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R/V Mirai Cruise Report
MR04-03
(Leg 1 and Leg 2)

June 06 – Aug 03, 2004
Tropical Ocean Climate Study (TOCS)

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

Leg. 1

Leg. 2

Contents

1. Cruise name and code

Tropical Ocean Climate Study
MR04-03 (Leg 1 and Leg 2)
Ship: R/V MIRAI
Captain: Masaharu Akamine and Yujiro Kita

2. Introduction and observation summary

2.1. Introduction

The warm water pool located at the western equatorial Pacific and eastern Indian Oceans has the highest sea surface temperature in the ocean all over the world. Therefore interaction between the ocean and atmosphere in that region becomes important for climate change such as ENSO (El Niño/Southern Oscillation) in the Pacific Ocean and Dipole mode in the Indian Ocean. This cruise is conducted for understanding the process of warm water convergence and divergence, and interaction processes in that region. For that purpose, we carried out deployment and recovery of the TRITON (TRIangle Trans Ocean buoy Network) buoys as the main mission. The TRITON buoys have advantage of analysis for long- term variability in the warm water pool. We also carried out other observations, such as ADCP moorings, CTD measurements and meteorological observation, for understanding the Ocean and atmospheric conditions.

2.2. Overview

2.2.1. Ship

R/V MIRAI
Captain Masaharu Akamine (Sekinehama ~ Hachinohe and Hachinohe ~ Sekinehama)
Captain Yujiro Kita (Hachinohe ~ Darwin ~ Hachinohe)

2.2.2. Cruise code

MR04-03

2.2.3. Project name

Tropical Ocean Climate Study

2.2.4. Undertaking institution

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

2.2.5. Chief Scientist

Leg 1: Iwao Ueki (JAMSTEC)
Leg 2: Hideaki Hase (JAMSTEC)

2.2.6. Period

Leg 1: June 6th, 2004 (Sekinehama) – July 2nd, 2004 (Darwin)
Leg 2: July 3rd, 2004 (Darwin) – August 3rd, 2004 (Sekinehama)

2.2.7. Research Participants

Total 20 scientists and technical staffs participated from 6different institutions and companies, including 3 Indonesian scientists and officer during Leg 1.

2.3. Observation summary

TRITON buoy deployment:	8 sites.
TRITON buoy recovery:	7 sites
ADCP buoy deployment:	2 sites
ADCP buoy recovery	2 sites
CTD including water sampling:	13 casts
XCTD:	98 launches
Rawin sonde:	82 launches
Surface meteorology:	continuous
Shipboard ADCP measurement:	continuous
Surface temperature and salinity measurements by intake method	continuous

*** Other specially designed observations have been carried out successfully.

Observed oceanic and atmospheric conditions

Leg 1: Observation in the western tropical Pacific

Oceanic and atmospheric conditions in the tropical Pacific region showed neutral condition and do not support the development El Niño and La Niña during the next few months. The TAO (Tropical Atmospheric and Ocean)/TRITON array data showed slightly warmer sea surface temperature (SST) in the eastern end of the warm pool region. According to this high SST distribution westerly winds dominate western end of the warm pool in the Pacific Ocean. An OLR (Outgoing Long-wave Radiation) analysis by NOAA/CPC suggests that this westerly wind domination is caused by eastward propagating MJO (Madden-Julian Oscillation) and westward going mixed Ross by-Gravity wave. As a result, convection activity was strengthened, and it was in a situation that there was easy to be a tropical cyclone (Typhoon). Actually we met three cyclones (T0406, T0407, and T0408) during this cruise. According to this strong westerly winds, the strong eastward current in the upper layer in the ocean was appeared. The highest velocity reaches 2 m/s along 130E line.

Leg 2: Observation in the eastern Indian Ocean

July is in a monsoon season in the Indian Ocean. During this cruise period, observed SST in the equatorial band was 29 deg-C, which is slightly cooler than one in July 2003, observed sea surface salinity (SSS) in the vicinity of the equator reached 34.7, which is higher than one in July 2003 by up to 0.5, and the upper layer thickness is same as one in July 2003, which is near normal.

We recovered one TRITON buoy, and deployed two buoys in the eastern Indian Ocean. Since the recovered buoy was seriously damaged due to vandalism, we reinforced the rack cover and tower of the surface buoy against artificially destroy.

In addition to the operations in the Indian Ocean, two TRITON buoys were deployed and one buoy was recovered in the western Pacific Ocean, which were suspended due to cyclone activities during leg 1. The other recovery/deployment operations (ADCP mooring, rawin sonde and ARGO floats etc.) and observation equipments (CTD, shipboard ADCP etc.) were mostly worked without significant problem.

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

3.1. Period

June 6, 2004 - August 3, 2004

3.2. Ports of call

Sekinehama, Japan	(Departure; June 6, 2004)
Hachinohe, Japan	(June 7, 2004)
Darwin, Australia	(July 2 -3, 2004)
Hachinohe, Japan	(August 2, 2004)
Sekinehama, Japan	(August 3, 2004)

3.3. Cruise log

SMT (Ship Mean Time)	**UTC**	**Event**
Jun. 06 (Sun.)		
16:00	07:00	Departure at Sekinehama, Japan (SMT = UTC + 9)
16:30	07:30	Safety guidance for participants
Jun. 07 (Mon.)		
09:00	00:00	Arrival at Hachinohe, Japan
14:50	05:50	Departure at Hachinohe
16:00	07:00	Fire and abandon ship drill
18:40	09:40	Start of continuous surface monitoring of surface sea water, and shipboard observations
Jun. 08 (Tue)		
10:00	01:00	Meeting for Leg 1 observations
16:45	07:45	Konpira-san ceremony
Jun. 09 (Wed.)		
		Cruise to 22.5N 139E
Jun. 10 (Thu.)		
15:51-18:01	06:51-09:01	C01 (22-30.03N, 138-59.89E) CTD cast with 36 water sampling down to 3,000 m depth
Jun. 11 (Fri.)		
		Cruise to 8N 137E
Jun.12 (Sat.)		
10:30	01:30	Meeting for moorings Cruise to 8N137E
Jun. 13 (Sun.)		
08:16-10:57	23:16-01:57	Deployment of TRITON buoy (07-38.95N, 136-41.92E)
12:54-14:31	03:54-05:31	C02-1 (07-51.23N, 136-29.67E) CTD cast with 36 water sampling down to 3,000 m depth
15:55-16:44	06:55-07:44	C02-2 (07-38.38N, 136-41.89E) CTD cast with 2 water sampling down to 1,000 m depth

Jun. 14 (Mon.)		
		Cruising to 2N138E
Jun. 15 (Tue.)		
06:40-07:19	21:40-22:19	C03-1 (02-04.51N, 138-04.71E) CTD cast with 2 water sampling down to 1,000 m depth
09:16-12:21	00:16-03:21	Recovery of TRITON buoy (02-04.02N, 138-03.74E)
Jun. 16 ((Wed.)		
08: 46-10:45	23:46-01:45	C03-2 (02-03.80N, 138-04.71E) CTD cast with 36 water sampling down to 3,000 m depth
12:50-15:41	03:50-06:41	Deployment of TRITON buoy (02-04.02N, 138-03.74E)
16:24-17:10	07:24-08:10	C03-3 (02-03.33N, 138-04.41E) CTD cast down to 1,000 m depth
		Cruise to EQ 138E
Jun. 17 (Thu.)		
08:15-11:35	23:15-02:35	Deployment of TRITON buoy (00-02.42N, 137-53.24E)
13:04-14:58	07:24-08:10	C04 (00-05.77N, 138-02.86E) CTD cast with 36 water sampling down to 3,000 m depth
Jun. 18 (Fri.)		
08:44-11:03	23:44-02:03	Recovery of TRION buoy (00-02.42N, 137-53.24)
13:13-15:39	04:13-06:39	Deployment of TRITON buoy (00-02.03N, 137-52.90E)
16:24	07:24	XCTD001 (00-02.41N, 137-52.55)
Jun. 19 (Sat.)		
08:37-11:06	23:37-02:06	Recovery of TRITON buoy (00-00.68S, 138-01.75E)
14:45-16:09	05:45-07:09	Recovery of ADCP buoy (00-00.70S, 138-01.90E)
Jun. 20 (Sun.)		
08:16-09:35	23:16-00:35	Deployment of ADCP buoy (00-00.71S, 138-01.73E)
		Cruise to 5N 137E
12:16	03:16	XCTD002 (00-30.03N, 137-57.51E)
14:10	05:10	XCTD003 (01-00.02N, 137-52.50E)
16:05	07:05	XCTD004 (01-30.03N, 137-47.90E)
18:00	09:00	XCTD005 (01-59.88N, 137-43.23E)
19:59	10:59	XCTD006 (02-30.01N, 137-38.62E)
22:03	13:03	XCTD007 (03-00-58N, 137-33.90E)
23:59	14:59	XCTD008 (03-30.01N, 137-24.95E)
Jun. 21 (Mon.)		
01:58	16:58	XCTD009 (03-59.99N, 137-24.95E)
04:00	19:00	XCTD010 (04-29.99N, 137-19.25E)
		Waiting for ocean condition recovery
13:11-16:07	04:11-07:07	Deployment of TRITON buoy (04-51.60N, 137-15.62E)
16:51	07:51	XCTD011 (04-51.97N, 137-16.63E)
June. 22 (Tue.)		
07:10	22:10	XCTD012 (04-56.69N, 137-24.89E)

		Waiting for ocean condition recovery
14:05-15:00	05:05-06:00	Launch the boat, but give up recovery of TRITON buoy at 5N 137E
		Cruising to 8N 137E
17:47	08:47	XCTD013 (05-30.00N, 137-13.58E)
20:04	11:04	XCTD014 (06-00.00N, 137-04.20E)
22:24	13:24	XCTD015 (06-30.00N, 136-54.41E)
Jun. 23 (Wed.)		
00:42	15:42	XCTD016 (07-00.00N, 136-45.58E)
03:04	18:04	XCTD017 (07-30.02N, 136-35.88E)
07:17	22:17	XCTD018 (07-51.96N, 136-30.41E)
		Waiting for ocean condition recovery
14:34-17:16	05:34-08:16	Recovery of TRITON buoy (07-50.42N, 136-31.63E)
Jun. 24 (Thu.)		
09:23-12:13	00:23-03:13	Recovery of TRITON buoy (04-56.91N, 137-26.00E)
13:24-15:17	04:24-06:17	C05 (04-56.93N, 137-24.74E) CTD cast with 36 water sampling down to 3,000 m depth
		Cruising to 8N130E
22:23	13:23	XCTD019 (05-31.76N, 136-00.00E)
Jun. 25 (Fri.)		
		Cruising to 8N 130E
03:16	18:16	XCTD020 (05-56.66N, 134-59.90E)
08:10	23:10	XCTD021 (06-21.26N, 134-00.06E)
13:07	04:07	XCTD022 (06-45.71N, 133-00.00E)
17:57	08:57	XCTD023 (07-10.48N, 132-00.00E)
22:31	13:31	XCTD024 (07-33.75N, 131-00.00E)
Jun. 26 (Sat.)		
		Waiting for ocean condition recovery
11:39	02:39	XCTD025 (07-55.26N, 130-03-79E)
14:39	05:39	XCTD026 (07-30.00N, 130-05.62E)
15:25	06:25	Launch ARGO float (07-25.28N, 130-05.27E)
18:05	09:05	XCTD027 (07-00.00N, 130-08.19E)
20:55	11:55	XCTD028 (06-30.00N, 130-16.74E)
23:50	14:50	XCTD029 (05-59.99N, 130-28.23E)
Jun.27 (Sun.)		
		Waiting for ocean condition recovery
03:08	18:08	XCTD030 (05-29.99N, 130-25.51E)
08:20	23:20	XCTD031 (05-00.00N, 129-59.93E)
		Cruising to 2N130E
11:34	02:34	XCTD032 (04-30.01N, 130-01.83E)
14:50	05:50	XCTD033 (04-00.02N, 129-57.62E)
18:19	09:19	XCTD034 (03-29.08N, 129-48.96E)
21:38	12:38	XCTD035 (03-00.00N, 129-43.24E)
Jun.28 (Mon.)		
00:39	15:39	XCTD036 (02-29.99N, 129-38.33E)
07:46	22:46	XCTD037 (02-07.03N, 129-35.38E)
08:00-11:00	23:00-02:00	Search for acoustic releaser of TRITON buoy around 2N 130E

13:41-15:26	04:41-06:26	Recovery of TRITON buoy (01-56.75N, 129-55.94E)
15:33	06:33	Launch ARGO float (02-01.27N, 129-56.74E)
18:10	09:10	Stop of continuous surface monitoring of surface sea water, and shipboard observations
		Cruise to Darwin
Jun. 29 (Tue.)		
		Cruise to Darwin
22:00	12:30	Ship mean time adjustment (SMT = UTC + 9.5)
Jun. 30 (Wed.)		
		Cruise to Darwin
Jul. 01 (Thu.)		
		Cruise to Darwin
Jul. 02 (Fri.)		
11:00	01:30	Arrival at Darwin, Australia
Jul. 03 (Sat.)		
17:40	08:10	Departure at Darwin, Australia (SMT = UTC + 9.5)
20:00	10:30	Start of continuous shipboard observations
Jul. 04 (Sun.)		
09:30	00:00	Start of Doppler radar observation
10:00	00:30	Meeting for Leg 2 observations
11:24	01:54	Start of continuous surface monitoring of surface sea water
13:00	03:30	Safety guidance for participants joined from Leg 2
13:30	04:00	Fire and abandon ship drill
16:45	07:15	Konpira-san ceremony
22:00	13:00	Ship mean time adjustment (SMT = UTC + 9)
Jul. 05 (Mon.)		
		Cruise to (5S, 95E)
22:00	13:30	Ship mean time adjustment (SMT = UTC + 8.5)
Jul. 06 (Tue.)		
		Cruise to (5S, 95E)
22:00	14:00	Ship mean time adjustment (SMT = UTC + 8)
Jul. 07 (Wed.)		
		Cruise to (5S, 95E)
22:00	14:30	Ship mean time adjustment (SMT = UTC + 7.5)
Jul. 08 (Thu.)		
		Cruise to (5S, 95E)
07:30	00:00	RS001 (08.08S, 101.30E) Rawinsonde observation
10:30	03:00	RS002 (07.72S, 100.31E)
13:30	06:00	RS003 (07.36S, 099.61E)
16:30	09:00	RS004 (06.99S, 098.89E)
19:30	12:00	RS005 (06.64S, 098.18E)
22:00	15:00	Ship mean time adjustment (SMT = UTC + 7)
22:00	15:00	RS006 (06.28S, 097.50E)
Jul. 09 (Fri.)		

01:00	18:00	RS007 (05.97S, 096.82E)
04:00	21:00	RS008 (05.60S, 096.12E)
07:00	00:00	RS009 (05.52S, 095.42E)
09:04-12:21	02:04-05:21	Deployment of TRITON buoy (05-02.21S, 094-58.58E)
10:00	03:00	RS010 (05.10S, 095.00E)
13:00	06:00	RS011 (05.03S, 094.97E)
13:01-14:18	06:01-07:18	C06 (05-02.75S, 094-58.06E) CTD cast with 36 water sampling down to 2,000 m depth
16:00	09:00	RS012 (04.95S, 094.85E)
19:00	12:00	RS013 (04.51S, 094.22E)
22:00	15:00	RS014 (04.08S, 093.55E)

Jul. 10 (Sat.)

01:00	18:00	RS015 (03.63S, 092.90E)
04:00	21:00	RS016 (03.17S, 092.23E)
07:00	00:00	RS017 (02.72S, 091.57E)
07:00	00:00	RS018 (02.59S, 091.37E)
10:00	03:00	RS019 (02.29S, 090.93E)
13:00	06:00	RS020 (01.81S, 090.22E)
14:02-15:16	07:02-08:16	C07 (01-40.35S, 089-59.10E) CTD cast with 36 water sampling down to 2,000 m depth
16:00	09:00	RS021 (01.67S, 089.98E)
19:00	12:00	RS022 (01.65S, 090.00E)
22:00	15:00	RS023 (01.67S, 089.95E)

Jul. 11 (Sun.)

01:00	18:00	RS024 (01.66S, 089.96E)
04:00	21:00	RS025 (01.68S, 089.95E)
07:00	00:00	RS026 (01.67S, 089.96E)
07:30-11:15	00:30-04:15	Recovery of TRITON buoy (01-39.42S, 089-59.60E)
10:00	03:00	RS027 (01.64S, 089.99E)
13:00	06:00	RS028 (01.60S, 090.07E)
16:00	09:00	RS029 (01.59S, 090.05E)
19:00	12:00	RS030 (01.60S, 090.07E)
22:00	15:00	RS031 (01.60S, 090.07E)

Jul. 12 (Mon.)

01:00	18:00	RS032 (01.60S, 090.07E)
04:00	21:00	RS033 (01.60S, 090.10E)
07:00	00:00	RS034 (01.60S, 090.06E)
08:13-11:30	01:13-04:30	Deployment of TRITON buoy (01-36.16S, 090-04.49E)
10:00	03:00	RS035 (01.61S, 090.02E)
13:00	06:00	RS036 (01.60S, 090.05E)
16:00	09:00	RS037 (01.17E, 090.02E)
19:00	12:00	RS038 (00.37S, 090.05E)
22:00	15:00	RS039 (00.01N, 090.07E)

Jul. 13 (Tue.)

01:00	18:00	RS040 (00.01N, 090.08E)
04:00	21:00	RS041 (00.00N, 090.07E)
07:00	00:00	RS042 (00.00N, 090.08E)

07:35-09:52	00:35-02:52	Recovery of subsurface ADCP mooring (00-00.37N, 090-03.35E)
10:00	03:00	RS043 (00.01S, 090.05E)
10:31-12:09	03:31-05:09	Deployment of subsurface ADCP mooring (00-00.40N, 090-03.39E)
13:00	06:00	RS044 (00.01N, 090.07E)
13:31-14:32	06:31-07:32	C08 (00-00.28S, 090-04.41E) CTD cast with 36 water sampling down to 2,000 m depth
14:45	07:45	XCTD038 (00-00.82S, 090-04.92E)
16:00	09:00	RS045 (00.07S, 090.17E)
16:00	09:00	RS046 (00.16S, 090.35E)
16:40	09:40	XCTD039 (00-15.16S, 090-29.76E)
19:00	12:00	RS047 (00.52S, 090.83E)
19:02	12:02	XCTD040 (00-37.88S, 091-00.01E)
21:20	14:20	XCTD041 (00-58.45S, 091-29.91E)
22:00	15:00	RS048 (01.00S, 091.56E)
23:39	16:39	XCTD042 (01-17.91S, 092-00.03E)

Jul. 14 (Wed.)

		Cruise to (8N, 130E)
01:00	18:00	RS049 (01.36S, 092.10E)
02:03	19:03	Launch ARGO float (01-38.31S, 092-30.17E)
02:04	19:04	XCTD043 (01-38.40S, 092-30.28E)
04:00	21:00	RS050 (01.79S, 092.73E)
04:24	21:24	XCTD044 (01-58.01S, 093-00.00E)
06:50	23:50	XCTD045 (02-19.09S, 093-30.00E)
07:00	00:00	RS051 (02.23S, 093.38E)
09:14	02:14	XCTD046 (02-38.91S, 094-00.00E)
10:00	03:00	RS052 (02.71S, 094.08E)
11:41	04:41	XCTD047 (02-59.01S, 094-30.00E)
13:00	06:00	RS053 (03.05S, 094.59E)
14:07	07:07	Launch ARGO float (03-18.65S, 094-59.96E)
14:11	07:11	XCTD048 (03-19.01S, 095-00.00E)
16:00	09:00	RS054 (03.46S, 095.21E)
16:35	09:35	XCTD049 (03-39.37S, 095-30.00E)
18:59	11:59	XCTD050 (03-59.24S, 095-59.92E)
19:00	12:00	RS055 (03.87S, 095.83E)
21:31	14:31	XCTD051 (04-20.10S, 096-31.00E)
22:00	15:00	RS056 (04.29S, 096.45E)
23:54	16:54	XCTD052 (04-39.57S, 096-59.99E)

Jul. 15 (Thu.)

		Cruise to (8N, 130E)
01:00	18:00	RS057 (04.68S, 097.04E)
02:20	19:20	XCTD053 (04-59.71S, 097-30.00E)
04:00	21:00	RS058 (05.10S, 097.66E)
04:52	21:52	XCTD054 (05-21.76S, 098-00.00E)
07:00	00:00	RS059 (05.53S, 098.29E)
07:17	00:17	XCTD055 (05-41.29S, 098-29.99E)
09:43	02:43	XCTD056 (05-59.52S, 099-00.73E)
10:00	03:00	RS060 (05.95S, 098.92E)
12:06	05:06	XCTD057 (06-20.14S, 099-29.99E)
13:00	06:00	RS061 (06.34S, 099.50E)
14:43	07:43	Launch ARGO float (06-40.09S, 099-59.45E)

14:48	07:48	XCTD058 (06-40.40S, 099-59.96E)
16:00	09:00	RS062 (06.72S, 100.07E)
17:17	10:17	XCTD059 (07-00.51S, 100-30.01E)
19:00	12:00	RS063 (07.13S, 100.68E)
19:48	12:48	XCTD060 (07-20.73S, 100-59.99E)
22:00	14:00	Ship mean time adjustment (SMT = UTC + 8)
23:00	15:00	RS064 (07.53S, 101.29E)
23:17	15:17	XCTD061 (07-40.42S, 101-30.00E)

Jul. 16 (Fri.)

		Cruise to (8N, 130E)
02:00	18:00	RS065 (07.89S, 101.87E)
02:00	18:00	XCTD062 (08-00.99S, 102-00.00E)
04:22	20:22	XCTD063 (08-20.45S, 102-29.74E)
05:00	21:00	RS066 (08.31S, 102.45E)
06:51	22:51	XCTD064 (08-40.28S, 102-59.98E)
09:16	01:16	XCTD065 (09-00.28S, 103-30.00E)
11:41	03:41	XCTD066 (09-19.81S, 103-59.98E)
14:06	06:06	XCTD067 (09-40.04S, 104-29.99E)
16:30	08:30	XCTD068 (10-00.00S, 105-00.02E)
18:31	10:31	XCTD069 (10-01.26S, 105-29.98E)
20:30	12:30	XCTD070 (10-02.52S, 106-00.05E)
22:30	14:30	XCTD071 (10-04.02S, 106-29.99E)

Jul. 17 (Sat.)

		Cruise to (8N, 130E)
00:31	16:31	XCTD072 (10-05.77S, 106-59.99E)
02:31	18:31	XCTD073 (10-07.47S, 107-30.00E)
04:31	20:31	XCTD074 (10-09.29S, 107-59.99E)
06:32	22:32	XCTD075 (10-10.95S, 108-30.00E)
08:36	00:36	XCTD076 (10-12.23S, 108-59.99E)
10:42	02:42	XCTD077 (10-13.24S, 109-30.02E)
12:48	04:48	XCTD078 (10-14.75S, 110-00.00E)
14:56	06:56	XCTD079 (10-16.84S, 110-29.99E)
17:05	09:05	XCTD080 (10-18.36S, 111-00.00E)
19:17	11:17	XCTD081 (10-19.97S, 111-30.02E)
21:27	13:27	XCTD082 (10-20.88S, 111-59.99E)
23:39	15:39	XCTD083 (10-23.05S, 112-29.98E)

Jul. 18 (Sun.)

		Cruise to (8N, 130E)
01:48	17:48	XCTD084 (10-25.02S, 112-59.99E)
03:53	19:53	XCTD085 (10-26.62S, 113-29.99E)
05:57	21:57	XCTD086 (10-27.38S, 114-00.00E)
08:03	00:03	XCTD087 (10-28.32S, 114-30.00E)
10:09	02:09	XCTD088 (10-30.43S, 114-59.99E)
12:19	04:19	XCTD089 (10-31.83S, 115-29.99E)
14:27	06:27	XCTD090 (10-33.10S, 116-00.01E)
16:29	08:29	XCTD091 (10-34.50S, 116-30.00E)
18:31	10:31	XCTD092 (10-36.12S, 117-00.10E)
20:37	12:37	XCTD093 (10-37.87S, 117-30.02E)
22:48	14:48	XCTD094 (10-39.05S, 118-00.01E)

Jul. 19 (Mon.)		
		Cruise to (8N, 130E)
00:58	16:58	XCTD095 (10-40.71S, 118-30.00E)
03:08	19:08	XCTD096 (10-42.37S, 119-01.19E)
05:04	21:04	XCTD097 (10-43.44S, 119-30.00E)
07:09	23:09	XCTD098 (10-45.04S, 119-59.98E)
09:00	01:00	Stop of all continuous observation due to enter into the Indonesian waters
22:00	13:00	Ship mean time adjustment (SMT = UTC + 9)
Jul. 20 (Tue.)		
		Cruise to (8N, 130E)
Jul. 21 (Wed.)		
		Cruise to (8N, 130E)
Jul. 22 (Thu.)		
		Cruise to (8N, 130E)
03:00	18:00	Re-start of shipboard observations
05:00	20:00	Re-start of continuous sea surface monitoring
Jul. 23 (Fri.)		
06:57-08:11	21:57-23:11	C09 (07-55.74N, 130-02.82E) CTD cast with 36 water sampling down to 2,000 m depth
08:13-12:48	23:13-03:48	Recovery of TRITON buoy (07-55.53N, 130-03.94E)
09:00	00:00	RS067 (07.94N, 130.04E)
12:00	03:00	RS068 (07.94N, 130.08E)
14:00	05:00	RS069 (07.98N, 130.01E)
15:00	06:00	RS070 (07.99N, 130.01E)
18:00	09:00	RS071 (08.01N, 130.00E)
21:00	12:00	RS072 (07.98N, 130.00E)
Jul. 24 (Sat.)		
00:00	15:00	RS073 (07.99N, 129.97E)
03:00	18:00	RS074 (07.98N, 130.02E)
06:00	21:00	RS075 (08.01N, 129.98E)
07:47-11:35	22:47-02:35	Deployment of TRITON buoy (07-58.83N, 130-02.10E)
09:00	00:00	RS076 (07.92N, 129.95E)
11:00	02:00	RS077 (07.98N, 130.03E)
12:00	03:00	RS078 (07.98N, 130.04E)
18:00	09:00	RS079 (07.35N, 130.03E)
21:00	12:00	RS080 (06.55N, 130.07E)
Jul. 25 (Sun.)		
12:00	03:00	RS081 (02.07N, 130.21E)
13:15-15:43	04:15-06:43	Deployment of TRITON buoy (02-01.69N, 130-11.39E)
15:00	06:00	RS082 (02.04N, 130.17E)
Jul. 26 (Mon.)		
		Cruise to (22.5N, 132E)

Jul. 27 (Tue.)		
		Cruise to (22.5N, 132E)
Jul. 28 (Wed.)		
20:30-22:22	11:30-13:22	C10 (22-30.09N, 131-59.87E) CTD cast with 36 water sampling down to 3,000 m depth
Jul. 29 (Thu.)		
		Cruise to Hachinohe
Jul. 30 (Fri.)		
		Cruise to Hachinohe
Jul. 31 (Sat.)		
		Cruise to Hachinohe
13:00	04:00	Stop of Doppler radar observation
Aug. 1 (Sun.)		
		Cruise to Hachinohe
10:01	01:01	Stop of continuous surface monitoring of surface sea water
Aug. 2 (Mon.)		
10:00	01:00	Arrival at Hachinohe
15:40	06:40	Departure at Hachinohe
Aug. 3 (Tue.)		
09:00	00:00	Arrival at Sekinehama

3.4 Cruise Track

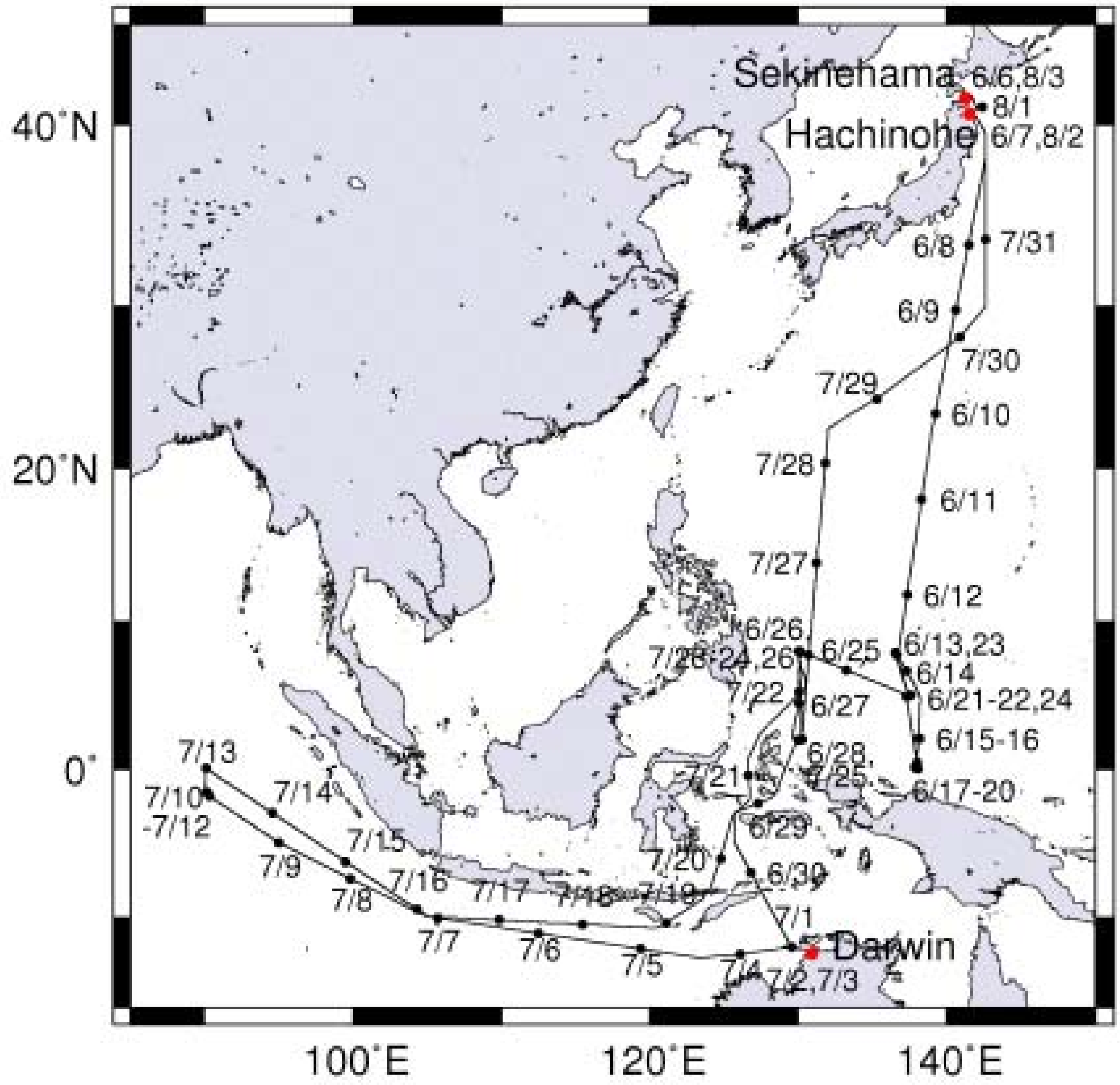

Fig.3.4-1 Cruise Track on MR04-03

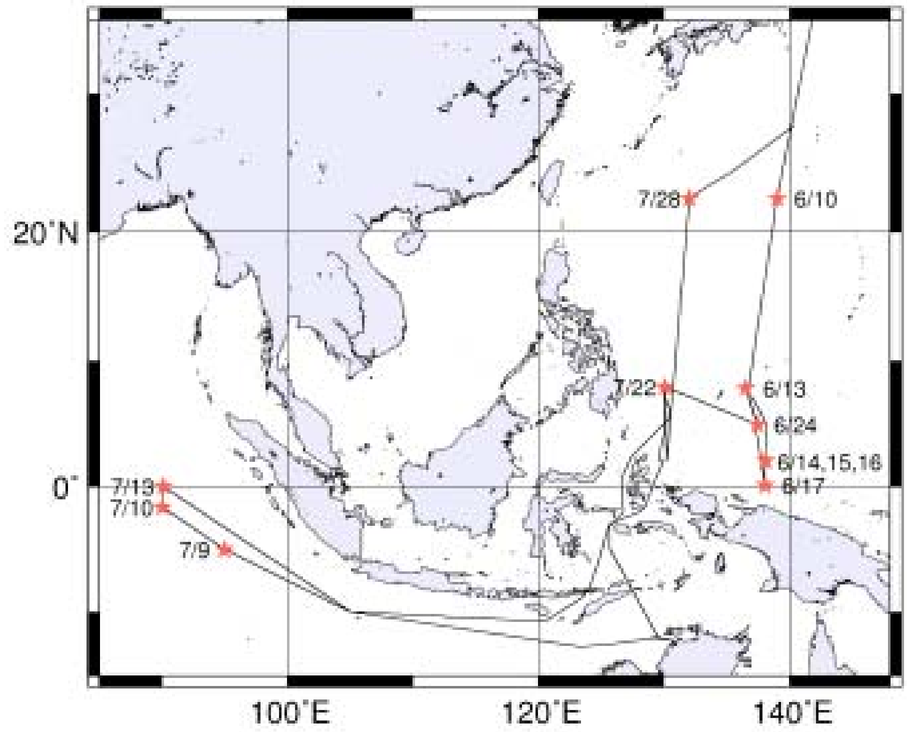

Fig.3.4-2　CTD stations on MR04-03

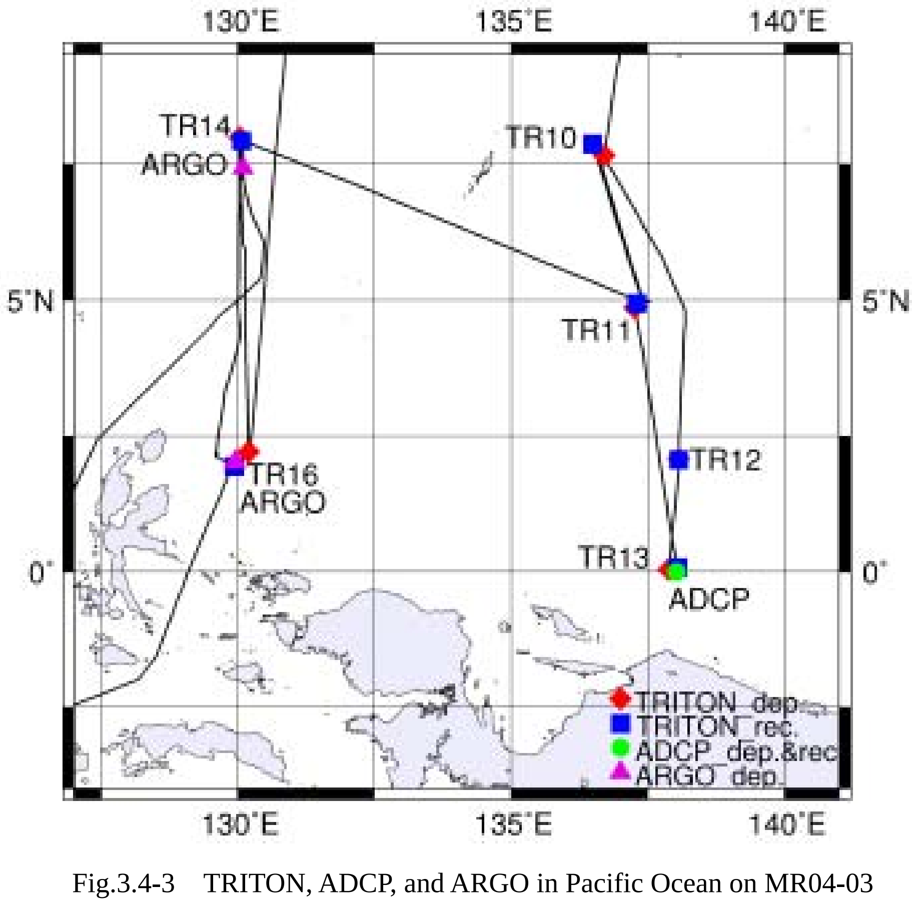

Fig.3.4-3　TRITON, ADCP, and ARGO in Pacific Ocean on MR04-03

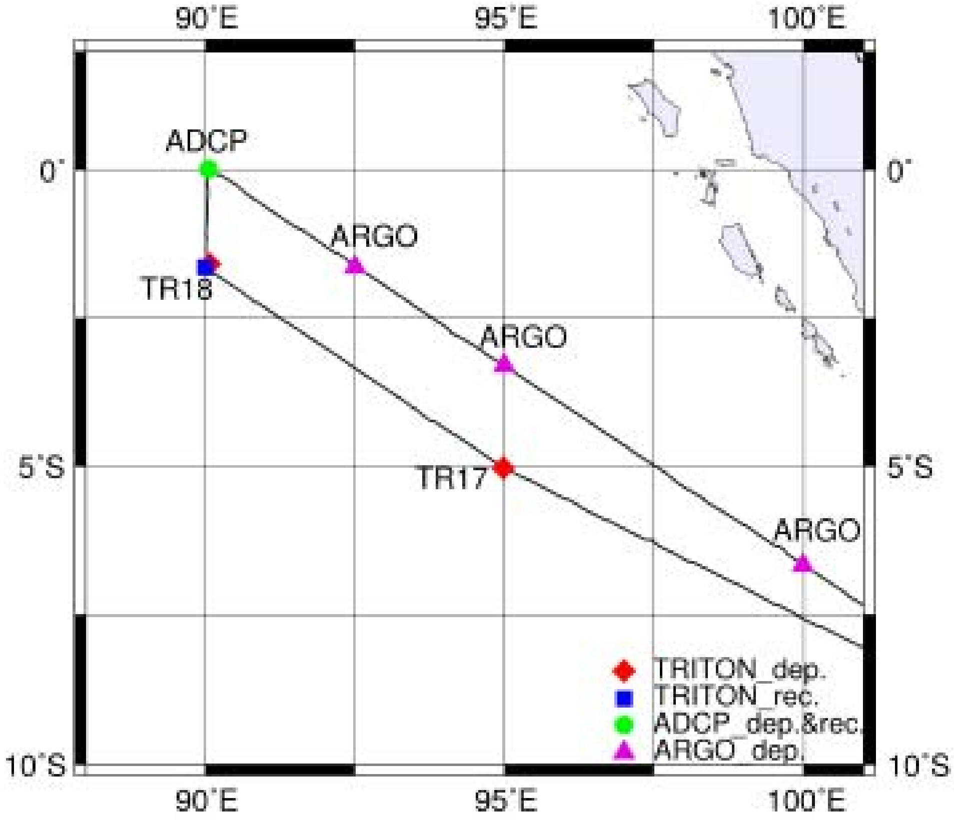

Fig.3.4-4　TRITON, ADCP and ARGO in Indian Ocean on MR04-03

4. Chief scientist

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Research scientist
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2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN

<Leg 2>
Hideaki Hase
Research scientist
IORGC, JAMSTEC
2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN

5. Participants list

5.1. R/V Mirai scientists and technical staffs

(*; Leg 1, **; Leg 2, ***; Leg 1 and Leg 2)

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Hideki Hase**	JAMSTEC
Shuichi Mori**	JAMSTEC
Mari Sakai **	JAMSTEC
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Albertus Sulaiman**	BPPT
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Fujio Kobayashi*	MWJ
Naoko Takahashi*	MWJ
Fuma Matsunaga***	MWJ
Keisuke Matsumoto***	MWJ
Tomohide Noguchi*	MWJ
Akinori Murata*	MWJ
Kenichi Katayama**	MWJ
Tomoyuki Takamori**	MWJ
Tetsuharu Iino**	MWJ
Satoko Asai**	MWJ
Naoshi Kuda***	MWJ
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Satoshi Okumura*	Global Ocean Development Inc. (GODI) 1-13-8, Kamiookanishi, Konan-ku, Yokohama, Kanagawa 233-0022, JAPAN
Wataru Tokunaga**	GODI
Norio Nagahama**	GODI
Kazuho Yoshida***	GODI

5.2. R/V MIRAI crew member

Crew List(Leg 1)

Masaharu Akamine	Master (Sekinehama~Hachinohe)
Yujiro Kita	Master
Takahiro Sakoda	Chief Officer
Haruhiko Inoue	1st Officer
Shingo Fujita	2nd Officer
Nobuo Hukaura	3rd Officer
Takeyuki Hukazawa	3rd Officer
Akiteru Ono	Chief Engineer
Shinji Tokunaga	1st Engineer
Takashi Omichi	2nd Engineer
Yoshihisa Kato	3rd Engineer
Shuji Nakabayashi	Chief Radio Officer
Keiichiro Shishido	2nd Radio Officer
Kenetsu Ishikawa	Boatswain
Yasuyuki Yamamoto	Able seaman
Kenichi Torao	Able seaman
Seiichiro Kawata	Able seaman
Kunihiko Omote	Able seaman
Hisao Oguni	Able seaman
Yukiharu Suzuki	Able seaman
Kazuyoshi Kudo	Able seaman
Tsuyoshi Monzawa	Able seaman
Takeharu Aisaka	Able seaman
Masashige Okada	Able seaman
Shuji Komata	Able seaman
Yukitoshi Horiuchi	No. 1 Oiler
Kiyoharu Emoto	Oiler
Yoshihiro Sugimoto	Oiler
Toshio Matsuo	Oiler
Nobuo Boushita	Oiler
Kazumi Yamashita	Oiler
Yasutaka Kurita	Chief Steward
Hatsuji Hiraishi	Cook
Kitoshi Sugimoto	Cook
Tatsuya Hamabe	Cook
Wataru Sasaki	Cook

Crew List(Leg 2)

Masaharu Akamine	Master (Hachinohe~Sekinehama)
Yujiro Kita	Master
Takahiro Sakoda	Chief Officer
Haruhiko Inoue	1st Officer
Shingo Fujita	2nd Officer
Nobuo Hukaura	3rd Officer
Takeyuki Hukazawa	3rd Officer
Akiteru Ono	Chief Engineer
Shinji Tokunaga	1st Engineer
Takashi Omichi	2nd Engineer
Yoshihisa Kato	3rd Engineer
Shuji Nakabayashi	Chief Radio Officer
Keiichiro Shishido	2nd Radio Officer
Kenetsu Ishikawa	Boatswain
Yasuyuki Yamamoto	Able seaman
Kenichi Torao	Able seaman
Kunihiko Omote	Able seaman
Hisao Oguni	Able seaman
Yukiharu Suzuki	Able seaman
Yosuke Kuwahara	Able seaman
Kazuyoshi Kudo	Able seaman
Tsuyoshi Monzawa	Able seaman
Takeharu Aisaka	Able seaman
Masashige Okada	Able seaman
Shuji Komata	Able seaman
Yukitoshi Horiuchi	No. 1 Oiler
Kiyoharu Emoto	Oiler
Yoshihiro Sugimoto	Oiler
Toshio Matsuo	Oiler
Nobuo Boushita	Oiler
Kazumi Yamashita	Oiler
Yasutaka Kurita	Chief Steward
Hatsuji Hiraishi	Cook
Hitoshi Ota	Cook
Tatsuya Hamabe	Cook
Wataru Sasaki	Cook

6 General observation
6.1 Meteorological measurement
6.1.1 Surface Meteorological Observation

Satoshi Okumura	(Global Ocean Development Inc.)	- leg 1 -
Wataru Tokunaga	(GODI)	- leg 2 -
Norio Nagahama	(GODI)	- leg 2 -
Kazuho Yoshida	(GODI)	- leg 1, 2 -
Not on-board:		
Kunio Yoneyama	(JAMSTEC) Principal Investigator	

(1) Objectives

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

(2) Methods

The surface meteorological parameters were observed throughout the MR04-03 cruise from the departure of Sekinehama on 6 June 2004 to arrival of Sekinehama on 3 Aug 2004.

At this cruise, we used two systems for the surface meteorological observation.

1. Mirai meteorological observation system
2. Shipboard Oceanographic and Atmospheric Radiation (SOAR) System

(2-1) Mirai meteorological observation system

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

(2-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system designed by BNL consists of major 3 parts.

1. Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation.
2. Zeno meteorological system designed by BNL – wind, air temperature, relative humidity, pressure, and rainfall measurement.
3. Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA)- centralized data acquisition and logging of all data sets.

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

(3) Preliminary results

Figures 6.1.1-1 show the time series of the following parameters; Wind (SOAR), air temperature (SOAR), sea surface temperature (EPCS), relative humidity (SOAR), precipitation (SOAR), short wave radiation (SOAR), infra-red radiation (SMET), pressure (SOAR) and significant wave height (SMET).

(4) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division. Corrected data sets will also be available from K. Yoneyama of JAMSTEC.

(5) Remarks

1. We used EPCS (see Section 6.4.1), for sea surface temperature data.
2. Navigation data were invalid during the period below due to the network or navigation system trouble.
   6/20 00:11 – 00:20
   6/21 17:06 – 17:07
   6/27 0:33 – 00:45, 01:16 – 01:30, 01:44 – 01:54
   7/22 14:03, 14:05, 14:07 – 14:08
   7/23 11:15, 7/27 04:12, 7/30 13:34
3. Long wave radiation data in SOAR system were invalid during the cruise.

Table 6.1.1-1 Instruments and installations of Mirai meteorological system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24m)
Thermometer	HMP45A	Vaisala, Finland	compass deck (21m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m) SST
Barometer	F-451	Yokogawa, Japan	weather observation room captain deck (13m)
Rain gauge	50202	R. M. Young, USA	compass deck (19m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10m)

S

Table 6.1.1-2 Parameters of Mirai meteorological observation system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log, DS-30 Furuno
4	Ship's heading	degree	Mirai gyro, TG-6000, Tokimec
5	Relative wind speed	m/s	6sec./10min. averaged
6	Relative wind direction	degree	6sec./10min. averaged
7	True wind speed	m/s	6sec./10min. averaged
8	True wind direction	degree	6sec./10min. averaged
9	Barometric pressure	hPa	adjusted to sea surface level 6sec. averaged
10	Air temperature (starboard side)	degC	6sec. averaged
11	Air temperature (port side)	degC	6sec. averaged
12	Dewpoint temperature (starboard side)	degC	6sec. averaged
13	Dewpoint temperature (port side)	degC	6sec. averaged
14	Relative humidity (starboard side)	%	6sec. averaged
15	Relative humidity (port side)	%	6sec. averaged
16	Sea surface temperature	degC	6sec. averaged
17	Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18	Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19	Down welling shortwave radiation	W/m^2	6sec. averaged
20	Down welling infra-red radiation	W/m^2	6sec. averaged
21	Significant wave height (fore)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period	second	hourly
24	Significant wave period	second	hourly

Table 6.1.1-3 Instruments and installation locations of SOAR system

Sensors	Type	Manufacturer	Location (altitude from surface)
Zeno/Met			
Anemometer	05106	R.M. Young, USA	foremast (25m)
Tair/RH	HMP45A	Vaisala, Finland	foremast (24m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
Barometer	61201	R.M. Young, USA	foremast (24m)
	with 61002 Gill pressure port (R.M. Young)		
Rain gauge	50202	R. M. Young, USA	foremast (24m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24m)
PRP			
Radiometer (short wave)	PSP	Eiko Seiki, Japan	foremast (25m)
Radiometer (long wave)	PIR	Eiko Seiki, Japan	foremast (25m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (25m)

Table 6.1.1-4 Parameters of SOAR system

	Parmeter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Sog	knot	
4	Cog	degree	
5	Relative wind speed	m/s	
6	Relative wind direction	degree	
7	Barometric pressure	hPa	
8	Air temperature	degC	
9	Relative humidity	%	
10	Rain rate (optical rain gauge)	mm/hr	reset at 50mm
11	Precipitation (capacitive rain gauge)	mm	
12	Down welling shortwave radiation	W/m^2	
13	Down welling infra-red radiation	W/m^2	
14	Defuse irradiance	W/m^2	

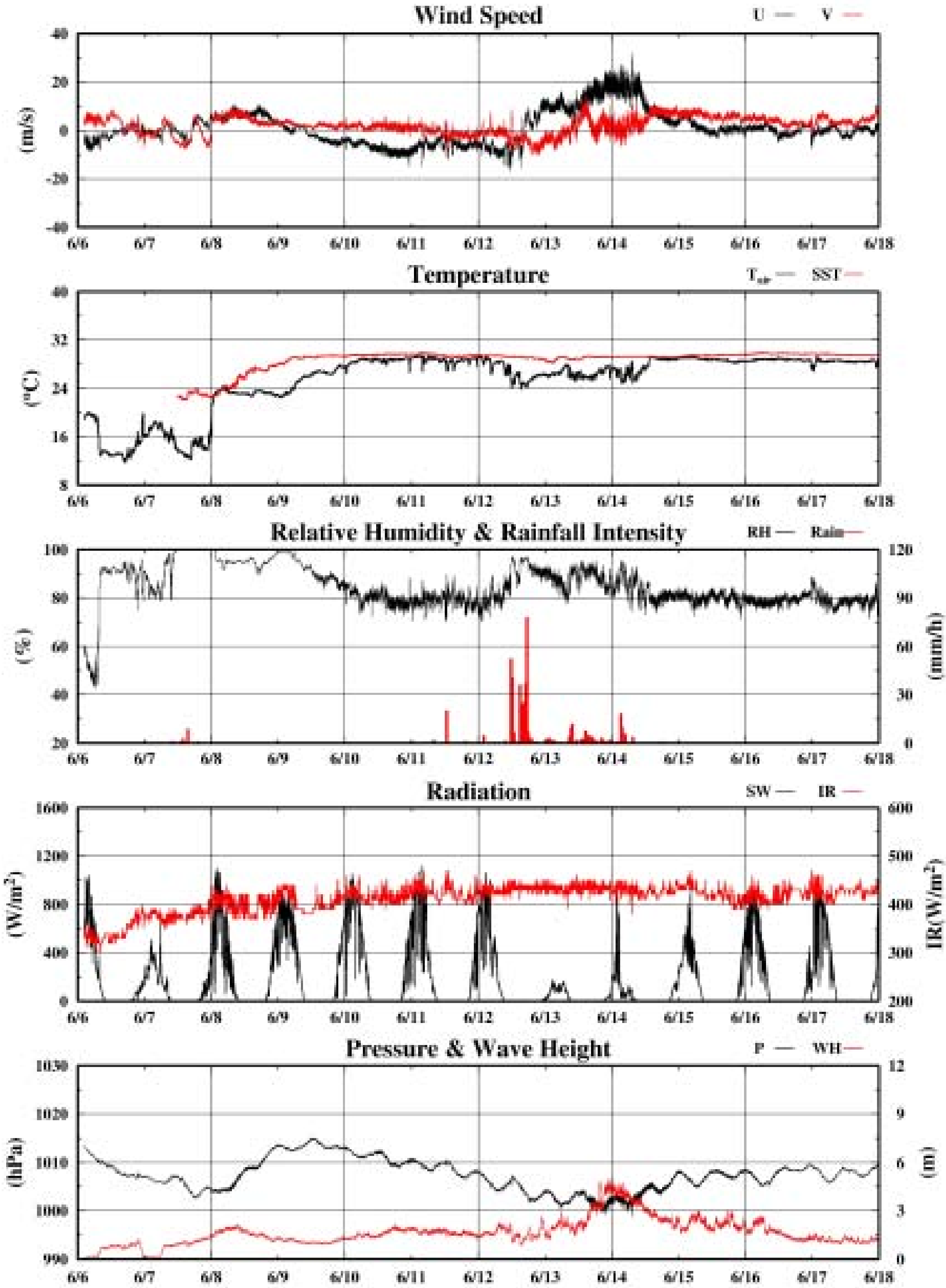

Fig 6-1-1.1 Time series of surface meteorological parameters during the cruise

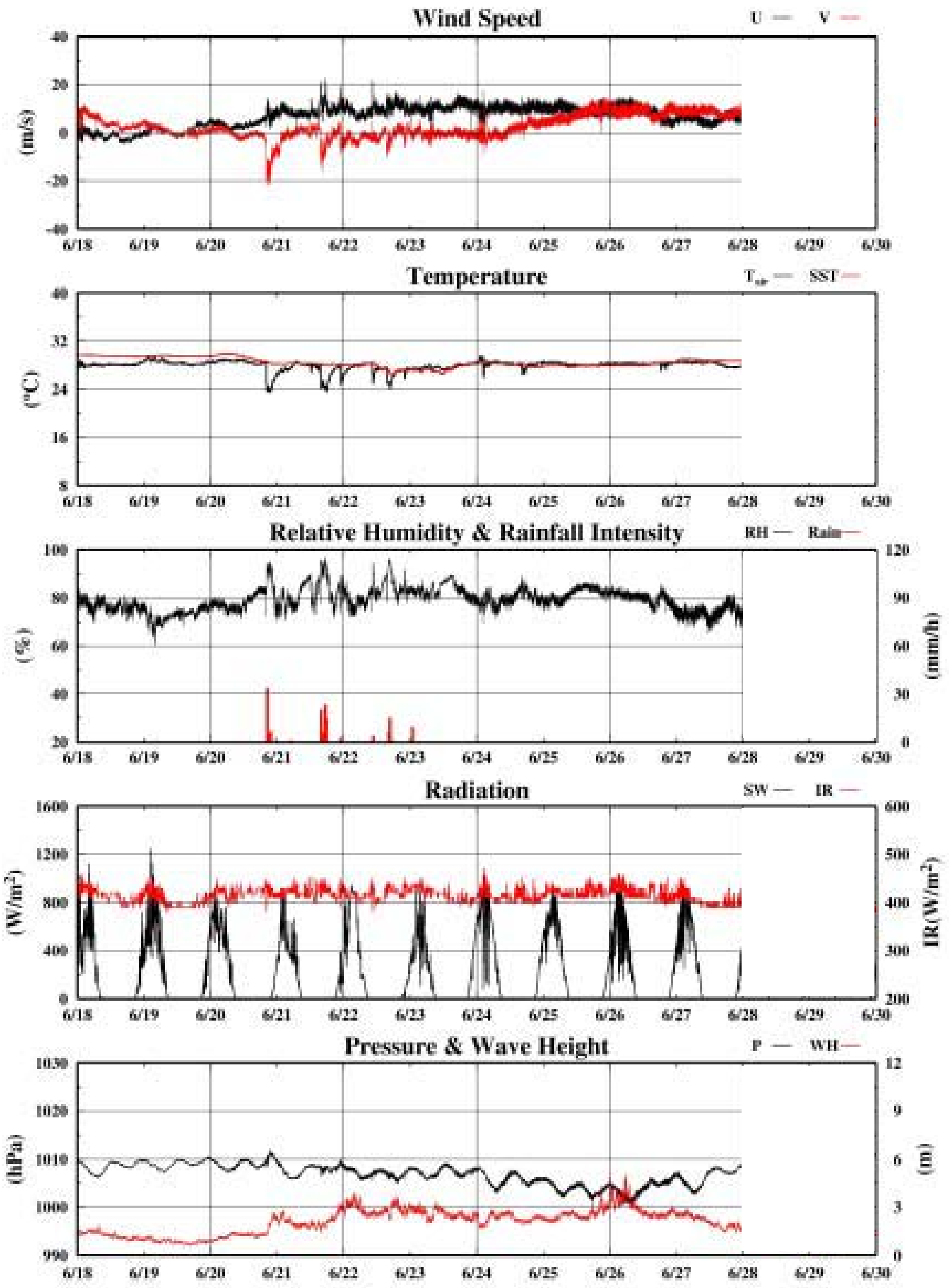

Fig 6-1-1.1 continued

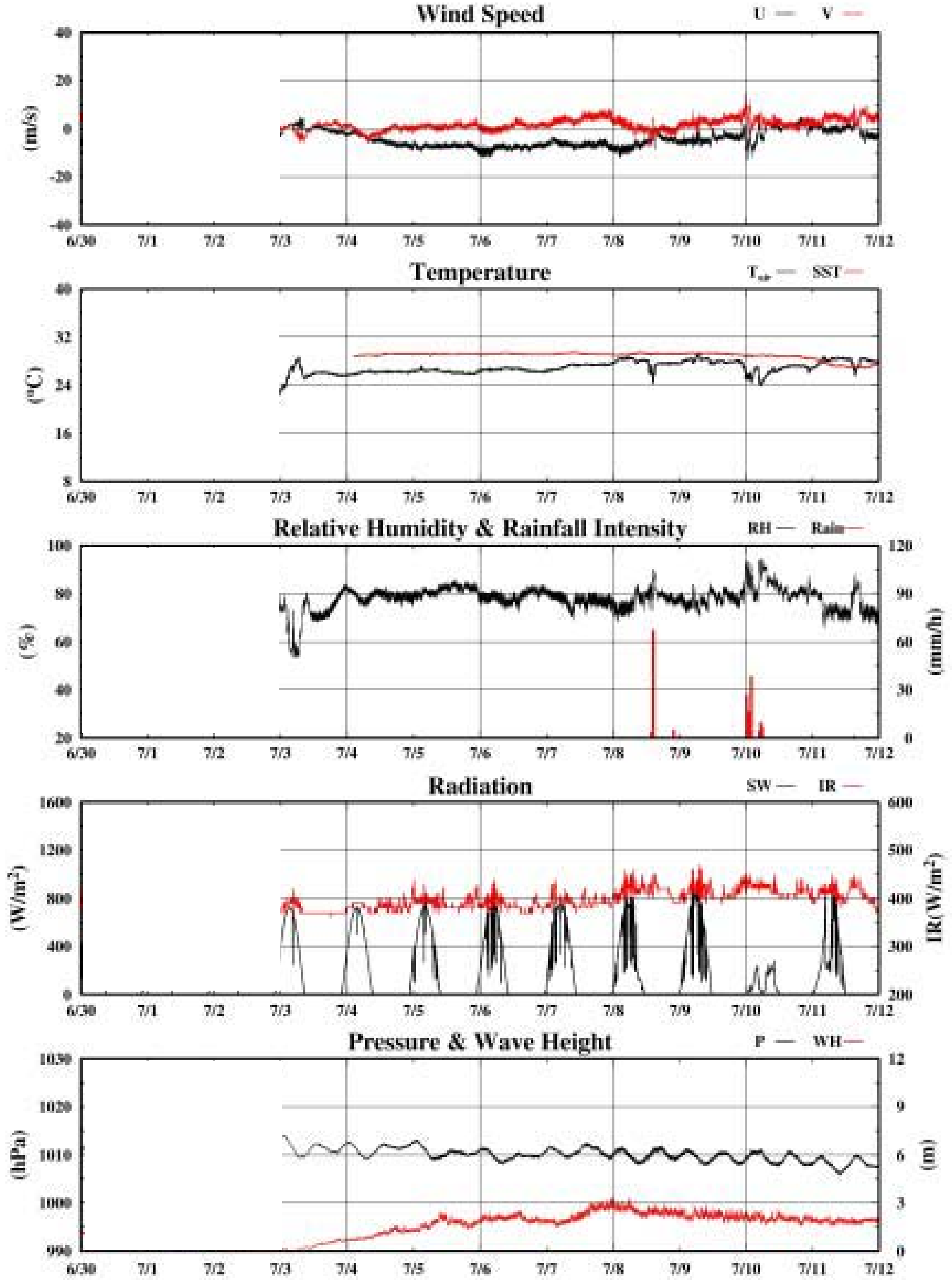

Fig 6-1-1.1 continued

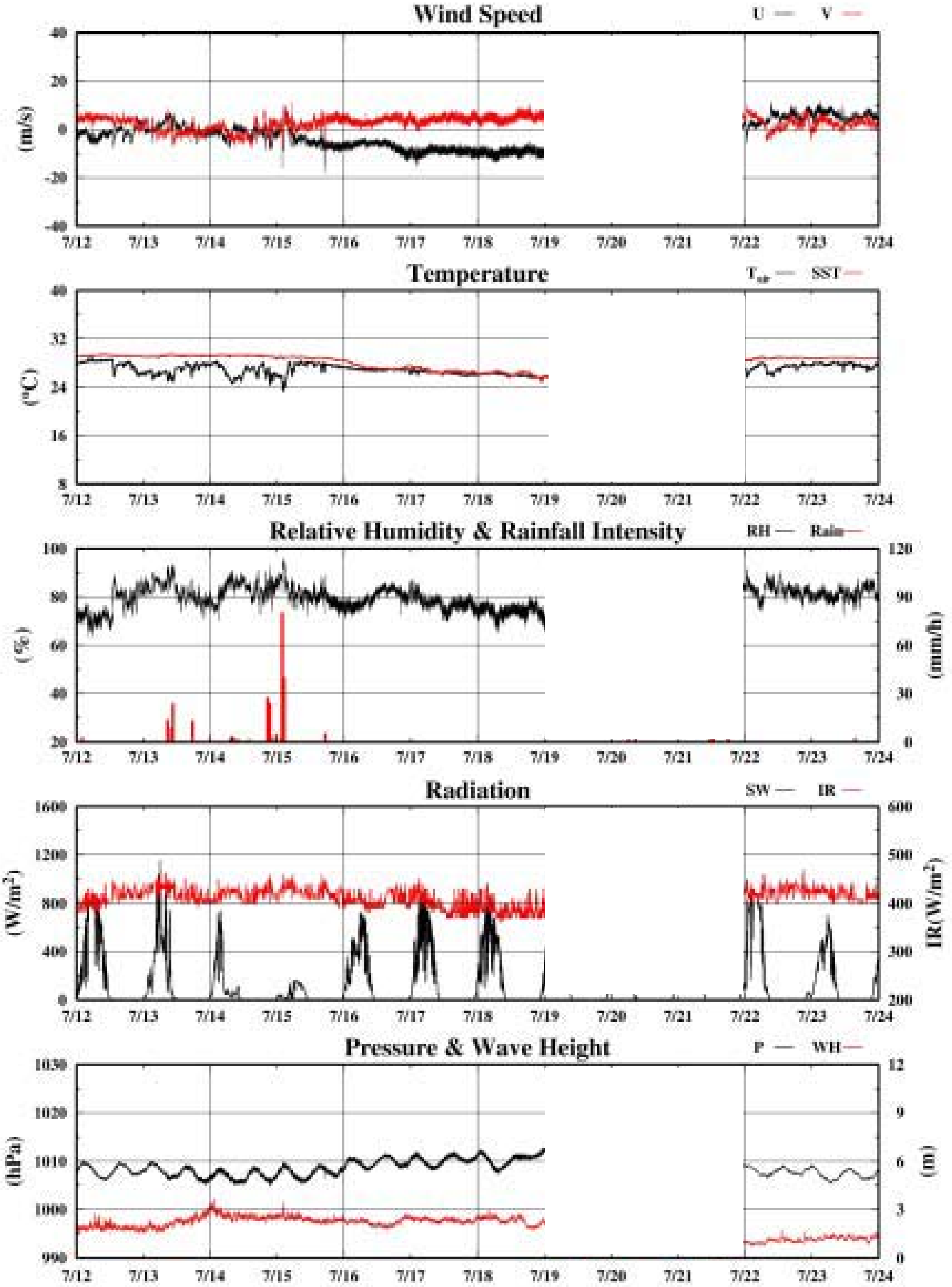

Fig 6-1-1.1 continued

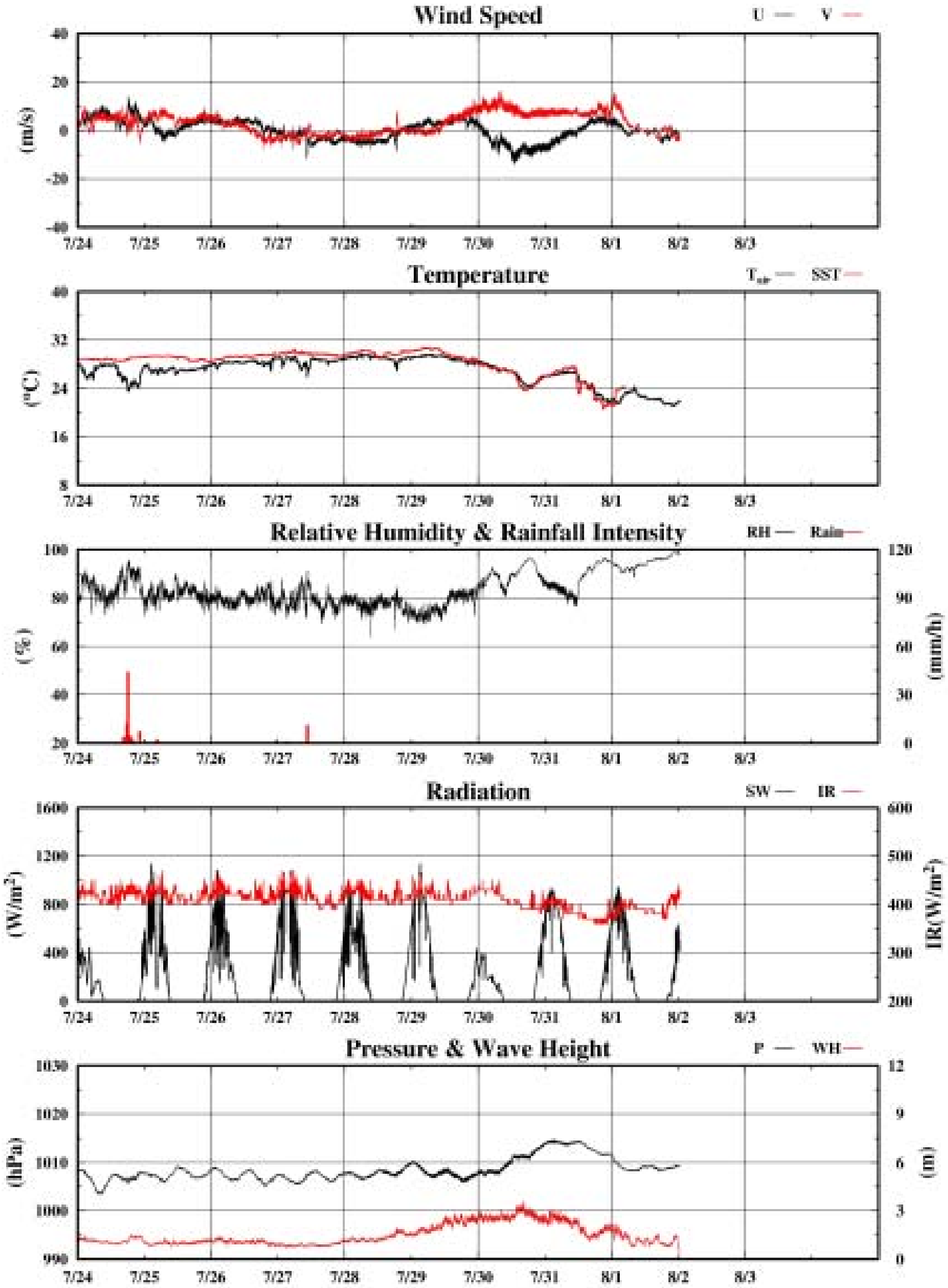

Fig 6-1-1.1 continued

6.1.2 Ceilometer Observation

Satoshi Okumura	(Global Ocean Development Inc.)	- leg1 -
Wataru Tokunaga	(GODI)	- leg2 -
Norio Nagahama	(GODI)	- leg2 -
Kazuho Yoshida	(GODI)	- leg1, 2 -
Not on-board:		-
Kunio Yoneyama	(JAMSTEC) Principal Investigator	

(1) Objectives

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

(2) Parameters

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

(3) Methods

We measured cloud base height and backscatter profile using ceilometer (CT-25K, VAISALA, Finland) throughout the MR04-K03 cruise from the departure of Sekinehama on 6 June 2004 to arrival of Sekinehama on 3 August 2004.

Major parameters for the measurement configuration are as follows;

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

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

(4) Preliminary results

The figure 6.1.2-1 shows the time series of the first, second and third lowest cloud base height.

(5) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division.

(6) Remark

We did not sample the data within territorial waters of Republic of Indonesia and Australia.

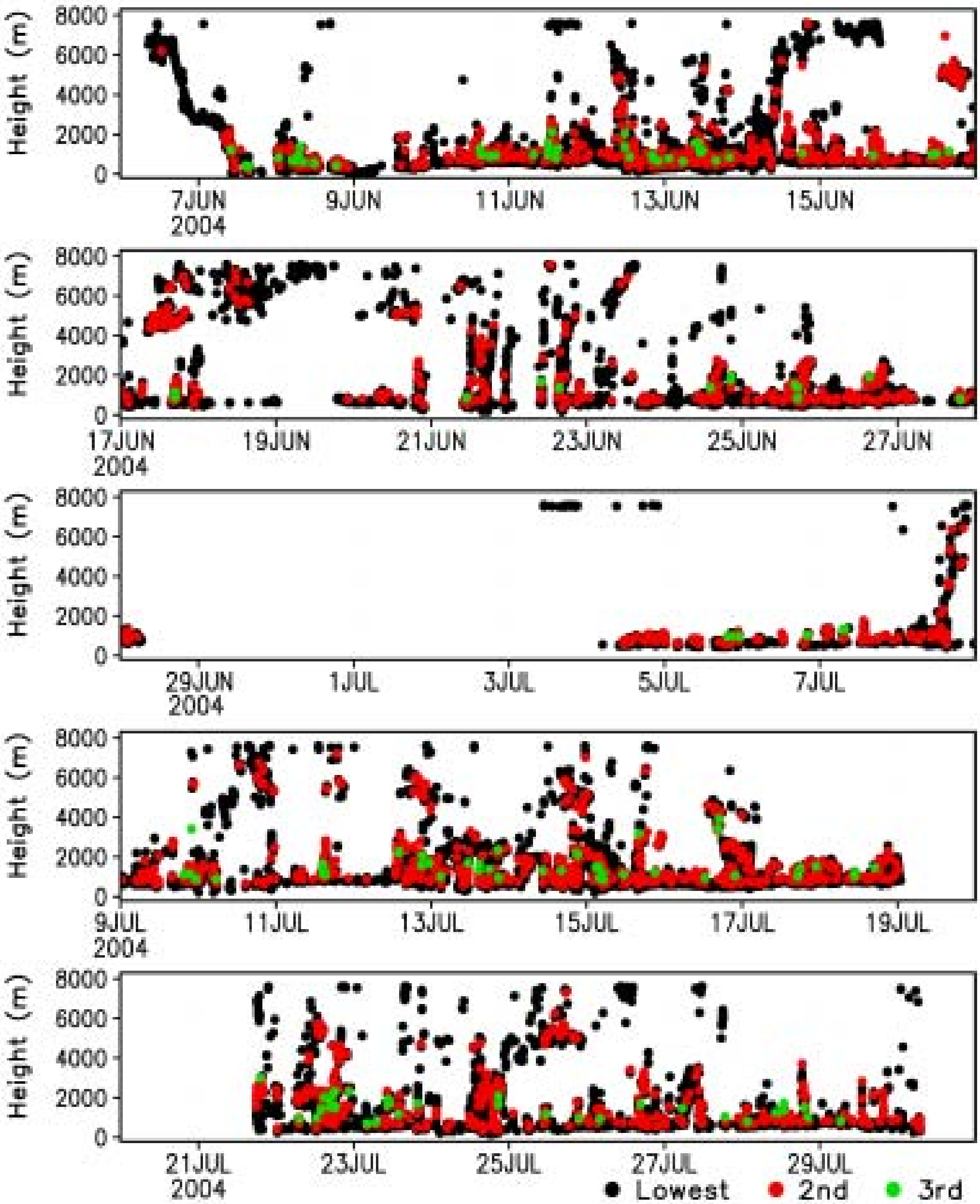

Figure 6.1.2-1 Cloud base height during the cruise.

6.2.1 CTD casts and water sampling

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Fujio Kobayashi (MWJ)*
Naoko Takahashi (MWJ)* Operation Reader
Shinichiro Yokogawa (MWJ)***
Tomoyuki Takamori(MWJ)** Operation Reader
Satoko Asai(MWJ)**
Taiki Shirakawa(MWJ)**
*:Leg1 **:Leg2 ***:leg1,2

(1) Objective

Investigation of oceanic structure and water sampling of each layer.

(2) Overview of the equipment

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 11plus deck unit is a rack-mountable interface which supplies DC power to the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. The serial data from the underwater unit is sent to the deck unit in RS-232 NRZ format using a 34560 Hz carrier-modulated differential-phase-shift-keying (DPSK) telemetry link. The deck unit decodes the serial data and sends them to a personal computer (Hewlett Packard Vectra VL, Intel(r) Celeron(tm), Microsoft Windows98 2nd edition) to display, at the same time, to storage in a disk file using SBE SEASOFT software.

The SBE 911plus system acquires data from primary and auxiliary sensors in the form of binary numbers corresponding to the frequency or voltage outputs from those sensors at 24 samples per second. The calculations required to convert from raw data to engineering units of the parameters are performed by the SBE SEASOFT in real-time. The same calculations can be carried out after the observation using data stored in a disk file.

The SBE 911plus system controls the 36-position SBE 32 Carousel Water Sampler. The Carousel accepts 12-litre water sample bottles. Bottles were fired through the RS-232C modem connector on the back of the SBE 11plus deck unit while acquiring real time data. The 12-litre Niskin-X water sample bottle (General Oceanics, Inc., USA) is equipped externally with two stainless steel

springs. The external springs are ideal for applications such as the trace metal analysis because the inside of the sampler is free from contaminants from springs.
SBE's temperature (SBE 3F) and conductivity (SBE 4) sensor modules were used with the SBE 9plus underwater unit fixed by a single clamp and "L" bracket to the lower end cap. The conductivity cell entrance is co-planar with the tip of the temperature sensor's protective steel sheath. The pressure sensor is mounted in the main housing of the underwater unit and is ported to outside through the oil-filled plastic capillary tube. A compact, modular unit consisting of a centrifugal pump head and a brushless DC ball bearing motor contained in an aluminum underwater housing pump (SBE 5T) flushes water through sensor tubing at a constant rate independent of the CTD's motion. Motor speed and pumping rate (3000 rpm) remain nearly constant over the entire input voltage range of 12-18 volts DC. Flow speed of pumped water in standard TC duct is about 2.3 m/s. SBE's dissolved oxygen sensor (SBE 43) was placed between the conductivity sensor module and the pump.

The system used in this cruise is summarized as follows:

Under water unit:

SBE, Inc., SBE 9plus, S/N 42423

Temperature sensor:

SBE, Inc., SBE 3-04/F, S/N 031525

Conductivity sensor:

SBE, Inc., SBE 4-04/0, S/N 041203

Pump:

SBE, Inc., SBE 5T, S/N 053293

D.O sensor:

SBE, Inc., SBE 43, S/N 430394

Altimeter:

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

Deck unit:

SBE, Inc., SBE 11plus, S/N 11P0730-2072

Carousel Water Sampler:

SBE, Inc., SBE 32, S/N 3221746-0278

Water sample bottle:

General Oceanics, Inc., 12-litre Niskin-X

(3) Pre-cruise calibration

3-1 Pressure

The Paroscientific series 4000 Digiquartz high pressure transducer (Paroscientific, Inc., USA) uses a quartz crystal resonator whose frequency of oscillation varies with pressure induced stress with 0.01 per million of resolution over the absolute pressure range of 0 to 15,000 psia (0 to 10,332 dbar). Also, a quartz crystal temperature signal is used to compensate for a wide range of temperature changes at the time of an observation. The pressure sensor (MODEL 415K-187) has a nominal accuracy of 0.015 % FS (1.5 dbar), typical stability of 0.0015 % FS/month (0.15 dbar/month) and resolution of 0.001 % FS (0.1 dbar).

Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA. The following coefficients were used in the SEASOFT:

S/N 42423 17- May, 1994

c1 = -6.958291e+04
c2 = -1.619244
c3 = 2.34327e-02
d1 = 2.96790e-02
d2 = 0
t1 = 2.812082e+01
t2 = -4.595919e-04
t3 = 3.894640e-06
t4 = 0
t5 = 0

Pressure coefficients are first formulated into

c = c1 + c2 * U + c3 * U^2
d = d1 + d2 * U
t0 = t1 + t2 * U + t3 * U^2 + t4 * U^3 + t5 * U^4

where U is temperature in degrees Celsius. The pressure temperature, U, is determined according to

U (degC) = M * (12 bit pressure temperature compensation word) – B

The following coefficients were used in SEASOFT:

M = 0.01161

B = -8.32759

(in the underwater unit system configuration sheet dated on May 24, 1994)

Finally, pressure is computed as

P (psi) = c * [1 – (t0^2 / t^2)] * {1 – d * [1 – (t0^2 / t^2)]}

where t is pressure period (microsec). Since the pressure sensor measures the absolute value, it inherently includes atmospheric pressure (about 14.7 psi). SEASOFT subtracts 14.7 psi from computed pressure above automatically.

Pressure sensor calibrations against a dead-weight piston gauge are performed at Marine Works Japan Ltd. in Yokosuka, Kanagawa, JAPAN, usually once in a year in order to monitor sensor time drift and linearity (Figure 6.2.1.1,Figure 6.2.1.2). The pressure sensor drift is known to be primarily an offset drift at all pressures rather than a change of span slope. The pressure sensor hysterisis is typically 0.2 dbar. The following coefficients for the sensor drift correction were also used in SEASOFT through the software module SEACON:

S/N 42423 28-April, 2004

slope = 0.9999312

offset = 0.1400218

The drift-corrected pressure is computed as

Drift-corrected pressure (dbar) = slope * (computed pressure in dbar) + offset

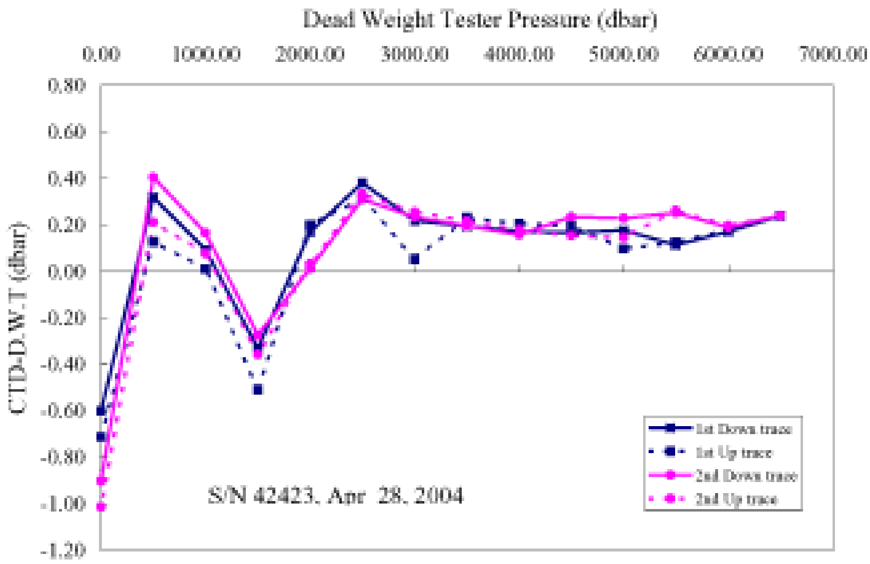


Figure 6.2.1.1: The residual pressures between the Dead Weight Tester and the CTD.

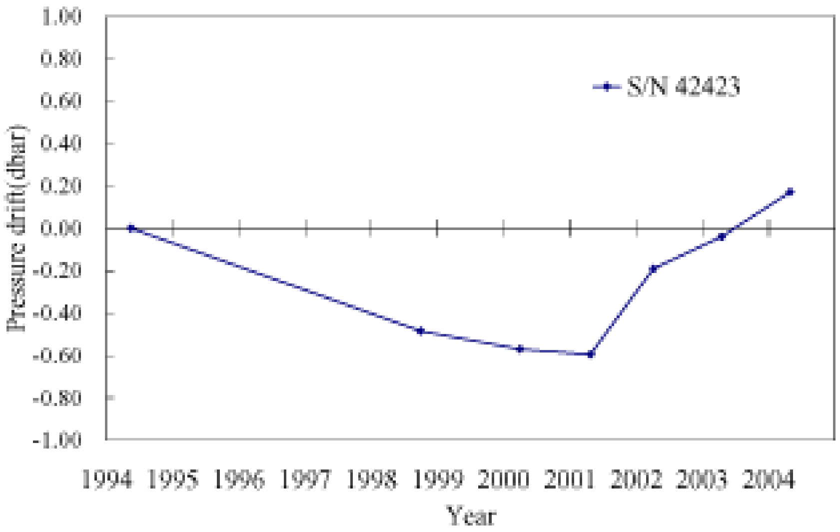


Figure 6.2.1.2: Drift (offset) of the pressure sensor measured by the Dead Weight Tester.

3-2 Temperature(SBE3)

The temperature sensing element is a glass-coated thermistor bead in a stainless steel tube, providing a pressure-free measurement at depths up to 10,500 m (S/N 031525). The sensor output frequency ranges from approximately 5 to 13 kHz corresponding to temperature from –5 to 35 degC. The output frequency is inversely proportional to the square root of the thermistor resistance, which controls the output of a patented Wien Bridge circuit. The thermistor resistance is exponentially related to temperature. The SBE 3F thermometer has a nominal accuracy of 0.001 degC, typical stability of 0.0002 degC/month and resolution of 0.0002 degC at 24 samples per second.
Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA (Figure 6.2.1.3, Figure 6.2.1.4). The following coefficients were used in SEASOFT:

S/N 031525 01-May, 2004

g = 4.84582896e-03
h = 6.75024335e-04
i = 2.64086529e-05
j = 2.11431577e-06
f0 = 1000.000

Temperature (ITS-90) is computed according to

Temperature (ITS-90) =

1 / {g + h * [ln(f0 / f)] + i * [ln^2(f0 / f)] + j * [ln^3(f0 / f)]} – 273.15

where f is the instrument frequency (kHz).

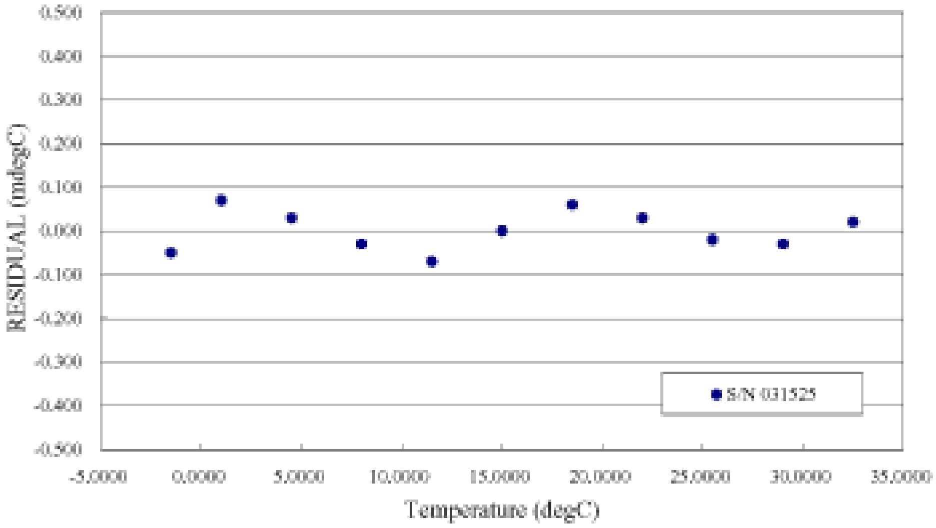


Figure 6.2.1.3: Residual temperature between bath and instrument temperatures.

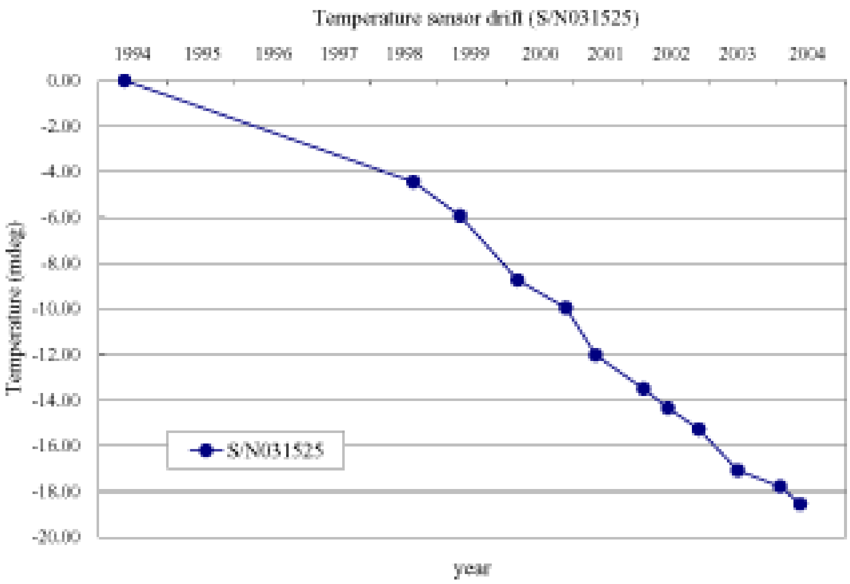


Figure 6.2.1.4: Drift of the temperature sensors based on laboratory calibrations.

3-3 Conductivity (SBE 4)

The flow-through conductivity sensing element is a glass tube (cell) with three platinum electrodes to provide in-situ measurements at depths up to 10,500 meters. The impedance between the center and the end electrodes is determined by the cell geometry and the specific conductance of the fluid within the cell. The conductivity cell composes a Wien Bridge circuit with other electric elements of which frequency output is approximately 3 to 12 kHz corresponding to conductivity of the fluid of 0 to 7 S/m. The conductivity cell SBE 4 has a nominal accuracy of 0.0003 S/m, typical stability of 0.0003 S/m/month and resolution of 0.00004 S/m at 24 samples per second.

Pre-cruise sensor calibrations were performed at SBE, Inc. in Bellevue, Washington, USA. The following coefficients were used in SEASOFT:

S/N 041203 30 April, 2004

g = -4.05242086e+000

h = 4.93532786e-01

i = 7.26654890e-005

j = 2.32093798e-005

CPcor = -9.57e-08 (nominal)

CTcor = 3.25e-06 (nominal)

Conductivity of a fluid in the cell is expressed as:

$$C (S/m) = (g + h * f^2 + i * f^3 + j * f^4) / [10 (1 + CTcor * t + CPcor * p)]$$

where f is the instrument frequency (kHz), t is the water temperature (degC) and p is the water pressure (dbar). The value of conductivity at salinity of 35, temperature of 15 degC (IPTS-68) and pressure of 0 dbar is 4.2914 S/m.

3-4 Oxygen (SBE 43)

The SBE 43 oxygen sensor uses a Clark polarographic element to provide in-situ measurements at depths up to 7,000 meters. Calibration stability is improved by an order of magnitude and pressure hysterisis is largely eliminated in the upper ocean (1000 m). Continuous polarization eliminates the wait-time for stabilization after power-up. Signal resolution is increased by on-board temperature compensation. This Sensor is also included in the path of pumped sea water. The oxygen sensor determines the dissolved oxygen concentration by counting the number of oxygen molecules per second (flux) that diffuse through a membrane, where the permeability of the membrane to oxygen is a function of temperature and ambient pressure. Computation of dissolved oxygen in engineering units is done in SEASOFT software through almost the same way as for the case of the SBE 13. The range for dissolved oxygen is 120 % of surface saturation in all natural waters; nominal accuracy is 2 % of saturation; typical stability is 2 % per 1000 hours.

The following coefficients were used in SEASOFT:

S/N 430394 28 April, 2004

Soc = 0.3441

Boc = 0.0000

TCor = 0.0017

PCor = 1.350e-04

Offset = -0.5148

tau = 0

Oxygen (ml/l) is computed as

$$\text{Oxygen (ml/l)} = [Soc * \{(v + offset) + (tau * doc/dt)\} + Boc * \exp(-0.03 * t)]$$
$$* \exp(TCor * t + PCor * p) * Oxsat(t, s)$$

$$Oxsat(t, s) = \exp[A1 + A2 * (100 / t) + A3 * \ln(t / 100) + A4 * (t / 100)$$
$$+ s * (B1 + B2 * (t / 100) + B3 * (t / 100) * (t / 100))]$$

where p is pressure in dbar, t is absolute temperature and s is salinity in psu. Oxsat is oxygen saturation value minus the volume of oxygen gas (STP) absorbed from humidity-saturated air. Its coefficients are as follows.

A1 = -173.4292

A2 = 249.6339

A3 = 143.3483

A4 = -21.8482

B1 = -0.033096

B2 = -0.00170

3-4 Altimeter

The Benthos PSA-916 Sonar Altimeter (Benthos, Inc., USA) uses 1,500m/s that the nominal speed of sound in water. But, PSA-916 compensates for sound velocity errors due to temperature, Salinity, and Pressure. In a PSA-916 operating at a 250 microsecond pulse at 200 kHz, the jitter of the detectors can be as small as 5 microseconds or approximately 0.4 centimeters total distance. Since the total travel time is divided by two, the jitter error is 0.2 centimeters. The unit (PSA-916T) is rated to a depth of 10,000 meters.

The following scale factors were used in SEASOFT:

S/N 1100

FSVolt * 300 / FSRange = 15

Offset = 0.0

(4) Data collection and processing

4-1 Data collection

CTD measurements were made using a SBE 9plus CTD equipped with temperature-conductivity sensors. The SBE 9plus CTD (sampling rate of 24 Hz) was mounted horizontally in a 36-position carousel frame. Auxiliary sensors included altimeter, dissolved oxygen sensors.

The package was lowered into the water from the starboard side and held 10 m beneath the surface for about one minute in order to activate the pump. After the pump was activated the package was lifted to the surface The package was lowered again at a rate of about 1.0 m/s to 3000m (maximum depth). For the up cast, the package was lifted at a rate of 1.0 m/s except for bottle firing stops. At each bottle firing stops, the bottle was fired.

The SBE 11plus deck unit received the data signal from the CTD. Digitized data were forwarded to a personal computer running the SEASAVE module of the SEASOFT acquisition and processing software, version 5.27b. Temperature, salinity, oxygen, and descent rate profiles were displayed in real-time with the package depth and altimeter reading.

4-2 Data collection problems

None

4-3 Data processing

SEASOFT consists of modular menu driven routines for acquisition, display, processing, and archiving of oceanographic data acquired with SBE equipment, and is designed to work with a compatible personal computer. Raw data are acquired from instruments and are stored as unmodified data. The conversion module DATCNV uses the instrument configuration and calibration coefficients to create a converted engineering unit data file that is operated on by all

SEASOFT post processing modules. Each SEASOFT module that modifies the converted data file adds proper information to the header of the converted file permitting tracking of how the various oceanographic parameters were obtained. The converted data is stored in rows and columns of ASCII numbers. The last data column is a flag field used to mark scans as good or bad.

The following are the SEASOFT-Win32 (Ver. 5.27b) processing module sequence and specifications used in the reduction of CTD data in this cruise. Some modules are originally developed for additional processing and post-cruise calibration.

DATCNV converted the raw data to scan number, pressure, depth, temperatures, conductivities. DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

ROSSUM created a summary of the bottle data. The bottle position, date, time were output as the first two columns. Scan number, pressure, depth, temperatures, conductivities and altitude were averaged over 3.0 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 1000 scans. Data greater than 10 standard deviations were flagged. The second pass computed a standard deviation over the same 1000 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, temperatures, conductivities and altimeter outputs.

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

FILTER 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. (Data to check the CTD pressure drift were prepared before SECTION.)

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.

DERIVE was re-used to compute salinity, sigma-theta, potential temperature and sigma-T.

BINAVG averaged the data into 1 dbar 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 pressures greater than the minimum and less than or equal to the maximum were averaged. Scans were interpolated so that a data record exists every dbar.

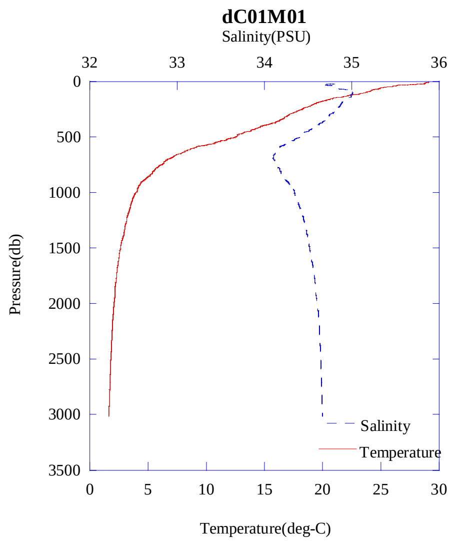
SPLIT was used to split data into the down cast and the up cast.

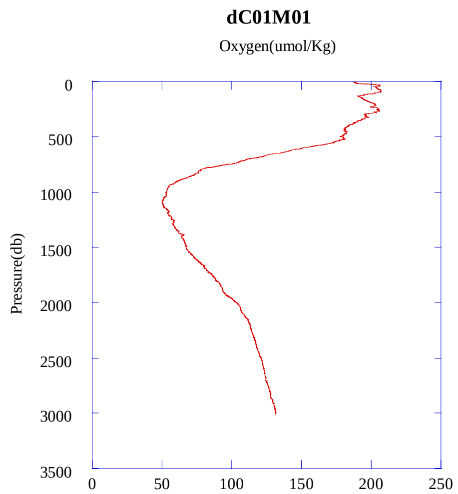
(5) Preliminary results

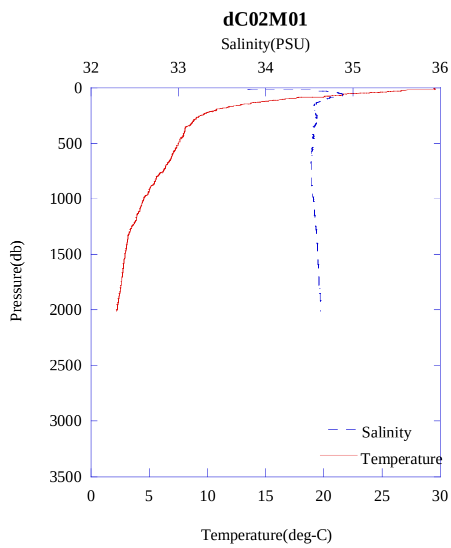
Total 13 casts of CTD measurements have been carried out (table 6.2.1(a)).
Vertical profiles of Temperature and salinity, oxygen are shown in Figure.6.2.1.5
～Figure.2.2.1.11 We also compared CTD-salinity and Bottle-salinity. The results are shown in table 2.2.1 (b).

Table6.2.1(a) CTD cast table

STNNBR	CASTNO	Sample type	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	Max	CTD data	Remarks
			yyyy/mm/dd	Start	End	Latitude	Longitude	(MNB)	OUT	pressure	file name	
St.C01	1	Sampling	2004/6/10	7:00	8:56	22-30.03N	138-59.89E	5273	3001.6	30011.5	C01m01	
St.C02	1	Sampling	2004/6/13	4:06	5:21	07-51.23N	136-29.67E	3350	2015.5	2002.9	C02m01	* 2 CTD sensors(T.S.K) put to CTD flame
	2	Triton	2004/6/13	7:03	7:41	07-38.38N	136-41.89E	3167	1009.7	1004.0	C02m02	*8N 137E deployment * 2 CTD sensors(T.S.K) put to CTD flame
St.C03	1	Triton	2004/6/14	21:40	22:19	02-04.51N	138-04.71E	4294	1009.3	1001.6	C03m01	*2N138E Recovery
	2	Sampling	2004/6/15	23:52	25:40	02-03.80N	138-03.96E	4336	2976.9	3002.7	C03m02	
	3	Triton	2004/6/16	7:30	8:06	02-03.33N	138-04.41E	4317	1006.6	1012.3	C03m03	*2N138E Deployment
St.C04	1	Sampling	2004/6/17	4:12	5:53	00-05.77N	138-02.86E	4135	2983.8	3003.3	C04m01	
St.C05	1	Sampling	2004/6/24	4:30	6:13	04-56.93N	137-24.74E	4063	3004.0	3009.9	C05m01	*5N137E Recovery
St.C06	1	Triton	2004/7/9	6:01	7:18	05-02.75N	094-58.06E	5010	1987.0	2001.0	C06M01	*5S 95E Recovery * 2 CTD sensors(T.S.K) put to CTD flame
St.C07	1	Triton	2004/7/10	7:02	8:16	01-40.35S	089-59.10E	4676	1987.3	2001.7	C07M01	*1.5S 90E Recovery * 2 CTD sensors(T.S.K) put to CTD flame
St.C08	1	ADCP	2004/7/13	6:31	7:32	00-00.28S	090-04.41E	4227	1982.7	2001.6	C08M01	*Eq 90E Deployment & Recovery * 2 CTD sensors(T.S.K) put to CTD flame
St.C09	1	Triton	2004/7/22	21:57	23:11	07-55.74N	130-02.82E	5643	1993.5	2003.7	C09M01	*8N130E Recovery
St.C10	1	Sampling	2004/7/28	11:30	13:22	22-30.09N	131-59-87E	5760	2965.9	3002.1	C10M01	







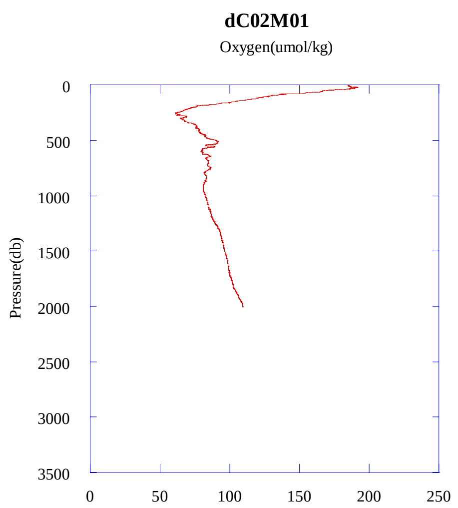


Fig 6.2.1.5 Vertical Profiles

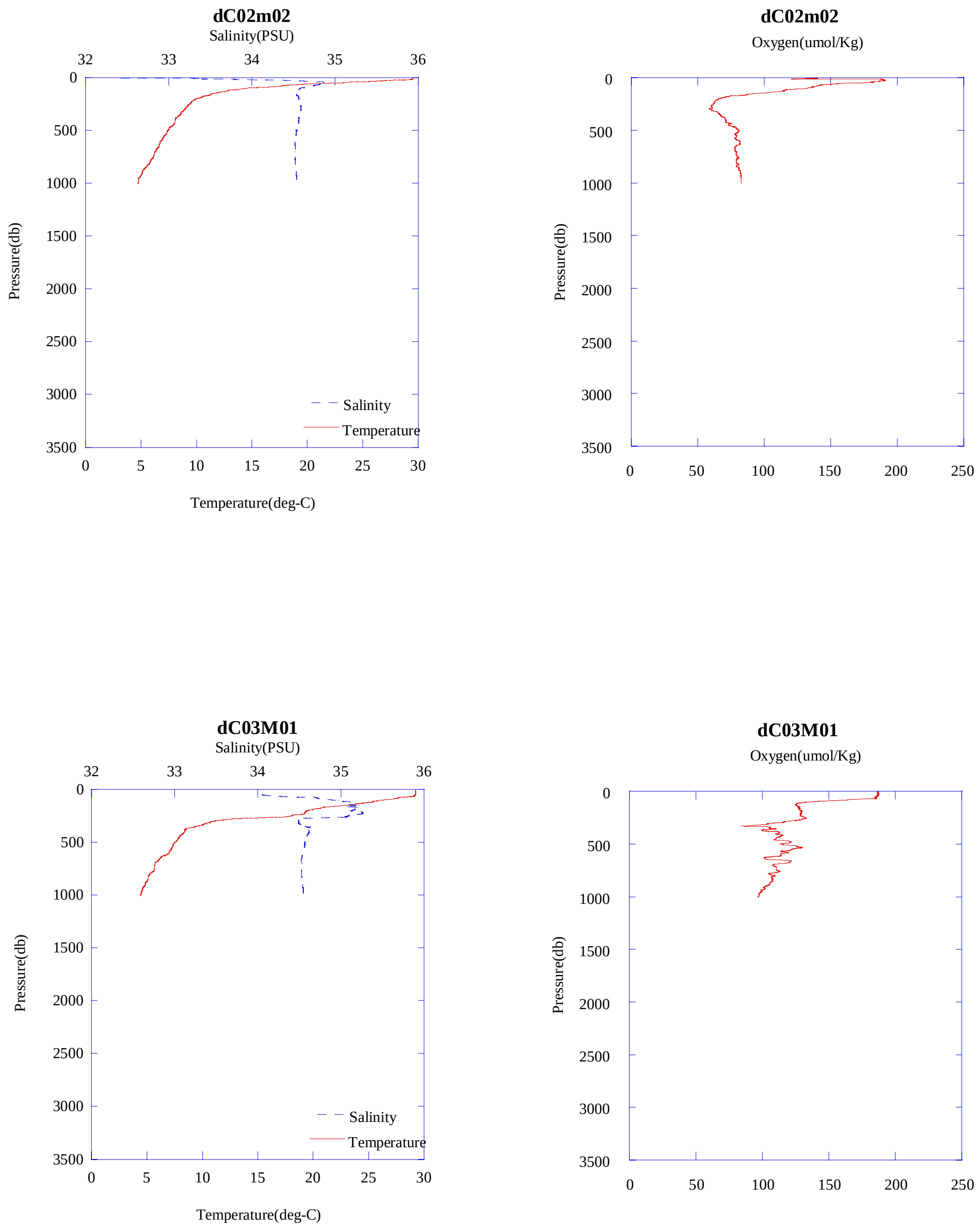
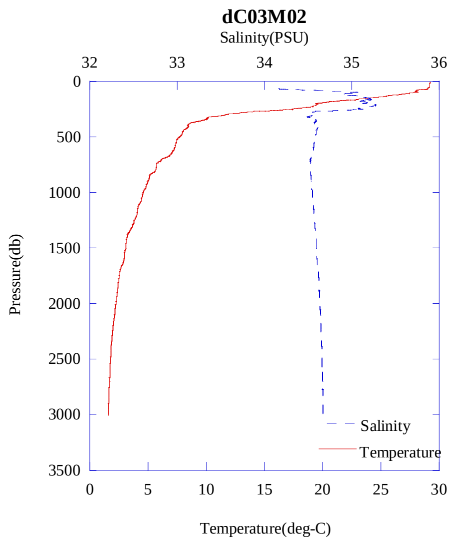
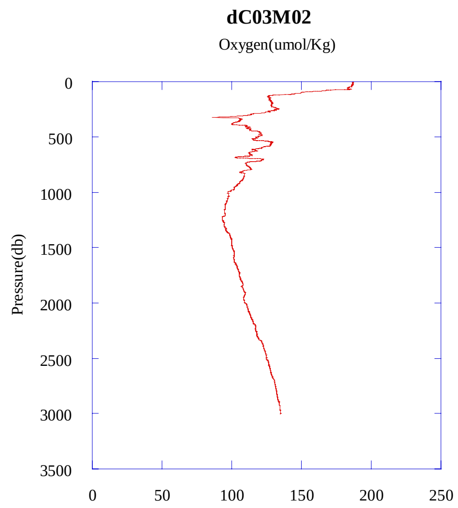
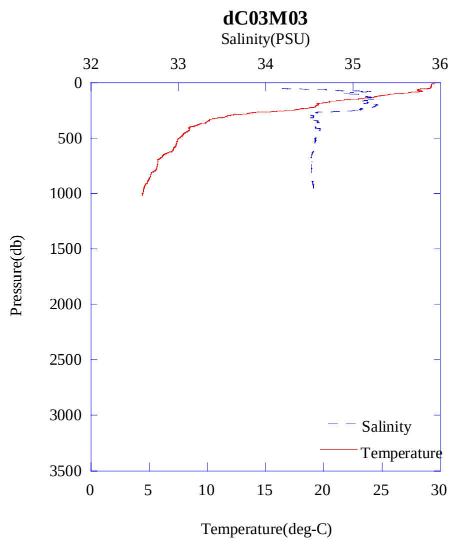


Fig 6.2.1.6 Vertical plofiles







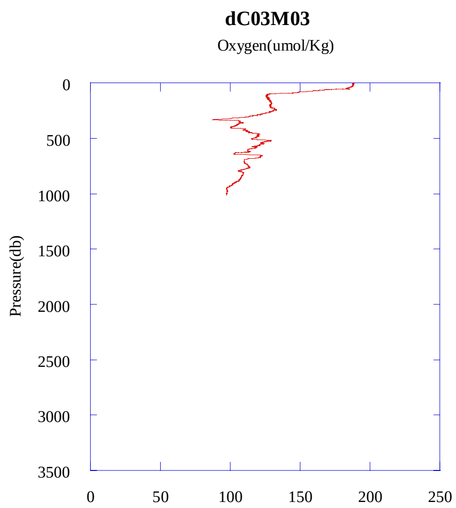
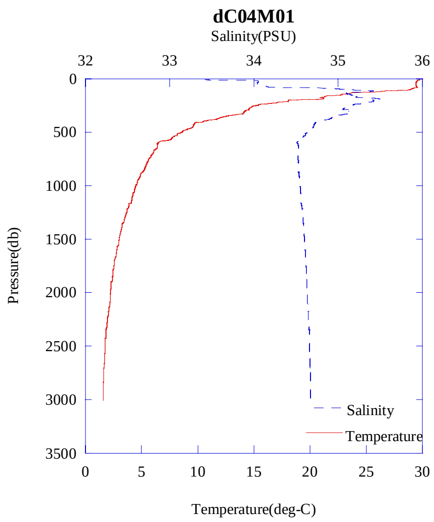
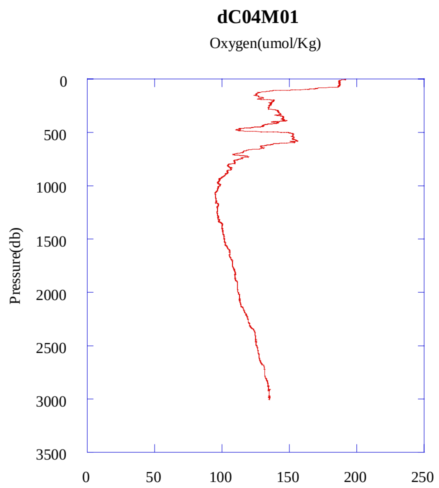
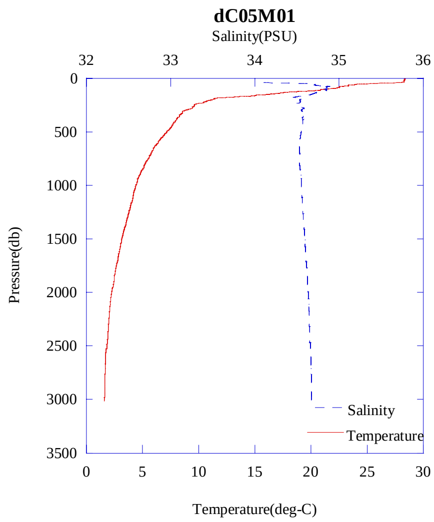


Fig 6.2.1.7 Vertical Profiles







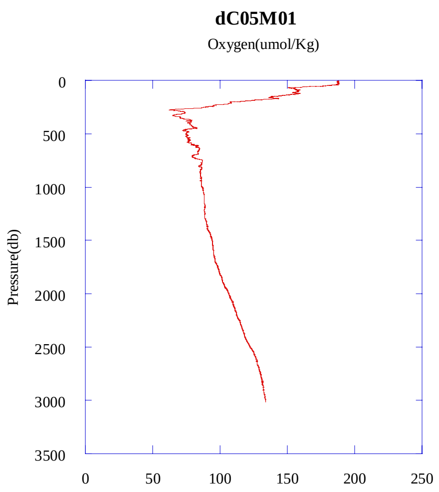
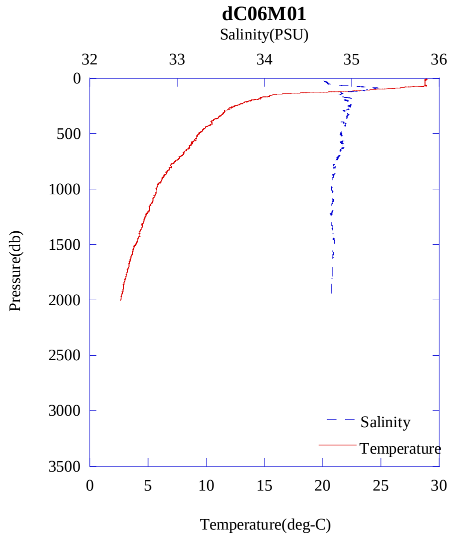
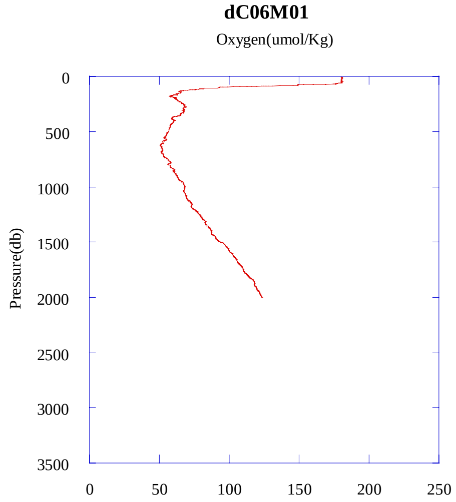
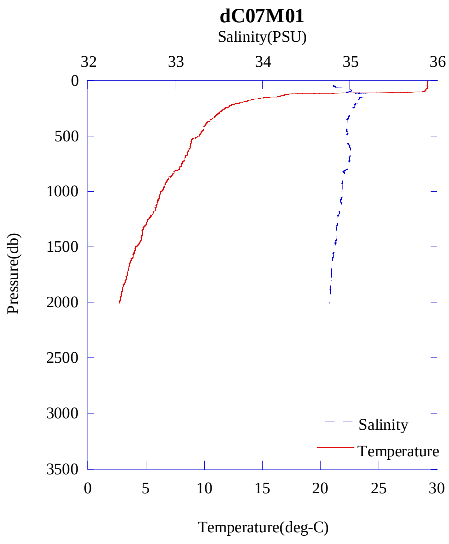


Fig 6.2.1.8 Vertical plofiles







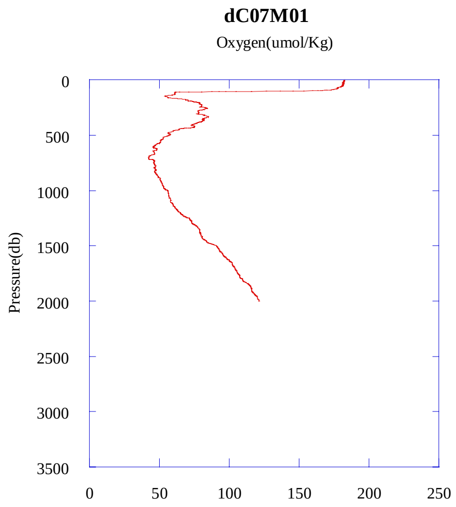
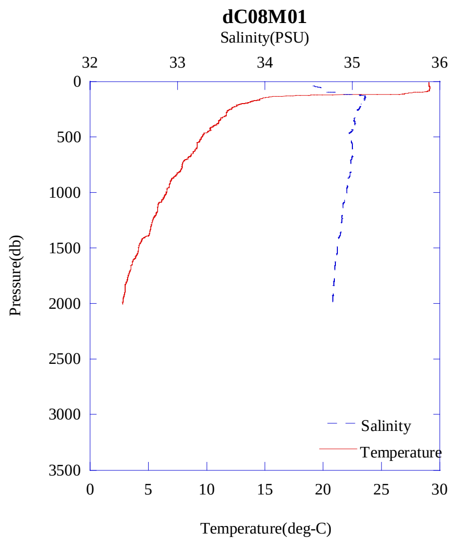
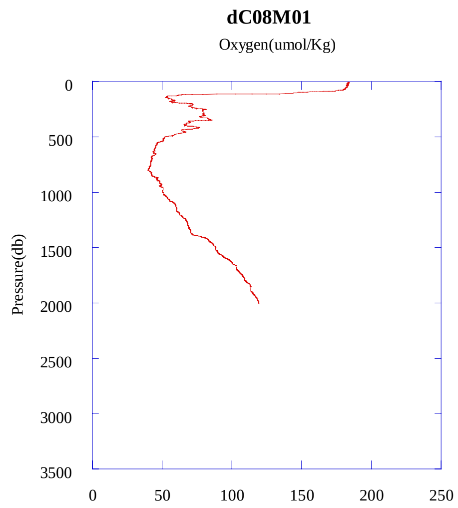
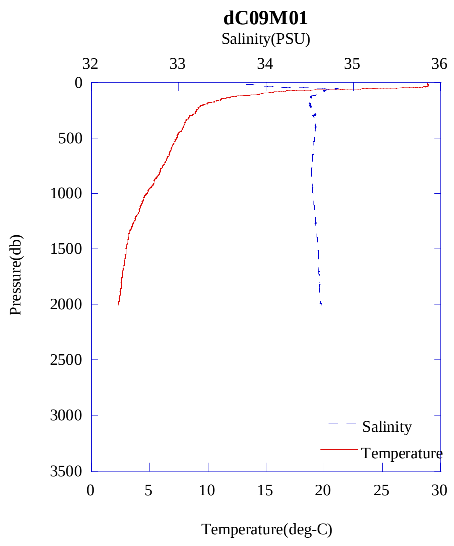


Fig 6.2.1.9 Vertical profiles







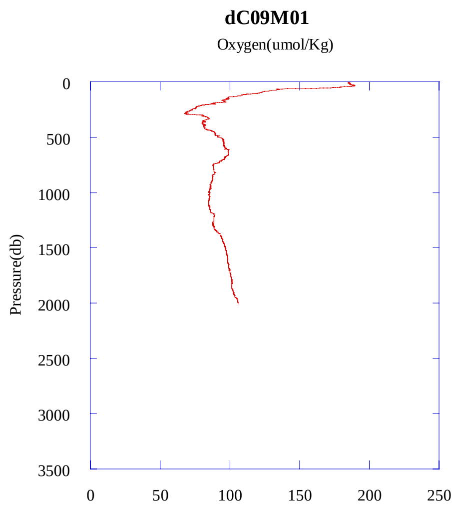


Fig 6.2.1.10 Vertical profiles

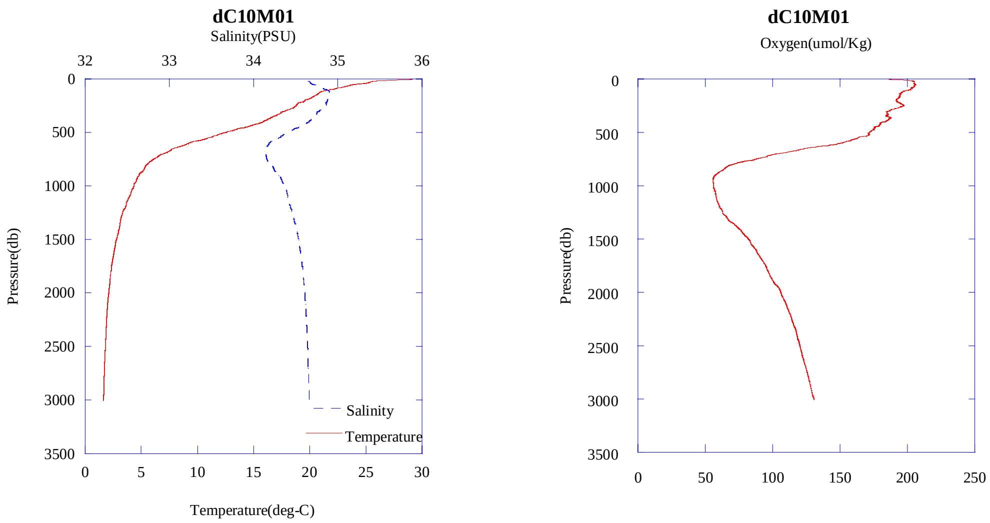


Fig 6.2.1.11 Vertical profiles

STNNBR	File name	Pressure(db)	CTD-salinity	Bottle-salinity	Bottlesalinity-CTDsalinity
C01	C01M01	3006	34.6640	34.6631	-0.0009
C01	C01M01	1000	34.3387	34.3381	-0.0006
C01	C01M01	1001	34.3400	34.3388	-0.0012
C02	C02M01	2005	34.6329	34.6330	0.0001
C02	C02M01	2005	34.6329	34.6337	0.0008
C02	C02M01	1000	34.5455	34.5453	-0.0002
C02	C02M01	1000	34.5455	34.5452	-0.0003
C02	C02M02	1002	34.5449	34.5458	0.0009
C02	C02M02	1003	34.5451	34.5463	0.0012
C03	C03M01	1000	34.5521	34.5532	0.0011
C03	C03M01	1001	34.5521	34.5533	0.0012
C06	C06M01	2001	34.7611	34.7632	0.0021
C06	C06M01	2001	34.7611	34.7631	0.0020
C06	C06M01	2001	34.7609	34.7633	0.0024
C06	C06M01	2001	34.7609	34.7631	0.0022
C07	C07M01	2001	34.7704	34.7719	0.0015
C07	C07M01	2001	34.7704	34.7717	0.0013
C07	C07M01	2000	34.7705	34.7719	0.0014
C07	C07M01	2000	34.7705	34.7720	0.0015
C08	C08M01	2000	34.7753	34.7767	0.0014
C08	C08M01	2000	34.7753	34.7785	0.0032
C08	C08M01	2000	34.7754	34.7768	0.0014
C08	C08M01	2000	34.7754	34.7767	0.0013
C09	C09M01	2001	34.6283	34.6302	0.0019
C09	C09M01	2001	34.6283	34.6301	0.0018
C09	C09M01	2002	34.6284	34.6295	0.0011
C09	C09M01	2002	34.6284	34.6296	0.0012
C10	C10M01	3001	34.6610	34.6625	0.0015
C10	C10M01	3001	34.6610	34.6625	0.0015
C10	C10M01	3002	34.6611	34.6628	0.0017
C10	C10M01	3002	34.6611	34.6628	0.0017

Table 6.2.1 (b) Comparison CTD-salinity and Bottle-salinity

(6) Data archive

All raw and processed CTD data files will be submitted to JAMSTEC Data Management Office (DMO).

6.2.2 XCTD observation

Iwao Ueki (JAMSTEC)	Principal Investigator (Leg1)	- Leg 1 -
Hideaki Hase (JAMSTEC)	Principal Investigator (Leg2)	- Leg 2 -
Mari Sakai (JAMSTEC)		- Leg 2 -
Satoshi Okumura (GODI)		- Leg 1 -
Wataru Tokunaga (GODI)		- Leg 2 -
Norio Nagahama (GODI)		- Leg 2 -
Kazuho Yoshida (GODI)		- Leg 1, 2 -

(1) Objective

Investigation of oceanic structure.

(2) Parameters

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

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

(3) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by digital converter (MK-100, Tsurumi-Seiki Co.) and was recorded by WinXCTD software (Ver.1.07, Tsurumi-Seiki Co.). We dropped 98 probes (X001 – X098) by automatic launcher.

(4) Observation log

Table 6.2.2-1 Summary of XCTD observation log

Station	Date	Start time	End time	Latitude	Longitude	MD [m]	WD [m]	SST [deg-C]	SSS [PSU]	Probe S/N
X001	2004/6/18	7:34:53	7:30	00-02.41N	137-52.55E	1035	4350	29.60	33.83	03042858
X002	2004/6/20	3:16:12	3:21	00-30.03N	137-57.51E	1036	3982	29.74	33.92	03042857
X003	2004/6/20	5:10:31	5:16	01-00.02N	137-52.50E	1036	4438	29.94	33.88	03042851
X004	2004/6/20	7:05:01	7:10	01-30.03N	137-47.90E	1036	4313	29.91	34.07	03042850
X005	2004/6/20	9:00:47	9:06	01-59.88N	137-43.23E	1036	4434	29.83	34.16	03084514
X006	2004/6/20	10:59:49	11:05	02-30.01N	137-38.62E	1036	4640	29.61	34.23	03042853
X007	2004/6/20	13:03:22	13:08	03-00.58N	137-33.90E	1035	4357	29.31	34.13	03084511
X008	2004/6/20	14:59:39	15:05	03-30.01N	137-29.13E	1036	4284	29.10	34.14	03042852
X009	2004/6/20	16:58:09	17:03	03-59.99N	137-24.95E	1036	4656	28.70	34.02	03042855
X010	2004/6/20	19:00:19	19:05	04-29.99N	137-19.25E	1033	4815	28.50	34.05	03042854
X011	2004/6/21	7:51:48	7:57	04-51.97N	137-16.63E	1035	4103	28.31	34.12	03042856
X012	2004/6/21	22:10:45	22:16	04-56.69N	137-24.89E	1035	4057	28.11	34.05	03042849
X013	2004/6/22	8:47:17	8:52	05-30.00N	137-13.58E	1033	4668	28.27	34.08	03042739

Table 6.2.2-1 (continued)

Station	Date	Start time	End time	Latitude	Longitude	MD [m]	WD [m]	SST [deg-C]	SSS [PSU]	Probe S/N
X014	2004/6/22	11:04:45	11:10	06-00.00N	137-04.20E	1035	4358	28.29	34.00	03042746
X015	2004/6/22	13:24:15	13:29	06-30.00N	136-54.41E	1036	4555	27.48	33.99	03042748
X016	2004/6/22	15:42:45	15:48	07-00.00N	136-45.58E	1013	4674	27.30	34.03	03042747
X017	2004/6/22	18:04:04	18:09	07-30.02N	136-35.88E	1018	2576	26.60	34.18	03042738
X018	2004/6/22	22:17:05	22:22	07-51.96N	136-30.41E	1036	3349	27.17	34.04	03042737
X019	2004/6/24	13:23:05	13:28	05-31.76N	136-00.00E	1034	4589	28.11	33.95	03042745
X020	2004/6/24	18:16:08	18:21	05-56.66N	134-59.90E	1034	5302	27.70	34.15	03042741
X021	2004/6/24	23:10:12	23:15	06-21.26N	134-00.06E	1034	6798	27.75	34.15	03042743
X022	2004/6/25	4:07:32	4:12	06-45.71N	133-00.00E	1025	2944	27.96	34.16	03042744
X023	2004/6/25	8:57:38	9:03	07-10.48N	132-00.00E	1034	4570	27.65	34.16	03042742
X024	2004/6/25	13:31:17	13:36	07-33.75N	131-00.00E	1033	5272	27.90	34.06	03084524
X025	2004/6/26	2:39:46	2:45	07-55.26N	130-03.79E	1036	5632	28.02	34.04	03042740
X026	2004/6/26	5:39:58	5:45	07-30.00N	130-05.62E	1036	5585	28.03	34.14	03084525
X027	2004/6/26	9:05:33	9:11	06-59.99N	130-08.19E	1036	5566	28.02	34.19	03084526
X028	2004/6/26	11:55:23	12:00	06-30.00N	130-16.74E	1017	5565	28.31	34.05	03084528
X029	2004/6/26	14:50:43	14:56	05-59.99N	130-28.23E	1028	5575	28.20	34.14	03084527
X030	2004/6/26	18:08:45	18:14	05-29.99N	130-25.51E	1036	5566	28.30	34.07	03084523
X031	2004/6/26	23:20:10	23:25	05-00.00N	129-59.93E	1034	5052	28.47	34.04	03084522
X032	2004/6/27	2:34:44	2:40	04-30.01N	130-01.83E	1035	4948	29.01	34.35	03084533
X033	2004/6/27	5:50:08	5:55	04-00.02N	129-57.62E	1035	4625	28.98	34.38	03084529
X034	2004/6/27	9:19:39	9:25	03-29.08N	129-48.96E	1036	4470	28.79	34.36	03084531
X035	2004/6/27	12:38:12	12:43	03-00.00N	129-43.24E	1033	2327	28.71	34.42	03084530
X036	2004/6/27	15:39:02	15:44	02-29.99N	129-38.33E	1034	1896	28.70	34.32	03084534
X037	2004/6/27	22:46:54	22:52	02-07.03N	129-35.38E	1035	3653	28.70	34.38	03084535
X038	2004/7/13	7:45:31	7:51	00-00.82S	090-04.93E	1034	3929	29.14	34.45	03084505
X039	2004/7/13	9:40:35	9:46	00-15.17S	090-29.76E	1034	4090	29.47	34.57	03084508
X040	2004/7/13	12:02:46	12:08	00-37.88S	091-00.02E	1035	4596	29.28	34.50	03084542
X041	2004/7/13	14:20:34	14:26	00-58.45S	091-29.91E	1034	4608	29.17	34.52	03084537
X042	2004/7/13	16:39:38	16:45	01-17.91S	092-00.03E	1034	4657	29.28	34.51	03084536
X043	2004/7/13	19:04:57	19:10	01-38.40S	092-30.28E	1035	4614	29.20	34.48	03084540
X044	2004/7/13	21:24:32	21:30	01-58.01S	093-00.00E	1036	4704	29.20	34.48	03084541
X045	2004/7/13	23:50:48	23:56	02-19.10S	093-30.01E	1035	4746	29.22	34.45	03084538
X046	2004/7/14	2:14:36	2:20	02-38.91S	094-00.00E	1034	4772	29.26	34.38	03084539
X047	2004/7/14	4:41:38	4:47	02-59.02S	094-30.01E	1034	4780	29.35	34.35	03105210
X048	2004/7/14	7:11:17	7:16	03-19.01S	095-00.00E	1035	4831	29.18	34.16	03084545
X049	2004/7/14	9:35:40	9:40	03-39.37S	095-30.00E	1034	4891	29.35	33.94	03105209
X050	2004/7/14	11:59:46	12:05	03-59.24S	095-59.92E	1033	4659	29.30	34.16	03084544
X051	2004/7/14	14:31:48	14:37	04-20.11S	096-31.00E	1033	5142	29.26	34.29	03105208
X052	2004/7/14	16:54:15	16:59	04-39.57S	096-60.00E	1033	5386	29.26	34.23	03084543
X053	2004/7/14	19:20:53	19:26	04-59.71S	097-30.00E	1033	4918	29.10	34.24	03105212
X054	2004/7/14	21:52:24	21:57	05-21.76S	098-00.00E	1033	5252	29.04	34.25	03105211
X055	2004/7/15	0:17:16	0:22	05-41.30S	098-30.00E	1036	5273	28.80	34.08	03105207
X056	2004/7/15	2:43:51	2:49	05-59.53S	099-00.73E	1035	5810	28.97	34.32	03105204
X057	2004/7/15	5:06:38	5:12	06-20.15S	099-29.99E	1034	4595	29.00	34.31	03105206

Table 6.2.2-1 (continued)

Station	Date	Start time	End time	Latitude	Longitude	MD [m]	WD [m]	SST [deg-C]	SSS [PSU]	Probe S/N
X058	2004/7/15	7:48:14	7:53	06-40.40S	099-59.96E	1035	5092	28.94	34.28	03105205
X059	2004/7/15	10:17:56	10:23	07-00.51S	100-30.01E	1035	5423	28.91	34.34	03105203
X060	2004/7/15	12:48:36	12:54	07-20.73S	100-59.99E	1036	5250	28.86	34.36	03105217
X061	2004/7/15	15:17:14	15:22	07-40.42S	101-30.01E	1035	5069	28.91	34.42	03105213
X062	2004/7/15	18:00:02	18:05	08-00.99S	102-00.00E	1036	5385	28.87	34.44	03105202
X063	2004/7/15	20:22:28	20:27	08-20.46S	102-29.75E	1036	5431	28.58	34.43	03105214
X064	2004/7/15	22:51:48	22:57	08-40.29S	102-59.99E	1036	5150	28.38	34.27	03105215
X065	2004/7/16	1:16:48	1:22	09-00.28S	103-30.00E	1036	5519	28.28	34.27	03105201
X066	2004/7/16	3:41:02	3:46	09-19.81S	103-59.99E	1034	5484	27.77	34.17	03105219
X067	2004/7/16	6:06:12	6:11	09-40.04S	104-30.00E	1035	4980	27.47	34.22	03105216
X068	2004/7/16	8:30:30	8:36	10-00.00S	105-00.02E	1035	4942	27.19	34.28	03115222
X069	2004/7/16	10:31:38	10:37	10-01.27S	105-29.98E	1035	4540	27.22	34.27	03115223
X070	2004/7/16	12:30:56	12:36	10-02.53S	106-00.05E	1033	4028	27.08	34.19	03115226
X071	2004/7/16	14:30:50	14:36	10-04.03S	106-29.99E	1035	5868	26.99	34.13	03115227
X072	2004/7/16	16:31:28	16:36	10-05.78S	106-60.00E	1035	6129	26.94	34.22	03115228
X073	2004/7/16	18:31:56	18:37	10-07.47S	107-30.00E	1035	6550	26.96	34.30	03115230
X074	2004/7/16	20:31:56	20:37	10-09.29S	107-59.99E	1035	6603	26.93	34.14	03115229
X075	2004/7/16	22:32:23	22:37	10-10.96S	108-30.01E	1035	6560	27.43	34.31	03115225
X076	2004/7/17	0:36:41	0:42	10-12.23S	108-60.00E	1035	6800	27.29	34.23	03115224
X077	2004/7/17	2:42:55	2:48	10-13.25S	109-30.02E	1036	6271	27.37	34.18	03115232
X078	2004/7/17	4:48:21	4:53	10-14.76S	110-00.00E	1035	6906	27.00	34.11	03115231
X079	2004/7/17	6:56:12	7:01	10-16.84S	110-30.00E	1034	7171	26.42	33.87	03115234
X080	2004/7/17	9:05:32	9:11	10-18.37S	111-00.00E	1033	4742	26.28	33.88	03115235
X081	2004/7/17	11:17:37	11:23	10-19.98S	111-30.02E	1036	3725	25.98	33.87	04037290
X082	2004/7/17	13:27:09	13:32	10-20.89S	111-60.00E	1035	3864	26.53	34.01	03115233
X083	2004/7/17	15:39:32	15:45	10-23.05S	112-29.99E	1034	3101	26.62	34.01	03115236
X084	2004/7/17	17:48:16	17:53	10-25.02S	112-59.99E	1035	2059	26.59	34.09	04037291
X085	2004/7/17	19:53:43	19:59	10-26.62S	113-30.00E	1035	1248	26.55	34.18	03115238
X086	2004/7/17	21:57:52	22:03	10-27.38S	114-00.00E	1035	2826	26.68	34.25	03105220
X087	2004/7/18	0:03:14	0:08	10-28.32S	114-30.01E	1035	1869	26.18	34.08	04037292
X088	2004/7/18	2:09:06	2:14	10-30.44S	114-59.99E	1034	2190	26.30	34.06	03115237
X089	2004/7/18	4:19:39	4:25	10-31.83S	115-30.00E	1035	3466	26.26	33.99	04037293
X090	2004/7/18	6:27:15	6:32	10-33.11S	116-00.01E	1036	3341	26.65	33.88	04037298
X091	2004/7/18	8:29:39	8:35	10-34.51S	116-30.00E	1033	4124	26.56	33.86	04037294
X092	2004/7/18	10:31:33	10:37	10-36.13S	117-00.11E	1035	4132	26.30	34.15	04037295
X093	2004/7/18	12:37:21	12:42	10-37.88S	117-30.02E	1034	3398	26.04	34.12	04037300
X094	2004/7/18	14:48:39	14:54	10-39.05S	118-00.02E	1034	3639	26.39	34.10	04037297
X095	2004/7/18	16:58:20	17:03	10-40.71S	118-30.00E	1034	3384	26.54	34.14	04037301
X096	2004/7/18	19:08:17	19:13	10-42.37S	119-01.19E	1035	3953	26.07	34.05	04037302
X097	2004/7/18	21:04:55	21:10	10-43.44S	119-30.01E	1033	3423	25.76	34.06	04037296
X098	2004/7/18	23:09:47	23:15	10-45.05S	119-59.99E	1035	1989	25.24	34.06	04037303

Acronyms in Table 6.2.2-1 are as follows;

- SST: Sea surface temperature [deg-C] measured by Continuous Sea Surface Monitoring System
- SSS: Sea surface salinity [PSU] measured by Continuous Sea Surface Monitorring System
- MD: Maximum measured depth [m]
- WD: Water Depth [m]

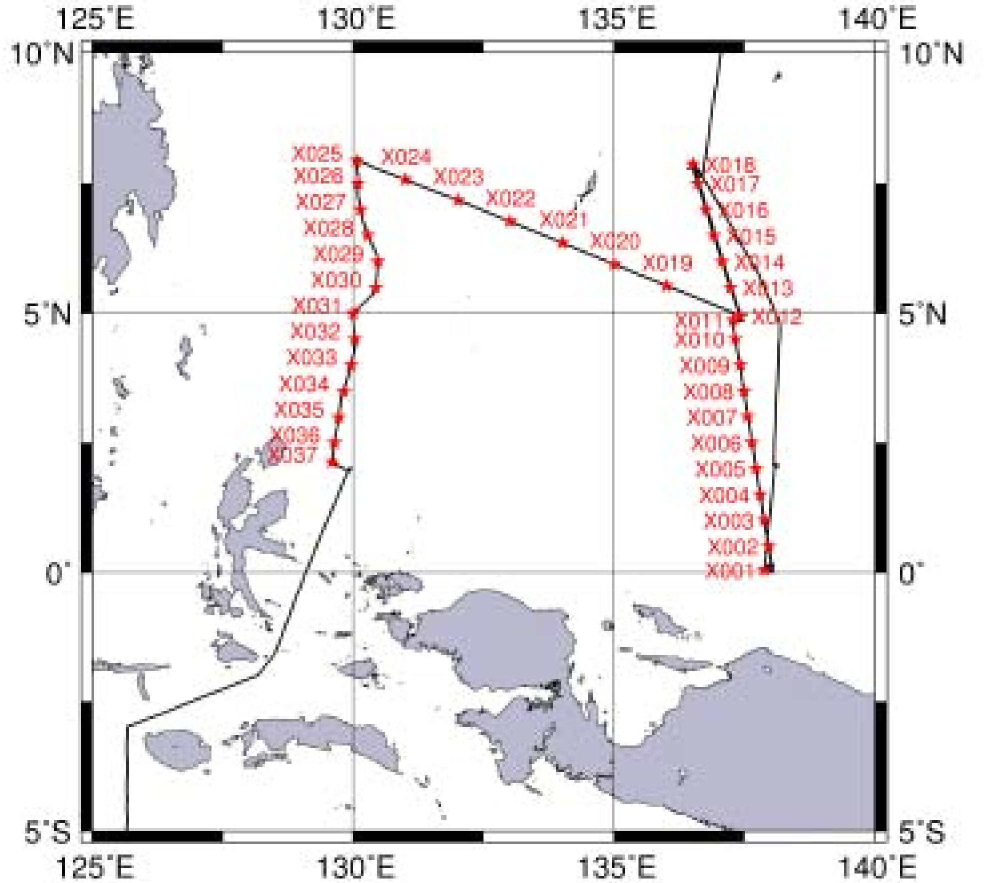


Fig. 6.2.2-1 XCTD Station in MR04-03 Leg1

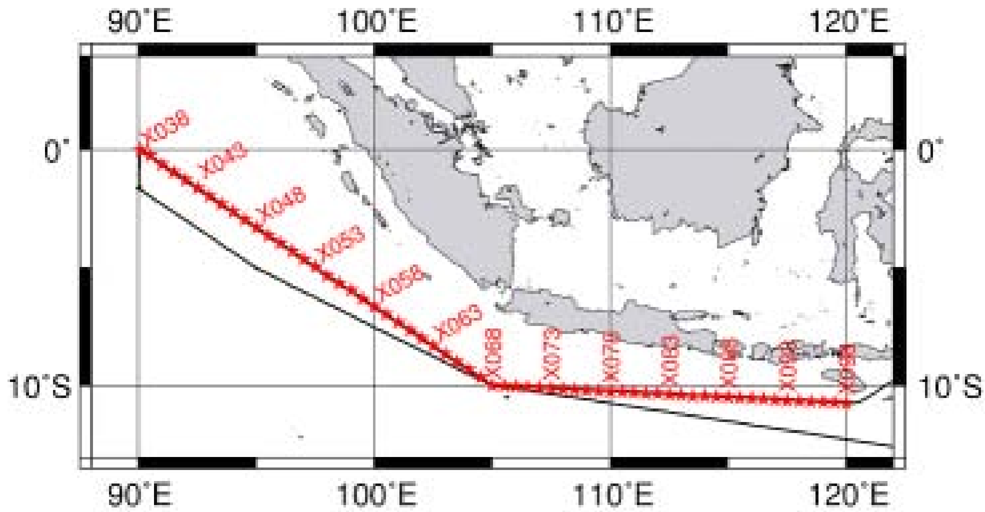


Fig. 6.2.2-2 XCTD stations in MR04-03 Leg2

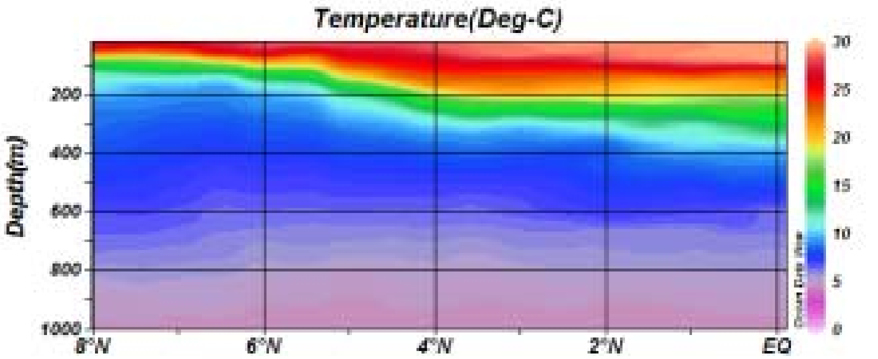


Fig. 6.2.2-3 Vertical section of Temperature along 8N137E – EQ138E Line.

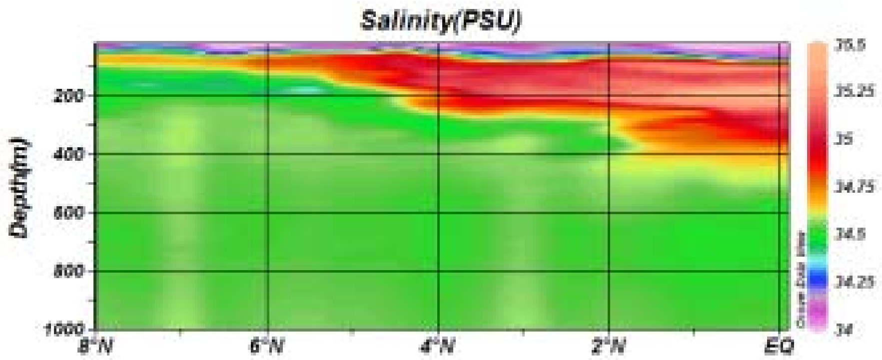


Fig. 6.2.2-4 Vertical section of Salinity along 8N137E – EQ138E Line.

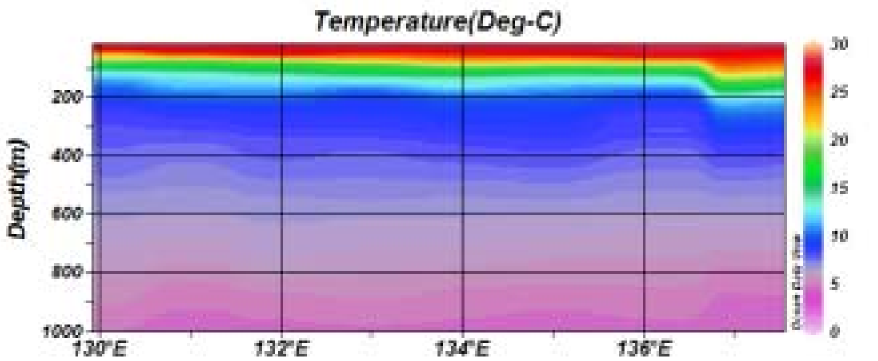


Fig. 6.2.2-5 Vertical section of Temperature along 5N137E – 8N130E Line.

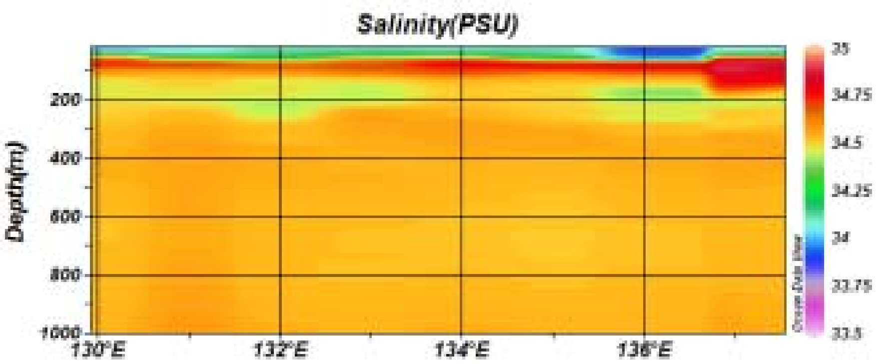


Fig. 6.2.2-6 Vertical section of Temperature along 5N137E – 8N130E Line.

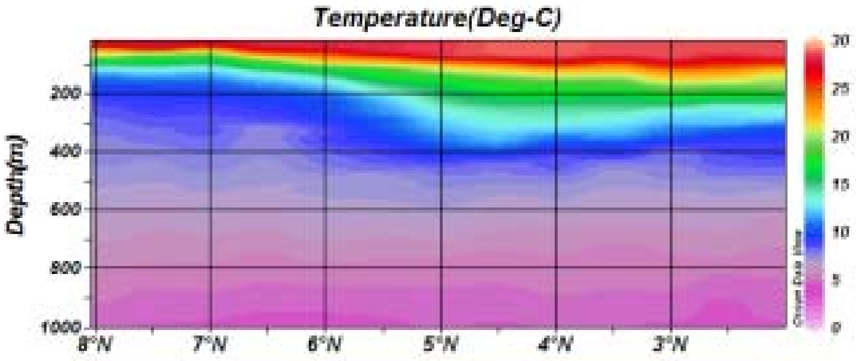


Fig. 6.2.2-7 Vertical section of Temperature along 8N130E – 2N130E Line.

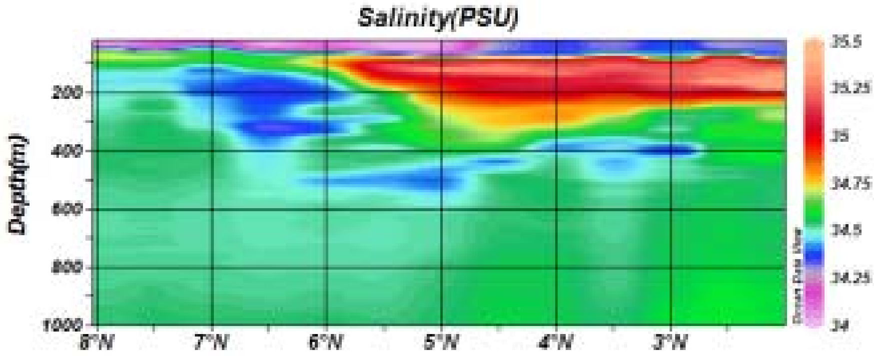


Fig. 6.2.2-8 Vertical section of Temperature along 8N130E – 2N130E Line.

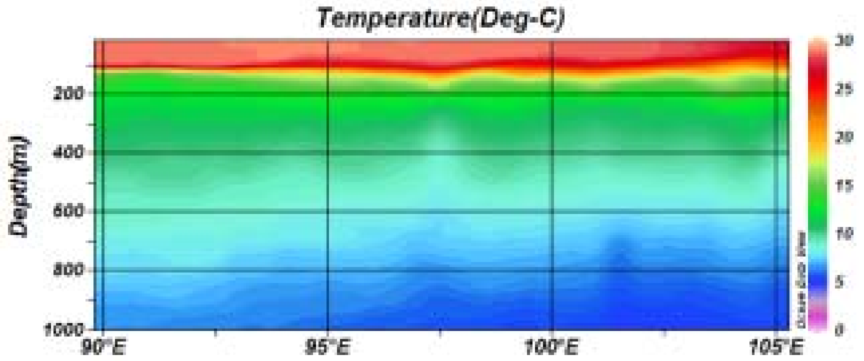


Fig. 6.2.2-9 Vertical section of Temperature along EQ90E – 10S105E Line.

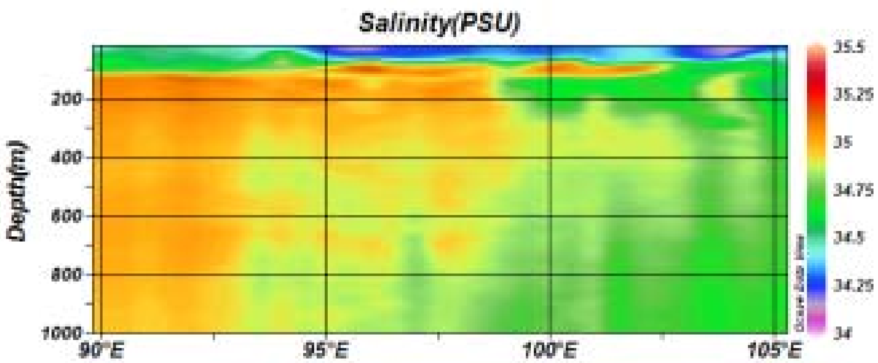


Fig. 6.2.2-10 Vertical section of Salinity along EQ90E – 10S105E Line.

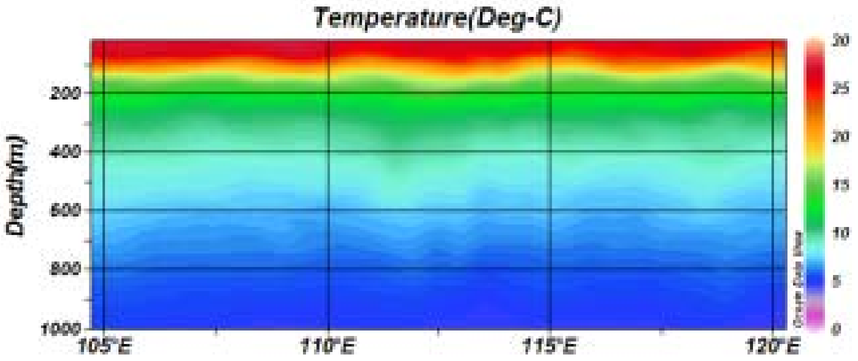


Fig. 6.2.2-11 Vertical section of Temperature along 10S105E – 10S120E Line.

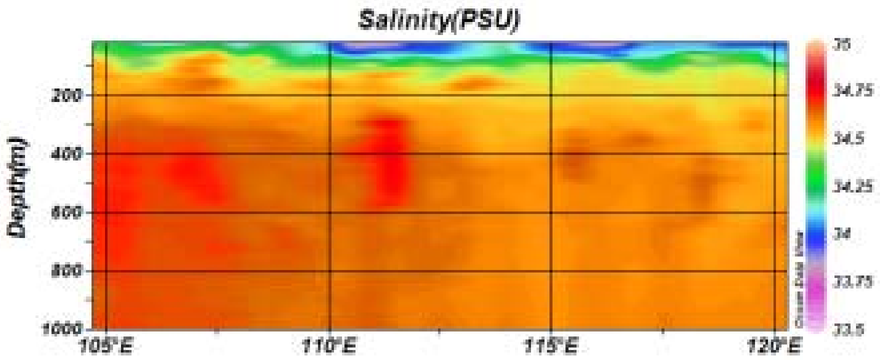


Fig. 6.2.2-12 Vertical section of Salinity along 10S105E – 10S120E Line.

6.3 Validation of CTD cast data

6.3.1. Salinity measurement of sampled seawater

(1) Personnel

Fujio Kobayashi (MWJ): Leg1
Kenichi Katayama (MWJ): Leg2

(2) Objective

Bottle salinity was measured in order to compare with CTD to calibrate CTD salinity.

(3) Instrument and Method

The salinity analysis was carried out on R/V MIRAI during the cruise of MR04-03 using the Guildline AUTOSAL salinometer model 8400B (S/N 62827), with additional peristaltic-type intake pump, manufactured by Ocean Scientific International, Ltd. We also used two Guildline platinum thermometers model 9450. One thermometer monitored an ambient temperature and the other monitored a bath temperature. The resolution of the thermometers was 0.001 deg C. The measurement system was almost same as Aoyama *et al.* (2003). The salinometer was operated in the air-conditioned ship's laboratory 'AUTOSAL ROOM' at a bath temperature of 24 deg C. An ambient temperature varied from approximately 20.8 deg C to 22.8 deg C, while a bath temperature is very stable and varied within +/- 0.002 deg C on rare occasion.

The measurement for each sample was done with a double conductivity ratio that is defined as median of 31 times reading of the salinometer. Data collection is started after 5 seconds and it takes about 10 seconds to collect 31 readings by a personal computer. If the difference between the double conductivity ratio measured for each sample is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If this condition isn't satisfied within 5 times in a series of measurement for each sample, we will consider the sample as the bad sample.

(3-1) Standardization

AUTOSAL model 8400B was standardized at the beginning of the sequence of measurements using IAPSO standard seawater (batch P144, conductivity ratio; 0.99987, salinity; 34.995). Because of the good stability of the AUTOSAL, calibration of the AUTOSAL was performed only once: The value of the Standardize Dial was adjusted at the time. 13 bottles of standard seawater were measured in total (one bad bottle was included), and their standard deviation to the catalogue value was 0.0001 (PSU). The value is used for the calibration of the measured salinity.

We also used sub-standard seawater which was obtained from 3,000-m depth in MR03-K01 cruise and filtered by Millipore filter (pore size of 0.45 μm), which was stored in a 20 liter polyethylene container. It was measured every about 10 samples in order to check the drift of the AUTOSAL.

(3-2) Salinity Sample Collection

Seawater samples were collected with 12 liter Niskin-X (Non-coating) bottles. The salinity sample bottle of the 250ml brown grass bottle with screw cap was used to collect the sample water. Each bottle and cap was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. The bottle was stored more than 24 hours in 'AUTOSAL ROOM' before the salinity measurement.

The kind and number of samples are shown as follows,

Table 6.3.1-1 Kind and number of samples

Kind of Samples	Number of Samples (Leg1)	Number of Samples (Leg2)
Samples for CTD	16	24
Samples for EPCS	21	24
Total	37	48

(4) Preliminary Results

Data of all samples were shown in Table 6.3.1-2. We estimated the precision of this method using 11 pairs of replicate samples taken by the same Niskin bottle, and compared the salinity of all samples except for surface samples to check the salinity data of CTD. The average and standard deviation of replicate samples were shown in Table 6.3.1-3.

The average of difference between measurement data and CTD data were -0.0011 (PSU) and the standard deviation was 0.0009 (PSU), and those of replicate samples were 0.0002 (PSU) and 0.0002 (PSU), respectively.

(5) Data Archive

The data of salinity sample will be submitted to the DMO at JAMSTEC.

(6) Reference

- Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki : Standard seawater comparison up to P129. Deep-Sea Research, I, Vol. 49, 1103～1114, 2002
- UNESCO : Tenth report of the Joint Panel on Oceanographic Tables and Standards. UNESCO Tech. Papers in Mar. Sci., 36, 25 pp., 1981

Table 6.3.1-2 Difference between bottle-sampling salinity and CTD salinity

	Station	Cast	Sample Bottle	Salinity (PSS-78)	Niskin Bottle No.	CTD Pressure (db)	CTD Salinity (PSS-78)	Salinity Diff. CTD-Salinity
Leg1	C01	1	0001	34.6982	Bucket	-	-	-
		1	0002	34.6631	1	3006.2	34.6640	0.0009
		1	0003	34.3381	25	1000.2	34.3387	0.0006
		1	0004	34.3388	30	1000.5	34.3400	0.0012
	C02	1	0005	33.7078	Bucket	-	-	-
		1	0006	34.6330	9	2004.5	34.6329	-0.0001
		1	0007	34.6337	9	2004.5	34.6329	-0.0008
		1	0008	34.5453	25	1000.2	34.5455	0.0002
		1	0009	34.5452	26	1000.3	34.5455	0.0003
	C02	2	0011	34.5458	10	1002.0	34.5449	-0.0009
		2	0010	34.5463	19	1002.6	34.5451	-0.0012
	C03	1	0013	34.5532	1	1000.3	34.5521	-0.0011
		1	0014	34.5533	10	1000.5	34.5521	-0.0012
	C03	2	0012	34.1407	Bucket	-	-	-
	C04	1	0015	33.3706	Bucket	-	-	-
	C05	1	0016	34.0382	Bucket	-	-	-
Leg2	C06	1	0001	34.6274	Bucket	-	-	-
		1	0002	34.7632	35	2000.9	34.7611	-0.0021
		1	0003	34.7631	35	2000.9	34.7611	-0.0020
		1	0004	34.7633	36	2000.8	34.7609	-0.0024
		1	0005	34.7631	36	2000.8	34.7609	-0.0022
	C07	1	0006	34.7177	Bucket	-	-	-
		1	0007	34.7719	35	2000.8	34.7704	-0.0015
		1	0008	34.7717	35	2000.8	34.7704	-0.0013
		1	0009	34.7719	36	1999.7	34.7705	-0.0014
		1	0010	34.7720	36	1999.7	34.7705	-0.0015
	C08	1	0011	34.7785	1	1999.9	34.7753	-
		1	0012	34.7767	1	1999.9	34.7753	-0.0014
		1	0013	34.7768	2	2000.2	34.7754	-0.0014
		1	0014	34.7767	2	2000.2	34.7754	-0.0013
	C09	1	0015	33.6934	Bucket	-	-	-
		1	0016	34.6302	9	2001.4	34.6283	-0.0019
		1	0017	34.6301	9	2001.4	34.6283	-0.0018
		1	0018	34.6295	10	2001.8	34.6284	-0.0011
		1	0019	34.6296	10	2001.8	34.6284	-0.0012
	C10	1	0020	34.7202	Bucket	-	-	-
		1	0021	34.6625	1	3001.2	34.6610	-0.0015
		1	0022	34.6625	1	3001.2	34.6610	-0.0015
		1	0023	34.6628	2	3002.2	34.6611	-0.0017
		1	0024	34.6628	2	3002.2	34.6611	-0.0017

Bad Sample

Average	-0.0011
Stdev	0.0009

6.4 Continuous monitoring of surface seawater

6.4.1 EPCS

(1) Personnel

Iwao UEKI	(JAMSTEC): Principal Investigator (Leg1)
Hideaki HASE	(JAMSTEC): Principal Investigator (Leg2)
Shinichiro YOKOGAWA	(MWJ): Operation Leader (Leg1-2)

(2) Objective

To measure salinity and temperature of near-sea surface water.

(3) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) can automatically measure salinity, temperature and particle size of plankton in near-sea surface water continuously, every 1-minute. This system is located in the "*sea surface monitoring laboratory*" on R/V MIRAI. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

Near-surface water was continuously pumped up to the laboratory and flowed into the *Continuous Sea Surface Water Monitoring System* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and was 12L/min. The flow rate is measured with flow meter.

Specification of the each sensor in this system of listed below.

a) Temperature and Salinity sensor

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.	
Serial number:	2118859-2641	
Measurement range:	Temperature -5 to +35℃,	Salinity0 to 6.5 S m-1
Accuracy:	Temperature 0.01 ℃ 6month-1,	Salinity0.001 S m-1 month-1
Resolution:	Temperatures 0.001℃,	Salinity0.0001 S m-1

b) Bottom of ship thermometer

Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.

Serial number: 032175

Measurement range: -5 to +35℃

Resolution: ±0.001℃

Stability: 0.002 ℃ year-1

c) Particle Size sensor

Model: P-05, Nippon Kaiyo LTD.

Serial number: P5024

Measurement range: 0.2681 mm to 6.666 mm

Accuracy: ±10% of range

Reproducibility: ±5%

Stability: 5% week-1

d) Flow meter

Model: EMARG2W, Aichi Watch Electronics LTD.

Serial number: 8672

Measurement range: 0 to 30 l min-1

Accuracy: ±1%

Stability: ±1% day-1

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

Leg1: 10:40-7/Jun./2004 to 09:03-28/Jun./2004.

Leg2: 02:25-4/Jul./2004 to 01:01-01/Aug./2004.

(It isn't observed from 01:00-19/Jul./2004 to 20:00-21/Jul./2004 for the Indonesian EEZ.)

(4) Preliminary Result

The figures of time series of the temperature (Bottom of ship thermometer) and salinity were shown in Fig. 6.4.1-1 to 4.

The figure of the correlation between salinity [sensor] and salinity analysis result were shown in Fig. 6.4.1-5.

(5) Date archive

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

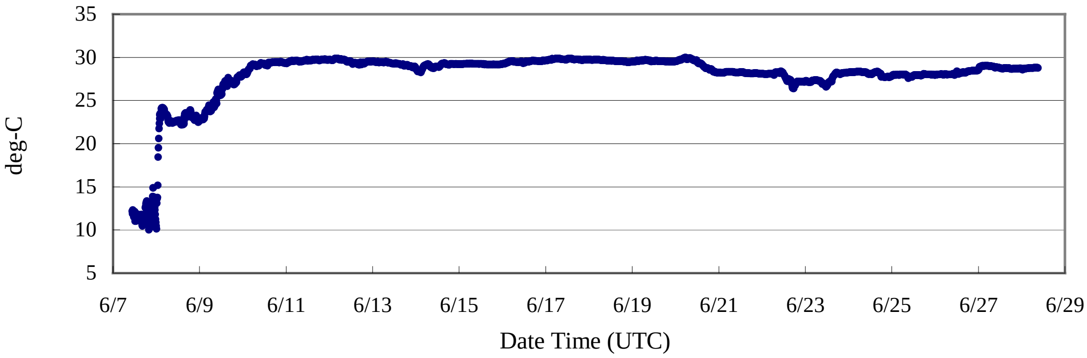


Fig. 6.4.1-1 Time series of temperature in the sea surface water. (Leg-1)

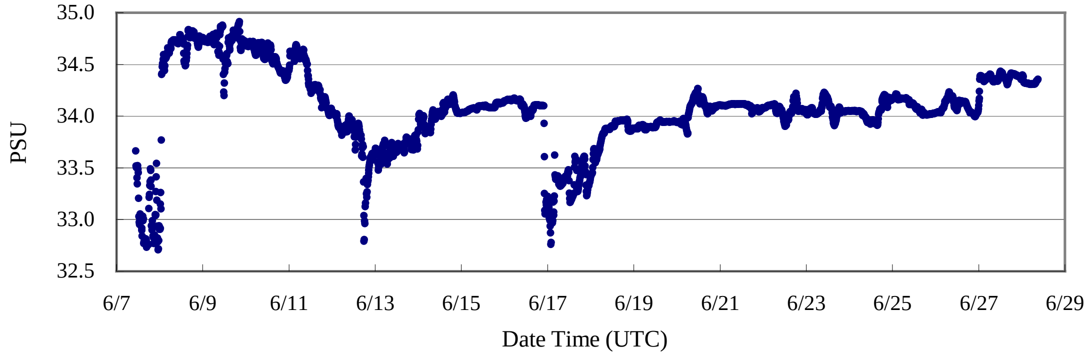


Fig. 6.4.1-2 Time series of salinity in the sea surface water. (Leg-1)

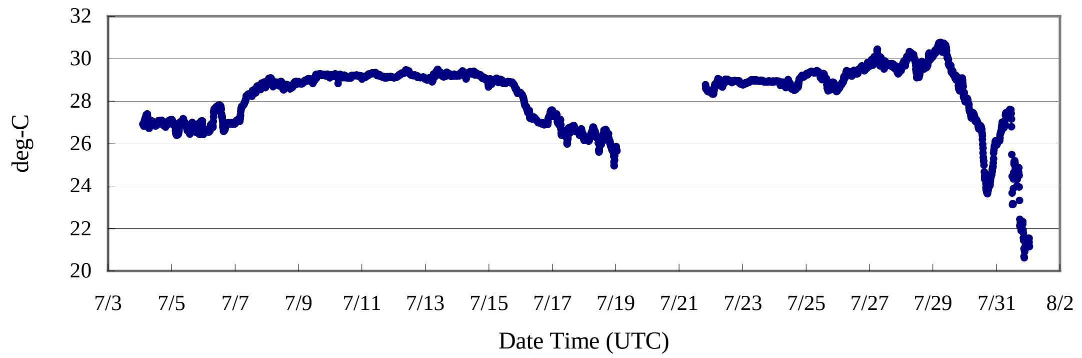


Fig. 6.4.1-3 Time series of temperature in the sea surface water. (Leg-2)

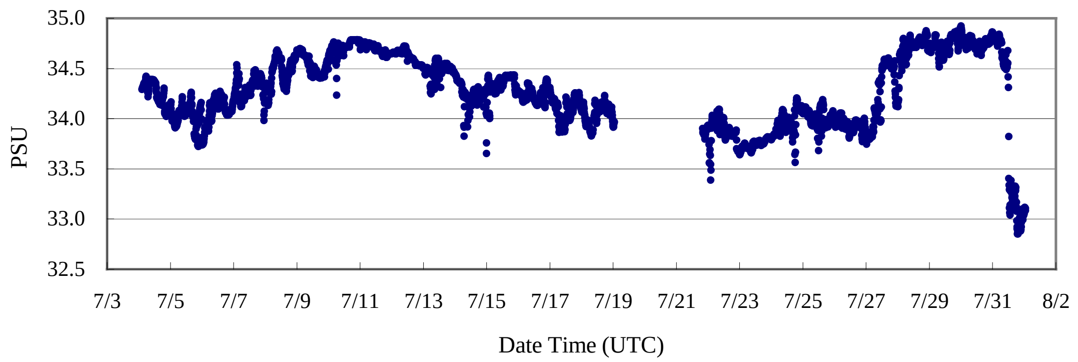


Fig. 6.4.1-4 Time series of salinity in the sea surface water. (Leg-2)

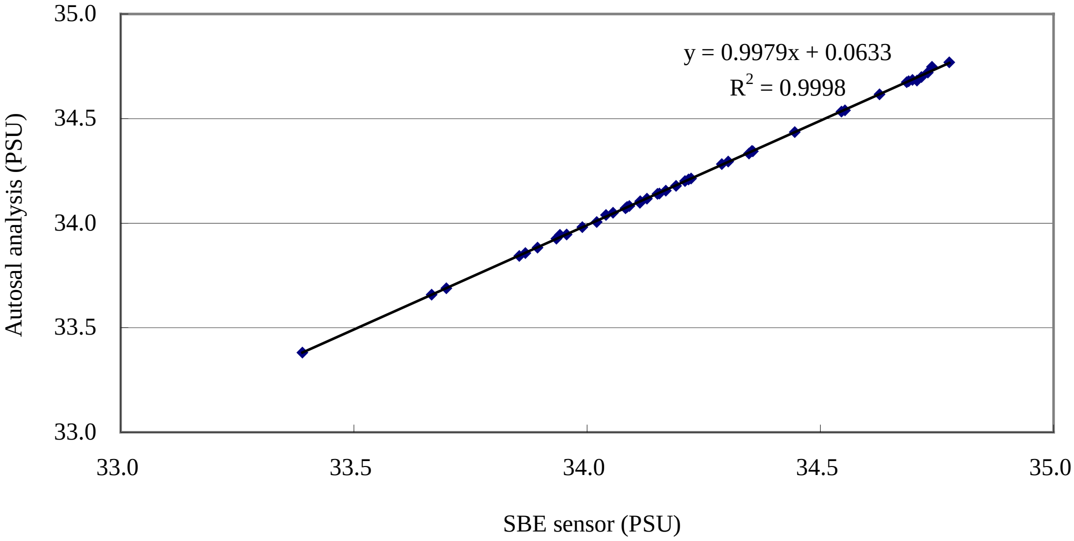


Fig. 6.4.1-5 The correlation between salinity [sensor] and salinity analysis result.

6.5 Shipboard ADCP

Iwao Ueki	(JAMSTEC): Principal Investigator	- leg 1 -
Hideaki Hase	(JAMSTEC): Principal Investigator	- leg 2 -
Satoshi Okumura	(GODI)	- leg 1 -
Wataru Tokunaga	(GODI)	- leg 2 -
Norio Nagahama	(GODI)	- leg 2 -
Kazuho Yoshida	(GODI)	- leg 1, 2 -

(1) Parameters

Current velocity of each depth cell [cm/s]
Echo intensity of each depth cell [dB]

(2) Methods

Upper ocean current measurements were made throughout MR04-03 cruise from Sekinehama, Japan on 7 June 2004 to Sekinehama, Japan on 3 August 2004 using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V MIRAI. The system consists of following components;

1. A 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating at 76.8 kHz (VM-75; RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
2. The Ship's main gyro compass (TG-6000; Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;
3. A GPS navigation receiver (Leica MX9400n) providing position fixes;
4. An IBM-compatible personal computer running data acquisition software (VmDas version 1.3 ; RD Instruments, USA).

The ADCP was configured for 16-m processing bin, a 8-m blanking interval. The sound speed is calculated from temperature at the transducer head. The transducer depth was 6.5 m; 40 velocity measurements were made at 16-m intervals starting 31 m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short-term average (.STA) and long-term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are as follows:

VM-ADCP Configuration

Bottom-Track Commands

BP = 000 ----------------- Pings per Ensemble (In bottom track mode, BP=001)

Environmental Sensor Commands

EA = +00000 -------------- Heading Alignment (1/100 deg)
EB = +00000 -------------- Heading Bias (1/100 deg)
ED = 00065 --------------- Transducer Depth (0 - 65535 dm)
EF = +0001 --------------- Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000 --------------- Heading (1/100 deg)
ES = 35 -------------------- Salinity (0-40 pp thousand)
EX = 00000 --------------- Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001 ------------- Sensor Source (C;D;H;P;R;S;T)

Timing Commands

TE = 00:00:02.00 --------- Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:02.00 ------------- Time per Ping (min:sec.sec/100)

Water-Track Commands

WA = 255 ----------------- False Target Threshold (Max) (0-255 counts)
WB = 1 -------------------- Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar)
WC = 064 ----------------- Low Correlation Threshold (0-255)
WD = 111 111 111 ------- Data Out (V;C;A PG;St;Vsum Vsum^2;#G;P0)
WE = 5000 ---------------- Error Velocity Threshold (0-5000 mm/s)
WF = 0800 ---------------- Blank After Transmit (cm)
WG = 001 ----------------- Percent Good Minimum (0-100%)
WI = 0 --------------------- Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1 --------------------- Rcvr Gain Select (0=Low,1=High)
WM = 1 -------------------- Profiling Mode (1-8)
WN = 040 ----------------- Number of depth cells (1-128)
WP = 00001 --------------- Pings per Ensemble (0-16384)
WS = 1600 ---------------- Depth Cell Size (cm)
WT = 0000 ---------------- Transmit Length (cm) [0 = Bin Length]
WV = 999 ----------------- Mode 1 Ambiguity Velocity (cm/s radial)

(4) Preliminary result

Fig. 6.5-1 and Fig.6.5-2 show 2-hourly averaged current vectors in the layer of 35-50m, 65-80m, 100-150m, 200-300m along cruise track in the western Pacific Ocean and the eastern Indian Ocean. The data was processed using CODAS (Common Oceanographic Data Access System), developed at the University of Hawaii.

(5) Data archive

These data obtained during this cruise will be submitted to the JAMSTEC Data Management Office, and will be opened to the public via “R/V Mirai Data Web Page” in JAMSTEC home page.

(6) Remarks

1. We did not collect data in the territorial waters of Australia, the Republic of Indonesia.
   06:34UTC 28 Jun – 10:30UTC 3 Jul 2004
   01:00UTC 19 Jul – 18:00UTC 21 Jul 2004
2. During the periods below, data was sampled in bottom track mode and the other data were sampled in water track mode.
   The departure on Sekinehama – 04:49UTC 7 June 2004
   10:30UTC 3 July – 15:30UTC 4 July 2004
3. Navigation data are invalid during the periods below.
   00:33UTC 27 Jun – 00:39UTC 27 Jun 2004
   01:16UTC 27 Jun – 01:18UTC 27 Jun 2004
4. No data due to the software error
   16:56UTC 22 Jun – 22:25UTC 22 Jun 2004

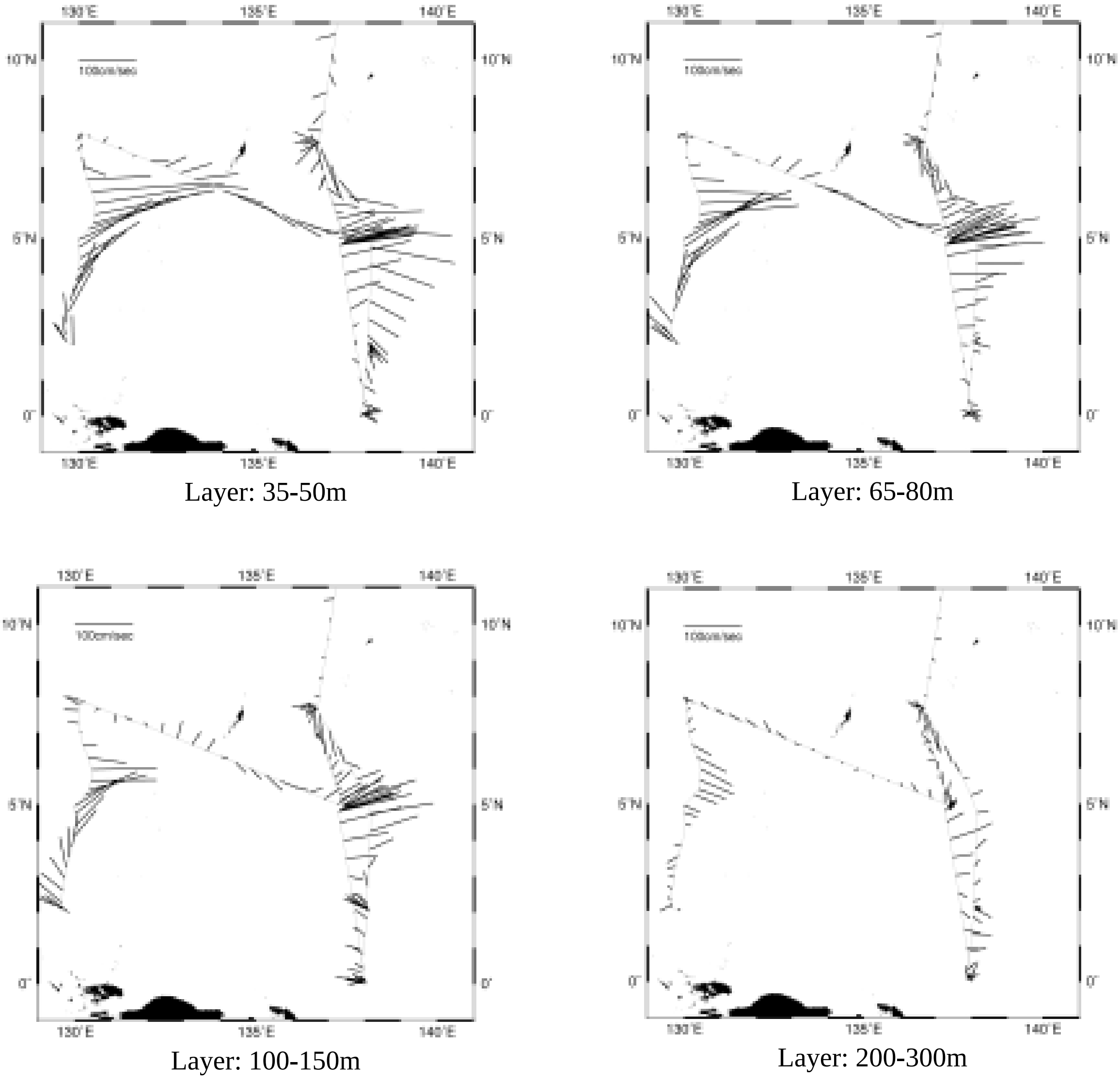
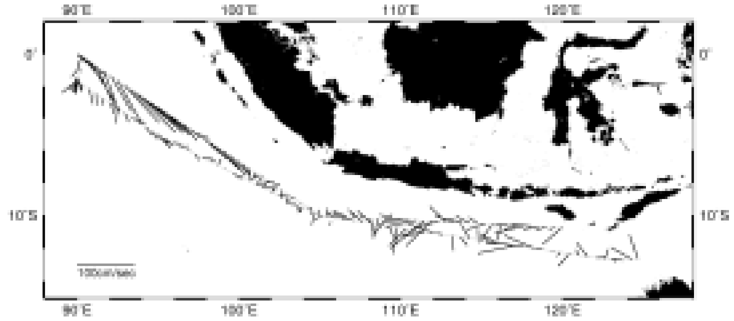
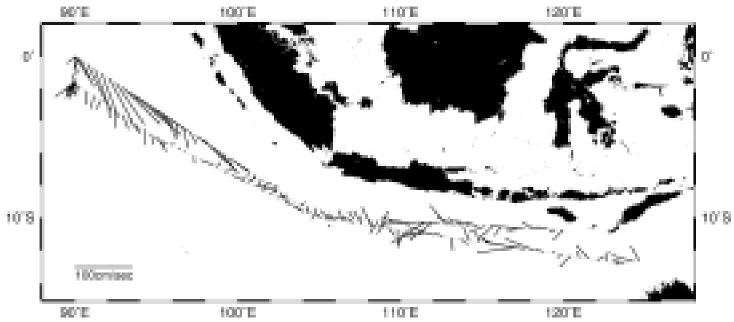


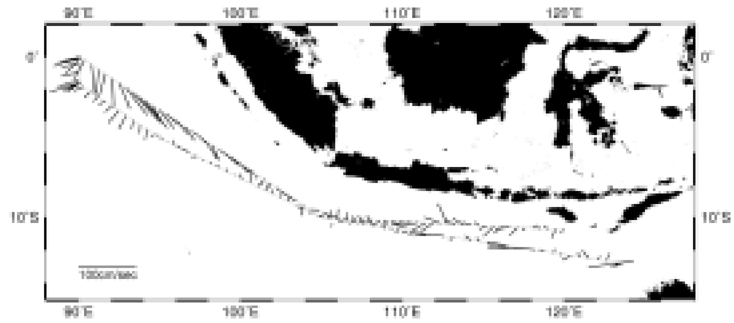
Fig. 6.5-1 2-hourly averaged current vectors along the cruise track in the western Pacific Ocean

Layer: 35-50m

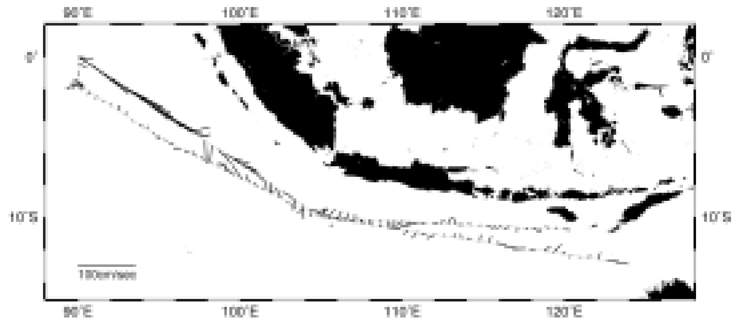




Layer: 65-80m



Layer: 100-150m



Layer: 200-300m

Fig. 6.5-2 2-hourly averaged current vectors along the cruise track in the eastern Indian Ocean

6.6 Underway geophysics
6.6.1 Sea Surface Gravity

Satoshi Okumura (Global Ocean Development Inc.) -Leg1-
Wataru Tokunaga (GODI) -Leg2-
Norio Nagahama (GODI) -Leg2-
Kazuho Yoshida (GODI) -Leg1, 2-
Not on-board:
Toshiya Fujiwara (JAMSTEC): Principal investigator

(1) Introduction

The difference of local gravity is an important parameter in geophysics and geodesy. We collected gravity data at the sea surface during the MR04-03 cruise from Sekinehama, Japan on 6 June 2004 to Sekinehama, Japan on 3 August 2004, and called at a port Darwin, Australia on 2 to 3 July 2004.

(2) Parameters

Relative Gravity [mGal]

(3) Data Acquisition

We have measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (LaCosat and Romberg Gravity Meters, Inc.) during this cruise. To convert the relative gravity to absolute one, we measured gravity using portable gravity meter (Scintrex gravity meter CG-3M), at Sekinehama Port and Darwin Port as reference points.

(4) Preliminary Results

Absolute gravity shown in Tabel 6.6.1-1

Table 6.6.1-1

No.	Date	U.T.C.	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *[1] [mGal]	L&R *[2] Gravity [mGal]
#01	June/6	01:04	Sekinehama	980371.85	343	617	980372.95	12671.6
#02	Aug/4	05:46	Sekinehama	980371.85	273	610	980372.73	12685.4

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

(5) Data Archives

Gravity data obtained during this cruise will be submitted to the JAMSTEC Data Management Division, and archived there.

(6) Remarks

1) Data recoding was stopped from 02:36UTC to 03:09UTC 8 July 2004, because of logging PC trouble.
2) We did not collect data in territorial waters as follows;
   a) Republic of Indonesia and Australia, 06:34UTC 28 June to 10:30UTC 3 July, 2004
   b) Republic of Indonesia, 01:00UTC 19 July to 18:00UTC 21 July, 2004

3) The following periods of navigation data(Position, Gyro, Speed, etc.) is not correct. Because of GPS received error or network server trouble.

   (UTC)
   6/20 00:11 – 00:20

6/21	17:06 – 17:07
6/27	00:33 – 00:45, 01:16 – 01:30, 01:44 – 01:54
7/22	14:03, 14:05, 14:07 – 14:08
7/23	11:15
7/27	04:12

6.6.2 Sea Surface Three-Component Magnetic Field

Satoshi Okumura	(Global Ocean Development Inc.)	-Leg1-
Wataru Tokunaga	(GODI)	-Leg2-
Norio Nagahama	(GODI)	-Leg2-
Kazuho Yoshida	(GODI)	-Leg1, 2-
Not on-board:		
Toshiya Fujiwara	(JAMSTEC): Principal investigator	

(1) Introduction

Measurements of magnetic force on the sea are required for the geophysical investigations of marine magnetic anomaly caused by magnetization in upper crustal structure. We measured geomagnetic field using a three-component magnetometer during the MR04-03 cruise from Sekinehama, Japan on 6 June 2004 to Sekinehama, Japan on 3 August 2004, and called at a port Darwin, Australia on 2 to 3 July 2004.

(2) Parameters

Three-component magnetic force [nT]
Ship's attitude [1/100 deg]

(3) Data Acquisition

A sensor of three-component fluxgate magnetmeter is set on the top of foremast. Sampling is controlled by 1pps (pulse per second) standard clock of GPS signals. Every one-second record is composed of navigation information, 8 Hz three-component of magnetic force, and VRU (Vertical Reference Unit) data.

For calibration of the ship's magnetic effect, we made a running like a "Figure of 8" (a pair of clockwise and anti-clockwise rotation). This calibration carried out 06:06UTC to 06:27UTC July 2004, about at 01-37S, 090-01E.

(4) Preliminary Results

The results will be published after primary processing.

(5) Data Archives

Magnetic force data obtained during this cruise will be submitted to the JAMSTEC Data Management Division, and archived there.

(6) Remarks

1) Data recoding was stopped from 01:13UTC to 02:53UTC 8 July 2004, because of logging PC trouble.
2) We did not collect data in territorial waters as follows;
   a) Republic of Indonesia and Australia, 06:34UTC 28 June to 10:30UTC 3 July, 2004
   b) Republic of Indonesia, 01:00UTC 19 July to 18:00UTC 21 July, 2004
3) The following periods of navigation data(Position, Gyro, Speed, etc.) is not correct. Because of GPS received error or network server trouble.

(UTC)

6/20	00:11 – 00:20
6/21	17:06 – 17:07
6/27	00:33 – 00:45, 01:16 – 01:30, 01:44 – 01:54
7/22	14:03, 14:05, 14:07 – 14:08
7/23	11:15
7/27	04:12

6.6.3 Swath Bathymetry

Satoshi Okumura	(Global Ocean Development Inc.)	-Leg1-
Wataru Tokunaga	(GODI)	-Leg2-
Norio Nagahama	(GODI)	-Leg2-
Kazuho Yoshida	(GODI)	-Leg1, 2-
Not on-board:		
Toshiya Fujiwara	(JAMSTEC): Principal investigator	

(1) Introduction

R/V MIRAI equipped a Multi Narrow Beam Echo Sounding system (MNBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.) The main objective of MNBES survey is collecting continuous bathymetry data along ship's track to make a contribution to geological and geophysical investigations and global datasets. We had carried out bathymetric survey during the MR04-03 cruise from Hachinohe, Japan on 7 June 2004 to Hachinohe, Japan on 1 August 2004, and called at a port Darwin, Australia on 2 to 3 July 2004.

In addition, we surveyed estimate developing position depth of TRITON buoys and ADCP mooring buoys, and we measured depth of fixed those buoys anchor position at the deployment sites.

(2) Data Acquisition

The "SEABEAM 2100" on R/V MIRAI was used for bathymetry mapping during the this cruise. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the surface (6.2m) sound velocity, and the others depth sound velocity calculated temperature and salinity profiles from CTD and XCTD data by the equation in Mackenzie (1981) during the cruise.

System configuration and performance of SEABEAM 2112.004,

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

(3) Preliminary Results

The results will be published after primary processing.

(4) Data Archives

Magnetic force data obtained during this cruise will be submitted to the JAMSTEC Data Management Office, and archived there.

(5) Remarks

1) We did not collect data in territorial waters as follows;
   a) Republic of Indonesia and Australia, 06:34UTC 28 June, 2004 to arrival at port Darwin.
   b) Republic of Indonesia, 01:00UTC 19 July to 18:00UTC 21 July, 2004

2) The following periods of navigation data(Position, Gyro, Speed, etc.) is not correct. Because of GPS received error or network server trouble.

(UTC)

6/20	00:11 – 00:20
6/21	17:06 – 17:07
6/27	00:33 – 00:45, 01:16 – 01:30, 01:44 – 01:54
7/22	14:03, 14:05, 14:07 – 14:08
7/23	11:15
7/27	04:12

7 Special Observation

7.1 TRITON moorings

7.1.1 TRITON Mooring Operation

(1) Personnel

Hideaki Hase	(JAMSTEC): Principal Investigator (on board Leg2)
Iwao Ueki	(JAMSTEC): Principal Investigator (on board Leg1)
Atsuo Ito	(JAMSTEC): Technical staff (on board Leg1,)
Takeo Matsumoto	(MWJ): Operation leader (on board Leg1,2)
Hiroshi Matsunaga	(MWJ): Technical staff (on board Leg1)
Shinichiro Yokogawa	(MWJ): Technical staff (on board Leg1,2)
Fujio Kobayashi	(MWJ): Technical staff (Son board Leg1)
Kenichi Katayama	(MWJ): Technical staff (on board Leg2)
Naoko Takahashi	(MWJ): Technical staff (on board Leg1)
Tomoyuki Takamori	(MWJ): Technical staff (on board Leg2)
Fuma Matsunaga	(MWJ): Technical staff (on board Leg1,2)
Satoko Asai	(MWJ): Technical staff (on board Leg2)
Akinori Murata	(MWJ): Technical staff (on board Leg1)
Tomohide Noguchi	(MWJ): Technical staff (on board Leg1)
Keisuke Matsumoto	(MWJ): Technical staff (on board Leg1,2)
Tetsuharu Iino	(MWJ): Technical staff (on board Leg2)
Naoshi Kuda	(MWJ): Technical staff (on board Leg1,2)
Daiki Shirakawa	(MWJ): Technical staff (on board Leg1,2)
Tomomi Watanabe	(MWJ): Technical staff (on board Leg2)

(2) Objectives

The large-scale air-sea interaction over the warmest sea surface temperature region in the western tropical Pacific Ocean called warm pool 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. Long term data sets of temperature, salinity, currents, so on have been required at fixed locations. In particular, the oceanic change due to the surface winds over the western tropical Pacific is important to study the relation with El Nino and rain fall over the ocean is also important parameter to study El Nino and Asia-Australian Monsoon. 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).

The seven TRITON buoys have been successfully recovered during this R/V Mirai cruise (MR04-K03-leg1,2), deployed eight TRITON buoys.

(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

Measurement range Conductivity : 0～+7

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

SCTI ORG-115DX

Atmospheric pressure

PAROSCIENTIFIC. 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	10004
Number on surface float	T08
ARGOS PTT number	03595
ARGOS backup PTT number	24239
Deployed date	13 Jun. 2004
Exact location	07 - 38.95N, 136 - 41.92E
Depth	3166 m

Nominal location	5N, 137E
ID number at JAMSTEC	11004
Number on surface float	T09
ARGOS PTT number	03779
ARGOS backup PTT number	24241
Deployed date	21 Jun. 2004
Exact location	04 - 51.60Ｎ, 137 - 15.62Ｅ
Depth	4096 m

Option sensors	Precipitation sensor (capacitive type) at Tower : S/N01084
	CT at 175 m : S/N 0567

Nominal location	2N, 138E
ID number at JAMSTEC	12006
Number on surface float	T10
ARGOS PTT number	09792
ARGOS backup PTT number	24242
Deployed date	16 Jun. 2004
Exact location	02 - 04.02N, 138 - 03.74 E
Depth	4325 m
Option sensors	Precipitation sensor (capacitive type) at Tower :S/N00772
	CT at 175 m : S/N 0547

Nominal location	EQ, 138E
ID number at JAMSTEC	13006
Number on surface float	T11
ARGOS PTT number	none
ARGOS backup PTT number	24243, 24244
Deployed date	18 Jun. 2004
Exact location	00 - 02.03N, 137 - 52.90 E
Depth	4384 m
Option sensors	CT at 175 m : S/N 0637

Nominal location	2N, 130E
ID number at JAMSTEC	16004
Number on surface float	T18
ARGOS PTT number	03593
ARGOS backup PTT number	13065
Deployed date	25 Jul. 2004
Exact location	02 - 01.69N, 130 - 11.39E
Depth	4372m
Option sensors	CTD at 175 m : S/N 1045

Nominal location	8N, 130E
ID number at JAMSTEC	14003
Number on surface float	T12
ARGOS PTT number	07960
ARGOS backup PTT number	24246
Deployed date	24 Jul. 2004
Exact location	07 - 58.83N, 130 - 02.10E
Depth	5722 m

Nominal location	1.5S, 90E
ID number at JAMSTEC	18004
Number on surface float	T27
ARGOS PTT number	20434

ARGOS backup PTT number 13066
Deployed date 12 Jul. 2004
Exact location 01 - 36.17S, 090 - 04.49E
Depth 4715m

Nominal location 5S, 95E
ID number at JAMSTEC 17003
Number on surface float T28
ARGOS PTT number 03781
ARGOS backup PTT number 07878
Deployed date 09 Jul. 2004
Exact location 05 - 02.21S, 094 - 58.58E
Depth 5013m

(6)) Locations of TRITON Buoys recovered

Nominal location 8N, 137E
ID number at JAMSTEC 10003
Number on surface float T02
ARGOS PTT number 11824
ARGOS backup PTT number 11592
Deployed date 09 Jun. 2003
Recovered date 23 Jun. 2004
Exact location 07 - 52.14N, 136 - 29.44E
Depth 3350 m

Nominal location 5N, 137E
ID number at JAMSTEC 11003
Number on surface float T03
ARGOS PTT number 11825
ARGOS backup PTT number 11593
Deployed date 11 Jun. 2003
Recovered date 24 Jun. 2004
Exact location 04 - 56.58N, 137 - 18.07E
Depth 4133 m
Option sensors Precipitation sensor (capacitive type) at Tower : S/N00801
CTD at 175 m : S/N 0493

Nominal location 2N, 138E
ID number at JAMSTEC 12005
Number on surface float T14
ARGOS PTT number 07962
ARGOS backup PTT number 07860
Deployed date 13 Jun. 2003
Recovered date 15 Jun. 2004
Exact location 02 - 04.00N, 138 - 03.85E
Depth 4334 m
Option sensors Precipitation sensor (capacitive type) at Tower : S/N00907

	CT at 175 m : S/N 0500

Nominal location	EQ, 138E
ID number at JAMSTEC	13005
Number on surface float	T15
ARGOS PTT number	none
ARGOS backup PTT number	7861, 7864
Deployed date	16 Jun. 2003
Recovered date	19 Jun. 2004
Exact location	00 - 04.27N, 138 - 02.80 E
Depth	4201 m
Option sensors	CT at 175 m : S/N 0610

Nominal location	8N, 130E
ID number at JAMSTEC	14002
Number on surface float	T16
ARGOS PTT number	09771
ARGOS backup PTT number	07871
Deployed date	24 Jun. 2003
Recovered date	23 Jul. 2004
Exact location	07 - 55.53N, 130 - 03.94E
Depth	5638 m

Nominal location	2N, 130E
ID number at JAMSTEC	16003
Number on surface float	T17
ARGOS PTT number	03595
ARGOS backup PTT number	07878
Deployed date	20 Jun. 2003
Recovered date	30 Jun. 2004
Exact location	01 - 56.48N, 129 - 55.85E
Depth	4431m
Option sensors	CTD at 175 m : S/N 0615

Nominal location	1.5S, 90E
ID number at JAMSTEC	18003
Number on surface float	T19
ARGOS PTT number	11827
ARGOS backup PTT number	24238
Deployed date	12 Jun. 2003
Recovered date	11 Jul. 2004
Exact location	01 - 39.42S, 089 - 59.60 E
Depth	4694m

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

(7) Details of deployed

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

Deployed and Repaired TRITON buoys

Observation No.	Location.	Details.
10004	8N 137E	Deploy with full spec.
11004	5N 137E	Deploy with full spec and one optional precipitation sensor and optional CT sensor.
12006	2N 137E	Deploy with full spec and one optional precipitation sensor and optional CT sensor.
13006	EQ 138E	Deploy with only underwater sensors and one optional CT sensor. No data transmission system.
16004	2N 130E	Deploy with only under water sensors and one optional CT sensor.
14003	8N 130E	Deploy with only underwater sensors.
17003	5S 95E	Deploy with only underwater sensors and Wind speed/direction module and Relative humidity air temperature module
18003	1.5S 90E	Deploy with full spec.

(8) Data archive

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

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

7.1.2 Inter-comparison between shipboard CTD and TRITON data

(1) Personnel

Hideaki Hase (JAMSTEC): Plincipal Investigator
Takeo Matsumoto (MWJ): Operation Leader

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of the buoy below sea surface. We used the same CTD (SBE 9/11Plus) system with general CTD observation (See section 5) on R/V MIRAI for this intercomparision. We conducted 1 CTD cast at each TRITON buoy site before recovery, conducted 1 CTD cast at each TRITON buoy site after deployment. The cast was performed immediately after the deployment and before recovery. R/V MIRAI was kept the distance from the TRITON buoy within 2 nm.

TRITON buoy data was sampled every 1 hour except for transmition to the ship. We compared CTD observation by R/V MIRAI data with TRITON buoy data using the 1 hour averaged value.

As our temperature sensors are expected to be more stable than conductivity sensors, conductivity data and salinity data are selected at the same value of temperature data. Then, we calculate difference of salinity from conductivity between the shipboard CTD data on R/V MIRAI and the TRITON buoy data for each deployment and recovery of buoys.

Compared site

Observation No.	Latitude	Longtitude	Condition
10004	8N	138E	After Deployment
12006	2N	137E	After Deployment
17003	1.5S	95E	After Deployment
10003	8N	138E	Before Recovery
12005	2N	137E	Before Recovery
14002	8N	130E	Before Recovery

(5) Results

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

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

The estimation were calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from –0.134 to 0.151 psu for all depths. Below 300db, salinity differences are from –0.011 to 0.009 psu (See the Figures 7.1.2-2 (a) and Table 7.1.2-1 (a)). The average of salinity differences was 0.004 psu with standard deviation of 0.047 psu.

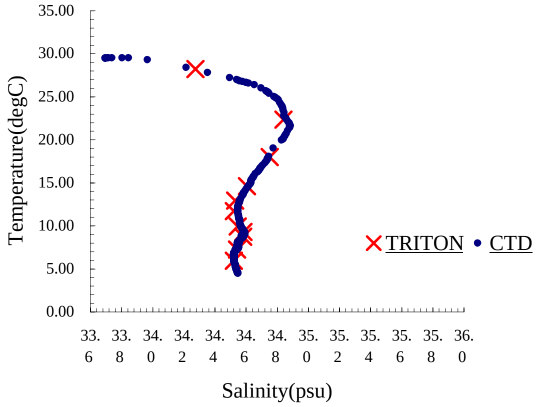
The estimation were calculated as recovered buoy data minus shipboard CTD (9Plus) data.

The salinity differences are from –0.399 to 0.112 psu for all depths. Below 300db, salinity differences are from –0.021 to 0.006 psu (See the Figures 7.1.2-2(b) and Table 7.1.2-1 (b)). The average of salinity differences was －0.003 psu with standard deviation of 0.082 psu.

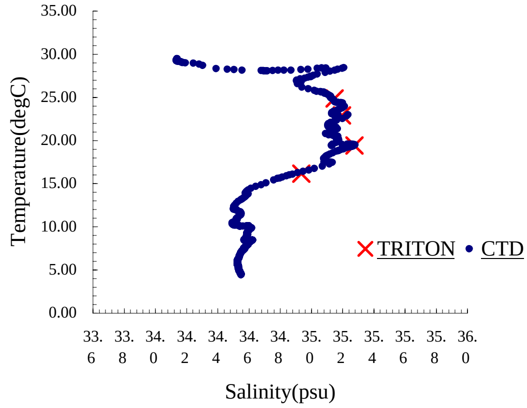
The estimation of time-drift were calculated as recovered buoy data minus deployed buoy data. The salinity change for 1 year are from –0.354 to 0.038 psu, for all depths. Below 300db, salinity change for 1 year are from –0.046 to 0.009 psu (See the figures 7.1.2-2(c)). The average of salinity differences was －0.045 psu with standard deviation of 0.095 psu.

(6) Data archive

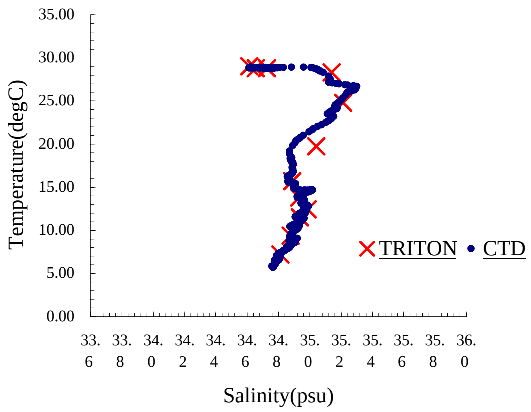
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)



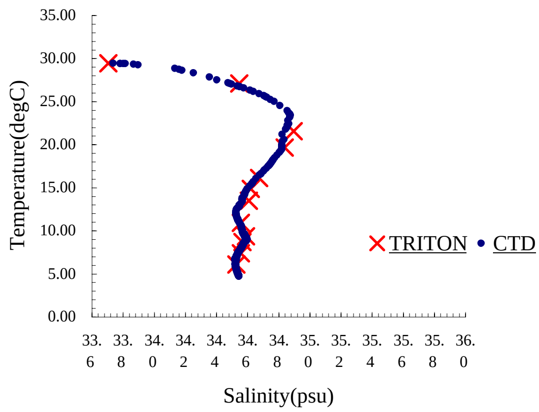
Observation No. 10004 after Deployment



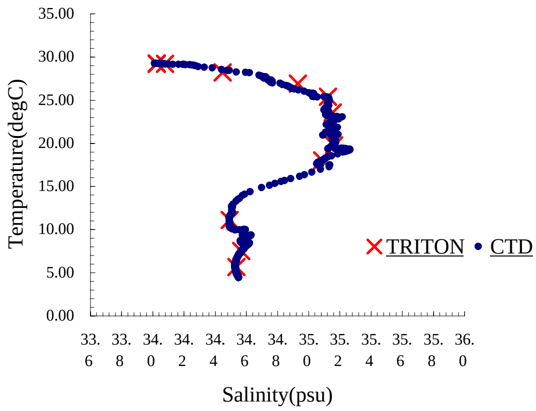
Observation No. 12006 after Deployment



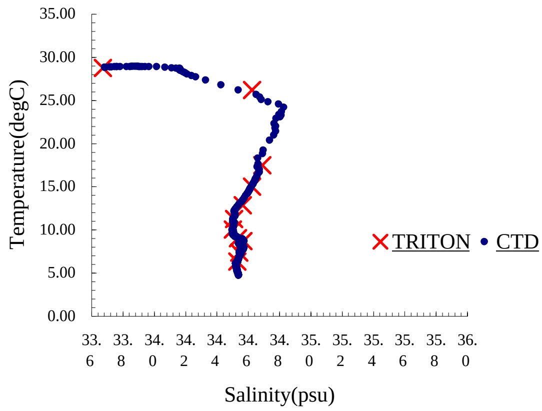
Observation No. 17003 after Deployment



Observation No. 10003 before Recovery



Observation No. 12005 before Recovery



Observation No. 14002 before Recovery

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

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

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
10004	1.5	0.00	-0.020	-0.134
10004	25.0	-0.20	-0.012	0.059
10004	50.0	0.02	0.000	-0.019
10004	75.0	-0.09	-0.009	0.006
10004	100.0	0.08	0.010	0.020
10004	125.0	-0.83	-0.086	-0.053
10004	150.0	-0.58	-0.058	-0.026
10004	200.0	-0.48	-0.047	-0.013
10004	250.0	0.01	0.000	-0.008
10004	300.6	-0.01	-0.001	-0.004
10004	500.0	-0.23	-0.022	-0.011
10004	749.8	-0.12	-0.012	-0.002
12006	1.5	no data	no data	
12006	25.0	no data	no data	
12006	50.0	no data	no data	
12006	75.0	no data	no data	
12006	100.0	no data	no data	
12006	125.0	0.01	0.004	0.017
12006	150.0	-0.05	-0.001	0.027
12006	200.0	-0.01	0.000	0.002
12006	250.0	0.05	0.011	0.056
12006	300.0	no data	no data	
12006	500.0	no data	no data	
12006	750.0	no data	no data	
17003	1.5	0.08	0.007	-0.008
17003	25.0	0.00	-0.008	-0.054
17003	50.0	0.00	-0.001	-0.008
17003	75.0	0.03	0.010	0.055
17003	100.0	0.04	0.008	0.033
17003	125.0	-0.05	0.014	0.151
17003	150.0	-0.02	0.001	0.023
17003	200.0	-0.01	0.001	0.012
17003	250.0	0.00	0.000	0.005
17003	301.8	-0.01	-0.002	-0.009
17003	500.0	0.01	0.001	-0.001
17003	746.9	0.00	0.000	0.009

Bad data

Para.	Average	Stdv.
TEMP	-0.08	0.21
SAL	0.004	0.047
COND	-0.008	0.022

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)
10003	1.5	0.02	-0.003	-0.031
10003	25.0	0.00	0.009	0.062
10003	50.0	-0.20	-0.014	0.051
10003	75.0	0.14	0.016	0.019
10003	100.0	0.08	0.010	0.020
10003	125.0	no data	no data	
10003	150.0	no data	no data	
10003	200.0	0.60	0.057	-0.005
10003	250.0	-0.01	0.000	0.006
10003	300.9	-0.13	-0.015	-0.025
10003	500.0	0.00	0.002	0.018
10003	747.6	-0.01	0.000	0.005
12005	1.5	-0.01	0.001	0.011
12005	25.0	0.00	0.002	0.011
12005	50.0	0.00	0.004	0.024
12005	75.0	0.02	-0.023	-0.173
12005	100.0	-0.04	0.012	0.112
12005	125.0	0.00	0.004	0.025
12005	150.0	-0.13	-0.010	0.028
12005	200.0	0.05	0.007	0.012
12005	250.0	-0.01	-0.002	-0.002
12005	300.7	-0.02	-0.001	0.002
12005	500.0	0.00	0.000	-0.001
12005	747.7	0.00	0.001	0.011
14002	1.5	-0.05	-0.007	-0.011
14002	25.0	0.00	-0.058	-0.399
14002	50.0	-0.02	0.010	0.087
14002	75.0	0.01	0.005	0.026
14002	100.0	-0.01	0.000	0.006
14002	125.0	0.01	0.004	0.029
14002	150.0	0.04	0.005	0.005
14002	200.0	0.12	0.011	-0.002
14002	250.0	0.00	0.001	0.000
14002	296.9	-0.01	0.000	-0.001
14002	500.0	0.00	-0.001	-0.016
14002	723.8	0.06	0.005	0.000

(red) Bad data

Para.	Average	Stdv.
TEMP	0.02	0.12
SAL	-0.003	0.082
COND	0.001	0.016

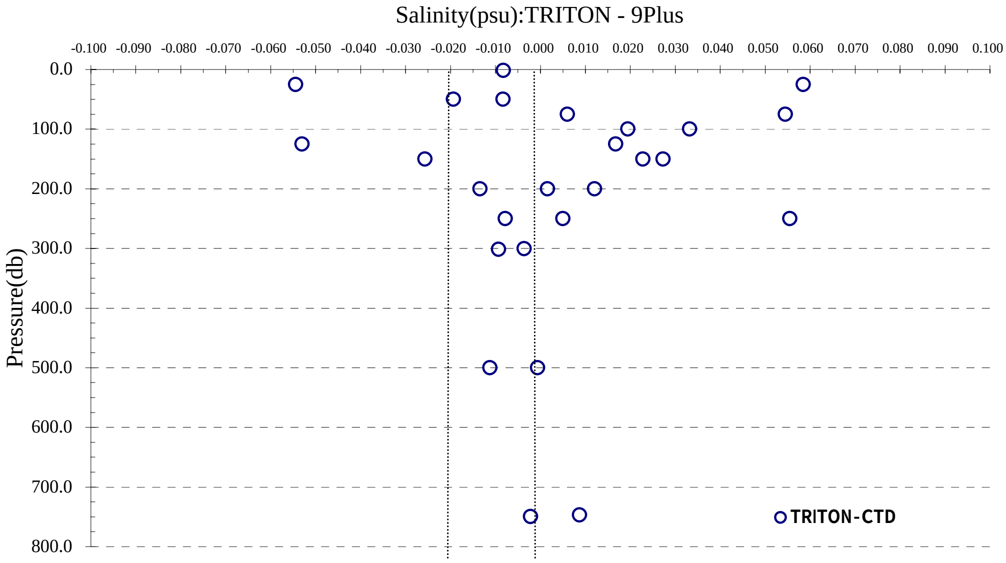


Fig.7.1.2.-2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

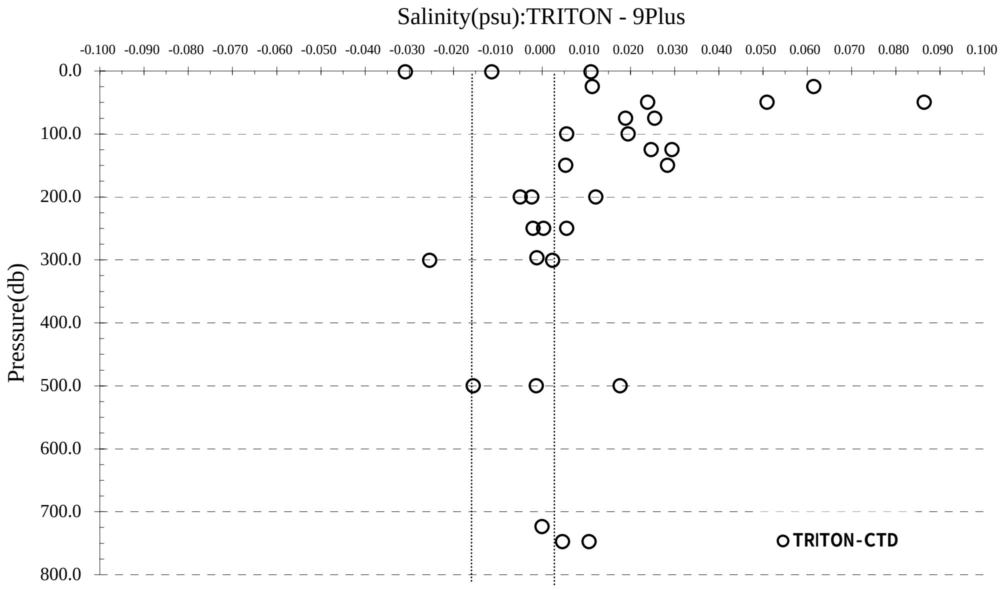


Fig.7.1.2.-2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

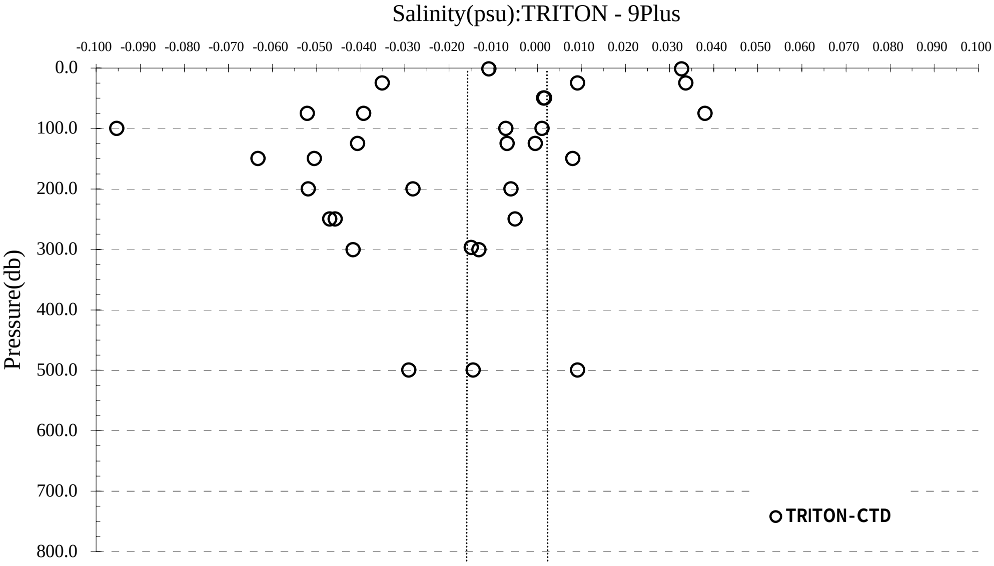


Fig.7.1.2.-2 (c) Salinity differences between deployment data and recovery data for 1year

7.2 ADCP subsurface mooring

(1) Personnel

Iwao Ueki	(JAMSTEC): Principal Investigator (Leg.1)
Hideaki Hase	(JAMSTEC): Principal Investigator (Leg.2)
Mari Sakai	(JAMSTEC): Technical staff (Leg.2)
Takeo Matsumoto	(MWJ): Operation leader (Leg.1-2)
Fujio Kobayashi	(MWJ): Technical staff (Leg.1)
Hiroshi Matsunaga	(MWJ): Technical staff (Leg.1)
Kenichi Katayama	(MWJ): Technical staff (Leg.2)
Naoko Takahashi	(MWJ): Technical staff (Leg.1)
Tomoyuki Takamori	(MWJ): Technical staff (Leg.2)
Fuma Matsunaga	(MWJ): Technical staff (Leg.1-2)
Tomohide Noguchi	(MWJ): Technical staff (Leg.1)
Keisuke Matsumoto	(MWJ): Technical staff (leg.1-2)
Akinari Murata	(MWJ): Technical staff (Leg.1)
Shinichiro Yokogawa	(MWJ): Technical staff (Leg.1-2)
Naoshi Kuda	(MWJ): Technical staff (Leg.1-2)
Taiki Shirakawa	(MWJ): Technical staff (Leg.1-2)
Tomomi Watanabe	(MWJ): Technical staff (Leg.2)

(2) Objectives

The purpose is to get the knowledge of physical process in the western equatorial Pacific Ocean. We have been observing subsurface currents using ADCP moorings along the equator. In this cruise (MR04-03), we recovered two subsurface ADCP mooring at Eq-138E/Eq-90E and deployed two ADCP moorings at Eq-138E/Eq-90E.

(3) Parameters

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

(4) Methods

Two instruments are mounted at the top float of the mooring. One is ADCP(Acoustic Doppler Current Profiler) to observe upper ocean layer currents from subsurface to 320m and 400m depth. The other is CTD to observe pressure, temperature and salinity for correction of sound speed and depth variability. Details of the instruments and their parameters are as follows:

1) ADCP

(a) Self-Contained Broadband ADCP 150 kHz (RD Instruments)

Distance to first bin : 8 m
Pings per ensemble : 16
Time per ping : 2.00 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds

Recovered ADCP
- Serial Number : 1150(Mooring No.030618-00138E)

Deployed ADCP
- Serial Number : 1678(Mooring No.040620-00138E)

(b) Self-Contained Work Horse Long Ranger ADCP 75 kHz (RD Instruments)

Distance to first bin : 7.04 m

Pings per ensemble : 27
Time per ping : 6.66 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds
Recovered ADCP
・Serial Number : 1645(Mooring No.030711-0090E)
Deployed ADCP
・Serial Number : 1248(Mooring No.040713-0090E)

2) CTD

(a)SBE-16 (Sea Bird Electronics Inc.)
Sampling Interval : 1800 seconds
Recovered CTD
・Serial Number : 1278 (Mooring No.030618-00138E)
Deployed CTD
・Serial Number : 1286 (Mooring No.040620-00138E)

(b)SBE-37 (Sea Bird Electronics Inc.)
Sampling Interval : 1800 seconds
Recovered CTD
・Serial Number : 1775 (Mooring No.030711-0090E)
Deployed CTD
・Serial Number : 1248 (Mooring No.040713-0090E)

3) Other instrument

(a) Acoustic Releaser (BENTHOS,Inc.)
Recovered Acoustic Releaser
・Serial Number :691 (Mooring No.030618-00138E)
・Serial Number :599 (Mooring No.030618-00138E)
・Serial Number :960 (Mooring No.030711-0090E)
・Serial Number :961 (Mooring No.030711-0090E)
Deployed Acoustic Releaser
・Serial Number :844 (Mooring No.040620-00138E)
・Serial Number :636 (Mooring No.040620-00138E)
・Serial Number :1104 (Mooring No.040713-0090E)
・Serial Number :937 (Mooring No.040713-0090E)

(b) Transponder (BENTHOS,Inc.)
Recovered Transponder
・Serial Number : 57114 (Mooring No.030618-00138E)
Deployed Transponder
・Serial Number : 67489 (Mooring No.040620-00138E)

(5) Deployment

The ADCP mooring deployed at Eq-138E was planned to play the ADCP at about 322m depth and at Eq-90E was planned to play the ADCP at about 399m depth . After we dropped the anchor, we monitored the depth of the acoustic releaser.

The position of the mooring No.040620-00138E
Date: 20 Jun. 2004 Lat: 00-00.71S Long: 138-01.73E Depth: 3938m
The position of the mooring No.040713-0090E
Date: 13 Jul. 2004 Lat: 00-00.40N Long: 90-03.39E Depth: 4409m

(6) Recovery

We recovered two ADCP moorings. One was deployed on 18 Jun.2003 (MR03-K03), the other was deployed on 11 Jul. 2003 (MR03-K03). After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. But we could not uploaded CTD data recovered at Eq-138E.

Results were shown in the figures in the following pages. Fig.7-2-1～Fig.7-2-3 show the ADCP velocity data (zonal and meridional component) at bin#29, bin#24, bin#16（Eq-138E）. Fig.7-2-4 shows CTD pressure, temperature and salinity data (Eq-90E). Fig.7-2-5, Fig.7-2-6 show the ADCP velocity data (zonal and meridional component) at bin#42, bin#34, bin#24 (Eq-90E).

(7) Data archive

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

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

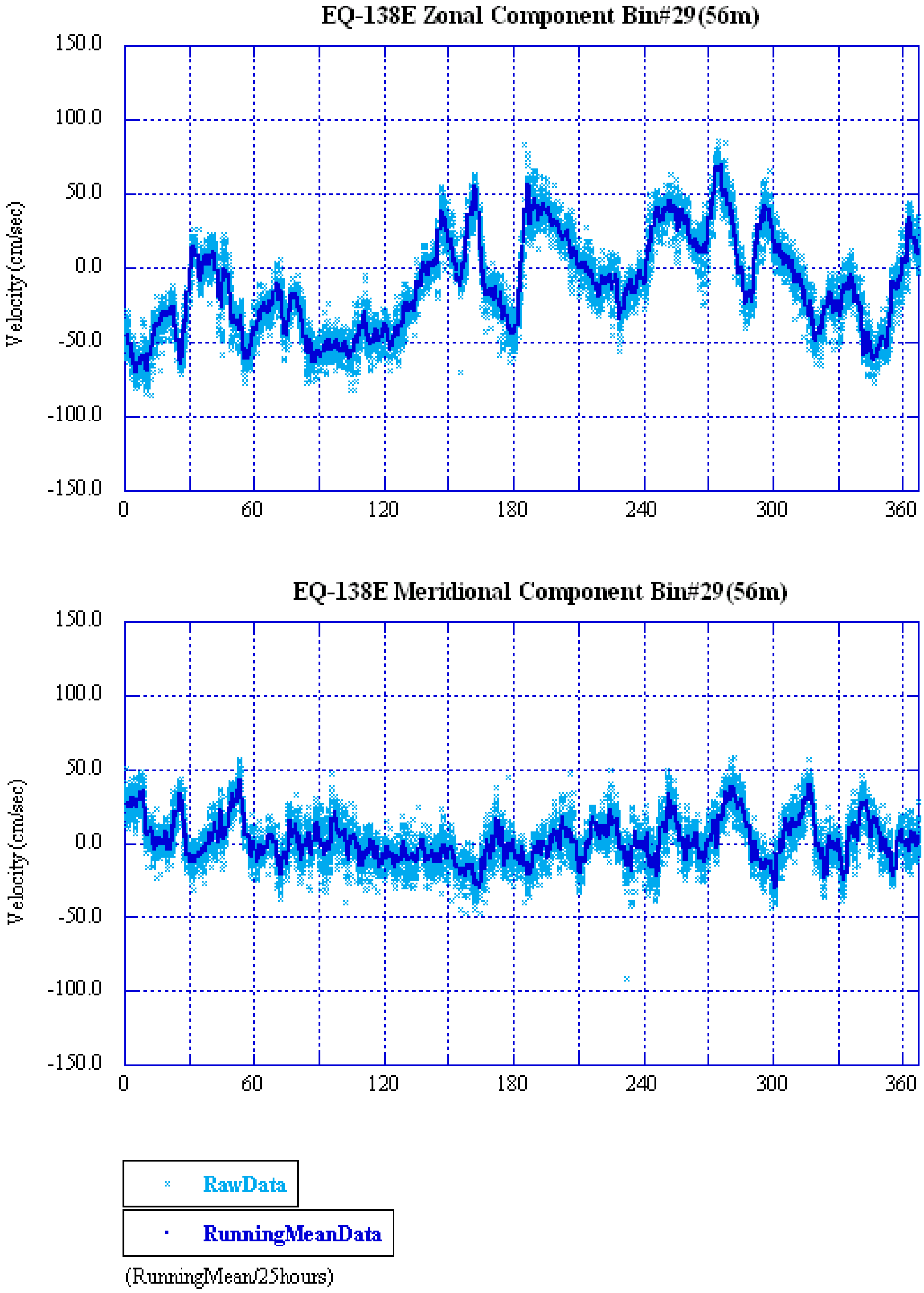
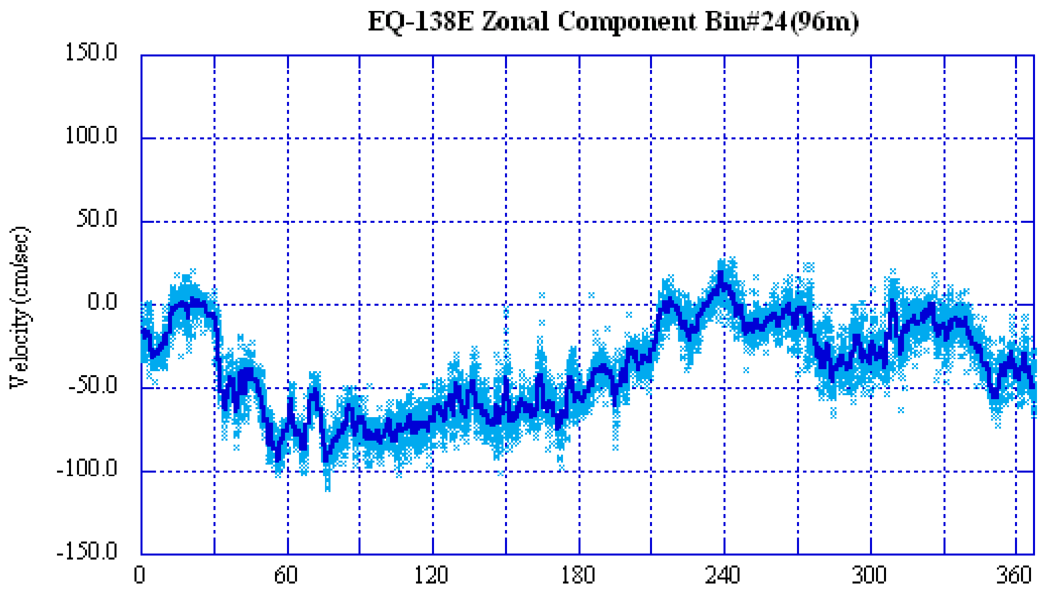


Fig.7-2-1 Time Series of zonal and meridional velocities of EQ-138E mooring at bin#29 (2003/6/18-2004/6/19)



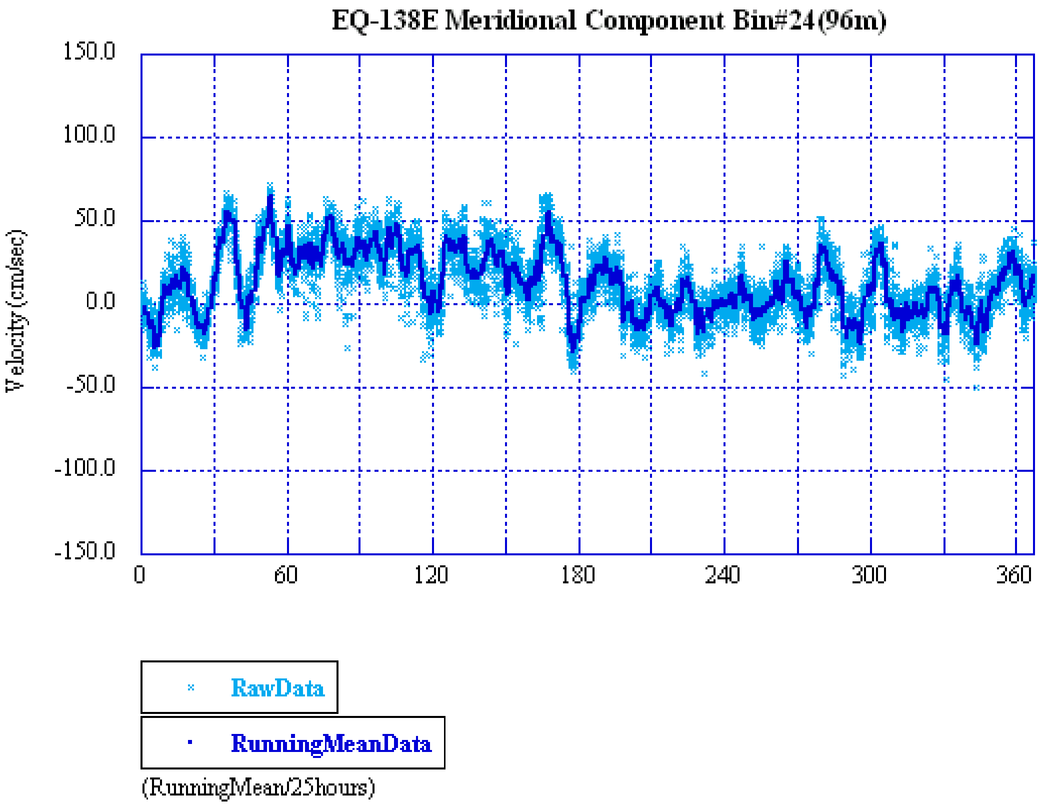


Fig.7-2-2 Time Series of zonal and meridional velocities of EQ-138E mooring at bin#24

(2003/6/18-2004/6/19)

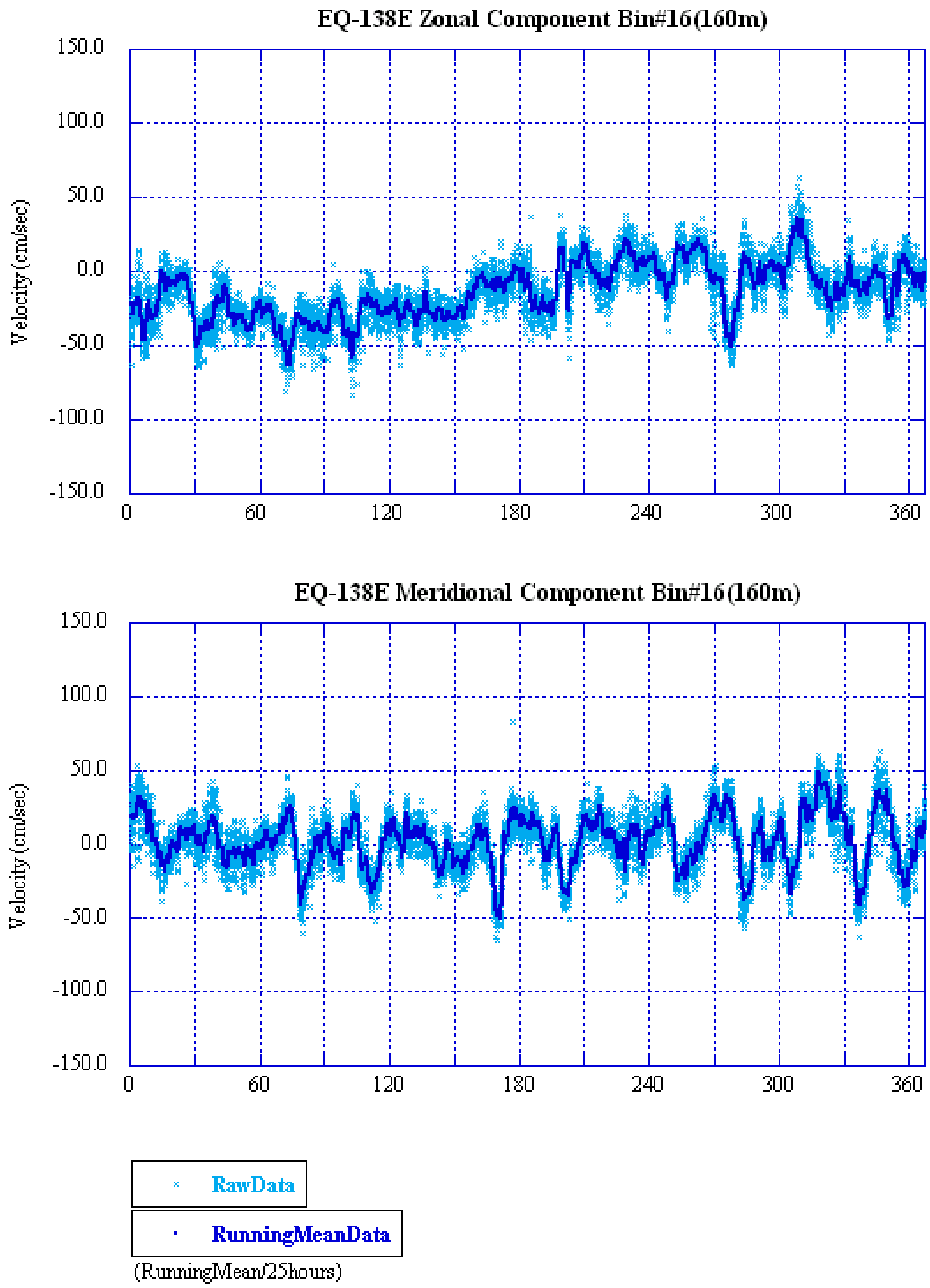


Fig.7-2-3 Time Series of zonal and meridional velocities of EQ-138E mooring at bin#16 (2003/6/18-2004/6/19)

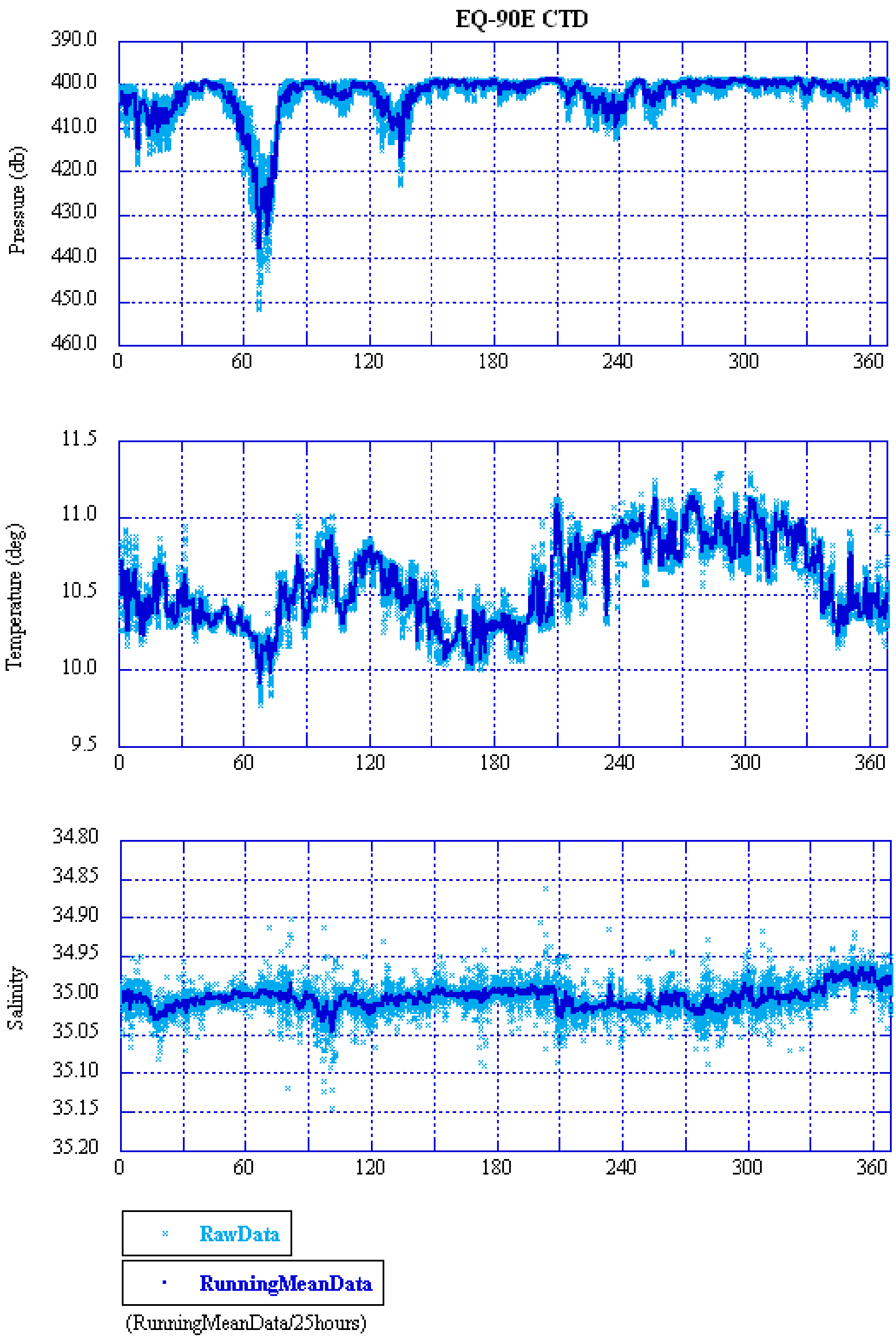


Fig.7-2-4 Time Series of pressure, temperature, salinity of obtained with CTD of EQ-90E mooring (2003/7/11-2004/7/13)

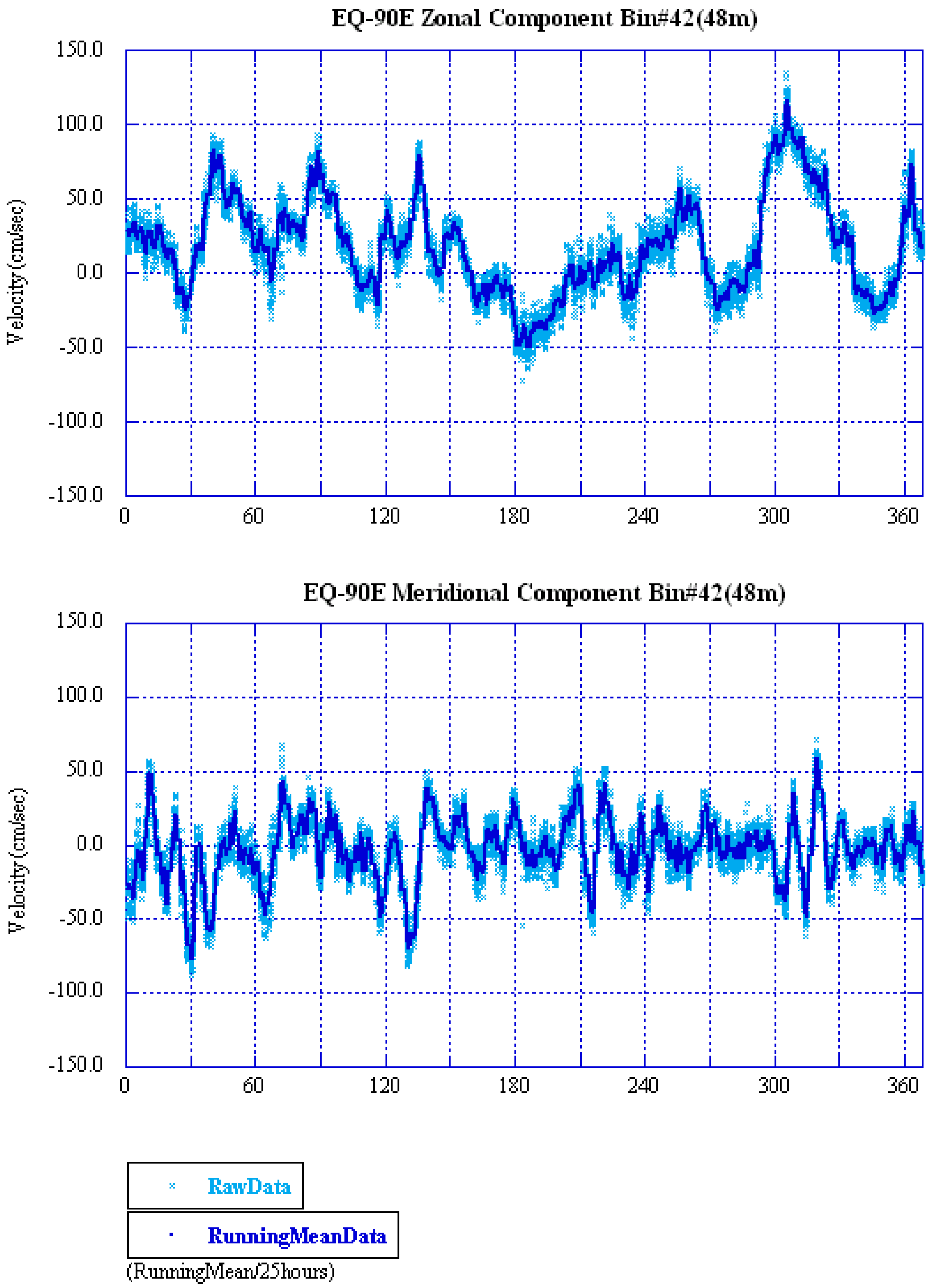


Fig.7-2-5 Time Series of zonal and meridional velocities of EQ-90E mooring at bin#42 (2003/7/11-2004/7/13)

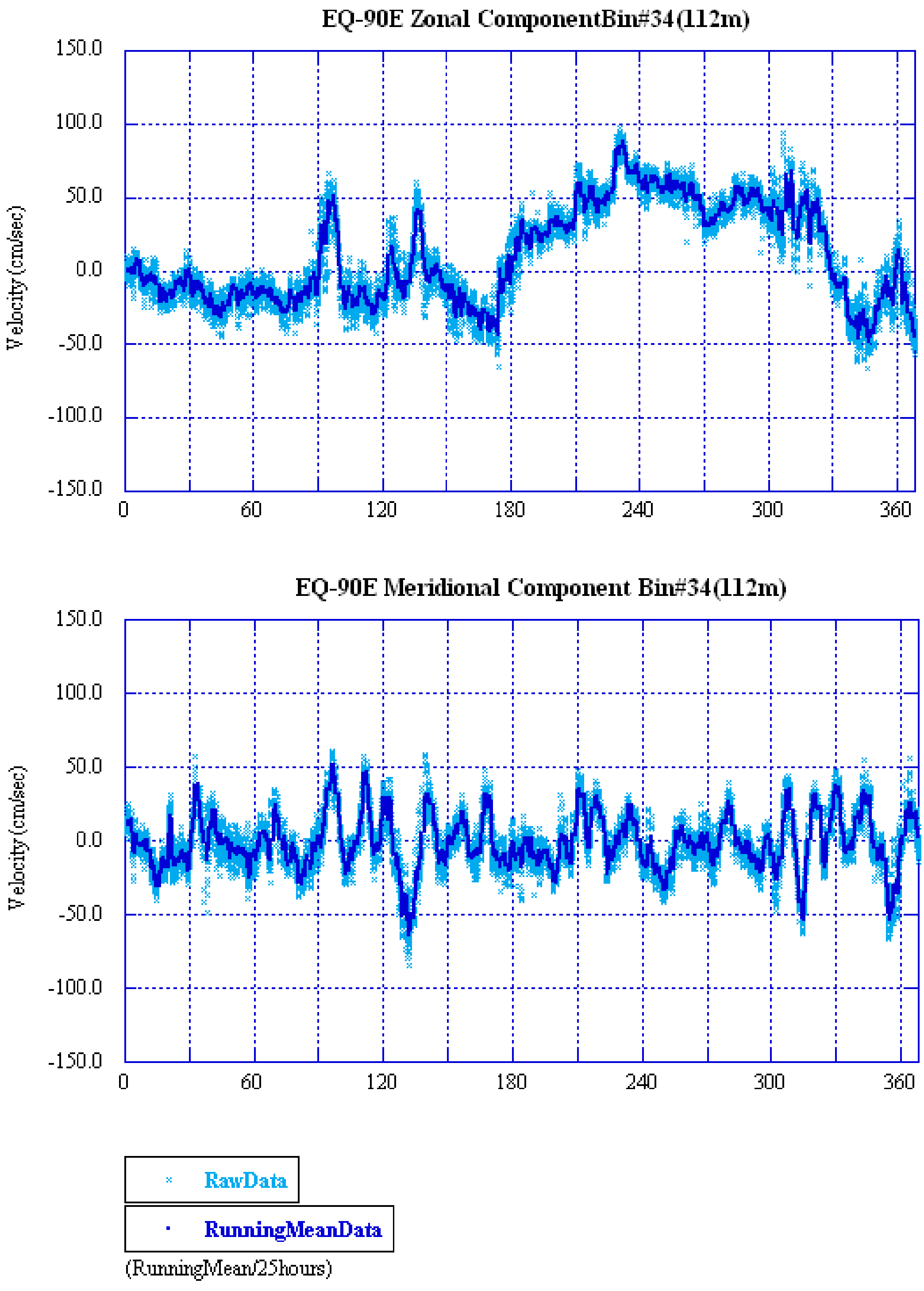


Fig.7-2-6 Time Series of zonal and meridional velocities of EQ-90E mooring at bin#34 (2003/7/11-2004/7/13)

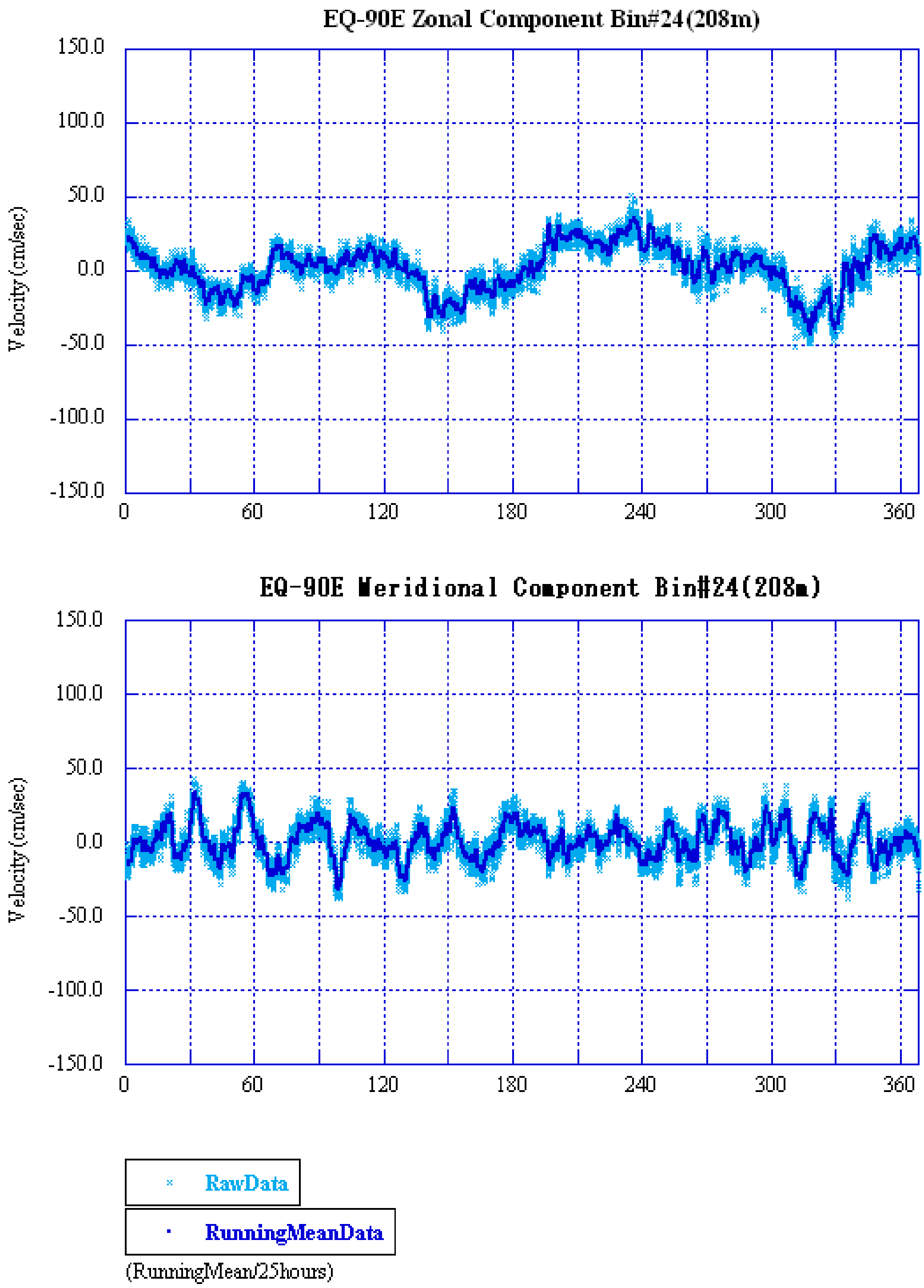


Fig.7-2-7 Time Series of zonal and meridional velocities of EQ-90E mooring at bin#24 (2003/7/11-2004/7/13)

7.3 Particulate matter (PM) observation

Michimasa Magi, Saeko Mito*, Haruko Kurihara*
RITE : Research Institute of Innovative Technology for the Earth
Tatsuo Fukuhara*
KANSO :
(* indicates on board personnel)

Objectives

In the view of the problem of the global warming, it is important to know the carbon cycles in ocean. Our purpose of this cruise is to collect basic information of the biological transport of organic material from surface waters into the deep sea using multiple stable isotopes.

Sampling and analytical methods on the shipboard

Sampling locations and layers of samples were listed at Table 7.3-1. Water samples were obtained from discrete depths using a Niskin-X sampling bottles attached to CTD-RMS. In addition to PM measurement, water sample was used for inorganic carbon(IC) and dissolved oxygen (DO) measurement. PM was collected onto pre-combusted (500^{o}C, 5 hours) glass fiber filter (GF/F, Whatman) by filtering about 20 to 50 L of seawater. Filter samples were dried at 60^{o}C over 12 hours. IC for $\delta^{13}C$ determination fixed as $SrCO_3$ by adding $Sr(OH)_2$ in the 1 L of seawater. The amount of DO was determined with Winkler method in 24 hours from sampling.

Further analysis in the laboratory

The amount of carbon (^{12}C and ^{13}C) and nitrogen (^{14}N and ^{15}N) in PMs were measured by a stable isotope ratio mass spectrometer (IsoPrime, Micromass) combined with the elemental analyzer (EA3024, EuroVector). Stable isotope ratios were expressed in δ notation according to the following;

$$\delta X\ (‰) = [R(samples)/R(standard) - 1] \times 1000$$

where X is ^{13}C or ^{15}N and R is the corresponding ratio $^{13}C/^{12}C$ or $^{15}N/^{14}N$. R(standard) for carbon and nitrogen are the PDB standard and atmospheric N_2 (AIR), respectively. Samples for $\delta^{13}C$ of IC ($SrCO_3$) were also determined as same manner as samples for PM.

Table 7.3-1 Lists of sampling position and parameters during leg.1.

Sampling point		A	#10	#11	#12	#13
Location		22.5N, 139E	8N, 137E	5N, 137E	2N, 138E	EQ, 138E
Date & Time[a)]		2004/6/10, 16:00	2004/6/13, 13:00	2004/6/24, 13:30	2004/6/16, 9:00	2004/6/17, 13:00
Maximum depth(m)		6000	3000	4000	4000	4000
Cast		1	1	1	1	1
Parameters		DO, N_2O[b)], ΣCO_2[b)], $H_2{}^{13}CO_3$, PM	DO, N_2O[b)], ΣCO_2[b)], PM	DO, N_2O[b)], ΣCO_2[b)], PM	DO, N_2O[b)], ΣCO_2[b)], PM	DO, N_2O[b)], ΣCO_2[b)], PM
Sampling gear	Sampling depth (m)	Amount of sampling water				
Niskin-X (12 L)	500	6 bottles	8 bottles	8 bottles	8 bottles	8 bottles
	1000	6 bottles	8 bottles	8 bottles	8 bottles	8 bottles
	1500	8 bottles	10 bottles	—	—	—
	2000	8 bottles	10 bottles	10 bottles	10 bottles	10 bottles
	3000	8 bottles	—	10 bottles	10 bottles	10 bottles
Bucket	0	40 L	40 L	40 L	40 L	40 L

a): Japanese Standard Time b): Samples for CRIEPI

Table 7.3-2 Lists of sampling position and parameters during leg.2.

Sampling point		#17	#18	#14	B
Location		5S, 95E	1.5S, 90E	8E, 130E	22.5N, 132E
Date & Time[a)]		2004/7/9, 11:00	2004/7/10, 12:00	2004/7/23, 7:00	2004/7/28, 20:30
Maximum depth(m)		5000	4000	6000	6000
Cast		1	1	1	1
Parameters		DO, PM	DO, PM	DO, PM	DO, ΣCO_2[b)], $H_2{}^{13}CO_3$, PM
Sampling gear	Sampling depth (m)	Amount of sampling water			
Niskin-X (12 L)	500	—	—	8 bottles	6 bottles
	1000	32 bottles	32 bottles	8 bottles	6 bottles
	1500	—	—	10 bottles	8 bottles
	2000	—	—	10 bottles	8 bottles
	3000	—	—	—	8 bottles
Bucket	0	40 L	40 L	40 L	40 L

a): Japanese Standard Time b): Samples for CRIEPI

Table7.3-3 Results of DO measurement during leg.1.

Latitude N	Longitude E	Depth (m)	DO (μmol/kg・sw)
22.50	139.00	0	nd
22.50	139.00	0	137
22.50	139.00	497	109
22.50	139.00	497	110
22.50	139.00	992	31
22.50	139.00	992	32
22.50	139.00	1486	45
22.50	139.00	1486	42
22.50	139.00	1978	62
22.50	139.00	1978	65
22.50	139.00	2967	83
22.50	139.00	2967	83
7.86	136.50	0	118
7.86	136.50	0	121
7.86	136.50	497	55
7.86	136.50	497	56
7.86	136.50	992	50
7.86	136.50	992	51
7.86	136.50	1489	60
7.86	136.50	1489	60
7.86	136.50	1983	69
7.86	136.50	1983	69
2.06	138.06	0	118
2.06	138.06	0	121
2.06	138.06	498	73
2.06	138.06	498	74
2.06	138.06	993	60
2.06	138.06	993	61
2.06	138.06	1979	69
2.06	138.06	1979	70
2.06	138.06	2964	86
2.06	138.06	2964	85
0.10	138.05	0	125
0.10	138.05	0	127
0.10	138.05	497	95
0.10	138.05	497	95
0.10	138.05	992	59
0.10	138.05	992	60
0.10	138.05	1979	70
0.10	138.05	1979	70
0.10	138.05	2964	85
0.10	138.05	2964	85
4.95	137.41	0	125
4.95	137.41	0	127
4.95	137.41	497	46
4.95	137.41	497	46
4.95	137.41	993	54
4.95	137.41	993	54
4.95	137.41	1981	66
4.95	137.41	1981	66
4.95	137.41	2966	85
4.95	137.41	2966	85

Table7.3-4 Results of DO measurement during leg.2.

Latitude N	Longitude E	Depth (m)	DO (μmol/kg・sw)
-5.05	94.97	0	116
-5.05	94.97	0	116
-5.05	94.97	993	43
-5.05	94.97	993	43
-1.67	89.99	0	116
-1.67	89.99	0	115
-1.67	89.99	993	35
-1.67	89.99	993	35
7.93	130.05	0	118
7.93	130.05	0	117
7.93	130.05	498	58
7.93	130.05	498	59
7.93	130.05	991	54
7.93	130.05	991	54
7.93	130.05	1488	61
7.93	130.05	1488	61
7.93	130.05	1981	67
7.93	130.05	1981	67
22.50	132.00	0	118
22.50	132.00	0	118
22.50	132.00	496	110
22.50	132.00	496	107
22.50	132.00	992	35
22.50	132.00	992	35
22.50	132.00	1488	51
22.50	132.00	1488	52
22.50	132.00	1980	67
22.50	132.00	1980	67
22.50	132.00	2964	83
22.50	132.00	2964	83

7.4 Argo float（profilring float）deployment

(1) Personnel

Nobie Shikama	(FORSGC): Principal Investigator (not on board)
Eitarou Oka	(FORSGC):not on board
Mizue Hirao	(FORSGC):not on board
Naoko Takahashi	(MWJ) :on board Leg1
Tomoyuki Takamori	(MWJ) :on board Leg1
Shigenari Murata	(MWJ) :on board Leg2
Satoko Asai	(MWJ) :on board Leg2

(2) Objectives

The objective of deployment is to clarify the structure and temporal/spatial variability of water masses in the subtropical North Pacific and Indian Ocean such as North Pacific and Indian Ocean Subtropical Mode Water.

The profiling floats launched in this cruise obtain vertical profiles of temperature and salinity automatically every ten days. The data from the floats will enable us to understand the phenomenon mentioned above with time/spatial scales much smaller than those in the previous studies.

(3) Parameters

・water temperature, salinity, and pressure

(4) Methods

1) Profiling float deployment

We launched 5 APEX floats of FORSGC. These floats equip an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 2000 dbar (called the parking depth), rising up to the sea surface every ten days by increasing their volume and thus changing the buoyancy. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting their positions and the CTD data to the land via the ARGOS system, and then return to the parking depth by decreasing volume. The status of floats and their launches are shown in Table 7.4-1.

(6) Data archive

All data acquired by the FORSGC floats through the ARGOS system is stored at FORSGC. The real-time data are provided to meteorological organizations via Global Telecommunication System (GTS) and utilized for analysis and forecasts of sea conditions.

Table 7.4-1 Status of floats and their launches

Float (FORSGC)

Float Type	APEX floats manufactured by Webb Research Ltd.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days (approximately 9 hours at the sea surface)
ARGOS transmit interval	30 sec
Target Parking Pressure	2000 dbar
Sampling layers	71 (2000, 1900, 1800, 1700, 1600, 1500, 1400, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 975, 950, 925, 900, 875, 850, 825, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 480, 460, 440, 420, 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 190, 180, 170, 160, 150, 140, 130, 120, 110, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10 [dbar])

Launches in Leg1

Owner	Type	S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch
FORSGC	APEX	1146	24749	03:53, Jun. 26	06:24, Jun. 26	07-25.65 N, 130-05.30 E
FORSGC	APEX	1147	24750	02:40, Jun. 28	06:33, Jun. 28	02-01.46 N, 129-56.85 E

Launches in Leg2

Owner	Type	S/N	ARGOS PTT ID	Date and Time of Reset (UTC)	Date and Time of Launch (UTC)	Location of Launch
FORSGC	APEX	1148	25134	17:00, Jul. 13	19:03, Jul. 13	01-38.31 S, 092-30.17 E
FORSGC	APEX	1149	25142	04:18, Jul. 14	07:07, Jul. 14	03-18.65 S, 094-59.96 E
FORSGC	APEX	1150	25361	04:34, Jul. 15	07:44, Jul. 15	06-40.09 S, 099-59.45 E

7.5 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto, Ichiro Matsui, Atsushi Shimizu and Akihide Kamei (National Institute for Environmental Studies, not on board), operation was supported by GODI.

(2) Objectives

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

(3) Measured parameters

- Vertical profiles of backscattering coefficient at 532 nm and 1064 nm.
- Vertical profile of depolarization ratio at 532 nm.

(4) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength dual polarization lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 100 mJ per pulse at 1064 nm and 50 mJ per pulse at 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 25 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a digital oscilloscope and stored on a hard disk with a computer. The lidar system was installed in the radiosonde container on the compass deck. The container has a glass window on the roof, and the lidar was operated continuously regardless of weather.

(5) Results

Figure 7.5-1 shows the time-height indication of the range-corrected signal during Leg.1-2 of the cruise.

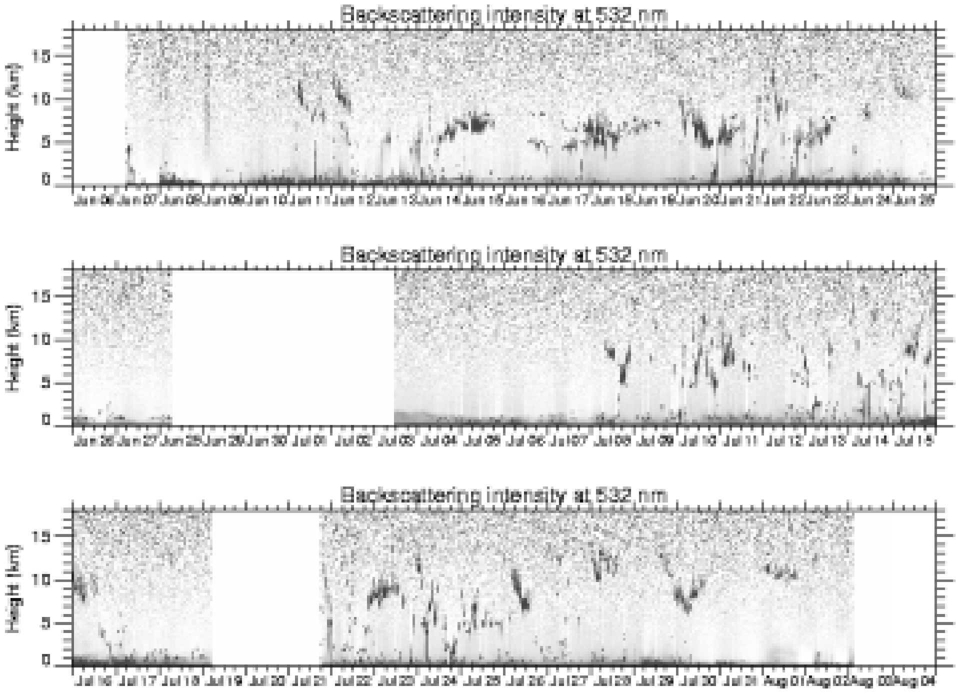


Fig. 7.5-1 Range-corrected signal at 532 nm.

In Leg.1, large scale cloud systems in middle altitude (5-8 km) were confirmed during June 14 and June 23 on the Pacific Ocean. Below these cloud system there were few aerosols. This relation of clouds and aerosols imply a wash out mechanism near the surface. Scattering from cirrus was not significant in this period. At the beginning of Leg.2, a stable aerosol mixing layer whose depth was about 1.5 km existed for a few days. In the Indian Ocean there were small fractures of various cloud systems. In the later half of Leg.2, cirrus clouds were repeatedly detected at 10-13 km height. Just before arriving Sekinehama, deep aerosol mixing layer with depth of 2 km were confirmed.

(6) Data archive

- raw data

  lidar signal at 532 nm (parallel polarization)

  lidar signal at 532 nm (perpendicular polarization) lidar signal at 1064 nm

period 06070545-08030230 (UTC), continuous (except during 06280630-07031045 and 07190445-07211815)

temporal resolution 15 min.

vertical resolution 7.5 m.

- processed data

  cloud base height, apparent cloud top height, cloud phase

  cloud fraction

  boundary layer height (aerosol layer upper boundary height)

  backscatter coefficient of aerosols

  depolarization ratio

7.6 Doppler Radar Observation

(1) Personnel

Shuichi Mori (IORGC/JAMSTEC): Principal Investigator
Wataru Tokunaga (GODI)
Norio Nagahama (GODI)
Kazuho Yoshida (GODI)

(2) Objective

The objective of Doppler radar observation is to understand precipitating convective systems in the eastern Indian Ocean during boreal summer monsoon season by obtain both spatial and temporal distribution of rainfall amount and property, and structures of the precipitating convective system.

(3) Method

The hardware specifications of this shipboard Doppler radar (RC-52B, manufactured by Mitsubishi Electric Co. Ltd., Japan) are:

Frequency:	5290 MHz
Beam Width:	better than 1.5 degrees
Output Power:	250kW (Peak Power)
Signal Processor:	RVP-7 (Sigmet Inc., U.S.A.)
Inertial Navigation Unit:	DRUH (Honeywell Inc., U.S.A.)
Application Software:	IRIS/Open (Sigmet Inc., U.S.A.)

The hardware is calibrated by checking (1) frequency, (2) mean power output, (3) pulse repetition frequency (PRF) for once a day, (4) transmitting pulse width and (5) receiver linearity at the beginning and the end of the observation period.

The observation is performed continuously from July 04 through 31, 2004 (except for 01 UTC on July 19 – 19 UTC on July 21). During the observation, the programmed “tasks” are repeated every 10 minutes. One cycle consists of one “volume scan” (consists of PPIs for 21 elevations) with Doppler-mode (160 km range for reflectivity and Doppler velocity), one-elevation “surveillance” PPI with Intensity-mode (300 km range for reflectivity). In the interval of the cycles, RHI (Range Height Indicator) scans were operated to obtain detailed vertical cross sections with Doppler-mode. The Doppler velocity is unfolded automatically by dual PRF unfolding algorithm. The parameters for the above three tasks are listed in Table 7.6-1. (Because of software bug, vessel speed correction did not apply for the original Doppler velocity data until July 19, 2004.)

Table 7.6-1

	Surveillance PPI	Volume Scan	RHI
Pulse Width	2 [microsec.]	0.5 [microsec.]	
Scan Speed	18 [deg./sec.]		Automatically determined
PRF	260 [Hz]	900/720 [Hz]	
Sweep Integration	32 samples		
Ray Spacing	1.0 [deg.]		0.2 [deg.]
Bin Spacing	250 [m]	125 [m]	
Elevations	0.5	0.5, 1.2, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.1, 11.3, 12.8, 14.6, 16.6, 18.9, 21.6, 25.0, 29.0, 34.0, 40.0	0.0 to 65.0
Azimuths	Full Circle		Optional
Range	300 km	160 [km]	

(4) Preliminary results

Continuous observation of Doppler radar has been carried out successfully without any trouble during this period. Detailed analyses with other obtained data are in future work after the quality check.

(5) Data archive

The inventory information of the Doppler radar data obtained during this cruise will be submitted to JAMSTEC Data Management Office (DMO). The original data will be archived at and available from Institute of Observational Research for Global Change (IORGC)/JAMSTEC.

7.7 Rawinsonde Observation

(1) Personnel

Shuichi Mori (IORGC/JAMSTEC): Principal Investigator

Wataru Tokunaga (GODI)

Norio Nagahama (GODI)

Kazuho Yoshida (GODI)

(2) Objective

The objective of rawinsonde observation is to understand precipitating convective systems in the eastern Indian Ocean during boreal summer monsoon season by obtain atmospheric environmental profiles of pressure, temperature, relative humidity, wind direction, and wind speed.

(3) Method

Atmospheric sounding by rawinsonde was carried out every 3 hours during July 08-15 and July 23-25, 2003 along the cruise track over the eastern Indian Ocean. Table 7.7-1 shows the summary of 54 launches in total. The observation system consists of receiver/processor (Vaisala DigiCORAⅢ MW21), GPS antenna (GA20), UHF telemetry antenna (RB20), balloon launcher (ASAP), 200g balloons (Totex TA-200), and GPS rawinsonde transmitters (Vaisala RS92-SGP, RS80-15GH, and RS80-15G). RS92-SGP and RS80-15G(H) transmitters were calibrated before launch with ground check kits of Vaisala GC25 and GC23, respectively.

(4) Preliminary results

Time-height cross sections of temperature, equivalent potential temperature, relative humidity, mixing ratio, zonal and meridional wind components, and cruise track with launching positions in Fig. 7.7-1. Vertical profiles of temperature, dew-point temperature are plotted on the thermodynamic chart wind profiles in Fig7.7-2. Detailed analyses with other obtained data are in future work after the quality check.

(5) Data archive

All sounding data have been sent to the world meteorological community by Global Telecommunication System (GTS) through Japan Meteorological Agency (JMA) immediately after the each observation. Raw data are stored in digital ASCII format that are available through JAMSTEC Data Management Office (DMO).

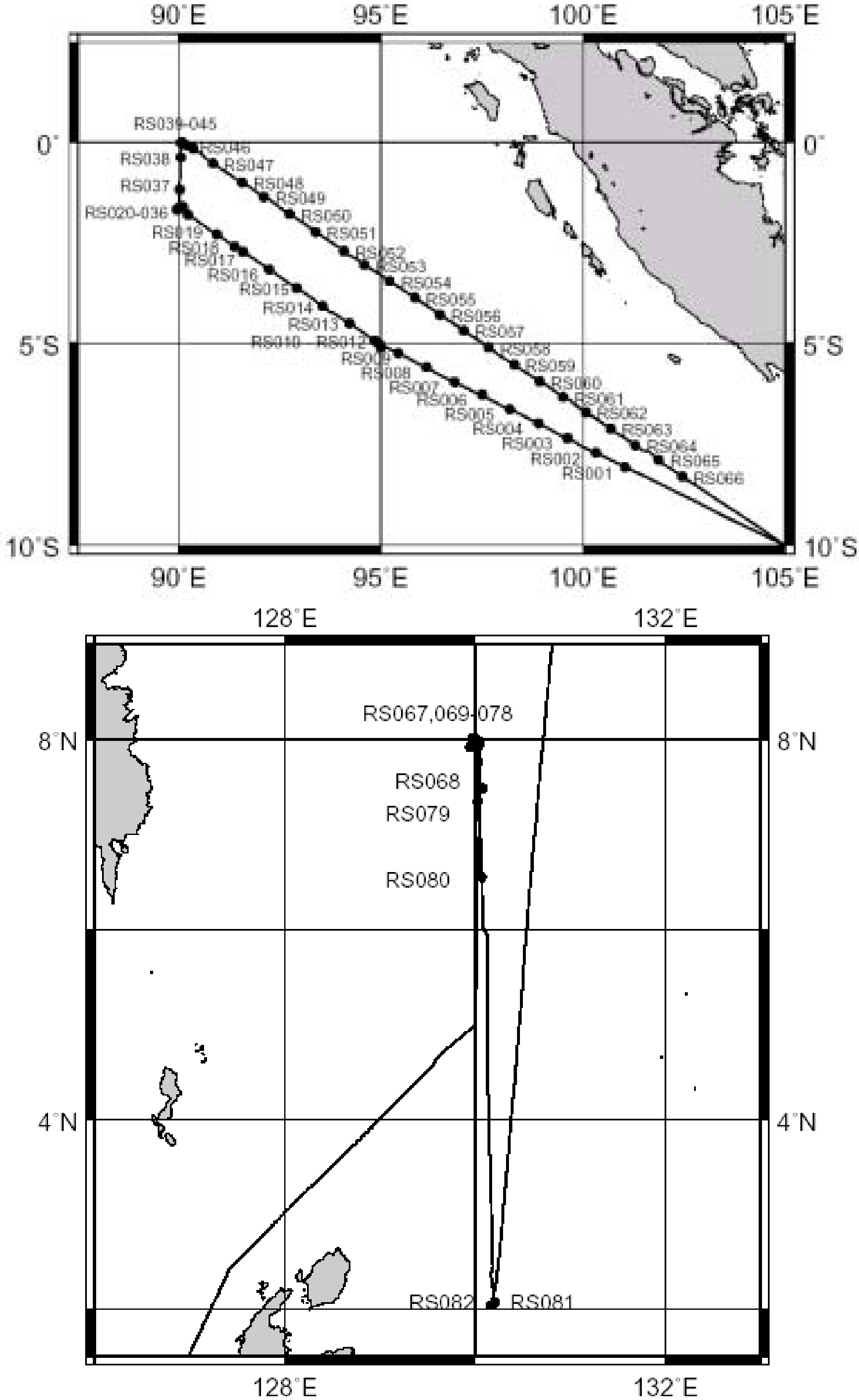


Fig. 7.7-1 Sounding positions and cruise track over the eastern Indian Ocean (upper panel) and western Pacific Ocean (lower panel). RS-XXX show sequential sounding number

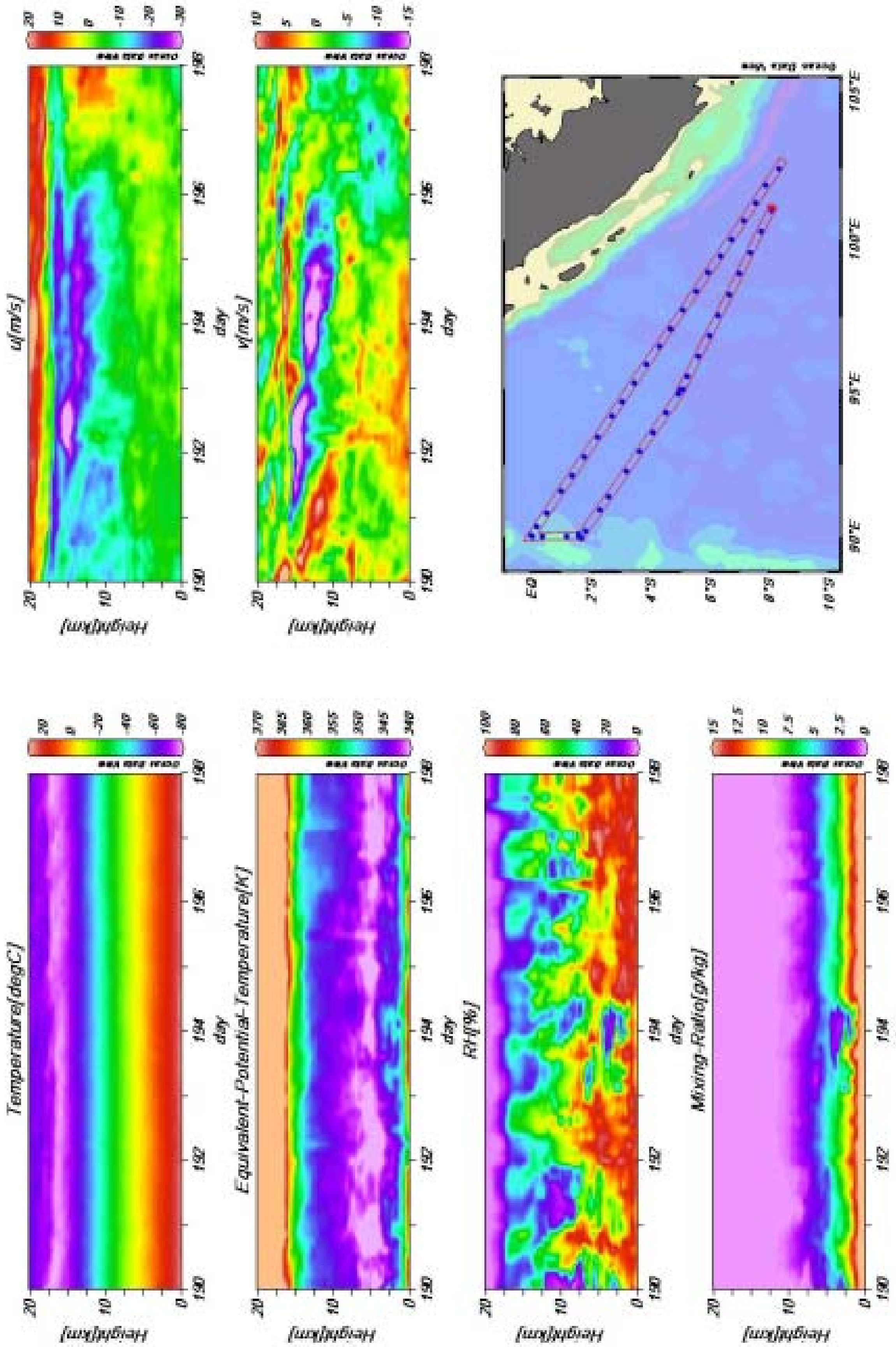


Fig. 7.7-2 Time-height cross sections of rawinsonde sounding data over the eastern Indian Ocean.

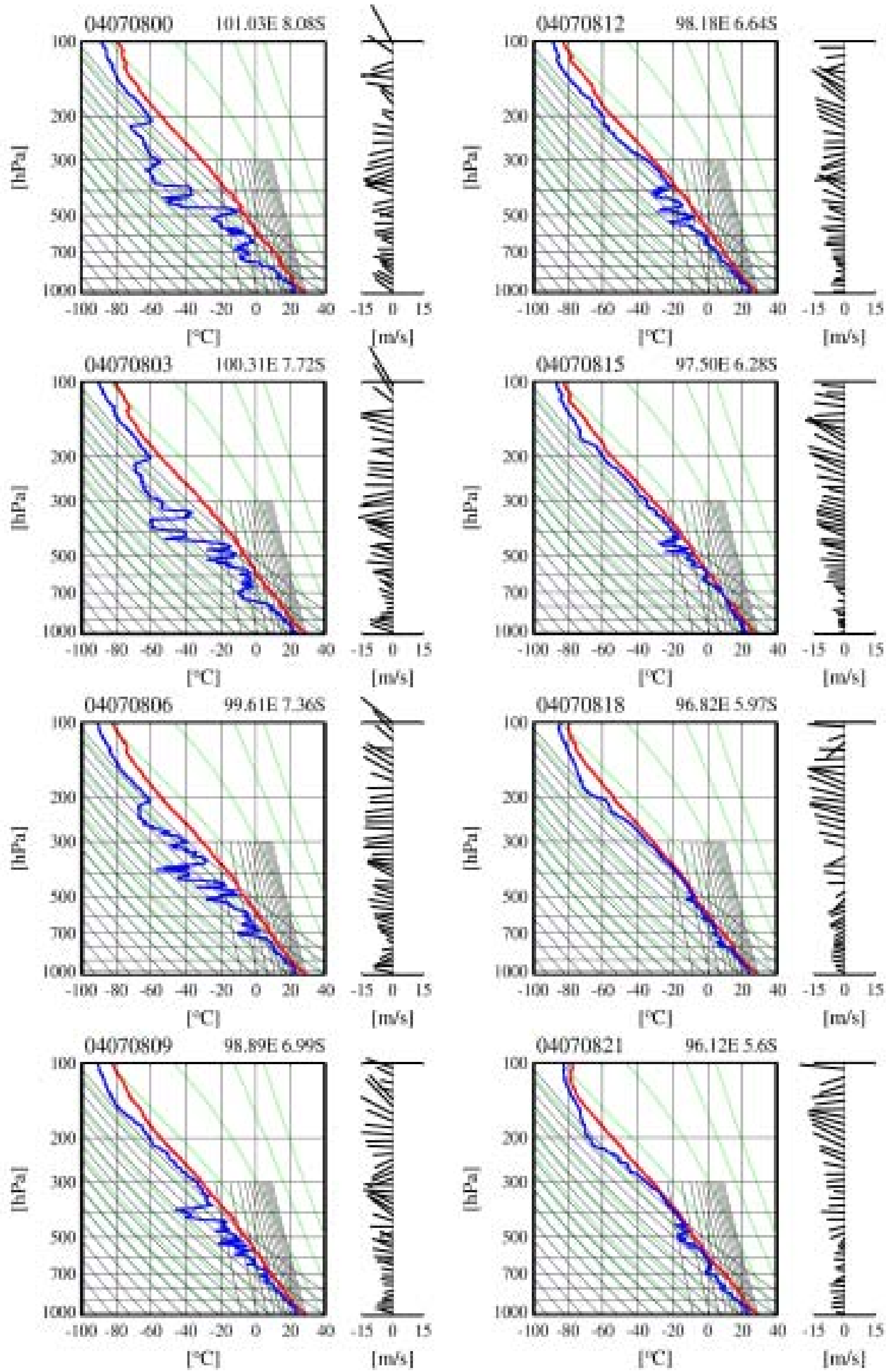


Fig. 7.7-3 Vertical profiles of temperature (red line) and dew-point temperature (blue line) are described on emagrams. Wind direction and speed are indicated by vectors on the each panel.

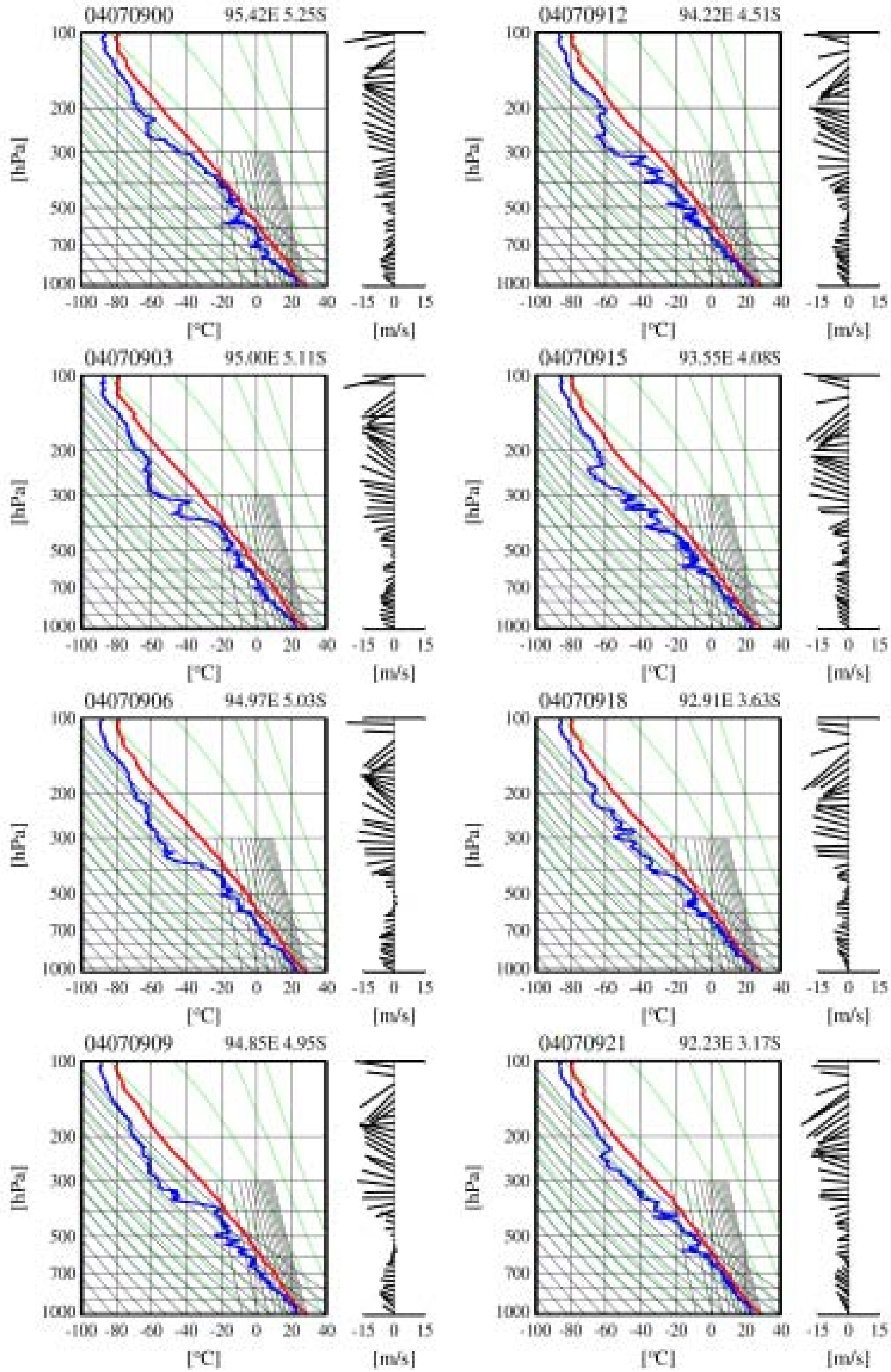


Fig. 7.7-3 (continued)

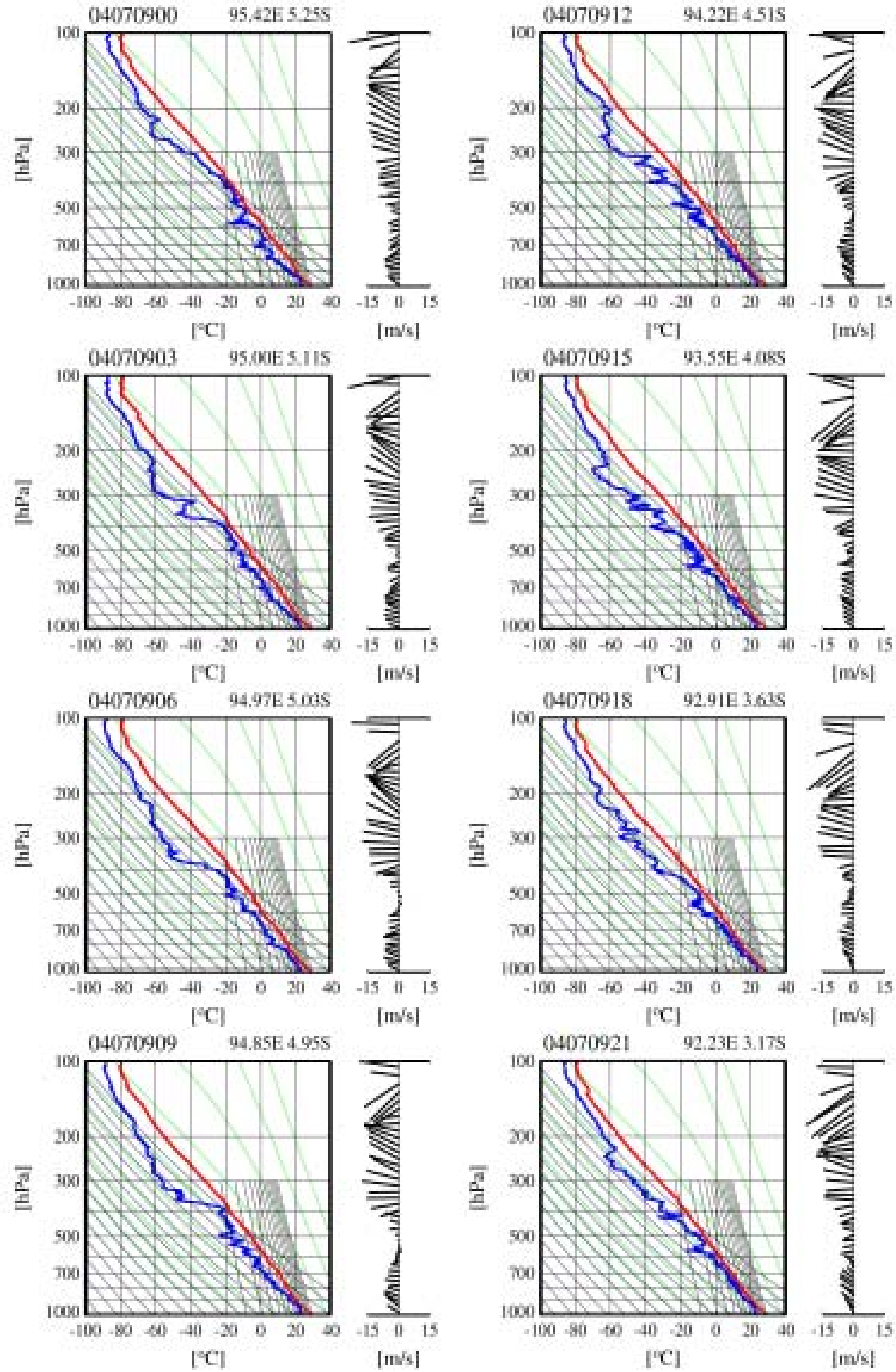


Fig. 7.7-3 (continued)

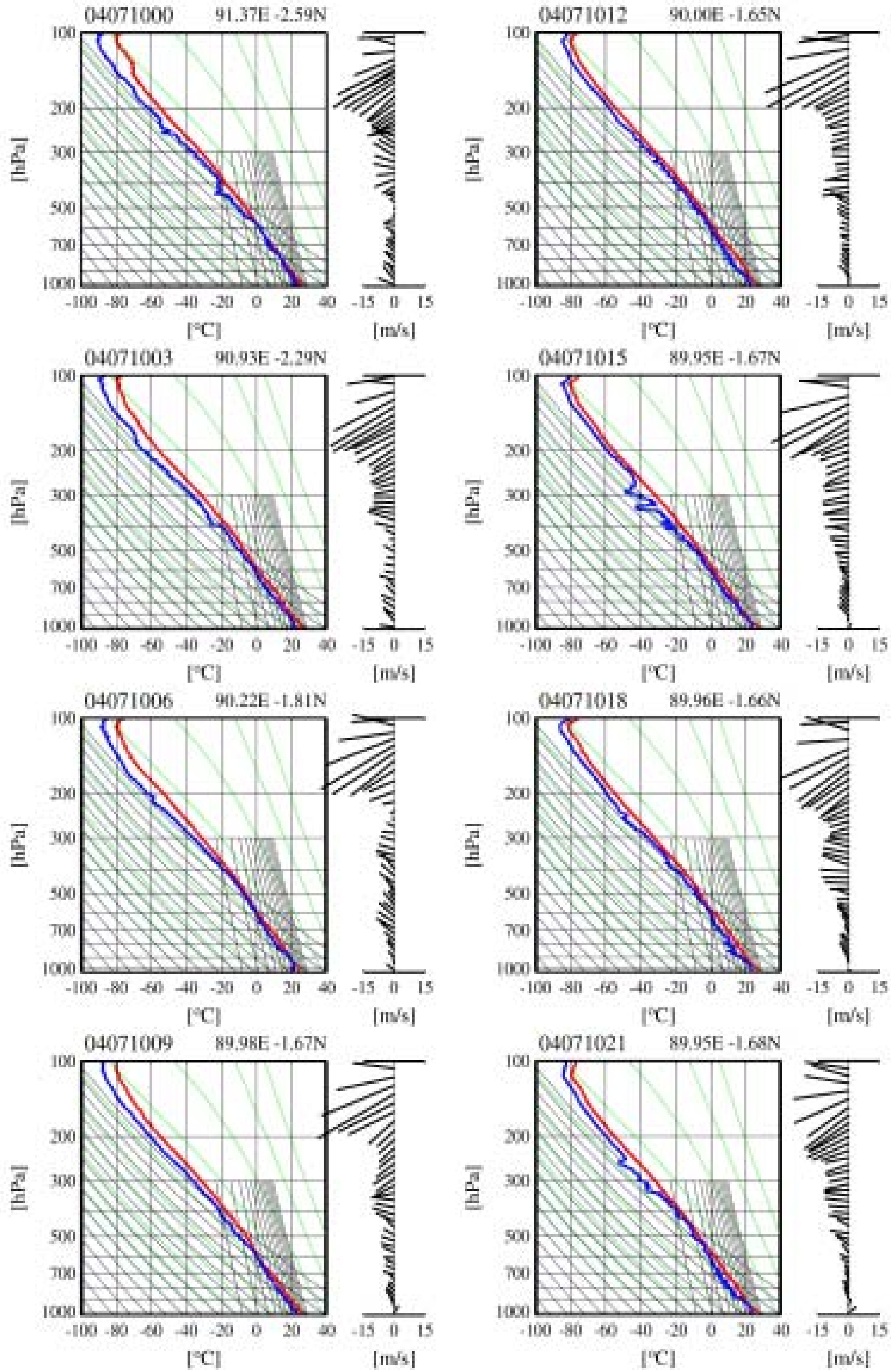


Fig. 7.7-3 (continued)

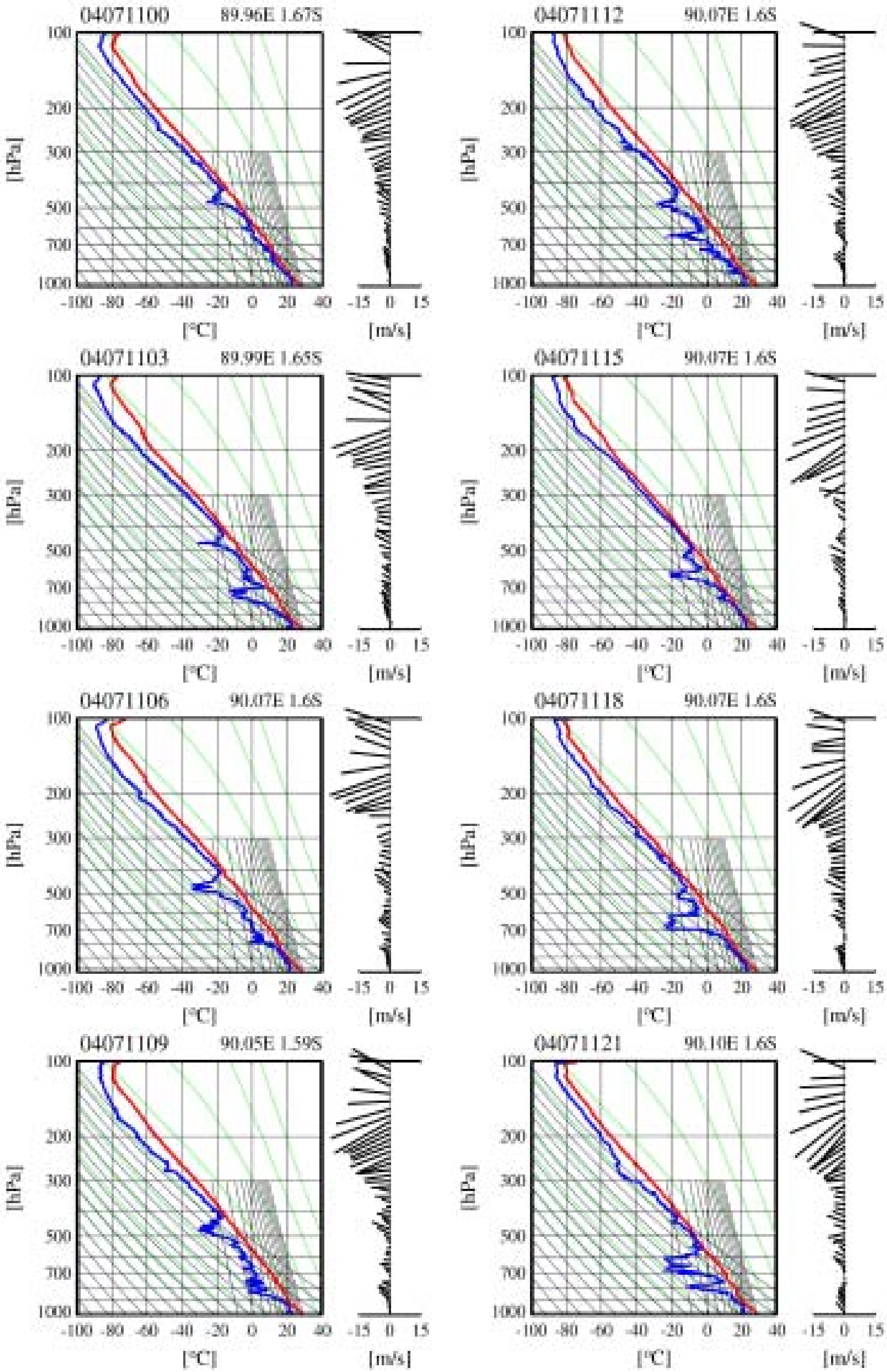


Fig. 7.7-3 (continued)

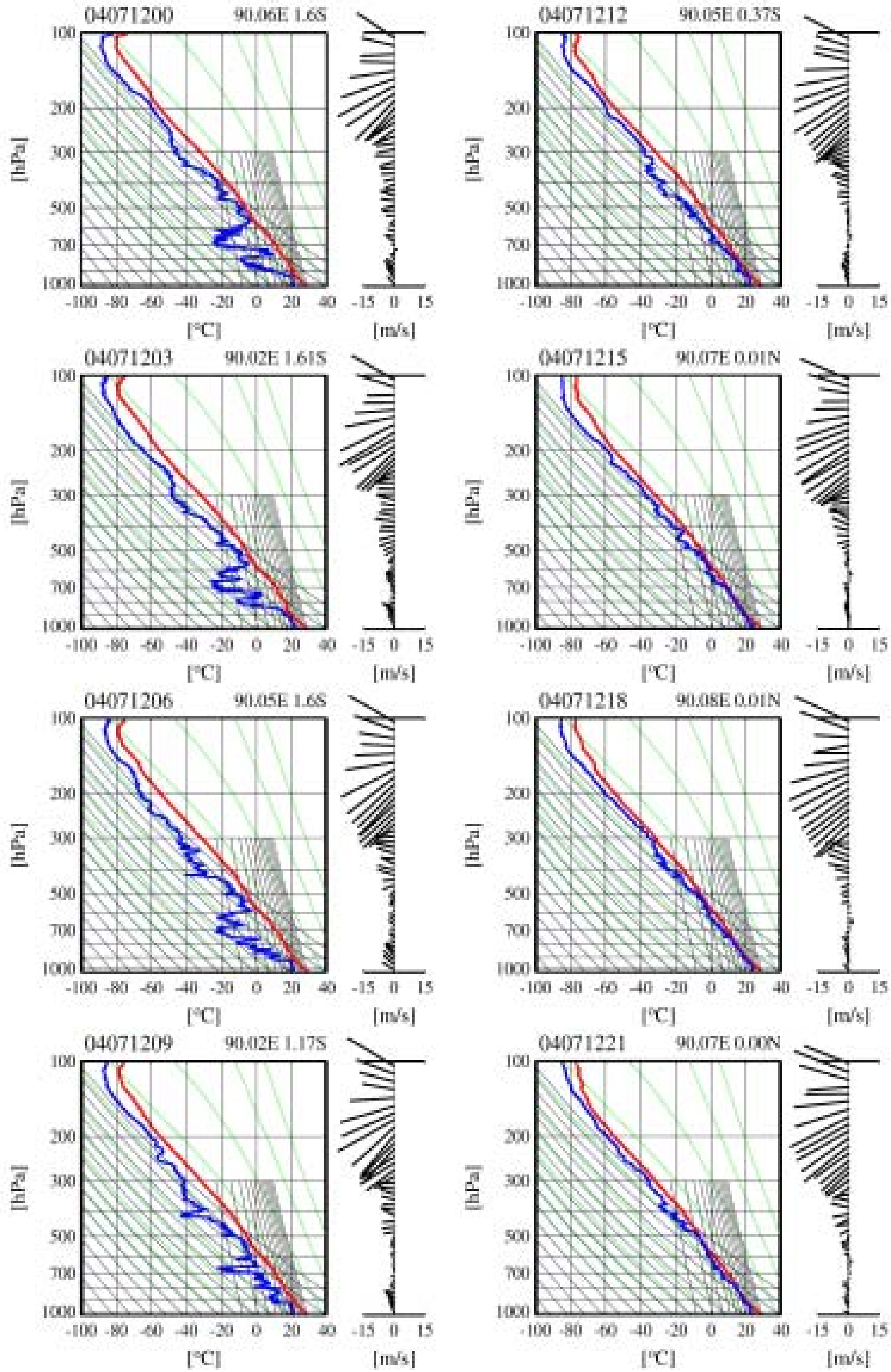


Fig. 7.7-3 (continued)

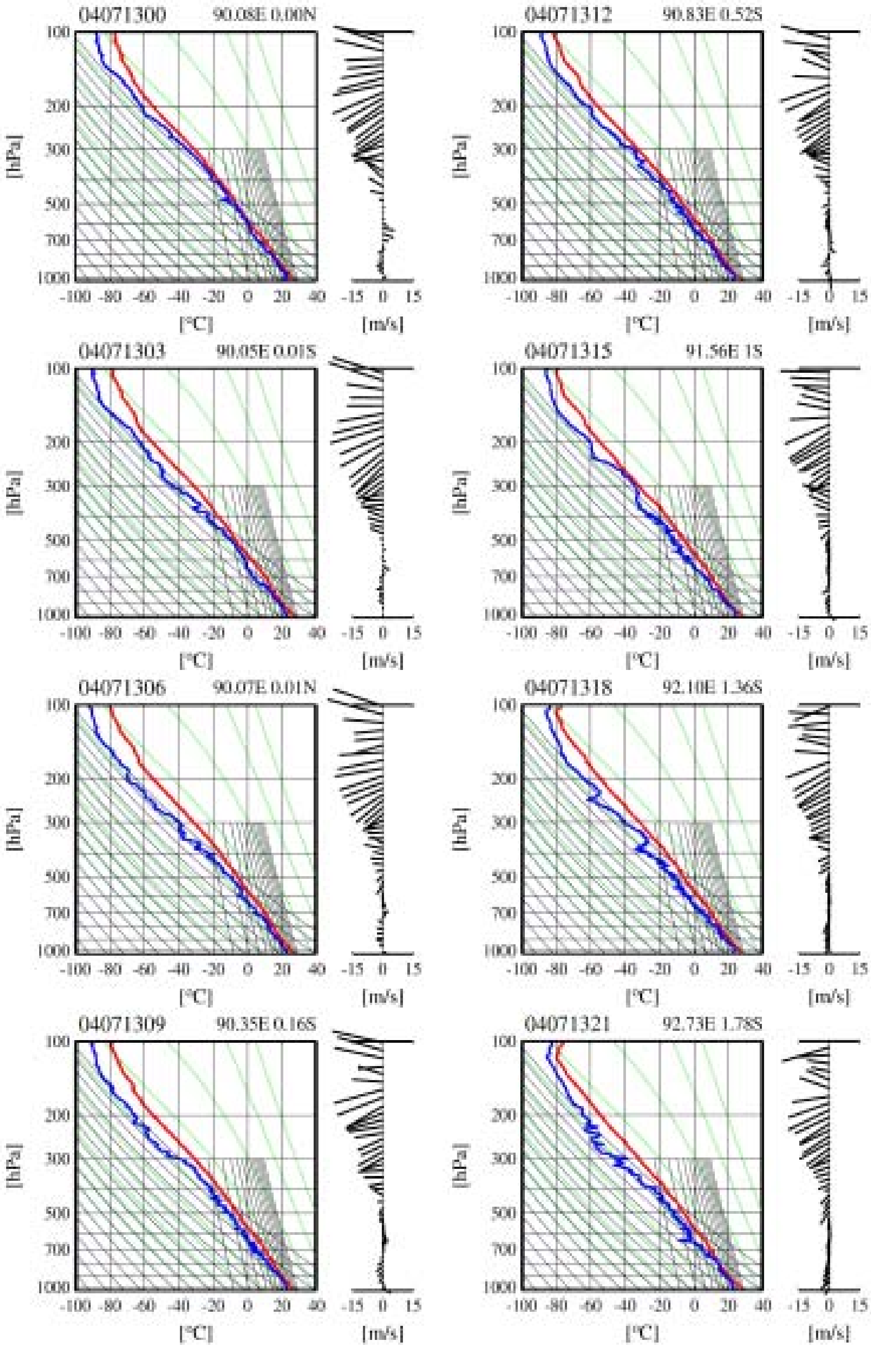


Fig. 7.7-3 (continued)

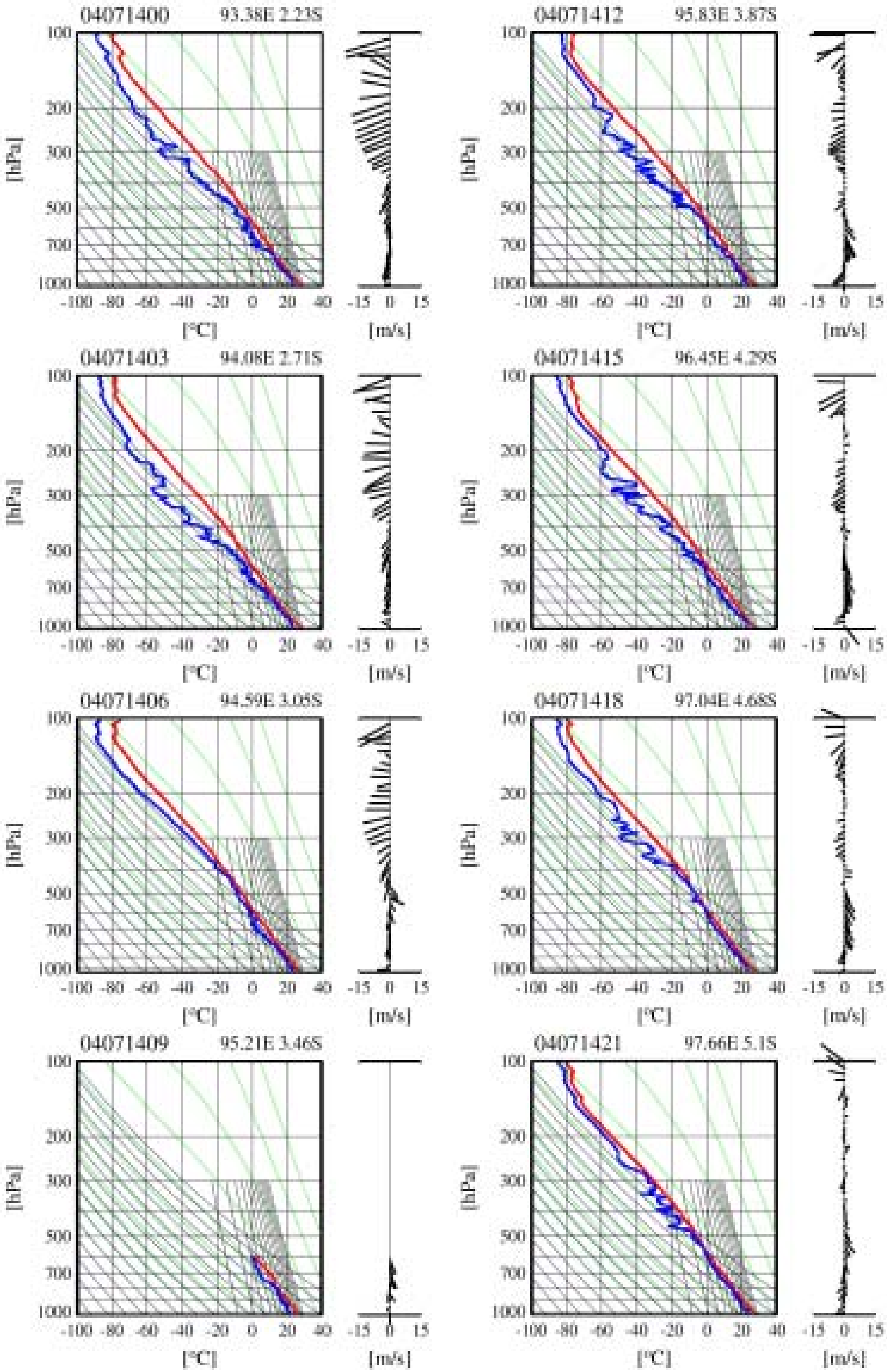


Fig. 7.7-3 (continued)

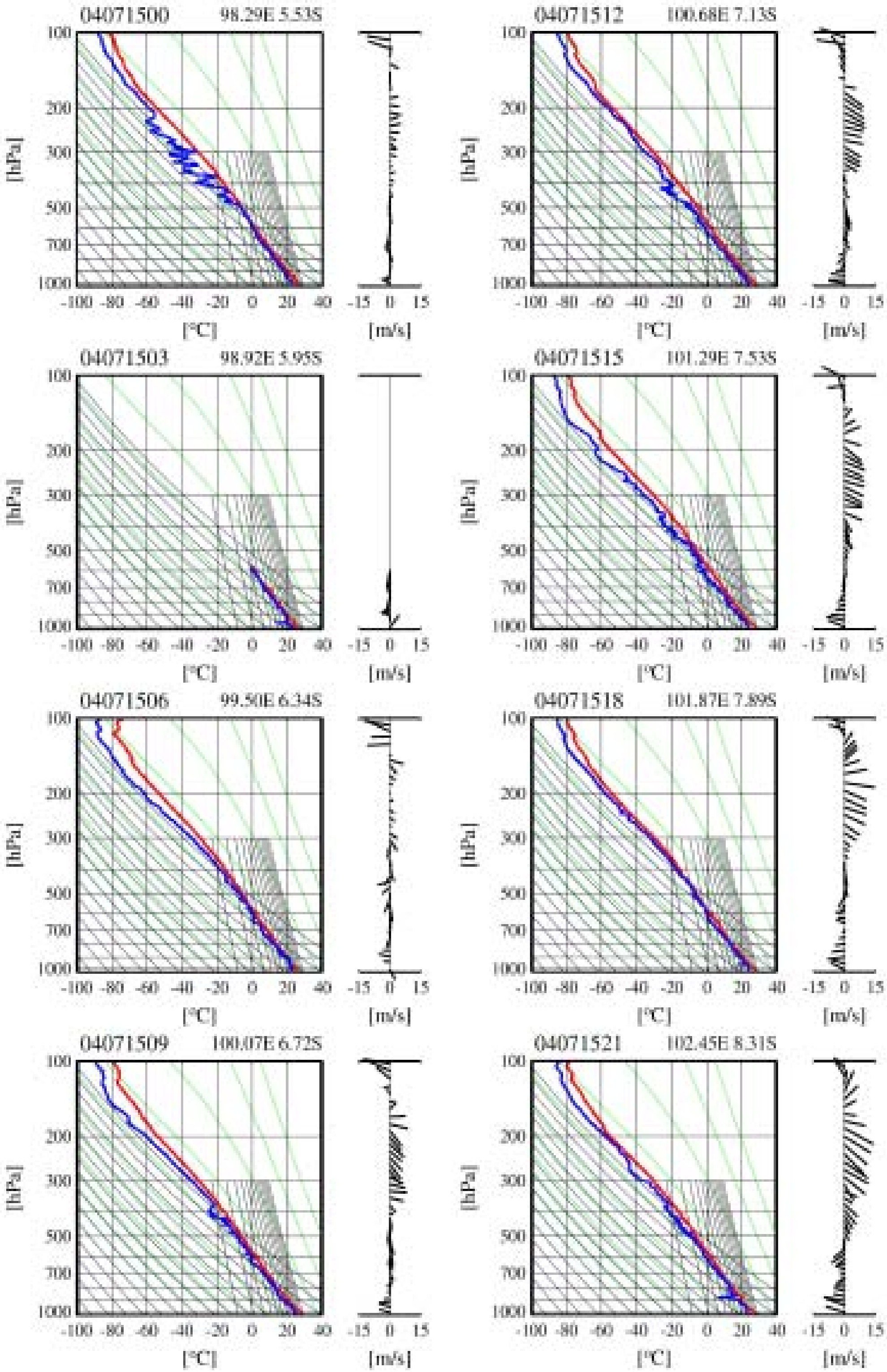


Fig. 7.7-3 (continued)

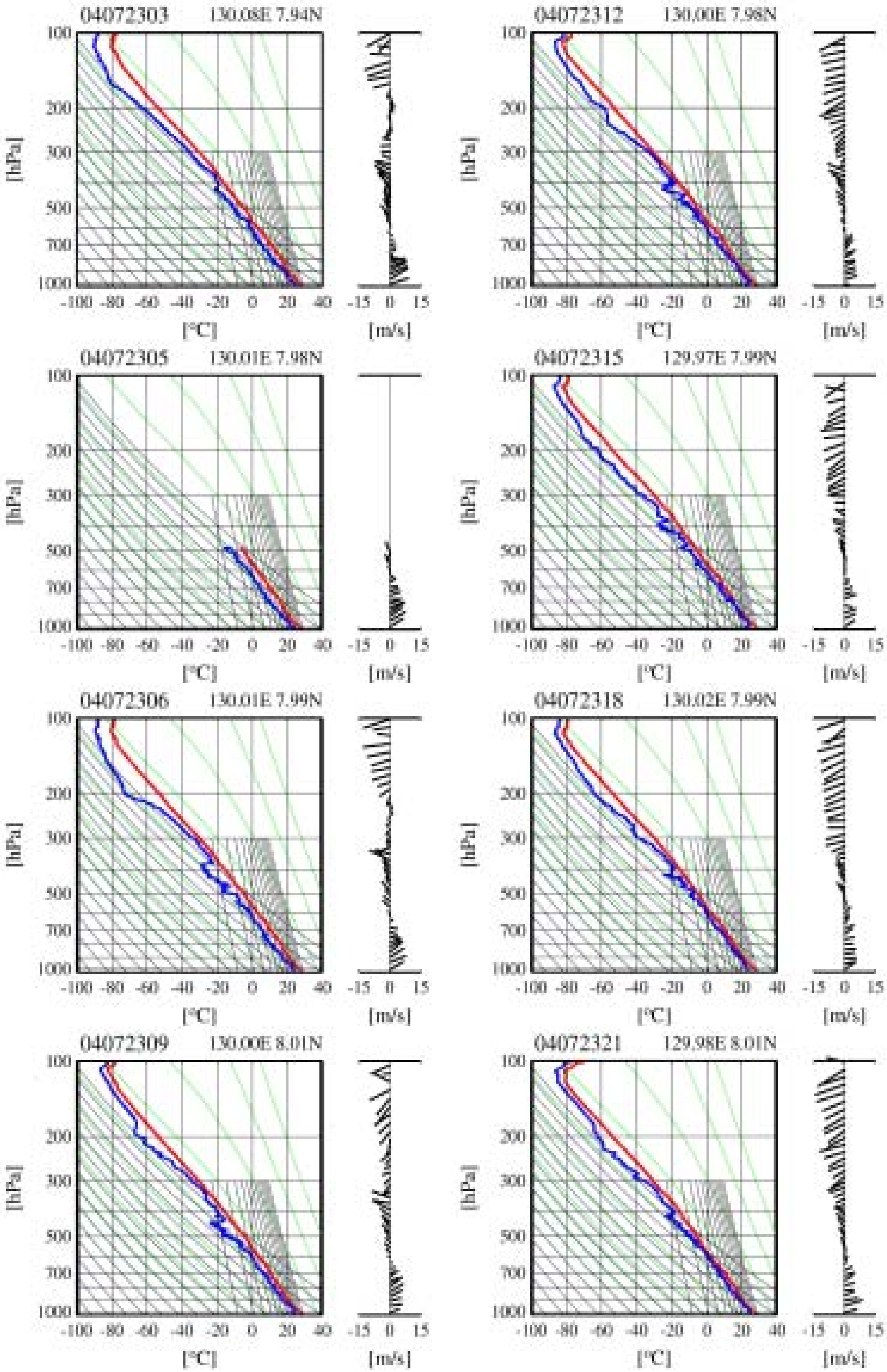


Fig. 7.7-3 (continued)

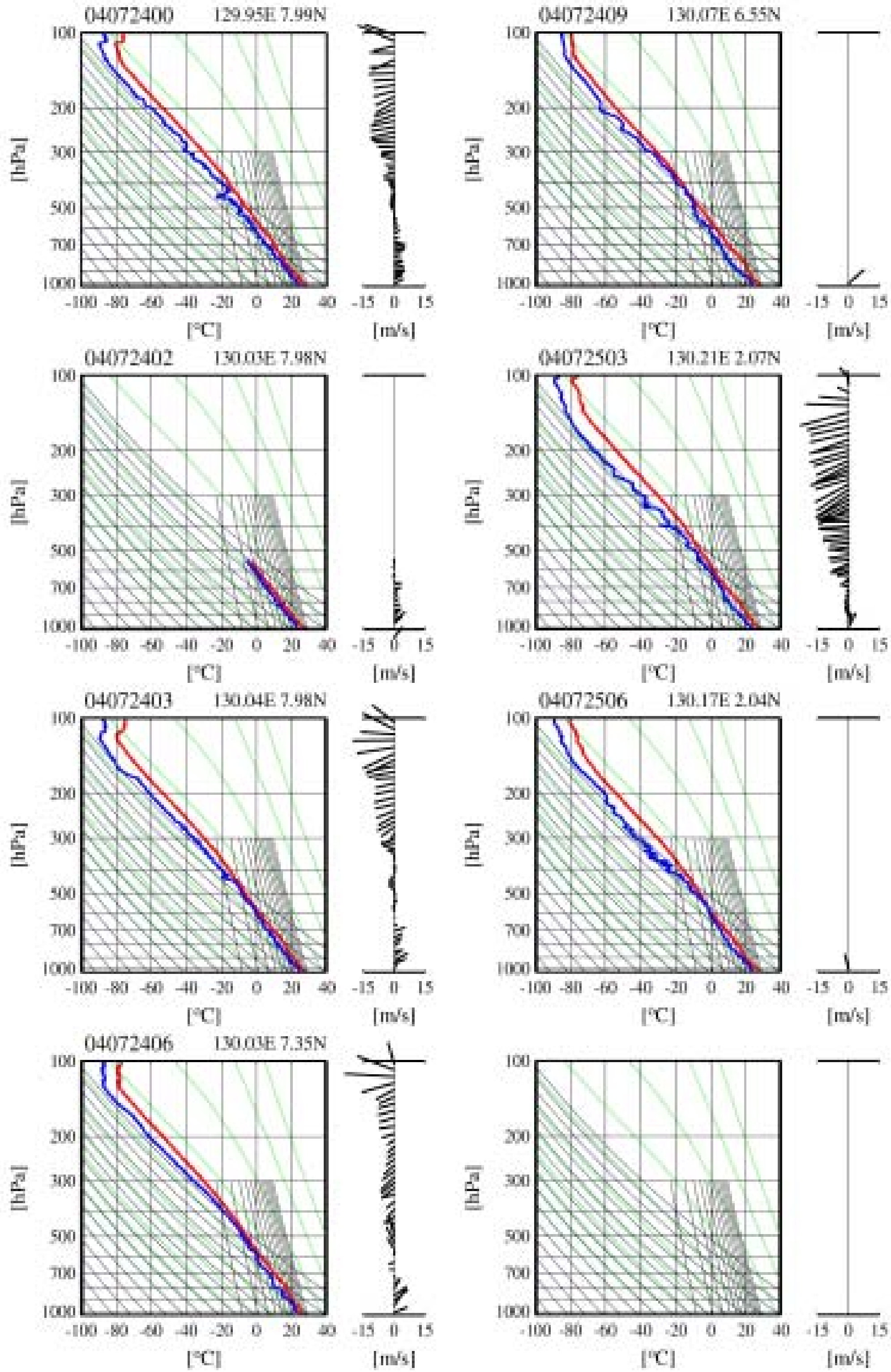


Fig. 7.7-3 (continued)

Table 7.7-1 Rawinsonde Observation Log

No.	Date & Time (UTC)				Position		Surface Data					Maximum Altitude		Cloud Amount & Type	
					Lon. E	Lat. N	P	T	RH	WD	WS				
	YY	MM	DD	HH	(deg.)	(deg.)	(hPa)	(deg. C)	(%)	(deg.)	(m/s)	(hPa)	(gpm)		
RS-001	04	07	08	00	101.30	-8.08	1009.2	27.6	76	125	10.4	36.4	22649	2	Cu, Ci, As
RS-002	04	07	08	03	100.31	-7.72	1010.9	29.0	72	109	11.4	30.8	23739	4	Cu, Ci, As
RS-003	04	07	08	06	99.61	-7.36	1009.7	29.1	72	101	9.0	26.5	24703	1	Cb, Ci
RS-004	04	07	08	09	98.89	-6.99	1008.0	28.0	81	104	5.5	24.6	25159	8	Cb, Cu, As
RS-005	04	07	08	12	98.18	-6.64	1008.8	28.2	80	89	4.6	37.0	22549	10	Cu, Cb, Sc, Ac
RS-006	04	07	08	15	97.50	-6.28	1010.9	24.6	84	76	2.7	35.3	22858	--	Unknown
RS-007	04	07	08	18	96.82	-5.97	1010.8	27.7	79	112	3.2	39.1	22193	--	Unknown
RS-008	04	07	08	21	96.12	-5.60	1009.2	27.8	76	95	3.9	38.6	22273	--	Unknown
RS-009	04	07	09	00	95.42	-5.52	1009.4	27.8	78	127	5.1	33.9	23095	3	Cu, As
RS-010	04	07	09	03	95.00	-5.10	1010.6	28.4	72	106	4.9	30.7	23776	1	Cu ,Ci, As
RS-011	04	07	09	06	94.97	-5.03	1009.8	28.4	74	115	5.3	27.5	24442	1	Cu, Cb, Cs
RS-012	04	07	09	09	94.85	-4.95	1007.6	28.9	75	122	6.3	29.6	23956	4	Cu, Cb, Sc, Ac
RS-013	04	07	09	12	94.22	-4.51	1008.7	28.1	80	131	4.3	39.8	22082	5	Cu, Cb, Ci, Ac
RS-014	04	07	09	15	93.55	-4.08	1009.9	28.0	78	125	4.6	31.0	23712	--	Unknown
RS-015	04	07	09	18	92.90	-3.63	1009.8	28.0	80	155	4.8	33.2	23266	0	Unknown
RS-016	04	07	09	21	92.23	-3.17	1007.9	28.1	76	151	5.6	35.9	22745	3	Cu
RS-017	04	07	10	00	91.57	-2.72	1008.7	27.0	86	160	9.8	646.7	3792	8	Cu, Cb
RS-018	04	07	10	00	91.37	-2.59	1009.3	25.3	93	111	8.2	53.3	20305	10	Cb, Cu, Sc
RS-019	04	07	10	03	90.93	-2.29	1010.4	25.4	85	98	7.1	29.1	24082	8	Cu, Cb, Ac, As
RS-020	04	07	10	06	90.22	-1.81	1010.5	24.5	85	127	4.2	31.0	23731	10	Cu, Cb
RS-021	04	07	10	09	89.98	-1.67	1008.2	26.5	84	213	3.5	34.1	23047	10	Cu, Cb, Sc
RS-022	04	07	10	12	90.00	-1.65	1007.9	26.7	80	183	3.6	32.8	23308	10	Cu, Cb, As, Sc
RS-023	04	07	10	15	89.95	-1.67	1009.5	27.1	80	224	1.8	29.9	23925	--	Unknown
RS-024	04	07	10	18	89.96	-1.66	1009.3	27.3	80	220	2.1	39.8	22090	--	Unknown
RS-025	04	07	10	21	89.95	-1.68	1008.0	27.3	81	234	4.1	39.7	22108	--	Unknown
RS-026	04	07	11	00	89.96	-1.67	1007.8	26.9	79	162	1.9	30.9	23699	4	Cu, Cb, As
RS-027	04	07	11	03	89.99	-1.64	1009.2	27.9	77	194	2.5	28.4	24260	6	Cu, As
RS-028	04	07	11	06	90.07	-1.60	1008.1	28.3	70	159	3.8	22.1	25864	7	Cu, Cb, Ac, Ci, Cc
RS-029	04	07	11	09	90.05	-1.59	1006.3	28.5	73	172	3.9	22.7	25669	6	Cu, Ac, Ci
RS-030	04	07	11	12	90.07	-1.60	1006.6	28.6	69	171	3.0	37.5	22461	4	Cu, Cb, Ci, Sc
RS-031	04	07	11	15	90.07	-1.60	1008.8	27.8	76	186	4.3	44.1	21477	--	Unknown
RS-032	04	07	11	18	90.07	-1.60	1009.0	28.5	76	156	5.8	37.5	22472	--	Unknown
RS-033	04	07	11	21	90.10	-1.60	1007.6	28.2	70	140	5.7	37.1	22507	--	Unknown
RS-034	04	07	12	00	90.06	-1.60	1007.2	27.9	70	138	4.7	30.5	23759	4	Cu, Cb, Ac, Ci
RS-035	04	07	12	03	9.02	-1.61	1009.3	28.3	72	161	3.3	25.2	25061	2	Cu, Ci, Cs
RS-036	04	07	12	06	90.05	-1.60	1008.2	29.3	65	121	6.5	24.9	25123	3	Cu, Cb, Ci
RS-037	04	07	12	09	90.02	-1.17	1006.3	28.8	67	158	5.6	34.4	23019	9	Cu, Cb, Ac, Ci
RS-038	04	07	12	12	90.05	-0.37	1006.5	28.6	70	159	4.4	31.7	23508	7	Cu, Cb, As, Ci
RS-039	04	07	12	15	90.07	0.01	1008.6	27.8	82	183	6.0	20.4	26375	--	Unknown
RS-040	04	07	12	18	90.08	0.01	1008.5	28.0	80	140	3.5	36.0	22726	--	Unknown
RS-041	04	07	12	21	90.07	0.00	1007.0	27.5	78	105	2.1	37.2	22493	--	Unknown
RS-042	04	07	13	00	90.08	0.00	1007.6	26.5	82	235	2.1	28.3	24275	10	Cu, Cb, As
RS-043	04	07	13	03	90.05	-0.01	1009.3	26.9	81	0	0.8	28.5	24230	10	Cu, Cb, As
RS-044	04	07	13	06	90.07	0.01	1008.3	27.1	82	282	1.7	30.2	23778	7	Cu, Cb, Sc, As, Ac
RS-045	04	07	13	09	90.17	-0.07	1006.7	26.4	88	224	3.8	822.7	1770	10	Cb
RS-046	04	07	13	09	90.35	-0.16	1006.1	26.0	86	302	4.2	36.3	22675	8	Cu, Cb, Ci
RS-047	04	07	13	12	90.83	-0.52	1006.6	26.9	84	349	4.9	36.8	22493	7	Cb, Cu, Ac, Sc
RS-048	04	07	13	15	91.56	-1.00	1008.1	27.5	83	313	3.6	30.2	23841	--	Unknown
RS-049	04	07	13	18	92.10	-1.36	1008.0	27.0	79	266	0.6	24.6	25151	--	Unknown
RS-050	04	07	13	21	92.73	-1.79	1006.1	27.9	74	33	3.5	25.1	25012	--	Unknown
RS-051	04	07	14	00	93.38	-2.23	1006.2	28.0	76	87	2.6	27.0	24549	2	Cu, Cb, As
RS-052	04	07	14	03	94.08	-2.71	1008.1	28.1	77	121	4.7	87.5	17296	5	Cu, As, Cs, Ci
RS-053	04	07	14	06	94.59	-3.05	1007.1	26.4	84	88	5.9	25.4	24975	10	Cu, Sc
RS-054	04	07	14	09	95.21	-3.46	1005.7	25.0	85	0	5.8	607.2	4285	10	Cu, Sc, Ac
RS-055	04	07	14	12	95.83	-3.87	1005.8	25.9	86	7	3.6	31.3	23615	8	Cu, Sc, Cb, Ac, As
RS-056	04	07	14	15	96.45	-4.29	1007.3	26.8	81	41	6.8	34.4	23030	--	Unknown
RS-057	04	07	14	18	97.04	-4.68	1007.9	27.1	79	52	3.0	33.9	23079	--	Unknown
RS-058	04	07	14	21	97.66	-5.10	1005.9	26.2	85	83	4.1	32.5	23354	--	Unknown
RS-059	04	07	15	00	98.29	-5.53	1006.4	26.2	84	121	4.5	30.7	23736	10	Cb, Cu, As, Ac
RS-060	04	07	15	03	98.92	-5.95	1009.1	24.2	96	218	6.9	584.4	4616	10	Cb, Sc
RS-061	04	07	15	06	99.50	-6.34	1007.6	25.9	85	213	4.0	25.3	25008	10	Cu, Sc

RS-062	04	07	15	09	100.07	-6.72	1006.2	28.4	77	106	5.1	25.3	24948	9	Cu, Cb, Ac, Ci
RS-063	04	07	15	12	100.68	-7.13	1006.7	28.1	80	100	7.7	32.2	23434	10	Cu, As
RS-064	04	07	15	15	101.29	-7.53	1008.8	28.0	79	112	8.5	30.2	23819	--	Unknown
RS-065	04	07	15	18	101.87	-7.89	1008.7	27.4	83	117	7.2	33.0	23272	--	Unknown
RS-066	04	07	15	21	102.45	-8.31	1007.1	27.7	77	107	9.2	29.6	23890	--	Unknown
RS-067	04	07	23	00	130.04	7.94	1008.5	27.9	79	274	5.3	--	--	10	As, Cu, Cb
RS-068	04	07	23	03	130.08	7.94	1006.8	27.9	81	253	9.3	24.0	25321	10	Cu, Cb, As, Ci
**RS-069	04	07	23	05	130.01	7.98	1005.9	27.9	82	239	7.5	484.6	6097	--	Unknown
RS-070	04	07	23	06	130.01	7.99	1005.4	28.0	80	240	7.6	25.3	6406	8	Cu, As, Ci
RS-071	04	07	23	09	130.00	8.01	1005.7	28.2	81	250	4.7	28.2	24269	7	Cu, Cb, Ac, As, Ci
RS-072	04	07	23	12	130.00	7.98	1007.3	27.3	75	285	2.1	27.3	24496	--	Unknown
RS-073	04	07	23	15	129.97	7.99	1007.3	28.0	79	237	5.7	29.7	23959	--	Unknown
RS-074	04	07	23	18	130.02	7.98	1006.2	27.7	80	235	5.8	30.1	23845	--	Unknown
RS-075	04	07	23	21	129.98	8.01	1005.9	27.9	82	257	6.0	33.4	23174	--	Unknown
RS-076	04	07	24	00	129.95	7.92	1007.2	27.8	78	241	5.1	45.6	21258	9	As, Ac, Cu, Cb, Cs
*RS-077	04	07	24	02	130.03	7.98	1007.6	27.0	88	218	6.0	548.7	5944	10	Cu, Sc, As, Ac
RS-078	04	07	24	03	130.04	7.98	1007.4	26.9	88	202	6.0	28.4	23243	10	As, Cu
RS-079	04	07	24	09	130.03	7.35	1005.4	25.7	87	249	6.7	26.1	24759	10	Cu, Cb, As
*RS-080	04	07	24	12	130.07	6.55	1003.5	28.1	80	229	9.6	39.5	22051	9	Cu, Cb, As
*RS-081	04	07	25	03	130.21	2.07	1007.1	26.7	85	209	7.0	26.8	24566	8	Cu, Cb, As
*RS-082	04	07	25	06	130.17	2.04	1005.8	27.5	82	166	7.3	25.8	24754	10	Cu, Cb, As

7.8 Observation of Rainfall Drop Size Distribution

(1) Personnel

Shuichi Mori (IORGC/JAMSTEC): Principal Investigator

Wataru Tokunaga (GODI)

Norio Nagahama (GODI)

Kazuho Yoshida (GODI)

(2) Objective

Rainfall Drop Size Distribution (DSD) data is obtained to study rainfall characteristics, that vary with its originated precipitating cloud system, i.e., clouds type (convective and stratiform) and development stage of precipitating clouds system (developing, mature, and dissipating). Both temporal and spatial variations of DSD characteristics are also interested over the Indian Ocean during boreal summer monsoon season.

(3) Method

An optical type disdrometer (Parsivel M300) and a Micro-Rain Radar (MRR2) were installed on the navigation and captain decks, respectively, as shown in Fig. 7.8-1. The range of drop diameters that can be measured by the M300 spans from 0.1 mm to 20 mm every 1 minute. The DSD data are collected then recorded every one minute with 32 drop size classes. The MRR2 obtains vertical profile of DSD up to 6000 m with resolutions of 1 minute and 200 m.

(4) Preliminary results

Continuous observation of DSD has been carried without significant trouble. The detailed analyses with other obtained datasets are in future work after the quality check.

(5) Data archive

Original samples will be preserved at Institute of Observational Research for Global Change (IORGC)/JAMSTEC. Both inventory information and analyzed dataset will be submitted to JAMSTEC Data Management Office (DMO).

Fig. 7.8-1
Look of the Persivel M300 (left panel) and MRR-2 (right panel) sensors installed on the vessel.

7.9 Horizontal distribution and optical properties of aerosols

(1) Personnel
Principal Investigator (not on board)
Tatsuo Endoh (Tottori University of Environmental Studies)

(2) Objectives
To clear and solve the problems of horizontal distribution and optical properties of aerosols, some observations were carried out the central region of the Northern Pacific Ocean. Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously.

(3) Introduction
One of the most important objects is to collect the calibration and validation data from the surface (Nakajima et al.1996, 1997 and 1999). It may be considered for the observation over the widely opening of the huge ocean to be desired ideally because of horizontal homogeneity. Furthermore, the back ground values of aerosol concentration are easily obtained over there (Ohta et al.1996, Miura et al. 1997 and Takahashi et al. 1996) and vertical profiles of aerosol concentration are obtained by means of extrapolation up to the scale height. It is desired to compare the integrated value of these profiles of aerosol concentration with optical thickness observed by the optical and radiative measurements (Hayasaka et al. 1998, Takamura et al.1994). Facing this object, the optical and radiative observations were carried out by mean of the Sky Radiometer providing more precise radiation data as the radiative forcing for global warming.

(4) Measuring parameters
Atmospheric optical thickness, Ångström coefficient of wavelength efficiencies, Direct irradiating intensity of solar, and forward up to back scattering intensity with scattering angles of 2-140degree and seven different wavelengths. GPS provides the position, heading direction of the vessel, and azimuth and elevation angle of sun. Horizon sensor provides rolling and pitching angles. Concentration and size distribution of atmospheric aerosol.

(5) Methods
The instruments used in this work are shown as following in Table 7.11-1.
Sky Radiometer measures irradiating intensities of solar radiation through seven different filters with the scanning angle of 2-140 degree. These data will provide finally optical thickness, Ångström exponent, single scattering albado and size distribution of atmospheric aerosols with a kind of retrieval method.
Optical Particle Counter measures the size of large aerosol particle and counts the number concentration with laser light scattering method and provides the size distribution in 0.3,0.5,1.0,2.0 and 5.0 micron of diameter with real time series display graphically.

(6) Results
Information of data and sample obtained are summarized in Table 7.11-2. The sky radiometer has been going well owing to calm and silent condition and less shivering circumstances problems provided by the R/V Mirai whose engines are supported by well defined cushions. Therefore, measured values will be expected to be considerably stable and provide good calculated parameters with higher quality. However, some noise waves were found to interfere the 16,13 and 12channel marine bands of VHF from sky radiometer. Fortunately, the origin and source were identified using a

VHF wide band receiver and the interference waves were kept by fairly separating from two VHF antennae and decreased to recovery of 100%.
Aerosols size distribution of number concentration have been measured by the Particle Counter and the time series data are displayed in real time with 5stages of size range of 0.3, 0.5, 1.0, 2.0, and 5.0 micron in diameter.

(7) Data archive

This aerosol data by the Particle Counter are able to be archived soon. However, the data of other kind of aerosol measurements are not able to be archived so soon. Data processing method will be developed and the data will be examined, arranged and finally provided as available data after certain duration. All data will be archived at ILTS (Endoh), Hokkaido University, CCSR (Nakajima), University of Tokyo and CEReS (Takamura), Chiba University after the quality check and submitted to JAMSTEC within 3-year.

Data inventory

Table 7.11-1. Information of obtained data inventory (method)

Item, No. data	Name	Instrument	Site position
Optical thickness Ångström exponent.	Endoh	Sky Radiometer (Prede, POM-01MK2)	roof of stabilizer
Aerosol Size distribution	Endoh	Particle Counter (Rion, KC-01C)	compass deck (inlet) & environmental research laboratory

Table 7.11-2. Data and sample inventory

Data/Sample	rate	site	object	name	state	remarks
Sun & Sky Light	1/5min (fine& daytime)	roof of stabilizer	optical thickness Ångström expt.	Endoh	land analysis	06/07-07/30