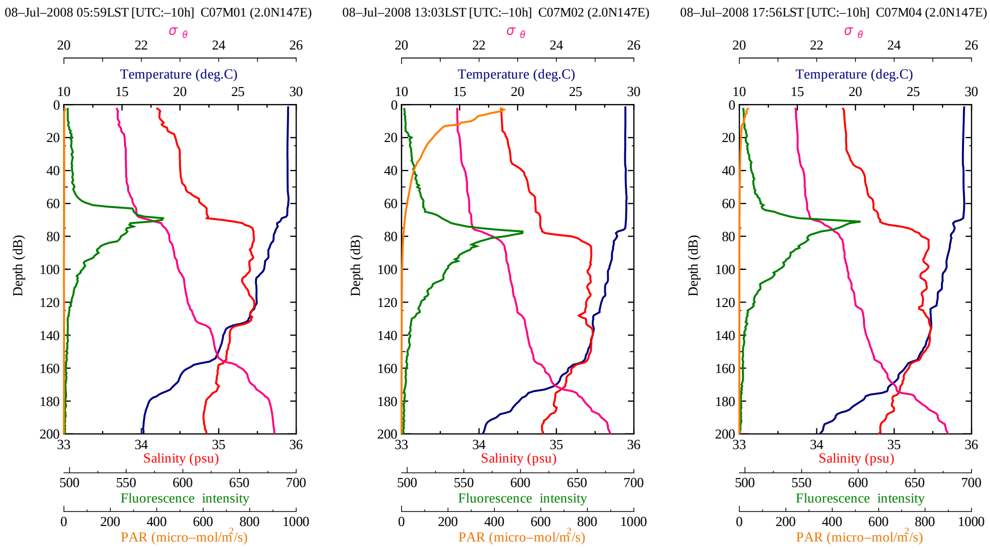


Fig.7.4.3 Oceanic profiles at (2-00N, 147E)

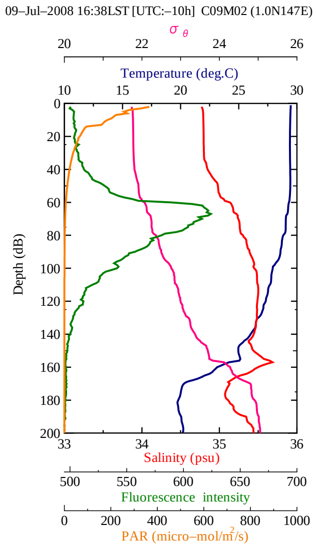


Fig.7.4.4 Oceanic profiles at (1-00N, 147E)

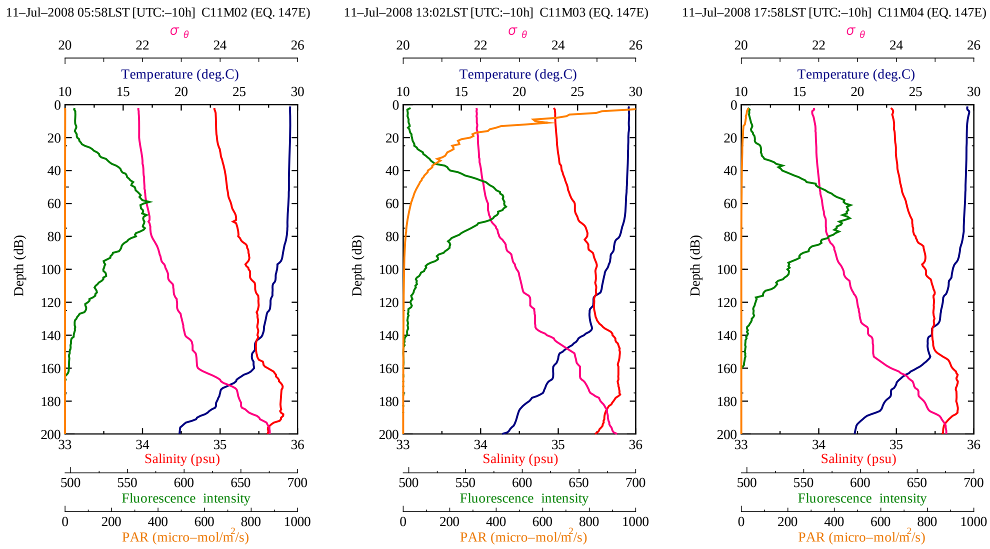


Fig.7.4.5 Oceanic profiles at (0-00, 147E)

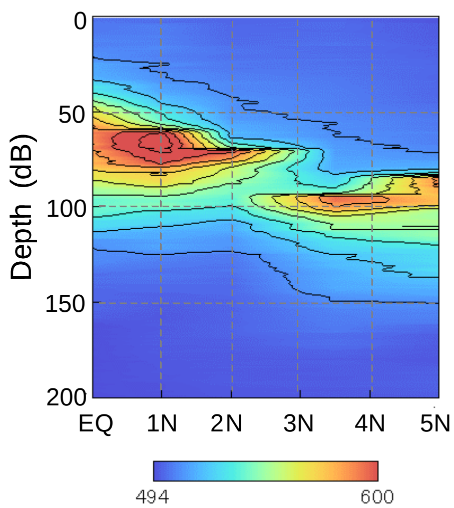


Fig.7.4.6 Depth-latitude Cross Section of fluorescence on 147E

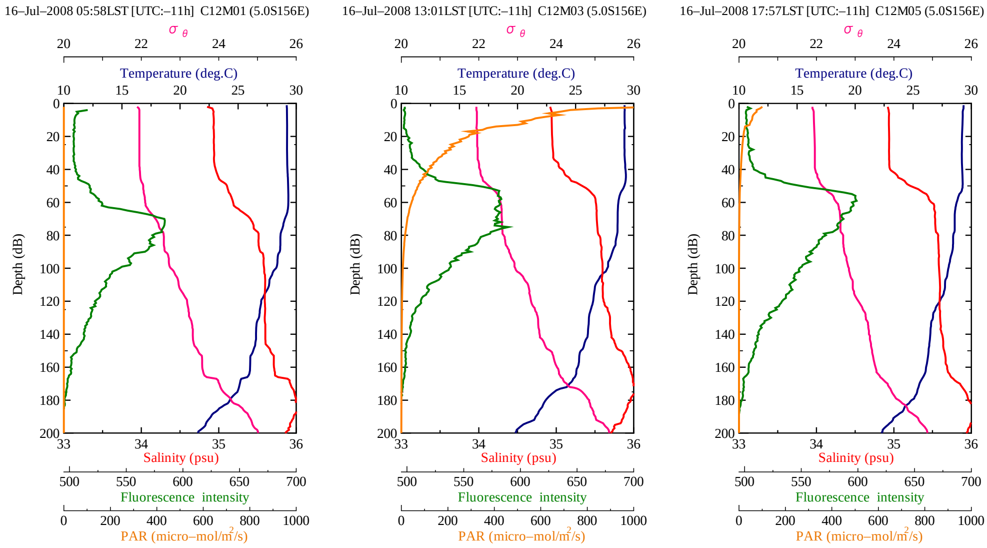


Fig.7.4.7 Oceanic profiles at (5-00S, 156E)

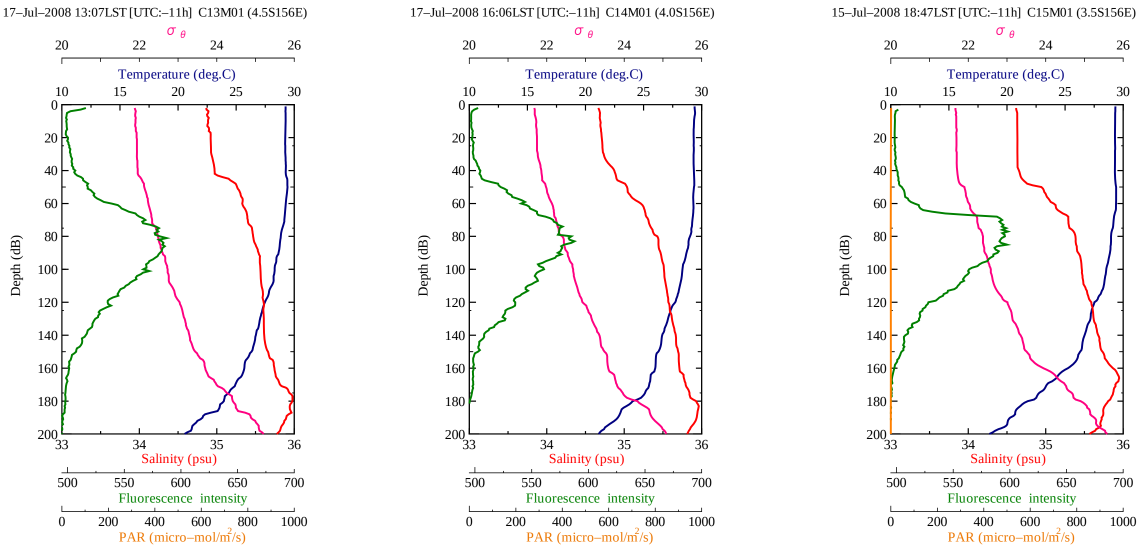


Fig.7.4.8 Oceanic profiles at (4-30S, 156E), (4-00S, 156E) and (3-30S, 156E)

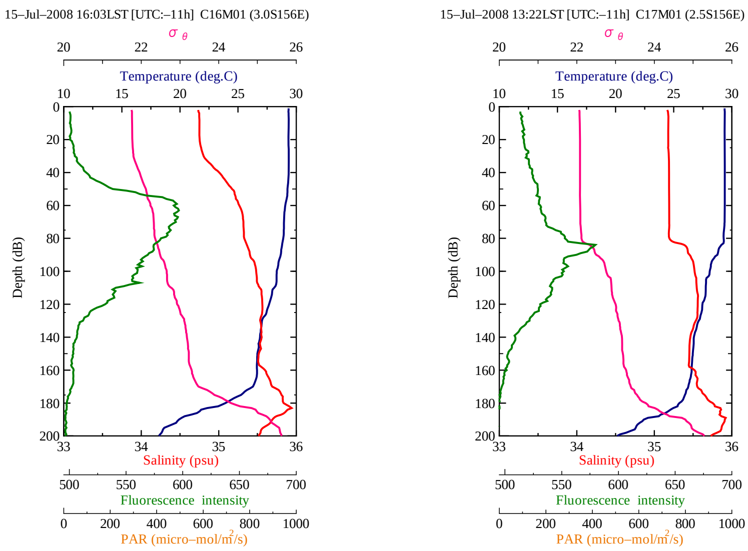


Fig.7.4.9 Oceanic profiles at (3-00S, 156E) and (2-30S, 156E)

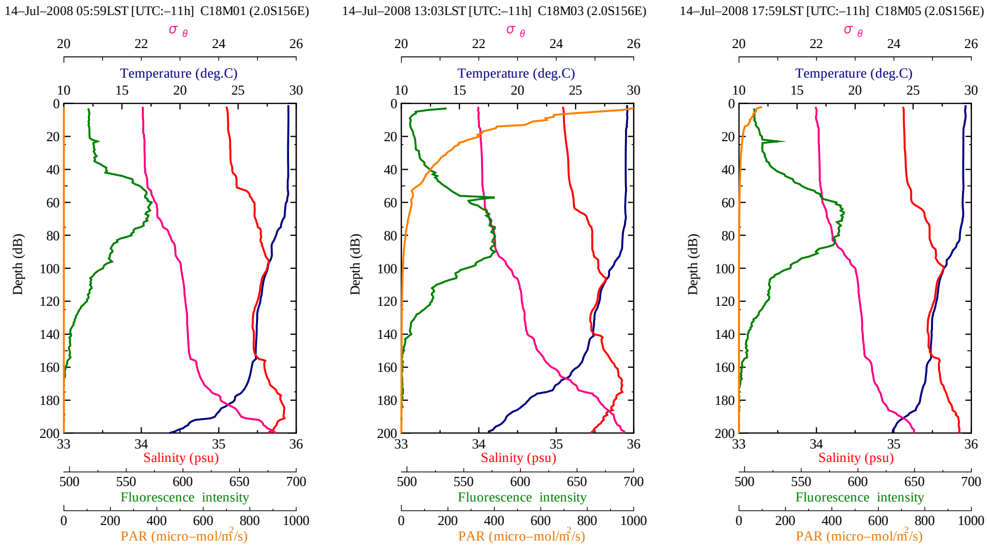


Fig.7.4.10 Oceanic profiles at (2-00S, 156E)

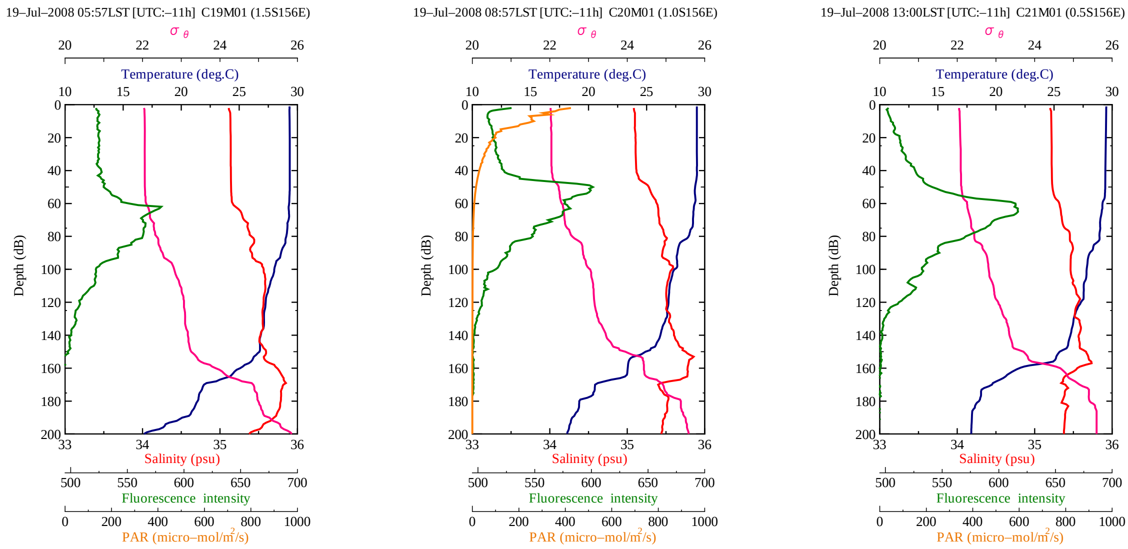


Fig.7.4.11 Oceanic profiles at (1-30S, 156E), (1-00S, 156E) and (0-30S, 156E)

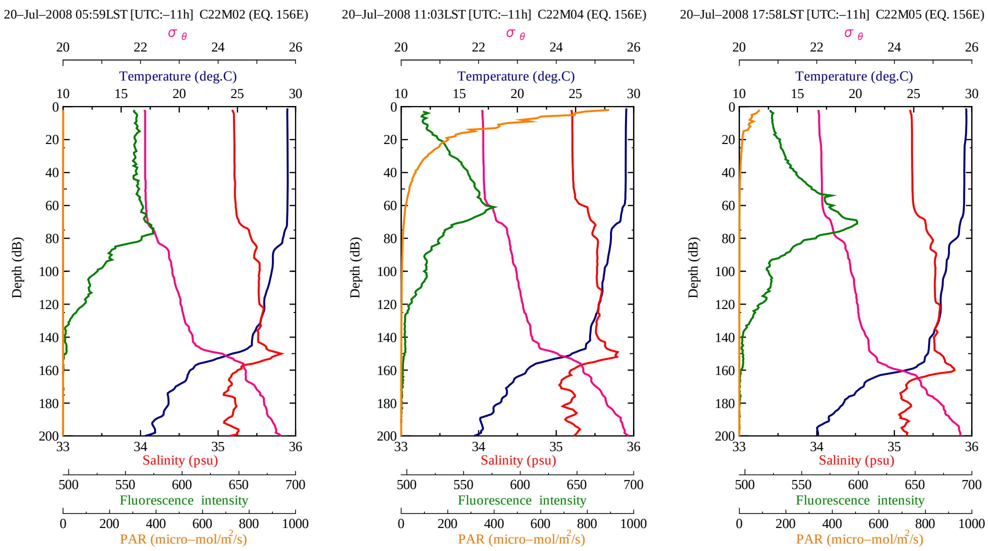


Fig.7.4.12 Oceanic profiles at (0-00, 156E)

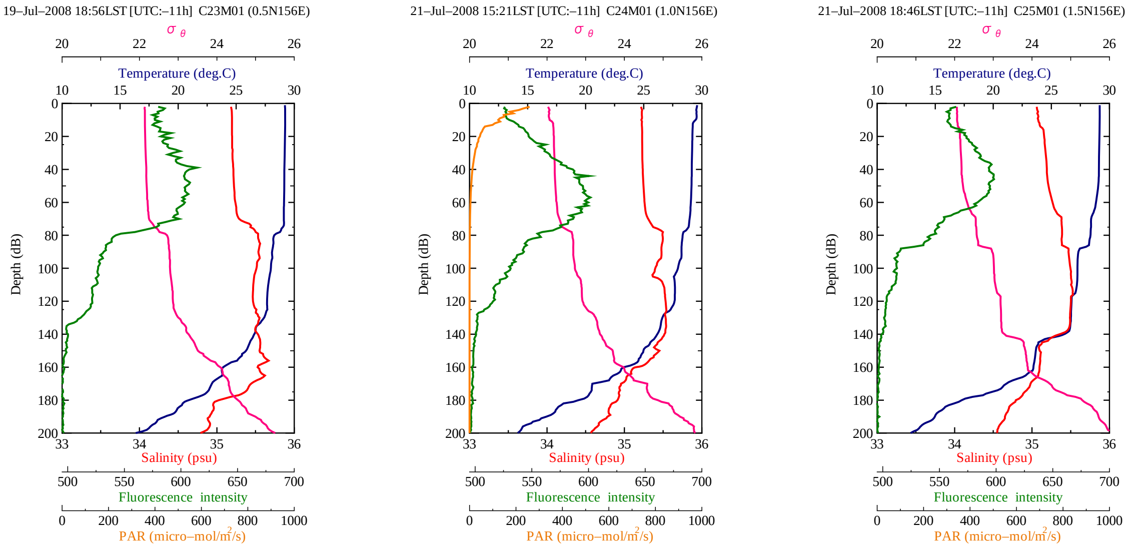


Fig.7.4.13 Oceanic profiles at (0-30N, 156E), (1-00N, 156E) and (1-30N, 156E)

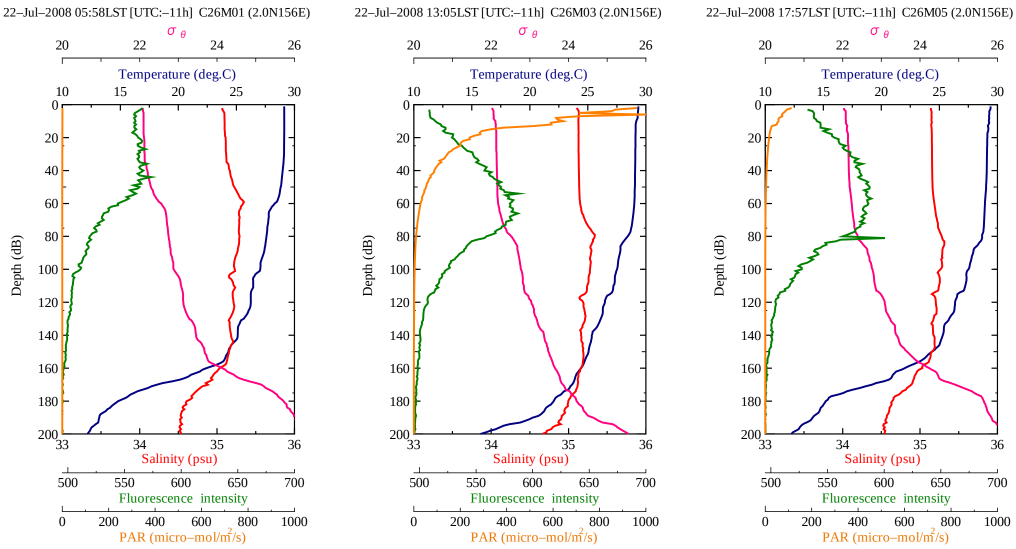


Fig.7.4.14 Oceanic profiles at (2-00N, 156E)

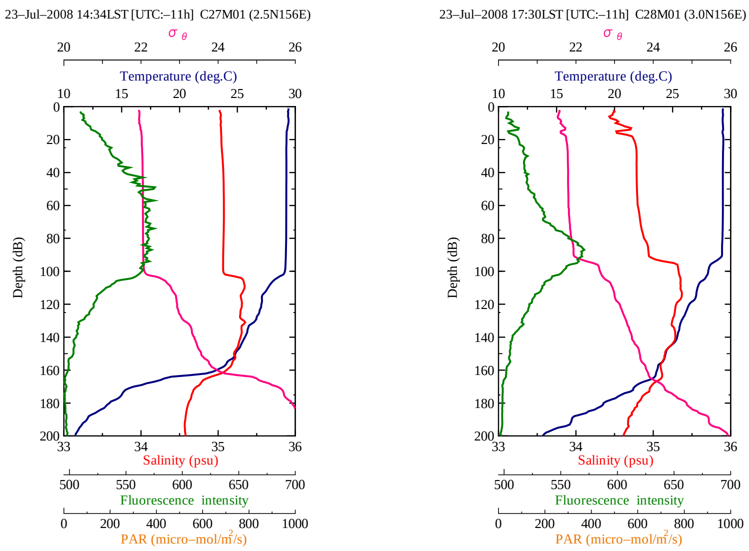


Fig.7.4.15 Oceanic profiles at (2-30N, 156E) and (3-00N, 156E)

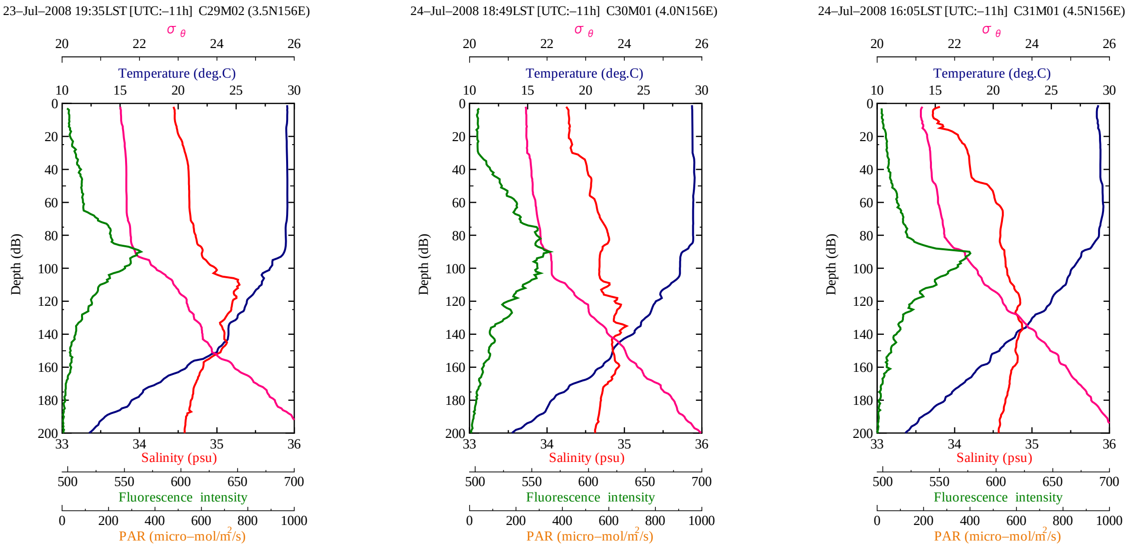


Fig.7.4.16 Oceanic profiles at (3-30N, 156E), (4-00N, 156E) and (4-30N, 156E)

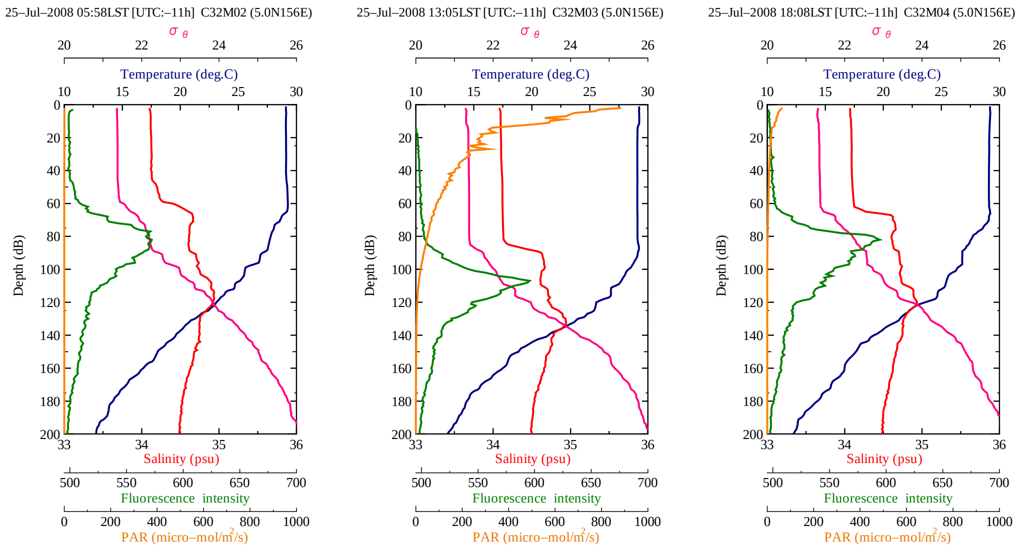


Fig.7.4.17 Oceanic profiles at (5-00N, 156E)

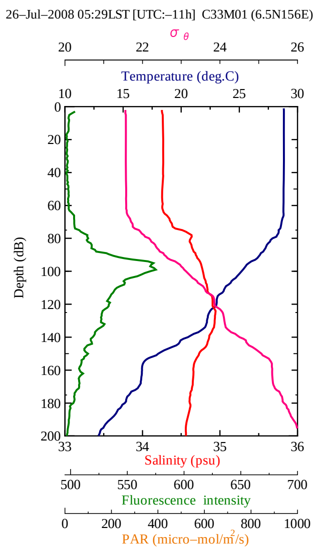


Fig.7.4.18 Oceanic profiles at (6-30N, 156E)

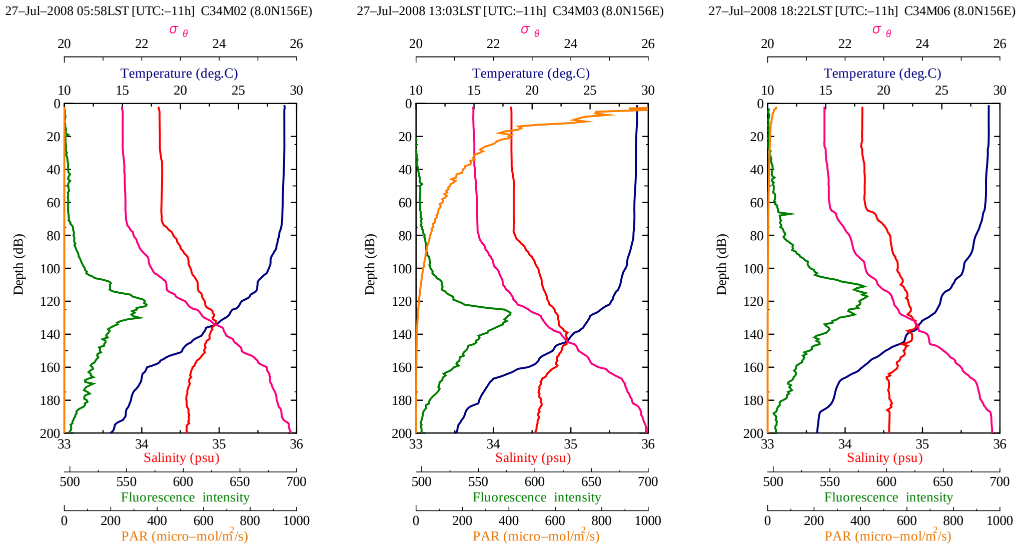


Fig.7.4.19 Oceanic profiles at (8-00N, 156E)

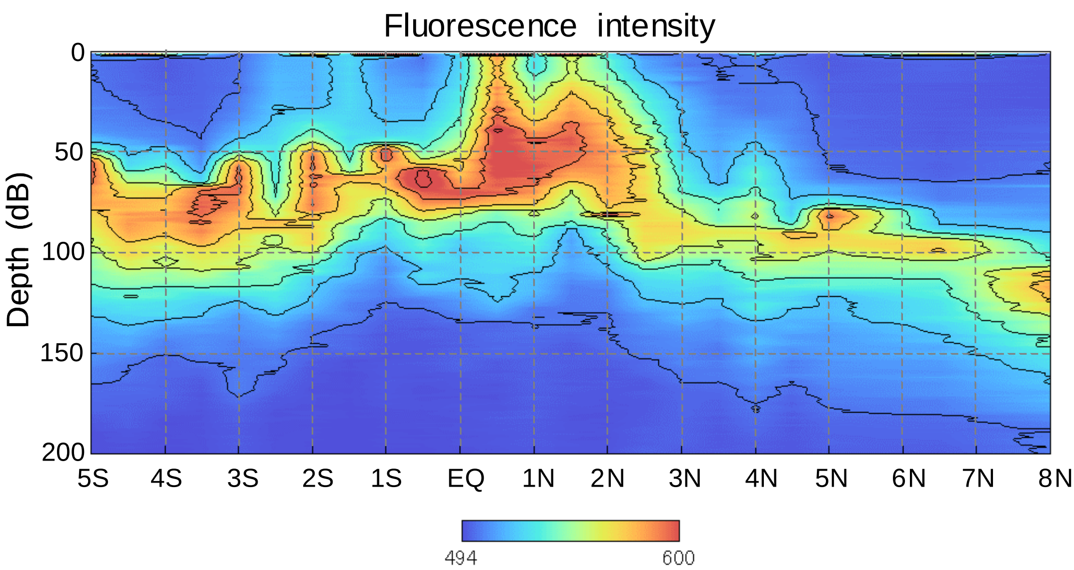


Fig.7.4.20 Depth-latitude Cross Section of fluorescence on 156E

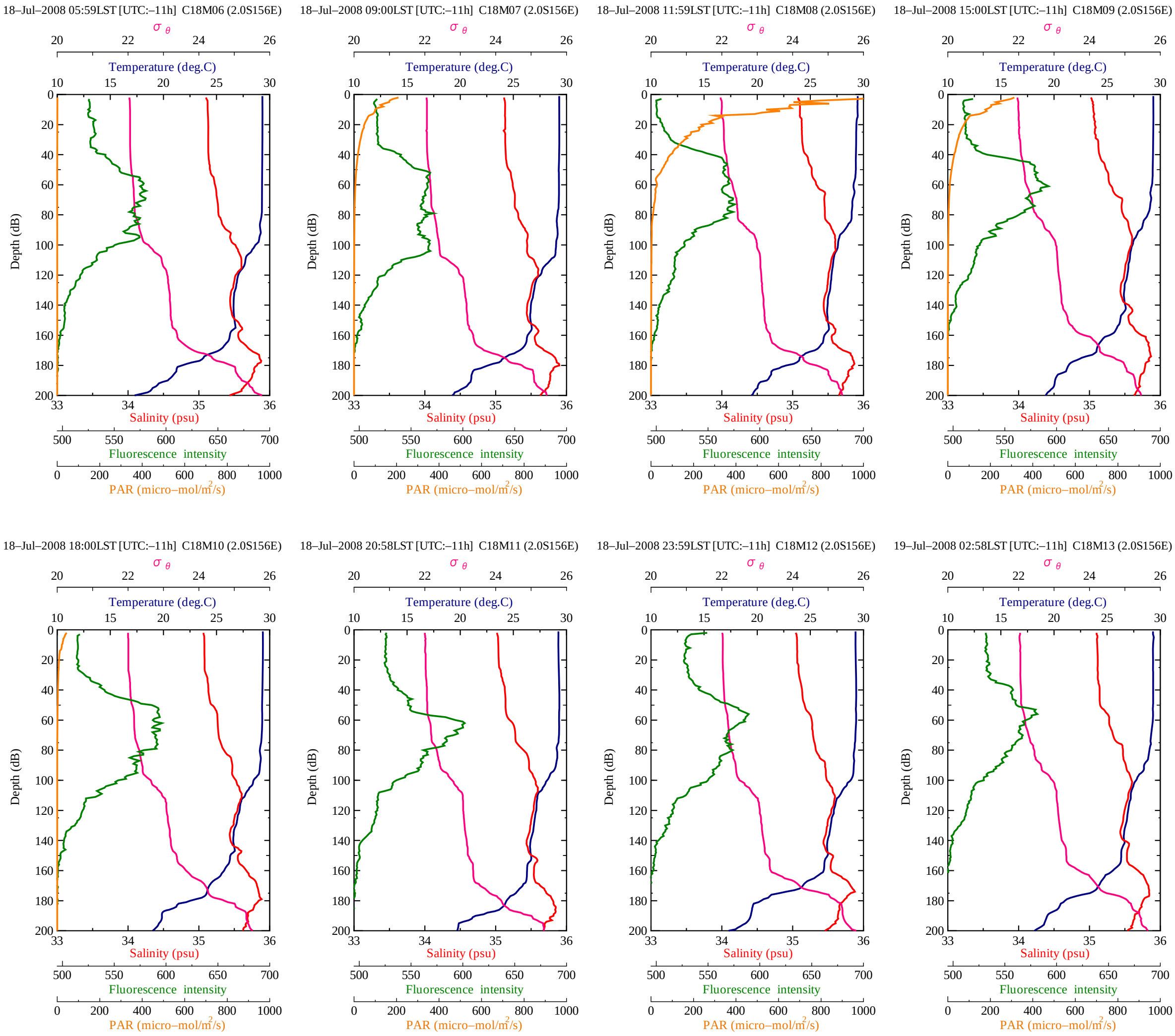


Fig.7.4.21 Oceanic profiles at (2-00S, 156E) during the fixed point observation.

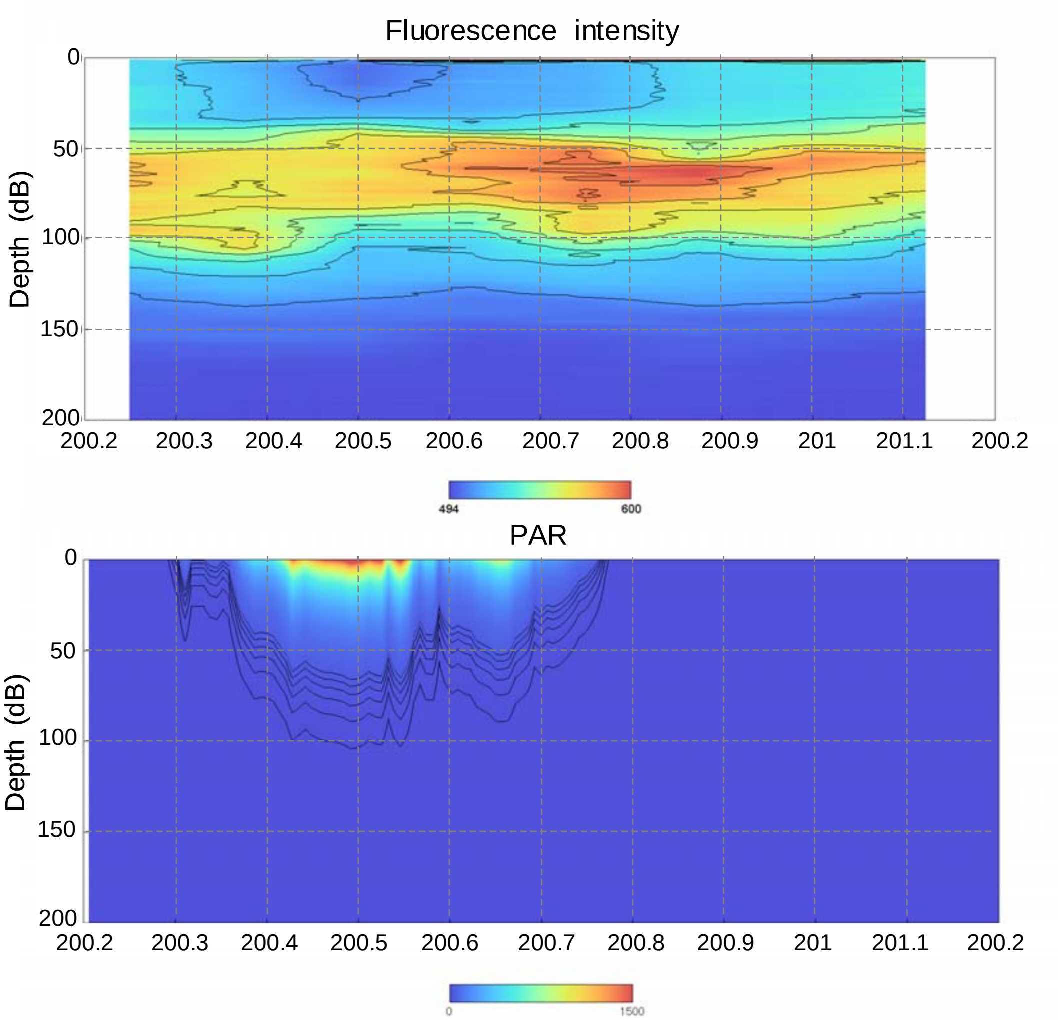


Fig.7.4.22 Depth-Time Cross Section of fluorescence and PAR at (2-00S, 156E) from July 18 to 19, 2008.

7.5. Performance test of pCO_2 sensor

Yoshiyuki Nakano, Tetsuichi Fujiki, Shuichi Watanabe (JAMSTEC, MIO)

(1) Objective

A lot of observations to obtain the fate of CO2 in the atmosphere which is related with long term climate change have been carried in the world. However, the sea surface pCO2 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 pCO2 in the whole ocean, new simplified automated pCO2 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 MR07-03 cruse in the open sea. The 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. 7.5-1). 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 5 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 for pCO_2 data every three days from the new sensor via satellite system. These values are consistent with Mirai data and past data in this area (Fig. 7.5-2).

(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.

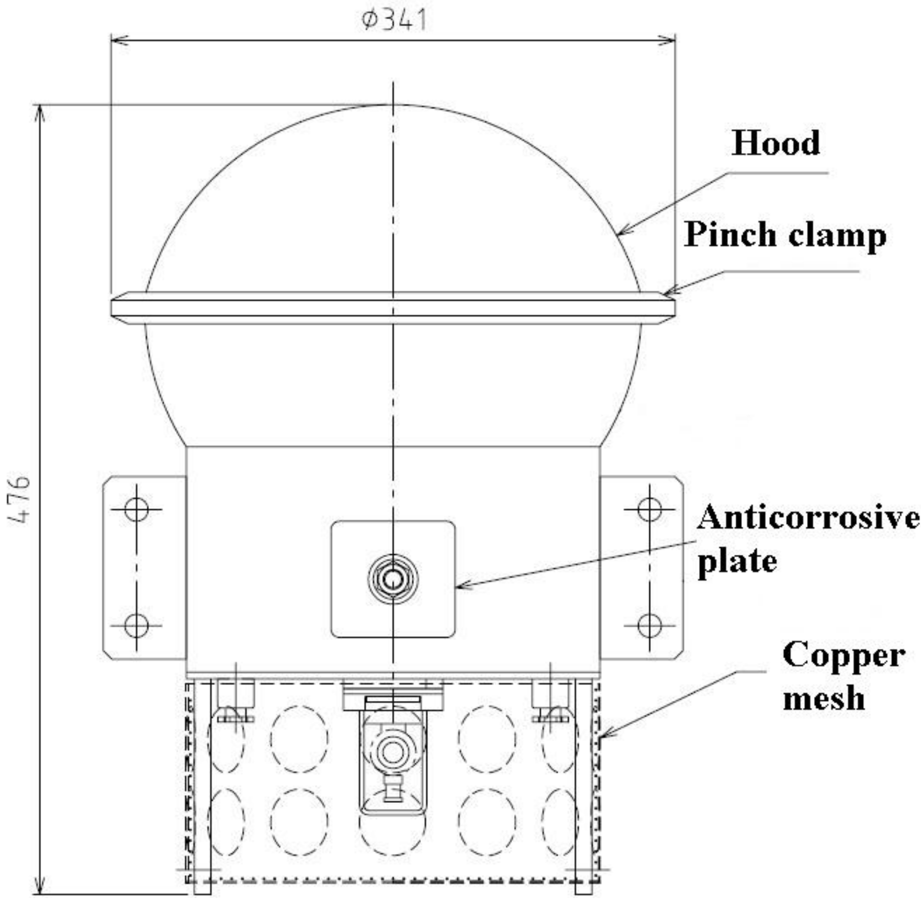


Fig. 7.5-1 Side view of pCO_2 sensor.

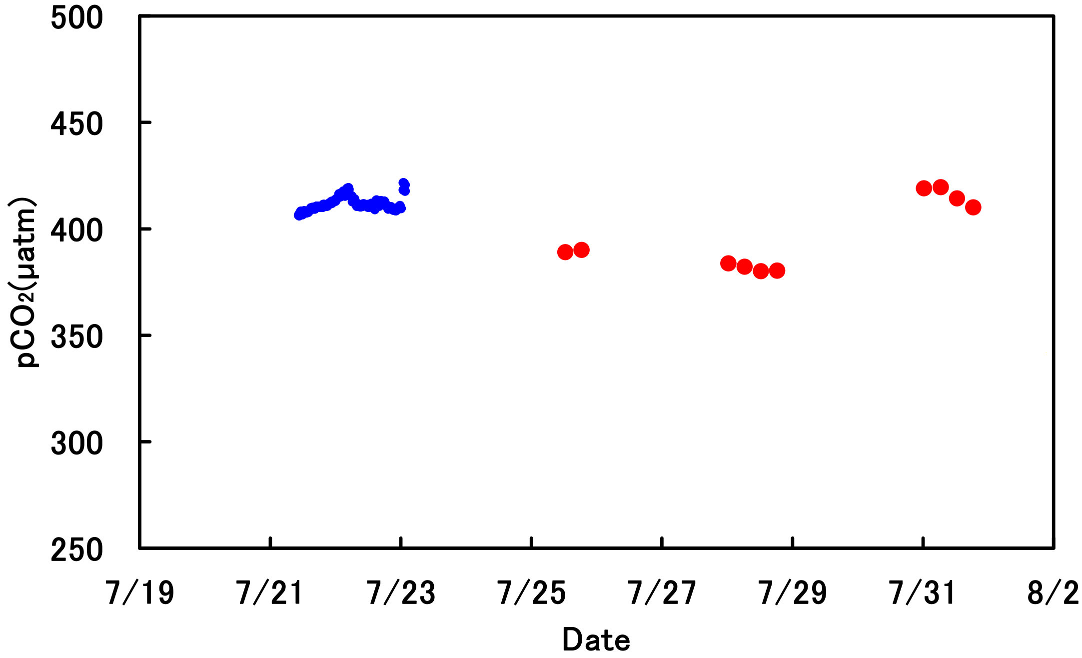


Fig. 7.5-2 Surface pCO_2 at mooring station. Blue circles are Mirai data and red circles are pCO_2 sensor data. Yellow band represents pCO_2 distribution range in this area (0-5°N, 152-160°E) over the past 40 years.

7.6. Long-term measurement by in-situ pH/pCO_2 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/pCO_2 sensors at 25m depth on 2N-156E station and recover 2 sets of in-situ pH/pCO_2 sensors (25m and 750m depth) set up in MR07-03 cruise.

(3) Parameters

Long-term measurement data of in-situ pH and pCO_2

(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 newly developed pH sensor was then applied to development of the pCO_2 sensor for in-situ pCO_2 measurement in seawater. The principle of pCO_2 measurement is as follows: the pH electrode and the Cl-ISE of the pH sensor are sealed with a gas permeable membrane filled with the inner solution. The pH sensor can detect the pCO_2 change as the inner solution pH changes which is caused by penetration of carbon dioxide through the membrane. An amorphous Teflon membrane manufactured by U.S. DuPont (Teflon AF™) was used as the gas permeable membrane for this pCO_2 sensor. The in-situ pH/pCO_2 sensors were installed to the mooring wire of TRITON buoy at 2N-156E station and in-situ data were measured every 10 minutes.

(5) Preliminary result

The in-situ pH/pCO_2 sensors set up in MR07-03 cruise were recovered from 25m and 750m depth. At 750m depth, there is no biofouling on pH and pCO_2 electrodes and pressure housings. Unfortunately, in-situ data of pH and pCO_2 were only measured every 10 minutes for 3 months because Li ion battery exhausted within 3 months. At 25m depth, the pressure housings were covered with biofouling. Furthermore, The pCO_2 electrode was missing and amplifier for the pH sensor was broken due to Li ion battery electrolyte leakage. A cause of these troubles will be vibration of the mooring wire. There is no biofouling on pH electrode because an electric charge exists on the ISFET-pH electrode. In-situ data of pCO_2 was also only measured every 10 minutes for 3 months because Li ion battery exhausted within 3 months. A change of daily periodicity was measured in in-situ pCO_2 at 25m depth, but it was not measured in in-situ pH and pCO_2 at 750m depth.

(6) Data archive

All data will be archived at CRIEPI after checking of data quality and submitted to the DMO at JAMSTEC within 2 years.

7.7 Air-Sea Turbulent CO_2 Flux by Eddy Covariance Technique

(1) Personnel: Fumiyoshi Kondo (Okayama University)
Osamu Tsukamoto (Okayama University): Principal Investigator * not on board
Hiroshi Ishida (Kobe University) * not on board

(2) Objective

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

(3) Method

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

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

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

(4) Results

Data will be processed after the cruise at Okayama University.

(5) Data Archive

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. Corrected data will be submitted to JAMSTEC Marine-Earth Data and Information Department.

Fig.7.7-1. Installation of the turbulent flux and ship motion correction systems on the top of the foremast.

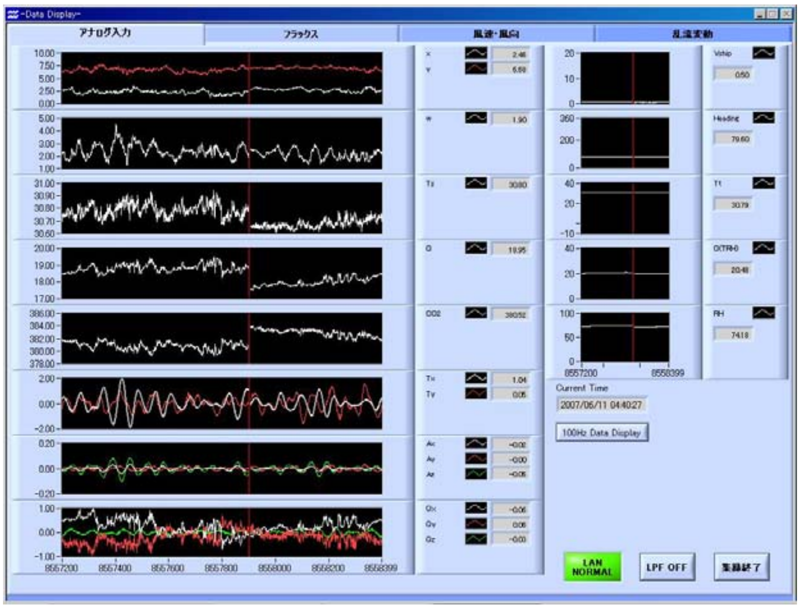


Fig.7.7-2. PC-based real time logging and monitoring system using LabVIEW8 software.

7.8 GPS Radiosonde

(1) Personnel

Ryuich Shirooka (JAMSTEC) Principal Investigator (not on board)
Mikiko Fujita (JAMSTEC)
Ryo Kimura (GODI) Operation Leader
Kazuho Yoshida (GODI)

(2) Objective

Atmospheric soundings of temperature, humidity, and wind speed/direction.

(3) Method

Atmospheric sounding by radiosonde was carried out every 12 hours from 1200Z July 3, 2008 through 0000Z August 04, 2008. In total, 68 soundings were carried out (Table 7.8-1). 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-SGP).

(4) Results

Time-height cross sections of equivalent potential temperature, relative humidity, zonal and meridional wind components are shown in Fig.7.8-1, respectively.

(5) Data archive

Data were sent to the world meteorological community via Global Telecommunication System through the Japan Meteorological Agency, immediately after the each observation. Raw data is recorded as ASCII format every 2 seconds during ascent. These raw datasets will be submitted to JAMSTEC Marine-Earth Data and Information Department and corrected datasets are available from Mirai Web site at http://www.jamstec.go.jp/mirai/.

Table 7.8-1 Radiosonde launch log. Surface values and maximum height.

ID	Date	Long.	Lat.	Pres	Tair	RH	WD	Wsp	Max height			Cloud	
	YYYYMMDDHH	deg	deg	hPa	degC	%	deg	m/s	hPa	m	duration	Amount	Type
RS001	2008070312	11.072	145.450	1009.2	26.8	86	132	5.6	38.7	22259	6278	-	unknown
RS002	2008070400	8.802	146.172	1008.5	28.3	75	179	6.0	48.0	20884	5592	3	Cu, Ci
RS003	2008070412	6.536	146.756	1009.1	28.6	72	166	5.2	30.1	23838	6712	-	unknown
RS004	2008070500	4.996	146.933	1008.9	28.0	71	134	1.8	53.9	20200	5954	1	Cu, Ci
RS005	2008070512	5.382	146.946	1008.8	27.8	77	52	3.2	35.4	22811	7268	-	unknown
RS006	2008070600	4.959	147.009	1008.6	26.9	83	155	3.2	30.7	23731	5700	10	Cu, Sc
RS007	2008070612	3.661	147.201	1008.2	27.4	76	196	1.1	29.7	23937	6536	-	unknown
RS008	2008070700	3.000	147.005	1009.0	27.1	82	355	1.0	23.9	25330	7088	1	Sc, Cu, Ac
RS009	2008070712	1.976	147.058	1008.5	28.5	76	125	5.0	38.2	22321	6600	-	unknown
RS010	2008070800	2.003	147.050	1010.3	27.7	79	111	6.5	27.3	24455	6184	9	Cu, Ci, Sc
RS011	2008070812	1.936	147.209	1010.1	26.4	86	143	3.6	28.1	24305	7028	-	unknown
RS012	2008070900	2.068	146.978	1010.0	28.8	73	76	4.0	24.5	25188	6408	4	Cu, Cs, Ci
RS013	2008070912	0.215	146.994	1009.9	28.4	74	97	3.3	35.0	22892	6036	-	unknown
RS014	2008071000	-0.022	146.971	1009.0	28.3	72	95	3.1	29.9	23919	5742	3	Cu, Ci
RS015	2008071012	-0.198	147.523	1008.0	28.3	72	123	3.8	34.1	23056	6694	-	unknown
RS016	2008071100	0.001	147.057	1008.5	28.8	70	122	4.3	23.5	25499	6854	1	Cu, Ci
RS017	2008071112	-0.086	147.071	1007.0	28.5	70	105	5.9	29.0	24103	6690	-	unknown
RS018	2008071200	0.065	146.977	1007.9	29.3	69	109	4.5	31.2	23615	6568	8	Cu, Ac
RS019	2008071212	-0.376	148.966	1007.7	28.1	79	87	7.1	25.8	24865	6864	-	unknown
RS020	2008071300	-1.020	151.746	1008.5	28.5	77	108	4.5	33.7	23165	5662	4	Cu, Cb
RS021	2008071312	-1.650	154.565	1008.9	28.6	73	86	5.3	29.0	24123	6428	1	unknown
RS022	2008071400	-1.993	156.019	1008.3	28.5	75	135	6.1	36.5	21810	6218	4	Cu, Sc
RS023	2008071412	-2.078	156.058	1007.7	28.1	80	140	5.9	31.7	23555	6458	-	unknown
RS024	2008071500	-1.916	155.774	1006.8	28.4	78	161	4.7	34.6	22971	5894	8	Cu, Ci
RS025	2008071512	-3.928	155.994	1006.5	27.5	78	136	8.0	33.7	23133	6328	-	unknown
RS026	2008071600	-4.965	156.001	1006.6	28.5	76	102	6.1	40.1	22038	5356	8	Cu, Ci, Sc
RS027	2008071612	-5.073	156.053	1007.0	28.7	76	114	6.7	32.1	23427	6476	3	Ci, Cs, Cu
RS028	2008071700	-5.051	155.980	1008.5	28.8	73	86	2.5	27.9	24352	6608	8	Cu, Sc
RS029	2008071712	-3.051	155.985	1008.2	27.5	76	138	5.6	36.0	22715	6902	10	Sc, Cu
RS030	2008071800	-1.988	156.026	1008.2	27.9	82	108	4.6	27.9	24349	6356	6	Cu, Ci
RS031	2008071812	-1.968	155.967	1006.8	28.4	78	100	7.0	26.1	24781	6890	6	Cu, As, Ac
RS032	2008071900	-0.994	155.994	1006.5	28.5	76	77	7.8	25.6	24977	5892	5	Cu, As
RS033	2008071912	0.020	155.962	1006.0	29.0	73	63	10.0	36.9	22606	6548	-	unknown
RS034	2008072000	-0.018	155.959	1006.7	29.4	68	89	6.9	34.9	22061	6002	7	Cu, Ci
RS035	2008072012	0.048	156.041	1006.7	28.8	72	82	8.0	29.8	23943	7092	-	unknown
RS036	2008072100	0.041	155.993	1006.5	29.3	66	112	4.1	35.9	22767	5794	7	Cu, Ci, Ac
RS037	2008072112	1.953	156.018	1006.4	28.2	77	124	4.9	35.1	22880	6402	-	unknown
RS038	2008072200	1.957	155.997	1006.5	28.7	72	107	4.3	33.1	23260	6134	6	Cu, Ci, Ac
RS039	2008072212	2.019	156.263	1006.3	28.4	75	125	4.4	35.8	22755	6498	-	unknown
RS040	2008072300	2.087	156.049	1006.7	28.2	80	221	0.8	25.6	24913	6470	3	Cu, Ci, Ac
RS041	2008072312	3.837	155.997	1007.2	26.9	85	57	5.4	104.1	16338	5876	-	unknown
RS042	2008072400	4.974	156.033	1005.1	27.2	77	257	5.5	25.6	24939	5981	10	Cu, Sc
RS043	2008072412	4.279	156.060	1006.0	27.7	81	67	8.5	27.1	24543	6776	-	unknown
RS044	2008072500	5.033	155.934	1006.5	29.3	71	118	5.7	27.5	24430	6440	7	Cu, Ci, Ac
RS045	2008072512	5.780	156.001	1007.6	28.2	80	98	7.0	33.1	23240	6368	-	unknown
RS046	2008072600	7.502	156.000	1007.7	28.4	78	87	4.1	34.6	23021	6070	10	Cu, Cb, As
RS047	2008072612	8.020	156.102	1008.7	28.1	81	94	4.9	32.3	23426	6698	-	unknown
RS048	2008072700	7.983	155.988	1008.4	28.8	72	124	5.5	31.8	23551	5896	1	Cu, Cb, As
RS049	2008072712	8.597	155.748	1008.9	28.6	75	99	10.3	36.0	22726	6248	-	unknown
RS050	2008072800	10.846	154.746	1008.6	29.2	68	125	7.4	26.2	24773	6534	4	Cu, As
RS051	2008072812	13.140	153.715	1009.0	28.6	70	102	6.9	47.1	21069	5772	-	unknown
RS052	2008072900	15.298	152.739	1008.8	28.7	75	126	5.3	30.4	23841	5860	7	Cu, Ci
RS053	2008072912	17.528	151.717	1009.8	27.6	75	82	3.8	33.0	23332	5790	-	unknown
RS054	2008073000	19.718	150.702	1011.1	28.7	72	160	5.9	58.1	19840	5180	7	Cu, Ci, Ac
RS055	2008073012	21.961	149.629	1012.6	25.9	87	139	12.2	34.8	23083	6534	-	unknown
RS056	2008073100	24.203	148.577	1012.7	25.0	93	189	10.4	30.7	23941	8544	10	Ns
RS057	2008073112	26.419	147.406	1010.3	27.9	81	337	0.9	38.1	22529	5720	-	unknown
RS058	2008080100	28.664	146.187	1010.0	28.3	79	278	1.1	134.1	14877	4652	1	Cu, Ci
RS059	2008080112	30.795	144.968	1008.2	27.2	79	197	4.2	32.0	23684	7086	-	unknown
RS060	2008080200	32.849	144.660	1007.0	26.9	80	40	5.3	49.9	20860	6180	10	Cu, Sc, As
RS061	2008080206	33.892	145.057	1005.8	27.3	78	94	5.5	39.5	22359	5758	7	Cu, Cc, As
RS062	2008080212	34.852	145.437	1007.2	26.2	77	86	7.4	38.1	22611	6508	-	unknown
RS063	2008080218	36.013	145.905	1006.8	26.0	76	129	3.7	47.3	21243	5884	-	unknown
RS064	2008080300	37.090	146.334	1007.9	24.9	85	149	2.2	35.6	23080	6826	4	Ci, St, Sc
RS065	2008080306	38.170	146.506	1007.3	24.4	91	169	4.7	26.9	24946	7518	9	Cc, Ac, As
RS066	2008080312	39.024	147.109	1007.6	23.4	97	160	7.7	34.5	23325	6102	-	unknown
RS067	2008080318	39.234	146.370	1006.5	24.0	93	189	5.1	33.0	23600	6504	-	unknown
RS068	2008080400	39.494	145.312	1006.3	22.8	92	184	10.1	29.9	24197	6949	8	Cs

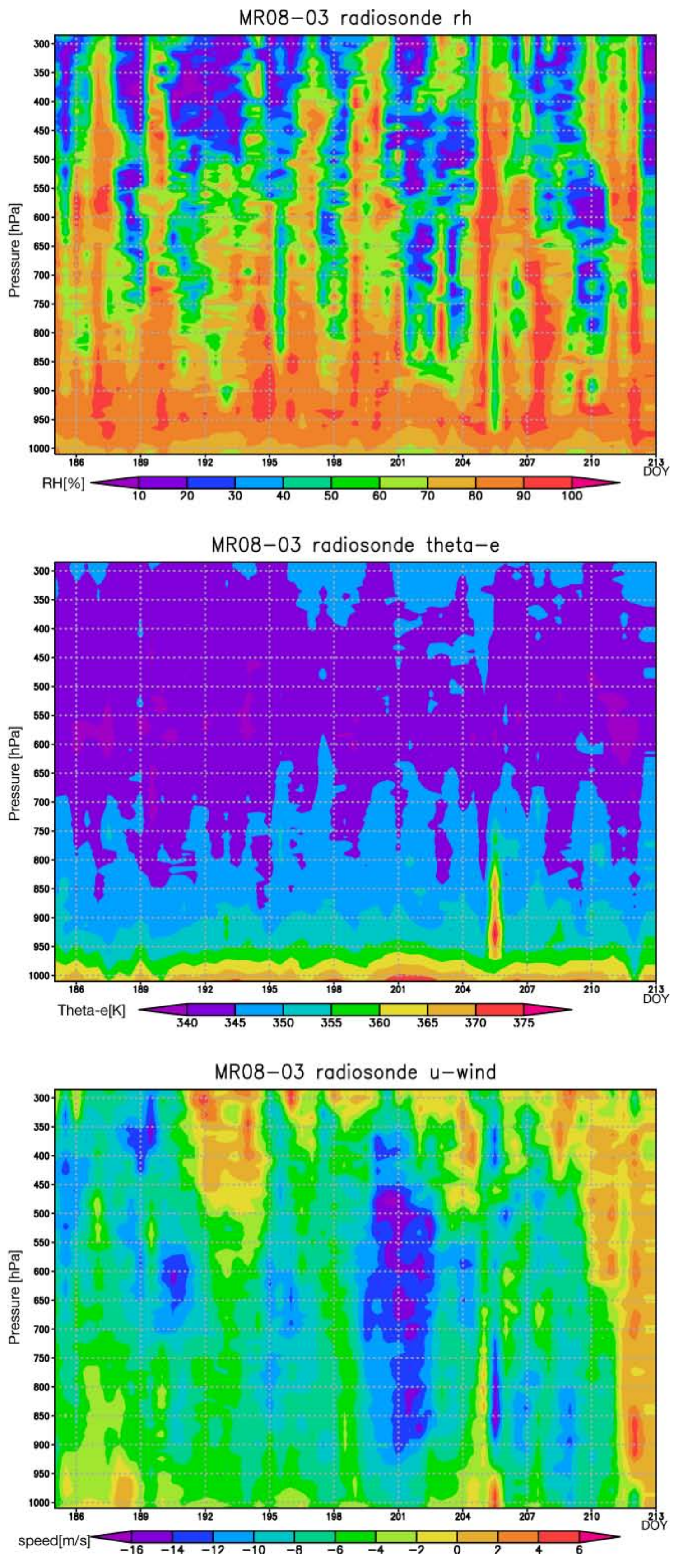


Fig. 7.8-1. Time-height cross sections of (upper) relative humidity (%), (middle) equivalent potential temperature (degK), and (c) zonal wind component (m/s).

7.9 Doppler Radar

(1) Personnel

Ryuichi Shirooka (JAMSTEC) Principal Investigator (not on board)
Mikiko Fujita (JAMSTEC)
Ryo Kimura (GODI) Operation Leader
Kazuho Yoshida (GODI)

(2) Objective

The objective of the Doppler radar observation in this cruise is to investigate three dimensional rainfall and kinematic structures of precipitation systems and their temporal and special variations.

(3) Method

The Doppler radar on board of MIRAI is used. The specification of the radar is:

Frequency:	5290 MHz
Beam Width:	less than 1.5 degrees
Output Power:	250 kW (Peak Power)
Signal Processor:	RVP-7 (Sigment Inc., USA)
Inertial Navigation Unit:	PHINS (Ixsea S.A.S., France)
Application Software:	IRIS/Open (Sigment Inc., USA)

Parameters of the radar are checked and calibrated at the beginning and the end of the intensive observation. Meanwhile, daily checking is performed for (1) frequency, (2) mean output power, (3) pulse width, and (4) PRF (pulse repetition frequency).

During the cruise, the volume scan consisting of 21 PPIs (Plan Position Indicator) is conducted every 10 minutes. A dual PRF mode with the maximum range of 160 km is used for the volume scan. Meanwhile, a surveillance PPI scan is performed every 30 minutes in a single PRF mode with the maximum range of 300 km. At the same time, RHI (Range Height Indicator) scans of the dual PRF mode are also operated whenever detailed vertical structures are necessary in certain azimuth directions. Detailed information for each observational mode is listed in Table 7.9-1. The Doppler radar observation is from July 3 to August 4, 2008.

(4) Preliminary results

Shown in Fig. 7.9-1 and Fig. 7.9-2 horizontal structure of a convective system of radar echo obtained from surveillance PPI scans during the cruise. During this period, many mesoscale convective systems have developed around the observational area.

(5) Data archive

All data of the Doppler radar observation during this cruise will be submitted to the JAMSTEC Marine-Earth Data and Information Department.

Table 7.9-1 Parameters for each observational mode

	Surveillance PPI	Volume Scan	RHI
Pulse Width	2 (microsec)	0.5 (microsec)	0.5 (microsec)
Scan Speed	18 (deg/sec)	18 (deg/sec)	Automatically determined
PRF	260 (Hz)	900/720 (Hz)	900/720 (Hz)
Sweep Integration	32 samples	40 samples	32 samples
Ray Spacing	1.0 (deg)	1.0 (deg)	0.2 (deg)
Bin Spacing	250 (m)	250 (m)	150 (m)
Elevation Angle	0.5	0.5, 1.0, 1.8, 2.6, 3.4, 4.2, 5.0, 5.8, 6.7, 7.7, 8.9, 10.3, 12.3, 14.5, 17.1, 20.0, 23.3, 27.0, 31.0, 35.4, 40.0	0.0 to 65.0
Azimuth	Full Circle	Full Circle	Optional
Range	300 (km)	160 (km)	160 (km)

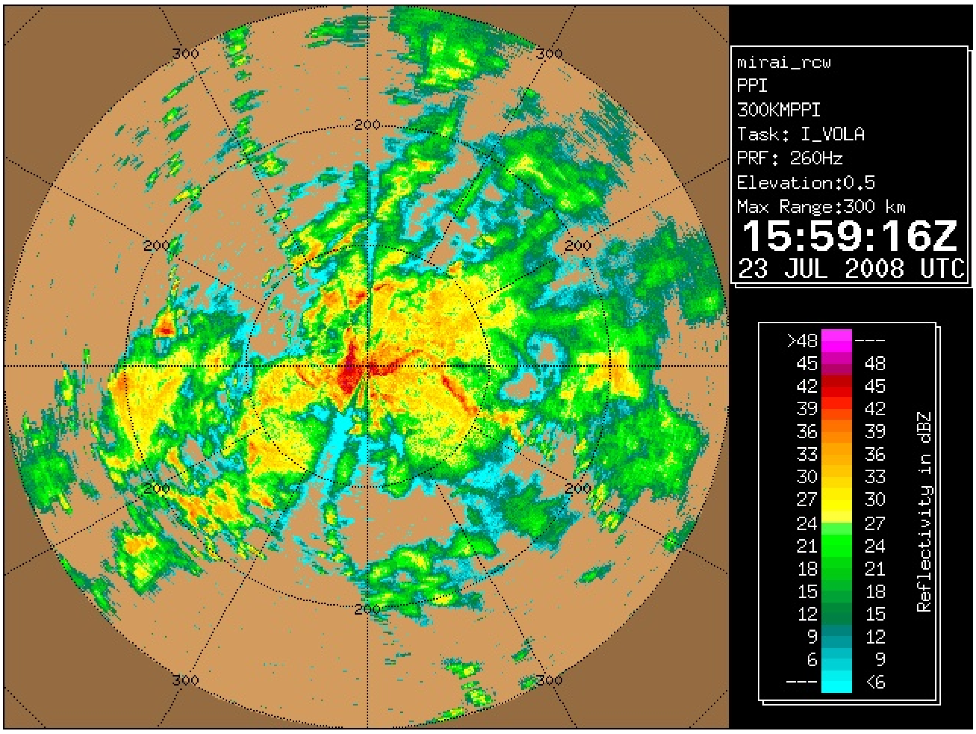


Figure 7.9-1: Horizontal distribution of cloud system obtained from the PPI scan at 1559 UTC, July 23, 2008..

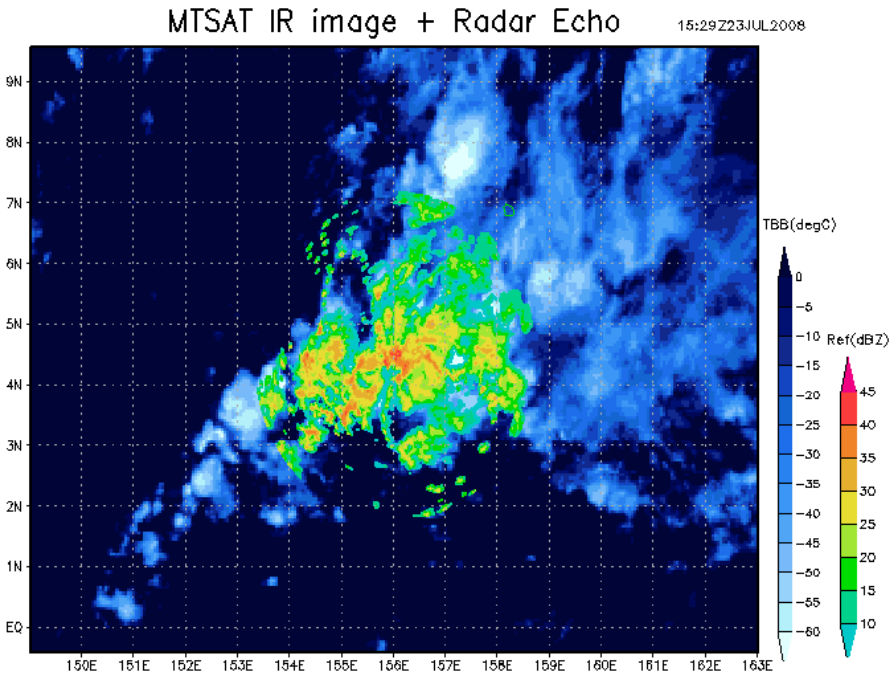


Figure 7.9-2: Horizontal distribution which was captured by the MTSAT IR-image and the PPI scan at 1529 UTC, July 23, 2008.

7.10 GPS Meteorology

(1) Personnel

Ryuichi Shirooka	(JAMSTEC)	Principal Investigator (not on board)
Mikiko Fujita	(JAMSTEC)	Operation Leader
Ryo Kimura	(GODI)	
Kazuho Yoshida	(GODI)	

(2) Objective

Getting the GPS satellite data to derived estimates of the total column integrated water vapor content of the atmosphere.

(3) Method

The GPS satellite data was archived to the receiver (Ashtech Xstream) with 5 sec interval. The GPS antenna (Margrin) was set on the deck at the part of stern. This observation was carried out from July 03 to August 05, 2008.

(4) Results

We will calculate the total column integrated water from observed GPS satellite data later.

(5) Data archive

Raw data is recorded as RINEX format every 5 seconds during ascent. These raw datasets is available from M. Fujita of JAMSTEC.

7.11 Lidar observations of clouds and aerosol

(1) Personnel

Nobuo Sugimoto, Ichiro Matsui, and Atsushi Shimizu (National Institute for Environmental Studies, not on board), lidar operation was supported by Yohei Suzuki (University of the Chiba) and GODI.

(2) Objectives

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

(3) Measured parameters

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

(4) Method

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

(5) Results

Data obtained in this cruise has not been analyzed.

(6) Data archive

- raw data

  lidar signal at 532 nm

  lidar signal at 1064 nm

  depolarization ratio at 532 nm

  temporal resolution 15 min.

  vertical resolution 6 m.

  data period (utc) : 01:05 Jul. 3, 2008 – 00:00 Aug. 6, 2008

- processed data
  - cloud base height, apparent cloud top height
  - phase of clouds (ice/water)
  - cloud fraction
  - boundary layer height (aerosol layer upper boundary height)
  - backscatter coefficient of aerosols
  - particle depolarization ratio of aerosols

7.12 Observation of cloud properties by synergy use of infrared radiometer and 95GHz cloud profiling radar

a) Infrared radiometer

(1) Personnel

Hajime Okamoto (CAOS, Tohoku University): Principal Investigator
Ryo Yoshida (CAOS, Tohoku University): Student, Master 2
Kaori Sato (CAOS, Tohoku University): Student, Doctor Course 3
Toshiaki Takano (Chiba University)
Yohei Suzuki　(Chiba University): Student, Master 1.
Nobuo Sugimoto (National Institute for Environmental Studies)
Ichiro Matsui (National Institute for Environmental Studies)

(2) Objective

The infrared radiometer (hereafter IR) is used to derive the temperature of the cloud base and emissivity of the thin ice clouds. Main objectives are to use study clouds and climate system in tropics by the combination of IR with active sensors such as lidar and 95GHz cloud radar. From these integrated approach, it is expected to extend our knowledge of clouds and climate system. Special emphasis is made to retrieve cloud microphysics in upper part of clouds, including sub-visual clouds that are recognized to be a key component for the exchange of water amount between troposphere and stratosphere. Since June 2006, spaceborn radar and lidar systems, CloudSat and CALIPSO are providing vertical and global distribution of clouds and aerosols. One important aim is to observe the same clouds and aerosols by the observational systems on R/V Mirai. Combination of space-based and ship based observations should provide the unique opportunity to study the complete system of theses clouds and aerosols in relation to its environments. We also added the new function for the protection of precipitation.

(3) Method

IR instrument directly provides broadband infrared temperature (9.6-10.5μm).

General specifications of IR system (KT 19II, HEITRONICS)

Temperature range	-100 to 100°C
Accuracy	0.5 °C
Mode	24hours
Time resolution	1 min.
Field of view	Less than 1° (will be estimated later)
Spectral region	9.6-10.5μm

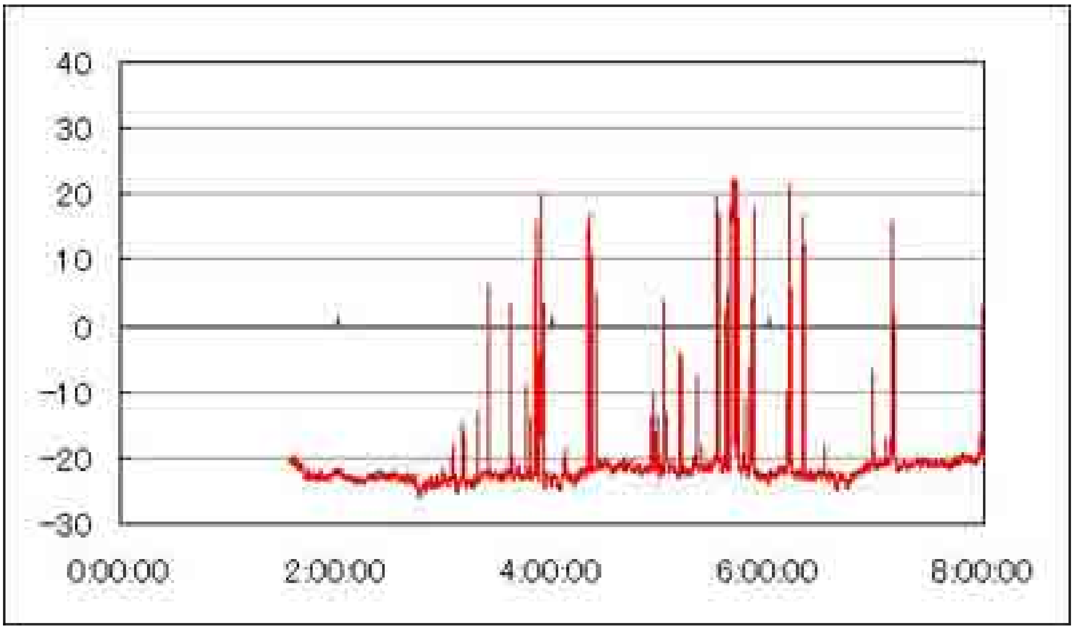
This is converted to broadband radiance around the wavelength region. This is further combined with the lidar or radar for the retrieval of cloud microphysics such as optical thickness at visible wavelength, effective particle size. The applicability of the retrieval technique of the synergetic use of radar/IR or lidar/IR is so far limited to ice clouds. The microphysics of clouds from these techniques will be compared with other retrieval technique such as radar/lidar one or radar with multi-parameter.

When the rain is observed by the rain sensor installed in the IR observing system, the radiometer is automatically rotated and stops at the downward position in order to prevent from the rain drops attached on the lens surface.

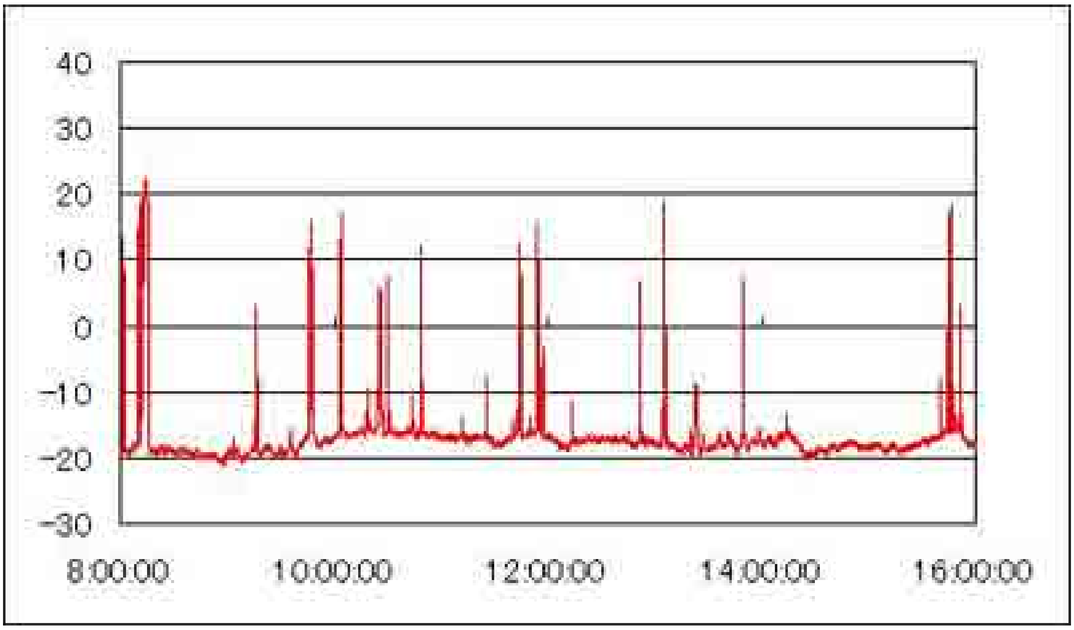
(4) Results

Fig. 7-12-1s (a,b,c) displays the temperature measured by IRT on July. 8 , 2008.

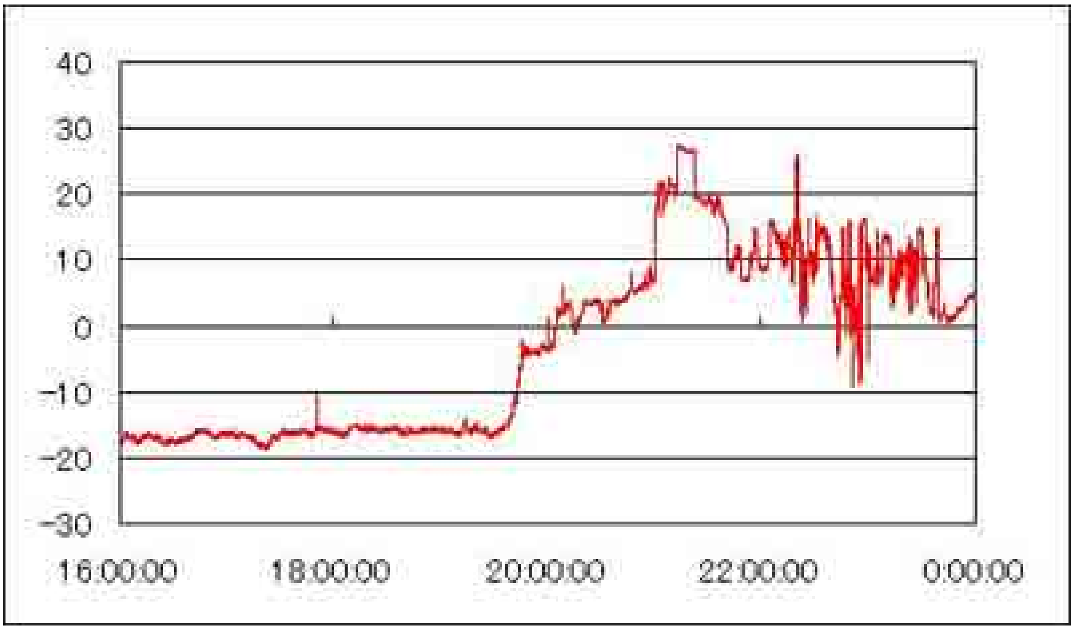
The horizontal line denotes the hours (UTC) and vertical axis is the temperature. The location is 1.60°N and 147.02 ° E. The measured temperature T above 0 ° C corresponds to the temperature of water cloud base and T<0 ° C reflects the results of contribution from clouds as well as water vapor. T>20 ° C indicated that the installation of the instrument were made in order to prevent from the attachment of water drops on the lens of the IRT. Together with the lidar and radar signals, rapid increase of temperature at 20:00 corresponds to the occurrence of relatively thick mid-level clouds at 6km.


40
30
20
10
0
-10
-20
-30
0:00:00
2:00:00
4:00:00
6:00:00
8:00:00

(a)


40
30
20
10
0
-10
-20
-30
8:00:00
10:00:00
12:00:00
14:00:00
16:00:00

(b)



(c)

Fig. 7-12-1.Temperature measured by the IRT in July. 08, 2008. during MR08-03 cruise.
(a) From 0 to 8 UTC, (b)from 8 to 16UTC and (c) 16 to 24UTC.

(5) Data archive

The data archive server is set inside Tohoku University and the original data and the results of the analyses will be available from us.

(6) Remarks

Basically the IRT is operated for 24 hours. The automatic rain protection system works very fine.

b) 95GHz cloud profiling radar

(1) Personnel

Hajime Okamoto (CAOS, Tohoku University): Principal Investigator
Ryo Yoshida (CAOS, Tohoku University): Student, Master 2
Kaori Sato (CAOS, Tohoku University): Student, Doctor Course 3

Toshiaki Takano (Chiba University)
Yohei Suzuki (Chiba University): Student, Master 1.
Nobuo Sugimoto (National Institute for Environmental Studies)
Ichiro Matsui (National Institute for Environmental Studies)

(2) Objective

Main objective for the 95GHz cloud radar is to detect vertical structure of cloud and precipitation in the observed region. Combinational use of the radar and lidar is recognized to be a powerful tool to study vertical distribution of cloud microphysics, i.e., particle size and liquid/ice water content (LWC/IWC).

(3) Method

Basic output from data is cloud occurrence, radar reflectivity factor and cloud microphysics. In order to derive reliable cloud amount and cloud occurrence, we need to have radar and lidar for the same record.

Radar / lidar retrieval algorithm has been developed in Tohoku University. The algorithm is applied to water cloud in low level and also cirrus cloud in high altitude. In order to analyze the radar data, it is first necessary to calibrate the signal to convert the received power to radar reflectivity factor, which is proportional to backscattering coefficient in the frequency of interest. Then we can interpolate radar and lidar data to match the same time and vertical resolution. Finally we can apply radar/lidar algorithm to infer cloud microphysics.

(4) Results

The time height cross-section of radar reflectivity factor obtained in July 8. 2008, during MR-08-03 cruise. Vertical extent is 20km. It is seen that there are thick layers from 0:30 to 1:50 UTC and relatively strong convective activities from 2:10 UTC.

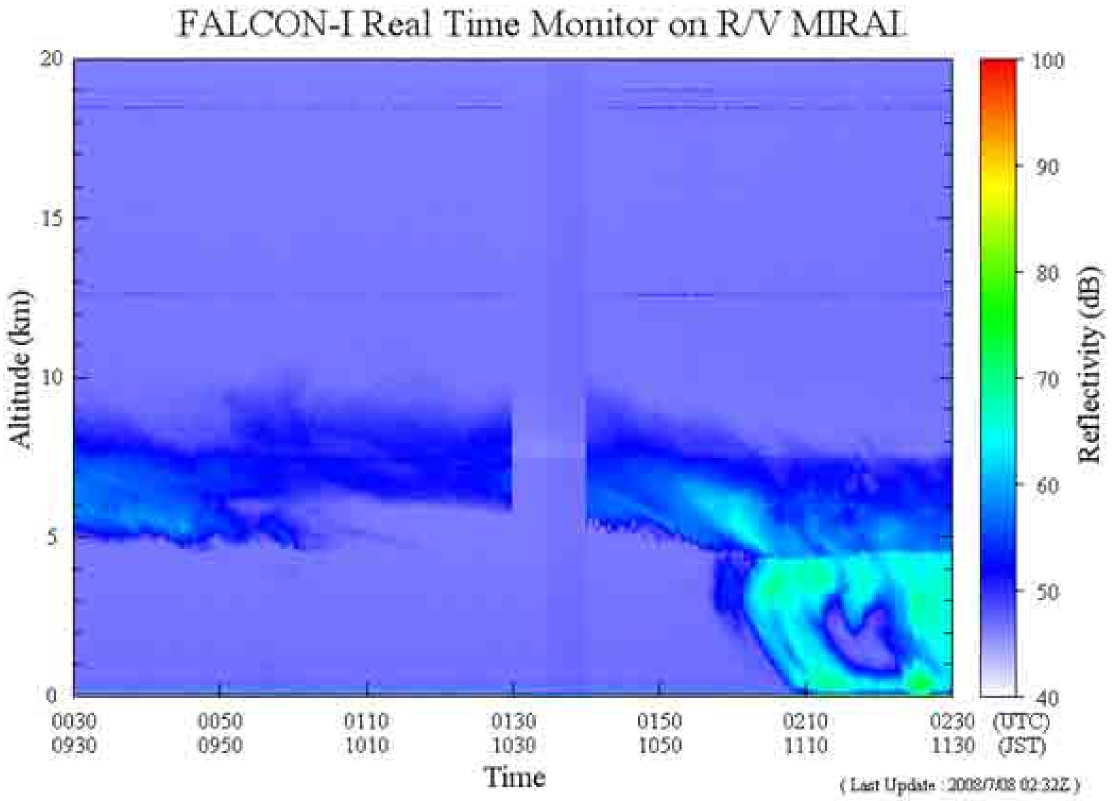


Fig. 7-12-2 Time height cross section of radar reflectivity factor in dBZe in July. 08, 2008 during MR08-03cruise.

(5) Data archive

The data archive server is set inside Tohoku University and the original data and the results of the analyses (cloud mask, precipitation mask, microphysical retrievals, cloud type classification) will be available from us.

(6) Remarks

The cloud radar is successfully operated for 24 hours.

7.13 Rain and Water Vapor Sampling for Stable Isotope Measurement

(1) Personnel

Naoyuki Kurita (JAMSTEC) Principal Investigator
Kimpei Ichiyanagi (JAMSTEC)
Hironori Fudeyasu (Hawaii Univ.)

(2) Objective

Stable isotopes in water (HDO and $H_2^{18}O$) are powerful tool to study of the moisture origin of precipitation associated with disturbances in tropical and sub-tropical regions. Sampling of atmospheric moisture, rainwater and surface seawater was performed for stable isotope analyses throughout the MR08-03 cruise from Guam on July 03, 2008 to Japan on August 06, 2008.

(3) Method

Following observation was carried out throughout this cruise.

- Atmospheric moisture sampling:

  Water vapor was sampled from the hight about 20m above the sea level. The air was drawn at rate of 2.8-3L/min through a plastic tube attached to top of the compass deck.The water vapor was trapped in a glass trap submarged into a ethanol cooled to 100 degree C by radiator, and then they are collected every 3 to 6 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 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) at 6 o'clock UTC every day. The surface water taken by bucket from the deck was also sampled in case the bucket water sampling has carried out..

(4) Results

Sampling of water vapor for isotope analysis is summarized in Table 7.13-1 (64 samples). The detail of rainfall sampling (26 samples) is summarized in Table 7.13-2. Described rainfall amount is calculated from the collected amount of precipitation. Sampling of surface seawater is summarized in Table 7.13-3 (32 samples).

(5) Data archive

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

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	Total (m^3)	MASS (ml)
V-1	2-Jul	10:40	2-Jul	22:24	144-37E	13-27N	1.45	31.0
V-2	2-Jul	22:33	3-Jul	12:14	145-29E	10-53N	1.61	34.5
V-3	3-Jul	12:20	3-Jul	22:45	146-08E	08-56N	1.24	28.0
V-4	3-Jul	22:48	4-Jul	10:43	146-44E	06-37N	1.29	26.0
V-5	4-Jul	10:48	4-Jul	22:45	146-55E	04-59N	1.29	27.0
V-6	4-Jul	22:50	5-Jul	10:42	146-57E	05-19N	1.28	26.5
V-7	5-Jul	10:45	5-Jul	22:43	147-01E	04-57N	1.29	26.0
V-8	5-Jul	22:48	6-Jul	10:41	147-08E	03-37N	1.28	26.0
V-9	6-Jul	10:46	6-Jul	22:42	147-00E	03-00N	1.29	26.0
V-10	6-Jul	22:48	7-Jul	10:41	147-02E	01-59N	1.29	26.0
V-11	7-Jul	10:47	7-Jul	22:45	147-03E	02-00N	1.30	26.4
V-12	7-Jul	22:48	8-Jul	10:44	147-10E	01-57N	1.28	26.0
V-13	8-Jul	10:49	8-Jul	22:39	146-58E	02-04N	1.28	26.0
V-14	8-Jul	22:44	9-Jul	10:38	146-59E	00-18N	1.28	26.0
V-15	9-Jul	10:43	9-Jul	22:38	146-57E	00-01N	1.28	26.0
V-16	9-Jul	22:42	10-Jul	10:36	147-30E	00-11S	1.28	26.0
V-17	10-Jul	10:41	10-Jul	22:39	147-04E	00-00S	1.29	26.1
V-18	10-Jul	22:42	11-Jul	10:39	147-03E	00-04S	1.27	26.0
V-19	11-Jul	10:43	11-Jul	22:36	146-59E	00-03N	1.28	25.0
V-20	11-Jul	22:39	12-Jul	10:42	148-51E	00-21S	1.29	26.0
V-21	12-Jul	10:45	12-Jul	22:40	151-37E	00-59S	1.28	26.0
V-22	12-Jul	22:44	13-Jul	22:34	156-01E	01-59S	2.35	26.0
V-23	13-Jul	22:38	14-Jul	10:39	156-02E	02-03S	1.29	47.0
V-24	14-Jul	10:48	14-Jul	22:37	155-46E	01-55S	1.28	26.5
V-25	14-Jul	22:42	15-Jul	10:38	155-59E	03-50S	1.29	28.0
V-26	15-Jul	10:42	15-Jul	22:34	156-00E	04-58S	1.28	27.5
V-27	15-Jul	22:39	16-Jul	10:32	156-02E	05-03S	1.28	28.0
V-28	16-Jul	10:38	16-Jul	22:46	155-59E	05-03S	1.31	27.0
V-29	16-Jul	22:51	17-Jul	10:39	155-19E	03-08S	1.28	26.5
V-30	17-Jul	10:43	17-Jul	22:39	156-00E	01-58S	1.30	26.0
V-31	17-Jul	22:43	18-Jul	10:38	155-58E	00-59S	1.28	28.0
V-32	18-Jul	10:43	18-Jul	22:45	155-59E	00-05N	1.30	28.0
V-33	18-Jul	22:48	19-Jul	10:39	155-58E	00-00S	1.28	26.5
V-34	19-Jul	10:43	19-Jul	22:34	155-56E	00-02N	1.28	27.0
V-35	19-Jul	22:41	20-Jul	10:35	156-01E	00-02N	1.28	25.5
V-36	20-Jul	10:39	20-Jul	22:33	156-00E	00-02N	1.29	25.0
V-37	20-Jul	22:39	21-Jul	10:35	156-00E	01-57N	1.30	26.0
V-38	21-Jul	10:40	21-Jul	22:33	155-59E	01-58N	1.28	26.0
V-39	21-Jul	22:42	22-Jul	10:43	156-13E	02-00N	1.30	26.0
V-40	22-Jul	10:47	22-Jul	22:35	156-03E	02-04N	1.28	26.0
V-41	22-Jul	22:39	23-Jul	10:33	155-19E	03-44N	1.29	26.5
V-42	23-Jul	10:37	23-Jul	22:34	156-01E	04-59N	1.29	26.0
V-43	23-Jul	22:39	24-Jul	10:34	156-02E	04-13N	1.29	26.0
V-44	24-Jul	10:38	24-Jul	22:32	155-56E	05-01N	1.29	26.5

V-45	24-Jul	22:37	25-Jul	10:31	156-00E	05-38N	1.29	27.0
V-46	25-Jul	10:35	25-Jul	22:31	155-59E	07-24N	1.29	27.0
V-47	25-Jul	22:34	26-Jul	10:31	156-05E	08-00N	1.29	27.0
V-48	26-Jul	10:36	26-Jul	22:29	156-00E	07-58N	1.29	26.0
V-49	26-Jul	22:34	27-Jul	10:28	155-47E	08-27N	1.29	26.0
V-50	27-Jul	10:34	27-Jul	22:37	154-47E	10-44N	1.31	26.0
V-51	27-Jul	22:41	28-Jul	10:31	153-45E	13-01N	1.28	24.5
V-52	28-Jul	10:35	28-Jul	22:35	152-47E	15-11N	1.29	26.0
V-53	28-Jul	22:43	29-Jul	10:31	151-46E	17-24N	1.27	26.0
V-54	29-Jul	10:35	29-Jul	22:30	150-45E	19-35N	1.29	25.0
V-55	29-Jul	22:35	30-Jul	10:38	149-40E	21-52N	1.30	26.0
V-56	30-Jul	10:42	30-Jul	22:48	148-36E	24-08N	1.31	27.0
V-57	30-Jul	22:52	31-Jul	10:33	147-27E	26-18N	1.26	27.0
V-58	31-Jul	10:38	31-Jul	22:29	146-15E	28-32N	1.25	27.0
V-59	31-Jul	22:32	1-Aug	10:40	145-01E	30-42N	1.31	28.0
V-60	1-Aug	10:43	1-Aug	22:29	144-37E	32-43N	1.27	26.0
V-61	1-Aug	22:32	2-Aug	10:36	145-23E	34-44N	1.30	26.0
V-62	2-Aug	10:41	2-Aug	22:25	146-16E	36-57N	1.27	23.0
V-63	2-Aug	22:29	3-Aug	10:37	147-05E	39-01N	1.31	26.0
V-64	3-Aug	10:40	3-Aug	23:54	145-14E	39-31N	1.44	28.0

Table 7-13-2 Summary of precipitation sampling for isotope analysis.

	Start				End				
	Date	Time (UT)	Lon	Lat	Date	Time (UT)	Lon	Lat	Rain (mm)
R-1	3-Jul	01:00	144-48E	13-00N	3-Jul	20:22	146-00E	09-22N	15.0
R-2	3-Jul	20:22	146-00E	09-22N	4-Jul	21:55	147-01E	04-57N	2.7
R-3	4-Jul	21:55	147-01E	04-57N	5-Jul	21:19	147-01E	04-57N	1.8
R-4	5-Jul	21:19	147-01E	04-57N	6-Jul	22:22	147-00E	03-03N	10.4
R-5	6-Jul	22:22	147-00E	03-03N	7-Jul	22:03	147-03E	02-00N	2.6
R-6	7-Jul	22:03	147-03E	02-00N	8-Jul	21:19	146-58E	02-04N	1.4
R-7	8-Jul	21:19	146-58E	02-04N	12-Jul	23:48	151-51E	01-03S	2.8
R-8	12-Jul	23:48	151-51E	01-03S	13-Jul	00:28	152-00E	01-04S	0.8
R-9	13-Jul	00:28	152-00E	01-04S	13-Jul	18:45	155-59E	01-58S	1.9
R-10	13-Jul	18:45	155-59E	01-58S	14-Jul	20:12	155-47E	01-56S	14.9
R-11	14-Jul	20:12	155-47E	01-56S	15-Jul	19:05	156-00E	05-00S	2.9
R-12	15-Jul	19:05	156-00E	05-00S	17-Jul	01:59	156-00E	04-30S	1.2
R-13	17-Jul	01:59	156-00E	04-30S	18-Jul	00:29	156-00E	01-59S	0.7
R-14	18-Jul	00:29	156-00E	01-59S	18-Jul	03:40	155-59E	01-59S	0.5
R-15	18-Jul	03:40	155-59E	01-59S	18-Jul	19:38	156-00E	01-27S	2.8
R-16	18-Jul	19:38	156-00E	01-27S	18-Jul	21:30	156-00E	01-03S	1.4
R-17	18-Jul	21:30	156-00E	01-03S	19-Jul	21:00	155-58E	00-00S	2.4
R-18	19-Jul	21:00	155-58E	00-00S	21-Jul	05:32	155-59E	01-02N	2.0
R-19	21-Jul	05:32	155-59E	01-02N	22-Jul	23:32	156-03E	02-05N	0.6
R-20	22-Jul	23:32	156-03E	02-05N	23-Jul	07:30	156-00E	03-15N	16.9
R-21	23-Jul	07:30	156-00E	03-15N	23-Jul	20:55	156-00E	05-01N	27.3
R-22	23-Jul	20:55	156-00E	05-01N	25-Jul	19:01	156-00E	06-31N	0.8
R-23	25-Jul	19:01	156-00E	06-31N	29-Jul	20:30	150-56E	19-13N	1.6

R-24	29-Jul	20:30	150-56E	19-13N	31-Jul	04:11	148-06E	25-11N	7.7
R-25	31-Jul	04:11	148-06E	25-11N	1-Aug	06:51	145-24E	30-03N	1.7
R-26	1-Aug	06:51	145-24E	30-03N	4-Aug	06:42	144-10E	39-50N	12.0

* Rainfall amount is calculated by SOJ data.

Table 7-13-3 Summary of surface seawater sampling for isotope analysis.

Sampling No.		Date	Time (UTC)	Position LON		LAT	
MR08-03 O-	1	2008/07/03	05:58	145-07	E	12-03	N
MR08-03 O-	2	2008/07/04	05:59	146-36	E	07-35	N
MR08-03 O-	3	2008/07/05	05:59	147-00	E	05-00	N
MR08-03 O-	4	2008/07/06	06:55	147-00	E	03-58	N
MR08-03 O-	5	2008/07/07	05:55	147-00	E	01-40	N
MR08-03 O-	6	2008/07/08	06:23	147-01	E	02-00	N
MR08-03 O-	7	2008/07/09	06:15	147-00	E	01-00	N
MR08-03 O-	8	2008/07/10	06:00	147-00	E	00-01	S
MR08-03 O-	9	2008/07/11	05:59	147-04	E	00-00	S
MR08-03 O-	10	2008/07/12	06:00	147-48	E	00-07	S
MR08-03 O-	11	2008/07/13	06:00	153-20	E	01-22	S
MR08-03 O-	12	2008/07/14	06:01	155-55	E	01-58	S
MR08-03 O-	13	2008/07/15	06:01	156-00	E	03-08	S
MR08-03 O-	14	2008/07/16	06:03	156-01	E	05-00	S
MR08-03 O-	15	2008/07/17	06:05	156-00	E	04-30	S
MR08-03 O-	16	2008/07/18	06:01	155-55	E	02-01	S
MR08-03 O-	17	2008/07/19	06:00	156-00	E	01-27	S
MR08-03 O-	18	2008/07/20	05:59	156-01	E	00-01	S
MR08-03 O-	19	2008/07/21	06:00	156-00	E	01-08	N
MR08-03 O-	20	2008/07/22	06:01	156-01	E	02-00	N
MR08-03 O-	21	2008/07/23	05:59	156-00	E	03-00	N
MR08-03 O-	22	2008/07/24	06:05	156-00	E	04-22	N
MR08-03 O-	23	2008/07/25	06:00	155-57	E	05-01	N
MR08-03 O-	24	2008/07/26	06:00	155-57	E	08-02	N
MR08-03 O-	25	2008/07/27	06:00	156-01	E	07-59	N
MR08-03 O-	26	2008/07/28	06:00	154-09	E	12-11	N
MR08-03 O-	27	2008/07/29	06:02	152-06	E	16-34	N
MR08-03 O-	28	2008/07/30	06:01	150-05	E	21-02	N
MR08-03 O-	29	2008/07/31	06:05	147-54	E	25-31	N
MR08-03 O-	30	2008/08/01	06:00	145-29	E	29-53	N
MR08-03 O-	31	2008/08/02	05:59	145-06	E	33-59	E
MR08-03 O-	32	2008/08/03	04:00	146-28	E	37-59	N

7.14 XCTD performance test

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(1) Background

XCTD observations have been conducted since 1999 in the Tropical Ocean Climate Study (TOCS) project of JAMSTEC. When we started XCTD observations, we conducted performance check during R/V Kaiyo cruise, KY99-09. Its result suggested that XCTD performance was enough good to describe variability in the tropical ocean above intermediate layer although there was small negative salinity bias of 0.03 to 0.04 psu. However, we found that negative bias in XCTD salinity became large after 2003. For example, it exceeded 0.1 psu during MR06-05 cruise (Figure 7-14-1). Similar results are also found in results during the other TOCS cruises (e.g., MR07-07). Because Japanese XCTD maker, Tsurumi-Seiki Co. Ltd, changed shape of thermistor leg in the hole of probe since 2003, it is possible that this large salinity bias is derived from the difference of thermistor shape. Therefore, we checked XCTD performance again.

(2) XCTD probes used in this test

Structure of head of XCTD is shown in Figure 7-14-2. When XCTD was developed at first, thermistor was located at the center of the hole of XCTD probes. We call this type “Long” (Figure 7-14-2a), which was manufactured until 2003. Because some troubles were reported in the volunteer ship observations in which probes were launched from high position, XCTD maker developed a shook-proof type probe with a shorter thermistor leg than “Long” (called “Short”, Figure 7-14-2b). Last year, another shook-proof type probe with a bended thermistor leg (called “Bended”, Figure 7-14-2c) was newly developed. Thus, we used these three different types of probes in this test.

(3) Operations

We conducted this test in the afternoon of 27 July 2008 near the TRITON buoy #1 (7-57N, 156-00E).

For this test, two CTD casts until 1000m depth were conducted. During each CTD cast, we launched two probes four times at the same time using two hand launchers or one hand launcher and auto launcher equipped in R/V Mirai (Table 7-14-1). Totally, sixteen XCTD probes were launched in this test from the second deck of R/V Mirai.

When CTD system was at 1000m depth in the both casts, water was sampled. This water was analyzed using AUTOSAL for salinity. Then, we confirmed that accuracy of CTD salinity is better than 0.002 psu.

(4) Results

Potential temperature – salinity relations for Short, Bended and Long-type probes are shown in Figure 7-14-3. Negative salinity bias appears in all types of probes but bias of Short-type is largest, on average. Bias of Long-type and Bend-type are almost same in the temperature range of > 10℃. Below this temperature, positive bias of Long-type is clear, particularly, in Long-2 and 3 probes exceeding 0.03 psu.

Graphs of CTD salinity minus XCTD salinity for temperature are plotted in Figure 7-14-4. Negative salinity bias is not constant but depends on temperature with a maximum about 0.07 PSU around 18-20℃ for all types of probe. Although shape of temperature dependency curve is similar in all probes, these curves disperse with width of +/- 0.02 psu. Note that these curves do not converge in low temperature range (<10℃) but diverse as same in high temperature range. Because of this large dispersion, bias of Short-type probe is not always larger than that of Long and Bended-type probes. (For example, bias of Long-5 is larger than that of Short-2.)

Thus, we derived following conclusions:

1) Maximum of negative salinity bias in this test is 0.07 psu
2) On average, bias of the Short-type probe is largest; however, it is not always larger than that of the Long and Bended-type probes.
3) Temperature dependency of salinity bias is almost same in these three types. It takes maximum around 18-20℃. The dependency curves disperse with width of +/- 0.02 psu in all temperature range.
4) Because of above results, we cannot conclude that large negative salinity bias found during the past TOCS cruises attributes to difference of shape of thermistor leg.

Acknowledgment

Dr.Y.Nakano and Ms.M.Fujita worked for launching XCTD probes using hand launchers during the test. CTD operations and sampled water analysis for this test were carried out by the technicians of Marine Work Japan Co. Ltd. Crew of R/V Mirai supported for conducting the test. We would like to thank them for their works.

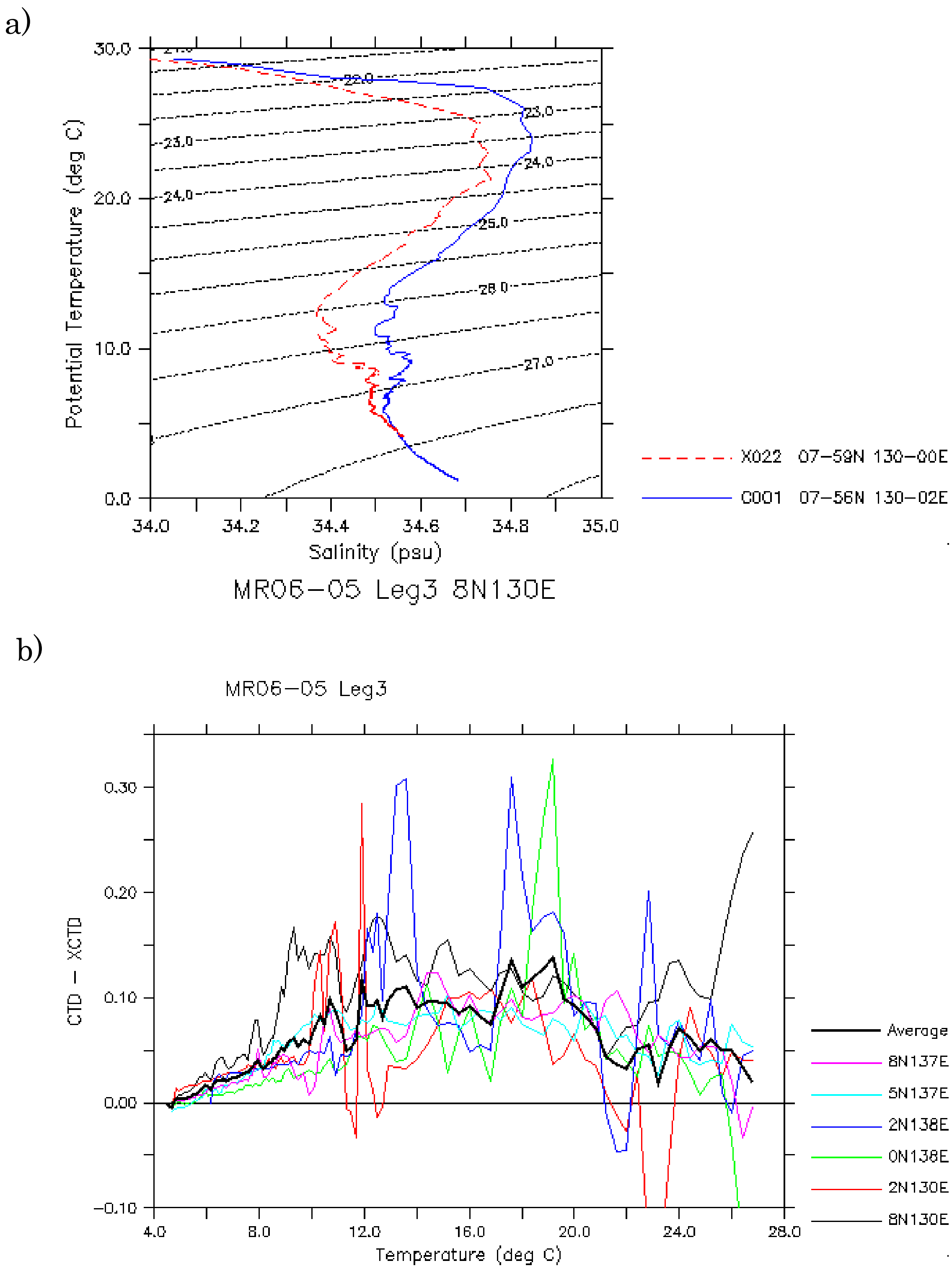


Figure 7-14-1. Comparison between CTD and XCTD observations during MR06-05 Leg3. a) Potential temperature – salinity relations at 8N130E. Time and space lags between these observations are 1 day and 3 miles, respectively. b) Graphs of CTD salinity minus XCTD salinity for temperature near the TRITON buoy locations. There were also time and space lags between CTD and XCTD observations (1 day and 3-5 miles).

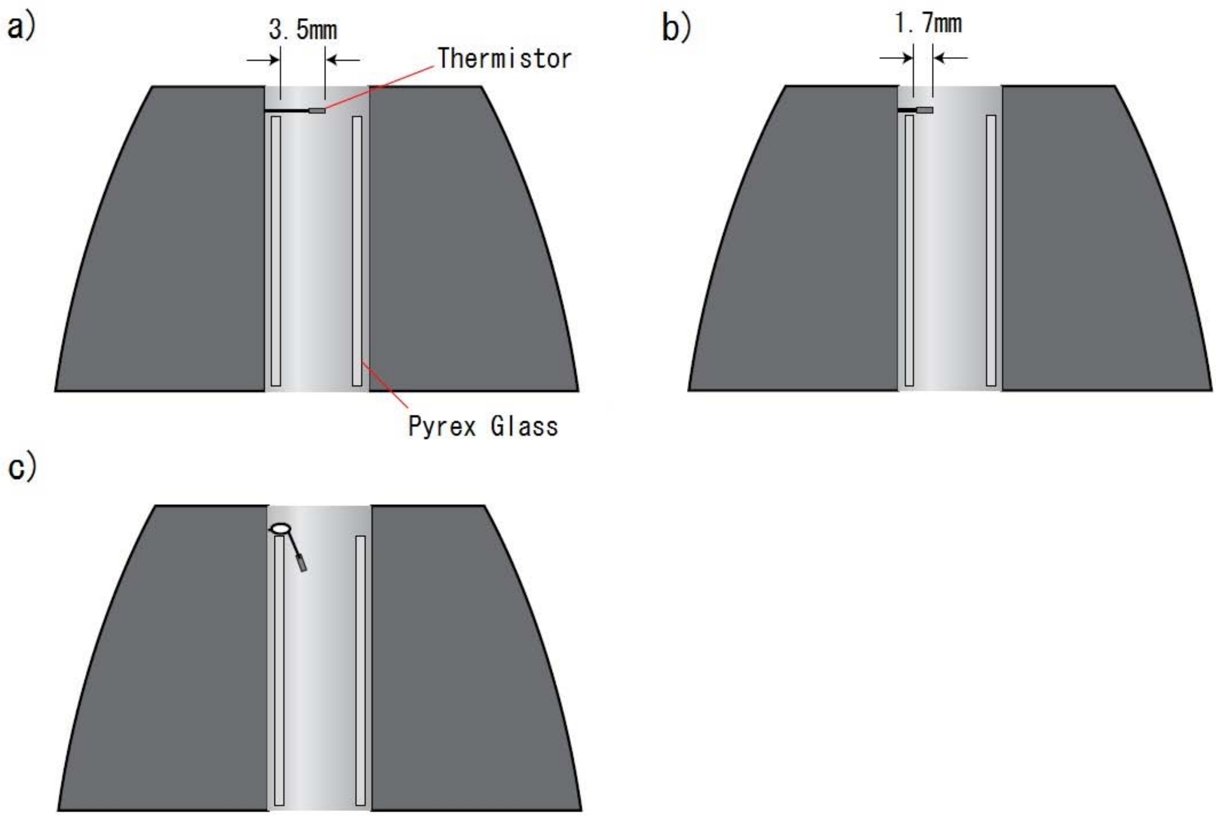


Figure 7-14-2. Structure of head of XCTD probes. a) Long, b) Short, and c) Bended-type, respectively.

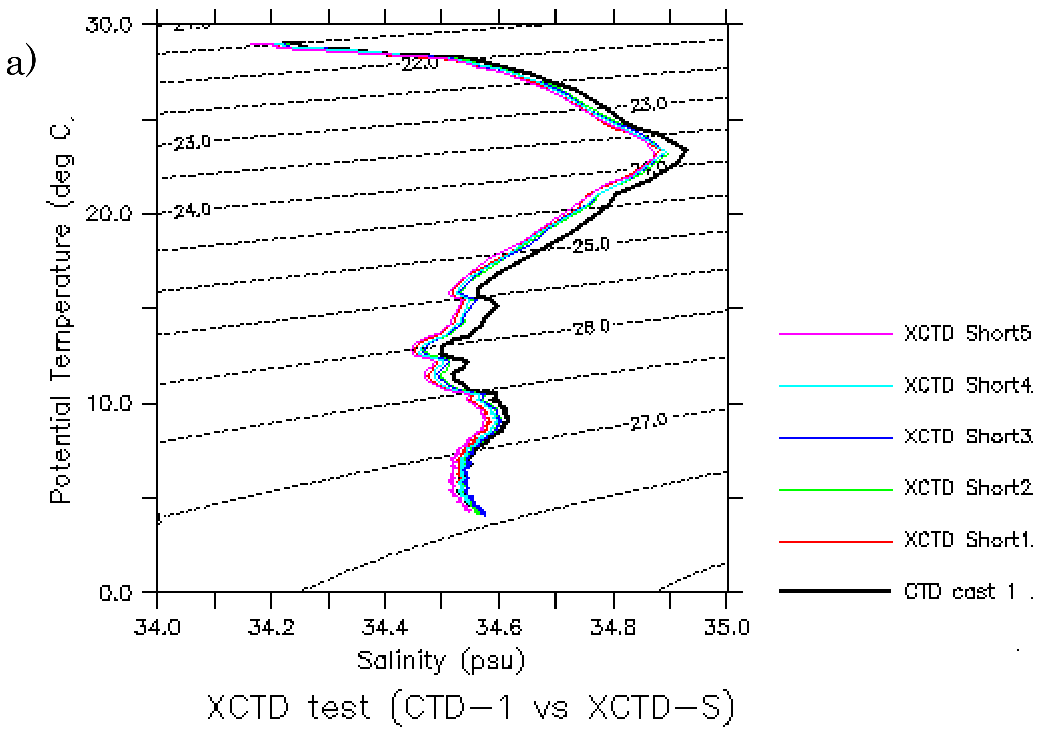
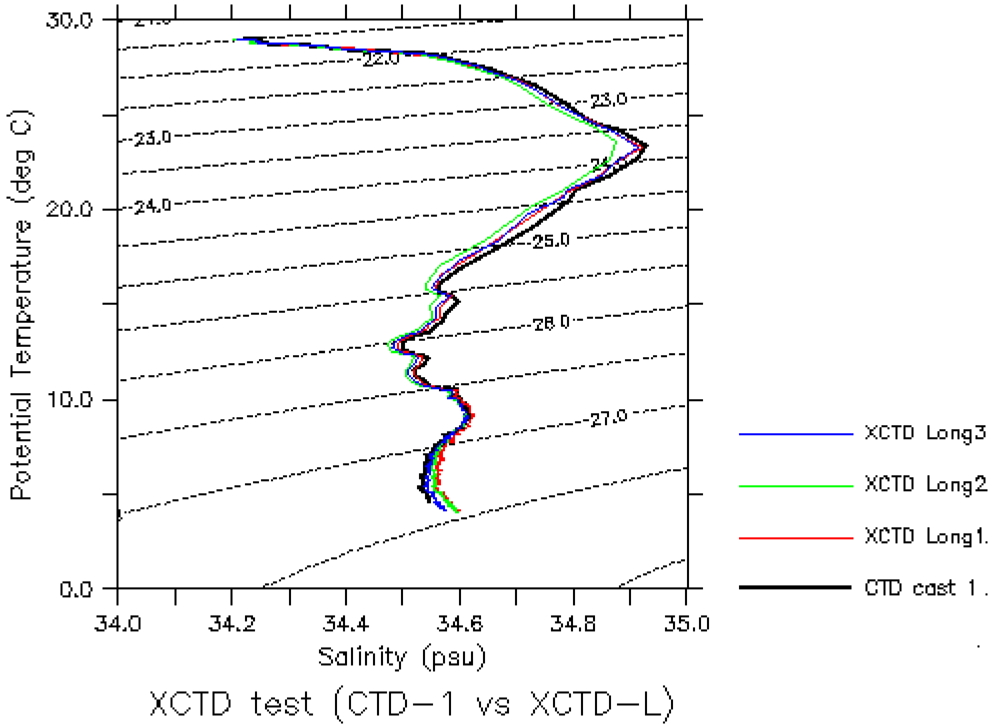


Figure 7-14-3. Potential temperature – salinity relations in the XCTD performance test. Results from a) CTD cast 1 versus Short-type XCTD probes, b) CTD cast 1 versus Long-type probes 1-3, c) CTD cast 2 versus Bended-type probes, d) CTD cast 2 versus Long-type probes 4-6, and e) average of two CTD cast versus averages of Short, Bended, and Long type probes, respectively.

b)



c)

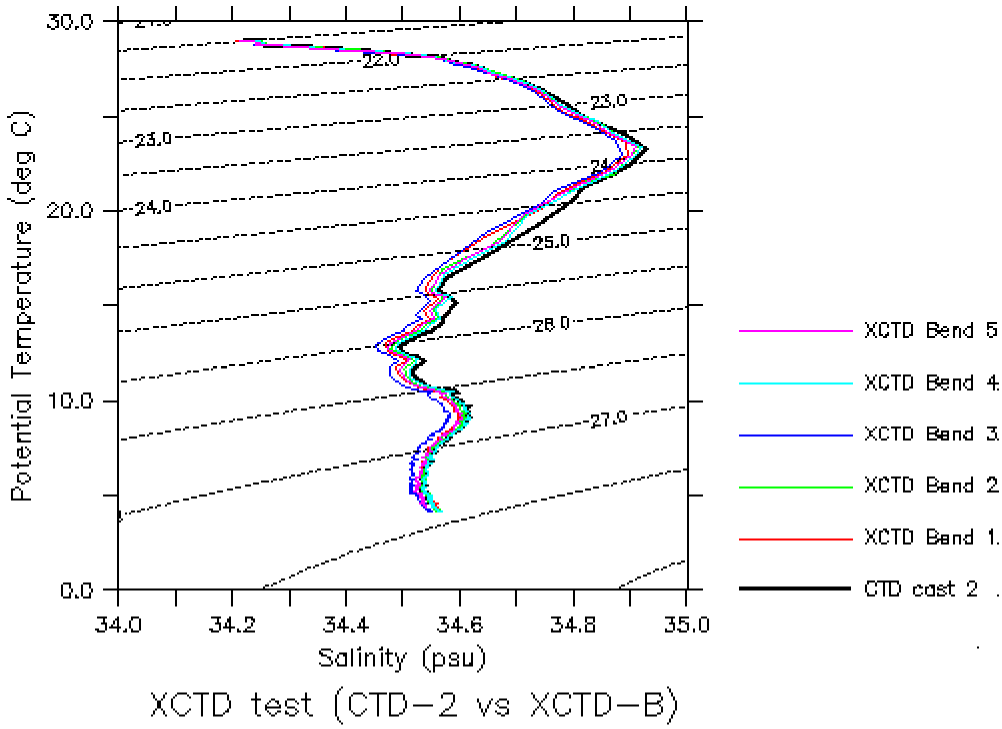
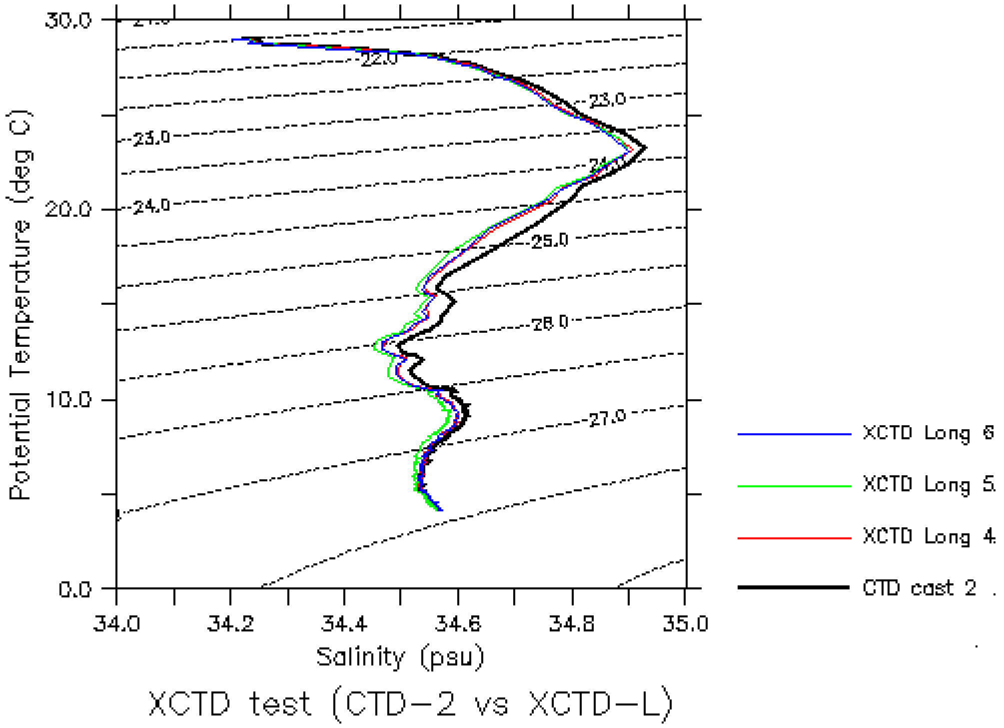


Figure 7-14-3. (continued.)

d)



e)

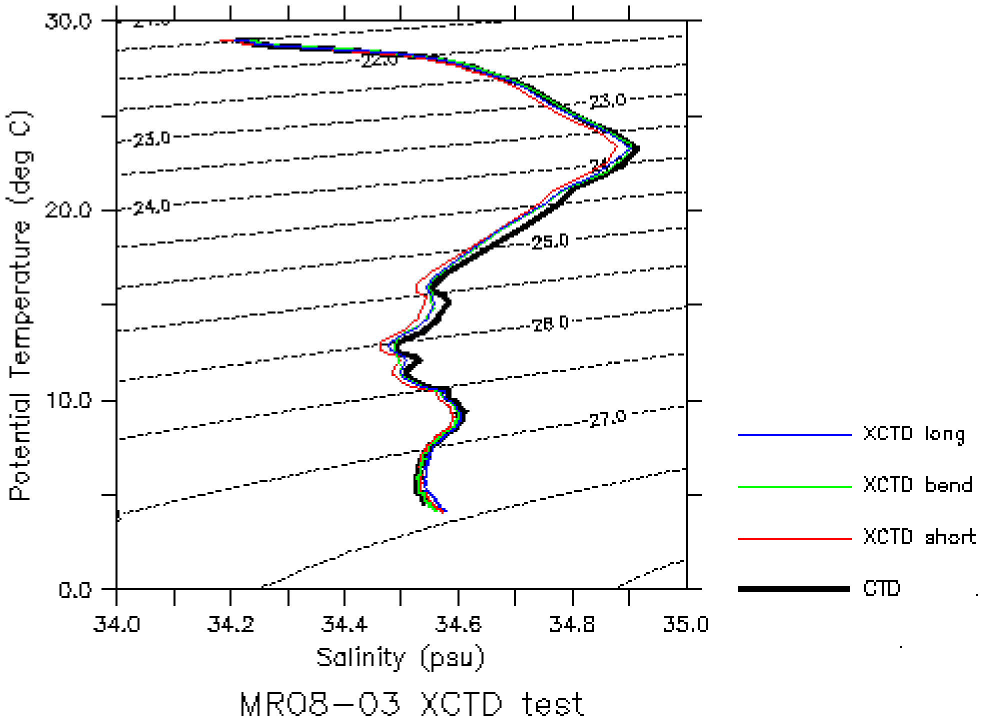
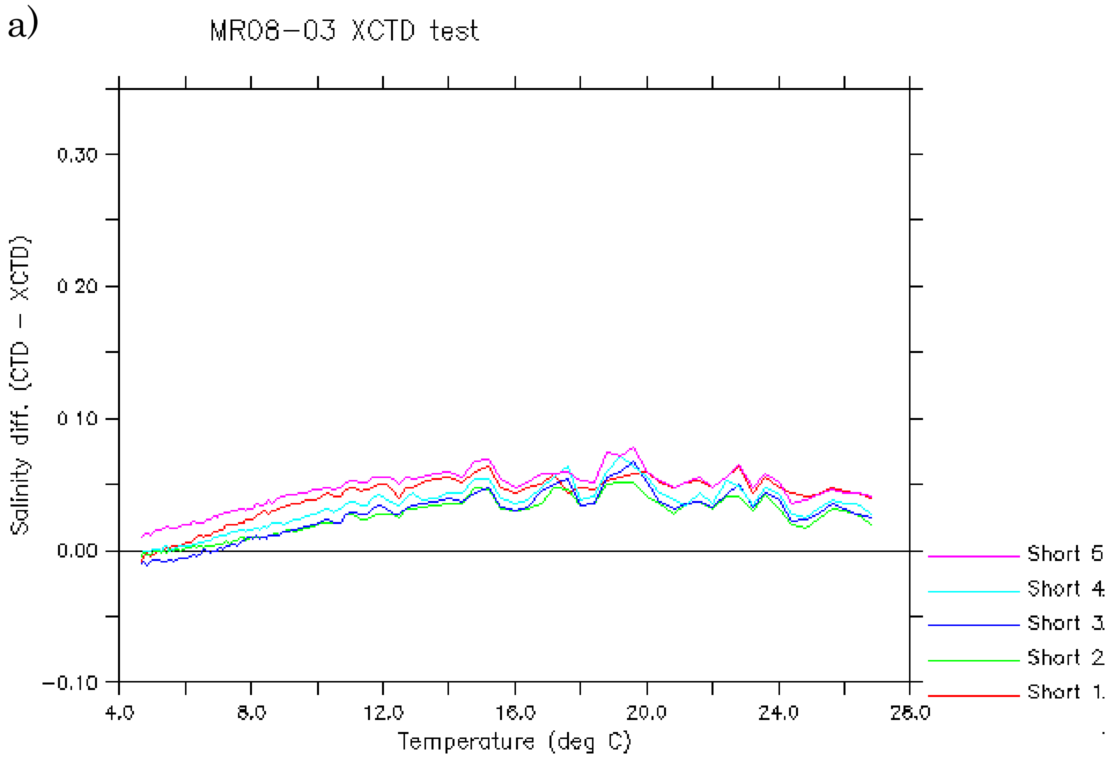


Figure 7-14-3. (continued.)

a)



b)

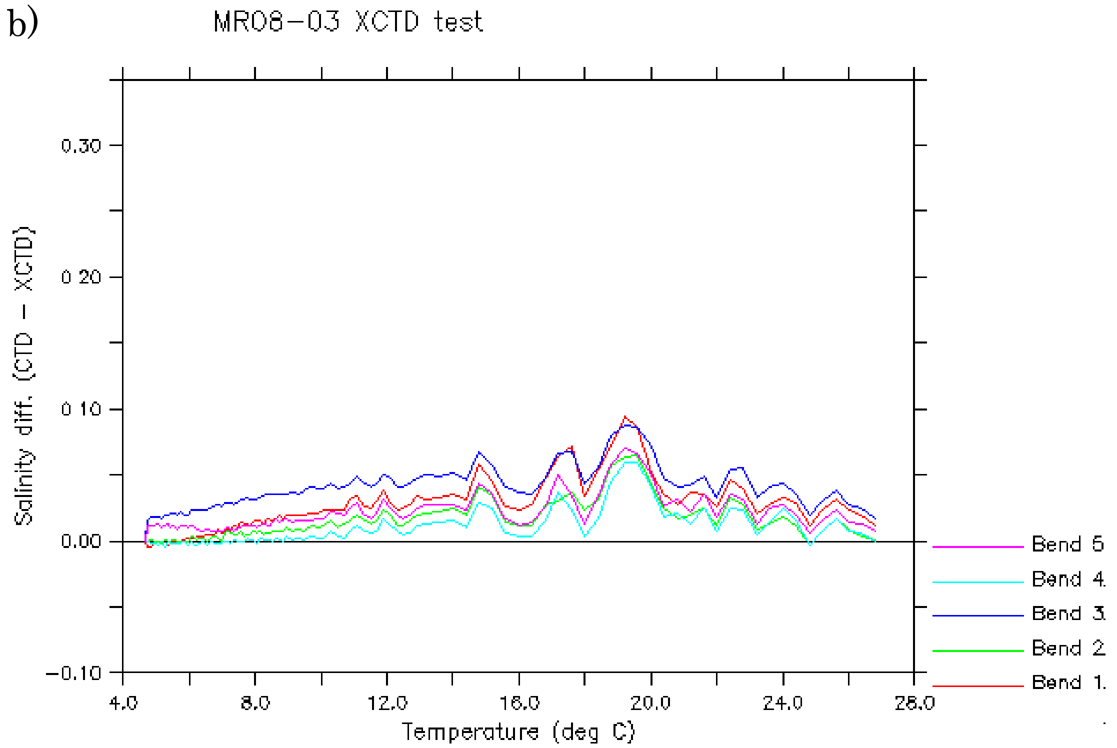
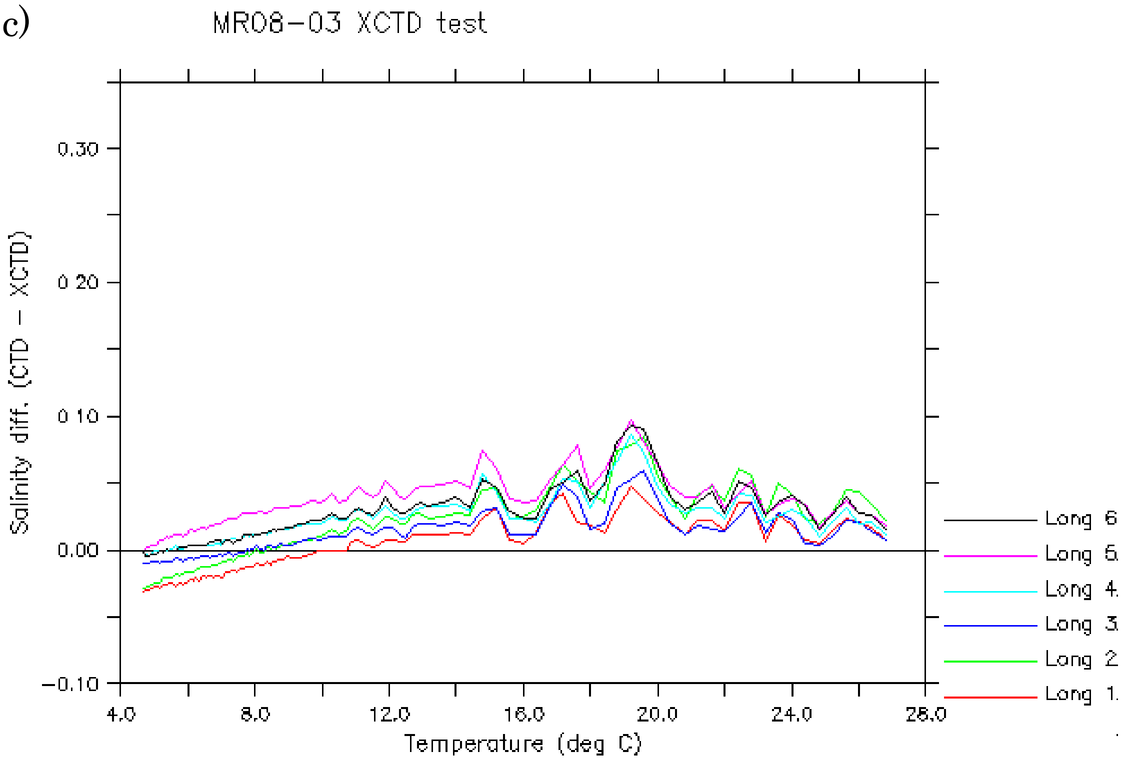


Figure 7-14-4. Graphs of CTD salinity minus XCTD salinity for temperature in this test. Results from a) Short-type XCTD probes, b) Bended-type probes, c) Long-type probes, and d) averages of these three type probes, respectively.

c)



d)

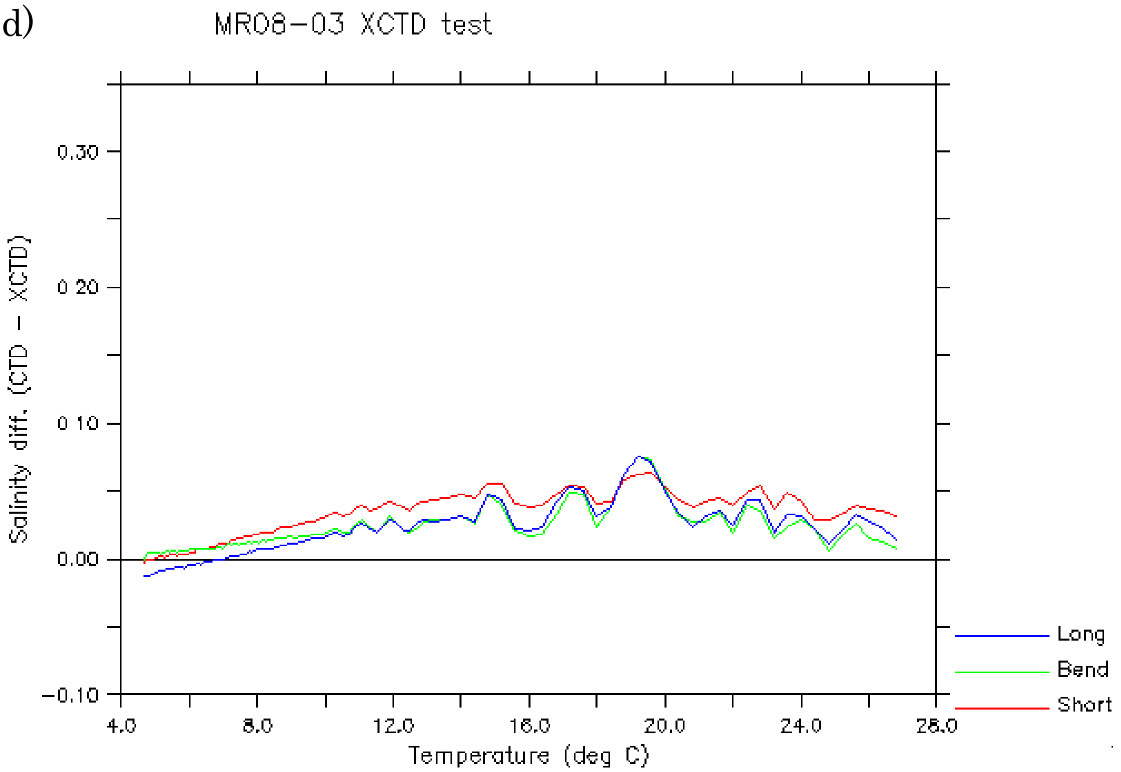


Figure 7-14-4. (continued.)

Table 7-14-1. List of probes used for XCTD performance test. For exmaple, one short-type probe (S/N07064659) and one long-type probe (S/N0805001) were launched at the same time (03:05 UTC) using two hand lanchers in the test 1. During each CTD cast, four tests were conducted.

		Tsurumi PC1 (MK130 + HAND Launcher ①)							Tsurumi PC2 (MK130 + HAND Launcher ②)					MIRAI system (MK100 + AUTO Launcher)						
		XCTD Probe Type							XCTD Probe Type					XCTD Probe Type						
		Short			Long	Bended			Short	Long			Bended	Short			Long	Bended		
CTD Cast 1 (02:58 – 03:45)	Test 1 (03:05)	S①	S/N	07064659	–	–	–	–	–	L①	S/N	08050001	–	–	–	–	–	–	–	–
	Test 2 (03:14)	S②	S/N	07064658	–	–	–	–	–	L②	S/N	08050002	–	–	–	–	–	–	–	–
	Test 3 (03:22)	S③	S/N	07064662	–	–	–	–	–	L③	S/N	08050003	–	–	–	–	–	–	–	–
	Test 4 (03:32)	S④	S/N	07064661	–	–	–	–	–	–	–	–	–	S⑤	S/N	07064660	–	–	–	–
CTD Cast 2 (04:08 – 04:59)	Test 5 (04:16)	–	–	–	–	B①	S/N	08048287	–	L④	S/N	08050004	–	–	–	–	–	–	–	–
	Test 6 (04:24)	–	–	–	–	B②	S/N	08048288	–	L⑤	S/N	08050005	–	–	–	–	–	–	–	–
	Test 7 (04:32)	–	–	–	–	B③	S/N	08048289	–	L⑥	S/N	08050006	–	–	–	–	–	–	–	–
	Test 8 (04:41)	–	–	–	–	B④	S/N	08048290	–		–	–	–	–	–	–	–	B⑤	S/N	08048291