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Tropical Ocean Climate Study (TOCS)
YK04-02

January 20 - February 26, 2004

Edited by

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Japan Marine Science and Technology Center (JAMSTEC)

TOCS YK04-02　Cruise Report

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1. Cruise Summary

Ship	: R/V Yokosuka
Chief Investigator	: Yoshifumi Kuroda (JAMSTEC)
Cruise Code	: YK04-02
Project Title	: Tropical Ocean Climate Study
Period	: January 19, 2004 (Guam) – February 21,2004 (Guam)－ February 26, 2004 (Yokosuka)
Ports of call	: Guam (USA) Yokosuka (Japan)
Institute	: JAMSTEC (Japan Marine Science and Technology Center)

Purpose:

The purpose of this cruise is to deploy and recover TRITON and ADCP moorings, which are observing surface meteorological parameters, temperature, salinity, current in the western tropical Pacific Ocean to monitor and understand the ENSO (El Nino/Southern Oscillation) phenomena.

Observation Summary :

Seven TRITON buoys at (8N, 5N, 2N, 0, 2S, 5S:156E and 2N,130E) were recovered.

Six TRITON buoys (8N, 5N, 2N, 0, 2S, 5S:156E) were redeployed.

One subsurface ADCP buoy at 0,156E was recovered, and redeployed.

Five ARGO floats were deployed.

Fifteen CTD casts were conducted near TRITON buoys and at ARGO float deployment sites to check temperature and salinity values derived from CT sensors of the TRITON buoy and ARGO floats.

Eight XCTD casts were conducted along 156E line to measure vertical profiles of temperature and salinity

Sea water at 1000m depth were sampled by Niskin bottles at CTD casts to check CTD salinity.

Outline of the TRITON operation:

We have carried out successfully the TRITON recovery and deployment at the six sites along 156E which was the major mission of this cruise. The TRITON operation started at 8N156E on January 23. When we have recovered 8N and 5N, and deployed 8N TRITON buoy, it was found the TRITON buoy at 2N130E had been drifting. Then we headed to the buoy on January 26 and did emergently recover the 2N130E TRITON on January 31. On the way to 5S156E, we tried to repair

the 0N147E which stopped the data transmission, but it could not be restored. We restarted the TRITON operation from 5S156E on February 5. Until then, the winds were weak and waves were low because of stable period of intraseasonal atmospheric disturbance. However, when we arrived at 2S156E the low pressure systems developed in both hemisphere and westerly winds became strong remarkably associated with intrasesonal disturbance arraival. During the deployment operation of 2S156E, we met a storm of over 15 m/s and 3-4 m waves and it was the severest condition through the TRITON operations during this cruise. To avoid the rough sea conditions we carried out 0,156E operation first, and then recovered 2S156E TRITON. When we arrived at 2N156E on February 15, the intraseasonal disturbance had passed through the region and calm sea condition returned. Then, we could deploy and recover the 2N TRITON and finally recover 5N TRITON in the hot air with no sea bleeze.

Besides the TRITON operation, we carried out Argo float deployments, recovery and deployment at the 0N156E ADCP mooring site and hydrographic casts using CTD and XCTD.

ENSO status:

We summarize the ENSO status based on the TAO/TRITON data of zonal wind, sea surface temperature (SST) and 20 degree-C isotherm depth along the equator. In the boreal summer 2002, strong coupling between the ocean and atmosphere occurred as the high SST region migrated eastward slowly together with active atmospheric convection, when the 2002-2003 El Nino began. In December 2002, the El Nino matured as the subsurface temperature at 100-150 m depth became 5 degree-C warmer than normal and SST from central to eastern Pacific 2 degree-C warmer than normal. However the El Nino collapsed suddenly associated with the arrival of upwelling Kelvin waves into the eastern equatorial Pacific in February 2003. At that time, the warm water was lost from the equatorial region and the SST in the eastern Pacific returned to normal. After the El Nino, the SST in the western equatorial Pacific kept the normal level until July 2003. Since then, the buoy data at 156E and 165E indicate over 30 degree-C and slightly higher than normal. However the 20 degree-C depth does not indicate any significant warm water accumulation in the western equatorial Pacific. During this cruise, we encountered strong westerly burst associated with intraseasonal disturbance and well developed tropical depression in the southern hemisphere which may developed due to the high SST. The salinity CTD and XCTD section along 156E indicated the low salinity water covered the surface layer and heavy precipitation of the equatorial region. At this 156E section, the 20 degree-C depth was also 10 m shallower than normal, and indicated no significant warm water accumulation. Thus, in the western tropical Pacific, the normal condition has continued since 2002-2003 El Nino.

Acknowledgments:

We would like to express special thanks to Captain Osamu Yukawa and crew of R/V Yokosuka of Nihon Marine Enterprise Co. Ltd. During the cruise, technicians of Marine Work Japan Co. Ltd. and the crew supported all observational and mooring works with excellent skill and spirit.

This cruise was conducted under the Tropical Ocean Climate Study (TOCS) project and TRITON project which are supported by Japanese Ministry of Education, Culture, Sports, Science and Technology.

2. Time table

Jan. 20 (Tue.)	SMT (Ship Mean Time) =UTC+10h	
	09:00	Departure from Guam
	10:30-10:45	Briefing for safety life on the ship
	13:00-14:00	Meeting of observation
Jan. 21 (Wed.)		
	08:22-09:46	CTD and water sampling (C01; 11-04.32N, 149-17.44E) down to 2000m
	09:50	Launching Argo float (11-04.79N, 149-17.90E)
	16:03-17:19	CTD and water sampling (C02; 10-29.81N, 150-37.97E) down to 2000m
	17:24	Launching Argo float (10-28.10N, 150-37.97E)
Jan. 22 (Thu.)		
		Cruise for (8N, 156E)
Jan. 23 (Fri.)		
	08:21-12:02	Deployment of TRITON mooring (08-01.00N, 156-57.01E)
	13:07-13:49	CTD and water sampling (C03; 08-01.18N, 155-56.14E) down to 1000m
	15:45-17:04	CTD and water sampling (C04; 07-58.27N, 156-00.56E) down to 2000m
	17:04	Launching Argo float (07-58.54N, 156-00.91E)
Jan. 24 (Sat.)		
	08:00	XCTD (X05; 06-59.97N, 155-59.99E)
	14:09	XCTD (X06; 06-00.03N, 156-00.00E)
Jan. 25 (Sun.)		
	08:09-10:54	Deployment of TRITON mooring (04-59.44N, 156-03.08E)
	12:59-13:50	CTD and water sampling (C07; 04-58.93N, 156-02.89E) down to 1000m
Jan. 26 (Mon.)		
	07:48-13:28	Recovery of TRITON mooring (07-58.22N, 155-59.19E)
Jan. 27 (Tue.)		
		Cruise for (2N, 130E)
Jan. 28 (Wed.)		
		Cruise for (2N, 130E)
Jan. 29 (Thu.)		
		Cruise for (2N, 130E)
Jan. 30 (Fri.)	SMT = UTC+9.5h	
		Cruise for (2N, 130E)
Jan. 31 (Sat.)	SMT = UTC+9h	
	07:00-09:08	Recovery of TRITON mooring (03-13.57N, 129-04.37E)
Feb. 1 (Sun.)		
		Cruise for (0, 147E)
Feb. 2 (Mon.)		
		Cruise for (0, 147E)

Feb. 3 (Tue.)

08:30-10:40	Check of TRITON buoy (00-01.87N, 146-59.63E)

Feb. 4 (Wed.) SMT=UTC+9.5h

	Cruise for (5S, 156E)

Feb. 5 (Thu.) SMT=UTC+10h

07:54-10:09	Deployment of TRITON mooring (04-58.01S, 156-00.99E)
10:57-11:39	CTD and water sampling (C08; 04-57.77S, 156-00.88E) down to 1000m
14:20-15:04	CTD and water sampling (C09; 05-01.47S, 156-01.80E) down to 1000m

Feb. 6 (Fri.)

07:49-10:35	Recovery of TRITON mooring (05-05.21S, 155-59.79E)
16:29	XCTD (X10; 03-59.96S, 155-59.96E)

Feb. 7 (Sat.)

07:56	XCTD (X11, 03-00.15S, 155-59.99E)

Feb. 8 (Sun.)

13:07-15:56	Deployment of TRITON mooring (01-59.08S, 156-01.43E)

Feb. 9 (Mon.)

10:56-11:29	CTD and water sampling (C12; 00-02.47S, 155-57.46E) down to 800m
12:58-17:28	Recovery of TRITON mooring (00-05.46S, 155-53.36E)

Feb. 10 (Tue.)

09:16-10:54	Recovery of ADCP mooring (00-00.04S, 156-08.52E)

Feb. 11 (Wed.)

08:01-11:02	Deployment of TRITON mooring at (00-00.78S, 155-57.88E)
11:17-11:53	CTD and water sampling (C13; 00-00.21S, 155-57.83E), down to 1000m
12:33-13:53	Deployment of ADCP mooring at (00-00.01N, 156-08.41E)

Feb. 12 (Thu.)

07:58-08:38	CTD and water sampling (C14; 01-58.28S, 155-59.63E), down to 1000m
09:02-11:30	Recovery of TRITON mooring (01-54.20S, 155-56.02E)
13:00-13:43	CTD and water sampling (C15; 01-58.63S, 156-01.52E), down to 1000m

Feb. 13 (Fri.)

07:57	XCTD (X16; 00-59.82S, 155-59.97E)
16:03	XCTD (X17; 00-59.99N, 155-59.98E)

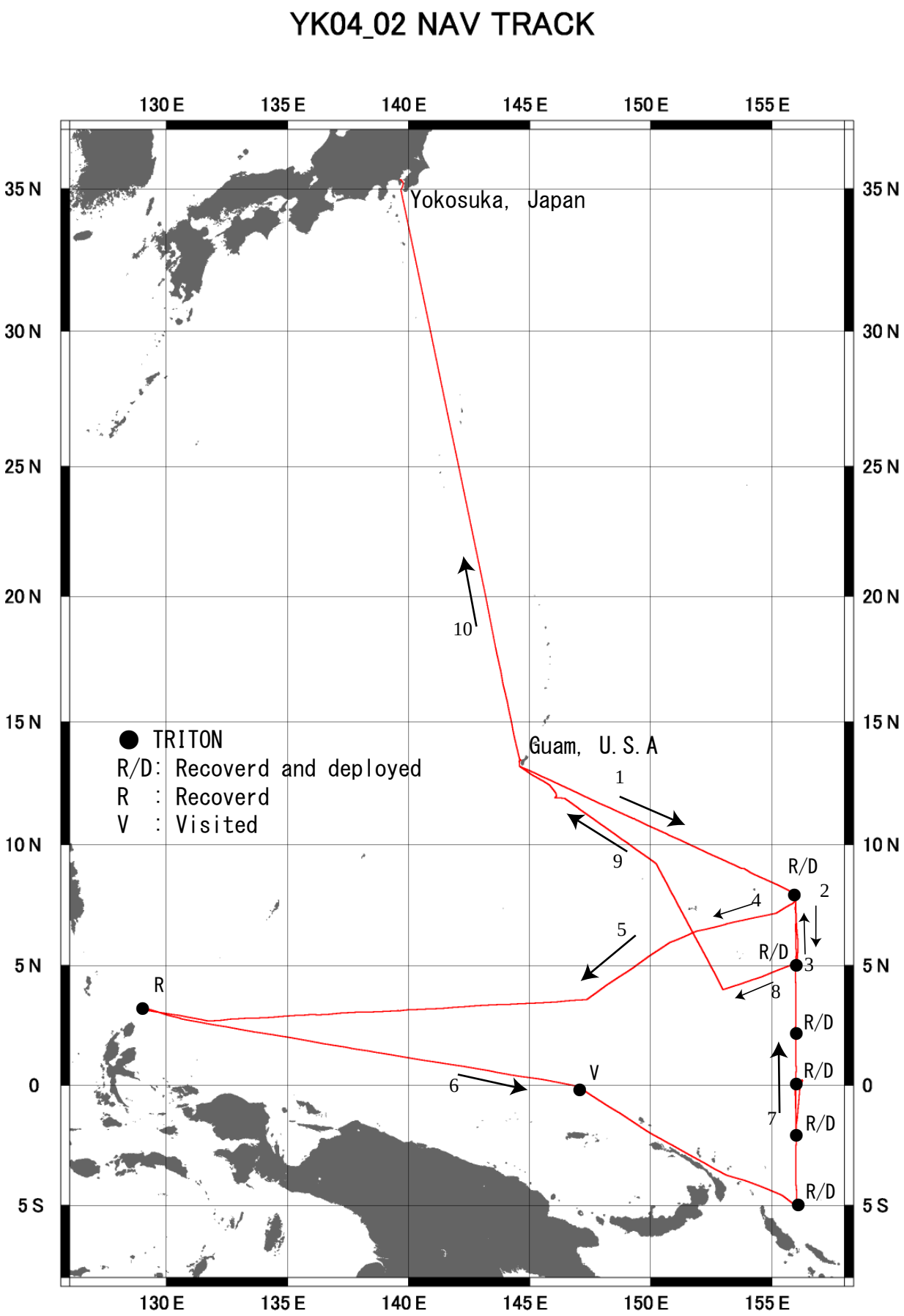
Feb. 14 (Sat.)

07:51-10:19	Deployment of TRITON mooring (01-57.15N, 155-59.96E)
10:40-11:24	CTD and water sampling (C18; 01-57.13N, 156-00.33E), down to 1000m
13:07-13:47	CTD and water sampling (C19; 02-01.45N, 155-59.57E), down to 1000m

Feb. 15 (Sun.)

	07:44-11:28	Recovery of TRITON mooring (02-03.85N, 155-55.48E)
Feb. 16 (Mon.)		
	06:55	XCTD (X20; 02-59.97N, 155-59.99E)
	15:57	XCTD (X21; 03-59.97N, 156-00.01E)
Feb. 17 (Tue.)		
	06:54-08:36	CTD and water sampling (C22; 05-01.92N, 155-58.57E), down to 2000m
	08:26-11:44	Recovery of TRITON mooring (05-05.50N, 156-00.12E)
	12:01	Launching Argo float (05-05.12N, 155-58.57E)
Feb. 18 (Wed.)		
	08:29-10:16	CTD and water sampling (C23; 04-01.92N, 153-58.57E), down to 2000m
	10:27	Launching Argo float (04-00.90N, 152-58.85E)
Feb. 19 (Thu.)		
		Cruise for Guam
Feb. 20 (Fri.)		
		Cruise for Guam
Feb. 21 (Sat.)		
	09:00	Arrival at Guam, U.S.A.
	12:30	Departure from Guam
Feb. 22 (Sun.)	SMT=UTC+9.5h	
		Cruise for Yokosuka
Feb. 23 (Mon.)	SMT=UTC+9h	
		Cruise for Yokosuka
Feb. 24 (Tue.)		
		Cruise for Yokosuka
Feb. 25 (Wed.)		
	07:30	Arrival at Yokosuka

3. Cruise Track



4. Participants list

4.1. R/V YOKOSUKA scientist and technical staff

Yoshifumi Kuroda	JAMSTEC
Shigeki Hosoda	JAMSTEC
Masaki Taguchi	MWJ
Koichi Takao	MWJ
Takeo Matsumoto	MWJ
Fuma Matsunaga	MWJ
Kentaro Shiraishi	MWJ
Kei Suminaga	MWJ
Naoshi Kuda	MWJ
Yuki Kako	MWJ
Yoichi Owada	MWJ
Masaki Shinushigome	MWJ
Kenzo Murata	MWJ
Shiori Taguchi	MWJ

JAMSTEC: Japan Marine Science Technology Center

2-15, Natsushima, Yokosuka, Kanagawa, Japan

MWJ: Marine Works Japan Ltd.

1-1-7, Mutsuura, Kawazawa-ku, Yokohama, Japan

4.2. R/V YOKOSUKA crewmember

Osamu Yukawa	Captain
Masayoshi Ishiwata	Chief Officer
Takafumi Aoki	2nd Officer
Kenta Oya	3rd Officer
Eigi Sakaguchi	Chief Engineer
Tadashi Abe	1st Engineer
Yoshinobu Hiratsuka	2nd Engineer
Masaya Sumida	3rd Engineer
Satoshi Watase	Chief Radio Officer
Hidehiro Ito	2nd Radio Officer
Makio Nakamura	Boatswain
Sakae Sasaki	Able Seaman
Seiji Hosokawa	Able Seaman
Syuji Takuno	Able Seaman
Tadahiko Toguchi	Able Seaman
Katsuhiko Sato	Able Seaman
Kengo Fujino	Able Seaman
Kiyoshi Yahata	No. 1 Oiler
Kazuo Abe	Oiler
Hiroshi Yamamoto	Oiler
Koichiro Toda	Assistant Oiler
Masanori Ueda	Assistant Oiler
Ryuichi Mitsumori	Chief Steward
Shinichi Amasaki	Steward
Ryuei Takemura	Steward
Kiyotaka Kosuji	Steward
Toyonori Shiraishi	Steward

5. Hydrographic measurement

5.1 CTD/XCTD operation

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC): Principal Investigator
Shigeki Hosoda	(JAMSTEC): Scientist
Masaki Taguchi	(MWJ): Technical Staff
Takeo Matsumoto	(MWJ): Operation Leader
Kentaro Shiraishi	(MWJ): Technical Staff
Kei Suminaga	(MWJ): Technical Staff
Fuma Matsunaga	(MWJ): Technical Staff
Kenzo Murata	(MWJ): Technical Staff
Naohisa Kuda	(MWJ): Technical Staff

(2) Objectives

Observation of temperature and salinity

(3) Parameters

Pressure, Temperature, Conductivity

(4) Method

CTD/Carousel Sampler Systems and XCTD were used during this cruise. It was the 5-liters 12-positions water sampler with Sea-Bird Electronics Inc. CTD(SBE9/11plus). The sensors attached on the CTD were one temperature sensor, one conductivity sensor, one pressure sensor. XCTD was Tsurumi seiki Ltd. XCTD (1000). The position, date(UTC), time(UTC) are given in Table5.2. and Fig5.1.

The CTD raw data was acquired on real time by using the SEASAVE Win32 utility from the SEASOFT software (ver.5.27) provided by SBE and stored on the hard disk of a IBM personal computer. Water samplings were made during up cast by sending a fire command from the computer.

The CTD raw data was processed by using the SBE Data processing (ver.5.27). Data processing procedures and utilities of the SBE Data processing were as follows:

DATCNV :	Converts the binary raw data to output on physical units. Output items are scan number, pressure, depth(salt water), temperature(ITS-90), salinity(PSS-78), decent rate. This utility selects the CTD data when bottles closed to output on another file.
SECTION :	Remove the unnecessary data.
CELL T.M.:	Perform conductivity cell thermal mass correction if salinity accuracies of better than 0.01 PSU in regions with steep gradients are desired. Typical values are alpha=0.03 and 1/beta.
FILTER:	Low-pass filter pressure data with a time constant of 0.15 seconds to increase pressure resolution for “LOOP EDIT”.
LOOP EDIT:	Mark scans where CTD is moving less than minimum velocity or traveling backwards due to ship roll.
BINAVG :	Calculates the averaged data in every 1 db..
DERIVE:	Compute salinity, density(σ θ), potential temperautre from conductivity, temperature and pressure.
SPLIT :	Splits the data made by BINAVG into down cast data, and up cast data.
ROSSUM :	Edits the data of water sampled to output a summary file.

Specifications of the sensors are listed below.

CTD : SBE 911 plus CTD system

- Under water unit:CTD 9plus Calibrated 24 Sep. 1993
  (S/N 09P8010-0319,Sea-Bird Electronics,Inc.)
- Temperature sensor:SBE03-02/F Primary Sensor Calibrated 28 Jun. 2003
  (S/N 031523,Sea-Bird Electronics,Inc.)

・Conductivity sensor:SBE04-02/0 Primary Sensor　Calibrated 30 Jun. 2003
(S/N 040960,Sea-Bird Electronics,Inc.)
・Deck unit: SBE11 (S/N 11P9833-0345,Sea-Bird Electronics,Inc.)

(5)Result

See the attached figures(Fig.5.3.～Fig.5.4).

(6)Data archive

All of raw and processed CTD/XCTD data files were copied into 3.5 inch magnetic optical disks (230MB,) and submitted to The JAMSTEC TOCS group of The Ocean Observation and Research Department.

5.2 Observation points and cast table

YK04-02

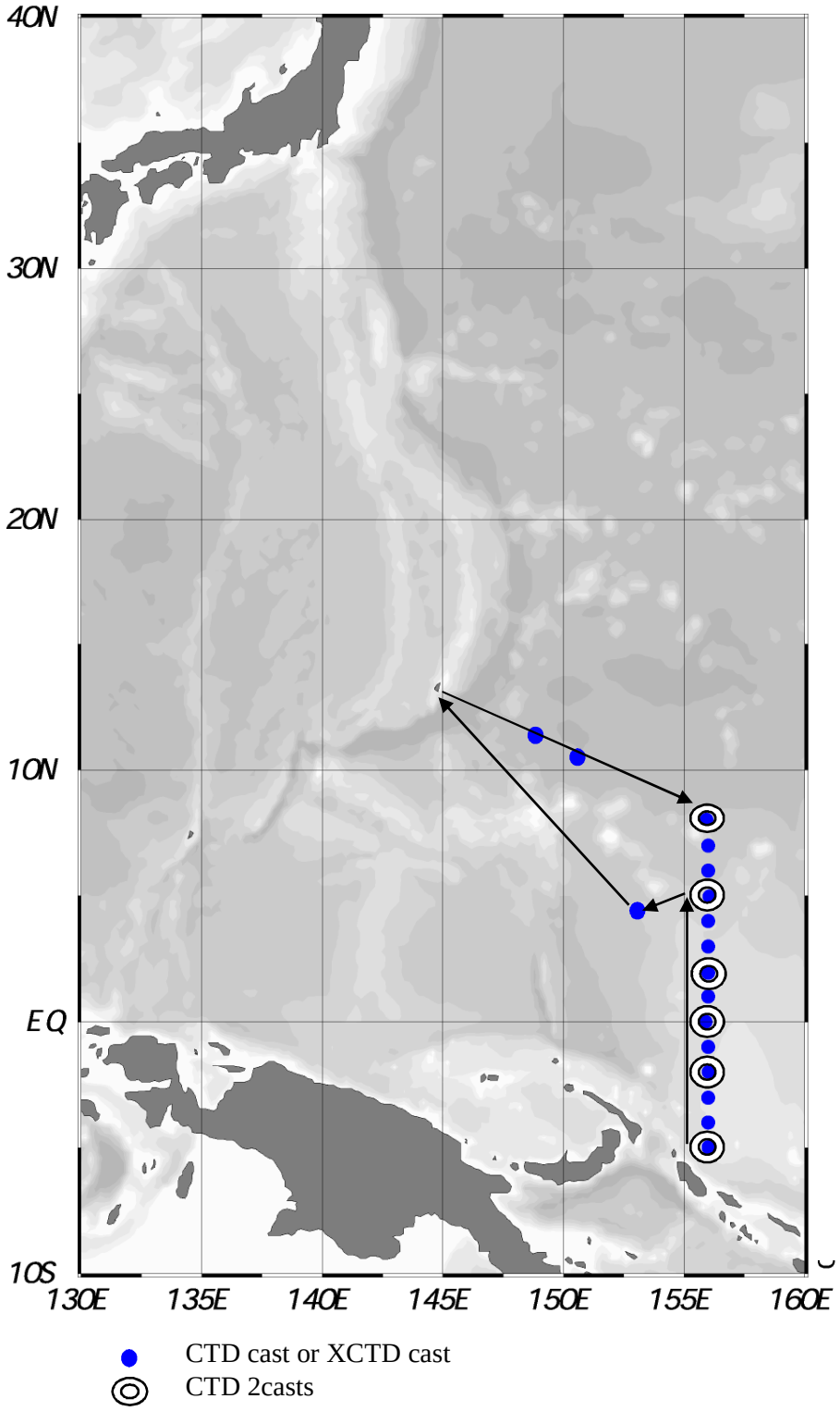


Fig.5.2.1 Observation points from Guam to Guam

Table 5.2.1 Cast table of CTD and XCTD

Sration	Date(UTC)	Lat.	Long.	Start	Bottom		End	File Name	Remark
				Time (UTC)	Pressure (db)	Wire out(m)	Time (UTC)		
C01	2004/1/20	11-04.32N	149-17.44E	22:22	2000	1986	23:46	C01 M01	ARGO
C02	2004/1/21	10-27.81N	150-37.97E	6:03	2000	1963	7:19	C02M01	ARGO
C03	2004/1/23	08-01.18N	155-56.14E	3:07	1000	989	3:49	C03M01	TRITON
C04	2004/1/23	07-58.27N	156-00.56E	15:45	2000	1968	7:04	C04M01	TRITON,ARGO
X05	2004/1/23	06-59.97N	155-59.99E	22:00				CTD-000120040123	
X06	2004/1/24	06-00.04N	156-00.01E	4:09				CTD-000220040124	
C07	2004/1/25	04-58.93N	156-02.89E	2:59	1000	984	3:50	C07M01	TRITON
C08	2004/2/5	04-57.77S	156-00.88E	0:57	1000	995	1:39	C08M01	TRITON
C09	2004/2/5	05-01.41S	156-01.80E	4:20	1000	995	5:04	C09M01	TRITON
X10	2004/2/6	03-59.96S	155-59.97E	6:29				CTD-000320040206	
X11	2004/2/6	03-00.15S	155-59.99E	21:56				CTD-000420040206	
C12	2004/2/9	00-02.47S	155-57.46E	0:56	800	790	1:29	C12M01	TRITON
C13	2004/2/11	00-00.21S	155-57.83E	1:17	1000	986	1:53	C13M01	TRITON
C14	2004/2/11	01-58.28S	155-59.63E	21:58	1000	984	22:38	C14M01	TRITON
C15	2004/2/12	01-58.63S	156-01.52E	3:00	1000	983	3:43	C15M01	TRITON
X16	2004/2/12	00-59.82S	155-59.97E	21:57				CTD-000620040212	
X17	2004/2/13	00-59.99N	155-59.99E	6:03				CTD-000720040213	
C18	2004/2/14	01-57.13N	156-00.33E	0:40	1000	999	1:24	C18M01	TRITON
C19	2004/2/14	02-01.45N	155-59.57E	3:03	1000	1002	3:47	C19M01	TRITON
X20	2004/2/15	02-59.97N	155-59.99E	20:55				CTD-000820040215	
X21	2004/2/16	03-59.98N	156-00.02E	5:57				CTD-000920040216	
C22	2004/2/16	05-01.92N	155-57.83E	20:54	2000	1985	22:36	C22M01	TRITON,ARGO
C23	2004/2/17	04-00.00N	153-00.03E	22:29	2000	1965	0:16	C23M01	ARGO

CTD (C**) total 15 casts
XCTD (X**) total 8 casts

5.3 Vertical profile

Vertical profiles of CTD or XCTD are shown. Profiles are temperature(ITS-90) and salinity(PSS78).

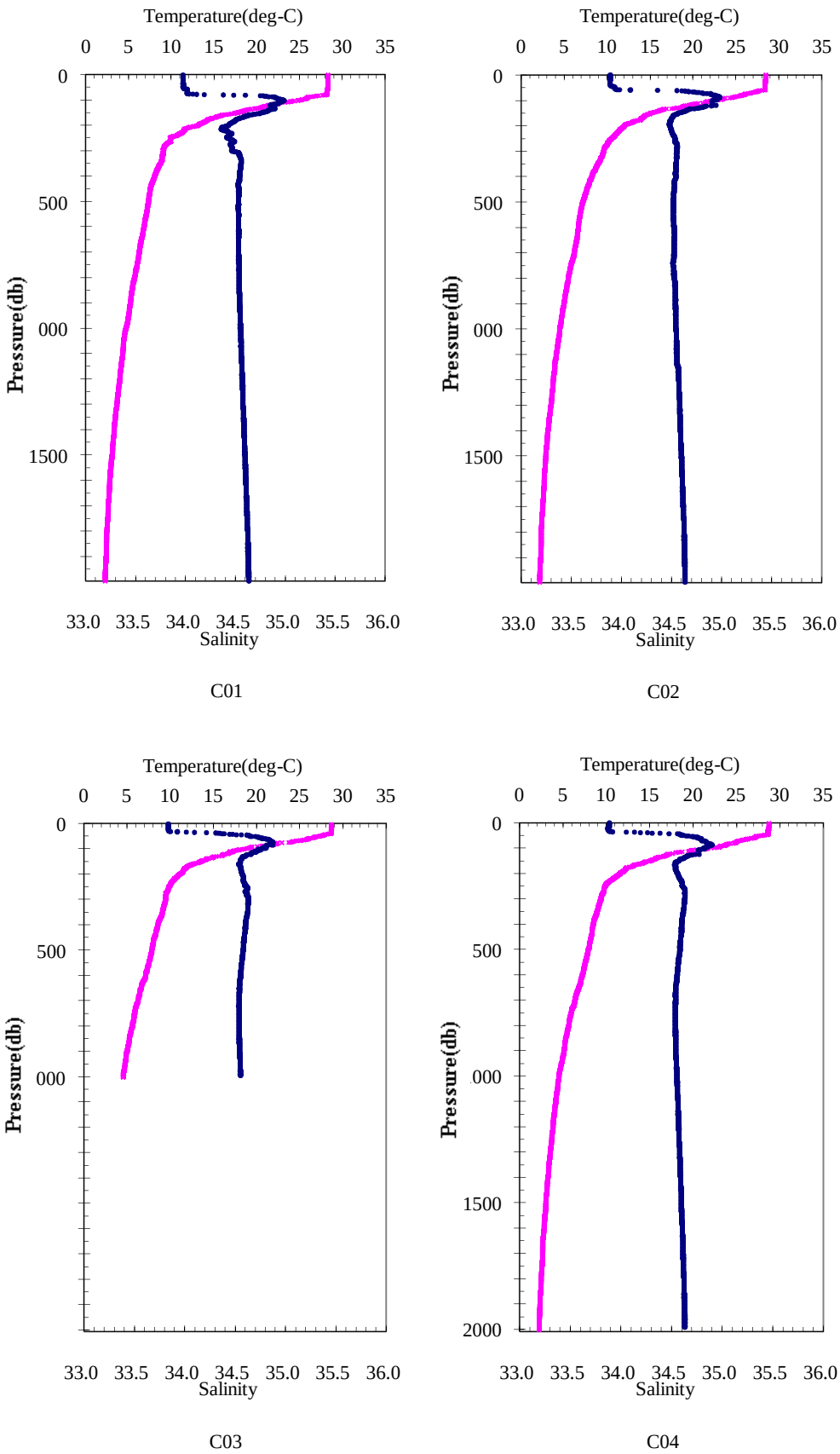


Fig.5.3.1 Vertical profiles of CTD and XCTD

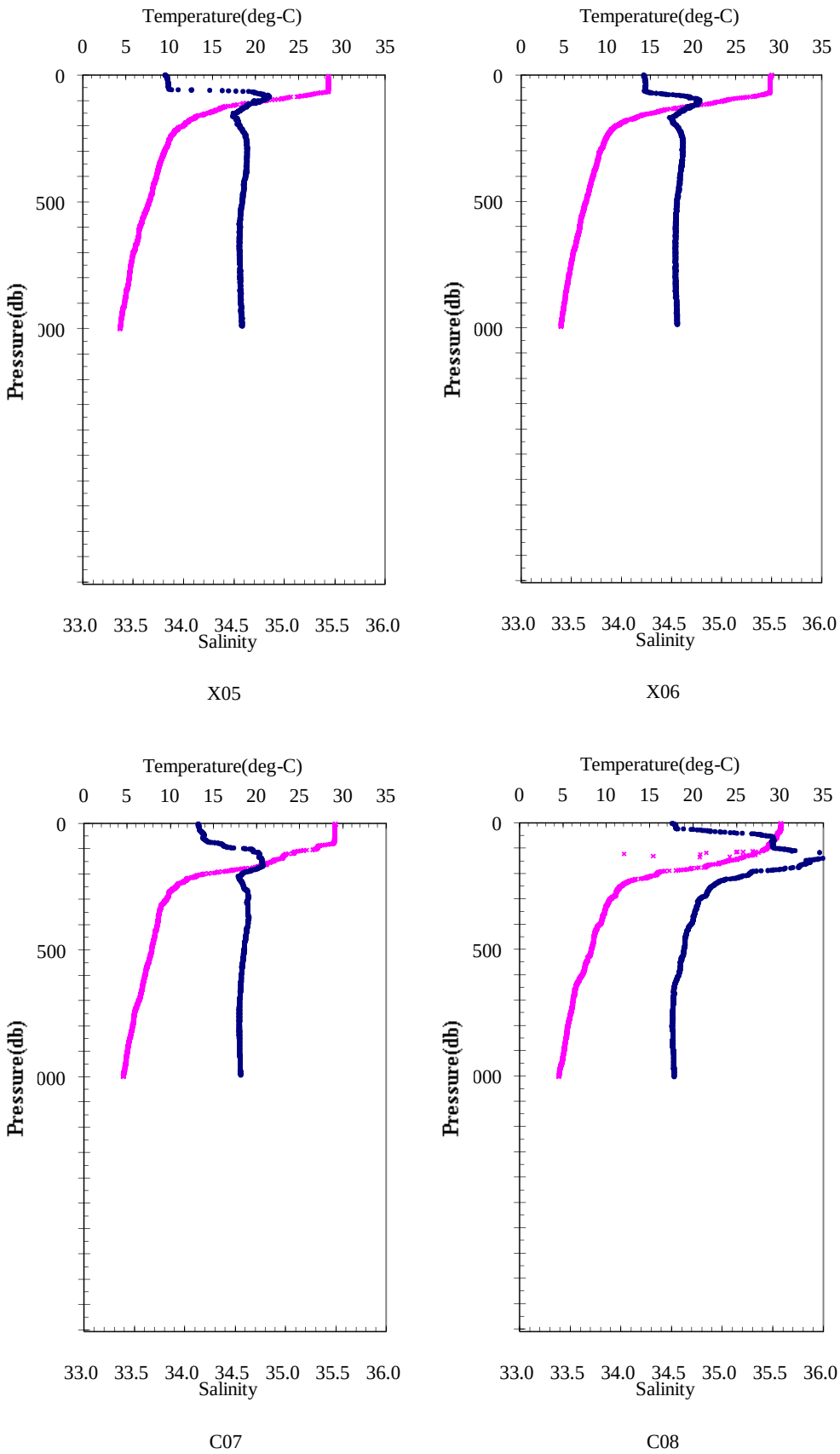


Fig.5.3.2 Vertical profiles of CTD and XCTD

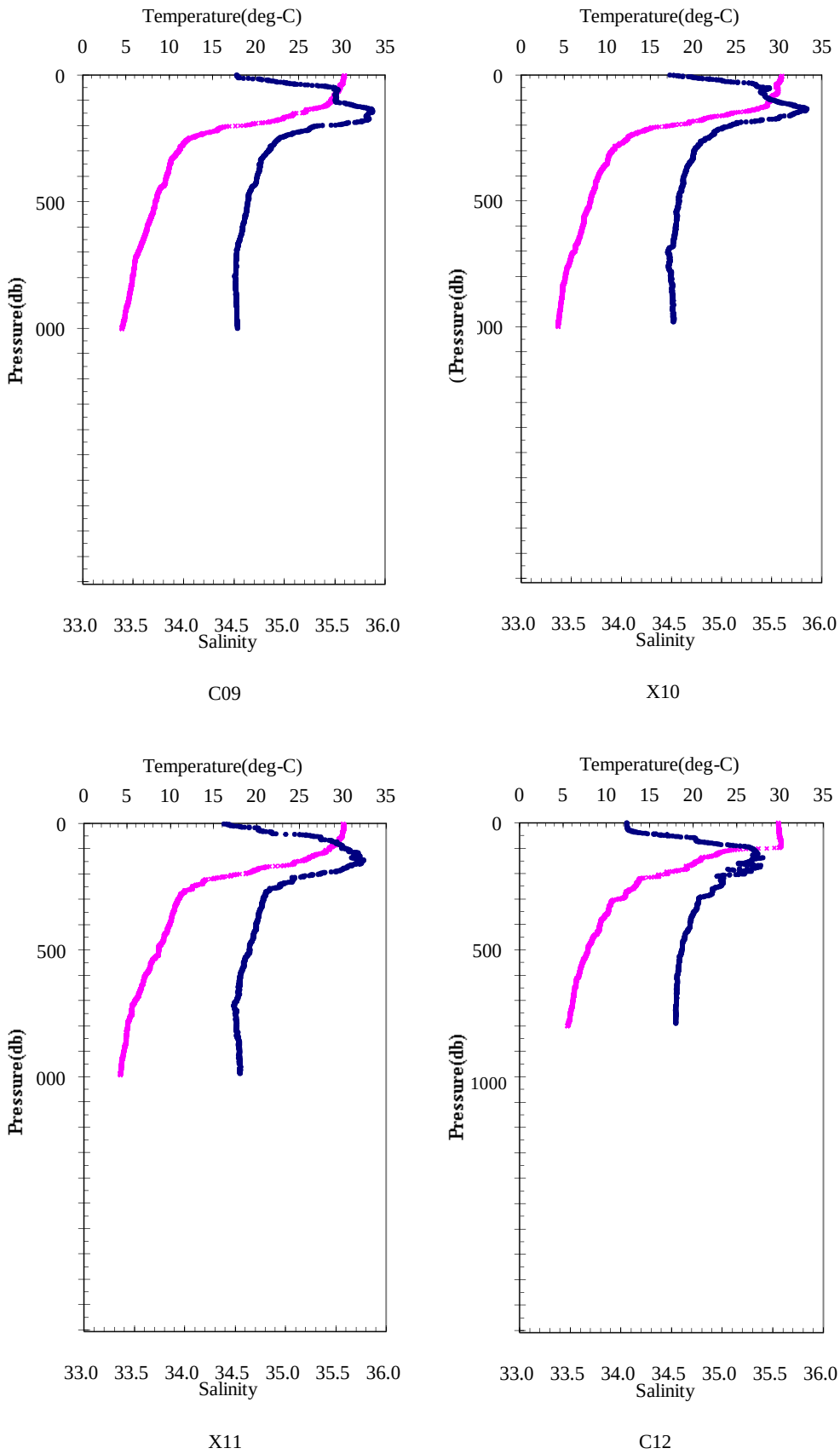


Fig.5.3.3 Vertical profiles of CTD and XCTD

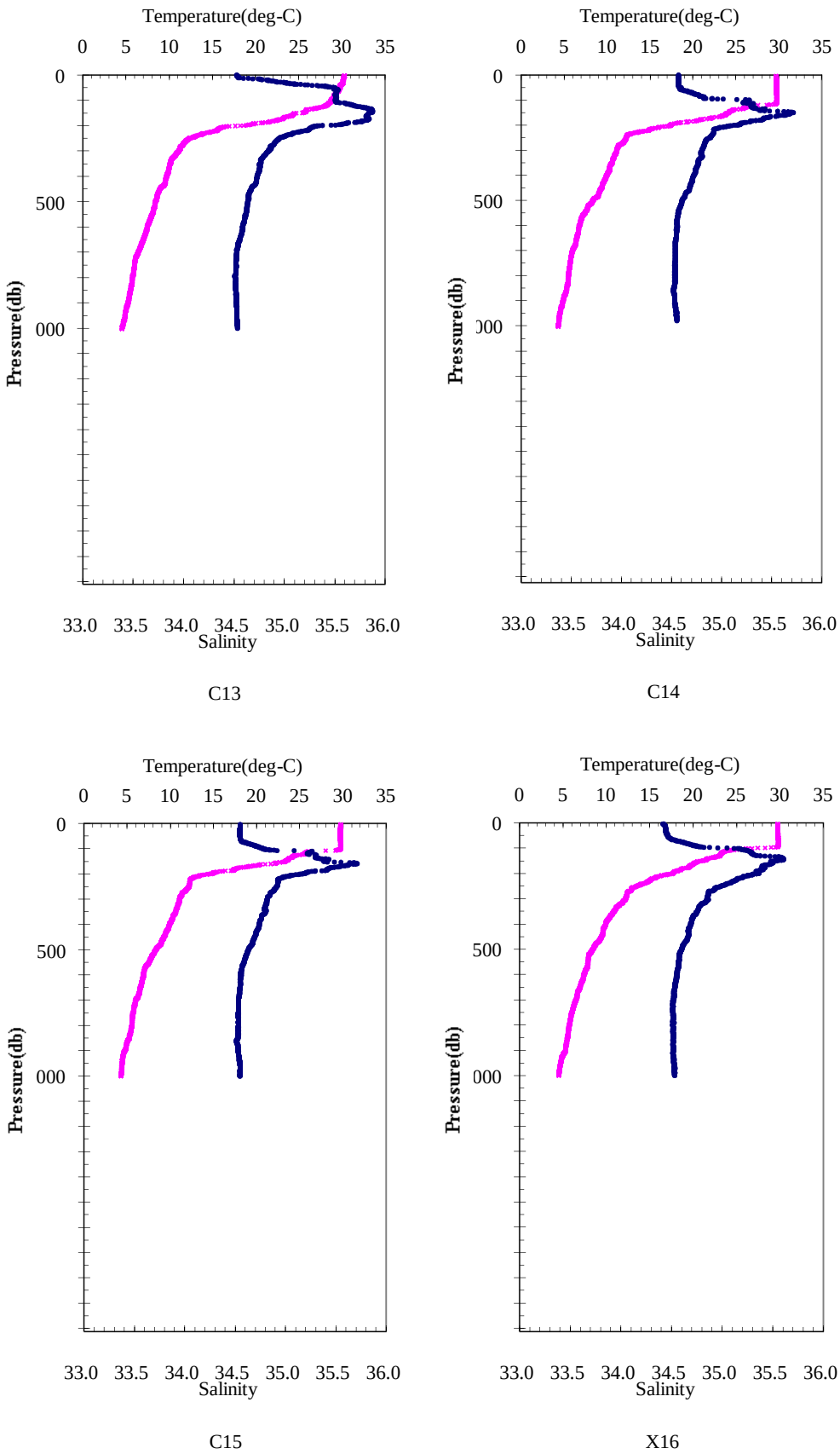


Fig.5.3.4 Vertical profiles of CTD and XCTD

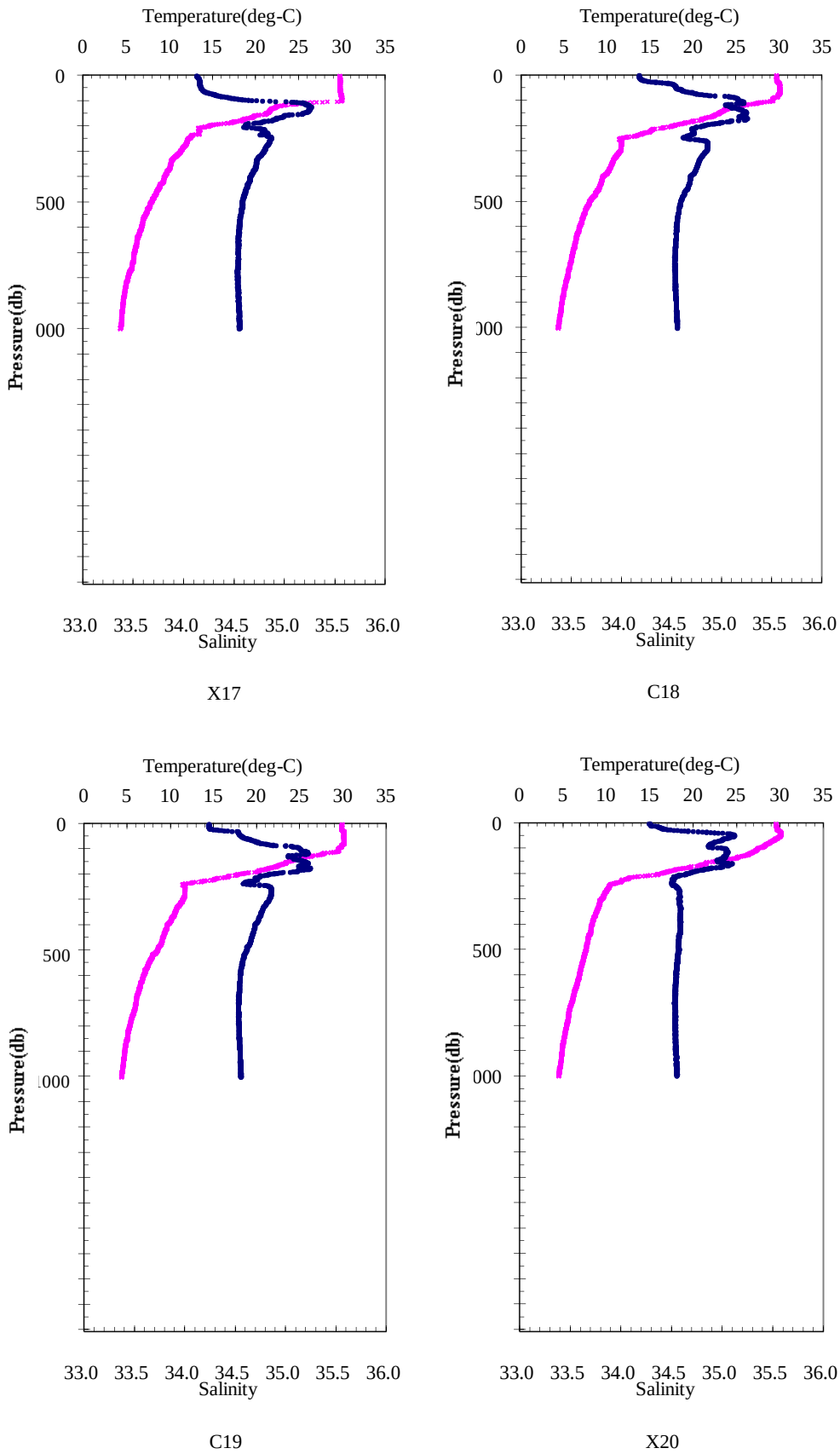
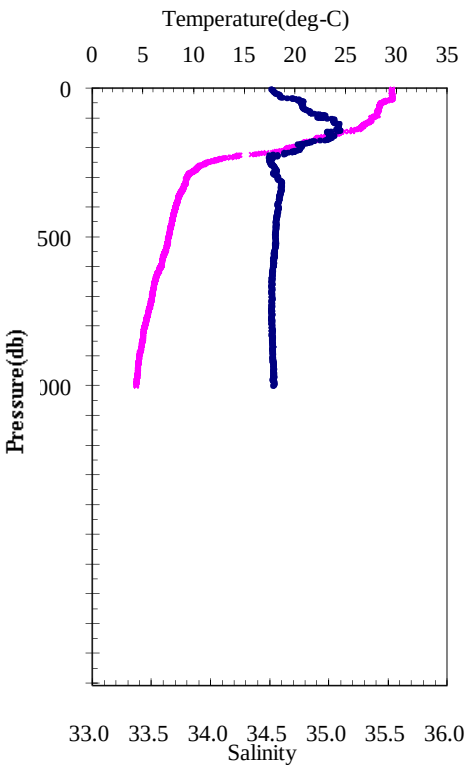
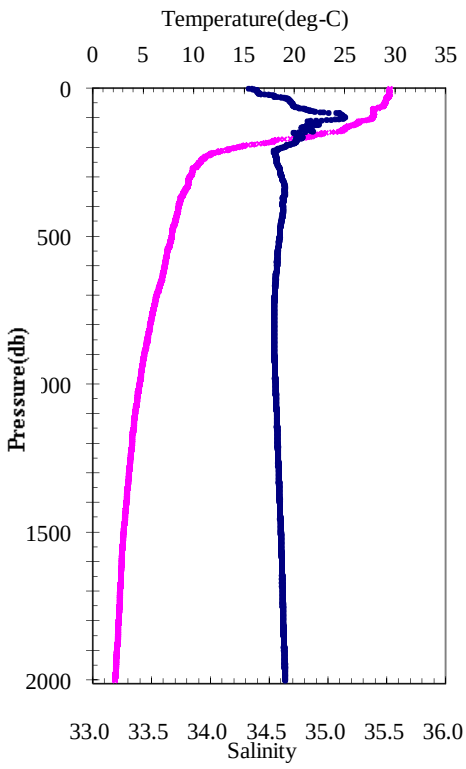


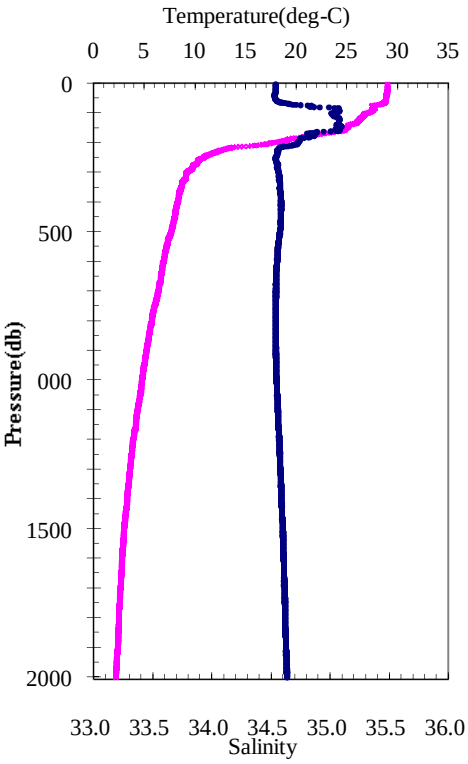
Fig.5.3.5 Vertical profiles of CTD and XCTD



X21



C22



C23

Fig.5.3.6 Vertical profiles of CTD and XCTD

5.4 Temperature and salinity sections, and T-S diagram

We observed from 8N156E to 5S156E. The figures are the cross section of temperature(ITS-90) and salinity(PSS78) and T-S diagram.

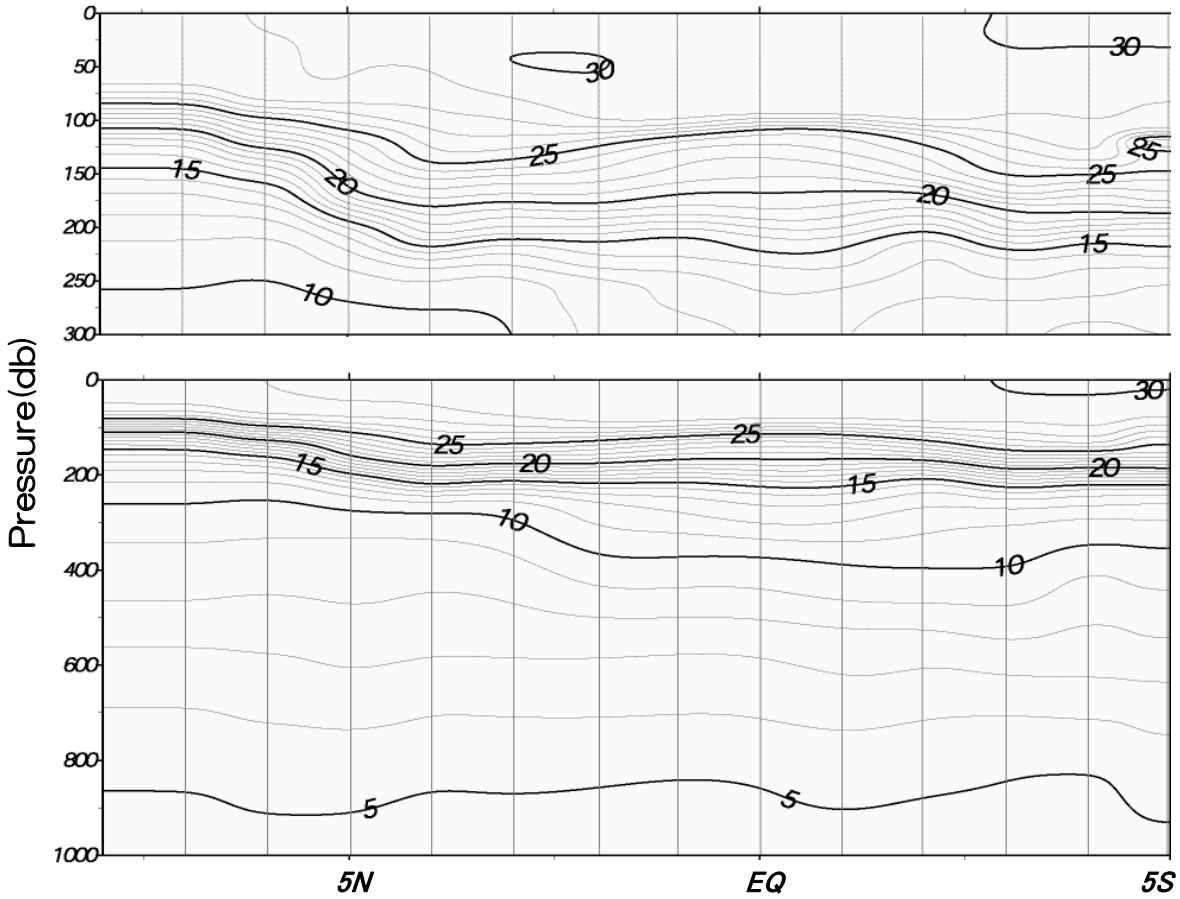


Fig.5.4.1 Temperature section along 156E

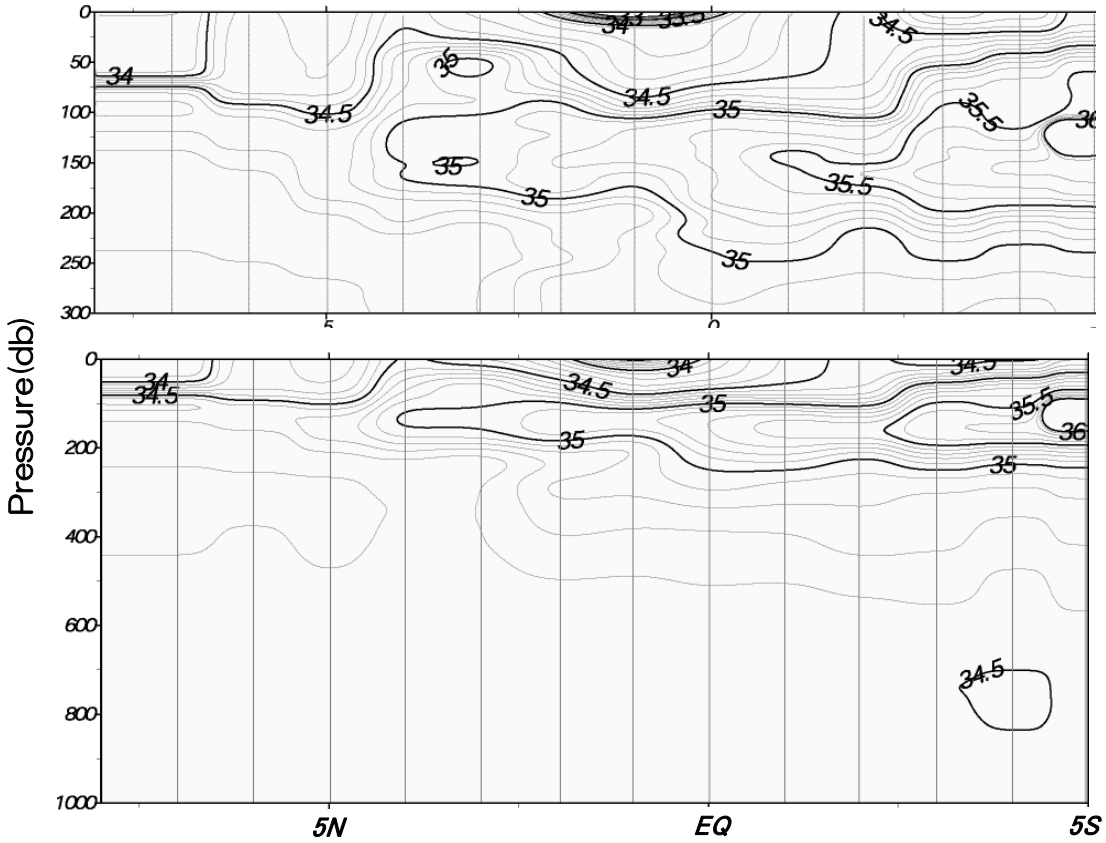


Fig.5.4.2 Salinity section along 156E

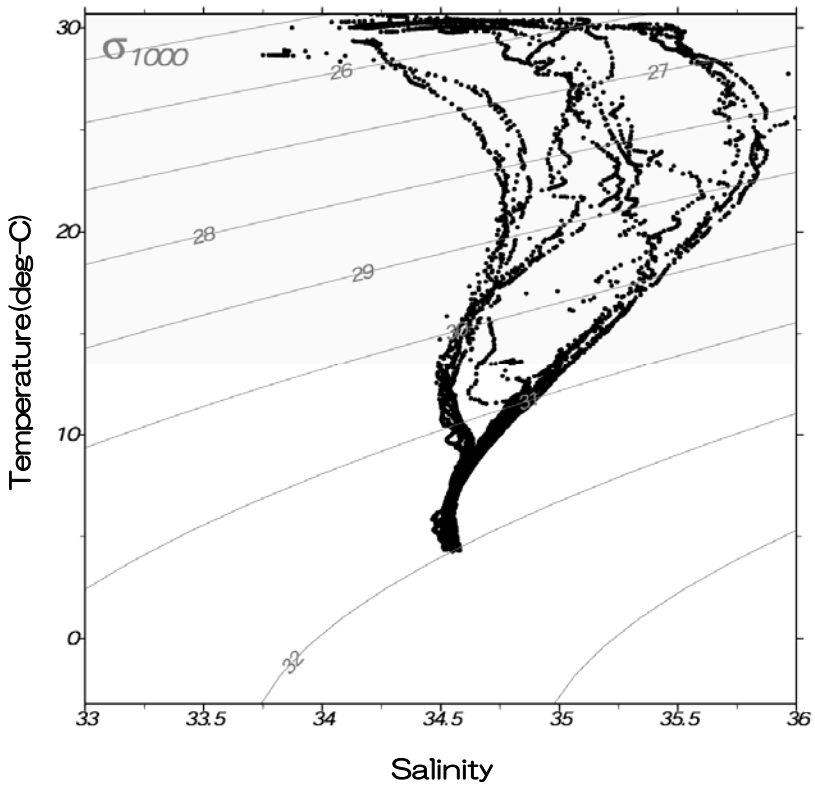


Fig.5.4.3 T-S diagram along 156E

5.5 Salinity measurements of sampled seawater for validation of CTD cast data

(1) Peronnel

Yoshifumi Kuroda	(JAMSTEC): Principal Investigator
Takeo Matsumoto	(MWJ): Operation Leader

(2) Objectives

To check the quality of CTD salinity.

(3) Parameters

Salinity of sampled water

(4) Method

Seawater samples were collected with 5-liter Niskin bottles for the deepest layer(1000 or 2000db) 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” after cruise YK04-02, which was modified by addition of an Ocean Scientific International peristaltic-type sample intake pump. The instrument was operated “101 Laboratoly” of Ocean Observation and Reserch Department, constant temperature laboratory at a bath temperature of 24 deg-C with the laboratory set under 21 deg-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 standardzations were made with IAPSO Standard Seawater batch P141 , of which 10 ampoules were consumed. These conductivity ration is 0.99993 (2K 1.99986, salinity 34.997). Sub-standard seawater was used to check the drift of the Autosal.

(5)Results

Analysis data of all samples were shown in Table.5.5.1. Ten 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 for the surface samples(See the Figure 5.5.1.).

The mean standardization drift was 0.00004 by 2K. There were 2 pairs of duplicate samples drawn. The standard deviations and mean of sample pairs were shown in table.5.5.2.

(6)Data archive

The data of salinity sample will be submitted to the JAMSTEC TOCS group of the Ocean Observation and Reserch Department.

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Table 5.5.1 Analysis data of all samples. Comparison Autosal and CTD

STATION NO.	BTL NO.	CTDPRS DBAR	CTDSAL PSS-78	BTLSAL PSS-78	DIFF.SAL SAL-CTD
C01	1	1999.5	34.6317	34.6308	-0.0009
C01	7	1999.4	34.6317	34.6326	0.0009
C02	7	2000.5	34.6366	35.1030	0.4664
C02	7	2000.5	34.6366	34.6361	-0.0005
C03	1	1000.2	34.5563	34.5561	-0.0002
C03	7	1000.4	34.5566	34.5556	-0.0010
C07	1	999.6	34.5549	34.5543	-0.0006
C07	7	1000.2	34.5557	34.5545	-0.0012
C08	1	1001.6	34.5307	34.5299	-0.0008
C08	7	1001.9	34.531	34.5345	0.0035
C09	8	1001.1	34.5306	34.5323	0.0017
C09	11	1001.2	34.5305	34.5318	0.0013
C12	1	800.6	34.5432	34.5435	0.0003
C12	7	800.3	34.5431	34.5459	0.0028
C13	1	1001.6	34.5552	34.5559	0.0007
C13	7	1001.1	34.5551	34.5548	-0.0003
C14	1	1000.7	34.5524	34.5530	0.0006
C14	7	1000.2	34.553	34.5518	-0.0012
C15	1	999.5	34.5491	34.5483	-0.0008
C15	7	1000	34.5492	34.5440	-0.0052
C18	1	1003.5	34.5594	34.5592	-0.0002
C18	7	1004.8	34.5607	34.5591	-0.0016
C19	1	1002	34.5597	34.5554	-0.0043
C19	7	1001.7	34.5594	34.5595	0.0001
C22	1	2000.2	34.6369	34.6370	0.0001
C22	7	2000.8	34.637	34.6368	-0.0002
C23	1	2000.9	34.6367	34.6356	-0.0011
C23	7	2000.6	34.6371	34.6358	-0.0013

99.9999 : No sample

Bad sample

	Average	Standard deviation
All Data	0.0163	0.0882
Removed Data	-0.0005	0.0017

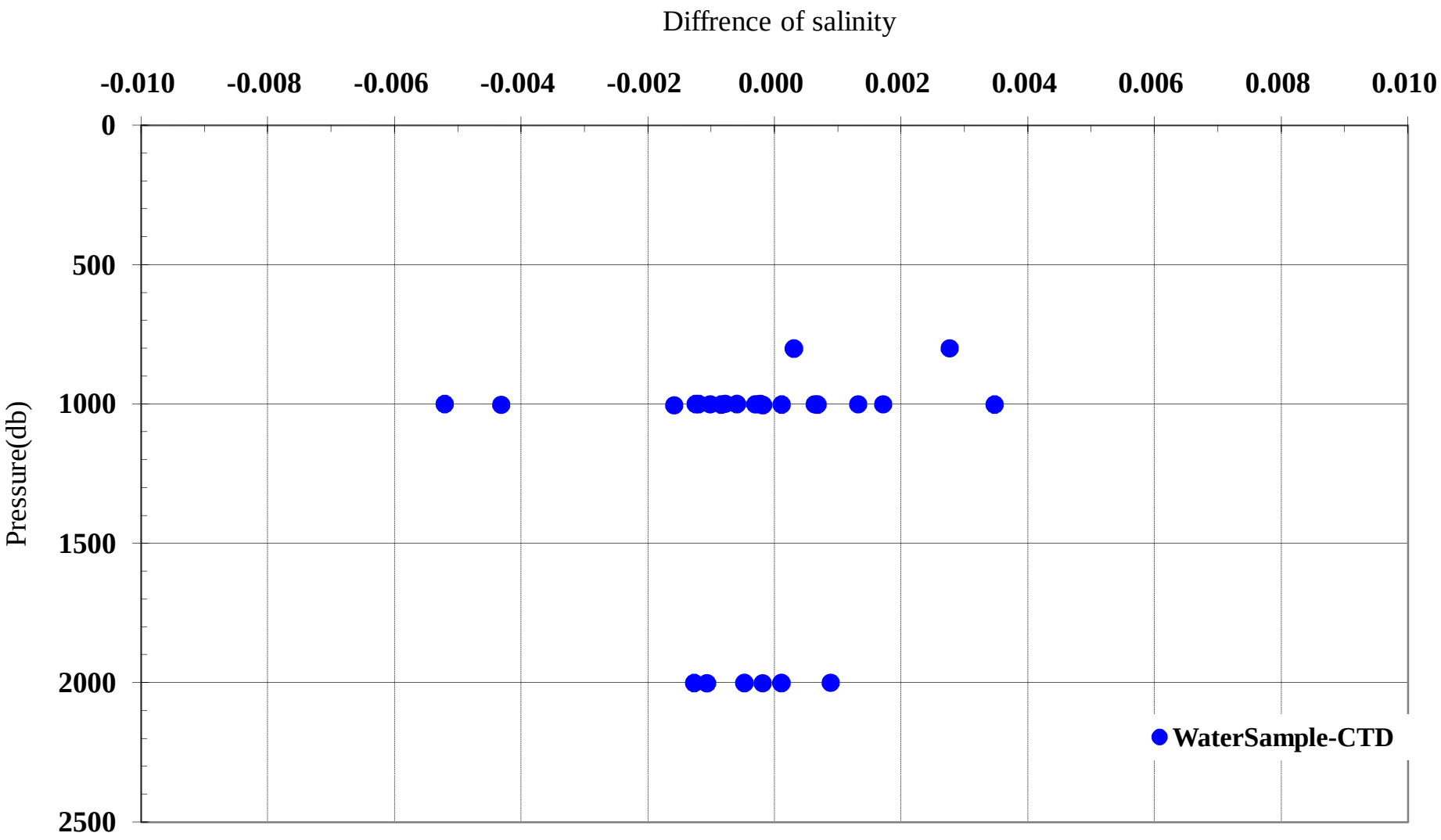


Fig 5.5.1 Difference of salinity between CTD and water samples

Table 5.5.2. There were 2 pairs of duplicate samples drawn.

STATION	BTL NO.	CTDPRS DBAR	CTDSAL PSS-78	BTLSAL1 PSS-78	BTLNBR	CTDPRS DBAR	CTDSAL PSS-78	BTLSAL2 PSS-78	COMPARI SAL-SAL1
C01	1	1999.5	34.6317	34.6308	7	1999.4	34.6317	34.6326	0.0018
C02	7	2000.5	34.6366	35.1030	7	2000.5	34.6366	34.6361	0.4668
C03	1	1000.2	34.5563	34.5561	7	1000.4	34.5566	34.5556	0.0005
C07	1	999.6	34.5549	34.5543	7	1000.2	34.5557	34.5545	0.0002
C08	1	1001.6	34.5307	34.5299	7	1001.9	34.5310	34.5345	0.0046
C09	8	1001.1	34.5306	34.5323	11	1001.2	34.5305	34.5318	0.0005
C12	1	800.6	34.5432	34.5435	7	800.3	34.5431	34.5459	0.0024
C13	1	1001.6	34.5552	34.5559	7	1001.1	34.5551	34.5548	0.0011
C14	1	1000.7	34.5524	34.5530	7	1000.2	34.5530	34.5518	0.0013
C15	1	999.5	34.5491	34.5483	7	1000	34.5492	34.5440	0.0043
C18	1	1003.5	34.5594	34.5592	7	1004.8	34.5607	34.5591	0.0001
C19	1	1002	34.5597	34.5554	7	1001.7	34.5594	34.5595	0.0041
C22	1	2000.2	34.6369	34.6370	7	2000.8	34.6370	34.6368	0.0002
C23	1	2000.9	34.6367	34.6356	7	2000.6	34.6371	34.6358	0.0002

Salinity duplicate statistics

	Average	Standard deviation	Number of pairs
All Data	0.0349	0.1243	14
Removed Data	0.0006	0.0006	9

Bad sample

6. TRITON moorings

6.1 TRITON operation

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC): Principal Investigator
Shigeki Hosoda	(JAMSTEC): Scientist
Koichi Takao	(MWJ): Technical Staff
Masaki Taguchi	(MWJ): Technical Staff
Takeo Matsumoto	(MWJ): Operation Leader
Kentaro Shiraishi	(MWJ): Technical Staff
Kei Suminaga	(MWJ): Technical Staff
Fuma Matsunaga	(MWJ): Technical Staff
Yoichi Owada	(MWJ): Technical Staff
Yuki Kako	(MWJ): Technical Staff
Naoshi Kuda	(MWJ): Technical Staff
Masaki Shinushigome	(MWJ): Technical Staff
Shiori Taguchi	(MWJ): Technical Staff
Kenzo Murata	(MWJ): Technical Staff

(2) Objectives

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

TRITON buoy array is integrated with the existing TAO(Tropical Atmosphere Ocean) array, which is presently operated by the Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration of the United States. TRITON is a component of international research program of CLIVAR (Climate Variability and Predictability), which is a major component of World Climate Research Program sponsored by the World Meteorological Organization, the International Council of Scientific Unions, and the Intergovernmental Oceanographic Commission of UNESCO. TRITON will also contribute to the development of GOOS (Global Ocean Observing System) and GCOS (Global Climate Observing System).

Seven TRITON buoys have been successfully recovered during this R/V YOKOSUKA cruise (YK04-02), six buoys deployed and one buoy visited.

(3) Measured parameters

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

(4) Instrument

1) CTD and CT

SBE-37 IM MicroCAT

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

2) CRN(Current meter)

SonTek Argonaut ADCM

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

3) Meteorological sensors

Precipitation

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 deployment

Nominal location	8N, 156E
ID number at JAMSTEC	01007
Number on surface float	T01
ARGOS PTT number	20380
ARGOS backup PTT number	07881
Deployed date	23 Jan. 2004
Exact location	08‐01.00N, 155‐57.01E
Depth	4383 m

Nominal location	5N, 156E
ID number at JAMSTEC	02007
Number on surface float	T21
ARGOS PTT number	20417
ARGOS backup PTT number	24233
Deployed date	25 Jan. 2004
Exact location	04‐59.44N, 156‐03.08E
Depth	3605 m
Option sensors	Precipitation sensor (capacitive type) on the tower

Nominal location	2N, 156E
ID number at JAMSTEC	03008
Number on surface float	T22
ARGOS PTT number	09793
ARGOS backup PTT number	24235
Deployed date	14 Feb. 2004
Exact location	01‐57.15N, 155‐59.96E

Depth	2568 m

Nominal location	EQ, 156E
ID number at JAMSTEC	04008
Number on surface float	T23
ARGOS PTT number	20451
ARGOS backup PTT number	24237
Deployed date	12 Feb. 2004
Exact location	00‐00.78S, 155‐57.88E
Depth	1941 m
Option sensors	Precipitation sensor (capacitive type) on the tower

Nominal location	2S, 156E
ID number at JAMSTEC	05006
Number on surface float	T24
ARGOS PTT number	20384
ARGOS backup PTT number	24240
Deployed date	08 Feb. 2004
Exact location	01‐59.05S, 156‐01.58E
Depth	1751 m

Nominal location	5S, 156E
ID number at JAMSTEC	06006
Number on surface float	T13
ARGOS PTT number	11823
ARGOS backup PTT number	11584
Deployed date	05 Feb. 2004
Exact location	04‐58.01S, 156‐00.99E
Depth	1510 m
Option sensors	Precipitation sensor (capacitive type) on the tower

(6) TRITON recovered

Nominal location	8N, 156E
ID number at JAMSTEC	01006
Number on surface float	T04
ARGOS PTT number	03593
ARGOS backup PTT number	24242
Deployed date	04 Jan. 2003
Recovered date	25 Jan. 2004
Exact location	07‐58.22N, 155‐59.19E
Depth	4773 m

Nominal location	5N, 156E
ID number at JAMSTEC	02006
Number on surface float	T05
ARGOS PTT number	01132
ARGOS backup PTT number	24243

Deployed date	06 Jan. 2003
Recovered date	16 Feb. 2004
Exact location	05 - 05.50N, 156 - 00.12 E
Depth	3610 m
Option sensors	Precipitation sensor (capacitive type) on the tower

Nominal location	2N, 156E
ID number at JAMSTEC	03007
Number on surface float	T06
ARGOS PTT number	09794
ARGOS backup PTT number	24244
Deployed date	04 Jan. 2003
Recovered date	14 Feb. 2004
Exact location	02 - 03.85N, 155 - 55.48 E
Depth	2577m

Nominal location	EQ, 156E
ID number at JAMSTEC	04007
Number on surface float	T07
ARGOS PTT number	03594
ARGOS backup PTT number	13065
Deployed date	02 Jan. 2002
Recovered date	09 Feb. 2004
Exact location	00 - 05.46S, 155 - 53.36 E
Depth	1954m

Nominal location	2S, 156E
ID number at JAMSTEC	05005
Number on surface float	T08
ARGOS PTT number	09426
ARGOS backup PTT number	13066
Deployed date	30 Dec. 2002
Recovered date	11 Feb. 2004
Exact location	01 - 54.20S, 155 - 56.02 E
Depth	1750 m

Nominal location	5S, 156E
ID number at JAMSTEC	06005
Number on surface float	T09
ARGOS PTT number	03779
ARGOS backup PTT number	13067
Deployed date	28 Dec. 2003
Recovered date	05 Feb. 2004
Exact location	05 - 05.21S, 155 - 59.79 E
Depth	1513 m
Option sensors	Precipitation sensor (capacitive type) on the tower

Nominal location	2N, 130E
ID number at JAMSTEC	16003
Number on surface float	T17
ARGOS PTT number	03595
ARGOS backup PTT number	07878
Deployed date	20 Jun. 2003
Recovered date	30 Jan. 2004
Exact location	03 - 13.57N, 129 - 04.37 E
Depth	4319m
Option sensors	CT at 175 m : S/N 0615

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

(6) Details of deployed

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

Deployed TRITON buoys

Observation No.	Location.	Details.
01007	8N156E	Deploy with full spec.
02007	5N156E	Deploy with full spec and one optional precipitation sensor.
03008	2N156E	Deploy with full spec.
04008	EQ156E	Deploy with full spec and one optional precipitation sensor.
05006	2S156E	Deploy with full spec.
06006	5S156E	Deploy with full spec and one optional precipitation sensor.

(7) Data archive

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

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

6.2 Inter-comparison between shipboard CTD and TRITON data

(1) Personnel

Kentaro Ando	(JAMSTEC): Plincipal Investigator not on board
Takeo Matsumoto	(MWJ): Operation Leader
Tetsuya Nagahama	(MWJ): Technical Staff not on board

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

・Temperature
・Conductivity
・Pressure

(4) Methods

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

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

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

(5) Results

Most of temperature, conductivity and salinity data from TRITON buoy showed good agreement with CTD cast data in T-S diagrams. See the Figures 6.2.1(a), (b).

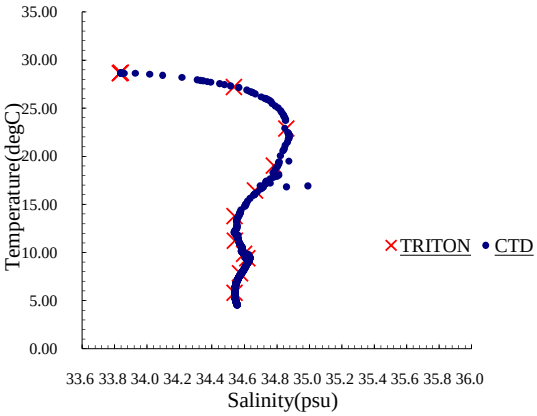
To evaluate the performance of the conductivity sensors on TRITON buoy, the data from had deployed buoy and shipboard CTD data at the same location were analysed.

The estimation were calculated as recovered buoy data minus shipboard CTD (9Plus) data. The salinity differences are from –0.330 to 0.120 psu for all depths. Below 300db, salinity differences are from –0.021 to 0.006 psu (See the Figures 6.2.2 (a) and Table 6.2.2 (a)). The average of salinity differences was 0.010 psu with standard deviation of 0.072 psu.

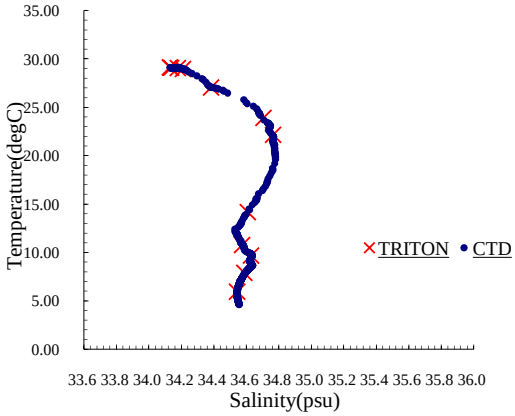
The estimation were calculated as deployed buoy data minus shipboard CTD data. The salinity differences are from –0.165 to 0.171 psu for all depths. Below 300db, salinity differences are from –0.019 to 0.001 psu (See the Figures 6.2.2 (b) and Table 6.2.2 (b)). The average of salinity differences was －0.002 psu with standard deviation of 0.043 psu.

(6) Data archive

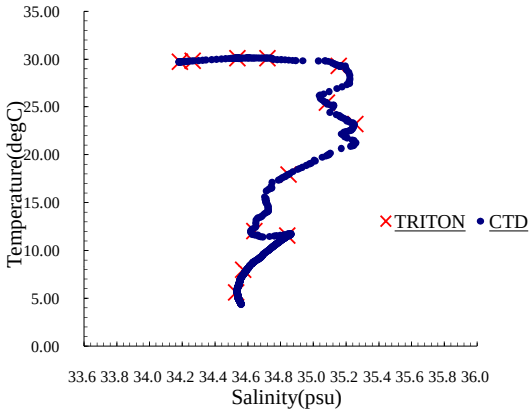
All raw and processed CTD data files were copied on 3.5 inch magnetic optical disks and submitted to JAMSTEC TOCS group of the Ocean Observation and Research Department. All original data will be stored at JAMSTEC Mutsu brunch. (See section 5)



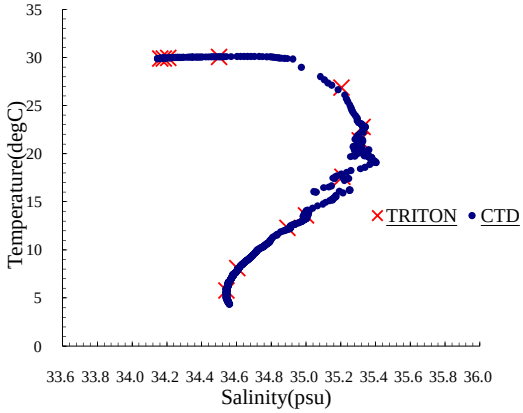
Observation No. 01007 after Deployment



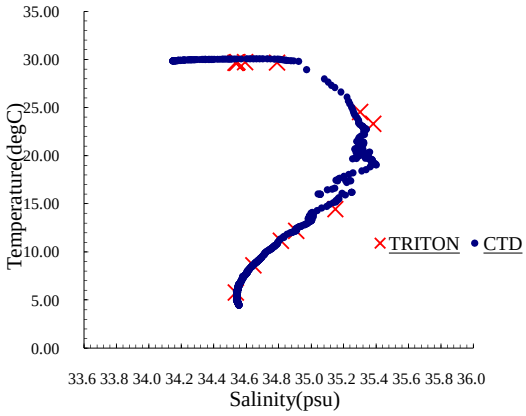
Observation No. 02007 after Deployment



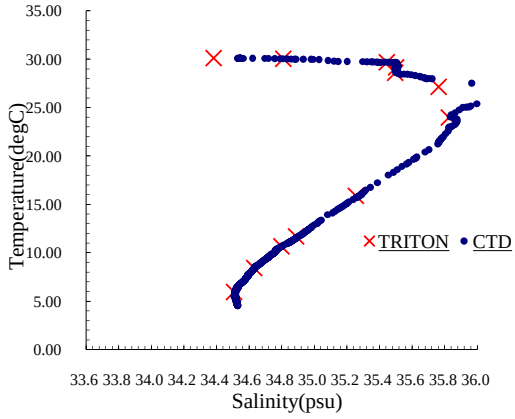
Observation No. 03008 after Deployment



Observation No. 04008 after Deployment

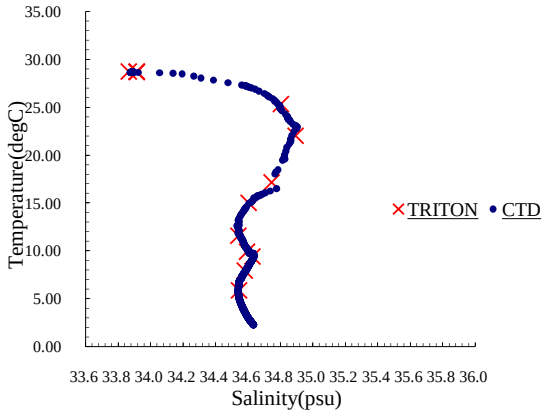


Observation No. 05006 after Deployment

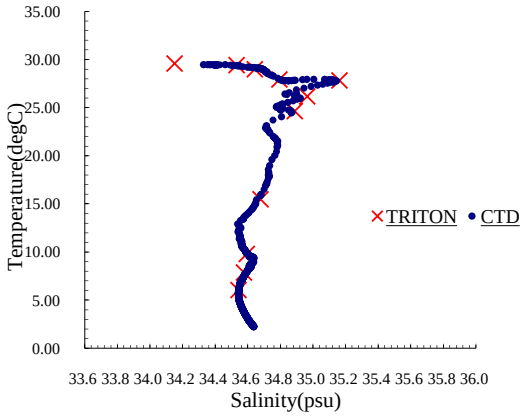


Observation No. 06006 after Deployment

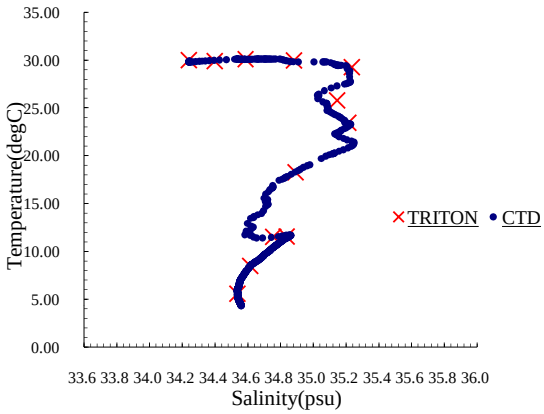
Fig.6.2.1 (a) T-S diagram of TRITON buoys data and shipboard CTD data



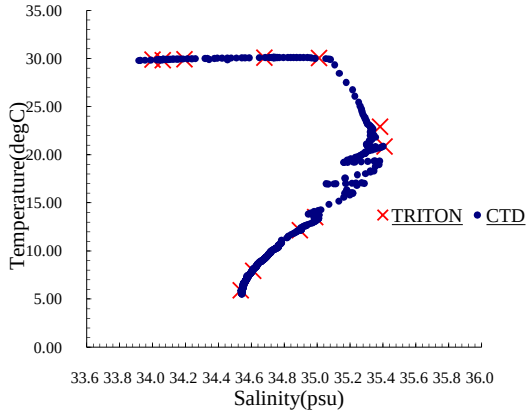
Observation No. 01006 before Recovery



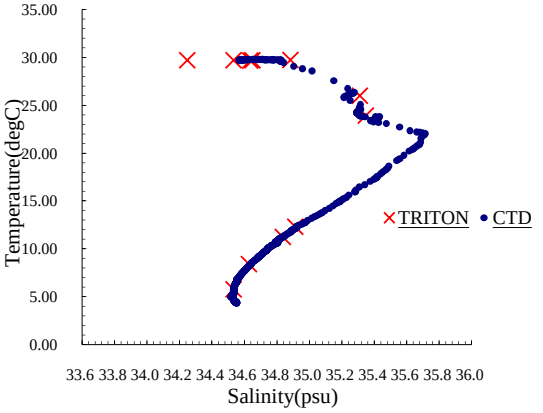
Observation No. 02006 before Recovery



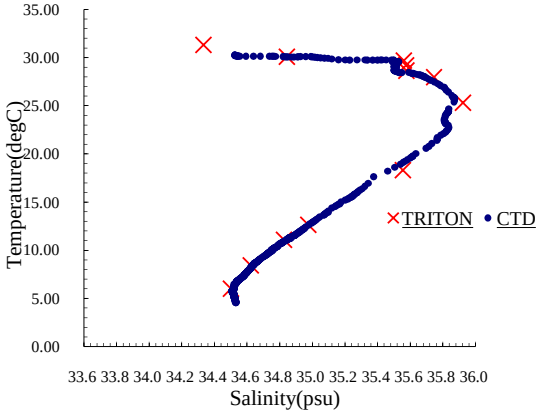
Observation No. 03007 before Recovery



Observation No. 04007 before Recovery



Observation No. 05005 before Recovery



Observation No. 06005 before Recovery

Fig.6.2.1 (b) T-S diagram of TRITON buoys data and shipboard CTD data

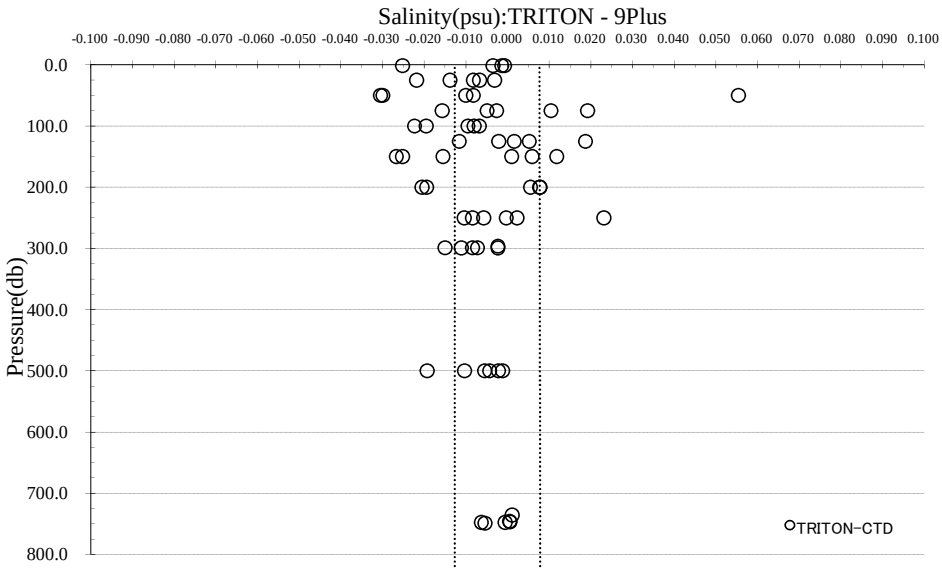


Fig.6.2.2 (a) Salinity differences between TRITON buoys data and shipboard CTD data after deployment

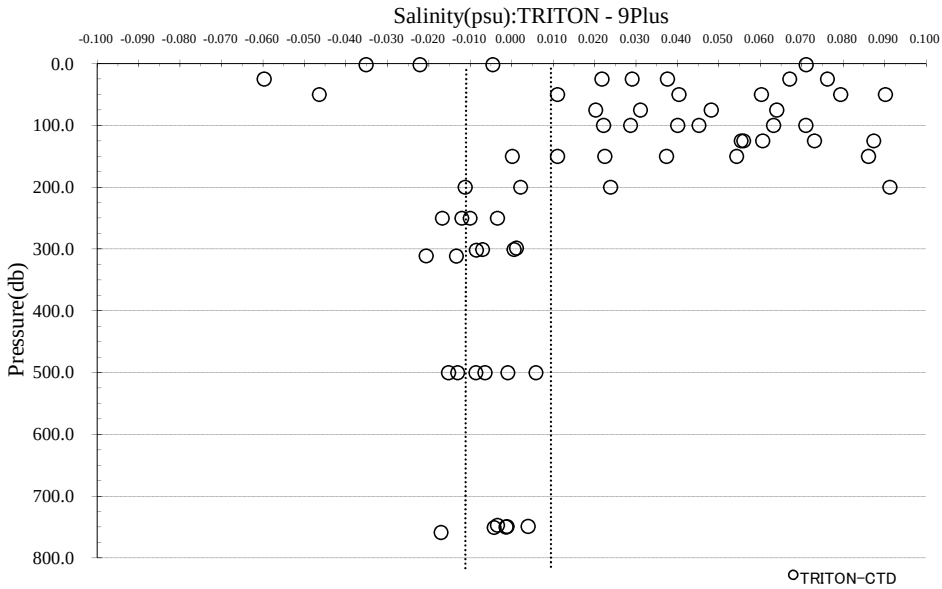


Fig.6.2.2 (b) Salinity differences between TRITON buoys data and shipboard CTD data before recovery

Table 6.2.1(a) Data differences between TRITON buoy data and ship board CTD data after deployment

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
01007	1.5	0.00	0.000	-0.001
01007	25.0	-0.02	-0.003	-0.007
01007	50.0	0.06	0.002	-0.030
01007	75.0	-0.03	-0.001	0.010
01007	100.0	0.06	0.004	-0.022
01007	125.0	0.15	0.014	-0.012
01007	150.0	-0.03	-0.006	-0.025
01007	200.0	-0.01	-0.003	-0.020
01007	250.0	0.01	0.001	0.002
01007	298.8	0.00	-0.002	-0.015
01007	500.0	0.00	-0.001	-0.010
01007	745.9	0.00	0.000	0.001
02007	1.5	0.01	0.001	-0.001
02007	25.0	0.00	0.000	-0.003
02007	50.0	0.00	-0.002	-0.010
02007	75.0	0.00	-0.001	-0.003
02007	100.0	0.00	-0.001	-0.008
02007	125.0	-0.21	-0.019	0.019
02007	150.0	0.05	0.006	0.006
02007	200.0	0.20	0.020	0.008
02007	250.0	0.00	0.000	-0.006
02007	299.0	0.00	0.000	-0.007
02007	500.0	0.00	0.000	-0.005
02007	747.6	0.00	0.000	-0.001
03008	1.5	0.00	-0.005	-0.025
03008	25.0	0.00	-0.001	-0.008
03008	50.0	0.00	-0.005	-0.031
03008	75.0	0.00	-0.003	-0.016
03008	100.0	0.00	-0.002	-0.020
03008	125.0	0.00	0.001	0.005
03008	150.0	0.00	0.002	0.012
03008	200.0	-0.01	-0.001	0.005
03008	250.0	-0.02	0.000	0.023
03008	298.9	0.00	-0.001	-0.008
03008	500.0	0.00	-0.002	-0.019
03008	747.7	-0.08	-0.008	-0.006
04008	1.5	0.06	0.031	0.171
04008	25.0	-0.01	0.017	0.123
04008	50.0	0.03	0.019	0.103
04008	75.0	-0.04	-0.026	-0.149
04008	100.0	-3.19	-0.305	0.237
04008	125.0	-0.12	-0.013	-0.002
04008	150.0	0.53	0.053	-0.016
04008	200.0	0.64	0.077	0.108
04008	250.0	0.09	0.009	0.000
04008	296.3	0.14	0.013	-0.002
04008	500.0	0.17	0.016	-0.001
04008	735.6	-0.12	-0.011	0.001

Table 6.2.1(a) Data differences between TRITON buoy data and ship board CTD data after deployment

Observation No.	Pressure (db)	Temperature (degC)	Conductivety (S/m)	Salinity (psu)
05006	1.5	0.00	-0.002	-0.004
05006	25.0	-0.02	-0.004	-0.014
05006	50.0	-0.02	-0.004	-0.008
05006	75.0	0.00	0.003	0.019
05006	100.0	0.00	-0.001	-0.007
05006	125.0	0.02	0.003	0.002
05006	150.0	0.01	0.002	0.001
05006	200.0	0.06	0.007	0.008
05006	250.0	0.00	-0.001	-0.010
05006	299.3	0.01	0.000	-0.011
05006	500.0	0.02	0.002	-0.004
05006	746.9	0.01	0.001	0.001
06006	1.5	0.00	-0.025	-0.163
06006	25.0	0.01	-0.002	-0.022
06006	50.0	0.00	0.008	0.055
06006	75.0	-0.04	-0.005	-0.005
06006	100.0	-0.01	-0.003	-0.009
06006	125.0	-0.01	-0.244	-1.740
06006	150.0	-0.06	-0.009	-0.027
06006	200.0	-0.01	-0.003	-0.019
06006	250.0	0.04	0.003	-0.008
06006	299.2	0.00	-0.001	-0.002
06006	500.0	0.01	0.001	-0.002
06006	748.8	0.00	-0.001	-0.005

Bad data

7. ADCP mooring

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC): Principal Investigator
Shigeki Hosoda	(JAMSTEC): Investigator
Masaki Taguchi	(MWJ): Operation Leader
Koichi Takao	(MWJ): Technical Staff
Takeo Matsumoto	(MWJ): Technical Staff
Fuma Matsunaga	(MWJ): Technical Staff
Kentaro Shiraishi	(MWJ): Technical Staff
Kei Suminaga	(MWJ): Technical Staff

(2) Objectives

The purpose is to get the knowledge of subsurface currents condition in the western equatorial pacific. In this cruise (YK04-02), we recovered and deployed a subsurface ADCP mooring at (Eq-156E).

(3) Parameters

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

(4) Methods

The mooring consists of a top float , senseors , ropes which length is about 2000 m, some additional floats , two releasers and anchor. Two sensors are mounted in the top float for observation. One is ADCP (Acoustic Doppler Current Profiler) to observe current profiles upward and the other is CTD to observe pressare, temperature and conductivity.

1) ADCP

Self-Contained Broadband ADCP 150 kHz (RD Instruments)
Distance to first bin : 17m
Pings per ensemble : 16
Time per ping : 2.00s
Bin length : 8.00m
Sampling Interval : 3600s

Recovered

- Serial Number : 1151 (Mooring No. 021013-00156E)

Deployed

- Serial Number : 1155 (Mooring No.040211-00156E)

2) CTD

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

Recovered

- Serial Number : 2611 (Mooring No.021013-00156E)

Deployed

- Serial Number : 1284 (Mooring No.040211-00156E)

(5) Deployment

The ADCP mooring was deployed at (Eq-156E). The mooring was planed to make the ADCP buoy

placed at about 300m.
Position of the mooring was shown below.

Results of calibration
・Mooring No.040211-00156E
11-Feb. 2004 Lat: 00°00.01N Long: 156°08.41E Depth: 1958m

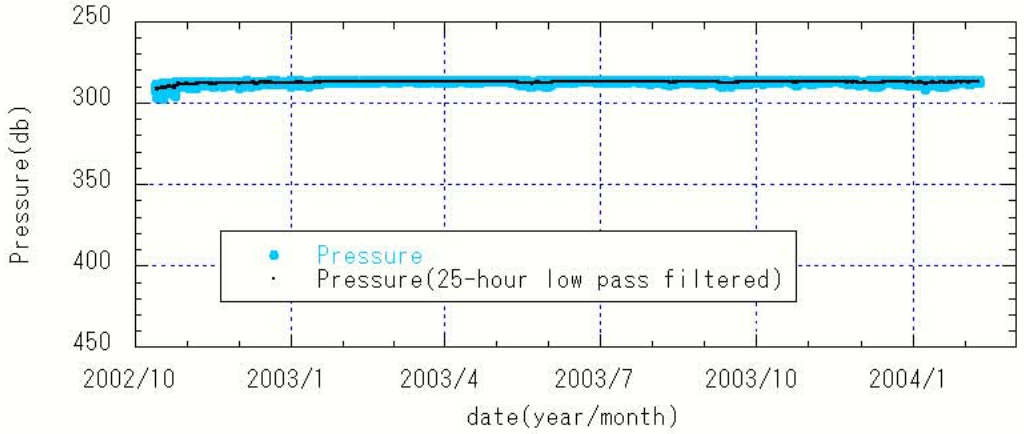
(6) Recovery

We recovered the ADCP mooring which was deployed on 13 Oct.2002 (KY02-10 cruise).

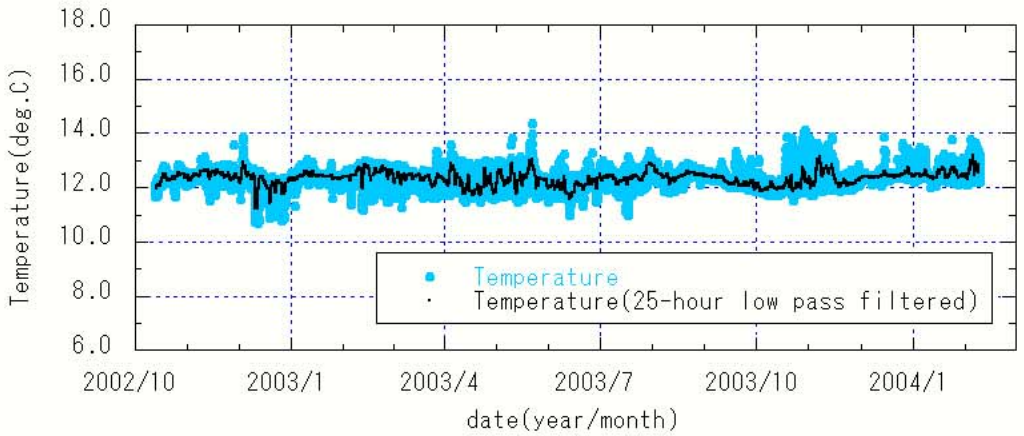
After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. Results were shown in figures on following pages. Figure 7.1 shows CTD pressure, temperature and salinity. Figures 7.2 and 7.3 show the time series and current profiles of the ADCP.

(7) Data archive

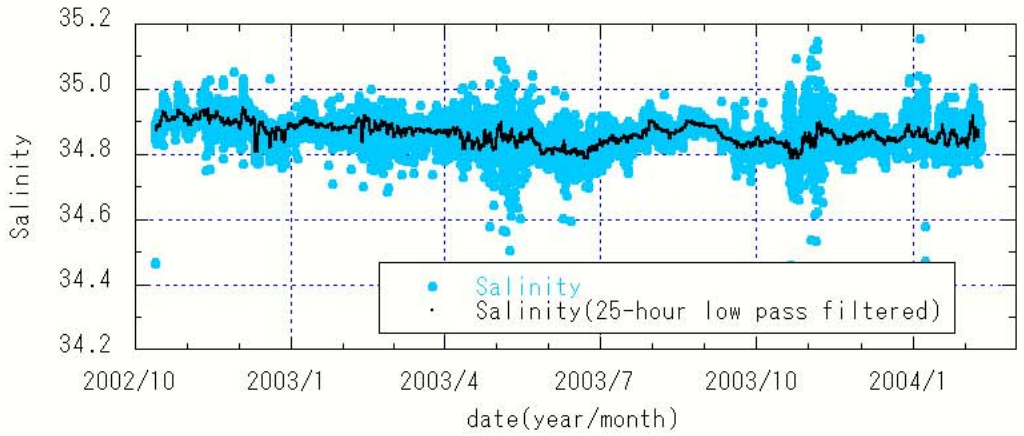
The current data will be reconstructed using CTD pressure data. All data, including CTD data, will be archived by The JAMSTEC TOCS group of The Ocean Observation and Research Department.



(a) Pressure



(b) Temperature



(c) Salinity

Fig.7.1 Time series of CTD data (EQ-156E, SBE-16).

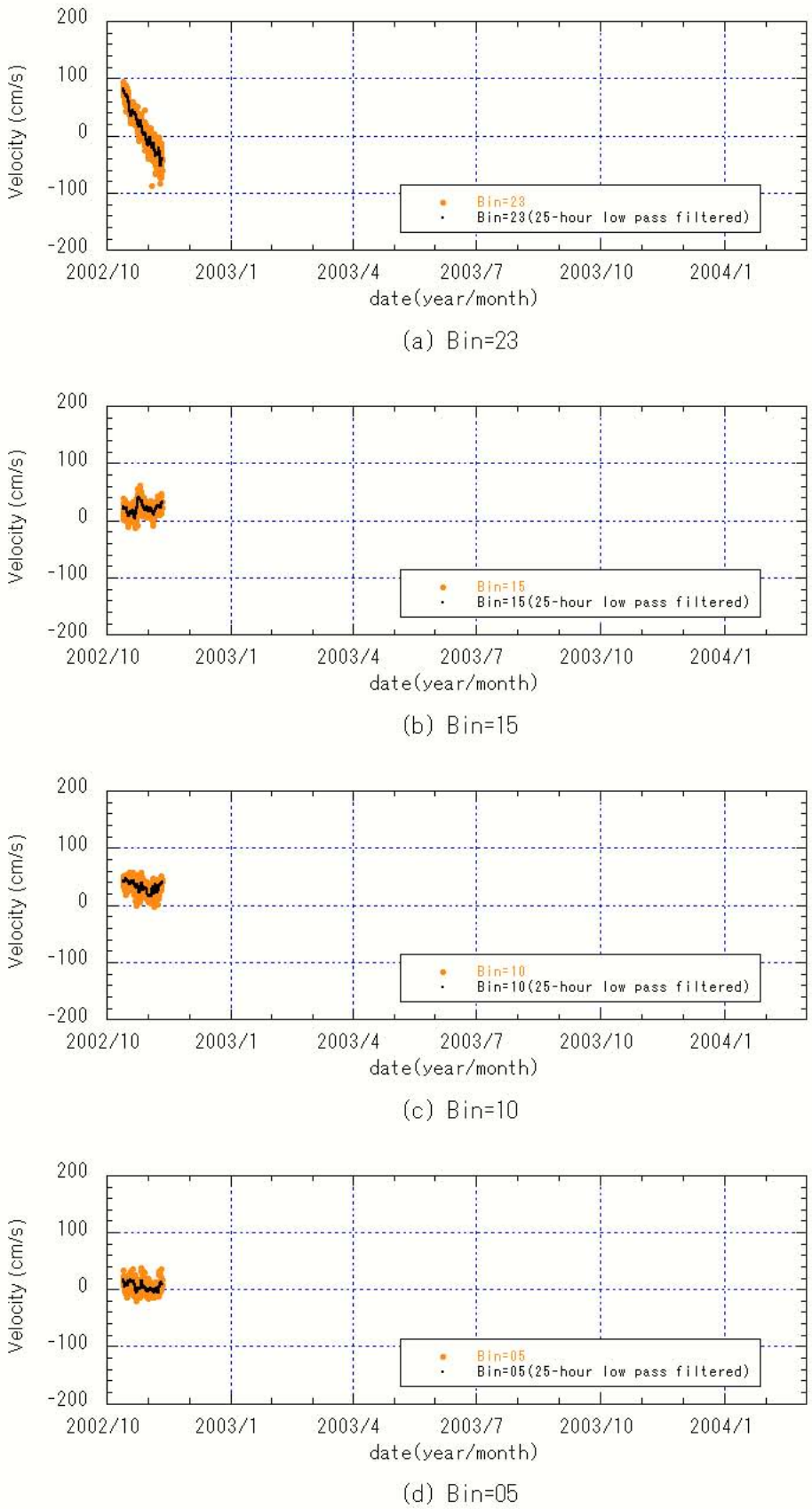


Fig.7.2(1) Time series of ADCP data (EQ-156E, Zonal component).

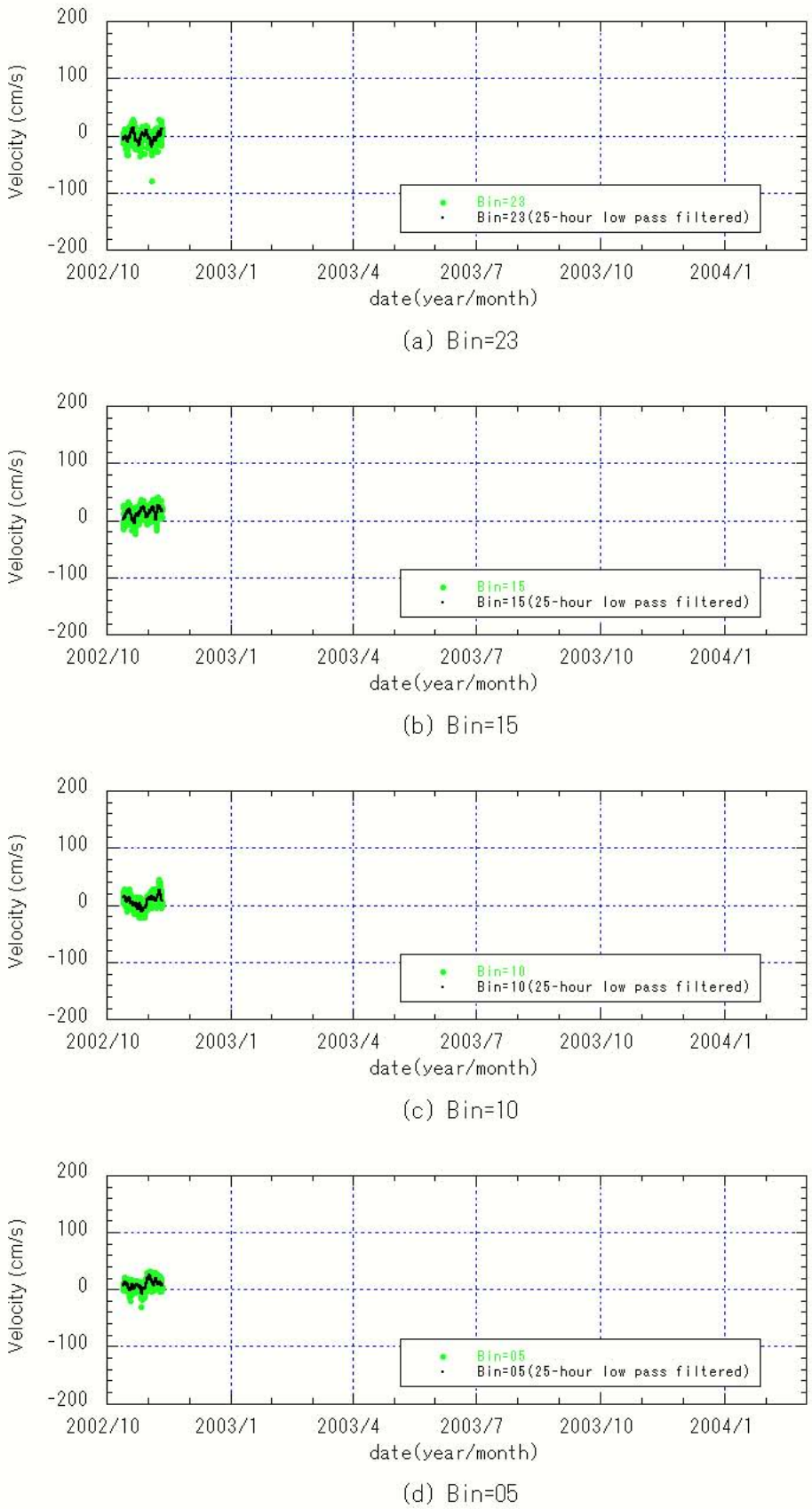
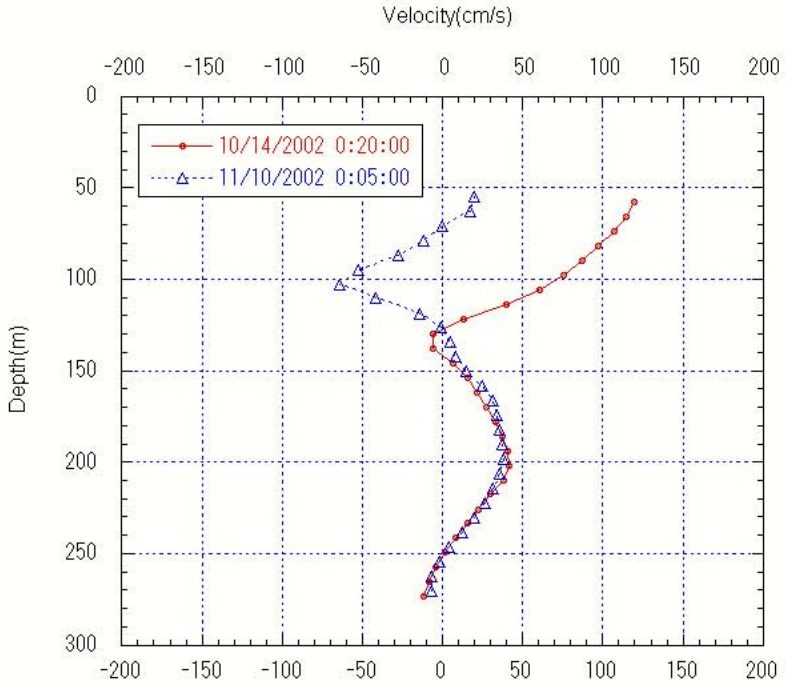
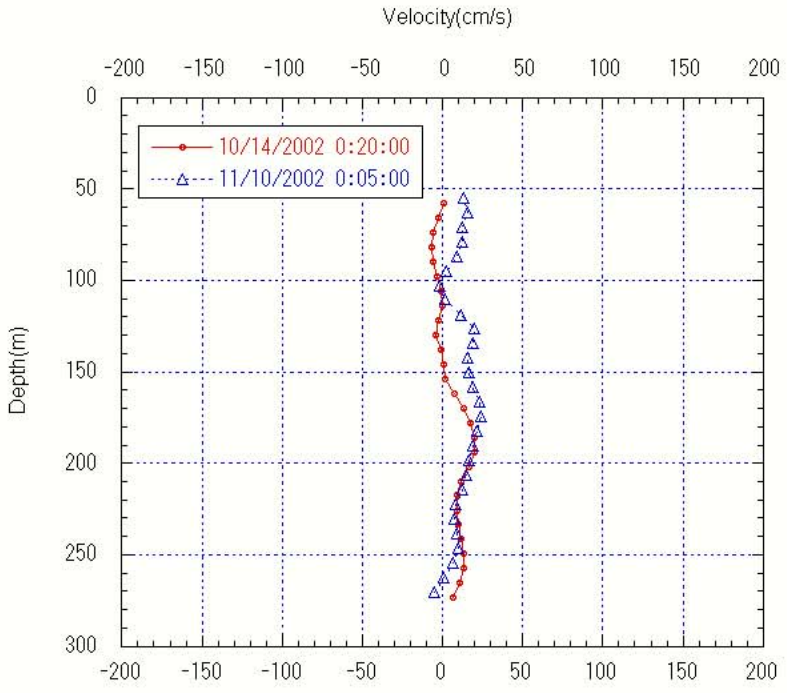


Fig.7.2(2) Time series of ADCP data (EQ-156E, Meridional component).



(a) Zonal component



(b) Meridional component

Fig.7.3 Current profiles of ADCP data (EQ-156E, 25-hour low pass filtered).