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R/V Mirai Cruise Report
MR01-K05
(Leg 1 – 2)

September 20 – November 5, 2001
Tropical Ocean Climate Study (TOCS)

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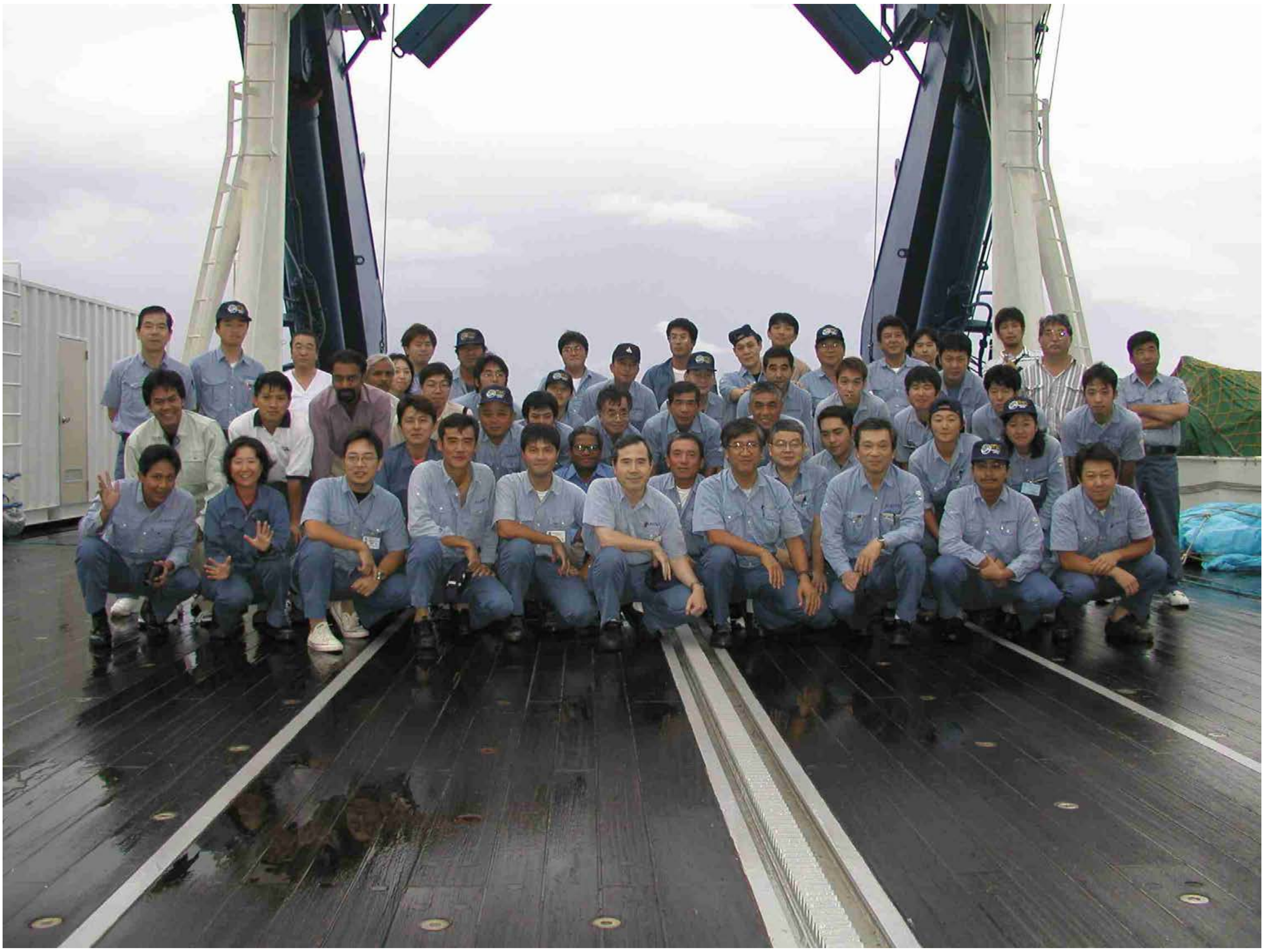


MR01-K05 Leg2

Contents

1. Cruise name and code

Tropical Ocean Climate Study
MR01-K05 (Leg 1 - 2)
Ship: R/V MIRAI
Captain: Masaharu Akamine

2. Introduction and observation summary

2.1. Introduction

This cruise has two major purposes. One is to observe physical oceanographic conditions in the western tropical Pacific Ocean for better understanding of air-sea interaction affecting on the ENSO (El Nino/Southern Oscillation) phenomena and its related climate change. The surface layer in the western tropical Pacific Ocean is characterized by high sea surface temperature, which plays major role in driving global atmospheric circulation. El Nino occurs when warm water migrates eastward, and causes short-term climate changes in the world dramatically. For example, the western Pacific area has very little rainfall when the "El Nino" occurred, as in 1997-98. This atmospheric and oceanic system is so complicated, and we still do not have enough knowledge about it.

The other purpose is to observe hydrographic conditions and its variability in the eastern tropical Indian Ocean associated with Asian Monsoon and Dipole Mode. Asian Monsoon may play an important role as a trigger of El Nino in the Pacific Ocean. Also the Indian Ocean has basin-scale interannual variability independent to ENSO mentioned as Dipole Mode variability. This climate system has various time scales. To investigate the mechanism, we need precise and detailed data for long period. Therefore, ocean and atmosphere observing mooring array is effective to obtain such data set. The major mission of this cruise is to deploy TRITON buoys developed at JAMSTEC for the long term measurements of ocean and atmosphere in the western tropical Pacific Ocean and the eastern Indian Ocean. We also deployed ADCP subsurface buoys in the Pacific and the Indian Oceans during this cruise.

The other purposes of this cruise are,

1) Temperature and salinity measurement using ARGO floats by Frontier Observational Research System for Global Change (FORSGC).
2) Optical measurement of properties of atmospheric aerosols by particle counter and sky radiometer by Hokkaido University.
3) Lidar backscatter measurements of lower atmosphere by National Institute for Environmental Studies (NIES) of Japan, Tohoku Institute of Technology and Communications Research Laboratory (CRI).
4) Cloud profiling radar measurements by CRI.

These measurements are also made successfully during this cruise.

2.2. Overview

2.2.1 Ship

R/V Mirai

Captain Masaharu Akamine

Total 35 crew members

2.2.2 Cruise code

MR01-K05

2.2.3 Project name

Tropical Ocean Climate Study

2.2.4 Undertaking institution

Japan Marine Science and Technology Center (JAMSTEC)

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

2.2.5 Chief scientist

Leg1: Yoshifumi Kuroda (JAMSTEC)

Leg2: Keisuke Mizuno (JAMSTEC)

2.2.6 Period

Leg1: September 21, 2001(Hachinohe)-October 16, 2001(Singapore)

Leg2: October 18,2001(Singapore)-November 5, 2001(Palau)

2.2.7 Research participants

Total 40 scientists and technical stuff participated from 11 different institutions, universities and companies including 10 foreign scientists and officers form Brunei, India, Indonesia, Malaysia and USA.

2.3 Observation summary

TRITON buoy deployment:	7 sites
TRITON buoy recovery:	3 sites
ADCP subsurface buoy deployment:	4 sites
ADCP subsurface buoy recovery:	4 sites
CTD (Salinity, Temperature, Depth):	20 casts down to 1000 or 2000m
XCTD (Salinity, Temperature, Depth):	94 times down to 1000m
Surface meteorology:	continuous
ADCP measurements:	continuous
Surface temperature, salinity measurements by intake method:	continuous

Other specially designed observations have been carried out successfully.

Observed oceanic and atmospheric conditions

ENSO status from TAO/TRITON buoy data:

The TAO/TRITON buoy data along the equator in the Pacific Ocean indicates pre El Nino conditions in October 2001. The 20 degree-C isotherm depth in the western tropical Pacific was deepened down to 210 m during March-April 2000 that was deepest one since 1990. The anomaly (30 m) is deeper than that (10 m) observed before 1997/1998 El Nino. Thus the warm pool in western tropical Pacific Ocean stored enough heat for next El Nino during the La Nina years of 1998-2000. The other condition to cause El Nino is to have a series of westerly wind burst associated with intraseasonal atmospheric disturbance over the western tropical Pacific Ocean that push the warm water from west to east. The westerly winds were observed in November 2000, February, May, June and July 2001 and the winds caused eastward propagating downwelling Kelvin waves. The wave caused by westerly winds in November 2000 reached eastern boundary of the Pacific and raised the sea surface temperature (SST) in the eastern Pacific. The oceanic change associated with the westerly wind burst in late June 2001 was dramatic. The westerly wind burst caused by stagnated convection system near 156E TRITON buoy sites that induced strong eastward currents of 1.5 m/s. The strong currents over 0.5 m/s continued for a month. The strong eastward jet induced a warm water convergence in the surface layer on the equator and the down ward displaced warm water propagated to the eastern Pacific. It was thought that the warm anomaly can develop as an El Nino immediately, but the seasonally locked prevailed easterly trade winds suppressed the SST. However, the TRITON buoy data at 2N, 138E that was deployed during this cruise indicated the 20 degree-C isotherm depth was 20 m shallower than normal. It means that the warm water has been lost from the western Pacific and has migrated already to east. The SST in the central Pacific is 0.5 degree-C higher than normal since September 2001, and the 20 degree-C isotherm depth is 40 m deeper than normal in the eastern Pacific. Thus, these buoy data indicate that a warm episode is developing in the tropical Pacific.

Leg1:

During this cruise period, the SST in the western tropical Pacific Ocean is warm as 29.4 - 30.5 degree-C, and low sea surface salinity was observed near 8N and off Mindanao with the salinity of 33.6-33.8 psu. Eastward surface currents widely distributed from 0N - 5N along 137/138E section. The eastward currents indicated unusually strong as 1 m/s in the thermocline layer of 225 - 275 m depth centered at 2N, 138E. The surface currents at 2N, 138E are considered as a retroflexed flow toward the equator after that the New Guinea Coastal Current crossed the equator at the western boundary. However, the subsurface currents in the thermcline layer seem to be a continuous flow from off Mindanao and Halmahera because the New Guinea Coastal Undercurrent is weak along the equator from 138E to 135E and salinity in the 225 - 275 m layer at 2N, 138E is lower than 35 psu. Here, the New Guinea Coastal Undercurrent crossed the equator near 135E because the salinity maximum in the 130 - 200 m depth layer was observed at there in the salinity section along the equator. The observed currents may reflect basin scale ocean circulation changes associated with the developing warm episode.

The atmospheric conditions were as follows. After the departure from the Hachinohe port, there was a typhoon but the ship steamed west of it and the winds blew from behind the ship. Thus, the ship could steam well although the winds were strong and waves were high. During the buoy operations in tropics the weather was calm and less squall. Since October 6th, atmospheric convection was activated off east Philippine and northeasterly winds of 10 - 15m/s were prevailed when the ship steamed Philippine coast.

Five TRITON buoys were deployed, two were recovered, and three ADCP subsurface buoys were deployed and two were recovered successfully during Leg 1.

The Ministry of Foreign Affairs of Japan warned that the area of Sulu Sea and south of Mindanao Island is dangerous to enter because some attack by terrorist group can happen against the US attack to Afghanistan. Following the warning, the ship changed the track to detour north of the Luzon Island and arrived at the port of Singapore.

Leg2:

November is in an inter-monsoon season in the Indian Ocean, climatology indicates that westerlies are prevailing in the equatorial zone and strong eastward current (equatorial jet) is generated along the equator usually. However, the observed hydrographic condition is different from climatological seasonal pattern. Although upper ocean current was mainly eastward in the 5N - 5S equatorial band along 90E, equatorial jet was not well developed. Westerly winds were observed in this area, and stronger than 10m/sec near equator but not persistent. SST along 90E in the equatorial zone is mostly 28.4 - 28.8 degree-C, and is lower than normal and slightly lower than last year (MR00-K07).

Since we could not obtain the Indian EEZ clearance, the scheduled cruise line was changed so as to keep the cruise track outside the EEZ. Therefore, scheduled observation line along 90E lacked northern part (i.e.10N - 5N). During the cruise of this leg, two TRITON buoys were first deployed in the Indian Ocean. Also we conducted recovery/deployment operation of ADCP moorings and deployment of Argo floats successfully. Observing equipments (CTD, ship-board ADCP etc.) were mostly worked without significant problem. CTD salinity sensor accuracy was estimated to be 0.003 - 4 based on CTD/Bottle-sample comparison. At CTD station C14 along 90E, D.O. sensor was broken and we replaced it with a spare sensor. The characteristics of these D.O. sensors were slightly different comparing to bottle sampled D.O. data. However, a simple data correction of CTD D.O. data is possible using CTD/Bottle data regression curve (See 6.3.2).

Same as Leg-1, we were given a warning not to pass the Sunda Strait, we changed the cruise track so as to pass the Alor strait. That makes out cruise distance longer and obliged to cancel a couple of CTD points.

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

September 20, 2001 – November 5, 2001

3.2 Ports of call

Sekinehama, Japan	(Departure; September 20, 2001)
Hachinohe, Japan	(September 21, 2001)
Singapore	(October 16 - 18, 2001)
Koror, Republic of Palau	(Arrival; November 5, 2001)

3.3 Cruise log

SMT (Ship Mean Time)	**UTC**	**Event**
Sep. 20 (Thu.)		
14:00	05:00	Departure at Sekinehama, Japan (SMT = UTC + 9)
15:00-	06:00-	Safety guidance on the R/V Mirai
Sep. 21 (Fri.)		
07:40	22:40	Arrival at Hachinohe, Japan Immigration for going aboard
15:10	06:10	Departure from Hachinohe Start of continuous shipboard observations (except of surface seawater monitoring)
16:45-17:00	07:45-08:00	Konpira-san
17:00-	08:00-	Start of Lidar, Cloud radar and pCO2 observation
Sep. 22 (Sat.)		
10:00-11:05	01:00-02:05	Boat station drill
13:00-14:35	04:00-05:35	Meeting for leg 1 observation, and for editing cruise report
Sep. 23 (Sun.)		
08:32-	23:32-	Start of continuous surface seawater monitoring
10:30-12:00	01:30-03:00	Seminar and discussion with foreign participants
Sep. 24 (Mon.)		
13:00-16:00	04:00-07:00	T01 Crane and cable test for CTD system (with sinker only; 23-48.78 N, 139-25.74 E), down to 3000 m
Sep. 25 (Tue.)		
08:06-11:30	23:06-02:30	T02 (19-55.08 N, 138-08.42 E, 4913 m) Crane and cable test for CTD system, down to 4850 m depth
12:55-13:20	03:55-04:20	Piracy station drill
13:35-17:00	04:35-08:00	T03 (19-25.89 N, 138-07.65 E, 5134 m) Crane and cable test for CTD system, down to 4918 m depth
Sep. 26 (Wed.)		
08:02-11:15	23:02-02:15	T04 (15-35.39 N, 138-11.81 E, 4712 m) Crane and cable test for CTD system, down to 4060 m, with releaser test

12:31-15:58	03:31-06:58	T05 (15-24.09 N, 138-09.65 E, 4676 m) Crane and cable test for CTD system, down to 4060 m, with releaser test
Sep. 27 (Thu.)		
		Steaming
Sep. 28 (Fri.)		
07:45-11:22	22:45-02:33	Deployment of TRITON buoy (07-50.39 N, 136-29.14 E, 3353 m)
12:15-13:13	03:15-04:13	C-01 (07-51.37 N, 136-29.69 E, 3348 m) CTD cast with water sampling, down to 1000 m depth
17:18-17:24	08:18-08:24	X001 (06-59.85 N, 136-43.45 E, 4811 m) XCTD observation
21:20-21:25	12:20-12:25	X002 (05-59.92 N, 137-00.05 E, 4426 m)
21:30-21:35	12:30-12:35	X002-2 (05-58.05 N, 137-00.61 E, 4668 m)
Sep. 29 (Sat.)		
08:12-12:05	23:12-03:05	Deployment of TRITON buoy (04-56.40 N, 137-17.56 E, 4133 m)
12:44-13:45	03:44-04:45	C-02 (04-58.22 N, 137-17.33 E, 3846 m) CTD cast with water sampling, down to 1000 m depth
18:07-18:13	09:07-09:13	X003 (03-59.98 N, 137-32.69 E, 4682 m)
22:15-22:20	13:15-13:20	X004 (02-59.83 N, 137-49.16 E, 4331 m)
Sep. 30 (Sun.)		
08:11-11:27	23:11-02:27	Deployment of TRITON buoy (02-03.79 N, 138-03.10 E, 4335 m)
12:30-13:31	03:30-04:31	C-03 (02-03.48 N, 138-02.25 E, 4320 m) CTD cast with water sampling, down to 1000 m depth at TRITON buoy deployment point
14:13-15:08	05:13-06:08	C-04 (02-00.96 N, 138-06.56 E, 4175 m) CTD cast with water sampling, down to 1000 m depth at TRITON buoy recovery point
Oct. 1 (Mon.)		
07:56-11:46	22:56-02:46	Recovery of TRITON buoy (01-59.90 N, 138-06.21 E, 4322 m)
14:00-16:20	05:00-07:20	Releaser test (01-37.15 N, 137-50.39 E), down to 3500m depth
Oct. 2 (Tue.)		
08:04-10:04	23:04-01:04	Deployment of the subsurface ADCP buoy (01-53.74 N, 138-02.27 E, 4681 m)
12:53-15:23	03:53-06:23	Releaser test (01-16.45 N, 138-02.53 E), down to 3500m depth
15:26-16:06	06:26-07:06	Ship-mounted magnetometer calibration
17:15-17:21	08:15-08:21	X005 (00-59.87 N, 138-03.43 E, 4373 m)
17:37-17:43	08:37-08:43	X005-2 (00-54.84 N, 138-03.28 E, 4373 m)
Oct. 3 (Wed.)		
08:11-11:05	23:11-02:05	Deployment of TRITON buoy (00-04.70 N, 138-02.61 E,

		4206 m)
12:27-13:23	03:27-04:23	C-05 (00-06.49 N, 138-02.39 E, 4210 m) CTD cast with water sampling, down to 1000 m depth at TRITON buoy deployment point
14:22-15:18	05:22-06:18	C-06 (00-02.46 N, 137-54.06 E, 4347 m) CTD cast with water sampling, down to 1000 m depth at TRITON buoy recovery point
Oct. 4 (Thu.)		
08:00-11:26	23:00-02:26	Recovery of TRITON buoy (00-01.91 N, 137-52.96 E, 4364 m)
Oct. 5 (Fri.)		
07:05-09:35	22:05-00:35	Recovery of subsurface ADCP buoy (00-00.94 S, 138-01.82 E, 3912 m)
12:26-13:56	03:26-04:56	Deployment of subsurface ADCP buoy (00-00.59 S, 138-01.80 E, 3946 m)
16:11-16:17	07:11-07:17	X006 (00-00.15 N, 137-29.26 E, 4255 m)
18:01-18:07	09:01-09:07	X007 (00-00.23 S, 136-59.89 E, 4441 m)
19:54-20:00	10:54-11:00	X008 (00-00.02 N, 136-29.92 E, 4743 m)
21:45-21:51	12:45-12:51	X009 (00-00.17 N, 135-59.95 E, 5042 m)
23:35-23:41	14:35-14:41	X010 (00-00.16 N, 135-29.95 E, 4764 m)
Oct. 6 (Sat.)		
01:24-01:29	16:24-16:29	X011 (00-00.56 N, 134-59.93 E, 1629 m)
05:09-05:14	20:09-20:14	X012 (00-23.86 N, 133-59.93 E, 3968 m)
09:02-09:07	00:02-00:07	X013 (00-48.30 N, 133-00.03 E, 3827 m)
13:04-13:09	04:04-04:09	X014 (01-13.85 N, 131-58.27 E, 4101 m)
16:58-17:04	07:58-08:04	X015 (01-35.87 N, 130-59.14 E, 3687 m)
19:27-03:36	10:27-18:36	Site survey using the SEABEAM at mooring point
Oct. 7 (Sun.)		
08:10-11:17	23:10-02:17	Deployment of TRITON buoy (01-56.38 N, 129-55.71 E, 4428 m)
14:58-15:04	05:58-06:04	X016 (01-56.51 N, 129-55.70 E, 4426 m)
15:21-15:27	06:21-06:27	X017 (01-56.46 N, 129-55.73 E, 4428 m)
19:23-19:29	10:23-10:29	X018 (03-00.07 N, 129-59.21 E, 3043 m)
23:18-23:23	14:18-14:23	X019 (04-00.05 N, 130-02.33 E, 4870 m)
Oct. 8 (Mon.)		
02:43-06:50	17:43-21:50	Site survey using the SEABEAM at mooring point
08:02-09:38	23:02-00:38	Sensor comparison test for ARGO profiling float (with wire cable; 05-07.79 N, 130-07.57 E, 5447 m)
10:05-11:48	01:05-02:48	Sensor comparison test for ARGO profiling float (no cable; 05-12.45 N, 130-00.42 E, 4684 m)
17:05-17:10	08:05-08:10	X020 (05-42.14 N, 129-00.00 E, 5291 m)
21:51-21:57	12:51-21:57	X021 (06-13.53 N, 128-00.01 E, 5612 m)
Oct. 9 (Tue.)		
02:27-02:32	17:27-17:32	X022 (06-45.64 N, 126-59.98 E, 6637 m)
07:05-09:35	22:05-00:35	Recovery of subsurface ADCP buoy (06-49.57 N, 126-42.59

		E, 3410 m)
12:59-14:44	03:59-05:44	Deployment of subsurface ADCP buoy (06-49.29 N, 126-42.65 E, 3441 m)
15:04-15:09	06:04-06:09	X023 (06-50.00 N, 126-42.74 E, 3418 m)
Oct. 10 (Wed.)		
		Steaming
Oct. 11 (Thu.)		
		Steaming
Oct. 12 (Fri.)		
14:02-15:45	05:02-06:45	Data discussion seminar for leg 1 observation
Oct. 13 (Sat.)		
15:00-17:00	06:00-08:00	TRITON buoy meeting
18:00-19:30	09:00-10:30	continued
Oct. 14 (Sun.)		
22:00-	13:00-	Ship mean time adjustment (SMT = UTC + 8)
Oct. 15 (Mon.)		
15:00-15:58	07:00-07:58	TRITON buoy seminar (What' s a TRITON buoy?)
Oct. 16 (Tue.)		
10:40	02:40	Arrival at Singapore (Singapore Cruise Centre)
Oct. 17 (Wed.)		
		Anchor at Singapore
Oct. 18 (Thu.)		
10:00	02:00	Departure from Singapore
13:10-14:06	05:10-06:06	Safety guidance for participants joining from Singapore
Oct. 19 (Fri.)		
13:15-13:35	05:15-05:35	Boat station drill
14:00-15:00	06:00-07:00	Meeting for leg 2 observation
Oct. 20 (Sat.)		
02:07-02:12	18:07-18:12	X024 (05-59.75 N, 095-00.02 E, 1279 m)
04:21-04:27	20:21-20:27	X025 (05-42.42 N, 094-30.05 E, 1938 m)
07:12-07:18	23:12-23:18	X026 (05-14.91 N, 094-00.06 E, 729 m)
09:58-10:03	01:58-02:03	X027 (04-47.56 N, 093-30.05 E, 1420 m)
12:45-12:50	04:45-04:50	X028 (04-20.55 N, 093-00.06 E, 4496 m)
13:30-15:15	05:30-07:15	Seminar for introduction of NIOT (National Institute of Ocean Technology, India), and for ARGO project
15:28-15:34	07:28-07:34	X029 (03-52.74 N, 092-30.05 E, 4252 m)
18:09-18:15	10:09-10:15	X030-1 (03-41.44 N, 092-00.04 E, 4109 m)
18:19-18:25	10:19-10:25	X030-2 (03-42.33 N, 091-58.60 E, 4101 m)
20:47-20:52	12:47-12:52	X031 (04-01.06 N, 091-30.00 E, 4040 m)
23:20-23:26	15:20-15:26	X032-1 (04-21.18 N, 091-00.00 E, 2631 m)

23:30-23:36	15:30-15:36	X032-2 (04-22.06 N, 090-58.55 E, 2605 m)
23:39-23:45	15:39-15:45	X032-3 (04-22.96 N, 090-57.12 E, 2540 m)
23:49-23:55	15:49-15:55	X032-4 (04-23.85 N, 090-55.65 E, 2460 m)

Oct. 21 (Sun.)

01:58-02:03	17:58-18:03	X033 (04-40.11 N, 090-30.02 E, 3175 m)
05:58-07:31	21:58-23:31	C-07 (04-59.94 N, 089-59.99 E, 3442 m) CTD cast with water sampling, down to 2000 m depth
07:39-07:44	23:39-23:44	X034 (04-59.13 N, 089-59.80 E, 3345 m)
09:33-09:39	01:33-01:39	X035 (04-30.03 N, 090-00.24 E, 3260 m)
12:14-14:10	04:14-06:10	C-08 (03-59.95 N, 090-00.13 E, 2842 m) CTD cast with water sampling, down to 2000 m depth
16:14-16:19	08:14-0819	X036 (03-30.01 N, 090-00.09 E, 2468 m)
18:21-19:49	10:21-11:49	C-09 (03-00.74 N, 090-00.07 E, 2527 m) CTD cast with water sampling, down to 2000 m depth
21:58-22:04	13:58-14:04	X037 (02-29.35 N, 089-59.95 E, 2758 m)

Oct. 22 (Mon.)

00:00-01:34	16:00-17:34	C-10 (01-59.96 N, 089-59.93 E, 2637 m) CTD cast with water sampling, down to 2000 m depth
03:40-03:45	19:40-19:45	X038 (01-30.01 N, 090-00.13 E, 2296 m)
05:58-07:30	21:58-23:30	C-11 (01-00.01 N, 090-00.21 E, 2310 m) CTD cast with water sampling, down to 2000 m depth
09:41-09:47	01:41-01:47	X039 (00-30.01 N, 090-01.87 E, 4062 m)
12:22-14:38	04:22-06:38	Recovery of subsurface ADCP buoy (00-00.33 N, 090-03.33 E, 4400 m)
14:46-16:26	06:46-08:26	C-12 (00-00.33 N, 090-02.93 E, 4379 m) CTD cast with water sampling, down to 2000 m depth
15:03-15:08	07:03-07:08	X040 (00-00.09 N, 090-03.06 E, 4376 m)
17:15-18:53	09:15-10:53	Deployment of subsurface ADCP buoy (00-00.44 N, 090-03.35 E, 4399 m)
21:13-21:19	13:13-13:19	X041 (00-29.98 S, 089-59.81 E, 3076 m)
23:10-23:15	15:10-15:15	X042 (01-00.16 S, 089-59.89 E, 3126 m)

Oct. 23 (Tue.)

01:12-06:40	17:12-22:40	Site survey using the SEABEAM at mooring point
08:43-12:00	00:43-04:00	Deployment of TRITON buoy (01-39.51 S, 089-59.57 E, 4697 m)
13:27-14:56	05:27-06:56	C-13 (01-40.33 S, 089-59.53 E, 4683 m) CTD cast with water sampling, down to 2000 m depth at TRITON buoy deployment point
17:54-19:19	09:54-11:19	C-14 (01-59.98 S, 089-59.83 E, 4736 m) CTD cast with water sampling, down to 2000 m depth
21:28-21:34	13:28-13:34	X043 (02-30.00 S, 090-00.13 E, 3520 m)
23:58-01:34	15:58-17:34	C-15 (03-00.02 S, 089-59.95 E, 3335 m) CTD cast with water sampling, down to 2000 m depth

Oct. 24 (Wed.)

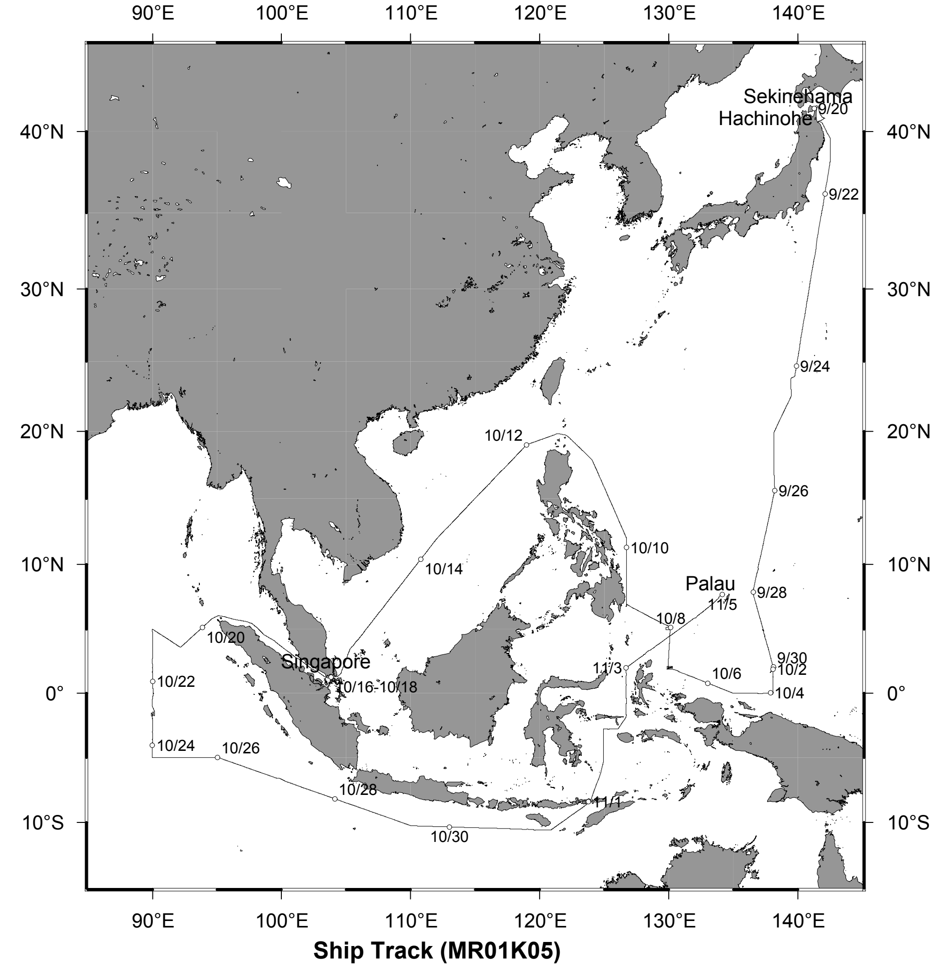
03:56-04:02	19:56-20:02	X044 (03-29.97 S, 090-00.22 E, 3800 m)
06:00-07:31	22:00-23:31	C-16 (03-59.90 S, 089-59.88 E, 3141 m) CTD cast with water sampling, down to 2000 m depth

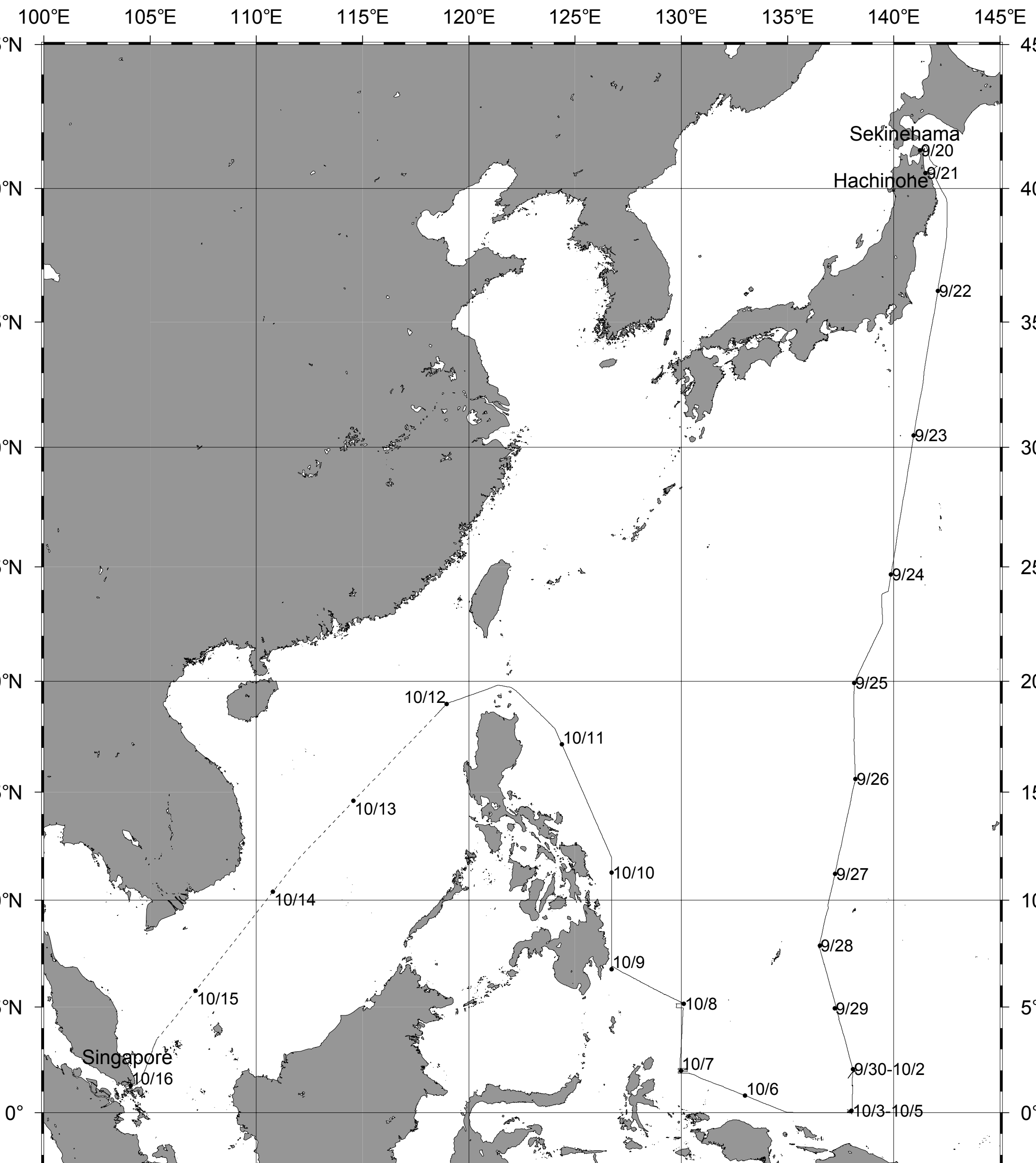
07:40	23:40	Deployment of ARGO profiling float (03-59.96 S, 089-59.86 E)
09:43-09:48	01:43-01:48	X045 (04-29.99 S, 089-59.78 E, 4622 m)
11:55-13:19	03:55-05:19	C-17 (04-59.99 S, 090-00.00 E, 4997 m) CTD cast with water sampling, down to 2000 m depth
12:07-12:13	04:07-04:13	X046 (05-00.02 S, 090-00.05 E, 5001 m)
13:27	05:27	Deployment of ARGO profiling float (05-00.09 S, 090-00.30 E)
15:32-15:38	07:32-07:38	X047-1 (05-00.29 S, 090-29.98 E, 5046 m)
15:43-15:48	07:43-07:48	X047-2 (05-00.29 S, 090-31.90 E, 5054 m)
17:43-19:13	09:43-11:13	C-18 (05-00.01 S, 091-00.02 E, 4984 m) CTD cast with water sampling, down to 2000 m depth
19:22	11:22	Deployment of ARGO profiling float (04-59.65 S, 091-00.08 E)
21:24-21:30	13:24-13:30	X048 (04-59.92 S, 091-30.00 E, 5009 m)
23:23-23:28	15:23-15:28	X049 (04-59.94 S, 091-59.97 E, 5010 m)
Oct. 25 (Thu.)		
01:20-01:26	17:20-17:26	X050 (04-59.83 S, 092-29.99 E, 5001 m)
03:24-04:57	19:24-20:57	C-19 (05-00.01 S, 093-00.05 E, 4602 m) CTD cast with water sampling, down to 2000 m depth
05:03	21:03	Deployment of ARGO profiling float (04-59.31 S, 093-00.25 E)
07:07-07:13	23:07-23:13	X051 (04-59.92 S, 093-30.00 E, 4919 m)
09:03-09:09	01:03-01:09	X052 (04-59.93 S, 094-00.01 E, 4972 m)
10:59-11:05	02:59-03:05	X053 (04-59.99 S, 094-29.98 E, 4981 m)
13:23-15:22	05:23-07:22	Recovery of subsurface ADCP buoy (04-59.87 S, 095-03.02 E, 5006 m)
15:32-16:05	07:32-08:05	Sensor comparison test for ARGO profiling float (with wire cable; 04-58.94 S, 095-02.57 E, 5007 m)
Oct. 26 (Fri.)		
08:12-11:29	00:12-03:29	Deployment of TRITON buoy (04-57.13 S, 094-58.64 E, 5009 m)
12:54-14:24	04:54-06:24	C-20 (04-57.64 S, 094-58.88 E, 5005 m) CTD cast with water sampling, down to 2000 m depth at TRITON buoy deployment point
13:05-13:11	05:05-05:11	X054 (04-57.72 S, 094-58.93 E, 5007 m)
14:28	06:28	Deployment of ARGO profiling float (04-58.01 S, 094-58.97 E)
17:01-17:07	09:01-09:07	X055 (05-08.25 S, 095-30.01 E, 5025 m)
19:08-19:13	11:08-11:13	X056 (05-18.71 S, 095-59.98 E, 4813 m)
21:13-21:19	13:13-13:19	X057 (05-29.45 S, 096-29.98 E, 4955 m)
23:19-23:25	15:19-15:25	X058 (05-39.97 S, 097-00.02 E, 4860 m)
Oct. 27 (Sat.)		
01:25-01:30	17:25-17:30	X059 (05-50.67 S, 097-30.00 E, 4979 m)
03:34-03:40	19:34-19:40	X060 (06-01.36 S, 097-59.99 E, 5551 m)
05:42-05:48	21:42-21:48	X061 (06-11.81 S, 098-29.98 E, 5129 m)
07:49-07:54	23:49-23:54	X062 (06-22.46 S, 099-00.00 E, 5444 m)
09:51-09:57	01:51-01:57	X063 (06-32.97 S, 099-29.98 E, 4700 m)

11:53-11:59	03:53-03:59	X064 (06-40.70 S, 100-00.00 E, 5116 m)
14:05-14:11	06:05-06:11	X065 (06-54.34 S, 100-30.00 E, 5364 m)
16:19-16:25	08:19-08:25	X066 (07-04.95 S, 100-59.99 E, 5516 m)
18:27-18:33	10:27-10:33	X067 (07-15.70 S, 101-29.98 E, 5303 m)
20:37-20:42	12:37-12:42	X068 (07-26.39 S, 102-00.00 E, 5485 m)
22:00	14:00	Ship mean time adjustment (SMT = UTC + 9)
Oct. 28 (Sun.)		
00:17-00:23	15:17-15:23	X069 (07-36.89 S, 102-30.00 E, 5902 m)
02:56-03:01	17:56-18:01	X070 (07-47.06 S, 103-00.00 E, 6078 m)
05:34-05:40	20:34-20:40	X071 (07-57.68 S, 103-29.99 E, 6165 m)
08:20-08:25	23:20-23:25	X072 (08-08.10 S, 103-59.98 E, 6265 m)
11:06-11:11	02:06-02:11	X073 (08-19.10 S, 104-29.99 E, 6367 m)
13:54-14:00	04:54-05:00	X074 (08-30.32 S, 104-59.99 E, 6644 m)
16:39-16:45	07:39-07:45	X075 (08-40.12 S, 105-29.99 E, 6105 m)
19:22-19:28	10:22-10:28	X076 (08-50.73 S, 105-59.98 E, 4355 m)
22:03-22:09	13:03-13:09	X077 (09-00.68 S, 106-29.99 E, 4045 m)
Oct. 29 (Mon.)		
00:53-00:58	15:53-15:58	X078 (09-11.66 S, 106-59.99 E, 3858 m)
03:50-03:55	18:50-18:55	X079 (09-22.28 S, 107-30.00 E, 3383 m)
06:38-06:44	21:38-21:44	X080 (09-32.59 S, 108-00.01 E, 3364 m)
09:24-09:29	00:24-00:29	X081 (09-43.06 S, 108-30.00 E, 3593 m)
12:12-12:18	03:12-03:18	X082 (09-53.83 S, 109-00.00 E, 3582 m)
14:59-15:04	05:59-06:04	X083 (10-04.26 S, 109-29.99 E, 4693 m)
17:41-17:46	08:41-08:46	X084 (10-14.84 S, 109-59.98 E, 6919 m)
22:35-22:40	13:35-13:40	X085 (10-17.18 S, 111-00.00 E, 4180 m)
Oct. 30 (Tue.)		
03:48-03:54	18:48-18:54	X086 (10-19.06 S, 112-00.02 E, 3779 m)
08:55-09:01	23:55-00:01	X087 (10-20.77 S, 113-00.00 E, 1736 m)
13:54-13:59	04:54-04:59	X088 (10-22.29 S, 113-59.97 E, 2864 m)
18:17-18:23	09:17-09:23	X089 (10-24.33 S, 114-59.98 E, 2470 m)
22:20-22:26	13:20-13:26	X090 (10-26.21 S, 116-00.00 E, 4101 m)
Oct. 31 (Wed.)		
02:12-02:17	17:12-17:17	X091 (10-27.63 S, 117-00.00 E, 4306 m)
06:14-06:19	21:14-21:19	X092-1 (10-29.90 S, 118-00.01 E, 3646 m)
06:25-06:31	21:25-21:31	X092-2 (10-29.98 S, 118-02.14 E, 3663 m)
10:25-10:31	01:25-01:31	X093 (10-31.22 S, 118-59.99 E, 3563 m)
14:54-15:00	05:54-06:00	X094 (10-34.62 S, 119-59.99 E, 1854 m)
Nov. 1 (Thu.)		
		Steaming
Nov. 2 (Fri.)		
		Steaming
Nov. 3 (Sat.)		
10:00-12:15	01:00-03:15	Seminar (Dr. Peter Hacker, Dr. Keisuke Mizuno, Dr. Agus Saleh Atmadipoera and Dr. Rahadian)

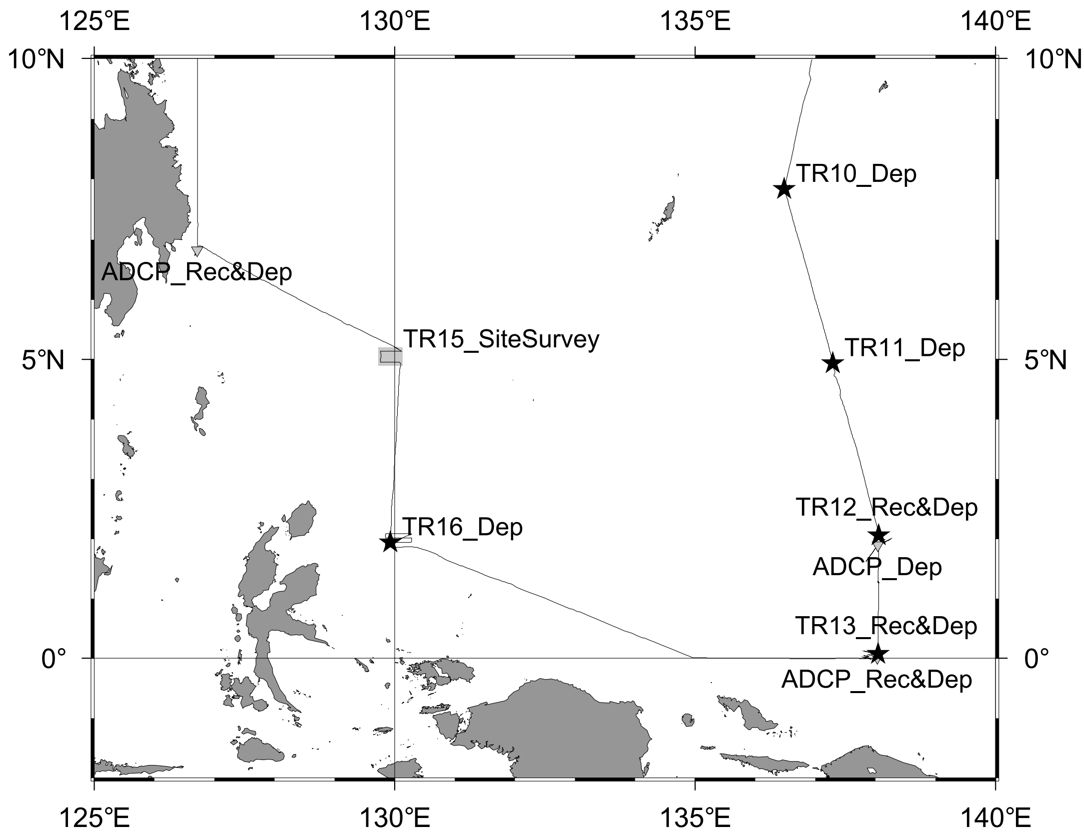
Nov. 4 (Sun.)		
-18:00	-09:00	Stop of continuous surface seawater monitoring
Nov. 5 (Mon.)		
16:00	07:00	Arrival at Koror, Republic of Palau

3.4 Cruise track

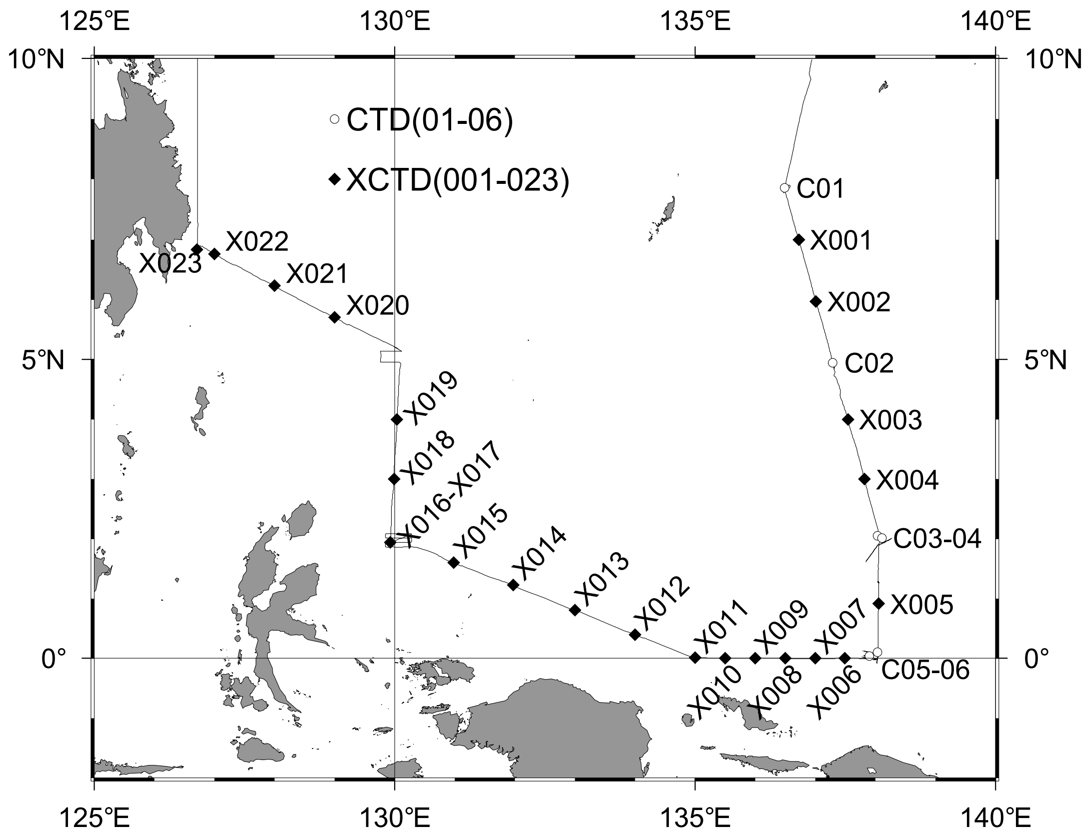




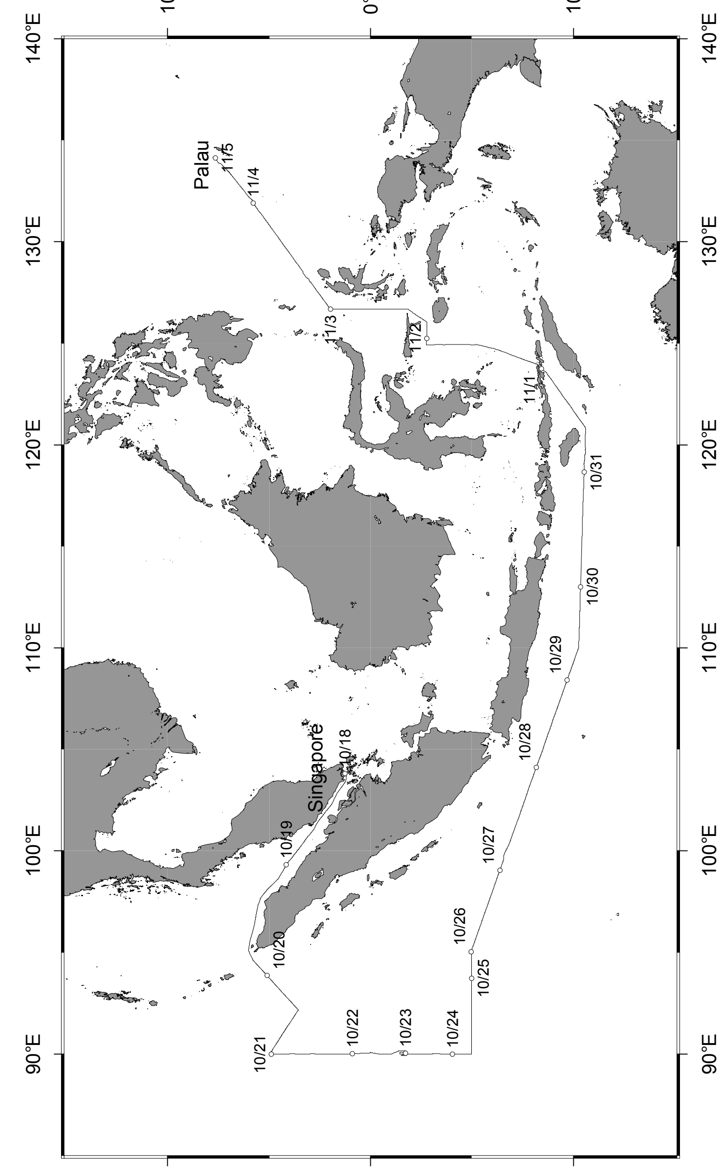
MR01-K05 Leg1 Cruise Track



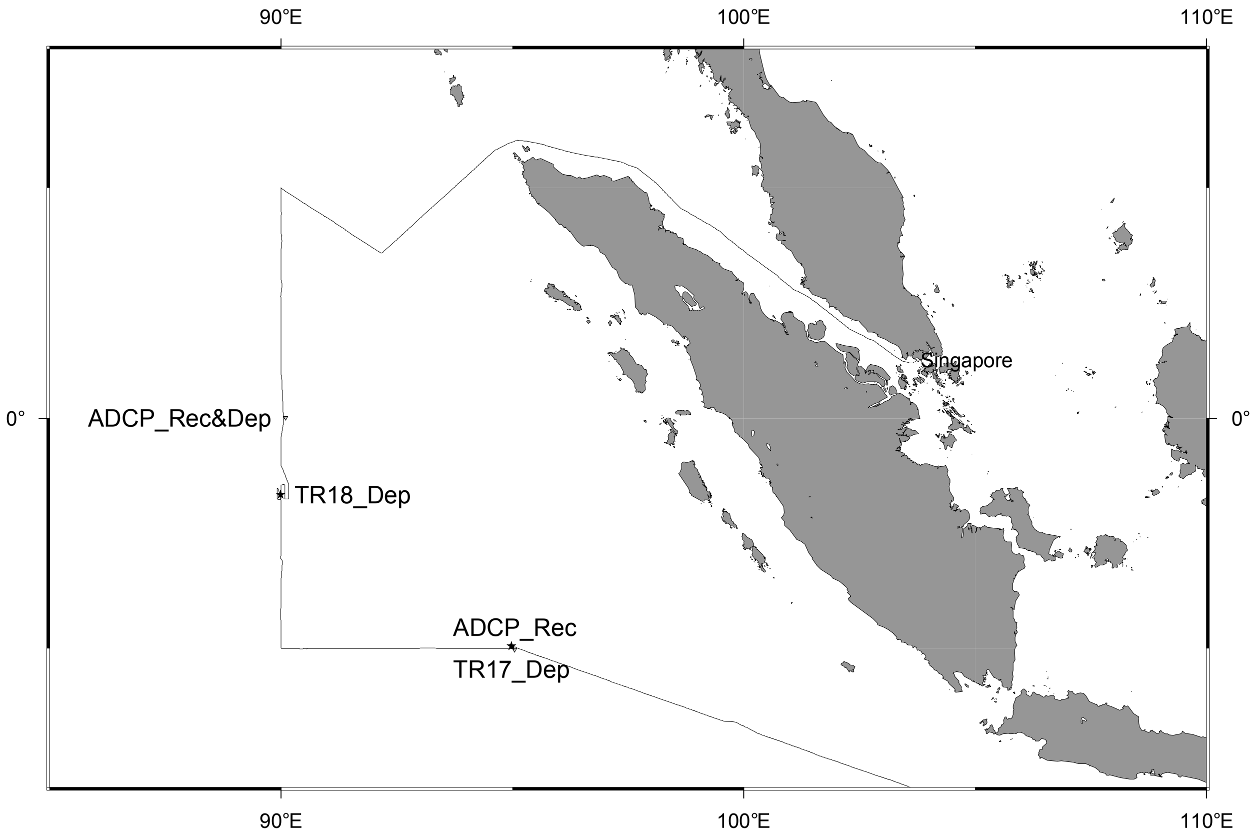
Leg1 TRITON & ADCP



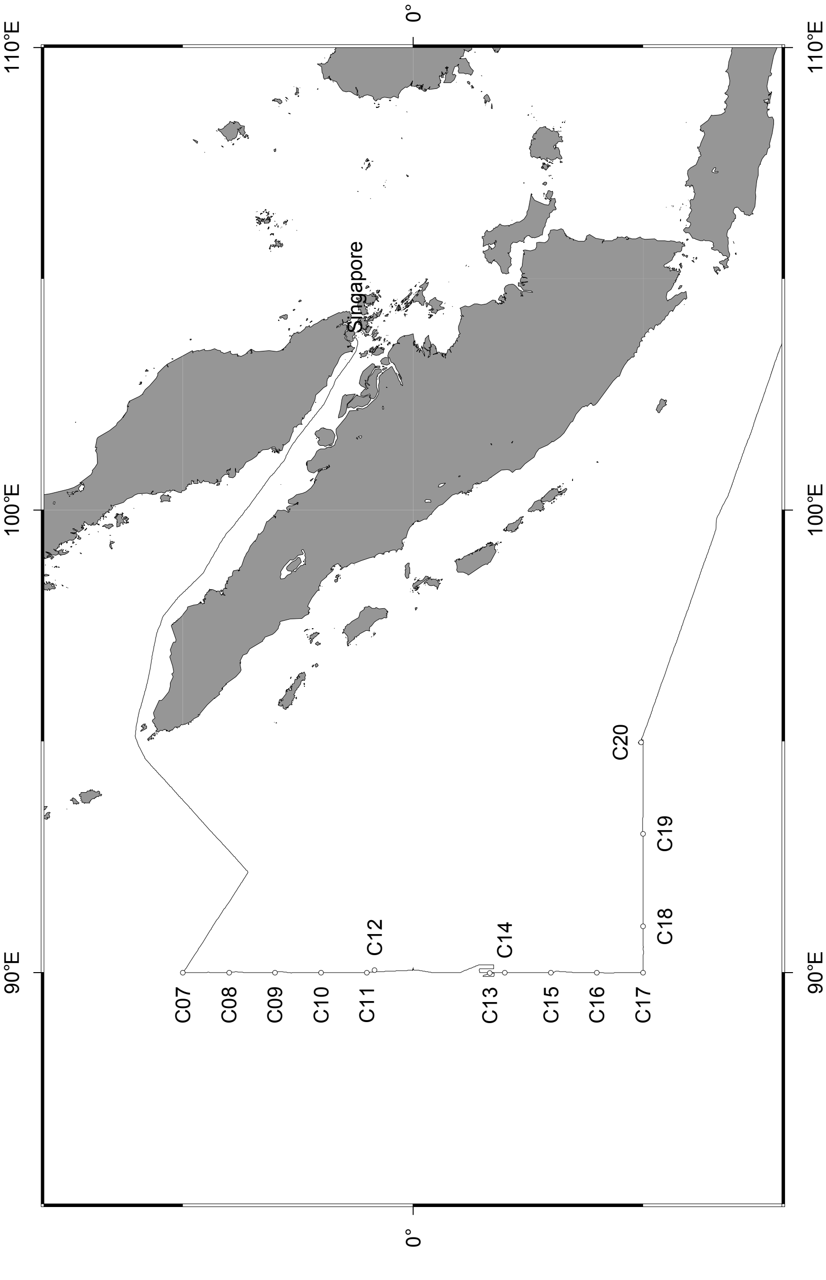
Leg1 CTD & XCTD Observation



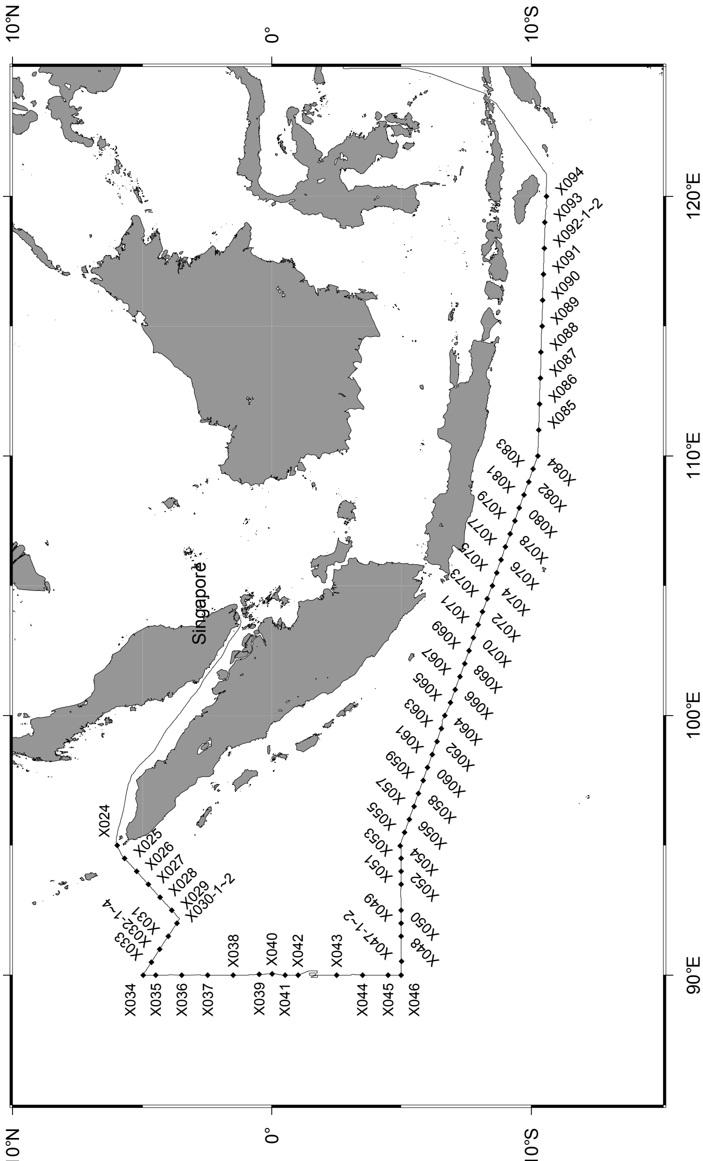
Ship Track (MR01K05) Leg2



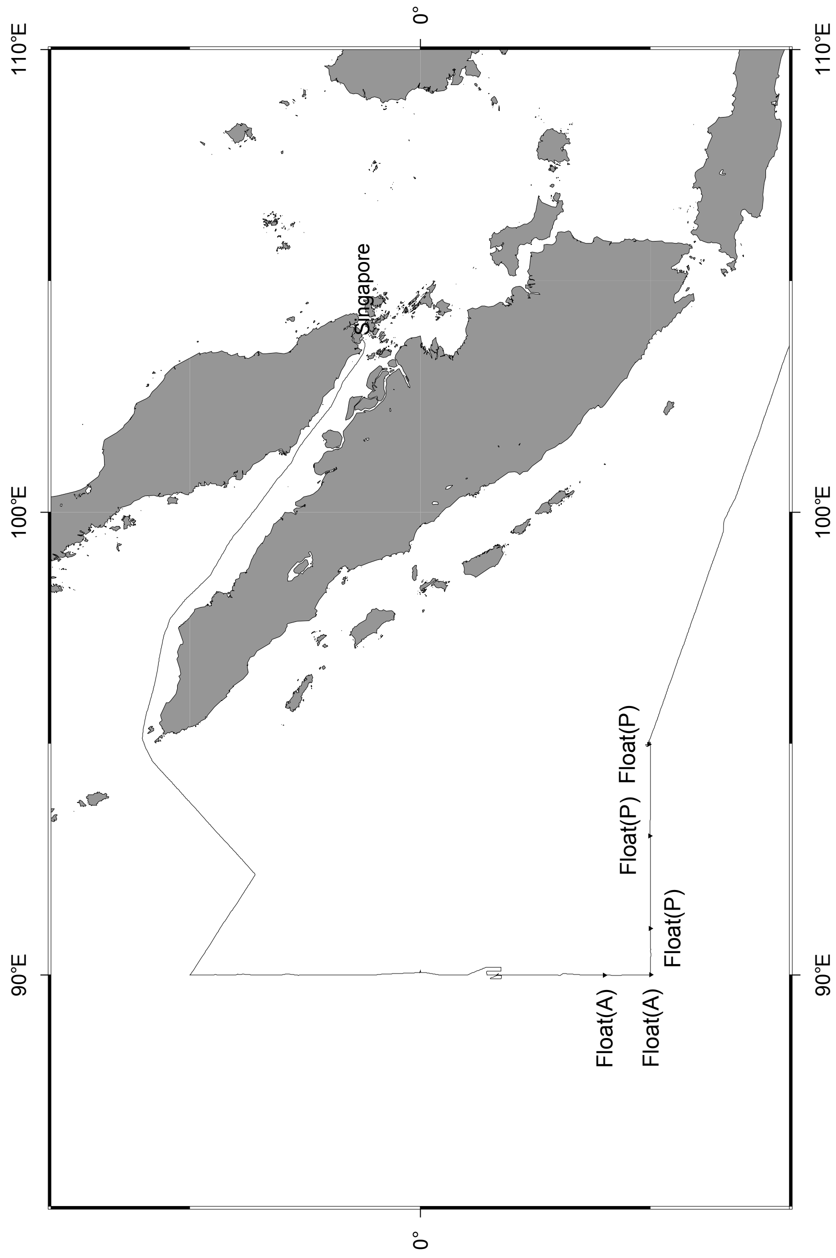
TRITON & ADCP (MR01K05) Leg2



CTD (MR01K05) Leg2



XCTD (MR01K05) Leg2



Float (MR01K05) Leg2

4. Chief scientist

<Leg 1>
Yoshifumi Kuroda
Associate Scientist
Ocean Observation and Research Department,
Japan Marine Science and Technology Center (JAMSTEC)
2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN

<Leg 2>
Keisuke Mizuno, Dr.
Senior Scientist
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Japan Marine Science and Technology Center (JAMSTEC)
2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN

5. Participants list
5.1 R/V Mirai scientist and technical staff

On board Scientist/ Engineers/ Technical Staff

Name	Institute	On board
Yoshifumi Kuroda	JAMSTEC	Sekinehama-Singapore
Keisuke Mizuno	JAMSTEC	Singapore-Palau (1)
Hideaki Hase	JAMSTEC	Sekinehama-Palau (1)
Masayuki Yamaguchi	JAMSTEC	Sekinehama-Singapore
Kensuke Takeuchi	FORSGC	Singapore-Palau (1)
Motoki Miyazaki	FORSGC	Sekinehama-Palau (1)
Agus Saleh Atmadipoera	BPPT	Sekinehama-Palau (1)
Rahadian	BPPT	Sekinehama-Palau (1)
Fernando Vijayan	NIO	Singapore-Palau (1)
Govindan Nampoothiri	NIO	Singapore-Palau (1)
Tata Sudhakar	NIOT	Singapore-Palau (1)
Peter Hacker	Univ. of Hawaii	Singapore-Palau (1)
Ichiro Matsui	NIES	Sekinehama-Singapore
Atsushi Shimizu	NIES	Singapore-Palau (1)
Akihide Kamei	CRL	Sekinehama-Singapore
Yuichi Ohno	CRL	Singapore-Palau (1)
Satoshi Okumura	GODI	Sekinehama-Singapore
Wataru Tokunaga	GODI	Sekinehama -Palau (1)
Akinori Uchiyama	GODI	Singapore-Palau (1)
Shinya Iwamida	GODI	Singapore-Palau (1)
Takuya Yoshida	GODI	Sekinehama-Singapore
Masayuki Fujisaki	MWJ	Sekinehama-Palau (1)
Atsuo Ito	MWJ	Singapore-Palau (1)
Takehiro Matsumoto	MWJ	Sekinehama-Singapore
Mizue Hirano	MWJ	Sekinehama-Palau (1)
Takayoshi Seike	MWJ	Sekinehama-Palau (1)
Tomoko Miyashita	MWJ	Sekinehama-Palau (1)
Kei Suminaga	MWJ	Sekinehama-Palau (1)
Tomohiko Sugiyama	MWJ	Sekinehama-Palau (1)
Soichi Moriya	MWJ	Sekinehama-Palau (1)
Junko Hamanaka	MWJ	Sekinehama-Palau (1)
Minoru Motoyanagi	MWJ	Sekinehama-Palau (1)
Fuma Matsunaga	MWJ	Sekinehama-Palau (2)
Nobuyuki Momosaka	Okayama Univ. of Sci.	Sekinehama-Singapore
Takayuki Nakao	Okayama Univ. of Sci.	Singapore-Palau (1)
Jaka Prastya	PUSSURTA TNI	Sekinehama-Palau (1)
Gabriel Yong Yot Vui	U. Brunei Darussalam	Sekinehama-Singapore
Mahammad Helmi Abdullah	Malaysian Meteorological Service	Singapore-Palau (1)
Osamu Miyauchi	EMS	Sekinehama-Singapore

(1) First port call
(2) Second port call

5.2. R/V MIRAI Crew member

Leg1:

Master	Masaharu Akamine
Chief Officer	Takaaki Hashimoto
1st Officer	Yuji Shibata
2nd Officer	Haruhiko Inoue
3rd Officer	Mitsunobu Asanuma
Chief Engineer	Koichi Higashi
1st Engineer	Nobuya Araki
2nd Engineer	Hiroaki Narumi
3rd Engineer	Koji Masuno
C.R.Officer	Shuji Nakabayashi
2nd.R.Officer	Naoto Morioka
Boatswain	Kenetsu Ishikawa
Able Seaman	Hirokazu Kinoshita
Able Seaman	Seiichiro Kawata
Able Seaman	Kazunori Horita
Able Seaman	Hisao Oguni
Able Seaman	Yuji Inoue
Able Seaman	Masaru Suzuki
Able Seaman	Kazuyoshi Kudo
Able Seaman	Takeharu Aisaka
Able Seaman	Tsuyoshi Monzawa
Able Seaman	Masashige Okada
Able Seaman	Shuji Komata
No.1 Oiler	Yukitoshi Horiuchi
Oiler	Fumio Inoue
Oiler	Yoshihiro Sugimoto
Oiler	Toshio Matsuo
Oiler	Kazumi Yamashita
Oiler	Daisuke Taniguchi
Chief Steward	Yasuaki Koga
Cook	Yasutaka Kurita
Cook	Takayuki Akita
Cook	Hatsuji Hiraishi
Cook	Kozo Uemura
Cook	Hiroyuki Yoshizawa

Leg2:

Master	Masaharu Akamine
Chief Officer	Takaaki Hashimoto
1st Officer	Yuji Shibata
2nd Officer	Haruhiko Inoue
３rd Officer	Takeshi Isohi
Chief Engineer	Koichi Higashi
1st Engineer	Nobuya Araki
2nd Engineer	Koji Masuno
3rd Engineer	Takahiro Machino
C.R.Officer	Shuji Nakabayashi
2nd.R.Officer	Keiichiro Shishido
Boatswain	Hirokazu Kinoshita
Able Seaman	Hisashi Naruo
Able Seaman	Yasuyuki Yamamoto
Able Seaman	Seiichiro Kawata
Able Seaman	Kunihiko Omote
Able Seaman	Kazunori Horita
Able Seaman	Masaru Suzuki
Able Seaman	Kazuyoshi Kudo
Able Seaman	Tsuyoshi Sato
Able Seaman	Takeharu Aisaka
Able Seaman	Tsuyoshi Monzawa
Able Seaman	Shuji Komata
No.1 Oiler	Sadanori Honda
Oiler	Yoshihiro Sugimoto
Oiler	Takashi Miyazaki
Oiler	Toshio Matsuo
Oiler	Kazumi Yamashita
Oiler	Daisuke Taniguchi
Chief Steward	Yasuaki Koga
Cook	Yasutaka Kurita
Cook	Takayuki Akita
Cook	Hatsuji Hiraishi
Cook	Hitoshi Ota
Cook	Hiroyuki Yoshizawa

6.1 Meteorological observation

6.1.1 Surface meteorological observation

(1) Personnel

Yoshifumi Kuroda (JAMSTEC)	Principal Investigator	-Leg1-
Keisuke Mizuno (JAMSTEC)	Principal Investigator	-Leg2-
Hideaki Hase (JAMSTEC)		-Leg1, 2-
Satoshi Okumura (GODI)		-Leg1-
Takuya Yoshida (GODI)		-Leg1-
Shinya Iwamida (GODI)		-Leg2-
Wataru Tokunaga (GODI)		-Leg1, 2-

(2) Objectives

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

(3) Methods

The surface meteorological parameters were observed throughout MR01-K05 cruise from the departure of Sekinehama, Japan on 20 September 2001 to the arrival of Koror, Republic of Palau on 5 November 2001.

This cruise, we used 2 systems for the surface meteorological observation.

1. Mirai meteorological observation system
2. Shipboard Oceanographic and Atmospheric Radiation (SOAR) system
3. Total Sky Imager (TSI)

The measured parameters of each system are listed in Table 6.1.1-1, 6.1.1-2, 6.1.1-3, 6.1.1-4 and 6.1.1-5.

(3-1) Mirai meteorological observation system

Instruments and archived parameters of Mirai meteorological observation system are listed in the table below. Data was collected and processed by KOAC-7800 weather data processor made by Koshin Denki, Japan. The data set has 6-second averaged every 6-second record and 10-minute averaged every 10-minute record.

Table 6.1.1-1 Instrument and their installation locations
of Mirai meteorological observation system

Sensors	Type	Manufacturer	Location (altitude from base line)
Anemometer	KE-500	Koshin Denki, Japan	Foremast (30m)
Thermometer	FT	Koshin Denki, Japan	Compass deck (27m)
Dewpoint meter	DW-1	Koshin Denki, Japan	Compass deck (27m)
Barometer	F451	Yokogawa, Japan	Captain deck (20m)
	Weather station room (tubing outside)		
Capacitive rain gauge	50202	R. M. Young, USA	Compass deck (25m)
Optical Rain gauge	ORG-115DR	ScTi, USA	Compass deck (25m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	Radar mast (28m)
Radiometer (long wave)	MS-200	Eiko Seiki, Japan	Radar mast (28m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	Bow (16m)

Table 6.1.1-2 Parameter of Mirai meteorological observation system

	Parameter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log
4	Ship's heading	degree	Mirai Gyro compass
5	Relative wind speed	m/s	6 sec. / 10 min. average
6	Relative wind direction	degree	6 sec. / 10 min. average
7	True wind speed	m/s	6 sec. / 10 min. average
8	True wind direction	degree	6 sec. / 10 min. average
9	Barometric pressure	hPa	6 sec. / 10 min. average Adjusted to the sea surface level
10	Air temperature (starboard side)	deg-C	6 sec. / 10 min. average
11	Air temperature (port side)	deg-C	6 sec. / 10 min. average
12	Dewpoint temperature (starboard side)	deg-C	6 sec. / 10 min. average
13	Dewpoint temperature (port side)	deg-C	6 sec. / 10 min. average
14	Relative humidity (starboard side)	%	6 sec. / 10 min. average
15	Relative humidity (port side)	%	6 sec. / 10 min. average
16	Rain rate (optical rain gauge)	mm/hr	1 hr / 12 hr accumulated
17	Rain rate (capacitive rain gauge)	mm/hr	1 hr / 12 hr accumulated
18	Down welling shotwave radiometer		Momentary / 12 hr accumulated
19	Down welling infra-red radiometer		Momentary / 12 hr accumulated
20	Sea surface temperature	deg-C	Under the water line –5 m
21	Significant wave height (fore)	m	3 hourly
22	Significant wave height (aft)	m	3 hourly
23	Significant wave period (fore)	second	3 hourly
24	Significant wave period (aft)	second	3 hourly

(3-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system, designed by BNL (Brookhaven National Laboratory, USA), is consisted of 3 parts.

1. Portable Radiation Package (PRP) designed by BNL – short and long wave down welling radiation.
2. Zeno meteorological system designed by BNL – wind, Tair/RH, pressure and rainfall measurement.
3. Scientific Computer System (SCS) designed by NOAA (National Oceanographic and Atmospheric Administration, USA) - centralized data acquisition and logging of all data sets.

SCS recorded PRP data every 6.5 seconds and Zeno meteorological data every 10 seconds. Instruments and their location are listed in Table 6.1.1-3. The archived parameters are in Table 6.1.1-4.

Table 6.1.1-3 Instruments installation locations of SOAR system

Sensor	Type	Manufacturer	Location (altitude from base line)
Anemometer	05106	R. M. Young, USA	Foremast (31m)
Tair/RH	HMP45A	R. M. Young, USA	Foremast (29m)
	With 43408 Gill aspirated radiation shield (R. M. Young)		
Barometer	61201	R. M. Young, USA	Foremast (30m)
	With 61002 Gill pressure port (R. M. Young)		
Capacitive rain gauge	50202	R. M. Young, USA	Foremast (30m)
Optical rain gauge	ORG-115DA	ScTi, USA	Foremast (30m)
Radiometer (short wave)	PSP	Eppley labs, USA	Foremast (31m)
Radiometer (long wave)	PIR	Eppley labs, USA	Foremast (31m)
Fast rotating Shadowband radiometer		Yankee, USA	Foremast (31m)

Table 6.1.1-4 Parameters of SOAR system

	Parameters	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Speed Over Ground (SOG)	knot	
4	Course Over Ground (COG)	degree	
5	Relative wind speed	m/s	
6	Relative wind direction	degree	
7	Barometric pressure	hPa	
8	Air temperature	deg-C	
9	Relative humidity	%	
10	Rain rate (optical rain gauge)	mm/hr	
11	Precipitation (capacitive rain gauge)	mm	Reset at 50 mm
12	Down welling shortwave radiation	W/m^2	
13	Down welling infra-red radiation	W/m^2	
14	Defuse irradiation	W/m^2	

(3-3) Total Sky Imager

The Total Sky Imager (TSI) at the top deck midship, altitude of 23m from base line. TSI was developed jointly by Penn. State University, BNL and Yankee Environmental System, Inc.(YES Inc.) and manufactured by YES Inc.. TSI recorded every 5 minutes from dawn to sunset. The archived parameters are in Table 6.1.1-5.

Table 6.1.1-5 Parameter of TSI System

	Parameters	Units	Remarks
1	Opaque cloud cover	%	
2	Thin cloud cover	%	

(4) Preliminary results

The time series of Wind (converted to U, V component), Air temperature, and Relative Humidity form SOAR system, Surface Pressure and Rainfall from Mirai meteorological observation system until 00Z November 4, 2001 is shown in Fig. 6.1.1. The time series of total cloud cover ratio from TSI system until 00Z November 4, 2001 is shown in Fig. 6.1.2-2 with Ceilometer Sky Condition.

(5) Data archives

These raw data obtained in this cruise will be submitted to the Data Management Office (DMO) in JAMSTEC, and will be opened to the public via "R/V Mirai Data Web Page" in JAMSTEC home page.

(6) Remarks

Radiometers for upwelling radiation measurement of Mirai meteorological observation system were not installed during this cruise. We did not sample the data in the EEZ of Socialist Republic of Vietnam from 02:29 (UTC) 12 October to 12:15 (UTC) 15 October 2001.

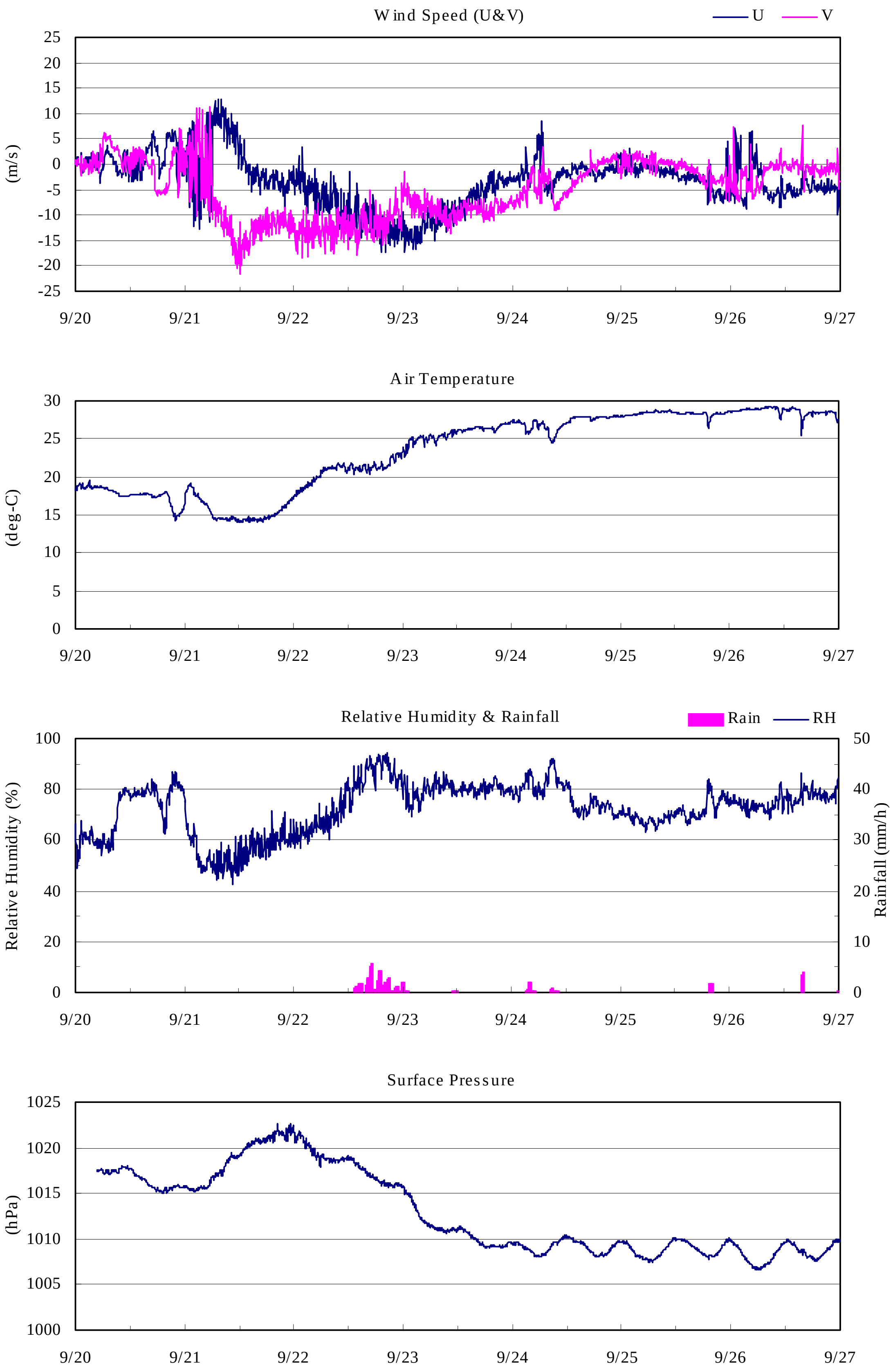


Fig. 6.1.1 Time series of Meteorological observation

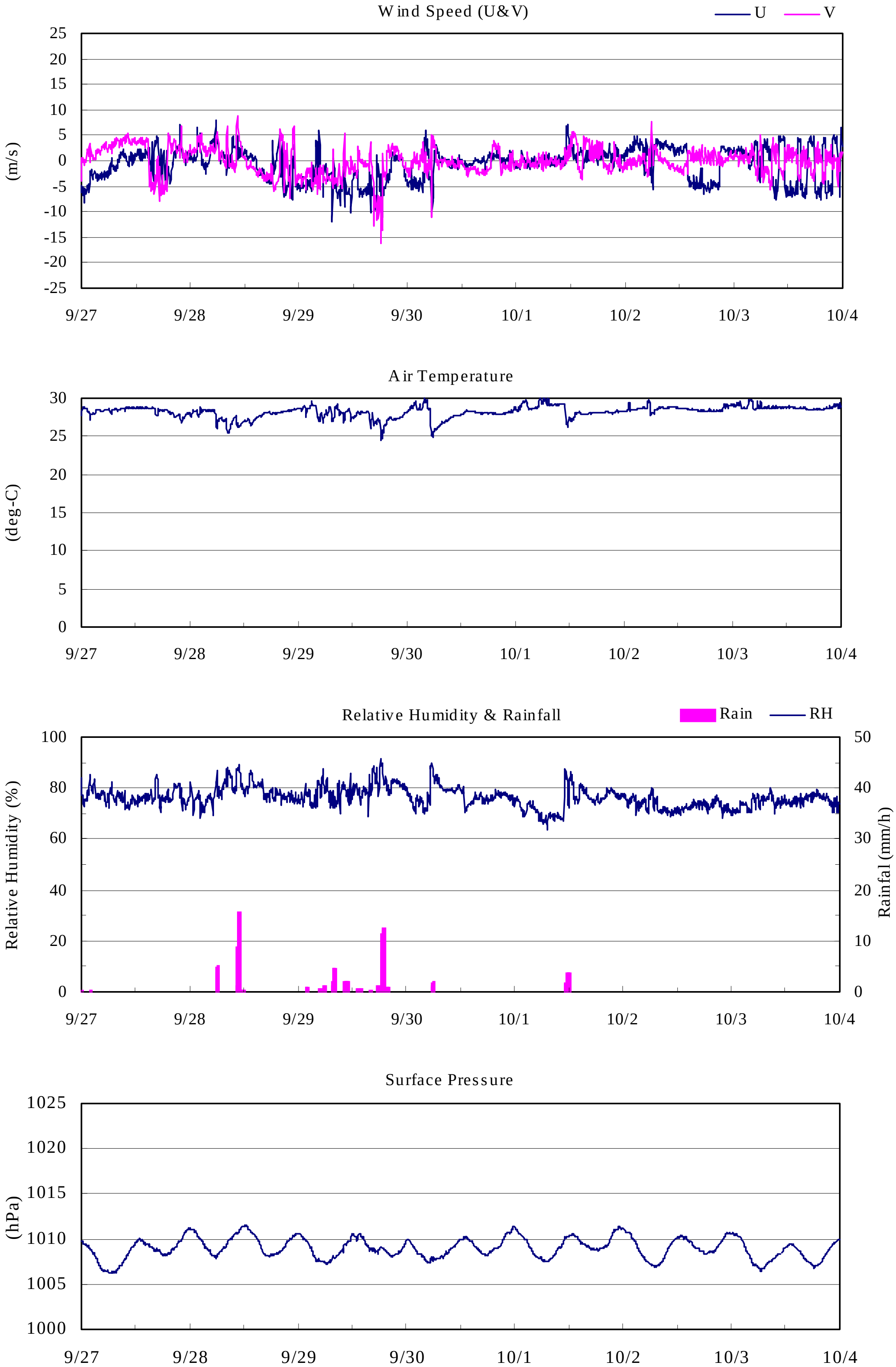


Fig. 6.1.1 (continued)

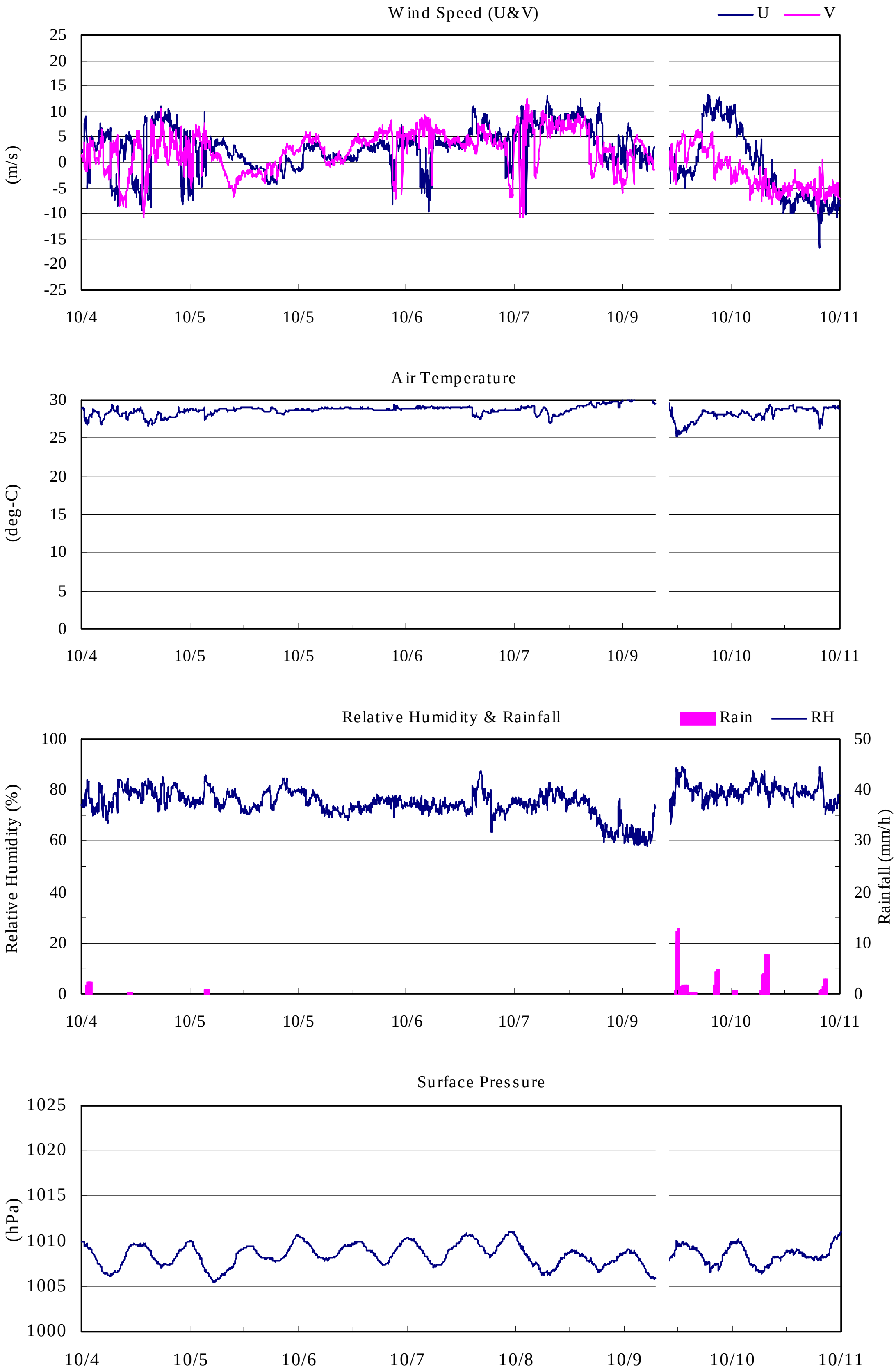


Fig. 6.1.1 (continued)

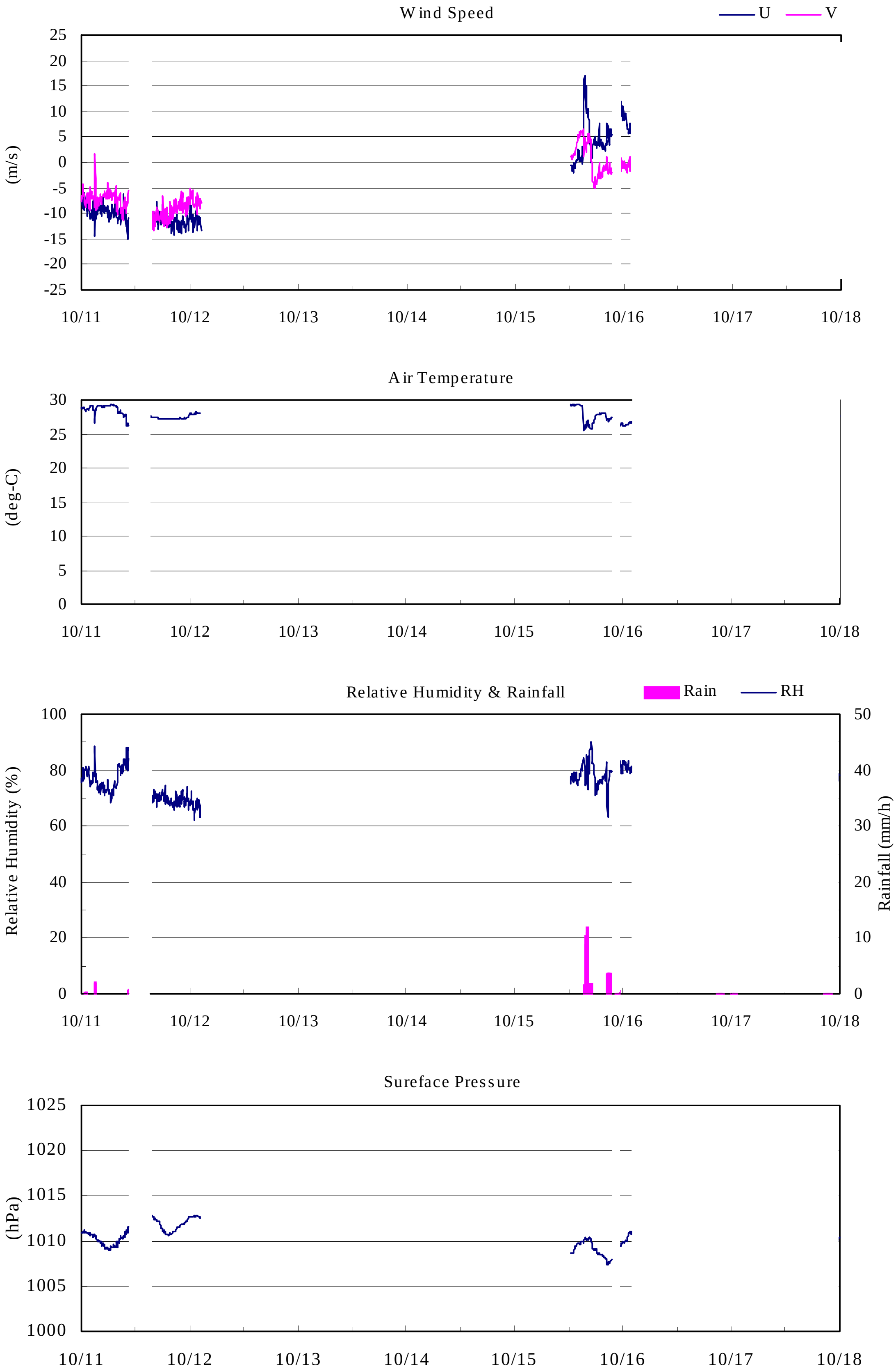


Fig. 6.1.1 (continued)

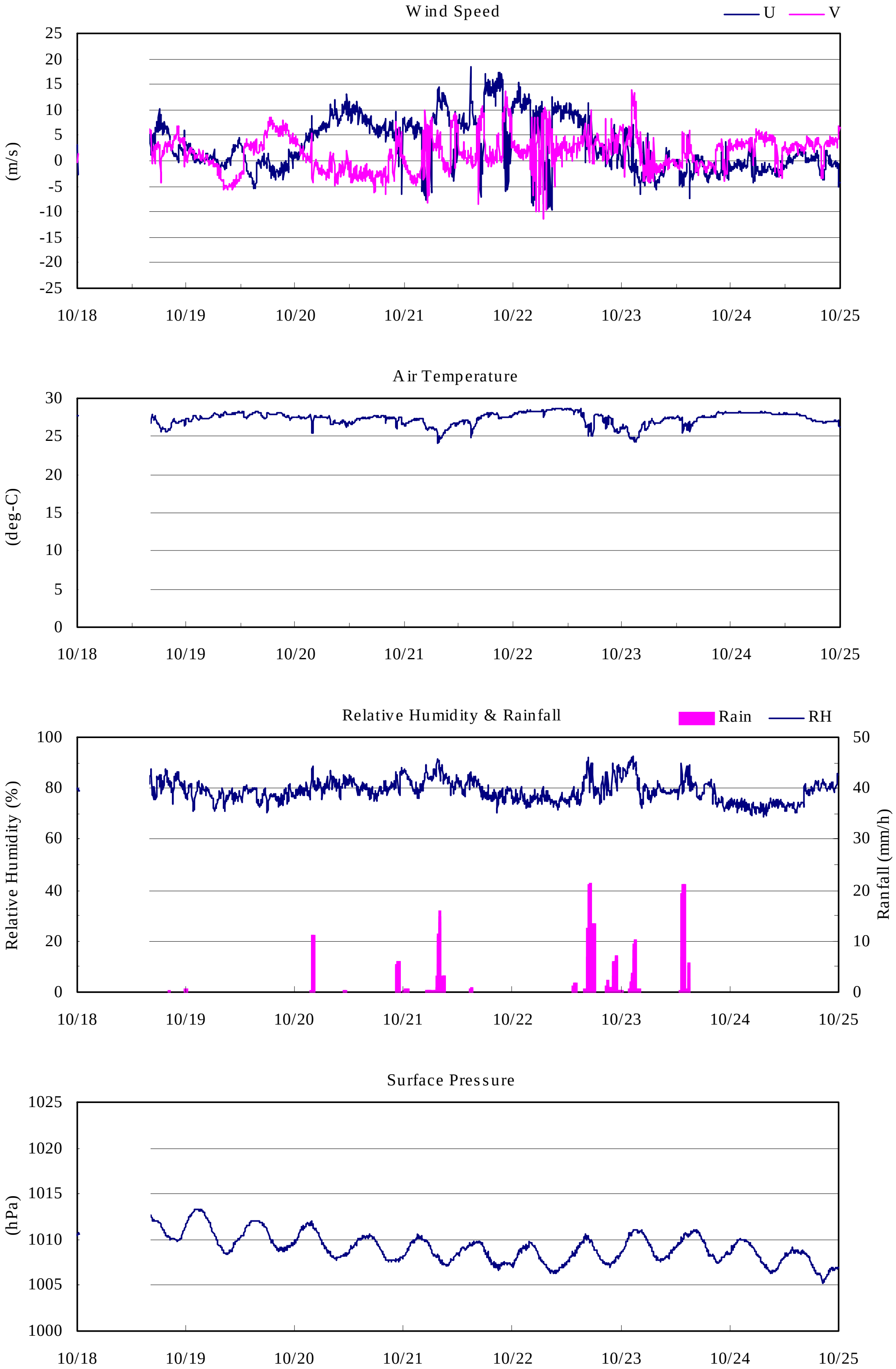


Fig. 6.1.1 (continued)

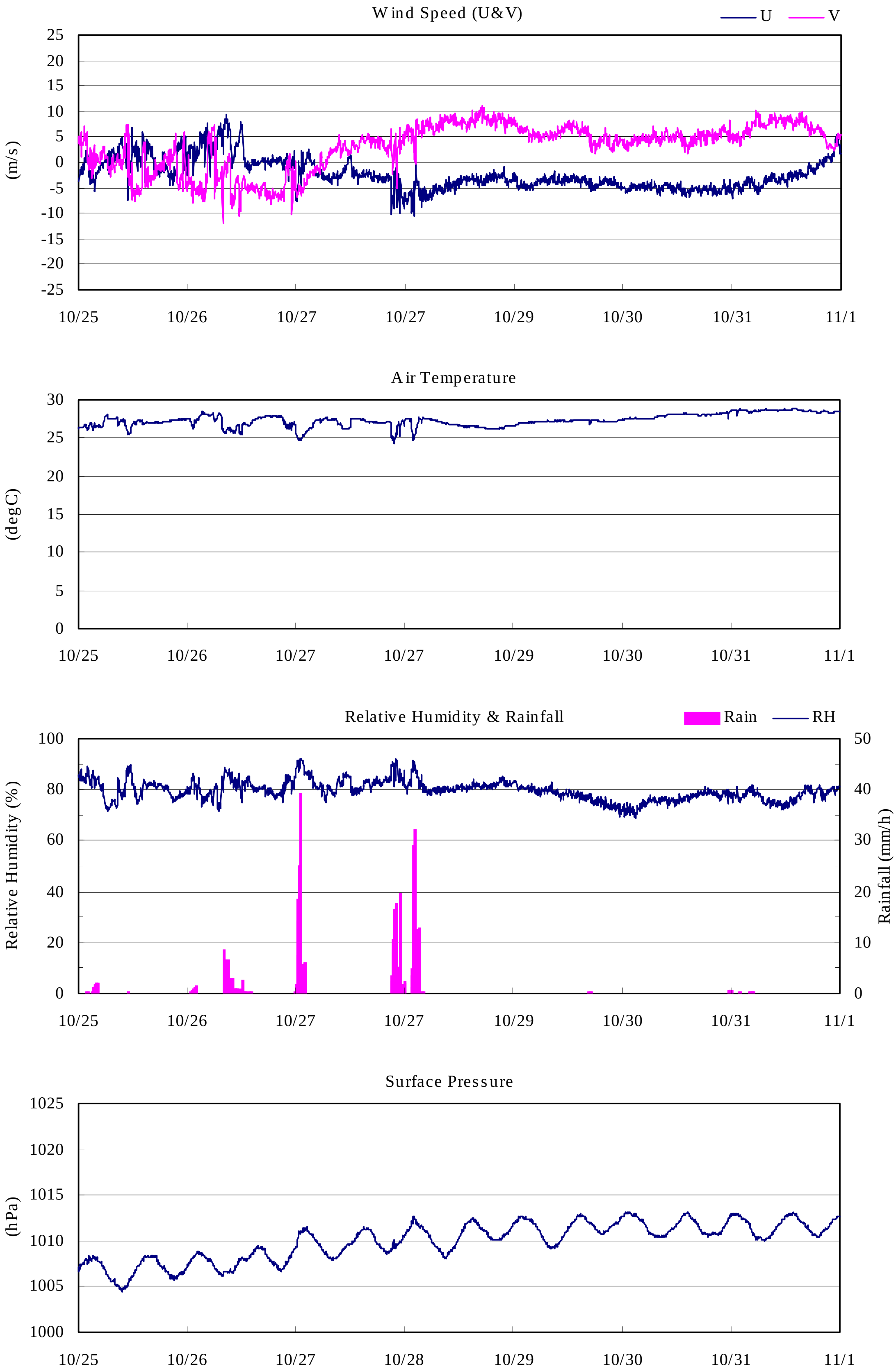


Fig. 6.1.1 (continued)

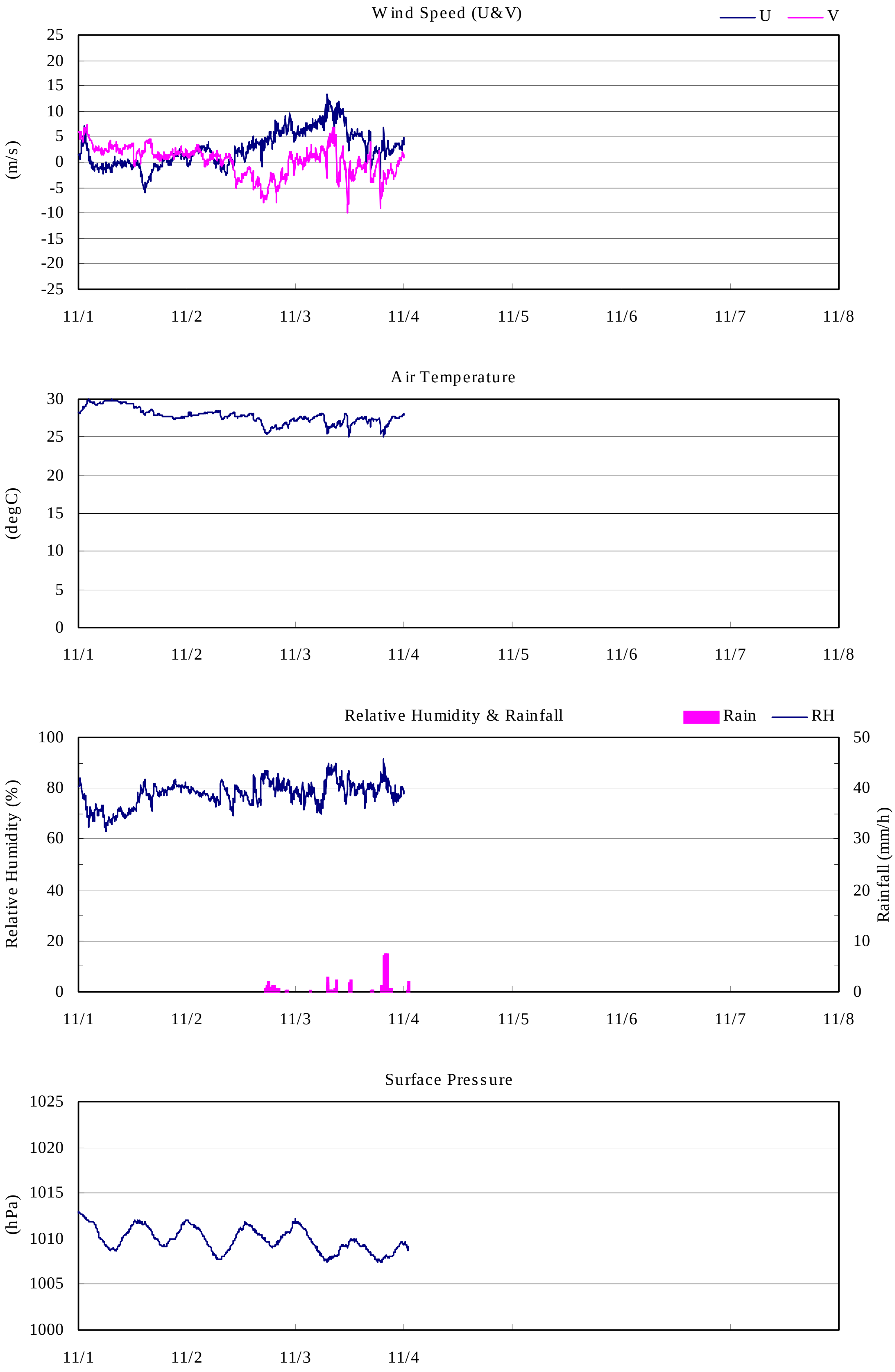


Fig. 6.1.1 (continued)

6.1.2 Ceilometer Observation

(1) Personnel

Yoshifumi Kuroda (JAMSTEC)	Principal Investigator	-Leg 1-
Keisuke Mizuno (JAMSTEC)	Principal Investigator	-Leg 2-
Satoshi Okumura (GODI)		-Leg 1-
Takuya Yoshida (GODI)		-Leg 1-
Shinya Iwamida (GODI)		-Leg 2-
Wataru Tokunaga (GODI)		-Leg 1, 2-

(2) Objectives

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

(3) Parameters

(3-1) Cloud base height [m]

(3-2) Backscatter profile, sensitivity and range normalized at 50ft resolution.

(3-3) Cloud cover [oktas] and height [m]; Sky Condition

(4) Methods

We measured cloud base height, backscatter profiles and Sky Condition (cloud cover) using CT-25K ceilometer (Ver. 2.0.) made by Vaisara, Finland and recorded by CT-VIEW software (Ver. 2.1.) made by Vaisara, Finland throughout MR01-K05 cruise from the departure of Sekinehama, Japan on 20 September 2001 to the arrival of Koror, Republic of Palau on 5 November 2001.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode Laser
Transmitting wavelength:	905 +/- 5 nm at 25 degree-C
Transmitting average power:	8.9 mW
Repetition rate:	5.57 kHz
Detector:	Silicon Avalanche Photodiode (APD)
Responsively 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 ~ 8 oktas

(5) Preliminary results

The time series of the detected cloud base height during the cruise is shown in Fig. 6.1.2-1 “C1”(Blue) is the lowest cloud base height, “C2”(Red) is the second lowest cloud base height, and “C3”(Green) is the highest cloud base height. And the time series of cloud cover of Sky Condition (oktas) and TSI (%) until 00Z 4 November 2001 is shown in Fig. 6.1.2-2. The results will be public after the analyses in the future.

(6) Data archives

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

(7) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam. 02:29 (UTC) 12 October to 12:15 (UTC) 15 October 2001.

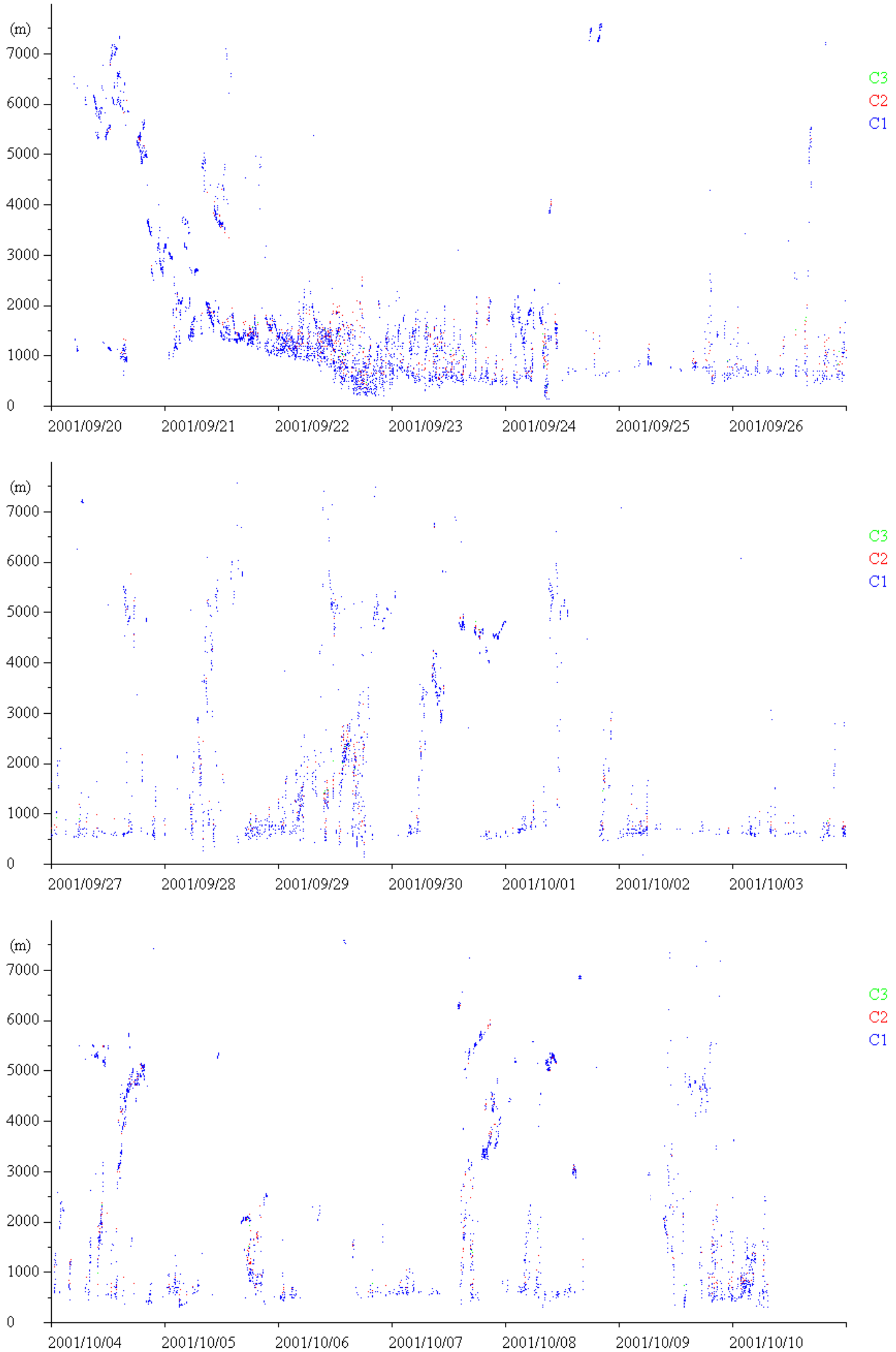


Fig. 6.1.2 Time series of Cloud base height

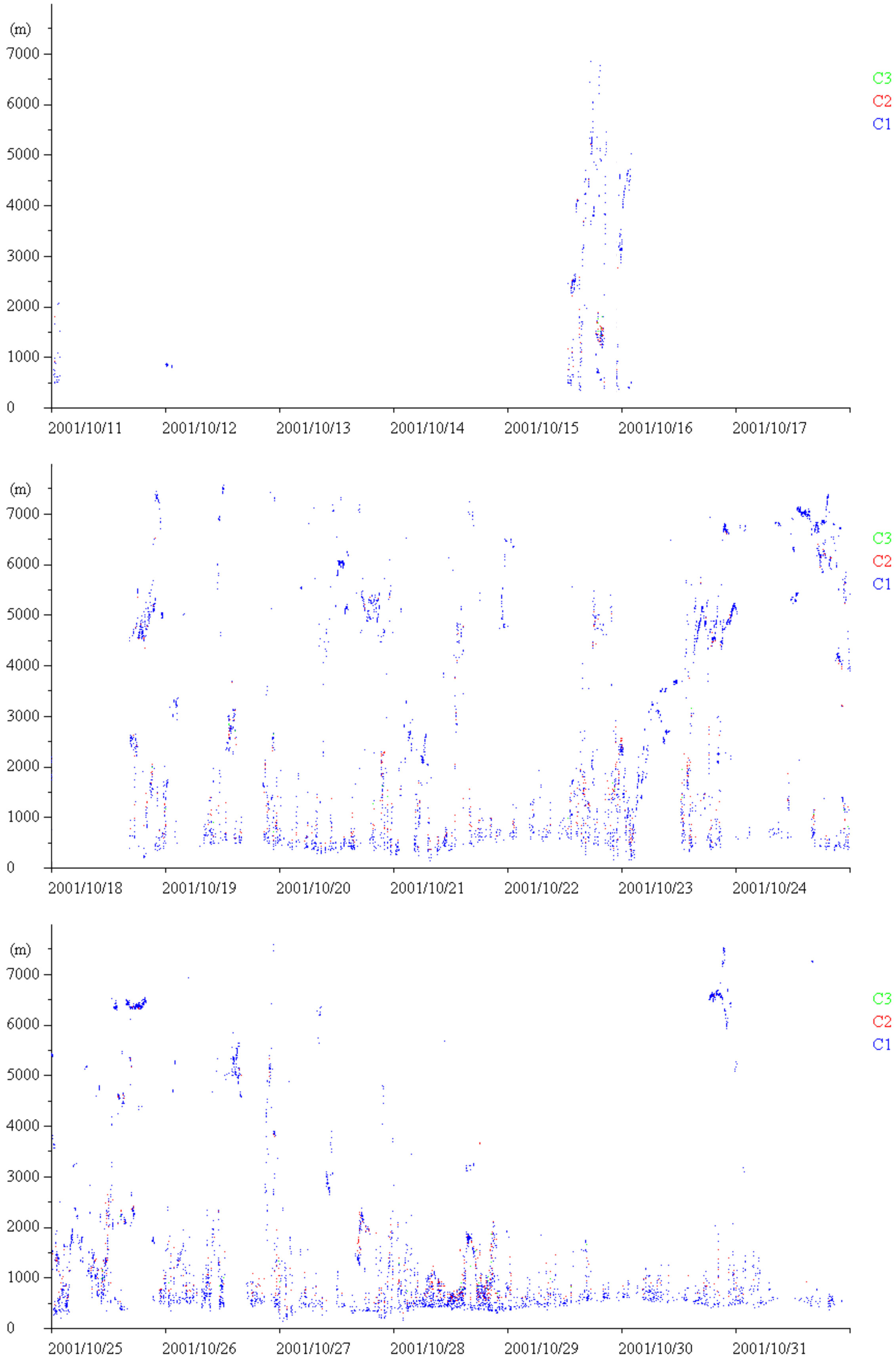


Fig. 6.1.2-1 (continued)

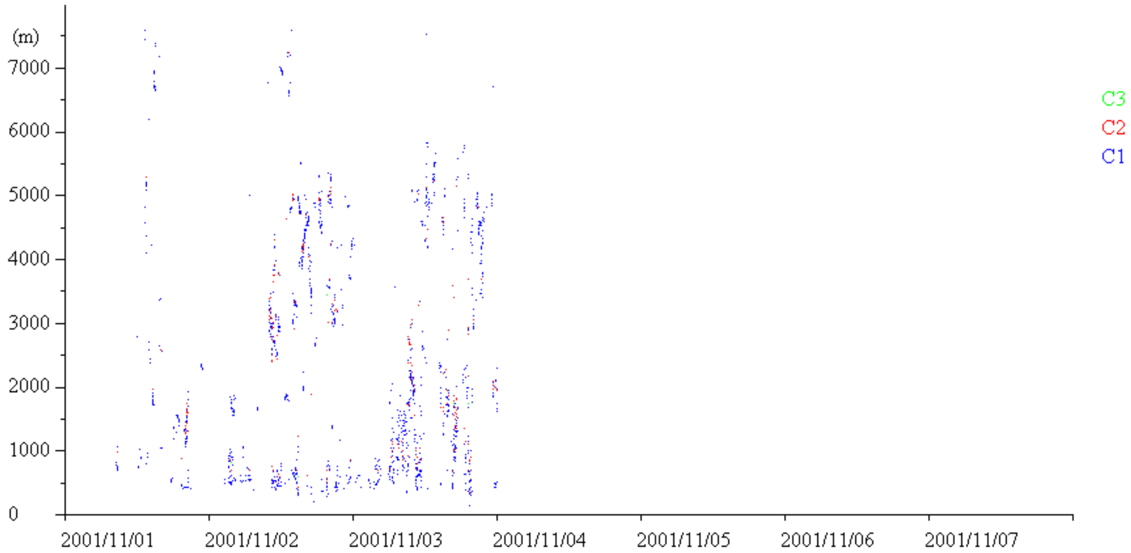


Fig. 6.1.2-1 (continued)

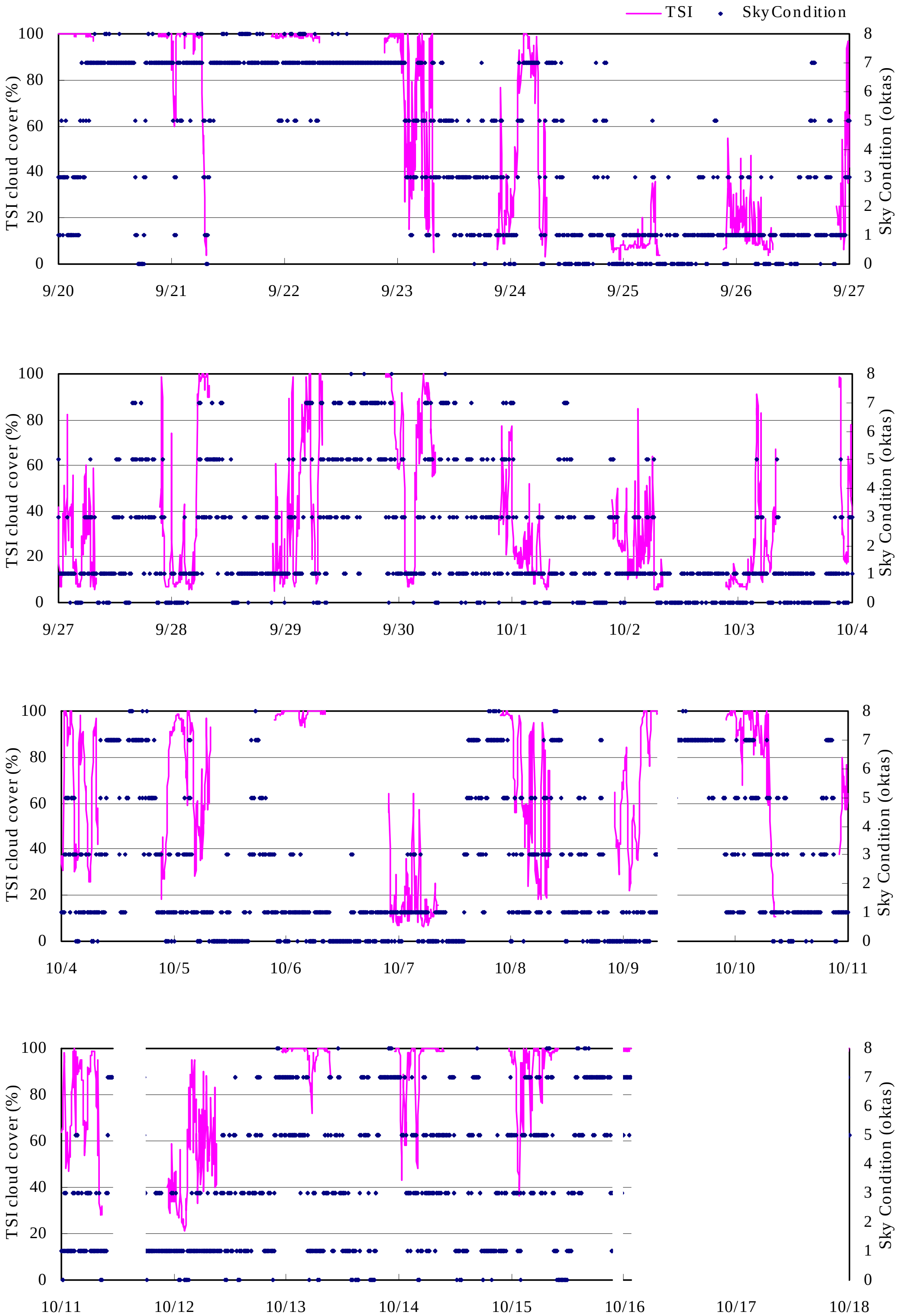


Fig. 6.1.2-2 The time series of cloud cover of Sky Condition (oktas) and TSI (%)

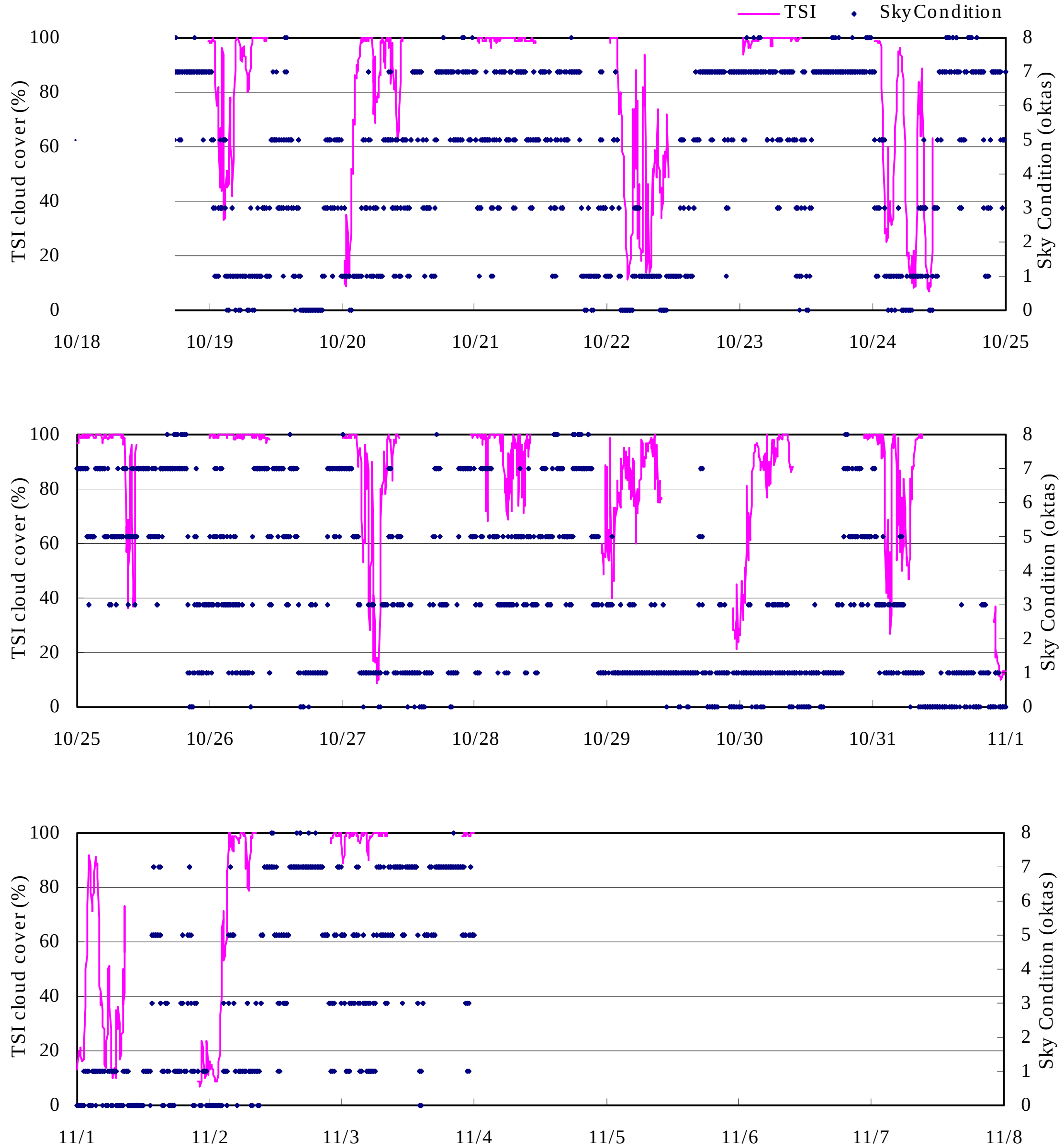


Fig. 6.1.2-1 (continued)

6.2 CTD/XCTD
6.2.1 CTD

(1) Personnel

Yoshifumi Kuroda (JAMSTEC):	Principal Investigator	(Leg.1)
Keisuke Mizuno (JAMSTEC):	Principal Investigator	(Leg.2)
Hideaki Hase (JAMSTEC):	Scientist	

Atsuo Ito (MWJ)
Masayuki Fujisaki (MWJ)
Takeo Matsumoto (MWJ)
Mizue Hirano (MWJ)
Takayoshi Seike (MWJ)
Kei Suminaga (MWJ)
Junko Hamanaka (MWJ)
Soichi Moriya (MWJ)
Fuma Matsunaga (MWJ)
Minoru Motoyanagi (MWJ)

(2) Objective

Investigation of oceanic structure.

(3) Parameters

Temperature
Conductivity
Pressure
Dissolved Oxygen (during leg 2)

(4) Methods

CTD/Carousel Water Sampling System, which is a 12-positions Calousel water sampler with Sea-Bird Electronics Inc. CTD (SBE9plus), was used during this cruise. 12-litters Niskin Bottles were used for sampling seawater. The sensors attached on CTD were a temperature sensor, a conductivity sensor, pressure sensor, dissolved oxygen sensor. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from star-board on working deck.

The CTD raw data were acquired on real time by using the SEASAVE utility from the SEASOFT software (ver.4.232) provided by SBE and stored on the hard disk of a personal computer. Seawater was sampled during up-cast by sending a fire command from the personal computer. We sampled seawater from 12 layers to calibrate salinity data during at all the stations. In the Indian ocean, we sampled seawater at 12 layers for chemical analysis (Table 6.2.1-(1)).

The CTD raw data was processed using SEASOFT (ver.4.232). Data processing procedures and used utilities of SEASOFT were as follows:

DATCNV: Convert the binary raw data to output on physical units.
This utility selects the CTD data when bottles closed to output on another file.

SECTION: Remove the unnecessary data.

ALIGNCTD: ALIGNCTD aligns oxygen measurements in time relative to pressure.
Oxygen sensor relative to pressure = 3.0 seconds

WILDEDIT: Obtain an accurate estimate of the true standard deviation of the data.
Std deviation for pass 1: 2
Std deviation for pass 2: 10
Point per block: 48

CELLTM:	Remove conductivity cell thermal mass effects from measured conductivity.
	Alpha = 0.3
	1/beta = 7.0
FILTER:	Filter the high frequency noise on the data
	Filter A = 0.15sec
	Variable to Filter: Pressure: Low Pass Filter A
LOOPEDIT:	Mark scan with 'badflag', if the CTD velocity is less than 0 m/s.
	Minimum Velocity Selection = Fixed Minimum Velocity
	Minimum CTD Velocity [m/sec] = 0.0
	Exclude Scan Marked Bad in LOOPEDIT = Yes
DERIVE:	Calculate oxygen data.
BINAVG:	Calculate the averaged in every 1 db.
DERIVE:	Calculate oceanographic parameters.
SPLIT:	Splits the data made in CNV files into up-cast and down-cast files.
ROSSUM:	Edits the data of water sampled to output a summary file.

Configuration file

St.C01 – C14: MR01K05.con
St.C15 – C20: MR01K05d.con

Specifications of the sensors are listed below.

CTD: SBE911plis CTD system
Under water unit: CTD 9plus (S/N 09P7030-0280, Sea-bird Electronics, Inc.)
Temperature sensors:
SBE3-04/F Primary sensor (S/N 032453, Sea-bird Electronics, Inc.)
Calibrated Date: 03 Aug. 2001
Conductivity sensors:
SBE4-04/F Primary sensor (S/N 042240, Sea-bird Electronics, Inc.)
Calibrated Date: 03 Aug. 2001
Pressure sensor: Digiquartz pressure sensor (S/N 51190)
Calibrated date: 02 Jan. 1997
Deadweight test date: 24 Apr. 2001
Oxygen sensor (St.C01-C14):
SBE13-04 (S/N 130339)
Calibrated date: 07 Sep. 2001
Oxygen sensor (St.C15-C20):
SBE13-04 (S/N 130540)
Calibrated date: 18 Jun. 2001
Deck unit: SBE11 (S/N 11P7030-0272, Sea-bird Electronics, Inc.).
Carousel water sampler:
SBE32 (S/N 3222295-0171, Sea-bird Electronics, Inc.).

(5) Preliminary result

See the attached figures (Fig.6.2.1-(1) – Fig.6.2.1-(10), Table.6.2.1).

(6) Other remarks

At St.C14, oxygen data was bad. We changed the D.O. sensor (SN130339) to another D.O. sensor (SN130540) after CTD observation at St.C14.

(7) Data archive

All raw and processed CTD data files were copied onto magnet-optical disk (MO). The data will be submitted to the Data Management Office (DMO) in JAMSTEC, and will be opened to public via “R/V MIRAI Data Web Page” in JAMSTEC home page.

MR01-K05(Leg.1,2) CTD cast table

Stn.	Date(UTC)	Time(UTC)		Start Position		Filename	Water Sampling	Remarks
		Start	End	Latitude	Longitude			
C01	09/28/'01	03:15	04:13	07-51.37N	136-29.69E	C01S01	Salinity	TRITON 10001 cast
C02	09/29/'01	03:44	04:45	04-58.22N	137-17.33E	C02S01	Salinity	TRITON 11001 cast
C03	09/30/'01	03:30	04:31	02-03.48N	138-02.25E	C03S01	Salinity	TRITON 12003 cast
C04	09/30/'01	05:13	06:08	02-00.96N	138-06.56E	C04S01	Salinity	TRITON 12002 cast
C05	10/03/'01	03:27	04:23	00-06.49N	138-02.39E	C05S01	Salinity	TRITON 13003 cast
C06	10/03/'01	05:22	06:18	00-02.46N	137-54.06E	C06S01	Salinity	TRITON 13002 cast
C07	10/20/'01	21:58	23:31	04-59.94N	089-59.84E	C07S01	Salinity, D.O.	
C08	10/21/'01	4:14	6:10	03-59.95N	090-00.13E	C08S01	Salinity, D.O.	
C09	10/21/'01	10:21	11:49	03-00.74N	090-00.07E	C09S01	Salinity, D.O.	
C10	10/21/'01	16:00	17:34	01-59.96N	089-59.93E	C10S01	Salinity, D.O.	
C11	10/21/'01	21:58	23:30	01-00.01N	090-00.21E	C11S01	Salinity, D.O.	
C12	10/22/'01	6:46	8:26	00-00.33N	090-02.93E	C12S01	Salinity, D.O.	
C13	10/23/'01	5:27	6:56	01-40.33S	089-59.53E	C13S01	Salinity, D.O.	TRITON 18001 cast
C14	10/23/'01	9:54	11:19	01-59.98S	089-59.83E	C14S01	Salinity, D.O.	Invalid D.O. data, cahange D.O. sensor after this cast
C15	10/23/'01	15:58	17:34	03-00.02S	089-59.95E	C15S01	Salinity, D.O.	
C16	10/23/'01	22:00	23:31	03-59.90S	089-59.88E	C16S01	Salinity, D.O.	
C17	10/24/'01	3:55	5:19	04-59.99S	090-00.00E	C17S01	Salinity, D.O.	
C18	10/24/'01	9:43	11:13	05-00.01S	091-00.02E	C18S01	Salinity, D.O.	
C19	10/24/'01	19:24	20:57	05-00.01S	093-00.05E	C19S01	Salinity, D.O.	
C20	10/26/'01	4:54	6:24	04-57.64S	094-58.88E	C20S01	Salinity, D.O.	TRITON 17001 cast

Table 6.2.1

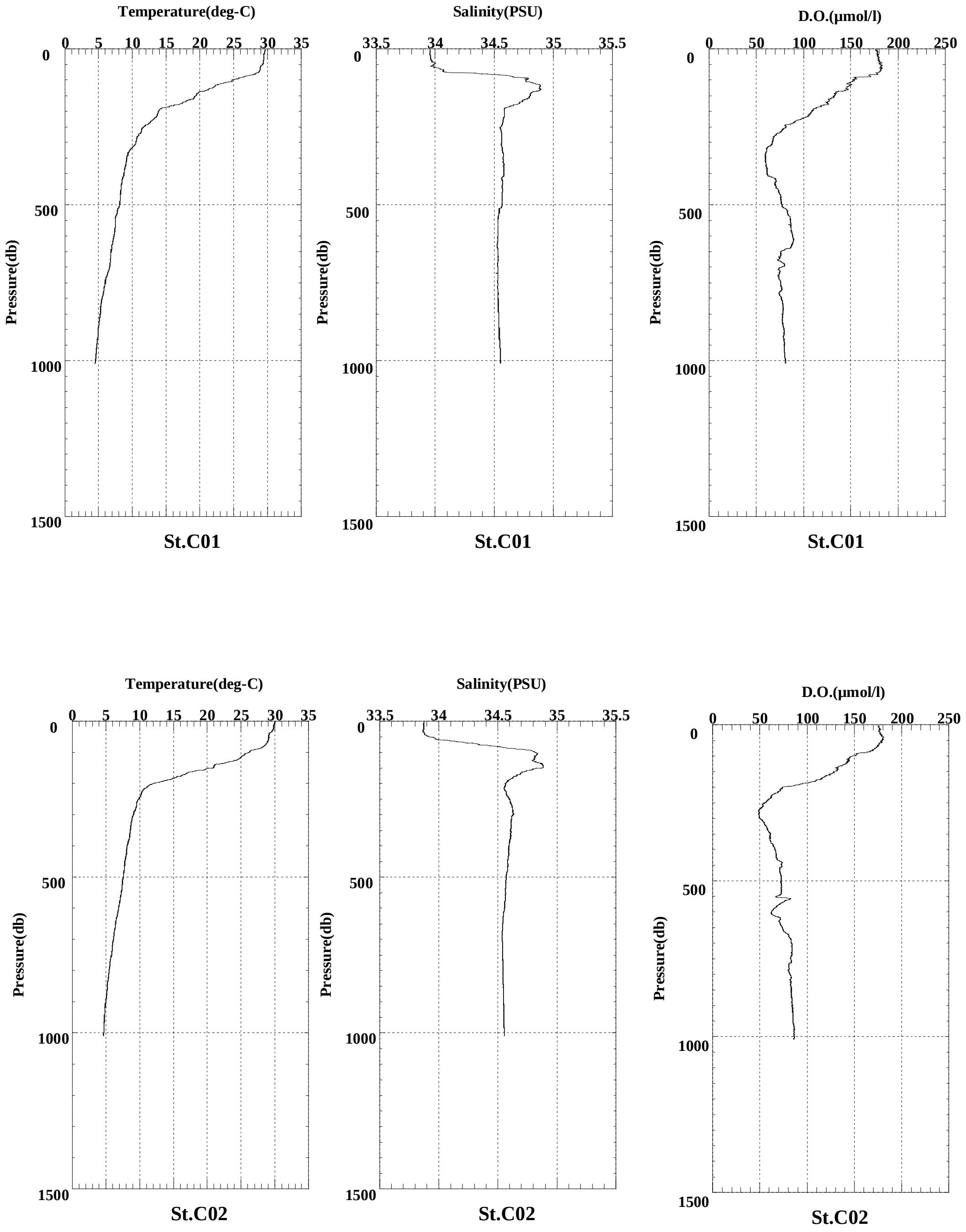

Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
Pressure(db)
St.C01
St.C02

Fig. 6.2.1-(1)

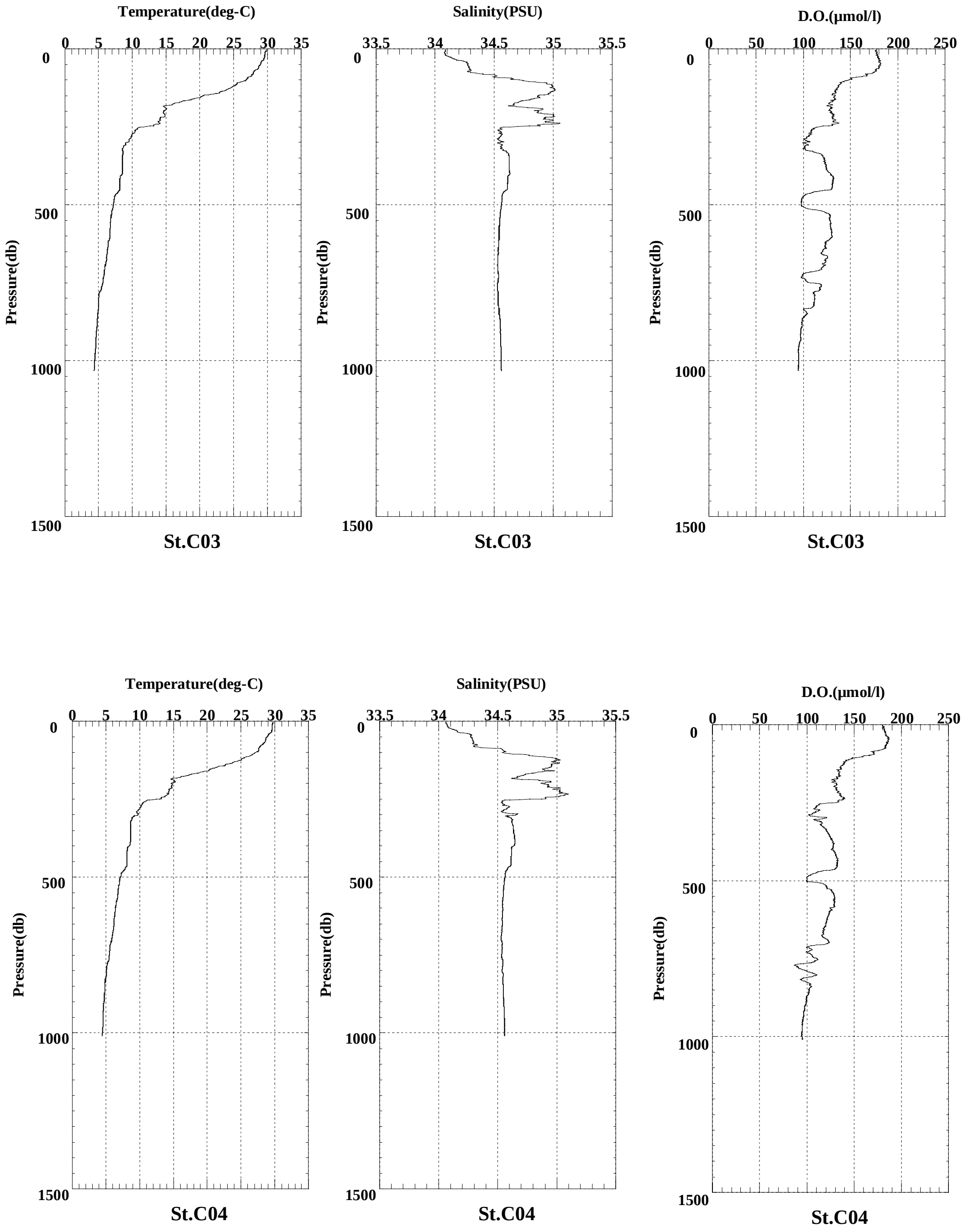

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500
St.C03
Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500
St.C04

Fig. 6.2.1-(2)

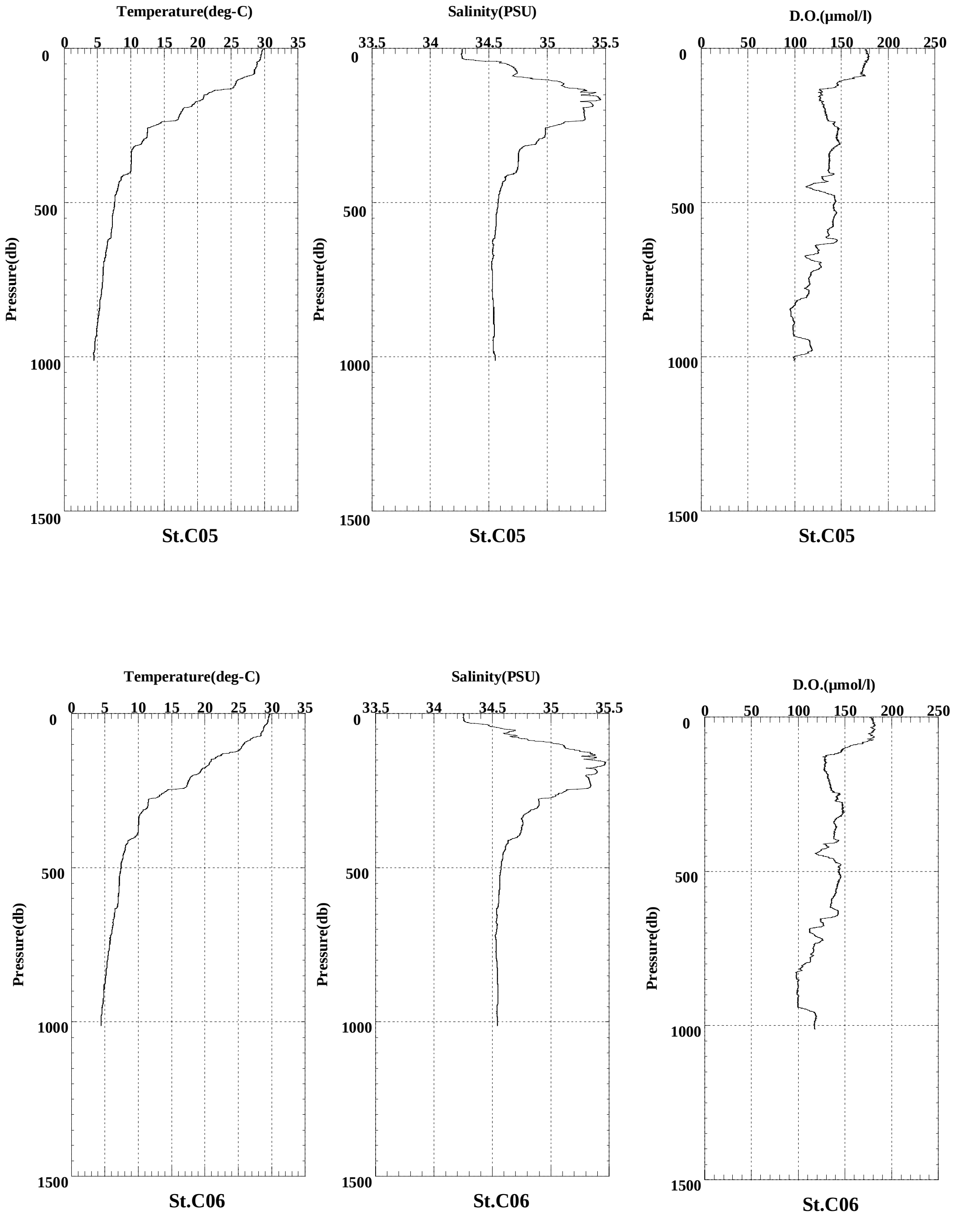

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500
St.C05
St.C05
St.C05
Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
St.C06
St.C06
St.C06

Fig. 6.2.1-(3)

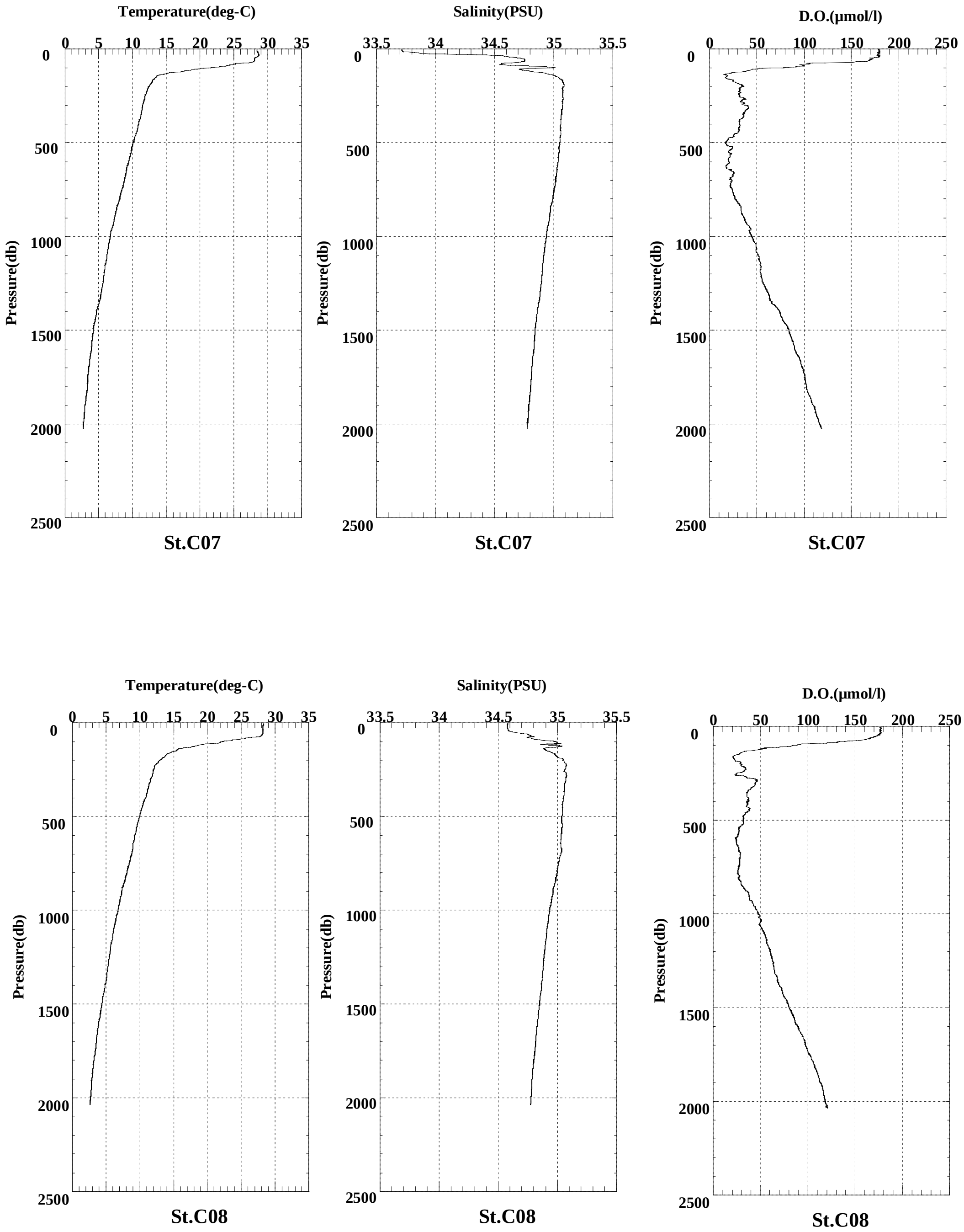

Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
Pressure(db)
St.C07
St.C07
St.C07
Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
Pressure(db)
St.C08
St.C08
St.C08

Fig. 6.2.1-(4)

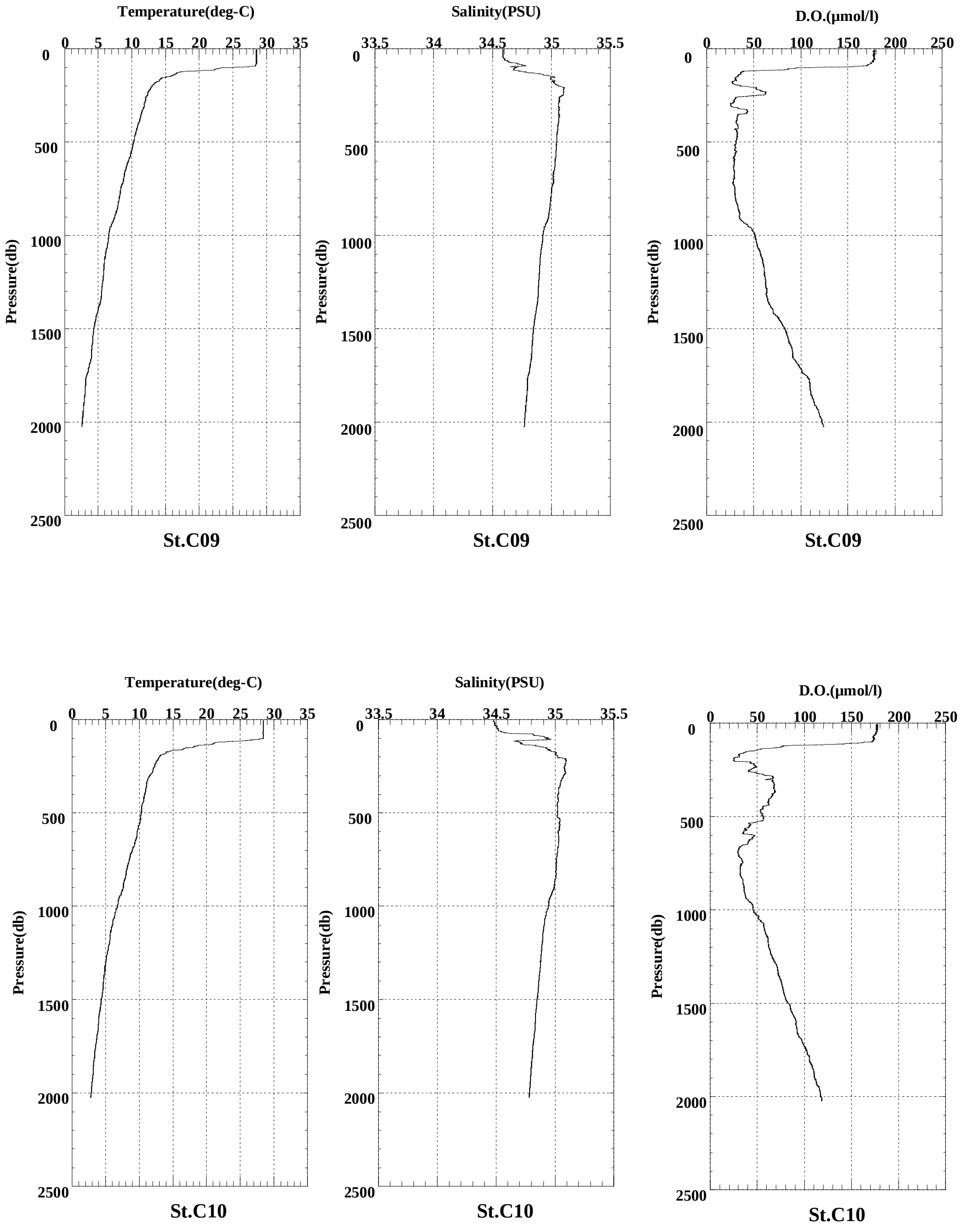

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500 2000 2500
St.C09
St.C09
St.C09
Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
St.C10
St.C10
St.C10

Fig. 6.2.1-(5)

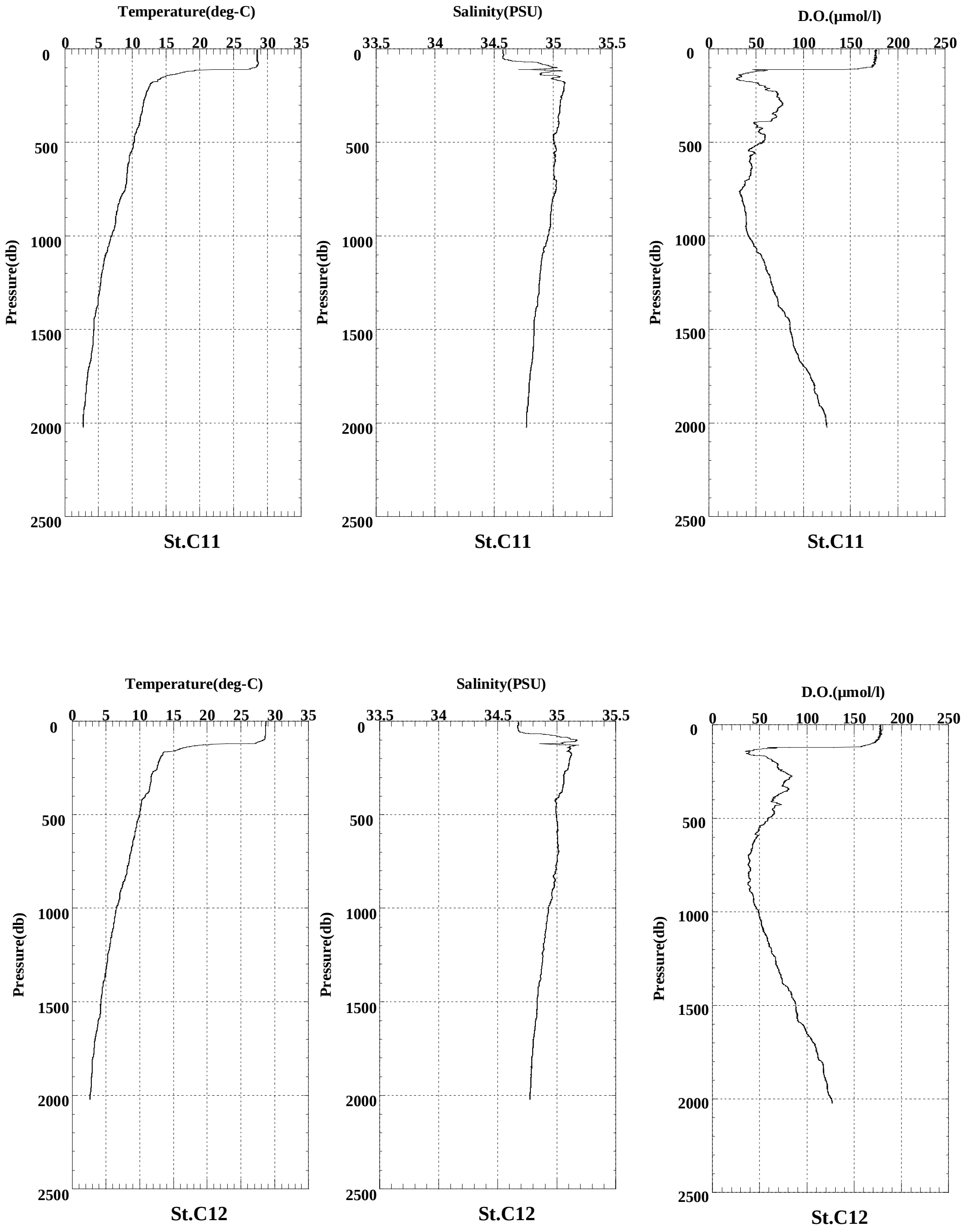
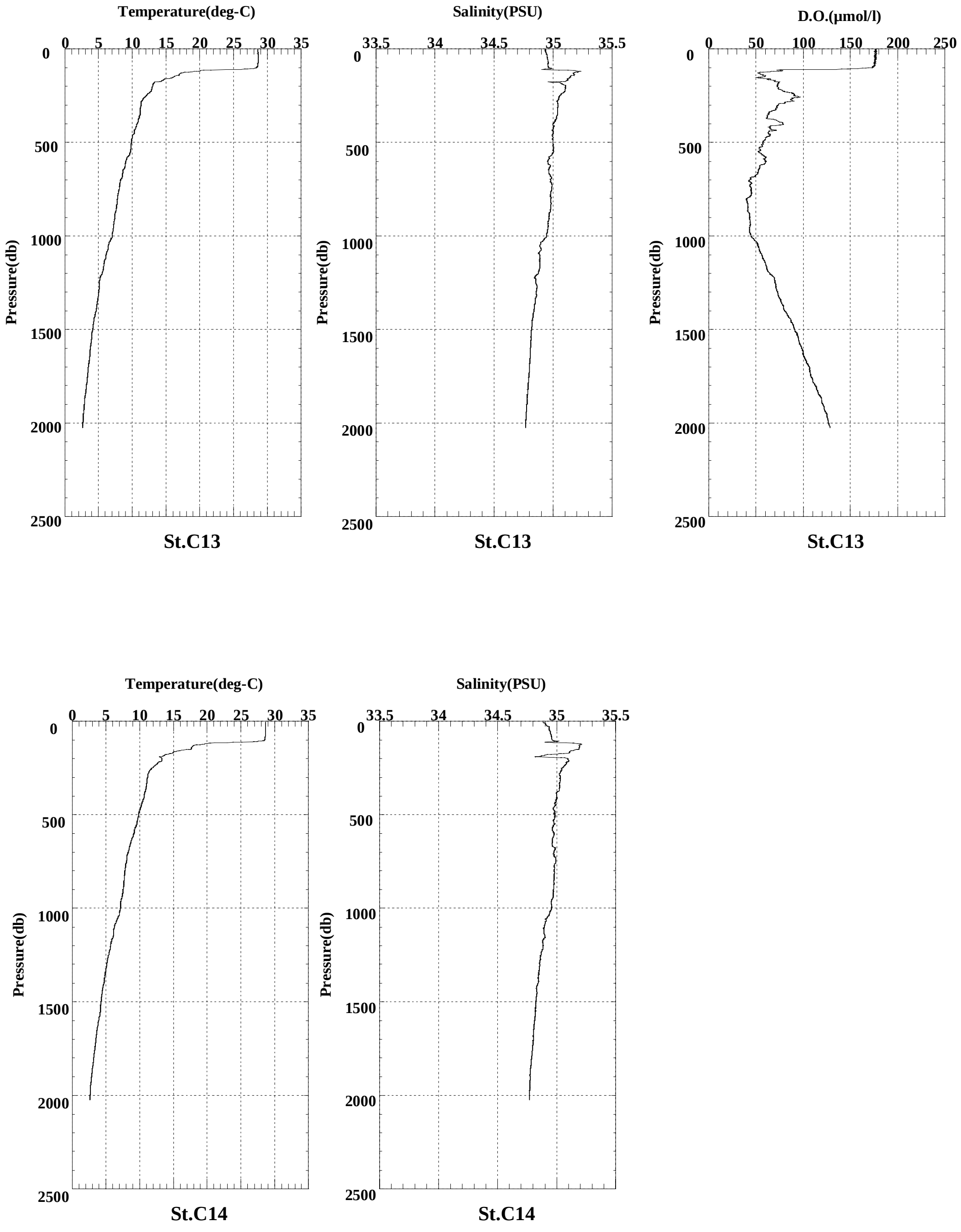

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500 2000 2500
St.C11
St.C11
St.C11
Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
St.C12
St.C12
St.C12

Fig. 6.2.1-(6)



Temperature(deg-C)
Salinity(PSU)
D.O.(µmol/l)
Pressure(db)
St.C13
St.C13
St.C13
Temperature(deg-C)
Salinity(PSU)
Pressure(db)
St.C14
St.C14

Fig. 6.2.1-(7)

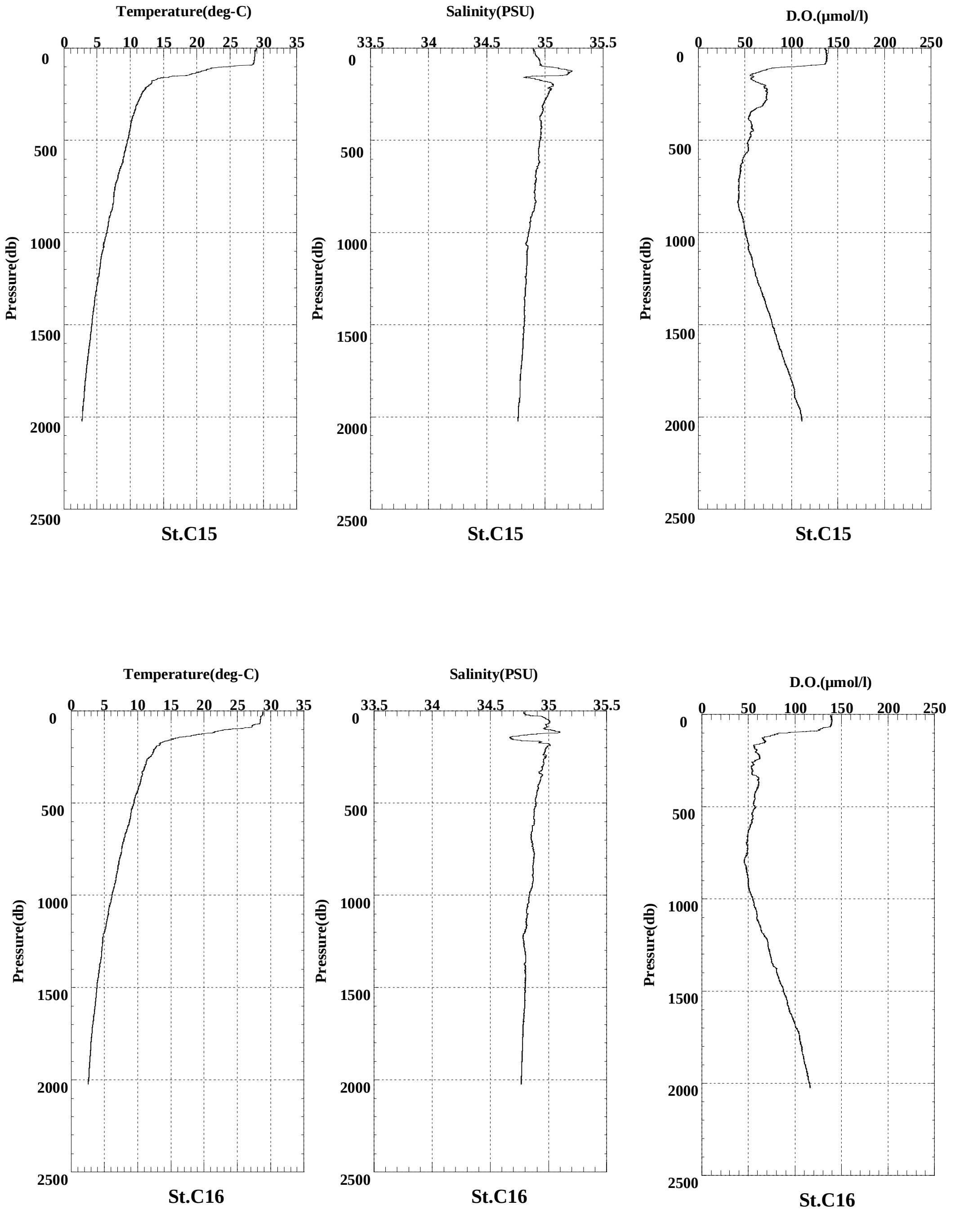

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500 2000 2500
St.C15
St.C15
St.C15
Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500 2000 2500
St.C16
St.C16
St.C16

Fig. 6.2.1-(8)

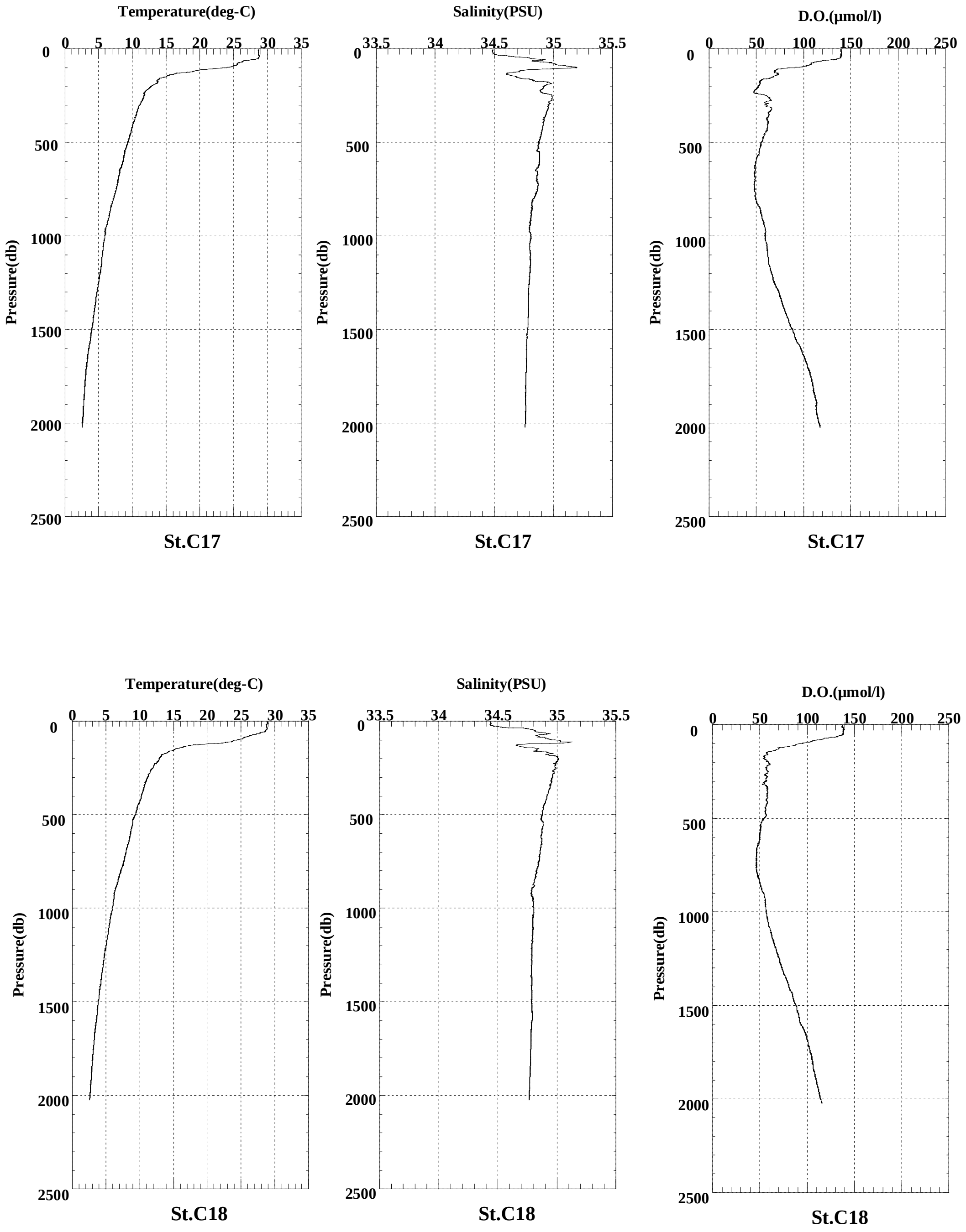

Temperature(deg-C)
0 5 10 15 20 25 30 35
Salinity(PSU)
33.5 34 34.5 35 35.5
D.O.(μmol/l)
0 50 100 150 200 250
Pressure(db)
0 500 1000 1500 2000 2500
St.C17
St.C17
St.C17
Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
St.C18
St.C18
St.C18

Fig. 6.2.1-(9)

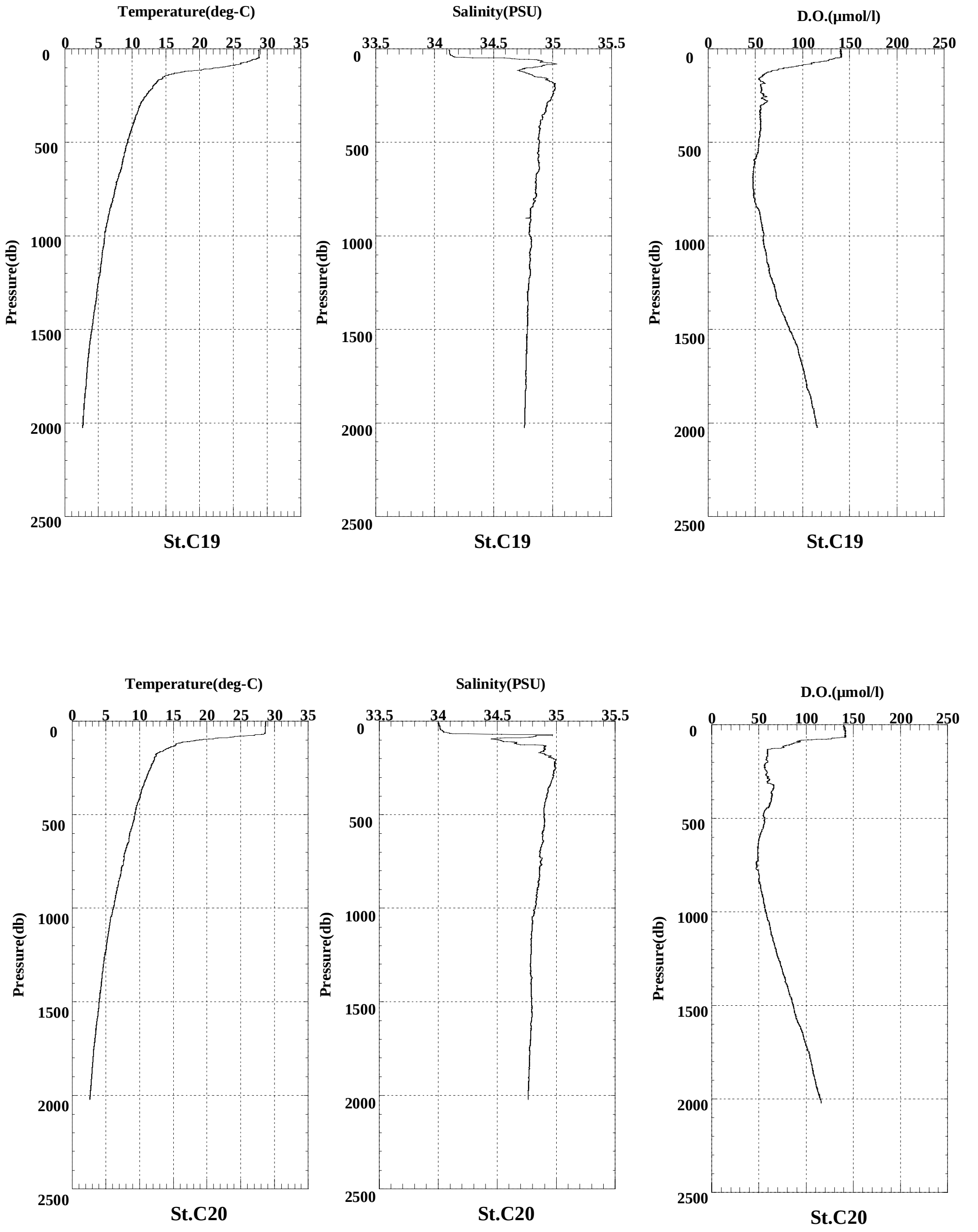

Temperature(deg-C)
Salinity(PSU)
D.O.(μmol/l)
Pressure(db)
St.C19
St.C20

Fig. 6.2.1-(10)

6.2.2 XCTD obserevation

(1) Personnel

Yoshifumi Kuroda (JAMSTEC)	Principal Investigator	- Leg 1 -
Keisuke Mizuno (JAMSTEC)	Principal Investigator	- Leg 2 -
Hideaki Hase (JAMSTEC)		- Leg 1, 2 -
Satoshi Okumura (GODI)		- Leg 1 -
Wataru Tokunaga (GODI)		- Leg 1, 2 -
Akinori Uchiyama (GODI)		- Leg 2 -
Shinya Iwamida (GODI)		- Leg 2 -
Takuya Yoshida (GODI)		- Leg 1 -
Keiichiro Shishido (R/V Mirai Crew)		- Leg 2 -

(2) Objective

Investigation of oceanic structure.

(3) Parameters

According to the manufacturer's information, 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 degree-C	+/- 0.02 degree-C
Depth	0 ~ 1000 m	

(4) Methods

We observed the vertical profiles of the sea water temperature and salinity measured by XCTD-1 manufactured by Tsurumi-Seiki Co.. The signal was converted by MK-100, Tsurumi-Seiki Co. and was recorded by WinXCTD software (Ver.1.04) made by Tsurumi-Seiki Co.. We dropped 102 probes (X001 – X094) by using hand launcher or automatic launcher.

Table 6.2.2-1 XCTD observation log

Station	Date	Time	Lat.	Log.	SST	SSS	MD	WD	Probe S/N
X001	2001/09/28	08:18	06-59.85N	136-43.45E	29.87	33.864	840	4811	01055260
X002-1	2001/09/28	12:20	05-59.92N	137-00.05E	29.74	33.569	840	4426	01055257
X002-2	2001/09/28	12:30	05-58.05N	137-00.61E	29.81	33.755	933	4668	01055379
X003	2001/09/29	09:07	03-59.98N	137-32.69E	29.81	33.846	908	4682	01055261
X004	2001/09/29	13:15	02-59.83N	137-49.16E	29.71	34.028	984	4331	01055406
X005-1	2001/10/02	08:15	00-59.87N	138-03.43E	30.25	34.263	916	4373	01055410
X005-2	2001/10/02	08:37	00-54.84N	138-03.28E	30.21	34.258	986	4373	01055407
X006	2001/10/05	07:11	00-00.15N	137-29.26E	29.55	34.276	962	4255	01055421
X007	2001/10/05	09:01	00-00.23S	136-59.89E	29.45	34.252	934	4441	01055412
X008	2001/10/05	10:54	00-00.02N	136-29.92E	29.53	34.193	959	4743	01055423
X009	2001/10/05	12:45	00-00.17N	135-59.95E	29.48	34.203	1021	5042	01055325
X010	2001/10/05	14:35	00-00.16N	135-29.95E	29.46	34.151	954	4764	01055415
X011	2001/10/05	16:24	00-00.56N	134-59.93E	29.41	34.115	1013	1629	01055414
X012	2001/10/05	20:09	00-23.86N	133-59.93E	29.37	34.147	931	3968	01055422
X013	2001/10/06	00:02	00-48.30N	133-00.03E	29.40	34.149	949	3827	01055413
X014	2001/10/06	04:04	01-13.85N	131-58.27E	29.57	34.126	855	4101	01055424
X015	2001/10/06	07:58	01-35.87N	130-59.14E	29.76	34.184	1033	3687	01055326

X016	2001/10/07	05:58	01-56.51N	129-55.70E	29.66	34.083	1036	4426	01055328
X017	2001/10/07	06:21	01-56.46N	129-55.73E	29.66	34.085	1036	4428	01055329
X018	2001/10/07	10:23	03-00.07N	129-59.21E	29.70	34.164	957	3043	01055330
X019	2001/10/07	14:18	04-00.05N	130-02.33E	29.70	34.193	980	4870	01055331
X020	2001/10/08	08:05	05-42.14N	129-00.00E	29.60	33.992	875	5291	01055333
X021	2001/10/08	12:51	06-13.53N	128-00.01E	29.72	33.910	813	5612	01055332
X022	2001/10/08	17:27	06-45.64N	126-59.98E	30.10	34.078	1009	6637	01055334
X023	2001/10/09	06:04	06-50.00N	126-42.74E	30.59	33.991	955	3418	01055335
X024	2001/10/19	18:07	05-59.75N	095-00.02E	28.67	32.793	1033	1279	01055316
X025	2001/10/19	20:21	05-42.42N	094-30.05E	29.40	33.597	1035	1938	01055318
X026	2001/10/19	23:12	05-14.91N	094-00.06E	29.14	33.699	1036	729	01055315
X027	2001/10/20	01:58	04-47.56N	093-30.05E	28.90	33.590	1035	1420	01055311
X028	2001/10/20	04:45	04-20.55N	093-00.06E	28.88	33.622	1034	4496	01055317
X029	2001/10/20	07:28	03-52.74N	092-30.05E	28.89	33.669	1035	4252	01055313
X030-1	2001/10/20	10:09	03-41.44N	092-00.04E	28.63	33.791	867	4109	01075632
X030-2	2001/10/20	10:19	03-42.33N	091-58.60E	28.64	33.775	839	4101	01055314
X031	2001/10/20	12:47	04-01.06N	091-30.00E	28.44	33.782	821	4040	01055312
X032-1	2001/10/20	15:20	04-21.18N	091-00.00E	28.53	34.260	761	2631	01055351
X032-2	2001/10/20	15:30	04-22.06N	090-58.55E	28.54	34.236	725	2605	01055350
X032-3	2001/10/20	15:39	04-22.96N	090-57.12E	28.50	34.276	783	2540	01055352
X032-4	2001/10/20	15:49	04-23.85N	090-55.65E	28.49	34.387	865	2460	01075634
X033	2001/10/20	17:58	04-40.11N	090-30.02E	28.47	34.432	1036	3175	01075631
X034	2001/10/20	23:39	04-59.13N	089-59.80E	28.44	33.730	1036	3345	01075635
X035	2001/10/21	01:33	04-30.03N	090-00.24E	28.80	34.378	1035	3260	01075636
X036	2001/10/21	08:14	03-30.01N	090-00.09E	28.23	34.495	1034	2468	01055320
X037	2001/10/21	13:58	02-29.35N	089-59.95E	28.51	34.541	957	2758	01055319
X038	2001/10/21	19:40	01-30.01N	090-00.13E	28.51	34.542	1014	2296	01075575
X039	2001/10/22	01:41	00-30.01N	090-01.87E	28.53	34.648	1036	4062	01075629
X040	2001/10/22	07:03	00-00.09N	090-03.06E	28.72	34.682	1036	4376	01075633
X041	2001/10/22	13:13	00-29.98S	089-59.81E	28.76	34.760	951	3076	01075628
X042	2001/10/22	15:10	01-00.16S	089-59.89E	28.59	34.894	982	3126	01075574
X043	2001/10/23	13:28	02-30.00S	090-00.13E	28.79	34.764	952	3520	01075626
X044	2001/10/23	19:56	03-29.97S	090-00.22E	28.82	34.841	1033	3800	01075624
X045	2001/10/24	01:43	04-29.99S	089-59.78E	28.84	34.729	1034	4622	01075627
X046	2001/10/24	04:07	05-00.02S	090-00.05E	28.74	34.494	1036	5001	01075630
X047-1	2001/10/24	07:32	05-00.29S	090-29.98E	29.26	34.624	634	5046	01075576
X047-2	2001/10/24	07:43	05-00.29S	090-31.90E	29.26	34.621	1035	5054	01055327
X048	2001/10/24	13:24	04-59.92S	091-30.00E	28.96	34.385	970	5009	01055321
X049	2001/10/24	15:23	04-59.94S	091-59.97E	28.91	34.302	927	5010	01075581
X050	2001/10/24	17:20	04-59.83S	092-29.99E	28.85	34.192	1035	5001	01055322
X051	2001/10/24	23:07	04-59.92S	093-30.00E	28.58	33.960	992	4919	01075584
X052	2001/10/25	01:03	04-59.93S	094-00.01E	28.53	33.947	966	4972	01075580
X053	2001/10/25	02:59	04-59.99S	094-29.98E	28.57	34.021	971	4981	01075578
X054	2001/10/26	05:05	04-57.72S	094-58.93E	28.70	34.007	985	5007	01075583
X055	2001/10/26	09:01	05-08.25S	095-30.01E	28.75	33.957	921	5025	01075577
X056	2001/10/26	11:08	05-18.71S	095-59.98E	28.68	33.718	885	4813	01075582
X057	2001/10/26	13:13	05-29.45S	096-29.98E	28.80	33.925	1024	4955	01075621
X058	2001/10/26	15:19	05-39.97S	097-00.02E	28.67	33.781	1028	4860	01075623
X059	2001/10/26	17:25	05-50.67S	097-30.00E	28.66	33.777	1035	4979	01075585
X060	2001/10/26	19:34	06-01.36S	097-59.99E	28.71	33.887	1035	5551	01075594
X061	2001/10/26	21:42	06-11.81S	098-29.98E	28.65	33.862	1034	5129	01075622

X062	2001/10/26	23:49	06-22.46S	099-00.00E	28.63	33.808	921	5444	01075579
X063	2001/10/27	01:51	06-32.97S	099-29.98E	28.50	33.570	1006	4700	01075592
X064	2001/10/27	03:53	06-40.70S	100-00.00E	28.57	33.503	955	5116	01075593
X065	2001/10/27	06:05	06-54.34S	100-30.00E	28.89	33.411	1035	5364	01075590
X066	2001/10/27	08:19	07-04.95S	100-59.99E	28.66	33.353	964	5516	01075589
X067	2001/10/27	10:27	07-15.70S	101-29.98E	28.48	33.596	999	5303	01075586
X068	2001/10/27	12:37	07-26.39S	102-00.00E	28.34	33.585	1016	5485	01075587
X069	2001/10/27	15:17	07-36.89S	102-30.00E	28.22	33.659	913	5902	01075564
X070	2001/10/27	17:56	07-47.06S	103-00.00E	27.89	33.344	982	6078	01075591
X071	2001/10/27	20:34	07-57.68S	103-29.99E	28.04	33.509	909	6165	01075567
X072	2001/10/27	23:20	08-08.10S	103-59.98E	28.02	33.504	976	6265	01075561
X073	2001/10/28	02:06	08-19.10S	104-29.99E	27.75	32.970	960	6367	01075563
X074	2001/10/28	04:54	08-30.32S	104-59.99E	28.51	33.298	986	6644	01075562
X075	2001/10/28	07:39	08-40.12S	105-29.99E	28.53	33.602	942	6105	01075588
X076	2001/10/28	10:22	08-50.73S	105-59.98E	28.29	33.720	1036	4355	01075568
X077	2001/10/28	13:03	09-00.68S	106-29.99E	27.41	33.986	1035	4045	01075572
X078	2001/10/28	15:53	09-11.66S	106-59.99E	27.54	33.687	1036	3858	01055378
X079	2001/10/28	18:50	09-22.28S	107-30.00E	27.96	33.321	960	3383	01075565
X080	2001/10/28	21:38	09-32.59S	108-00.01E	27.94	33.304	1036	3364	01075570
X081	2001/10/29	00:24	09-43.06S	108-30.00E	26.82	34.157	920	3593	01075569
X082	2001/10/29	03:12	09-53.83S	109-00.00E	27.49	34.229	1035	3582	01075573
X083	2001/10/29	05:59	10-04.26S	109-29.99E	27.66	34.259	1034	4693	01075571
X084	2001/10/29	08:41	10-14.84S	109-59.98E	27.78	34.290	996	6919	01055374
X085	2001/10/29	13:35	10-17.18S	111-00.00E	27.64	34.300	964	4180	01055382
X086	2001/10/29	18:48	10-19.06S	112-00.02E	28.29	33.295	977	3779	01055377
X087	2001/10/29	23:55	10-20.77S	113-00.00E	27.90	34.194	941	1736	01055381
X088	2001/10/30	04:54	10-22.29S	113-59.97E	28.64	34.244	882	2864	01055371
X089	2001/10/30	09:17	10-24.33S	114-59.98E	28.67	34.220	950	2470	01055375
X090	2001/10/30	13:20	10-26.21S	116-00.00E	28.68	34.264	915	4101	01055383
X091	2001/10/30	17:12	10-27.63S	117-00.00E	28.59	33.757	943	4306	01055372
X092-1	2001/10/30	21:14	10-29.90S	118-00.01E	28.47	34.133	878	3646	01055373
X092-2	2001/10/30	21:25	10-29.98S	118-02.14E	28.45	34.155	849	3663	01055258
X093	2001/10/31	01:25	10-31.22S	118-59.99E	28.92	34.196	973	3563	01055384
X094	2001/10/31	05:54	10-34.62S	119-59.99E	29.15	34.275	849	1854	01055259

Acronyms in Table 6.2.2-1 are as follows;

SST: Sea surface temperature [degree-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]

(5) Preliminary result

Vertical sections are shown in the following figures combined with CTD data. Fig.6.2.2-1 and Fig.6.2.2-2 are temperature and salinity plots along 137E/138E from 8N to EQ, Fig.6.2.2-3 and Fig.6.2.2-4 are along the ship's track from 2N130E to EQ138E, Fig.6.2.2-5 and Fig.6.2.2-6 are along the ship's track from 2N135E to 7N127E, Fig.6.2.2-7 and Fig.6.2.2-8 are along the ship's track from 95E to 90E, Fig.6.2.2-9 and Fig.6.2.2-10 are along 90E from 5N to 5S, Fig.6.2.2-11 and Fig.6.2.2-12 are along the ship's track from 5S90E to 10S120E respectively.

(6) Data archive

XCTD data obtained during this cruise will be submitted to the DMO (Data Management Office) in JAMSTEC, and will be opened to the public via "R/V Mirai Data Web Page" in JAMSTEC home page.

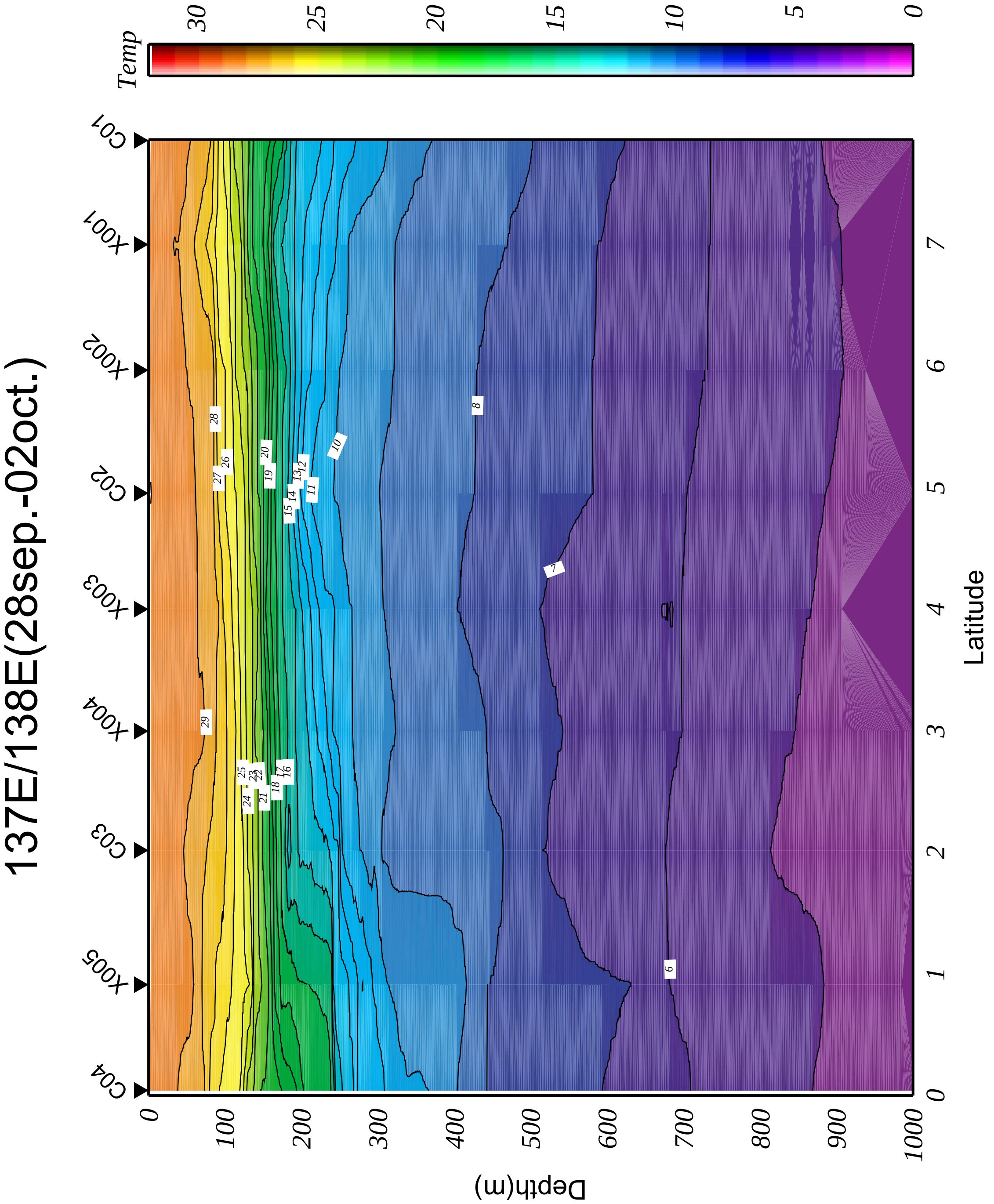


Fig. 6.2.2-1 Temperature along 137E/138E from 8N to EQ

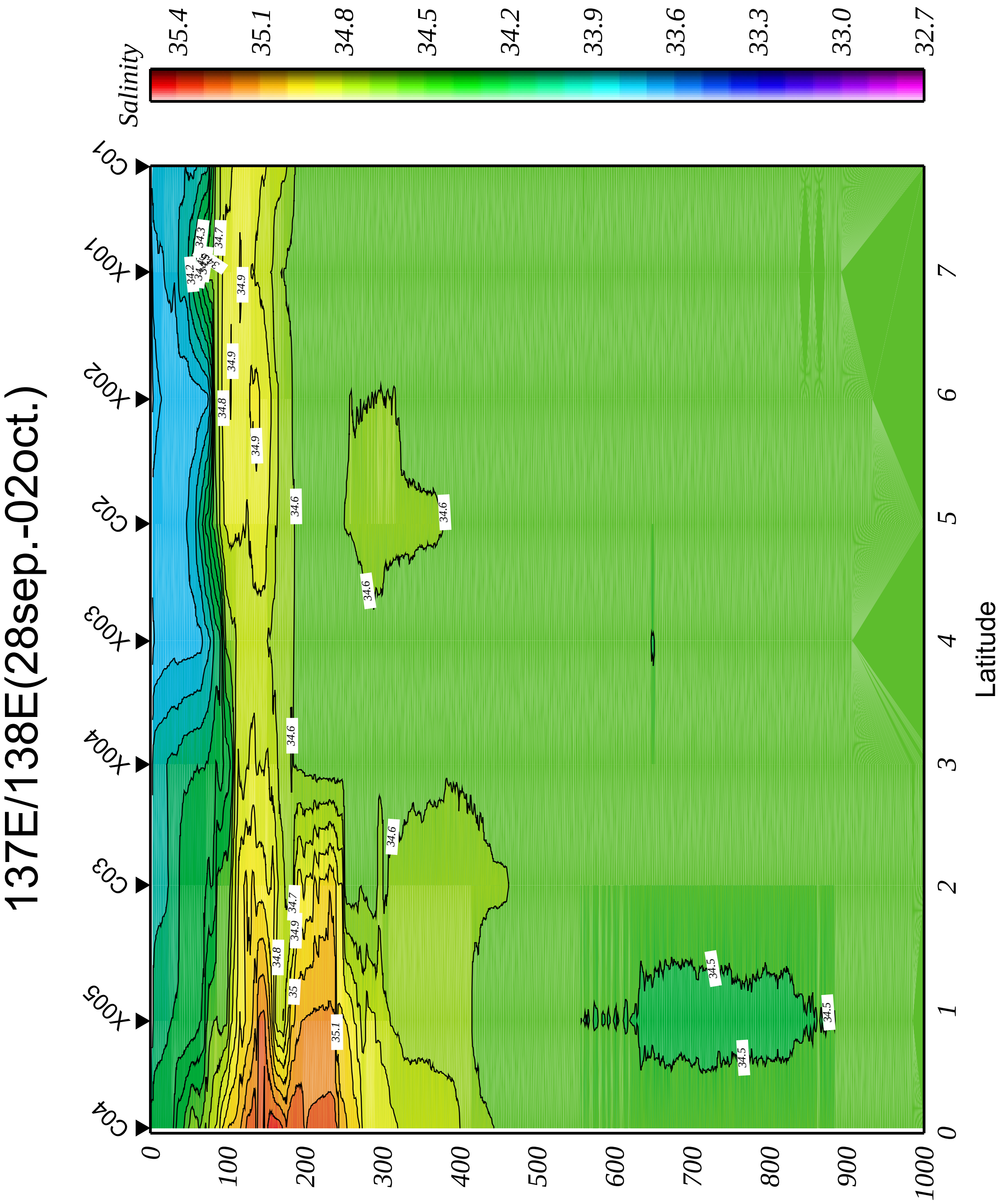


Fig. 6.2.2-2 Salinity along 137E/138E from 8N to EQ

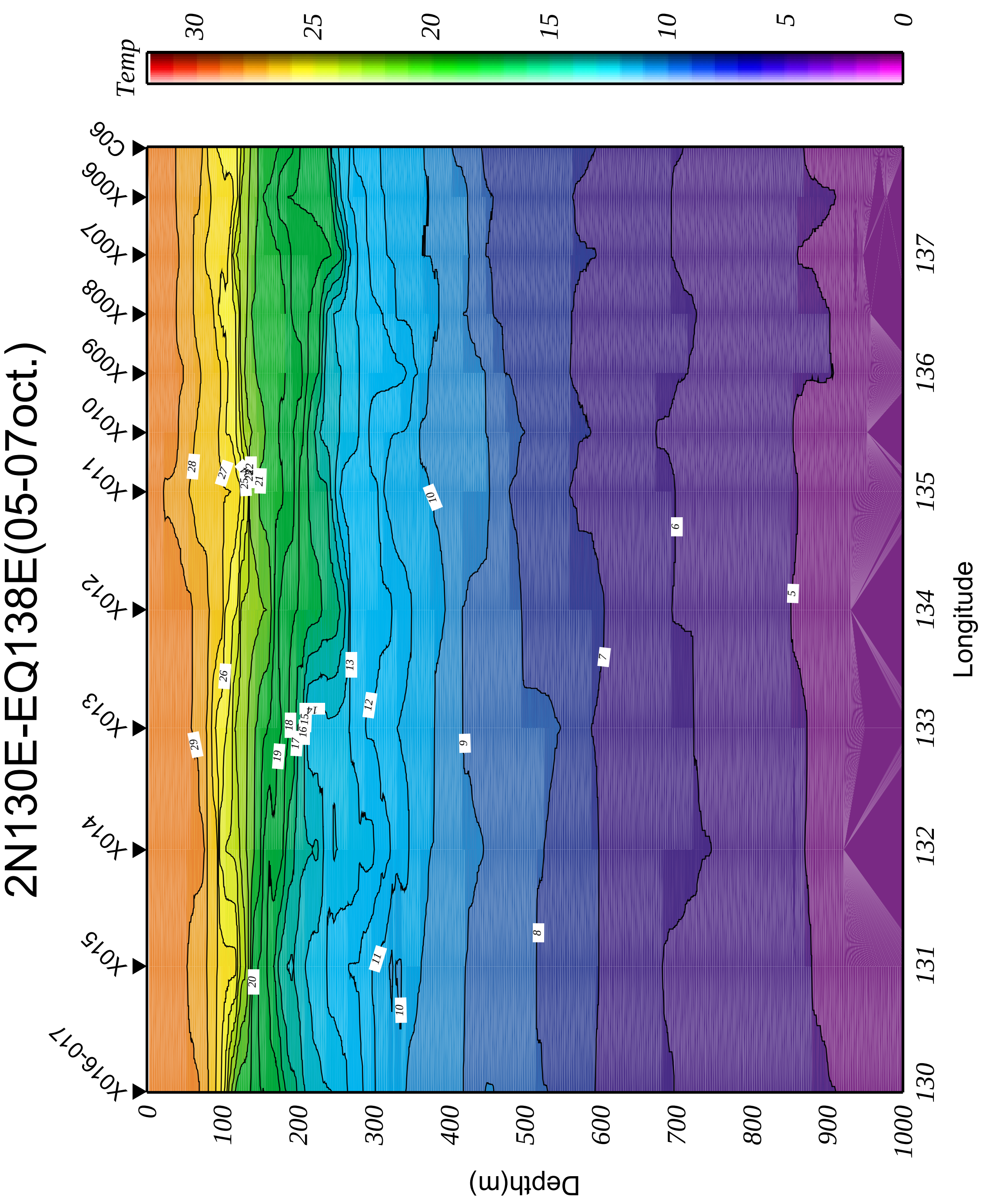


Fig. 6.2.2-3 Temperature along ship’s track from 2N, 130E to EQ, 138E

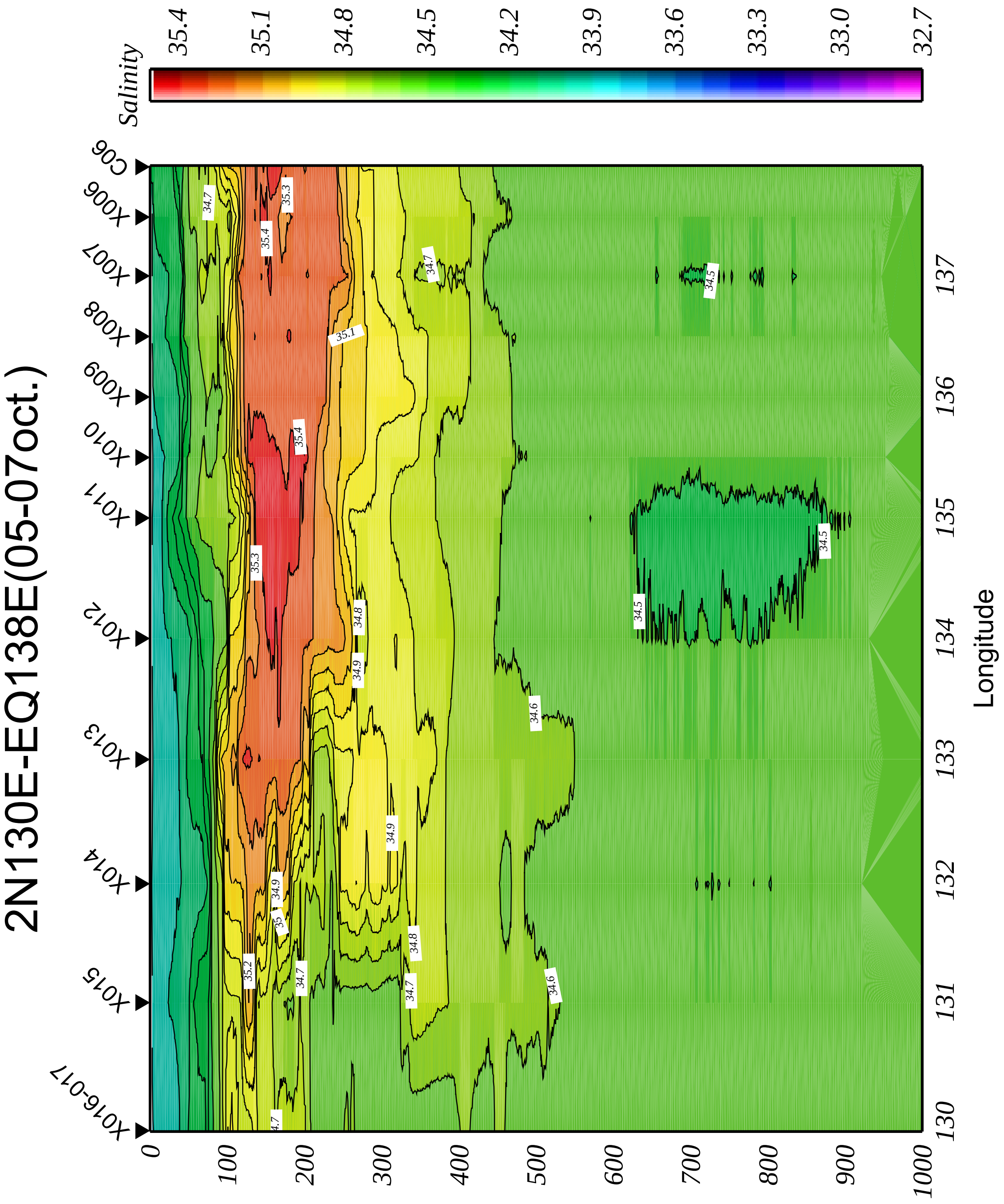


Fig. 6.2.2-4 Salinity along ship's track from 2N, 130E to EQ, 138E

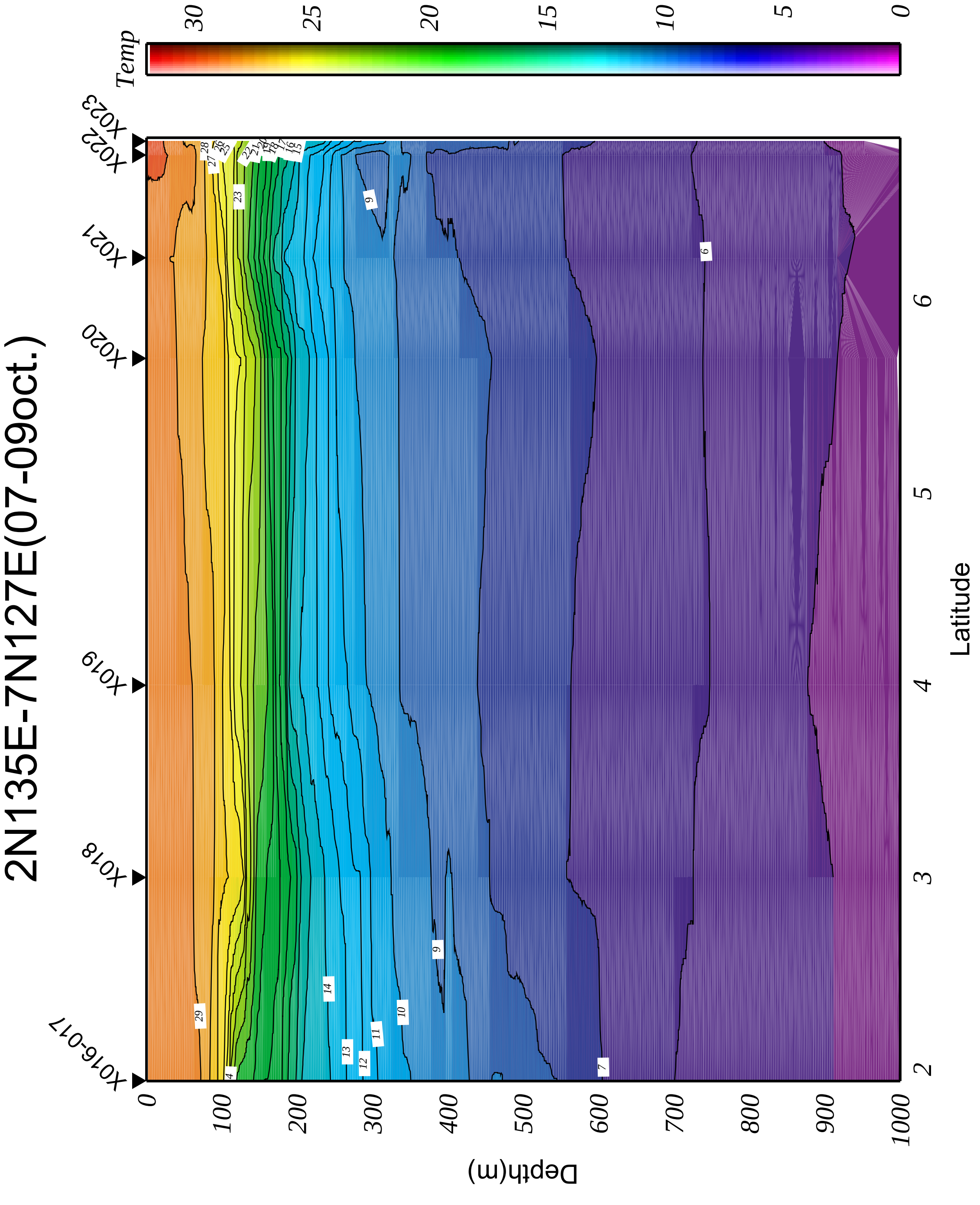


Fig. 6.2.2-5 Temperature along ship’s track from 2N, 135E to 7N, 127E

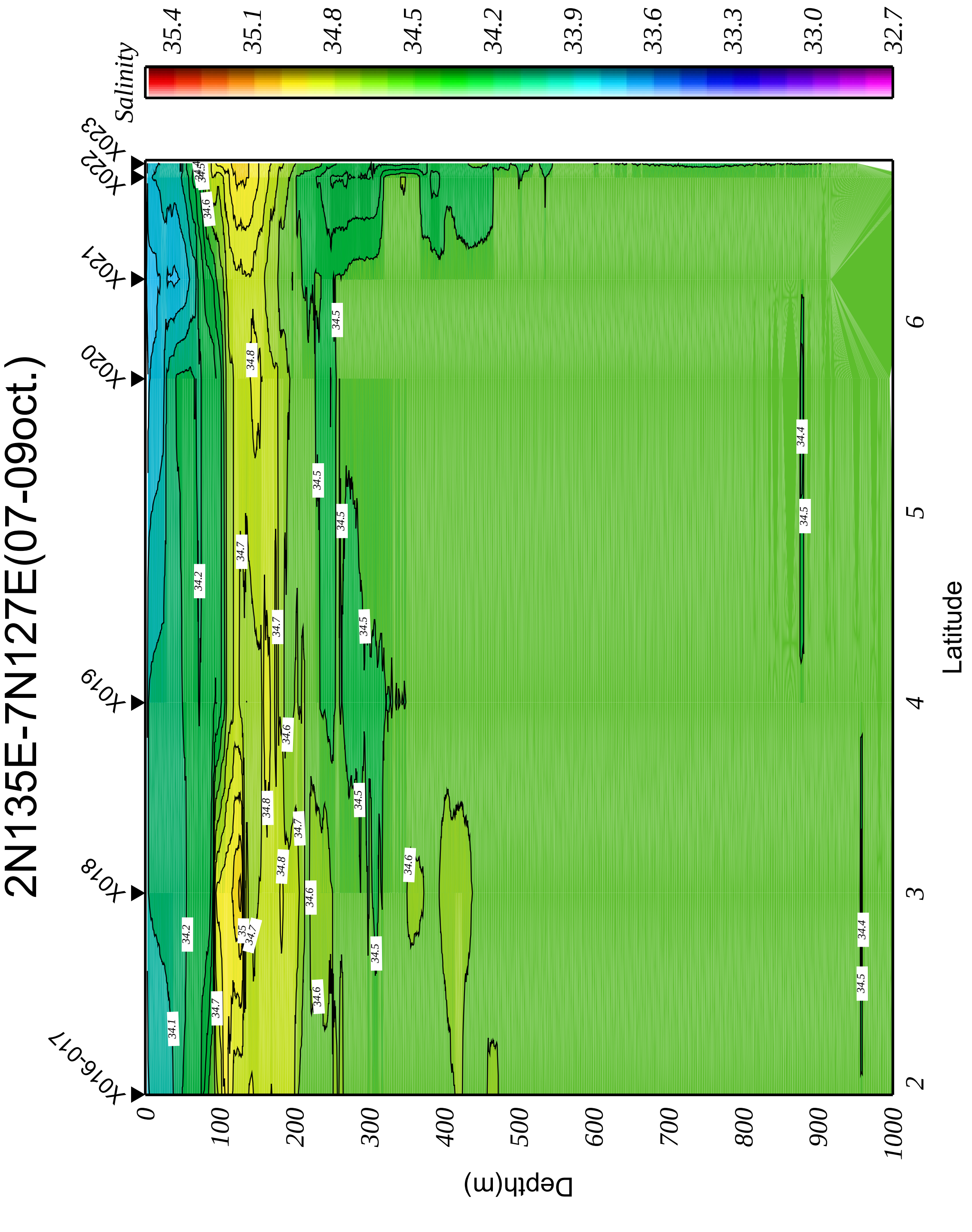


Fig. 6.2.2-6 Salinity along ship’s track from 2N, 135E to 7N, 127E

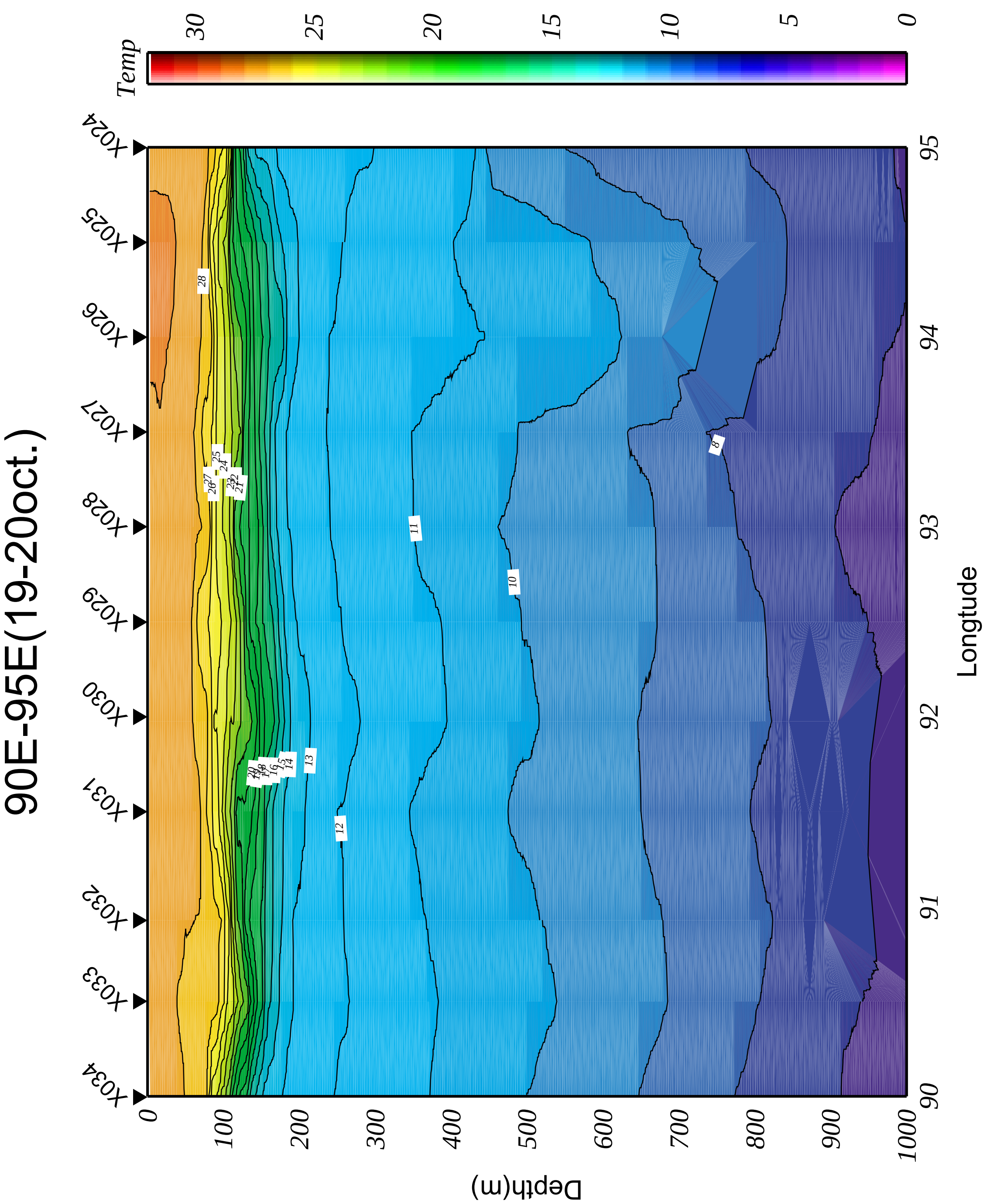


Fig. 6.2.2-7 Temperature along ship's track from 95E to 90E

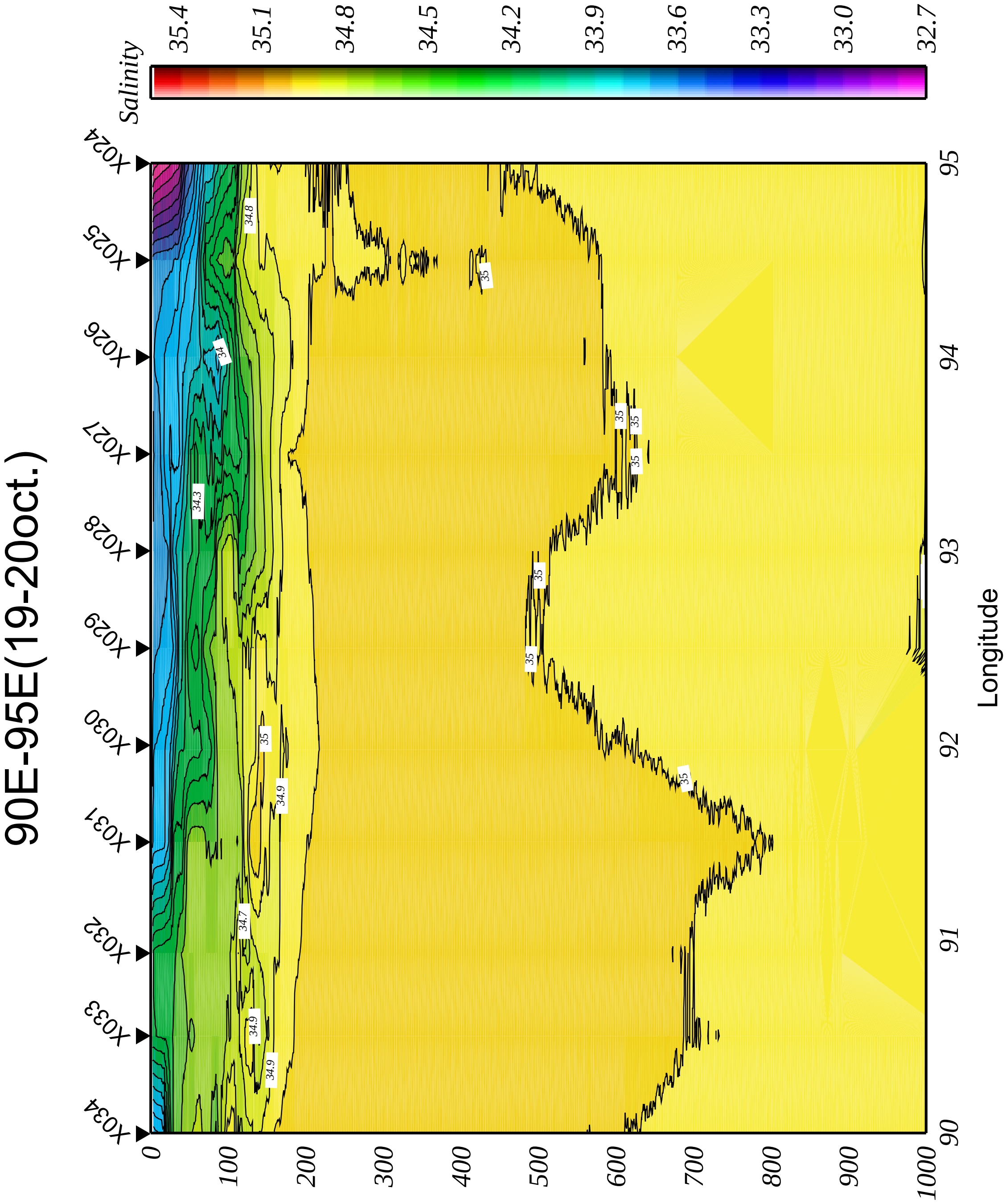


Fig. 6.2.2-8 Salinity along ship’s track from 95E to 90E

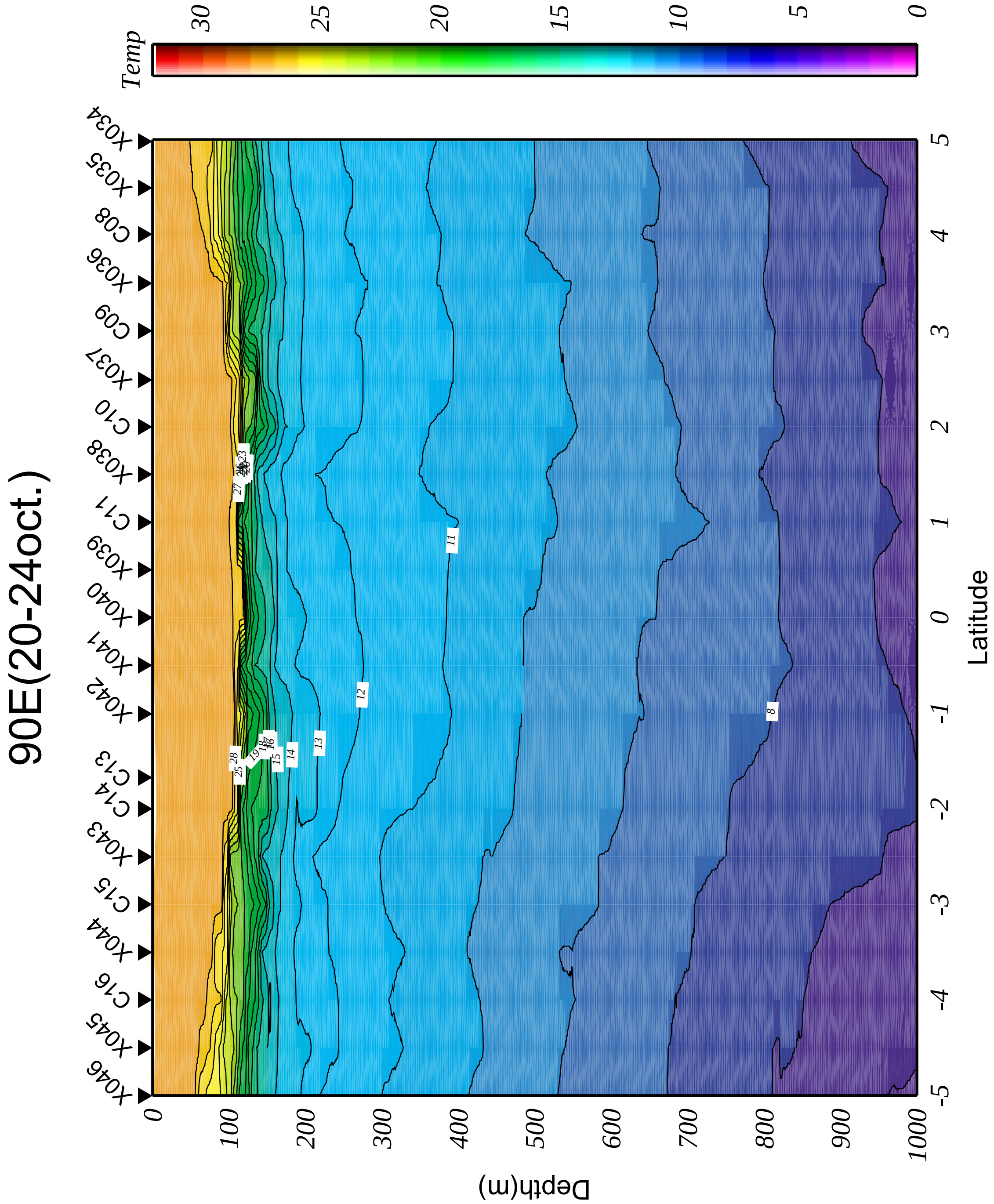


Fig. 6.2.2-9 Temperature along 90E from 5N to 5S

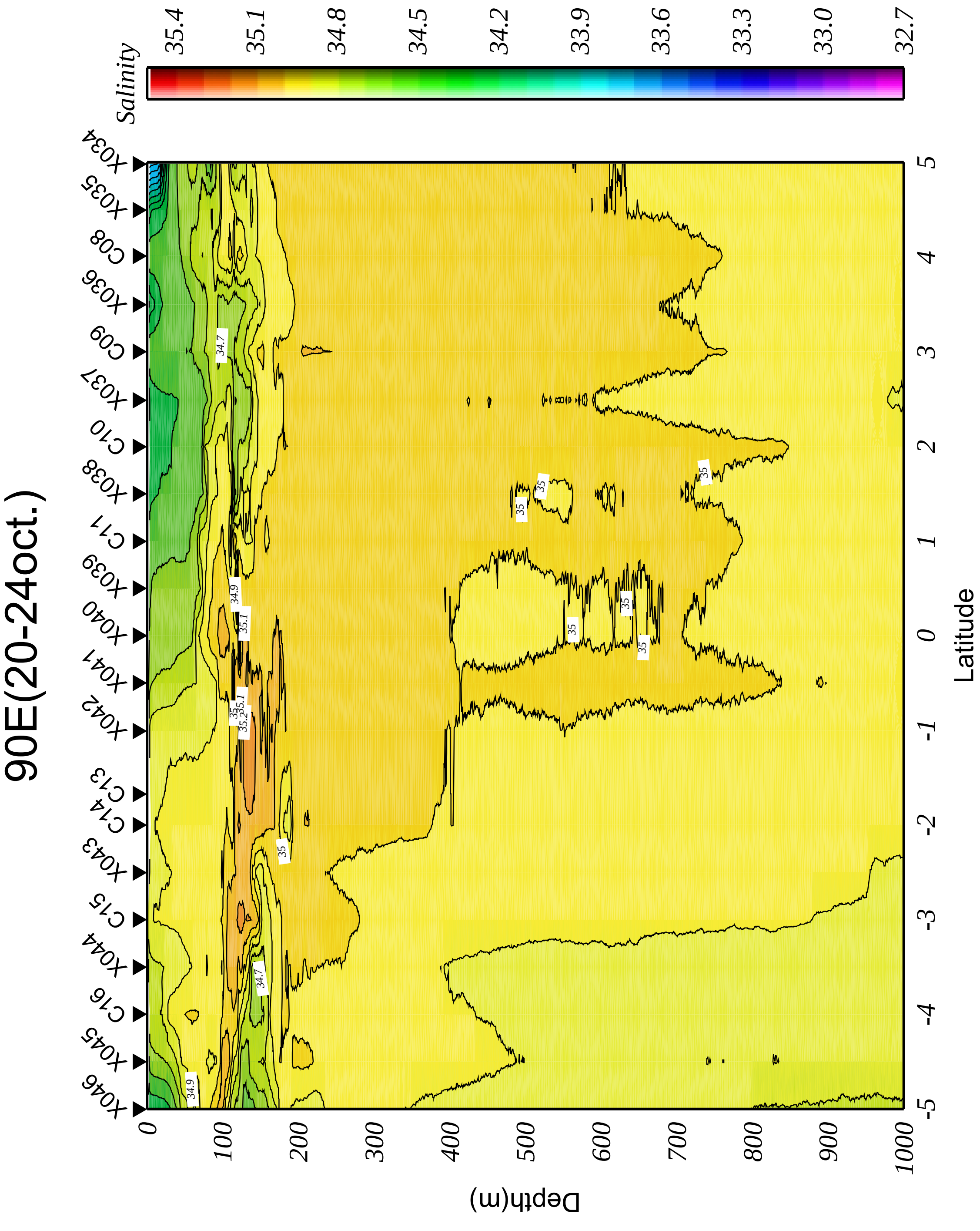


Fig. 6.2.2-10 Salinity along 90E from 5N to 5S

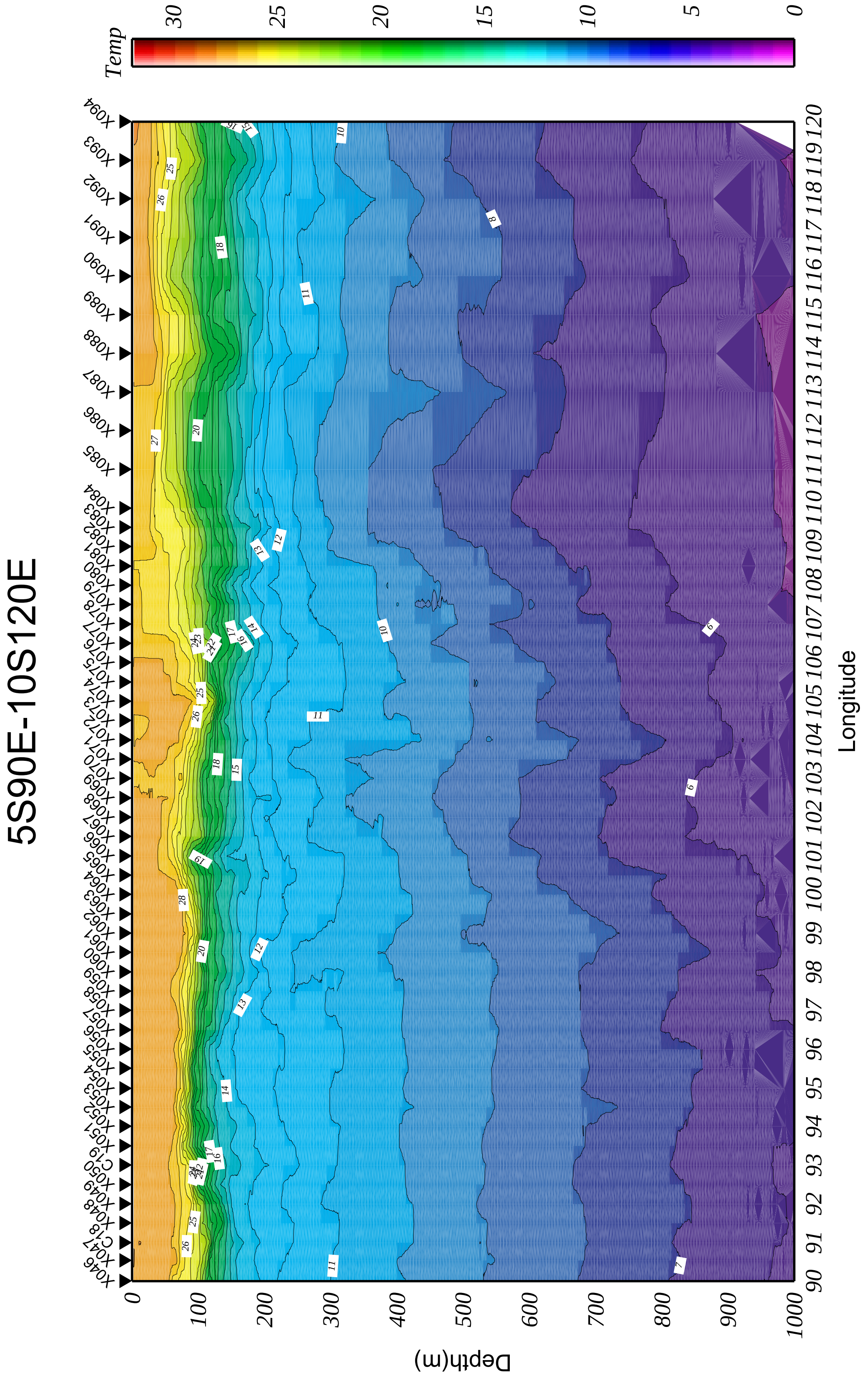


Fig. 6.2.2-11 Temperature along ship’s track from 5S, 90E to 10S, 120E

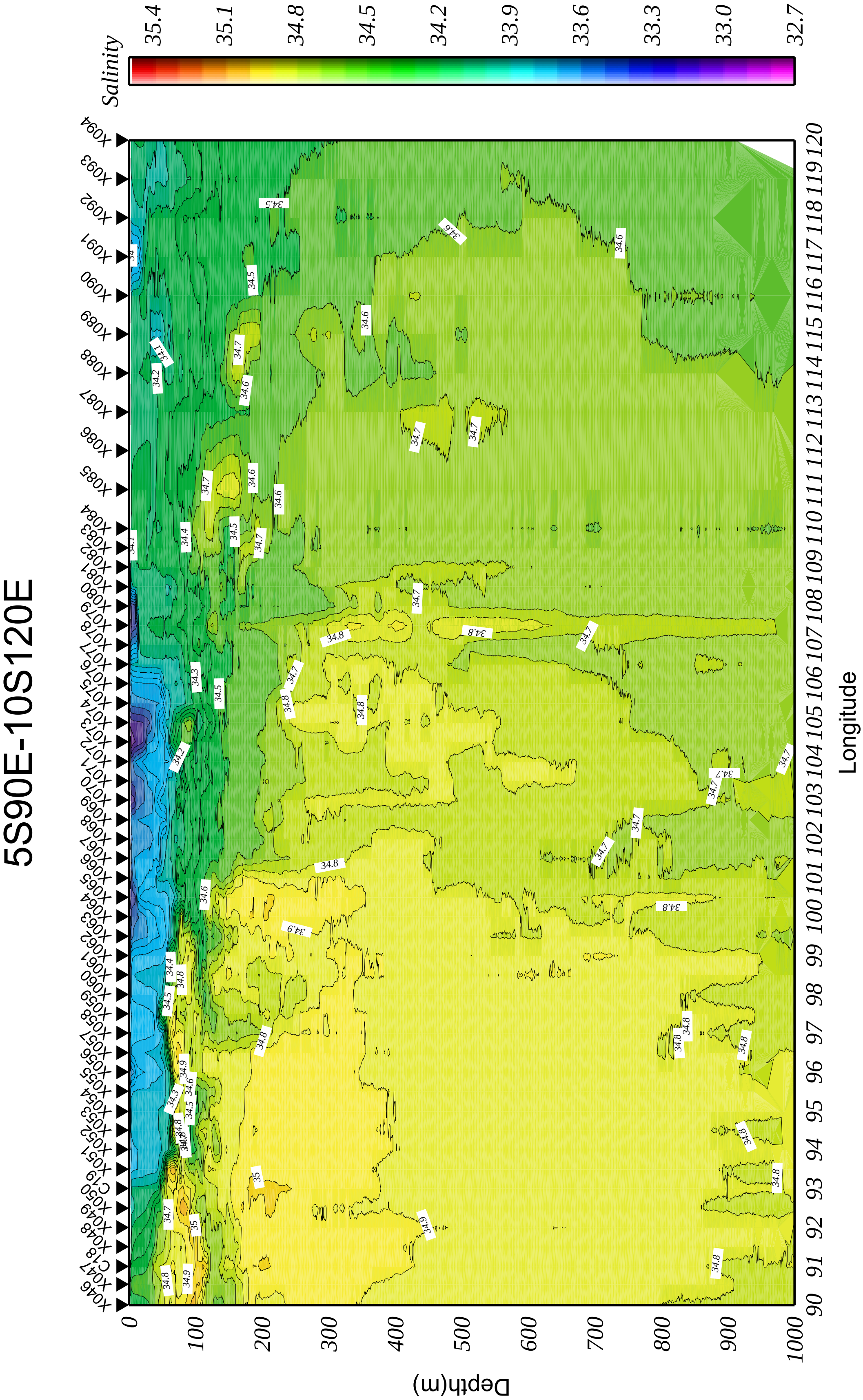


Fig. 6.2.2-12 Salinity along ship’s track from 5S, 90E to 10S, 120E

6.3 Validation of CTD cast data
6.3.1 Salinity measurements of sampled seawater

(1) Personnel

Yoshifumi Kuroda (JAMSTEC)	Principal Investigator	Leg 1
Keisuke Mizuno (JAMSTEC)	Principal Investigator	Leg 2
Takeo Matsumoto (MWJ)		on board Leg 1
Atsuo Ito (MWJ)		on board Leg 2
Masayuki Fujisaki (MWJ)		on board Leg 1-2
Takayoshi Seike (MWJ)		on board Leg 1-2

(2) Objectives

To check the quality of CTD salinity.

(3) Parameters

Salinity of sampled water

(4) Method

Seawater samples were collected with a bucket for the surface, 12-liter Niskin bottles for the deepest layer(4920db) and the other layers. They were stored in 250ml Phoenix brown glass bottles. The salinity analysis of samples were carried out using “Guildline Autosal 8400B Salinometer”, which was modified by addition of an Ocean Scientific International peristaltic-type sample intake pump. The instrument was operated in the “Autosal Room” of R/V Mirai constant temperature laboratory at a bath temperature of 24deg-C with the laboratory set under 24degree-C. A double conductivity ratio was defined as a median of 31 readings of the salinometer. Data collection was started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer. The salinometer standardizations were made with IAPSO Standard Seawater (Ocean Scientific International Ltd.) batch P137 in Leg 1 and batch P139 in Leg 2. The conductivity ratio of batch P137 is 0.99995 (2K 1.99990, salinity 34.999), and batch P139 is 0.99993 (2K 1.99986, salinity 34.997). Sub-standard seawater was used to check the drift of the Autosal.

(5) Results

Results in Leg 1 and Leg 2 were summarized in Table 6.3.1-1, 6.3.1-2, respectively. Salinity comparison between CTD data and Autosal data sampled were shown in Fig. 6.3.1-1 for Leg 1, and Fig. 6.3.1-2 for Leg 2.

Two pairs of duplicate samples taken by the same Niskin bottle and bucket were analyzed to estimate the precision of this method. To check the salinity data of CTD, we compared the salinity of all samples except the surface samples.

The mean standardization drift was 0.00006 by 2K. There were two pairs of duplicate samples drawn in Leg 1. The standard deviation and average were shown in table 6.3.1-3.

Table6.3.1.-3: Salinity duplicate statistics

Quantity	Average	Standard deviation	Number of pairs
Duplicates	0.0003	0.0001	2
*Flag 2 only			

(6) Data archive

The data of salinity samples will be submitted to the DMO (Data Management Office) in JAMSTEC.

Table.6.3.1.-1. Analysis data of all samples. Comparison Autosal and CTD

Line	Station	Niskin No.	CTD Pres. dBar	CTD Sal. Uncorrected	Salinity PSS-78	Autosal-CTD Diffrence	Flag
TEST	T-2	1	4920.036	34.6859	34.6868	0.0009	2
TEST	T-2	7	4919.393	34.6857	34.6862	0.0005	2
Leg1	C01	1	1008.707	34.5514	bad sample		9
Leg1	C02	1	1008.298	34.5538	34.5517	-0.0021	2
Leg1	C03	1	1007.909	34.5569	34.5569	0.0000	2
Leg1	C04	1	1006.976	34.5563	34.5554	-0.0009	2
Leg1	C05	1	1010.936	34.5536	34.5524	-0.0012	2
Leg1	C06	1	1010.357	34.5413	34.5388	-0.0025	2
Leg1	C01	2	754.730	34.5258	34.5260	0.0002	2
Leg1	C02	2	756.045	34.5348	34.5376	0.0028	2
Leg1	C03	2	755.918	34.5245	34.5265	0.0020	2
Leg1	C04	2	755.938	34.5273	34.5286	0.0013	2
Leg1	C05	2	756.588	34.5267	34.5275	0.0008	2
Leg1	C06	2	756.137	34.5267	34.5261	-0.0006	2
Leg1	C01	3	503.976	34.5616	34.5610	-0.0006	2
Leg1	C02	3	503.965	34.5650	34.5647	-0.0003	2
Leg1	C03	3	504.134	34.5504	34.5513	0.0009	2
Leg1	C04	3	505.755	34.5546	34.5560	0.0014	2
Leg1	C05	3	502.857	34.5727	34.5734	0.0007	2
Leg1	C06	3	504.195	34.5691	34.5687	-0.0004	2
Leg1	C01	4	299.856	34.5533	34.5564	0.0031	2
Leg1	C02	4	302.498	34.6145	34.6156	0.0011	2
Leg1	C03	4	303.161	34.5633	34.5609	-0.0024	2
Leg1	C04	4	301.868	34.6493	34.6325	-0.0168	2
Leg1	C05	4	302.151	34.9047	34.9147	0.0100	2
Leg1	C06	4	302.705	34.8812	34.8796	-0.0016	2
Leg1	C01	5	250.089	34.5545	34.5528	-0.0017	2
Leg1	C02	5	251.988	34.5624	34.5701	0.0077	2
Leg1	C03	5	251.617	34.5665	34.5610	-0.0055	2
Leg1	C04	5	251.007	34.9140	34.9167	0.0027	2
Leg1	C05	5	249.928	35.0772	35.0640	-0.0132	2
Leg1	C06	5	252.169	35.1276	35.1184	-0.0092	2
Leg1	C02	6	201.267	34.5759	34.5779	0.0020	2
Leg1	C03	6	201.360	34.8697	34.8733	0.0036	2
Leg1	C05	6	200.380	35.3072	35.3098	0.0026	2
Leg1	C06	6	201.798	35.3604	35.3191	-0.0413	2
Leg1	C01	7	150.828	34.7901	34.7911	0.0010	2
Leg1	C02	7	150.796	34.7972	34.8052	0.0080	2
Leg1	C03	7	151.475	34.8605	34.8560	-0.0045	2
Leg1	C04	7	149.796	34.9234	34.9287	0.0053	2
Leg1	C05	7	151.983	35.3422	35.3424	0.0002	2
Leg1	C06	7	151.479	35.3382	35.3699	0.0317	2
Leg1	C01	8	125.149	34.8779	34.8550	-0.0229	2

Leg1	C02	8	126.169	34.8604	34.8678	0.0074	2
Leg1	C03	8	125.117	35.0115	34.9982	-0.0133	2
Leg1	C04	8	125.662	34.9726	34.9837	0.0111	2
Leg1	C05	8	126.323	35.1473	35.2662	0.1189	2
Leg1	C06	8	126.187	35.2389	35.2822	0.0433	2
Leg1	C01	9	100.533	34.7794	34.7976	0.0182	2
Leg1	C02	9	101.371	34.8127	34.8276	0.0149	2
Leg1	C03	9	100.113	34.7017	34.8304	0.1287	2
Leg1	C04	9	100.214	34.5568	34.5985	0.0417	2
Leg1	C05	9	100.930	35.0498	35.0671	0.0173	2
Leg1	C06	9	101.281	35.0454	35.0929	0.0475	2
Leg1	C01	10	75.890	34.0923	34.3427	0.2504	2
Leg1	C02	10	75.858	34.4226	34.4677	0.0451	2
Leg1	C03	10	76.165	34.3123	34.3756	0.0633	2
Leg1	C04	10	75.176	34.3005	34.3076	0.0071	2
Leg1	C05	10	75.638	34.7373	34.7911	0.0538	2
Leg1	C01	11	50.907	33.9820	33.9936	0.0116	2
Leg1	C02	11	50.954	33.8890	33.9095	0.0205	2
Leg1	C03	11	50.838	34.2750	34.2861	0.0111	2
Leg1	C04	11	50.864	34.2690	34.2769	0.0079	2
Leg1	C05	11	50.541	34.6088	34.6966	0.0878	2
Leg1	C06	11	50.876	34.6064	34.6499	0.0435	2
Leg1	C01	12	25.809	33.9589	33.9639	0.0050	2
Leg1	C02	12	25.187	33.8720	33.8744	0.0024	2
Leg1	C03	12	26.027	34.1043	34.1166	0.0123	2
Leg1	C04	12	25.814	34.1206	34.1488	0.0282	2
Leg1	C05	12	25.503	34.2667	34.2802	0.0135	2
Leg1	C06	12	25.488	34.2627	34.3731	0.1104	2

All data	Avg.	0.0167
	Stdv.	0.0413
Below 300dl	Avg.	-0.0001
	Stdv.	0.0043

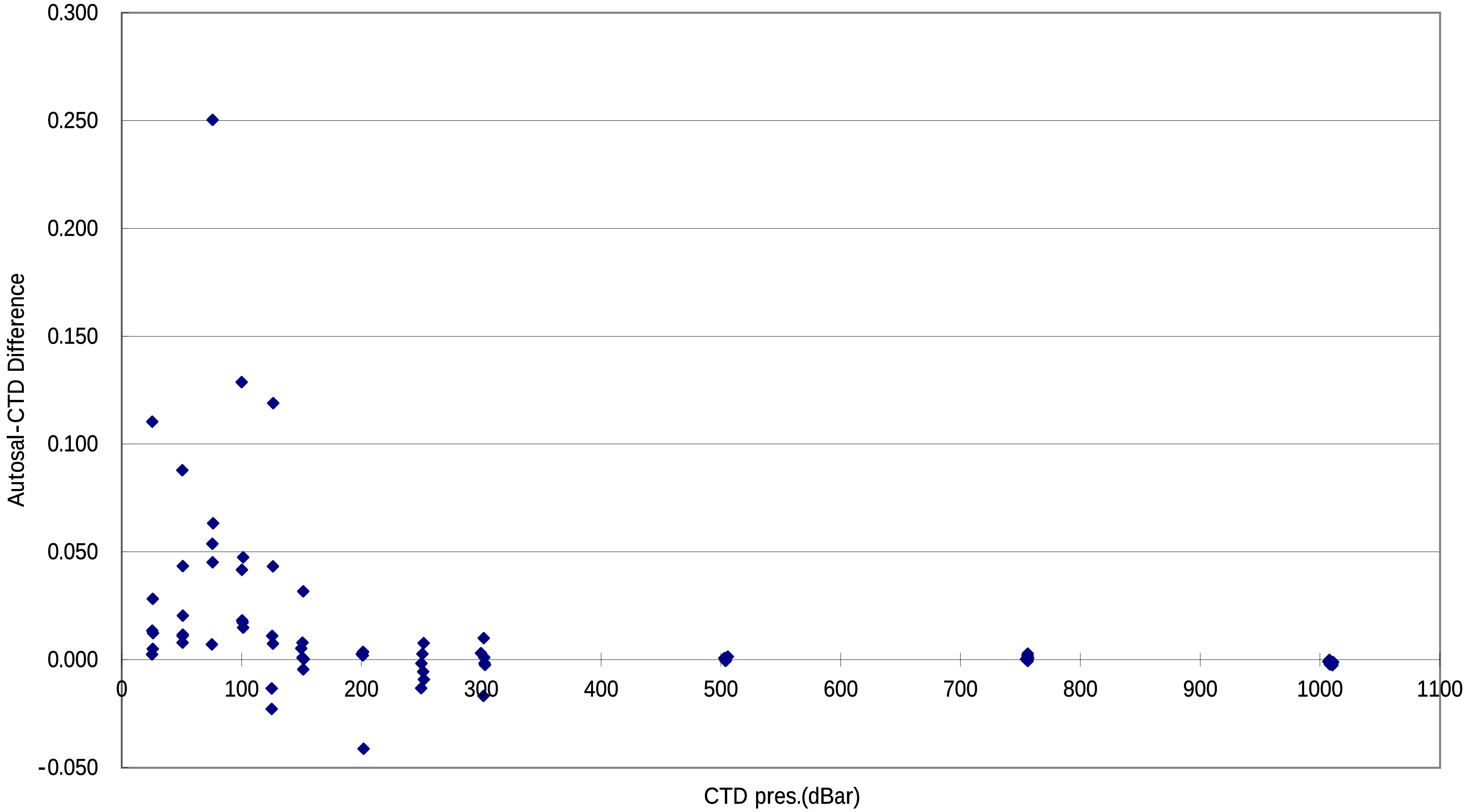


Fig. 6.3.1-1 Salinity difference in Leg.1

Table.6.3.1.-2. Analysis data of all samples. Comparison Autosal and CTD

Line	Station	Niskin No.	CTD Pres. dBar	CTD Sal. Uncorrected	Salinity PSS-78	Autosal-CTD Diffrence	Flag
Leg2	C07	1	2021.832	34.7748	34.7756	0.0008	2
Leg2	C08	1	2022.180	34.7739	34.7744	0.0005	2
Leg2	C09	1	2021.818	34.7698	34.7764	0.0066	2
Leg2	C10	1	2022.116	34.7800	34.7797	-0.0003	2
Leg2	C11	1	2021.423	34.7731	34.7732	0.0001	2
Leg2	C12	1	2021.298	34.7707	34.7712	0.0005	2
Leg2	C13	1	2022.426	34.7674	34.7679	0.0005	2
Leg2	C14	1	2022.399	34.7668	34.7670	0.0002	2
Leg2	C15	1	2020.464	34.7691	34.7693	0.0002	2
Leg2	C16	1	2023.103	34.7625	34.7631	0.0006	2
Leg2	C17	1	2021.291	34.7609	34.7607	-0.0002	2
Leg2	C18	1	2020.915	34.7625	34.7630	0.0005	2
Leg2	C19	1	2020.115	34.7611	34.7619	0.0008	2
Leg2	C20	1	2021.032	34.7590	34.7636	0.0046	2
Leg2	C07	2	1515.160	34.8371	34.8376	0.0005	2
Leg2	C08	2	1522.825	34.8427	34.8446	0.0019	2
Leg2	C09	2	1515.747	34.8445	34.8453	0.0008	2
Leg2	C10	2	1514.579	34.8416	34.8414	-0.0002	2
Leg2	C11	2	1513.499	34.8351	34.8350	-0.0001	2
Leg2	C12	2	1514.563	34.8315	34.8372	0.0057	2
Leg2	C13	2	1514.518	34.8126	34.8129	0.0003	2
Leg2	C14	2	1514.512	34.8193	34.8282	0.0089	2
Leg2	C15	2	1513.943	34.8195	34.8199	0.0004	2
Leg2	C16	2	1513.747	34.7946	34.7960	0.0014	2
Leg2	C17	2	1513.190	34.7770	34.7765	-0.0005	2
Leg2	C18	2	1515.468	34.7836	34.7861	0.0025	2
Leg2	C19	2	1514.120	34.7807	34.7840	0.0033	2
Leg2	C20	2	1514.906	34.7907	34.7926	0.0019	2
Leg2	C07	3	1008.799	34.9269	34.9262	-0.0007	2
Leg2	C08	3	1007.446	34.9267	34.9251	-0.0016	2
Leg2	C09	3	1008.046	34.9245	34.9239	-0.0006	2
Leg2	C10	3	1008.354	34.9319	34.9386	0.0067	2
Leg2	C11	3	1007.738	34.9508	34.9505	-0.0003	2
Leg2	C12	3	1008.954	34.9246	34.9239	-0.0007	2
Leg2	C13	3	1008.843	34.9413	34.9408	-0.0005	2
Leg2	C14	3	1009.059	34.9546	34.9551	0.0005	2
Leg2	C15	3	1007.380	34.8553	34.8539	-0.0014	2
Leg2	C16	3	1009.971	34.8282	34.8279	-0.0003	2
Leg2	C17	3	1008.731	34.8057	34.8049	-0.0008	2
Leg2	C18	3	1008.439	34.8025	34.8023	-0.0002	2
Leg2	C19	3	1008.399	34.8134	34.8304	0.0170	2
Leg2	C20	3	1007.980	34.8092	34.8106	0.0014	2

Leg2	C07	4	806.839	34.9698	no sample		9
Leg2	C08	4	805.373	34.9884	34.9876	-0.0008	2
Leg2	C09	4	806.304	34.9949	34.9929	-0.0020	2
Leg2	C10	4	807.265	35.0038	35.0031	-0.0007	2
Leg2	C11	4	809.524	34.9889	34.9869	-0.0020	2
Leg2	C12	4	805.817	34.9830	34.9812	-0.0018	2
Leg2	C13	4	806.913	34.9759	34.9793	0.0034	2
Leg2	C14	4	807.111	34.9778	34.9779	0.0001	2
Leg2	C15	4	805.880	34.9153	34.9146	-0.0007	2
Leg2	C16	4	806.657	34.8655	34.8687	0.0032	2
Leg2	C17	4	806.637	34.8189	34.8177	-0.0012	2
Leg2	C18	4	809.235	34.8177	34.8184	0.0007	2
Leg2	C19	4	805.439	34.8327	34.8345	0.0018	2
Leg2	C20	4	806.286	34.8569	34.8565	-0.0004	2
Leg2	C07	5	604.296	35.0300	35.0282	-0.0018	2
Leg2	C08	5	604.401	35.0293	35.0342	0.0049	2
Leg2	C09	5	604.486	35.0293	35.0271	-0.0022	2
Leg2	C10	5	604.575	35.0271	35.0256	-0.0015	2
Leg2	C11	5	603.581	35.0109	35.0098	-0.0011	2
Leg2	C12	5	604.382	35.0014	35.0010	-0.0004	2
Leg2	C13	5	604.535	34.9531	34.9528	-0.0003	2
Leg2	C14	5	604.565	34.9655	34.9667	0.0012	2
Leg2	C15	5	604.914	34.9499	34.9493	-0.0006	2
Leg2	C16	5	604.170	34.8718	34.8635	-0.0083	2
Leg2	C17	5	604.567	34.8768	34.8806	0.0038	2
Leg2	C18	5	604.684	34.8612	34.8599	-0.0013	2
Leg2	C19	5	604.398	34.8755	34.8753	-0.0002	2
Leg2	C20	5	604.805	34.8827	34.8820	-0.0007	2
Leg2	C07	6	503.269	35.0455	35.0603	0.0148	2
Leg2	C08	6	503.142	35.0333	35.0320	-0.0013	2
Leg2	C09	6	503.554	35.0379	35.0371	-0.0008	2
Leg2	C10	6	504.426	35.0165	35.0152	-0.0013	2
Leg2	C11	6	503.023	35.0028	35.0020	-0.0008	2
Leg2	C12	6	503.483	34.9920	34.9911	-0.0009	2
Leg2	C13	6	504.261	34.9940	34.9937	-0.0003	2
Leg2	C14	6	504.668	34.9811	34.9803	-0.0008	2
Leg2	C15	6	504.236	34.9491	34.9479	-0.0012	2
Leg2	C16	6	503.535	34.8872	34.8815	-0.0057	2
Leg2	C17	6	503.217	34.8741	34.8707	-0.0034	2
Leg2	C18	6	505.835	34.8635	34.8695	0.0060	2
Leg2	C19	6	504.138	34.8815	34.8838	0.0023	2
Leg2	C20	6	503.330	34.8899	34.8919	0.0020	2

Leg2	C07	7	403.028	35.0515	35.0513	-0.0002	2
Leg2	C08	7	402.438	35.0416	no sample		9
Leg2	C09	7	402.215	35.0576	35.0716	0.0140	2
Leg2	C10	7	403.380	35.0195	35.0159	-0.0036	2
Leg2	C11	7	402.582	35.0421	35.0401	-0.0020	2
Leg2	C12	7	402.604	34.9853	34.9837	-0.0016	2
Leg2	C13	7	403.251	35.0019	34.9996	-0.0023	2
Leg2	C14	7	402.451	34.9930	34.9941	0.0011	2
Leg2	C15	7	404.455	34.9636	34.9621	-0.0015	2
Leg2	C16	7	403.186	34.9020	34.9014	-0.0006	2
Leg2	C17	7	402.965	34.9077	34.9081	0.0004	2
Leg2	C18	7	403.196	34.9056	34.9044	-0.0012	2
Leg2	C19	7	404.699	34.8896	34.8902	0.0006	2
Leg2	C20	7	403.753	34.9143	34.9288	0.0145	2
Leg2	C07	8	302.733	35.0636	35.0630	-0.0006	2
Leg2	C08	8	301.485	35.0631	35.0594	-0.0037	2
Leg2	C09	8	302.120	35.0600	35.0583	-0.0017	2
Leg2	C10	8	302.695	35.0705	35.0670	-0.0035	2
Leg2	C11	8	301.589	35.0503	35.0514	0.0011	2
Leg2	C12	8	301.976	35.0530	35.0514	-0.0016	2
Leg2	C13	8	302.562	35.0296	35.0280	-0.0016	2
Leg2	C14	8	301.714	35.0210	35.0226	0.0016	2
Leg2	C15	8	302.884	34.9771	34.9736	-0.0035	2
Leg2	C16	8	303.686	34.9364	34.9363	-0.0001	2
Leg2	C17	8	302.278	34.9491	34.9524	0.0033	2
Leg2	C18	8	302.349	34.9511	34.9539	0.0028	2
Leg2	C19	8	302.082	34.9456	34.9439	-0.0017	2
Leg2	C20	8	302.301	34.9633	34.9620	-0.0013	2
Leg2	C07	9	201.307	35.0773	35.0677	-0.0096	2
Leg2	C08	9	200.875	35.0453	35.0565	0.0112	2
Leg2	C09	9	200.675	35.0038	35.0154	0.0116	2
Leg2	C10	9	202.011	35.0122	35.0148	0.0026	2
Leg2	C11	9	200.678	35.0838	35.0826	-0.0012	2
Leg2	C12	9	202.265	35.0977	35.1031	0.0054	2
Leg2	C13	9	202.708	35.0947	35.0942	-0.0005	2
Leg2	C14	9	201.053	35.0823	35.0837	0.0014	2
Leg2	C15	9	202.363	35.0463	35.0474	0.0011	2
Leg2	C16	9	201.436	34.9734	34.9707	-0.0027	2
Leg2	C17	9	199.466	34.9084	34.9135	0.0051	2
Leg2	C18	9	202.409	34.9946	34.9930	-0.0016	2
Leg2	C19	9	200.366	35.0113	35.0140	0.0027	2
Leg2	C20	9	202.127	34.9714	34.9805	0.0091	2

Leg2	C07	10	151.945	34.9672	34.9688	0.0016	2
Leg2	C08	10	150.726	34.9488	34.9533	0.0045	2
Leg2	C09	10	151.633	34.9104	34.9202	0.0098	2
Leg2	C10	10	151.265	34.9038	34.9239	0.0201	2
Leg2	C11	10	150.511	35.0329	35.0241	-0.0088	2
Leg2	C12	10	150.615	35.1035	35.1044	0.0009	2
Leg2	C13	10	150.856	35.1241	35.1256	0.0015	2
Leg2	C14	10	150.626	35.1779	35.1742	-0.0037	2
Leg2	C15	10	152.001	34.8452	34.8533	0.0081	2
Leg2	C16	10	151.040	34.7525	34.8142	0.0617	2
Leg2	C17	10	151.057	34.6760	34.7112	0.0352	2
Leg2	C18	10	151.132	34.8032	34.8529	0.0497	2
Leg2	C19	10	152.000	34.9461	34.9434	-0.0027	2
Leg2	C20	10	150.374	34.8942	34.8913	-0.0029	2
Leg2	C07	11	101.069	34.8248	34.8901	0.0653	2
Leg2	C08	11	100.056	34.9699	34.9787	0.0088	2
Leg2	C09	11	100.521	34.7682	34.7632	-0.0050	2
Leg2	C10	11	101.368	34.8618	34.8767	0.0149	2
Leg2	C11	11	100.320	34.9783	34.9755	-0.0028	2
Leg2	C12	11	100.745	35.1469	35.1400	-0.0069	2
Leg2	C13	11	101.153	34.9818	35.0004	0.0186	2
Leg2	C14	11	99.643	34.9496	34.9800	0.0304	2
Leg2	C15	11	100.959	35.0189	35.0451	0.0262	2
Leg2	C16	11	102.749	35.0281	35.0309	0.0028	2
Leg2	C17	11	103.177	35.0860	35.1427	0.0567	2
Leg2	C18	11	100.882	35.0224	35.0345	0.0121	2
Leg2	C19	11	101.324	34.7416	34.7453	0.0037	2
Leg2	C20	11	100.792	34.5399	34.5737	0.0338	2
Leg2	C07	12	51.041	34.7056	34.7152	0.0096	2
Leg2	C08	12	49.257	34.6363	34.6560	0.0197	2
Leg2	C09	12	51.104	34.5980	34.5988	0.0008	2
Leg2	C10	12	51.121	34.4900	34.4928	0.0028	2
Leg2	C11	12	49.640	34.5802	34.5836	0.0034	2
Leg2	C12	12	50.502	34.6885	34.7659	0.0774	2
Leg2	C13	12	50.073	34.9503	34.9553	0.0050	2
Leg2	C14	12	49.853	34.9338	34.9418	0.0080	2
Leg2	C15	12	50.512	34.9334	34.9367	0.0033	2
Leg2	C16	12	50.743	34.9930	34.9950	0.0020	2
Leg2	C17	12	49.762	34.6763	34.7538	0.0775	2
Leg2	C18	12	50.626	34.8079	34.8238	0.0159	2
Leg2	C19	12	49.910	34.6403	34.7049	0.0646	2
Leg2	C20	12	50.591	34.0357	34.0442	0.0085	2

All data	Avg.	0.0050
	Stdv.	0.0144
Below 300dl	Avg.	0.0006
	Stdv.	0.0037

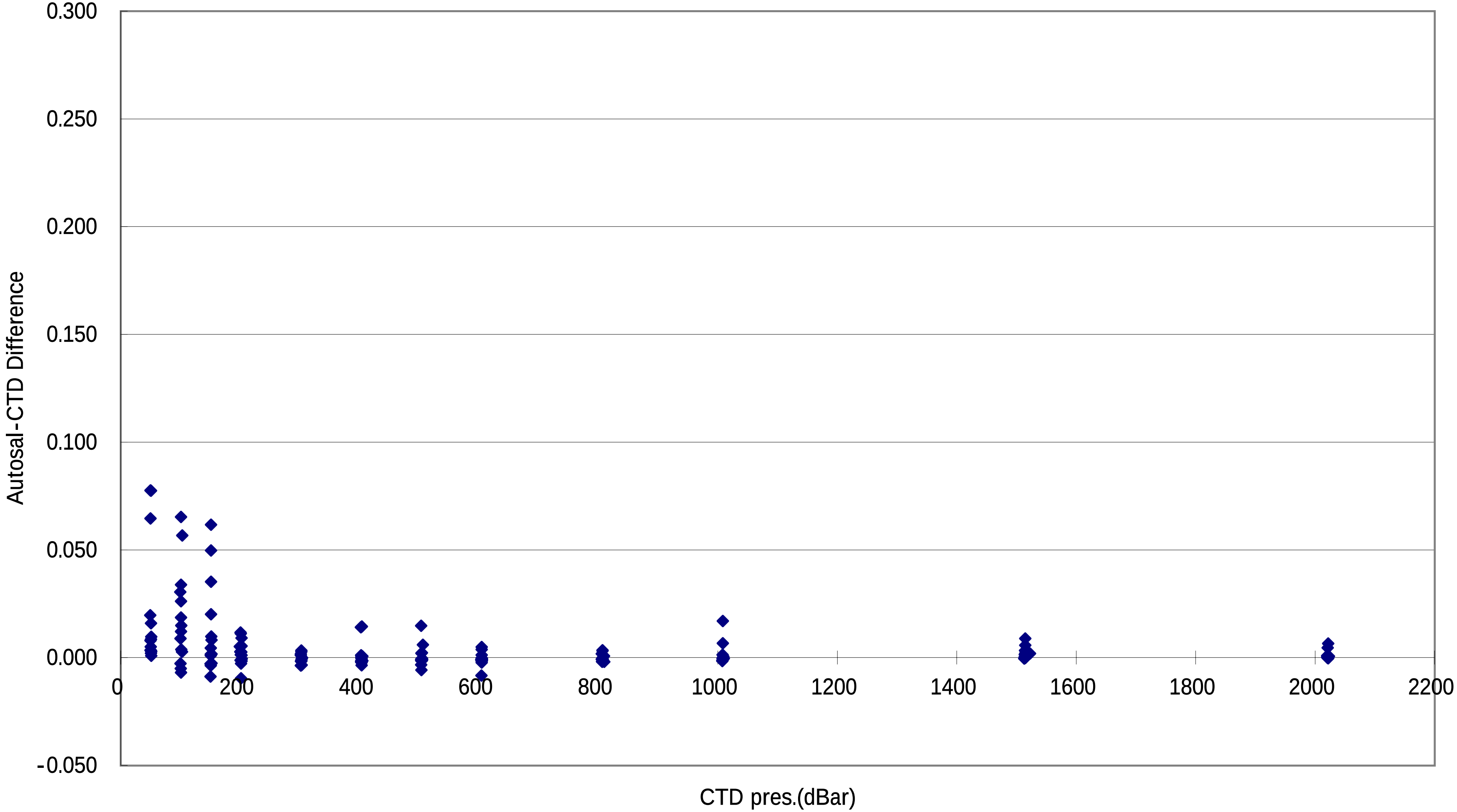


Fig. 6.3.1-2 Salinity difference in Leg.2

6.3.2 Dissolved oxygen analysis

(1) Personnel

Keisuke Mizuno (JAMSTEC) Principal Investigator
Tomoko Miyashita (MWJ)
Takayoshi Seike (MWJ)

(2) Introduction

Precise determination of dissolved oxygen using the Winkler titration with potentiometric detection.

(3) Methods

(a) Instruments and apparatus

Glass bottle:

Glass bottle for D.O. measurements consist of the ordinary BOD flask (ca.180ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966).

Dispenser:

Eppendorf Comforpette 4800/1000・l (dispensed for the 1 ml of H_2SO_4 and standard KIO_3 solution)
OPTIFIX/1ml (dispensed for the picking reagents)
Metrohm Model 725 Multi Dosimat / 20ml of titration vessel (dispensed for the standard KIO_3 solution)

Titrator:

Metrohm Model 716 DMS Titrino / 10 ml of titration vessel (resolution of titration is 0.001 ml)
Metrohm Pt Electrode / 6.9904.030

Software:

Date acquisition and endpoint evaluation / Metrohm, Titrino Workcell.

(b) Methods

Sampling and analytical methods were based on the WHP Operations and Methods (Culberson, 1991, Dickson, 1994)

(b-1) Sampling

Seawater samples for the dissolved oxygen measurement were collected from 12 litter Niskin bottles to calibrated dry glass bottles. During each sampling, 3 bottle volumes of seawater sample were overflowed to minimize contamination with atmospheric oxygen and the seawater temperature at the time of collection was measured for correction. After the sampling, $MnCl_2$ (aq.) 1ml and NaOH / NaI (aq.) 1ml were added into the glass bottle, and then shook the bottle were well. After the precipitation has settled, we shook the bottle vigorously to disperse the precipitate.

(b-2) Dissolved oxygen analysis

The samples were analyzed by 1 sets of Metrohm titrators with 10 ml piston buret and Pt Electrode using whole bottle titration. Titration was determined by the potentiometeric methods and the endpoint for titration was evaluated by the software of Metrohm, Titrino Workcell.

Concentration of D. O. was calculated by equation (1) – (6) (Dickson, 1994).

$$C(O_2)=n(O_2)-7.6\times10^{-8}\text{mol} / m(\text{sample}) \quad (1)$$

$$n(O_2)=1.5\cdot(V-V_{blank})\cdot V(KIO_3)\cdot M(KIO_3) / V_{std} - V_{blank} \quad (2)$$

$$V(KIO_3)= V(\text{pipette},20^\circ C)\{1+\alpha_v(t_L-20^\circ C)\} \quad (3)$$

$$M(KIO_3)=M(KIO_3,20^\circ C)\,\rho_w(t_L) / \rho_w(20^\circ C) \quad (4)$$

$$m\,(\text{sample}) = (V(O_2\text{-flask}) - 2\,\text{cm}^3) \cdot \rho_{sw}(S,t) \quad (5)$$

$$V(O_2\text{-flask}) = V(O_2\text{-flask}, 20℃)\{1 + \alpha_v(t - 20℃)\} \quad (6)$$

$C\,(O_2)$: Concentration of D. O.
m(sample): The mass of sea water that was pickled
$n\,(O_2)$: The total number of moles of O_2 reacted (sample + reagents)
V: Volume of $Na_2S_2O_3$ (aq.) needed to titrate the sample
V_{blank}: Volume of $Na_2S_2O_3$ (aq.) needed to titrate the blank
V_{std}: Average volume of $Na_2S_2O_3$ (aq.) used to titrate $V(KIO_3)$ of standard KIO_3 solution
$V\,(KIO_3)$: Volume of KIO_3 in the temperature at the time of standard
$M\,(KIO_3)$: Molarity of KIO_3 in the temperature at the time of standard
V(pipette, 20℃): Volume of the pipette in 20 ℃
α_v: The rate of expansion
$M(KIO_3$, 20℃)): Molarity of KIO_3 in 20℃
$\rho_w(t_L)$: Density of water in t_L ℃
t_L: The laboratory temperature
$V(O_2$ - flask): Volume of the oxygen flask
$\rho_{sw}(S,t)$: Density of the sea water in salinity S and t ℃

(4) Preliminary Result

The vertical profiles of D. O. were shown in Figs.6.3.2-1 - 3.

The profiles of comparison of D.O.[sensor] and D.O. analysis result were shown in Fig. 6.3.2-4. The D. O. data during C14 cast was extremely bad.

(5) Data archive

The data will be submitted to the DMO (Data Management Office) in JAMSTEC.

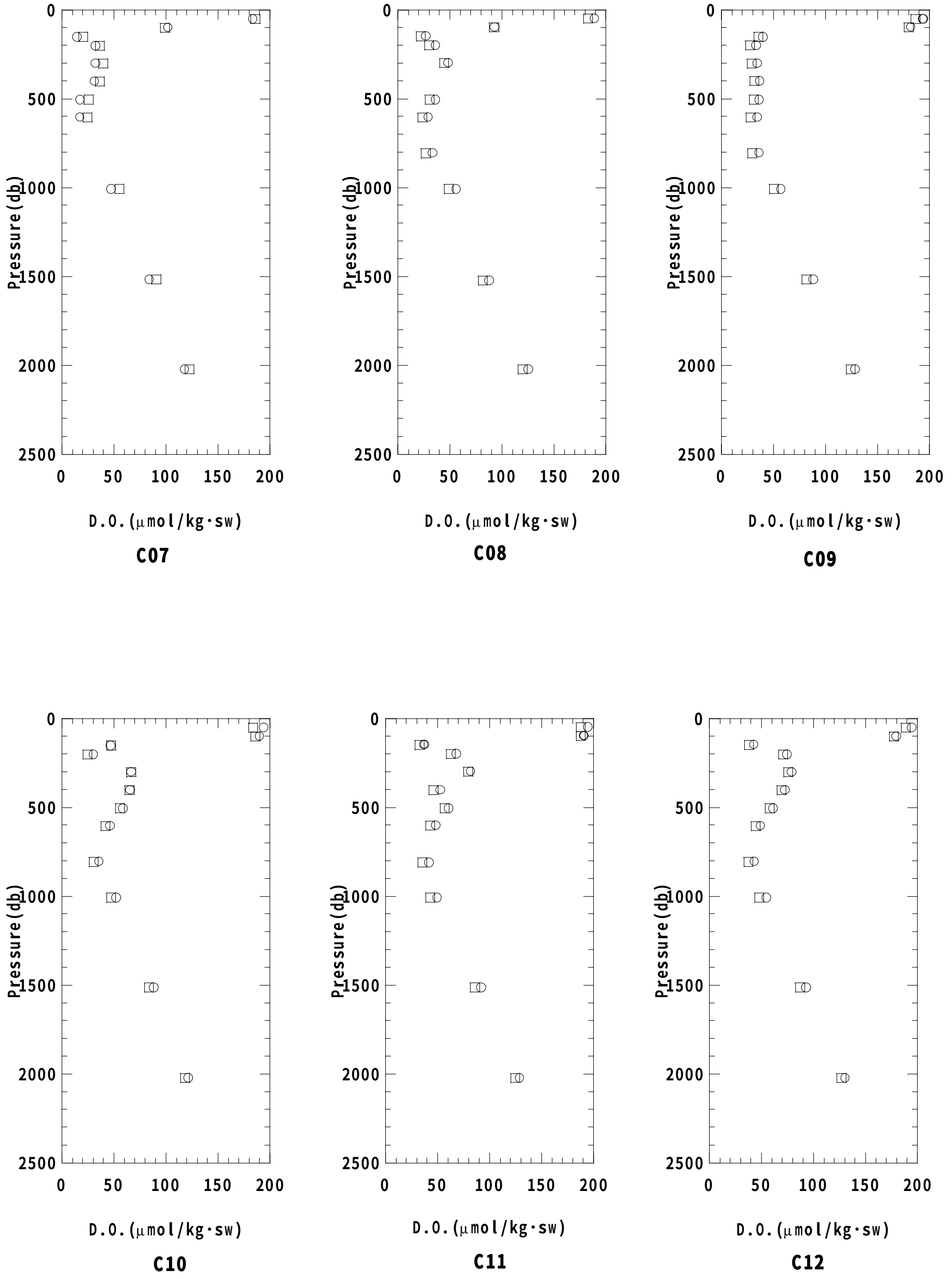
(6) References

Culberson, C.H.(1991) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole.,pp1-15

Culberson, C.H., G.Knapp, R.T.Williams and F.Zemlyak (1991) A comparison of methods for the determination of dissolved oxygen in seawater. (WHPO 91-2)

Dickson, A.G. (1994) Determination of dissolved oxygen in sea water by Winkler titration, in WHP Operations and Methods, Woods Hole.,pp1-14

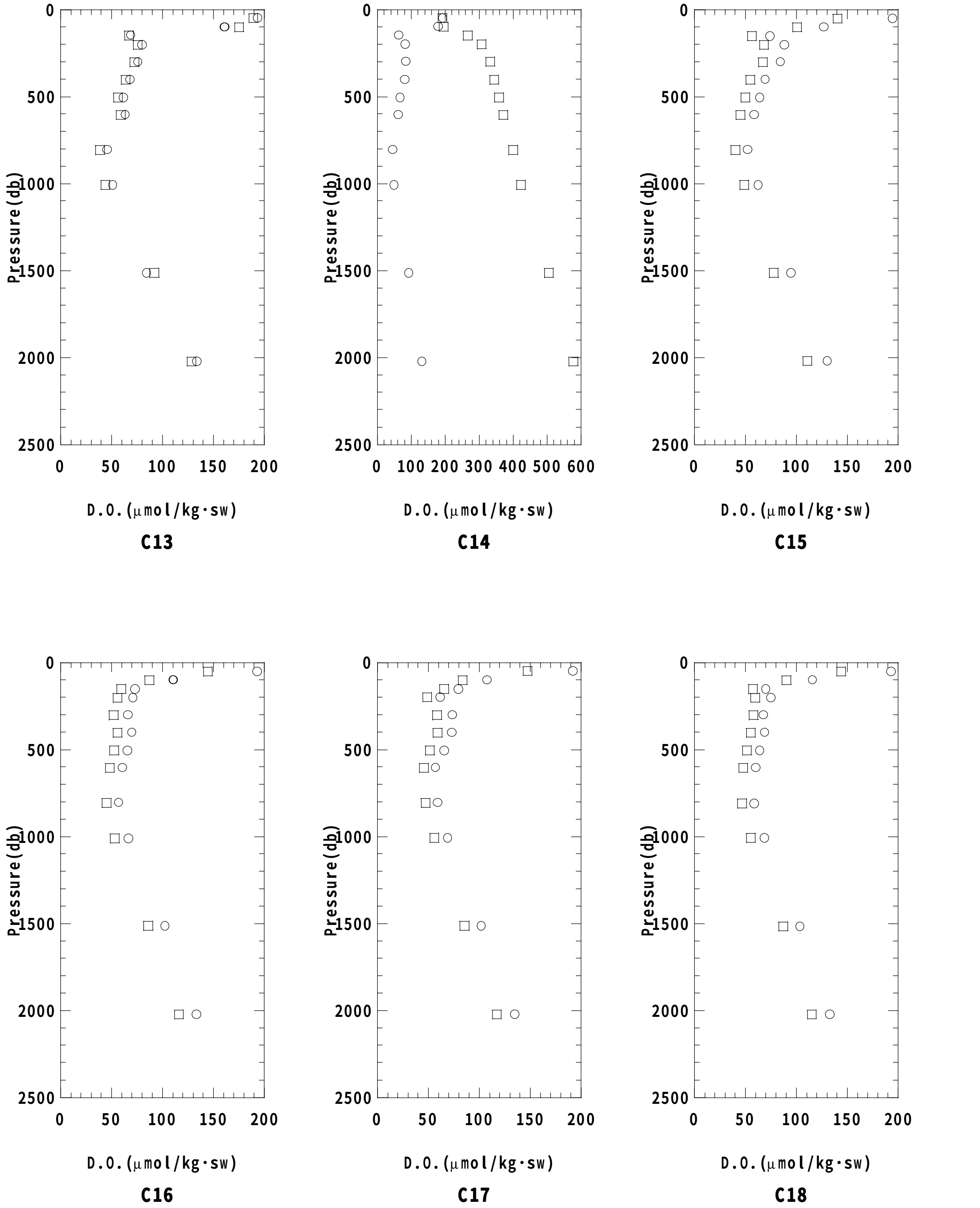
Murray, N.,J.P.Riley and T.R.S. Wilson (1968) The solubility of oxygen in Winkler regents used for the determination of dissolved oxygen, Deep-Sea Res.,15,237-238.



○；D.O.(μmol/kg・sw)

□；D.O.[sensor] (μmol/kg・sw)

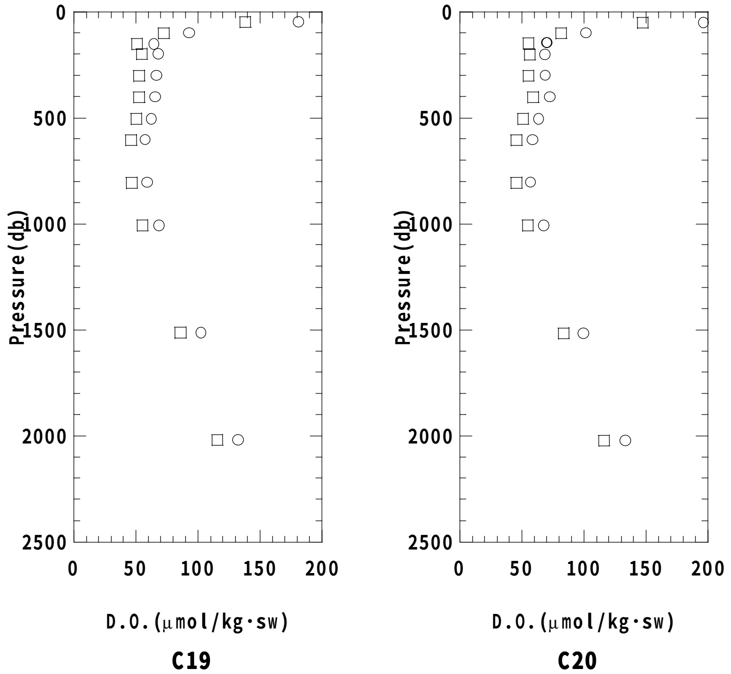
Fig. 6.3.2-1 Vertical profiles at each stations.



○ ; D.O.(μmol/kg・sw)

□ ; D.O.[sensor] (μmol/kg・sw)

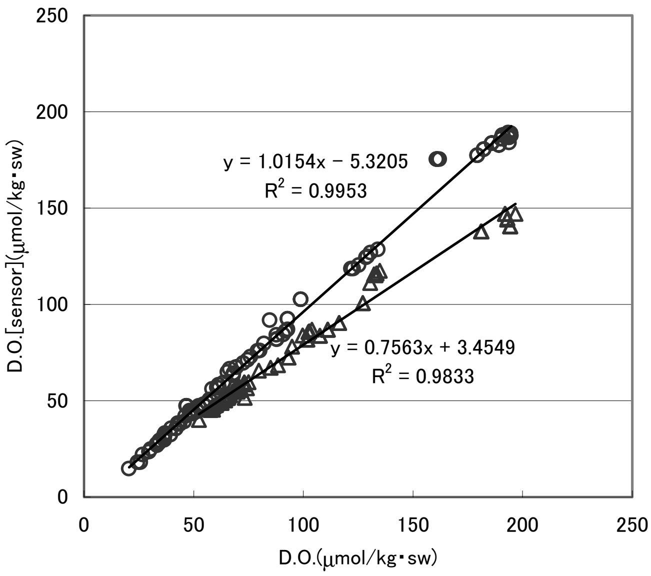
Fig. 6.3.2-2 Vertical profiles at each stations.



○ ; D.O.(μmol/kg・sw)

□ ; D.O.[sensor] (μmol/kg・sw)

Fig. 6.3.2-3 Vertical profiles at each stations.



○ ; C07-C13

△ ; C15-C20

Fig. 6.3.2-4 The profiles of comparison of D.O.[sensor] and D.O. analysis result

6.4 Continuous monitoring of surface seawater
6.4.1 EPCS

(1) Name & Affiliation

Yoshifumi Kuroda (JAMSTEC)	Principal Investigator	Leg 1
Keisuke Mizuno (JAMSTEC)	Principal Investigator	Leg 2
Tomoko Miyashita (MWJ)		

(2) Objective

In order to measure salinity, temperature, dissolved oxygen, and fluorescence of near-sea surface water.

(3) Methods

EPCS (Nippon Kaiyo Co., Ltd.) has five kind of sensors and fluorescence photometer and can automatically measure salinity, temperature, dissolved oxygen, fluorescence 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 machine every 1-minute together with time and position of ship, and displayed in the data management PC.

Near-surface water was continuously pumped up to the laboratory and flowed into the *EPCS* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and it was 12L/min except with fluorometer (about 0.3L/min). The flow rate is measured with two flow meters and each value was checked everyday.

Specifications of the each sensor in this system are listed below.

a) Temperature and salinity sensor

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number:	2118859-3128
Measurement range:	Temperature -5 to +35 degree-C, Salinity 0 to 6.5 S m-1
Accuracy:	Temperature 0.01 degree-C 6month-1, Salinity0.001 S m-1 month-1
Resolution:	Temperatures 0.001 degree-C, 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 degree-C
Resolution:	±0.001 degree-C
Stability:	0.002 degree-C year-1

c) Dissolved oxygen sensor

Model:	2127A, Oubisufair Laboratories Japan INC.
Serial number:	44733
Measurement range:	0 to 14 ppm
Accuracy:	±1% at 5 degree-C of correction range
Stability:	1% month-1

d) Fluorometer

Model:	10-AU-005, TURNER DESIGNS
Serial number:	5562 FRXX
Detection limit:	5 ppt or less for chlorophyll a
Stability:	0.5% month-1 of full scale

e) Particle size sensor

Model:	P-05, Nippon Kaiyo LTD.
Serial number:	P5024
Measurement range:	0.02681 mmt to 6.666 mm
Accuracy:	±10% of range
Reproducibility:	±5%
Stability:	5% week-1

f) 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.

Leg 1 22-Sep.-'01 23:32 to 09-Oct.-'01 18:56
The data missing periods due to data download are as follows.
26-Sep.-'01 01:23 to 26-Sep.-'01 01:46
30-Sep.-'01 07:06 to 30-Sep.-'01 07:37

Leg 2 18-Oct.-'01 15:13 to 31-Oct.o'01 23:59
The data missing period due to data download is as follows.
30-Oct.-'01 00:26 to 30-Oct.-'01 00:40

(4) Preliminary Result

The time series of the salinity are shown in Fig.6.4.1-1 and -2.
The time series of the temperature are shown in Fig.6.4.1-3 and -4.
The time series of the fluorescence are shown in Fig.6.4.1-5 and -6.
The time series of the D.O. are shown in Fig.6.4.1-7 and -8.
The comparison of EPCS salinity and water sample salinity is shown in Fig.6.4.1-9.
The comparison of EPCS D.O. and water sample D.O. is shown in Fig.6.4.1-10.

(5) Date archive

The data will be submitted to the DMO (Data Management Office) in JAMSTEC, and will be opened to the public via "R/V Mirai Data Web Page" in JAMSTEC home page.

(6) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam (02:29 (UTC) October 12 to 12:15 (UTC) October 15, 2001).

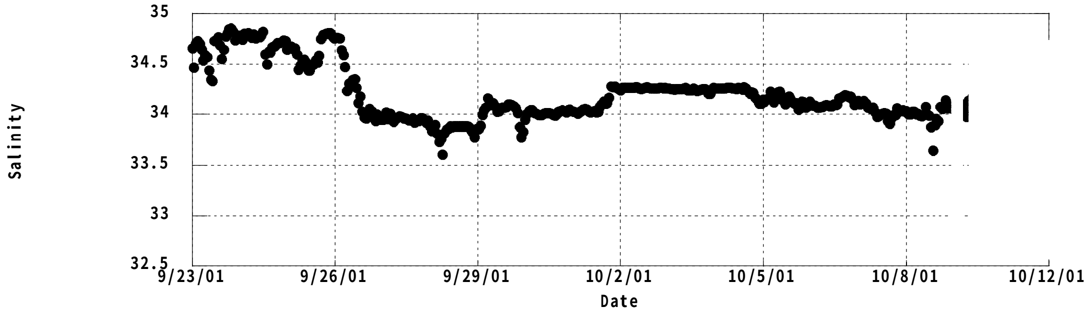


Fig. 6.4.1-1 Time series of the salinity (Leg 1).

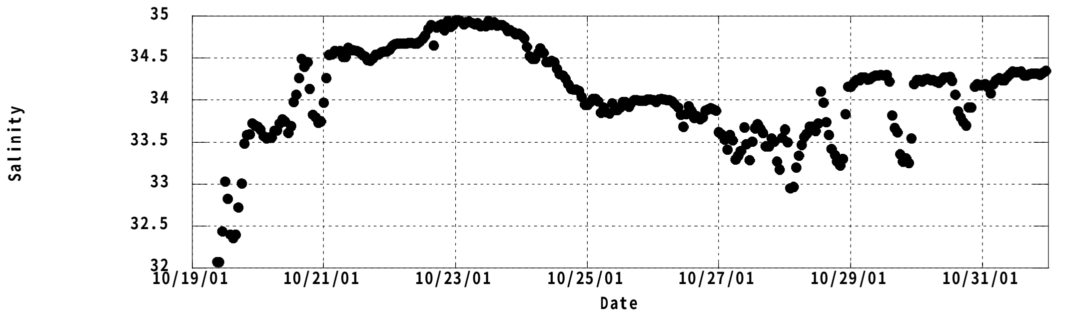


Fig. 6.4.1-2 Time series of the salinity (Leg 2).

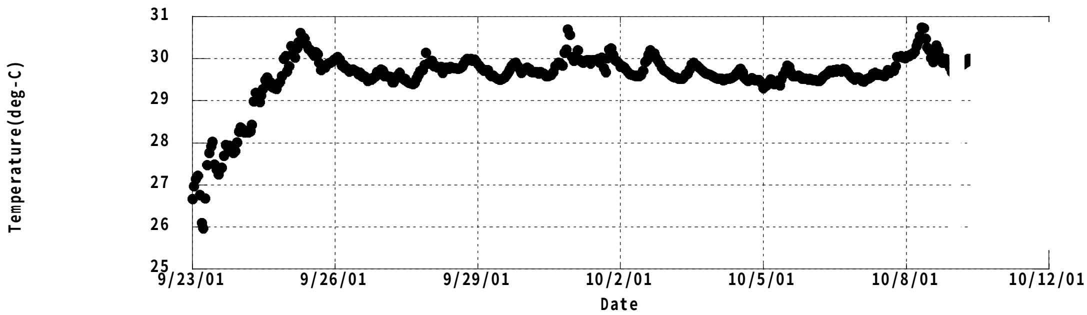


Fig. 6.4.1-3 Time series of the temperature (Leg 1).

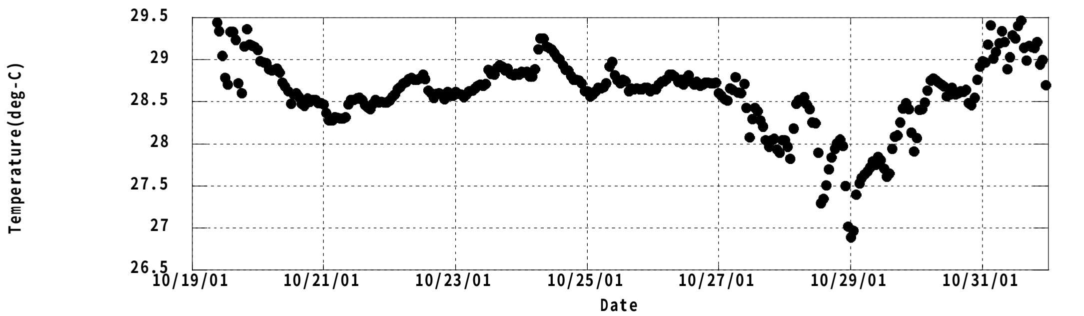


Fig. 6.4.1-4 Time series of the temperature (Leg 2).

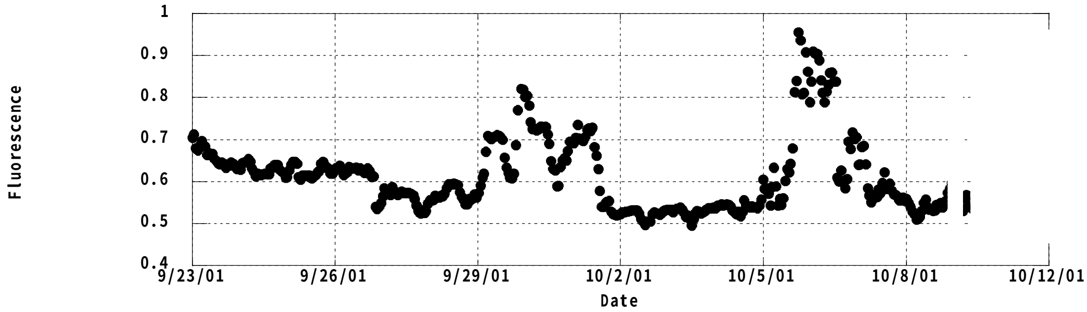


Fig. 6.4.1-5 Time series of the fluorescence (Leg 1).

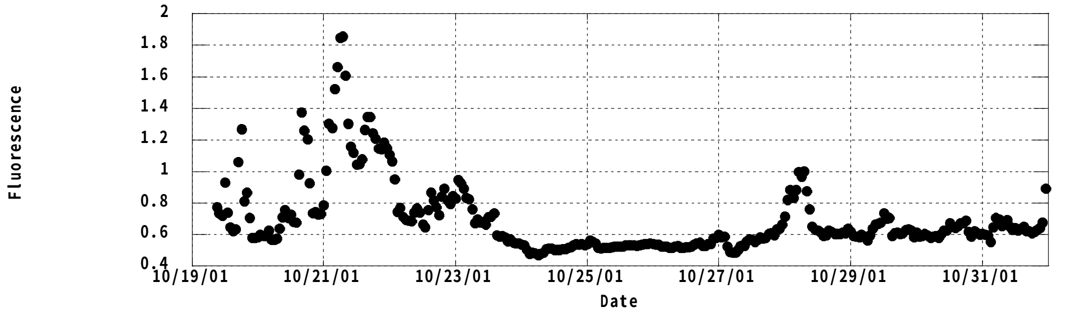


Fig. 6.4.1-6 Time series of the fluorescence (Leg 2).

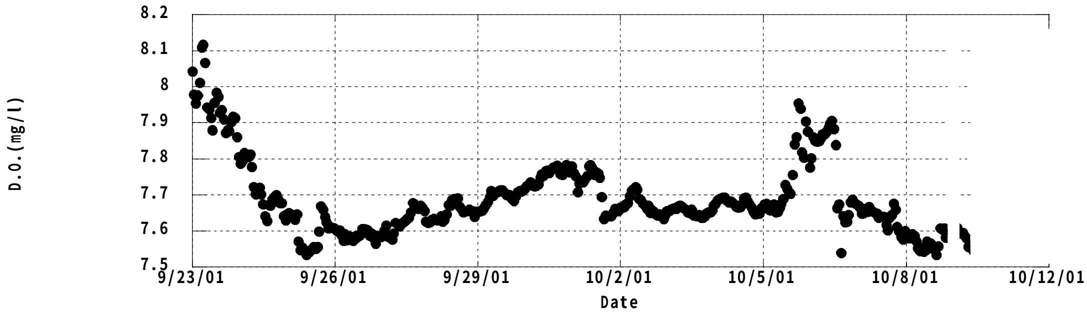


Fig. 6.4.1-7 Time series of the dissolved oxygen (Leg 1).

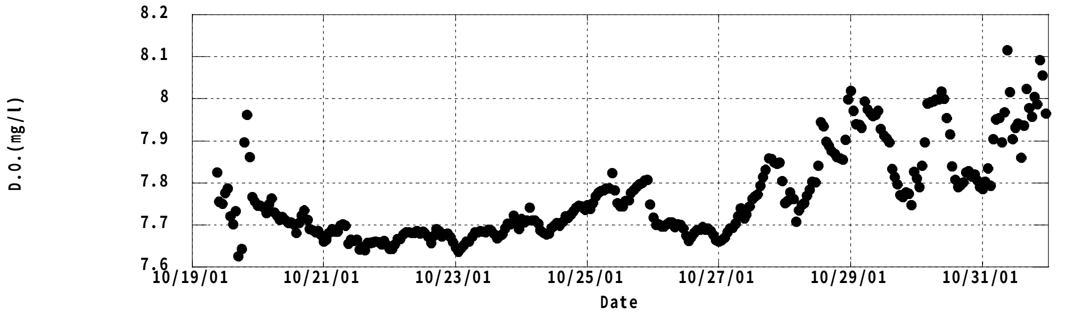


Fig. 6.4.1-8 Time series of the dissolved oxygen (Leg 2).

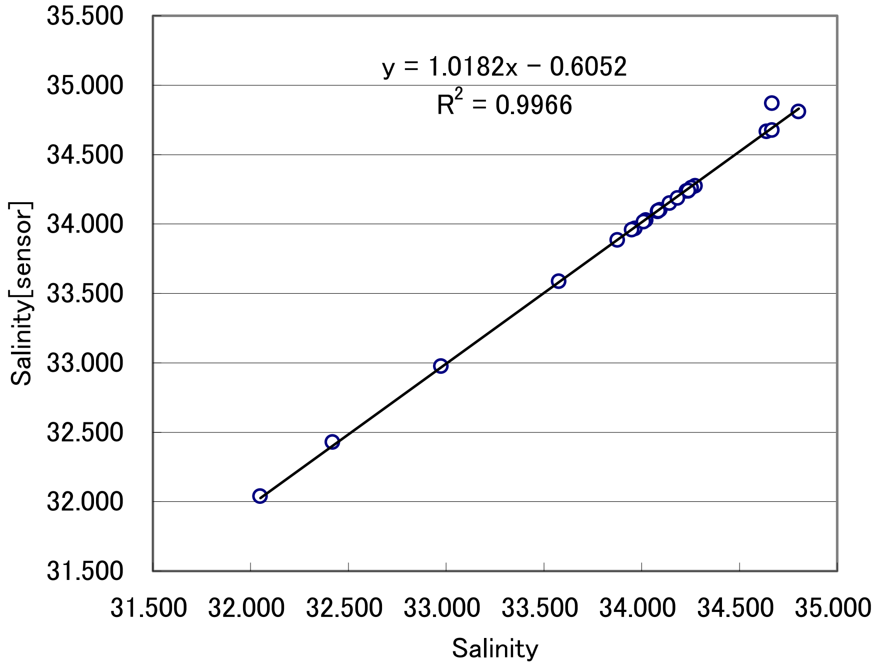


Fig. 6.4.1-9 The comparison of EPCS salinity and water sample salinity.

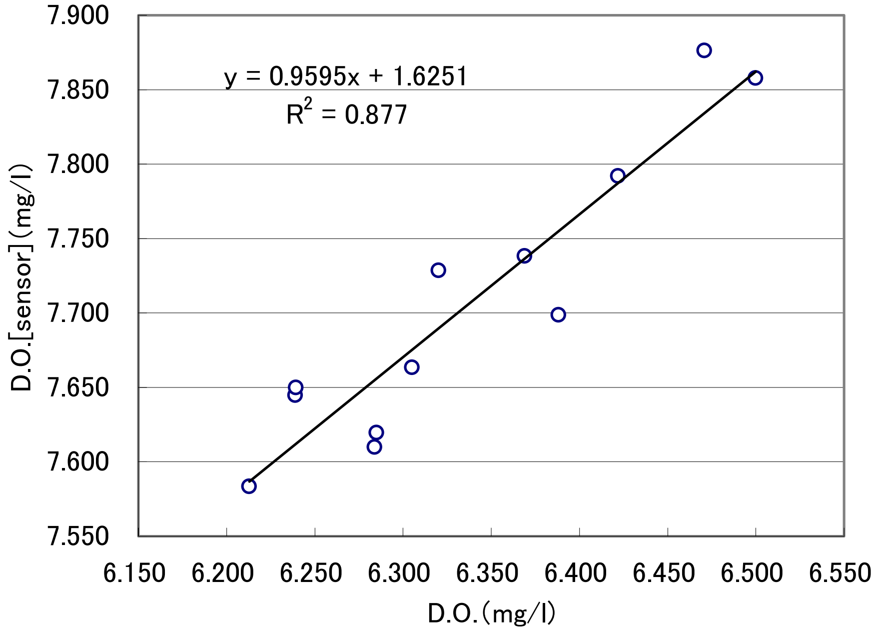


Fig. 6.4.1-10 The comparison of EPCS D.O. and water sample D.O..

6.4.2 pCO_2

(1) Personnel name and affiliation

Akihiko Murata (JAMSTEC)	Principal Investigator	not on board
Junko Hamanaka (MWJ)	Operation leader	

(2) Objective

Continuous measurement of partial pressure of carbon dioxide (CO_2) in the atmosphere and surface seawater.

(3) Instrument and methods

Concentrations of CO_2 in marine boundary air and in the air equilibrated with surface seawater were measured continuously from September 21 to 28 and October 20 to 24, 2001. The non-dispersive infrared (NDIR) gas analyzer (BINOSTM) was used as a detector. We measured CO_2 concentration in air twice, in the air equilibrated with seawater seven times, and in standard gases once every 1.5 hours.

Air was taken continuously from the bow and introduced into the NDIR analyzer through a mass flow controller which controlled at 0.5 L min^{-1}, a cooling unit, a Perma Pure dryer, and a desiccant holder (Mg $(ClO_4)_2$).

Seawater was taken continuously at ca. 4.5 m below the sea level and introduced into a shower-head type equilibrator at a rate of 6.5 L min^{-1}. The air equilibrated with seawater was circulated using an air pump at 0.5 L min^{-1} in a closed loop, and introduced into the NDIR analyzer through a mass flow controller which controlled at 0.5-0.6 L min^{-1}, two cooling units, a Perma Pure dryer, and the desiccant holder.

Four CO_2 standard gases (248, 299, 321 and 371 ppm) in synthetic air were used to calibrate the measuring system.

(4) Data archive

The data will be submitted to the DMO (Data Management Office) in JAMSTEC within 3 years after this cruies.

6.5 Shipboard ADCP

(1) Personnel name and affiliation

Hideaki Hase (JAMSTEC):	Principal Investigator	- Leg 1, 2 -
Satoshi Okumura (GODI):	Operation Leader	- Leg 1-
Wataru Tokunaga (GODI):		- Leg 1, 2 -
Takuya Yoshida (GODI)		- Leg 1 -
Shinya Iwamida (GODI)		- Leg 2 -

(2) Parameters

(2-1) N-S (North-South) and E-W (East-West) velocity components at each depth cell [cm/s]

(2-2) Echo intensity at each depth cell [dB]

(3) Methods

Upper ocean current measurement was made throughout MR01-K05 cruise (Departure from Sekinehama, Japan on 20 September, 2001 to arrival at Koror, Republic of Palau on 5 November, 2001, excluding the EEZ of Vietnam and Cambodia) using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system. The system consists of the following components:

1) An incoherent (Broad Bandwidth, uncoded pulse) 4-beam Doppler sonar operating at 76.8 kHz (model VM-75 made by RD Instruments), mounted with the 30-degree beam angle from the vertical and 45-degree azimuth from the keel,
2) Ship's main gyrocompass (Tokimec, Japan) continuously providing ship's heading data to the ADCP.
3) GPS navigation receiver (Leica MX9400) providing position fixes,
4) IBM compatible personal computer running data acquisition software (Win TRANSECT, SEA Corporation, Japan). The PC clock is adjusted with GPS time by watchdog program every 5 minutes.

Major parameters for the measurement configuration are as follows.

Frequency:	75 kHz
Average:	every 300 sec
Depth cell length:	16 m
Blank length:	8 m
Number of depth cells:	40
First depth cell position:	30.9 m
Last depth cell position:	654.9 m
Ping interval:	2 sec
Pings per ensemble (water track):	50
Pings per ensemble (bottom track):	10

(4) Data processing and preliminary results

The data processing was done using the CODAS (Common Oceanographic Data Acquisition System) software, which is developed at the University of Hawaii (Firing et al., 1995). The software is available via anonymous ftp and web browser (see http://noio.soest.hawaii.edu/). The system handles the process (averaged) data obtained by RDI data acquisition software. It is designed for the automated processing of many velocity profiles at a time, and for the facility of calibrations.

Figures (Fig. 6.5-1 (a) - (e) and Fig. 6.5-2 (a) - (e)) show the horizontal velocity vectors on the cruise track averaged for the horizontal scale of 0.5 degree by 0.5 degree. The periods are from September 27 to October 11 during Leg 1, and from October 19 to October 31 during Leg 2. In vertical direction, the data are averaged between the depths of 35, 75, 125, 175, 225, 275, 325, 375, 425 and 475 m with the centered-average scheme of the CODAS software. The orientation of each arrow indicates the current direction: up is northward and to the right is eastward. Figure 6.5-3 shows vertical section of zonal current velocity along 90E. Positive value indicates eastward current.

(5) References

Firing, E., J. Ranada and P. Caldwell (1995): Processing ADCP data with the CODAS software system version 3.1, software manual provided via the web site: http://noio.soest.hawaii.edu/, 212pp.

(6) Data archive

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

(7) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam (02:29 (UTC) October 12 to 12:15 (UTC) October 15, 2001).

Figures:

Figure 6.5-1 (a) Vector plots of horizontal current velocity averaged between 35 m and 75 m depth (upper), and between 75 m and 125 m depth (lower) from September 27 to October 11, 2001.

Figure 6.5-1 (b) Vector plots of horizontal current velocity averaged between 125 m and 175 m depth (upper), and between 175 m and 225 m depth (lower) from September 27 to October 11, 2001.

Figure 6.5-1 (c) Vector plots of horizontal current velocity averaged between 225 m and 275 m depth (upper), and between 275 m and 325 m depth (lower) from September 27 to October 11, 2001.

Figure 6.5-1 (d) Vector plots of horizontal current velocity averaged between 325 m and 375 m depth (upper), and between 375 m and 425 m depth (lower) from September 27 to October 11, 2001.

Figure 6.5-1 (e) Vector plots of horizontal current velocity averaged between 425 m and 475 m depth from September 27 to October 11, 2001.

Figure 6.5-2 (a) Vector plots of horizontal current velocity averaged between 35 m and 75 m depth (upper), and between 75 m and 125 m depth (lower) from October 19 to October 31, 2001.

Figure 6.5-2 (b) Vector plots of horizontal current velocity averaged between 125 m and 175 m depth (upper), and between 175 m and 225 m depth (lower) from October 19 to October 31, 2001.

Figure 6.5-2 (c) Vector plots of horizontal current velocity averaged between 225 m and 275 m depth (upper), and between 275 m and 325 m depth (lower) from, October 19 to October 31 2001.

Figure 6.5-2 (d) Vector plots of horizontal current velocity averaged between 325 m and 375 m depth (upper), and between 375 m and 425 m depth (lower) from October 19 to October 31, 2001.

Figure 6.5-2 (e) Vector plots of horizontal current velocity averaged between 425 m and 475 m depth from October 19 to October 31, 2001.

Figure 6.5-3 Vertical section of zonal current velocity along 90E.

Current vector plot

Sep 27 to Oct 11, 2001

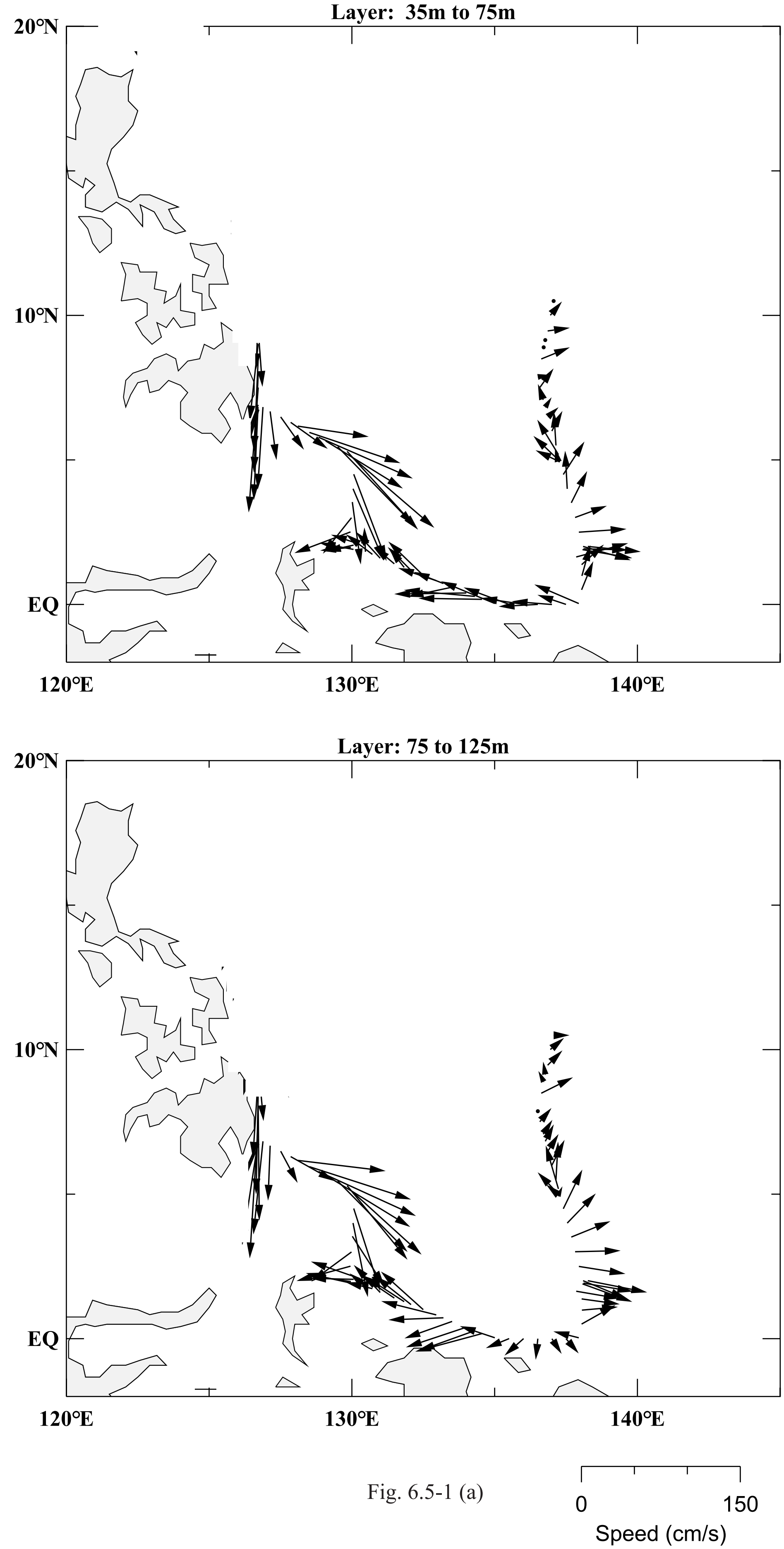


Fig. 6.5-1 (a)

Current vector plot

Sep 27 to Oct 11, 2001

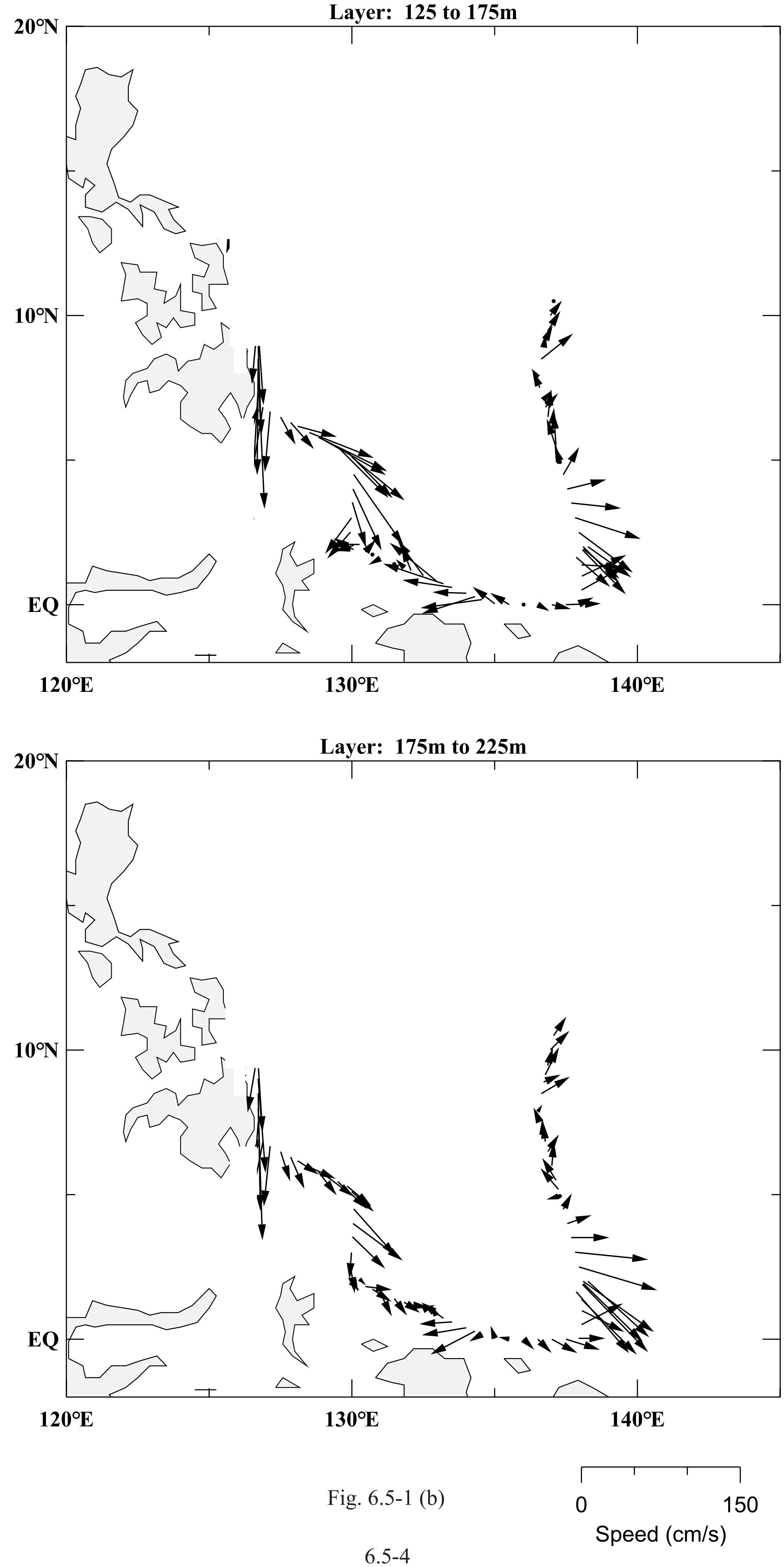
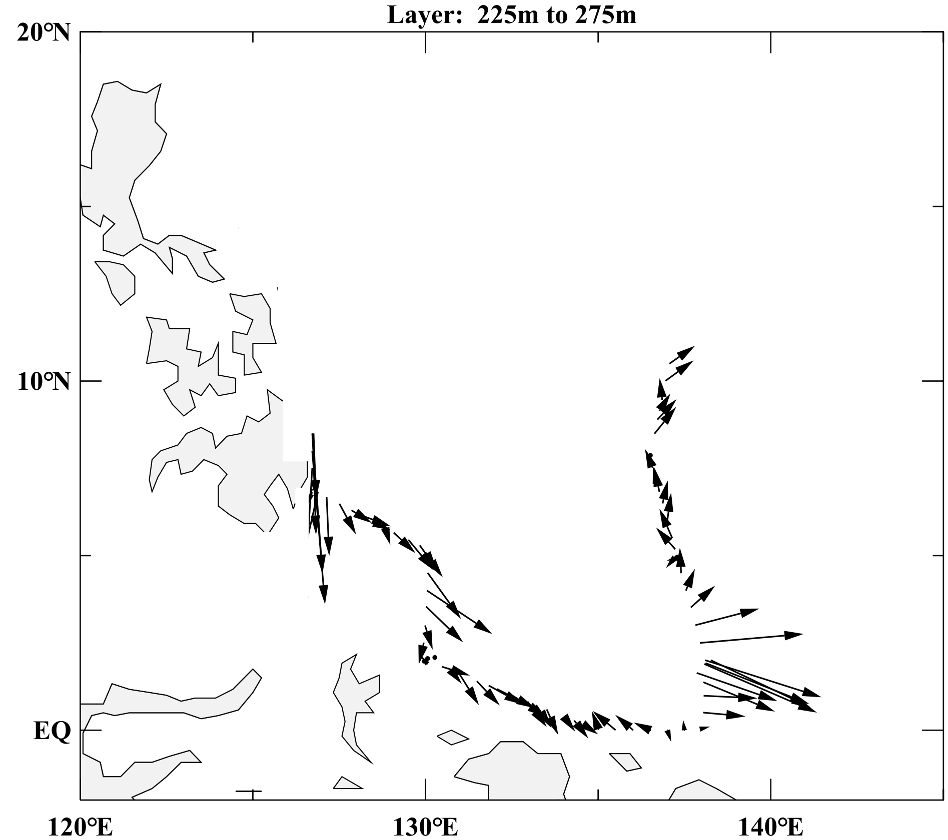


Fig. 6.5-1 (b)

Current vector plot

Sep 27 to Oct 11, 2001



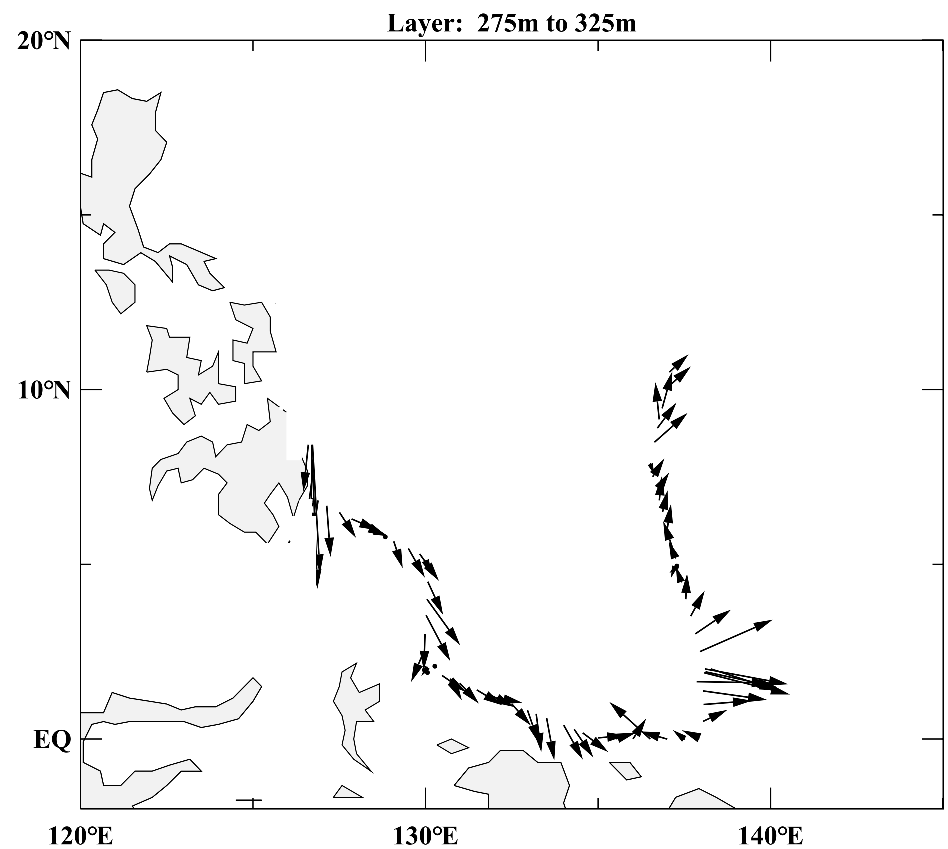
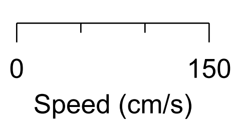


Fig. 6.5-1 (c)



Current vector plot

Sep 27 to Oct 11, 2001

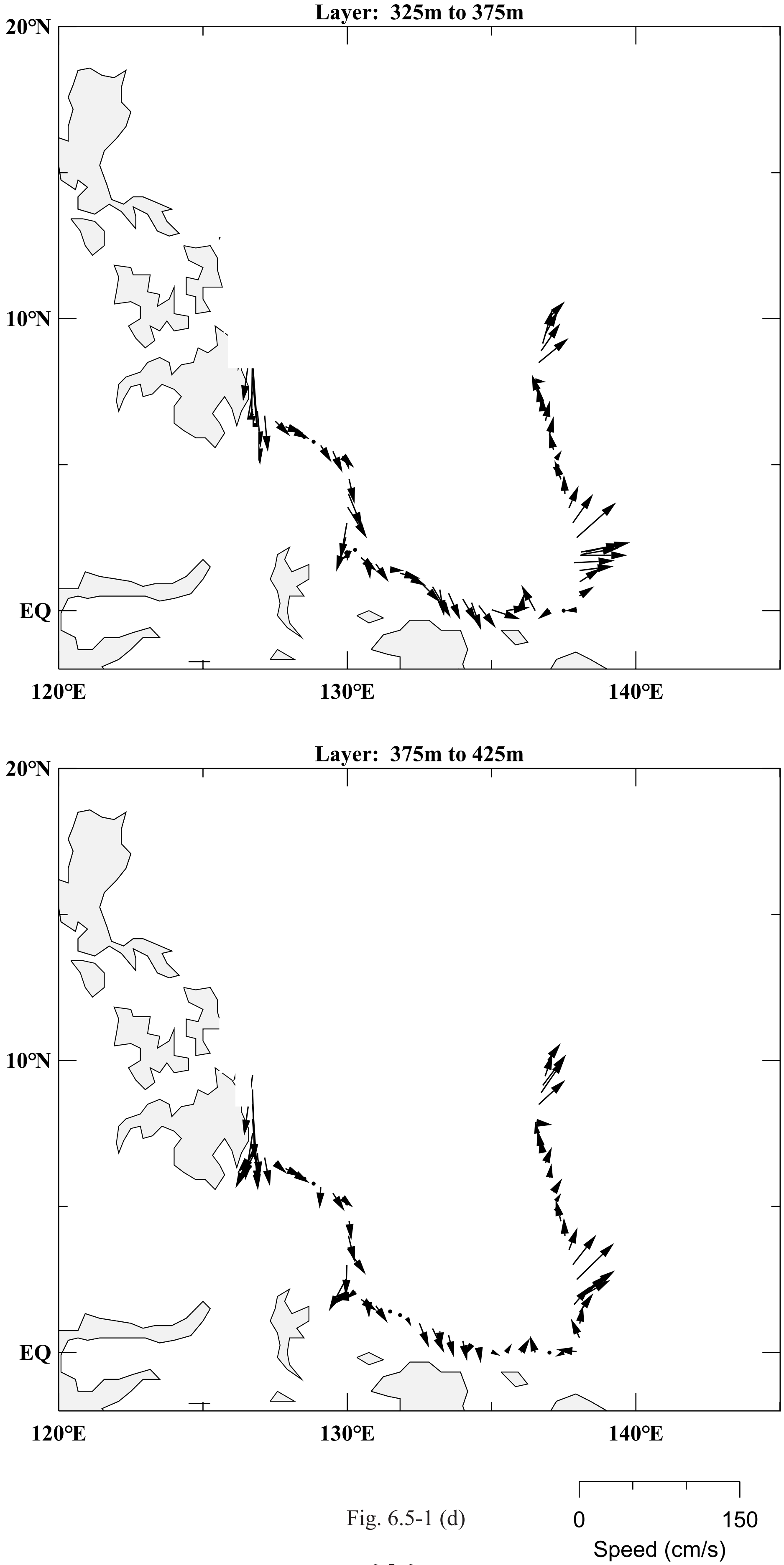


Fig. 6.5-1 (d)

Current vector plot

Sep 27 to Oct 11, 2001

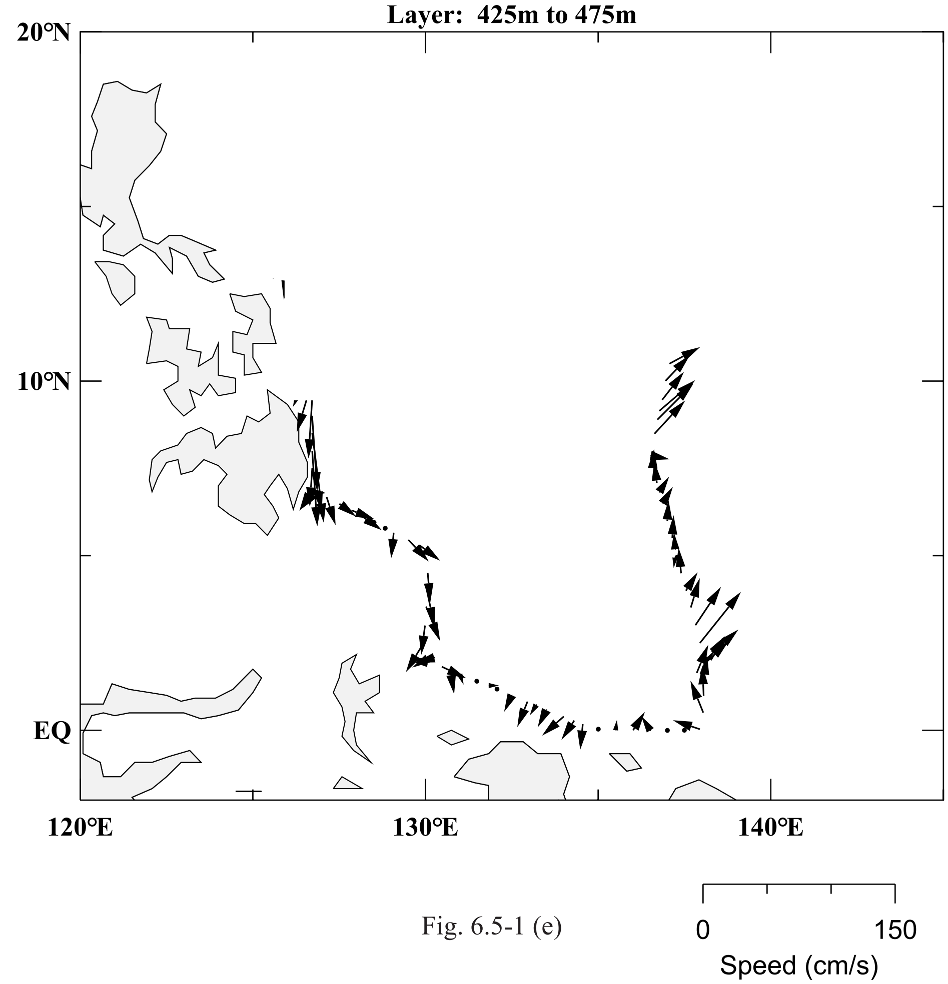
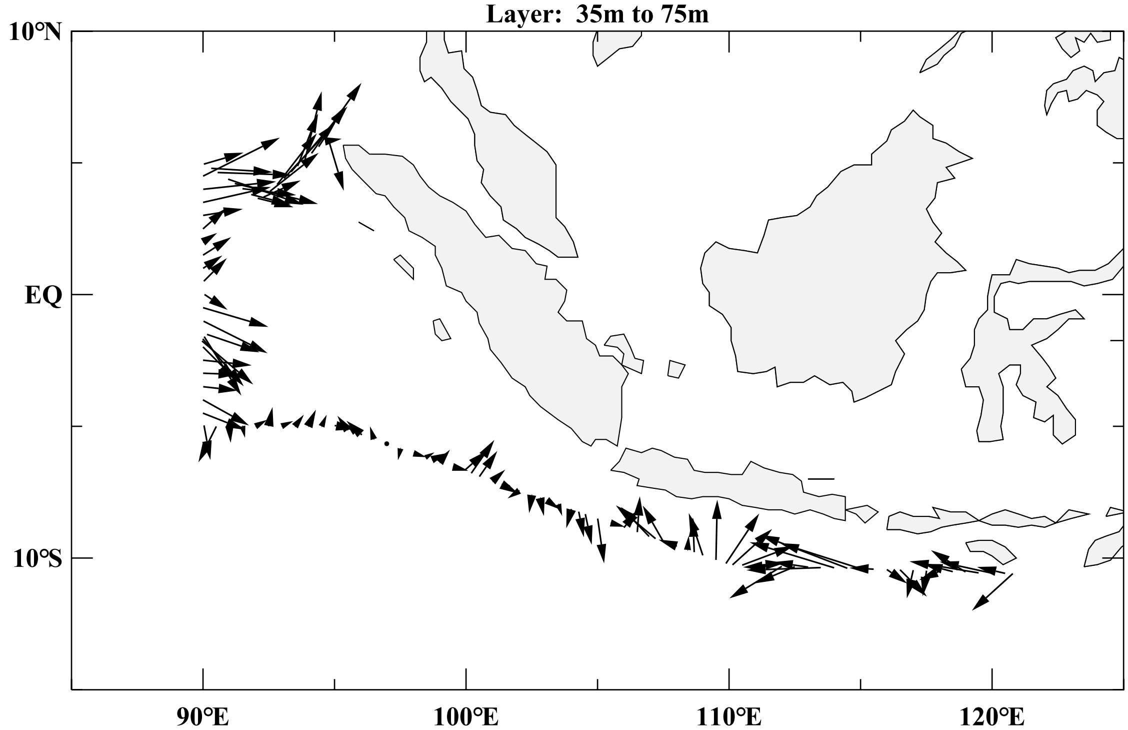


Fig. 6.5-1 (e)

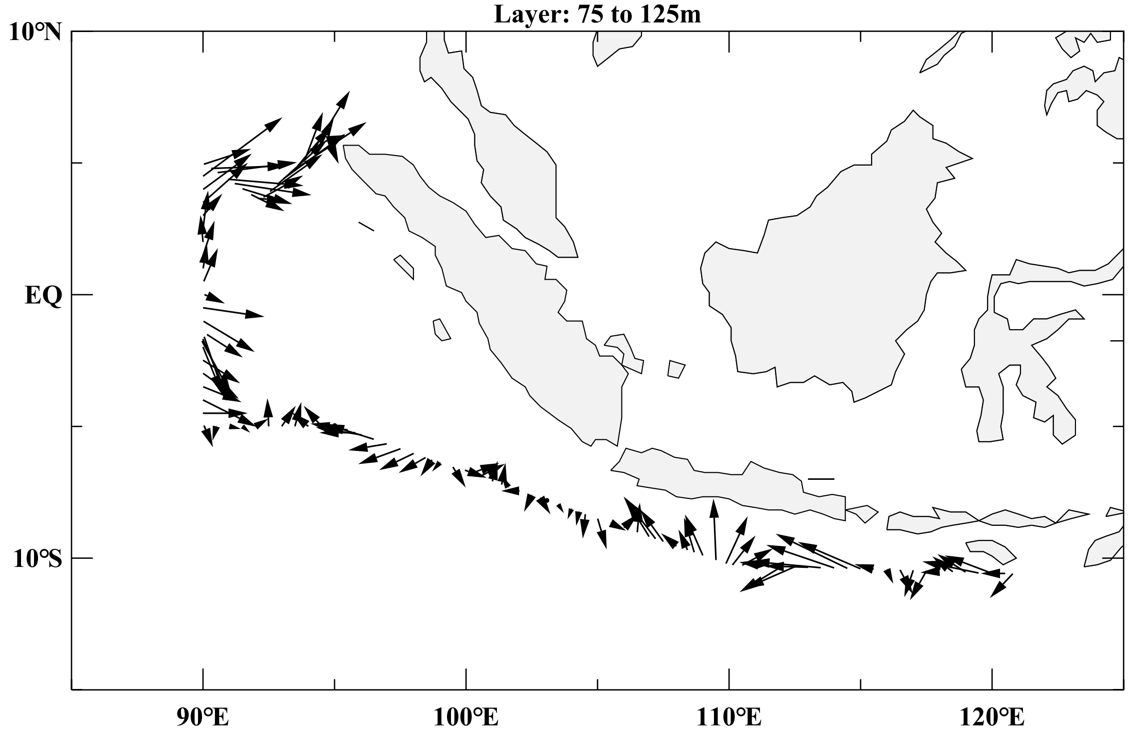
Current vector plot

Oct 19 to Oct 31, 2001

Layer: 35m to 75m



Layer: 75 to 125m



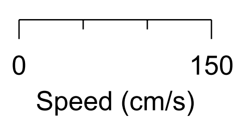
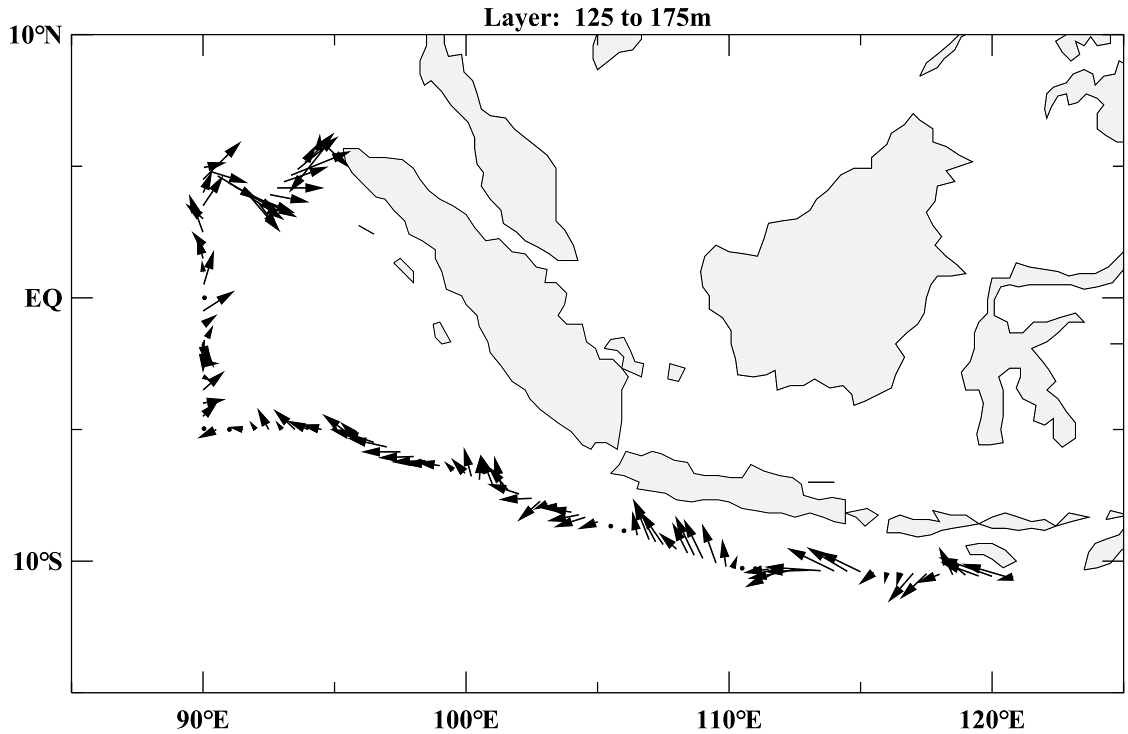


Fig. 6.5-2 (a)

Current vector plot

Oct 19 to Oct 31, 2001



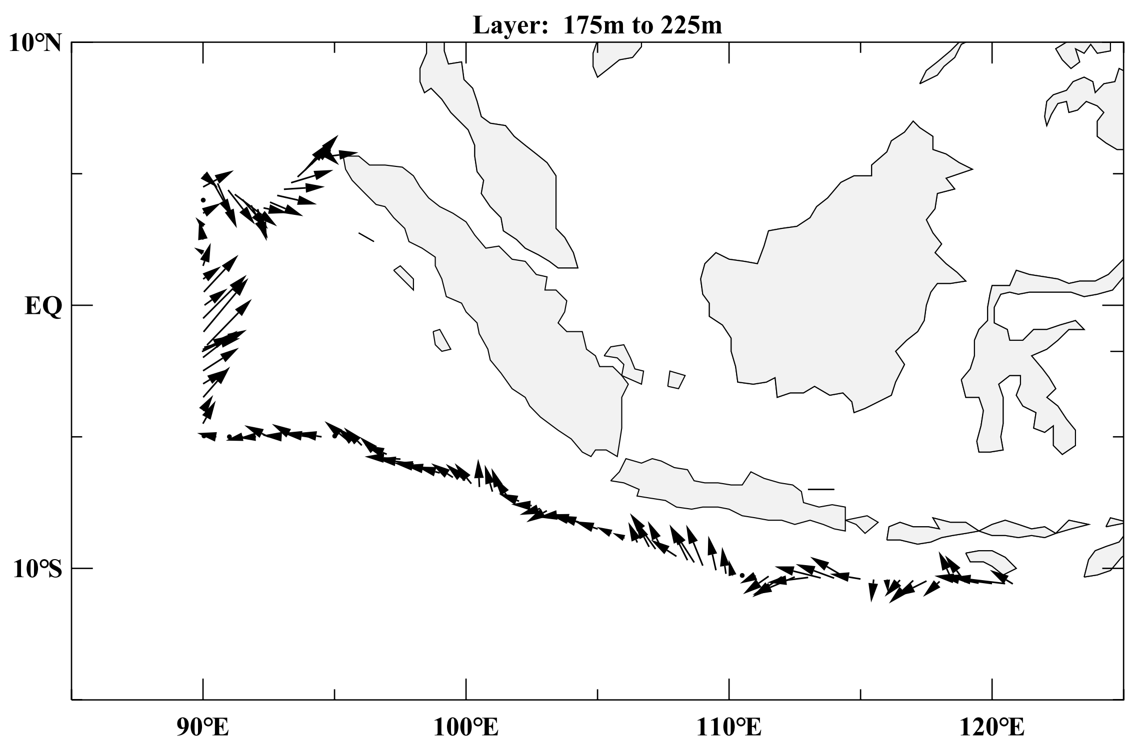
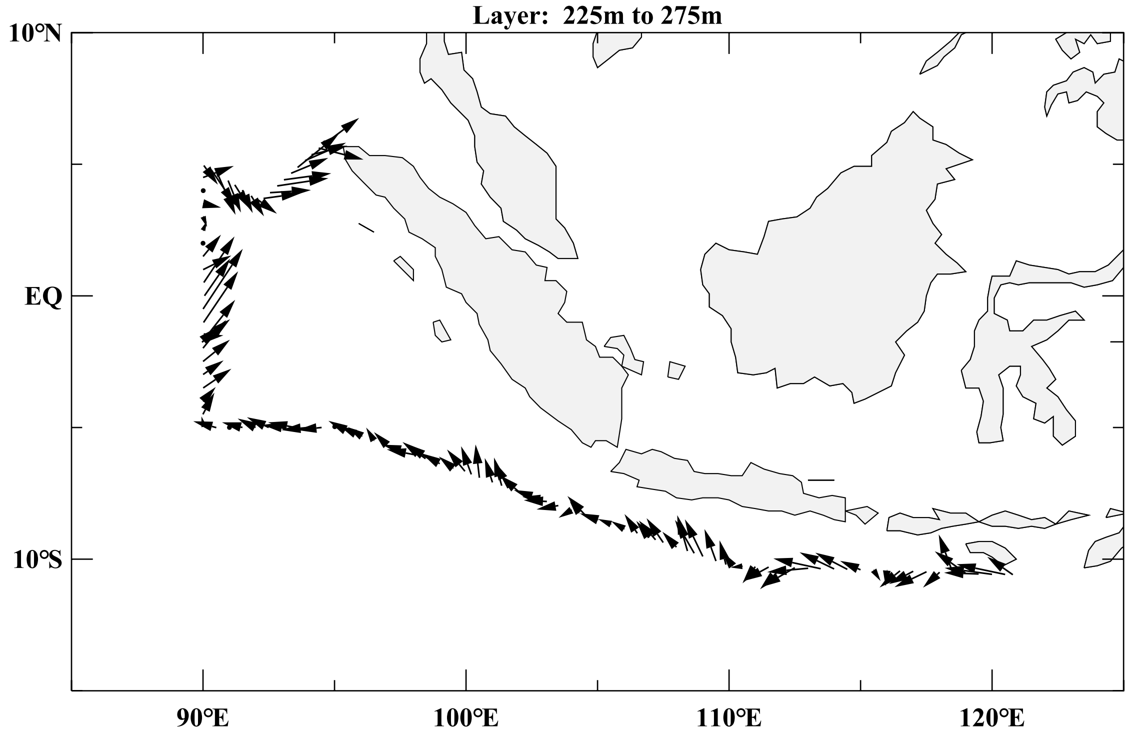
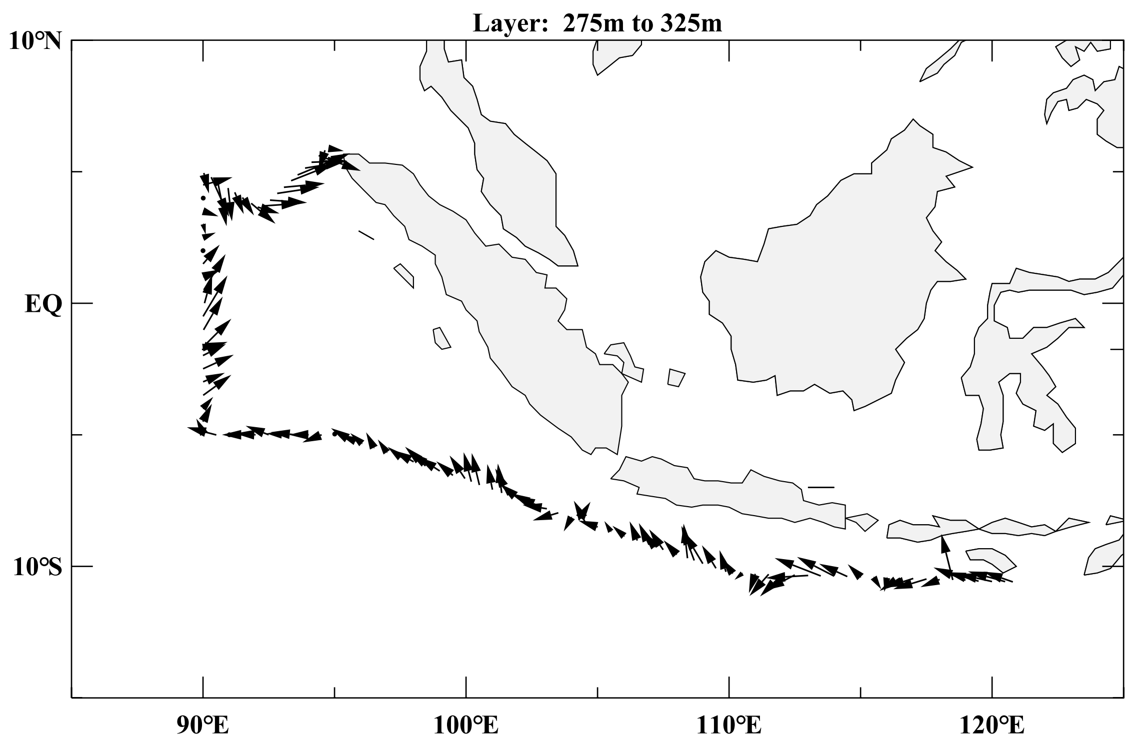


Fig. 6.5-2 (b)

Current vector plot

Oct 19 to Oct 31, 2001





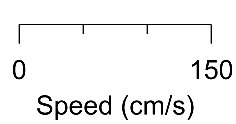


Fig. 6.5-2 (c)

Current vector plot

Oct 19 to Oct 31, 2001

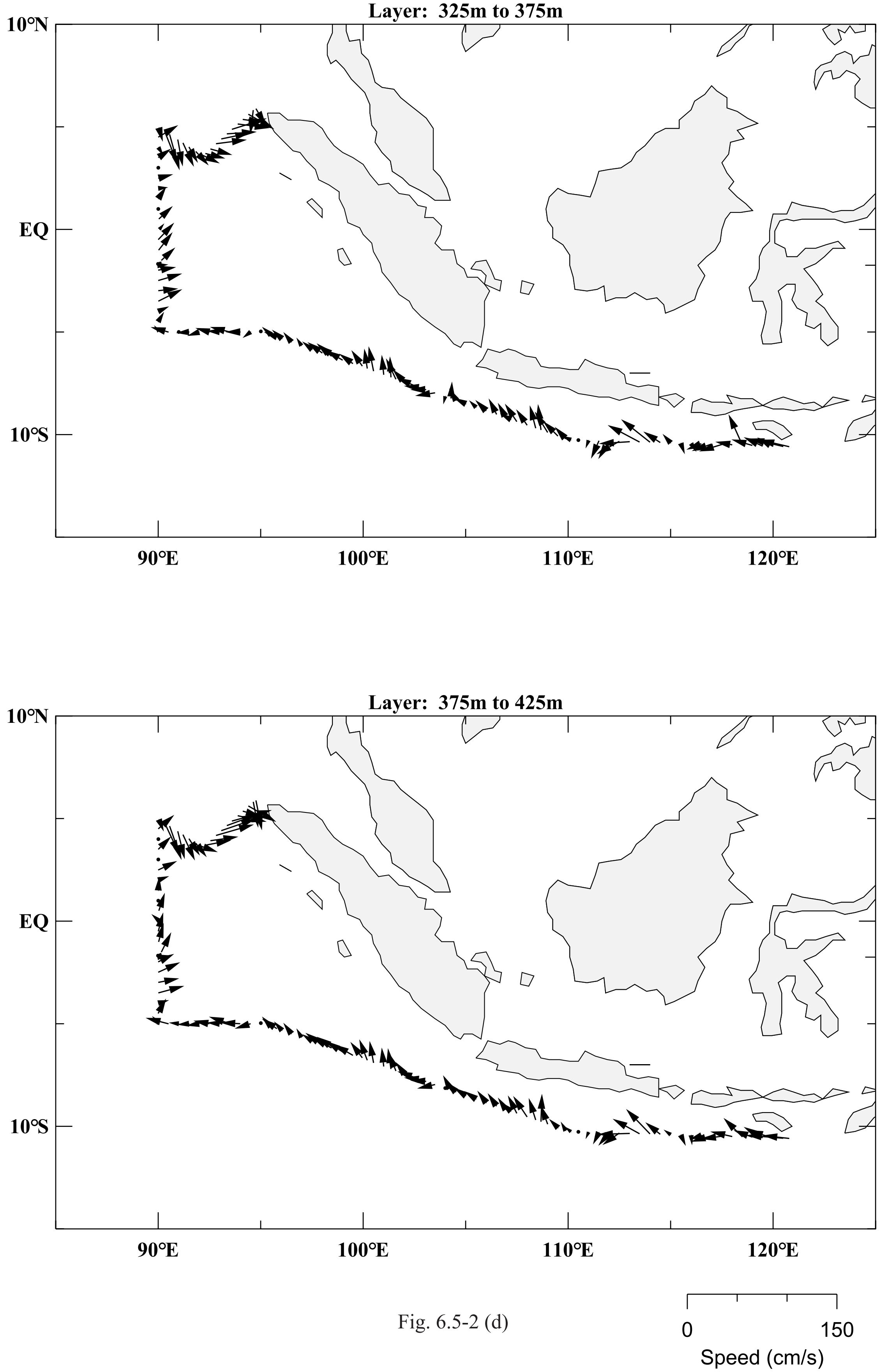


Fig. 6.5-2 (d)

Current vector plot

Oct 19 to Oct 31, 2001

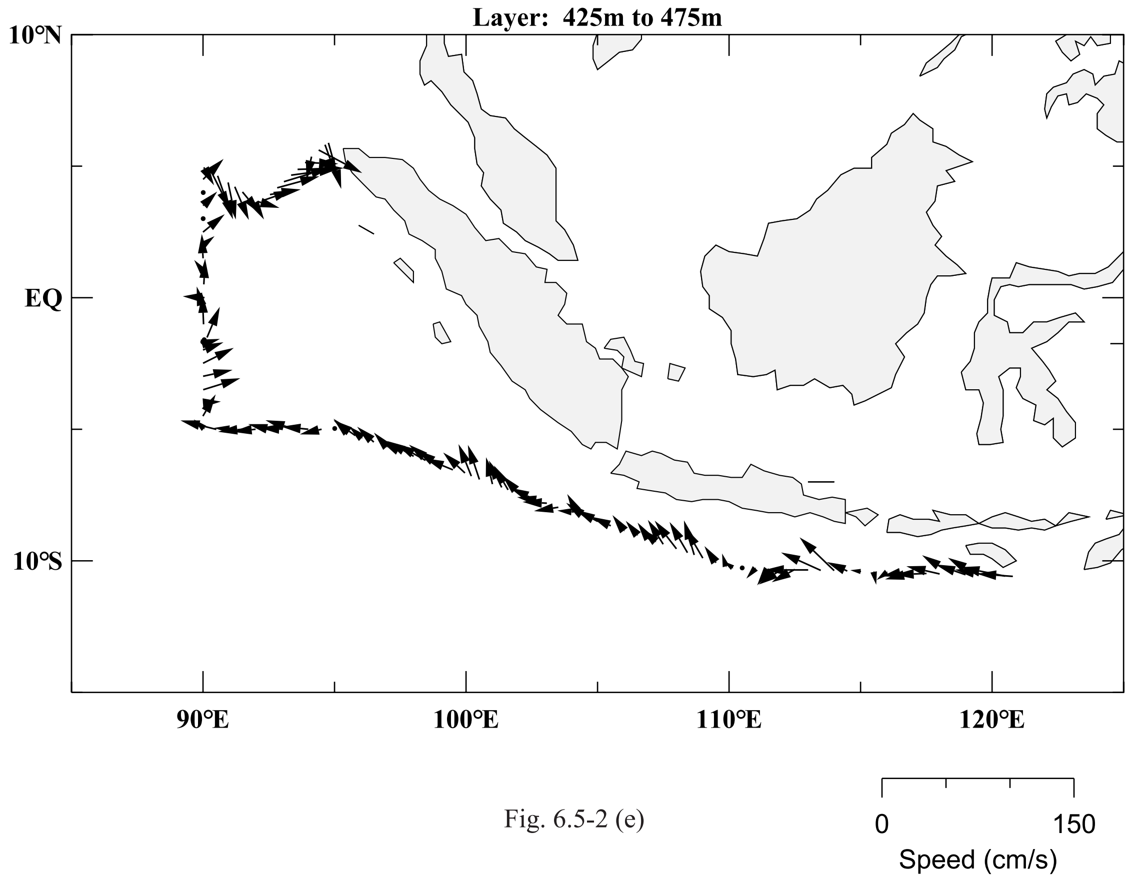


Fig. 6.5-2 (e)

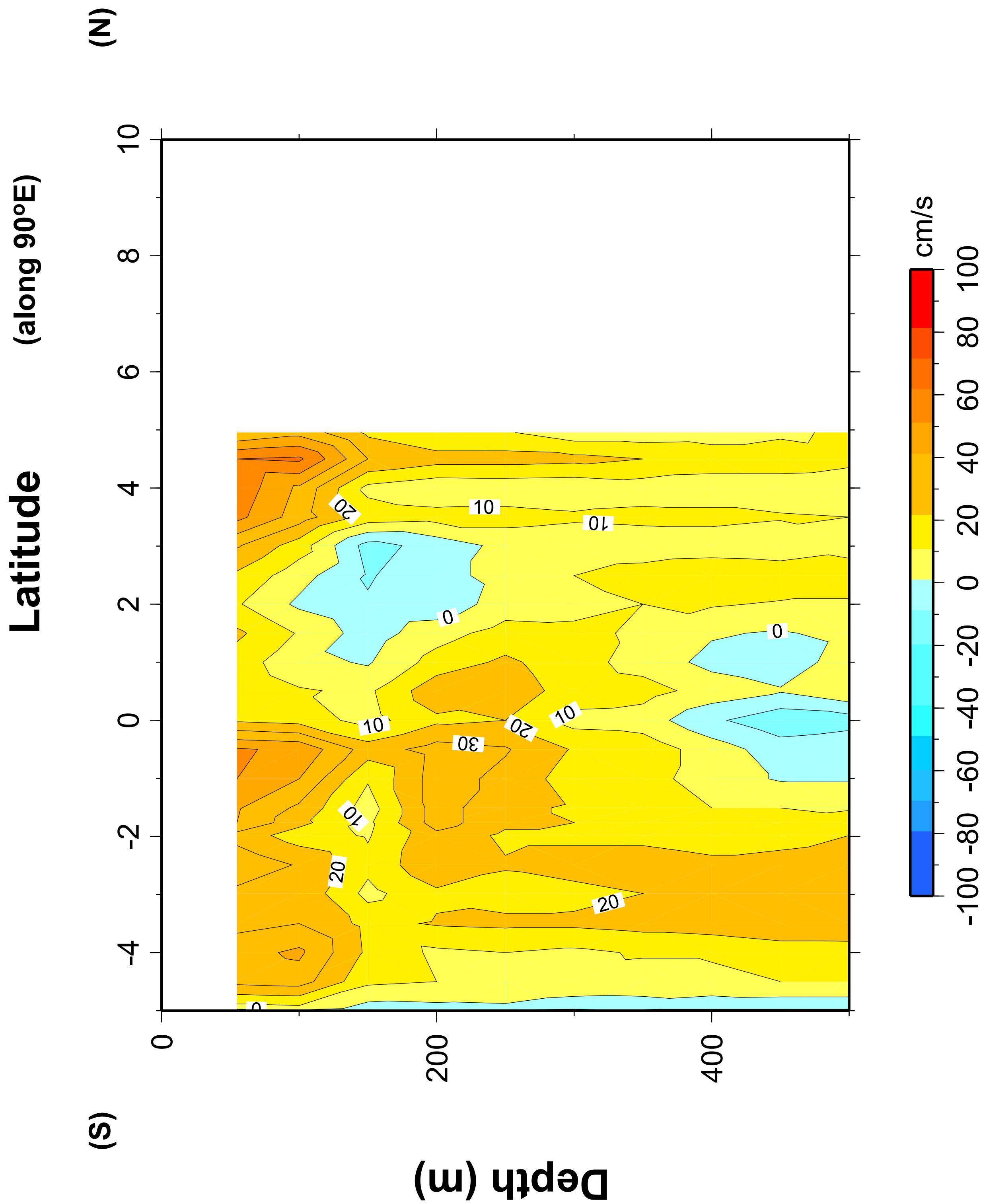


Fig. 6.5-3

6.6 Underway geophysics

6.6.1 Sea Surface Gravity

(1) Personnel

Satoshi Okumura (GODI)	Operation leader	-Leg 1-
Takuya Yoshida (GODI)		-Leg 1-
Akinori Uchiyama (GODI)	Operation leader	-Leg 2-
Shinya Iwamida (GODI)		-Leg 2-
Wataru Tokunga (GODI)		-Leg 1, 2-

(2) Objective

The relative variation of the sea surface gravity is measured continuously during the cruise.

(3) Instruments

Surface gravity is measured using LaCoste-Romberg gravity meter S-116. To determine the drift of the surface gravity sensor, we measured the gravity values at each port using an Automated Gravity Meter CG-3M Autogav, SCINTREX, in order to validate the surface gravity sensor.

(4) Summary

We carried out gravity measurement during MR01-K05 cruise from the departure of Sekinehama, Japan on 20 September 2001 to arrival of Koror, Republic of Palau on 5 November 2001. Detailed data analysis based on the measurements will be done on the shore base.

(5) Data archive

Gravity data obtained in this cruise will be submitted to the DMO (Data Management Office) in JAMSTEC, and will be opened to the public within 3 years after this cruise.

(6) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam. 02:29 (UTC) 12 October to 12:15 (UTC) 15 October 2001.

6.6.2 Surface three-component magnetometer

(1) Personnel

Satoshi Okumura (GODI)	Operation leader	-Leg 1-
Takuya Yoshida (GODI)		-Leg 1-
Akinori Uchiyama (GODI)	Operation leader	-Leg 2-
Shinya Iwamida (GODI)		-Leg 2-
Wataru Tokunga (GODI)		-Leg 1, 2-

(2) Objective

For geophysical investigation, the three components of total geomagnetic filed is measured continuously during the cruise.

(3) Instruments

The three-component fluxgate magnetometer system of SFG-1214 is manufactured by Tierra Tecnica, Inc., Japan.

(4) Parameters

Three component magnetic force	[nT]
Ship's attitude (Roll, Pitch and Heading)	[1/100 deg]

(5) Summary

We measured three components of magnetic field during MR01-K05 cruise from the departure of Sekinehama, Japan on 20 September 2001 to arrival of Koror, Republic of Palau on 5 November 2001.

(6) Data archives

Magenetic data obtained in this cruise will be submitted to the DMO (Data Management Office) in JAMSTEC, and will be opened to the public within 3 years after this cruise.

(7) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam. 02:29 (UTC) 12 October to 12:15 (UTC) 15 October 2001. 8-cross running measurement is carried out at 06:26 to 07:06 (UTC) 2 October in order to validate the sensor.

6.6.3 Multi-narrow beam echo sounding system

(1) Personnel

Satoshi Okumura (GODI)	Operation leader	-Leg 1-
Wataru Tokunaga (GODI)		-Leg 1, 2-
Akinori Uchiyama (GODI)	Operation leader	-Leg 2-
Shinya Iwamida (GODI)		-Leg 2-
Takuya Yoshida (GODI)		-Leg 1-
Keiichiro Shishido (R/V Mirai crew)		-Leg 2-

(2) Objectives

(2-1) For the geophysical investigation

(2-2) For the operation of TRITON buoys and ADCP subsurface buoy moorings.

The bathymetry observation is carried out using SEA BEAM routinely during the cruise.

(3) Instruments

A 12kHz SEA BEAM 2112 Multi Narrow Beam Bathymetric Survey System with 4kHz sub-bottom Profiler manufactured by the Sea Beam Instruments, Inc., USA is used for measuring water depth.

(4) Summary

We carried out bathymetric survey during MR01K05 cruise. Sound velocity profiles were corrected using CTD, XCTD and XBT data.

(5) Data archive

Bathymetry data obtained in this cruise will be submitted to the DMO (Data Management Office) in JAMSTEC, and will be opened to the public within 3 years after this cruise.

(6) Remarks

We did not sample the data in the EEZ of Socialist Republic of Vietnam. 02:29 (UTC) 12 October to 12:15 (UTC) 15 October 2001.

7 Special Observations
7.1 TRITON moorings
7.1.1 TRITON Mooring Operation

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC): Principal Investigator	(on board Leg1)
Keisuke Mizuno	(JAMSTEC): Principal Investigator	(on board Leg2)
Masayuki Fujisaki	(MWJ): Operation leader	(on board Leg1, 2)
Masayuki Yamaguchi	(JAMSTEC): Engineer	(on board Leg1)
Hideaki Hase	(JAMSTEC): Scientist	(on board Leg1, 2)
Atsuo Ito	(MWJ): Technical staff	(on board Leg2)
Takeo Matsumoto	(MWJ): Technical staff	(on board Leg1)
Kei Suminaga	(MWJ): Technical staff	(on board Leg1, 2)
Takayoshi Seike	(MWJ): Technical staff	(on board Leg1, 2)
Tomohiko Sugiyama	(MWJ): Technical staff	(on board Leg1, 2)
Mizue Hirano	(MWJ): Technical staff	(on board Leg1, 2)
Soichi Moriya	(MWJ): Technical staff	(on board Leg1, 2)
Junko Hamanaka	(MWJ): Technical staff	(on board Leg1, 2)
Tomoko Miyashita	(MWJ): Technical staff	(on board Leg1, 2)
Fuma Matsunaga	(MWJ): Technical staff	(on board Leg1, 2)
Minoru Motoyanagi	(MWJ): Technical staff	(on board Leg1, 2)

(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 has not been well understood. Long-term data sets of temperature, salinity, currents, and 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 rainfall 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 two TRITON buoys have been successfully recovered during this R/V Mirai cruise, and deployed seven TRITON buoys.

(3) Measured parameters

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

(4) Instruments

1) CTD and CT

SBE-37 IM MicroCAT

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

2) CRN (Current meter)

SonTek Argonaut ADCM

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

3) Meteorological sensors

Precipitation

SCTI ORG-115DX

Atmospheric pressure

PARPSCIENTIFIC. 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

1) TRITON buoys deployed

Nominal location	8N, 137E
ID number at JAMSTEC	10001
Number on surface float	T03
ARGOS PTT number	11825
ARGOS backup PTT number	24242
Deployed date	28 Sep. 2001
Exact location	07 - 50.39N, 136 - 29.14E
Depth	3353 m

Nominal location	5N, 137E	
ID number at JAMSTEC	11001	
Number on surface float	T04	
ARGOS PTT number	11826	
ARGOS backup PTT number	24243	
Deployed date	29 Sep. 2001	
Exact location	04 - 56.40N, 137 - 17.57E	
Depth	4133 m	
Option sensors	CT sensor at 175m:	S/N 1056

Nominal location	2N, 138E
ID number at JAMSTEC	12003
Number on surface float	T05
ARGOS PTT number	1132
ARGOS backup PTT number	13065
Deployed date	30 Sep. 2001
Exact location	02 - 03.79N, 138 - 03.10E

Depth	4335 m	
Option sensors	CRN at 40m:	S/N D86
	CT at 175m:	S/N 0625
	Pressure sensor at 1.5 m depth	
	Precipitation sensor (capacitive type) at tower	

Nominal location	EQ, 138E	
ID number at JAMSTEC	13003	
Number on surface float	T06	
ARGOS PTT number	none	
ARGOS backup PTT number	24245, 24246	
Deployed date	03 Oct. 2001	
Exact location	00 - 04.70N, 138 - 02.61E	
Depth	4206 m	
Option sensors	CRN at 40m:	S/N D88
	CT at 175m:	S/N 0985

Nominal location	2N, 130E	
ID number at JAMSTEC	16001	
Number on surface float	T07	
ARGOS PTT number	3594	
ARGOS backup PTT number	24244	
Deployed date	07 Oct. 2001	
Exact location	01 - 56.38N, 130 - 02.61E	
Depth	4428 m	
Option sensors	CT at 175m:	S/N 0995

Nominal location	5S, 90E
ID number at JAMSTEC	17001
Number on surface float	T08
ARGOS PTT number	3595
ARGOS backup PTT number	13066
Deployed date	07 Mar. 2001
Exact location	05 - 01.95S, 156 - 01.53E
Depth	5009 m
Option sensors	Precipitation sensor (capacitive type) at tower

Nominal location	1.5S, 95E
ID number at JAMSTEC	18001
Number on surface float	T09
ARGOS PTT number	3779
ARGOS backup PTT number	13067
Deployed date	14 Mar. 2001
Exact location	02 - 06.04N, 146 - 56.94E
Depth	4697 m
Option sensors	Pressure sensor at 1.5 m depth
	Precipitation sensor (capacitive type) at tower

2) TRITON recovered

Nominal location	2N, 138E
ID number at JAMSTEC	12002

Number on surface float	T24
ARGOS PTT number	20431
ARGOS backup PTT number	24233
Deployed date	01 Nov. 2000
Recovered date	01 Oct. 2001
Exact location	01 - 59.90N, 138 - 06.21E
Depth	4331 m

Nominal location	EQ, 138E
ID number at JAMSTEC	13002
Number on surface float	T25
ARGOS PTT number	none
ARGOS backup PTT number	24234
Deployed date	30 Oct. 2000
Recovered date	04 Oct. 2001
Exact location	00 - 01.91N, 137 - 52.96E
Depth	4370 m

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

(6) Details of deployed

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

Deployed and repaired TRITON buoys

Observation No.	Location.	Details.
10001	8N 137E	Deploy at full spec.
11001	5N 137E	Deploy at full spec.
12003	2N 138E	Deploy at full spec.
13002	EQ 138E	Deploy at only underwater sensors.No comunication system.
16001	2S 130E	Deploy at only underwater sensors.
17001	5S 95E	Deploy at full spec.
18001	1.5S 90E	Deploy at full spec.

(7) Data archive

Those hourly averaged data 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 the 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

Kentaro Ando	(JAMSTEC):	not on board
Takeo Matsumoto	(MWJ):	on board Leg 1
Tetsuya Nagahama	(MWJ):	not on board

(2) Objective

Validation of the TRITON CTD data

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

TRITON buoy underwater sensors are equipped along a wire cable of buoy. We used the same CTD system with general CTD observation (See section 6.2.1) by R/V MIRAI for this intercomparision. We conducted CTD casts at each TRITON buoy site. The casts were performed immediately after the deployment and before recovery. R/V MIRAI was kept the distance from the TRITON buoy within 1 nm.

TRITON buoy data was sampled every 1 hour. We compared the CTD cast data from the R/V MIRAI with the 1-hour averaged TRITON buoy data. As the temperature sensors are more stable than conductivity sensors, the conductivity data and salinity data are selected, where the temperature data indicate the same value. Then, we calculated difference of salinity and conductivity between MIRAI and TRITON buoy at each deployment and recovery.

(5) Results

Most of temperature, conductivity and salinity data from TRITON buoy showed good agreement with CTD cast data (Fig.7.1.2-1). To estimate the conductivity sensors on TRITON buoy, the data from deployed buoy and from shipboard CTD cast at the same location were analysed. The estimation was calculated as deployed buoy data minus shipboard CTD (9Plus) data. The salinity differences are –0.044 from 0.069 psu for all depths. But -1.003 and -1.257 are disregarded because of TRITON bad data. Below 300db, salinity differences are –0.015 from 0.013 psu (Fig 7.1.2-2 and Table.7.1.2-1). The average of salinity differences was −0.005 with standard deviation of 0.089 psu.

(6) Data archive

All of raw and processed CTD data files were copied into 3.5-inch magnetic optical disks and submitted to JAMSTEC Data Management Office. All original data will be stored at the JAMSTEC Mutsu Institute.

Table 7.1.2.-1 Data differences between TRITON buoys data and ship board CTD(9Plus) data

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
10001	1.5	0.41	0.043	0.008
10001	25	0.00	-0.002	-0.004
10001	50	0.00	-0.001	-0.004
10001	75	0.00	0.000	0.005
10001	100	-0.03	-0.006	-0.017
10001	125	-0.03	-0.003	0.008
10001	150	-0.03	-0.004	0.001
10001	200	0.15	-0.095	-1.003
10001	250	0.00	-0.001	-0.006
10001	300	-0.01	-0.002	-0.001
10001	500	0.00	-0.001	-0.004
10001	750	0.00	-0.001	-0.008
11001	1.5	0.00	0.000	0.007
11001	25	0.00	0.000	0.006
11001	50	0.01	0.010	0.065
11001	75	0.00	0.003	0.022
11001	100	-0.02	0.007	0.069
11001	125	0.01	0.003	0.021
11001	150	0.01	-0.001	-0.013
11001	200	-0.02	-0.006	-0.044
11001	250	0.00	-0.001	-0.011
11001	300	0.02	0.001	-0.015
11001	500	0.00	0.000	-0.007
11001	750	0.00	0.000	0.005
12003	1.5	0.07	0.010	0.018
12003	25	0.00	0.005	0.036
12003	50	0.00	0.002	0.017
12003	75	0.01	0.005	0.031
12003	100	-0.01	-0.178	-1.257
12003	125	0.03	0.007	0.033
12003	150	0.04	0.009	0.046
12003	200	-0.02	-0.001	0.009
12003	250	0.03	0.004	0.013
12003	300	0.01	0.001	0.008
12003	500	0.00	0.000	0.013
12003	750	-0.01	-0.002	-0.007
17001	1.5	0.00	-0.096	-0.657
17001	25	0.00	0.000	0.006
17001	50	0.00	-0.002	-0.008
17001	75	0.01	0.002	0.012
17001	100	-0.06	-0.003	0.027
17001	125	-0.02	-0.002	0.002
17001	150	-0.02	-0.001	0.013
17001	200	0.01	-0.001	-0.013
17001	250	0.00	-0.001	-0.002

17001	300	0.00	-0.001	-0.001
17001	500	0.00	0.000	0.006
17001	750	0.00	-0.001	0.001
18001	1.5	0.01	0.001	0.006
18001	25	0.00	-0.002	-0.006
18001	50	0.00	0.000	0.004
18001	75	0.00	-0.001	0.003
18001	100	0.04	0.005	0.011
18001	125	0.07	0.010	0.034
18001	150	0.01	0.001	0.001
18001	200	0.00	-0.001	-0.001
18001	250	0.00	0.000	0.005
18001	300	0.00	-0.001	0.000
18001	500	0.00	-0.002	-0.009
18001	750	0.00	0.000	-0.002

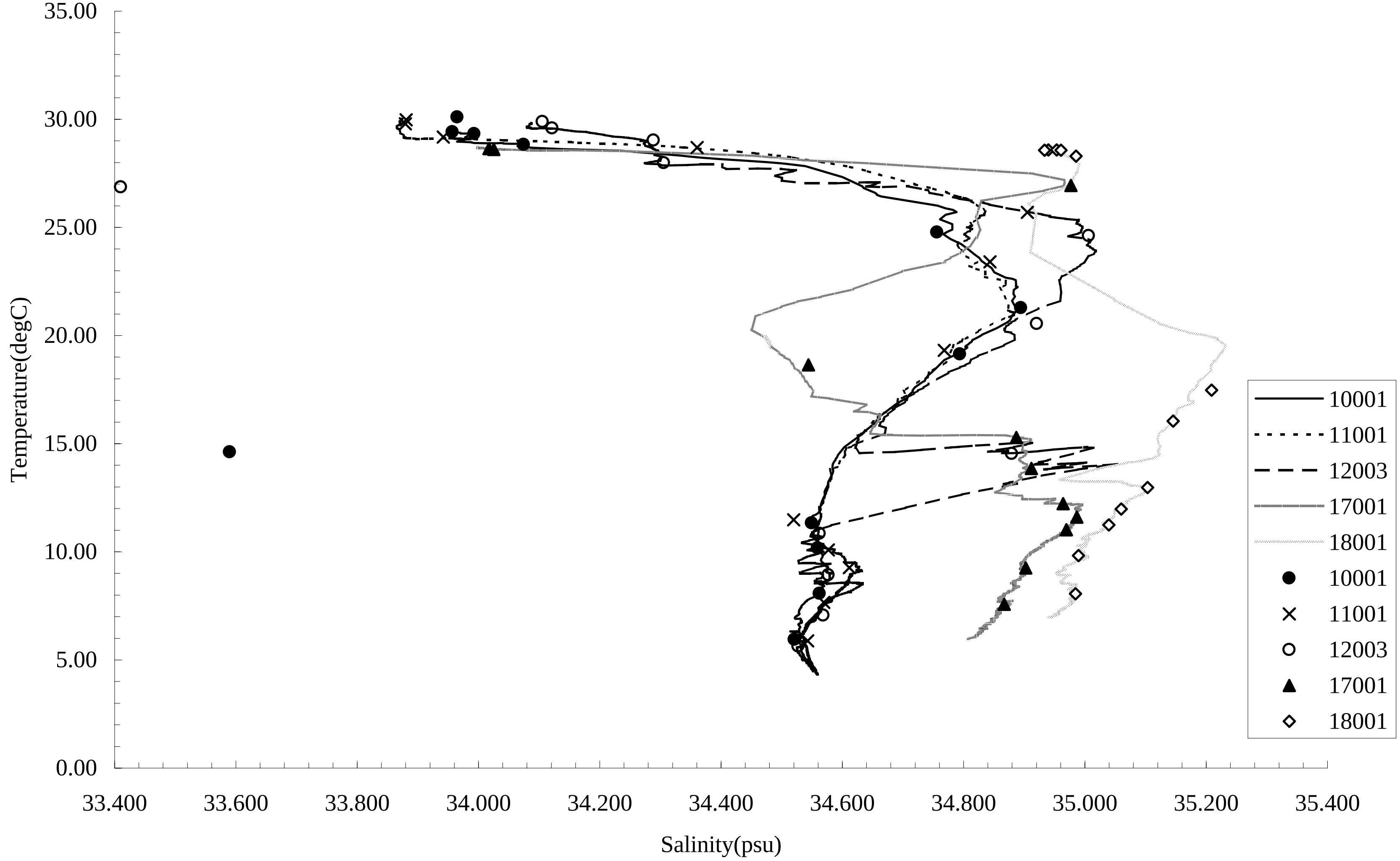


Fig.7.1.2.-1 T-S diagram (TRITON buoys data and ship board CTD(9Plus) data)

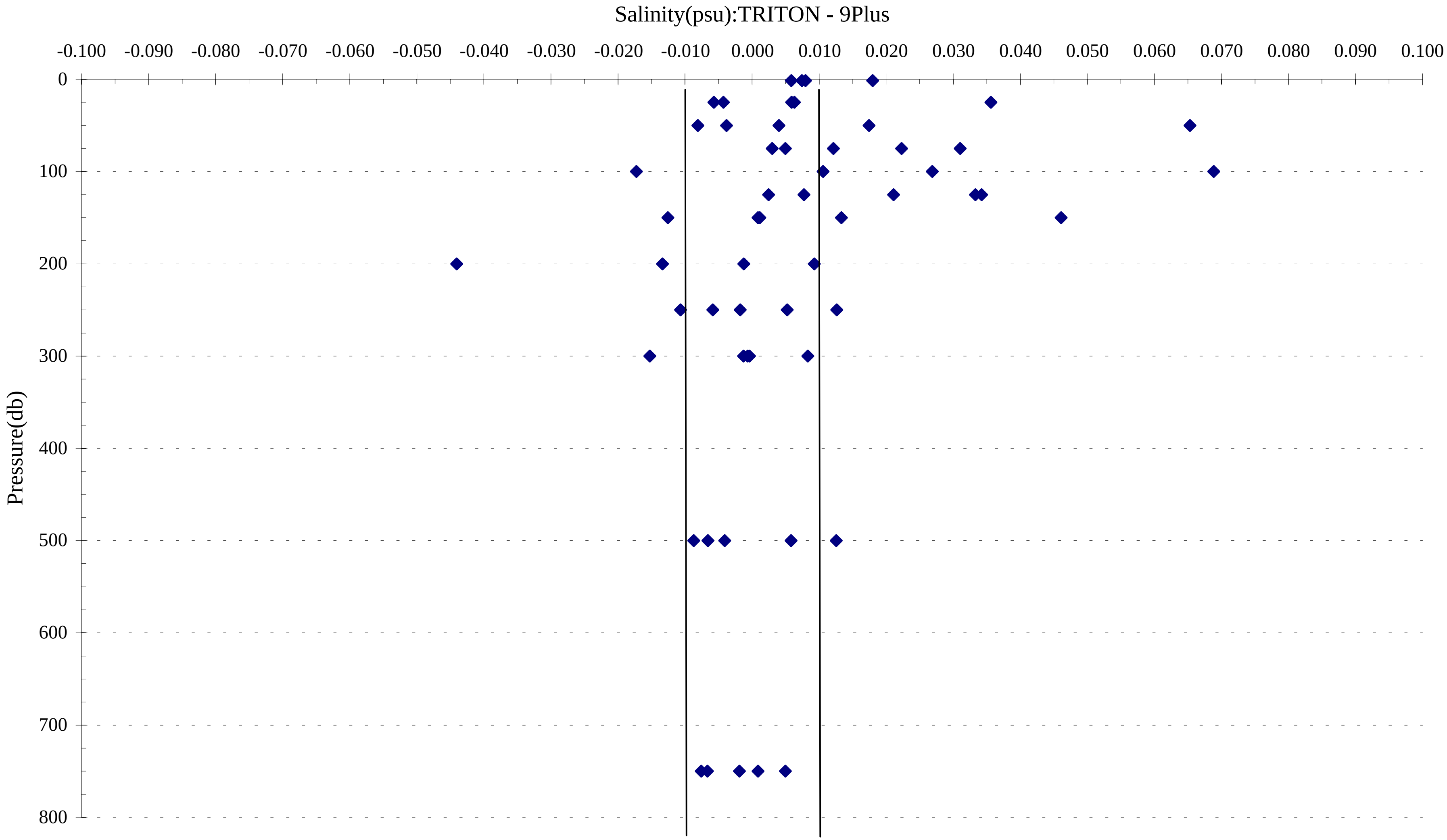


Fig.7.1.2.-2 Salinity differences between TRITON buoys data and ship board CTD(9Plus) data

7.2 ADCP subsurface mooring

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC):	Principal Investigator (Leg.1)
Keisuke Mizuno	(JAMSTEC):	Principal Investigator (Leg.2)
Kensuke Takeuchi	(FORSGC):	Scientist
Yukio Masumoto	(FORSGC):	P. I. for 0, 90E ADCP mooring (not on board)
Hideaki Hase	(JAMSTEC):	Scientist
Masayuki Fujisaki	(MWJ):	Operation leader
Atsuo Ito	(MWJ):	Technical staff
Takeo Matsumoto	(MWJ):	Technical staff
Kei Suminaga	(MWJ):	Technical staff
Takayoshi Seike	(MWJ):	Technical staff
Mizue Hirano	(MWJ):	Technical staff
Junko Hamanaka	(MWJ):	Technical staff
Tomoko Miyashita	(MWJ):	Technical staff
Tomohiko Sugiyama	(MWJ):	Technical staff
Souichi Moriya	(MWJ):	Technical staff
Fuma Matsunaga	(MWJ):	Technical staff
Minoru Moyanagi	(MWJ):	Technical staff

(2) Objective

The purpose is to get the knowledge of physical process in the western equatorial Pacific Ocean and the eastern equatorial Indian Ocean. We have been observing currents using ADCP mooring along the equator. In this cruise (MR01-K05), we recovered four subsurface ADCP moorings at 0-138E, 7N-127E, 0-90E and 5S-95E, and deployed four moorings at 2N-138E, 0-138E, 7N-127E and 0-90E.

(3) Parameters

- ・Vertical profile of current velocity
- ・Echo intensity
- ・Pressure, Temperature and Conductivity

(4) Methods

Two instruments are mounted on the top float of the mooring. One is upward-looking ADCP (Acoustic Doppler Current Profiler) to observe current velocities from about 300m to surface, and the other is CTD to observe pressure, temperature and salinity at 300 m depth. Details of instruments and their parameters as follows;

1) ADCP

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

Distance to first bin:	8 m
Ping per ensemble:	16
Time per ping:	2.00 seconds
Bin length:	8 m
Sample interval:	3600 seconds

Recovered ADCP

*Serial Number:	1222 (Mooring No. 001031-00138E)
	1150 (Mooring No. 000924-7N127E)
	1223 (Mooring No. 001117-05S095S)

Deployed ADCP

*Serial Number:	1152 (Mooring No. 011001-2N138E)
	1225 (Mooring No. 011005-00138E)
	1154 (Mooring No. 011009-7N127E)

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

Distance to first bin:	7.04 m
Ping per ensemble:	27
Time per ping:	6.66 seconds
Bin length:	8 m
Sample interval:	3600 seconds

Recovered ADCP

*Serial Number: 1248 (Mooring No. 001114-0090E)

Deployed ADCP

*Serial Number: 1645 (Mooring No. 011022-0090E)

2) CTD

(a) SBE-16 (Sea Bird Electronics Inc.)

Sample Interval: 1800 seconds

Recovered CTD

*Serial Number:	1282 (Mooring No. 001031-00138E)
	1276 (Mooring No. 000924-7N127E)
	1280(Mooring No. 001117-05S095S)

Deployed CTD

*Serial Number:	1283 (Mooring No. 011001-2N138E)
	1284 (Mooring No. 011005-00138E)
	1281 (Mooring No. 011009-7N127E)

(b) SBE-37 (Sea Bird Electronics Inc.)

Sample Interval: 3600 seconds

Recovered CTD

*Serial Number: 1388 (Mooring No. 001114-0090E)

Deployed ADCP

*Serial Number: 1775 (Mooring No. 011022-0090E)

3) Current Meter

(a) RCM-8 (AANDERAA Instruments: These instruments belong to Tokyo Univ.)

Recovered Current Meter

*Serial Number: 6641 (700 m) (Mooring No. 001031-00138E)

Deployed Current Meter

*Serial Number: 4008 (700 m) (Mooring No. 011005-00138E)

(b) RCM-9 (AANDERAA Instruments: These instruments belong to JAMSTEC.)

Recovered Current Meter

*Serial Number: 541 (400 m) (Mooring No. 000924-7N127E)

*Serial Number: 542 (700 m) (Mooring No. 000924-7N127E)

Deployed Current Meter
*Serial Number: 355 (400 m) (Mooring No. 011009-7N127E)
357 (700 m) (Mooring No. 011009-7N127E)

4) Other instruments

(a) Acoustic Releaser (BENTHOS, Inc.)

Recovered Acoustic Releaser
*Serial Number: 916 (upper) (Mooring No. 001031-00138E)
692 (lower) (Mooring No. 001031-00138E)
677 (upper) (Mooring No. 000924-7N127E)
712 (lower) (Mooring No. 000924-7N127E)
937 (upper) (Mooring No. 001114-0090E)
936 (lower) (Mooring No. 001114-0090E)
630 (upper) (Mooring No. 001117-05S095E)
632 (lower) (Mooring No. 001117-05S095E)

Deployed Acoustic Releaser
*Serial Number: 631 (upper) (Mooring No. 011001-2N138E)
719 (lower) (Mooring No. 011001-2N138E)
956 (upper) (Mooring No. 011005-00138E)
636 (lower) (Mooring No. 011005-00138E)
664 (upper) (Mooring No. 011008-7N127E)
689 (lower) (Mooring No. 011008-7N127E)
960 (upper) (Mooring No. 0110*-00090E)
961 (lower) (Mooring No. 0110*-00090E)

(5) Deployment

The ADCP moorings were deployed at 2N-138E, 0-138E, 7N-127E and 0-90E. At 2N-138E, 0-138E, 7N-127E, the ADCP sensor were planned to place at about 300 m depth, and at 0-90E to place at about 400 m depth.

We released ADCP buoy first, and dropped the anchor last. We monitored the depth of acoustic releaser (Fig. 7.2-1) in order to estimate the falling rate of the anchor. The positions of the moorings were shown below.

Mooring No.: 011001-2N138E
Date: 01 Oct. 2001 Lat:01-53.74N Long: 138-02.27E Depth: 4681m
Mooring No.: 011005-00138E
Date: 05 Oct. 2001 Lat:00-00.59S Long: 138-01.80E Depth: 3946m
Mooring No.: 011009-7N127E
Date: 09 Oct. 2001 Lat:06-49.29N Long: 126-42.65E Depth: 3441m
Mooring No.: 011022-00090E
Date: 22 Oct. 2001 Lat:0-00.44N Long: 90-03.35E Depth: 43990m

(6) Recovery

We recovered four ADCP moorings. After the recovery, we uploaded ADCP and CTD data into a computer, and then converted into ASCII code. Figures 7.2-2 ~ -5 show CTD pressure, temperature and salinity data. Figures 7.2-6 ~ -17 show the velocity data (meridional and zonal compartments).

Mooring No.: 001031-00138E

Deployment date	31 Oct. 2000
Recovery date	04 Oct. 2001

Mooring No.: 000924-7N127E

Deployment date	24 Sep. 2000
Recovery date	08 Oct. 2001

Mooring No.: 001114-0090E

Deployment date	14 Nov. 2000
Recovery date	22 Oct. 2001

Mooring No.: 001117-05S095E

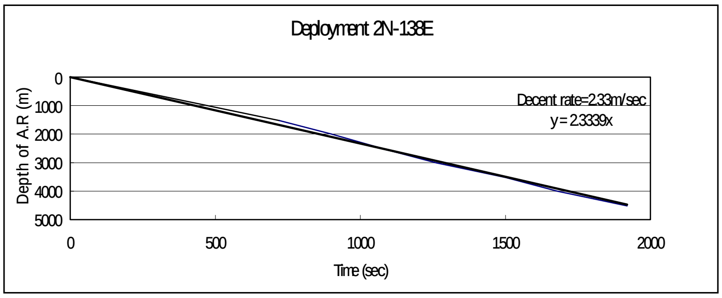
Deployment date	17 Nov. 2000
Recovery date	25 Oct. 2001

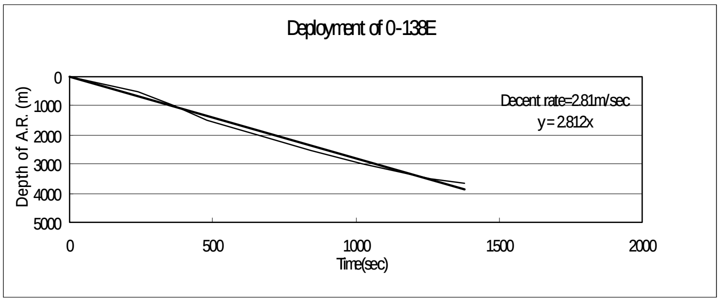
(7) Data processing

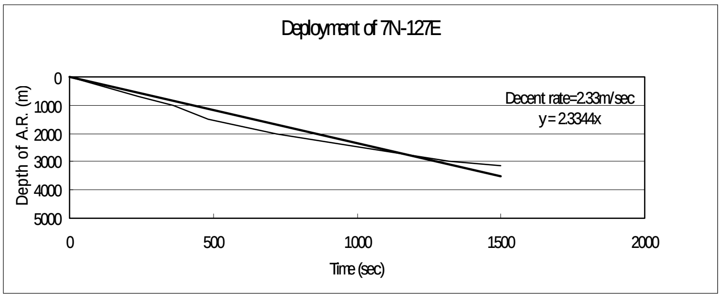
The raw data (CTD, ADCP) were converted into ASCII code. Since pressure data of CTD at 7N-127 was missing, we estimated the depth data by applying D-T curve obtained by a XCTD drop at the location. Moreover, the ADCP velocity data was reversed in east-west direction. Normally, the ADCP data are stored in a file, but the data at 2N-127E and 5S-95E were separated in many files. In these cases, the data gaps were found and the missing data periods were quite short time.

(8) Data archive

The velocity data will be reconstructed using CTD depth data. The all data will be archived by the member of TOCS project at JAMSTEC, and will be submitted to TAO project office as a component of TAO current meter array after the quality check. All data will submitted to DMO at JAMSTEC within 3 years after this cruise.







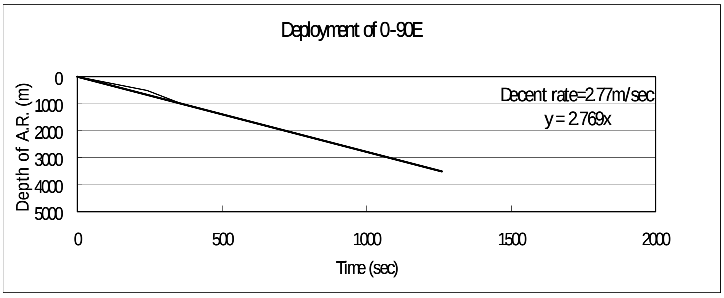
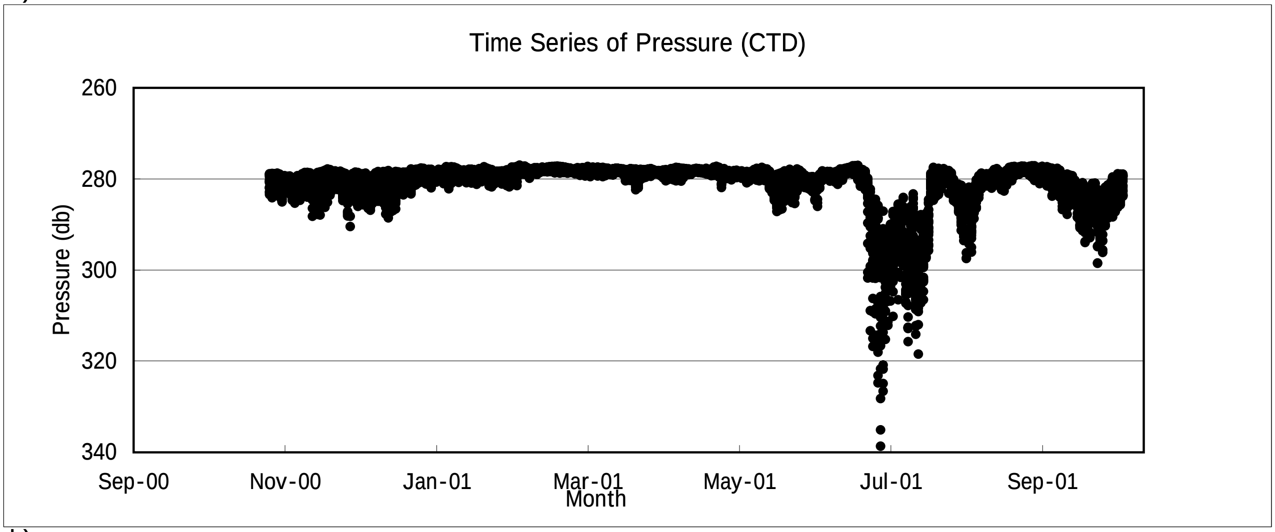
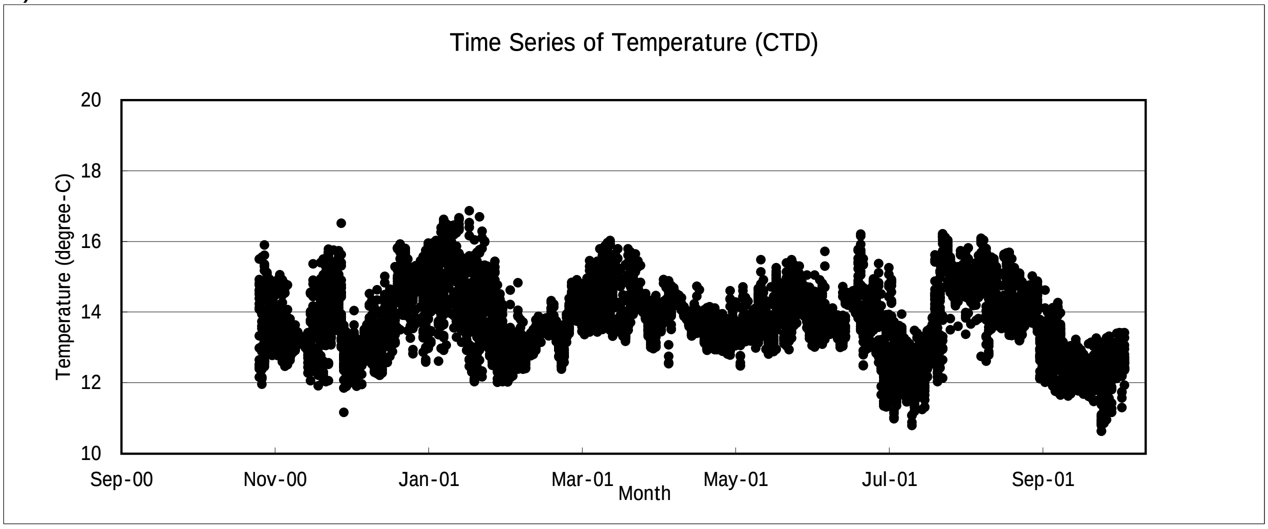


Fig. 7.2-1 Acoustic releaser depth monitor
(A.R.: Acoustic Releaser)

a)



b)



c)

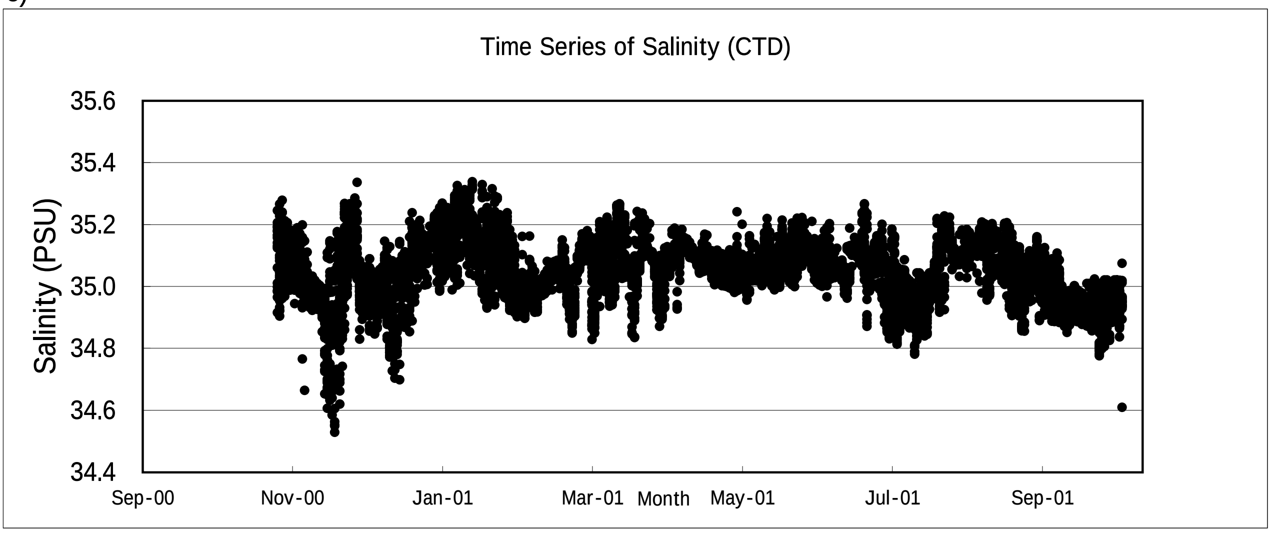
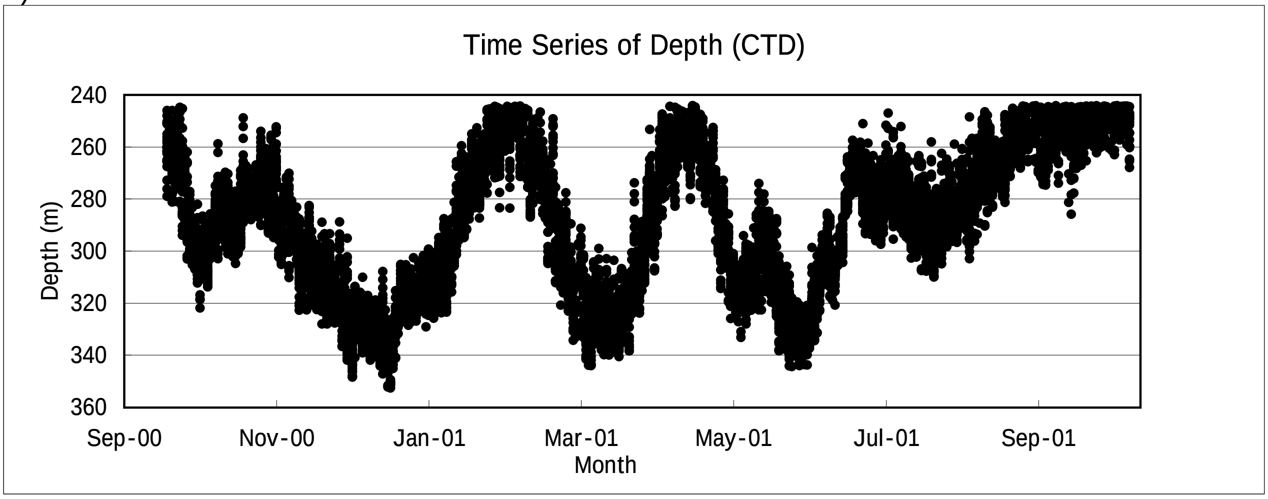


Fig. 7.2-2 Time series of (a) presure, (b) temperature and (c) salinity obtained by CTD of 0-138E ADCP mooring from 31 Oct. 2000 to 04 Oct. 2001

a)



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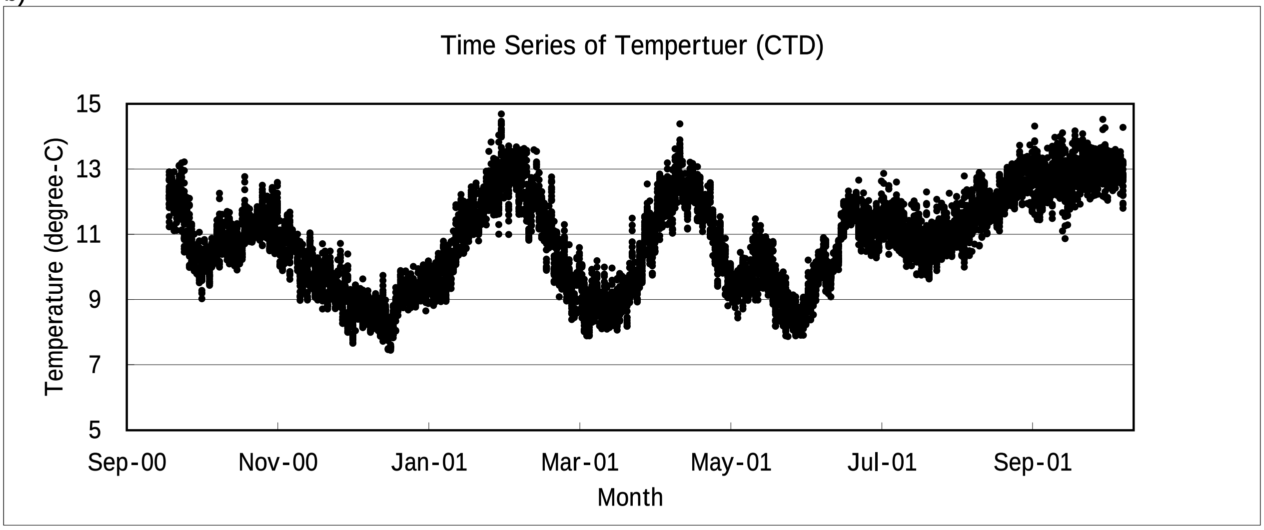

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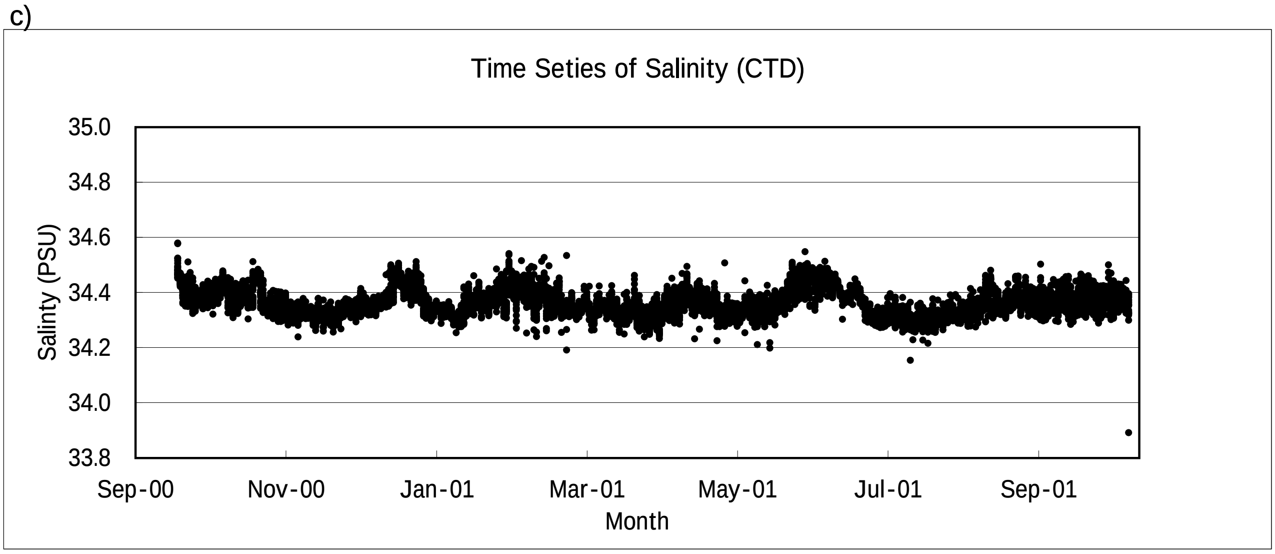
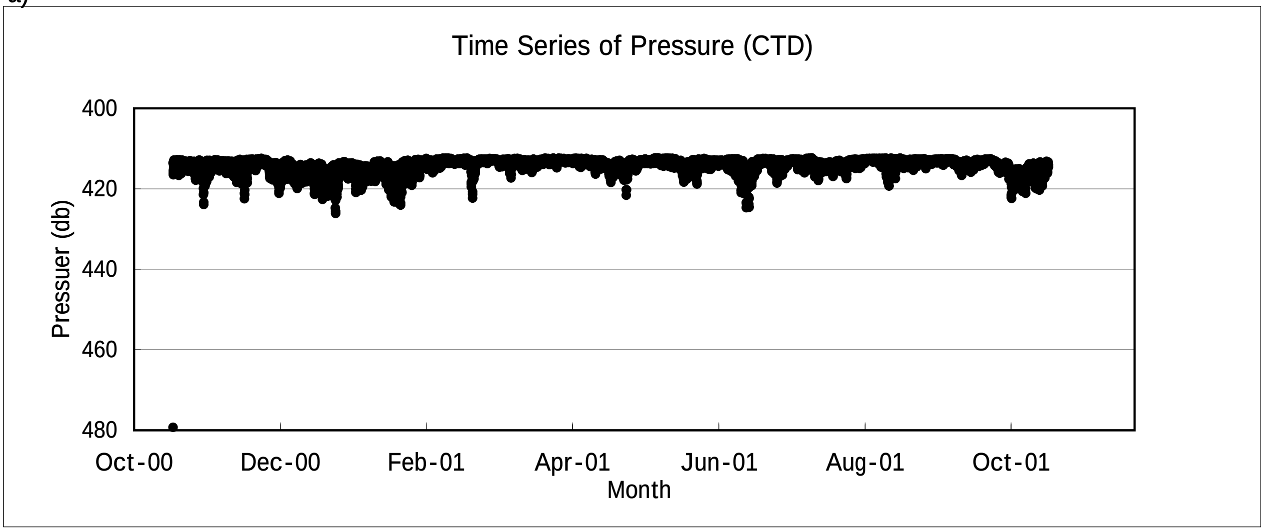
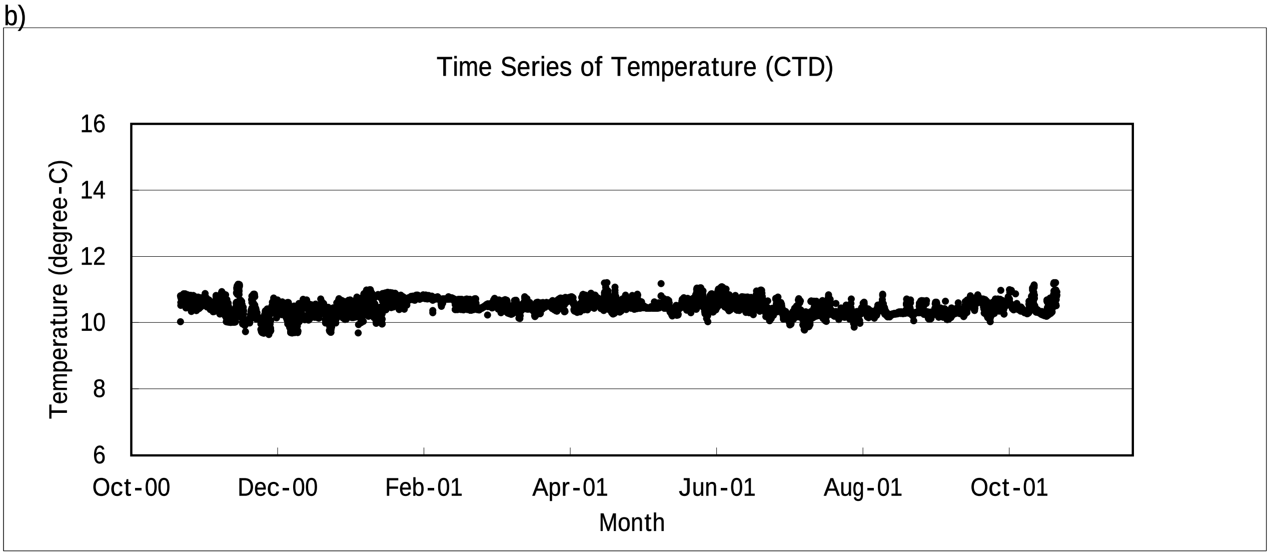


Fig. 7.2-3 Time series of (a) depth, (b) temperature and (c) salinity obtained by CTD of 7N-127E ADCP mooring from 28 Sep.. 2000 to 08 Oct. 2001

a)



b)



c)

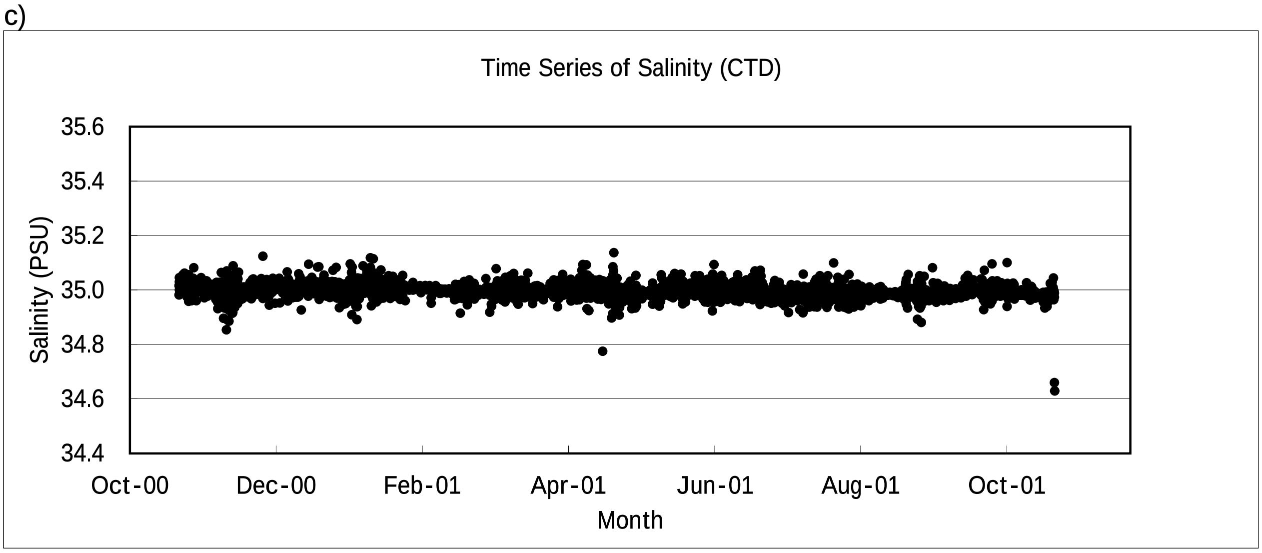
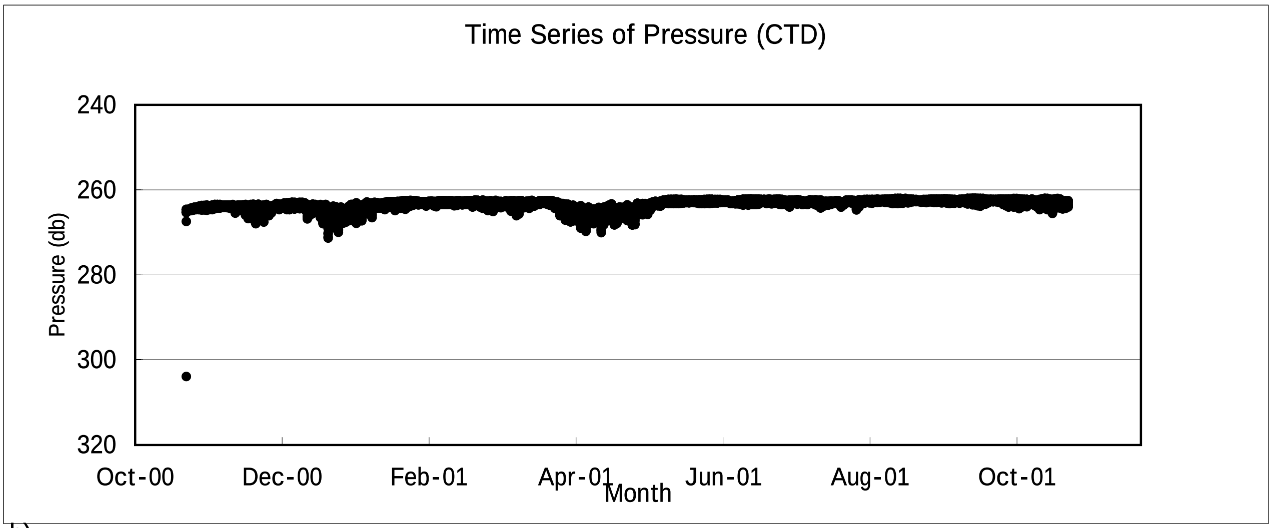
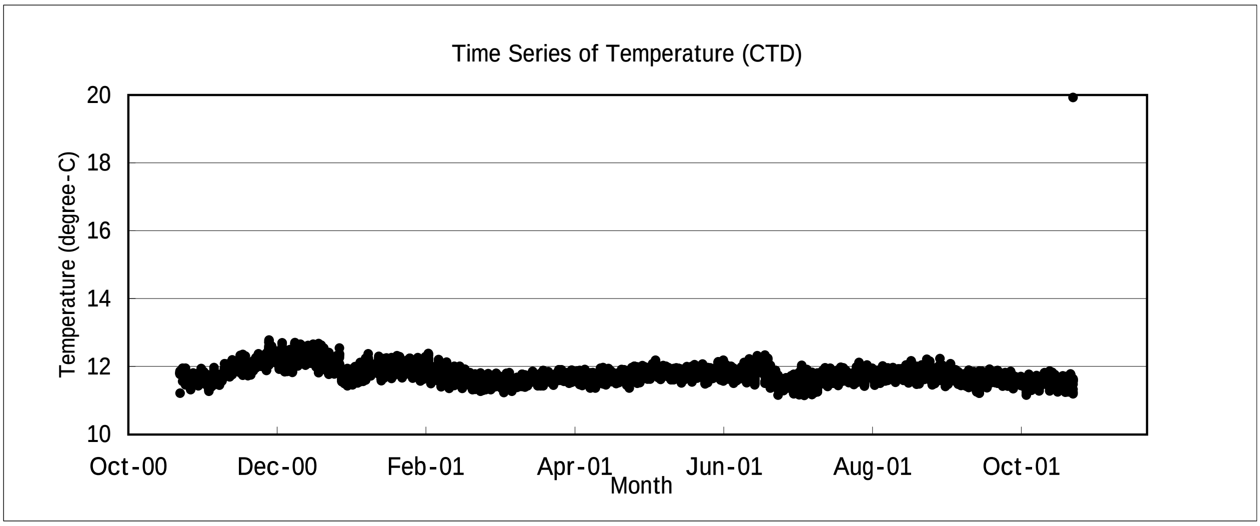


Fig. 7.2-4 Time series of (a) pressure, (b) temperature and (c) salinty obtained by CTD of 0-90E ADCP mooring from 13 Nov. 2000 to 22 Oct. 2001

a)



b)



c)

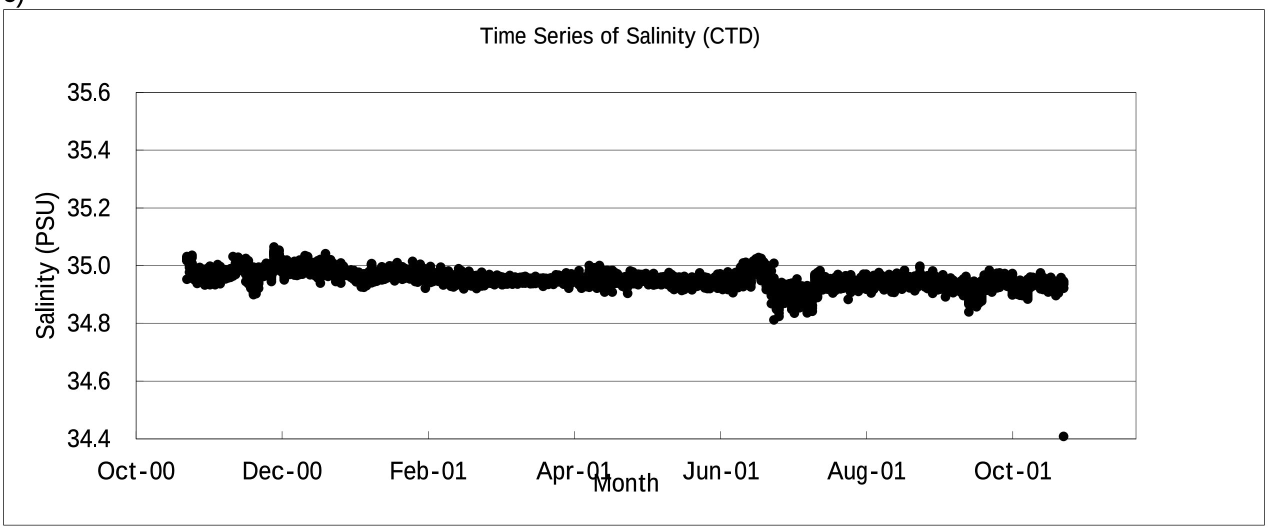
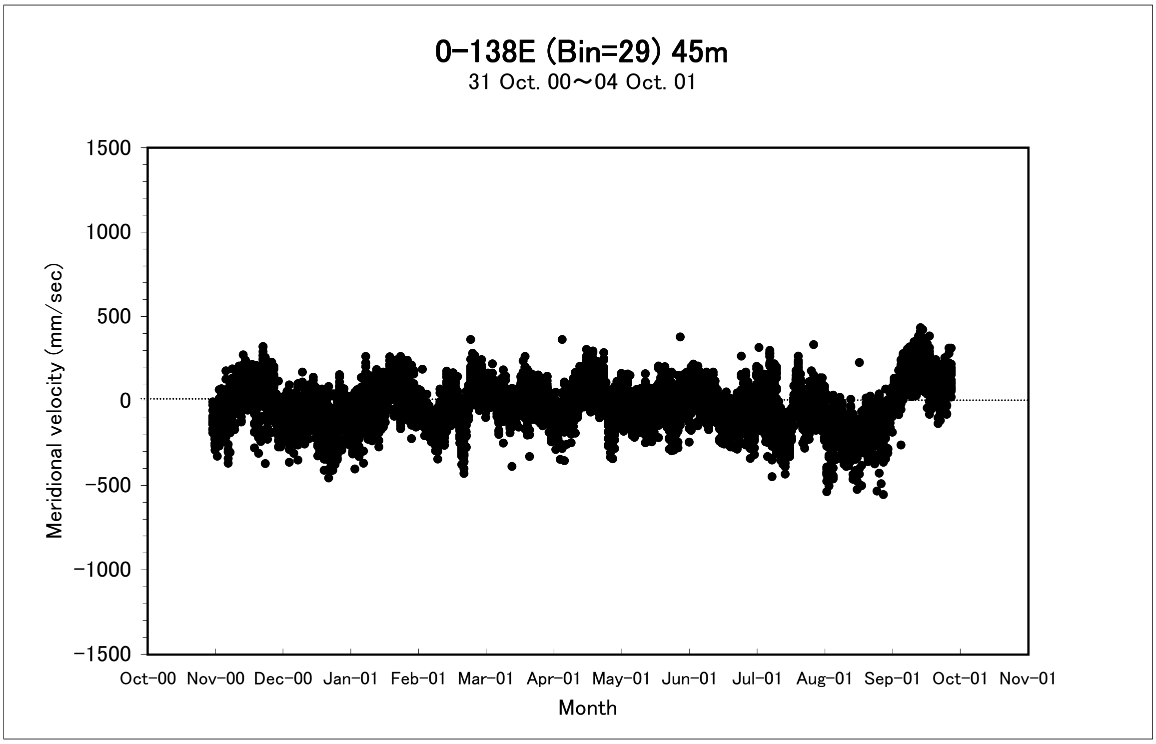


Fig. 7.2-5 Time series of (a) pressure, (b) temperature and (c) saclinty obtained by CTD of 5S-95E ADCP mooring from 17 Nov. 2000 to 25 Oct. 2001

ADCP meridional and zonal velocities



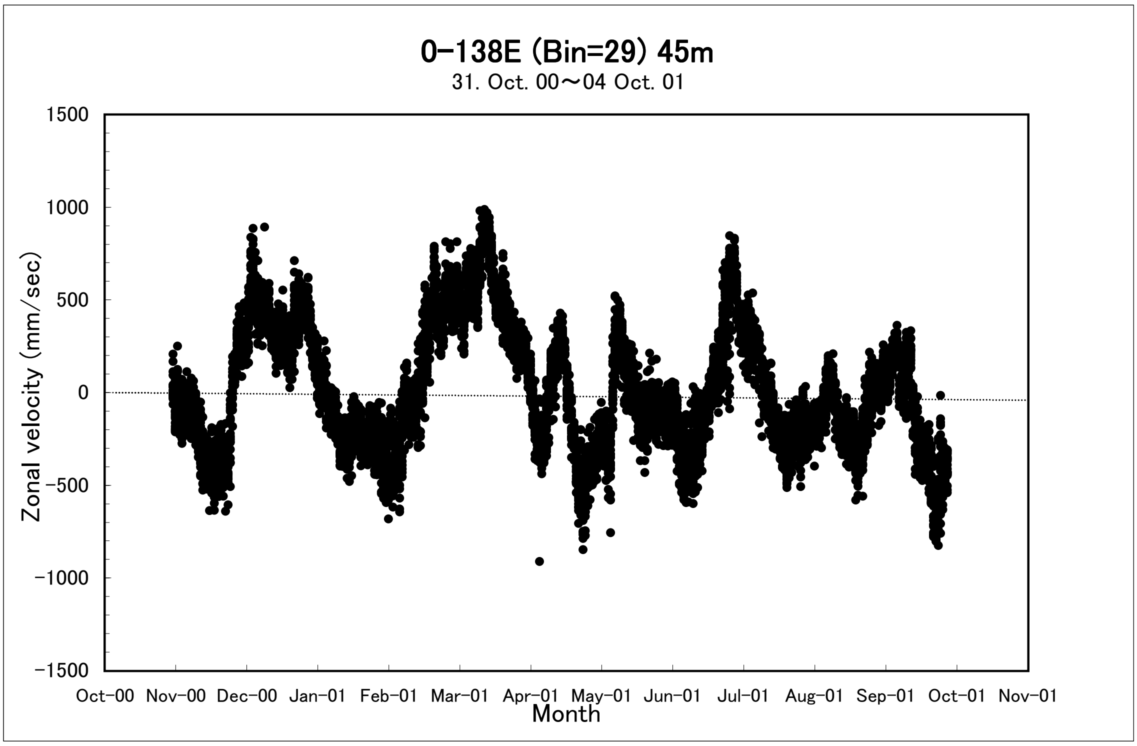
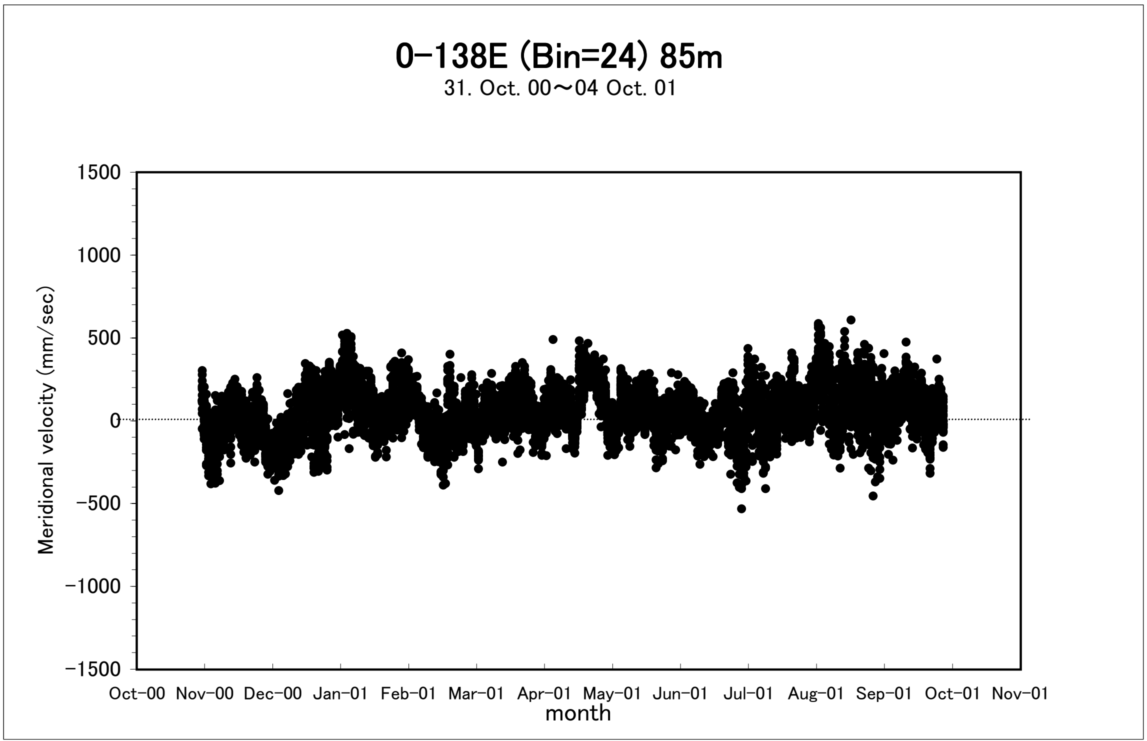


Fig. 7.2-6 Time series of meridional and zonal velccities of 0-138E ADCP mooring at 45m depth

ADCP meridional and zonal velocities



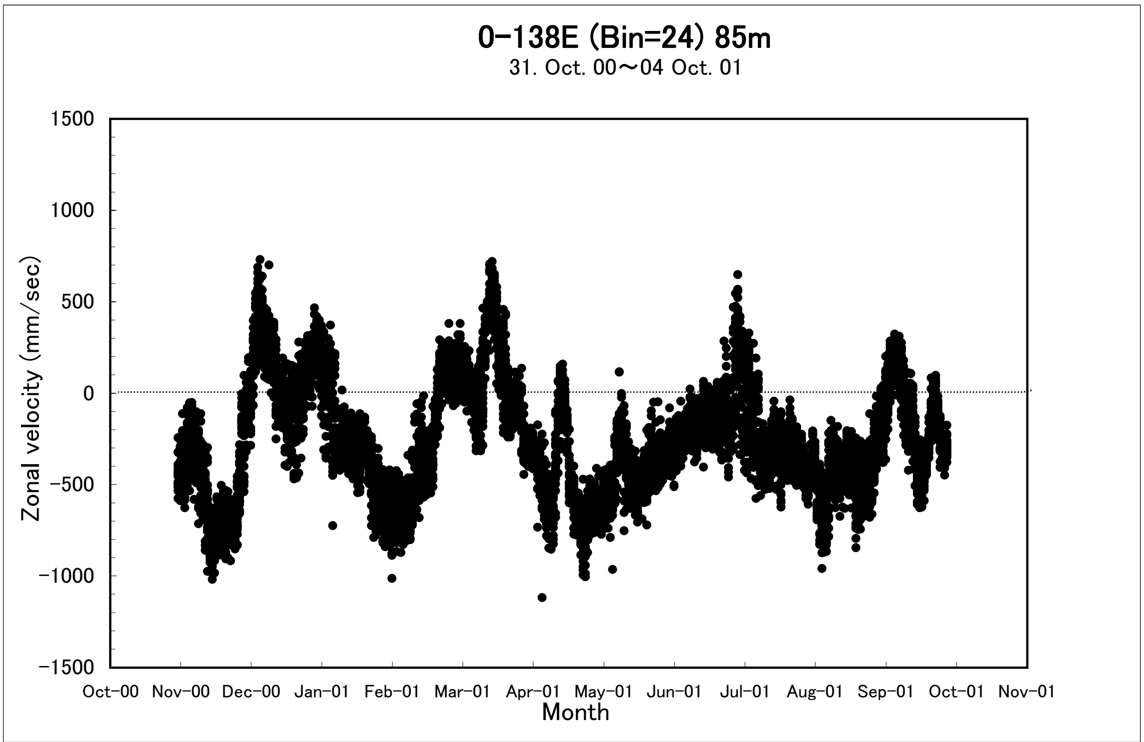
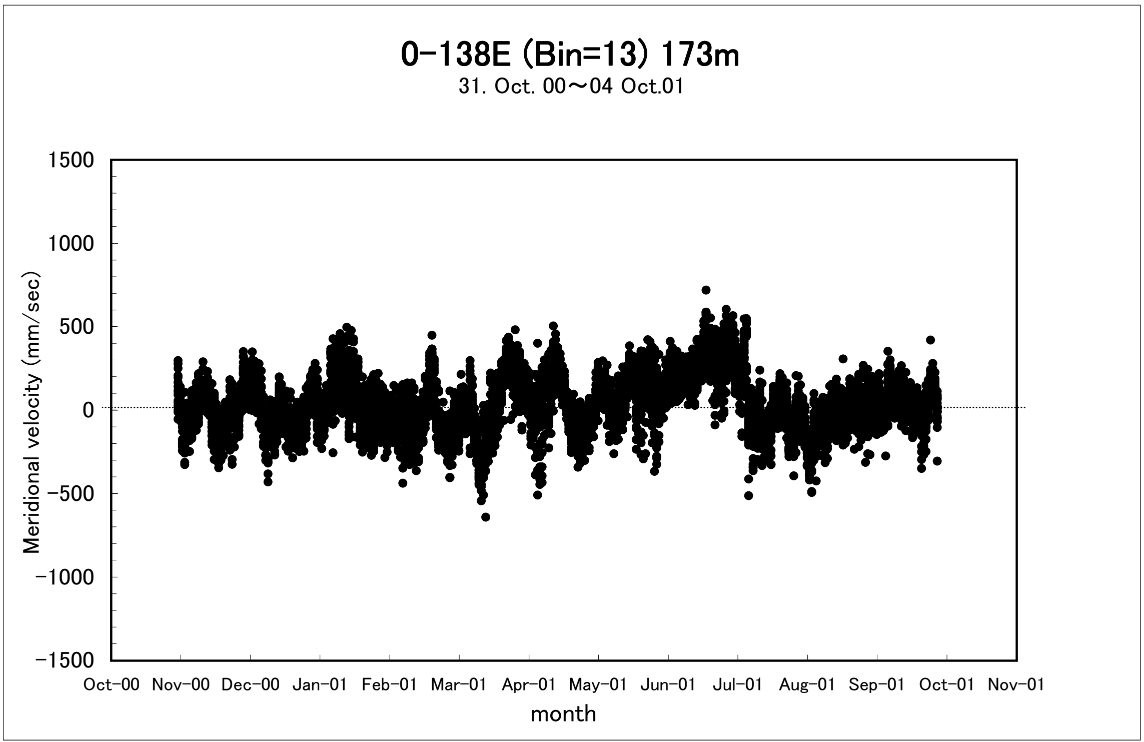


Fig. 7.2-7 Time series of meridional and zonal velccities of 0-138E ADCP mooring at 85m depth

ADCP meridional and zonal velocities



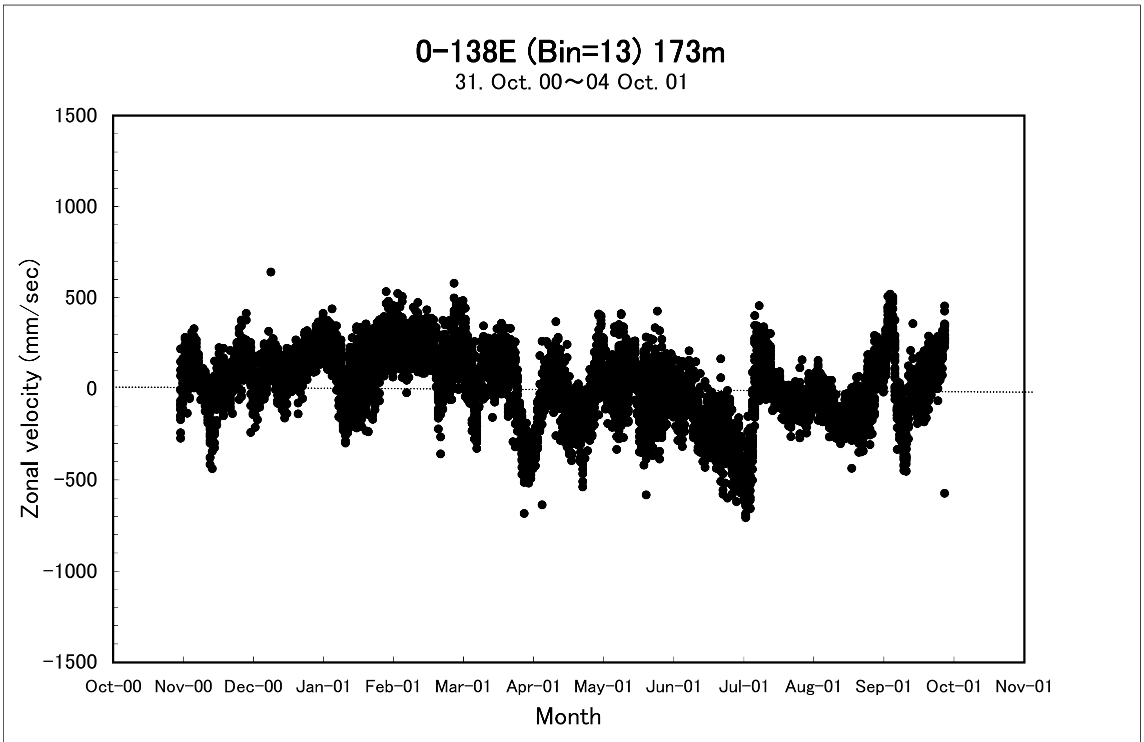
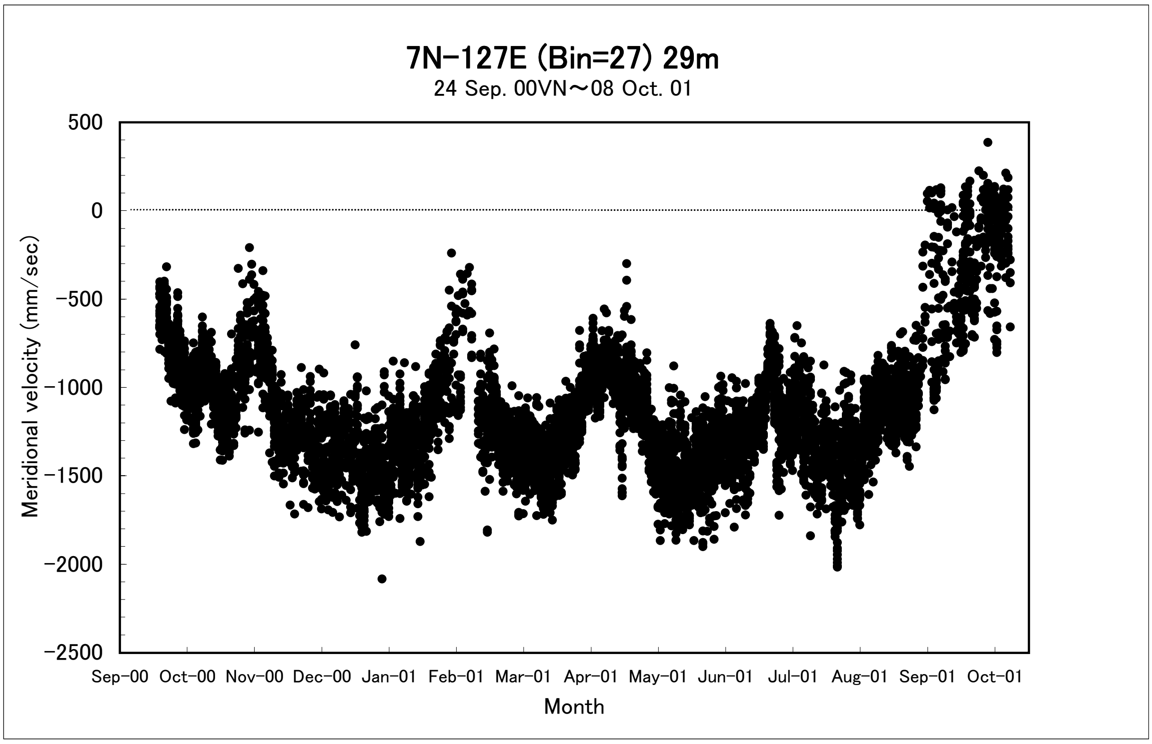


Fig. 7.2-8 Time series of meridional and zonal velccities of 0-138E ADCP mooring at 173m depth

ADCP meridional and zonal velocities



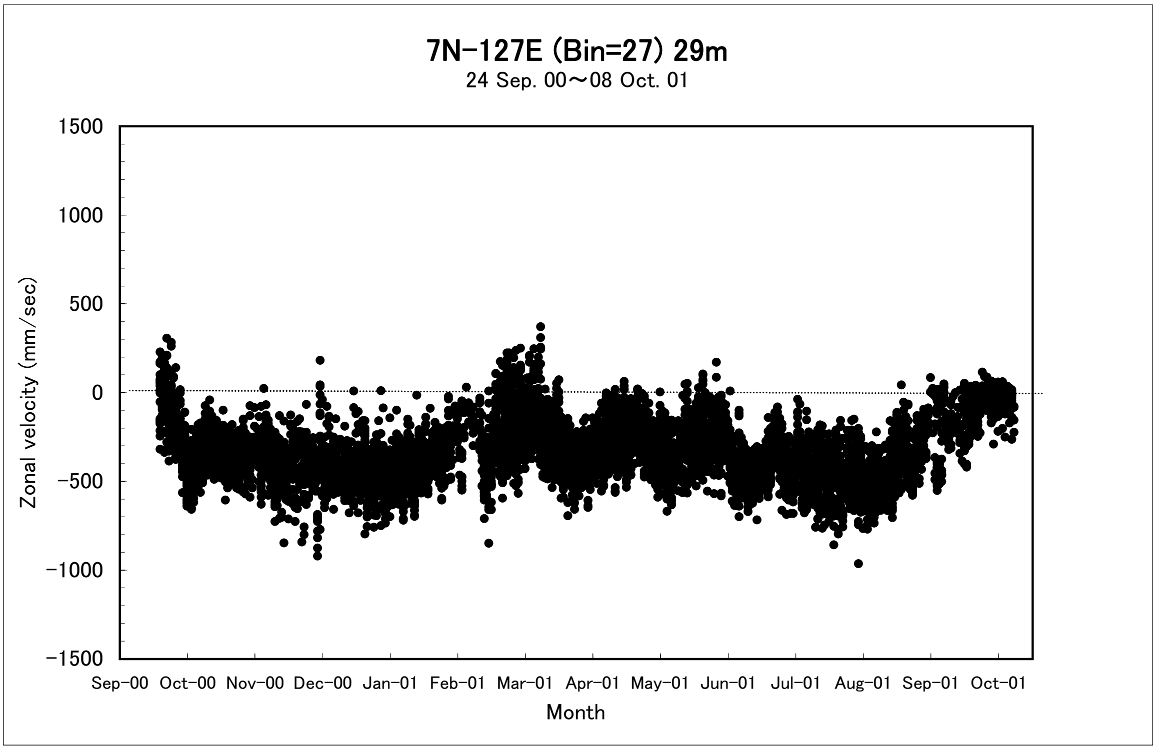
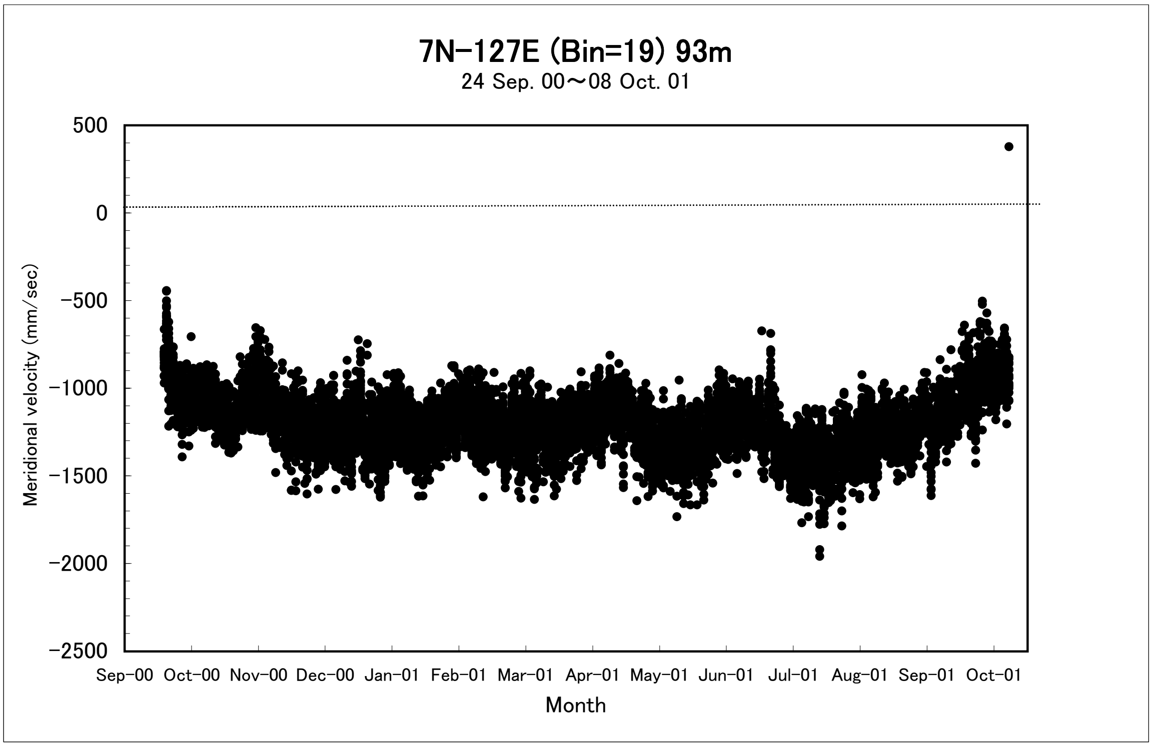


Fig. 7.2-9 Time series of meridional and zonal velccities of 7N-127E ADCP mooring at 29m depth

ADCP meridional and zonal velocities



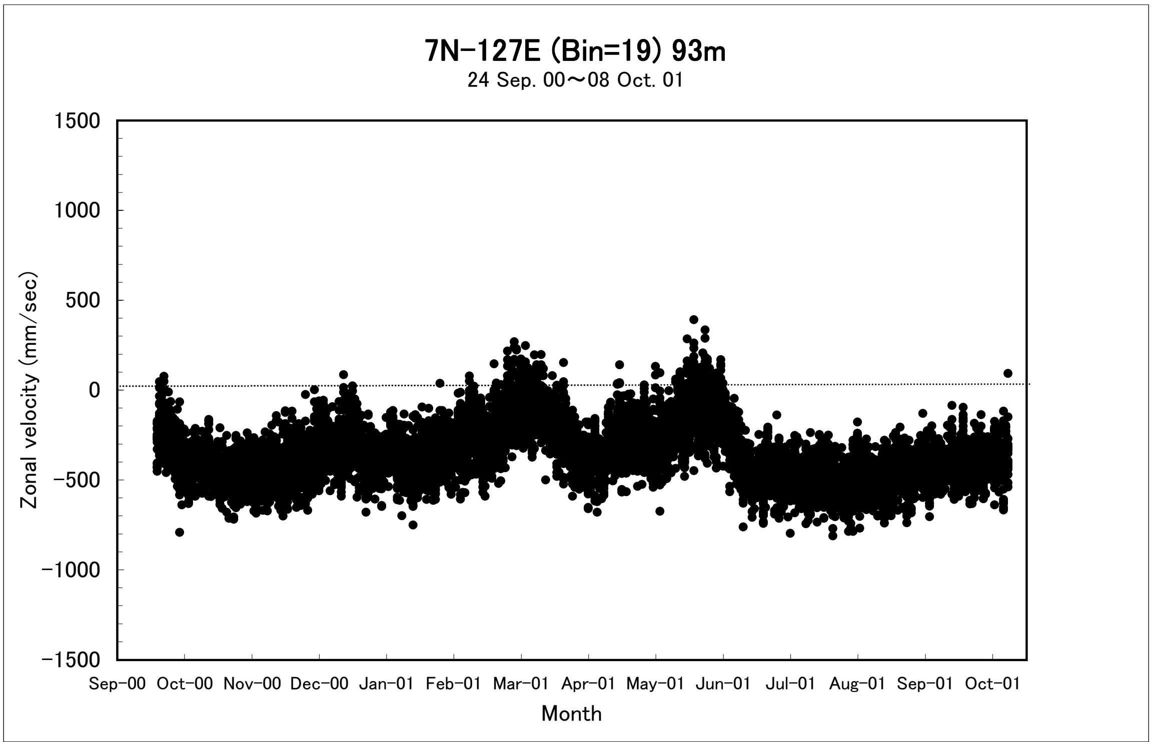
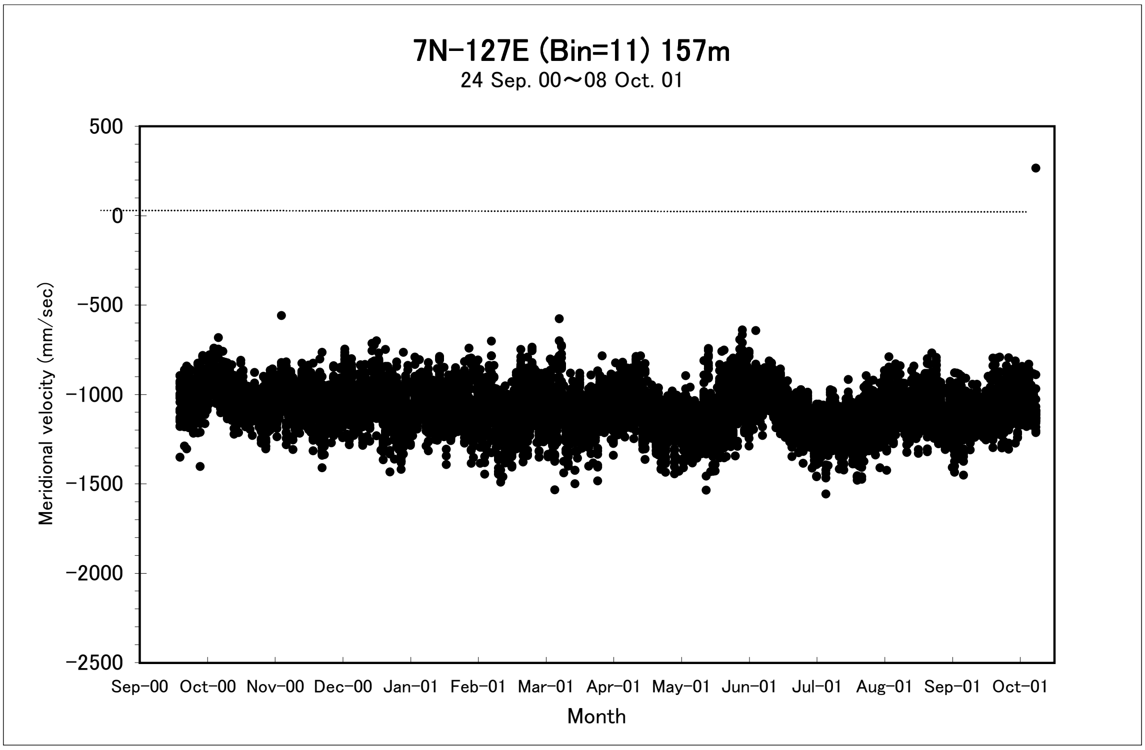


Fig. 7.2-10 Time series of meridional and zonal velccities of 7N-127E ADCP mooring at 93m depth

ADCP meridional and zonal velocities



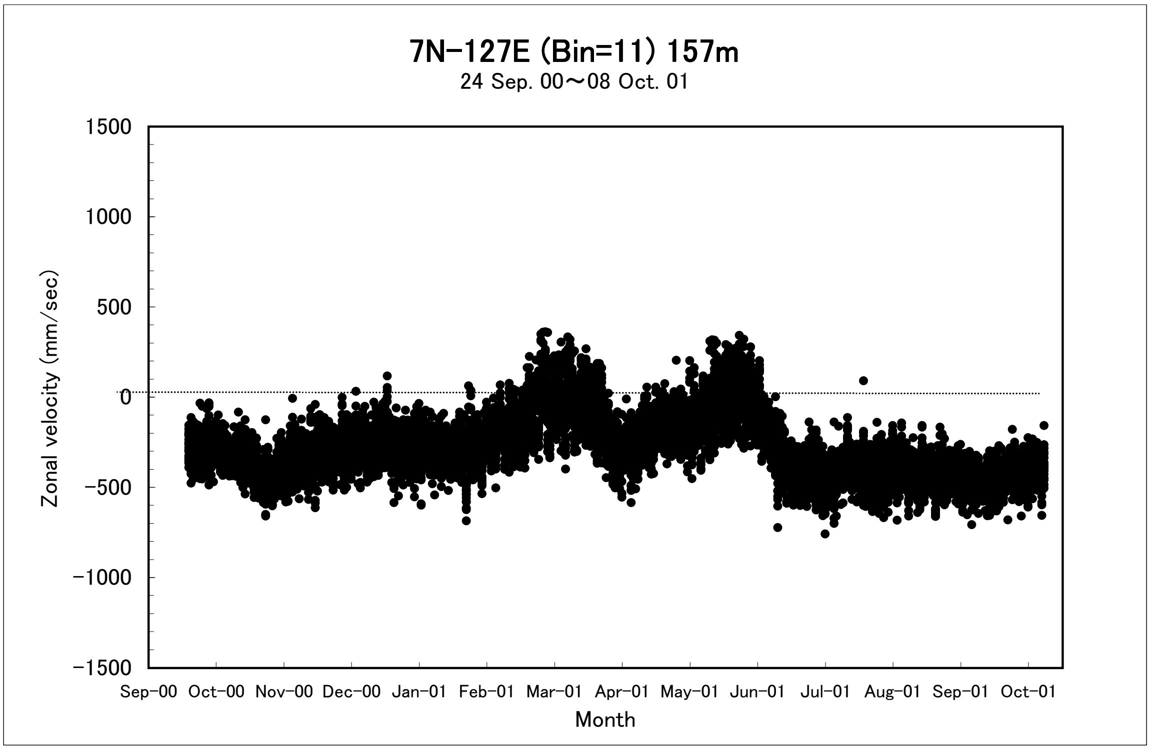
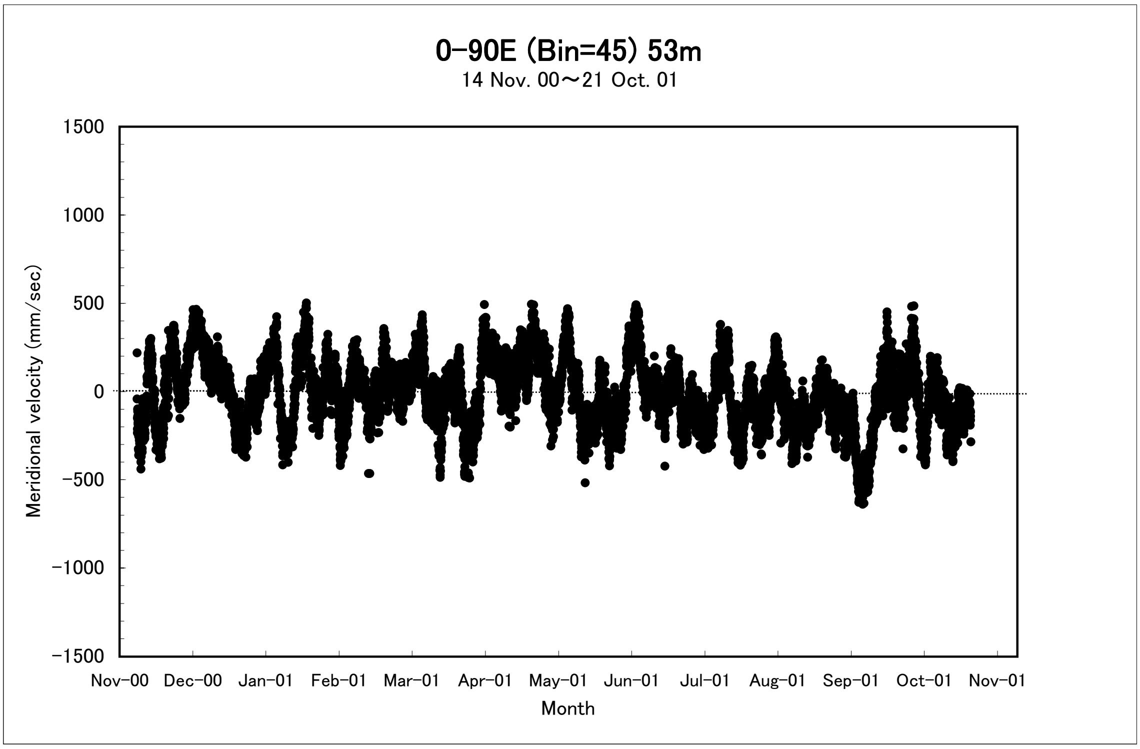


Fig. 7.2-11 Time series of meridional and zonal velccities of 7N-127E ADCP mooring at 157m depth

ADCP meridional and zonal velocities



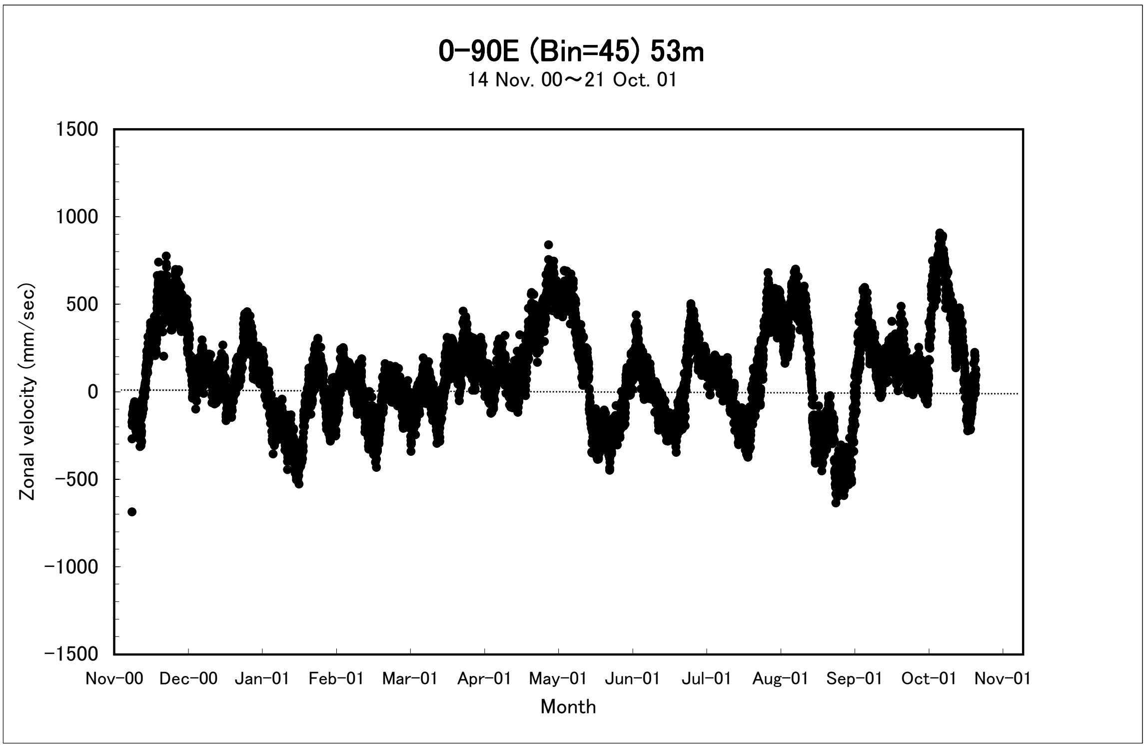
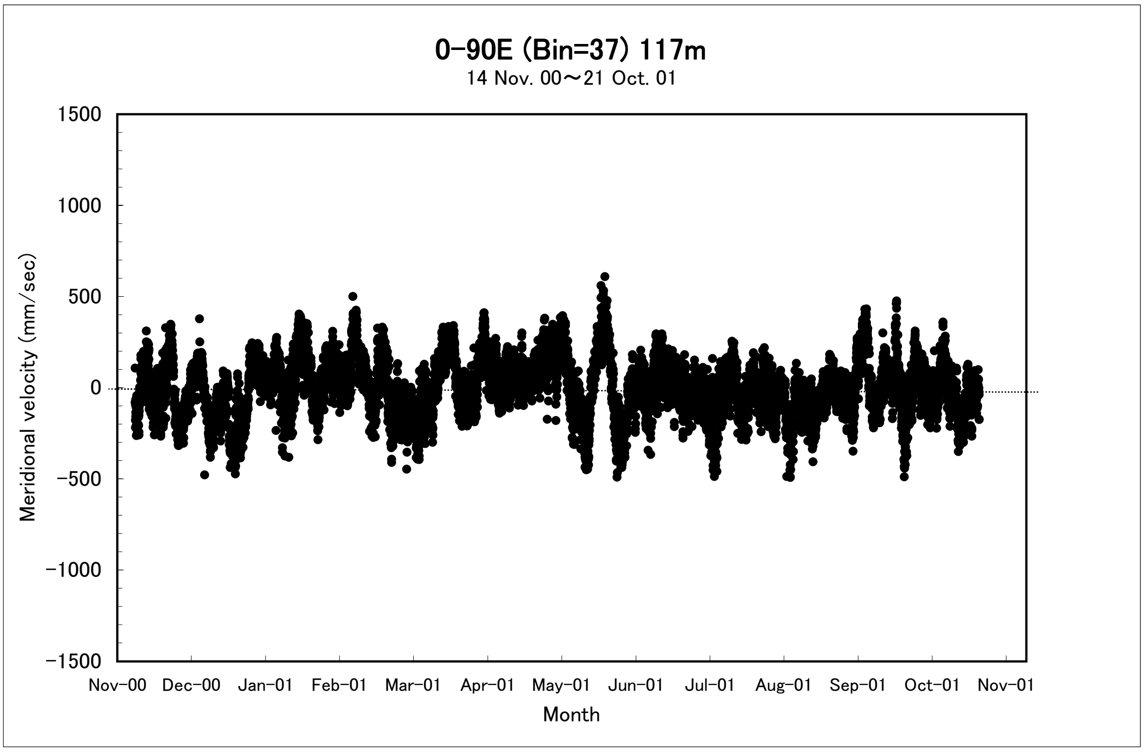


Fig. 7.2-12 Time series of meridional and zonal velccities of 0-90E ADCP mooring at 53m depth

ADCP meridional and zonal velocities



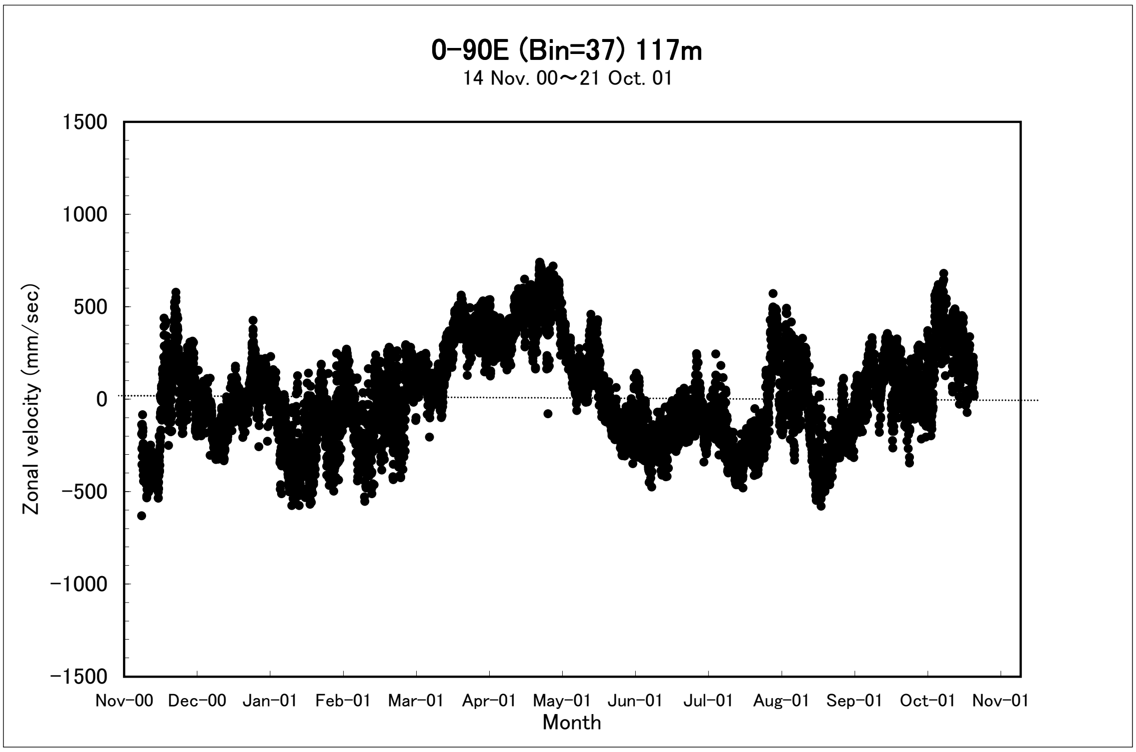
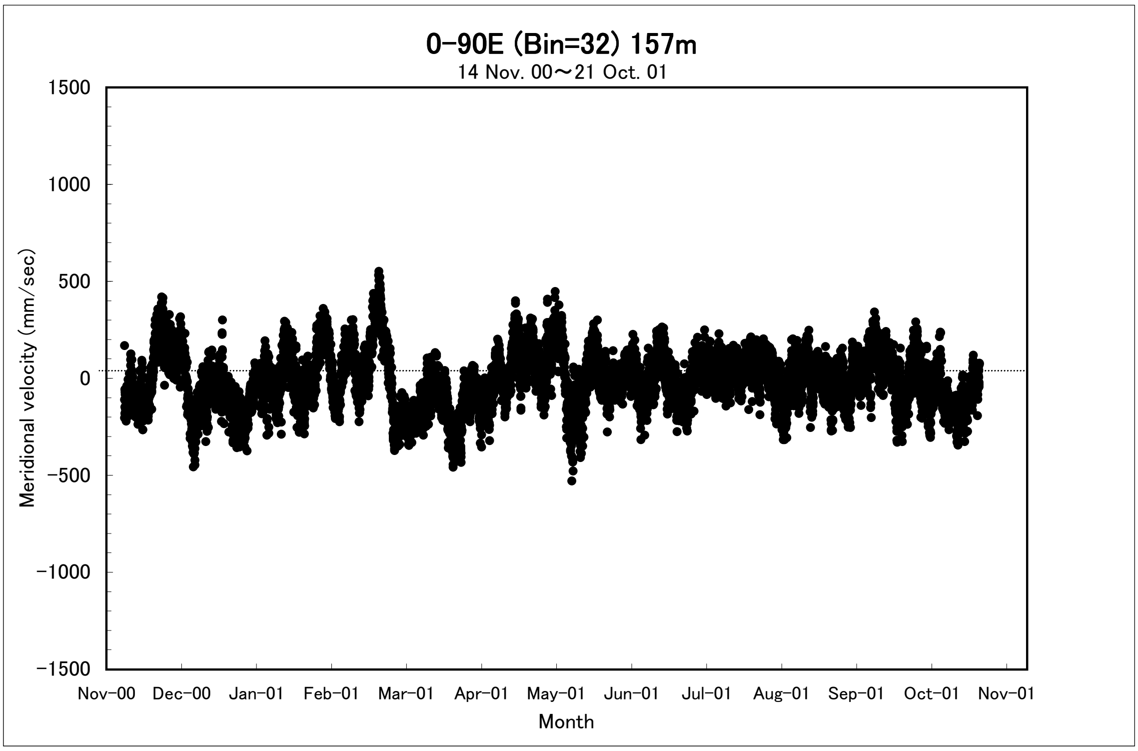


Fig. 7.2-13 Time series of meridional and zonal velccities of 0-90E ADCP mooring at 117m depth

ADCP meridional and zonal velocities



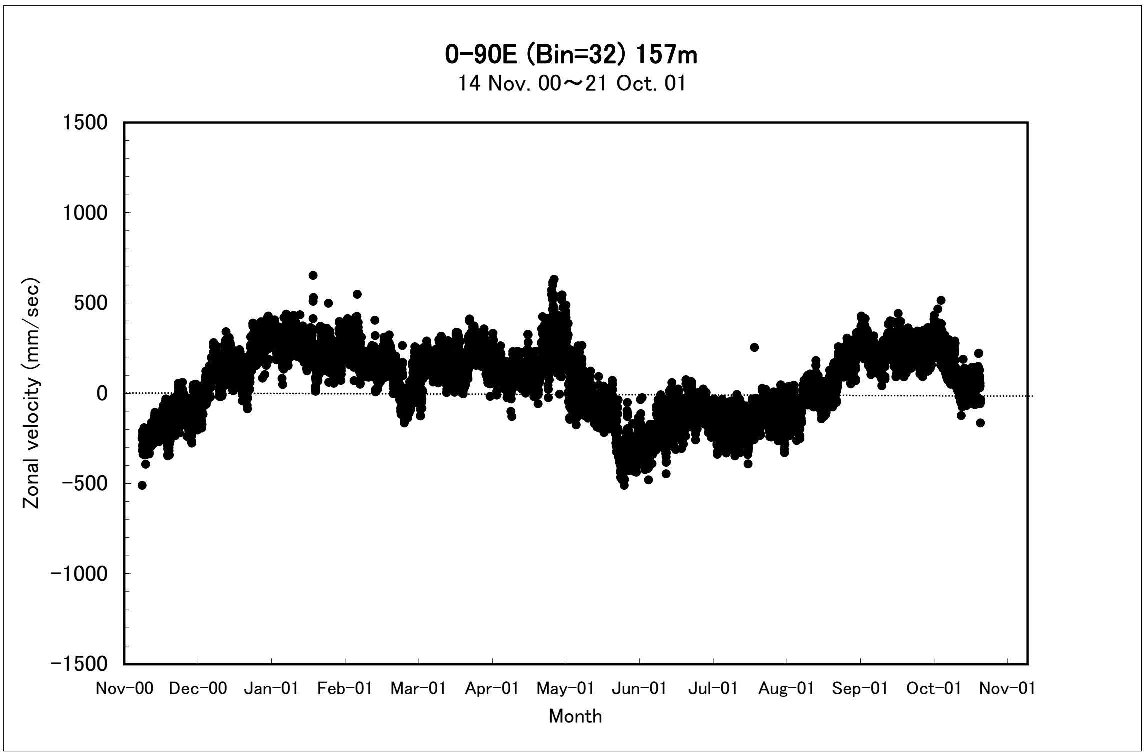
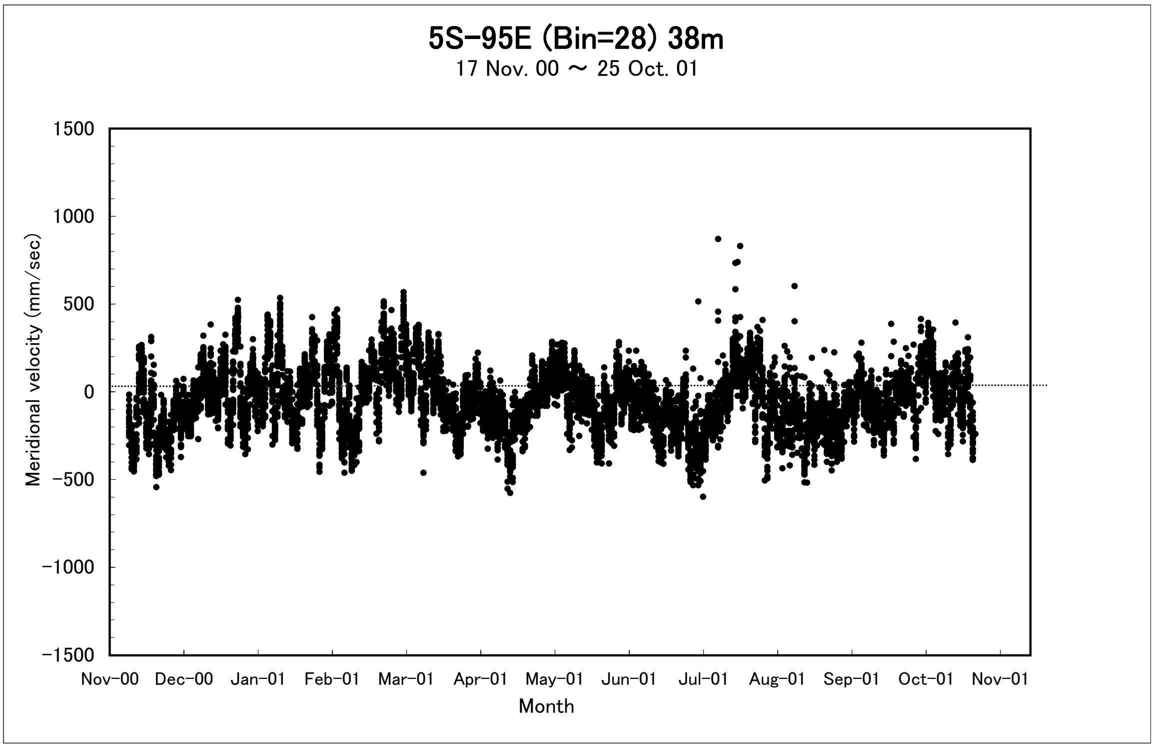


Fig. 7.2-14 Time series of meridional and zonal velccities of 0-90E ADCP mooring at 157m depth

ADCP meridional and zonal velocities



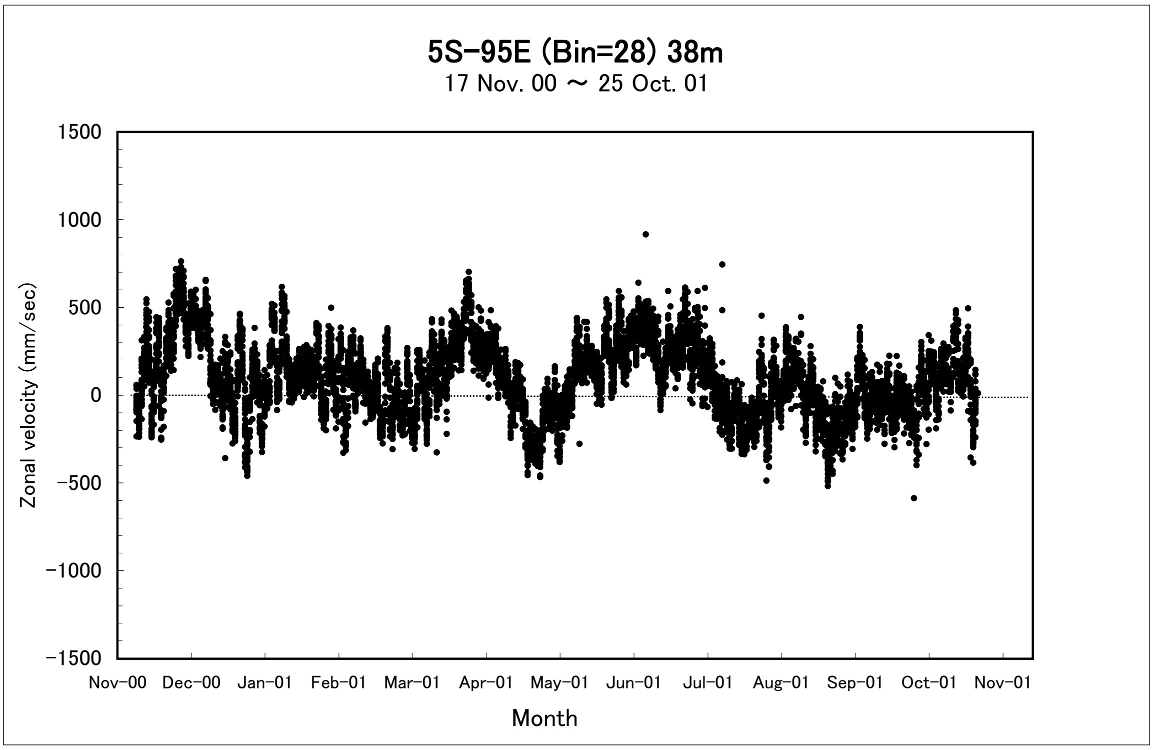
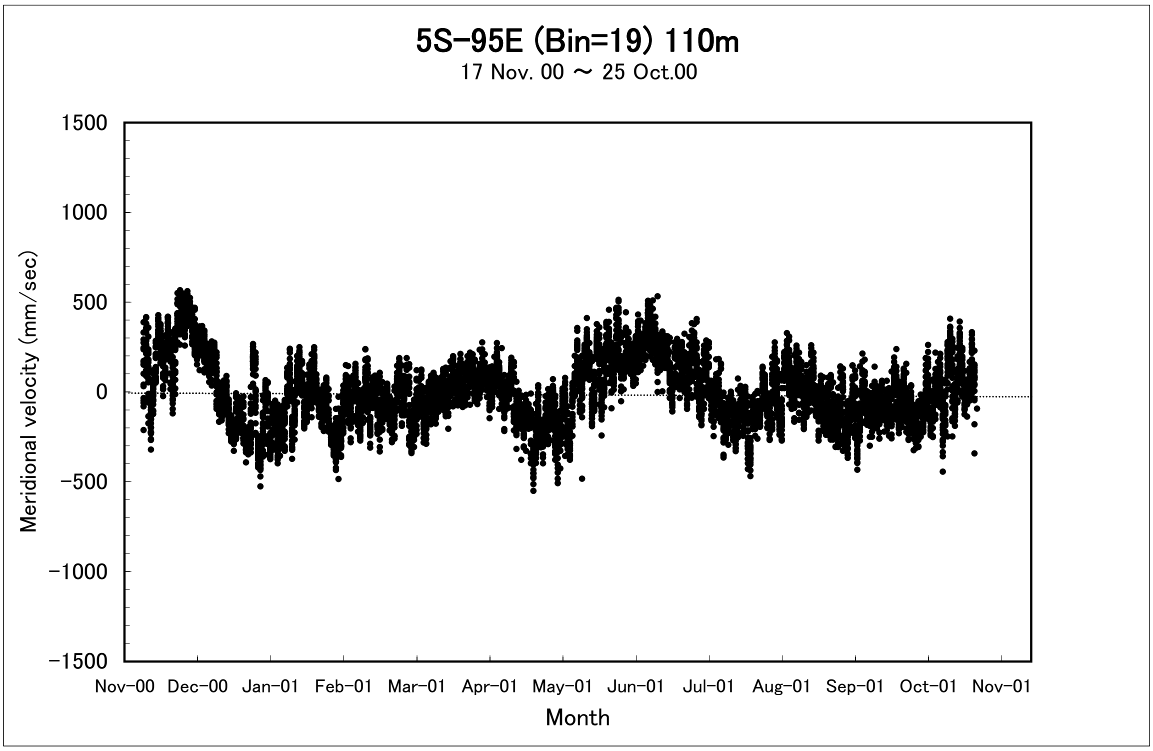


Fig. 7.2-15 Time series of meridional and zonal velccities of 5S-95E ADCP mooring at 38m depth

ADCP meridional and zonal velocities



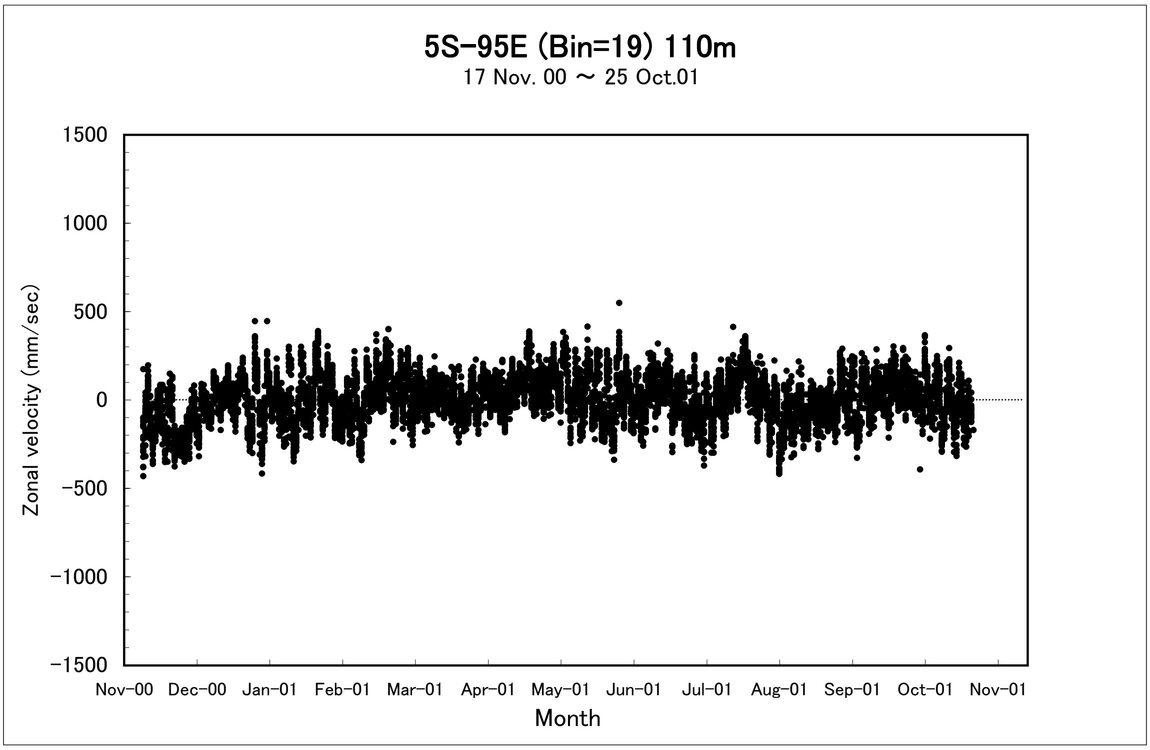
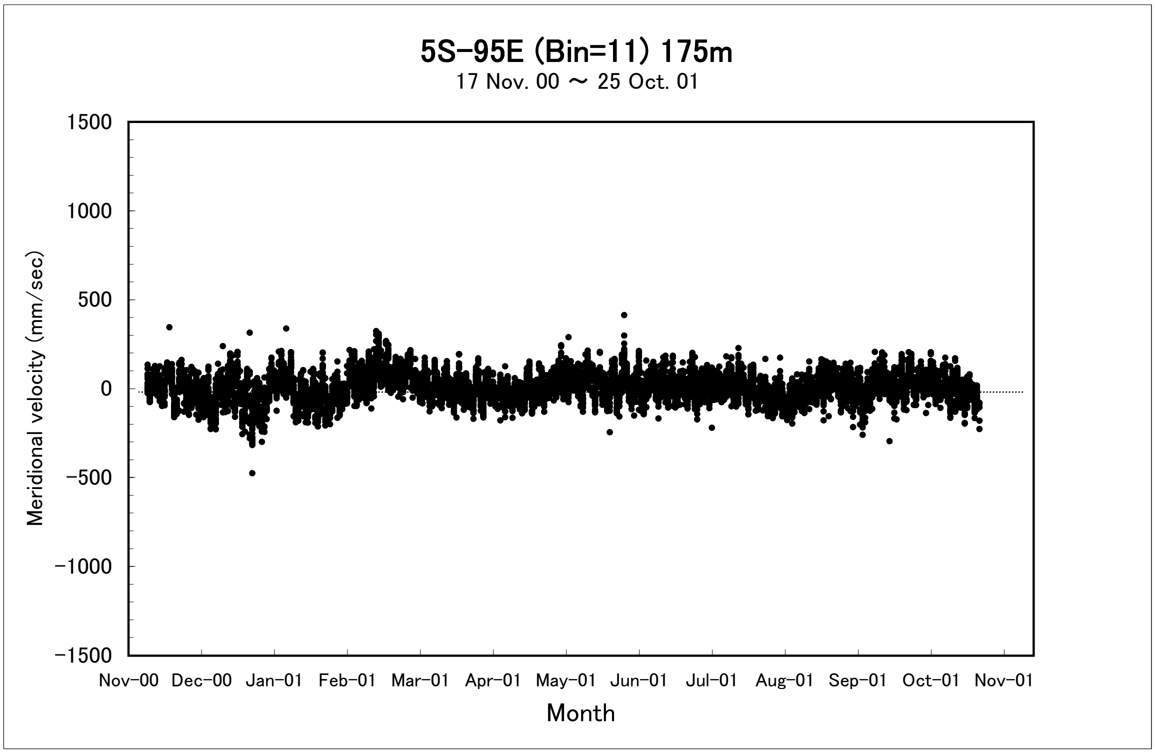


Fig. 7.2-15 Time series of meridional and zonal velccities of 5S-95E ADCP mooring at 110m depth

ADCP meridional and zonal velocities



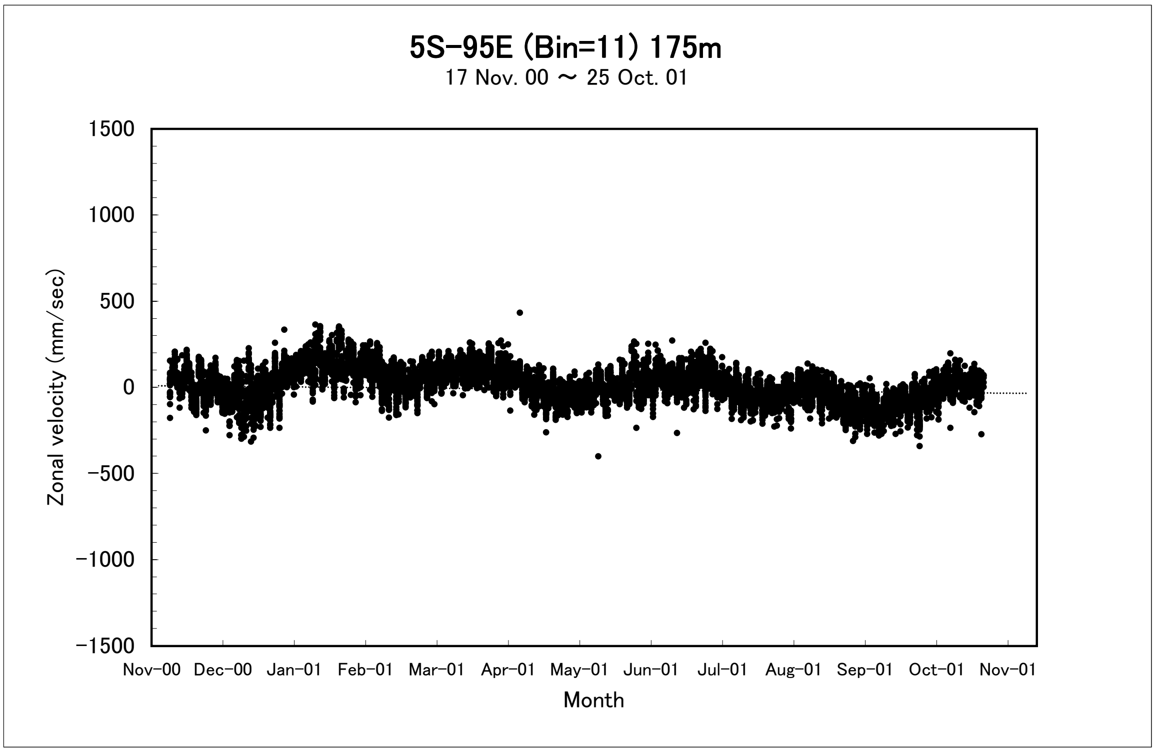


Fig. 7.2-17 Time series of meridional and zonal velccities of 5S-95E ADCP mooring at 175m depth

7.3 Aerosol measurement

(1) Personnel

Principal Investigator (not on board)

Tatsuo Endoh (Institute of Low Temperature Science, Hokkaido University)

On board scientists

Ichiro Matsui (National Institute for Environmental Studies)

Atsushi Shimizu (National Institute for Environmental Studies)

Co-workers (not on board)

Tamio Takamura (Center of environmental remote sensing science, Chiba University)

Sachio Ohta (Engineering environmental resource laboratory, Graduate school of engineering, Hokkaido University)

Teruyuki Nakajima (Center of climate system research, University of Tokyo)

(2) Objects/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.

(3) 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.

(4) Methods

The instruments used in this work are shown as following in Table 7.3-1.

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.

(5) Results

Information of data and sample obtained are summarized in Table 7.3-2. 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.

(6) 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.

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Data inventory

Table 7.3-1. 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 7.3-2. 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	9/20'01-11/5'01
Size distribution of aerosols	1/2.5min	compass deck	concentration of aerosols	Endoh	on board	9/20'01-11/5'01

7.4 ARGO float (profiling float)

(1) Personnel

Kensuke Takeuchi	(FORSGC)	Principal Investigator
Keisuke Mizuno	(JAMSTEC)	
Motoki Miyazaki	(FORSGC)	
Kentaro Ando	(JAMSTEC)	not on board
Kenji Izawa	(JAMSTEC)	not on board
Yasushi Takatsuki	(JAMSTEC)	not on board
Naoto Iwasaka	(FORSGC)	not on board
Taiyo Kobayashi	(FORSGC)	not on board
Eitaro Oka	(FORSGC)	not on board
Yasuko Ichikawa	(FORSGC)	not on board
Asako Inoue	(MWJ)	not on board

(2) Objectives

Five Argo floats were deployed as a part of the international Argo project and the Japanese ARGO project. The purpose of these projects is to observe the upper ocean on global scales in real-time using numerous profiling floats: for better understanding of ocean variations associated with climate variability, and for improvement of long-range weather forecasts. Since the locations of deployments are near one of the poles of the Indian Ocean Dipole Mode Oscillation, the floats are especially expected to provide information about variations of the upper ocean associated with the oscillation.

(3) Parameters

- Vertical profiles of water temperature, salinity, and pressure
- Location and time of observation
- Ocean currents at the sea surface and the parking depth

(4) Methods

The floats deployed during this cruise were 2 APEX floats manufactured by Webb Research and 3 PROVOR floats manufactured by MTEOCEAN Data Systems. The APEX floats were launched at 4°S, 90°E and 5°S, 90°E, and the PROVOR floats were launched at 5°S, 91°E, 5°S, 93°E and 5°S, 95°E. All the floats are launched just after CTD observation at the same location, so that we can use CTD data for calibration of the float sensors (cf. Session 6.2.1).

The floats are designed to drift at a specified depth called “parking depth” or “drifting depth” (1500 m in this case) for a specified period, and then change their buoyancy by increasing their volume to rise up to the sea surface. In the case of PROVOR floats, they dive to the profile he depth (2000 m in this case) before their ascent. During their ascent, they measure temperature, salinity, and pressure. The floats remain at the sea surface for about 10 to 24 hours, transmit their positions and the CTD data to ARGOS satellites, and then return to the parking depth by decreasing their volume. Each of the ascent and descent takes about 5-10 hours. The specification of the floats and their deployment status are shown in Table 7.4-1. It should be noted that the actual periods at the parking depth and the sea surface are less than those specified, because of the time used for descent and ascent.

(5) Data archive

All data acquired through the ARGOS system is stored and analyzed at FORSGC. The real-time data are provided to meteorological organizations via the Global Telecommunication System (GTS) and are utilized for analysis and forecasts of sea conditions. In addition, the data will be also opened to the public via "Japan ARGO home page".
(http://www.jamstec.go.jp/ARGO/J_ARGOe.html)

Table 7.4-1 Float status and deployment status

Float type	APEX manufactured by Webb Research Ltd.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days (Parking Depth, 213 hours; Sea Surface, 27 hours)
ARGOS transmit interval	44sec
Target Parking Pressure	1500 dbar
Sampling layers (58)	Bottom pressure, 1500, 1400, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 980, 960, 940, 920, 900, 880, 860, 840, 820, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 480, 460, 440, 420, 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 180, 160, 140, 120, 100, 80, 60, 40, 20, 0 [dbar]

WMO ID	Float S/N	ARGOS PTT ID	Reset Date and Time (UTC)	Deployed Date and Time (UTC)	Deployed Position
	235	06509	21:32, October 23	23:39, October 23	3-59.94S, 89-59.88E
	368	11470	03:30, October 24	05:27, October 24	5-00.09S, 90-00.28E

Float Type	PROVOR manufactured by METOCEAN Data Systems Ltd.
CTD sensor	SBE41CP manufactured by Sea-Bird Electronics Inc.
Number of cycles	255 (max)
Cycle	10 days
Ascent time	02:00 (UTC)
Drift sample period	24 hours
ARGOS transmit interval	30 sec
Sampling interval	11 sec
Drift depth	1500 dbar
Profiling depth	2000 dbar
Grounding mode	0
Extent of shallow profile	600 dbar

WMO ID	Float S/N	ARGOS PTT ID	Reset Date and Time (UTC)	Deployed Date and Time (UTC)	Deployed Position
	MT010	24334	10:31, October 24	11:21, October 24	4-59.66S, 91-00.07E
	MT009	23819	20:34, October 24	21:03, October 24	4-59.31S, 93-00.25E
	MT011	24369	05:50, October 26	06:28, October 26	4-58.02S, 94-58.98E

7.5 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto (NIES):	Principal Investigator	not on board
Ichiro Matsui (NIES)		Leg 1
Atsushi Shimizu (NIES)		Leg 2
Kazuhiro Asai (Tohoku Institute of Technology)		not on board

(2) Objectives

Objectives of the observations and experiments in this cruise are

- to study distribution and optical characteristics of dust and other aerosols using a two-wavelength dual polarization lidar,
- to study microphysical parameters of ice clouds and thin water clouds with the combination of the lidar and the cloud profiling radar,
- to study a new polarization bistatic lidar method for measuring cloud particle size of lower water clouds.

(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 a 20-ft container with the cloud profiling radar (CPR) of the Communications Research Laboratory (CRL). The container has a glass window on the roof, and the lidar was operated continuously regardless of weather.

The experiment on the bistatic lidar method was performed with additional receivers installed at distances of 13 m and 15 m from the lidar transmitter. The bistatic receivers detect backscatter from the lower clouds at a scattering angle of about 179 deg. Clouds particle size is derived from the ratio of signal intensity of two polarization components.

(5) Results

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

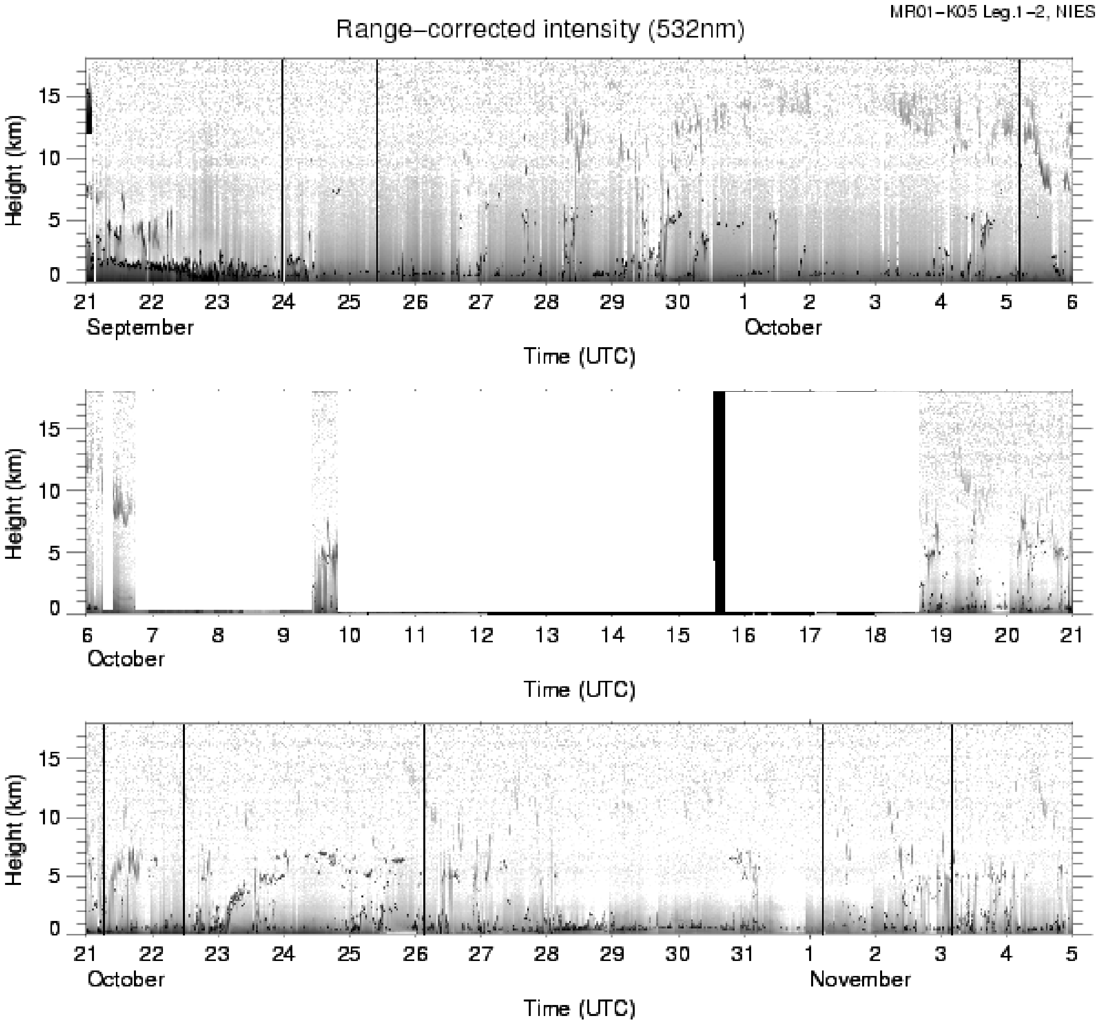


Fig. 7.5-1 Range-corrected signal at 532 nm.

Latitudinal variations of vertical cloud distribution are confirmed. At the beginning of the cruise, descending of lower clouds from 2 km to several hundred meters is found. It corresponds to the latitudinal change of atmospheric boundary layer depth. The lower clouds at 600 m are continuously observed over western Pacific and eastern Indian oceans. Also higher cirrus around 15 km is detected in lower latitude where the tropopause is supposed to be located at 16-18 km.

A close look into a middle cloud reveals fine structures of cloud system accompanied by precipitation. We can see a melting layer located at around 5 km, where the intensity and the depolarizaion ratio change greatly in vertical direction. Typical patterns are seen on October 9, 21, and November 3, for instance.

Concentrations of aerosols in boundary layer seem to be denser in higher latitude than in lower latitude, if we can neglect fluctuations of the laser transmittance energy.

The experiment on the bistatic lidar was performed after October 27. Although data of this experiment requires post-cruise comparisons with calculated scattering patterns by Mie-theory, we could obtain sufficient amount of data for our purpose of the study.

(6) Data archive

All data will be archived at National Institute for Environmental Studies, and will be submitted to the DMO (Data Management Office) in JAMSTEC within 3 years after this cruies.

- raw data
  - lidar signal at 532 nm (parallel polarization)
  - lidar signal at 532 nm (perpendicular polarization)
  - lidar signal at 1064 nm
  - period 09200524-11040700 (UTC), continuous (except during 10120230-10160245)
  - temporal resolution 10 sec.
  - vertical resolution 6 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 Cloud radar observation

(1) Personnel

Akihide Kamei	(Communications Research Laboratory, on board Leg 1)
Yuichi Ohno	(Communications Research Laboratory, on board Leg 2)
Hiroshi Kumagai	(Communications Research Laboratory)
Hiroshi Kuroiwa	(Communications Research Laboratory)
Hiroaki Horie	(Communications Research Laboratory)
Hajime Okamoto	(Tohoku University)

(2) Objectives

Clouds are known to affect primarily the energy and water cycle in the climate system. Their interactions with aerosols, with many chemical reactions in the atmosphere, and with the radiative energy transfer are still not understood. For this cruise, we work for studying vertical distribution and microphysics of clouds and aerosols by using cloud profiling radar (CPR) of Communications Research Laboratory (CRL) in collaboration with the lidar systems of National Institute for Environmental Studies (NIES). One of the great advantages in the active remote sensing is that these sensors provide cloud boundaries with high accuracy. The basic elements of observations are cloud boundaries, cloud microphysics such as effective radius and ice/liquid water content (IWC/LWC), fall velocity of the cloud particles, depolarizations (non-sphericity), and vertical distribution of aerosols. In addition, we expect to study longitudinal and latitudinal distribution of clouds and aerosols.

(3) Parameters

The CPR is operated in the vertical pointing mode and measures backscattering intensity of cloud particles by dual polarization. The radar measurements provide radar reflectivity factor, Doppler velocity, and linear depolarization ratio (LDR) in the vertical direction. (The lidar measurements provide backscattering coefficient in the vertical direction.) The microwave radiometer provides water vapor amounts and liquid water paths of water clouds.

(4) Methods

CRL has developed an airborne W-band CPR named SPIDER operating at 95GHz. For the cruise of the R/V Mirai, the CPR system was modified to be suitable for shipborne measurements. The CPR and the lidar system were co-located in the same container on the upper deck of the R/V Mirai. Thus it is possible to perform radar/lidar algorithm to retrieve vertical profiles of effective radius and ice/liquid water content of ice and thin water clouds. The microwave radiometer with dual-frequencies (23.8GHz and 31.4GHz) was also installed. The CPR operation has continued almost all time. The basic operating parameters for CPR measurements are listed in Table 7.6-1.

(5) Results

Figure 7.6-1 shows an example for time-altitude profile of reflectivity factor (dBZ) and Doppler velocity (m/s) observed with the CPR on 30 September 2001. The vertical axis indicates altitude between 0 and about 20 km with every 82.5 m range resolution. The horizontal axis indicates time (JST). The combination of the CPR and the microwave radiometer is used to retrieve cloud droplet effective radius and liquid water content of thick water clouds. Since the lidar instrument has a capability to detect aerosol signals, we might expect to study cloud-aerosol interactions. These studies will bring significant progress in our understandings of a role of clouds in relation to the cloud feedback processes and climate impact of anthropogenic aerosols through the cloud-aerosol interaction processes.

(6) Data Archive

All data obtained during this cruise will contribute to the APEX project directed by Prof. Teruyuki Nakajima (University of Tokyo) in a way that comparing these data sets with the modeling and satellite data should bring a breakthrough for the cloud-aerosol interaction studies. The CPR and the microwave radiometer data are archived at Communications Research Laboratory.

Table 7.6-1: Basic operating parameters for CPR measurements.

Pulse Width (nsec)	1100		2125	
Filter (MHz)	1.0		0.5	
Polarized Wave	VVHV			
Doppler	cc, cc, cc			
Pulse Repetition Time (μsec)	120×3, 4640	150×3, 6550	220×3, 4340	220×3, 2840
Number of Noise Samples	8			
Number of Range Gates	180	241	92	123
Gate Spacing (m)	82.5		162.5	
Range Gate Delay (m)	150			
Maximum Range (m)	15000	20032.5	15100	20137.5
Average Number	44	32	88	64
External Average	1			
Acquisition Time (msec)	220	224	440	224

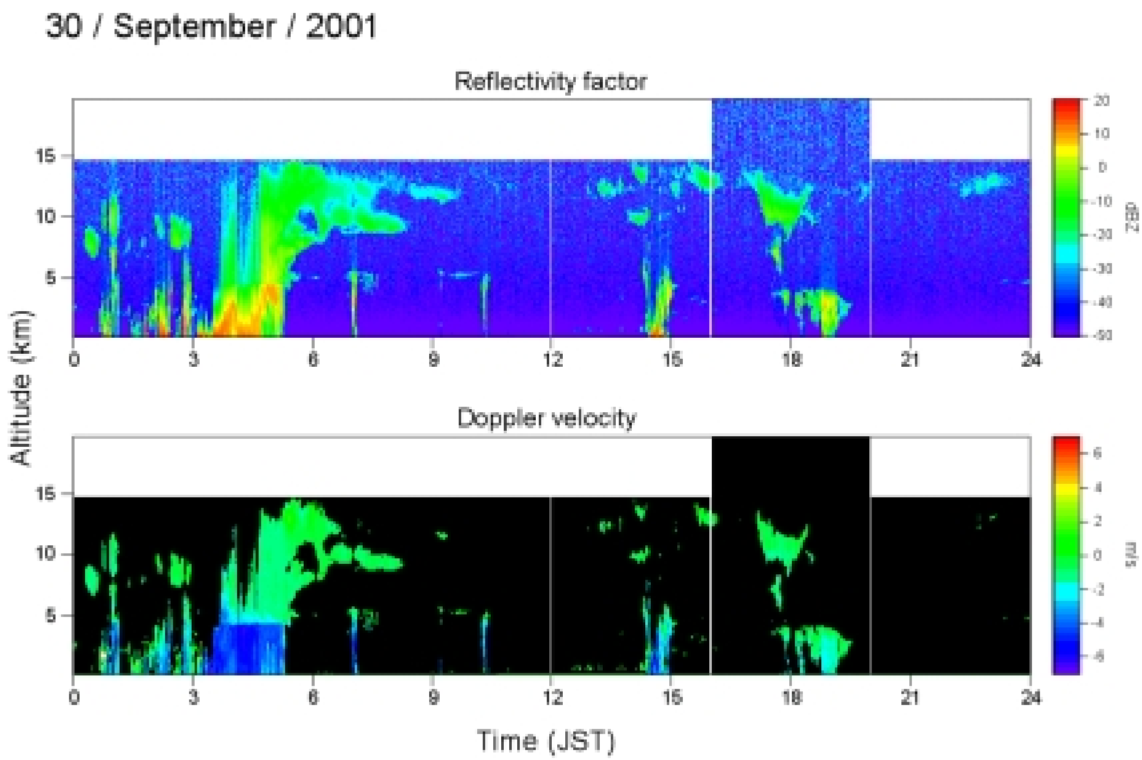


Fig. 7.6-1: Reflectivity factor and Doppler velocity for CPR observations on 30 September 2001.

7.7 Sensor comparison test for profiling float

(1) Personnel

Motoki Miyazaki	(FORSGC)	Principal Investigator	Leg 1, 2
Keisuke Mizuno	(JAMSTEC)		Leg 2
Kensuke Takeuchi	(FORSGC)		Leg 2
Hideaki Hase	(JAMSTEC)		Leg 1, 2
Satoshi Okumura	(GODI)		Leg 1
Wataru Tokunaga	(GODI)		Leg 1, 2
Kentaro Ando	(JAMSTEC)		not on board
Kenji Izawa	(JAMSTEC)		not on board
Yasushi Takatsuki	(JAMSTEC)		not on board
Asako Inoue	(MWJ)		not on board
Taiyo Kobayashi	(FORSGC)		not on board
Eitaro Oka	(FORSGC)		not on board

(2) Objectives

In the internationally coordinated Argo programs, 3000 Argo floats with a CTP (conductivity, Temperature, pressure) sensor are now planned for deployment in the world ocean. The goal of this program is to provide high accuracy temperature (accuracy of 0.005 degC) and salinity (accuracy of 0.01 PSS-78) data to improve our forecast ability of world climate change. However, conductivity sensors are less stable compared to temperature sensor. Therefore, we need to evaluate the accuracy and stability of conductivity sensor designed for Argo floats. During this cruise, we performed an experiment to estimate the accuracy and stability of several CTP sensors using a “profiling test” to evaluate the dynamic accuracy during profiling. Details are described in the next session.

(3) Methods

The sensors tested were SBE41CP, EXCELL CTD, and TSK-CTD (prototype model). They are designed for Argo floats. SBE41CP is manufactured by Sea-Bird Electronics, Inc. EXCELL CTD is manufactured by Falmouth Scientific, Inc. (hereafter EXCELL), and TSK-CTD is manufactured by Tsurumi-Seiki Co., LTD. The conductivity sensor of SBE41CP is a conductive type. EXCELL and TSK-CTD are inductive types. The CTD system used as the reference was the SBE9/17plus system with SBE3 and SBE4 sensors with pumps, manufactured by Sea-Bird Electronics, Inc. These sensors were mounted on a special profiling system, which was designed for free-rise profiling to the surface using self-buoyancy. (Photos7.7-1).

The location of the experiment is listed in Table 7.7-1 and the specification and serial number of the sensors are listed in Table 7.7-2. The data from SBE41CP, EXCELL and TSK-CTD were recorded on internal RAM and the data from SBE9plus were recorded on SBE17plusV2 SEARAM. All data were downloaded after the cast via serial interface.

(4) Preliminary result

Vertical profiles from SBE9plus (Fig. 7.7-1) and STP data of the difference between SBE41CP (S/N53) and SBE9plus at station 001 are shown in Fig. 7.7-2. Except for the thermocline depth (70-170m) and the bottom of the mixed layer, most of the temperatures and salinities are within 0.005 degree-C and 0.015 psu. In the thermocline, temperature and salinity differences exceeded 0.04 degree-C and 0.04 psu, respectively. SBE41CP (S/N54) is shown in Fig.7.7-3.In the thermocline temperatures difference are within 0.03 degree-C. Both SBE41CP has a 0.01 psu offset below the thermocline. For the TSK-CTD, except in the thermocline, most of the temperatures are within 0.005 degree-C. The salinity offset exceeded 0.04 psu; in the thermocline depth offset was decreased. The pressure difference between all sensors and SBE9plus were within +/- 5 dbar.

(5) Data archive

The data obtained in this experiment will be submitted to the DMO (Data Management Office) in JAMSTEC within 1 year after the cruise.

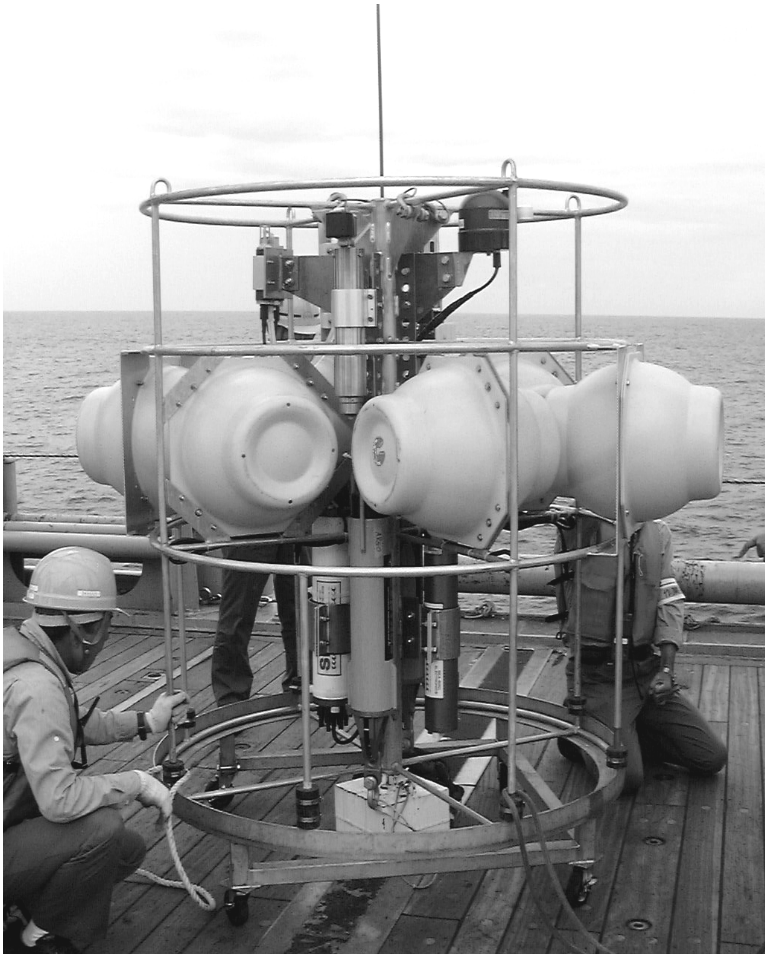


Photo. 7.7-1. Appearance of profiling frame and sensors

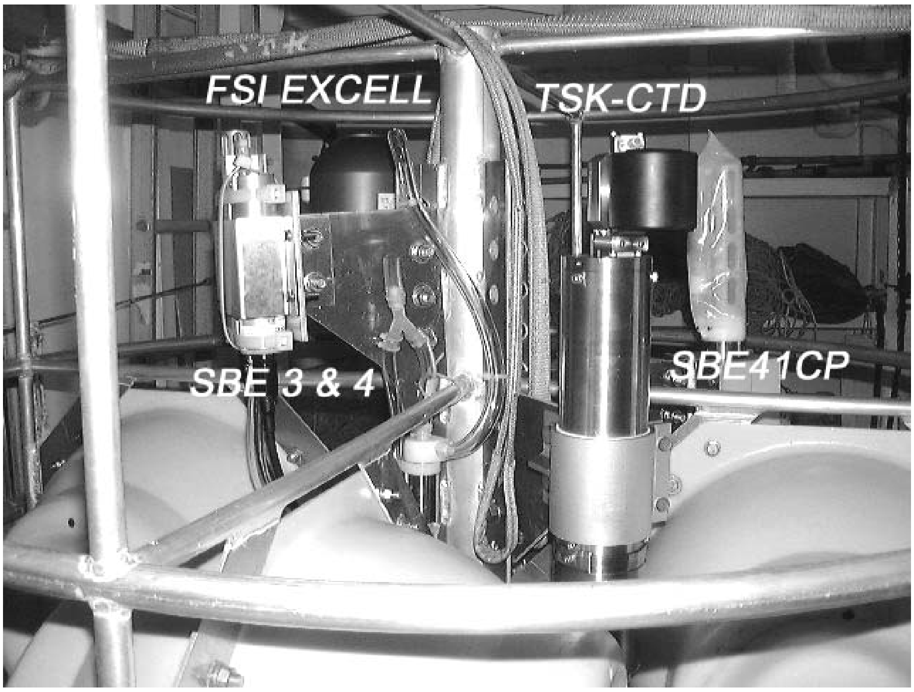


Photo.7.7-2. Appearance of target and reference sensors

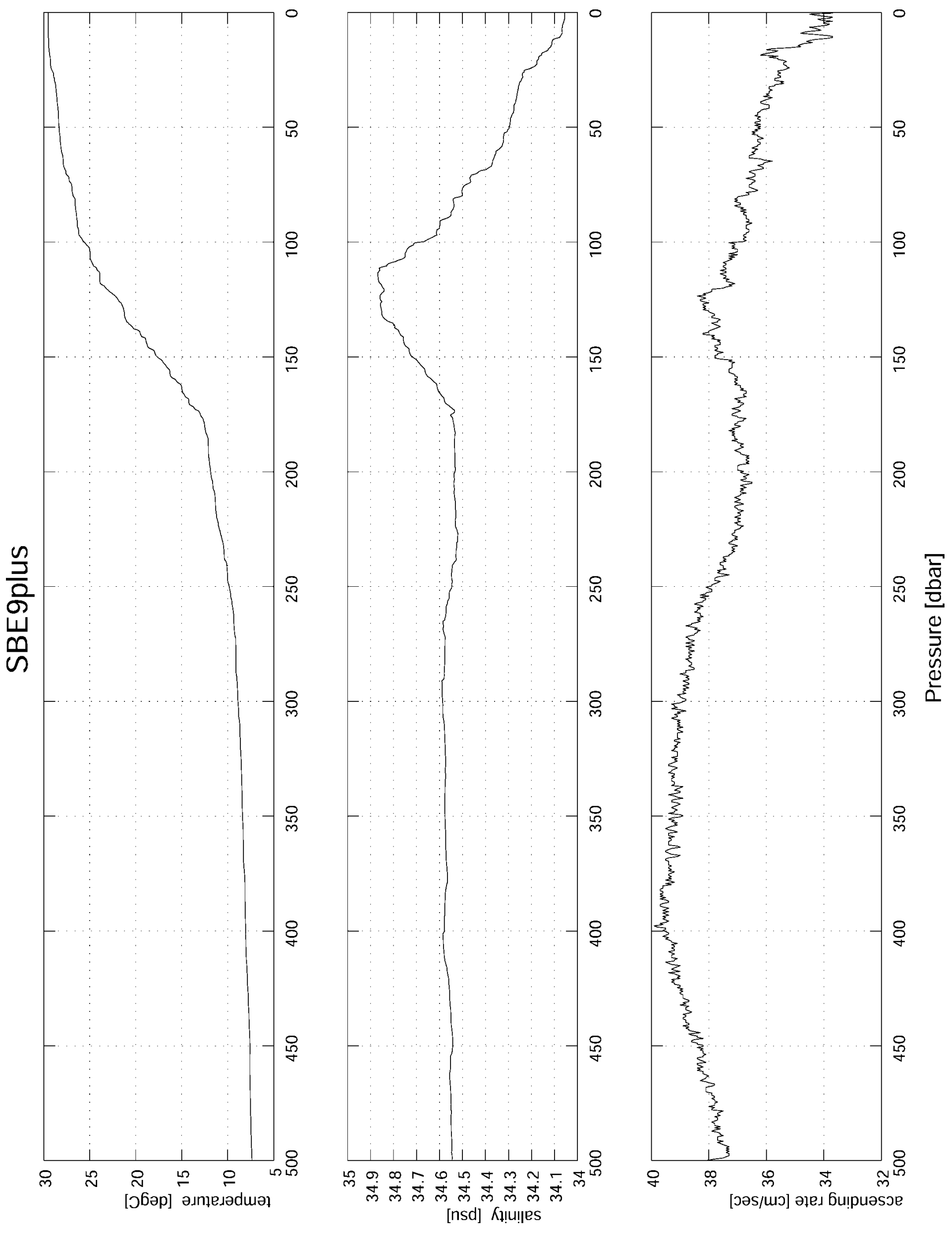


Fig.7.7-1Vertical profiles of temperature (upper) and salinity (middle) from the reference sensor. Vertical profile of ascending rate at station 001 (lower).

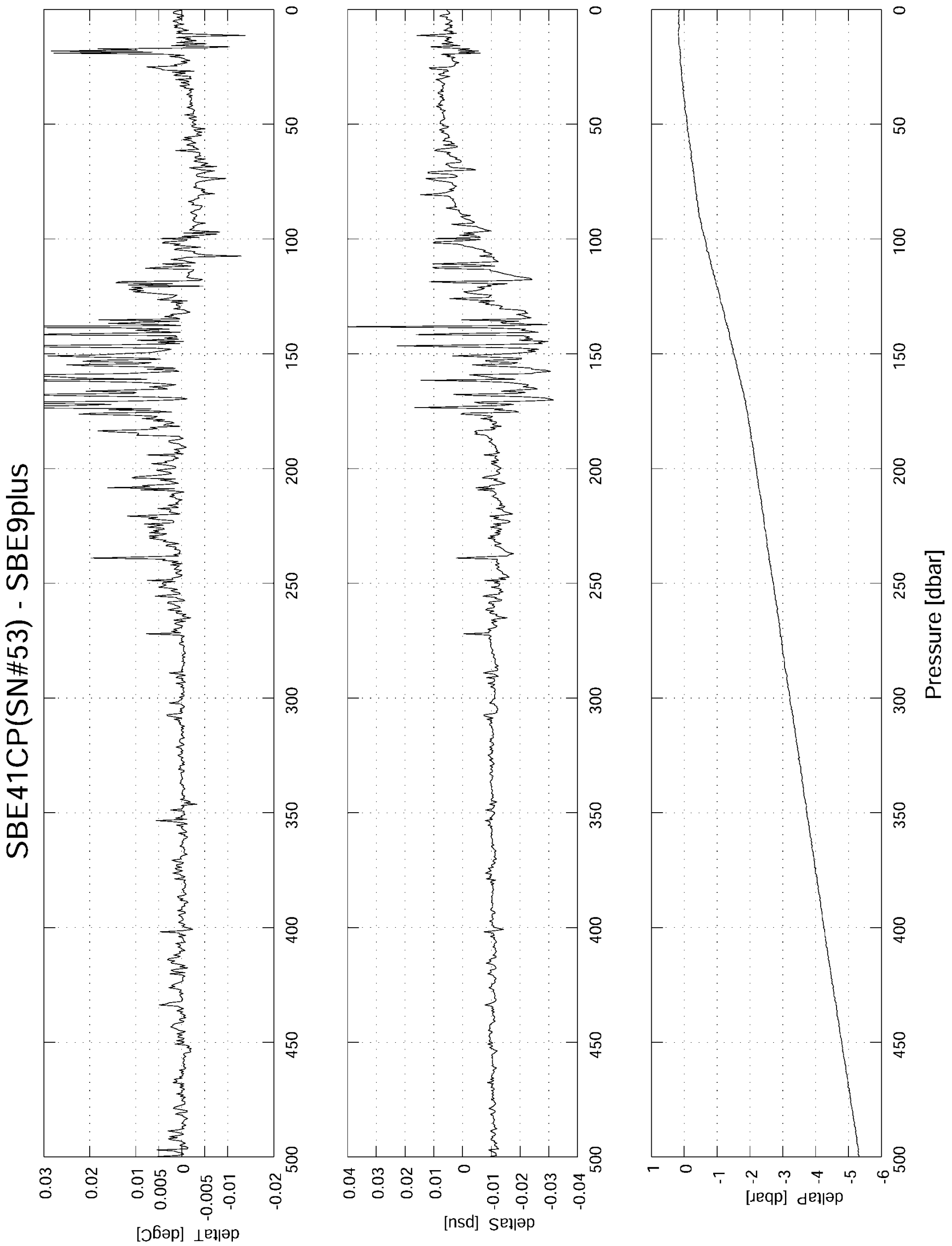


Fig.7.7-2Vertical profiles of temperature, salinity and pressure differences between SBE41CP (S/N53) and SBE9plus at station 001.

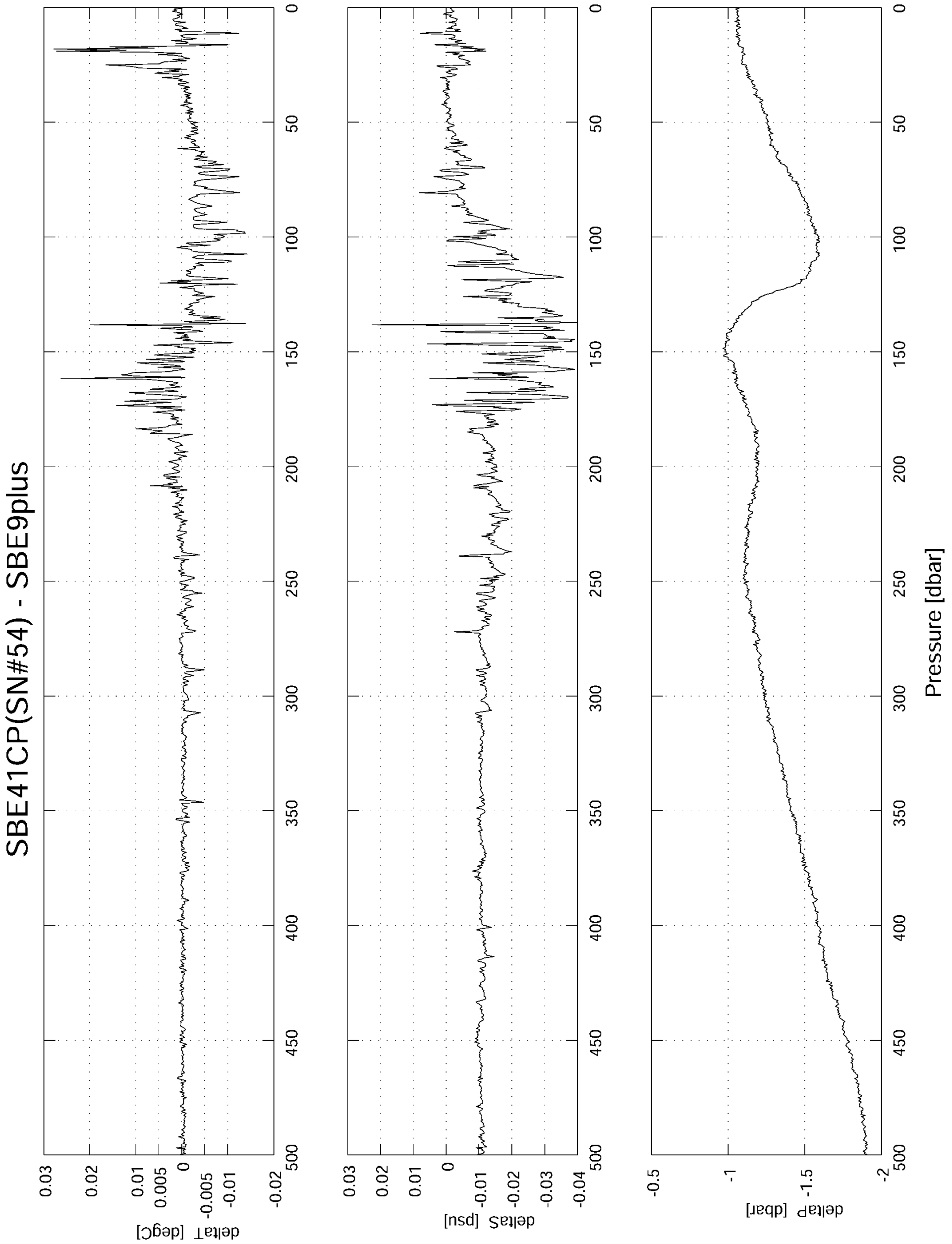


Fig.7.7-3Vertical profiles of temperature, salinity and pressure differences between SBE41CP (S/N54) and SBE9plus at station 001.

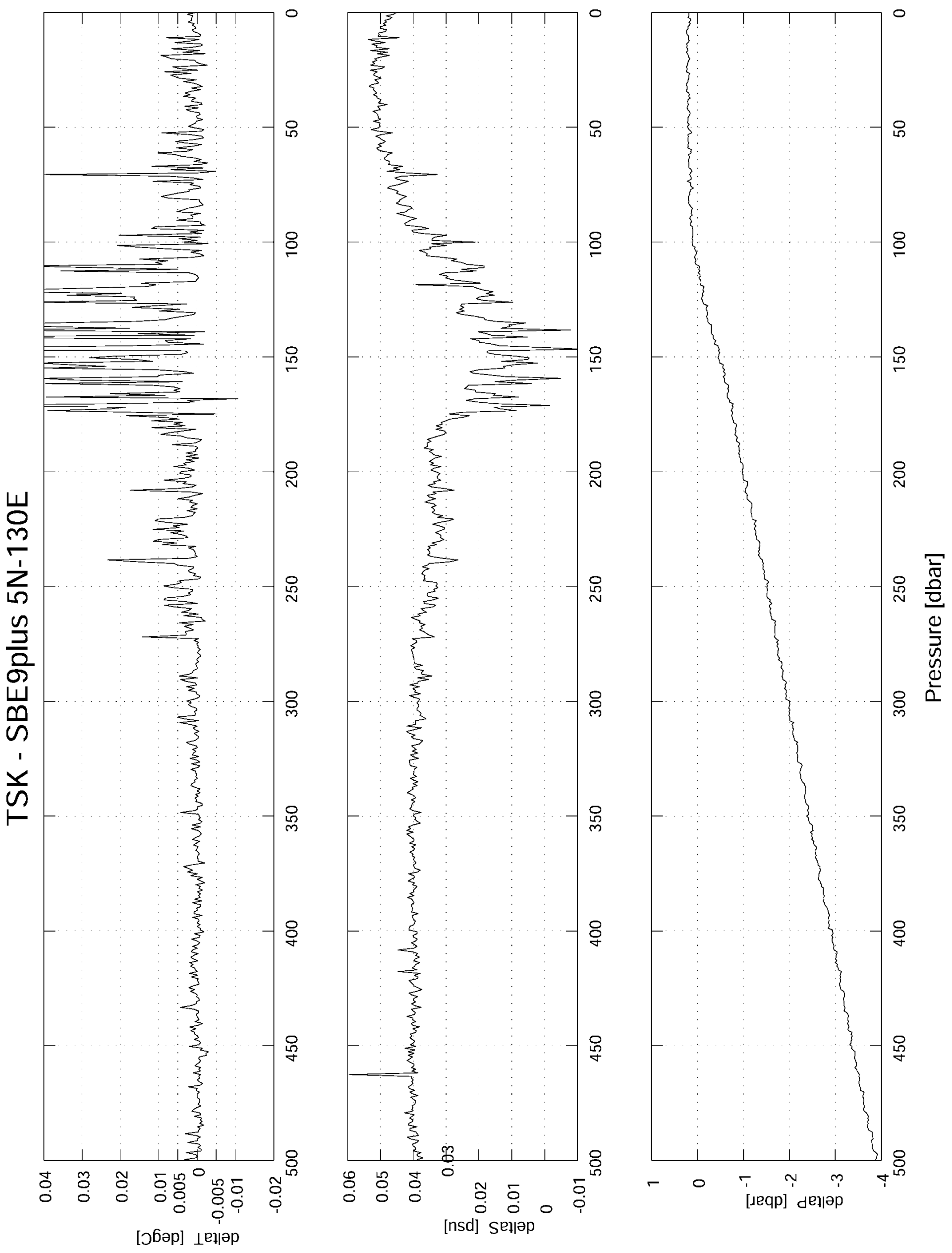


Fig.7.7-4Vertical profiles of temperature, salinity and pressure differences between TSK-CTD and SBE9plus at station 001.

Table 7.7-1. Station List

Station	Date and Time (UTC)	Position	Depth	Trim weight
001	Oct.8 01:05 - 02:48	5N, 130E	500	10 kg

Table 7.7-2. The spec and serial number of the sensors

Target sensor

	Conductivity sensor	S/N	Sampling rate
SBE41CP	Electrode	53,54	1.289 seconds
EXCELL-CTD	Inductive	1324	2.8 frames/second
TSK-CTD	Inductive		2 seconds

Reference sensor

SBE9plus (Sea-Bird Electronics, Inc.)

S/N 240

Pressure: Paroscientific Digiquarts sensor (S/N 43435)

Temperature: SBE3 [Thermister] (S/N 1207, calibrated on Nov. 18, 2000)

Conductivity: SBE4 [conductivity cell] (S/N 0960, calibrated on Aug. 8, 2001)

Data sampling rate: 24 frames/second

	Range	Resolution	Precision
Temperature	-2 - 32 degC	< 0.0002 degC	< +/- 0.0015 degC
Conductivity	0 – 70 mS/cm	< 0.0004 mS/cm	< +/- 0.003 mS/cm
Pressure	0 – 6500 dbar	< 0.06 dbar	< +/- 1 dbar

7.8 pCO_2/PCO_2 Measurement

(1) Personnel name and affiliation

Osamu Tsukamoto (Okayama University): Principal Investigator	not on board
Nobuyuki Momosaka (Okayama University of Science)	Leg 1
Takayuki Nakao (Okayama University of Science)	Leg 2

(2) Objective

<Leg.1>

Latitudinal distribution of pCO_2 and PCO_2 between Sekinehama and the equatorial station(2.33ºN, 137.55ºE).

Time variation of pCO_2 at the equatorial station(2.00ºN, 138.00ºE) and station(0.00ºN,138.00ºE).

Longitudinal distribution of pCO_2 and PCO_2 between station (00.48ºN, 133.00ºE) to the station(17.09ºN, 124.22ºE).

<Leg.2>

Longitudinal distribution of PCO_2 between Singapore (1.13ºN, 103.30ºE) to the station (4.10ºN, 90.00ºE).

Longitudinal distribution of pCO_2 and PCO_2 between station(4.49ºN, 90.00ºE) to the station (9.53ºN, 108.58ºE).

Latitudinal distribution of pCO_2 and PCO_2 between station(4.59ºN, 90.00ºE) to the station (5.00ºS, 91.00ºE).

(3) Parameters

Carbon dioxide in the sea water (pCO_2)

Carbon dioxide in the atmosphere (PCO_2)

(4) Methods

Carbon dioxide in the sea water and carbon dioxide in the atmosphere were measured using the measurement system which is made by the S-ONE company.

The present CO_2 instrument only requires a small amount of sea water sample to measure pCO_2. 500 ml sea water is enough to determine pCO_2.

It located in the sea surface laboratory on this ship.

Surface sea water was pumped up to the laboratory. Sample air was introduced from foremast.

We had measured from September 20 to November 4, 2001. We checked the system everyday.

Specification of the carbon dioxide measurement system was listed below.

Unit 1: CO_2 analyzer
- Model: LI-6252 LI-COR ,INC.
- Serial number: IR-62-286
- Measurement range: 0-5V

Unit 2: Gas mixing unit
- Model: SO96NL-T, S-ONE, INC.

Unit 3: Equilibrumeter
- Model: SO96NL-T, S-ONE, INC.

Unit 4: Data processing equipment (personal computer)

(5) Results

<Leg.1>

This term, the condition of the air pump was bad, and the PCO_2 could not be measured. Fig. 7.8.1 shows the latitudinal distribution of pCO_2 during Sekinehama(41.20ºN, 140.42ºE) to Sta. (2.33ºN, 137.55ºE), from September 20 to September 30, 2001. pCO_2 value was about 320ppmv around

Sekinehama. Then, pCO_2 value(High value: 360ppmv) increase in 41ºN – 30ºN , as R/V Mirai went south. But, there was not change from 30ºN to equator.

Fig .7.8.2 shows the time variation of pCO_2 from October 1 to October 5, 2001 at the equatorial sta. (2.00ºN, 138.00ºE) and sta. (0.00ºN, 138.00ºE). The raw pCO_2 values show that low value in nighttime and high value in daylight hours.

Fig. 7.8.3 shows the longitudinal distribution of pCO_2 during Sta. (00.48ºN, 133.00ºE) to the Sta. (17.09ºN, 124.22ºE) from October 6 to October 10, 2001. pCO_2 value was about 360ppmv around the Sta. (00.48ºN, 133.00ºE). pCO_2 value became about 350ppmv as R/V Mirai went to the west. And, the phenomenon that pCO_2 became 330ppmv around 130ºE was seen.

<Leg.2>

Fig. 7.8.4 shows the longitudinal distribution of PCO_2 during Singapore (1.13ºN, 103.30ºE) to Sta. (4.10ºN, 90.00ºE), from October 18 to October 21, 2001. PCO_2 value was changed to range of 370-390ppmv in this term. Fig .7.8.5 shows the latitudinal distribution of pCO_2 and PCO_2 during Sta. (4.59ºN, 90.00ºE) to the Sta. (5.00ºS, 91.00ºE) from October 21 to October 24, 2001. This sea area is found to be a CO_2 sink except for around equatorial sea. Fig. 7.8.6 shows the longitudinal distribution of pCO_2 and PCO_2 from October 24 to October 29, 2001 during sta. (4.49ºN, 90.00ºE) and sta. (9.53ºN, 108.58ºE). This sea area is found to be a CO_2 sink.

(6) Data archive

The raw data were stored on a magnetic optical disk which will be kept at Data Management Office, JAMSTEC. The raw data were corrected and will be published.

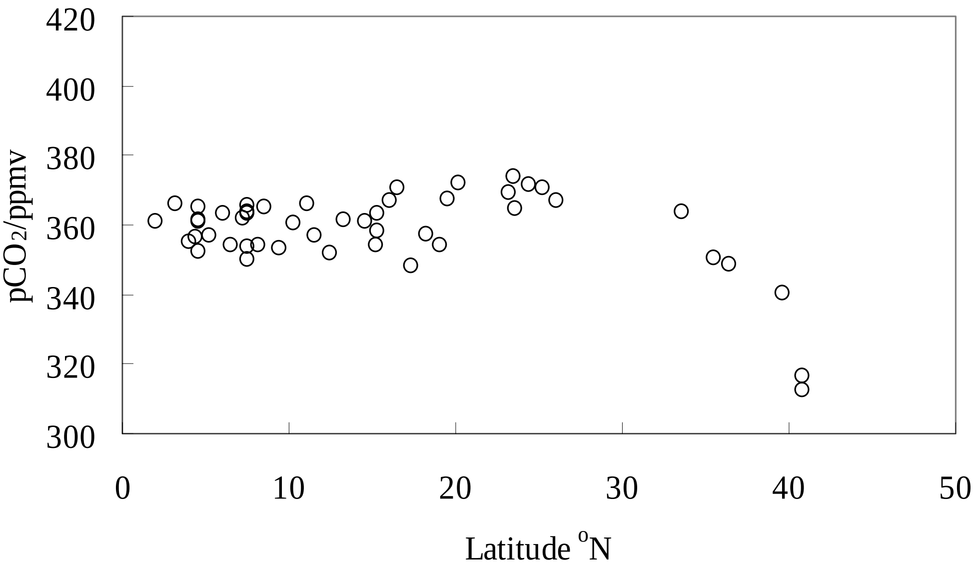


Fig.7.8.1 Latitudinal distribution of carbon dioxide in the sea water (pCO_2) during Sekinehama to the Sta. (2.33ºN, 137.55ºE) from September 20 to September 30, 2001.

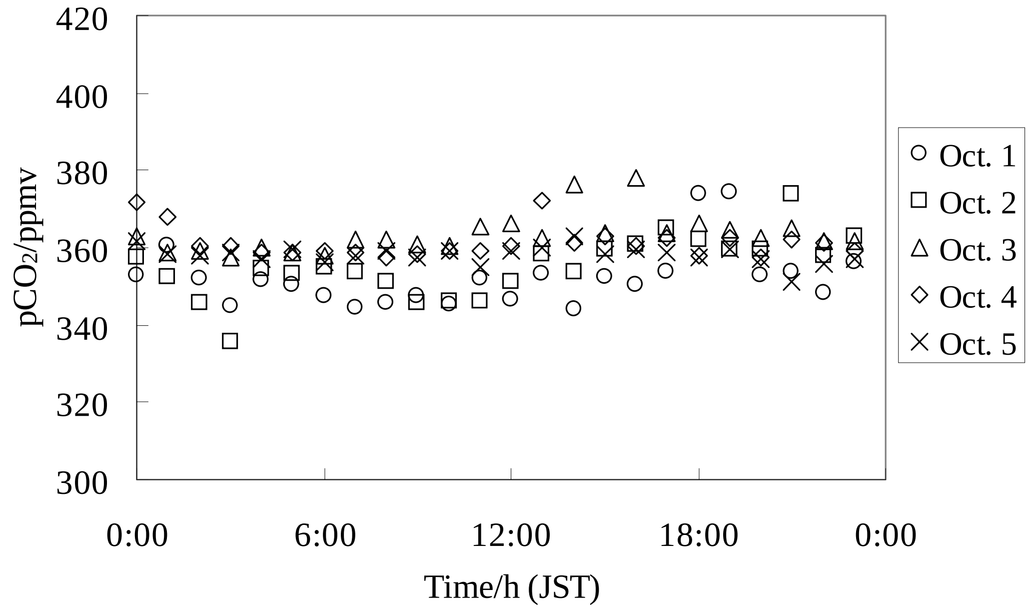


Fig.7.8.2 Time variation of carbon dioxide in the sea water (pCO_2) from October 1 to October 5, 2001 at the Sta. (2.00°N, 138.00°E) and Sta. (0.00°N, 138.00°E).

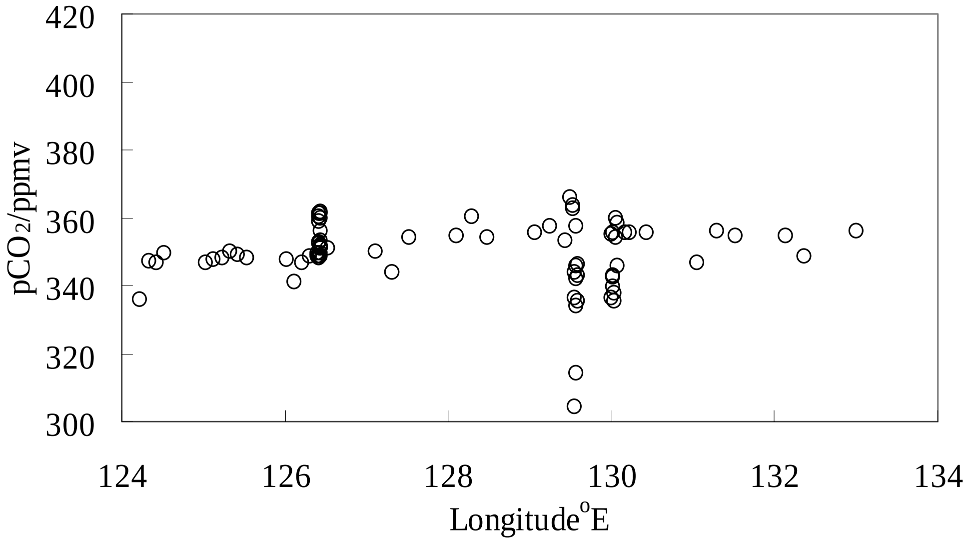


Fig.7.8.3 Longitudinal distribution of carbon dioxide in the sea water (pCO_2) during Sta. (00.48°N, 133.00°E) to the Sta. (17.09°N, 124.22°E) from October 6 to October 10, 2001.

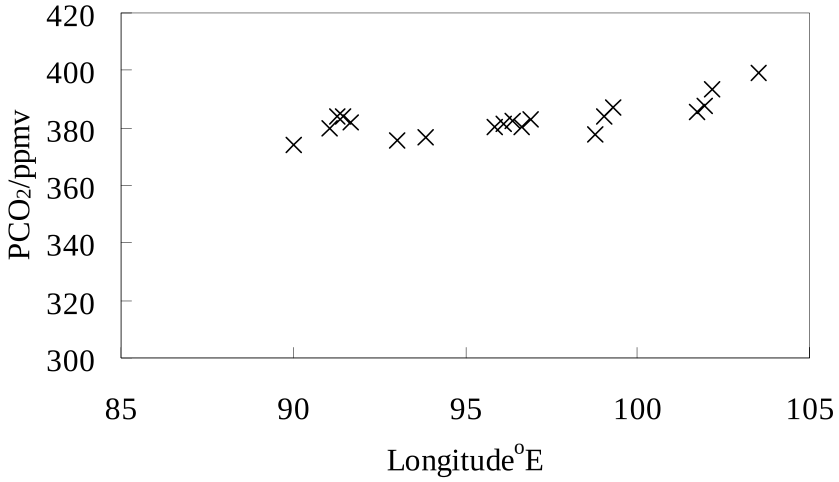


Fig.7.8.4 Longitudinal distribution of PCO_2 during Singapore (1.13°N, 103.30°E) to Sta. (4.10°N, 90.00°E), from October 18 to October 21, 2001. ×PCO_2

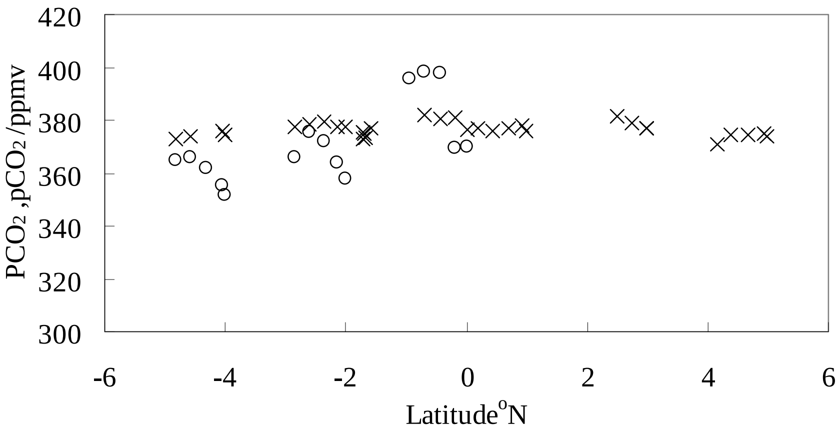


Fig.7.8.5 Latitudinal distribution of pCO_2 and PCO_2 during Sta. (4.59°N, 90.00°E) to the Sta. (5.00°S, 91.00°E) from October 21 to October 24, 2001. ○pCO_2, ×PCO_2

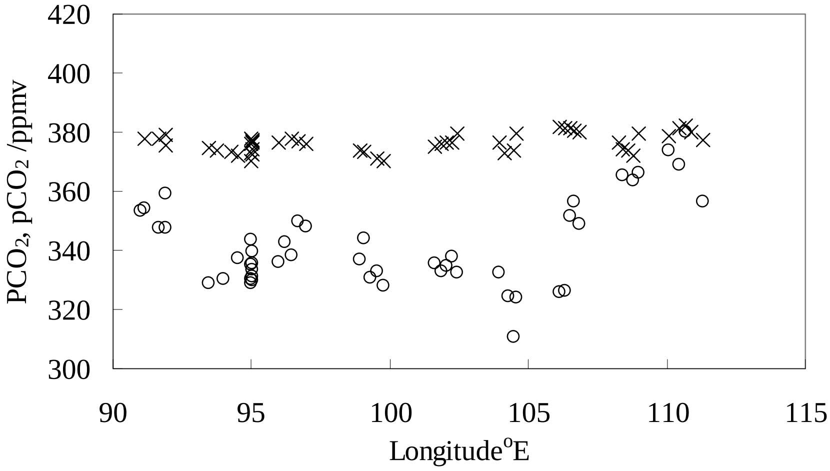


Fig.7.8.6 longitudinal distribution of pCO_2 and PCO_2 during October 24 to October 29, 2001 from sta. (4.49°N, 90.00°E) to sta. (9.53°N, 108.58°E).
○pCO_2, ×PCO_2

8 Ship's handling for buoy operation

8.1 Ship’s handling for deployment TRITON buoys and ADCP mooring system

(1) Personnel

Masaharu Akamine, Master of R/V MIRAI

And ship’s crew

(2) Objectives

In order to deploy a TRITON buoy and an ADCP system to the demanded depth of water correctly, it is necessary to know a distance required for deploying them. It aims at investigating the time required, a adequate speed, the external force of the wind or the current and the distance backed to the time that a anchor arrives at seabed in order to draw the approximation formula for computing the distance required.

(3) Observation parameters

- Ship’s position, course, speed
- Directions of the wind and the current, velocities of the wind and the current
- Vectors of the wind and the current, the resultant force
- Working hours
- Position of sinker

(4) Methods

(4.1) Measurement of the actual ship-movement

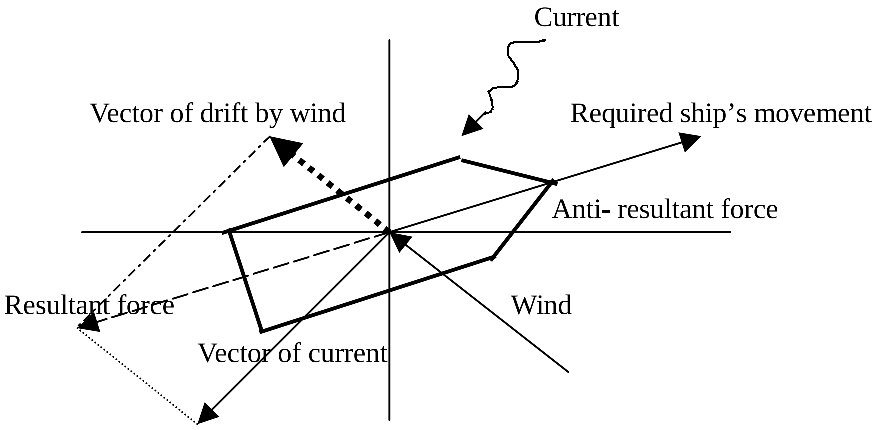
Measurement of the ship-movement at engine stopped is executed by a set-drift before the deployment TRITON buoy in order to make in advance a comparison between reality and expectation. A direction and a velocity of the ship-movement in the external force influence is measured by a radio navigation device “ Sains” assembled by Sena Co., Ltd. Japan and a Doppler sonar “DS-30” assembled by FURUNO Electric Co., Ltd. Japan.

(4.2) Measurement of the wind and the current

The wind direction and speed are measured by KOAC-7800 weather data processor and sensors assembled by Koshin Denki.

The current direction and speed are continuously measured by a Doppler sonar “DS-30” installed at the bottom of the ship.

The vector resultant force is calculated by the wind and the current data in real-time according to the following vector diagram. The wind is transformed into the vector of the drift using an approximate formula given by some hydrodynamic tests.



(4.3) Ship's speed

According to the results measured in past voyages, on the deploy of the TRITON buoy, the ship's speed is set up so as to keep her speed on 1.5~ 3 knots at ship's through-the-water while the nylon ropes has let out, to keep her speed on 1 ~ 2 knots at ship's through-the-water while the cable has paid out and the recovery buoys/releasers/sinker have connected. In order to avoid the occurrence of their kink accident and to maintain a safety of the works, an average speed through all work around 1.5-2 knots at ship's through-the-water becomes one aim.

On the deploy of ADCP mooring system, the speed is accepted a standard that is faster than the TRITON.

(4.4) Ship's course

The ship's course is expected by the vector calculation of the wind-drift and the current as indicated in (4.2), making reference to the data of the set-drift carried out before the deploying operation of the TRITON buoys/the ADCP mooring systems.

If there is a great difference between the direction of the wind and that of the current, the selection of her course shall be attached importance to a bigger one of the vector value and shall be in need of the direction of depth contour in the bathymetric map.

(4.4) Working hours for the deployment TRITON buoy/ADCP mooring systems

The time that the ship needed for each work is investigated taking data in past voyages into account.

(4.5) Tension of the wire cable and the nylon ropes

The distance of the TRITON buoy and the ship's stern is continuously measured by her radar installed in the center of the ship (about 87 meters from her stern).

The tension of the cable/the ropes streamed astern may be secondarily checked as compared the distance of radar with the length of the cable/ropes actually let out from her stern.

The control of her speed is done so as not to increase much the difference in length between the two, checking the above-mentioned data and the cable/ropes tension measurement by the stern that is a primary means.

(4.5) Decision of the anchored position

The position of the sinker arrived at the seabed is fixed with a radio navigation device, an acoustic navigation device and the ship's radars.

The radio navigation device: "Sains" assembled by Sena Co., Ltd. Japan.

The acoustic navigation device: "SSBL processor (13kHz)" assembled by Oki Electric Co. Ltd. Japan.

The ship's radar: "JMA9000 X band" and "JMA 9000 S band " assembled by JRC Ltd.
"MM950 X & S band" assembled by Consilium Selesmar, Italy.

(5) Results

(5.1) Ship's speed

TRITON buoy

The results are shown in Table 8.1-1, Fig.8.1-1.

By the results of this time, the average speed of the deploy buoy works was around 2 knots at ship's through-the-water with all the buoy works from TRITON buoy No.1 to No.8.

The speed shown in Fig.8.1-1 has two distinct characteristics, i.e., when having let out the cable, the speed is fixed, and when having let out the rope, the reduction in the speed is seen for connection of the ropes

On the past voyages, the experiment that finds out the optimum cable/ropes tension was conducted using the CTD sensor that were attached on the cable at 300 meters and 750 meters from the surface float. The depth of CTD sensor were measured and the catenary curve was found. The experiment result at this time becomes one standard as follows.

Events	The difference of the radar-distance and the actual length of the cable/ropes streamed astern
While paying out cable	Within 200 m
When setting releaser	Within 650 m

The measurement point of the cable is a time of the connection part of the wire cable and nylon rope passing the ship's stern.

The measured values on this voyage are within the limits of the standard except for T-06. About T-06, since the towing was performed, finally it fitted within the limits of this.

Unit: meter

TRITON NO.	T-3	T-4	T-5	T-6	T-7	T-8	T-9	Standard
Length of cable	750	750	750	750	750	750	750	
Radar's distance	655	655	640	620	675	675	620	
Difference	95	95	110	130	75	75	130	200
Length to releaser	3300	4145	4235	4230	4305	4700	4850	
Radar's distance	2870	3520	3960	3410	3700	4280	4360	
Difference	430	625	275	820	605	420	490	650

ADCP mooring system

The result is shown in Table 8.1-2.

In the ADCP mooring system, the mean speed of four deployment works was 2.6 knots at ship's through-the-water.

(5.2) Ship's course

TRITON buoy

The results are shown in Table 8.1-3.

The ship's course was adjusted so that the ship could cope with the external force influence to change variously, leading the wire cable and the nylon ropes right astern.

By the results of this time, about the course of the ship, a big difference is not recognized between expectation and the reality.

ADCP mooring system

The results are shown in Table 8.1-4.

Although the big difference had arisen between expectation and the actual result about 0-138E, it gave top priority to the direction of depth contour in the bathymetric map since the seabed of this site was complicated geographical feature.

About others, a big difference is not recognized between expectation and the reality.

(5.3) Working hours

TRITON buoy

The results are shown in Table 8.1-1, Fig.8.1-2.

Except time paying out the nylon ropes, the times that the ship needed for each work show to be fixed nearly.

The mean time spent in each work is as follows.

The time that spent in paying out a wire cable 1 hour 13 minutes

The time that spent in setting recovery buoys, releasers and a sinker 18 minutes

(Including 11 minutes spent excessively for towing a sinker) Total 1 hour 31 minutes

The numerical value that divided the length of total nylon ropes by Y of the following formula is the time that spent in paying out nylon ropes

Y = 0.5 x Length of total nylon ropes + 1600 (by recurrence type to lead from the results shown in Fig. 8.1-2)

ADCP mooring system

The results are shown in Table 8.1-2,Fig.8.1-3.

The times that the ship needed for each work show to be fixed nearly.

The mean time spent in each work is as follows.

The time spent on paying out a wire cable		13 minutes
The time spent on paying out kevler ropes		40 minutes
The time spent on setting glass balls, releasers		3 minutes
The time spent on setting a sinker		9 minutes
The time spent on towing a sinker		20 minutes
	Total	1 hour 25 minutes

The numerical value that divided the length of total kevler ropes by Y of the following formula is the time that spent in paying out kevler ropes

Y = 0.52 x Length of total kevler ropes + 3050 (by recurrence type to lead from the results shown in Fig. 8.1-3)

(5.4) Sinker's position

TRITON buoy/ADCP mooring system

The difference between position of **the sinker dropped** and that of **the sinker arrived at the seabed** were shown in Table 8.1-5. In the result, the mean horizontal distance between both occupied about 12 % of depth of the water. An approximate formula is given with these past records in Table 8.1-5. This distance shall be added to the necessary distance for the deployment of TRITON buoy in order to bring the sinker up on the site in the required depth.

Table 8.1-5 was shown that the direction from the position of **the sinker dropped** to the position of **the sinker arrived at the seabed** was nearly the same course as the ship was finally towing the sinker in all cases.

In case of the ADCP mooring system, position of the sinker was fixed at a point that the sinker had been dropped because weight of the sinker for the whole system was heavy as compared with the TRITON buoy.

(5.5) Required depth

The depth of water of the position in which the TRITON buoy/ADCP mooring system was actually moored with demanded depth of water are shown below.

TRITON buoy	No.	Actual	Demanded	Difference (%)
	T-03	3353 m	3350 m	3 m (0.09)
	T-04	4133	4120	13 m (0.3)
	T-05	4335	4344	9 m (0.2)

T-06	4206	4216	10 m (0.2)
T-07	4428	4410	18 m (0.4)
T-08	4697	4685	12 m (0.3)
T-09	5009 m	5005 m	4 m (0.008)

ADCP mooring system

2N-138E	4681 m	4710m	29 m (0.6)
0 - 138E	3947	3930	17 m (0.4)
7N-127E	3441	3440	1 m (0.03)
0 - 90E	4399	4401	2 m (0.04)
			A ratio to actual

The depth of water was measured by a SEA-BEAM 2100 with depth accuracy within 0.5%. Except for 2N-138E ADCP mooring system, all were within the depth accuracy.

About 2N-138E ADCP mooring system, although the measurement of near the planned mooring site was carried out, a place deeper than the present depth of water was not able to be found.

(6) Distance for Deployment TRITON buoy

It is required that the TRITON with a sea surface buoy is moored to a more exact position. Therefore this paragraph describes the TRITON buoy.

All of the ship's movement for the deploying operation of the buoy was in existence within required limits of each operation as stated above.

An approximate formula for the distance of the deployment TRITON buoy is derived from the actual data indicated in Table 8.1-1, Table 8.1-3,Table 8.1-5 and Fig. 8.1-1, Fig.8.1-2.

It is shown as follows:

$$D = (U1 - Vw) \times k1 + (U2 - Vw) \times L / k2 + S$$

Where,

D: Distance of the deployment TRITON buoy, not included distance for towing the sinker. (Unit: mile)

U1: The average speed in the ship's through-the-water while the cable being paid out, the recovery buoys and the releasers being set, and the sinker being stood by. (Unit: knot)
1~2 knots is given by the past records as indicated in (4.3).

U2: The average speed in the ship's through-the-water while the nylon ropes being paid out. (Unit: knot)

1.5~3 knots is given by the past records as indicated in (4.3).

Vw: The average quantity of the current influences a forward movement of the ship. (Unit: knot)

The value is calculated by a formula to multiple a cosine of an angle A in the current's speed.

Where, A= the angle that the ship's course line intersects the direction line of the current.

On this voyage, it is as follows when comparison with calculation and an actual result is performed. There is almost no difference of both.

Buoy No.	Actual	Calculation
T-03	- 0.2 knots	- 0.2 knots
T-04	- 0.4	- 0.3
T-05	- 0.8	- 0.8
T-06	- 1.0	- 0.7
T-07	0.2	0.3
T-08	- 0.7	- 0.6
T-09	- 0.4	- 0.3

L: Length of all the nylon ropes except that of the nylon ropes between the recovery buoys. (Unit: meter)

k1: All the working hours for the cable being paid out, the recovery buoys and the releasers being set, and the sinker being stood by except the sinker being towed. (Unit: hour)

(k1=1hour and 20 minutes is transformed to 1.33 by the decimal system. This value is given from the past records in Table 8.1-1)

k2: The average length of the nylon ropes paid out per hour. (Unit: meter)

(k2=0.5 x length of all nylon ropes + 1600. This value is given by a regression through the data shown in Fig. 8.1-2)

S: The distance between the position of the sinker dropped and the position of the sinker arrived at the seabed. (Unit: meter)

(The distance between two points=0.1 x the required depth + 141)

This value is given by the approximate formula as indicated in Table 8.1-5.

<u>What is necessary is just to maneuver as one standard, so that the ship may come to the buoy mooring site point when attaching the releaser exactly. Namely a sailing distance to the sinker dropped position from the mooring point is the distance to which the sinker returns.</u>

(7) Data archive

All data will be archived on board.

(8) Remarks

In this voyage, the effect of the swell among the external force was big more than the imagination. Especially it was felt when there were few winds and streams. Although it can observe easily about the direction of the swell, it is a future research subject to get to know the degree that the swell gives to the ship's maneuver quantitatively.

About the deployment of the TRITON buoy/ the ADCP mooring system, it was enable to draw the pattern approximation formula through an old actual result. In order to make this approximation formula into what has more high accuracy, a lot of data are required. We want to also endeavor after collection of data through experience from now on.

Table 8.1-1 SUMMARY OF WORKING TIME FOR DEPLOYMENT TRITON BUOY ON MR01-K05

TRITON No.		T-03	T-04	T-05	T-06	T-07	T-08	T-09	MR01-K02	
Required depth(m)		3350	4120	4344	4216	4410	4685	5020	-	
Location		8N,137E	5N,137E	2N,138E	0,138E	2N,130E	1.5S,90E	5S,95E	-	
Works	Date	28-Sep	29-Sep	30-Sep	3-Oct	7-Oct	23-Oct	26-Oct	14-Mar	
Com'ced		8:39	8:14	8:16	8:10	8:09	8:42	8:11	8:00	
Buoy into sea		8:50	8:28	8:28	8:22	8:19	8:54	8:22	8:10	
Set 250m Sensor		9:09	9:43	8:51	8:44	8:44	8:40	8:42	8:20	
Set 500m Sensor		9:19	9:55	9:04	8:55	9:05	8:51	8:54	8:23	
Set 750m Sensor		9:32	10:05	9:18	9:12	9:17	10:01	9:12	8:33	
Pay out Nylon Rope		9:49	10:21	9:37	9:13	9:38	10:18	9:27	9:12	
Set Recovery Buoy		10:12	10:46	10:00	9:34	10:00	10:36	9:48	9:27	
Set Recovery Buoy		10:21	10:53	10:09	9:41	10:07	10:43	9:56	9:37	
Pay out Nylon Rope		10:22	10:54	10:10	9:42	10:08	10:44	9:57	9:41	
Set Releaser		10:56	11:35	10:53	10:23	10:45	11:28	10:51	10:06	
S/B sinker		11:03	11:41	11:00	10:34	10:52	11:35	10:57	10:07	
Let go sinker		11:04	11:42	11:01	10:42	10:53	11:36	10:58	10:15	Average
	for fairing etc.		0:50			0:15	0:26			
H	for cable	1:10	1:17	1:21	1:03	1:14	1:10	1:16	1:12	**1:12**
o	for ropes	0:57	1:06	1:06	1:02	0:59	1:02	1:15	0:40	**1:00**
u	for recovery B'y	0:10	0:08	0:10	0:08	0:08	0:08	0:09	0:14	**0:09**
r	for sinker	0:08	0:07	0:08	0:19	0:08	0:08	0:07	0:09	**0:09**
Total		2:25	3:28	2:45	2:32	2:44	2:54	2:47	2:15	**2:32**
Length of all ropes(m		**2330**	**3185**	**3275**	**3270**	**3345**	**3740**	**3890**	**1997**	**3,129**
Length of ropes(m/h		2,453	2,895	2,977	3,165	3,402	3,619	3,112	2,996	3,084
D	for cable (mile)	1.84	2.89	1.3	0.94	2.71	2.05	1.55	2.29	1.95
I	for ropes (mile)	1.49	1.9	1.74	1.54	2.34	2.2	2.14	1.68	1.88
s	for recovery (mile	0.18	0.17	0.11	0.1	0.22	0.12	0.15	0.39	0.18
t	for sinker (mile)	0.14	0.11	0.17	0.39	0.25	0.16	0.17	0.36	0.22
Total (mile)		3.65	5.07	3.32	2.97	5.52	4.53	4.01	4.72	**4.22**
S	for cable (knot)	1.6	1.4	1.0	0.9	1.8	1.3	1.2	1.9	1.38
p	for ropes (knot)	1.6	1.7	1.6	1.5	2.4	2.1	1.7	2.5	1.9
ee	for recovery(knot	1.1	1.3	0.7	0.8	1.7	0.9	1.0	1.7	1.2
d	for sinker (knot)	1.1	0.9	1.3	1.2	1.9	1.2	1.5	2.4	1.4
Av. OG speed (knot)		1.5	1.5	1.2	1.2	2.0	1.6	1.4	2.1	**1.7**
Av. Log speed(knot)		1.7	1.9	2	2.2	1.8	2.3	1.8	2.5	2.0

Remarks; As for TRITON #T04, Hours for cable exclude 50 minutes consumed in surplus for installing the fairing (250 m).
As for TRITON #T06, Hours for sinker include 10 minutes consumed in surplus for towing a sinker.
As for TRITON #T07, Hours for cable exclude 15 minutes consumed in surplus for repairing the sensor.
As for TRITON #T08, Hours for cable exclude 26 minutes consumed in surplus for installing the fairing (150 m).

Table 8.1-2 SUMMARY OF WORKING TIME FOR DEPLOYMENT ADCP MOORING ON MR01-K05

ADCP No.		1	2	3	4	
Location		2N,138E	0, 138E	7N,127E	0,90E	
Required depth (m)		4710	3930	3440	4401	
Works	Date	2-Oct	5-Oct	9-Oct	22-Oct	
Com'ced		8:04	12:27	12:59	17:12	
ADCP into sea		8:06	12:28	13:00	17:15	
ABS Buoy into sea		8:08	12:32	13:05	17:18	
Number of sensor		0	1	2	0	
S/N into sea		8:14	12:45	13:13	17:24	
Glass Ball into sea		9:01	13:23	13:48	18:07	
Releaser into sea		9:04	13:26	13:51	18:10	
S/B sinker		9:24	13:26	14:11	18:10	
Let go sinker		9:33	13:34	14:20	18:21	Average
H	for wire cables	0:10	0:18	0:14	0:12	**0:13**
o	for kevler ropes	0:47	0:38	0:35	0:43	**0:40**
u	for releaser	0:03	0:03	0:03	0:03	**0:03**
r	for towing	0:20	0:00	0:20	0:00	**0:20**
	for sinker	0:09	0:08	0:09	0:11	**0:09**
Total		1:29	1:07	1:21	1:09	**1:26**
Length of system(m)		4377.4	3572.1	3092.9	3965	**3,751.9**
Length of all ropes(m)		3982	2960	2500	3500	3,236
Length of ropes(m/h)		5,083	4,674	4,286	4,884	4,764
D	for cable (mile)	0.21	0.58	0.16	0.24	0.30
I	for ropes (mile)	1.94	1.99	1.25	1.8	1.75
s	for releaser(mile)	0.02	0.02	0.02	0.02	0.02
t	for towing (mile)	0.47	0	0.7	0	0.59
.	for sinker (mile)	0.23	0.32	0.26	0.33	0.29
		2.87	2.91	2.39	2.39	2.93
S	for cable (knot)	1.3	1.9	0.7	1.2	1.3
p	for ropes (knot)	2.5	3.1	2.1	2.5	2.6
ee	for releaser(knot)	0.4	0.4	0.4	0.4	0.4
d	for sinker (knot)	1.4	2.4	2.0	1.8	1.9
Av. OG speed (knot)		1.9	2.6	1.8	2.1	2.0
Av. Log speed(knot)		2.6	2.9	3.3	2.5	2.8

Table 8.1-3 SUMMARY OF SHIP'S HANDLING FOR DEPLOYING TRITON BUOY ON MR01-K05

			Course			Speed			Deploy dist			Wind		Current		Vector				Required	Working
No.	Location	Date	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Direct.	Velocity	Direct.	Velocity	Direct.	speed	C.Co.	C.C.F.	Depth(Actual)	hours
T3	8N,137E	28-Sep	225	224	1	1.5	1.5	-0.0	3.8	3.7	0.1	200	2	60	0.2	12	0.5	224	-0.2	3350(3353)	2:25
T4	5N,137E	29-Sep	90	90	0	1.4	1.5	-0.0	5	5.1	-0.0	60	7	300	0.3	10	1.2	85	-0.3	4120(4133)	3:28
T5	2N,138E	30-Sep	280	274	6	1.2	1.2	-0.0	3.3	3.3	-0.0	90	4	95	0.8	29	0.3	294	-0.8	4344(4335)	2:45
T6	0,138E	3-Oct	100	100	0	1.3	1.2	0.1	2.9	3	-0.0	270	2	290	0.7	39	0.5	124	-0.7	4216(4206)	2:32
T7	2N,130E	7-Oct	225	225	0	2.0	2.0	-0.0	5	5.5	-0.5	210	7.5	240	0.3	-9	0.7	209	0.3	4410(4428)	2:44
T8	5S,156E	23-Oct	340	340	0	1.4	1.6	-0.2	4.9	4.5	0.3	150	5	130	0.7	-88	0.2	237	-0.6	4685(4697)	2:54
T9	5S,95E	15-Mar	300	297	3	1.4	1.4	-0.0	3.9	4	-0.1	330	5.5	100	0.3	-14	1.0	301	-0.3	5005(5009)	2:47
Unit			deg.	deg.	deg.	knot	knot	knot	mile	mile	mile	deg.	m/s	deg.	Knot	deg.	knot	deg.	knot	meter	Hours

Remarks: Vector means the resultant force of the wind-drift and the current. Exp.=Expectation, Act.=Actual, Diff.=difference, The working hours means the actual hours for all the work including the work for towing the sinker, Dist.=Distance, Direct.=Direction, C.CO=Calculation Course, deg.=degree. C.C.F.=Component of current force.The course is shown on the course made good basis and the speed is on her over the ground basis.

As for TRITON No.T4, it took the excessive time for 50 minutes to install fairings in the range of 250 meters of the wire cable so that the ship ran to 1.2 miles in surplus compared with a usual distance.
As for TRITON No.T6, it took the excessive time for 10 minutes for towing the sinker.
As for TRITON No.T7, it took the excessive time for 15 minutes for repair of the sensor, therefore 0.5 miles of excessive distance occurred.
As for TRITON No.T8, the ship did 0.6 miles of an extra distance since it took the excessive time for 26 minutes to install fairings in the range of 150 meters of the wire cable.

An approximation for finding the value of the necessary distance for deploying the TRITON buoy

Required depth ? (unit:meter)	5020		
Length of all the nylon ropes ? (unit:meter)	3890	Speed is given by the" C.C.F "value in the above table?	-0.3
Neccesary distance for deploying a buoy (unit:mile)	**4.0**	Estimated average log speed for deploying a buoy (unit:knot)	**1.5**

The above mentioned value in square brackets is one for location 5S,95E as an example.

Table 8.1-4 SUMMARY OF SHIP'S HANDLING FOR DEPLOYING ADCP MOORING ON MR01-K05

			Course			Speed			Deploy dist			Wind		Current		Vector				Required	Working
No.	Location	Date	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Exp.	Act.	Diff.	Direct.	Velocity	Direct.	Velocity	Direct.	speed	C.Co.	C.C.F.	Depth(Actual)	hours
1	2N,138E	2-Oct	290	288	2	1.8	1.9	-0.1	2.7	2.9	-0.2	310	2	100	0.7	-14	1.0	285	-0.7	4710(4681)	1:29
2	0,138E	5-Oct	70	69	1	2.1	2.6	-0.4	2.9	2.9	0.0	240	6	310	0.7	-47	0.9	187	-0.4	3930(3947)	1:07
3	7N,127E	9-Oct	340	342	-2	1.7	1.8	-0.1	2.5	2.4	0.1	190	4	200	1.7	-7	1.2	18	-1.3	3440(3441)	1:21
4	0,90E	22-Oct	280	278	2	2.2	2.1	0.1	2.5	2.4	0.1	250	11	140	0.4	11	1.7	276	-0.3	4401(4399)	1:09
Unit			deg.	deg.	deg.	knot	knot	knot	mile	mile	mile	deg.	m/s	deg.	Knot	deg.	knot	deg.	knot	meter	Hours

Remarks: Vector means the resultant force of the wind-drift and the current. Exp.=Expectation, Act.=Actual, Diff.=difference, The working hours means the actual hours for all the work including the work for towing the sinker, Dist.=Distance, Direct.=Direction, C.CO=Calculation Course, deg.=degree. C.C.F.=Component of current force.The course is shown on the course made good basis and the speed is on her over the ground basis.

As for ADCP 2N-138E, it took the excessive time for 20 minutes to tow the sinker.
As for ADCP 7N-127E, it took the excessive time for 20 minutes for towing the sinker.
As for ADCP 0-138E, although the speed difference had arisen, since working hours were short, the distance became the same as the result.

An approximation for finding the value of the necessary distance for deploying the ADCP mooring system

Required depth ? (unit:meter)	4401		
Length of all the kevler ropes ? (unit:meter)	3500	Speed is given by the" C.C.F "value in the above table?	-0.3
Neccesary distance for deploying a buoy (unit:mile)	**2.5**	Estimated average log speed for deploying a ADCP (unit:knot)	**2.2**

The above mentioned value in square brackets is one for location 0,90E as an example.

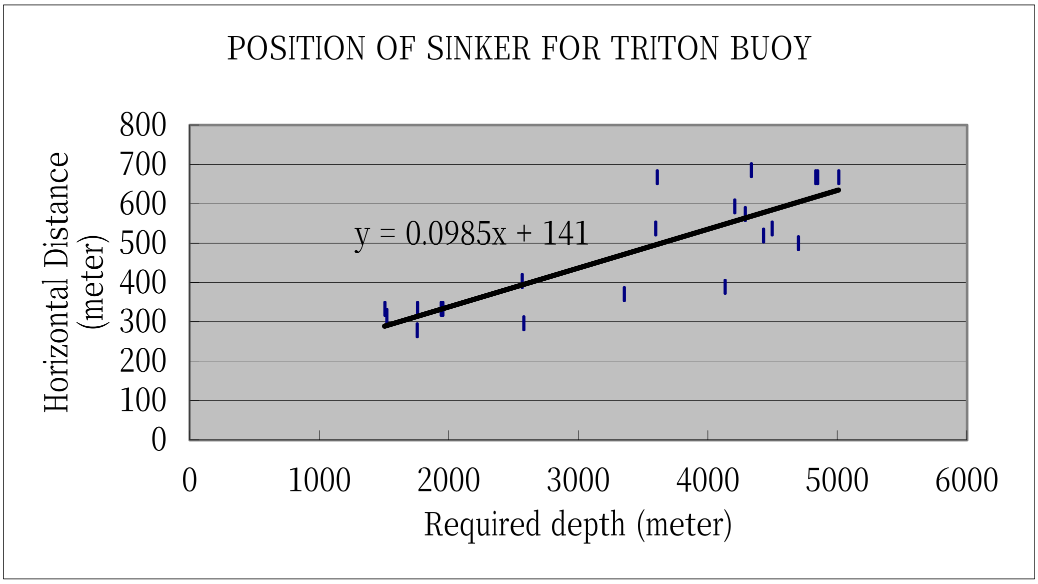
Table 8.1-5 HORIZONTAL DISTANCE OF DROPPED POSITION AND ANCHORED POSITION DURING MR01-K05

Buoy No.	position		Depth (meter)	Distance (meter)	Direction (degree)	Ratio to depth
	Let go sinker	Fixed				
T03	7-50.27N 136-28.98E	7-50.39N 136-29.14E	3353	370	52 <231>	11%
T04	4-56.47N 137-17.77E	4-56.41N 137-17.58E	4133	389	254 <094>	9%
T05	2-03.82N 138-02.74E	2-03.80N 138-03.11E	4335	685	93 <270>	16%
T06	0-04.65N 138-02.92E	0-04.71N 138-02.61E	4206	593	282 <096>	14%
T07	1-56.10N 129-55.69E	1-56.38N 129-55.71E	4428	519	5 <215>	12%
T08	1-39.29S 89-59.42E	1-39.51S 89-59.58E	4697	500	144 <325>	11%
T09	4-56.938S 94-58.34E	4-57.13S 94-58.64E	5009	667	123 <300>	13%
ADCP1	1-53.74N 138-02.10E	1-53.75N 138-02.28E	4681	333	87 <279>	7%
ADCP2	0-00.55S 138-01.89E	0-00.60S 138-01.80E	3947	185	242 <061>	5%
ADCP3	6-49.46N 126-42.59E	6-49.29N 126-42.65E	3441	333	160 <343>	10%
ADCP4	0-00.33N 90-03.29E	0-00.45N 90-03.36E	4399	241	31 <270>	4%

<>final course

According to the following chart, a horizontal distance between a position of the sinker dropped and a position of the sinker arrived at the seabed is approximated.

X = the required depth, Y = the distance in which the sinker regresses.



The above mentioned graphic chart includes data at past voyages.

Fig.8.1-1 SPEED IN THE SHIP'S THROUGH-THE-WATER

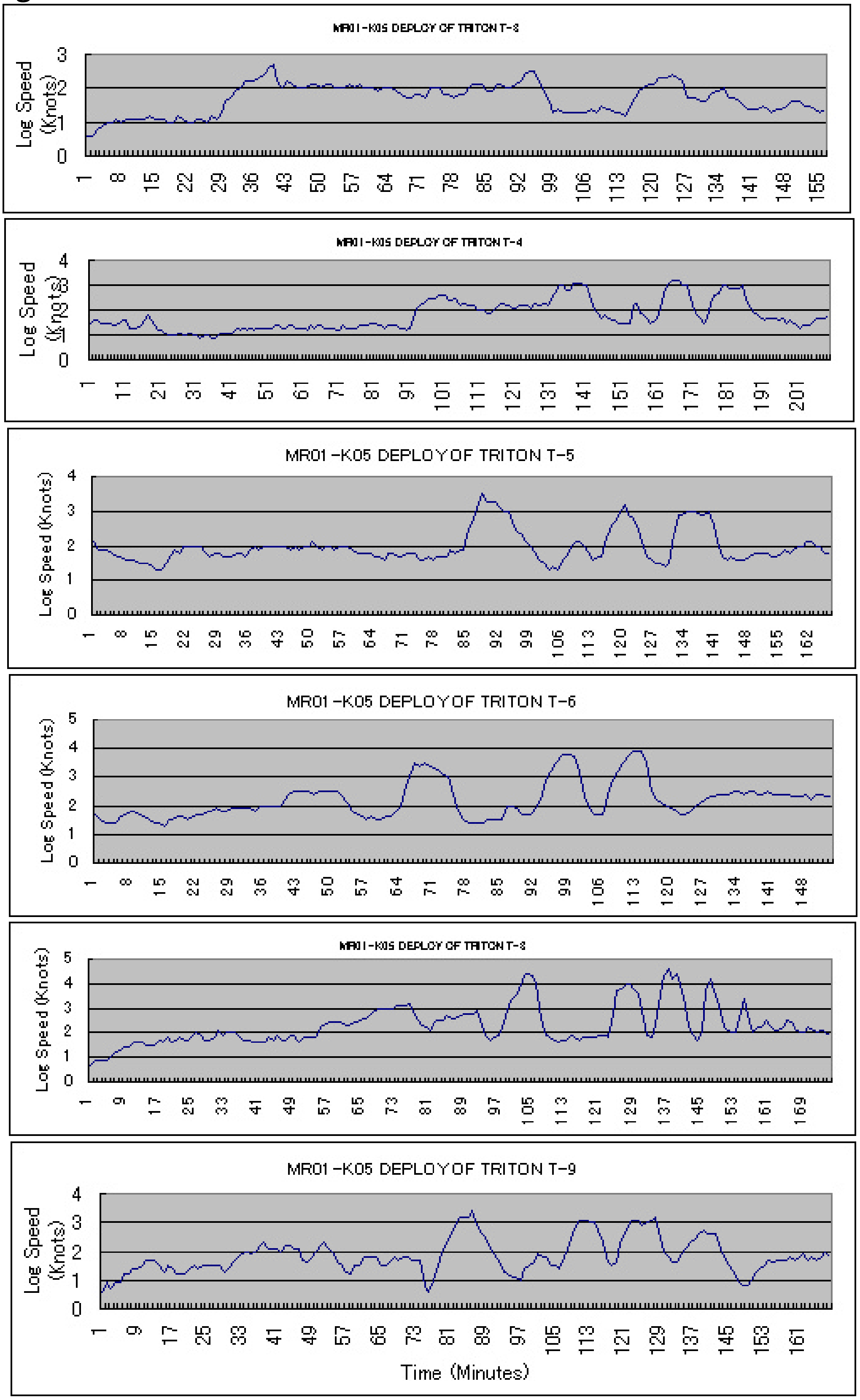
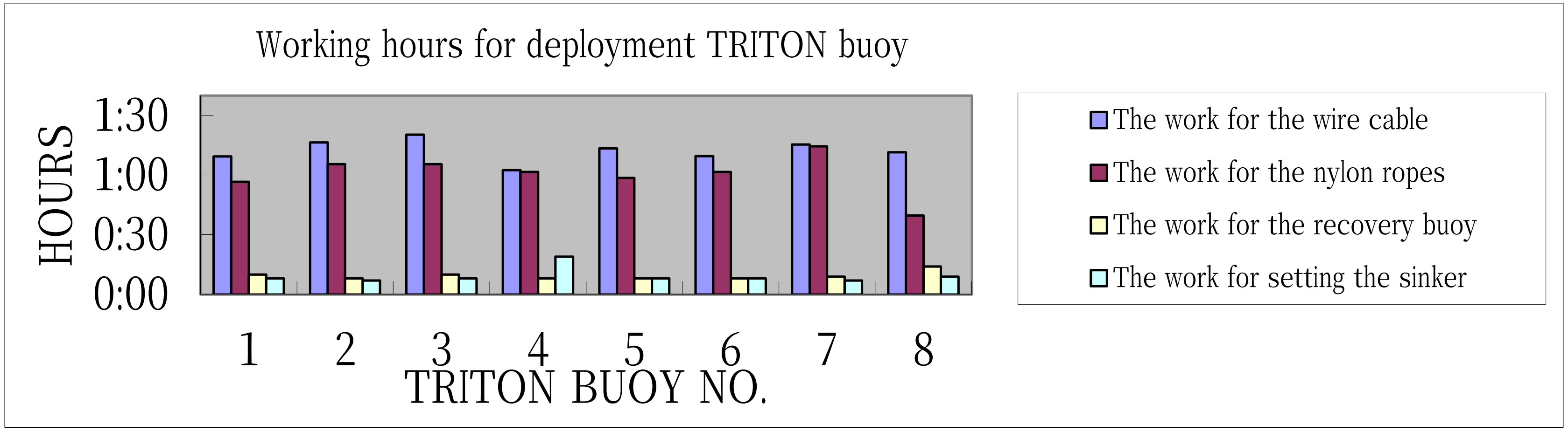
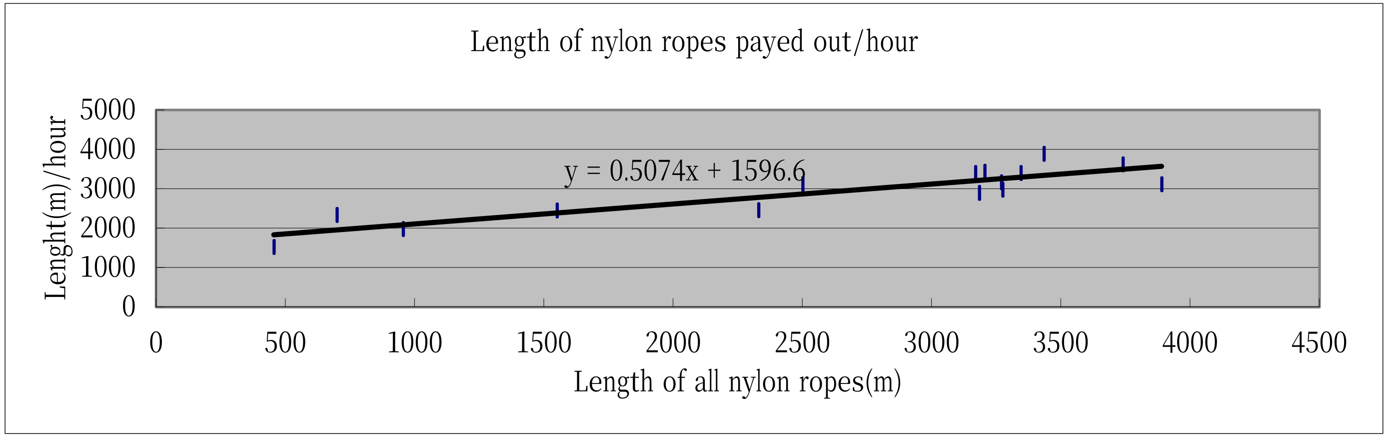


Fig. 8.1-2 SUMMARY OF WORKING TIME FOR DEPLOYMENT TRITON BUOY ON MR01-K05

The hours in each work are nearly fixed as shown in the following chart.



As for the work for the nylon ropes with which working hours are different in proportion to the length, a following regression formula is derived from the relation between the lenghth of all the nylon ropes and that of the nylon ropes paid out per hour.

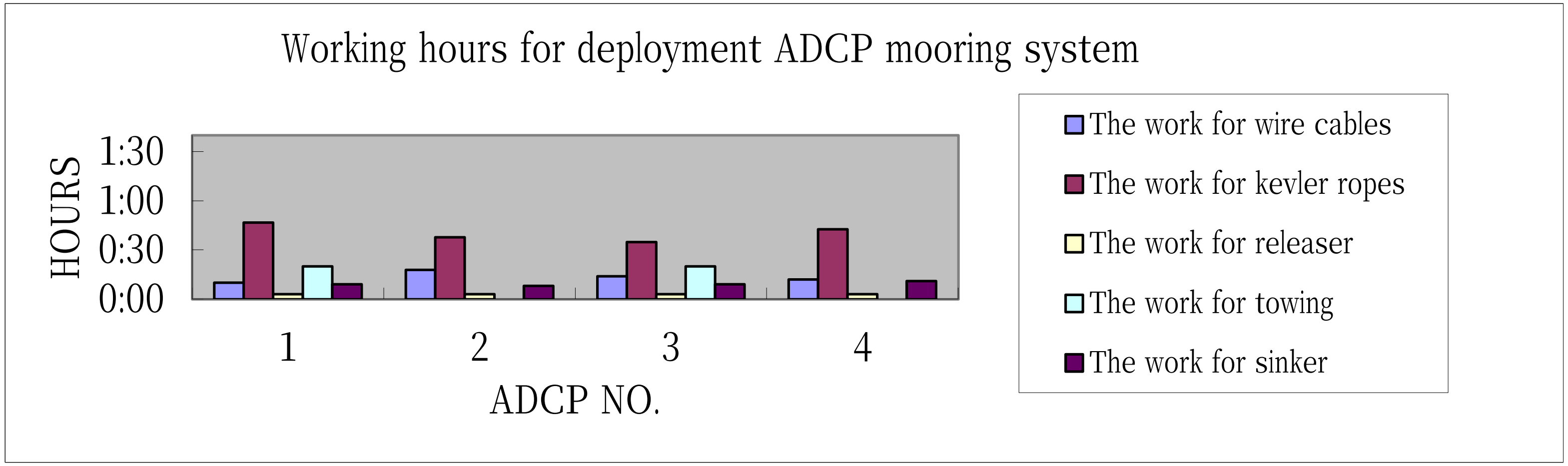


Actual results before voyage MR01-K05 are included in the above-mentioned data.

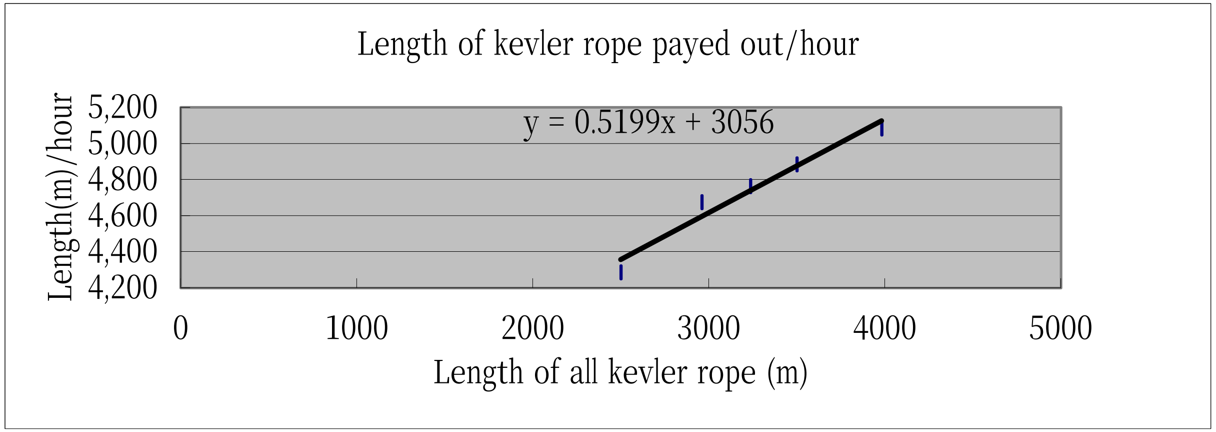
length of the nylon ropes sent out/hour = 0.5 x length of all the nylon ropes + 1600
(unit: meter)

Fig. 8.1-3 SUMMARY OF WORKING TIME FOR DEPLOYMENT ADCP MOORING ON MR01-K05

The time spent in each work is nearly fixed as shown in the following figure.



As for the work for the kevler ropes, a following regression formula is derived from the relation between the lenghth of all the kevler ropes and that of the kevler ropes paid out per hour.



Length of the kevler ropes sent out/hour = 0.52 x length of all the kevler ropes + 3050
(unit: meter)

8.2 Ship's handling for recovery TRITON buoys and ADCP mooring systems

(1) Personnel

Masaharu Akamine, Master of R/V MIRAI

And ship's crew

(2) Objectives

It aims at establishing a method of approaching a TRITON buoy and an ADCP float which are adrift on the sea surface, being external force influenced and at collecting data on working hours for the recovery of the TRITON buoy/the ADCP mooring systems in order to be helpful to us in doing a next work.

(3) Observation parameters

- Movements of the TRITON buoy and the ADCP float released from the seabed
- Ship's position, course, speed
- Directions of the wind and the current, velocities of the wind and the current

(4) Methods

(4.1) Measurement of the actual ship-movement

Measurement of the ship-movement at coming close to the buoy and float is carried out in a radio navigation device assembled by Sena Co., Ltd. Japan.

(4.2) Measurement of the wind and the current

The wind direction and speed are measured by KOAC-7800 weather data processor and sensors assembled by Koshin Denki.

The current direction and speed are continuously measured by a Doppler sonar installed at the bottom of the ship. The Doppler sonar is assembled by FURUNO Electric Co., Ltd.

(4.3) Measurement of the releaser-movement in the sea

The releaser is operated by an acoustic navigation device (with elevator for transmission and reception device) assembled by Oki Electric Co.,Ltd. Japan.

(5) Results

(5.1) How to approach the buoy/the float

The results are illustrated in Fig.8.2-1 ~ Fig.8.2-6 and the following matters are pointed out.

(a) The ship stopped downwind and downstream on a distance of about 500 meters from the TRITON buoy and the ADCP anchored point.

(b) The TRITON buoys/the ADCP floats were released from the seabed by the acoustic navigation device, and the ADCP floats/recovery buoys/glass balls surfaced on the point as measurement.

(c) The buoys/floats/glass balls and etc. released from the seabed were adrift by the largest external force among the wind, the stream and the swell. In this case, we have to take into consideration the difference of the stream in shallow depth of water and in deep depth of water, and the wind pressure area of the buoy or the floats and etc.

(d) Except for the ADCP (0-90E) work that has not used the working boat due to the sea state being bad, others carried out by using the working boat. About ADCP (0-90E), the glass-balls that are in the lower part of the ADCP system were caught by the grapnel, and the ADCP system was recovered by the method contrary to usual.

(e) The able seamen who were on board the working boat connected a sling rope to the TRITON buoy or the ADCP float.

(f) In order to pick up the sling rope, the ship approached the lee of them to a distance of about 20 meters.

(g) When there is neither the wind nor the stream, the glass ball surfaces right above and has possibility that it may entangle in the mooring ropes. About the ADCP (5S-95E), In the stage which pulled up the sling rope connected to the TRITON buoy or the ADCP float, the ship towed it until the glass ball surfaced.

(h) The bow was turned on the wind, the sling rope was wound up, and The TRITON buoy or The ADCP float was recovered.

(i) While recovering the mooring ropes/cables, the ship was steered so that they might be led right astern.

(5.2) Working hours for recovery the buoy/ADCP mooring systems

The result is shown in Table 8.2-１and the following matters are pointed out.

(a) The time consumed on each work in recovery of all the TRITON buoys was nearly constant except the working time for the recovery of the nylon ropes that have different lengths.

(b) As for the time when the recovery buoys surfaced on the sea, there was not a big difference all.

(c) Although the fishing line had twined round the wire cables of TRITON buoy T04, working hours were not delayed sharply.

(d) The working time of the boat was controlled by the timing that a release signal is sent from the acoustic navigation device installed in the bottom of the ship.

(e) About the recovery of ADCP, although the difference was in the length of the kevler ropes of each ADCP, all ended work in 2 hours and about 30 minutes.

(f) In case of the recovery of the ADCP mooring system, the working boat was lowered after surfacing of glass balls had been confirmed.

(g) In the recovery of the ADCP (5S-95E), the work hours by the boat became short as compared with other ADCP recoveries since the ship towed it before the glass ball rose to the surface.

(6) Data archive

All data will be archived on board.

(7) Remarks

In this voyage, the effect of the swell among the external force was big more than the imagination. Especially it was felt when there were few winds and streams. In these recovery works, when deciding the ship’s course, and when launching and picking up the working boat, the direction of the swell was taken into consideration. Since it is necessary to know the degree of the influence that the swell gives to the ship’s handling quantitatively, it will be a future research subject.

All results including the swell influence are very much beneficial when we work in future. The results will be accumulated in this sense.

Table 8.2-1 RECOVERY OF TRITON BUOY/ADCP MOORING SYSTEM DURING VOYAGE MR01-K05

TRITON NUMBER	T-24	T-25
Location	2N, 138E	0,138E
Date	1-Oct	4-Oct
Length of buoy system(m)	4330	4370
Com'ced work	7:50	8:02
Sent working-boat	7:57	8:06
Released from sinker	8:09	8:28
Recovery buoy surfaced	8:23	8:35
Sling rope connected with buoy	8:40	8:44
Picked up the boat	8:41	8:49
Winded up buoy	8:57	9:05
Recovery of cable	9:15	9:20
Recovery of rope	10:04	10:09
Recovery of releaser	11:47	11:25
Finished the work	11:48	11:26
Total working hours	3:58	3:24

Time consumed

			Average
* in rising of recovery buoy	0:14	0:07	0:10
in working of boat (included *)	0:51	0:47	0:49
in recovery of TRITON buoy	0:34	0:31	0:32
in recovery of cable	0:49	0:49	0:49
in recovery of ropes	1:44	1:17	1:30
Total working hours	3:58	3:24	3:51

Remarks: Fishing line

TRITON NUMBER	1	2
Approaching course (deg)	300	160
Course of recovery (deg)	260	80
Wind direction (deg)	55	275
Wind velocity (m/s)	2.4	3.6
Current direction (deg)	100	290
Current velocity (knot)	0.6	0.9
Swell direction	ENE	West
Wave height (m)	1	0.6

ADCP NUMBER	1	2	3	4
Location	0, 138E	7N, 127E	0, 90E	5S, 95E
Date	5-Oct	9-Oct	22-Oct	25-Oct
Length of ADCP system(m)	3567.6	3108.1	3932.1	4655.1
Com'ced work	7:02	7:02	12:13	13:20
Released from sinker	7:04	7:03	12:23	13:23
Top buoy surfaced	7:05	7:05	12:26	13:25
Sent working-boat	7:56	7:58	13:07	13:31
Sling rope connected with buoy	8:03	8:10	13:25	13:40
Picked up the boat	8:09	8:13	13:25	13:53
Top buoy on deck	8:21	8:23	14:33	14:03
Sensors on deck	8:46	8:53	14:14	14:17
Kevler rope on deck	9:32	9:32	14:14	15:17
Recovery of glass ball/releaser	9:33	9:33	13:30	15:18
Finished the work	9:34	9:34	14:36	15:21
Total working hours	2:32	2:32	2:23	2:01

Time consumed

					Average
* in rising of buoy/floats	0:01	0:02	0:03	0:02	0:01
in working of boat (included *)	1:07	1:11	1:12	0:33	1:00
in recovery of Top buoy/sensors	0:37	0:40	0:22	0:24	0:30
in recovery of Kevler ropes	0:46	0:39	0:44	1:00	0:47
in recovery of releaser	0:02	0:02	0:05	0:04	0:03
Total working hours	2:32	2:32	2:23	2:01	2:22

・No boat use
・Reverse recovery

ADCP NUMBER	1	2	3	4
Approaching course (deg)	128	0	270	70
Course of recovery (deg)	70	260	250	310
Wind direction (deg)	260	205	250	270
Wind velocity (m/s)	6.1	3.7	10	3
Current direction (deg)	260	205	140	120
Current velocity (knot)	0.7	1.2	0.5	0.4
Swell direction	NW	South	SW	SE
Wave height (m)	0.9	1.5	2.4	2.5

Fig. 8.2-1   FIGURE OF RECOVERY BUOY

Triton buoy number: **T**24 (2N, 138E)

Date: **1** st Oct. 2001

Wind: <055> 2.4 m/s, Current: <100> 0.6 knot

Swell: ENE, Wave height: 1.0m, Weather: **b c**

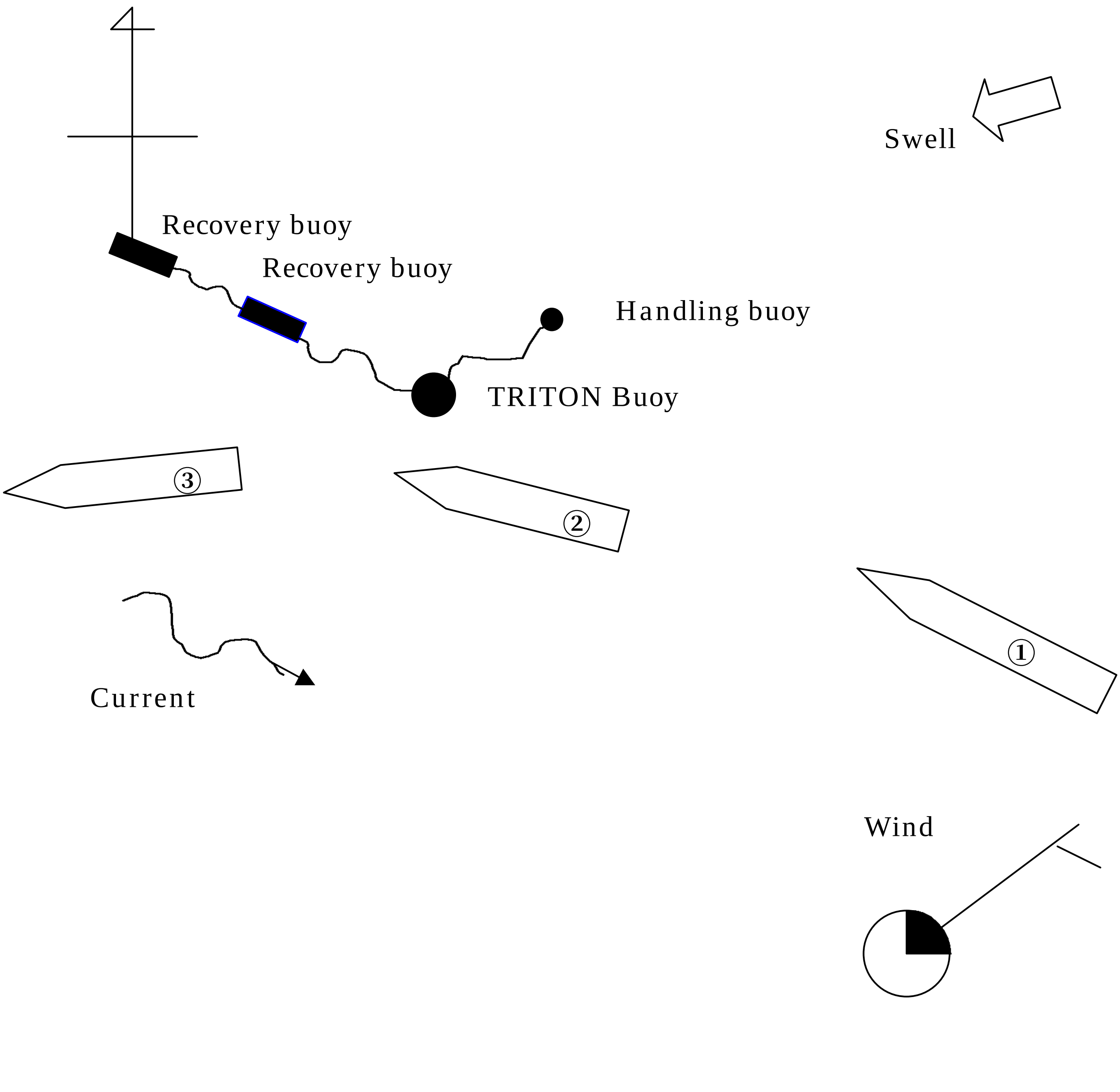


Fig.8.2-2 FIGURE OF RECOVERY BUOY

Triton buoy number: **T** 25 (0, 138E)

Date: 4th Oct.2001

Wind: <275> 3.6 m/s, Current: <290> 0.9 knot

Swell: West, Wave height: 0.6 m, Weather: c

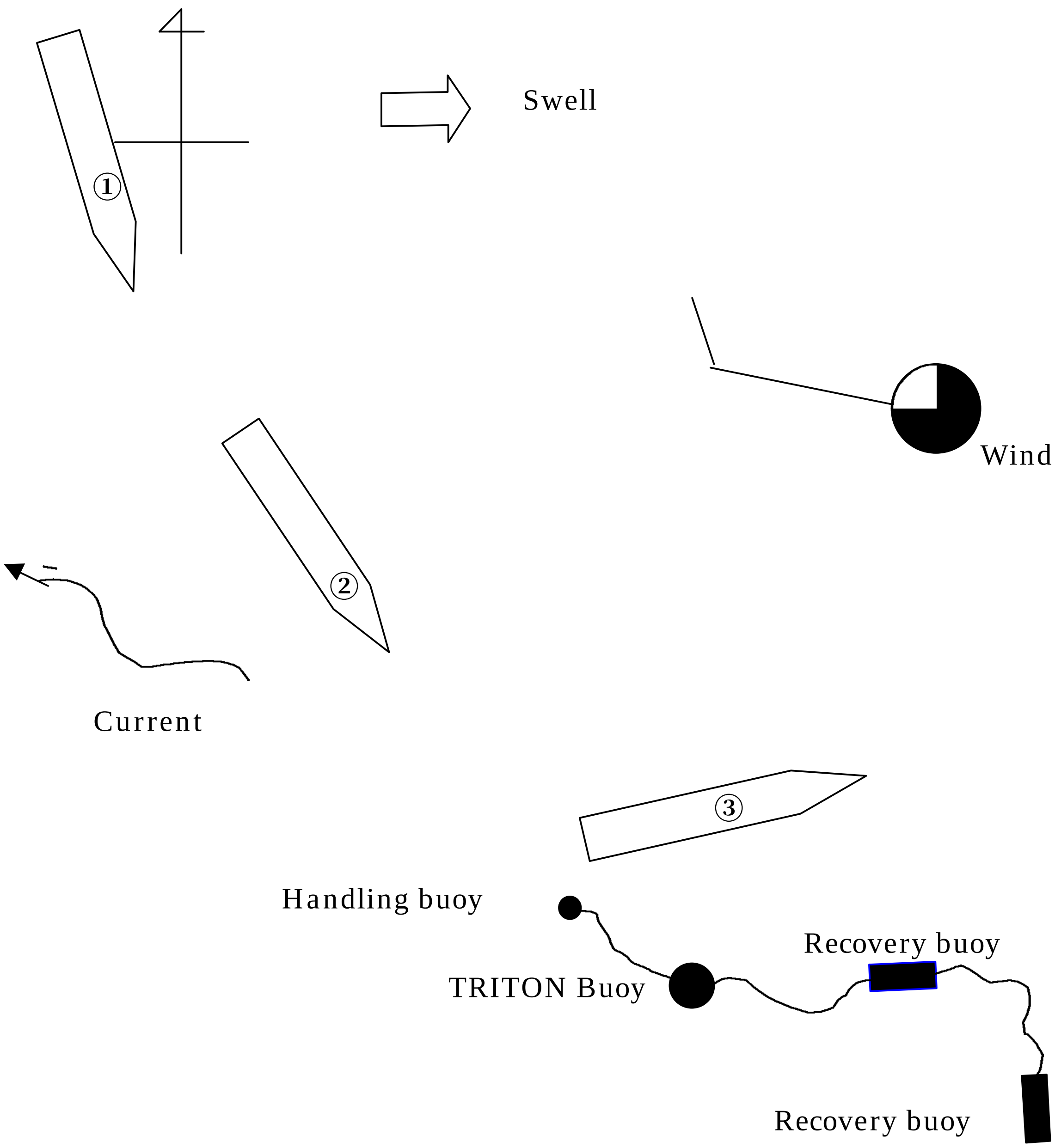


Fig.8.2-3 FIGURE OF RECOVERY ADCP
Location: 0, 138E
Date: 5th Oct.2001
Wind: <260> 6.1 m/s, Current: <260> 0.7 knot
Swell: NW, Wave height: 0.9 m, Weather: c

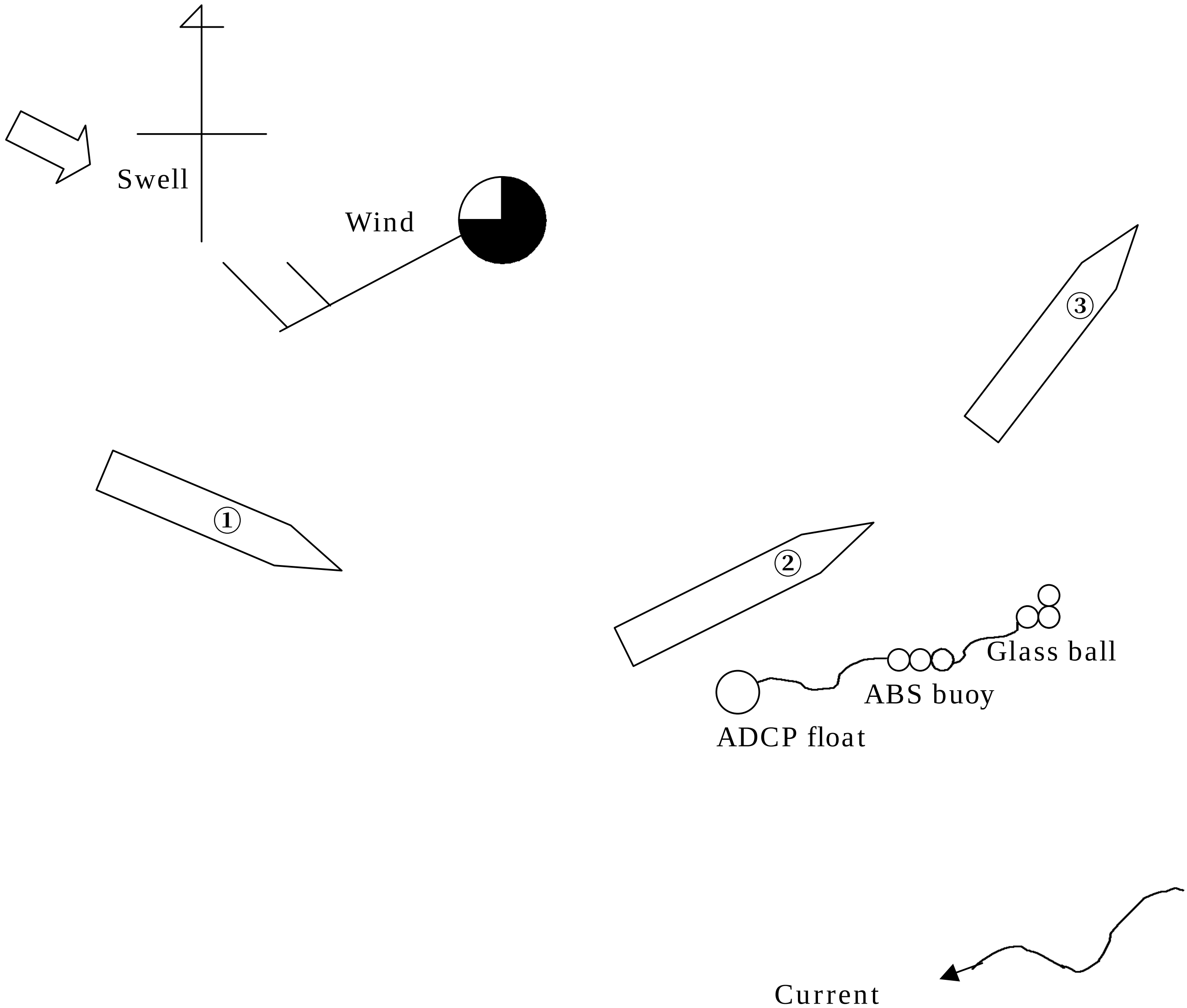


Fig.8.2-4 FIGURE OF RECOVERY ADCP

Location: 7 N, 127E

Date: 9th Oct.2001

Wind: <205> 3.7 m/s, Current: <205> 1.2 knot

Swell: South, Wave height: 1.5 m, Weather: c

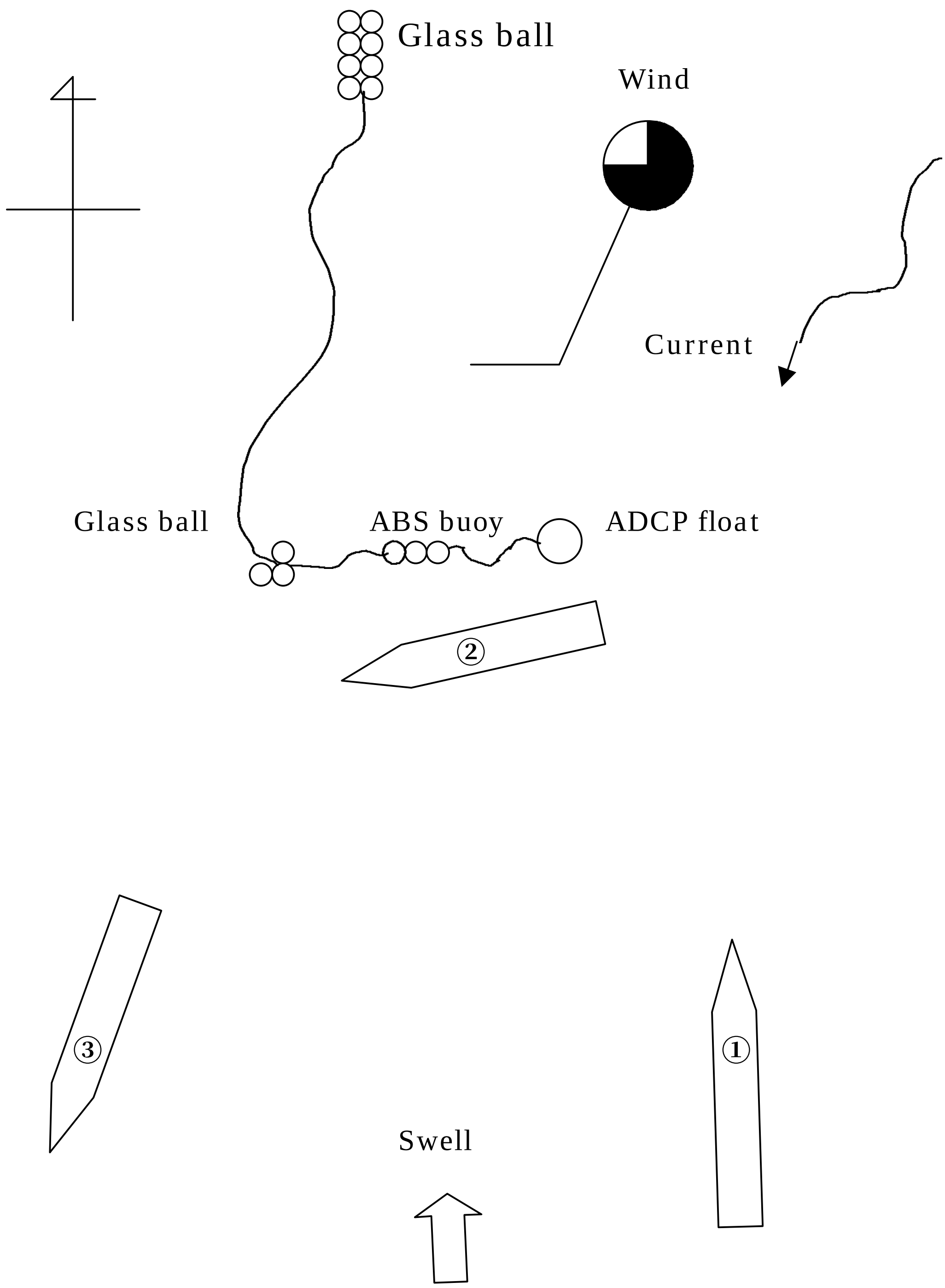


Fig.8.2-5 FIGURE OF RECOVERY ADCP

Location: 0, 90E

Date: 22nd Oct.2001

Wind: <250> 10 m/s, Current: <140> 0.5 knot

Swell: SW, Wave height: 2.4 m, Weather: **b**c

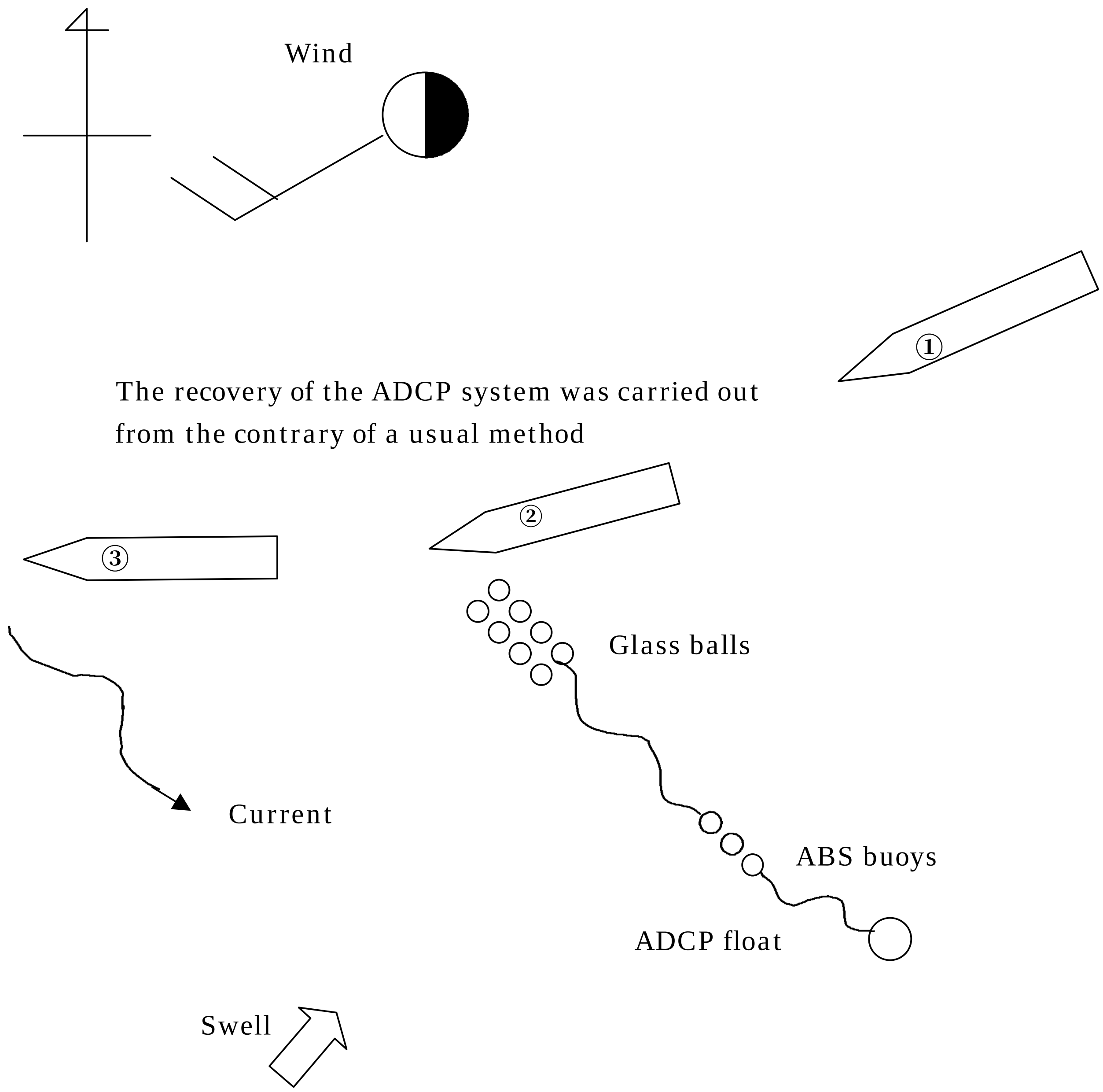


Fig.8.2-6　FIGURE OF RECOVERY ADCP

Location: 5S, 95E

Date: 25th Oct.2001

Wind: <270> 3　m/s, Current: <120> 0.4 knot

Swell: SE, Wave height: 2.5 m, Weather: bc