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R/V Kaiyo Cruise Report
KY09-01

February 9, 2009 – May 11, 2009

Tropical Indian Ocean and Pacific Ocean

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

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Note:

This cruise report is a preliminary documentation as of the end of the cruise. It may not be revised even if new findings and others are derived from observation results after publication. It may also be changed without notice. Data on the cruise report may be raw or not processed. Please ask the chief scientists 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

Title of the cruise: Tropical Ocean Climate Study

Cruise code: KY09-01

Ship: R/V Kaiyo (Captain: Hitoshi Tanaka)

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

Title of proposal: MAX-DOAS measurements of aerosols and NO_2

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 and in the eastern Indian Ocean for better understanding of climate variability involving the ENSO (El Nino/Southern Oscillation) and Indian Ocean Dipole phenomenon. 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. Zonal migration of the WWP in the western Pacific is associated with El Nino and La Nina, which cause drastic climate changes in the world such as found during 1997-98 El Nino and 1999 La Nina. 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 TRITON (TRIangle Trans-Ocean buoy Network) buoys and 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 the network of TRITON buoys along 130E and 138E lines in the western equatorial Pacific and 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 Hitoshi Tanaka

2) Cruise code

KY09-01

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)

MAX-DOAS measurements of aerosols and NO_2

4) Undertaking institution

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

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

BPPT (Agency for the Assessment and Application of Technology)

Add: Jl. M.H. Thamrin 8, Jakarta 10340, Indonesia

5) Chief scientist

Kentaro Ando (JAMSTEC) for Leg1

Yasuhisa Ishihara (JAMSTEC) for Leg2

Shoichiro Baba (JAMSTEC) for Leg 3

6) Period

Feb 9, 2009 (Yokohama, Japan) – May 11, 2009 (Yokosuka, Japan)

7) Research participants

Two scientists, two engineers, and twenty-five technical staffs from three Japanese institutions and companies

One scientist, one engineer, and three security officers from Indonesian government

2.3 Observation summary

TRITON mooring recovery and re-installation:	6 moorings were deployed and recovered
m-TRITON mooring recovery and re-installation:	2 mooring were deployed and recovered
Subsurface ADCP mooring recovery and re-installation:	1 moorings were deployed and recovered
CTD (Conductivity, Temperature and Depth) and water sampling:	61 casts
XCTD:	48 casts
XBT:	46 casts
Current measurements by shipboard ADCP:	continuous
Sea surface temperature, by seasnake	continuous
Surface meteorology:	continuous
aerosols and NO_2	continuous

Regarding TRITON buoy maintenance work, we recovered and re-installed nine buoys at 130E and 137/138E lines during this cruise without any big trouble. The so-called "Iron mask" meteorological tower has been used on the buoy at 8N130E, and fortunately the tower was not vandalized heavily in comparison with the past buoys with normal tower at this site. It may be good timing to consider how we will use the "Iron-mask" tower for other places by modifying. During the recovery work at 2N130E, the tension of nylon rope of the TRITON on deck became tightened stronger than usual. Then, we turned our ship opposite side to release tension and approached to the nearest position to releaser, which position we could monitor relative to ship in real-time by ocean acoustic cruising system in R/V Kaiyo.   Finally, we could recover with planned tension.

We have been also maintaining the subsurface ADCP buoys in the eastern equatorial Indian Ocean since 2000. One ADCP buoys at 0N90E was recovered and re-installed during this cruise with no trouble. Its data was successfully acquired.

During this cruise, we conducted 61 CTD casts for various purposes. For TRTION sensor check, CTD casts were conducted down to 1000m depth near the recovered buoy for the purpose to compare with TRITON salinity sensors which are installed from surface to the depth of 750m. Observations of internal waves at Seram sea and Lombok strait with CTD system were conducted for 12 hours in daytime in cooperation with BPPT.   The depth of measurement for these casts were 600-1000 meters depth.

XCTD/XBT observations were conducted along the ship tracks throughout the cruise.

2.4 Observed Oceanic and Atmospheric Conditions

After the termination of 2007/08, the central equatorial Pacific was once again under the colder-than-normal condition during this boreal winter.   This La Nina-like colder-than-normal condition showed slightly negative anomaly, accompanied positive anomalies at its eastern and western sides (tri-pole structure) tentatively, and terminated in May 2009 (Figure 2.4).

Temperature sections along 130E and 138E are shown in Figure 5.2.2-2 and 5.2.2-4. Sea surface temperature along these lines exceeded 29℃ south of 5N, suggesting SST in the western part of the warm pool is higher than normal due to the La Nina-like condition in the entire Pacific. This condition in the western part of warm pool persists from February to May 2009 (Figure 2.4).

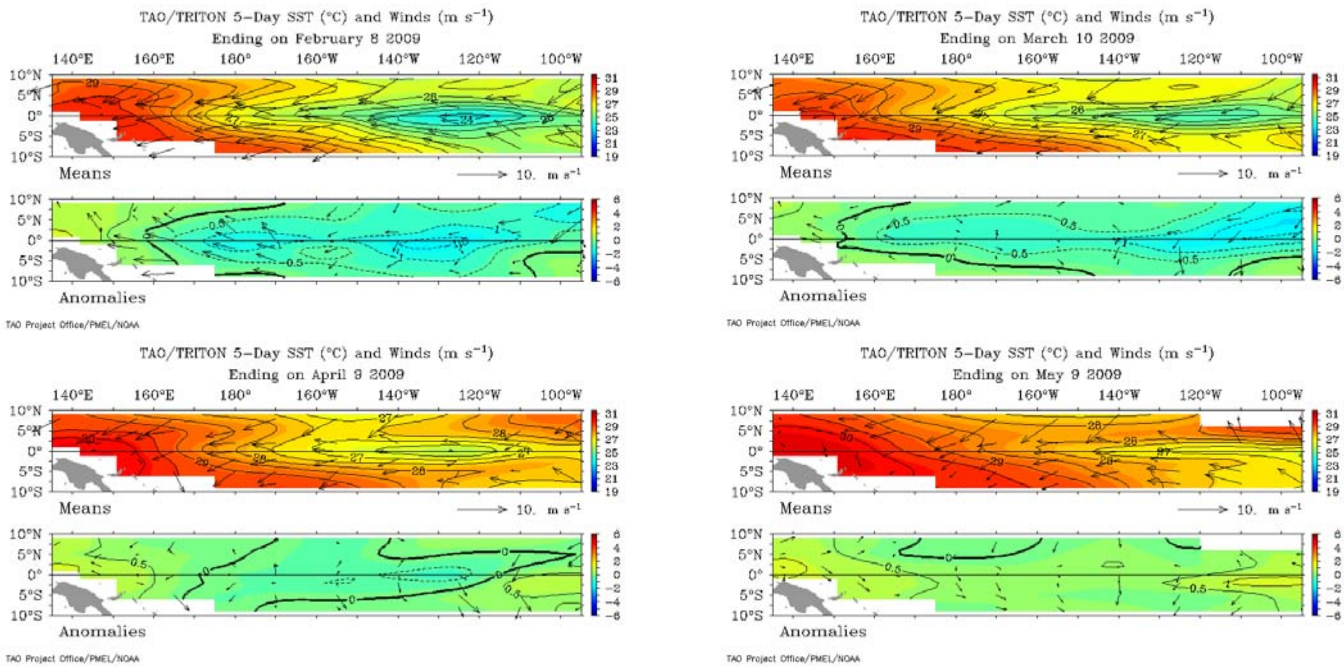


Figure 2.4-1   5-days average and anomaly of SST and surface wind ending on February 8 (left-top), March 10 (right-top), April 9 (left-bottom), and May 9 (right-bottom) from PMEL TAO web site.

In the eastern tropical Indian ocean, both m-TRITON buoy data at 5S95E and 1.5S90E show 28-30 degree-C in March to May 2009. Compared with climatology, SST in the eastern Indian Ocean is slightly low. Not like in 2006, 2007 and 2008 IOD cases, negative temperature anomaly in the thermocline, which is suggested to be predictor of IOD event in the next fall, is not found and IOD event will not likely occur this year.

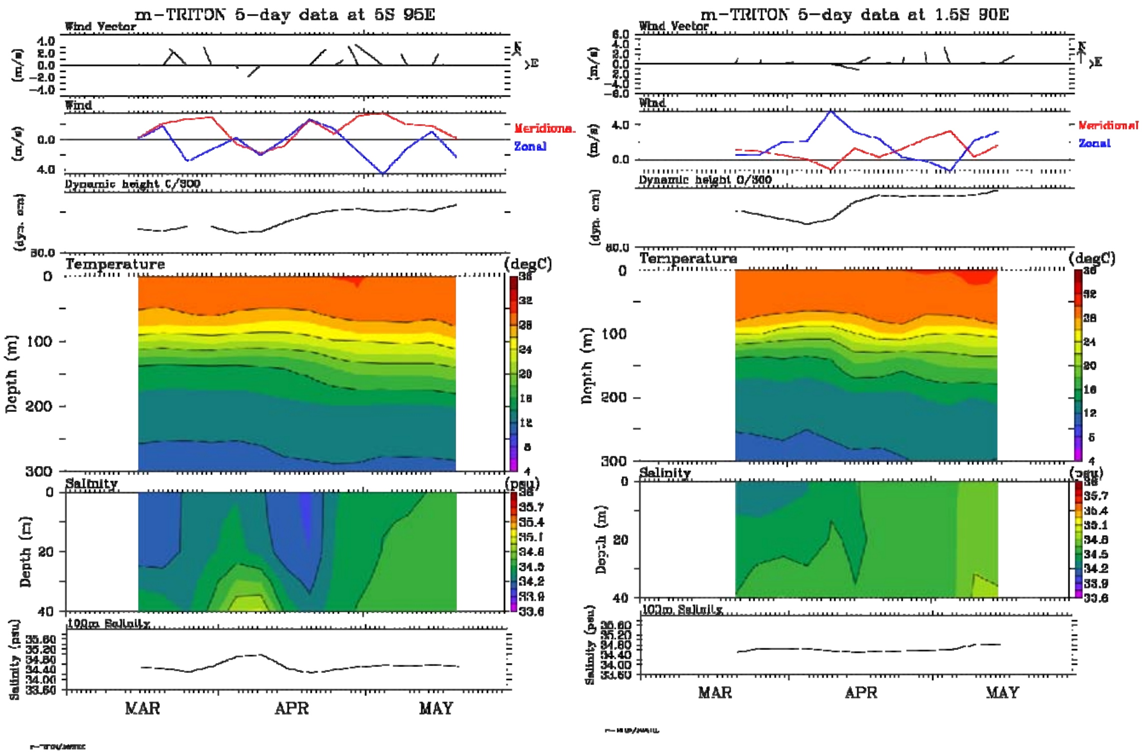


Figure 2.4-2 Real-time data of surface wind, dynamic height, temperaure and salinity sections transmitted from the m-TRITON data deployed at 5S95E (left) and at 1.5S90E (right) in the Indian ocean.

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

3.1 Period

February 09, 2009 – May 11, 2009

3.2 Ports of call

Yokohama, Japan (Departure: February 9, 2009)
Guam, USA (Arrival: February 15, 2009, Departure: February 18, 2009)
Bali, Indonesia (Arrival: March 7, 2009, Departure: March 10, 2009)
Bali, Indonesia (Arrival: March 29, 2009, Departure: April 1, 2009)
Guam, USA (Arrival: April 10, 2009, Departure: April 13, 2009)
Guam, USA (Arrival: April 29, 2009, Departure: May 1, 2009)
Yokohama, Japan (Arrival: May 11, 2009)

3.3 Cruise Log

SMT	UTC	Event
Feb. 09 (Mon) 2009		
14:00	05:00 (-1day)	Departure from Yokohama, Japan,
		Start continuous observation
15:00	06:00	Lecture on the safty and comfortable life in Kaiyo
16:40	07:40	Konpira Ceremony
Feb. 10 (Tue) 2009		
09:00	23:00	Boat drill
	(SMT was adjusted to Guam local time. UTC+10)	
Feb. 15 (Sun) 2009		
10:00	00:00	Arrival to Apura port, Guam, USA
13:30	03:30	Meeting on the off-loading TRITON gears in Guam
Feb. 16 (Mon) 2009		
07:55 – 16:30	21:55 – 06:30	Off-loading TRITON gears (#10, #11, #12, #13)
Feb. 18 (Wed) 2009		
10:00	0:00	Departure from Apula, Guam, USA
13:00-13:30	03:00-03:30	Lecture on the safety life in Kaiyo
Feb. 19 (Thu) 2009		
06:57	20:57	XBT#1 (11.59.99N, 140-42.90E)
08:00-11:35	22:00-02:35	Pirate attach drill
23:17		XBT#2 (10-59.99N, 138-01.89E)
24:00	14:00	Ship mean time adjusted to JST (UTC+9)
Feb. 20 (Fri) 2009		
15:43	06:43	XBT#3 (9-59.99N, 135-21.80E)
Feb. 21 (Sat) 2009		

07:34	22:34	XBT#4 (8-59.98N, 132-42.12E)
08:51 – 09:46	23:51 – 00:46	Test cast CTD (9-59.9949N, 135-21.8062E)
Feb. 22 (Sun.) 2009		
08:00 – 12:21	23:00 – 03:21	Deployment of TRITON #14 (8N, 130E)
13:36 – 14:28	04:36 – 05:28	CTD/JAM-TD#1 (1000m) at TRITON deployment site
15:10 – 16:04	06:10 – 07:04	CTD/JAM-TD#2 (1000m) at TRITON recovery site
16:35 – 16:58	07:35 – 07:58	Boat operation: Attaching work-ropes to recovery of TRITON
Feb. 23 (Mon) 2009		
07:03 –12:58	22:03 – 03:58	Recovery of TRITON #14 (8N, 130E)
13:01	04:01	XCTD#1 (8N130E)
14:05	05:05	XBT#5 (7-45N, 130E)
15:46	06:46	XCTD#2 (7-30N, 130E)
17:28	08:28	XBT#6 (7-15N, 130E)
18:51	09:51	XCTD#3 (7-00N, 130E)
20:07	11:07	XBT#7 (6-45N, 130E)
21:27	12:27	XCTD#4 (6-30N, 130E)
22:55	13:55	XBT#8 (6-15N, 130E)
Feb. 24 (Tue) 2009		
00:27	15:55	XCTD#5 (6-00N, 130E)
02:01	17:01	XBT#9 (5-45N, 130E)
03:37	18:37	XCTD#6 (5-30N, 130E)
05:11	20:11	XBT#10 (5-15N, 130E)
06:41	21:41	XCTD#7 (5-00N, 130E)
08:09	23:09	XBT#11 (4-45N, 130E)
10:21	01:21	XCTD#8 (4-30N, 130E)
11:54	02:54	XBT#12 (4-15N, 130E)
13:21	04:21	XCTD#9 (4-00N, 130E)
14:47	05:47	XBT#13 (3-45N, 130E)
16:14	07:14	XCTD#10 (3-30N, 130E)
17:34	08:34	XBT#14 (3-15N, 130E)
18:57	09:57	XCTD#11 (3-00N, 130E)
20:20	11:20	XBT#15 (2-45N, 130E)
21:46	12:46	XCTD#12 (2-30N, 130E)
23:07	14:07	XBT#16 (2-15N, 130E)
Feb. 25 (Wed.) 2009		
07:00 – 10:45	22:00 – 01:45	Deployment of TRITON #16 (2N, 130E)
11:11 – 12:05	02:11 – 03:05	CTD/JAM-TD#3 (1000m) at TRITON deployment site
12:11- 12:30	03:11 – 03:30	Boat operation to switch on monitoring camera of TRITON buoy#16

13:30-19:30	04:30-10:30	Repair and replace CTD/Rosetta system
Feb. 26 (Thu.) 2009		
06:30 –07:28	21:30 – 22:28	CTD/JAM-TD#4 (1000m) at TRITON recovery site
07:50-16:35	22:50 – 09:35	Recovery of TRITON buoy#16 (2N,130E)
16:46	09:46	XCTD#13 (2-00N, 130E)
Feb. 27 (Fri.)		
	Cruising to Seram CTD point	
	SMT is adjusted to Bali time (UTC+8hr)	
Feb. 28 (Sat.)		
18:30-23:30	10:30-15:30	Cross Lafamatola strait, northern strait of Seram Sea by shipboard ADCP
Mar. 1 (Sun) 2009		
06:42 – 18:06	22:42 – 10:06	Yo-yo CTD in Seram Sea (800m: 3 cast, 1000m: 14 casts, and 2400m: 1 cast)
20:00 – 01:30	12:00 – 17:30	Cross western strait of Seram Sea
Mar. 2 (Mon.) – Mar. 4 (Wed.), 2009		
	Crusing to Lombok CTD point	
Mar. 5 (Thu.), 2009		
16:00 –	08:00 -	Start repeat cross sections at Lombok
Mar. 6 (Fri.) 2009		
– 05:00	– 21:00	End repeat cross sections at Lombok
06:30 – 18:00	22:30 – 10:00	Yo-yo CTD in Lombok
Mar. 7 (Sat.) 2009		
10:00	02:00	Arrival to Bali
Mar. 8 (Sun.) – Mar.9, 2009		
Fueling etc.		
Mar. 10 (Mon.), 2009		
09:00	01:00	Lecture on the safty and comfortable life in Kaiyo
10:00	02:00	Departure from Bali
		Start continuous observation
11:00	03:00	Meeting about m-TRITON buoys and ADCP operation
15:00	07:00	Start sea-snake SST observation
23:39	15:39	XCTD#14 (8-35S, 113E)
Mar. 11 (Tue.), 2009		
06:00	22:00	XCTD#15 (8-30S, 112E)
06:05	22:05	XBT#17 (8-30S, 112E)
09:00	01:00	Boat drill
11:59	03:59	XCTD#16 (8-31S, 111E)

18:13	10:13	XCTD#17 (8-20S, 110E)
18:21	10:21	XBT#18 (8-20S, 110E)
23:58	16:58	XCTD#18 (8-13S, 109E)

(SMT was adjusted to UTC+7)

Mar. 12 (Wed.), 2009

06:38	23:38	XCTD#19 (8-06S, 108E)
06:46	23:46	XBT#19 (8-06S, 108E)
09:00	02:00	Meeting about No.17 buoy mooring system recovery operation
13:35	06:35	XCTD#20 (7-45S, 107E)
21:05	14:05	XCTD#21(7-23S, 106E)
21:15	14:15	XBT#20 (7-23S, 106E)

Mar. 13 (Thu.), 2009

04:37	21:37	XCTD#22 (6-57S, 105E)
12:05	05:05	XCTD#23 (6-28S, 104E)
12:13	05:13	XBT#21 (6-27S, 104E)
19:30	12:30	XCTD#24 (6-00S, 103E)

Mar. 14 (Fri.), 2009

02:58	19:58	XCTD#25 (5-34S, 102E)
03:06	20:06	XBT#22 (5-34S, 102E)
10:00	03:00	Meeting about m-TRITON deployment operation
10:14	03:14	XCTD#26 (5-23S, 101E)
17:14	10:14	XCTD#27 (5-19S, 100E)
17:22	10:22	XBT#23 (5-19S, 100E)

Mar. 15 (Fri.), 2009

00:13	17:13	XCTD#28 (5-16S, 99E)
07:30	00:30	XCTD#29 (5-11S, 98E)
07:38	00:30	XBT#24 (5-11S, 98E)
14:23	07:23	XCTD#30 (5-09S, 97E)
21:01	14:01	XCTD#31 (5-06S, 96E)
21:10	14:10	XBT#25 (5-06S, 96E)

Mar. 16 (Mon.) 2009

07:14 – 11:08	00:14 – 04:08	Deployment of m-TRITON #17 (5S, 95E)
12:52 – 13:34	05:52 – 06:34	CTD#5 (1000m) at m-TRITON deployment site
13:37	06:37	XCTD#32 (5-02S, 95E)

13:45	06:45	XBT#26 (5-01S, 95E)
14:30- 17:30	07:30 – 10:30	Tracking operation for acoustic release system of m-TRITON buoy#17

(SMT was adjusted to UTC+6)

Mar. 17 (Tue.) 2009

06:54-11:02	23:54 – 04:02	Recovery of mooring parts of m-TRITON buoy#17 (5S, 95E)
15:45	09:45	XCTD#33 (4-30S, 94-19E)
22:47	15:47	XCTD#34 (4S, 93-35E)
22:54	15:54	XBT#27 (4S, 93-34E)

Mar. 18 (Wed.) 2009

03:55	21:55	XCTD#35 (3-30S, 92-51E)
09:40	03:40	XCTD#36 (3S, 92-07E)
09:47	03:47	XBT#28 (3S, 92-06E)
15:04	09:04	XCTD#37 (2-30S, 91-23E)
20:26	14:26	XCTD#38 (2S, 90-39E)
20:34	14:34	XBT#29 (2S, 90-38E)

Mar. 19 (Thu.) 2009

07:16 – 10:32	01:16 – 04:32	Deployment of m-TRITON #18 (1.5S, 90E)
12:51 – 13:37	06:51 – 07:37	CTD#6 (1000m) at m-TRITON deployment site
13:40	07:45	XCTD#39 (1.5S, 90-06E)
14:25 – 15:10	08:25 – 09:10	CTD#7 (1000m) at m-TRITON recovery site

Mar. 20 (Fri.) 2009

06:50-10:48	00:50 – 04:48	Recovery of m-TRITON buoy#18 (1.5S, 90E)
15:26	09:26	XCTD#40 (1S, 90-02E)
15:33	09:33	XBT#30 (1S, 90-02E)
19:27	13:27	XCTD#41 (0-30S, 90-03E)

Mar. 21 (Sat.) 2009

06:57 – 08:33	00:57 – 02:33	Recovery of ADCP (EQ, 90E)
09:26 – 11:26	03:26 – 05:26	Deployment of ADCP (EQ, 90E)
12:51 – 13:35	06:51 – 07:35	CTD#8 (1000m) at ADCP deployment site
13:38	07:38	XCTD#42 (EQ, 90-03E)
13:45	07:45	XBT#31 (EQ, 90-02E)

Mar. 23 (Mon.) 2009

16:03－25:12	10:03 – 19:12	Sea bottom survey by MNB (8S, 95E)

Mar. 25 (Wed.) 2009

10:00－11:00	04:00 – 05:00	Short seminar

(SMT was adjusted to UTC+7)

Mar. 26 (Thu.) 2009

10:00－11:00	03:00 – 04:00	Short seminar

Mar. 27 (Fri.) 2009

(SMT was adjusted to UTC+8)

Mar. 28 (Sat.) 2009

15:00	07:00	End sea-snake SST observation

Mar. 29 (Sun.) 2009

08:00	00:00	Arrival to Bali

Apr. 1(Thu) 2009

		Departure from Bali

Apr. 10(Fri) 2009

		Arrival to Guam

(SMT was adjusted to Guam local time. UTC+10h)

Apr. 11(Sat) 2009

07:30-14:00	21:30-04:00	Off-loading recovery m-TRITON gears (#17, #18)
		On-loading TRITON gears (#10,#11,#12,#13)

Apr.13 (Mon) 2009

13:00	03:00	Lecture on the safty and comfortable life in Kaiyo
15:00	05:00	Departure from Apula, Guam, USA

Apr.14 (Tue) 2009

04:31	18:31	XBT#32(12N,143E)
09 :00	23 :00	Meeting TRITON operation and continuos observation
11 :00	01 :00	Boat drill
14:06	04:06	XBT#33(11N,142E)

Apr. 15(Wed.) 2009

00:08	14:08(-1day)	XBT#34 (10N140E)

11:57	01:57	XBT#35(9N139E)

Apr. 16(Thu.) 2009

06:02-06:37	20:02-20:37	CTD #9 (1000m) at TRITON recovery site
07:21-11:43	21:21-01:43	Recovery of TRITON #10 (8N, 137E)

Apr. 17(Fri.) 2009

07:41-10:32	21:21-00:32	Deployment of TRITON #10 (8N, 137E)
13:01-13:36	03:01-03:36	CTD #10 (1000m) at TRITON recovery site
22:47	12:47	XCTD#43(7N137E)

Apr. 18(Sat.) 2009

12:48	02:48	XCTD#44(6N137E)

Apr. 19(Sun.) 2009

07:28-11:03	21:28-01:03	Deployment of TRITON #11 (5N, 137E)
11:30	01:30	Lunch small boat and power up a monitoring camera on the TRITON#11 and take pictures of TRITON#11
13:02-13:34	03:03-03:34	CTD #11 (1000m) at TRITON deployment site
14:16-14:50	04:16-04:50	CTD #12 (1000m) at TRITON recovery site
16:30-05:00	06:30-19:00	Kaiyo stays by TRITON #11 deployment site

Apr. 20(Mon.) 2009

07:11-12:00	21:11-02:00	Recovery of TRITON #11 (5N, 137E)
23:29	13:29	XCTD#45(4N138E)

Apr. 21(Tue.) 2009

13:55	03:55	XCTD#46(3N138E)

Apr. 22(Wed.) 2009

06:04-06:35	20:04-20:35	CTD #13 (1000m) at TRITON recovery site
06:49-11:00	20:49-01:00	Recovery of TRITON #12 (2N, 138E)

Apr. 23(Thu.) 2009

07:15-10:46	21:15-00:46	Deployment of TRITON #12 (2N, 138E)
13:03-13:36	03:03-03:36	CTD #14 (1000m) at TRITON deployment site

Apr. 24(Fri.) 2009

06:04-06:37	20:04-20:37	CTD #15 (1000m) at TRITON recovery site
07:36-12:11	21:36-02:11	Recovery of TRITON #13 (EQ, 138E)

Apr. 25(Sat.) 2009

07:14-10:54	21:14-00:54	Deployment of TRITON #13 (EQ, 138E)
13:24-13:55	03:24-03:55	CTD #16 (1000m) at TRITON deployment site
14:04	04:04	XBT#36(EQ, 138E)
20:16	10:16	XBT#37(1N, 138E)

Apr. 26(Sun.) 2009

02:22	16:22	XBT#38(2N, 139E)
08:08	22:08	XBT#39(3N, 140E)
13:35	03:35	XBT#40(4N, 140E)
18:50	08:50	XBT#41(5N, 141E)

Apr. 27(Mon.) 2009

00:06	14:06	XBT#42(6N, 141E)
05:45	19:45	XBT#43(7N, 142E)
11:34	01:34	XBT#44(8N, 142E)
17:03	07:03	XBT#45(9N, 143E)
23:18	13:18	XBT#46(10N, 143E)
07:14-11:42	21:14-01:42	Sampled Salinity measurement (AUTOSAL)

Apr. 29(Wed.) 2009

09:00	23:00	Arrival to Guam
10:30	00:30	Check observational equipments

Apr. 30(Thu.) 2009

08:00-12:00	22:00-02:30	On-loading recovery m-TRITON gears (#17, #18)

May 01(Fri.) 2009

09:00	23:00	Departure from Guam

May 11 (Mon.) 2009

09:00	00:00	Arrival to Yokohama

3.4 Cruise track

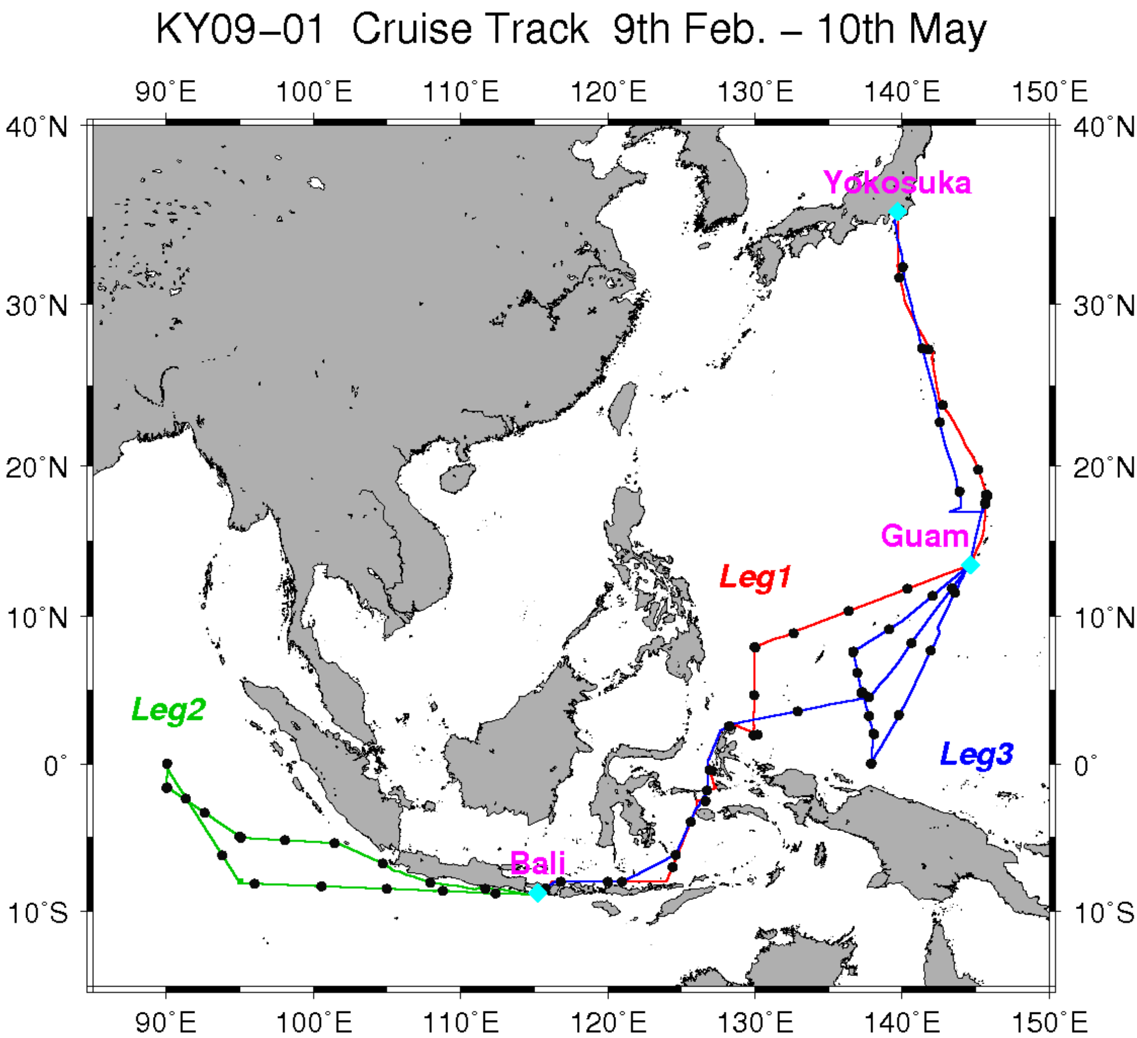


Fig 4-1.1 KY09-01 Cruise track and noon positions

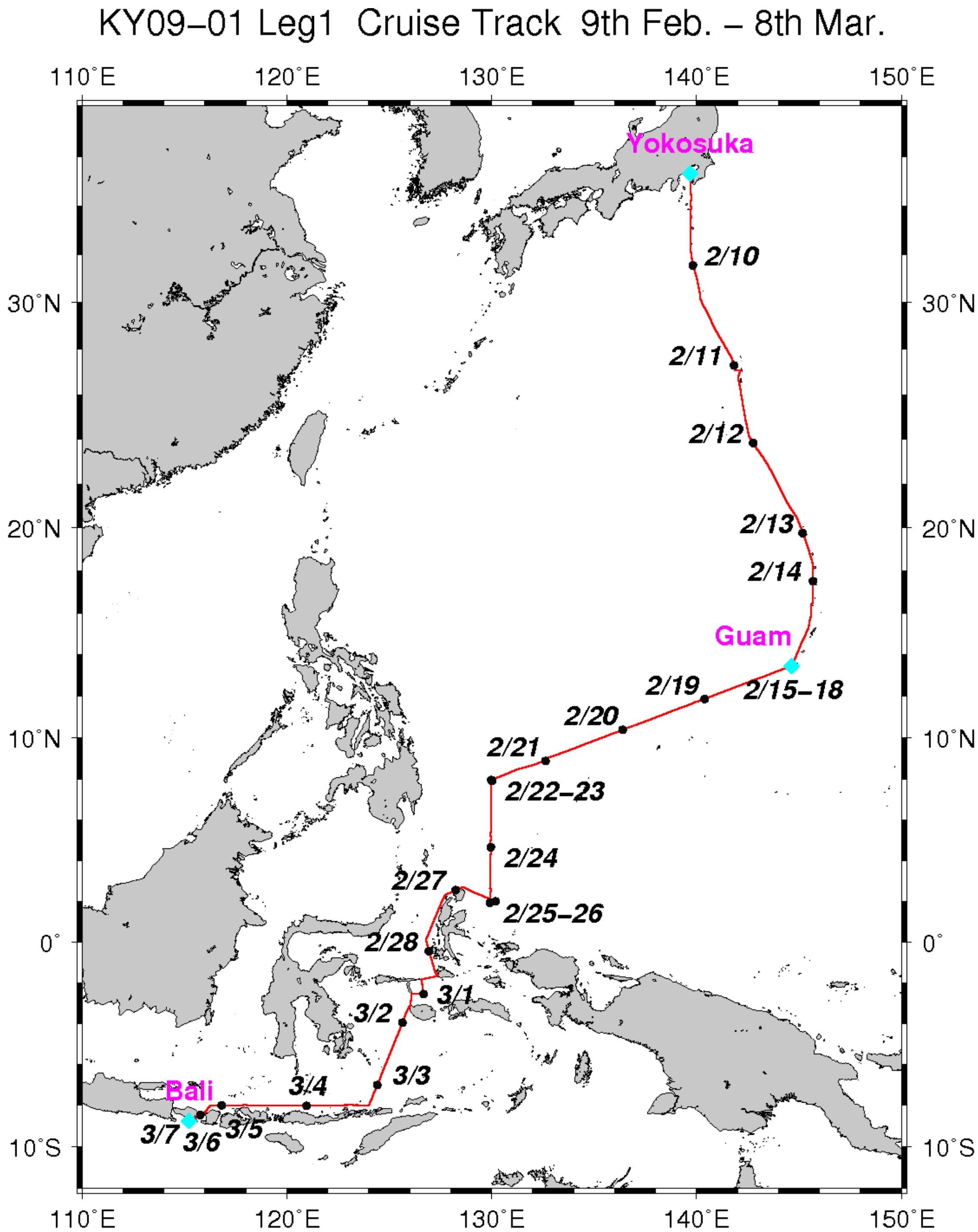


Fig 4-1.2 KY09-01 Leg-1 Cruise track and noon positions

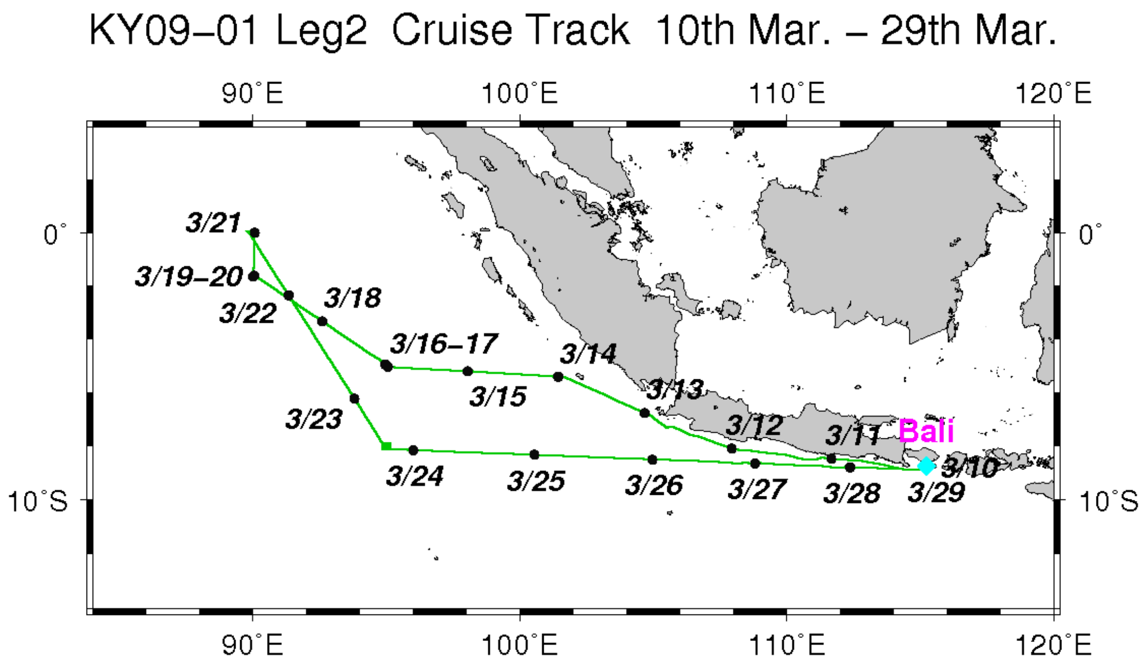


Fig 4-1.3 KY09-01 Cruise Leg-2 track and noon positions

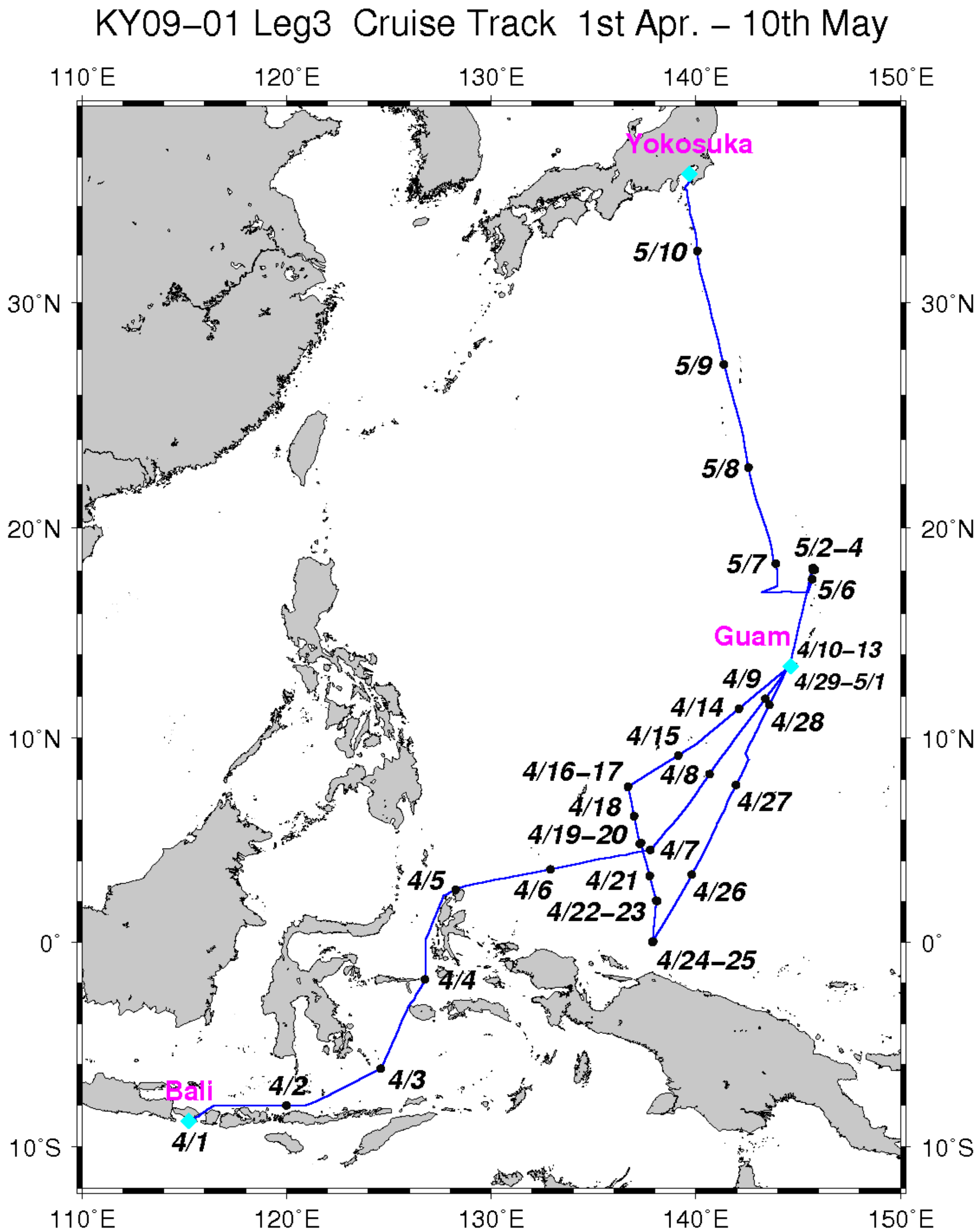


Fig 4-1.4 KY09-01 Cruise Leg-3 track and noon positions

4. Chief scientist, Science Party, and participants list

4.1 Chief Scientist

4.1.1 Leg-1

Chief Scientist

Kentaro Ando
Research Scientist
Institute of Observational Research for Global Change (IORGC),
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Co-chief Scientist (from Yokosuka to Guam)

Yugo Kanaya
Senior Scientist
Frontier Research Center for Global Change (FRCGC),
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Co-chief Scientist (from Guam to Bali)

Fadli Syamsudin
Scientist
BPPT (Agency for the Assessment and Application of Technology)

4.1.2 Leg-2

Chief Scientist

Yasuhisa Ishihara
Engineer
Marine Technology Center (MARITEC)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

4.1.3 Leg-3

Chief Scientist

Shoichiro Baba

Engineer

Marine Technology Center (MARITEC)

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

Co-chief Scientist (from Guam to Guam)

Winarno

Scientist

BPPT (Agency for the Assessment and Application of Technology)

4.2 Science Party

4.2.1. Tropical Ocean Climate Study

Kentaro Ando

Iskhaq Iskandar

Keisuke Mizuno (not on board)

Yukio Masumoto (not on board)

Yuji Kashino (not on board)

Iwao Ueki (not on board)

Akio Ishida (not on board)

Hideaki Hase (not on board)

Takuya Hasegawa (not on board)

As an international collaborative project under IA between JAMSTEC and BPPT, Fadli Syamusdin and Winarno from BPPT joined the party

4.2.2. TRITON operation program

Yasuhisa Ishihara

Shoichiro Baba

Akitoshi Shimura (not on board)

Masayuki Yamaguchi (not on board)

Naoko Takahashi (not on board)

4.2.3. 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)

Yasuhisa Ishihara

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)

Akitoshi Shimura (not on board)

Masayuki Yamaguchi (not on board)

Naoko Takahashi (not on board)

4.2.4. MAX-DOAS measurements of aerosols and NO_2

Hitoshi Irie (not on board)

Hisahiro Takashima

Yugo Kanaya

4.3. R/V KAIYO scientist and technical staff

Kentaro Ando	JAMSTEC	Leg 1
Yasuhisa Ishihara	JAMSTEC	Leg 2
Shoichiro Baba	JAMSTEC	Leg 3
Iskhaq Iskandar	JAMSTEC	Leg 2
Yugo Kanaya	JAMSTEC	Leg 1 (to Guam)
Hisahiro Takashima	JAMSTEC	Leg 1 (to Guam)
Fadli Syamusdin	BPPT	Leg 1
Winarno	BPPT	Leg 3
Hiroshi Matsunaga	MWJ	Leg1,3
Keisuke Matsumoto	MWJ	Leg 1, 2, and 3
Tomohide Noguchi	MWJ	Leg2,3
Hirokatsu Uno	MWJ	Leg2
Akira Watanabe	MWJ	Leg1
Hiroki Ushiromura	MWJ	Leg 1, 2, and 3
Takeo Matsumoto	MWJ	Leg2
Kenichi Katayama	MWJ	Leg1
Fujio Kobayashi	MWJ	Leg1
Toru Idai	MWJ	Leg1

Makito Yokota	MWJ	Leg2
Takatoshi Kiyokawa	MWJ	Leg1,2
Akira So	MWJ	Leg2
Hirotada Moki	MWJ	Leg1,2
Takatomo Shirozume	MWJ	Leg1,2
Masaki Furuhata	MWJ	Leg3
Masaki Yamada	MWJ	Leg3
Yasushi Hashimoto	MWJ	Leg3
Oshitani Shungo	MWJ	Leg3
Kenichi Kato	MWJ	Leg3
Kazuma Nakano	MWJ	Leg3
Kouhei Osakabe	MWJ	Leg3
Shinya Okumura	GODI	Leg 1
Soichiro Sueyoshi	GODI	Leg 2
Wataru Tokunaga	GODI	Leg 3
Major Gentio Harsono	Indonesian Navy	Leg 1
Hermawan Teguh	Indonesian Navy	Leg 2
Satria Dikdik	Indonesian Navy	Leg 3

JAMSTEC: Japan Agency for Marine-Earth Science and Technology
GODI: Global Ocean Development Inc.
MWJ: Marine Works Japan Ltd.
BPPT: Agency for the Assessment and Application of Technology of Indonesia

5 Observations

5.1 Meteorological measurement

5.1.1 Surface meteorological observations

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator
Shinya Okumura	- Leg1 - (Global Ocean Development Inc., GODI)
Souichiro Sueyoshi	- Leg2 - (GODI)
Wataru Tokunaga	- Leg3 - (GODI)

(2) Objectives

The purpose of these measurements is to observe surface meteorological parameters as a basic dataset of the meteorology. These parameters will be use to understand the temporal variation of the meteorological condition along the ship truck.

(3) Methods

Surface meteorological parameters were observed throughout the KY09-01 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. In order to evaluate the influence that ship body affects wind environment, additional anemometers at compass deck (Leg1) and bridge wing (starboard side, Leg1 and Leg2) were installed.

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 6 seconds and 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

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

Comparison with the portable barometer value, PTB220CASE, VAISALA.

iii.Thermometer (air temperature and relative humidity)

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

(4) Preliminary results

Figures 5.1.1-1 to 5.1.1-3 shows the examples of time series of the following parameters;

Wind direction and speed
Sea surface temperature
Air temperature
Relative humidity
Precipitation
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. The dataset observed in archipelago area in Indonesia will be published two years later.

(6) Remarks

The wind direction data of anemometer on the radar mast is not correct during Leg1 cruise, because of rotating anemometer mount by vibration of the ship.

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)
			Compass deck (22m)
			Bridge wing (18m)
Tair/RH	HMP45A	Vaisala, Finland	
with 43408 Gill aspirated radiation shield		R.M. Young, USA	Radar mast (24 m)
			Compass deck (16m)
			Bridge wing (13m)
Barometer	61201	R.M. Young, USA	
with 61002 Gill pressure port		R.M. Young, USA	Radar mast (24 m)
			Navigation deck (15m)
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	

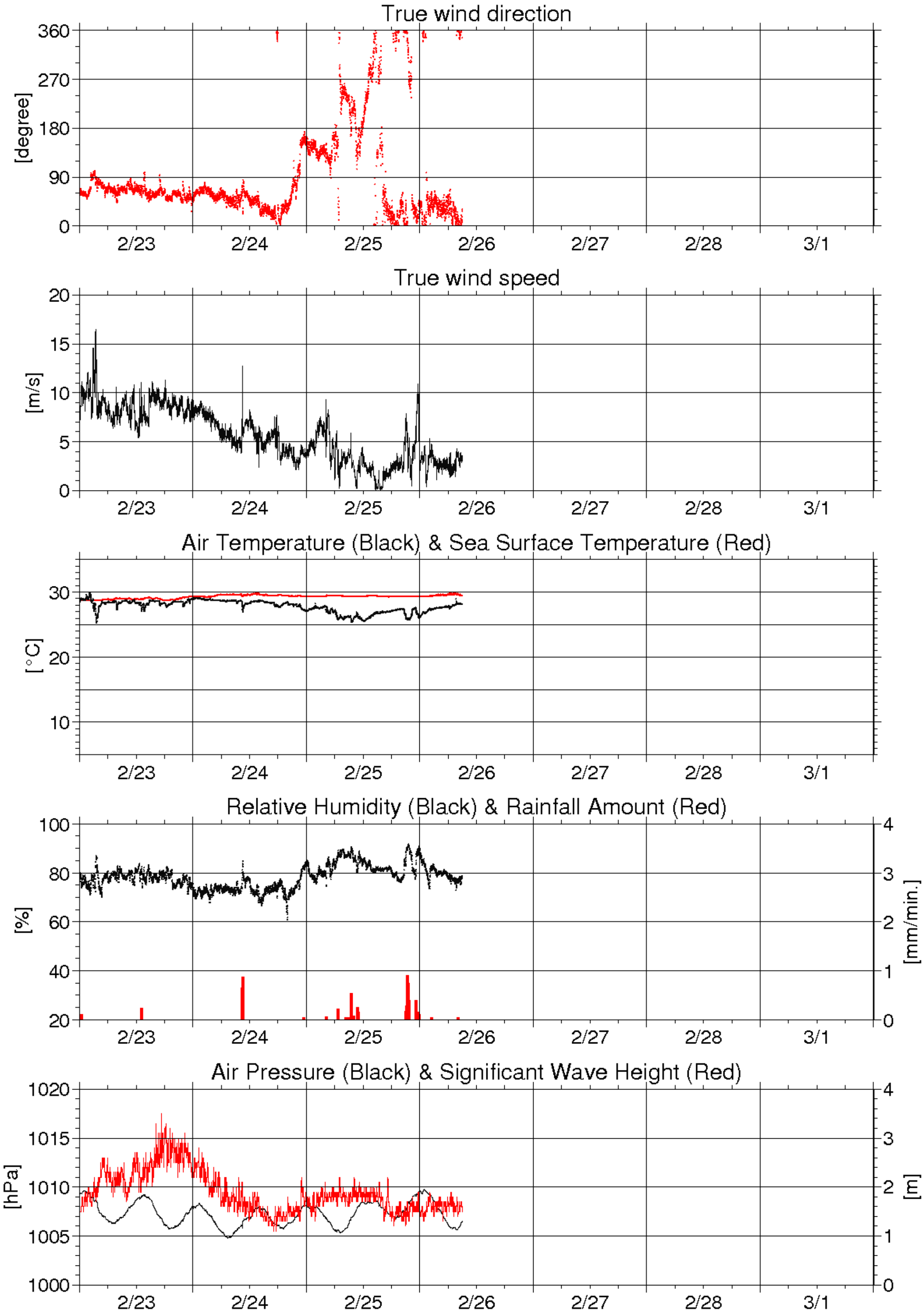


Fig.5.1.1-1 Time series examples of surface meteorological parameters during the KY09-01 Leg.1 cruise

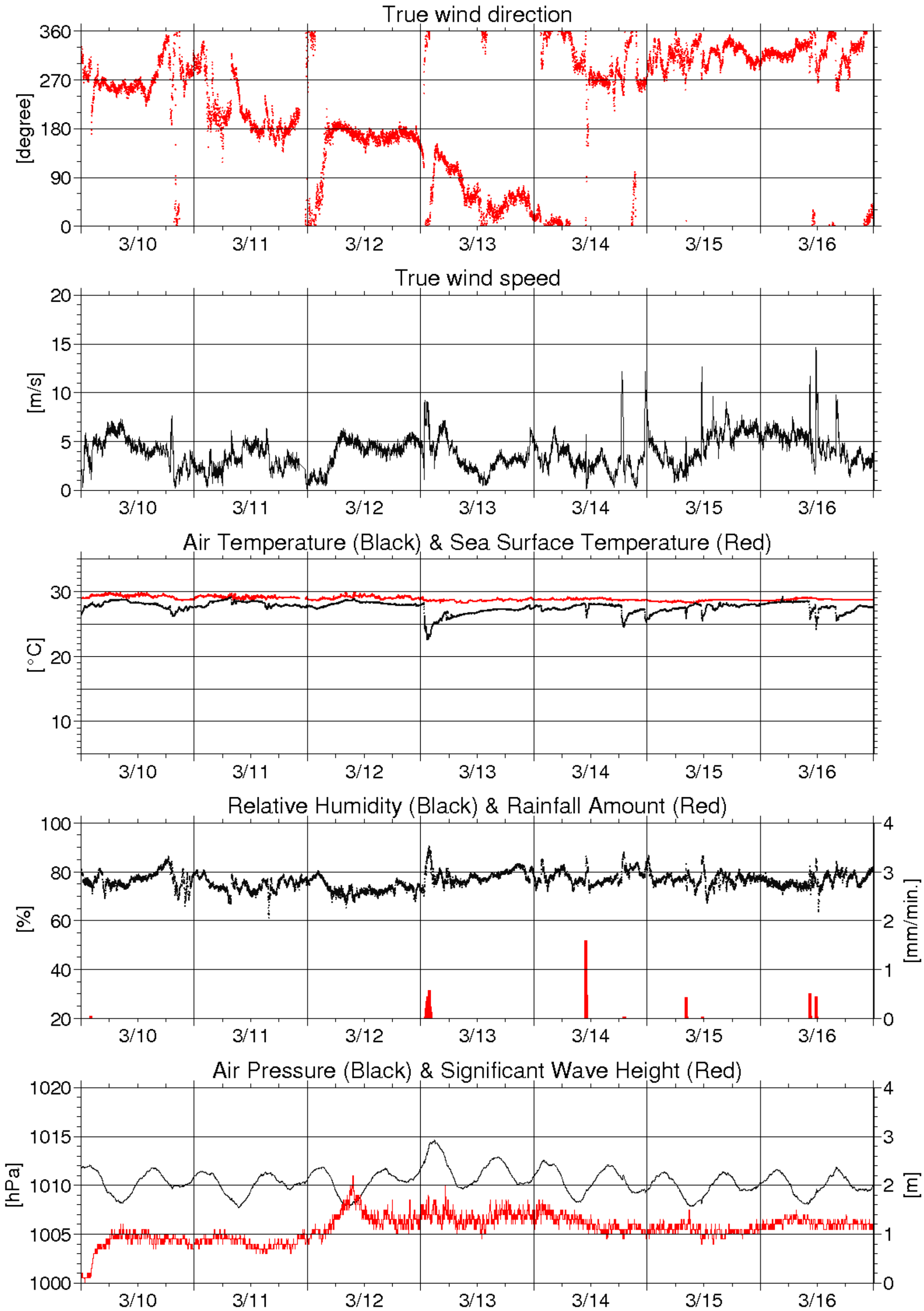


Fig.5.1.1-2 Time series examples of surface meteorological parameters during the KY09-01 Leg.2 cruise

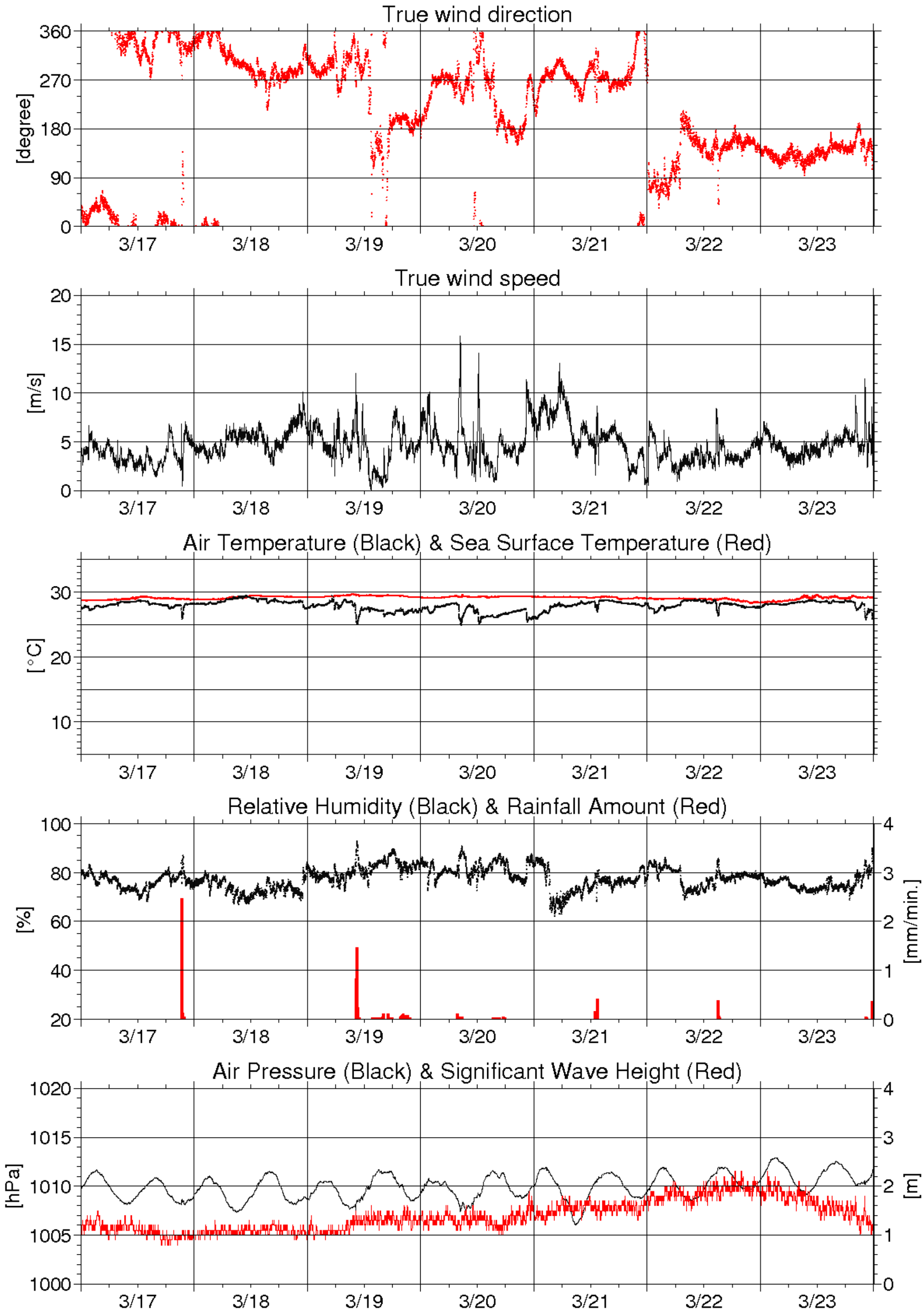


Fig.5.1.1-2 (Continued)

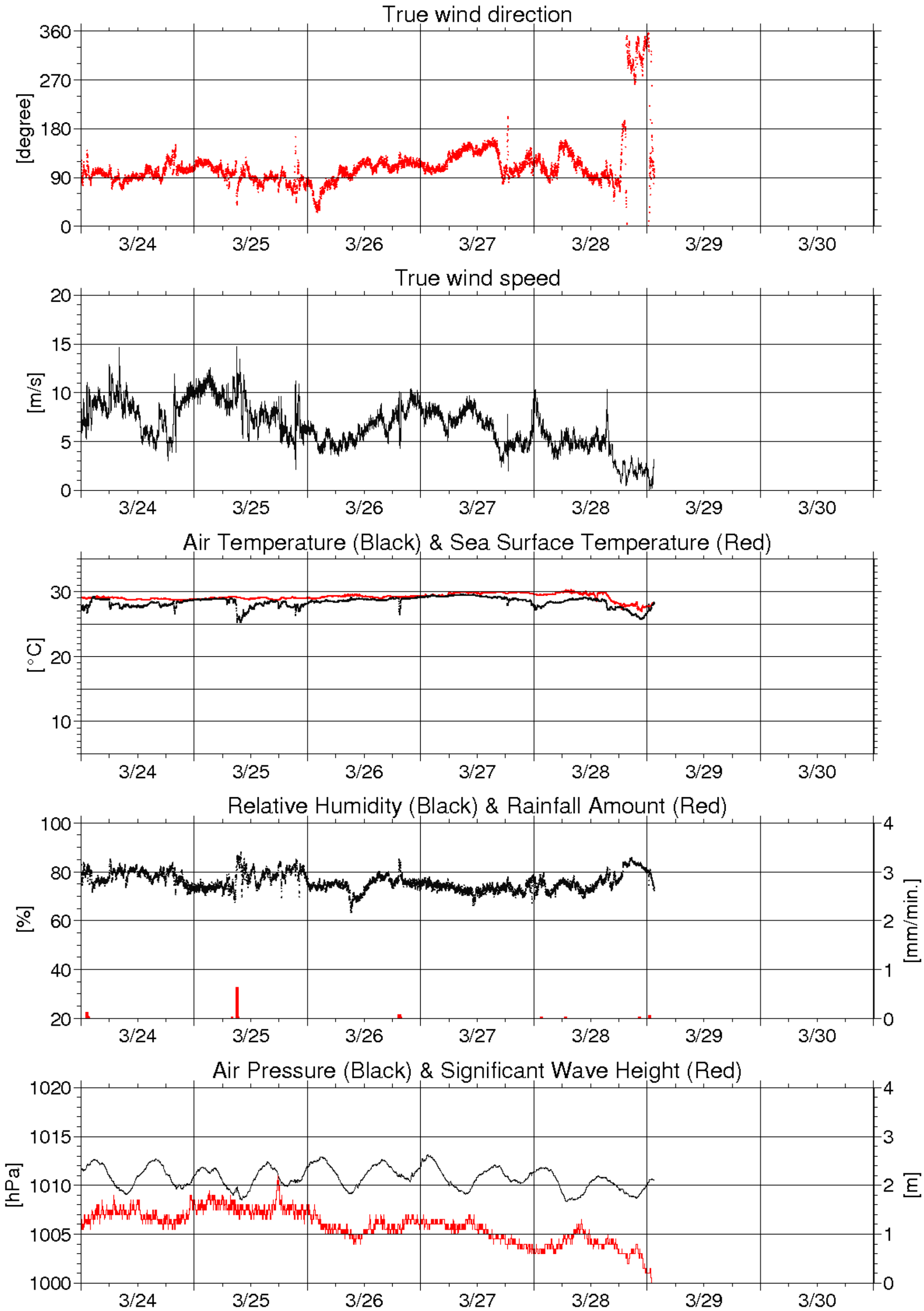


Fig.5.1.1-2 (Continued)

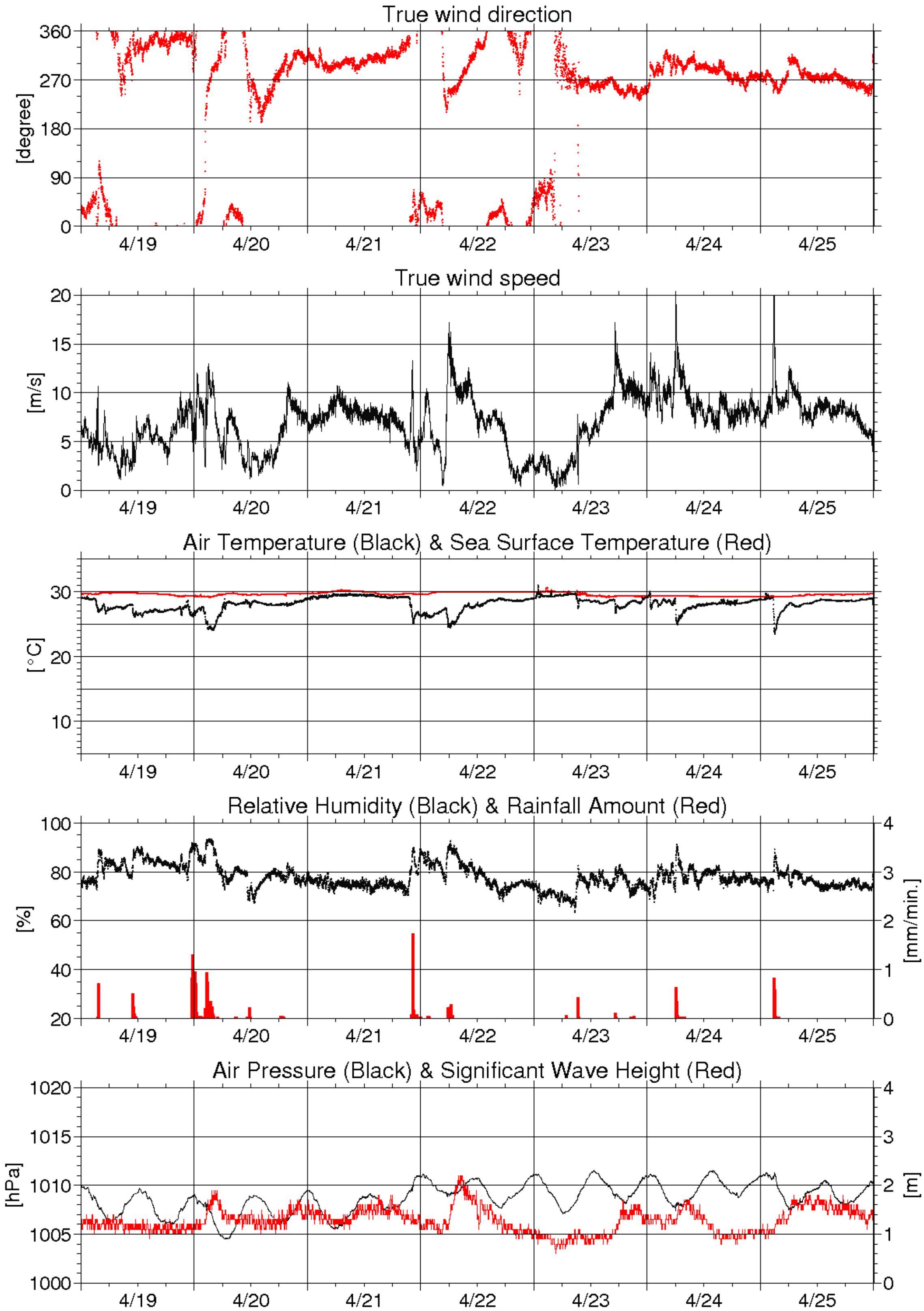


Fig.5.1.1-3 Time series examples of surface meteorological parameters during the KY09-01 Leg.3 cruise

5.1.2 SSST by SeaSnake

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator
Shinya Okumura	- Leg1 - (Global Ocean Development Inc., GODI)
Souichiro Sueyoshi	- Leg2 - (GODI)
Wataru Tokunaga	- Leg3 - (GODI)

(2) Objective

The purpose of this measurement is to observe the very-near sea surface temperature (called Skin Sea Surface Temperature) measurement by using a special floating temperature sensor during the cruise. 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 5 meter under the sea surface.

(3) Methods

To measure the skin sea surface temperature (SSST), the SeaSnake SSST-meter, the floating thermistor, was installed from the bow of the ship. In this cruise, SSST was observed using two thermistors (107 Campbell, USA) and measured output voltage every 10 seconds. 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-41 :	9.545556E-04	-1.927352E-04	-1.185653E-07
KYSSST-42 :	9.537750E-04	-1.928159E-04	-1.186452E-07

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 shows the time series of skin sea surface temperature. SSST was plotted using the data from KYSSST-41 and KYSSST-42 thermistors.

(5) Data archives

These data will be submitted to the Data Integration and Analysis Group (DIAG) of JAMSTEC just after the cruise. The dataset observed in archipelago area in Indonesia will be published two years later.

(6) Remarks

1. SSST (Skin Sea Surface Temperature) data were available in the following periods.
   04:00UTC 18 Feb. 2009 – 21:57UTC 22 Feb. 2009
   22:08UTC 22 Feb. 2009 – 07:54UTC 06 Mar. 2009
   05:13UTC 10 Mar. 2009 – 07:00UTC 28 Mar. 2009
   07:44UTC 13 Apr. 2009 – 06:05UTC 28 Apr. 2009
   (Except for US EEZ and territorial water)

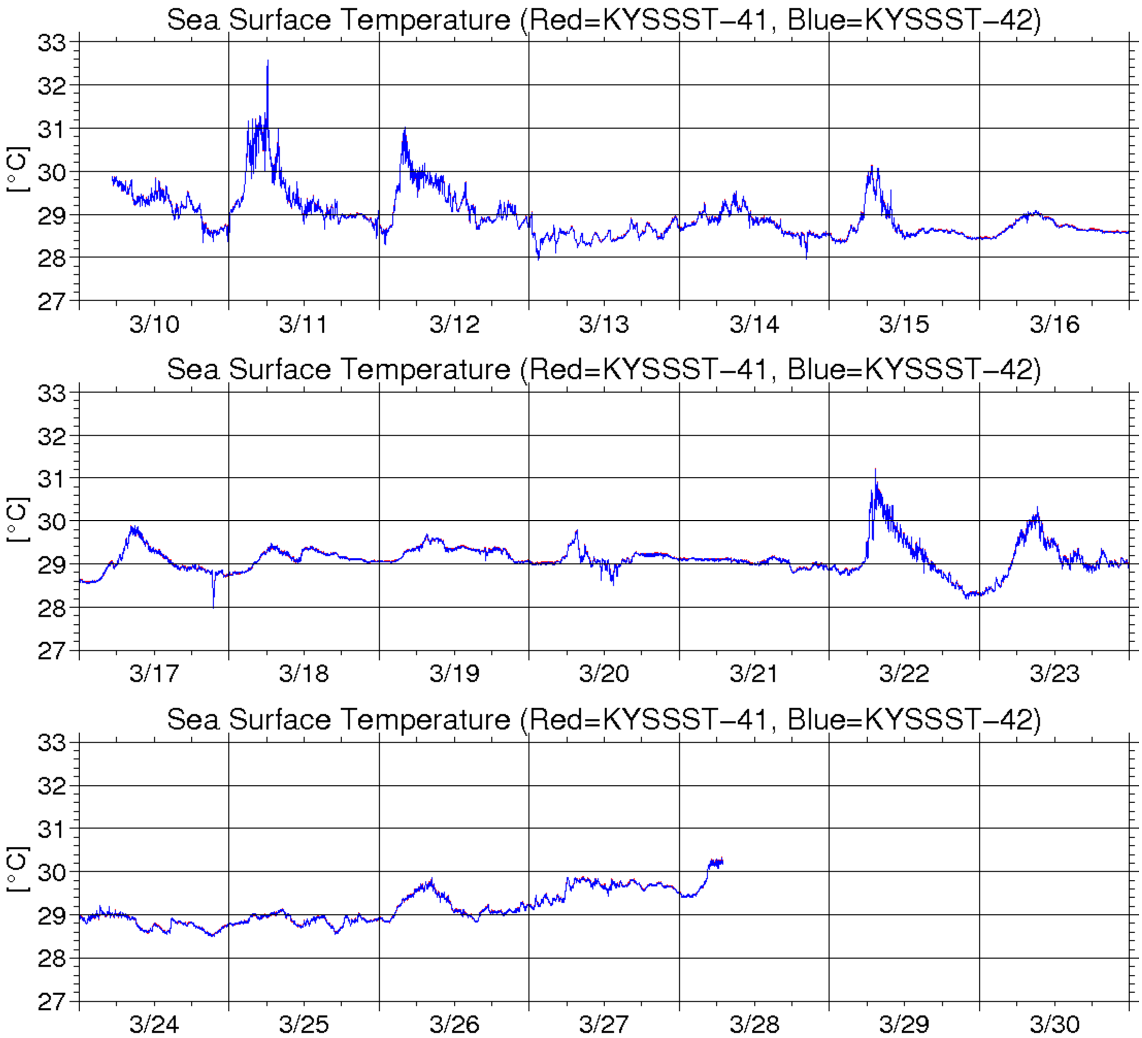


Fig 5.1.2-1 Time series examples of SSST during the KY09-01 (leg-2)
(Red: KYSSST-41, Blue: KYSSST-42)

5.2 CTD/XCTD/XBT

5.2.1. CTD

(1) Personnel

Leg1

Kentaro Ando	(JAMSTEC) : Principal investigator
Kenichi Katayama	(MWJ) : Operation leader
Akira Watanabe	(MWJ)
Fujio Kobayashi	(MWJ)
Hiroki Ushiromura	(MWJ)

Leg2

Yasuhisa Ishihara	(JAMSTEC) : Principal investigator
Tomohide Noguchi	(MWJ) : Operation leader
Hiroki Ushiromura	(MWJ)

Leg3

Shoichiro Baba	(JAMSTEC) : Principal investigator
Tomohide Noguchi	(MWJ) : Operation leader
Hiroki Ushiromura	(MWJ)
Shungo Oshitani	(MWJ)

(2) Objectives

Measurements 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), pressure, and altimeter. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD system was deployed from aft decks. During this cruise, total 61 casts of CTD observation at 18 stations were carried out (see Table 5.2.1).

(4) List of sensors and equipments

Under water unit: SBE, Inc., SBE 9plus, S/N 09P8010-0319
Under water unit: SBE, Inc., SBE 9plus, S/N 09P5457-0240
Temperature sensor: SBE, Inc., SBE 03-04/F, S/N 031465 (Primary)
Temperature sensor: SBE, Inc., SBE 03-04/F, S/N 031462 (Secondary)

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 04-04/0, S/N 041174 (Primary)
Conductivity sensor:	SBE, Inc., SBE 04-04/0, S/N 041045 (Secondary)
Conductivity sensor:	SBE, Inc., SBE 04-02/0, S/N 040960 (Primary)
Conductivity sensor:	SBE, Inc., SBE 04-02/0, S/N 041148 (Secondary)
Pump:	SBE, Inc., SBE 5T, S/N 050846 (Primary)
Pump:	SBE, Inc., SBE 5T, S/N 050847 (Secondary)
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P9833-0345
Deck unit:	SBE, Inc., SBE 11plus, S/N 11P8010-0307
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 3252859-0696
Carousel Water Sampler:	SBE, Inc., SBE 32, S/N 329833-0026
Altimeter:	Teledyne Benthos, Inc., PSA-916T, S/N 1239
Water sample bottle:	General Oceanics, Inc., 5-litre Niskin

(5) Data processing

The SEASOFT-Win32 (Ver. 7.18c) 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.

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 1.75 scans (1.75/24 = 0.073 seconds).

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 100 scans. Data greater than 2 standard deviations were flagged. The second pass computed a standard deviation over the same 100 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).

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.

(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 5.2.1-1 and Figure 5.2.1-2.

(7) Data archive

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

Table 5.2.1 CTD Cast Table

		Date(UTC)	Time(UTC)		Bottom Position		Depth	Wire	Max	Max	CTD	
Stn.	Cast	mmddyy	Start	End	Latitude	Longitude	(MNB)	Out	Depth	Pressure	File name	Remarks
T01	1	022009	23:57	24:45	08-53.54N	132-37.37E	4414.0	1008.2	1001.52	1009.95	T01S01	Test cast, releaser test at the bottom
C01	1	022209	04:39	05:27	07-58.96N	130-00.19E	5718.0	1000.2	1001.72	1008.93	C01S01	TRITON deploy
C02	1	022209	06:14	07:02	07-55.99N	130-02.69E	5641.0	1001.0	1001.14	1009.12	C02S01	TRITON recovery
C03	1	022509	02:15	03:04	01-56.69N	129-55.19E	4429.0	1002.9	998.10	1005.95	C03S01	TRITON deploy Carousel did not work properly
C04	1	022509	21:38	22:27	02-01.01N	130-11.90E	4378.0	1001.7	1000.22	1008.14	C04S01	TRITON recovery
C05	1	022809	21:45	22:11	02-32.39S	126-40.24E	-	-	-	-	C05S01	Seram repeat(Yo-Yo) observation
C05	2	022809	22:44	23:13	02-32.12S	126-40.23E	-	-	-	-	C05S02	Seram repeat(Yo-Yo) observation
C05	3	020809	23:20	23:46	02-32.29S	126-40.24E	-	-	-	-	C05S03	Seram repeat(Yo-Yo) observation
C05	4	022809	23:50	24:21	02-32.27S	126-40.17E	-	-	-	-	C05S04	Seram repeat(Yo-Yo) observation
C05	5	030109	00:24	00:55	02-32.29S	126-40.13E	-	-	-	-	C05S05	Seram repeat(Yo-Yo) observation
C05	6	030109	00:59	01:31	02-32.33S	126-40.13E	-	-	-	-	C05S06	Seram repeat(Yo-Yo) observation
C05	7	030109	01:35	02:07	02-32.33S	126-40.09E	-	-	-	-	C05S07	Seram repeat(Yo-Yo) observation
C05	8	030109	02:10	02:43	02-32.29S	126-39.93E	-	-	-	-	C05S08	Seram repeat(Yo-Yo) observation
C05	9	030109	02:46	03:17	02-32.30S	126-39.85E	-	-	-	-	C05S09	Seram repeat(Yo-Yo) observation
C05	10	030109	03:19	03:51	02-32.22S	126-39.67E	-	-	-	-	C05S10	Seram repeat(Yo-Yo) observation
C05	11	030109	03:54	04:25	02-32.16S	126-39.61E	-	-	-	-	C05S11	Seram repeat(Yo-Yo) observation
C05	12	030109	04:28	04:59	02-32.11S	126-39.57E	-	-	-	-	C05S12	Seram repeat(Yo-Yo) observation
C05	13	030109	05:02	05:36	02-31.76S	126-39.41E	-	-	-	-	C05S13	Seram repeat(Yo-Yo) observation
C05	14	030109	05:38	06:08	02-31.48S	126-39.28E	-	-	-	-	C05S14	Seram repeat(Yo-Yo) observation
C05	15	030109	06:11	06:43	02-31.59S	126-39.32E	-	-	-	-	C05S15	Seram repeat(Yo-Yo) observation
C05	16	030109	06:45	07:17	02-31.77S	126-39.26E	-	-	-	-	C05S16	Seram repeat(Yo-Yo) observation
C05	17	030109	07:20	07:51	02-31.84S	126-39.18E	-	-	-	-	C05S17	Seram repeat(Yo-Yo) observation
C05	18	030109	07:54	09:04	02-31.97S	126-39.04E	-	-	-	-	C05S18	Seram repeat(Yo-Yo) observation
C06	1	030509	22:35	23:05	08-27.39S	115-45.95E	-	-	-	-	C06S01	Lombok repeat(Yo-Yo) observation
C06	2	030509	23:23	23:45	08-27.60S	115-45.97E	-	-	-	-	C06S02	Lombok repeat(Yo-Yo) observation
C06	3	030509	23:48	24:08	08-27.63S	115-46.11E	-	-	-	-	C06S03	Lombok repeat(Yo-Yo) observation
C06	4	030609	00:11	00:32	08-27.56S	115-46.24E	-	-	-	-	C06S04	Lombok repeat(Yo-Yo) observation
C06	5	030609	00:34	00:54	08-27.50S	115-46.28E	-	-	-	-	C06S05	Lombok repeat(Yo-Yo) observation
C06	6	030609	00:57	01:17	08-27.48S	115-46.25E	-	-	-	-	C06S06	Lombok repeat(Yo-Yo) observation
C06	7	030609	01:20	01:39	08-27.58S	115-46.22E	-	-	-	-	C06S07	Lombok repeat(Yo-Yo) observation
C06	8	030609	01:45	02:05	08-27.70S	115-46.21E	-	-	-	-	C06S08	Lombok repeat(Yo-Yo) observation
C06	9	030609	02:10	02:30	08-27.79S	115-46.16E	-	-	-	-	C06S09	Lombok repeat(Yo-Yo) observation
C06	10	030609	02:35	02:55	08-27.82S	115-46.22E	-	-	-	-	C06S10	Lombok repeat(Yo-Yo) observation
C06	11	030609	03:00	03:20	08-27.93S	115-46.23E	-	-	-	-	C06S11	Lombok repeat(Yo-Yo) observation
C06	12	030609	03:25	03:45	08-28.09S	115-46.30E	-	-	-	-	C06S12	Lombok repeat(Yo-Yo) observation
C06	13	030609	03:50	04:11	08-28.20S	115-46.24E	-	-	-	-	C06S13	Lombok repeat(Yo-Yo) observation
C06	14	030609	04:15	04:35	08-28.32S	115-46.22E	-	-	-	-	C06S14	Lombok repeat(Yo-Yo) observation
C06	15	030609	04:40	05:00	08-28.42S	115-46.27E	-	-	-	-	C06S15	Lombok repeat(Yo-Yo) observation
C06	16	030609	05:05	05:24	08-28.47S	115-46.24E	-	-	-	-	C06S16	Lombok repeat(Yo-Yo) observation
C06	17	030609	05:30	05:50	08-28.48S	115-46.03E	-	-	-	-	C06S17	Lombok repeat(Yo-Yo) observation
C06	18	030609	05:55	06:15	08-28.68S	115-45.87E	-	-	-	-	C06S18	Lombok repeat(Yo-Yo) observation
C06	19	030609	06:20	06:40	08-28.94S	115-45.70E	-	-	-	-	C06S19	Lombok repeat(Yo-Yo) observation
C06	20	030609	06:45	07:04	08-29.03S	115-45.62E	-	-	-	-	C06S20	Lombok repeat(Yo-Yo) observation
C06	21	030609	07:10	07:29	08-28.85S	115-45.61E	-	-	-	-	C06S21	Lombok repeat(Yo-Yo) observation
C06	22	030609	07:35	07:55	08-28.71S	115-45.67E	-	-	-	-	C06S22	Lombok repeat(Yo-Yo) observation
C06	23	030609	08:00	08:19	08-28.54S	115-45.72E	-	-	-	-	C06S23	Lombok repeat(Yo-Yo) observation
C06	24	030609	08:25	08:45	08-28.44S	115-45.73E	-	-	-	-	C06S24	Lombok repeat(Yo-Yo) observation
C06	25	030609	08:50	09:09	08-28.32S	115-45.72E	-	-	-	-	C06S25	Lombok repeat(Yo-Yo) observation
C06	26	030609	09:15	09:34	08-28.27S	115-45.64E	-	-	-	-	C06S26	Lombok repeat(Yo-Yo) observation
C06	27	030609	09:40	10:00	08-28.17S	115-45.55E	-	-	-	-	C06S27	Lombok repeat(Yo-Yo) observation
C07	1	031609	06:00	06:31	05-01.75S	095-01.72E	5009.0	999.9	1000.70	1008.40	C07S01	JEPP deploy
C08	1	031909	07:02	07:34	01-35.20S	090-06.55E	4700.0	1003.4	1001.18	1007.73	C08S01	JEPP deploy
C09	1	031909	08:35	09:07	01-39.52S	090-01.37E	4695.0	1002.5	1001.11	1008.36	C09S01	JEPP recovery
C10	1	032109	07:01	07:32	00-00.42N	090-02.82E	4334.0	1006.1	1000.01	1007.83	C10S01	ADCP recovery and deploy
C11	1	041509	20:02	20:37	07-38.16N	136-42.20E	3172.0	1001.0	999.92	1007.58	C11S01	TRITON recovery
C12	1	041709	03:01	03:36	07-38.70N	136-41.27E	3171.0	1000.8	1000.11	1008.25	C12S01	TRITON deploy
C13	1	041909	03:02	03:34	04-51.34N	137-16.15E	4093.0	1013.6	1000.06	1008.07	C13S01	TRITON deploy
C14	1	041909	04:16	04:50	04-54.93N	137-17.76E	4020.0	1052.5	999.47	1007.37	C14S01	TRITON recovery
C15	1	042109	20:04	20:35	02--03.36N	138-04.62E	4317.0	1001.8	1000.39	1008.14	C15S01	TRITON recovery
C16	1	042309	03:03	03:36	02-03.37N	138-04.60E	4325.0	1005.6	1001.31	1009.02	C16S01	TRITON deploy
C17	1	042309	20:04	20:37	00-01.57N	137-54.47E	4343.0	1000.3	1001.14	1009.25	C17S01	TRITON recovery
C18	1	042509	03:24	03:55	00-02.21N	137-54.13E	4353.0	1001.9	1000.52	1008.50	C18S01	TRITON deploy

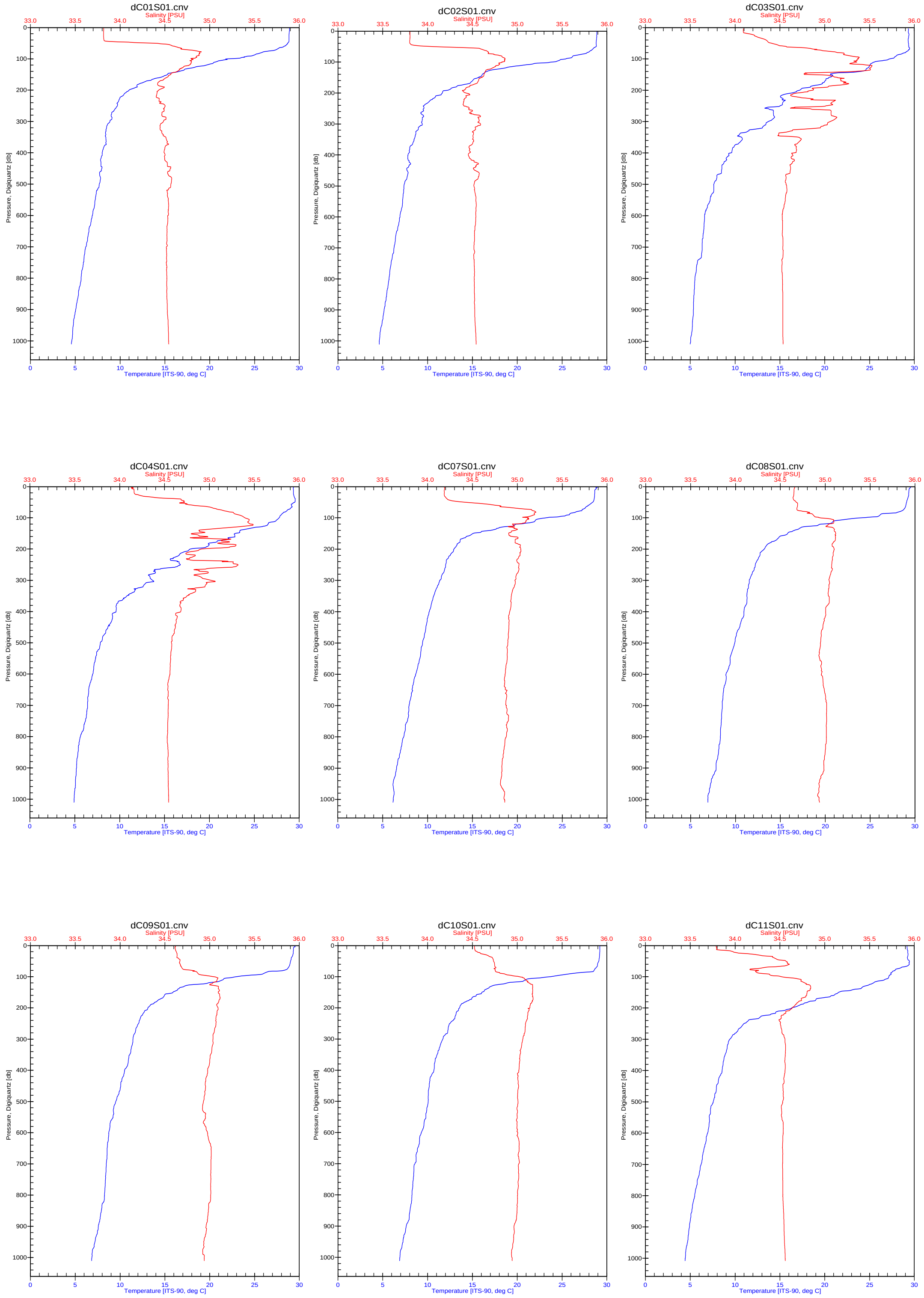


Figure 5.2.1-1 CTD profile

(C01S01, C02S01, C03S01, C04S01, C07S01, C08S01, C09S01, C10S01 and C11M01)

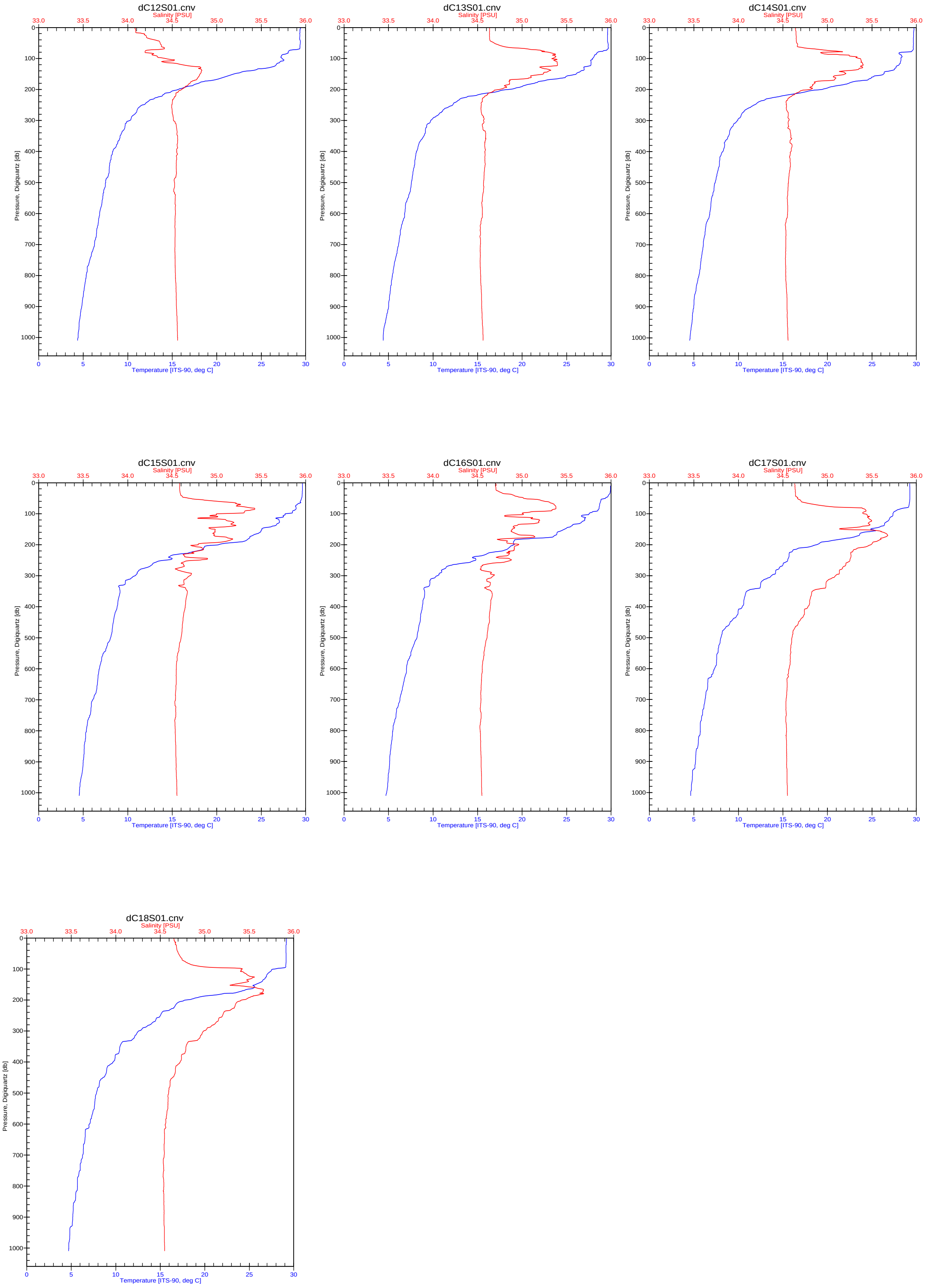


Figure 5.2.1-2 CTD profile

(C12S01, C13S01, C14S01, C15S01, C16S01, C17S01 and C18S01)

5.2.1.1 Inter-comparison with TRITON data

(1) Personnel

Kentaro Ando	(JAMSTEC): Principal Investigator (Leg-1)
Yasuhisa Ishihara	(JAMSTEC): Principal Investigator (Leg-1)
Shoichiro Baba	(JAMSTEC): Principal Investigator (Leg-1)
Hiroshi Matsunaga	(MWJ): Operation Leader
Kenichi Katayama	(MWJ): Technical staff
Tomohide Noguchi	(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 on R/V KAIYO for this intercomparison. We conducted 1 CTD cast at each TRITON buoy site before recovery, conducted 1 CTD cast at each TRITON buoy site after deployment. The cast was performed immediately after the deployment and before recovery. R/V KAIYO was kept the distance from the TRITON buoy within about 2 nm. TRITON buoy data was sampled every 1 hour except for transmission to the ship. We compared CTD observation by R/V KAIYO 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 KAIYO and the TRITON buoy data for each deployment and recovery of buoys

Compared site

Observation No.	Latitude	Longitude	Condition
10008	8N	137E	After Deployment
11008	5N	137E	After Deployment
12010	2N	138E	After Deployment
13010	EQ	138E	After Deployment
14006	8N	130E	After Deployment
10007	8N	137E	Before Recover
11007	5N	137E	Before Recover
12009	2N	137E	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 5.2.1.1.-1(a)(b).

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

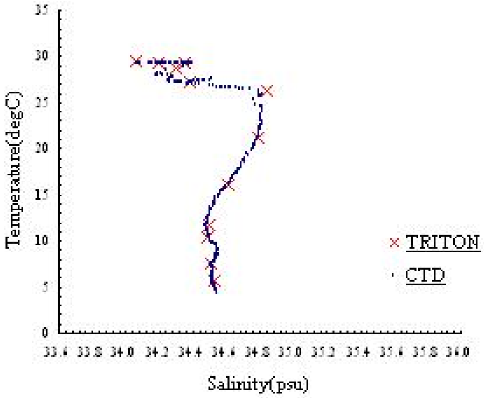
The estimations were calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from -0.0722 to 0.0649 for all depths. Below 300db, salinity differences are from -0.0237 to 0.0119 (See the Figures 5.2.1.1.-2 (a) and Table 5.2.1.1.-1 (a)). The absolute average of all salinity differences was 0.0177 with absolute standard deviation of 0.0186.

The estimations were calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.191 to 0.1389 for all depths. Below 300db, salinity differences are from –0.0123 to 0.0076 (See the Figure 5.2.1.1.-2(b) and Table 5.2.1.1.-1 (b)). The absolute average of salinity differences was 0.045 with absolute standard deviation of 0.0502.

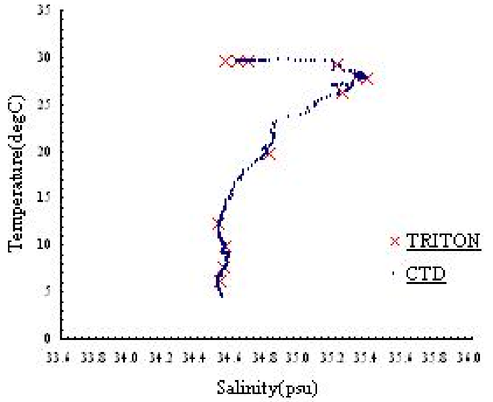
The estimations of time-drift were calculated as recovered buoy data minus deployed buoy data. The difference of salinity over 1 year had the variation ranging from 0.0004 to 1.0038, for all depths. Below 300db, the difference of salinity over 1 year had the variation ranging from 0.0004 to 0.0462 (See the figures 5.2.1.1.-2(c)). The absolute average of salinity differences was 0.0783 with absolute standard deviation of 0.1673.

(6) Data archive

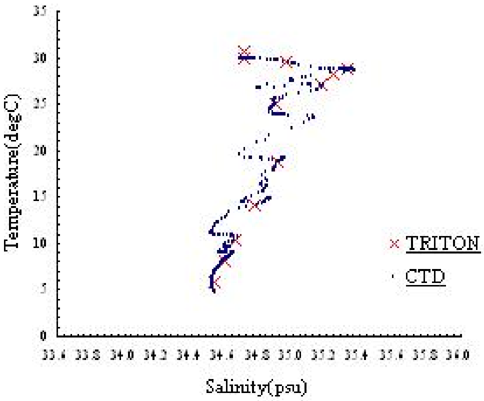
These CTD data will be submitted to Data Integration and Analyses Group (DIAG) of JAMSTEC. All original data will be stored at JAMSTEC Mutsu branch. (See section 5)



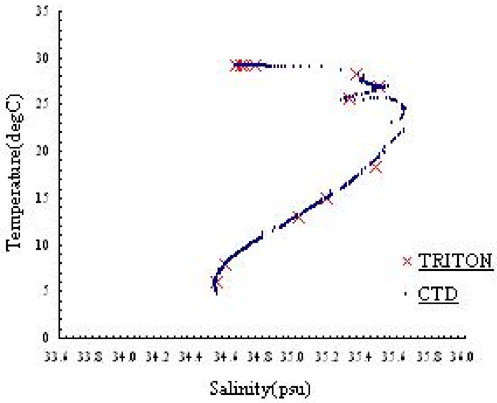
Observation No. 10008 after Deployment



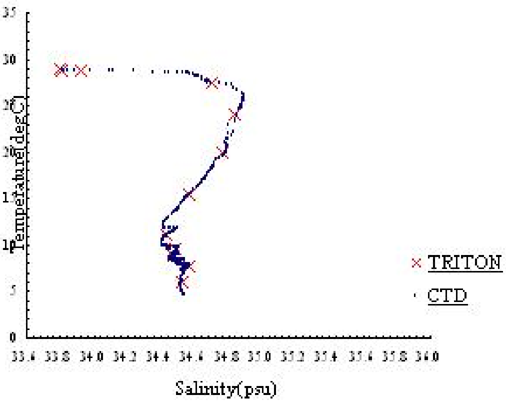
Observation No. 11008 after Deployment



Observation No. 12010 after Deployment

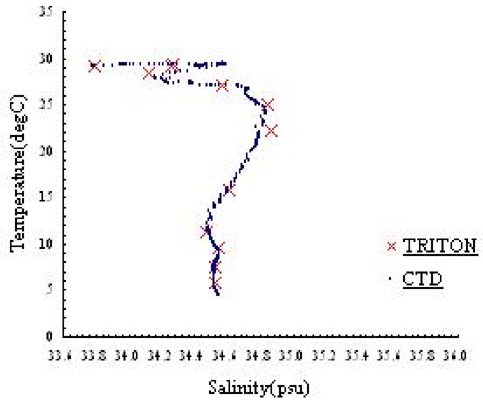


Observation No. 13009 after Deployment

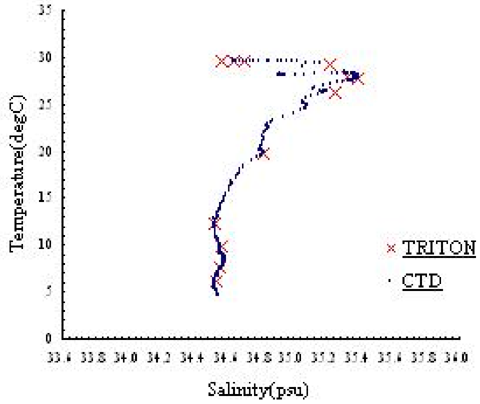


Observation No. 14007 after Deployment

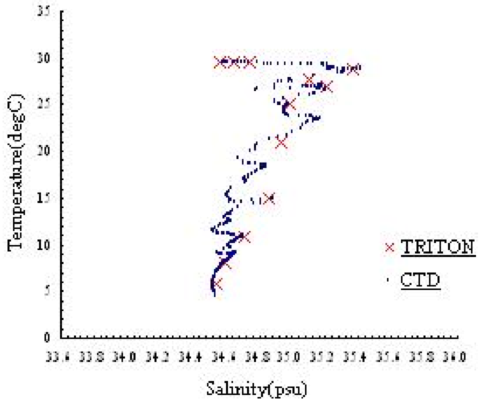
Fig.5.2.1.1.-1(a) T-S diagram of TRITON buoys data and shipboard XCTD data



Observation No. 10007 Before Recovery



Observation No. 11007 Before Recovery



Observation No. 12009 Before Recovery

Fig.5.2.1.1.-1(b) T-S diagram of TRITON buoys data and shipboard CTD data

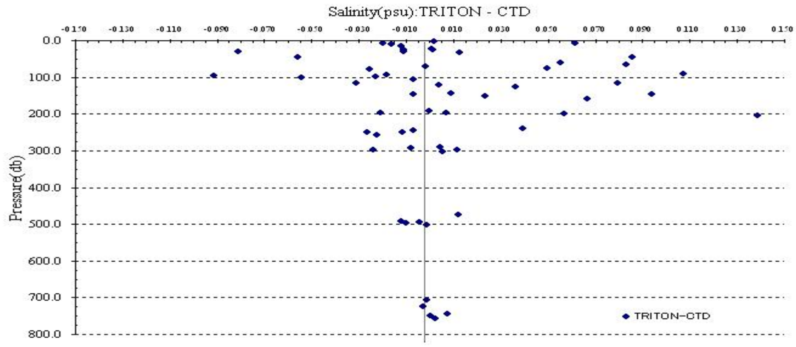


Fig.5.2.1.1.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

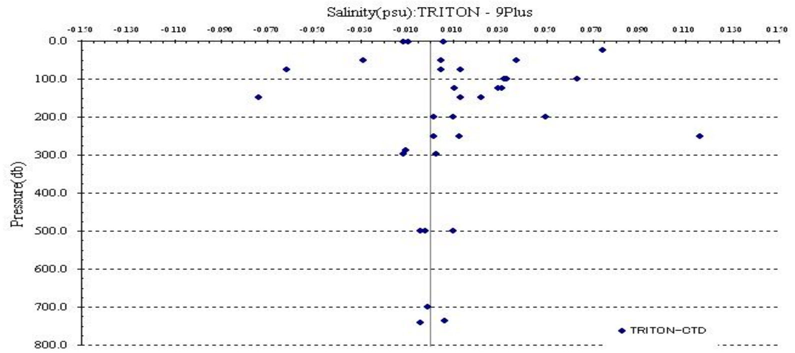


Fig.5.2.1.1.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

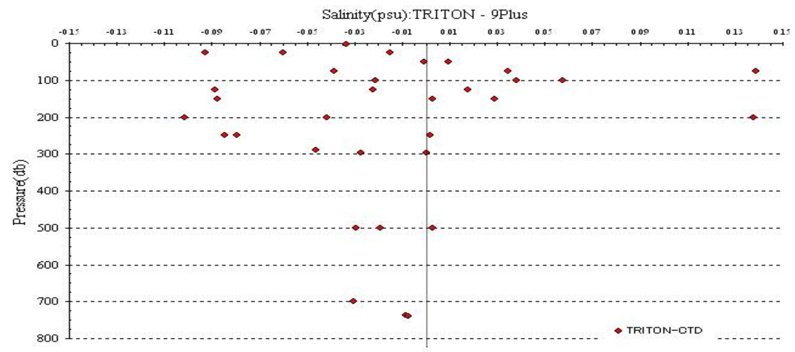


Fig.5.2.1.1.-2 (c) Salinity differences between deployment data and recovery data for 1year Observation No.10,11,12

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

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
10008	3.0	-0.07	-0.007	0.002
10008	22.0	-0.01	-0.001	0.001
10008	48.0	0.00	-0.028	-0.191
10008	72.0	0.00	-0.024	-0.166
10008	96.0	0.01	-0.012	-0.091
10008	127.0	0.00	0.005	0.036
10008	158.0	0.21	0.031	0.066
10008	197.0	0.02	0.002	0.007
10008	250.0	0.01	-0.001	-0.026
10008	290.0	0.00	0.001	0.005
10008	498.0	0.00	-0.001	-0.010
10008	758.0	-0.01	-0.001	0.002
11008	31.0	-0.11	-0.024	-0.081
11008	31.0	-0.08	-0.010	-0.011
11008	60.0	0.00	0.009	0.055
11008	75.0	-0.30	-0.025	0.050
11008	101.0	-0.01	-0.009	-0.055
11008	106.0	0.00	-0.001	-0.007
11008	147.0	0.04	0.017	0.094
11008	192.0	0.05	0.005	0.000
11008	246.0	-0.01	-0.001	-0.007
11008	294.0	0.00	-0.001	-0.008
11008	491.0	0.00	0.000	-0.012
11008	706.0	0.00	0.000	-0.001
12010	8.0	0.00	0.008	0.061
12010	11.0	0.00	-0.002	-0.016
12010	45.0	0.00	0.012	0.086
12010	66.0	-0.02	0.010	0.083
12010	92.0	0.02	0.017	0.107
12010	115.0	0.01	0.012	0.080
12010	144.0	0.01	0.002	0.009
12010	204.0	0.05	0.023	0.139
12010	257.0	0.01	-0.001	-0.023
12010	302.0	-0.01	0.000	0.006
12010	503.0	0.00	0.000	-0.001
12010	744.0	-0.01	0.000	0.008
13010	16.0	0.00	-0.003	-0.012
13010	25.0	-0.01	-0.001	0.002
13010	32.0	0.00	0.003	0.012
13010	79.0	0.00	-0.004	-0.026
13010	98.0	-0.02	-0.005	-0.023
13010	122.0	0.00	0.001	0.004
13010	151.0	0.02	0.005	0.023
13010	199.0	0.10	0.017	0.057
13010	250.0	0.01	-0.001	-0.012
13010	297.0	0.00	0.002	0.012
13010	495.0	0.00	0.000	-0.004
13010	750.0	0.00	-0.001	0.000
14007	7.0	0.00	-0.003	-0.020
14007	25.0	0.00	-0.002	-0.011
14007	46.0	0.00	-0.008	-0.056
14007	70.0	-0.01	-0.001	-0.002
14007	93.0	0.06	0.004	-0.019
14007	117.0	-0.03	-0.006	-0.031
14007	146.0	0.07	0.006	-0.007
14007	197.0	-0.02	-0.004	-0.021
14007	241.0	0.01	0.005	0.039
14007	297.0	0.02	-0.001	-0.024
14007	474.0	0.00	0.002	0.012
14007	724.0	0.00	0.000	-0.003

bad data

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

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
10007	1.5	0.00	0.001	0.006
10007	25.0	0.01	-0.028	-0.200
10007	50.0	0.00	-0.005	-0.029
10007	75.0	-0.10	-0.008	0.013
10007	100.0	-0.05	-0.001	0.032
10007	125.0	-0.10	-0.006	0.031
10007	150.0	0.01	0.002	0.013
10007	200.0	0.00	0.001	0.010
10007	250.0	-0.02	-0.001	0.012
10007	297.2	-0.01	0.000	0.002
10007	500.0	0.00	0.000	-0.002
10007	736.6	-0.01	0.000	0.007
11007	1.5	-0.02	-0.004	-0.012
11007	25.0	0.02	0.013	0.074
11007	50.0	0.03	0.004	0.005
11007	75.0	0.00	0.001	0.005
11007	100.0	0.02	0.011	0.063
11007	125.0	-0.01	0.001	0.011
11007	150.0	0.02	-0.008	-0.074
11007	200.0	0.02	0.008	0.050
11007	250.0	0.09	0.022	0.116
11007	288.9	0.02	0.001	-0.011
11007	500.0	0.00	0.000	0.010
11007	700.2	-0.01	-0.001	-0.001
12009	1.5	0.07	0.005	-0.009
12009	25.0	0.00	-0.072	-0.490
12009	50.0	0.01	0.006	0.037
12009	75.0	0.00	-0.009	-0.062
12009	100.0	0.07	0.011	0.033
12009	125.0	0.02	0.006	0.029
12009	150.0	-0.03	0.000	0.022
12009	200.0	-0.06	-0.006	0.002
12009	250.0	0.00	0.001	0.002
12009	298.0	0.00	-0.001	-0.011
12009	500.0	0.04	0.004	-0.004
12009	740.5	0.04	0.003	-0.004

bad data

5.2.2 XCTD/XBT

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator: Leg1
Yasuhisa Ishihara	(JAMSTEC) Principal Investigator: Leg2
Syoichiro Baba	(JAMSTEC) Principal Investigator: Leg3
Hiroki Ushiromura	(Marine Works Japan Ltd., MWJ): Leg1 – Leg3
Fujio Kobayashi	(MWJ): Leg1
Kenichi Katayama	(MWJ): Leg1
Akira Watanabe	(MWJ): Leg1
Hirokatsu Uno	(MWJ): Leg2
Akira So	(MWJ): Leg2
Hirotada Moki	(MWJ): Leg1 – Leg2
Takatomo Shirodume	(MWJ): Leg1 – Leg2
Kenichi Kato	(MWJ): Leg3
Yasushi Hashimoto	(MWJ): Leg3
Syungo Oshitani	(MWJ): Leg3
Kazuma Nakano	(MWJ): Leg3
Kohei Osakabe	(MWJ): Leg3

(2) Objectives

Measurements 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 KY09-01 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 (Leg1), Table 5.2.2-2 (Leg2), and Table 5.2.2-3 (Leg3). The observation sites of XBT and XCTD, three temperature-depth sections along 130E, ship track from 5S95E to 0-90E, and 138E line are shown in Figure 5.2.2-1 to 5.2.2-4.

(5) Data archives

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

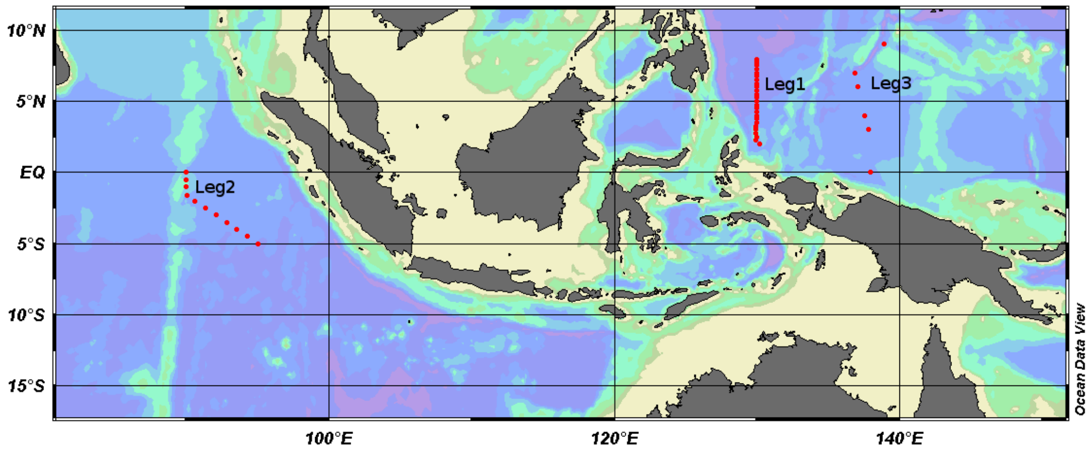


Figure 5.2.2-1 XCTD and XBT locations shown in Figure 5.2.2-2, 5.2.2-3, and 5.2.2-4.

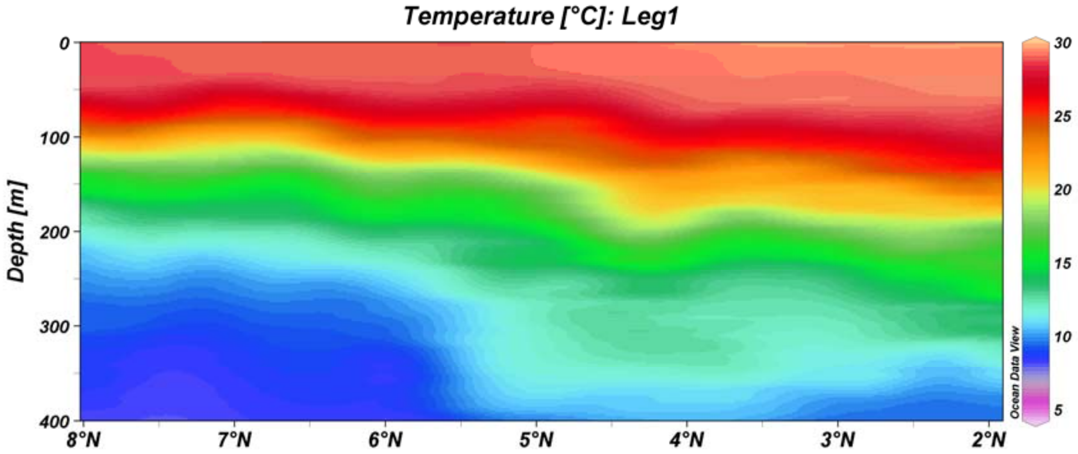


Figure 5.2.2-2 Temperature sections along 130E from 8N to 2N during leg-1 by XBT and XCTD.

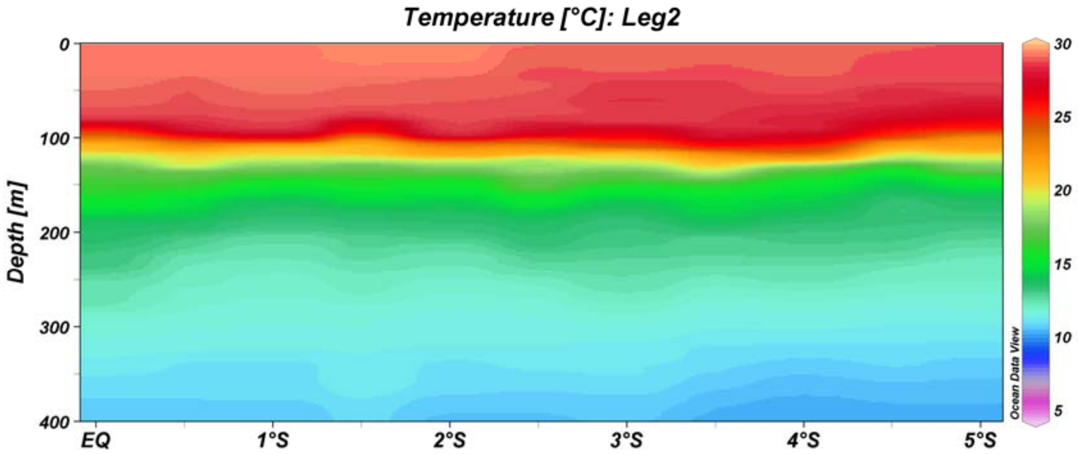


Figure 5.2.2-3 Temperature sections along ship track from 5S95E to 0-90E during leg-2 by XBT and XCTD.

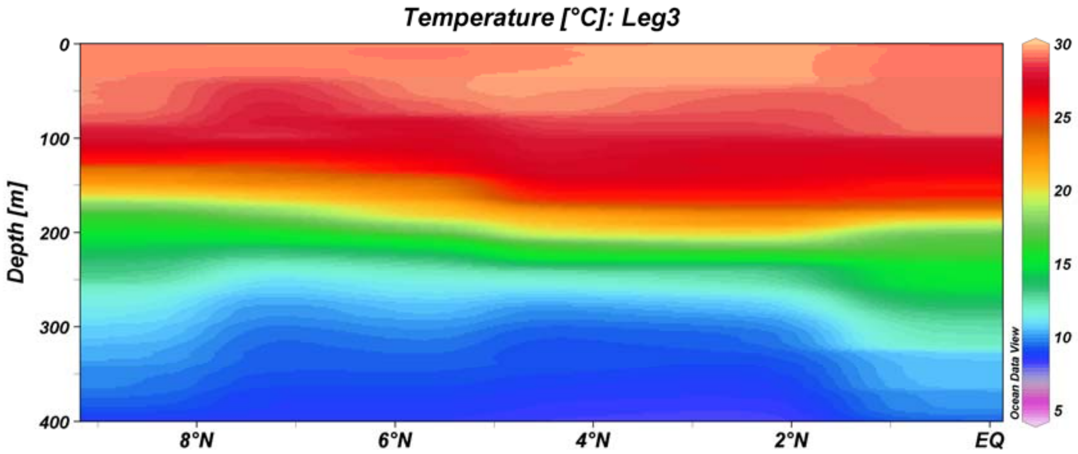


Figure 5.2.2-4 Temperature sections along 138-137E from 8N to Eq. during leg-3 by XBT and XCTD.

Table 5.2.2-1 KY09-01 Leg1 XCTD/XBT Observation Log

Probe Type	Date (UTC)	Time (UTC)	Latitude (N)	Longitude (E)	File Name	Probe S/N	Remarks
XBT	2009/2/18	21:57:52	11-59.9888	140-42.9019	BT-052620090218	019944	
XBT	2009/2/19	14:17:41	10-59.9895	138-01.8905	BT-052720090219	019945	
XBT	2009/2/20	06:42:54	09-59.9808	135-21.7502	BT-052820090220	019946	
XBT	2009/2/20	22:34:22	08-59.9829	132-42.1177	BT-052920090220	019947	
XCTD	2009/2/23	04:01:36	07-54.3883	129-57.7608	CTD-033920090223	08091204	
XBT	2009/2/23	05:05:44	07-44.9796	129-57.6320	BT-053120090223	019948	
XCTD	2009/2/23	06:46:40	07-29.9790	129-57.5018	CTD-034020090223	08091205	
XBT	2009/2/23	08:28:19	07-14.9818	129-57.6242	BT-053220090223	019949	
XCTD	2009/2/23	09:51:22	06-59.9800	129-57.4734	CTD-034120090223	08091206	
XBT	2009/2/23	11:07:38	06-44.9803	129-57.7543	BT-053320090223	019950	
XCTD	2009/2/23	12:27:47	06-29.9761	129-57.8142	CTD-034220090223	08091207	
XBT	2009/2/23	13:55:50	06-14.9814	129-57.3350	BT-053420090223	019951	
XCTD	2009/2/23	15:27:24	05-59.9790	129-57.3222	CTD-034320090223	08091208	
XBT	2009/2/23	17:01:06	05-44.9833	129-57.3644	BT-053520090223	019952	
XCTD	2009/2/23	18:37:47	05-29.9830	129-57.1508	CTD-034420090223	08091209	
XBT	2009/2/23	20:11:27	05-14.9789	129-56.9201	BT-053620090223	0919953	
XCTD	2009/2/23	21:41:04	04-59.9817	129-56.9874	CTD-034520090223	08091210	
XBT	2009/2/23	23:09:28	04-44.9827	129-56.9194	BT-053720090223	019954	
XCTD	2009/2/24	01:21:54	04-29.9840	129-57.6939	CTD-034620090224	08091211	
XBT	2009/2/24	02:54:04	04-14.9835	129-56.8150	BT-053820090224	019955	
XCTD	2009/2/24	04:21:47	03-59.9810	129-56.4402	CTD-034720090224	08091212	

Table 5.2.2-1 KY09-01 Leg1 XCTD/XBT Observation Log (continued)

Probe Type	Date (UTC)	Time (UTC)	Latitude (N)	Longitude (E)	File Name	Probe S/N	Remarks
XBT	2009/2/24	05:47:42	03-44.9496	129-56.3910	BT-053920090224	019956	
XCTD	2009/2/24	-	-	-	CTD-034820090224	08091213	Probe trouble Canceled
XCTD	2009/2/24	07:14:54	03-29.4177	129-56.1625	CTD-034920090224	08091214	
XBT	2009/2/24	08:34:24	03-14.9824	129-55.8868	BT-054020090224	0919957	
XCTD	2009/2/24	09:57:31	02-59.9878	129-55.9091	CTD-035020090224	08091215	
XBT	2009/2/24	11:20:00	02-44.9868	129-55.7341	BT-054120090224	019958	
XCTD	2009/2/24	12:46:36	02-29.9835	129-56.9503	CTD-035120090224	08091216	
XBT	2009/2/24	14:07:05	02-14.9869	129-55.9880	BT-054220090224	019959	
XCTD	2009/2/26	07:46:19	02-01.4081	130-10.9478	CTD-035220090226	08091217	

Table 5.2.2-2 KY09-01 Leg2 XCTD/XBT Observation Log

Probe Type	Date (UTC)	Time (UTC)	Latitude(S)	Longitude (E)	File Name	Probe S/N	Remarks
XCTD	2009/3/10	15:39:41	08-35.3630	112-59.9689	CTD-035320090310	08091218	
XCTD	2009/3/10	21:59:40	08-30.1049	111-59.9734	CTD-035420090310	08091219	
XBT	2009/3/10	22:05:01	08-30.0291	111-59.1226	BT-054420090310	019960	
XCTD	2009/3/11	03:59:32	08-30.9264	110-59.9810	CTD-035520090311	08091220	
XCTD	2009/3/11	10:13:00	08-20.1776	109-59.9811	CTD-035620090311	08091221	
XBT	2009/3/11	10:21:06	08-19.9919	109-58.8095	BT-054520090311	019961	
XCTD	2009/3/11	16:58:09	08-13.3498	108-59.9829	CTD-035720090311	08091222	
XCTD	2009/3/11	23:38:14	08-06.4780	107-59.9781	CTD-035820090311	08091223	
XBT	2009/3/11	23:46:40	08-06.0456	107-58.7371	BT-054620090311	019962	
XCTD	2009/3/12	06:35:29	07-45.2200	106-59.9901	CTD-035920090312	08091224	
XCTD	2009/3/12	-	-	-	CTD-036020090312	08091225	Probe trouble Canceled
XCTD	2009/3/12	14:05:38	07-23.1459	105-58.1976	CTD-036020090312	08091227	
XBT	2009/3/12	14:14:15	07-22.5689	105-57.1180	BT-054720090312	019963	
XCTD	2009/3/12	21:37:10	06-56.6117	104-59.9870	CTD-036120090312	08091226	
XCTD	2009/3/13	05:05:16	06-27.7111	103-59.9876	CTD-036220090313	08091228	
XBT	2009/3/13	05:13:19	06-27.2202	103-58.8820	BT-054820090313	019964	
XCTD	2009/3/13	12:30:02	06-00.2469	102-59.9856	CTD-036320090313	08091229	
XCTD	2009/3/13	19:58:49	05-34.0407	101-59.9785	CTD-036420090313	08091230	
XBT	2009/3/13	20:06:37	05-33.5572	101-58.9834	BT-054920090313	019965	
XCTD	2009/3/14	03:14:10	05-22.8258	100-59.9818	CTD-036520090314	08091231	

Table 5.2.2-2 KY09-01 Leg2 XCTD/XBT Observation Log (continued)

Probe Type	Date (UTC)	Time (UTC)	Latitude (S)	Longitude (E)	File Name	Probe S/N	Remarks
XCTD	2009/3/14	10:14:21	05-19.0983	099-59.9799	CTD-036620090314	08091232	
XBT	2009/3/14	10:22:45	05-19.0294	099-58.7702	BT-055020090314	019966	
XCTD	2009/3/14	17:13:48	05-15.6059	098-59.9763	CTD-036720090314	08091233	
XCTD	2009/3/15	00:30:23	05-11.3650	097-59.8610	CTD-036820090315	08091234	
XBT	2009/3/15	00:38:04	05-11.3244	097-58.8539	BT-055120090315	019967	
XCTD	2009/3/15	07:23:09	05-08.7940	096-59.9902	CTD-036920090315	08091235	
XCTD	2009/3/15	14:01:58	05-05.6876	095-59.9849	CTD-037020090315	08091236	
XBT	2009/3/15	14:10:04	05-05.6683	095-58.7484	BT-055220090315	019968	
XCTD	2009/3/16	06:37:17	05-01.5756	095-01.8679	CTD-037120090316	08091237	
XBT	2009/3/16	06:45:25	05-00.5470	095-01.2145	BT-055420090316	019969	
XCTD	2009/3/17	09:45:38	04-29.9958	094-19.3273	CTD-037220090317	08091238	
XCTD	2009/3/17	15:47:00	03-59.9849	093-35.2209	CTD-037320090317	08091239	
XBT	2009/3/17	15:54:35	03-59.3696	093-34.3154	BT-055520090317	019970	
XCTD	2009/3/17	21:55:58	03-29.9880	092-51.1122	CTD-037420090317	08091249	
XCTD	2009/3/18	03:40:06	02-59.9956	092-07.2326	CTD-037520090318	08091250	
XBT	2009/3/18	03:47:39	02-59.3265	092-06.2890	BT-055620090318	019971	
XCTD	2009/3/18	09:04:43	02-29.9886	091-23.3163	CTD-037620090318	08091251	
XCTD	2009/3/18	14:26:54	01-59.9864	090-39.4155	CTD-037720090318	08091252	
XBT	2009/3/18	14:34:19	01-59.3550	090-38.4466	BT-055720090318	019972	
XCTD	2009/3/19	07:40:25	01-35.1632	090-06.4176	CTD-037820090319	08091253	
XCTD	2009/3/20	09:26:22	00-59.9875	090-02.3191	CTD-037920090320	08091254	

Table 5.2.2-2 KY09-01 Leg2 XCTD/XBT Observation Log (continued)

Probe Type	Date (UTC)	Time (UTC)	Latitude (N・S)	Longitude (E)	File Name	Probe S/N	Remarks
XBT	2009/3/20	09:33:52	00-59.0237S	090-02.3093	BT-055920090320	019973	
XCTD	2009/3/20	13:27:39	00-29.9769S	090-02.9709	CTD-038020090320	08091255	
XCTD	2009/3/21	07:38:38	00-00.5950N	090-02.7211	CTD-038120090321	08091256	
XBT	2009/3/21	07:45:55	00-00.6752N	090-01.7433	BT-056120090321	019974	

Table 5.2.2-3 KY09-01 Leg3 XCTD/XBT Observation Log

Probe Type	Date (UTC)	Time (UTC)	Latitude (N)	Longitude (E)	File Name	Probe S/N	Remarks
XBT	2009/4/13	18:31:26	11-59.9813	142-48.5885	BT-056320090413	019975	
XBT	2009/4/14	-	-	-	BT-056420090414	019976	Probe trouble Canceled
XBT	2009/4/14	04:06:15	10-59.6797	141-35.2196	BT-056420090414	019977	
XBT	2009/4/14	14:08:31	09-59.9792	140-22.4238	BT-056520090414	019976	
XBT	2009/4/15	01:57:16	08-59.9819	138-52.7358	BT-056620090415	019978	
XCTD	2009/4/17	12:47:48	06-59.9869	136-49.7092	CTD-038220090417	08091257	
XCTD	2009/4/18	02:48:50	05-59.9859	137-01.4853	CTD-038320090418	08091258	
XCTD	2009/4/20	13:29:37	03-59.9888	137-33.0051	CTD-038420090420	08091259	
XCTD	2009/4/21	03:55:57	02-59.4458	137-49.0778	CTD-038620090421	08091260	
XBT	2009/4/25	04:04:54	00-02.6749	137-54.3504	BT-057120090425	019979	
XBT	2009/4/25	10:16:18	01-00.0216	138-28.4166	BT-057220090425	019980	
XBT	2009/4/25	16:22:10	02-00.0284	139-03.8631	BT-057320090425	019981	
XBT	2009/4/25	22:08:48	03-00.0321	139-38.0153	BT-057420090425	019982	
XBT	2009/4/26	03:35:54	04-00.0281	140-10.0002	BT-057520090426	019983	
XBT	2009/4/26	08:50:11	05-00.0246	140-40.1759	BT-057620090426	019984	
XBT	2009/4/26	14:06:37	06-00.0342	141-07.9428	BT-057720090426	019985	
XBT	2009/4/26	19:45:09	07-00.0248	141-35.9332	BT-057820090426	019986	
XBT	2009/4/27	01:34:35	08-00.0274	142-07.3091	BT-057920090427	019987	
XBT	2009/4/27	07:03:55	09-00.0240	142-32.7832	BT-058020090427	019988	

5.3 Water sampling

5.3.1 Salinity

(1) Personnel

Kentaro Ando	(JAMSTEC) Principal Investigator: Leg1
Yasuhisa Ishihara	(JAMSTEC) Principal Investigator: Leg2
Syoichiro Baba	(JAMSTEC) Principal Investigator: Leg3
Hiroki Ushiromura	(Marine Works Japan Ltd., MWJ): Leg1 – Leg3
Fujio Kobayashi	(MWJ): Leg1
Akira Watanabe	(MWJ): Leg1
Makito Yokota	(MWJ): Leg2

(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 12 hours in the laboratory before the salinity measurement.

The number of samples in each Leg are shown as follows ;

Table 5.3.1-1 Number of samples in each Leg

Leg	Number of Samples
Leg1	16
Leg2	8
Leg3	16
Total	40

b. Instruments and Method

The salinity analysis was carried out on R/V KAIYO during the cruise of KY09-01 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 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 +/- 0.004 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, a ninth filling of the cell was done and the bottle salinity above was calulated. 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	:	P149 (Leg1)
conductivity ratio	:	0.99984
salinity	:	34.994
preparation date	:	5th-October-2007

batch	:	P150 (Leg2, Leg3)
conductivity ratio	:	0.99978
salinity	:	34.991
preparation date	:	22nd-May-2008

<Leg1>

Standardization control of the salinometer was set to 399 and measurements were done at this setting during Leg1. The value of STANDBY was 5714 to 5716 and that of ZERO was 0.0+0001 to 0.0+0003. The conductivity ratio of IAPSO Standard Seawater batch P149 was 0.99984 (double conductivity ratio was 1.99968) and was used as the standard for salinity. We measured 10 bottles of P149.

Fig.5.3.1-1 shows the history of the double conductivity ratio of the Standard Seawater batch P149 (Leg1). The average of the double conductivity ratio was 1.99967 and the standard deviation was 0.00002, which is equivalent to 0.0004 in salinity.

Fig.5.3.1-2 shows the history of the double conductivity ratio of the Standard Seawater batch P149 (Leg1) after correction. The average of the double conductivity ratio after correction was 1.99968 and the standard deviation was 0.00002, which is equivalent to 0.0003 in salinity.

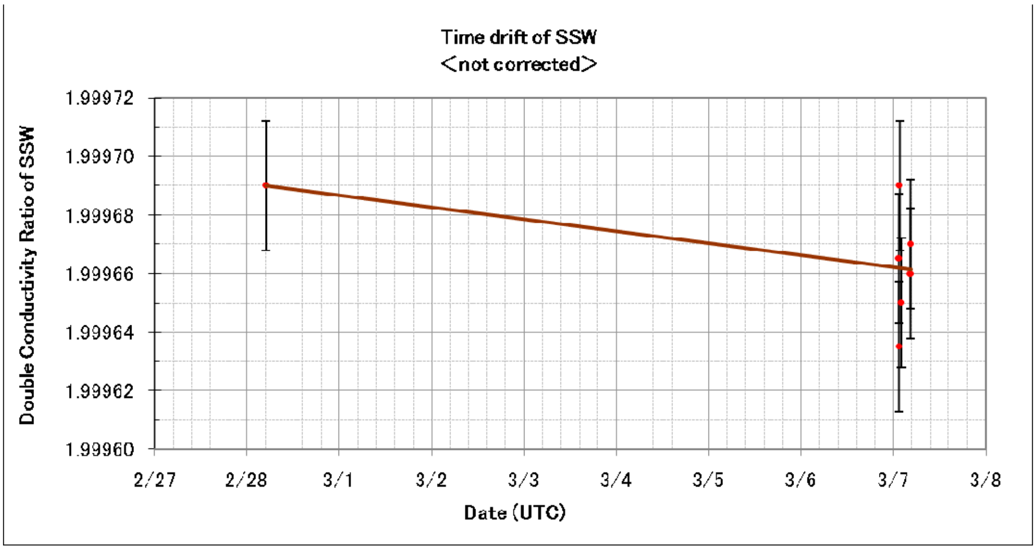


Fig. 5.3.1-1 History of double conductivity ratio for the Standard Seawater batch P149 (Leg1) (before correction)

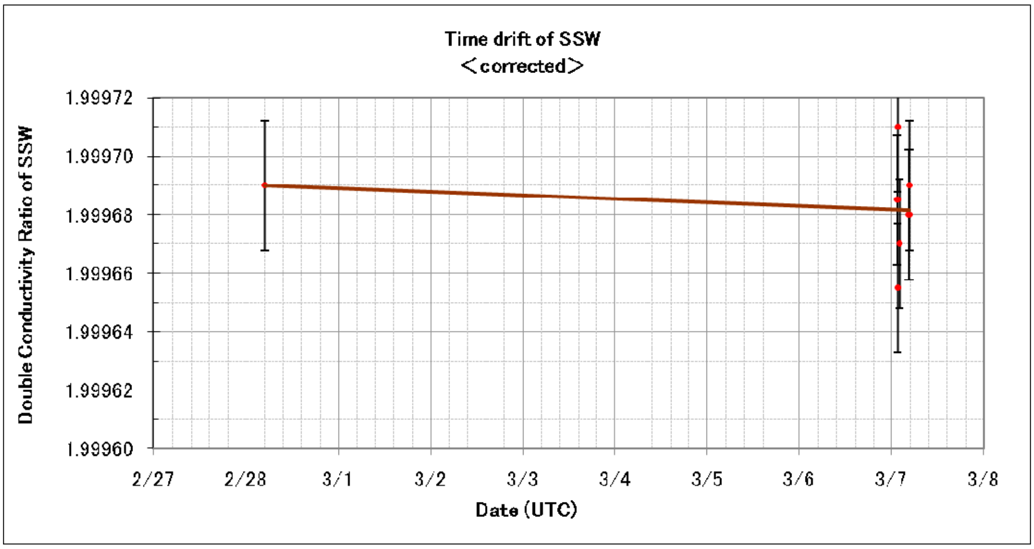


Fig. 5.3.1-2 History of double conductivity ratio for the Standard Seawater batch P149 (Leg1) (after correction)

<Leg2>

Standardization control of the salinometer was set to 402 and measurements were done at this setting during Leg2. The value of STANDBY was 5716 to 5718 and that of ZERO was 0.0+0002 to 0.0+0004. 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. We measured 8 bottles of P150.

Fig.5.3.1-3 shows the history of the double conductivity ratio of the Standard Seawater batch P150 (Leg2). 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.5.3.1-4 shows the history of the double conductivity ratio of the Standard Seawater batch P150 (Leg2) 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 0.0003 in salinity.

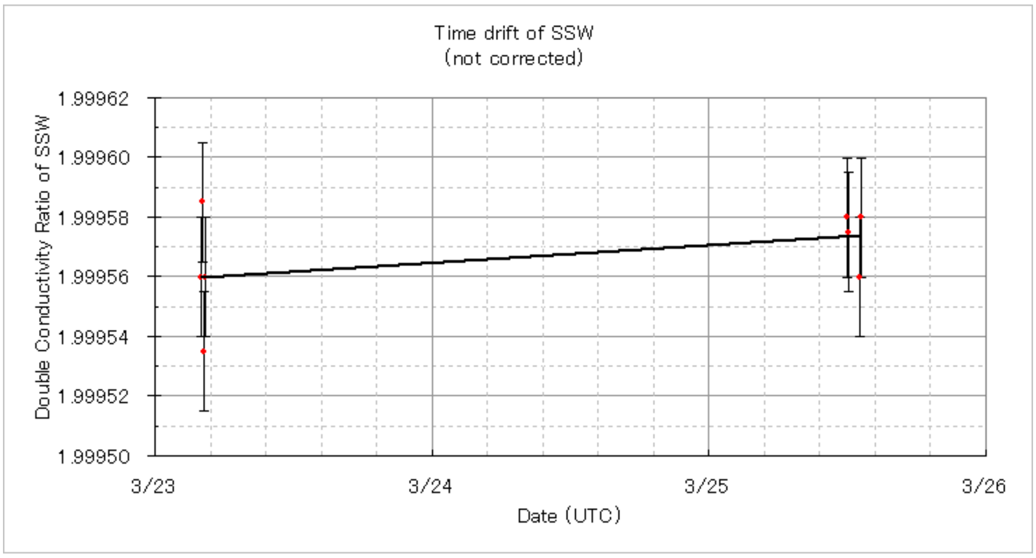


Fig. 5.3.1-3 History of double conductivity ratio for the Standard Seawater batch P150 (Leg2) (before correction)

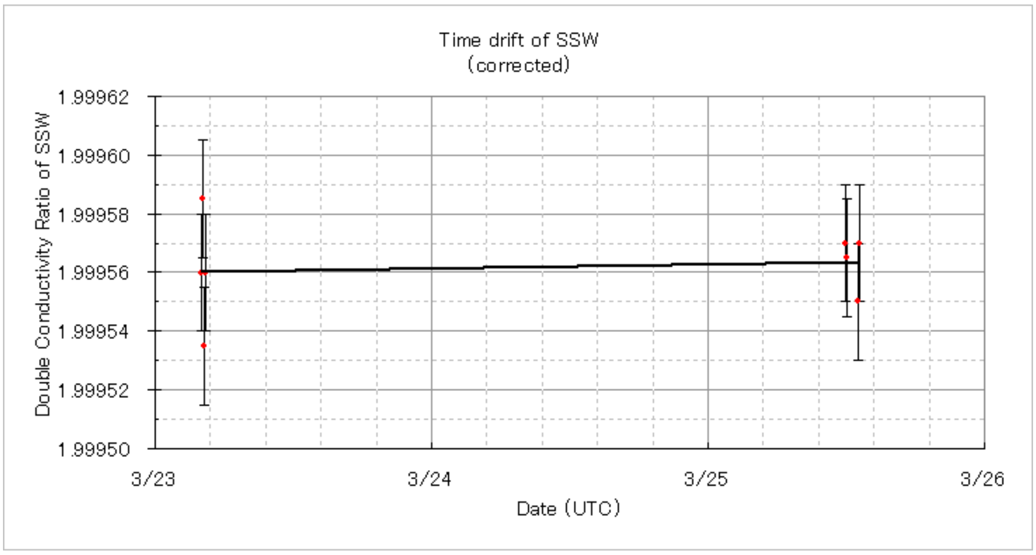


Fig. 5.3.1-4 History of double conductivity ratio for the Standard Seawater batch P150 (Leg2) (after correction)

<Leg3>

Standardization control of the salinometer was set to 404 and measurements were done at this setting during Leg3. The value of STANDBY was 5718 to 5719 and that of ZERO was 0.0+0002 to 0.0+0003. 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. We measured 4 bottles of P150.

Fig.5.3.1-5 shows the history of the double conductivity ratio of the Standard Seawater batch P150 (Leg3). The average of the double conductivity ratio was 1.99958 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

Fig.5.3.1-6 shows the history of the double conductivity ratio of the Standard Seawater batch P150 (Leg3) after correction. The average of the double conductivity ratio after correction was 1.99957 and the standard deviation was 0.00001, which is equivalent to 0.0002 in salinity.

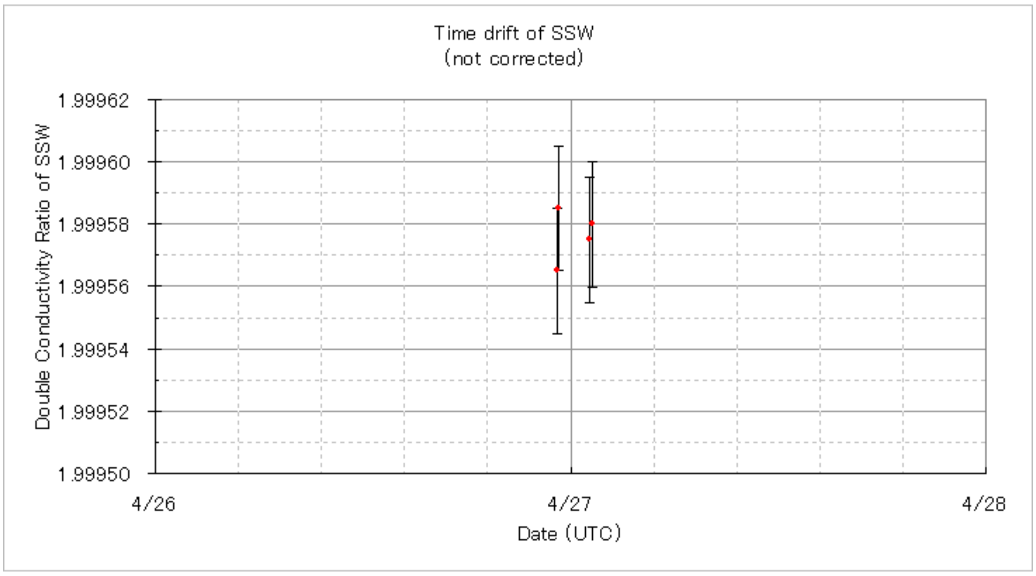


Fig. 5.3.1-5 History of double conductivity ratio for the Standard Seawater batch P150 (Leg3) (before correction)

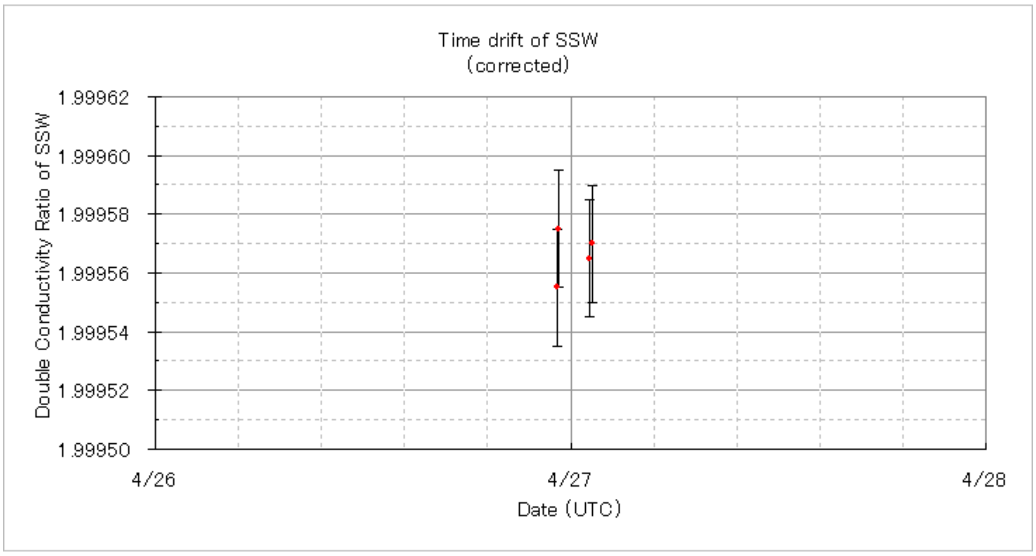


Fig. 5.3.1-6 History of double conductivity ratio for the Standard Seawater batch P150 (Leg3) (after correction)

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

c. Replicate Samples

<Leg1>

I estimated the precision of this method using 8 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 8 pairs of replicate samples were 0.0003 and 0.0002 in salinity, respectively.

<Leg2>

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 0.0002 and 0.0002 in salinity, respectively.

<Leg3>

I estimated the precision of this method using 8 pairs of replicate samples taken from the same Niskin bottle. The average and the standard deviation of absolute difference among 8 pairs of replicate samples were 0.0003 and 0.0002 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
Fadli Syamsudin	(BPPT)
Shinya Okumura	- Leg1 - (Global Ocean Development Inc., GODI)
Souichiro Sueyoshi	- Leg2 - (GODI)
Wataru Tokunaga	- Leg3 - (GODI)

(2) Objective

To observe the current profile along cruise track and on-station by using ship board ADCP

(3) Methods

Upper ocean current measurements were made throughout KY09-01 cruise, using the hull mounted Acoustic Doppler Current Profiler (ADCP) system. For most of its operation, the instrument was configured for water-tracking mode 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 use 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) 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 analysis

These data were processed LTA data using CODAS (Common Oceanographic Data Access System) software, developed at the University of Hawaii.

(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. The dataset observed in archipelago area in Indonesia are published two years later.

5.5 TRITON Buoys

5.5.1 Operation of the TRITON buoys

(1) Personnel

-Leg1-

Kentaro Ando	(JAMSTEC): Principal Investigator Leg1	
Hiroshi Matsunaga	(MWJ): Operation Leader	*
Toru Idai	(MWJ): Technical Staff	
Fujio Kobayashi	(MWJ): Technical Staff	
Kenichi Katayama	(MWJ): Technical Staff	
Keisuke Matsumoto	(MWJ): Technical Staff	*
Takatoshi Kiyokawa	(MWJ): Technical Staff	
Hiroki Ushiromura	(MWJ): Technical Staff	*
Akira Watanabe	(MWJ): Technical Staff	
Hirotada Moki	(MWJ): Technical Staff	
Takatomo Shirotsume	(MWJ): Technical Staff	

* On board Leg1 & 3

-Leg3-

Shoitiro Baba	(JAMSTEC): Principal Investigator Leg3
Masaki Furuhata	(MWJ): Technical Staff
Tomohide Noguchi	(MWJ): Technical Staff
Masaki Yamada	(MWJ): Technical Staff
Yasushi Hashimoto	(MWJ): Technical Staff
Shungo Oshitani	(MWJ): Technical Staff
Kenichi Kato	(MWJ): Technical Staff
Kazuma Nakano	(MWJ): Technical Staff
Kohei Osakabe	(MWJ): Technical Staff

(2) Objectives

The purpose of this mission is to deploy and recover the TRITON buoys along 130E and 137/138E lines in the western Pacific.

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).

(3) Measured parameters

Meteorological parameters: wind speed, direction, atmospheric pressure, air temperature, relative humidity, radiation, precipitation.

Oceanic parameters: water temperature and conductivity at 1.5m, 25m, 50m, 75m, 100m, 125m, 150m, 200m, 300m, 500m 750m, depth at 300m and 750m, currents at 10m.

(4) Instrument

1) CTD and CT

SBE-37 IM MicroCAT

A/D cycles to average : 4
Sampling interval : 600sec
Measurement range, Temperature : -5～+35 deg-C
Measurement range, Conductivity : 0～+7 S/m
Measurement range, Pressure : 0～full scale range

2) CRN(Current meter)

SonTek Argonaut ADCM

Sensor frequency : 1500kHz
Sampling interval : 1200sec
Average interval : 120sec

3) Meteorological sensors

Precipitation

R.M.YOUNG COMPANY MODEL50202/50203

Atmospheric pressure

PAROPSCIENTIFIC.Inc. DIGIQUARTZ FLOATING BAROMETER 6000SERIES

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

Woods Hole Institution ASIMET

Sampling interval : 60sec
Data analysis : 600sec averaged

(5) Locations of TRITON buoys deployment

Nominal location	8N, 137E
ID number at JAMSTEC	10008
Number of surface float	T02
ARGOS PTT number	27399
ARGOS backup PTT number	29696
Deployed date	17 Apr 2009
Exact location	07 ‐ 39.04N, 136 ‐ 41.97Ｅ
Depth	3,164 m

Nominal location	5N, 137E
ID number at JAMSTEC	11008
Number of surface float	T05
ARGOS PTT number	27394

ARGOS backup PTT number	29697
Deployed date	19 Apr 2009
Exact location	04 - 51.43N, 137 - 15.07E
Depth	4,097 m

Nominal location	2N, 138E
ID number at JAMSTEC	12010
Number of surface float	T08
ARGOS PTT number	27389
ARGOS backup PTT number	24245
Deployed date	23 Apr 2009
Exact location	02 - 04.00N, 138 - 03.73E
Depth	4,342 m

Nominal location	EQ, 138E
ID number at JAMSTEC	13010
Number of surface float	T03
ARGOS PTT number	27401
ARGOS backup PTT number	24246
Deployed date	25 Apr 2009
Exact location	00 - 02.04N, 137 - 53.02E
Depth	4,359 m

Nominal location	8N, 130E
ID number at JAMSTEC	14007
Number of surface float	T04
ARGOS PTT number	28377
ARGOS backup PTT number	29710
Deployed date	22 Feb 2009
Exact location	07 - 58.98N, 130 - 01.07E
Depth	5,720 m

Nominal location	2N, 130E
ID number at JAMSTEC	16008
Number of surface float	T13
ARGOS PTT number	None
ARGOS backup PTT number	29692,29694
Deployed date	25 Feb 2009
Exact location	01 - 56.39N, 129 - 56.05E
Depth	4,428 m

(6) TRITON recovered

Nominal location	8N, 137E
ID number at JAMSTEC	10007
Number of surface float	T09
ARGOS PTT number	01132

ARGOS backup PTT number	11592
Deployed date	13 Jan. 2008
Recovered date	16 Apr 2009
Exact location	07 - 38.99N, 136 - 41.94E
Depth	3,170 m

Nominal location	5N, 137E
ID number at JAMSTEC	11007
Number of surface float	T12
ARGOS PTT number	09793
ARGOS backup PTT number	11593
Deployed date	11 Jan. 2008
Recovered date	20 Apr 2009
Exact location	04 - 56.37N, 137 - 18.23E
Depth	4,132 m

Nominal location	2N, 138E
ID number at JAMSTEC	12009
Number of surface float	T27
ARGOS PTT number	03779
ARGOS backup PTT number	24239
Deployed date	09 Jan. 2008
Recovered date	22 Apr 2009
Exact location	02 - 03.90N, 138 - 03.87E
Depth	4,334m

Nominal location	EQ, 138E
ID number at JAMSTEC	13009
Number of surface float	T16
ARGOS PTT number	N/A
ARGOS backup PTT number	24715, 24241
Deployed date	07 Jan. 2008
Recovered date	24 Apr 2009
Exact location	00 - 01.94N, 137 - 53.32E
Depth	4,360 m

Nominal location	8N, 130E
ID number at JAMSTEC	14006
Number of surface float	T28
ARGOS PTT number	07960
ARGOS backup PTT number	24242
Deployed date	18 Jan. 2008
Recovered date	23 Feb 2009
Exact location	07 - 55.59N, 130 - 03.58E
Depth	5,639 m

Nominal location	2N, 130E

ID number at JAMSTEC	16007
Number of surface float	T20
ARGOS PTT number	N/A
ARGOS backup PTT number	24718, 29700
Deployed date	15 Jan. 2008
Recovered date	26 Feb 2009
Exact location	02 - 00.71N, 130 - 12.60E
Depth	4,371 m

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

(7) Details of deployed

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

Deployed TRITON buoys

Observation No.	Location.	Details.
10008	8N-137E	Full spec and one optional TD sensor at 300m
11008	5N-137E	Full spec and three optional sensors. (CT at 175m, TD at 750m and Monitoring camera system.)
12010	2N-138E	Full spec and one optional CT sensor at 175m.
13010	EQ-138E	Full underwater sensors and two optional sensors. (CT at 175m and Monitoring camera system.)
14007	8N-130E	Full spec and one optional supersonic WND sensor.
16008	2N-130E	Full underwater sensors and two optional sensors. (CT at 175m and Monitoring camera system.)

(8) Data archive

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

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

5.5.2 Operation of the m-TRITON buoys

(1) Personnel

Yasuhisa Ishihara	(JAMSTEC): Principal Investigator
Keisuke Matsumoto	(MWJ): Operation Leader
Hirokatsu Uno	(MWJ): Technical Staff
Takeo Matsumoto	(MWJ): Technical Staff
Akira So	(MWJ): Technical Staff
Tomohide Noguchi	(MWJ): Technical Staff
Makito Yokota	(MWJ): Technical Staff
Takatoshi Kiyokawa	(MWJ): Technical Staff
Hiroki Ushiromura	(MWJ): Technical Staff
Hirotada Moki	(MWJ): Technical Staff
Takatomo Shirotsume	(MWJ): Technical Staff

(2) Objective

The purpose of this mission is to deploy and recover the m-TRITON buoys in the eastern Indian Ocean.

The large-scale air-sea interaction over the warmest sea surface temperature region in the eastern tropical Indian Ocean called warm pool that affects the global atmosphere and associated with Indian Ocean Dipole phenomena. However, the formation mechanism of the warm pool and the air-sea interaction over the warm pool has not been well understood. Therefore long term data sets of temperature, salinity, currents and meteorological elements have been required at fixed locations. The JEPP Indian ocean moored buoy program has started to obtain the basic data to improve the predictions of Indian Ocean Dipole and Indian ocean monsoon, under the funded research of MEXT.

The m-TRITON buoy array is integrated into the RAMA array, which is presently maintained and developed by multi-national efforts. RAMA 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. RAMA will also contribute to the development of GOOS (Global Ocean Observing System) and GCOS (Global Climate Observing System).

(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:

<u>Oceanic sensors</u>

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) 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

3) CRN (Current meter)

SonTek Argonaut ADCM

Sensor frequency : 1500kHz

Sampling interval : 1200sec

Average interval : 120sec

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 05106

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 compass, GPS and Inductive modem.

2) ARGOS transmitter

Hourly averaged data are being transmitted through ARGOS transmitter.

(4) Results

Locations of deployment and recovery are as follow:

Locations of deployment

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

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
Exact location	01 - 36.24S, 90 - 04.46Ｅ
Depth	4,711 m

Locations of recovery

Nominal location	5S,95E
ID number at JAMSTEC	17501
ARGOS PTT number	29040
ARGOS backup PTT number	29792
Deployed date (UTC)	10 Feb.2008
Recovered date (UTC)	17 Mar 2009
Exact location	04 - 57.11S, 94 - 58.91E
Depth	5,007 m

Nominal location	1.5S,90E
ID number at JAMSTEC	18502
ARGOS PTT number	29020
ARGOS backup PTT number	29791
Deployed date (UTC)	08 Feb.2008
Recovered date (UTC)	20 Mar 2009
Exact location	01 - 39.64S, 89 - 59.73E
Depth	4,689 m

(5) Data archive

Hourly averaged data 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 (not on board)
Iskhaq Iskandar	(JAMSTEC): on board
Tomohide Noguchi	(MWJ): Operation leader
Keisuke Matsumoto	(MWJ)
Hiroki Ushiromura	(MWJ)
Hirokatsu Uno	(MWJ)
Takeko Matsumoto	(MWJ)
Akira So	(MWJ)
Makito Yokota	(MWJ)
Takatoshi Kiyokawa	(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 (KY09-01 Leg2), 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 : 7176 (Mooring No.090321-0090E)

Recovered ADCP
・ Serial Number : 1645 (Mooring No.080206-0090E)

2) CTD

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

Deployed CTD

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

 SBE-37 (Sea Bird Electronics Inc.)

Sampling Interval: 1800 seconds

Recovered CTD

- Serial Number : 1775 (Mooring No.080206-0090E)

3) Other instrument

 Acoustic Releaser (BENTHOS,Inc.)

Deployed Acoustic Releaser

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

Recovered Acoustic Releaser

- Serial Number: 630 (Mooring No.080206-0090E)
- Serial Number: 692 (Mooring No.080206-0090E)

(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.090321-0090E

Date: 21 Mar. 2009 Lat: 00-00.3537N Long: 90-03.8111E Depth: 4,420m

(6) Recovery

We recovered one ADCP mooring which was deployed on 06 Feb. 2008 (MR07-07 Leg2 cruise). We uploaded ADCP and CTD data into a computer. The raw data, then, were converted into ASCII code. Figure 5.6 show results from the mooring.

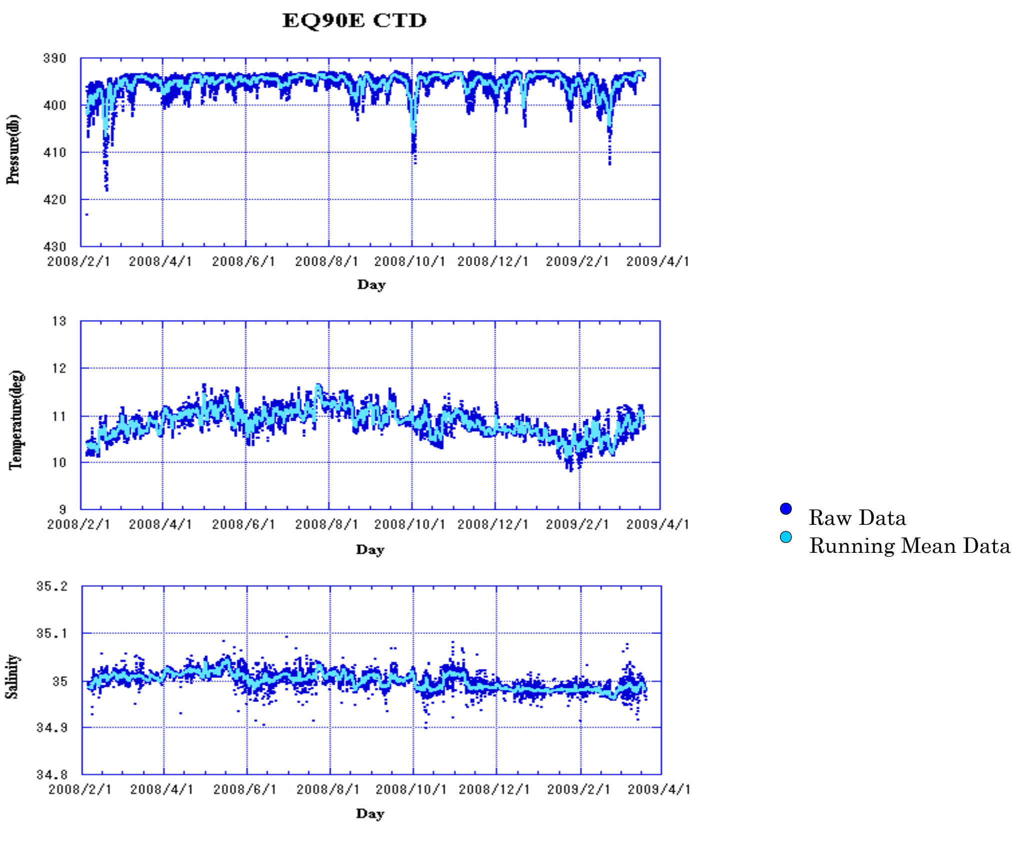


Fig.5.6-1 Time-series of the observed pressure (*top panel*), temperature (*middle panel*) and salinity (*bottom panel*) obtained from CTD at (0°S, 90°E). The *dark-blue* curve indicates the raw data, while the *light-blue* curve shows the filtered data from 25 hours running-mean.

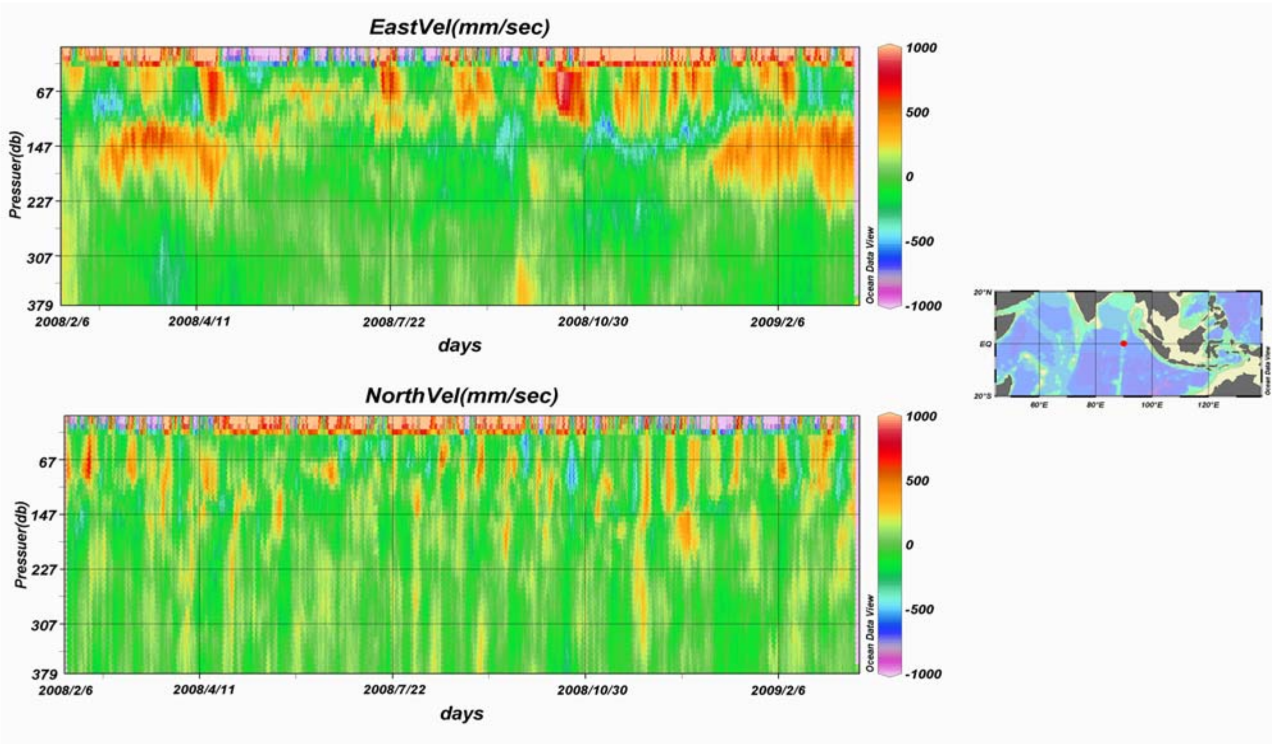


Fig.5.6-2. Time-depth sections of observed zonal (*top panel*) and meridional (*bottom panel*) currents obtained from ADCP mooring at (0°S, 90°E).

(7) Results

In general, the raw data for the observed zonal and meridional currents show some basic features of the oceanic circulations in the eastern equatorial Indian Ocean. In particular, the observed zonal currents captured the semiannual surface eastward jets so-called the Wyrtki jet during April and October/November 2008. Pronounced intraseasonal variations are also observed in the upper layer. In the deeper layer, strong subsurface eastward currents are observed during March – April 2008, and from January 2009 until mooring was recovered. In addition, we also found subsurface eastward currents underlying surface westward currents from June to August 2008. We speculate that this specific feature is related to the Indian Ocean Dipole 2008. However, further analysis is required to clarify this interesting phenomenon.

The observed meridional currents, on the other hand, show the alternating northward and southward currents with period of about less than one month. This high-frequency variation may be related to the presence of the mixed Rossby-gravity waves generated by the wind-stress curl over the region as previously observed.

(8) 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. In addition, all data will be submitted to Data Integration and Analyses Group (DIAG) of JAMSTEC.

5.7 MAX-DOAS measurements of aerosols and NO_2

(1) Personnel

Hitoshi IRIE	Principal Investigator (JAMSTEC, not on board)
Yugo KANAYA	(JAMSTEC)
Hisahiro TAKASHIMA	(JAMSTEC)
Shinya OKUMURA	(GODI)
Souichiro SUEYOSHI	(GODI)
Wataru TOKUNAGA	(GODI)

(2) Objectives

Under a Japan EOS Promotion Program (JEPP, FY2006-2010), a ground-based instrument utilizing the MAX-DOAS (Multi-Axis Differential Optical Absorption Spectroscopy) technique is found to be a power tool to conduct automatic observations of atmospheric aerosols and NO_2 for their long-term monitoring and climate research. However, such automatic, long-term observations have not been performed on a research vessel. In this cruise, we attempt an automatic, unattended operation of MAX-DOAS for about three months to confirm its capability. In addition, we clarify latitudinal distributions of aerosols and NO_2 over western Pacific Ocean.

(3) Methods

The MAX-DOAS system used here records spectra of scattered sunlight (UV/visible) at every second. Measurements were made at various elevation angles of 3, 5, 10, 20, 30, and 70 degrees using a movable mirror, which repeated the same sequence of elevation angles every 30 min. At the top deck of R/V Kaiyo, the telescope unit was placed on a gimbal mount, which compensates for the pitch and roll of the ship. A sensor measuring pitch and roll of the telescope unit is used together to measure an offset of elevation angle due to incomplete compensation by the gimbal. The line of sight was in direction of the starboard of the ship.

After optimizing parameters for the active gimbal system (e.g., delay time) during the Leg 1 period, we confirmed that the amplitudes of the pitch and roll angles measured at the telescope unit were smaller than those of the ship, suggesting the compensation was effective. The effectiveness depended on conditions; excellent performance was achieved when a single frequency (cycle ~ 14 s) was dominant in the roll of the ship, while it was spoiled when high frequency components (cycles < ca. 8 s) became evident. Nonetheless, we obtained ample data at the target elevation angles with sufficient precision as shown below.

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

(4) Preliminary results

Figure 5.7.1 shows the time series example of AEC and NO_2 mixing ratio at altitudes of 0-1 km between February 5 and 11, 2009. AEC and NO_2 were measured continuously, as expected. A clear latitudinal distribution of NO_2 is readily seen, but not for aerosols.

(5) Data archives

These data for the whole cruise period will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC after the full analysis of the raw spectrum data is completed, which will be <<2 years after the end of the cruise.

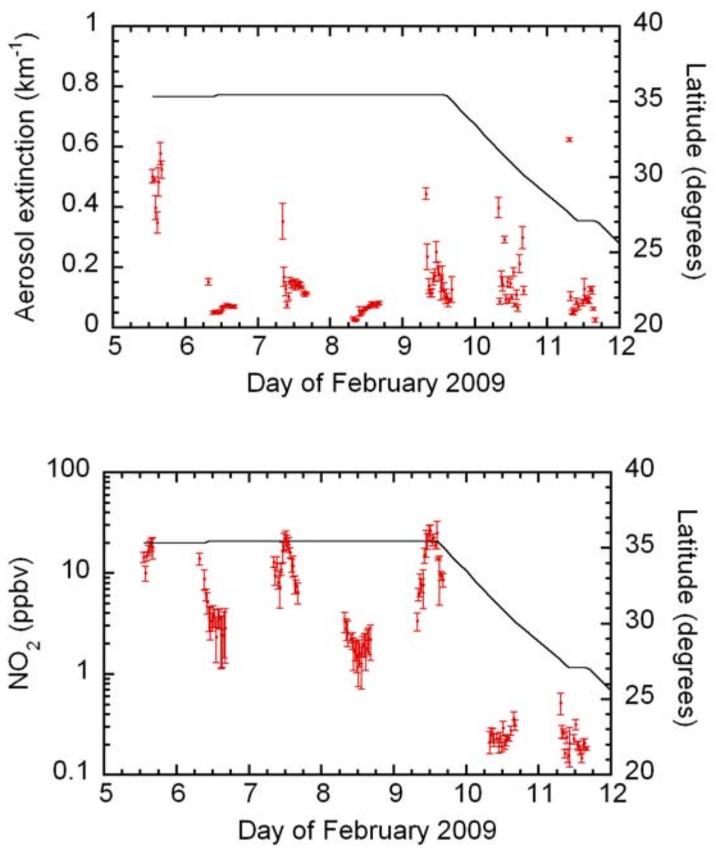


Figure 5.7.1. Time series of the aerosol extinction coefficient at 476 nm and NO_2 mixing ratio derived from MAX-DOAS between February 5 and 11, 2009. Values are for the layer of 0-1 km.