doi : 10.17596/0003212

R/V Kaiyo Cruise Report
KY09-09
Leg-2

October 9, 2009 – December 11, 2009
(except the period of November 2-6, 2009)

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

Table of contents

1. Cruise name and code

Title of the cruise: Tropical Ocean Climate Study

Cruise code: KY09-09

Ship: R/V Kaiyo (Captain: Samejima)

Title of proposal: Tropical Ocean Climate Study

Title of proposal: Indian Ocean Moored Buoy Network Initiative for Climate Study, Japan Earth Observation System Promotion Program

2. Introduction and observation summary

2.1 Introduction

The purpose of this cruise is to observe ocean and atmosphere in the eastern Indian Ocean for better understanding of climate variability involving Indian Ocean Dipole phenomenon and basin wide warming associated with El Nino. Particularly, warm water pool (WWP) in the western tropical Pacific and in the eastern Indian Ocean is characterized by the highest sea surface temperature in the world, and plays a major role in driving global atmospheric circulation. Cold water appearance in the eastern Indian Ocean warm pool region and warm water appearance in the western Indian Ocean would be the onset of Indian Ocean Dipole phenomena. However, this atmospheric and oceanic system is so complicated that scientific knowledge is still not enough.

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 m-TRITON (small size TRITON), 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 and develop the international RAMA buoy network, by using m-TRITON buoys in the eastern Indian Ocean. Additionally, subsurface Acoustic Doppler Current Profiler (ADCP) buoys at the equator are maintained to obtain time-series data of equatorial ocean current. Atmospheric compositions and general meteorological observations are conducted during the cruise.

2.2 Overview

1) Ship

R/V Kaiyo

Captain Samejima

2) Cruise code

KY09-09 (leg-2)

3) Project name

Tropical Ocean Climate Study and Operation of TRITON buoy

Indian Ocean Moored Buoy Network Initiative for Climate Study (Japan Earth Observation System Promotion Program by MEXT

4) Undertaking institution

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

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

5) Chief scientist

Kentaro Ando (JAMSTEC)

6) Period

Oct 9, 2009 (Yokohama, Japan) – Dec 11, 2009 (Yokosuka, Japan)

7) Research participants

One scientist, one engineer, and ten technical staffs from JAMSTEC, MWJ, and GODI.

2.3 Observation summary

m-TRITON mooring deployment:	3 moorings
m-TRITON mooring recovery:	2 moorings
Subsurface ADCP mooring recovery and re-installation: 1 mooring were deployed and recovered	
CTD (Conductivity, Temperature and Depth) and water sampling:	5 casts
XCTD:	12 casts
XBT:	15 casts
Current measurements by shipboard ADCP:	continuous
Sea surface temperature, by seasnake	continuous
Surface meteorology:	continuous

Regarding m-TRITON buoy maintenance work, we recovered and re-installed nine buoys at 1.5S90E and 5S95e during this cruises, and we could deploy the new site in RAMA at 8S95E. We have been also maintaining the subsurface ADCP buoys in the eastern equatorial Indian Ocean since 2000. One ADCP buoys at 0N-90E was recovered and re-installed during this cruise. Unfortunately, the data was not recovered, and the reason of trouble is unknown.

During this cruise, we conducted CTD casts for checking TRTION sensor data quality, CTD casts were conducted down to 1000m depth near the recovered buoy for the purpose to compare with m-TRITON salinity sensors.

XCTD/XBT observations were conducted along the ship tracks throughout the cruise, and surface meteorological measurements and sea-surface temperature measurements by Sea-Snake were conducted continuously except in the prohibited areas.

2.4 Observed Oceanic and Atmospheric Conditions

In the eastern tropical Indian ocean, all m-TRITON buoy data at 5S95E, 1.5S90E and 8S95E show below 30 degree-C in November 2009. Compared with climatology, SST observed by three buoys were similar to the climatology. Not like in 2006, 2007 and 2008 years when the Indian Ocean Dipole events occurred, negative temperature anomalies in the surface and subsurface layer were not found. At least during the cruise, it is concluded that the surface condition in the eastern Indian ocean was normal.

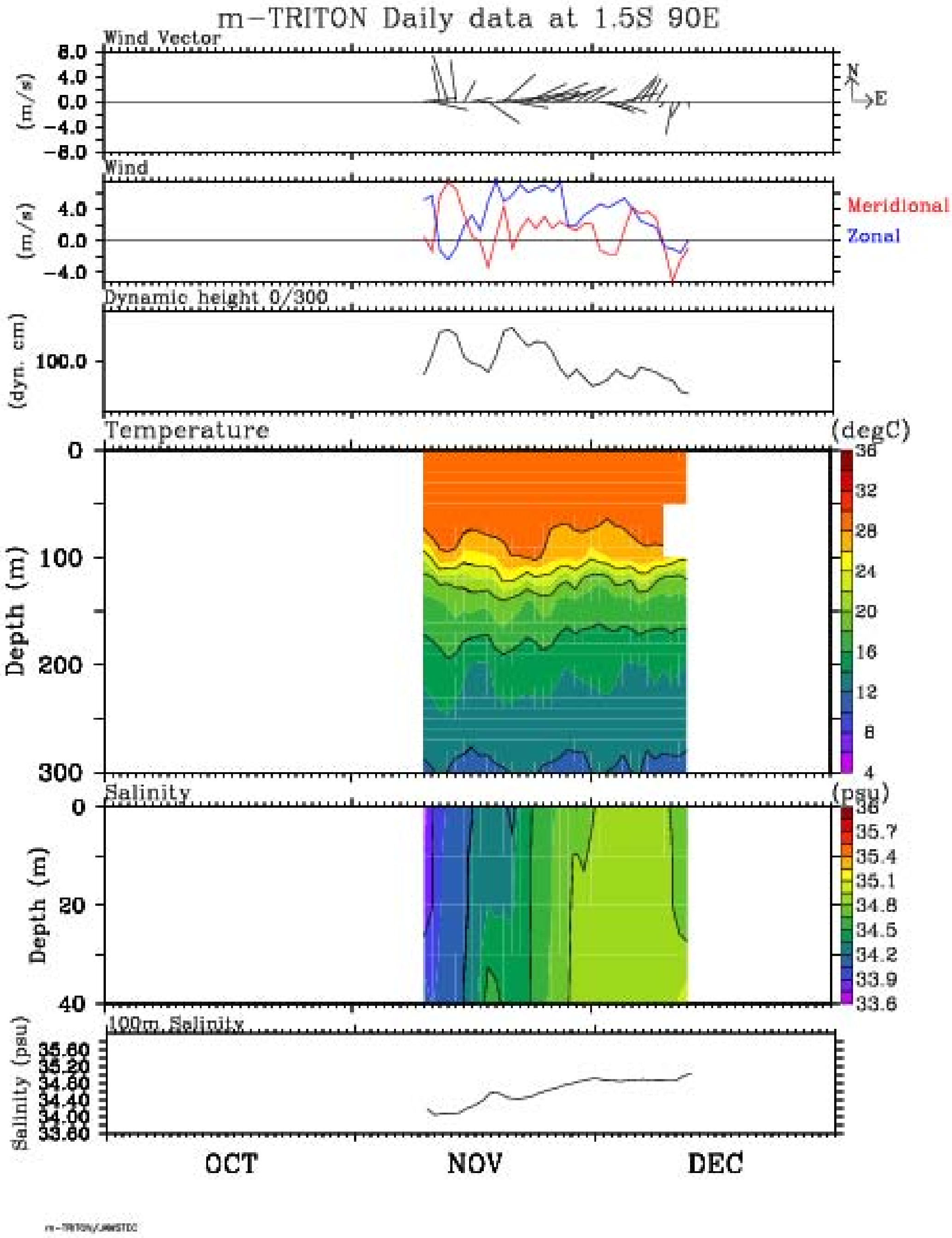

Figure 2.4-1 Real-time data of surface wind, dynamic height, temperaure and salinity sections transmitted from the m-TRITON data deployed at 1.5S90E. The data shown here was the satellite transmitted before December 16, 2009.

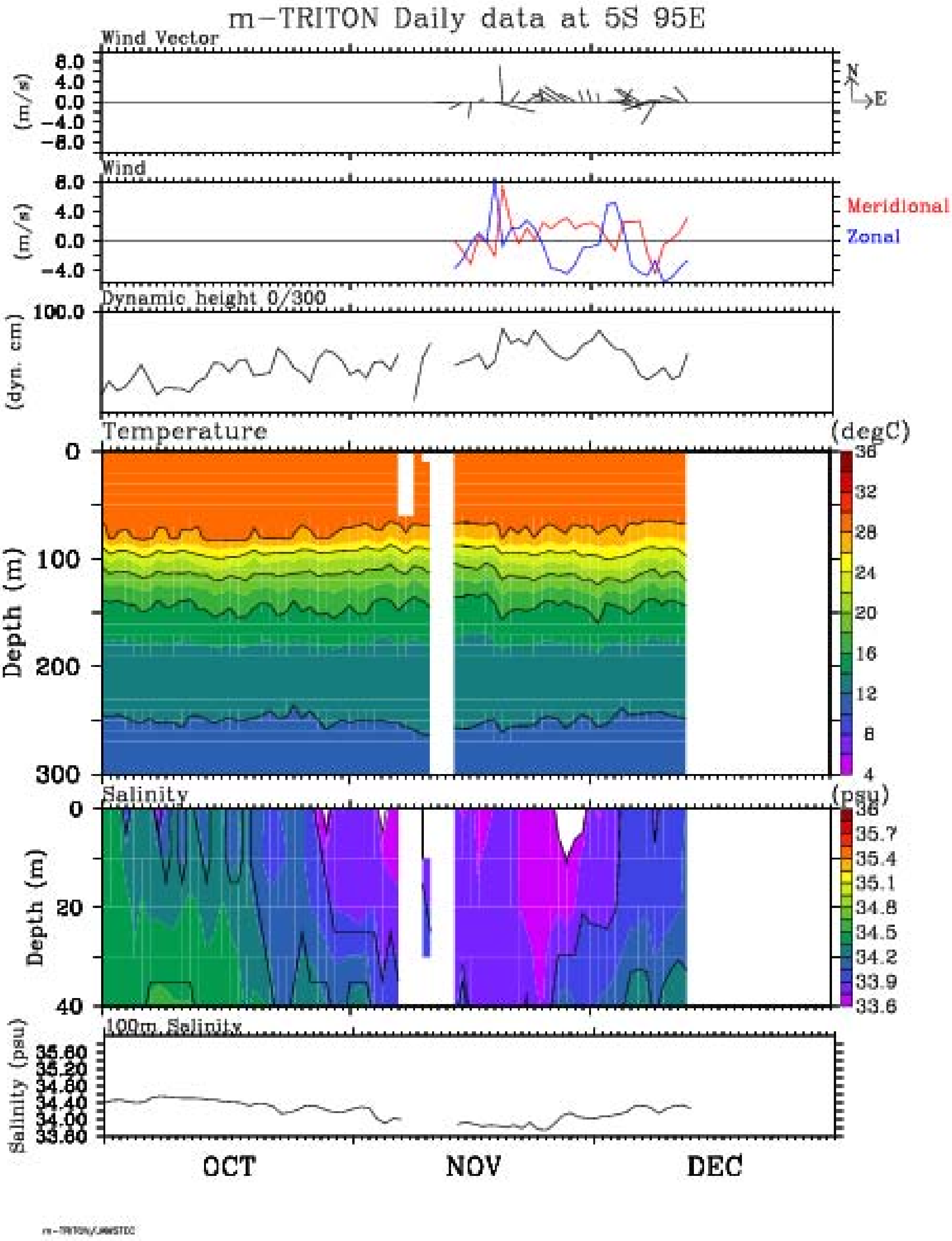

Figure 2.4-2 Real-time data of surface wind, dynamic height, temperaure and salinity sections transmitted from the m-TRITON data deployed at 5S95E. The data shown here was the satellite transmitted before December 16, 2009.

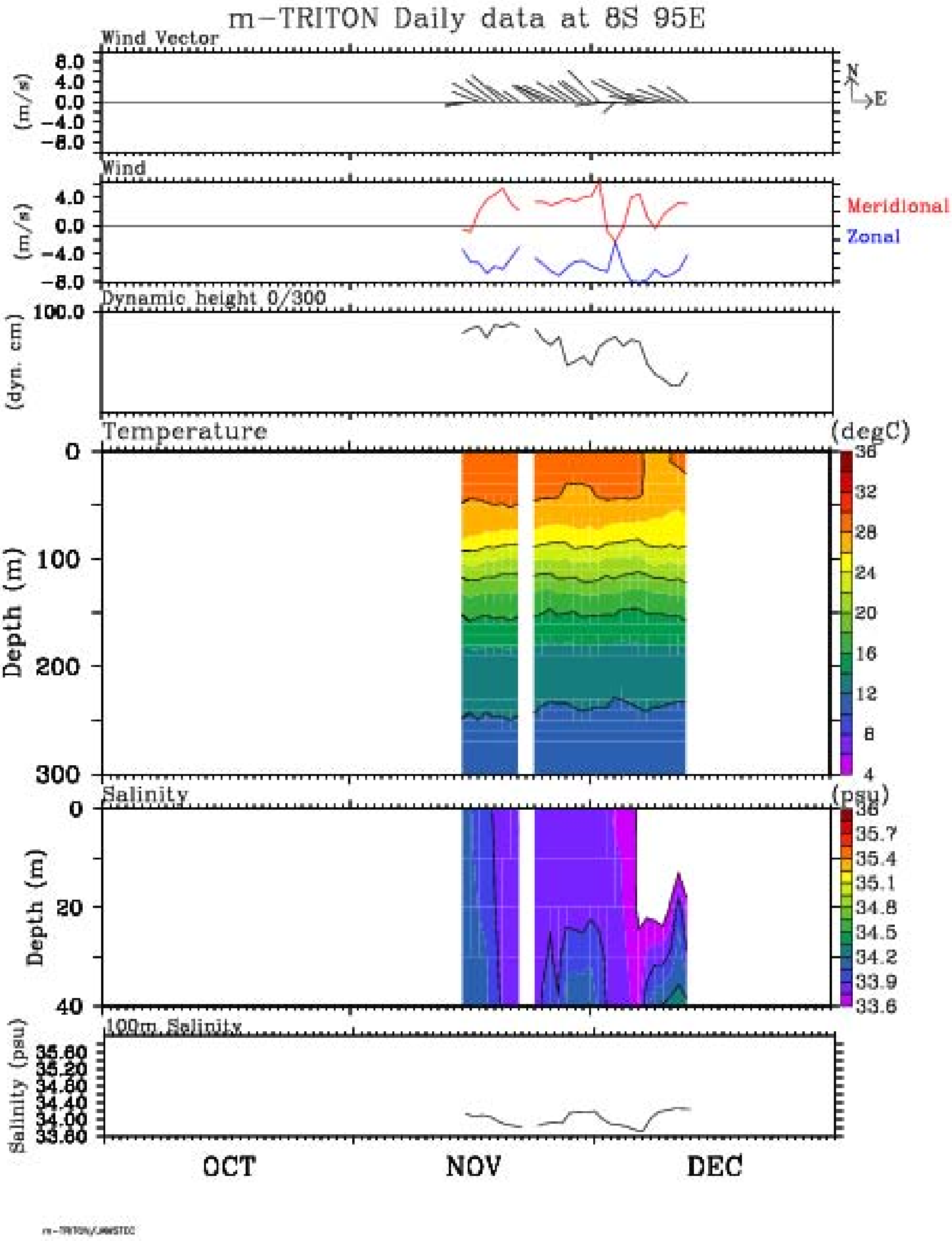

Figure 2.4-3 Real-time data of surface wind, dynamic height, temperaure and salinity sections transmitted from the m-TRITON data deployed at 8S95E. The data shown here was the satellite transmitted before December 16, 2009.

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

3.1 Period

Oct 10, 2009 – Dec 11, 2009

3.2 Ports of call

Yokosuka, Japan (Departure: October 9, 2009)
Bali, Indonesia (Arrival: October 23, 2009, Departure: October 26, 2009)
Bali, Indonesia (Arrival: November 19, 2009, Departure: November 22, 2009)
Guam, USA, (Arrival: December 4, Departure December 4, 2009)
Yokosuka, Japan (December: May 9, 2009)

3.3 Cruise Log

SMT	UTC	Event
Oct. 10 (Sat) 2009		
12:30	03:30	Departure from Yokohama, Japan, Start continuous observation
Oct. 17 (Sat),2009		
21:53	12:53	Stop continuous observation
Oct. 23 (Fri) 2009		
09:40	02:40	Arrival to Bali
	(SMT was adjusted to Bali local time. UTC+8)	
Oct. 26 (Mon) 2009		
13:30	03:30	Meeting on the safety life on Kaiyo
16:00	08:00	Departure from Bali, Indonesia
Oct. 27 (Tue) 2009		
16:45 – 17:00	08:45-09:00	Kompira ceremony
Oct. 28 (Wed) 2009 – Nov. 5 (Thu) 2009		
Cruising to Leg-1 survey area, and Leg-1 seabeam survey		
Ship mean time was adjusted to UTC+6.		
Nov. 6 (Fri) 2009		
09:55	03:55	Start continuous observation
10:00-10:49	04:00-04:59	CTD test cast 2000m ()
11:00	05:00	Start Seasnake SSST measurement
Nov. 7 (Sat) 2009		
05:53	23:53	Enable to releaser of 0-90E ADCP
07:00	01:00	As long-line fishing gears were close to ADCP mooring, we gave up recovery and deployment at 0-90E, and headed to 1.5S-90E.
14:20	08:20	XCTD (01-33.6S, 90-02E)

14:37-23:10	08:37-17:10	Recovery of m-TRITON (1.5S-90E)
Nov. 8 (Sun) 2009		
08:35-12:33	02:35-06:33	Recovery of ADCP (0-90E)
13:58-17:35	07:58-11:35	Deployment of ADCP (0-90E)
18:27-18:58	12:27-12:58	CTD/water sampling (0-90E)
19:07	13:07	XCTD (00-01.80N, 90-03.62E)
19:17	13:17	XBT (00-00.34N, 90-03.55E)
Nov. 9 (Mon) 2009		
05:58 - 11:50	23:58 - 05:50	Deployment of m-TRITON (1.5S-90E)
12:22 - 12:40	06:22 - 06:40	SSBL measurement of anchor position
13:25 - 13:53	07:25 - 07:53	CTD for comparison with m-TRITON at 1.5S-90E
14:02	08:02	XCTD (1-41.83S, 89-59.30E)
14:10	08:10	XBT (1-41.71S, 89-59.30E)
15:05 - 19:40	09:05 - 13:40	Meteorological sensor comparison test
20:24 - 20:33	13:24 - 13:33	Buoy data transmission check (succeeded)
23:33	10:33	XCTD (2-000.01S, 90-28.26E)
23:41	10:41	XBT (2-00.80S, 90-29.43E)
Nov. 10 (Tue) 2009		
03:51	21:51	XBT (2-29.82S, 91-12.72E)
08:18	02:18	XCTD (3-00.06S, 91-57.45E)
08:26	02:26	XBT (3-00.75S, 91-58.52E)
12:54	06:54	XBT (3-30.01S, 92-42.45E)
17:33	11:33	XCTD (4-00.01S, 93-26.26E)
17:40	11:40	XBT (4-00.69S, 93-27.73E)
22:08	16:08	XBT (04-29.99S, 94-11.55E)
Nov. 11 (Wed) 2009		
06:15 – 11:53	00:15 – 05:53	Deployment of m-TRITON (5S-95E)
12:29 – 12:35	06:29 – 06:35	SSBL measurement of anchor position
13:25 – 13:53	07:25 – 07:53	CTD for comparison with buoy deployed
13:58	07:58	XCTD (4-58.98S, 94-59.58E)
14:06	08:06	XBT (4-58.67S, 94-59.13E)
14:53 – 15:20	08:53 – 09:20	CTD for comparison with buoy to be recovery
19:42 – 21:19	13:42 – 15:19	Buoy data transmission check (fault)
21:55 – 02:40	15:55 – 20:40	Meteorological sensor comparison test
Nov. 12 (Thu) 2009		
06:00	00:00	Waiting m-TRITON recovery due to rough sea
12:46 – 19:56	06:46 – 13:56	Recovery of m-TRITON (5S-95E)
Nov. 13 (Fri) 2009		
09:33 – 11:24	03:33 – 05:24	Replacement of top buoy of m-TRITON (5S-95E)
10:43	04:43	XBT (5-30.02S, 94-59.12E)

13:39	07:39	XCTD (06-00.01S, 94-59.86E)
13:46	07:46	XBT (06-01.27S, 94-59.89E)
Nov. 14 (Sat.) 2009		
08:27 – 13:28	02:27 – 07:28	Deployment of m-TRITON (8S, 95E)
14:05 - 14:10	08:05 - 08:10	SSBL measurement of anchor position
14:28 – 14:55	08:28 – 08:55	CTD for comparison with buoy deployed
14:59	08:59	XCTD (7-59.70S, 95-00.09E)
15:06	09:06	XBT (7-59.94S, 95-00.29E)
15:30 - 19:40	09:30 - 13:40	Meteorological sensor comparison test
20:20 - 20:22	14:20 - 14:22	Buoy data transmission check (succeeded)
Nov. 15 (Sun) 2009		
05:56	23:56	XBT (7-58.51S, 96-45.37E)
07:14	01:14	XCTD (7-58.40S, 97-00.02E)
07:22	01:22	XBT (7-58.39S, 97-01.21E)
09:56	03:56	XBT (7-57.99S, 97-30.00E)
12:42	06:42	XCTD (7-57.55S, 98-00.03E)
12:49	06:49	XBT (7-57.50S, 98-01.28E)
15:21	09:21	XBT (7-57.12S, 98-30.01E)
18:04	12:04	XCTD (7-57.19S, 99-00.01E)
18:11	12:11	XBT (7-57.20S, 99-01.09E)
20:45	14:45	XBT (7-56.18S, 99-30.02E)
23:28		Stop SSST and other continuous observation
Nov. 16 (Mon) - 18 (Wed) 2009		
Cruising to Bali, Indonesia		
Nov. 19 (Thu) – 22 (Sun) 2009		
Calling port at Bali		
Nov. 23 (Mon) 2009		
Cruising to Yokosuka		
Dec. 11 (Fri), 2009		
09:00		Arrival to Yokosuka, JAMSTEC

On the way to Yokosuka, the ship stopped at Berau, Palau for disembarking patient and taking to the hospital, and also stopped at Guam for fueling.

3.4 Cruise track

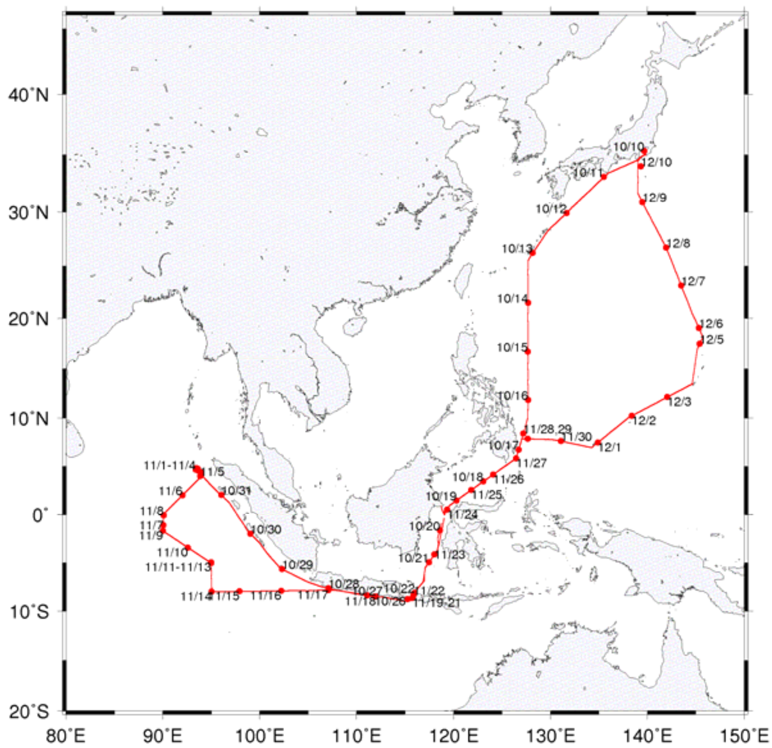

Fig 3.4-1 KY09-09 Cruise track and noon positions

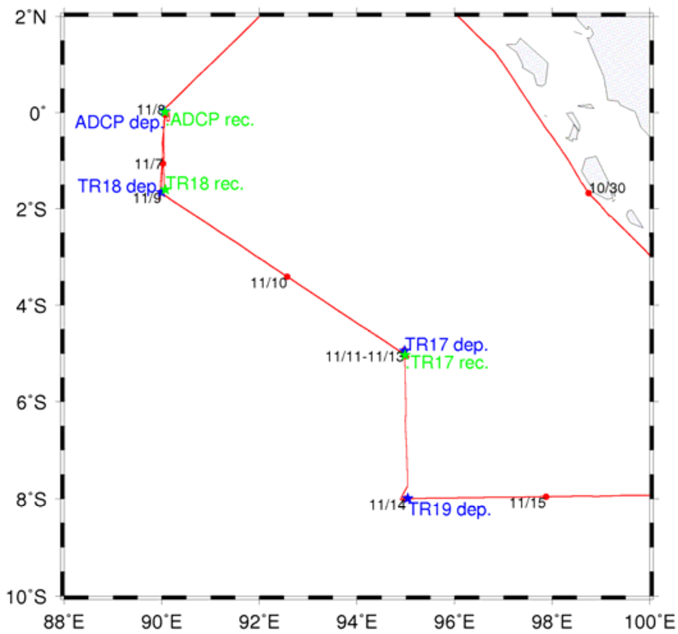

Fig 3.4-2 KY09-09 Leg-2 Cruise track and noon positions

4. Chief scientist, Science Party, and participants list

4.1 Chief Scientist

Chief Scientist

Kentaro Ando

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

4.2 Science Party

4.2.1. Tropical Ocean Climate Study

Kentaro Ando

Yuji Kashino (not on board)

Iwao Ueki (not on board)

Takuya Hasegawa (not on board)

Takanori Horii (not on board)

4.2.2. Indian Ocean Moored Buoy Network Initiative for Climate Study, Japan Earth Observation System Promotion Program (funded research contracted with MEXT, Ministry of Education, Culture, Science and Technology)

Tatsuya Fukuda

Yasuhisa Ishihara (not on board)

Keisuke Mizuno (not on board)

Yukio Masumoto (not on board)

Iwao Ueki (not on board)

Hideaki Hase (not on board)

Takanori Horii (not on board)

Masayuki Yamaguchi (not on board)

Naoko Takahashi (not on board)

4.3. R/V KAIYO scientist and technical staff

Kentaro Ando	JAMSTEC	Bali – Bali
Tatsuya Fukuda	JAMSTEC	Bali – Bali
Hiroshi Matsunaga	MWJ	Bali – Bali

Satoshi Ozawa	MWJ	Bali – Bali
Kenichi Katayama	MWJ	Bali – Bali
Hiroki Ushiromura	MWJ	Bali – Bali
Takeo Matsumoto	MWJ	Bali – Bali
Takatoshi Kiyokawa	MWJ	Bali – Bali
Yoshiki Kido	MWJ	Bali – Bali
Takami Mori	MWJ	Bali – Bali
Kazuho Yoshida	GODI	Yokosuka-Bali-Bali
Norio Nagahama	GODI	Bali-Yokosuka

JAMSTEC: Japan Agency for Marine-Earth Science and Technology

GODI: Global Ocean Development Inc.

MWJ: Marine Works Japan Ltd.

5 Observations

5.1 Meteorological measurement

5.1.1 Surface meteorological observations

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator
Kazuho Yoshida	(Global Ocean Development Inc., GODI)
Norio Nagahama	(GODI)

(2) Objectives

Surface meteorological parameters were 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 KY09-09 cruise. Surface meteorological measurement system was consist of three components as follows,

i. Meteorological sensors (anemometer, thermometer, barometer, rain gauge)

The instruments and their locations are listed in Table.5.1.1-1.

ii. A/D conversion and integrating data

The signal voltage from each sensor was converted to digital data by using CR1000 data logger (Campbell Scientific Inc., USA).

iii. Data Acquisition and Recording

Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA) – centralized data acquisition and logging of all data sets.

SCS recorded each data every 10 seconds until 17th October and every 6 seconds since the day. SCS also recorded significant wave height and wave encounter period of wave height meter (Tsurumi Seiki, WM-2) and navigation data from Radio Navigation System of R/V KAIYO. Measured parameters are listed in Table.5.1.1-2.

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

i. Rain gauge

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

ii. Barometer

Comparison with the portable barometer value, PTB220CASE, VAISALA.

iii.Thermometer (air temperature and relative humidity)

Comparison with the portable thermometer value, HMI41/HMP45, VAISALA.

(4) Preliminary results

Figures 5.1.1-1 shows the time series of wind direction and speed, sea surface temperature, air temperature, relative humidity, precipitation, atmospheric pressure, significant wave height.

(5) Data archives

These meteorological data will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC just after the cruise.

(6) Tests for the estimation of affection by the ship body

In this cruise, we installed two humidity and temperature sensors on the backward side of R/V KAIYO in addition to two sensors on the forward side. The backward sensors were installed to acquire humidity and air temperature which were expected not to be affected by the hull, in case that the wind blew from the stern. We made the averaged data set with our post-process program on the basis of the result of KY09-01 cruise. This program select the windward side for better data of air- temperature and humidity.

To test the affection by the hull, we measured the meteorological data by changing relative wind direction in 0, 45, 90, 135, 180, 225, 270 and 315 degrees in 9th, 11th and 14th November. During these tests, R/V KAIYO also stayed near m-TRITON buoy, so that we could also compare the data observed by R/V KAIYO with it by the buoys.

Figure 5.1.1-2 and figure 5.1.1-4 show tracks of R/V KAIYO and m-TRITON buoy during the tests. Figure 5.1.1-3, figure 5.1.1-5 and figure 5.1.1-6 show the time series of the averaged meteorological data of R/V KAIYO and m-TRITON buoys. These data were corrected to 10m altitude from sea surface. In these figures, data from backward sensors were plotted only when relative wind direction was 180±15 degree. Figure 5.1.1-6 shows data of R/V KAIYO only because we could not get the data of TR17 buoy due to the trouble.

Every kind of data from R/V KAIYO and buoys seem to be fairly consistent. After the cruise, we will calibrate the individual sensors and analyze the observed data in detail with its results.

Table.5.1.1-1 Instruments and installation locations of Meteorological sensors

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	05106	R.M. Young, USA	Radar mast (27m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	Compass deck (16m)
	HMP155	Vaisala, Finland	
with PVC-04 aspirated radiation shield		Plede, Japan	Working deck (8m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	Radar mast (24 m)
Rain gauge	50202	R.M. Young, USA	Radar mast (26 m) Compass deck (16m)

Table.5.1.1-2 Recording parameters of SCS

Parameter	Units	Remarks
1 Latitude	degree	
2 Longitude	degree	
3 LOG speed	knot	
4 Gyro heading	degree	
5 Speed Over Ground	knot	
6 Course Over Ground	degree	
7 Relative wind speed	m/s	
8 Relative wind direction	degree	
9 Barometric pressure	hPa	
10 Air temperature	degC	
11 Relative humidity	%	
12 Precipitation	mm	reset at 50 mm
13 Wave height	m	
14 Wave encounter period	second	

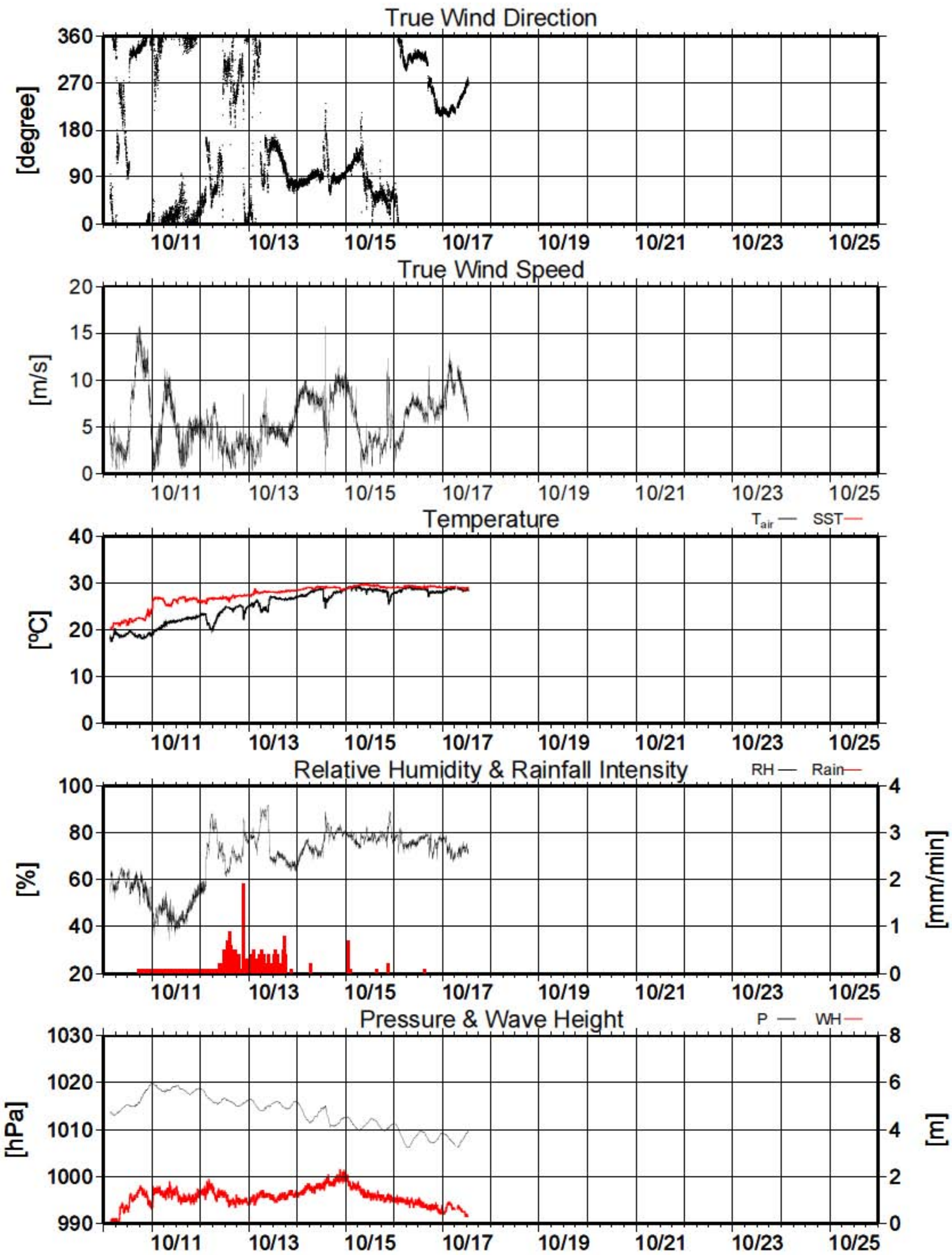

Fig.5.1.1-1 Time series of surface meteorological parameters during the KY09-09 cruise (1st): True Wind Direction, (2nd) :True Wind Speed, (3rd): Air temperature[Black] and Sea Suface Temperature[Red], (4th): Relative Humdity[Black] and Rainfall I ntensity[Red] and (5th) Air Pressure[Black] and Significant Wave Height[Red]

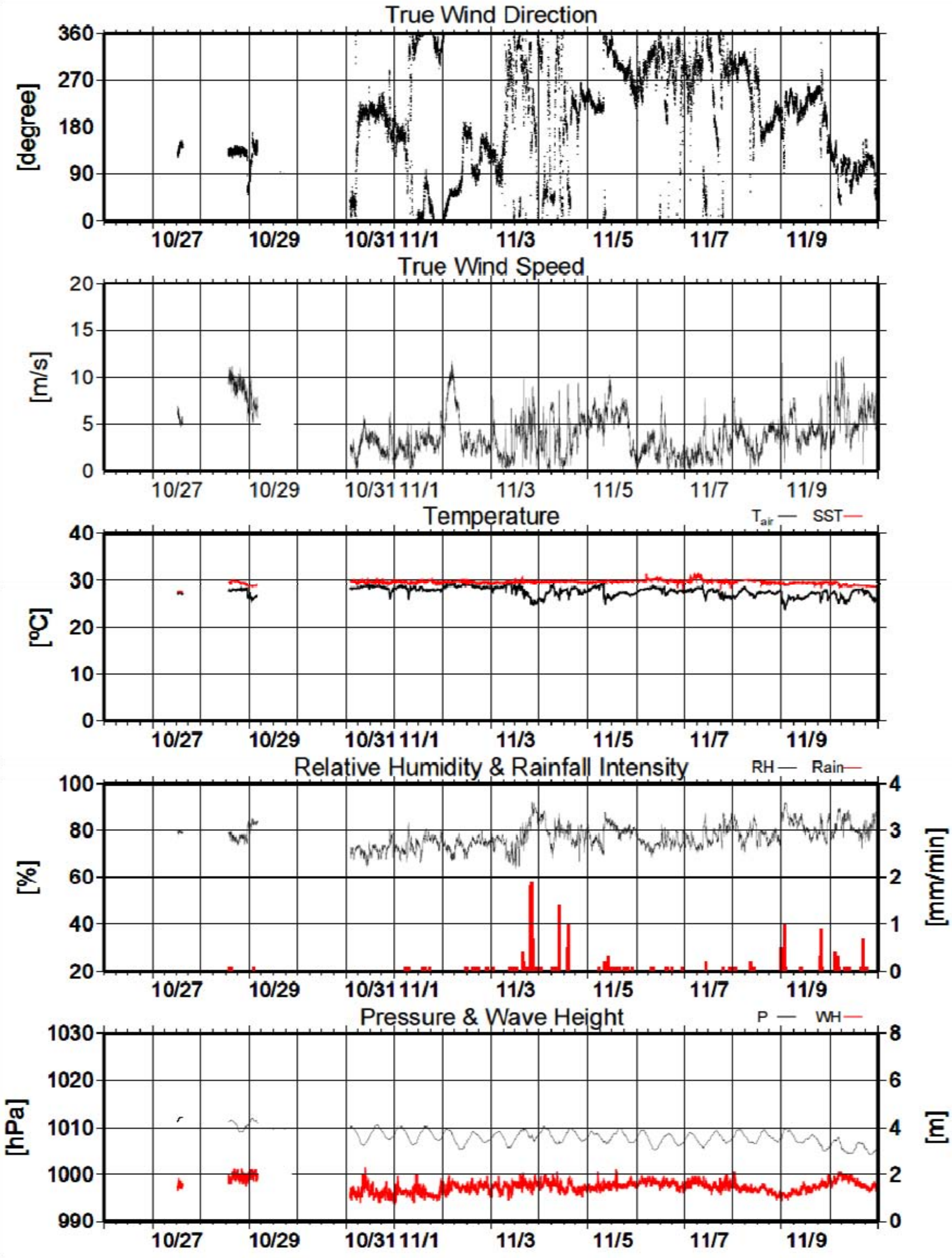

Fig.5.1.1-1 (Continued)

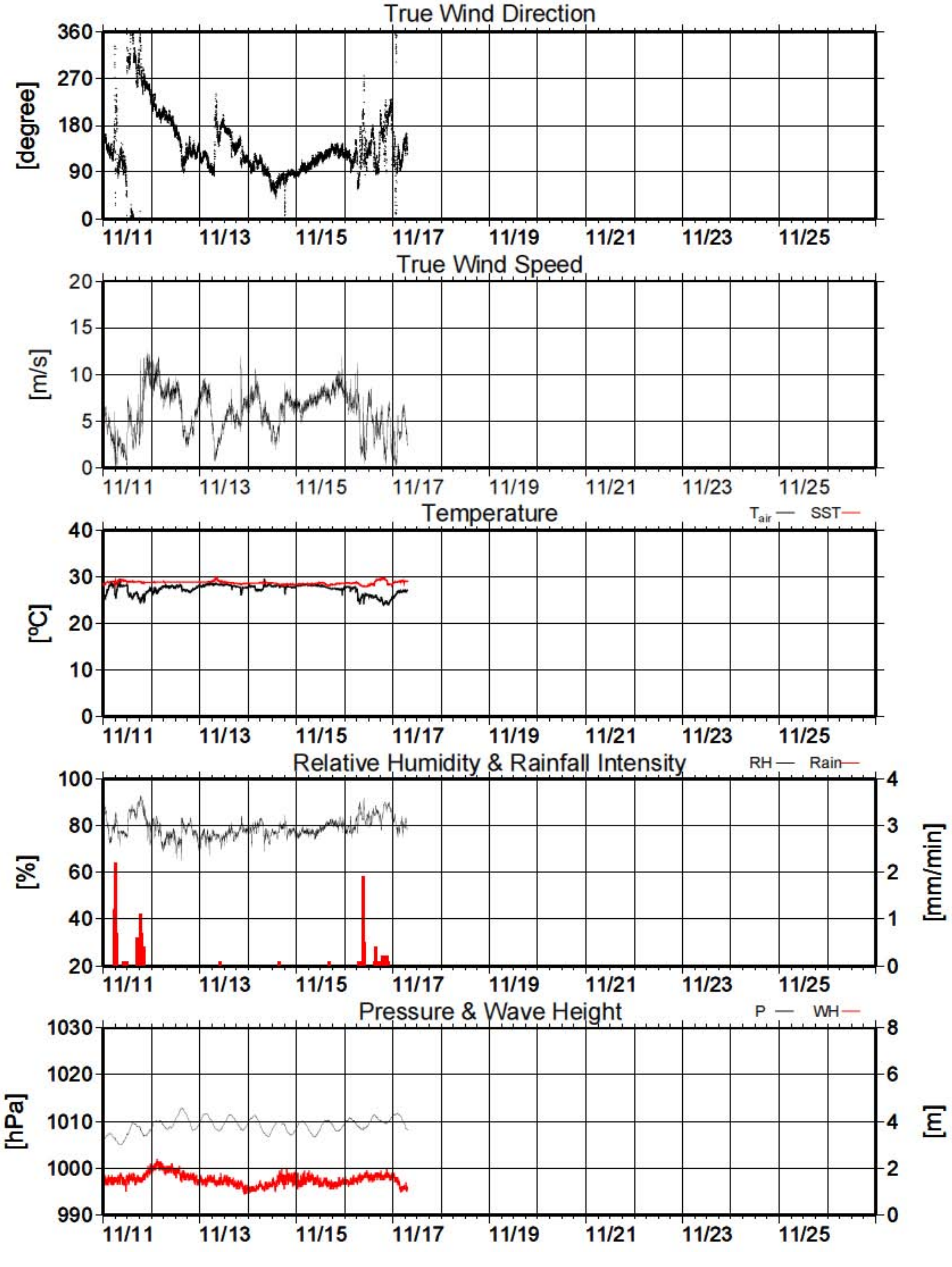

Fig.5.1.1-1 (Continued)

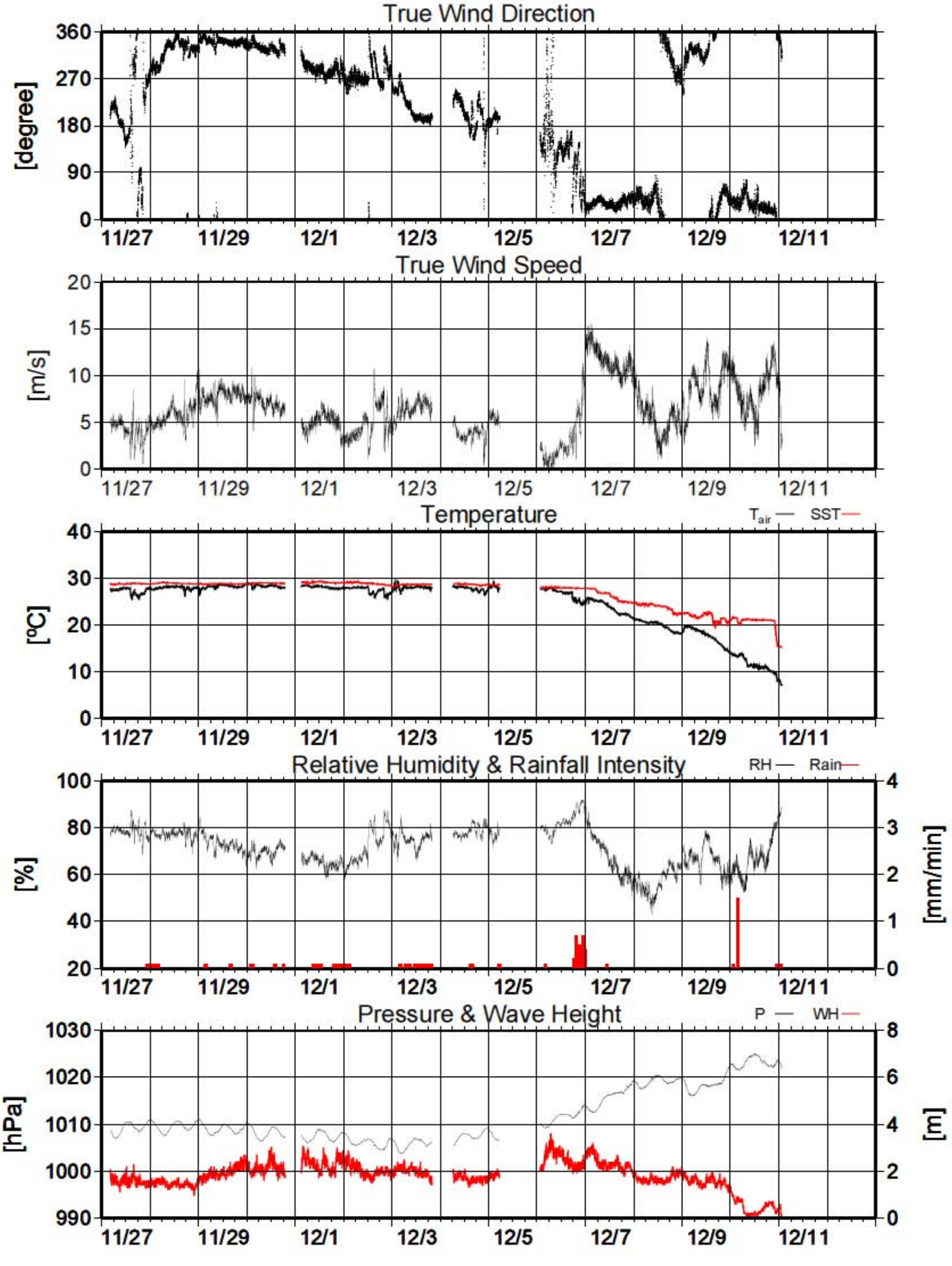

Fig.5.1.1-1 (Continued)

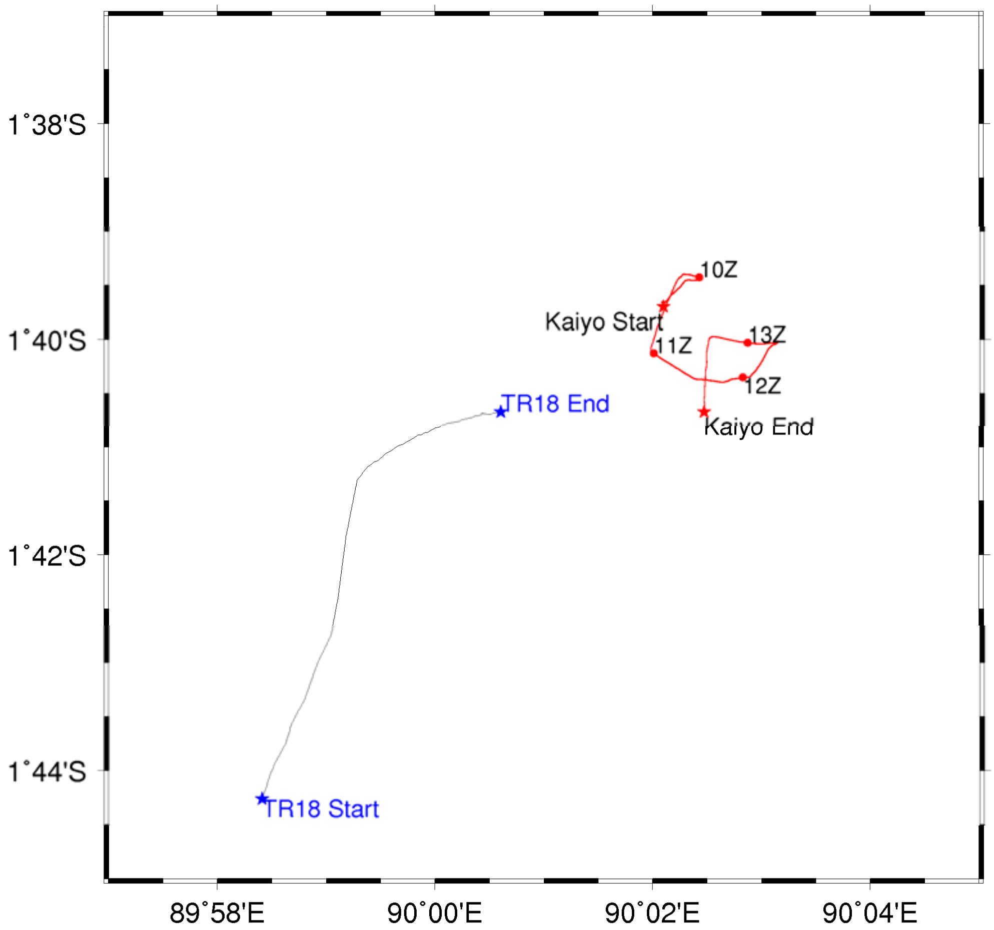

Fig.5.1.1-2 Tracks of R/V KAIYO (Red) and m-TRITON buoy (TR18;Blue) in 09th November.

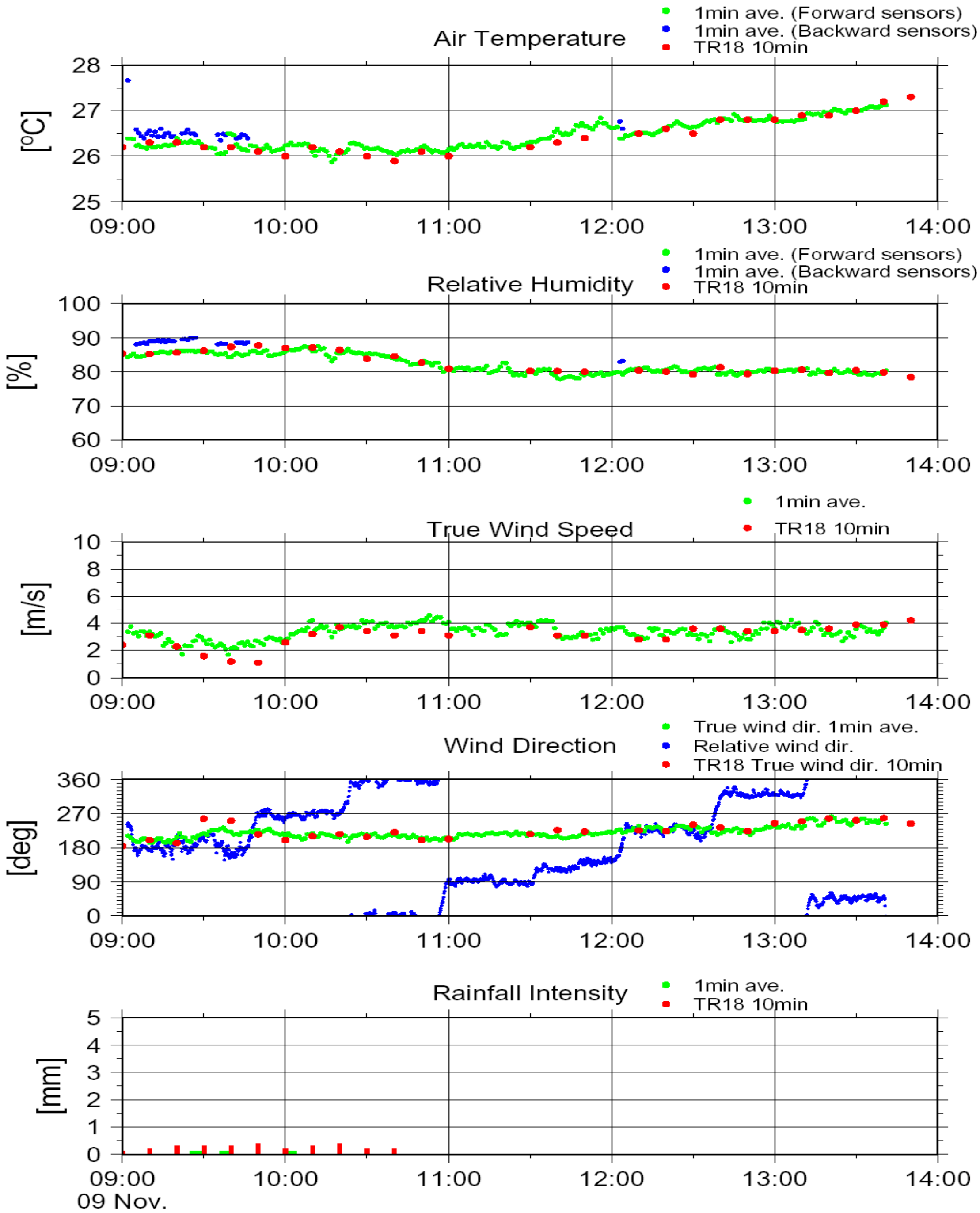

Fig.5.1.1-3 Meteorological data of R/V KAIYO and m-TRITON buoy (TR18; 09th Nov.)

(1st): Air temperature observed by the forward sensors of R/V KAIYO [Green], by the backward sensors of R/V KAIYO[Blue] and TR18 [Red],

(2nd) : Relative humidity observed by the forward sensors of R/V KAIYO [Green], by the backward sensors of R/V KAIYO [Blue] and TR18 [Red],

(3rd): True wind speed of R/V KAIYO [Green] and TR18 [Red]

(4th): True wind direction of R/V KAIYO [Green], Relative wind direction of R/V KAIYO [Blue], and True wind direction of TR18 [Red]

(5th): Rainfall intensity of R/V KAIYO [Green] and TR18[Red].

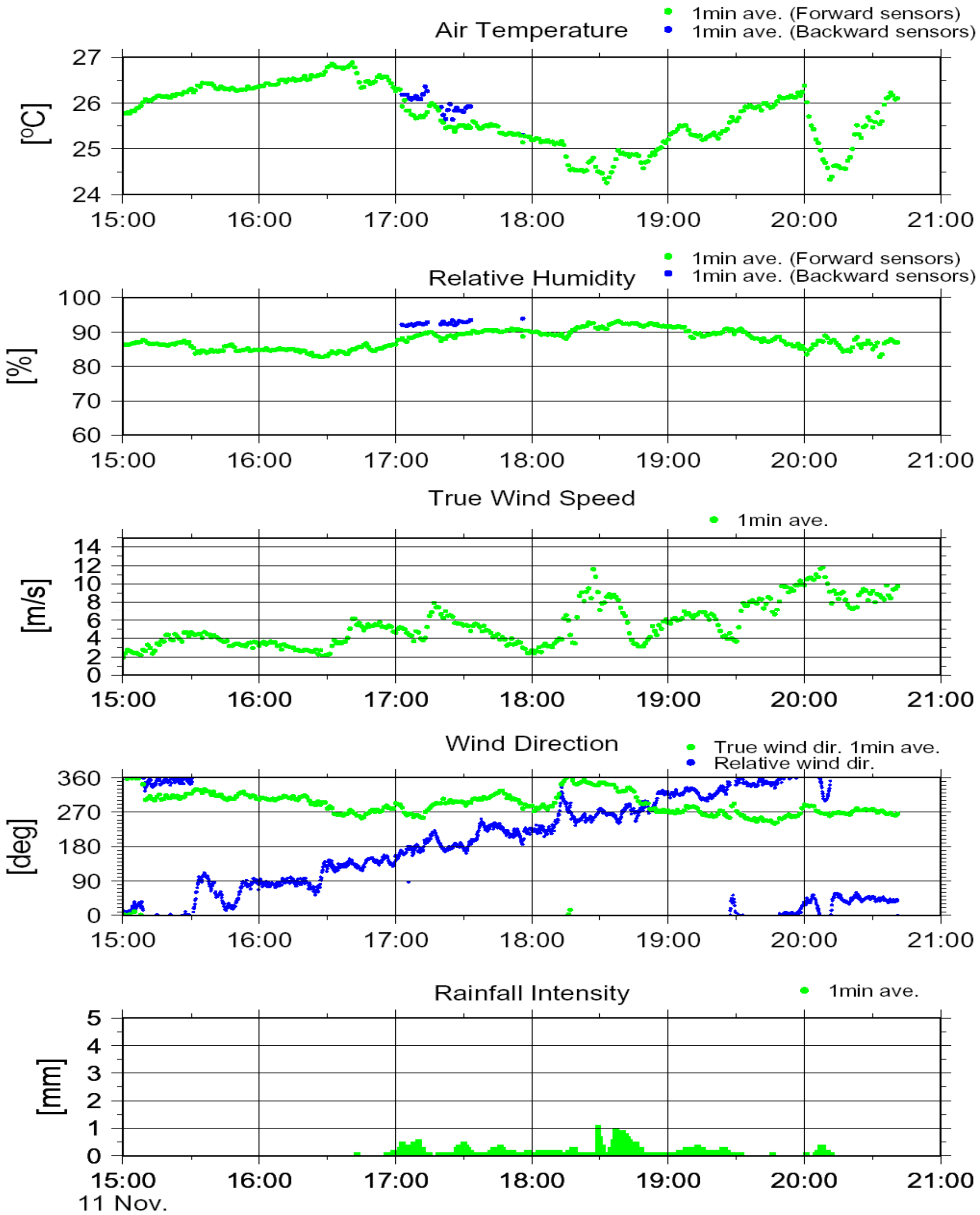

Fig.5.1.1-4 Meteorological data of R/V KAIYO (11th Nov.)

(1st): Air temperature observed by the forward sensors of R/V KAIYO [Green] and by the backward sensors [Blue],

(2nd): Relative Humidity observed by the forward sensors of R/V KAIYO [Green], by the backward sensors [Blue] ,

(3rd): True wind speed of R/V KAIYO [Green]

(4th): True wind direction of R/V KAIYO [Green] and Relative wind direction of R/V KAIYO [Blue],

(5th): Rainfall intensity of R/V KAIYO [Green]

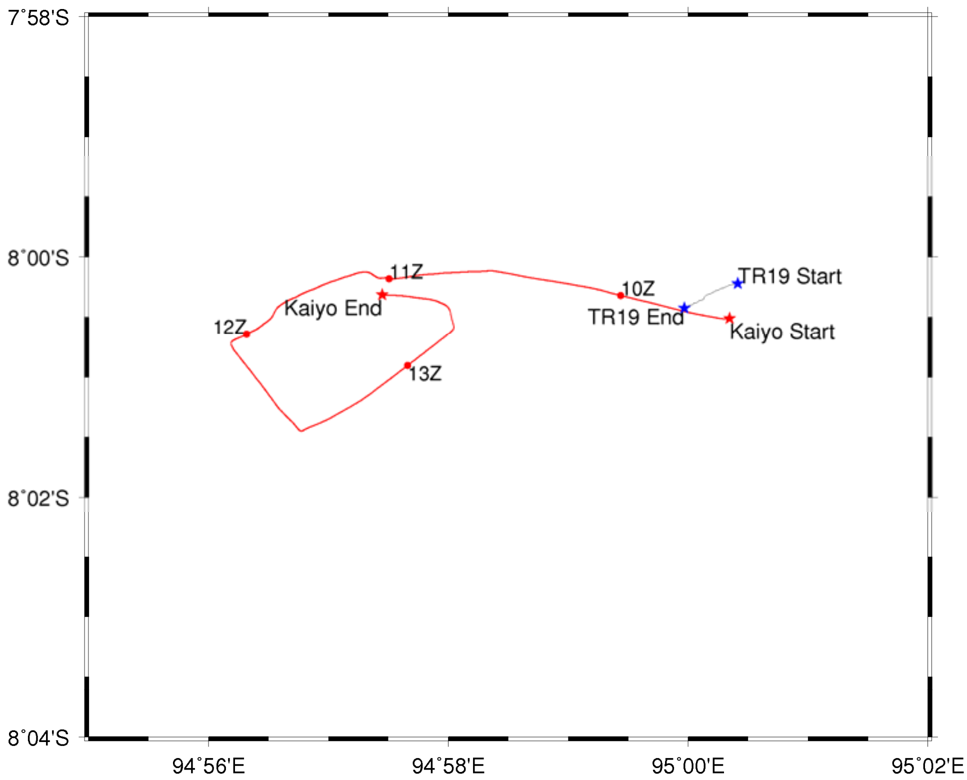

Fig.5.1.1-5 Tracks of R/V KAIYO (Red) and m-TRITON buoy (TR19;Blue) in 14th November

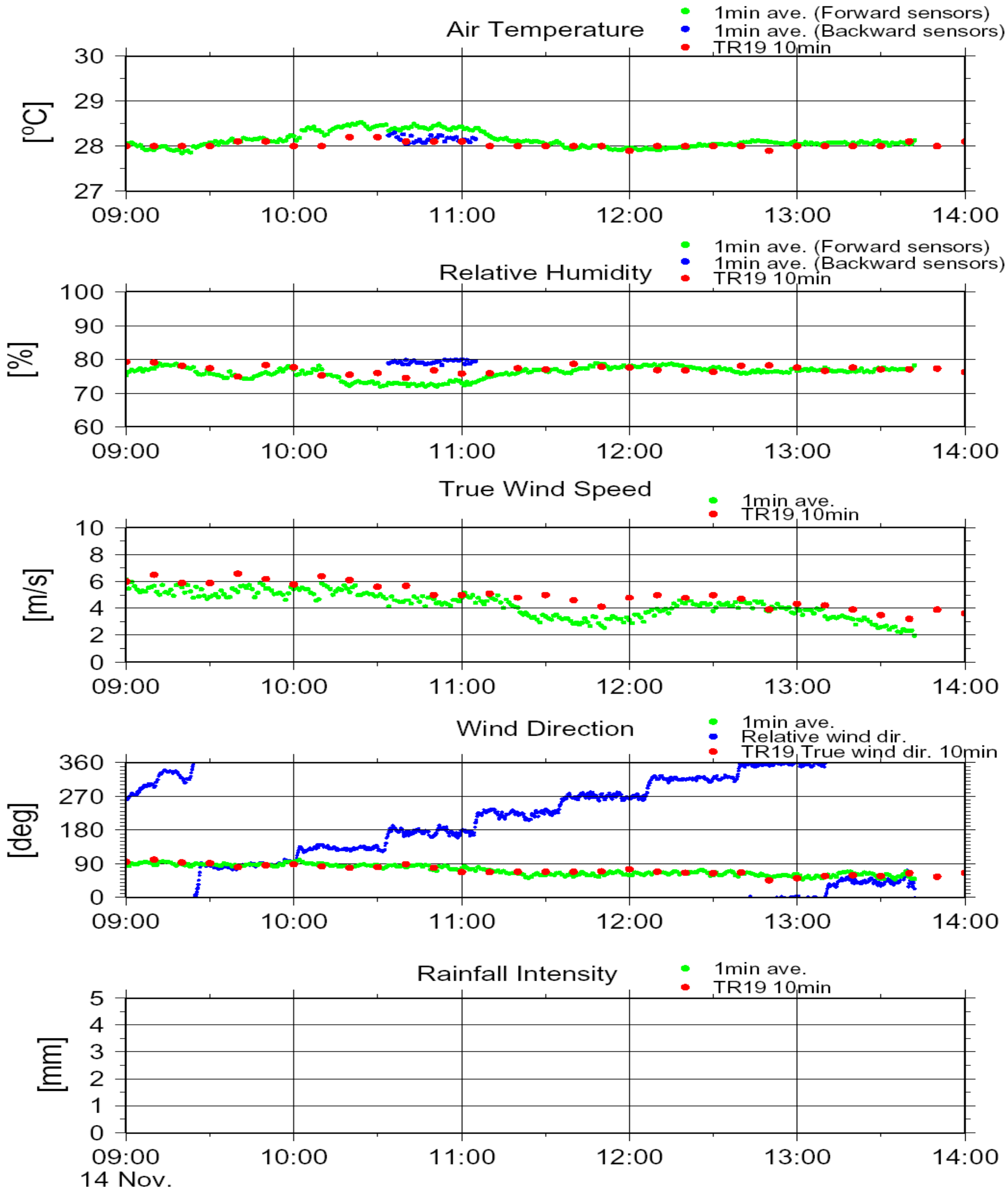

Fig.5.1.1-6 Meteorological data of R/V KAIYO and m-TRITON buoy (TR19; 14th Nov.)

(1st): Air temperature observed by the forward sensors of R/V KAIYO [Green], by the backward sensors of R/V KAIYO [Blue] and TR19 [Red],

(2nd) : Relative humidity observed by the forward sensors of R/V KAIYO [Green], by the backward sensors of R/V KAIYO [Blue] and TR19 [Red],

(3rd): True wind speed of R/V KAIYO [Green] and TR19 [Red]

(4th): True wind direction of R/V KAIYO [Green], Relative wind direction of R/V KAIYO [Blue], and True wind direction of TR19 [[Red]

(5th): Rainfall intensity of R/V KAIYO [Green] and TR19[Red].

5.1.2 SSST by SeaSnake

(1) Personnel

Kentaro Ando	(JAMSTEC) :Principal Investigator
Kazuho Yoshida	(Global Ocean Development Inc., GODI)
Norio Nagahama	(GODI)

(2) Objective

The sea surface temperature (SST) is an important parameter for air-sea interaction. However, measuring “true” surface temperature using the ship’s SST sensor has a difficulty that the sensor position is located 6 meter under the sea surface. The “close-to-true” sea surface temperature (called Skin Sea Surface Temperature) measurement was carried out using a special floating temperature sensor during the cruise.

(3) Methods

To measure the skin sea surface temperature (SSST), the SeaSnake SSST-meter which is the floating thermistor was deployed from the bow. In this cruise, SSST was observed using two thermistors (107 Campbell, USA) and measured output voltage every 10 seconds until 15th October and every 6th seconds since 6th November. We converted sensor output voltage to SSST by using Steinhart-Hart equation led by the calibration data. Each coefficient is as below.

Sensor	a	b	c
KYSSST-31 :	9.545140E-04	-1.926143E-04	-1.195264E-07
KYSSST-32 :	9.408092E-04	-1.945149E-04	-1.142926E-07
KYSSST-41 :	7.570188E-04	-2.181924E-04	-5.549276E-08
KYSSST-42 :	8.161734E-04	-2.103629E-04	-7.592083E-08

Equation

y = a + b * x + c * x3,

x = log (1 / ((Vref / V - 1) * R2 - R1))

T = 1 / y - 273.15

Vref = 2500[mV], R1=249000[Ω], R2=1000[Ω]

T: Temperature [degC], V: Sensor output voltage [mV]

(4) Preliminary results

Fig. 5.1.2-1 to Fig. 5.1.2-3 shows the time series of skin sea surface temperature. SSST was plotted using the data of KYSSST-41 and KYSSST-42 thermistors until 15th November, and KYSSST-31 and KYSSST-32 thermistors since 8th December.

(5) Data archives

These data will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC just after the cruise.

(6) Remarks

1. SSST (Skin Sea Surface Temperature) data were available in the following periods.
   06:30UTC 11 Oct. 2009 – 09:08UTC 15 Oct. 2009
   05:14UTC 06 Nov. 2009 – 17:28UTC 15 Nov. 2009
   05:33UTC 07 Dec. 2009 – 21:30UTC 10 Dec. 2009

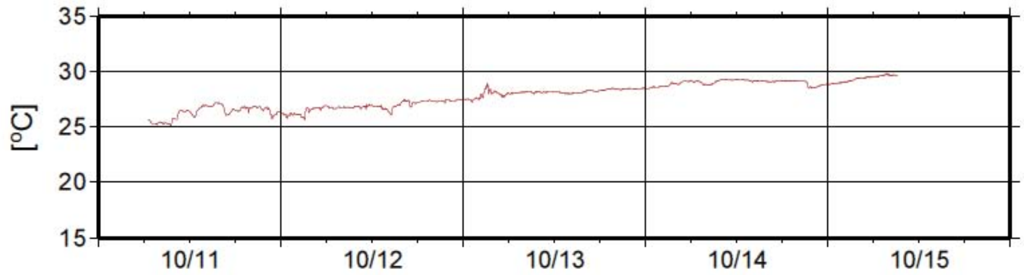

Fig 5.1.2-1 Time series of SSST during KY09-09 (Yokosuka to Bali)
(Black: KYSSST-41, Red: KYSSST-42)

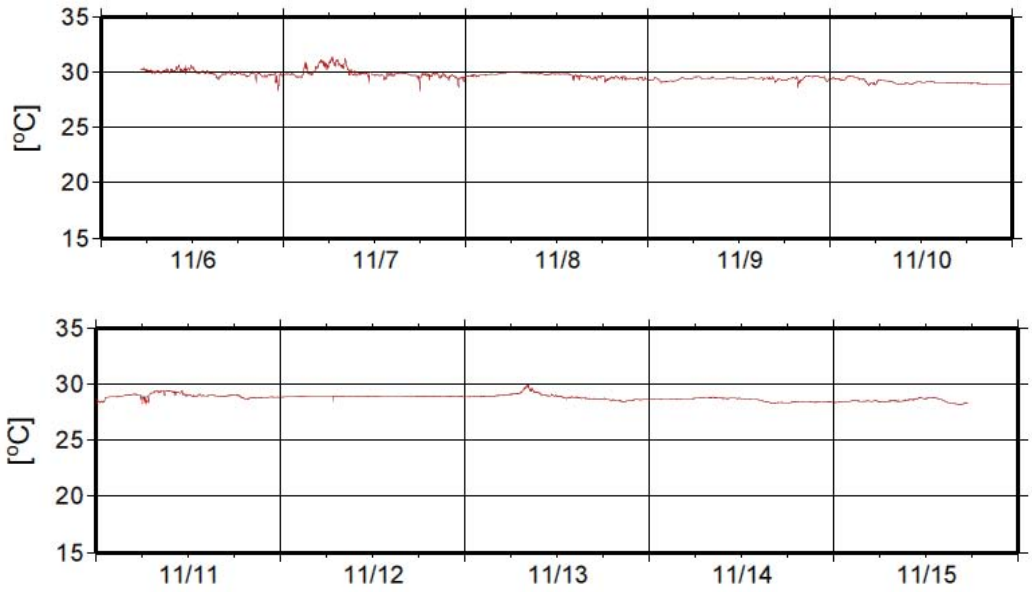

Fig 5.1.2-2 Time series of SSST during KY09-09 (Bali to Bali)
(Black: KYSSST-41, Red: KYSSST-42)

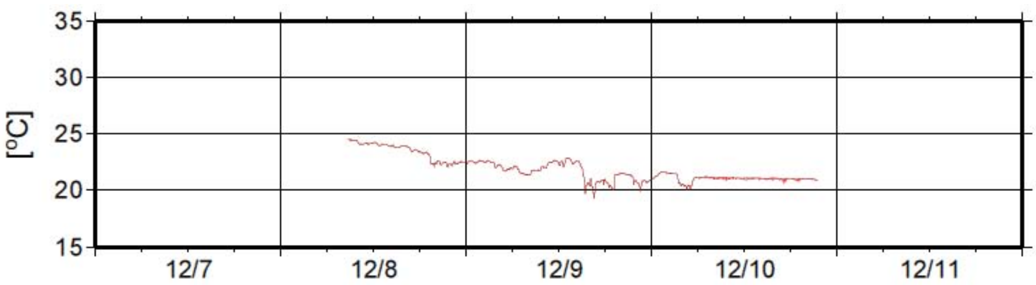

Fig 5.1.2-3 Time series of SSST during KY09-09 (Bali to Yokosuka)
(Black: KYSSST-31, Red: KYSSST-32)

5.2.1. CTD measurements

(1) Personnel

Kentaro Ando	(JAMSTEC) : Principal investigator
Kenichi Katayama	(MWJ) : Operation leader
Satoshi Ozawa	(MWJ)

(2) Objectives

Investigation of oceanic structure and water sampling.

(3) Overview of the equipment and observation

CTD/Carousel water sampling system (CTD system), which is 12-position Carousel Water Sampler (SBE 32) with SBE 9plus (Sea-Bird Electronics Inc.), was used during this cruise. 5-litre Niskin bottles were used for sampling seawater. The sensors attached on the CTD were temperature (Primary and Secondary), conductivity (Primary and Secondary), and pressure. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD system was deployed from aft decks by using winch system. During this cruise, 6 casts of CTD observation were carried out (see Table 5.2.1).

(4) List of sensors and equipments

Under water unit: SBE, Inc., SBE 9plus, S/N 09P5457-0240

Temperature sensor:	SBE, Inc., SBE 03-02/F, S/N 031523 (Primary)
Temperature sensor:	SBE, Inc., SBE 03-02/F, S/N 031207 (Secondary)
Conductivity sensor:	SBE, Inc., SBE 04-02/0, S/N 041148 (Primary)
Conductivity sensor:	SBE, Inc., SBE 04-02/0, S/N 040960 (Secondary)
Pump:	SBE, Inc., SBE 5T, S/N 050847 (Primary)
Pump:	SBE, Inc., SBE 5T, S/N 050863 (Secondary)
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P39850-0705
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3252859-0696
Water sample bottle:	General Oceanics, Inc., 5-litre Niskin

(5) Data processing

The SEASOFT-Win32 (Ver. 7.18d) 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, 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.

BOTTLESUM 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 and descent rate were averaged over 3.0 seconds. And primary salinity, primary sigma-theta, primary potential temperature, secondary salinity, secondary sigma-theta and secondary potential temperature were computed.

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, 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).

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.

(6) Preliminary Results

Date, time and locations of the CTD casts are listed in Table 5.2.1. Vertical profile (down cast) of primary temperature and primary salinity with pressure are shown in Figure 5.2.1.

(7) Data archive

All raw and processed data files will be submitted to JAMSTEC Data Integration and Analyses Group (DIAG) and corrected datasets will be available from Mirai Web site at http://www.jamstec.go.jp/mirai/.

Table 5.2.1 CTD Cast Table

Stn.	Cast	Date(UTC)	Time(UTC)		Bottom Position		Depth	Wire	Max	Max	CTD	Remarks
		mmddyy	Start	End	Latitude	Longitude	(MNB)	Out	Depth	Pressure	File name	
T01	1	110609	04:04	04:48	02-09.97N	092-09.50E	4279.0	2004.0	2003.3	2024.1	T01S01	Test cast, SBE32 carousel test
C01	1	110809	12:32	12:58	00-01.78N	090-03.36E	4439.0	1010.0	1000.3	1008.2	C01S01	ADCP deploy & recovery
C02	1	110909	07:27	07:53	01-41.75S	089-59.00E	4595.0	1030.0	1000.7	1008.6	C02S01	m-TRITON deploy
C03	1	111109	07:29	07:53	04-59.12S	094-59.67E	5000.0	1005.0	1000.2	1007.8	C03S01	m-TRITON deploy
C04	1	111109	08:55	09:20	05-03.00S	094-56.33E	5012.0	1023.0	1001.5	1009.3	C04S01	m-TRITON recovery
C05	1	111409	08:30	08:54	07-59.56S	095-00.63E	5205.0	1003.0	1000.7	1009.3	C05S01	m-TRITON deploy

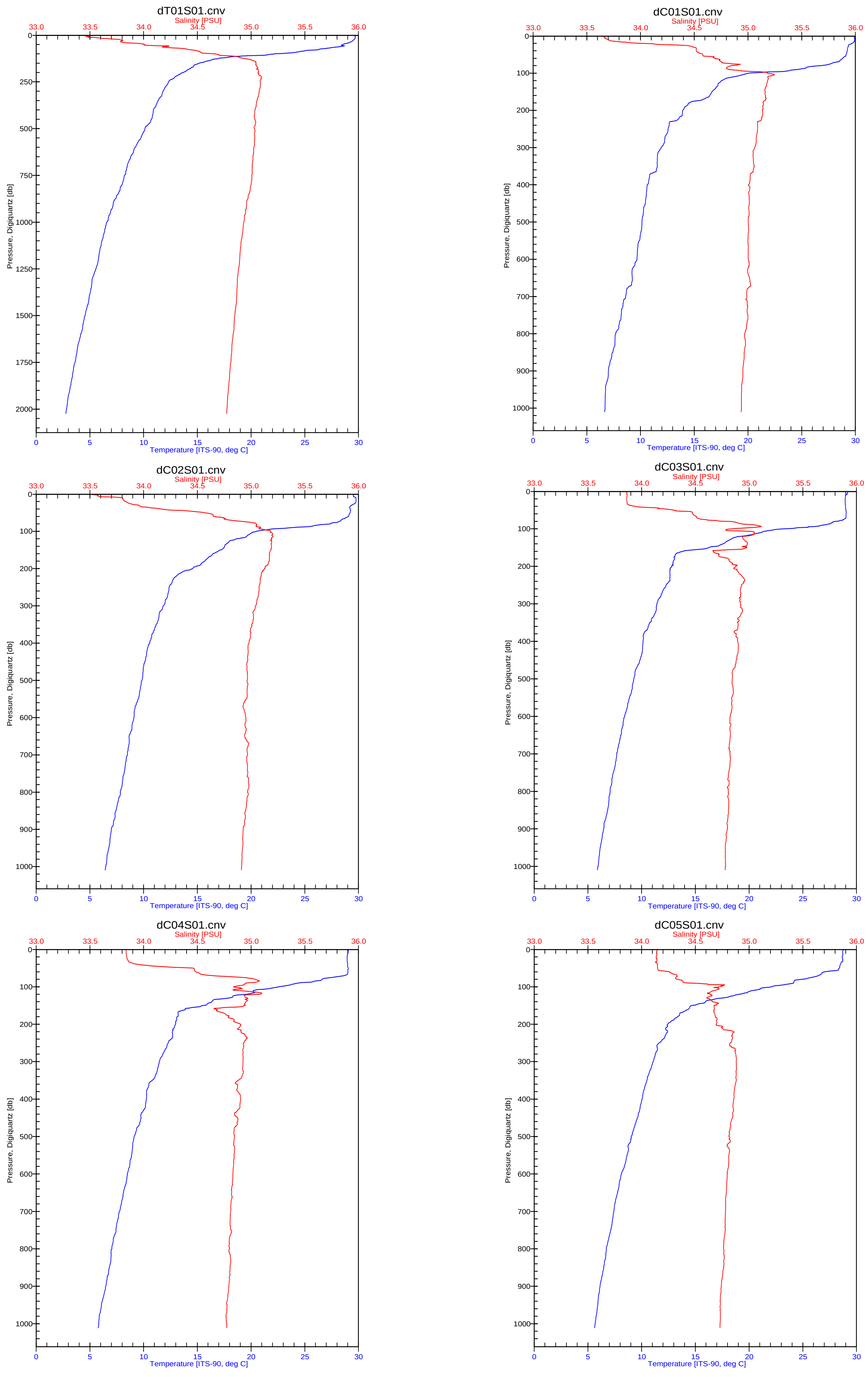

Figure 5.2.1 CTD profile

(T01S01, C01S01, C02S01, C03S01, C04S01, and C05S01)

5.2.1.1 Inter-comparison with m-TRITON data

(1) Personnel

Kentaro Ando (JAMSTEC): Principal Investigator
Tatsuya Fukuda (JAMSTEC):Buoy Engineer
Hiroshi Matsunaga (MWJ): Operation Leader
Kenichi Katayama (MWJ): Technical staff

(2) Objectives

m-TRITON CTD data validation

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

m-TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We conducted CTD cast at the m-TRITON buoy position before recovery and after deployment. For comparision, R/V KAIYO kept the distance from the m-TRITON buoy within about 2 nm. We compared CTD observation by R/V KAIYO data with m- TRITON buoy data.

Compared site

Observation No.	Latitude	Longitude	Condition
18504	1.5S	90E	After Deployment
19501	8S	95E	After Deployment
17502	5S	95E	Before Recover

(5) Results

Difference between m-TRITON buoy data and CTD data is shown figure from Fig.5.2.1.1(a) to Fig.5.2.1.1(d)

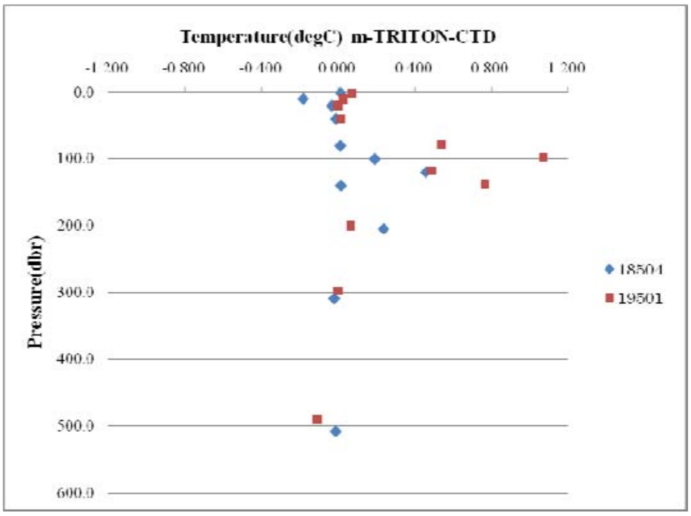

Fig.5.2.1.1(a) Temperature difference between m-TRITON buoy(18504,19501) data and CTD data after deployment

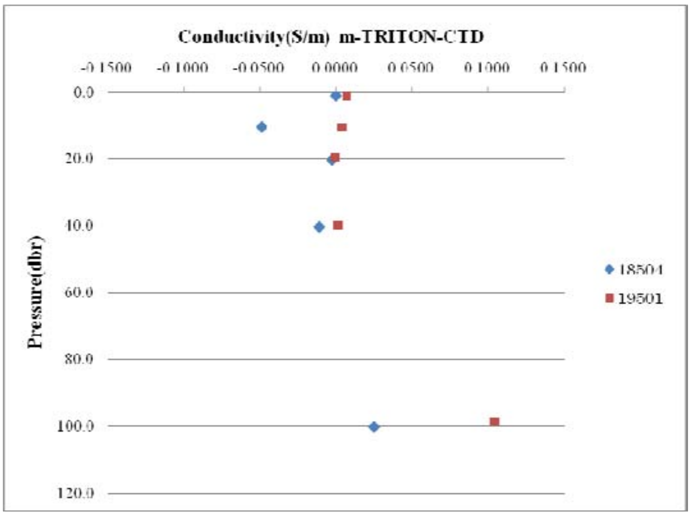

Fig.5.2.1.1(b) Conductivity difference between m-TRITON buoy(18504,19501) data and CTD data after deployment

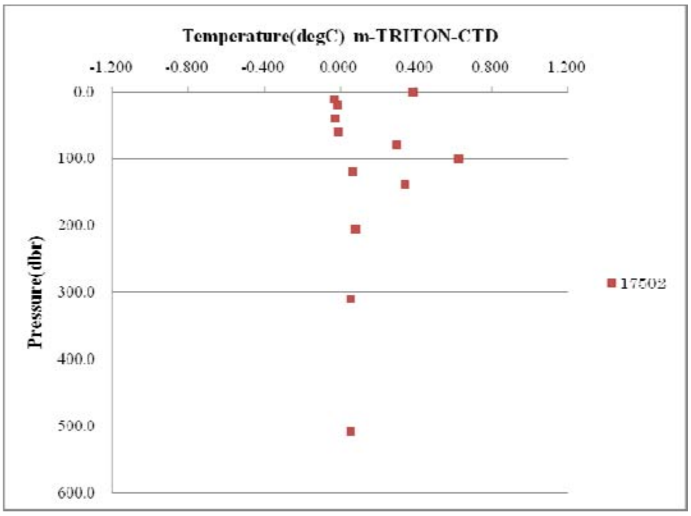

Fig.5.2.1.1(c) Temperature difference between m-TRITON buoy(17502) data and CTD data before Recovery.

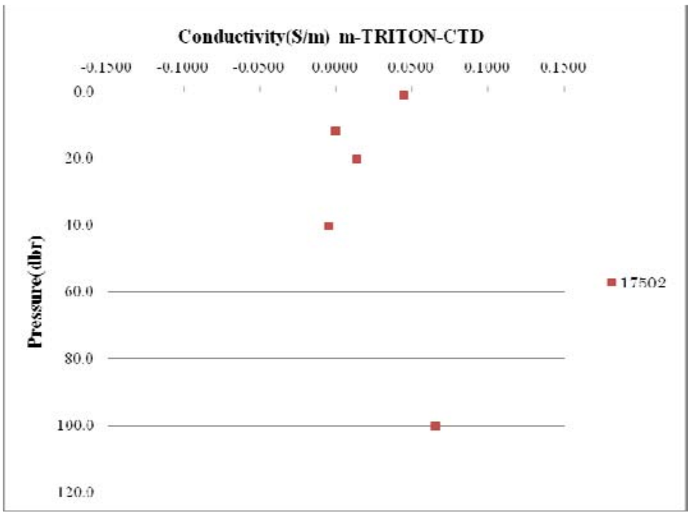

Fig.5.2.1.1(d) Conductivity difference between m-TRITON buoy(17502) data and CTD data before recovery.

(6) Data archive

The data in the interval of 10 minutes were transmitted via ARGOS satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters. And the data will be distributed world wide through internet from the JAMSTEC web site (http://www.jamstec.go.jp/).

5.2.2 XCTD/XBT

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator
Tatsuya Fukuda	(JAMSTEC) Buoy Engineer
Hiroki Ushiromura	(MWJ) Operation Leader
Hiroshi Matsunaga	(MWJ)
Satoshi Ozawa	(MWJ)
Kenichi Katayama	(MWJ)
Takami Mori	(MWJ)
Yoshiki Kido	(MWJ)
Kazuho Yoshida	(GODI)

(2) Objectives

Investigation of oceanic structure

(3) Methods

We observed oceanic structure for sea water temperature and salinity by using XCTD/XBT profiling system TS-MK-130L (The Tsurumi Seiki Co, Ltd: TSK) which is made up of a digital converter (TS-MK-130), a personal computer for data acquisition, a hand-held launcher (LM-3A), and probes (XCTD-1 and XBT T-7) on R/V KAIYO during KY09-09 Leg2 cruise.

The specifications of the XCTD/XBT system and probes are shown as follows ;

XCTD (Model XCTD-1)

Maximum Depth	: 1000m
Ship Speed	: 12 knots
Range	: Temperature: -2 to +35 deg C
	: Conductivity: 0 to 60 mS/ cm
Resolution	: Temperature: 0.01 deg C
	: Conductivity: 0.015 mS/ cm
Accuracy	: Temperature: ±0.02 deg C
	: Conductivity: ±0.03 mS/ cm

XBT (Model T-7)

Maximum Depth	: 760m
Ship Speed	: 15 knots
Range	: Temperature: -2 to +35 deg C
Resolution	: Temperature: 0.01 deg C
Accuracy	: Temperature: ±0.2 deg C

* XCTD (eXpendable Conductivity, Temperature, and Depth probe)
XBT (eXpendable Bathy Thermograph)

(4) Preliminary results

Date, time, locations, and other information for the XCTD/XBT observations are listed in Table 5.2.2-1 and Temperature Sections are shown in Fig.5.2.2-1~5.

(5) Data archives

These data will be submitted to Data Integration and Analyses Group (DIAG) of JAMSTEC just after the cruise.

Table 5.2.2-1 KY09-09 Leg2 XCTD/XBT Observation Log

Probe Type	Date (UTC)	Time (UTC)	Latitude	Longitude	File Name	Probe S/N	Remarks
XCTD	2009/11/7	08:20:41	01-33.6568S	090-02.8769E	CTD-004820091107	09074868	
XCTD	2009/11/8	13:07:40	00-01.8056N	090-03.6204E	CTD-004920091108	09074869	
XBT	2009/11/8	13:17:13	00-00.3461N	090-03.5484E	BT-001720091108	069991	
XCTD	2009/11/9	08:02:31	01-41.8376S	089-59.1113E	CTD-005020091109	09074870	
XBT	2009/11/9	08:10:34	01-41.7169S	089-59.2991E	BT-001820091109	069992	
XCTD	2009/11/9	17:33:15	02-00.0147S	090-28.2635E	CTD-005120091109	09074871	
XBT	2009/11/9	17:41:25	02-00.8015S	090-29.4319E	BT-001920091109	069993	
XBT	2009/11/9	21:51:15	02-29.8279S	091-12.7222E	BT-002020091109	069996	
XCTD	2009/11/10	02:18:49	03-00.0626S	091-57.4513E	CTD-005220091110	09074872	
XBT	2009/11/10	02:26:08	03-00.7501S	091-58.5220E	BT-002120091110	069995	
XBT	2009/11/10	06:54:04	03-30.0057S	092-42.4562E	BT-002220091110	069994	
XCTD	2009/11/10	11:33:06	04-00.0156S	093-26.7950E	CTD-005320091110	09074873	
XBT	2009/11/10	11:40:45	04-00.6904S	093-27.7313E	BT-002320091110	069997	
XBT	2009/11/10	16:08:38	04-29.9888S	094-11.5464E	BT-002420091110	069998	
XCTD	2009/11/11	07:58:46	04-58.9847S	094-59.5893E	CTD-005420091111	09074874	
XBT	2009/11/11	08:06:15	04-58.6735S	094-59.1326E	BT-002620091111	069999	
XBT	2009/11/13	10:43:17	05-30.0208S	094-59.1321E	BT-002720091113	070000	
XCTD	2009/11/13	13:39:11	06-00.0142S	094-59.8627E	CTD-005520091113	09074875	
XBT	2009/11/13	13:46:34	06-01.2706S	094-59.8904E	BT-002820091113	070001	
XCTD	2009/11/14	08:59:21	07-59.6986S	095-00.4918E	CTD-005620091114	09074876	
XBT	2009/11/14	09:06:44	07-59.9427S	095-00.2893E	BT-003020091114	070002	

Table 5.2.2-1 KY09-09 Leg2 XCTD/XBT Observation Log (continued)

Probe Type	Date (UTC)	Time (UTC)	Latitude	Longitude	File Name	Probe S/N	Remarks
XBT	2009/11/14	23:56:48	07-58.5066S	096-45.3700E	BT-003120091114	070005	
XCTD	2009/11/15	01:14:57	07-58.4044S	097-00.0230E	CTD-005720091115	09074879	
XBT	2009/11/15	01:22:14	07-58.3915S	097-01.2147E	BT-003220091115	070003	
XBT	2009/11/15	03:56:40	07-57.9942S	097-30.0093E	BT-003320091115	070004	
XCTD	2009/11/15	06:42:12	07-57.5535S	098-00.0341E	CTD-005820091115	09074878	
XBT	2009/11/15	06:49:06	07-57.5011S	098-01.2776E	BT-003420091115	070006	
XBT	2009/11/15	09:21:13	07-57.1237S	098-30.0080E	BT-003520091115	070007	
XCTD	2009/11/15	12:04:20	07-57.1945S	099-00.0116E	CTD-005920091115	09074877	
XBT	2009/11/15	12:11:30	07-57.1951S	099-01.0929E	BT-003620091115	070008	
XBT	2009/11/15	14:45:31	07-56.1684S	099-30.0246E	BT-003720091115	070009	

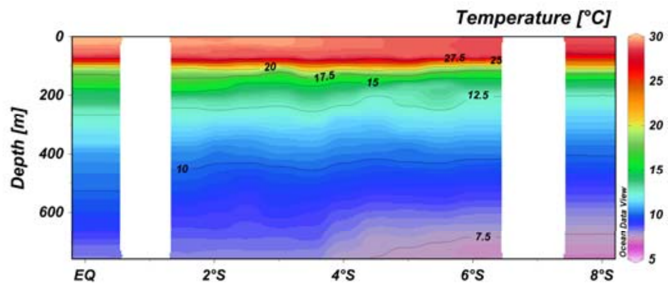

Fig.5.2.2.1 Line1 XBT temperature

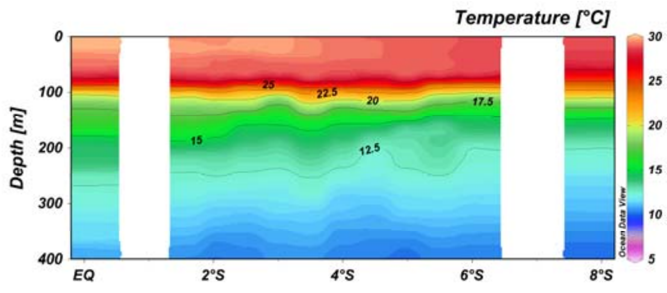

Fig.5.2.2.2 Line1 XBT temperature (above 400m)

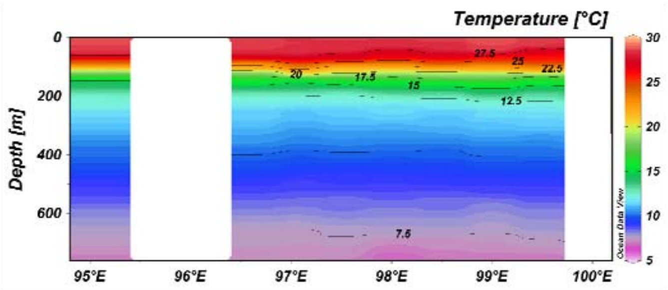

Fig.5.2.2.3. Line2 XBT temperature

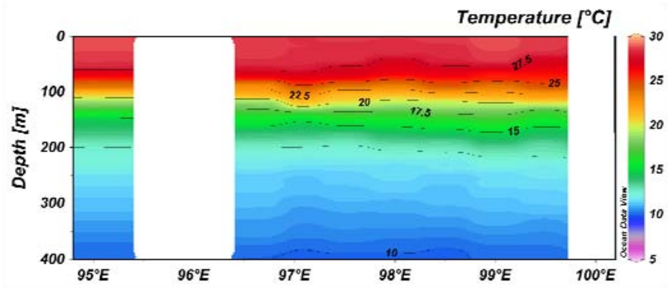

Fig.5.2.2.4 Line2 XBT temperature (above 400m)

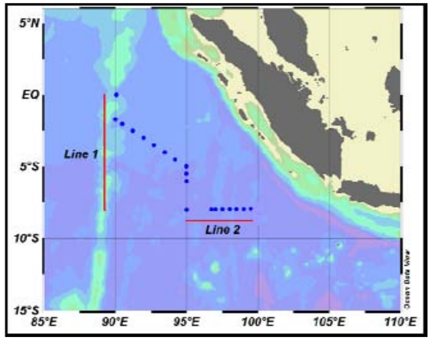

Fig.5.2.2.5 Observation map

5.3 Water sampling

5.3.1 Salinity

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator
Hiroki Ushiromura	(Marine Works Japan Ltd., MWJ)

(2) Objectives

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

(3) Methods

a. Salinity Sample Collection

Seawater samples were collected with 5 liter Niskin bottles. 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 3 days in the laboratory before the salinity measurement.

The number of samples taken are 9.

b. Instruments and Method

The salinity analysis was carried out on R/V KAIYO during the cruise of KY09-09 Leg2 using the salinometer (Model 8400B “AUTOSAL” ; Guildline Instruments Ltd.: S/N 66183 with an additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). A precision digital thermometer (Model 9540 ; Guildline Instruments Ltd.) was used to monitor a bath temperature of the salinometer. Another thermometer (Thermo Recorder TR-71U; T & D Corporation) monitored the ambient temperature during this cruise.

The specifications of the AUTOSAL salinometer and thermometers 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 deg C
Limits of error ±deg C	:	0.01 deg C (24 hours @ 23 deg C ±1 deg C)

Repeatability	:	±2 least significant digits

Thermometer (Thermo Recorder TR-71U; T & D Corporation)

Measurement Range	:	-40 to +110 deg C
Resolution	:	0.1 degC
Accuracy	:	±0.3 deg C (-20 to 80 deg C)

The measurement system was almost the same as described in 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 20 deg C to 23 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 cell was cleaned with soap after the measurement of the day.

(4) Preliminary results

a. Standard Seawater

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

batch	:	P150
conductivity ratio	:	0.99978
salinity	:	34.991
preparation date	:	22nd-May-2008

Standardization control of the salinometer was set to 408 and measurements were done at this setting during Leg2. The value of STANDBY was 5720 to 5721 and that of ZERO was 0.0+0000 to 0.0+0001. The conductivity ratio of IAPSO Standard Seawater batch P150 was 0.99978 (double conductivity ratio was 1.99956) and was used as the standard for salinity. I measured 7 bottles of P150.

Fig.5.3.1-1 shows the history of the double conductivity ratio of the Standard Seawater batch P150. The average of the double conductivity ratio was 1.99957 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity.

Fig.5.3.1-2 shows the history of the double conductivity ratio of the Standard Seawater batch P150 after correction. The average of the double conductivity ratio after correction was 1.99956 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

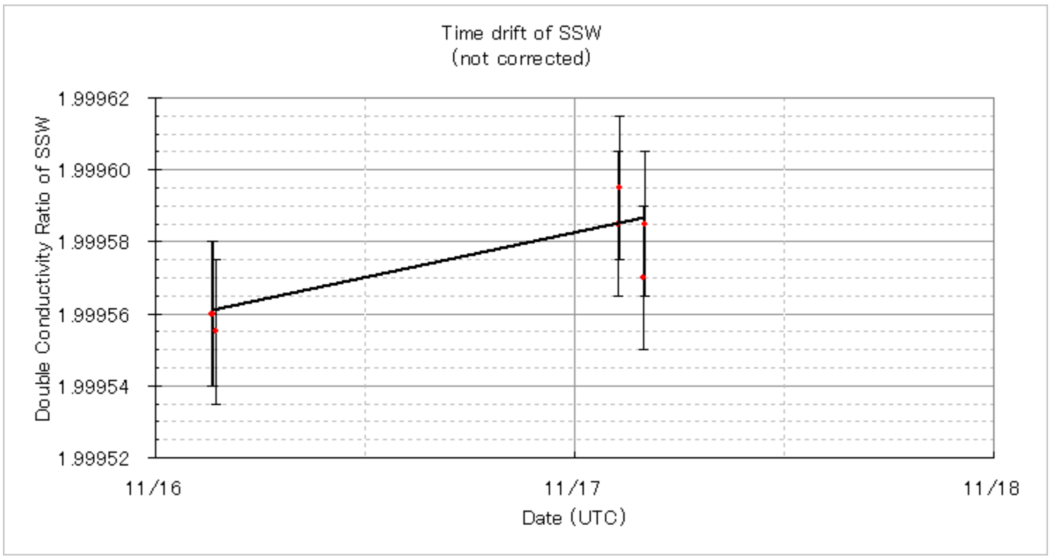

Fig. 5.3.1-1 History of double conductivity ratio for the Standard Seawater batch P150 (before correction)

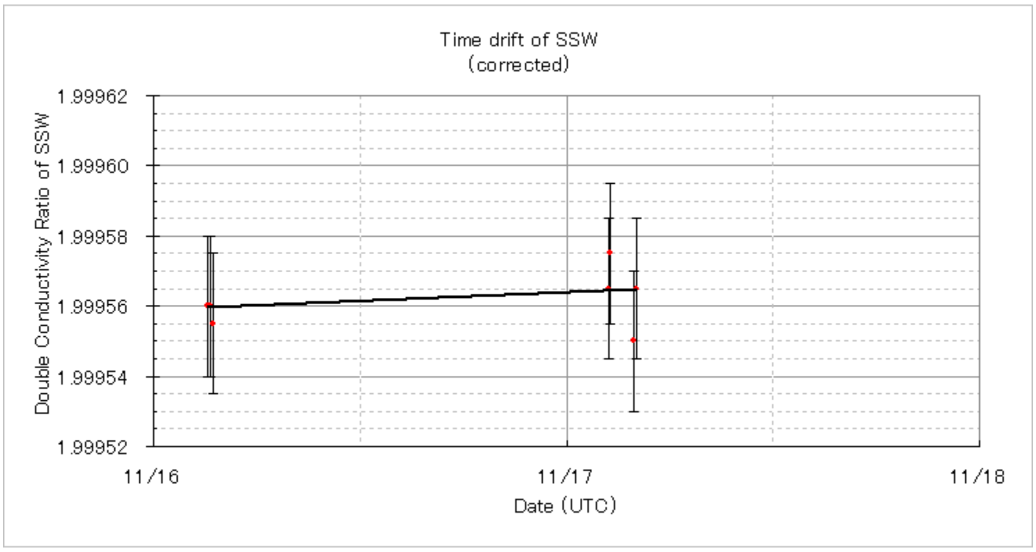

Fig. 5.3.1-2 History of double conductivity ratio for the Standard Seawater batch P150 (after correction)

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 5 samples in order to check for the possible sudden drifts of the salinometer.

c. Replicate Samples

I estimated the precision of this method using 4 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 4 pairs of replicate samples were 0.0005 and 0.0001 in salinity, respectively.

(5) Data archives

These data will be submitted to Data Integration and Analyses Group (DIAG) of JAMSTEC just after the cruise.

(6) Remarks

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

5.4 Shipboard ADCP

(1) Personnel

Kentaro Ando	(JAMSTEC) :Principal Investigator
Kazuho Yoshida	(Global Ocean Development Inc., GODI)
Norio Nagahama	(GODI)

(2) Objective

The objective is to obtain continuous measurement of the current profile along cruise track and on-station.

(3) Methods

Upper ocean current measurements were made throughout KY09-09 cruise, using the hull mounted Acoustic Doppler Current Profiler (ADCP) system. 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;

1) R/V KAIYO has installed the Ocean Surveyor for vessel-mount (acoustic frequency 38 kHz; Teledyne RD Instruments). It has a phased-array transducer with single ceramic assembly and creates 4 acoustic beams electronically. It’s mounted the transducer head rotated to a ship-relative angle of 45 degrees azimuth from the keel.
2) For heading source, it uses ship’s gyro compass (TG8000, Tokimec, Japan), continuously providing heading to the ADCP system directory.
3) GPS navigation receiver (Trimble SPS220) provides position fixes. In addition, StarFix 4100LRS (Fugro) provides differential signal to GPS, positioning accuracy improves.
4) We used VmDas version 1.4.2 (TRD Instruments) for data acquisition.
5) The sound speed at the transducer does affect the vertical bin mapping and vertical velocity measurement, is calculated from temperature, salinity (constant value; 35.0 psu) and depth (5.0 m; transducer depth) by equation in Medwin (1975).

The data was configured for 8 m processing bin, 16 m intervals and starting 24 m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively.

(4) Preliminary results

Fig. 5.4-1 to Fig. 5.4-2 shows 60 minutes averaged surface (1st ~ 5th layer and 6th ~ 10th layer current vectors along the ship track.

(5) Data archive

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

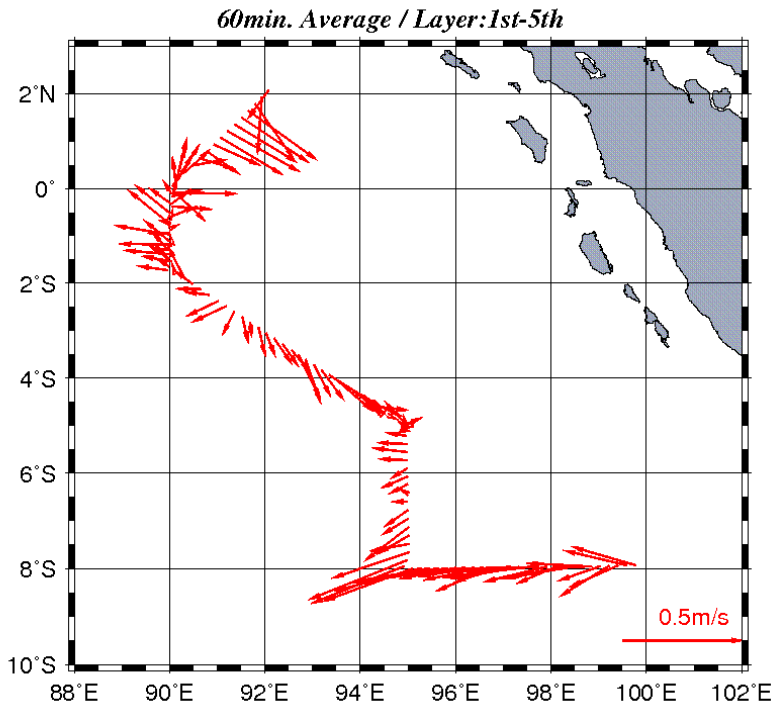

Fig. 5.4-1 current vector along the ship track (Depth:24m~104m).

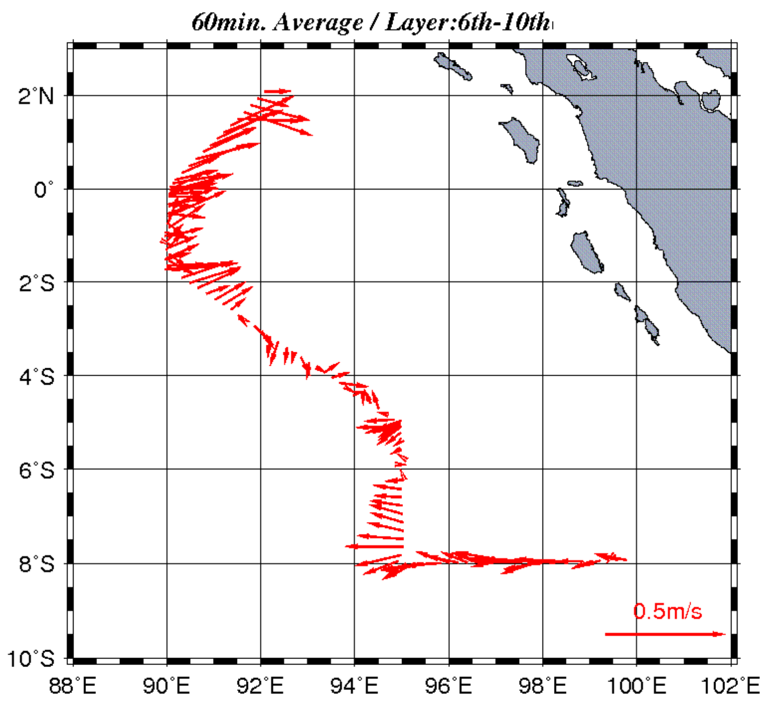

Fig. 5.4-2 current vector along the ship track (Depth:104m~184m).

5.5 TRITON buoys
5.5.1 Operation of the m-TRITON buoys

(1) Personnel

Kentaro Ando	(JAMSTEC): Principal Investigator
Tatsuya Fukuda	(JAMSTEC):Buoy Engineer
Hiroshi Matsunaga	(MWJ): Operation leader
Satoshi Ozawa	(MWJ)
Hiroki Ushiromura	(MWJ)
Kenichi Katayama	(MWJ)
Takeo Matsumoto	(MWJ)
Takatoshi Kiyokawa	(MWJ)
Takami Mori	(MWJ)
Kido Yoshiki	(MWJ)

(2) Objective

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

TRITON buoy (included m-TRITON buoy) array is integrated with the existing TAO (Tropical Atmosphere Ocean) array, which is presently operated by the National Data Buoy Center/National Oceanic and Atmospheric Administration of the United States. In the Indian Ocean, TRITON buoy consists as a part of RAMA (Research Moored Buoy Array for Asian-African-Australian Monsoon Analysis and Prediction) buoy array, which has been maintained and developed by multi-national efforts. Both TRITON buoys in Pacific ocean and Indian Ocean 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).

In this cruise, two m-TRITON buoys were successfully recovered and three m-TRITON buoys were deployed.

(3) Method

The m-TRITON buoy observes oceanic parameters and meteorological parameters as follows:

Meteorological parameters:	wind speed, direction, air temperature, relative humidity, shortwave radiation, precipitation.
Oceanic parameters:	water temperature and conductivity, current

Details of the instruments used on the m-TRITON buoy are summarized as follows:

Oceanic sensors

1) CTD (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)

SBE-37 IM Micro CAT

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) CTD (Conductivity-Temperature and Depth meter, JAMSTEC)

JES10-CTDIM

Sampling interval : 600sec

Measurement range, Temperature : -5～+40 deg-C

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

Measurement range, Pressure : 0～1000 m

3) TD (Temperature and Depth meter, Sea Bird Electronics Inc.)

SBE-39 IM

Sampling interval : 600sec

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

Measurement range, Pressure : 0～full scale range

4) CRN (Current meter, Teledyne RD Instruments,Inc)

Doppler Volume Sampler

Sampling interval : 600sec

Sensor frequency : 2400kHz

Velocity Range: ±6m/s

Meteorological sensors

1) Precipitation (R.M.Young Co.)

MODEL50202/50203

Sampling interval : 600sec

2) Relative humidity/air temperature (Rotronic Co.)

MODEL MP101A

Sampling interval : 600sec

3) Shortwave radiation (Eppley Co.)

MODEL PSP

Sampling interval : 600sec

4) Wind speed/direction (R.M.Young Co.)

MODEL Y85000

Sampling interval : 600sec

*Meteorological sensors were assembled that used A/D (Analougue/Digital) conversion PCB (Print Cycle Board) made from MARITEC (Marine Technology Center)/JAMSTEC

Data logger and ARGOS transmitter

1) Data logger

I/O: RS485 has controlled of meteorological sensors.

RS232C has controlled of GPS and Inductive modem.

2) ARGOS transmitter

The data in the interval of 10 minute are being transmitted through ARGOS transmitter.

(4) Results

Locations of deployment and recovery are as follow:

Locations of Recovery

Nominal location	1.5S,90E
ID number at JAMSTEC	18503
ARGOS PTT number	247A1D4
ARGOS backup PTT number	24742
Deployed date (UTC)	19 Mar 2009
Recovered date (UTC)	07 Nov 2009
Exact location	01 - 36.24S, 90 - 04.47E
Depth	4,711 m

Nominal location	5S, 95E
ID number at JAMSTEC	17502
ARGOS PTT number	24770
ARGOS backup PTT number	27411
Deployed date (UTC)	16 Mar. 2009
Recovered date (UTC)	12 Nov 2009
Exact location	05 - 01.99S, 94 - 59.20E
Depth	5,016 m

Locations of Deployment

Nominal location	1.5S,90E
ID number at JAMSTEC	18504
ARGOS PTT number	3E052BE
ARGOS backup PTT number	29792
Deployed date (UTC)	9 Nov.2009
Exact location	01 - 39.59S, 89 - 59.69E
Depth	4,688 m

Nominal location	5S,95E
ID number at JAMSTEC	17503
ARGOS PTT number	29040

ARGOS backup PTT number	27406
Deployed date (UTC)	11 Nov.2009
Exact location	04 - 56.91S, 94 - 58.35E
Depth	5,005 m
Nominal location	8S,95E
ID number at JAMSTEC	19501
ARGOS PTT number	3E052AD
ARGOS backup PTT number	29791
Deployed date (UTC)	14 Nov.2009
Exact location	07 - 59.97S, 95 - 02.60E
Depth	5,207 m

(5) Data archive

The data in the interval of 10 minutes or 1 hour were transmitted via ARGOS satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters. And the data will be distributed world wide through internet from the JAMSTEC web site (http://www.jamstec.go.jp/).

5.6 Subsurface ADCP moorings

(1) Personnel

Kentaro Ando	(JAMSTEC): Principal Investigator
Satoshi Ozawa	(MWJ): Operation leader
Hiroshi Matsunaga	(MWJ)
Hiroki Ushiromura	(MWJ)
Kenichi Katayama	(MWJ)
Takeko Matsumoto	(MWJ)
Takatoshi Kiyokawa	(MWJ)
Takami Mori	(MWJ)
Kido Yoshiki	(MWJ)

(2) Objective

The purpose of this ADCP observation is to get knowledge of physical process underlying the dynamics of oceanic circulation in the eastern equatorial Indian Ocean. Sub-surface currents are observed by using ADCP moorings at 90°E right on the equator. In this cruise (KY09-09), we deployed as well as recovered sub-surface ADCP moorings at 0°S, 90°E.

(3) Parameters

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

(4) Method

Two instruments are mounted at the top float of the mooring. One is ADCP (Acoustic Doppler Current Profiler) to observe upper-ocean currents from subsurface down to around 400m depths. The second instrument mounted below the float is CTD, which observes pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are described as follows:

1) ADCP
 Work Horse Long Ranger ADCP 75 kHz (Teledyne RD Instruments, Inc.)
Distance to first bin: 15.5 m
Pings per ensemble: 27
Time per ping: 6.66 seconds
Bin length: 8.00 m
Sampling interval: 3600 seconds
Deployed ADCP
・ Serial Number : 1248 (Mooring No.091108-0090E)
Recovered ADCP
・ Serial Number : 7176 (Mooring No.080206-0090E)

2) CTD

□ SBE-37 (Sea Bird Electronics Inc.)

Sampling Interval: 1800 seconds

Deployed CTD

- Serial Number : 1338 (Mooring No.091108-0090E)

□ SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval: 1800 seconds

Recovered CTD

- Serial Number : 1275 (Mooring No.090321-0090E)

3) Other instrument

□ Acoustic Releaser (BENTHOS,Inc.)

Deployed Acoustic Releaser

- Serial Number: 664 (Mooring No.091108-0090E)
- Serial Number: 956 (Mooring No.091108-0090E)

Recovered Acoustic Releaser

- Serial Number: 600 (Mooring No.090321-0090E)
- Serial Number: 666 (Mooring No.090321-0090E)

(5) Deployment

Deployment of the ADCP mooring at 0°S, 90°E was planned to mount the ADCP at about 400m depth. During the deployment, we monitored the depth of the acoustic releaser after dropping the anchor.

・The position of the mooring No.091108-0090E

Date: 08 Nov. 2009 Lat: 00-01.4435N Long: 90-03.5173E Depth: 4,255m

(6) Recovery

We recovered one ADCP mooring which was deployed on 21 Mar. 2009 (KY09-01 Leg2 cruise).

After the recovery, we uploaded ADCP and CTD data into a computer. But we could not upload the ADCP DATA because of the communications error. The CTD raw data were converted into ASCII code. Figure 5.6 show results from the mooring.

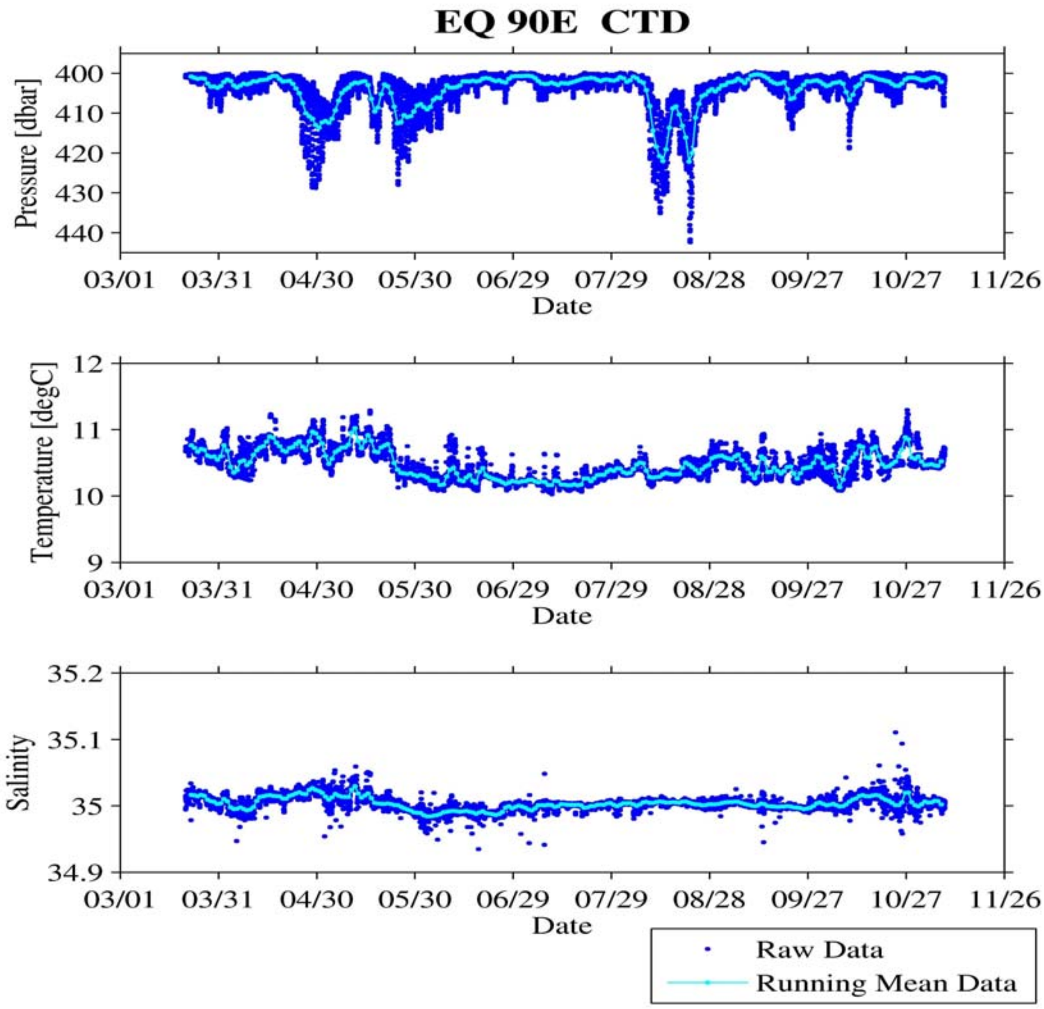

Fig.5.6-1 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at (0°S, 90°E). The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean

(7) Data archive

The all data will be archived by the member of TOCS project at JAMSTEC. In addition, all data will be submitted to Data Integration and Analyses Group (DIAG) of JAMSTEC.