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R/V Mirai Cruise Report
MR99-K01

February 8-March31, 1999
Tropical Ocean Climate Study (TOCS)

Edited by
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(JAMSTEC)

Contents

1. Introduction

The purpose of this cruise is to observe physical oceanographic conditions in the western tropical Pacific Ocean to achieve a 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. Especially, 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 few rainfall when the "El Nino" occurred, as in 1997-98. This atmospheric and oceanic systems is so complicated, and we still do not have enough knowledge about it. This climate system have the long time scale. To investigate the mechanism, we need precise and detailed data for the long period continuously. 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. We have successfully deployed during this R/V Mirai cruise, although we must have recovered one TRITON buoy because of unexpected. It is the first step to establish long-term measurements for the TRITON program.

2. Summary

2.1 Ship

R/V Mirai
Captain Takaaki Hashimoto
Total 35 crew members

2.2 Cruise code

MR99-K01

2.3 Project name

Tropical Ocean Climate Study

2.4 Undertaking institution

Japan Marine Science and Technology Center (JAMSTEC)
2-15, Natsushima, Yokosuka, 237, Japan

2.5 Chief scientist

Yoshifumi Kuroda (JAMSTEC)

2.6 Period

February 8 , 1999 - March 31, 1999

2.7 Ports of call

Hachinohe, Japan	(Departure; February 8, 1999)
Guam, USA	(February 13-14, 1999)
Honiara, Solomon Islands	(March 10-12, 1999)
Chuuk, Federated States of Micronesia	(March 24-25, 1999)
Shimonoseki, Japan	(Arrival; March 31, 1999)

2.8 Research participants

Total 30 scientists and technical stuff participated from 8 different institutions and universities.

2.9 Observation summary

TRITON buoy deployment: 9 sites (one at 0,156E was recovered because of adrift)

CTD/DO (Salinity, Temperature, Depth, Dissolved Oxygen):
35 casts down to 1000m (including 3 CTD casts in 24 hour at each TRITON buoy sites for data validation)

Surface meteorology: continuous

Atmospheric sounding: 61 times

ADCP measurements: continuous

Doppler radar measurements: continuous

Surface temperature, salinity measurements by intake method: continuous

Other specially designed observations have been carried out sucessfully.

2.10 Observed oceanic and atmospheric conditions

This MR99-K01 cruise has been carried out under a La Nina stage after the recovery from historical 1997-1998 El Nino event. Along the 147E section, 8-13 m/s easterly trade wind was dominant. Swell was 2-3 m high due to prevailed trade winds and developed northern north Pacific Low, which made rather difficult buoy deployment operation. Warm water was well accumulated in the western tropical Pacific as the 29 deg-C water covered surface 100 m from the equator to 5N along 147E. The warm water was also observed 4N-5N and 3S-5S along 156E, but the equator of 2S-2N temperature was relatively cool as 28 deg-C which is caused by equatorial upwelling by prevailed easterly trade winds. The tendency was same at 165E, the trade wind was dominant and the surface water was quite low as 27 deg-C at the equator. Large scale cloud system frequently popped up over the tropical ocean west of 150E, and Papua New Guinea to Solomon Islands. The former may be caused by the high sea surface temperature and latter is associated with the seasonally migrated Inter Tropical Convergence Zone. Along the equator, the freshened surface mixing layer of 34.2 psu was observed at 147E which was about 1 psu lower than those at 156E and 165E. This is evidence of heavy local precipitation in the west. As above, the warm water in the western tropical Pacific Ocean has been well accumulated and made convection system active in that region.

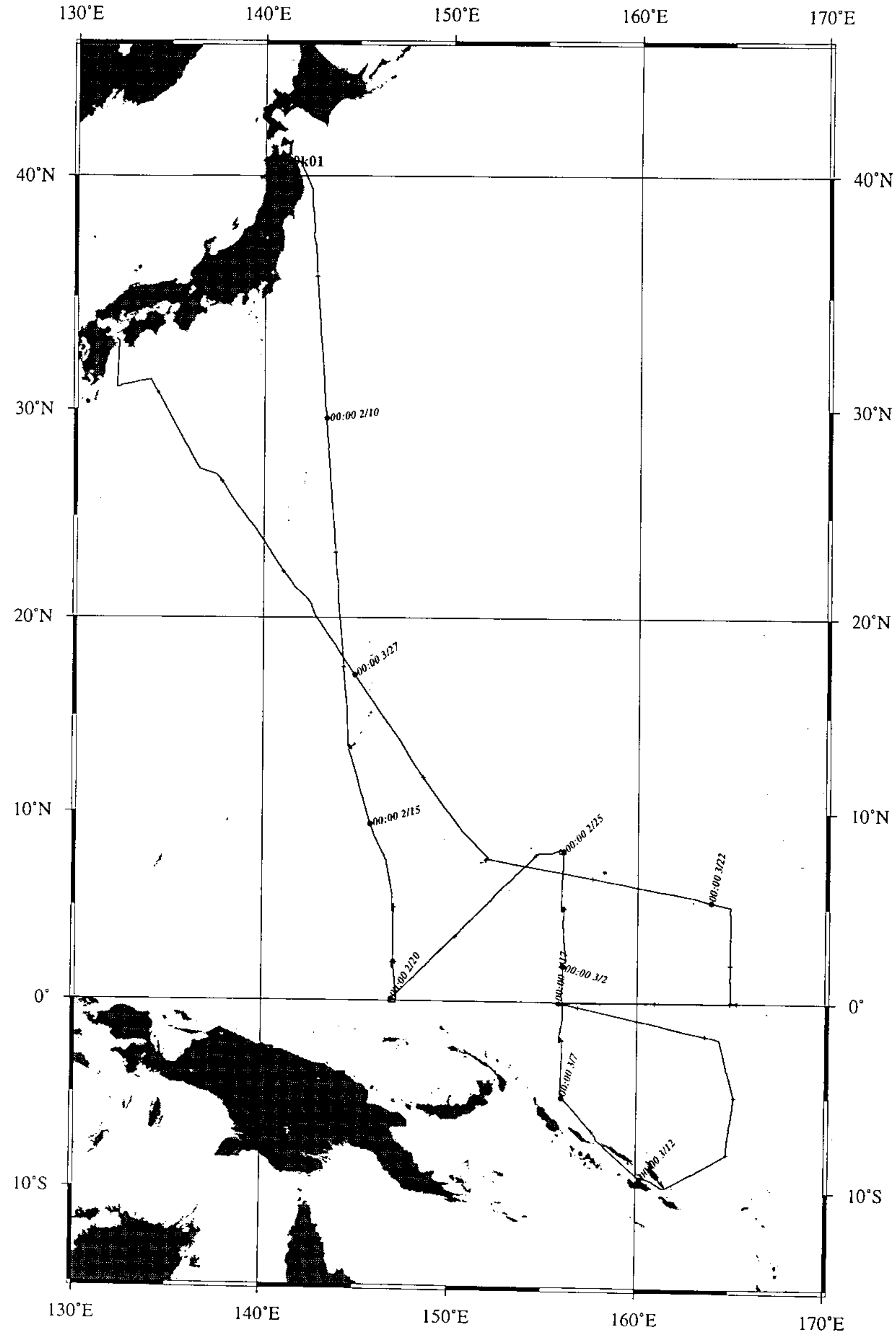
3. Cruise Track

(1) Cruise track

(2) TRITON sites

(3) TRITON and ATLAS sites

(4) Radio sonde sites

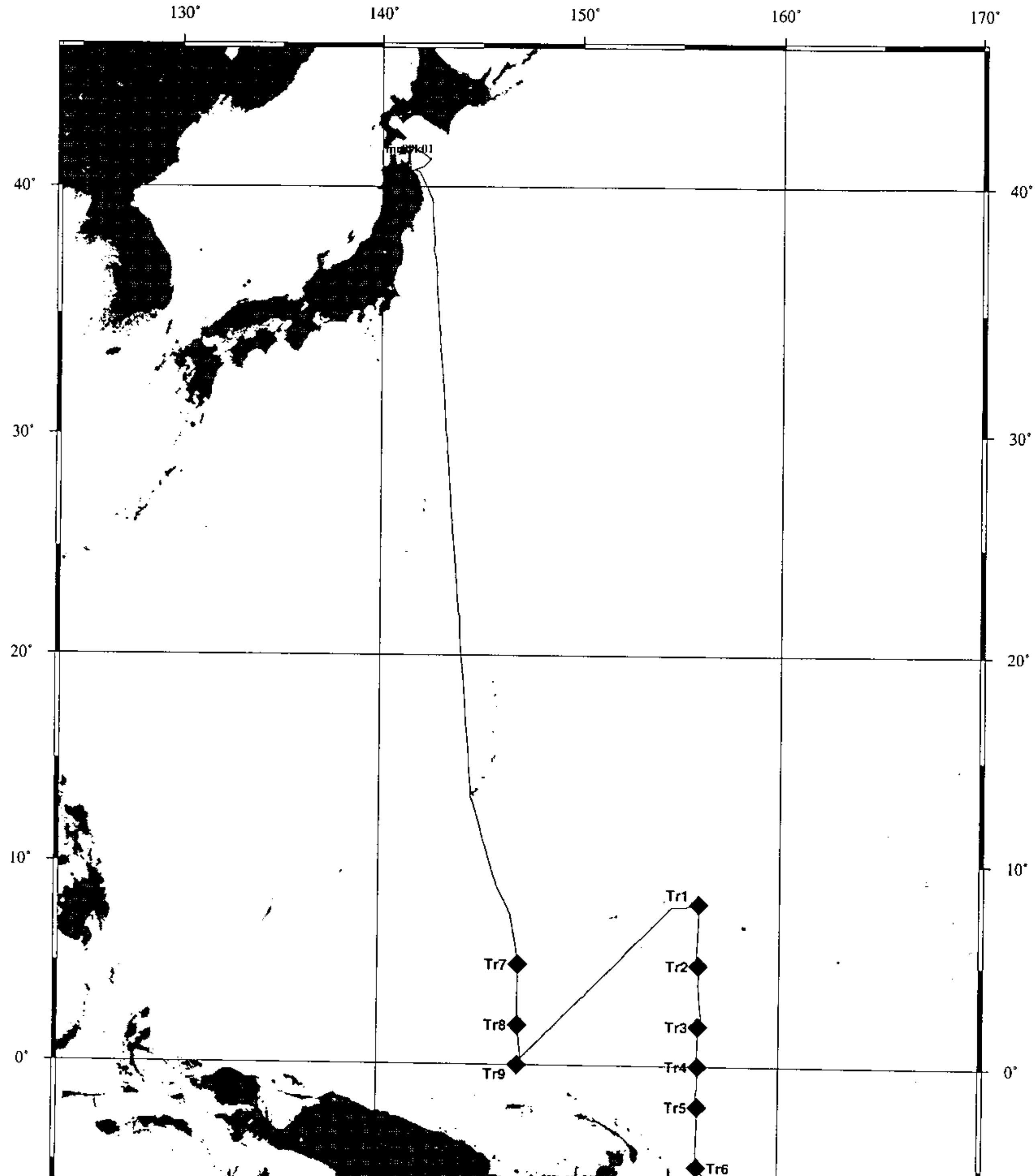


Ship Track (MR99-K01)

GMT Mar 31 05:11

Mercator Projection

on board report

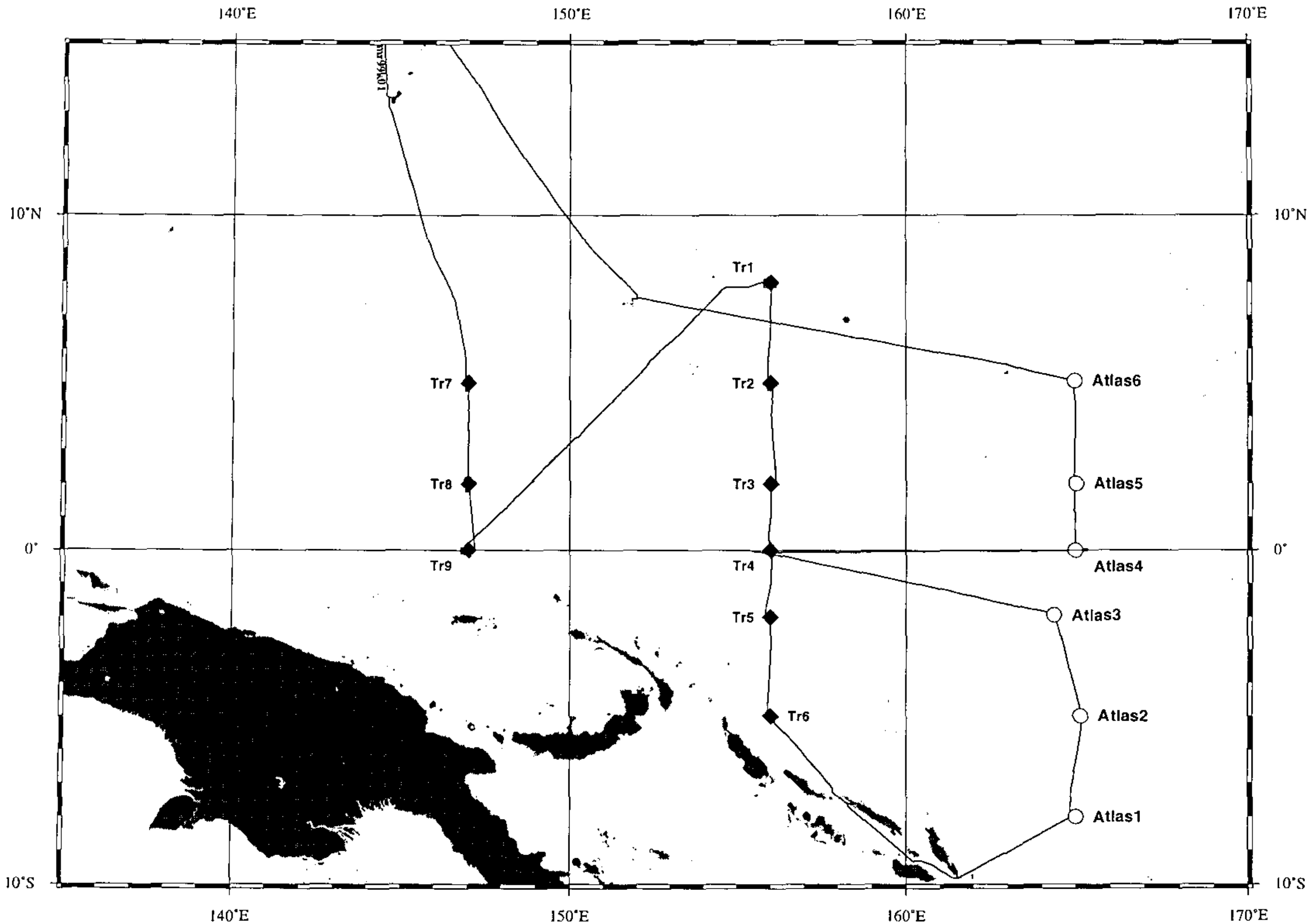


Ship Track (MR99-K01) & Triton Site

GMT Mar 10 04:16

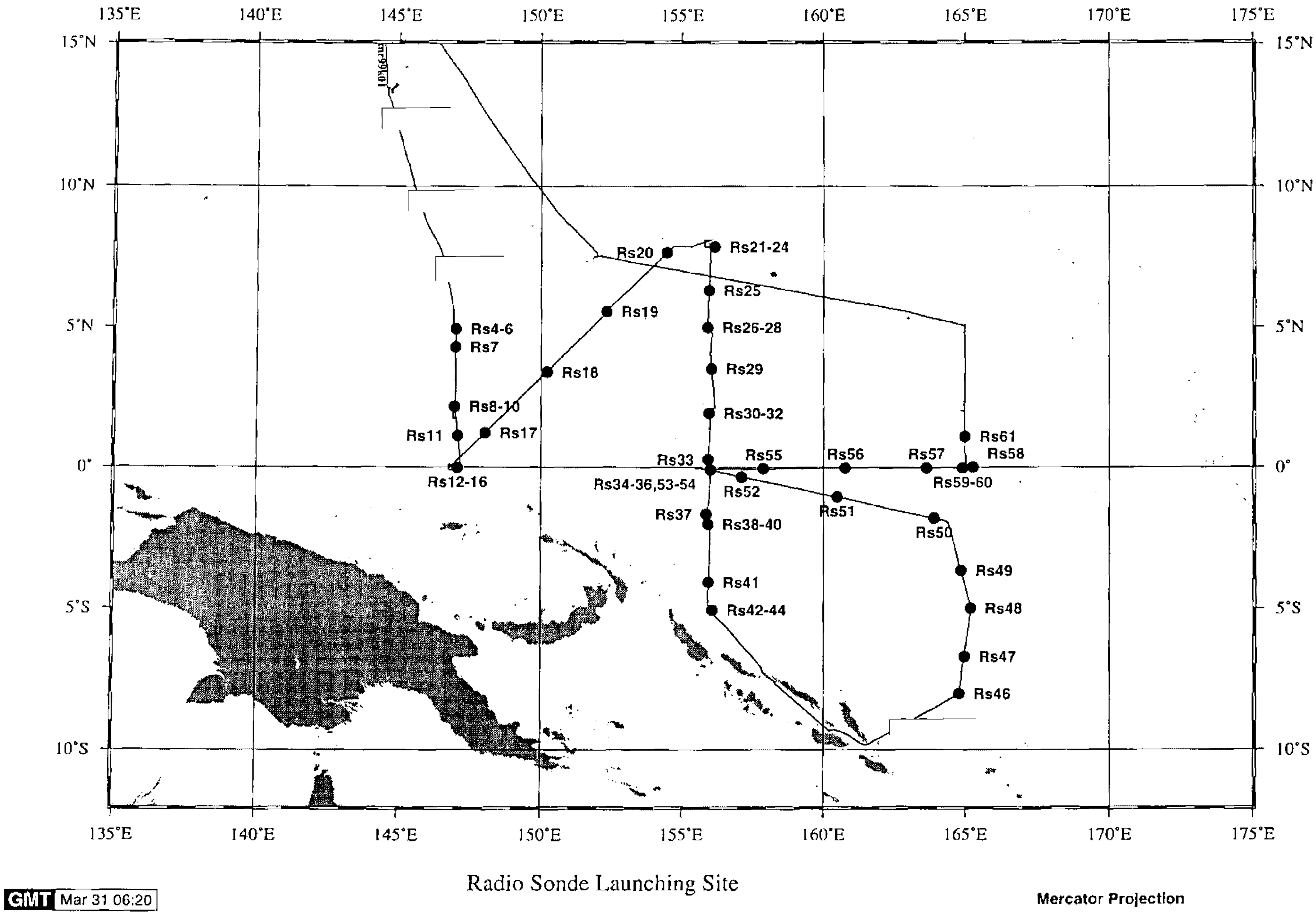
Mercator Projection

on board report



Ship Track (MR99-K01), Triton & Atlas Site

GMT Mar 31 06:20 Mercator Projection



Radio Sonde Launching Site

4. Cruise Log

Feb.08 (Mon.) Cloudy

04:00 Departure from Hachinohe

Start of continuous observations (Shipboard ADCP, Aerosols, Lider, pCO2, etc.)

05:00 Boat Drill

05:30 Briefing for safety life on the ship

06:10 Meeting on observations

09:00 Start of surface meteorological observation report for Japan Meteorological Agency

Feb.09 (Tue.) Fine/Cloudy (Fine to cloudy)

00:00 Assembly of TRITON buoys

Preparation for observations

04:00 On-the-spot explanation as to the instruments on compass deck by scientists

Feb.10 (Wed.) Fine

00:00 Assembly and telecommunication test of TRITON buoys

Preparation for observations

05:30 Meeting on deployment of TRITON buoys

Feb.11 (Th.) Fine/Cloudy|Rain (Fine to cloudy, occasionally rain)

00:00 Assembly and telecommunication test of TRITON buoys

Preparation for observations

05:30 Test launch of radiosonde

Feb.12 (Fri.) Fine|Cloudy|Shower

00:00 Telecommunication test of TRITON buoys

Preparation for observations

13:00 Ship mean time adjustment (SMT=UTC+9h -> +10h)

22:00 Arrival at Guam

23:00 Loading of PMEL/NOAA's gear

Feb.13 (Sat.) Fine/Cloudy|Shower

00:00 Running test of data communication system of TRITON buoys

23:00 Running test of data communication system of TRITON buoys

Feb.14 (Sun.) Fine/Cloudy|Shower

06:00 Departure from Guam

08:00 Meeting on deployment of TRITON buoys and observations

Feb.15 (Mon.) Fine|Cloudy|Shower

23:30 RS-04 (04-55N, 147-01E)

Feb.16 (Tue.) Fine|Cloudy

00:54-04:55 Deployment of TRITON buoy

at (04-51.7N, 146-57.5E), depth=4252m

01:21 Surface buoy

(hereafter, only the time when main part reached the sea surface is noted)

03:31 Recovery buoy
04:36 Releaser
04:55 Sinker
05:23 Landing

06:32 C02 (04-53N, 146-58E)
06:40 Start of continuous (24hours) surface meteorological measurement with bow boom
11:27 RS-05 (04-52N, 146-59E)
18:27 C03 (04-53N, 146-58E)
23:30 RS-06 (04-50N, 147-01E)

Feb.17 (Wed.) Fine

06:27 C04 (04-53N, 146-58E) CTD cast with water sampling
11:30 RS-07 (04-17N, 147-00E)
23:28 RS-08 (02-11N, 146-58E)

Feb.18 (Th.) Fine

02:26-05:03 Deployment of TRITON buoy
at (02-04.5N, 146-56.6E), depth=4490m

02:43 Surface buoy
03:46 Recovery buoy
04:43 Releaser
05:03 Sinker
05:30 Landing

06:28 Start of continuous (24hours) surface meteorological measurement with bow boom
06:29 C05 (02-06N, 146-57E)
11:29 RS-09 (02-04N, 146-54E)
18:32 C06 (02-06N, 146-57E)
23:30 RS-10 (02-05N, 146-55E)

Feb.19 (Fri.) Cloudy/Fine

06:26 C07 (02-06N, 146-57E) CTD cast with water sampling
11:29 RS-11 (01-08N, 147-05E)
22:51-01:22 Deployment of TRITON buoy
at (00-04.6N, 146-51.1E), depth=4307m

23:07 Surface buoy
00:13 Recovery buoy
01:07 Releaser
01:22 Sinker

23:34 RS-12 (00-05N, 146-49E)

Feb.20 (Sat.) Fine|Shower

01:34 C08 (00-05N, 146-51E)
01:50 Start of continuous (24hours) surface meteorological measurement with bow boom
11:28 RS-13 (00-07N, 146-53E)
13:26 C09 (00-06N, 146-51E)
23:30 RS-14 (00-04N, 146-52E)

Feb.21 (Sun.) Fine|Shower

01:00 C10 (00-06N, 146-51E)
06:03 C11 (00-01S, 146-52E) CTD cast down to 2866m depth and check of acoustic releaser

09:00 Meeting on recovery of ADCP mooring
11:38 RS-15 (00-01S, 146-55E)
21:56 C12 (00-01S, 147-04E) CTD cast down to 500m depth and check of acoustic releaser
22:32-23:55 Deployment of ADCP mooring
at (00-00.0N, 147-05.4E), depth=4505m
22:35 Surface buoy
23:39 Releaser
23:55 Sinker
00:24 Landing
23:30 RS-16 (00-01S, 147-05E)

Feb.22 (Mon.) Cloudy/Fine
03:53 C13 (00-03N, 146-51E) CTD cast with water sampling
11:41 RS-17 (01-14N, 148-03E)
23:51 RS-18 (03-22N, 150-13E)

Feb.23 (Tue.) Cloudy
11:26 RS-19 (05-33N, 152-20E)
23:32 RS-20 (07-40N, 154-28E)

Feb.24 (Wed.) Cloudy/Fine
11:27 RS-21 (07-52N, 156-10E)
22:56-01:52 Deployment of TRITON buoy
at (07-58.0N, 156-01.9E), depth=4844m
23:15 Surface buoy
00:31 Recovery buoy
01:31 Releaser
01:52 Sinker
02:21 Landing
23:30 RS-22 (07-58N, 155-59E)

Feb.25 (Th.) Fine/Cloudy|Shower
02:12 Start of continuous (24hours) surface meteorological measurement with bow boom
02:35 C14 (07-59N, 156-02E)
11:27 RS-23 (08-00N, 156-04E)
12:55 C15 (08-00N, 156-02E)
23:30 RS-24 (07-59N, 155-59E)

Feb.26 (Fri.) Cloudy/Fine
02:28 C16 (08-00N, 156-02E) CTD cast with water sampling
07:34 C17 (07-00N, 156-00E) CTD cast with water sampling
11:31 RS-25 (06-18N, 155-58E)
22:49-01:34 Deployment of TRITON buoy
at (05-01.2N, 155-58.1E), depth=3606m
23:05 Surface buoy
00:32 Recovery buoy
01:16 Releaser
01:34 Sinker
01:52 Landing
23:30 RS-26 (04-59N, 155-55E)

Feb.27 (Sat.) Fine

01:50 Start of continuous (24hours) surface meteorological measurement with bow boom
02:02 C18 (05-02N, 155-58E)
11:28 RS-27 (05-03N, 155-54E)
12:57 C19 (05-03N, 155-59E)
23:28 RS-28 (05-03N, 156-06E)

Feb.28 (Sun.) Fine
01:55 C20 (05-03N, 155-58E) CTD cast with water sampling
08:37 C21 (04-00N, 156-00E) CTD cast with water sampling
11:45 RS-29 (03-30N, 156-03E)
22:44-01:02 Deployment of TRITON buoy
at (01-55.0N, 156-00.1E), depth=2549m
23:02 Surface buoy
00:19 Recovery buoy
00:40 Releaser
01:02 Sinker
01:15 Landing
23:29 RS-30 (01-55N, 155-58E)

Mar.01 (Mon.) Fine
01:16 Start of continuous (24hours) surface meteorological measurement with bow boom
01:35 C22 (01-56N, 156-00E)
11:28 RS-31 (01-55N, 156-02E)
12:56 C23 (01-56N, 156-00E)
23:28 RS-32 (01-55N, 156-02E)

Mar.02 (Tue.) Fine
01:29 C24 (01-57N, 156-00E) CTD cast with water sampling
07:37 C25 (01-00N, 156-00E) CTD cast with water sampling
11:28 RS-33 (00-16N, 155-56E)
22:40-00:45 Deployment of TRITON buoy
at (00-05.4S, 156-02.0E), depth=1956m
22:54 Surface buoy
00:05 Recovery buoy
00:28 Releaser
00:45 Sinker
23:29 RS-34 (00-06S, 156-01E)

Mar.03 (Wed.) Fine
01:00 Start of continuous (24hours) surface meteorological measurement with bow boom
01:11 C26 (00-04S, 156-02E)
04:00 Meeting on utilization of data
11:29 RS-35 (00-04S, 156-05E)
12:52 C27 (00-04S, 156-02E)
23:57 RS-36 (00-01S, 156-00E)

Mar.04 (Th.) Fine
00:58 C28 (00-04S, 156-02E) CTD cast with water sampling
07:46 C29 (01-00S, 156-00E) CTD cast with water sampling
11:30 RS-37 (01-40S, 155-52E)
22:47-00:41 Deployment of TRITON buoy

at (02-01.0S, 155-57.2E), depth=1754m

23:03 Surface buoy

00:09 Recovery buoy

00:30 Releaser

00:41 Sinker

00:52 Landing

23:26 RS-38 (02-01S, 155-56E)

Mar.05 (Fri.) Cloudy|Shower

01:00 Start of continuous (24hours) surface meteorological measurement with bow boom

01:23 C30 (01-59S, 155-58E) CTD cast down to 1376m depth and adjustment of CTD winch

11:27 RS-39 (01-59S, 155-59E)

12:54 C31 (02-00S, 155-57E)

23:27 RS-40 (02-01S, 155-55E)

Mar.06 (Sat.) Fine

00:54 C32 (02-00S, 155-57E) CTD cast with water sampling

06:47 C33 (03-00S, 156-00E) CTD cast with water sampling

11:55 RS-41 (04-05S, 155-57E)

22:42-00:41 Deployment of TRITON buoy

at (05-03.3S, 156-03.0E), depth=1504m

22:57 Surface buoy

00:06 Recovery buoy

00:26 Releaser

00:41 Sinker

00:50 Landing

23:29 RS-42 (05-04S, 156-02E)

Mar.07 (Sun.) Cloudy|Shower

01:00 Start of continuous (24hours) surface meteorological measurement with bow boom

01:10 C34 (05-05S, 156-03E)

11:29 RS-43 (05-07S, 156-05E)

12:54 C35 (05-05S, 156-03E)

23:28 RS-44 (05-04S, 156-03E)

Mar.08 (Mon.) Cloudy|Shower/Fine

00:54 C36 (05-05S, 156-03E) CTD cast with water sampling

04:00 Meeting on unloading of scientist's instruments in Shimonoseki

12:00 Ship mean time adjustment (SMT=UTC+10h -> +11h)

Mar.09 (Tue.) Fine

01:07 Adjournment of Doppler radar observation

23:00 Call at Honiara

Mar.10 (Wed.) Cloudy|Rain

04:00 Meeting on open house for VIPs and reception

21:00 Preparation for open house for VIPs

Mar.11 (Th.) Fine

06:00 Open house for VIPs

07:00 Reception at dining saloon

23:00 Departure from Honiara

Mar.12 (Fri.) Fine

02:00 Meeting on recovery and deployment of ATLAS buoy

21:25-00:09 Recovery of ATLAS buoy
at (08-02.3S, 164-48.9E)
22:27 Surface buoy on deck
23:28 RS-46 (08-02S, 164-47E)
Mar.13 (Sat.) Fine
02:35-04:21 Deployment of ATLAS buoy
at (08-02.1S, 164-48.2E), depth=3917m
02:49 Surface buoy
04:21 Sinker
04:48 C37 (08-03S, 164-49E) CTD cast with water sampling
11:31 RS-47 (06-43S, 164-58E)
21:21-23:32 Recovery of ATLAS buoy
at (04-59.7S, 165-11.9E)
22:24 Surface buoy on deck
23:26 RS-48 (05-00S, 165-11E)
Mar.14 (Sun.) Fine/Cloudy|Shower
02:53-04:13 Deployment of ATLAS buoy
at (05-00.0S, 165-11.7E), depth=2517m
03:01 Surface buoy
04:13 Sinker
04:35 C38 (04-59S, 165-12E) CTD cast with water sampling
07:00 Meeting on schedule of this cruise
11:30 RS-49 (03-40S, 164-51E)
19:36-20:10 Repair of ATLAS buoy
at (01-55.5S, 164-22.9E)
20:20 C39 (01-55S, 164-22E) CTD cast with water sampling
23:28 RS-50 (01-49S, 163-54E)
Mar.15 (Mon.) Cloudy
11:29 RS-51 (01-03S, 160-29E)
23:30 RS-52 (00-20S, 157-07E)
Mar.16 (Tue.) Cloudy|Shower
02:00 Meeting on recovery of the drifting TRITON buoy
05:07-06:56 Recovery of TRITON buoy (upper part)
at (00-01.3S, 155-29.9E)
05:59 Surface buoy on deck
06:20 10m current meter on deck
06:56 500m CT on deck
10:00-11:06 Calibration of releaser’s position
11:28 RS-53 (00-05S, 156-02E)
21:35 Finding of recovery buoy
22:05-22:53 Recovery of TRITON buoy (1 recovery buoy and releasers)
at (00-03.7S, 155-50.8E)
22:43 #5 recovery buoy on deck

22:53 Releasers on deck
23:30 RS-54 (00-04S, 155-46E)
23:47 Finding of recovery buoys
Mar.17 (Wed.) Fine
00:07-01:51 Recovery of TRITON buoy (4 recovery buoys, nylon rope and wire)
at (00-04.5S, 155-51.6E)
00:46 #4 recovery buoy on deck
00:55 #3 recovery buoy on deck
01:14 #2, #1 recovery buoys on deck
01:51 Nylon rope and wire on deck
11:30 RS-55 (00-03S, 157-53E)
23:31 RS-56 (00-02S, 160-46E)
Mar.18 (Th.) Fine/Cloudy|Shower
11:29 RS-57 (00-01S, 163-38E)
21:54-23:58 Recovery of ADCP mooring
at (00-00.1S, 165-17.6E)
22:24 Surface buoy on deck
23:50 Releasers on deck
23:28 RS-58 (00-00N, 165-16E)
Mar.19 (Fri.) Fine
02:08-03:34 Deployment of ADCP mooring
at (00-00.1S, 165-17.8E), depth=4400m
02:14 Surface buoy
03:18 Releaser
03:34 Sinker
04:03 Landing
11:28 RS-59 (00-01N, 164-54E)
22:10-00:18 Recovery of ATLAS current meter buoy
at (00-00.0N, 165-00.6E)
22:59 Surface buoy on deck
23:28 RS-60 (00-01N, 164-58E)
Mar.20 (Sat.) Fine
02:40-05:24 Deployment of ATLAS current meter buoy
at (00-00.4N, 165-00.1E), depth=4415m
03:12 Surface buoy
05:16 Releaser
05:24 Sinker
06:02 Landing
05:43 C40 (00-00S, 165-01E) CTD cast with water sampling
11:31 RS-61 (01-05N, 164-59E)
21:21-23:36 Recovery of ATLAS buoy
at (01-59.8N, 164-57.7E)
22:10 Surface buoy on deck
Mar.21 (Sun.) Fine|Cloudy
02:48-04:23 Deployment of ATLAS buoy
at (01-59.7N, 164-58.1E), depth=4187m

02:55 Surface buoy
04:23 Sinker
04:58 Landing
04:50 C41 (01-59N, 164-58E) CTD cast with water sampling
18:28 C42 (05-05N, 164-59E) CTD cast with water sampling

Mar.22 (Mon.) Cloudy
11:00 Ship mean time adjustment (SMT=UTC+11h -> +10h)

Mar.23 (Tue.) Fine

Mar.24 (Wed.) Cloudy|Shower
04:00 Call at Chuuk

Mar.25 (Th.) Fine
02:00 Departure from Chuuk

Mar.26 (Fri.) Fine
Steaming to Shimonoseki, Japan

Mar.27 (Sat.) Fine
Start of continuous observations (Shipboard ADCP, Lider, pCO2, etc.)

Mar.28 (Sun.) Fine
12:00 Ship mean time adjustment (SMT=UTC+10h -> +9h)

Mar.29 (Mon.) Cloudy

Mar.30 (Tue.) Rain

Mar.31 (Wed.) Cloudy
04:00 Arrival at Shimonoseki

5.Participants List

R/V Mirai Scientists and Technical Staff during MR99-K01

Yoshifumi Kuroda	Japan Marine Science and Technology Center(JAMSTEC)
Toshihiko Yano	JAMSTEC
Norifumi Ushijima	JAMSTEC
Masaki Hanyuu	Global Ocean Development Inc. (GODI)
Toshio Furuta	GODI
Fumitaka Yoshiura	GODI
Koichi Takao	Marine Works Japan Ltd.(MWJ)
Jitsuo Tanaka	MWJ
Takehiko Shiribiki	MWJ
Masayuki Fujisaki	MWJ
Nobuharu Komai	MWJ
Hirokatsu Uno	MWJ
Fuyuki Shibata	MWJ
Takeo Matsumoto	MWJ
Takahiro Kazama	MWJ
Tomohiro Horiuchi	MWJ
Kimiko Nishijima	MWJ
Takashi Harimoto	Kansai Environmental Engineering Center Co.,Ltd
Muhammad Ilyas	Bandan Pengkajian dan Penerapan Teknologi(BPPT)
Andri Purwandani	BPTT
Andrew Shepherd	Pacific Marine Environmental Laboratory(PMEL)
J. Michel Strick	PMEL
Yasushi Narita	Keio Univ.
Masayuki Tajima	Keio Univ.
Ichiro Matsui	National Institute of Environmental Science

Kazuhiro Asai	Tohoku Institute of Technology (TIT)
Isao Tamamushi	TIT
Tetsuya Sugata	TIT
Tatsuo Endo	Hokkaido Univ.
Atsushi Ueda	Hokkaido Univ.

R/V Mirai Crew Members during MR99-K01

Captain	Takaaki Hashimoto
Chief Officer	Kenji Kurihara
First Officer	Yukio Dowaki
Second Officer	Hiroki Maruyama
Third Officer	Haruhiko Inoue
Chief Engineer	Yoichiro Watanabe
First Engineer	Minoru Ikeda
Second Engineer	Shinichiro Koga
Third Engineer	Katsunori Kajiyama
Chief Radio Officer	Etsuji Kuromi
Second Radio Officer	Noboru Ichinose
Boatswain	Kenetsu Ishikawa
Able Seaman	Seiichiro Kawata
Able Seaman	Kazuyoshi Kudo
Able Seaman	Tsuyoshi Monzawa
Able Seaman	Hisao Oguni
Able Seaman	Akito Oshige
Able Seaman	Minoru Sato
Able Seaman	Tsuyoshi Sato
Able Seaman	Isao Taguchi
Able Seaman	Jo Tanimoto
Able Seaman	Akio Tasaki
Able Seaman	Yasuyuki Yamamoto
No.1 Oiler	Shoji Murata
Oiler	Shozo Abe
Oiler	Fumio Inoue
Oiler	Shinobu Miyamoto
Oiler	Takashi Miyazaki
Oiler	Yoshihiro Sugimoto
Chief Steward	Yasuyuki Koga
Steward	Takayuki Akita
Steward	Osamu Araki
Steward	Yasutaka Kurita
Steward	Hiroyuki Hayashida
Steward	Hitoshi Ota

Embarkation Period

	Sekinehama		Guam		Honiara		Chuuk		Shimonoseki
Yoshifumi Kuroda	↑	○		○		○		○	↓
Toshihiko Yano	↑	○		○		○	↓		
Norifumi Ushijima	↑	○		○	↓				
Masaki Hanyuu	↑	○		○		○	↓		
Toshio Furuta	↑	○		○		○		○	↓
Fumitaka Yoshiura			↑	○		○		○	↓
Koichi Takao	↑	○		○		○	↓		
Jitsuo Tanaka	↑	○		○	↓				
Takehiko Shiribiki	↑	○		○		○	↓		
Masayuki Fujisaki	↑	○		○		○	↓		
Nobuharu Komai	↑	○		○		○		○	↓
Hirokatsu Uno	↑	○		○		○	↓		
Fuyuki Shibata	↑	○		○		○	↓		
Takeo Matsumoto	↑	○		○		○	↓		
Takahiro Kazama	↑	○		○		○	↓		
Tomohiro Horiuchi	↑	○		○		○	↓		
Kimiko Nishijima	↑	○		○		○	↓		
Takeshi Harimoto	↑	○		○		○		○	↓
Muhammad Ilyas			↑	○	↓				
Andri Purwandani			↑	○	↓				
Andrew Shepherd					↑	○	↓		
J. Michel Strick					↑	○	↓		
Yasushi Narita	↑	○		○	↓				
Masayuki Tajima	↑	○		○	↓				
Ichiro Matsui	↑	○		○	↓				
Kazuhiro Asai	↑	○	↓						
Isao Tamamushi	↑	○		○		○		○	↓
Tetsuya Sugata	↑	○		○		○		○	↓
Tatsuo Endo	↑	○	↓						
Atsushi Ueda	↑	○		○	↓				

6. General Observation

6.1 Meteorological measurement

6.1.1 Surface meteorological observation

(1) Personnel

Masaki Hanyu (GODI): Operation leader
Fumitaka Yoshiura (GODI): Operator

(2) Objectives

To record the weather conditions.

(3) Parameters

Press.: Atmospheric pressure adjusted to the sea surface level [hPa]
Dry Air Temp.: Atmospheric dry temperature [deg－C]
Wet Air Temp.: Atmospheric wet temperature [deg－C]
Dew P.T.: Dew point temperature [deg－C]
RH: Relative humidity [%]
Rain: Previous 1 hour precipitation [mm]
W.D.: 10 minutes averaged wind direction [deg]
W.S.: 10 minutes averaged wind speed [m/s]
SST: Sea surface temperature [deg－C]
Wv.Ht: Significant wave height measured first 20 minutes at every 3 hours (0200, 0500, 0800, 1100, 1400, 1700, 2000, 2300UTC) [m]
Wv.PD: Period of Wv.Ht [sec]
Radiation: Short and long wave radiation from solar（upward looking radiometer）[MJ/m^2]
Short and long wave radiation from the sea surface （downward looking radiometer）[MJ/m^2]
Cloud amount: Cloud amout
Weather: Weather

(3) Methods

We observed several surface meteorological parameters during the cruise by KOAC-7800 weather data processor and sensors assembled by Koshin Denki, Japan. Sensors are listed below.

Sensor	Type	Maker	Location（Altitude from baseline）
Anemometer:	KE-500	Koshin Denki, Japan	Formast（30.16m）
Thermometer:	FT	Koshin Denki, Japan	Compass Deck（24.85m）
Dew point meter:	DW-1	Koshin Denki, Japan	Compass Deck（24.85m）
Barometer:	F-451	Yokogawa, Japan	Weather observation room, Captain Deck（19.50m）
Rain gauge:	50202	Young, U.S.A.	Compass Deck（25.35m）
Optical Rain gauge:	ORG-115DR	SCTI, U.S.A.	Compass Deck（24.70m）
Radiometer:	MS-801（short wave）	Eiko Seiki, Japan	Radar mast（34.70m）
	MS-200（long wave）	Eiko Seiki, Japan	Albedo boom（14.86m）

Wave height meter: MW-2 Tsurumi-seiki, Japan Bow（16.00m）

Radiometers are located on the top of the radar mast for downward and at the albedo boom for upward radiation, respectively. Table 6.1.1-1 shows the time that we set the albedo boom at the outside of the ship.

Table 6.1.1 –1

From （UTC）	To （UTC）
Feb. 16 05:43	Feb. 17 07:00
Feb. 18 05:41	Feb. 19 07:30
Feb. 20 01:40	Feb. 22 04:56
Feb. 25 02:03	Feb. 26 03:24
Feb. 27 01:00	Feb. 28 12:30
Mar. 01 01:30	Mar. 02 02:24
Mar. 03 01:10	Mar. 04 02:10
Mar. 05 01:10	Mar. 06 01:20
Mar. 07 01:00	Mar. 08 13:18

Sea water sampling pomp ran from Feb.08 07:25Z to . All data was stored in MO disk every 6 seconds. Cloud amount, wet air temperature and weather are recorded by officers and crew of R/V MIRAI every 3 hours.

(4) Preliminary Result

Table 6.1.1-2 and Figure 6.1.1.-1－7 show the results of observation.

It must be noted that after Feb.14, 1999 rain gauge data showed often too much high values. At present we guess that electric disconnection often occurred and reset the electric value. Further analysis is needed.

(5) Data archive

Surface meteorological data will be submitted to the DMO (Data Management Office), JAMSTEC and will be under their control. Every 6 seconds data files, every 10 minutes data files and every 1hour data files are contained in the 3.5”MO disk.

Table 6.1.1-1

Time UTC 99 FEB	Ship's T.	Position Lat.	Log.	W.D. (deg)	W.S. (m/s)	Weather	Press. (hPa)	Dry Temp. (DEG-C)	Wet Temp. (DEG-C)	Dew P.T. (DEG-C)	RH (%)	Sea W.T. (DEG-C)	Cloud Amout	Rain (mm/h)	Wv.Ht. (m)	Wv.PD. (sec)
08 09	08 18	N39-39	E142-24	330	14.6	bc	1016.7	0.4	-2.0	-8.4	52	7.6	N/A	0.0	3.7	24
12	21	N38-54	E142-31	340	11.2	bc	1019.6	1.6	-0.1	-8.7	46	12.0	N/A	0.0	4.2	23
15	09 00	N38-09	E142-36	320	10.4	bc	1020.3	1.8	0.0	-6.7	54	11.8	N/A	0.0	3.9	21
18	3	N37-23	E142-38	350	9.3	bc	1020.0	2.0	0.0	-5.6	57	9.8	N/A	0.0	3.3	21
21	6	N36-38	E142-45	20	10.4	bc	1019.8	4.8	2.5	-1.1	65	19.3	N/A	0.0	3.3	21
09 00	9	N35-52	E142-46	10	8.5	bc	1020.0	7.5	5.5	-0.5	57	18.8	7	0.0	3.4	20
3	12	N35-06	E142-50	40	7.0	o	1017.8	10.9	7.5	2.5	56	19.0	N/A	0.0	3.4	20
6	15	N34-21	E142-55	70	9.5	o	1015.7	11.5	8.0	3.0	56	19.6	8	0.0	3.4	20
9	18	N33-34	E142-57	80	11.9	o	1015.2	12.5	10.0	6.1	65	19.1	7	0.0	3.2	15
12	21	N32-47	E143-02	20	5.2	bc	1016.0	11.2	10.0	6.4	72	20.3	N/A	0.7	2.6	15
15	10 00	N32-00	E143-06	290	11.0	bc	1015.3	14.7	11.5	7.8	63	20.5	N/A	0.0	3.2	18
18	3	N31-12	E143-10	310	11.9	bc	1016.1	15.0	12.0	6.8	58	20.6	N/A	0.0	3.1	17
21	6	N30-23	E143-13	300	9.9	bc	1017.2	16.5	12.5	6.8	52	20.6	7	0.0	2.8	18
10 00	9	N29-35	E143-18	280	10.5	c	1019.5	17.8	12.5	6.1	46	20.6	7	0.0	2.8	18
3	12	N28-45	E143-21	290	10.5	o	1019.5	18.4	14.0	8.0	51	20.5	N/A	0.0	2.3	16
6	15	N27-58	E143-25	310	5.9	bc	1019.0	19.0	14.0	7.0	45	21.4	2	0.0	2.6	19
9	18	N27-12	E143-30	320	4.8	bc	1020.0	18.5	14.0	7.5	49	22.0	3	0.0	2.0	18
12	21	N26-24	E143-33	10	5.2	bc	1021.8	18.7	14.0	8.9	53	22.1	N/A	0.0	1.9	17
15	11 00	N25-36	E143-36	60	6.2	bc	1020.4	19.3	15.0	9.0	51	22.3	N/A	0.0	1.6	15
18	3	N24-48	E143-41	60	7.7	o	1018.9	19.9	16.5	11.6	59	22.6	N/A	0.0	2.0	15
21	6	N24-00	E143-45	80	7.7	c	1018.3	20.8	16.5	11.3	55	24.9	N/A	0.0	1.6	13
11 00	9	N23-14	E143-49	110	10.5	bc	1018.0	22.9	19.0	14.9	61	24.7	4	0.0	2.2	12
3	12	N22-25	E143-52	90	9.7	c	1015.2	23.1	20.0	16.5	66	24.8	N/A	0.0	2.2	13
6	15	N21-44	E143-59	70	9.2	c	1013.6	23.2	22.0	18.7	76	26.2	8	0.0	2.3	11
9	18	N21-02	E143-59	80	11.0	bc	1013.2	24.2	23.0	21.2	83	26.6	4	0.0	2.3	12
12	21	N20-20	E144-01	100	8.1	bc	1014.3	24.5	23.5	21.6	84	26.9	N/A	0.0	2.4	13
15	12 00	N19-38	E144-05	60	6.2	bc	1013.4	24.9	24.5	22.8	88	27.0	N/A	0.0	2.4	12
18	3	N18-55	E144-10	60	5.3	p/o	1011.4	25.2	25.0	22.9	87	27.0	N/A	1.0	2.2	11
21	6	N18-13	E144-13		7.6	bc	1011.6	25.4	25.0	23.1	87	27.6	3	0.0	2.1	12
12 00	9	N17-31	E144-16		9.3	p/bc	1012.3	26.1	26.0	23.8	87	28.2	4	2.3	1.9	12
3	12	N16-48	E144-19	80	7.5	c/p	1009.8	27.3	26.5	24.1	83	28.0	5	1.6	2.2	13
6	15	N16-12	E144-22	90	10.1	o	1007.5	26.3	26.0	23.6	85	28.3	N/A	0.1	2.5	11
9	18	N15-37	E144-26	110	9.7	r	1008.8	25.2	25.0	23.3	90	28.2	8	0.1	2.4	12
12	21	N14-59	E144-28	100	9.8	r	1009.4	25.4	25.5	23.8	91	27.8	8	0.7	2.1	10
15	13 01	N14-23	E144-30	110	10.0	r	1008.5	24.8	25.5	23.4	92	27.6	N/A	1.8	2.0	10
18	4	N13-51	E144-31	70	3.3	o	1006.7	25.4	25.0	23.7	90	27.4	N/A	0.0	2.0	10
14 09	14 19	N12-55	E144-42	130	9.6	q	1007.1	25.5	26.5	23.3	88	28.3	7	9.9	2.1	6
12	22	N12-14	E144-54	130	11.7	o&q	1008.8	26.0	26.0	24.2	90	28.4	N/A	2.2	2.0	7
15	15 01	N11-31	E145-06	130	10.4	r	1008.4	25.5	26.0	23.9	91	28.3	N/A	2.8	1.8	7
15																
6	16	N08-19	E146-10	190	10.4	o&q	1008.6	26.0	27.0	23.3	85	29.1	8	1.0	2.0	7
9	19	N07-39	E146-30	140	7.8	bc	1009.3	28.0	26.0	24.0	79	29.1	4	0.0	1.7	6
12	22	N06-57	E146-41	150	8.2	bc	1010.8	28.0	27.0	24.3	80	29.4	4	0.0	1.8	7
15	16 01	N06-12	E146-49	130	7.2	bc	1009.8	28.2	26.5	24.3	80	29.4	4	0.0	1.9	9
18	4	N05-26	E146-55	160	13.7	bc	1008.8	25.7	25.5	23.0	85	29.7	6	0.5	1.9	9
21	7	N04-45	E146-59	170	6.2	o&q	1010.7	26.1	26.0	24.4	90	29.8	8	18.4	1.9	8
16 00	10	N04-52	E147-00	190	1.5	bc	1011.6	27.6	26.5	24.2	82	29.7	2	0.0	2.0	8
3	13	N04-52	E146-59	150	4.3	bc	1009.5	30.6	28.5	23.0	64	29.8	2	0.0	1.8	7
6	16	N04-51	E146-57	150	6.6	c	1008.5	29.2	27.5	23.5	72	30.0	4	0.0	1.8	8
9	19	N04-56	E146-57	320	1.0	c	1009.7	28.0	26.5	23.6	77	29.8	6	0.0	1.7	8
12	22	N04-53	E147-00	220	0.9	r	1011.1	26.9	25.0	22.0	75	29.8	8	1.2	1.9	8

Table 6.1.1-1

15	17 01	N04-50	E146-59	210	2.9	bc	1010.7	27.2	26.5	23.6	81	29.8	2	0.0	1.8	8
18	4	N04-53	E146-57	260	1.9	bc	1009.5	26.8	26.0	23.2	81	29.8	2	0.0	2.4	12
21	7	N04-53	E146-58	20	3.2	c	1011.9	25.7	25.0	23.3	87	29.9	5	6.8	1.7	8
17 00	10	N04-52	E146-59	310	1.5	bc	1012.4	27.8	26.5	22.9	75	29.9	3	0.0	1.8	10
3	13	N04-52	E146-59	90	1.4	bc	1010.0	29.4	29.0	23.2	69	30.0	3	0.0	1.5	9
6	16	N04-53	E146-57	100	1.1	bc	1008.9	29.8	29.5	23.7	70	30.2	3	0.0	1.5	9
9	19	N04-52	E147-01	70	2.3	bc	1010.0	28.2	26.0	23.1	74	30.4	3	0.0	1.7	10
12	22	N04-05	E146-59	40	2.2	bc	1011.5	28.4	26.5	22.9	72	30.2	2	0.0	1.5	10
15	18 01	N03-17	E147-00	40	1.4	bc	1010.6	28.2	25.5	22.5	71	29.9	2	0.0	1.5	9
18	4	N02-29	E146-59	340	1.2	bc	1010.4	27.9	26.0	22.9	75	29.9	3	0.0	1.4	10
21	7	N01-45	E146-59	360	2.7	bc	1011.7	28.1	26.0	23.1	74	30.1	3	0.0	1.7	15
18 00	10	N02-03	E147-05	340	3.1	bc	1013.1	29.5	27.0	23.1	69	30.1	3	0.0	1.6	12
3	13	N02-06	E146-56	310	3.7	bc	1011.1	28.8	28.5	23.2	72	30.2	3	0.0	1.7	9
6	16	N02-04	E146-56	270	5.0	bc	1009.9	28.4	27.5	23.9	76	30.5	5	0.0	1.6	9
9	19	N02-08	E146-55	340	3.1	bc	1010.0	28.3	26.0	22.9	72	30.3	5	0.0	1.7	8
12	22	N02-04	E146-54	350	6.7	bc	1010.8	26.0	26.0	23.4	85	30.1	5	0.0	2.0	8
15	19 01	N02-03	E146-54	360	7.6	bc	1009.2	27.8	25.5	22.6	74	30.0	2	0.0	1.9	8
18	4	N02-05	E146-56	10	8.9	bc	1008.1	28.1	26.0	22.9	73	29.9	3	0.0	1.9	8
21	7	N02-06	E146-56	30	7.1	bc	1009.4	28.1	25.0	23.2	75	29.8	6	0.0	1.9	7
19 00	10	N02-05	E146-54	40	6.2	c	1011.2	28.9	26.5	23.3	72	29.9	8	0.0	1.7	7
3	13	N02-05	E146-56	50	7.9	bc	1009.1	28.7	27.0	23.0	71	29.8	6	0.0	1.8	8
6	16	N02-05	E146-56	70	3.9	bc	1007.4	29.4	28.0	22.8	67	30.0	5	0.0	1.5	7
9	19	N01-41	E147-01	70	4.5	bc	1008.4	28.0	26.5	22.9	74	29.8	3	0.0	2.3	15
12	22	N00-56	E147-06	70	5.4	bc	1009.8	28.4	26.5	23.4	74	29.7	2	0.0	1.7	14
15	20 01	N00-09	E147-11	60	4.1	bc	1008.8	28.4	28.0	23.4	75	29.8	2	0.0	1.7	17
18	4	N00-00	E147-07	60	2.9	bc	1008.3	28.1	26.5	23.4	76	29.8	4	0.0	1.3	10
21	7	N00-05	E146-49	260	3.2	bc	1009.7	27.1	26.5	22.9	78	29.9	4	4.6	1.4	11
20 00	10	N00-05	E146-49	50	3.4	bc	1010.9	28.9	26.5	24.2	76	29.9	5	6.4	1.3	8
3	13	N00-05	E146-50	250	4.2	bc	1008.8	29.0	27.5	23.7	73	29.9	6	0.0	1.1	7
6	16	N00-04	E146-49	110	0.3	bc	1006.5	29.8	29.5	24.3	72	30.5	6	0.0	N/A	N/A
9	19	N00-04	E146-46	70	1.3	bc	1007.8	28.9	26.5	22.9	70	30.0	6	0.0	1.2	8
12	22	N00-07	E146-52	350	1.9	bc	1009.6	28.2	26.5	23.6	76	30.1	2	0.0	1.2	7
15	21 01	N00-04	E146-50	80	1.7	r	1008.8	28.5	26.5	23.8	76	30.0	4	0.0	1.1	8
18	4	N00-01	E146-49	260	2.7	bc	1007.6	27.3	25.5	23.8	81	29.9	4	0.1	1.1	8
21	7	N00-06	E146-51	20	3.7	bc	1009.4	28.0	27.0	23.6	77	29.9	5	0.0	1.1	8
21 00	10	N00-02	E146-50	340	2.2	bc	1010.5	29.8	29.0	23.8	70	29.9	6	0.1	1.0	8
3	13	N00-00	E146-52	260	3.1	bc	1008.1	29.9	29.0	23.8	70	30.1	6	0.0	1.1	8
6	16	N00-00	E146-52	350	3.8	bc	1006.4	27.8	27.0	23.8	79	30.1	7	0.0	1.1	8
9	19	N00-00	E146-57	20	5.6	bc	1007.6	28.9	26.5	23.7	73	30.1	7	0.0	1.3	7
12	22	S00-01	E146-54	10	9.4	bc	1009.2	28.6	26.5	23.4	74	30.0	7	0.0	1.3	7
15	22 01	S00-04	E146-51	10	7.8	bc	1007.9	28.5	26.0	22.8	71	29.9	7	0.0	1.4	6
18	4	S00-06	E146-54	20	8.3	bc	1006.6	28.3	25.5	22.2	69	29.9	7	0.0	1.2	7
21	7	N00-00	E147-04	360	9.1	bc	1007.7	28.4	26.0	22.4	70	29.8	7	0.0	1.2	6
22 00	10	N00-00	E147-05	360	7.2	bc	1009.8	29.8	27.0	22.7	66	30.1	6	0.0	1.2	6
3	13	N00-00	E146-52	360	6.9	bc	1007.6	30.1	26.5	22.1	63	30.0	6	0.0	1.2	6
6	16	N00-15	E147-03	350	5.2	bc	1006.6	29.5	26.5	22.8	67	30.2	5	0.0	1.2	6
9	19	N00-46	E147-35	10	4.7	bc	1008.7	28.6	26.0	22.4	69	30.0	6	0.0	1.2	6
12	22	N01-18	E148-08	10	6.2	bc	1009.2	28.7	26.0	22.5	69	30.0	6	0.0	1.2	6
15	23 01	N01-50	E148-39	10	5.1	bc	1007.9	28.2	26.0	23.2	74	30.0	6	0.0	1.2	6
18	4	N02-23	E149-10	40	7.5	bc	1006.2	28.2	26.0	23.4	75	29.8	5	0.2	1.2	6
21	7	N02-55	E149-43	50	8.8	o	1007.2	28.8	26.0	23.3	72	29.8	8	0.0	1.2	6
23 00	10	N03-24	E150-15	50	7.8	c	1009.1	29.6	26.0	23.5	70	29.8	8	0.2	1.2	6
3	13	N03-59	E150-47	50	5.8	c	1006.7	30.2	26.5	22.7	64	30.0	9	0.0		
6	16	N04-33	E151-21	80	4.9	c	1006.3	28.9	27.0	23.5	73	30.1	9	0.0		
9	19	N05-07	E151-55	80	9.3	r	1007.7	26.2	26.0	23.7	86	29.9	8	1.0		
12	22	N05-40	E152-25	90	9.7	c	1008.0	28.3	26.0	23.7	76	29.7	9	0.0		
15	24 01	N06-12	E152-59	70	10.9	bc	1007.4	28.6	26.0	23.2	73	29.5	5	0.0		
18	4	N06-44	E153-31	80	10.1	bc	1007.2	28.0	25.5	23.4	76	29.5	5	0.2		
21	7	N07-16	E154-04	90	9.3	o	1009.4	28.2	25.0	22.4	71	29.2	8	0.0		

Table 6.1.1-1

24 00	10	N07-46	E154-33	80	9.6	c	1010.5	28.9	25.5	22.2	67	29.1	9	0.0		
3	13	N07-51	E155-16	80	8.4	c	1007.5	28.7	26.0	22.3	68	29.0	8	0.0	1.7	5
6	16	N08-05	E155-59	80	8.1	bc	1006.7	28.6	26.0	22.3	69	29.0	6	0.0	1.5	5
9	19	N07-53	E155-48	80	12.3	bc	1007.9	27.8	26.0	22.5	73	28.9	3	0.0	2.3	11
12	22	N07-58	E156-09	80	11.7	bc	1008.9	27.7	25.5	22.9	75	28.9	4	0.0	1.9	7
15	25 01	N07-58	E156-00	80	10.7	bc	1007.1	27.7	25.5	22.5	73	28.9	3	0.0	2.0	7
18	4	N07-58	E155-56	80	10.0	bc	1007.0	27.8	25.5	23.2	76	28.9	4	0.0	2.0	7
21	7	N07-57	E156-01	70	11.1	bc	1008.9	28.0	25.5	23.0	74	28.9	6	0.0	1.9	7
25 00	10	N07-57	E155-59	60	12.1	bc	1009.5	28.5	25.5	22.6	70	28.9	6	0.0	2.3	7
3	13	N07-59	E156-01	60	9.6	bc	1007.1	28.8	26.0	23.5	73	29.0	7	0.0	2.3	7
6	16	N07-58	E155-58	60	8.8	c	1006.9	28.9	26.0	22.9	70	29.0	8	0.0	2.6	8
9	19	N08-00	E156-01	70	8.6	c	1008.6	26.9	25.0	23.2	80	28.9	7	0.0	2.6	8
12	22	N07-59	E156-03	70	7.1	c	1008.8	27.1	25.5	23.5	81	29.0	8	0.0	2.6	8
15	26 01	N07-59	E155-58	130	7.6	r	1008.5	24.6	25.0	22.5	88	28.9	10	3.5	2.3	8
18	4	N07-59	E155-57	100	4.9	c	1007.2	26.4	25.0	22.7	80	28.9	7	0.0	2.4	8
21	7	N07-59	E156-03	90	9.0	r	1009.2	25.4	25.0	23.0	87	29.0	8	0.8	2.3	8
26 00	10	N07-59	E155-57	80	9.2	r	1010.2	25.8	25.5	23.2	86	28.9	10	0.5	2.4	8
3	13	N07-59	E156-02	90	12.6	o	1007.7	26.0	25.0	22.0	79	28.9	10	0.0	2.5	7
6	16	N07-20	E156-00	80	13.7	c	1006.8	27.4	26.5	22.6	75	29.0	9	0.0	2.8	15
9	19	N06-52	E155-59	90	14.1	c	1008.0	27.0	26.0	23.0	79	29.0	8	0.0	2.6	12
12	22	N06-06	E155-57	90	12.5	c	1008.7	27.3	26.0	23.6	80	29.3	8	0.0	2.8	15
15	27 01	N05-19	E155-55	90	9.1	c	1007.0	27.4	26.0	23.6	80	29.5	8	0.0	2.5	14
18	4	N04-58	E155-59	90	9.2	bc	1006.6	27.7	26.0	23.7	79	29.5	3	0.0	1.8	7
21	7	N05-01	E155-57	90	9.1	bc	1008.1	28.0	26.0	23.6	77	29.5	3	0.0	1.8	8
27 00	10	N04-59	E155-55	110	8.7	bc	1008.6	28.6	27.0	24.0	76	29.5	3	0.0	1.9	6
3	13	N05-02	E155-58	90	8.2	bc	1006.1	30.2	28.0	23.4	67	29.7	4	0.0	1.7	7
6	16	N05-01	E155-56	110	7.8	bc	1005.7	27.6	27.0	22.6	74	29.7	7	1.1	2.0	7
9	19	N05-03	E155-57	130	5.4	bc	1007.8	26.3	25.5	23.5	85	29.6	6	3.6	1.9	8
12	22	N05-02	E155-58	120	8.7	c	1008.4	26.9	25.5	22.9	79	29.5	9	0.4	1.8	6
15	28 01	N05-01	E155-56	140	7.3	c	1007.0	26.7	26.0	23.7	84	29.5	9	0.0	2.1	8
18	4	N05-02	E155-56	80	10.9	bc	1006.8	27.5	26.0	23.8	80	29.5	6	0.3	2.1	6
21	7	N05-01	E155-59	80	8.2	bc	1008.6	28.5	26.0	23.5	75	29.5	5	0.0	2.3	8
28 00	10	N05-02	E155-59	80	6.5	bc	1009.3	29.8	26.5	23.2	68	29.5	4	0.0	2.2	7
3	13	N05-01	E155-58	80	9.5	bc	1006.6	30.8	26.5	22.7	62	29.6	4	0	2.1	7
6	16	N04-32	E156-03	90	8.4	bc	1006.0	29.2	27.0	23.4	71	29.8	4	0	2.5	14
9	19	N03-59	E156-00	110	7.3	bc	1008.2	28.8	26.0	23.2	72	29.8	4	0	2.2	7
12	22	N03-22	E156-03	130	5.1	c	1009.1	27.6	26.5	24.0	81	29.5	7	0.0	2.1	12
15	MAR. 01 01	N02-36	E156-08	100	8.7	c	1007.2	27.4	26.0	23.3	78	28.7	8	0.0	2.3	13
18	4	N02-05	E155-53	90	8.0	bc	1006.3	27.2	26.0	22.9	78	28.5	5	0.0	2.8	18
21	7	N01-55	E155-58	90	7.1	bc	1007.6	27.8	26.0	22.8	75	28.5	7	0.0	2.1	8
MAR. 01 00	10	N01-55	E155-58	100	7.2	bc	1008.5	29.0	26.5	23.2	71	28.5	7	0.0	1.9	7
3	13	N01-53	E155-59	100	4.7	bc	1006.3	29.6	27.0	23.4	70	28.7	6	0.0	2.1	8
6	16	N01-55	E155-55	110	7.0	bc	1005.8	28.7	27.0	22.9	71	28.7	6	0.0	2.0	8
9	19	N01-57	E156-00	110	5.1	bc	1007.7	27.6	26.0	22.8	75	28.7	7	0.0	1.9	8
12	22	N01-56	E156-00	130	4.4	bc	1009.0	27.7	26.0	23.3	77	28.6	5	0.0	1.8	9
15	02 01	N01-57	E155-57	120	4.6	bc	1006.7	27.3	25.5	23.0	78	28.6	5	0.0	2.2	9
18	4	N01-56	E155-59	130	3.1	bc	1005.5	27.0	26.0	23.3	80	28.5	5	0.0	2.0	9
21	7	N01-53	E156-04	130	4.6	bc	1007.1	27.5	25.5	23.0	77	28.6	3	0.0	1.8	9
02 00	10	N01-55	E156-00	120	3.8	bc	1007.4	29.0	26.5	23.5	72	28.6	6	0.0	2.2	10
3	13	N01-59	E156-01	110	7.5	bc	1005.0	28.9	26.5	23.3	72	28.8	4	0.0	1.7	8
6	16	N01-21	E156-00	110	7.8	bc	1004.4	28.2	26.5	22.9	73	28.8	3	0.0	2.0	14
9	19	N00-52	E155-59	110	8.5	bc	1006.1	27.6	26.0	22.3	73	28.7	3	0.0	1.9	14
12	22	N00-06	E155-56	100	7.9	bc	1007.6	27.6	25.0	22.0	72	28.5	3	0.0	1.8	14
15	03 01	N00-01	E156-05	100	8.0	bc	1005.7	27.3	25.5	22.2	74	28.5	5	0.0	1.4	7
18	4	S00-05	E156-01	90	8.2	bc	1004.9	27.4	25.0	22.5	75	28.6	4	0.0	1.7	8
21	7	S00-05	E156-00	100	8.1	bc	1006.4	27.5	26.0	22.4	74	28.6	5	0.0	1.7	8
03 00	10	S00-05	E156-01	90	8.6	bc	1006.4	28.9	26.0	22.5	68	28.6	4	0.0	1.7	7
3	13	S00-05	E156-01	80	7.4	bc	1003.5	29.3	27.0	22.7	68	28.8	3	0.0	1.7	8

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6	16	S00-04	E156-00	100	7.7	bc	1002.8	28.2	26.5	22.8	73	28.8	3	0.0	1.5	7
9	19	S00-04	E155-59	110	5.2	bc	1004.9	27.7	25.5	22.8	75	28.7	5	0.0	1.7	9
12	22	S00-03	E156-02	110	7.0	bc	1006.4	27.6	26.0	23.2	77	28.6	4	0.0	1.5	8
15	04 01	S00-03	E155-58	110	5.8	bc	1005.2	26.4	26.0	23.2	82	28.6	5	0.0	1.7	8
18	4	S00-04	E156-00	110	7.9	bc	1003.9	27.2	25.5	22.1	74	28.6	3	0.0	1.8	7
21	7	S00-04	E156-04	110	6.9	bc	1005.8	27.8	25.5	22.5	73	28.6	3	0.0	1.8	8
04 00	10	N00-00	E155-59	110	8.7	bc	1006.3	28.4	26.0	22.1	69	28.6	3	0.0	1.9	8
3	13	N00-00	E156-09	110	8.7	bc	1003.7	28.3	27.0	21.9	69	28.6	3	0.0	1.7	6
6	16	S00-34	E156-00	100	8.2	bc	1003.1	28.1	26.5	22.6	72	28.8	4	0.0	2.0	10
9	19	S01-04	E155-59	110	7.2	bc	1005.9	27.7	25.5	22.4	73	28.8	2	0.0	2.0	9
12	22	S01-52	E155-50	70	6.1	bc	1007.3	27.7	25.5	22.8	75	29.3	3	0.0	1.8	14
15	05 01	S02-01	E155-57	60	6.1	bc	1005.4	27.6	25.5	22.8	75	29.2	3	0.0	1.5	7
18	4	S02-02	E155-53	70	4.8	bc	1004.6	27.5	25.5	22.4	74	29.3	3	0.0	1.5	7
21	7	S02-00	E155-55	80	5.5	bc	1006.2	27.2	26.0	23.4	80	29.2	6	0.0	1.5	8
05 00	10	S02-01	E155-56	100	7.2	c	1007.0	28.5	26.5	23.2	82	29.2	7	0.2	1.7	8
3	13	S01-59	E155-54	60	6.1	o	1005.1	26.8	26.5	23.9	84	29.2	9	1.4	1.9	9
6	16	S02-01	E155-57	90	8.8	c	1004.2	28.2	26.5	23.3	75	29.3	7	0.0	1.8	8
9	19	S01-59	E155-58	70	6.6	bc	1006.5	27.2	26.0	23.3	80	29.2	5	0.0	1.9	9
12	22	S01-58	E155-57	80	6.2	bc	1007.1	27.7	26.0	22.9	75	29.1	6	0.0	2.0	9
15	06 01	S02-00	E155-52	80	5.6	bc	1005.0	27.6	25.5	22.9	76	29.1	6	0.0	1.9	8
18	4	S02-00	E155-52	70	6.7	bc	1004.8	27.4	25.5	22.7	76	29.1	5	0.0	1.9	8
21	7	S02-00	E155-55	80	8.3	bc	1005.9	27.7	26.0	22.8	75	29.0	3	0.0	1.6	8
06 00	10	S02-00	E155-55	80	8.8	bc	1006.8	28.9	26.5	23.0	70	29.1	3	0.0	1.7	7
3	13	S02-01	E155-59	80	9.1	bc	1004.5	29.4	27.0	22.6	67	29.2	4	0.0	1.8	9
6	16	S02-49	E156-00	90	9.4	bc	1003.1	29.0	26.5	22.5	68	29.6	5	0.0	1.9	12
9	19	S03-20	E155-58	90	7.5	bc	1005.3	28.4	26.5	22.6	71	29.6	3	0.0	1.9	13
12	22	S04-07	E155-57	110	7.5	bc	1007.2	28.5	26.0	22.4	70	29.6	3	0.0	1.5	10
15	07 01	S04-54	E155-58	100	4.9	bc	1005.5	28.3	26.0	22.7	72	29.6	4	0.0	1.4	11
18	4	S05-02	E156-05	110	5.8	bc	1005.0	28.2	26.0	22.5	71	29.6	3	0.0	1.1	6
21	7	S05-02	E156-04	90	5.6	bc	1006.1	28.5	26.0	22.9	72	29.6	3	0.1	1.2	7
07 00	10	S05-03	E156-02	90	5.5	c	1007.4	27.3	26.0	22.1	73	29.6	7	0.3	1.2	7
3	13	S05-07	E156-01	70	3.4	r	1004.9	26.0	26.0	23.2	85	29.7	8	0.6	1.2	8
6	16	S05-04	E156-01	150	1.5	c	1004.8	28.3	27.0	23.5	75	29.7	7	0.0	1.3	7
9	19	S05-03	E156-07	130	0.7	bc	1006.7	27.1	26.0	22.9	78	29.6	5	0.0	1.3	7
12	22	S05-06	E156-03	120	4.1	c/p	1008.1	26.5	26.0	23.6	84	29.6	6	0.0	1.6	7
15	08 01	S05-06	E156-03	140	2.6	o	1006.7	26.6	25.5	22.7	79	29.6	8	0.0	1.3	7
18	4	S05-04	E156-03	80	2.5	o	1005.9	26.4	25.5	22.4	79	29.6	8	0.0	1.3	7
21	7	S05-03	E156-04	50	2.2	o	1007.6	26.1	25.0	22.4	80	29.6	8	0.0	1.2	6
08 00	10	S05-04	E156-02	150	3.6	o	1007.9	26.4	26.0	22.9	81	29.6	8	0.0	1.1	7
3	13	S05-00	E155-58	160	3.2	c	1005.5	29.1	26.0	23.4	72	30.0	7	0.0	1.4	11
6	16	S05-02	E155-57	90	3.0	c	1005.1	27.2	24.5	21.8	72	29.9	7	0.1	1.2	7
9	19	S05-05	E156-02	110	6.0	c	1006.7	27.3	25.5	22.7	76	29.6	8	0.0	1.2	7
12	22	S05-07	E156-02	90	5.5	c	1007.8	28.7	26.0	22.3	69	29.6	7	0.0	0.9	7
15	09 02	S05-29	E156-23	80	6.3	c	1006.2	28.1	26.0	22.1	70	29.4	7	0.0	1.2	8
18	5	S05-59	E156-51	70	4.7	bc	1005.9	27.6	25.5	22.8	75	29.7	6	0.0	1.2	8
21	8	S06-26	E157-14	90	4.2	bc	1007.9	27.2	25.5	22.0	73	29.7	6	0.0	1.0	8

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9	20	S09-22	E162-22	70	4.4	bc	1008.8	27.2	25.5	22.9	78	29.4	6	0.2	1.1	7
12	23	S09-01	E163-03	90	4.6	bc	1009.8	27.3	25.0	23.0	78	29.5	3	0.0	1.2	6
15	13 02	S08-37	E163-45	70	4.2	bc	1008.0	27.1	25.5	23.4	80	29.3	3	0.0	1.2	7
18	5	S08-14	E164-26	90	4.5	bc	1007.6	26.6	25.0	23.3	82	29.3	3	0.0	1.1	6
21	8	S08-02	E164-49	60	6.4	bc	1009.4	28.1	26.0	23.3	76	29.2	5	0.0	1.3	7
13 00	11	S08-02	E164-47	70	4.6	bc	1009.4	28.6	26.5	22.1	68	29.3	4	0.0	1.2	8
3	14	S08-03	E164-46	70	4.9	bc	1007.3	29.8	28.0	22.7	66	29.5	6	0.0	1.4	9
6	17	S08-01	E164-48	80	5.2	bc	1007.4	28.5	26.0	23.1	73	29.6	7	0.0	1.3	8
9	20	S07-16	E164-52	80	5.3	bc	1009.5	27.8	26.0	23.0	75	29.4	4	0.0	1.3	8
12	23	S06-33	E164-57	90	7.4	bc	1009.9	28.0	25.5	22.9	74	29.4	4	0.0	1.3	8
15	14 02	S05-46	E165-05	80	6.4	bc	1007.2	27.3	25.5	23.0	78	29.3	4	0.0	1.3	8
18	5	S05-00	E165-12	80	6.4	bc	1007.2	26.7	25.5	23.5	83	28.2	5	0.0	1.3	8
21	8	S05-00	E165-11	90	4.9	bc	1008.6	27.5	26.0	23.6	79	28.2	2	0.0	1.3	8
14 00	11	S05-00	E165-09	90	5.4	bc	1008.0	29.4	26.0	23.4	70	28.5	4	0.0	1.2	7
3	14	S05-00	E165-10	100	5.9	bc	1005.4	29.2	27.0	23.1	69	28.6	3	0.0	1.3	7
6	17	S04-58	E165-11	80	6.4	bc	1005.5	26.5	25.5	23.2	82	28.4	5	0.0	1.4	8
9	20	S04-13	E164-59	90	7.2	bc	1007.7	27.1	25.5	23.5	81	28.4	3	0.0	1.2	8
12	23	S03-29	E164-46	70	8.6	bc	1008.2	27.1	25.0	22.8	77	28.3	3	0.0	1.3	9
15	15 02	S02-44	E164-36	70	7.5	bc	1006.8	26.9	25.0	22.3	76	28.2	4	0.0	1.3	8
18	5	S02-02	E164-24	80	7.2	bc	1006.7	26.6	25.0	22.3	77	28.1	2	0.0	1.4	9
21	8	S01-55	E164-21	80	6.5	bc	1008.2	27.4	25.0	22.7	76	28.1	2	0.0	1.2	6
15 00	11	S01-45	E163-37	70	6.5	bc	1007.5	28.2	27.0	23.1	74	27.8	6	0.0	1.5	16
3	14	S01-34	E162-45	70	6.5	bc	1004.7	27.8	26.5	22.9	75	27.4	5	0.0	1.6	19
6	17	S01-23	E161-56	80	7.1	c	1004.9	27.2	25.5	22.5	76	28.1	9	0.0	1.7	18
9	20	S01-11	E161-06	80	6.4	bc	1007.2	26.8	25.0	22.7	79	27.8	5	0.0	1.8	19
12	23	S01-01	E160-16	80	8.2	bc	1007.9	26.8	25.0	22.7	79	27.9	3	0.0	1.6	17
15	16 02	S00-50	E159-26	90	7.6	bc	1005.9	26.4	25.0	22.9	81	27.8	3	0.0	1.8	18
18	5	S00-39	E158-35	90	7.7	bc	1005.1	26.5	25.0	22.6	79	28.4	1	0.0	2.1	21
21	8	S00-28	E157-43	90	7.3	bc	1006.7	27.4	25.5	22.9	77	28.3	7	0.0	1.8	20
16 00	11	S00-17	E156-50	70	8.5	c	1007.3	27.9	26.5	22.5	72	28.3	8	0.0	1.9	20
3	14	S00-05	E155-57	60	7.9	c	1005.1	28.0	26.0	22.6	73	28.3	9	0.0	1.8	20
6	17	S00-01	E155-27	80	6.1	o	1005.1	27.6	25.5	22.5	74	28.4	10	0.0	1.1	7
9	20	S00-03	E155-50	100	7.4	r	1007.1	26.6	25.5	23.1	81	28.3	10	1.1	1.1	5
12	23	S00-04	E155-59	90	6.9	c	1008.1	27.2	25.0	22.9	78	28.2	8	0.0	1.4	7
15	17 02	S00-03	E155-54	100	7.5	bc	1006.1	26.9	25.0	23.0	79	28.2	6	0.0	1.4	7
18	5	S00-03	E155-47	90	8.3	bc	1005.2	26.7	25.0	21.9	75	28.2	3	0.0	1.4	7
21	8	S00-02	E155-46	100	8.7	bc	1006.7	27.0	25.0	22.6	77	28.2	3	0.0	1.2	5
17 00	11	S00-04	E155-51	90	8.6	N/A	1007.4	28.1	N/A	22.0	69	28.2	N/A	0.0	1.3	5
3	14	S00-03	E155-59	90	7.8	bc	1005.1	28.6	25.5	22.0	67	28.3	3	0.0	1.2	5
6	17	S00-03	E156-39	80	7.1	bc	1004.2	27.9	25.5	22.7	73	28.4	3	0.0	1.2	5
9	20	S00-03	E157-21	90	6.7	bc	1006.5	26.8	25.0	22.5	78	28.1	2	0.0	1.2	5
12	23	S00-03	E158-03	100	7.5	bc	1008.1	26.9	25.0	23.1	80	28.0	3	0.0	1.4	6
15	18 02	S00-02	E158-47	100	7.2	bc	1006.4	26.7	25.5	23.3	82	27.8	3	0.0	1.4	7
18	5	S00-01	E159-31	100	6.9	bc	1005.4	26.7	25.0	23.3	82	27.9	3	0.0	1.2	5
21	8	S00-01	E160-15	90	7.9	bc	1006.7	27.1	25.5	23.0	78	27.9	3	0.0	1.1	5

Table 6.1.1-1

18 00	11	S00-01	E160-55	80	8.5	bc	1006.6	28.0	25.5	22.7	73	27.9	2	0.0	1.2	5
3	14	N00-00	E161-39	100	6.7	bc	1005.1	28.1	26.0	23.1	74	28.0	3	0.0	1.4	5
6	17	S00-01	E162-22	100	8.1	bc	1004.9	27.8	25.5	23.0	75	28.1	3	0.0	1.5	5
9	20	S00-01	E163-06	100	8.2	bc	1007.4	27.2	25.0	22.8	77	28.1	2	0.0	1.4	5
12	23	S00-02	E163-47	100	8.0	bc	1008.0	26.9	25.0	23.1	80	28.0	5	0.0	1.4	5
15	19 02	S00-01	E164-31	110	11.6	bc	1005.6	26.1	25.0	22.8	82	27.9	6	0.0	1.5	5
18	5	S00-01	E165-16	110	11.8	bc	1005.7	26.3	24.5	22.2	78	27.5	2	0.0	1.5	4
21	8	N00-00	E165-16	110	10.8	bc	1007.6	26.7	25.0	22.5	78	27.5	5	0.0	1.9	7
19 00	11	N00-00	E165-14	110	10.5	bc	1007.2	27.5	25.0	22.3	73	27.6	5	0.0	1.6	7
3	14	N00-00	E165-17	100	10.5	bc	1005.0	27.7	26.0	22.3	73	27.6	5	0.0	1.9	6
6	17	N00-03	E164-58	100	10.4	bc	1004.7	27.7	25.0	221.0	72	27.9	5	0.0	3.0	20
9	20	N00-01	E164-57	110	10.8	bc	1006.3	26.6	24.5	22.2	77	27.8	2	0.0	1.9	7
12	23	N00-00	E164-53	90	10.6	bc	1007.6	26.0	24.5	21.9	78	27.8	3	0.0	2.1	7
15	20 02	N00-00	E164-48	90	10.5	bc	1005.5	26.0	24.5	21.5	76	27.7	4	0.0	2.0	7
18	5	N00-00	E165-02	90	10.6	bc	1005.5	26.1	24.0	21.9	78	27.6	2	0.0	1.8	6
21	8	N00-00	E165-00	100	12.6	bc	1006.6	27.0	24.5	22.3	76	27.6	4	0.0	2.2	6
20 00	11	N00-00	E164-57	90	11.0	bc	1007.0	27.3	25.0	21.0	69	27.7	4	0.0	1.6	6
3	14	N00-00	E164-58	80	10.0	bc	1005.1	28.2	25.5	21.8	69	27.8	4	0.0	2.2	7
6	17	N00-00	E165-00	90	10.2	bc	1004.3	27.3	25.0	22.4	75	27.8	3	0.0	2.2	7
9	20	N00-31	E164-59	100	11.8	bc	1005.9	26.7	25.0	22.3	77	27.9	4	0.0	2.1	9
12	23	N01-15	E164-57	100	11.3	bc	1006.5	26.6	25.0	22.7	79	28.0	4	0.0	2.1	8
15	21 02	N01-59	E164-58	100	9.9	bc	1004.8	27.0	25.0	23.0	79	28.5	2	0.0	2.3	9
18	5	N02-00	E164-54	90	9.1	bc	1004.6	26.3	26.0	23.3	84	28.5	3	0.0	2.0	8
21	8	N01-59	E164-57	100	10.1	N/A	1006.1	27.6	N/A	23.2	77	28.5	N/A	0.0	1.9	7
21 00	11	N02-00	E164-56	90	9.8	N/A	1006.6	28.8	N/A	23.2	72	28.6	N/A	0.0	2.0	7
3	14	N01-59	E164-56	90	10.9	bc	1004.3	29.3	26.0	22.9	68	28.6	3	0.0	2.1	7
6	17	N02-01	E164-58	110	11.5	bc	1004.2	27.4	26.0	23.8	81	28.6	6	0.0	2.1	7
9	20	N02-47	E164-58	100	10.8	c	1006.3	27.4	26.0	23.5	80	28.8	8	0.0	2.4	9
12	23	N03-33	E164-58	90	12.7	bc	1007.1	27.6	26.0	23.2	77	28.7	6	0.0	2.3	9
15	22 02	N04-20	E164-58	90	9.6	bc	1006.2	27.2	26.0	24.0	83	28.7	6	0.0	2.3	9
18	5	N05-04	E164-59	70	8.8	c	1005.8	26.9	26.0	23.9	84	28.6	8	0.0	2.1	7
21	8	N05-06	E164-44	80	12.4	o	1008.1	28.2	26.0	23.1	74	28.7	9	0.0	3.3	19
22 00	11	N05-17	E163-55	70	9.6	o	1008.8	28.1	26.0	23.4	76	28.7	10	0.0	3.5	17
3	14	N05-22	E163-08	60	8.3	o	1006.8	28.2	26.5	23.6	76	28.6	10	0.0	3.2	18
6	17	N05-39	E162-20	70	8.6	o	1006.8	28.2	26.5	23.4	75	29.0	9	0.0	2.8	17
9	20	N05-48	E161-32	90	8.5	c	1009.2	28.1	26.0	23.4	76	29.0	7	0.0	2.9	17
12	22	N05-56	E160-45	80	6.9	bc	1010.3	27.9	26.5	23.7	78	29.0	4	0.0	2.7	18
15	23 01	N06-04	E159-57	90	6.2	c	1008.6	27.7	26.0	23.7	79	29.1	9	0.0	2.8	18
18	4	N06-14	E159-10	80	7.6	bc	1007.6	27.5	26.0	24.0	81	29.3	5	0.0	2.6	17
21	7	N06-22	E158-22	70	10.4	o	1009.1	27.6	N/A	23.8	80	29.3	8	0.0	2.9	19
23 00	10	N06-31	E157-34	70	11.1	bc	1008.7	28.7	26.5	23.9	75	29.3	4	0.0	2.2	17
3	13	N06-40	E156-46	80	9.0	bc	1006.8	29.4	27.5	24.6	76	29.4	4	0.0	2.9	18
6	16	N06-48	E155-59	70	10.0	bc	1006.5	28.8	26.5	23.7	74	29.4	3	0.0	2.7	17
9	19	N06-57	E155-13	70	11.0	bc	1008.7	28.4	26.5	23.6	76	29.3	4	0.0	3.2	22
12	22	N07-06	E154-25	60	10.3	bc	1010.1	28.3	26.5	23.8	76	29.6	4	0.0	2.6	16
15	24 01	N07-14	E153-38	50	11.7	bc	1008.0	27.7	26.0	23.9	80	29.8	4	0.0	3.0	19
18	4	N07-23	E152-50	60	12.0	bc	1007.5	27.4	26.0	23.4	79	29.8	5	0.0	3.1	18
21	7	N07-31	E152-05	70	10.2	bc	1008.9	28.0	26.0	23.4	76	29.7	6	0.0	2.7	16
24 00	10	N07-26	E151-50	N/A	N/A	bc	1009.8	29.2	26.5	23.0	69	29.9	6	0.0	0.2	8
3	13	N07-26	E151-50	N/A	N/A	bc	1007.9	27.6	26.0	23.9	80	30.3	7	0.0	0.3	9
6	16	N07-26	E151-50	N/A	N/A	o	1007.0	27.5	26.0	24.2	82	30.4	9	0.1	0.2	7
9	19	N07-26	E151-50	N/A	N/A	o	1008.3	26.4	25.5	23.6	85	30.4	9	4.0	0.2	8
12	22	N07-26	E151-50	N/A	N/A	r	1009.5	26.3	26.0	22.8	81	30.3	10	0.5	0.2	7
15	25 01	N07-26	E151-50	N/A	N/A	r	1008.2	25.6	25.0	23.1	86	30.1	10	0.0	0.2	7
18	4	N07-26	E151-50	N/A	N/A	o	1007.0	24.9	25.0	23.0	89	29.9	10	3.3	0.2	8
21	7	N07-26	E151-50	N/A	N/A	c	1008.8	27.1	26.0	22.4	76	29.6	8	0.0	0.2	8
25 00	10	N07-26	E151-50	N/A	N/A	N/A	1009.9	28.4	N/A	23.4	74	29.4	N/A	0.0	0.3	7
3	13	N07-30	E151-56	120	5.9	bc	1007.3	29.1	26.5	23.5	72	29.6	6	0.0	0.4	6
6	16	N08-03	E151-34	130	3.8	bc	1006.6	28.4	26.5	23.7	76	28.5	5	0.0	2.3	15

Table 6.1.1-1

9	19	N08-38	E150-58	60	9.5	o	1008.5	25.4	25.5	23.1	87	28.9	9	0.0	2.3	13
12	22	N09-15	E150-26	90	10.3	bc	1010.2	25.4	25.0	22.6	85	28.6	6	0.0	2.6	13
15	26 01	N09-54	E149-57	90	8.9	bc	1009.1	27.2	25.5	22.7	76	28.7	4	0.0	2.7	12
18	4	N10-33	E149-27	70	8.1	bc	1008.2	27.1	25.0	23.4	80	28.7	5	0.0	2.5	13
21	7	N11-12	E148-59	80	12.0	c	1009.3	27.7	25.5	23.2	77	28.9	8	0.0	3.1	13
26 00	10	N11-50	E148-32	80	10.7	bc	1010.8	28.8	26.5	22.9	71	29.0	3	0.0	3.2	13
3	13	N12-30	E148-05	90	9.9	bc	1009.0	28.6	26.0	22.8	71	28.8	3	0.0	3.1	12
6	16	N13-11	E147-39	90	9.6	bc	1008.0	28.3	25.5	22.8	72	28.9	3	0.0	3.0	12
9	19	N13-51	E147-14	90	9.4	bc	1009.9	27.7	25.5	22.6	74	28.7	4	0.0	3.0	12
12	22	N14-30	E146-45	80	9.2	bc	1011.2	27.5	25.5	23.4	78	28.8	3	0.0	3.1	12
15	27 01	N15-08	E146-17	80	8.9	bc	1011.1	27.4	25.5	22.9	77	28.8	3	0.0	2.9	13
18	4	N15-47	E145-49	90	8.2	bc	1010.2	27.1	25.0	22.1	74	28.8	3	0.0	2.8	13
21	7	N16-26	E145-21	100	7.6	bc	1011.4	27.7	25.5	23.0	76	28.8	3	0.0	2.6	14
27 00	10	N17-06	E144-52	100	6.3	bc	1012.9	29.4	27.0	22.8	67	28.9	3	0.0	2.7	14
3	13	N17-46	E144-23	100	5.5	bc	1011.8	29.2	27.5	22.7	68	29.0	3	0.0	2.6	13
6	16	N18-27	E143-56	90	5.3	bc	1010.8	28.2	26.0	23.2	74	29.1	3	0.0	2.2	13
9	19	N19-08	E143-26	90	5.5	bc	1012.0	27.7	25.5	22.7	75	28.9	4	0.0	2.0	12
12	22	N19-50	E142-57	70	4.7	bc	1013.7	26.9	25.0	23.2	81	27.7	1	0.0	2.1	13
15	28 01	N20-32	E142-35	60	3.0	bc	1013.9	25.9	25.0	22.9	84	27.4	5	0.0	1.7	11
18	4	N21-10	E142-06	50	2.9	bc	1012.7	25.6	24.5	21.8	79	27.5	3	0.0	1.8	15
21	7	N21-44	E141-32	30	5.0	bc	1014.1	24.8	25.0	22.6	88	26.1	5	0.0	2.7	16
28 00	10	N22-20	E141-03	360	0.9	b	1015.1	26.0	25.0	22.1	79	25.7	1	0.0	1.4	12
3	13	N22-56	E140-37	270	2.9	bc	1013.8	27.0	25.5	20.6	68	27.4	3	0.0	1.8	15
6	16	N23-28	E140-14	280	4.6	bc	1012.0	26.2	24.0	20.8	72	28.1	3	0.0	2.0	15
9	19	N24-02	E139-49	320	6.0	b	1012.9	24.6	24.0	20.6	78	27.1	1	0.0	1.7	13
12	21	N24-34	E139-24	10	6.9	b	1015.1	23.3	23.0	19.6	80	24.5	1	0.0	1.6	12
15	29 00	N25-07	E138-57	40	7.9	bc	1015.4	21.6	20.5	17.8	79	24.0	3	0.0	1.5	9
18	3	N25-36	E138-31	30	7.0	c	1015.3	20.5	19.0	15.9	75	22.0	8	0.0	1.7	9
21	6	N26-07	E138-08	10	7.8	b	1016.8	20.2	17.5	13.1	64	24.5	1	0.0	1.9	8
29 00	9	N26-41	E137-44	20	8.5	bc	1017.8	20.5	17.5	13.3	63	24.0	5	0.0	2.4	7
3	12	N27-05	E137-10	30	9.9	bc	1017.4	19.7	17.5	12.4	63	22.9	7	0.0	1.9	9
6	15	N27-20	E136-30	60	9.4	bc	1016.8	19.3	15.5	10.9	58	22.4	5	0.0	2.0	7
9	18	N27-52	E136-09	70	12.8	c	1017.6	18.2	16.0	12.3	69	22.6	8	0.0	2.0	7
12	21	N28-26	E135-47	70	12.4	o	1019.7	17.2	15.0	11.0	67	22.4	10	0.0	2.5	8
15	30 00	N29-01	E135-25	70	12.6	o	1019.7	16.0	14.0	8.6	61	21.1	10	0.0	2.2	7
18	3	N29-34	E135-03	80	12.3	o	1019.2	15.4	12.5	8.3	63	21.1	10	0.0	2.0	8
21	6	N30-10	E134-41	90	12.6	o	1020.6	13.5	13.0	8.5	72	21.0	10	0.0	2.2	8
30 00	9	N30-44	E134-18	90	15.2	o	1019.2	14.3	13.0	8.4	68	20.2	10	0.5	2.1	11
3	12	N31-20	E133-55	90	14.8	o	1018.6	13	12.5	9.3	79	19.7	10	0.2	2.4	11
6	15	N31-14	E133-09	80	12.9	r	1016.1	12.5	12.5	10.9	90	19.7	10	4.2	5	17
9	18	N31-06	E132-23	70	13.1	o	1014.9	14.1	12.5	12	87	20.8	10	0.3	3.8	16
12	21	N31-22	E132-07	70	13.4	r	1016.1	14.7	13.5	12.4	86	22	10	3.4	2.6	9
15	31 00	N32-08	E132-09	60	12.3	r	1017.2	14.6	14.5	11.5	82	21.6	10	0.2	2.7	8
18	3	N32-48	E132-11	340	10.9	bc	1018.3	10.3	9.5	7.6	84	19.2	10	0	1.5	10
21	6	N33-16	E131-59	10	8.7	o	1020.7	8.9	8	5.8	81	15.7	6	0	0.7	6
31 00	9	N33-47	E131-34	260	3.7		1022.1	9.4		4.9	73	19.5		0	0.3	10

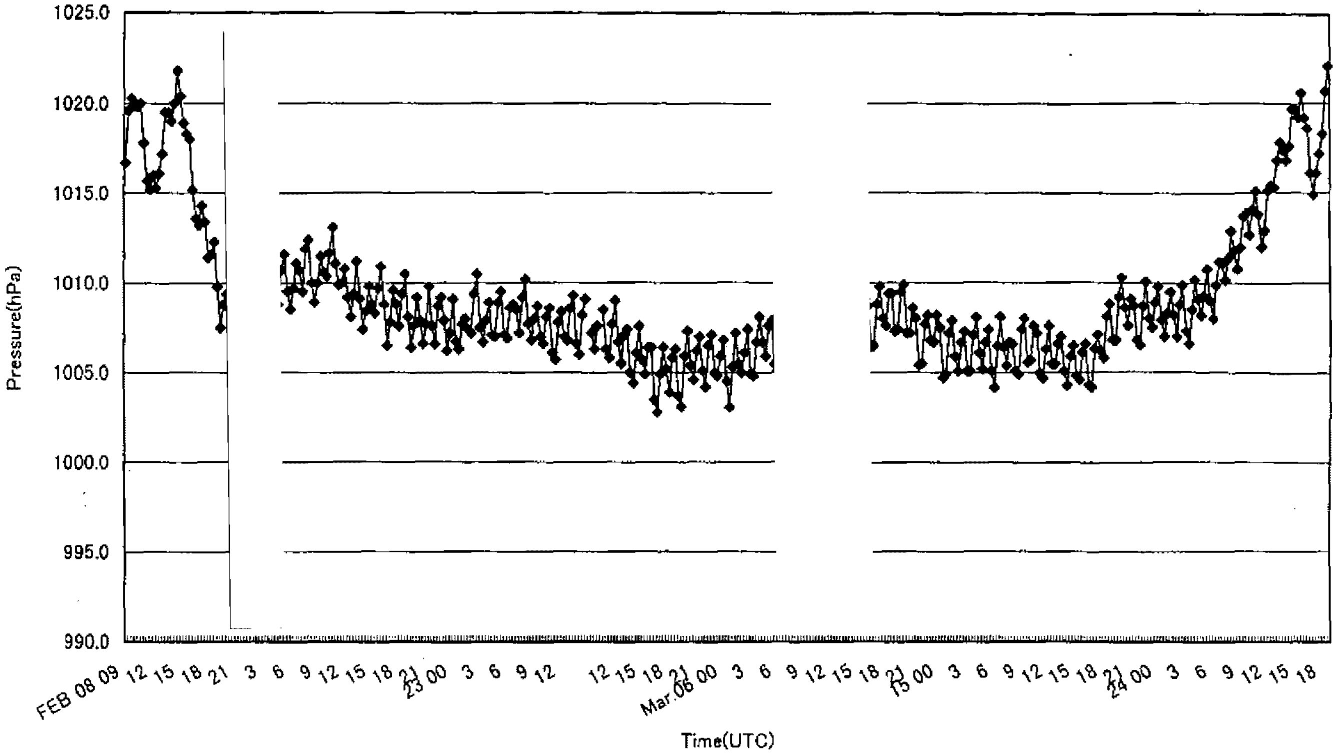


Fig.6.1.1-1 Pressure

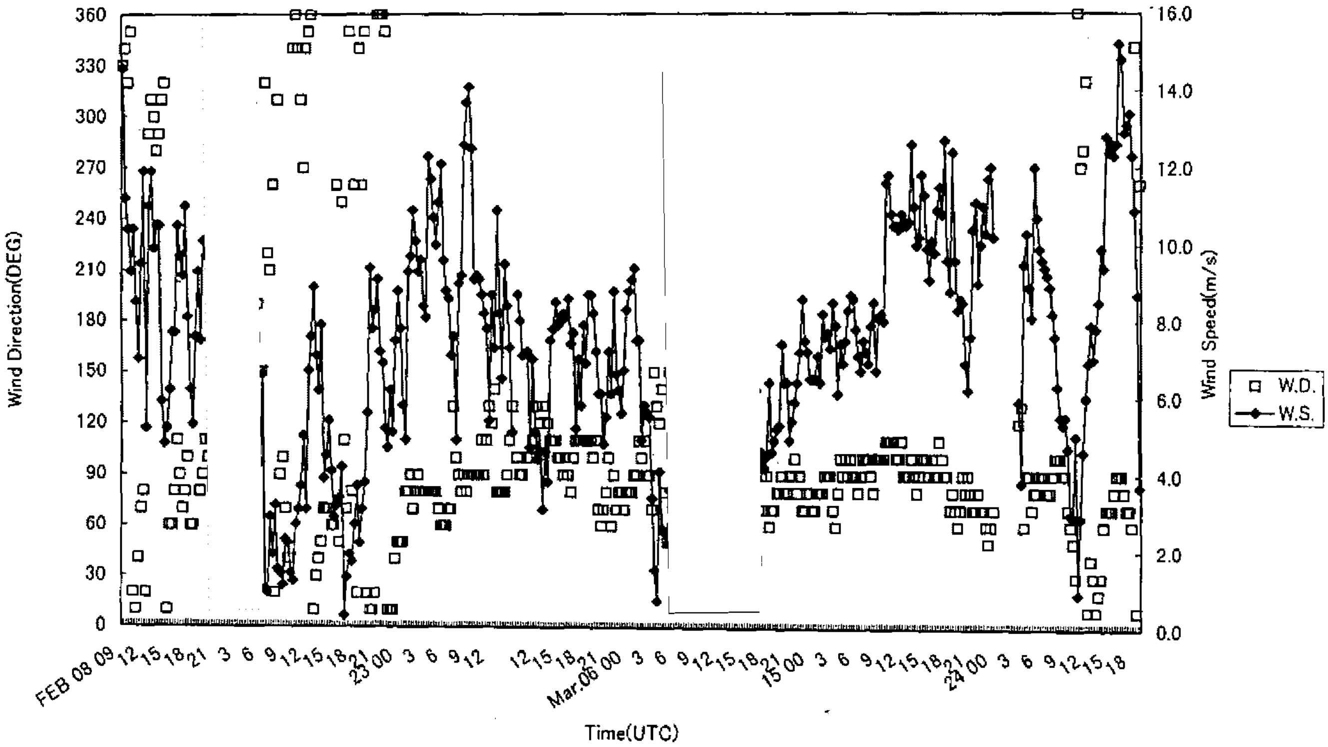


Fig. 6.1.1-2 Wind Speed and Direciton

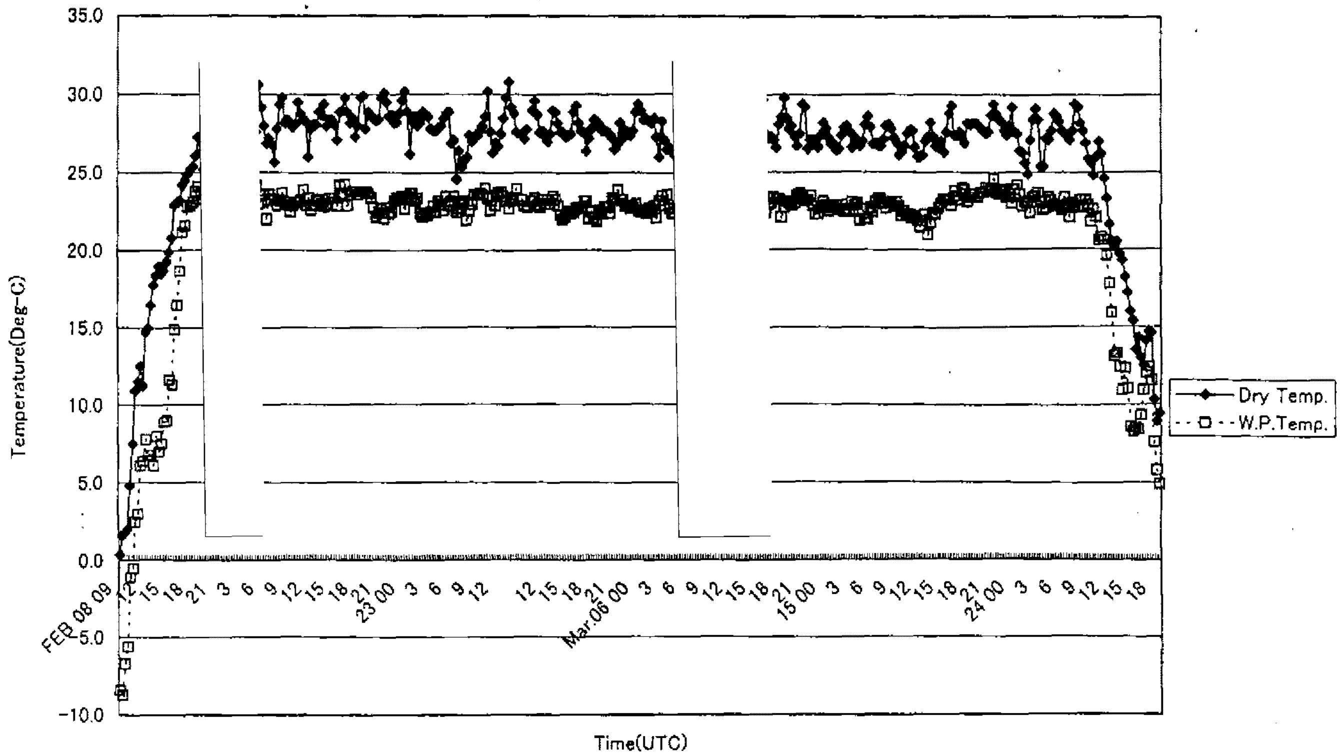


Fig. 6.1.1-3 Temperature and Dew Point Temperature

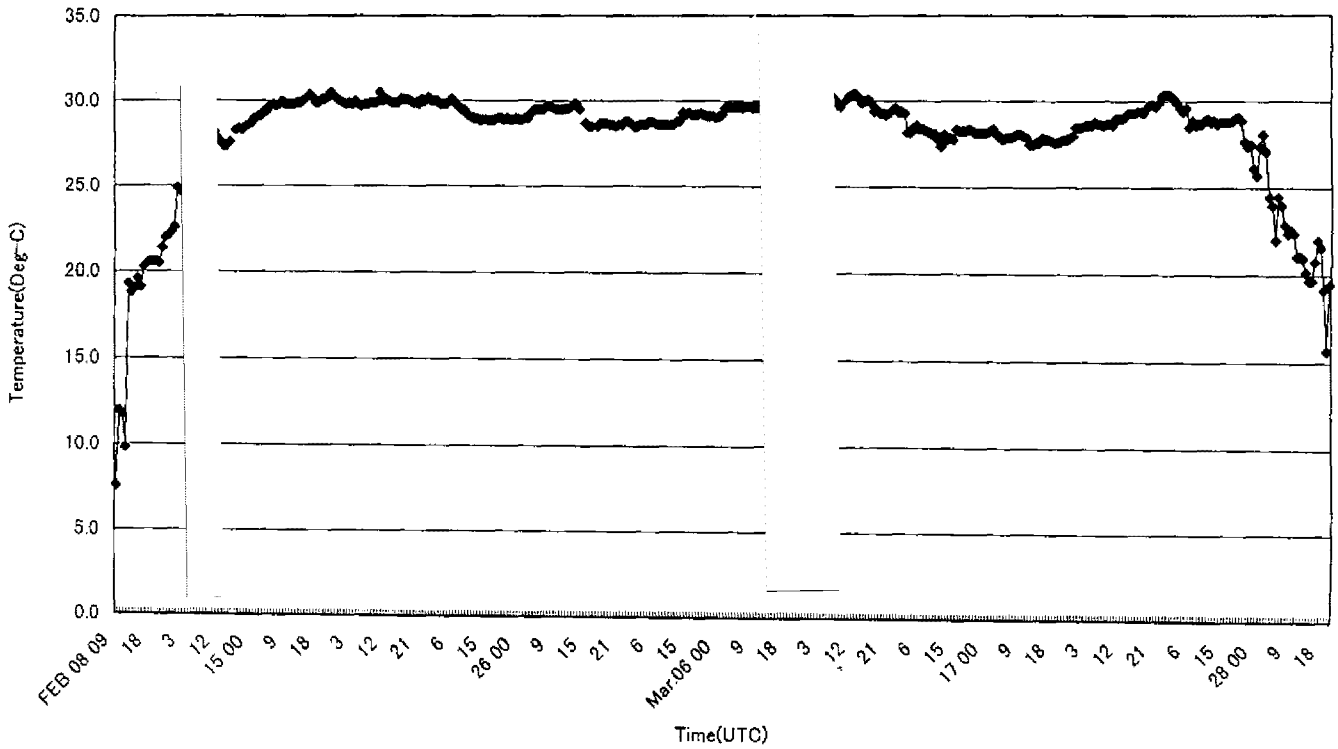


Fig. 6.1.1-4 Sea Surface Temperature

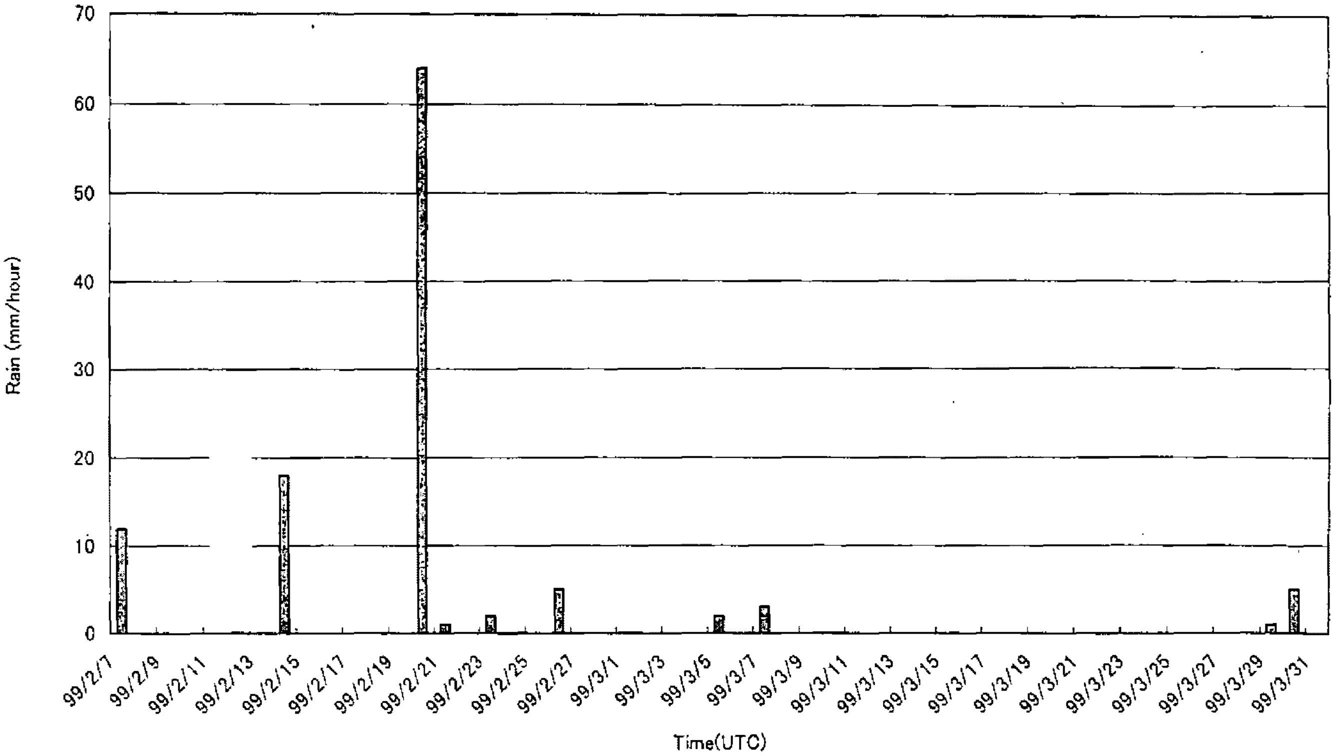


Fig. 6.1.1-5 Rain (Optical Raingage)

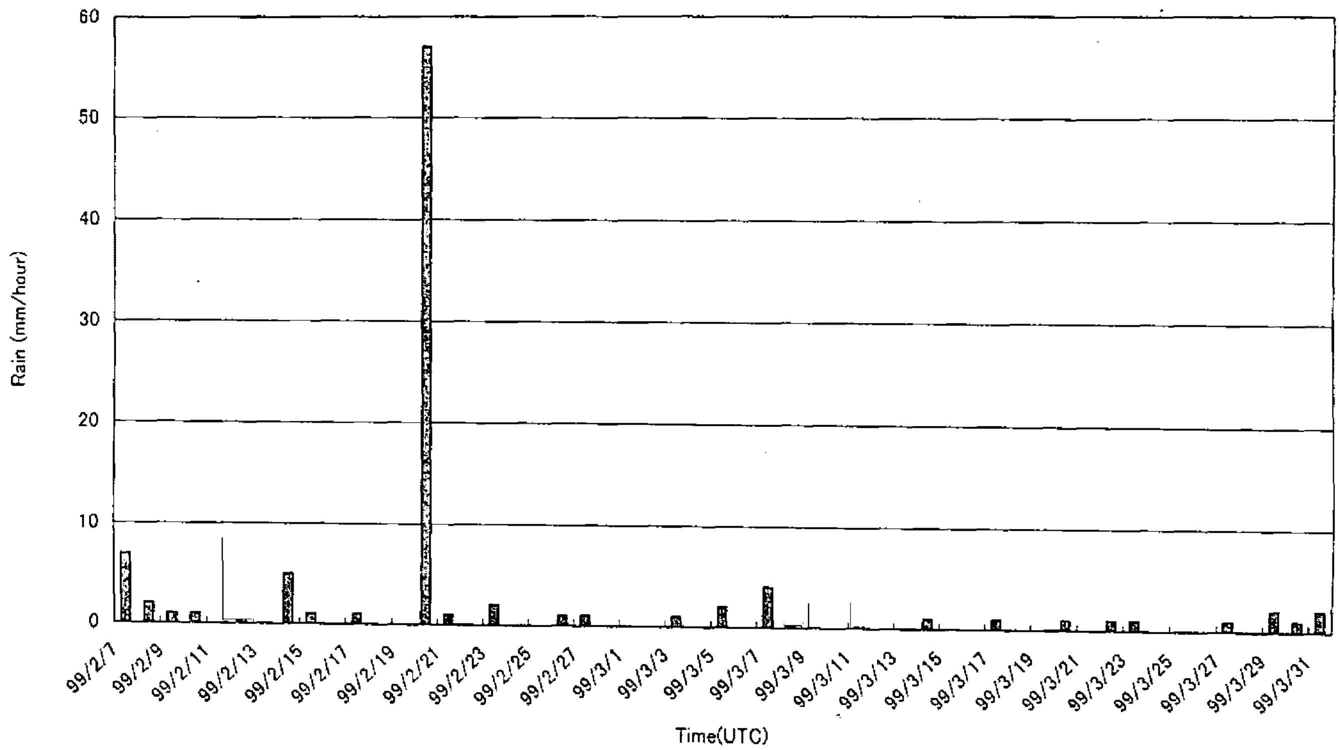


Fig. 6.1.1-6 Rain (Raingage)

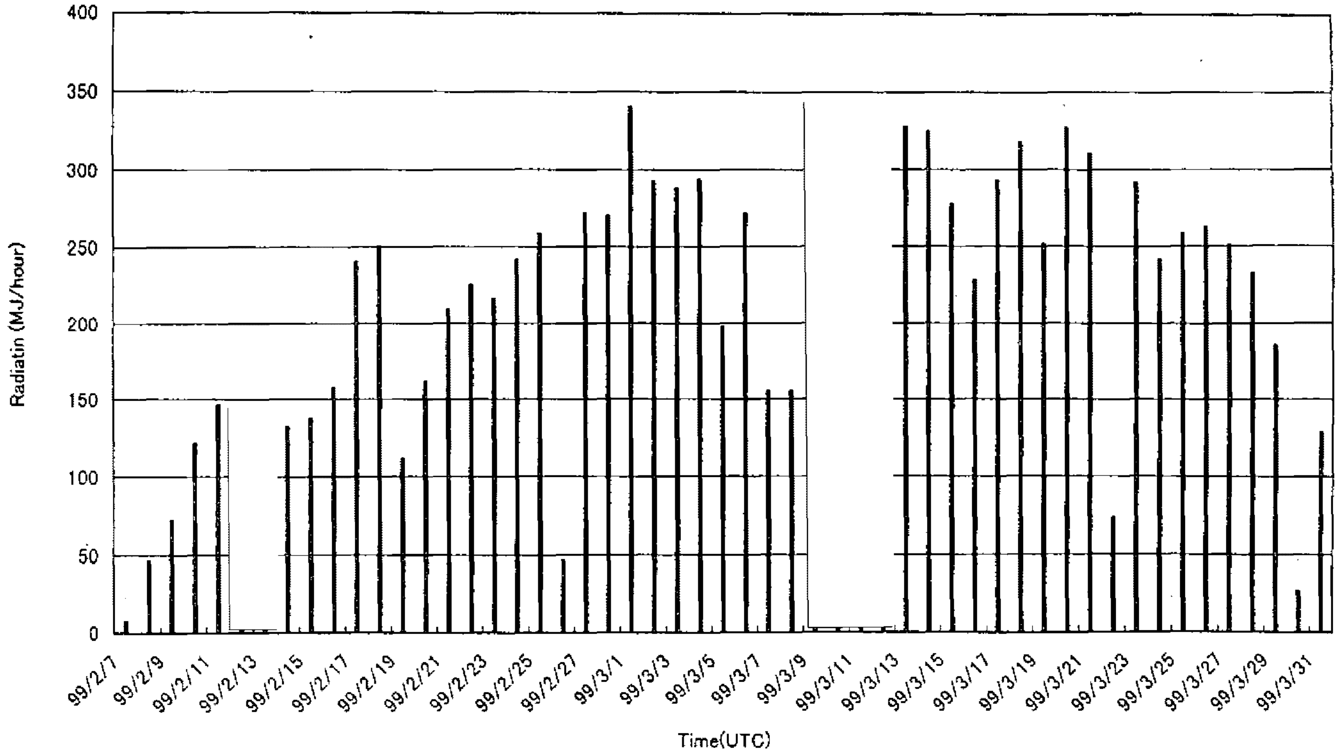


Fig. 6.1.1-7 Short wave radiation from solar

6 .1.2 Atmospheric sounding

(1) Personal

Toshihiko Yano (JAMSTEC) : Operation leader

Fumitaka Yoshiura (GODI) : Operator

(2) Objectives

To promote our understanding about the air-sea interaction over the "warm water pool"area in the western tropical Pacific.

(3) Measured parameters

The range and accuracy of parameters measured by the radiosonde are as follows：

Parameter	Range	Accuracy
Pressure	3 — 1060 hPa	0.5 hPa
Temperature	−90 — +60 deg−C	0.2 deg−C
Relative humidity	0 — 100 %	3 %
Wind speed	0 — 180 m/s	0.5 m/s

(4) Methods

We observed vertical profiles of pressure, temperature, relative humidity, and wind speed/direction using VAISALA DigiCORA MW 11 semi−Automatic Radiosonde System. The system consists of Main processor (MW11), GPS Antenna (GA20), UHF Telemetry Antenna (RB21), Personal Computer (TOSHIBA Dynabook 430CDT), Printer (EPSON LX−1050), Balloon Launcher (ASAP JAMSTEC), and Radiosonde (VAISALA RS80-15G).

The surface data was measured by handy humidity and temperature meter (VAISALA HMI 41／45), onboard Resonator digital barometer (YOKOGAWA AP-100) and anemometer (KOSHIN KC1570A).

We also utilized a humidity calibrator (VAPORPAK H-31, Digilog Instruments) when we calibrate each sensor before launch.

It is also worth to note about our procedure to launch the balloons. Namely, in order to avoid (or at least reduce) the influence of sensor arm heating and/or launching from the air- conditioned sea container over the tropical ocean, which mainly cause the surface humidity error, the inside of launcher room of container was ventilated well before launching until sensors showed appropriate value (difference are less than 0.5℃ and 5%) comparing to outside man-measured temperature and humidity.

We launched the radiosonde every 12 hours at 00Z, 12Z, from Feb. 15,1999 to Mar. 8,1999, and from Mar.12 , 1999 to Mar.20,1999. We obtained 61 sounding data during the cruise.

Table 7.1.2-1 shows radosonde launch log.

(5) Preliminary Results

Figure6.1.2- 1 shows the EMAGRAM and wind profiles with sounding time（YYMMDDTT UTC）and position.

Generally, easterly winds were dominant at entire troposphere during the cruise, except at higher troposphere (400 ～ 200hPa) between the equator and around 5S line, where the westerlies were dominant with maximum speed of 10m/sec at below 200hPa. Lower troposphere (below ～ 800hPa) winds are classified into two types, (1) weak less than 3m/sec along 147E line, and (2) strong over 10m/sec east of 156E and/or after February 24.

As often found in the past cruises, relatively strong dry layers with temperature inversion were observed above 500hPa near the equator, that is corresponding to the fact that deep convections were rarely observed during whole cruise. (eg. See sections radar observations and satellite IR images.)

（6）Data archive

All sounding data have been sent through GTS to meteorological agencies in the world. Raw data stored in magneto optical disk in ASCII format and available through JAMSTEC DMO.

Table 6.1.2-1

No	Time(UTC) YY MM DD TT	Position Lat.	Log.	Surface Press. (hPa)	Surface Temp. (DEG-C)	Surface RH (%)	Surface W.D. (deg)	Surface W.S. (m/s)	Max Alitude (hPa)	Max Alitude (m)	Cloud Amount	Cloud type
3	99 02 15 12	07.09N	146.66E	1008.9	28.3	85	143	8.3	32.8	23101	1	N/A
4	99 02 16 00	04.93N	147.02E	1010.4	27.3	77	280	2.2	765.2	2407	9	Ci,Ac,Cu
5	99 02 16 12	04.87N	146.99E	1009.1	25.6	78	129	2.9	57.4	19672	10	Cb
6	99 02 17 00	04.84N	147.01E	1010.7	28.1	75	220	0.9	63.6	19142	2	Ci,Cu,Cb,Ac
7	99 02 17 12	04.28N	147.00E	1009.5	28.4	76	54	3.2	36.5	22410	0	N/A
8	99 02 18 00	02.18N	146.97E	1011.2	29.5	70	354	2.8	23.1	25439	4	Ci,Cu
9	99 02 18 12	02.07N	146.90E	1009.8	26.6	88	353	10.4	19.1	26608	3	Ci,Cu,Cb?
10	99 02 19 00	02.09N	146.92E	1009.5	28	73	42	7.8	17.7	27098	10-	Ac,Cu,Sc
11	99 02 19 12	01.14N	147.09E	1007.8	28.4	78	72	5.3	22.6	25506	1	N/A
12	99 02 20 00	00.09N	146.82E	1008.6	27.4	80	17	1.4	29.3	23821	8	Ci,Ac,Cu
13	99 02 20 12	00.12N	146.88E	1007.7	28.4	78	353	3.6	29.5	23805	3	Cu,Cb,Ac
14	99 02 21 00	00.06N	146.86E	1008.9	29.6	67	319	2.3	48.4	20675	5	Ci,Cu
15	99 02 21 12	00.02S	146.91E	1007.4	28.9	76	16	7.8	28.3	24059	7	Ci,Cu
16	99 02 22 00	00.01S	147.08E	1008.1	29.5	69	349	8.2	26.9	24384	9	Ac,Cu
17	99 02 22 12	01.23N	148.05E	1007.5	28.8	70	16	6.4	22.2	25618	6	Ac,Cu
18	99 02 23 00	03.37N	150.21E	1007.2	29.6	68	55	7.5	17.7	27089	10-	Ci,Ac,Cu
19	99 02 23 12	05.55N	152.33E	1006.4	28.3	73	63	9.5	65.5	18914	10-	As,Ac
20	99 02 24 00	07.66N	154.46E	1009.0	28.7	70	86	8.5	61.3	19295	10-	Ci,Ac,Cu
21	99 02 24 12	07.86N	156.17E	1007.1	27.8	78	61	13.0	28.0	24134	3	Sc,Cu,Ci
22	99 02 25 00	07.96N	155.98E	1007.8	28.7	74	57	12.7	48.3	20749	6	Ci,Cu
23	99 02 25 12	08.00N	156.07E	1007.3	27.1	83	63	9.4	47.5	20827	10	Sc,Cb

24	99 02 26 00	07.99N	155.98E	1008.5	25.8	87	78	10.2	37.2	22392	10	Sc,Cu
25	99 02 26 12	06.30N	155.96E	1007.1	27.5	82	88	14.1	26.6	24446	10-	Cs,Cu
26	99 02 27 00	04.98N	155.91E	1007.0	27.6	76	102	8.6	54.5	19986	3	Ci,Ac,Cu
27	99 02 27 12	05.05N	155.90E	1006.7	27.3	87	112	6.6	21.3	25871	4	Cu,Sc
28	99 02 28 00	05.05N	156.01E	1007.3	29.8	70	83	8.9	21.5	25795	4	Ci,Cu
29	99 02 28 12	03.50N	156.05E	1007.4	28.5	76	112	5.0	27.6	24208	6	Cu,Ci
30	99 03 01 00	01.92N	155.96E	1007.1	28.5	76	110	7.3	N/A	N/A	7	Ci,Ac,Cu
31	99 03 01 12	01.94N	156.02E	1006.9	27.7	80	97	5.8	30.1	23667	7	Cu
32	99 03 02 00	01.92N	156.04E	1005.7	28.8	72	115	4.2	32.2	23232	7	Ci,Cu
33	99 03 02 12	00.27N	155.93E	1005.5	27.5	77	94	8.1	35.9	22539	4	Ci,As
34	99 03 03 00	00.10S	156.01E	1005.3	28.6	72	94	8.0	46.4	20997	6	Ci,Cu
35	99 03 03 12	00.06S	156.08E	1004.6	27.7	81	115	7.7	24.8	24847	3	Cu,Ac,Ci
36	99 03 04 00	00.01S	156.00E	1004.6	28.7	71	106	9.7	24.3	25037	2	Ci,Cu
37	99 03 04 12	01.67S	155.87E	1005.4	27.9	76	65	6.4	43.5	21341	2	Cu,Ci
38	99 03 05 00	02.02S	155.94E	1005.2	28.1	76	76	8.4	37.7	22230	8	Ci,Ac,Cu
39	99 03 05 12	01.98S	155.99E	1005.5	27.6	81	76	8.1	39.4	21968	8	Ac,Cu
40	99 03 06 00	02.02S	155.92E	1005.2	29.1	72	74	8.1	33.3	22971	5	Cu,Ci
41	99 03 06 12	04.08S	155.95E	1005.4	28.6	74	111	8.3	38.3	22120	3	Cu,Ci
42	99 03 07 00	05.07S	156.04E	1005.8	27.7	76	65	7.8	22.8	25413	9	Ci,Cu
43	99 03 07 12	05.12S	156.08E	1006.3	27.3	83	192	2.9	47.6	20817	3	Ci,Cu
44	99 03 08 00	05.06S	156.05E	1006.6	26.1	78	133	4.7	23.5	25173	9	Ci,Ac,Cu
45	99 03 12 12	09.10S	162.86E	1008.0	27.3	79	355	11.5	40.3	21837	1	Ac,Cu
46	99 03 13 00	08.03S	164.79E	1007.6	29.6	65	50	1.9	30.3	23575	6	Ci,Cu,Cb
47	99 03 13 12	06.72S	164.96E	1008.2	28.0	75	85	6.5	49.0	20639	2	Cu
48	99 03 14 00	05.00S	165.18E	1006.7	29.2	71	98	6.6	29.4	23756	3	Cu
49	99 03 14 12	03.66S	164.85E	1006.7	26.9	83	65	6.2	44.6	21178	2	Cu
50	99 03 15 00	01.81S	163.90E	1006.0	28.2	73	67	6.7	36.6	22396	8	Ac,Cu
51	99 03 15 12	01.05S	160.49E	1006.3	26.7	81	80	7.7	57.7	19650	0	
52	99 03 16 00	00.34S	157.12E	1005.7	28.6	74	60	8.2	32.0	23272	9	Ci,Ac,Cu
53	99 03 16 12	00.08S	156.03E	1006.2	27.0	80	86	7.2	43.6	21371	8	N/A
54	99 03 17 00	00.07S	155.76E	1006.0	27.5	72	96	7.9	29.8	23715	1	Ci,Cu
55	99 03 17 12	00.05S	157.88E	1006.3	27.0	81	98	7.1	43.0	21444	5	Cu
56	99 03 18 00	00.03S	160.77E	1005.0	28.3	75	81	8.6	34.7	22727	1	Cu
57	99 03 18 12	00.02S	163.64E	1006.3	26.8	83	112	9.5	37.5	22265	3	Cu
58	99 03 19 00	00.00N	165.27E	1006.1	28.7	71	109	8.8	31.0	23486	2	Cu
59	99 03 19 12	00.02N	164.90E	1005.9	26.6	79	106	11.7	55.9	19867	1	Cu
60	99 03 20 00	00.01N	164.97E	1005.4	28.6	67	91	7.7	45.9	21031	3	Ci,Cu
61	99 03 20 12	01.09N	164.98E	1005.4	26.7	80	87	8.4	44.8	21221	2	Cu

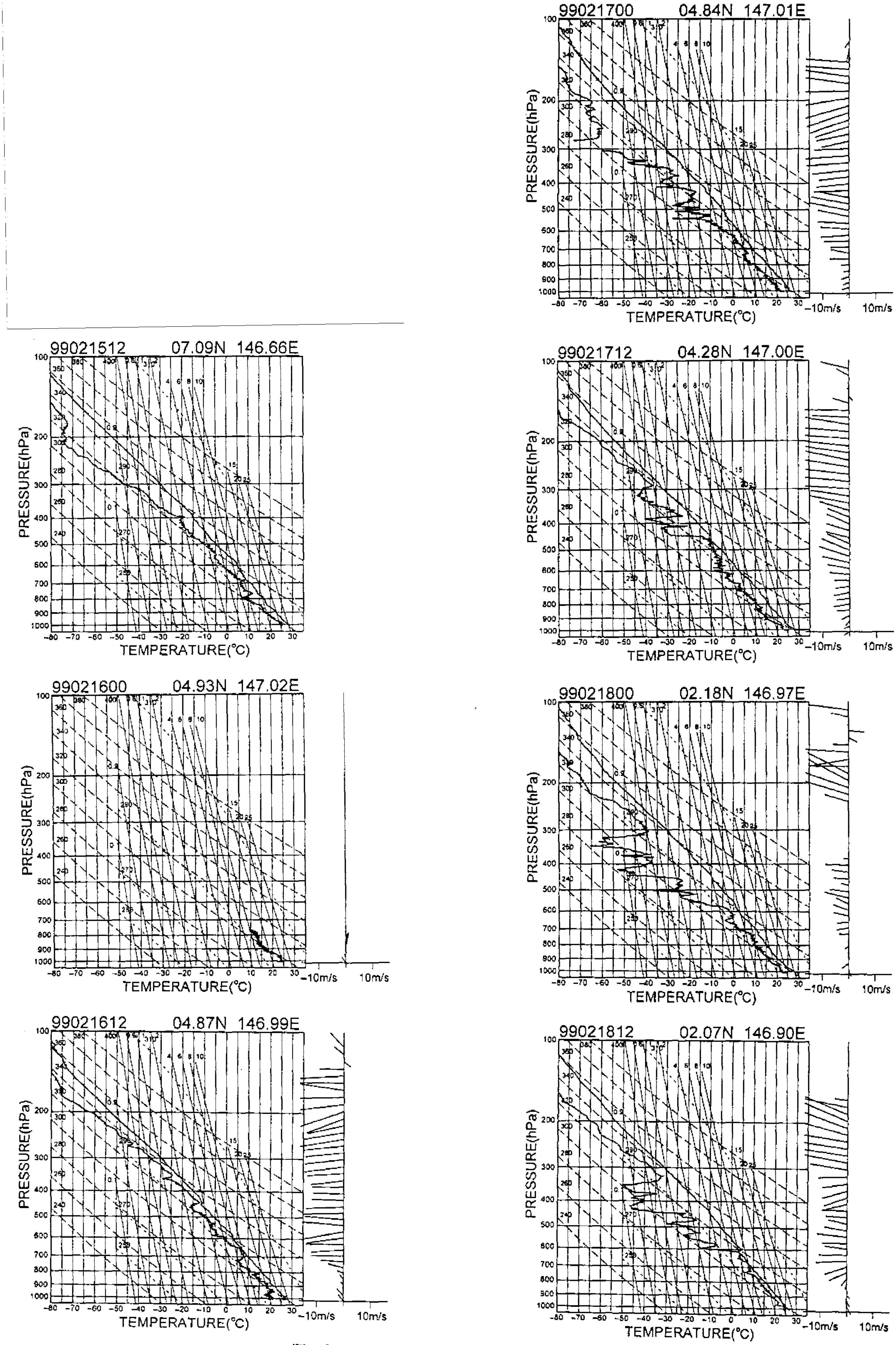
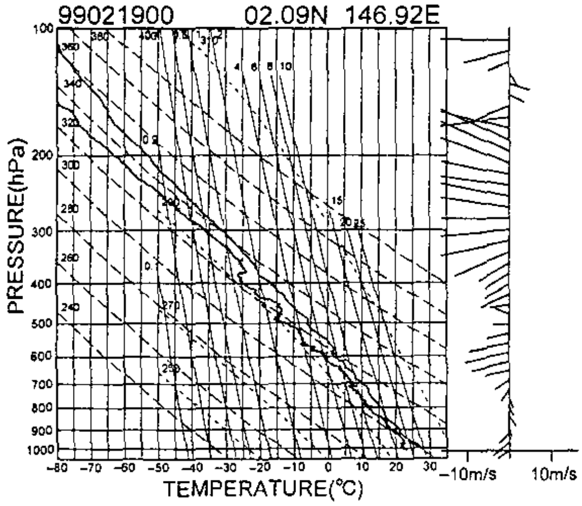
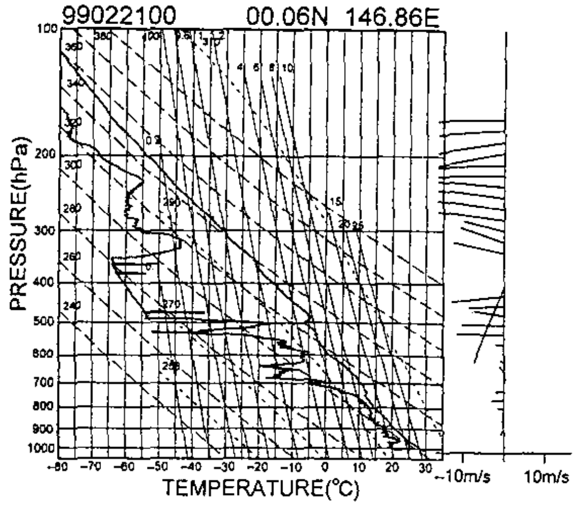
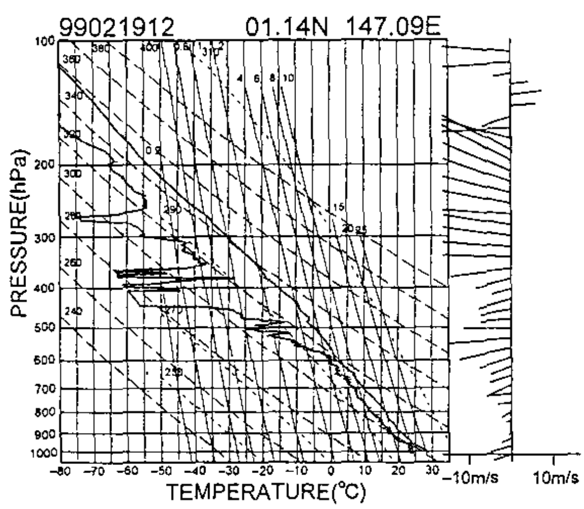
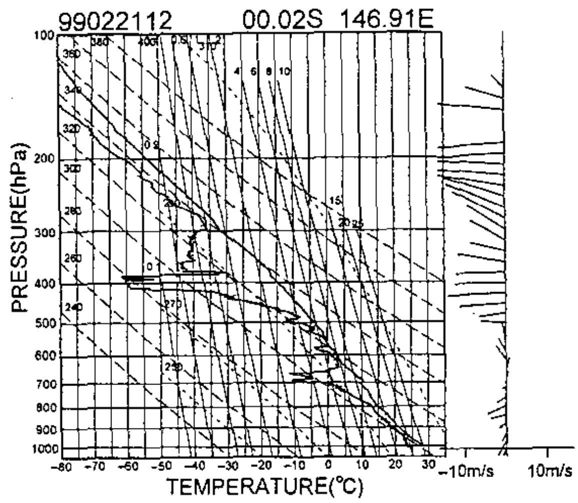


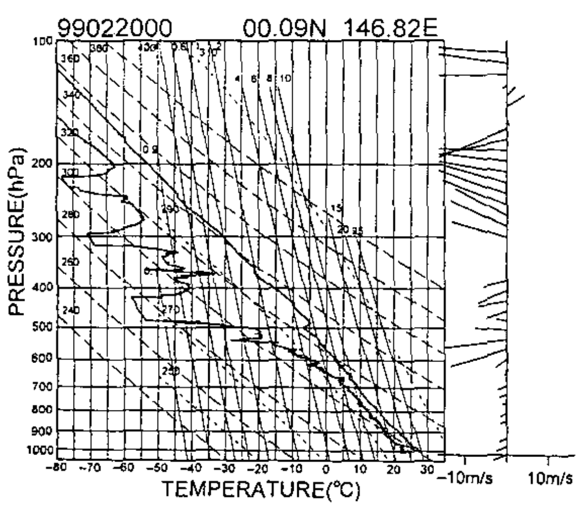
Fig 6.1.2-1 EMAGRAM and wind profile


99021900 02.09N 146.92E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022100 00.06N 146.86E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99021912 01.14N 147.09E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022112 00.02S 146.91E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s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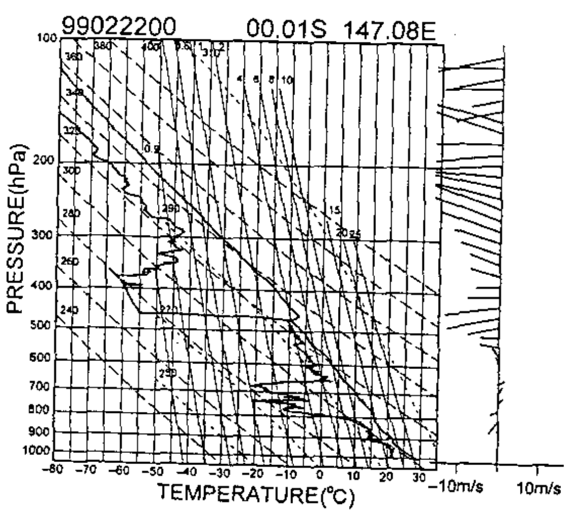
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s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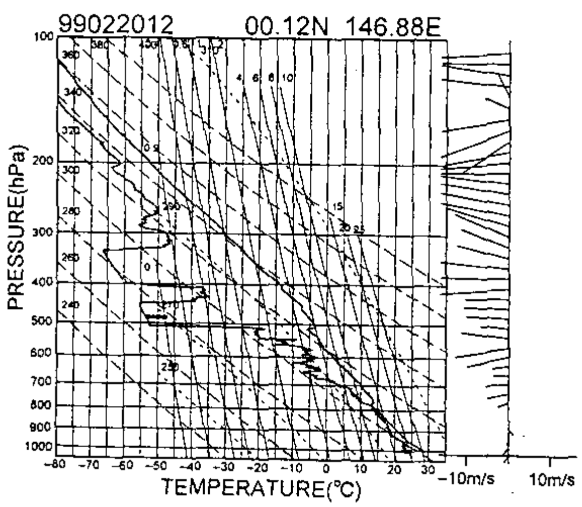
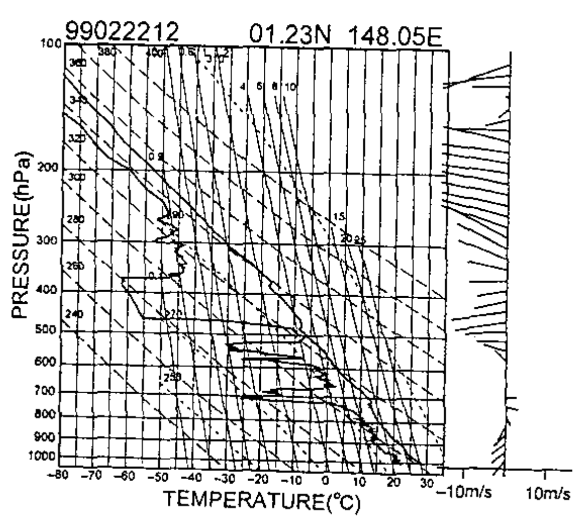
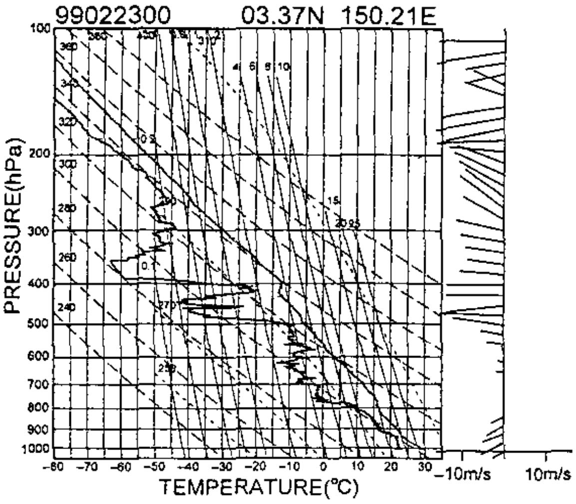
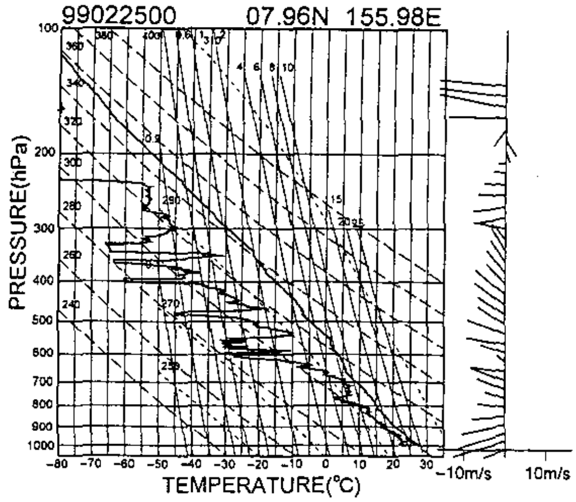
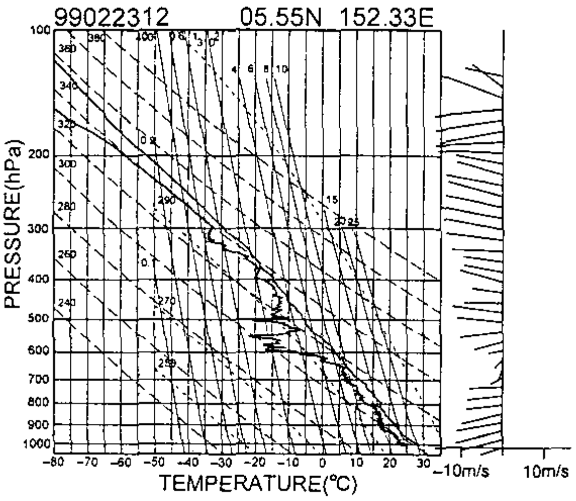
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

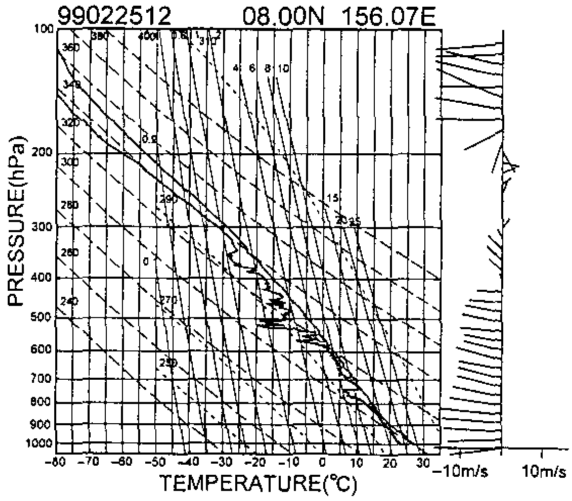

99022012 00.12N 146.88E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

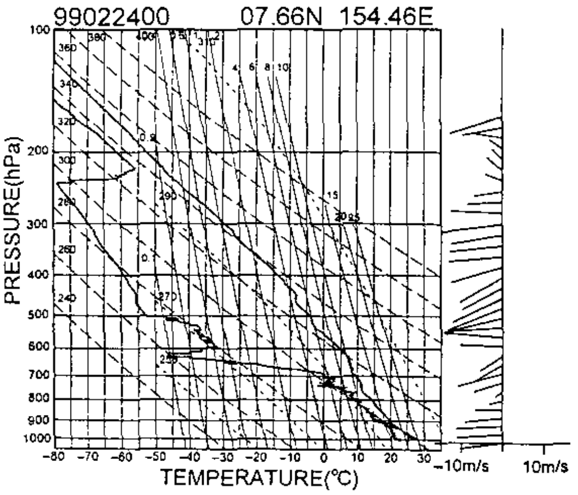

99022212 01.23N 148.05E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

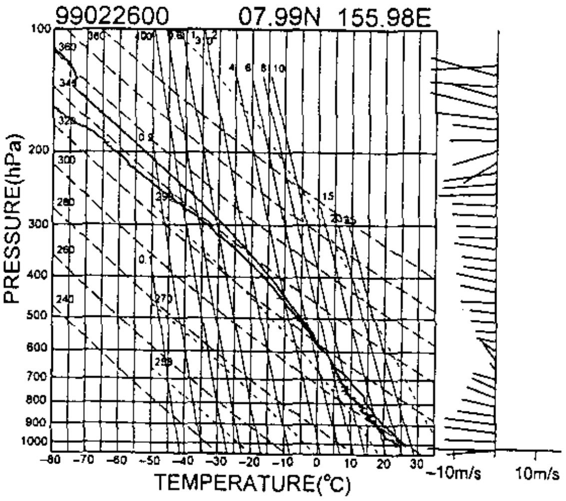

99022300 03.37N 150.21E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

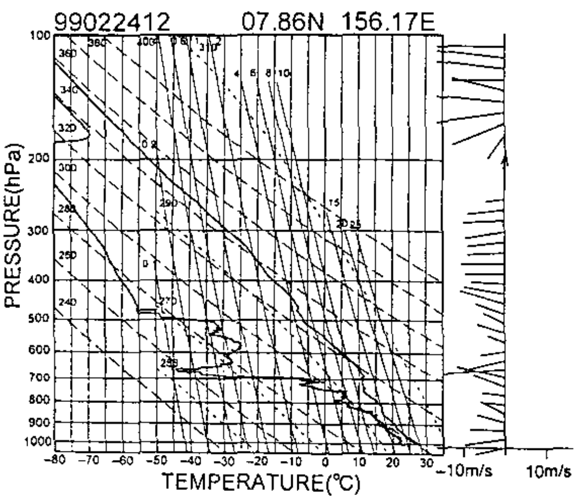

99022500 07.96N 155.98E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

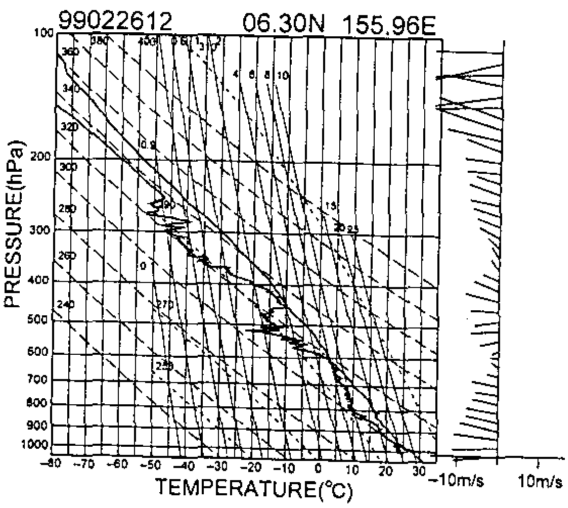

99022312 05.55N 152.33E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

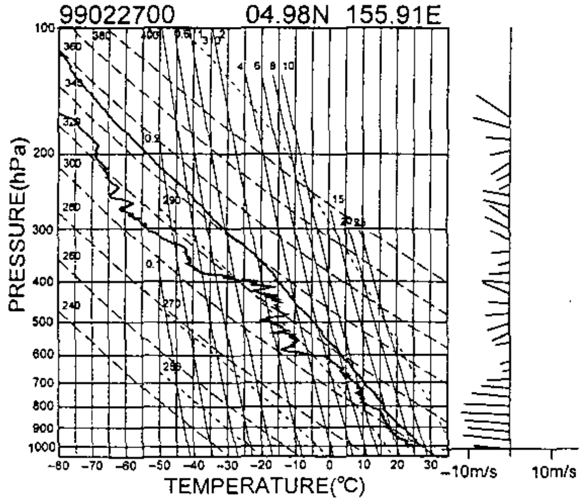

99022512 08.00N 156.07E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s

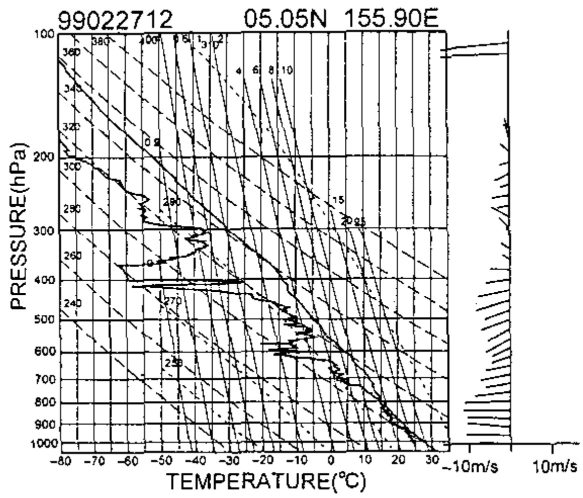

99022400 07.66N 154.46E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022600 07.99N 155.98E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022412 07.86N 156.17E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022612 06.30N 155.96E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s 10m/s


99022700 04.98N 155.91E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s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PRESSURE(hPa)
TEMPERATURE(°C)
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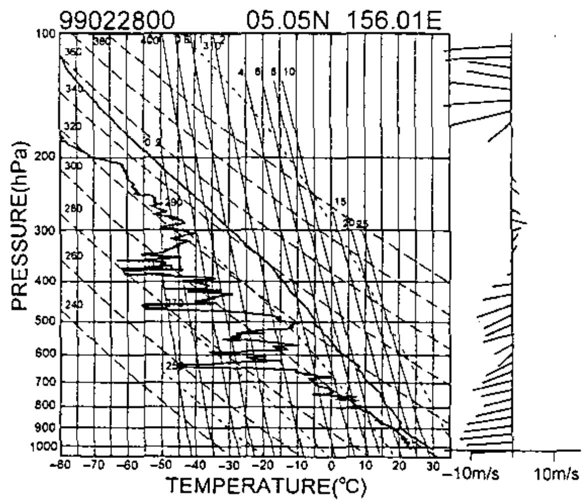
10m/s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PRESSURE(hPa)
TEMPERATURE(°C)
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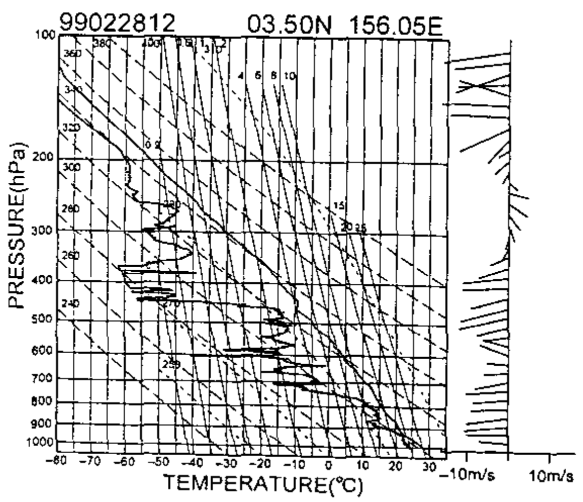
10m/s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TEMPERATURE(°C)
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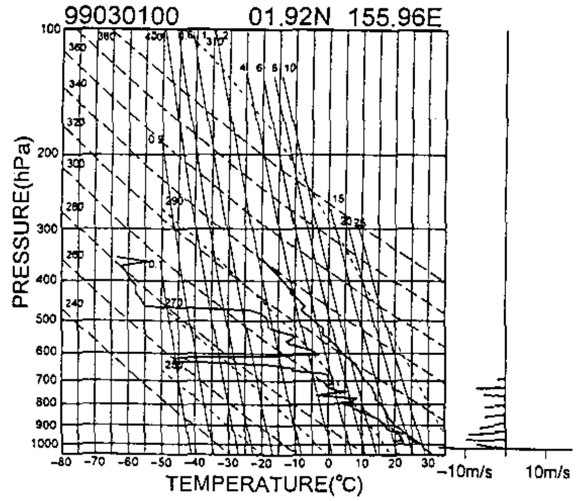
10m/s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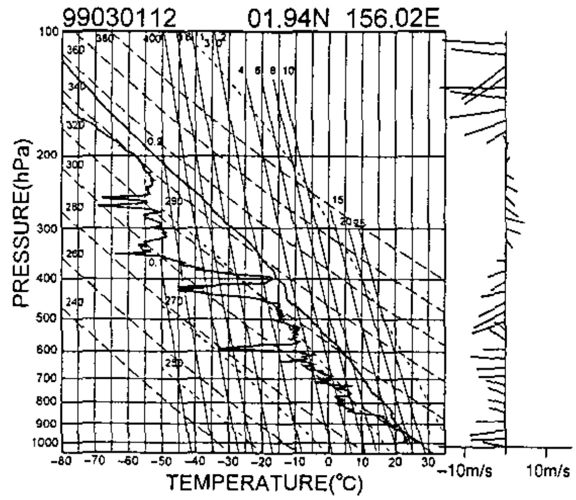
TEMPERATURE(°C)
-10m/s
10m/s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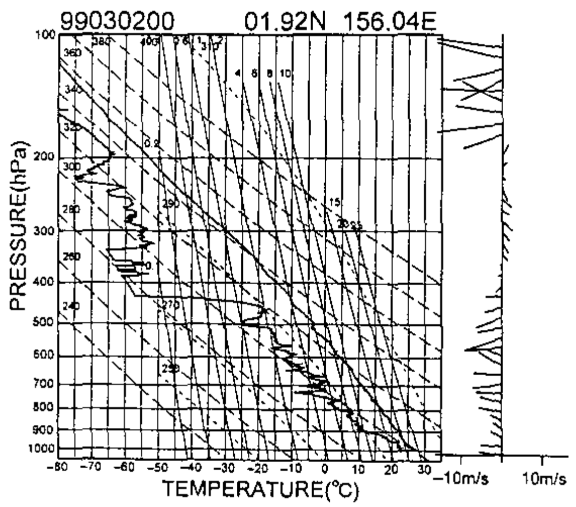
99030200 01.92N 156.04E
PRESSURE(hPa)
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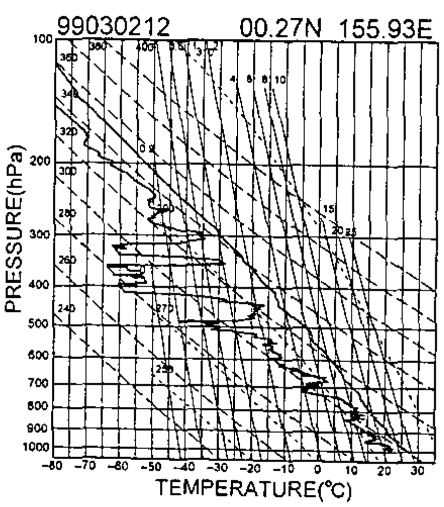
99030212 00.27N 155.93E
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TEMPERATURE(°C)

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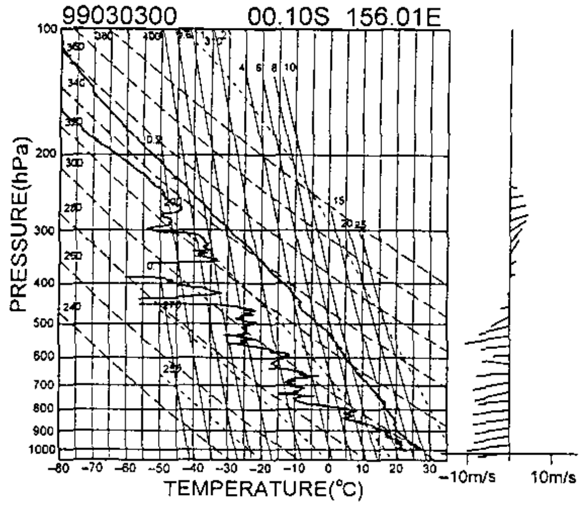

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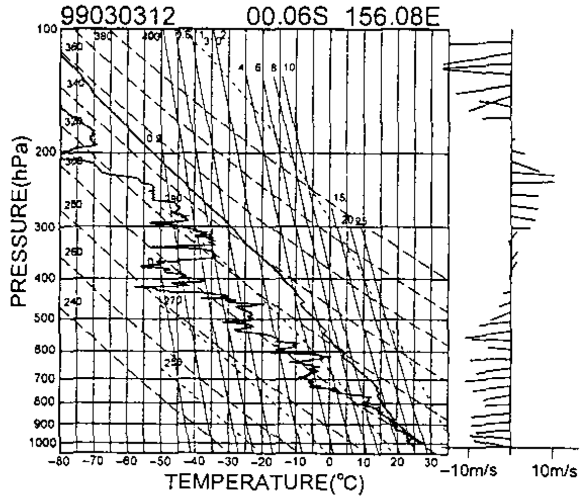

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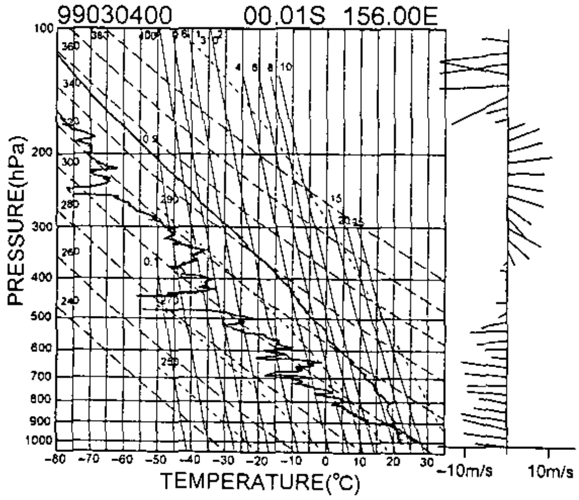

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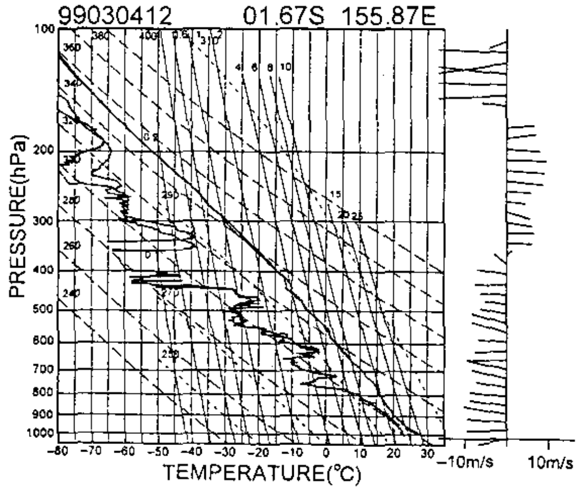

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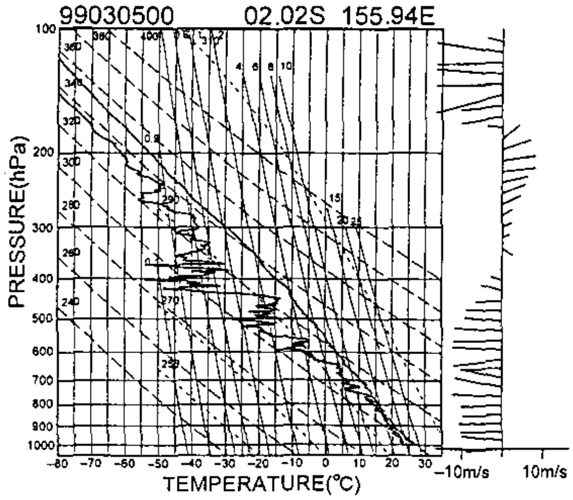

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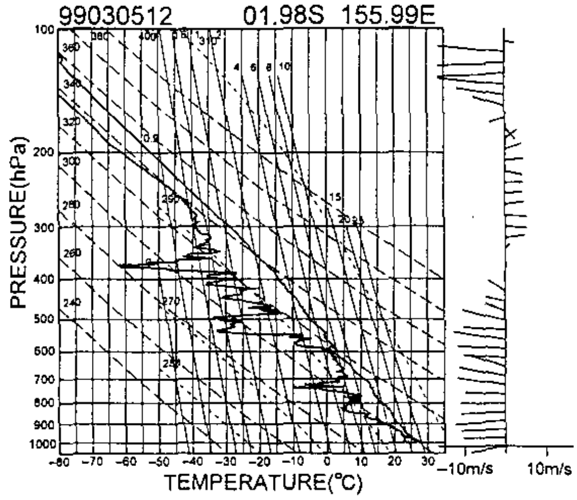

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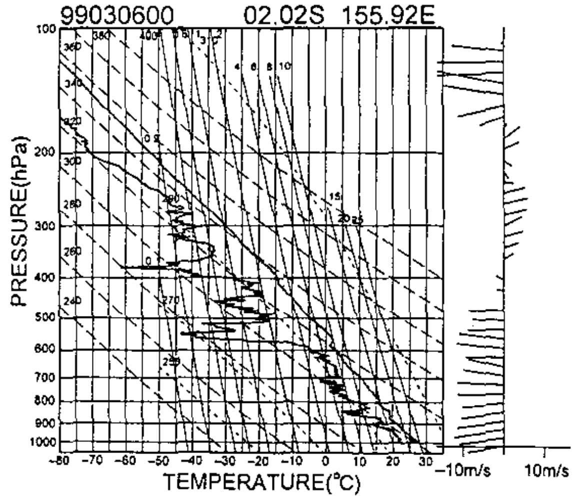

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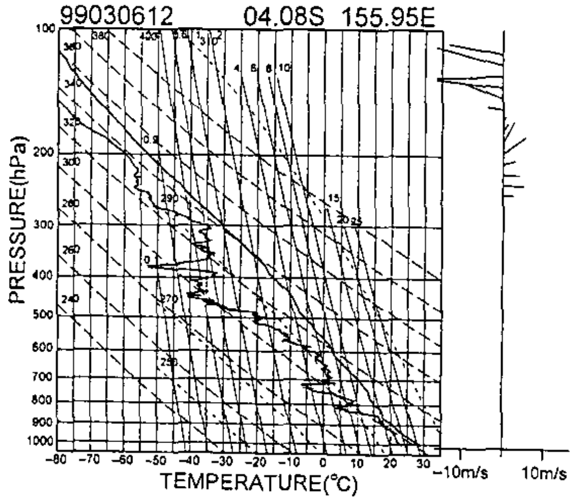

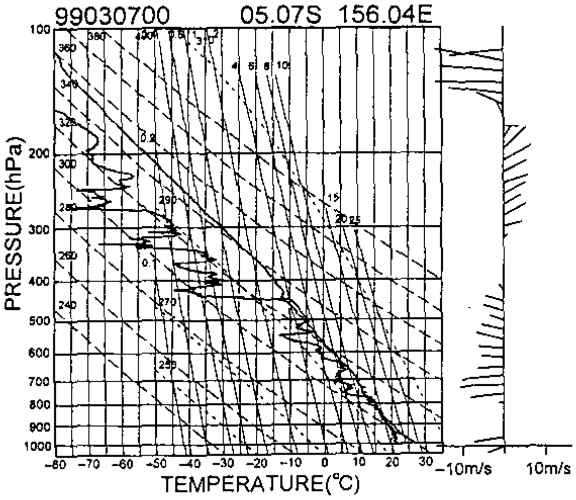
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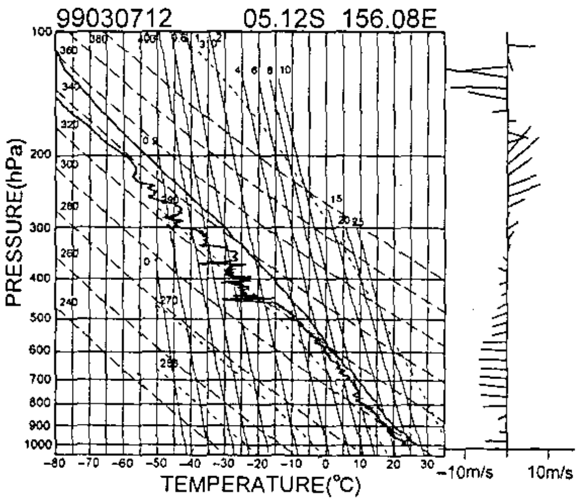
10m/s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PRESSURE(hPa)
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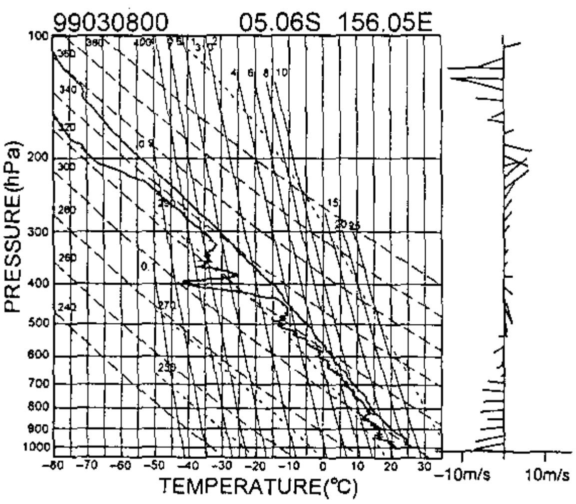
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TEMPERATURE(℃)
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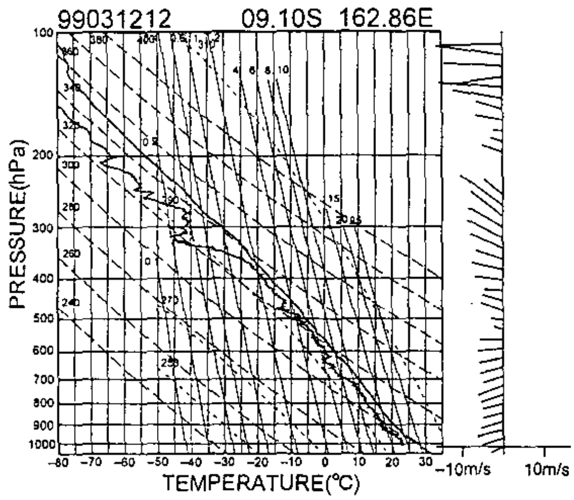
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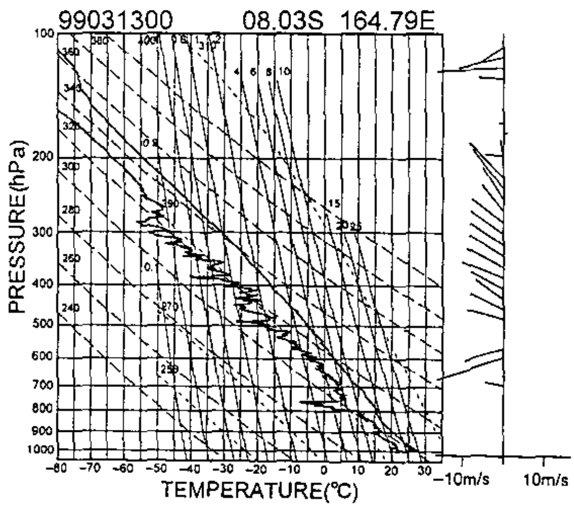
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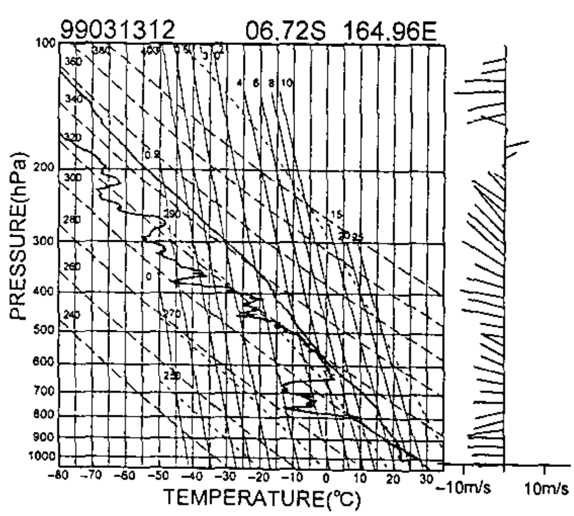
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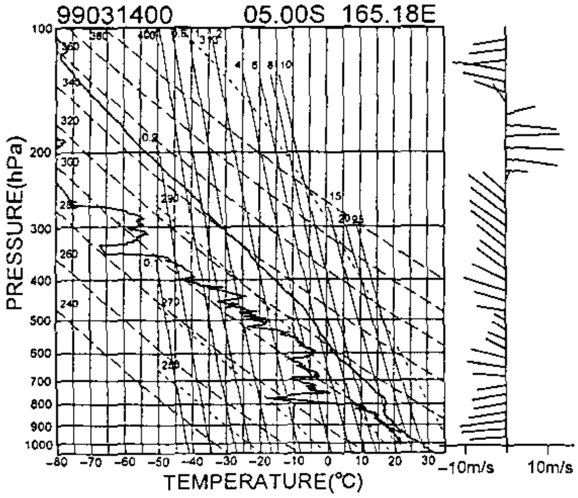
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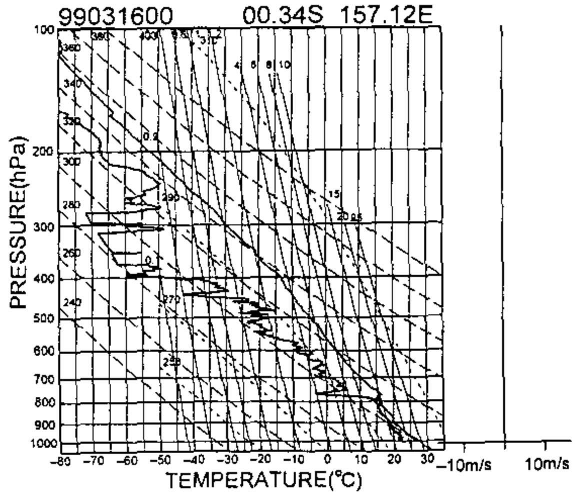
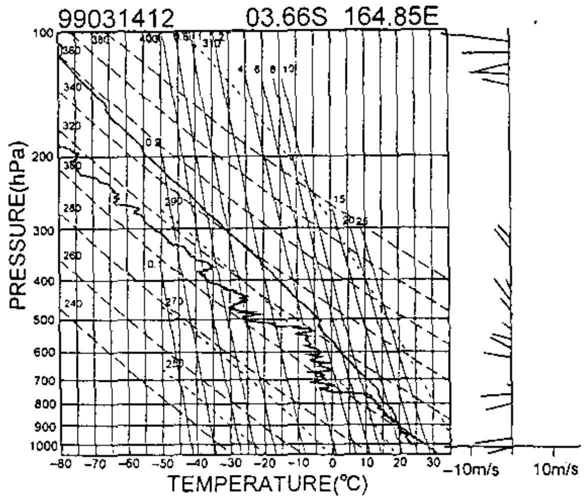
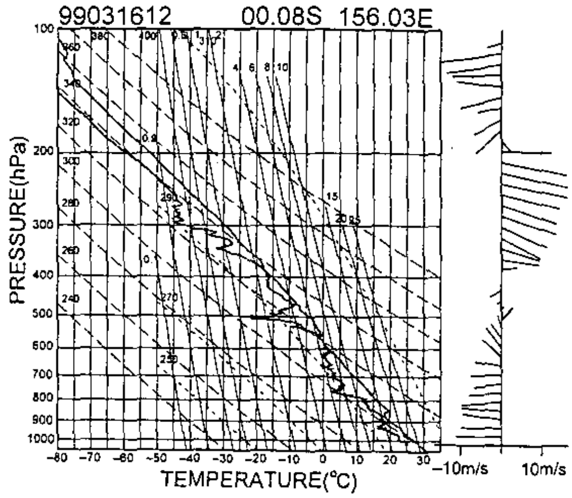
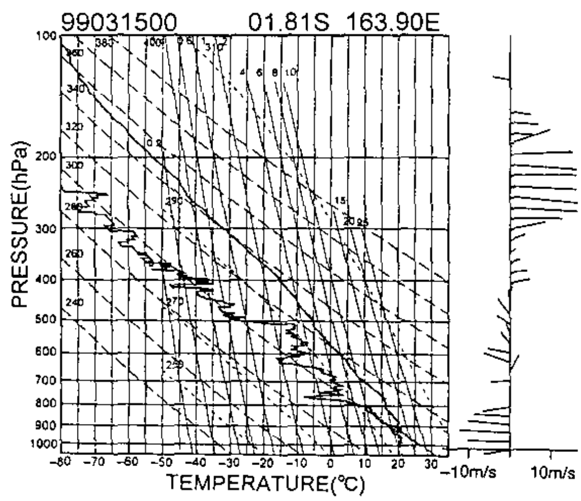
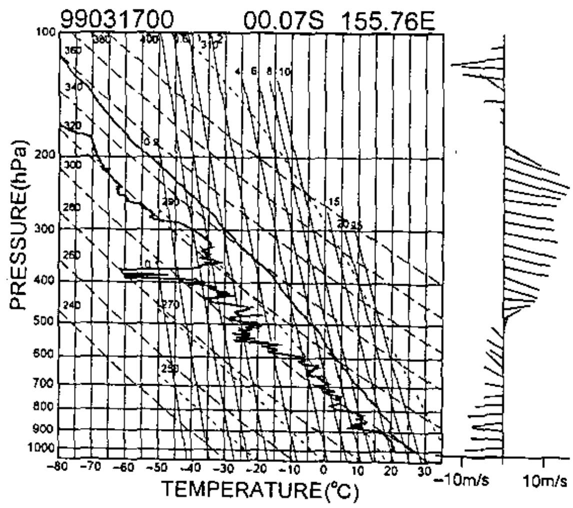
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

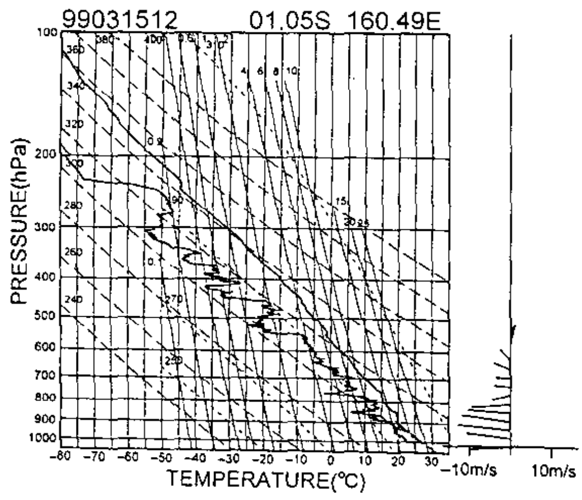

99031600 00.34S 157.12E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

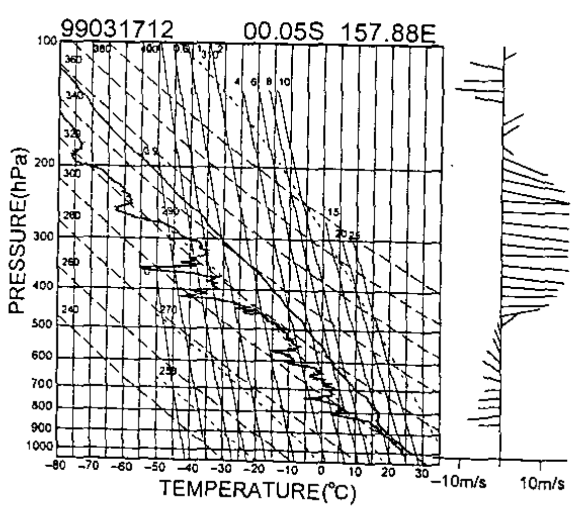

99031412 03.66S 164.85E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

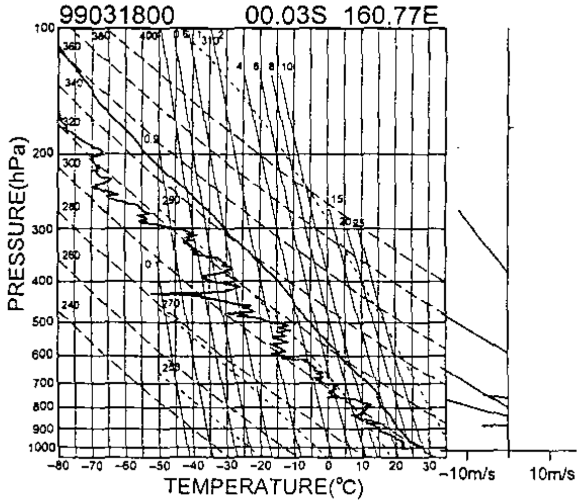

99031612 00.08S 156.03E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

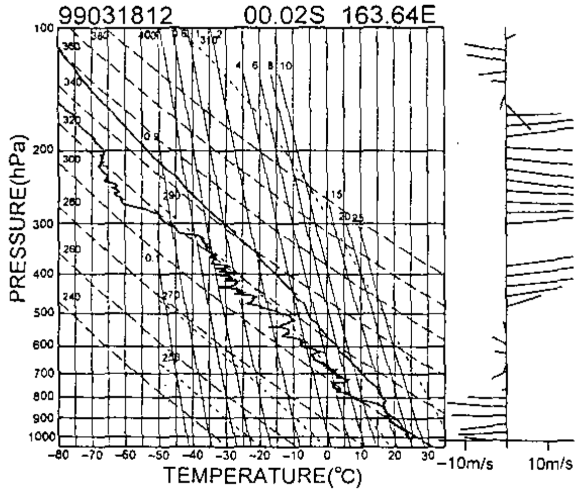

99031500 01.81S 163.90E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

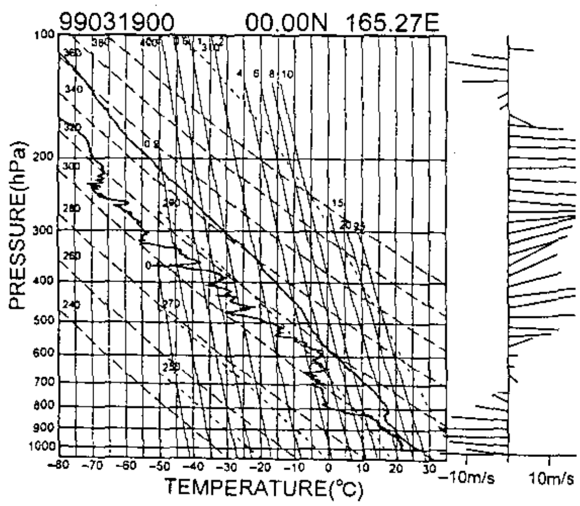

99031700 00.07S 155.76E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

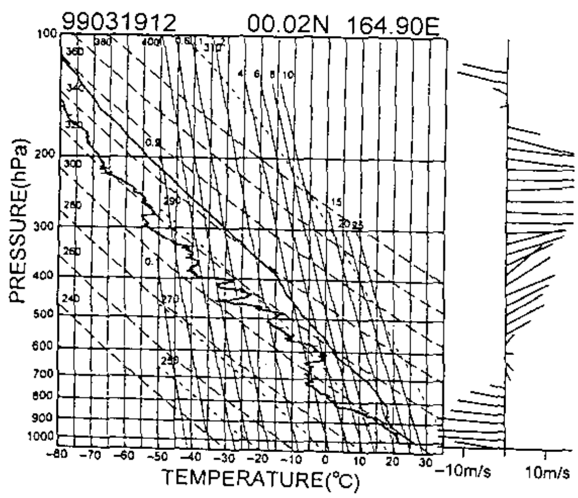

99031512 01.05S 160.49E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

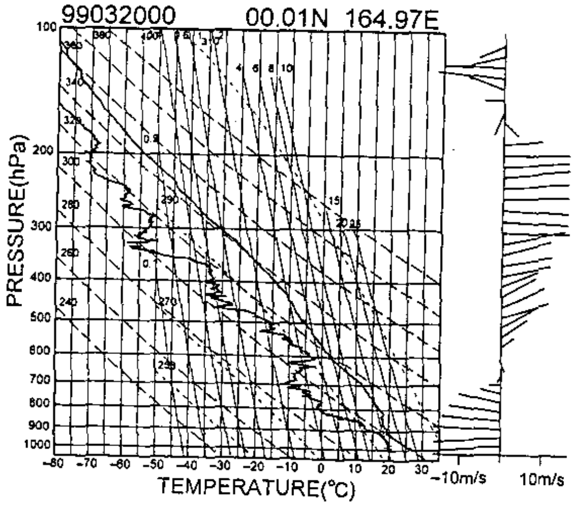

99031712 00.05S 157.88E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

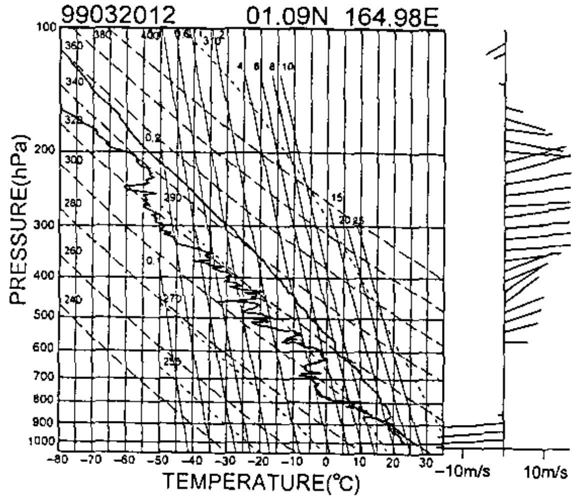

99031800 00.03S 160.77E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s


99031812 00.02S 163.64E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s


99031900 00.00N 165.27E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s


99031912 00.02N 164.90E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s


99032000 00.01N 164.97E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s


99032012 01.09N 164.98E
PRESSURE(hPa)
TEMPERATURE(°C)
-10m/s
10m/s

6.1.3 Ceilometer

(1) Personnel

Masaki Hanyu (GODI) : Operation Leader
Fumitaka Yoshiura (GODI)
Toshihiko Yano (JAMSTEC)

(2) Parameters

(2.1) Cloud base height [m]

(2.2) Backscatter profile, sensitivity and range normalized at 30m resolution

(3) Methods

We measured cloud base height and backscatter profiles using CT-25K (Vaisala, Finland) ceilometer throughout MR99-K01 cruise from the departure of Hachinohe, Japan on 8 February 1999 to the arrival of Shimonoseki, Japan on 31 March 1999. Backscatter profiles were recorded only after 27/0300UTC February.

Major parameters for the measurement configuration are as follows;

Laser source :	Indium Gallium Arsenide (InGaAs) Diode
Transmitting wave length :	905 +-5 nm at 25deg-C
Transmitting average power :	8.9 mW
Repetition rate :	5.57 kHz
Detector :	Silicon avalanche photodiode (APD)
	Responsibility at 905 nm : 65 A/W
Measurement range :	0-7.5 km
Resolution :	50 ft in full range
Sampling rate :	60 sec

(4) Preliminary results

Examples of lidar echo images are shown on the following pages. These shows time-series variation of cloud base height and rainfall.

(5) Data archives

Ceilometer data obtained during this cruise will be submitted to the DMO (Data Management Office), JAMSTEC and will be under their control.

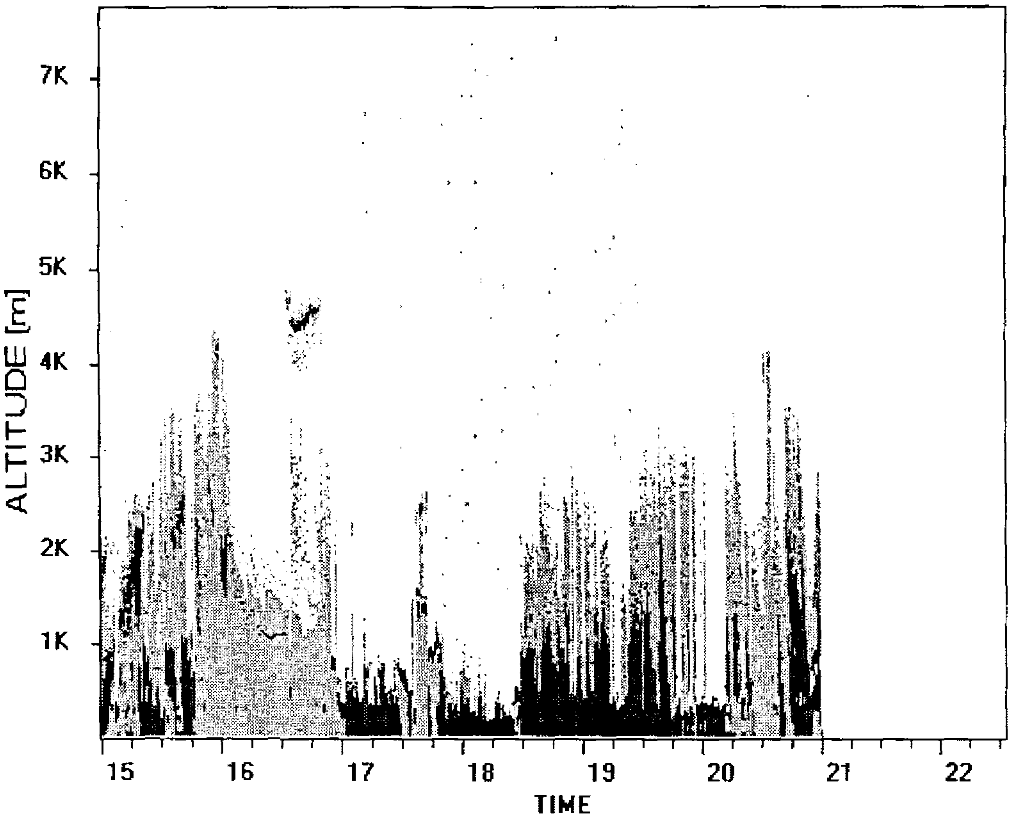


Fig.6.1.3-1 08/15Z-08/21Z Mar 1999

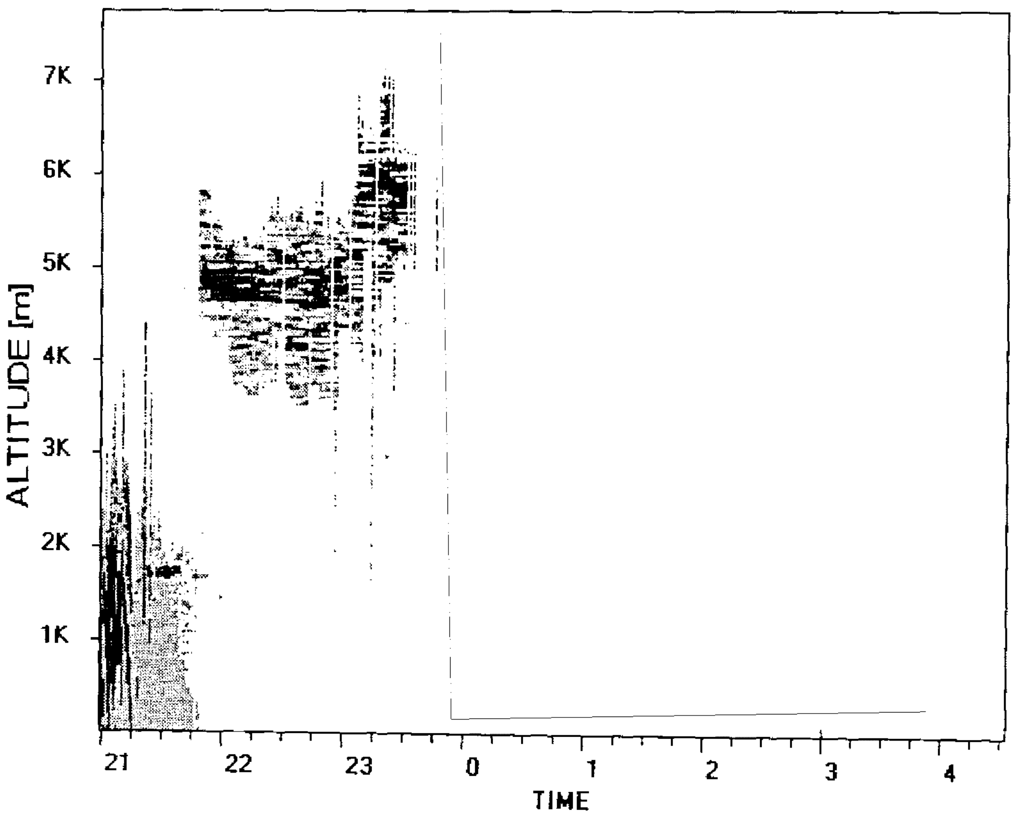


Fig.6.1.3-2 08/21Z-09/03Z Mar 1999

6.2 CTD

6.2.1 CTD

(1) Personnel

Masayuki Fujisaki (MWJ) : Operation leader
Koichi Takao (MWJ)
Nobuharu Komai (MWJ)
Takehiko Shiribiki (MWJ)
Hirokatsu Uno (MWJ)
Fuyuki Shibata (MWJ)
Takeo Matsumoto (MWJ)
Tomohiro Horiuchi (MWJ)
Takahiro Kazama (MWJ)
Kimiko Nishijima (MWJ)

(2) Objectives

Investigation of the oceanic (down to 1000m) structure.

(3) Parameters

・Temperature
・Conductivity
・Pressure
・Dissolved Oxygen (D.O.)

(4) Methods

CTD/Rosette Multi-bottle Array Systems (CTD/RMS) were used during this cruise. It was the 12-liters 12-positions intelligent General Oceanic RMS (GO1016) water sampler with Sea-Bird Electronics Inc. CTD (SBE9plus). The sensors attached on CTD were two temperature sensors, two conductivity sensors, one pressure sensor, one D.O. sensor and one altimeter sensor. Items of CTD Cast Table (Table 6.2.1-1) are position, date (UTC), time (UTC). Figure 6.2.1-1 shows sites of CTD cast, "open circle" indicates sites of CTD cast for comparison with TRITON buoys data, "solid circle" does for general CTD cast

The CTD raw data was acquired on real time by using the SEASAVE utility from the SEASOFT software (ver.4.226) 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 SEASOFT (ver.4.207). Data processing procedures and used utilities of SEASOFT were as follows:

DATCNV: Converts the binary raw data to output on physical units.
Output items are scan number, pressure, temperature, salinity, oxygen, sigma-theta,
depth. Simultaneously, this utility selects the CTD data when bottles closed to output on another file.

SECTION: Remove the unnecessary data.

BINAVG: Calculates the averaged data in every 1 db..

ROSSUM: Edits the data of water sampled to output a summary file.

SPLIT: Splits the data made by DATCNV into down cast data.

Specifications of the sensors are listed below.

CTD: SBE 911plus CTD system

Under water unit: CTD 9plus (S/N 09P9833-0357, Sea-Bird Electronics, Inc.)

Temperature sensor: SBE3-04/F Primary Sensor (S/N 031314, Sea-Bird Electronics, Inc.)

Conductivity sensor: SBE4-04/0 Primary Sensor (S/N 041088, Sea-Bird Electronics, Inc.)

Temperature sensor: SBE3-04/F Secondary Sensor (S/N 031525, Sea-Bird Electronics, Inc.)

Conductivity sensor: SBE4-04/0 Secondary Sensor (S/N 041205, Sea-Bird Electronics, Inc.)

Oxygen sensor: MODEL 13-04-B (S/N 130339, Sea-Bird Electronics, Inc. from stn.c1 to stn.c13)

Oxygen sensor: MODEL 13-04-B (S/N 130338, Sea-Bird Electronics, Inc. from stn.c14 to stn.c42)

Deck unit: SBE11 (Sea-Bird Electronics, Inc.)

(5) Result

See the attached figures.

(6) Data archive

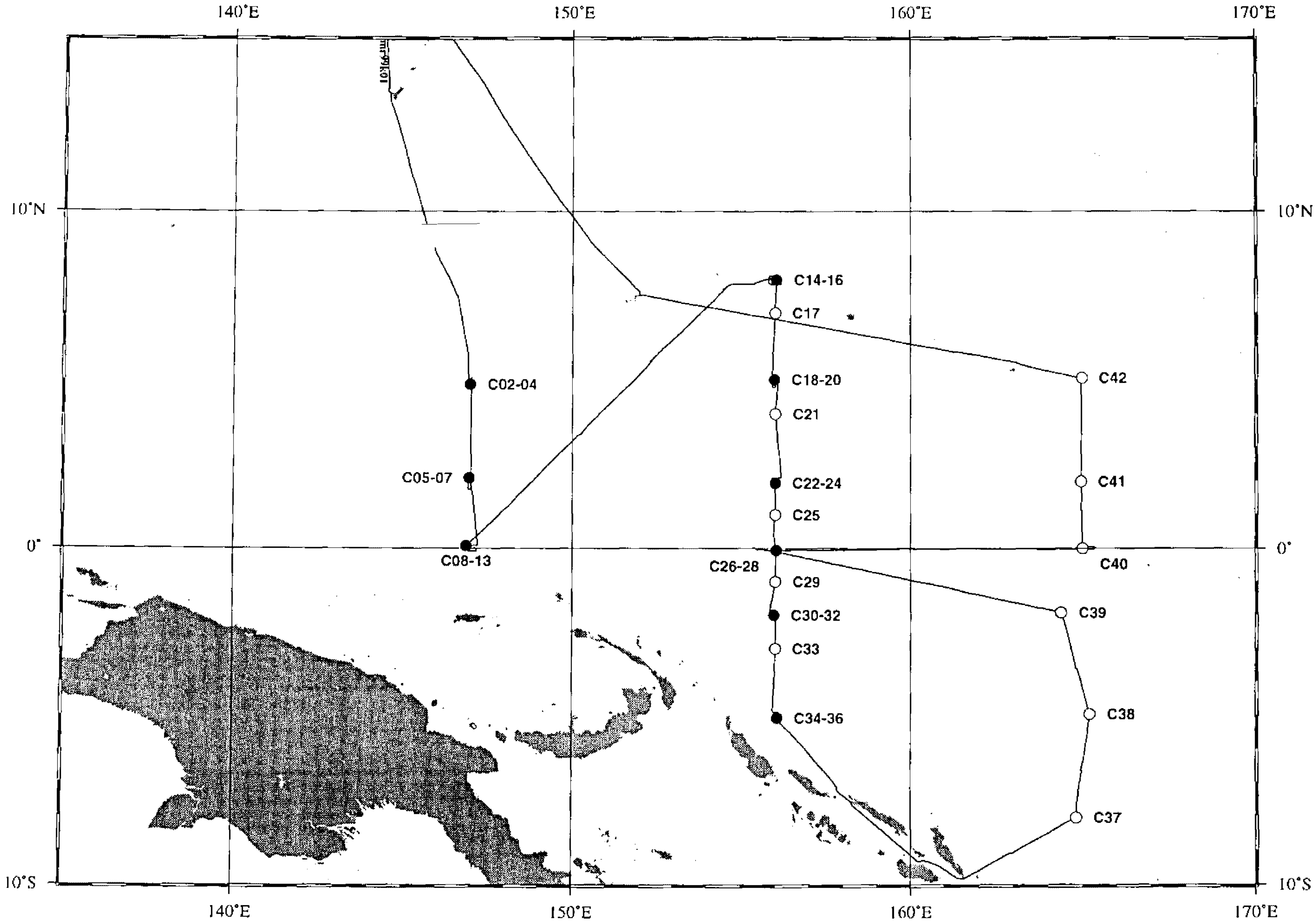
All of raw and processed CTD data files were copied into 3.5 inch magnetic optical disks (230MB) and submitted to JAMSTC Data Management Office. All original data will be stored at JAMSTEC Mutsu brunch.

(7) Remarks

The D.O. sensor on the CTD was malfunctioning and we will eliminate D.O. data from stn.C1 to stn.C13.

Stn.	Date(UTC)	Time(UTC)		Start Position		Filename	Water Sampling	Remarks
		Start	End	Latitude	Longitude			
C02	2/16/'99	06:32	07:09	04-53.23N	146-57.70E	C02.DAT	×	TRITON 07001 1st. Cast
C03	2/16/'99	18:27	19:06	04-53.20N	146-57.70E	C03.DAT	×	TRITON 07001 2nd. cast
C04	2/17/'99	06:27	07:08	04-53.09N	146-57.58E	C04.DAT	○	TRITON 07001 3rd. cast
C05	2/18/'99	06:29	07:09	02-05.94N	146-56.59E	C05.DAT	×	TRITON 08001 1st. cast
C06	2/18/'99	18:32	19:06	02-05.85N	146-56.83E	C06.DAT	×	TRITON 08001 2nd. cast
C07	2/19/'99	06:26	07:09	02-05.80N	146-56.58E	C07.DAT	○	TRITON 08001 3rd. cast
C08	2/20/'99	01:34	02:18	00-04.98N	146-51.28E	C08.DAT	×	TRITON 09001 1st. cast
C09	2/20/'99	13:26	14:01	00-05.81N	146-51.31E	C09.DAT	×	TRITON 09001 2nd. Cast
C10	2/21/'99	01:00	01:35	00-05.65N	146-51.28E	C10.DAT	×	TRITON 09001 3rd. cast
C11	2/21/'99	06:03	07:43	00-00.77S	146-51.97E	C11.DAT	×	
C12	2/21/'99	21:56	22:17	00-00.77S	147-03.92E	C12.DAT	×	
C13	2/22/'99	03:53	04:42	00-02.84N	146-51.11E	C13.DAT	○	TRITON 09001 4th. Cast
C14	2/25/'99	02:35	03:07	07-59.04N	156-02.02E	C14.DAT	×	TRITON 01002 1st. cast
C15	2/25/'99	12:55	13:32	07-59.54N	156-01.99E	C15.DAT	×	TRITON 01002 2nd. cast
C16	2/26/'99	02:28	03:15	07-59.50N	156-02.03E	C16.DAT	○	TRITON 01002 3rd. Cast
C17	2/26/'99	07:34	08:20	07-00.02N	156-00.00E	C17.DAT	○	
C18	2/27/'99	02:02	02:41	05-02.12N	155-57.98E	C18.DAT	×	TRITON 02002 1st. cast
C19	2/27/'99	12:57	13:32	05-02.58N	155-58.51E	C19.DAT	×	TRITON 02002 2nd. cast
C20	2/28/'99	01:55	02:46	05-02.58N	155-58.10E	C20.DAT	○	TRITON 02002 3rd. cast
C21	2/28/'99	08:37	09:32	03-59.74N	156-00.29E	C21.DAT	○	
C22	3/01/'99	01:35	02:11	01-56.46N	155-59.95E	C22.DAT	×	TRITON 03002 1st. Cast
C23	3/01/'99	12:56	13:34	01-56.14N	155-59.97E	C23.DAT	×	TRITON 03002 2nd. cast
C24	3/02/'99	01:29	02:10	01-56.50N	155-59.98E	C24.DAT	○	TRITON 03002 3rd. cast
C25	3/02/'99	07:37	08:19	01-00.02N	155-59.95E	C25.DAT	○	
C26	3/03/'99	01:11	01:56	00-03.99S	156-01.96E	C26.DAT	×	TRITON 04002 1st. Cast
C27	3/03/'99	12:52	13:33	00-03.93S	156-01.94E	C27.DAT	×	TRITON 04002 2nd. cast
C28	3/04/'99	00:58	01:54	00-03.87S	156-01.95E	C28.DAT	○	TRITON 04002 3rd. cast
C29	3/04/'99	07:46	08:34	00-59.99S	156-00.08E	C29.DAT	○	
C30	3/05/'99	01:23	02:12	01-59.49S	155-57.50E	C30.DAT	×	TRITON 05002 1st. cast
C31	3/05/'99	12:54	13:31	01-59.55S	155-57.44E	C31.DAT	×	TRITON 05002 2nd. cast
C32	3/06/'99	00:54	01:40	01-59.52S	155-57.05E	C32.DAT	○	TRITON 05002 3rd. cast
C33	3/06/'99	06:47	07:34	02-59.91S	155-59.88E	C33.DAT	○	
C34	3/07/'99	01:10	01:50	05-04.82S	156-02.97E	C34.DAT	×	TRITON 06002 1st. Cast
C35	3/07/'99	12:54	13:31	05-04.78S	156-03.11E	C35.DAT	×	TRITON 06002 2nd. Cast
C36	3/08/'99	00:54	01:44	05-04.83S	156-02.98E	C36.DAT	○	TRITON 06002 3rd. cast
C37	3/13/'99	04:48	05:42	08-03.27S	164-48.61E	C37.DAT	○	
C38	3/14/'99	04:35	05:30	04-58.50S	165-11.96E	C38.DAT	○	
C39	3/14/'99	20:20	21:21	01-55.44S	164-22.17E	C39.DAT	○	
C40	3/20/'99	05:43	06:33	00-00.40S	165-00.56E	C40.DAT	○	
C41	3/21/'99	04:50	05:40	01-58.64N	164-57.73E	C41.DAT	○	
C42	3/21/'99	18:28	19:14	05-04.66N	164-59.21E	C42.DAT	○	

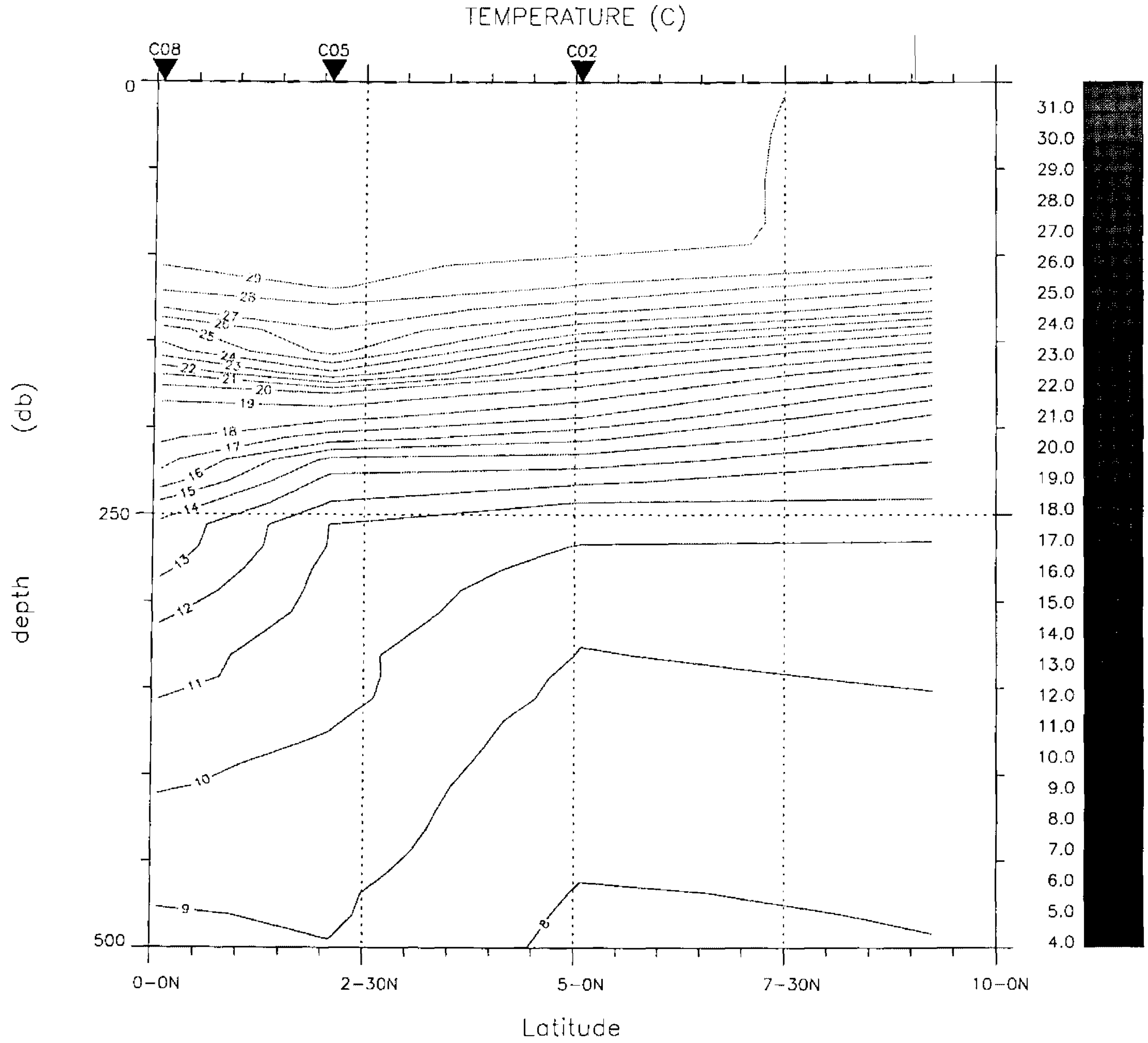
CTD cast table
(Table 6.2.1-1)



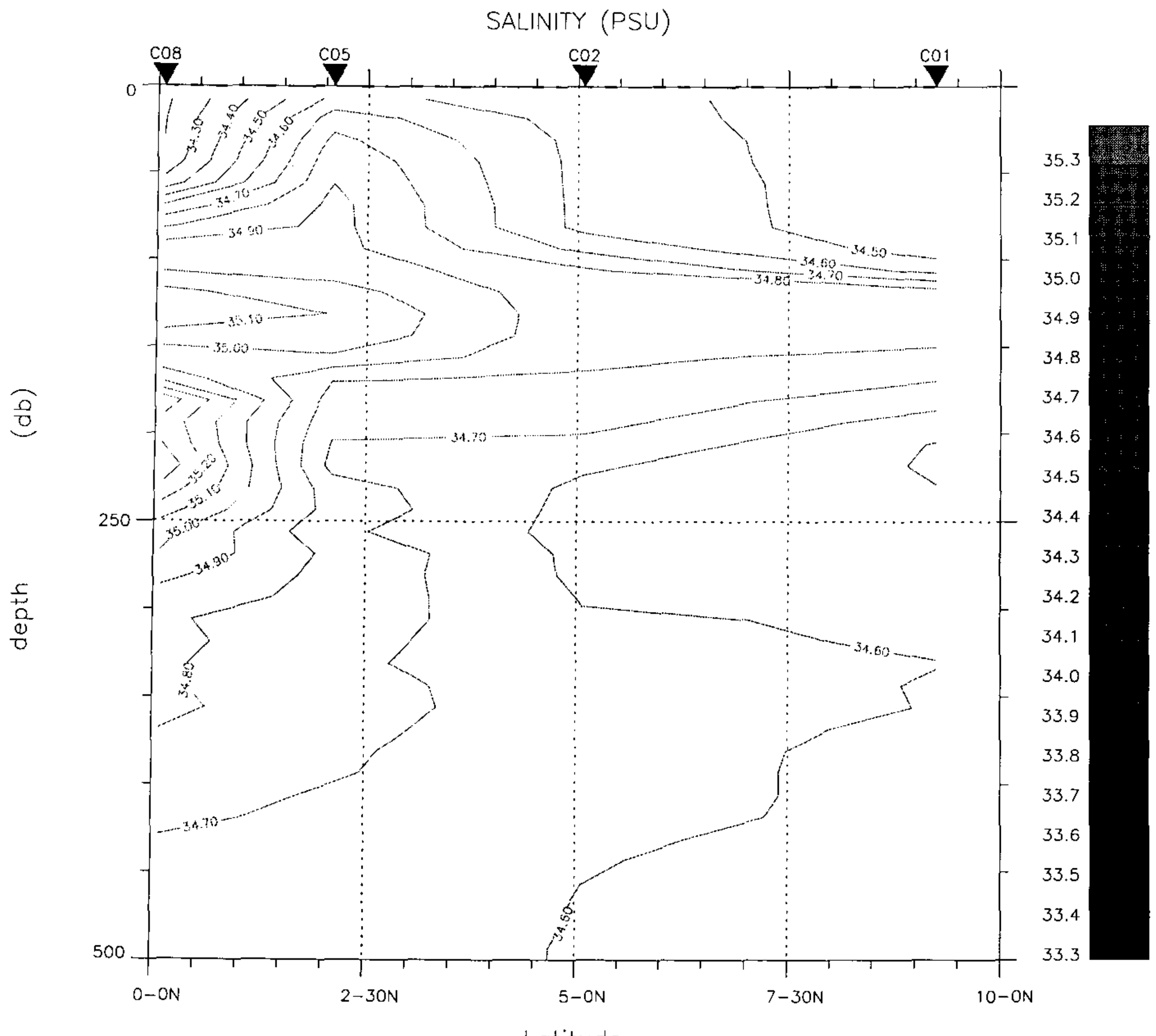
CTD Casting Site

GMT Mar 31 06:19 Mercator Projection on board report

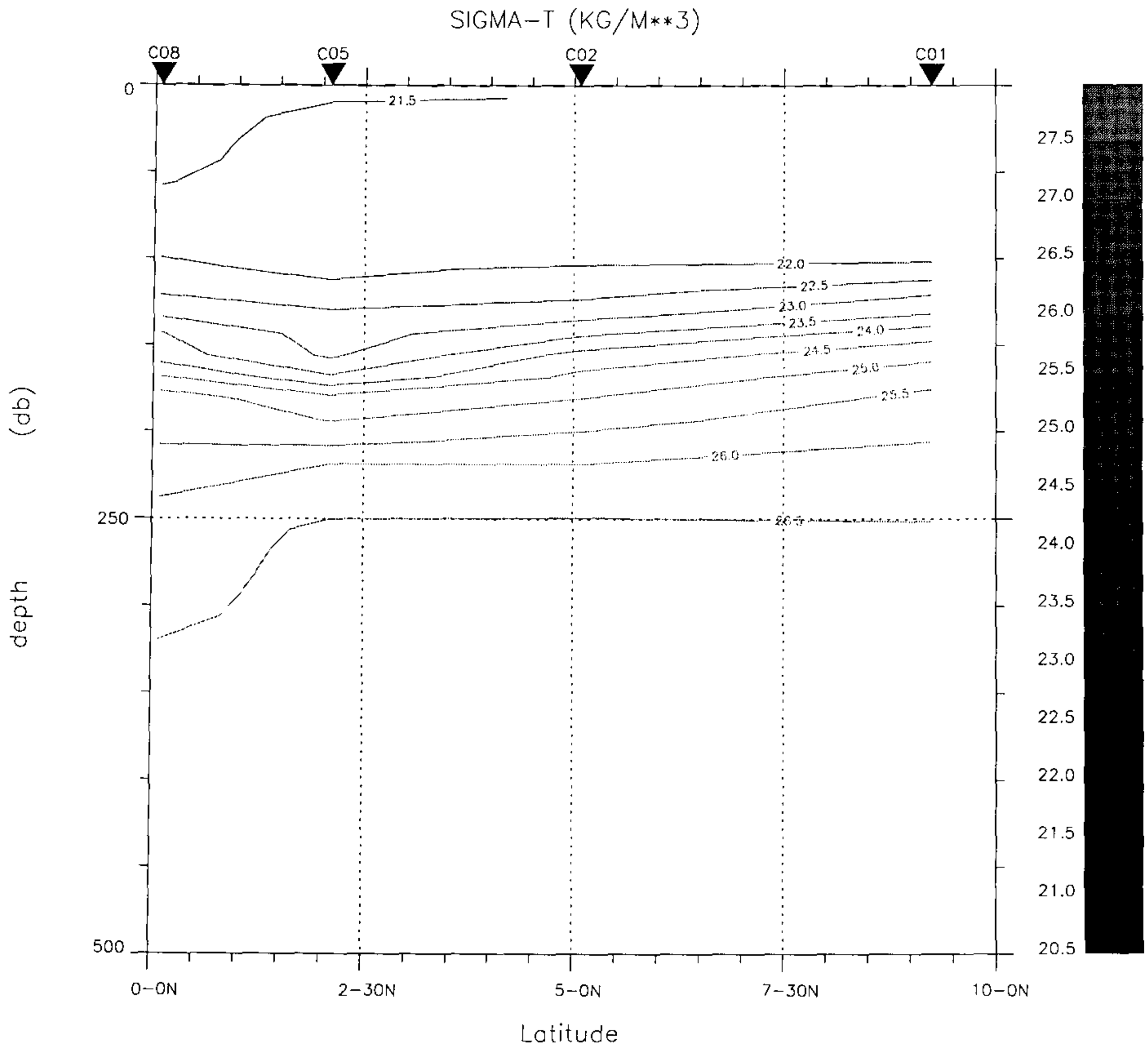
Fig. 6.2.1-1



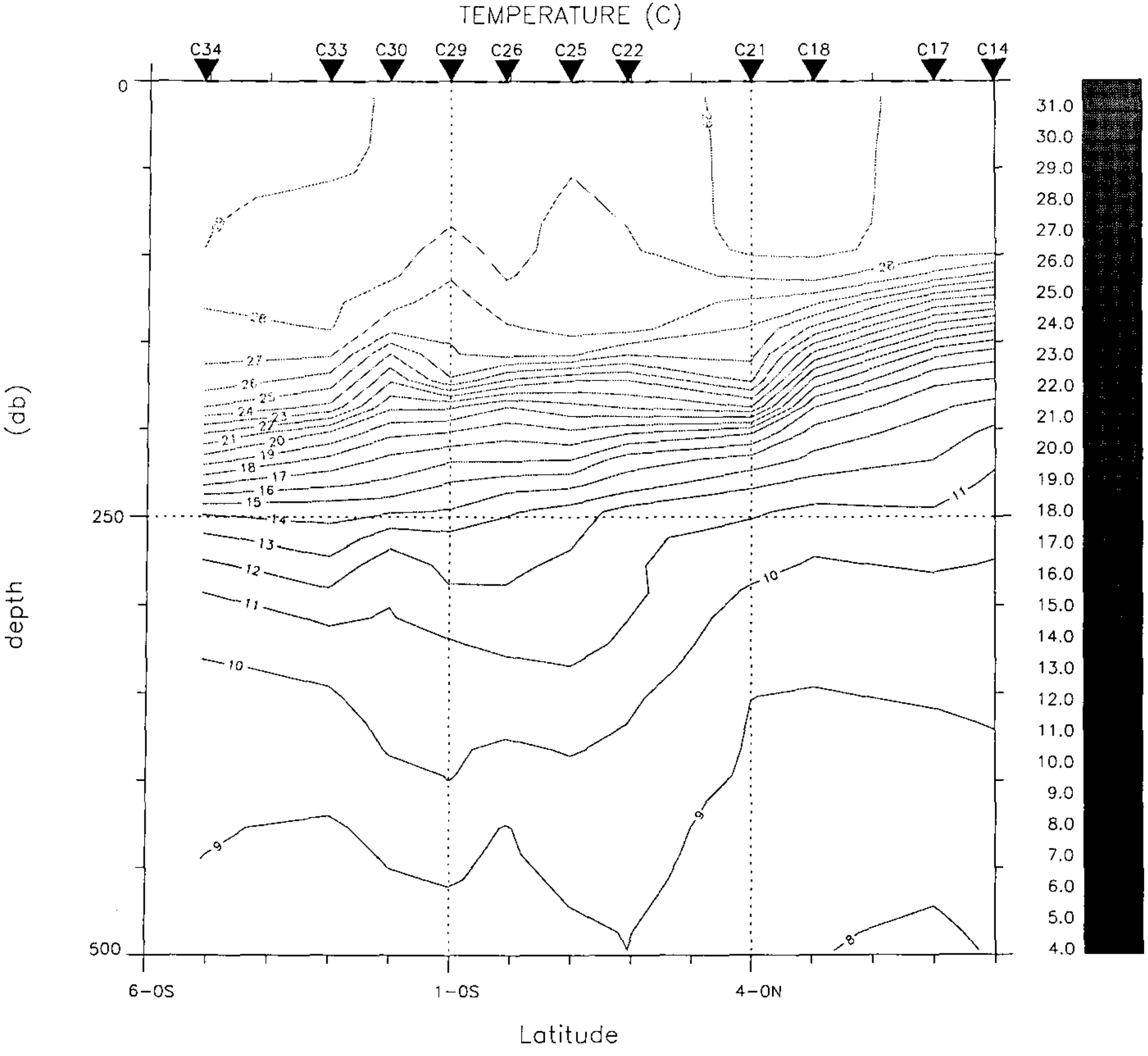
MR99-K01 1999/02/15 - 1999/02/20



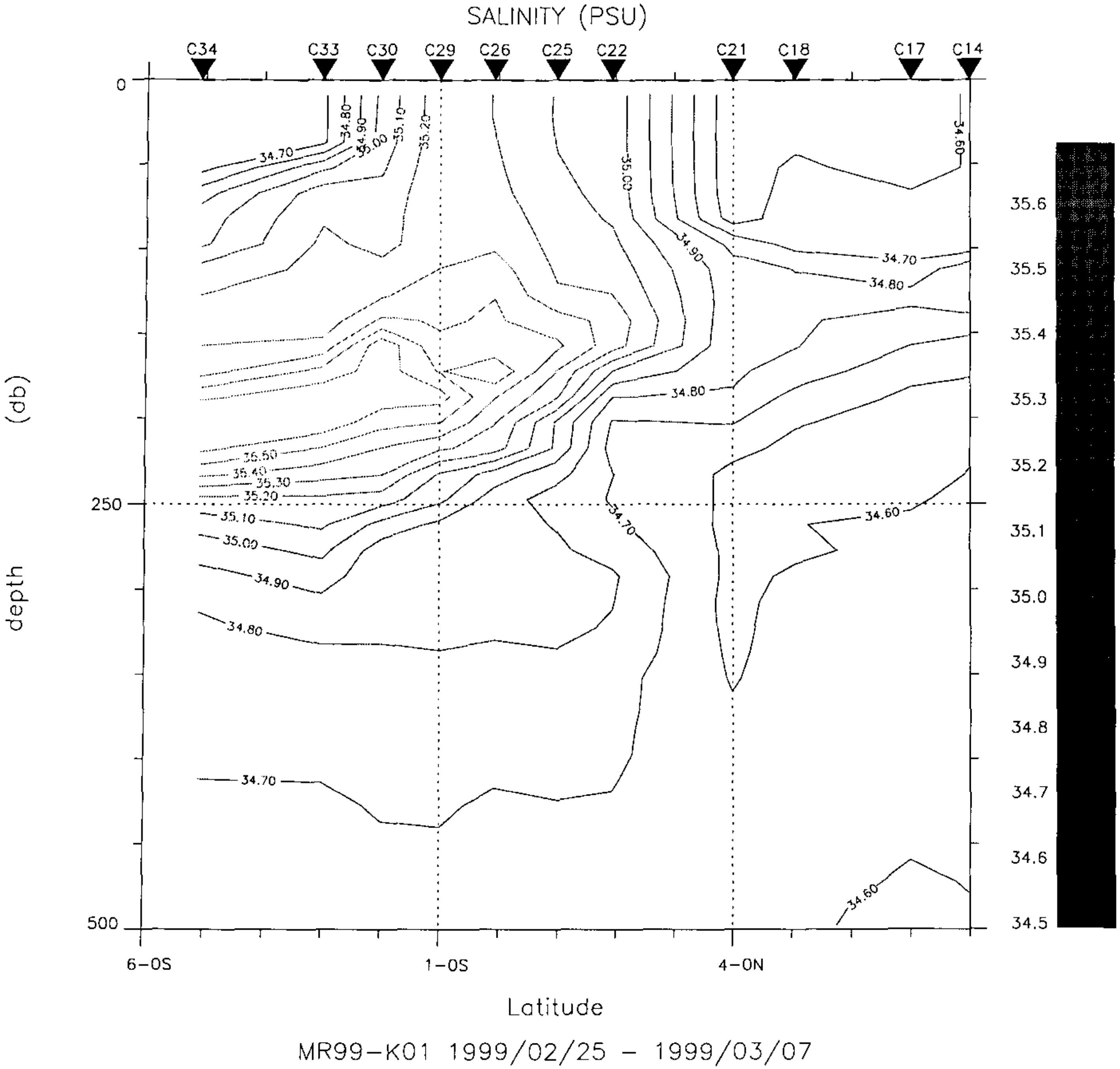
MR99-K01 1999/02/15 - 1999/02/20

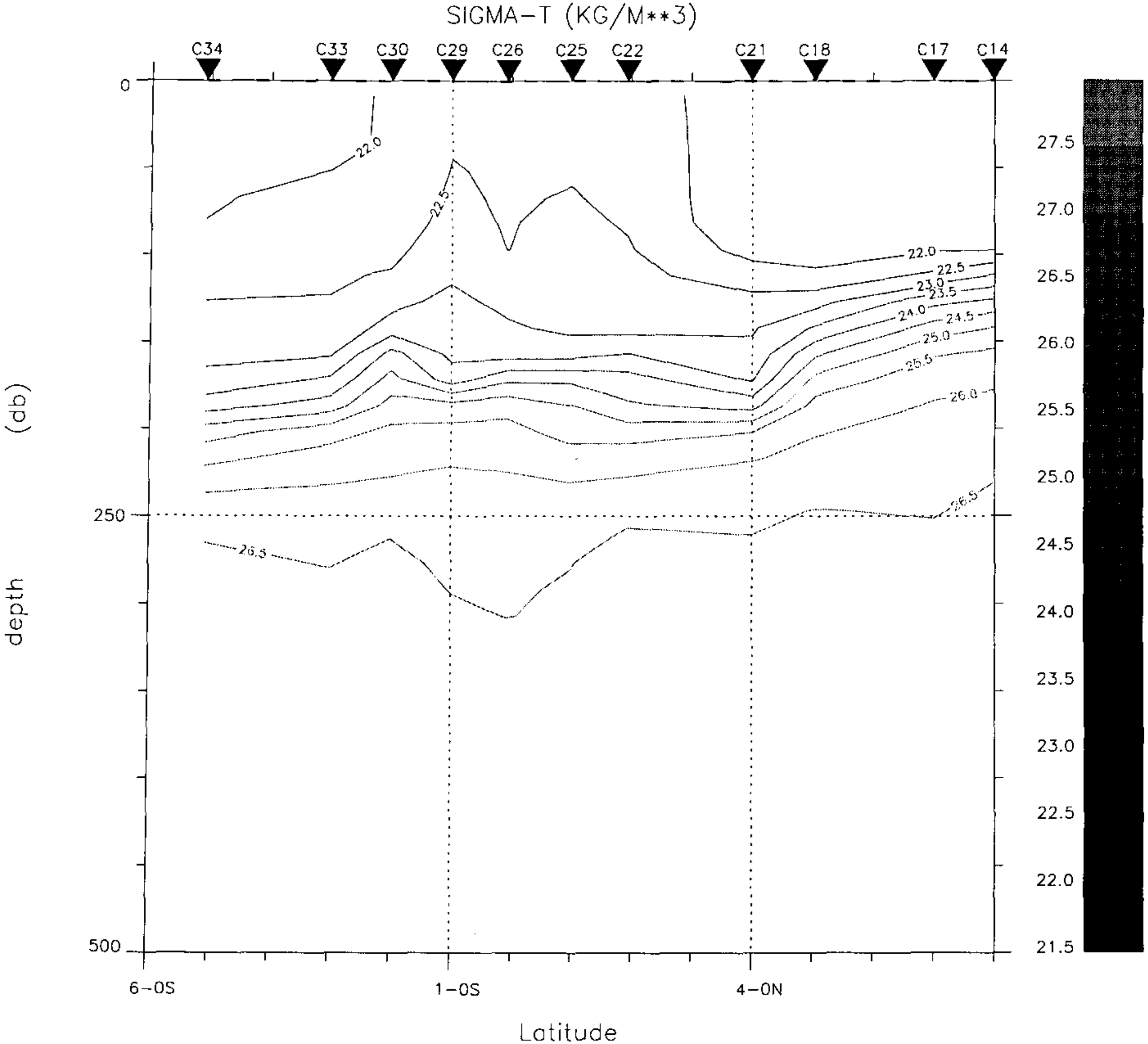


MR99-K01 1999/02/15 - 1999/02/20

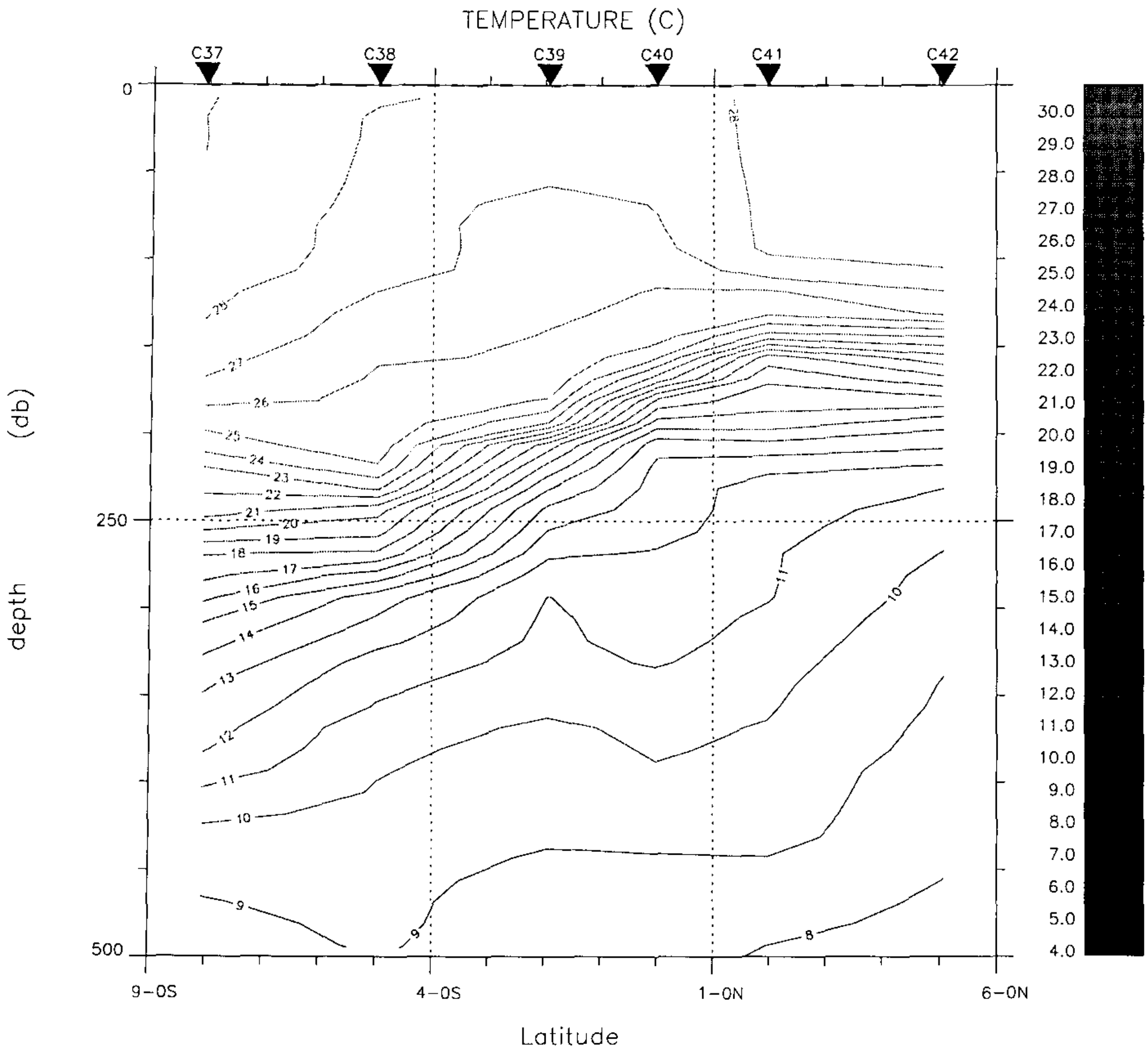


MR99-K01 1999/02/25 - 1999/03/07

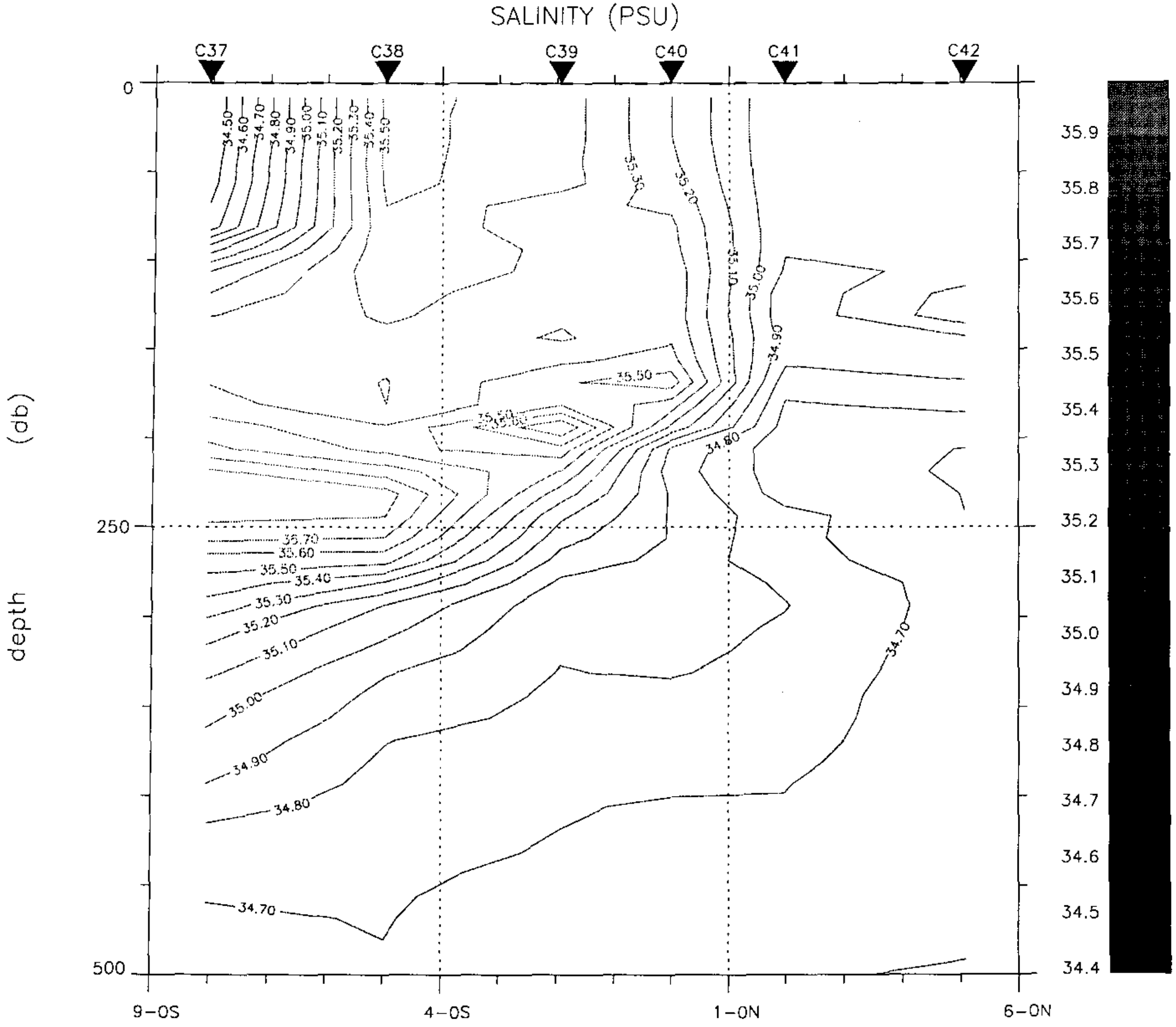

SALINITY (PSU)
C34
C33
C30
C29
C26
C25
C22
C21
C18
C17
C14
depth (db)
0
250
500
6-0S
1-0S
4-0N
Latitude
35.6
35.5
35.4
35.3
35.2
35.1
35.0
34.9
34.8
34.7
34.6
34.5
MR99-K01 1999/02/25 - 1999/03/07



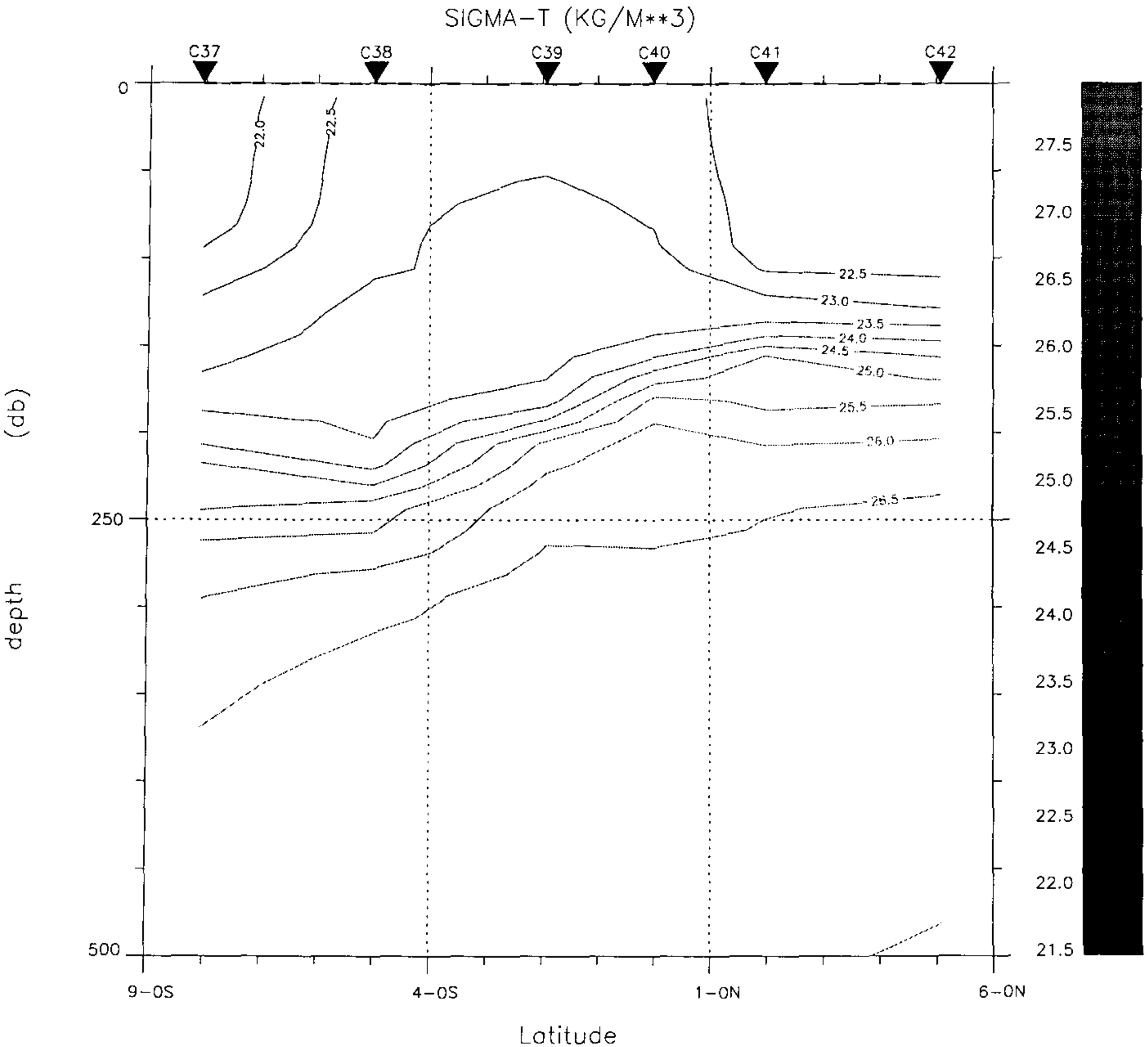
MR99-K01 1999/02/25 - 1999/03/07



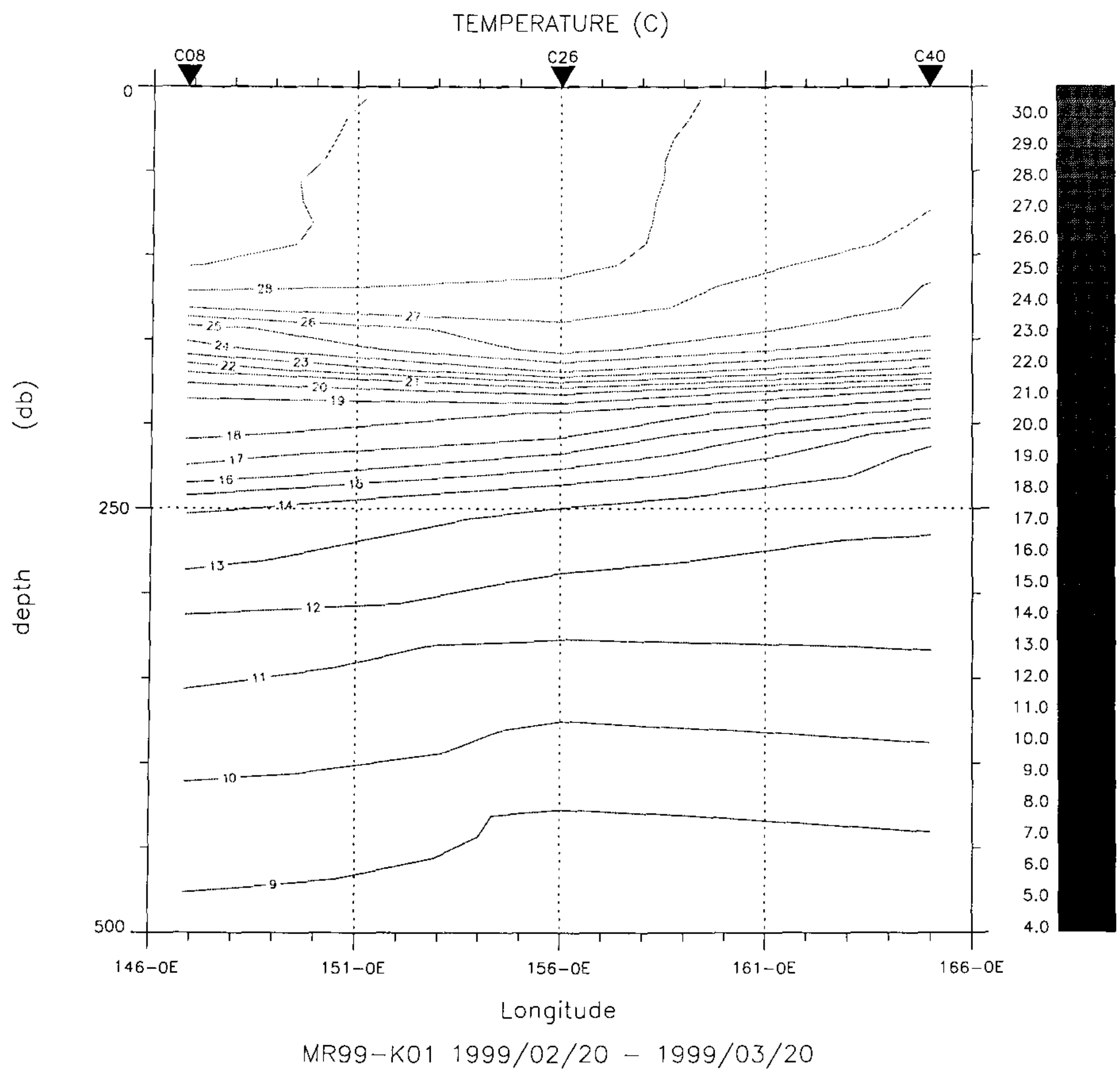
MR99-K01 1999/03/13 – 1999/03/21

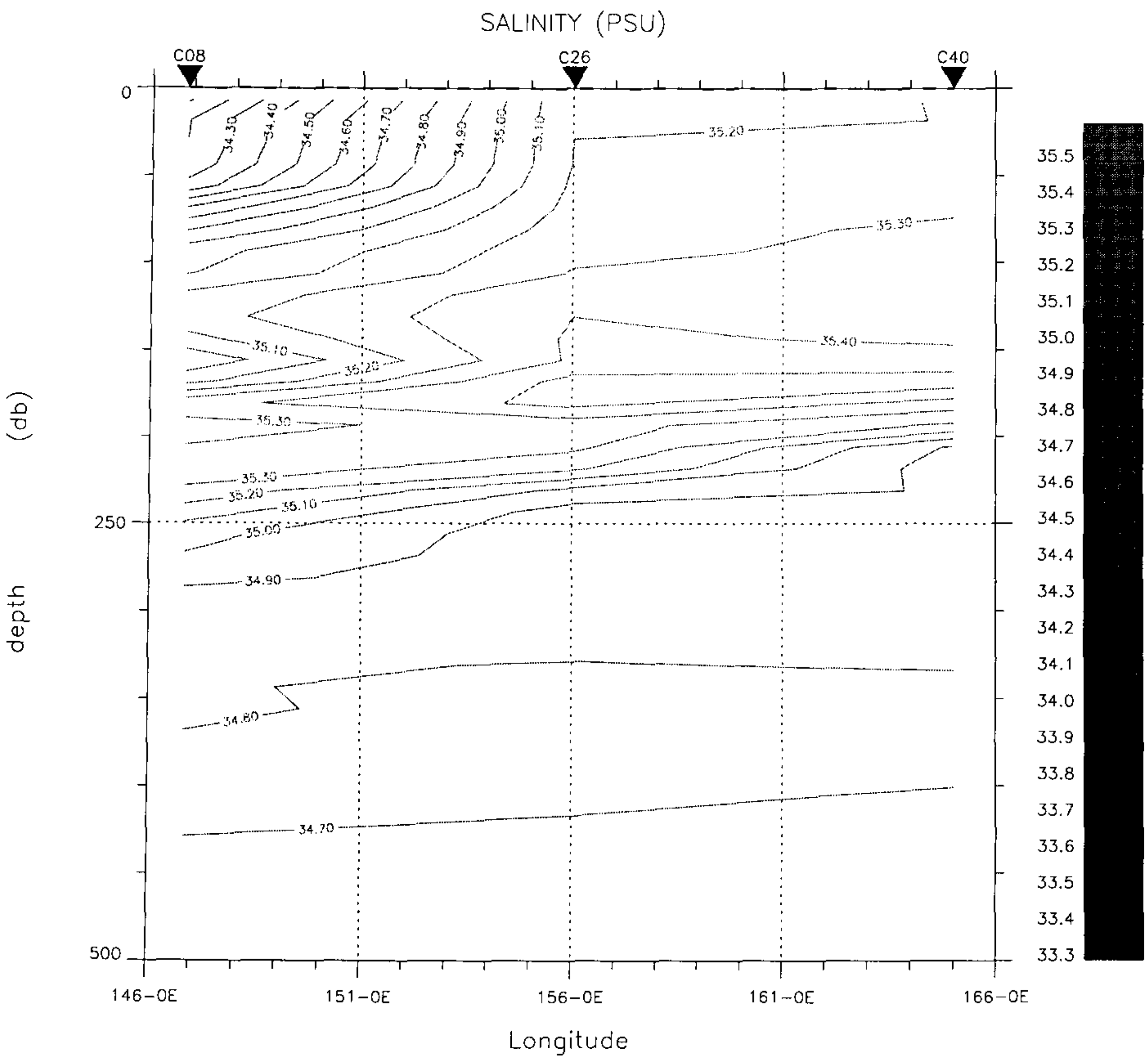


MR99-K01 1999/03/13 - 1999/03/21

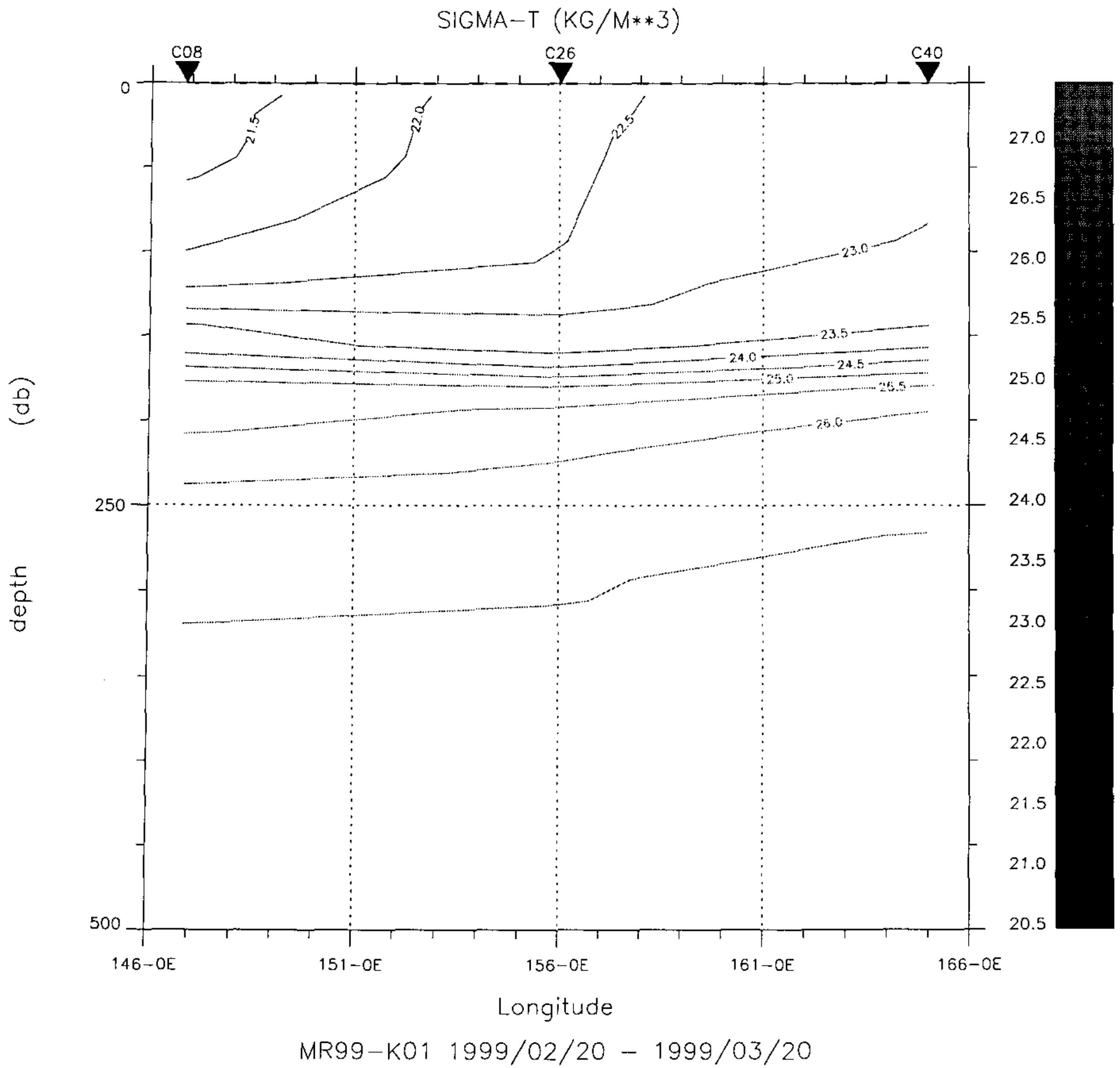


MR99-K01 1999/03/13 - 1999/03/21


TEMPERATURE (C)
C08
C26
C40
0
250
500
depth (db)
28
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
146-0E
151-0E
156-0E
161-0E
166-0E
Longitude
30.0
29.0
28.0
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
MR99-K01 1999/02/20 - 1999/03/20



MR99-K01 1999/02/20 - 1999/03/20


SIGMA-T (KG/M**3)
C08
C26
C40
0
250
500
depth (db)
21.5
22.0
22.5
23.0
23.5
24.0
24.5
25.0
25.5
26.0
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
146-0E
151-0E
156-0E
161-0E
166-0E
Longitude
MR99-K01 1999/02/20 - 1999/03/20

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

(1) Personnel

Takehiko Shiribiki (MWJ)
Nobuharu Komai (MWJ)

(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 (1000m) and the other layers. They were stored in 250ml Phoenix brown glass bottles. The salinity measurements were carried out using "Guildline Autosal 8400B Salinometer", which was modified by addition of an Ocean Scientific International peristaltic-type sample intake pump, with a bath temperature of 24 deg-C. The instrument was operated in the "Autosal Room" of R/V Mirai. 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 batch P133 whose conductivity is 0.99986 (salinity 34.995). Sub-standard seawater was used to check the drift of the Autosal.

(5) Results

Analysis data of all samples were shown in Table 6.2.2-1. Ten pairs of duplicate samples taken by the same Niskin bottle and bucket were analyzed to estimate the precision of this method (shadow line shows duplicate sample in Table 6.2.2-1). The standard deviation of difference (one sigma) was 0.0018. To check the salinity data of CTD, we compared the salinity of all samples except for the surface samples (Fig 6.2.2-1). We also compared the salinity of 19 samples which taken from 1000m depth with the salinity of CTD at the same depth (Table 6.2.2-2 and Fig 6.2.2-2). The standard deviation of difference of salinity at 1000m was 0.0020 (one sigma). We compared the salinity of samples at 500m depth of each TRITON buoy site with the salinity of CTD at the same depth (Table 6.2.2-2).

(6) Data archive

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

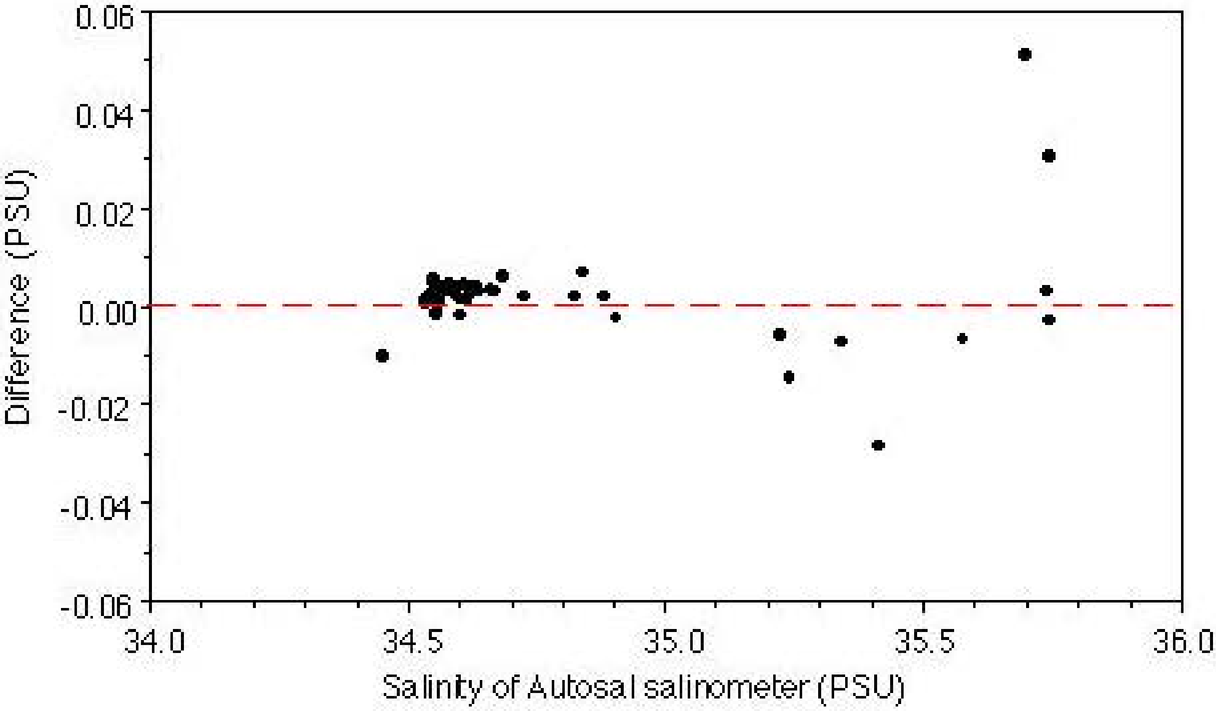


Fig 6.2.2-1 Difference of salinity between CTD and Autosal salinometer

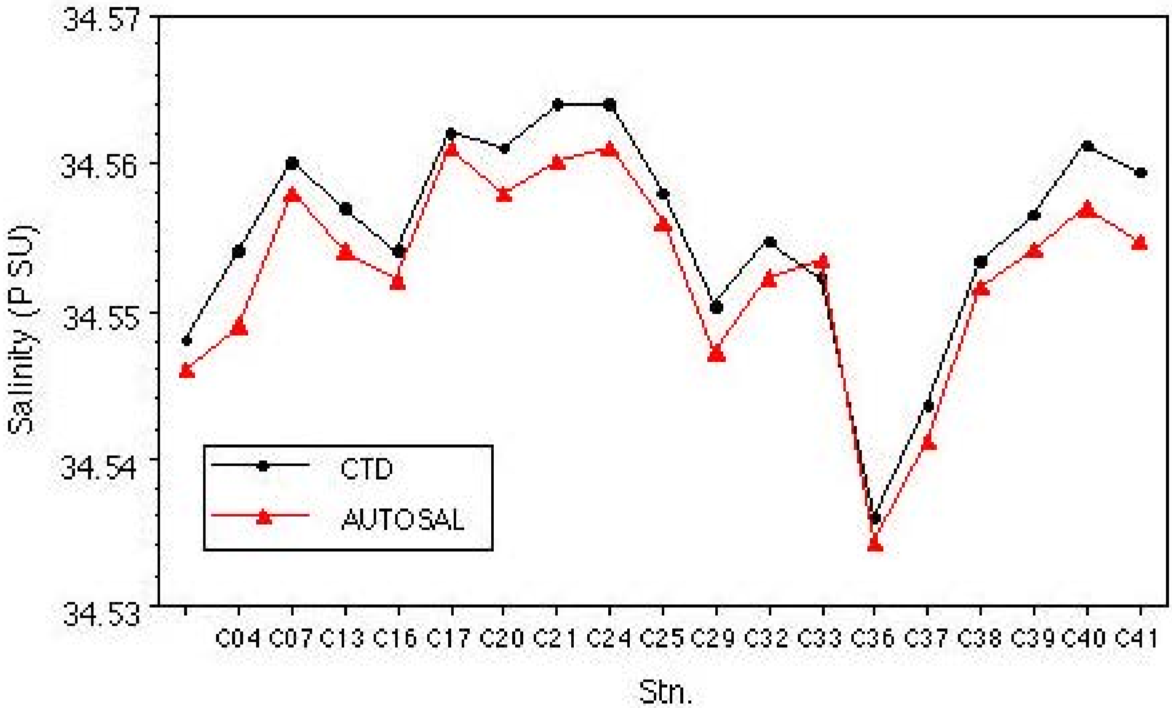


Fig 6.2.2-2 Comparison of salinity between CTD and Autosal salinometer at 1000m depth

Table 6.2.2-1 Salinity comparison between CTD and water samples

Stn	Depth (db)	CTD	Autosal	CTD-Autosal
		(PSU)		
C04	0	No data	34.4971	—
C04	504	34.5838	34.5792	0.0046
C04	1009	34.5543	34.5488	0.0055
C04	1009	34.5543	34.5490	0.0053
C07	0	No data	34.3597	—
C07	504	34.6620	34.6584	0.0036
C07	504	34.6620	34.6585	0.0035
C07	1009	34.5603	34.5577	0.0026
C13	0	No data	34.2228	—
C13	1009	34.5571	34.5543	0.0028
C13	504	34.6290	34.6247	0.0043
C16	0	No data	34.5907	—
C16	1008	34.5545	34.5529	0.0016
C16	1008	34.5545	34.5517	0.0028
C16	503	34.5899	34.5863	0.0036
C17	1008	34.5619	34.5610	0.0009
C17	0	No data	34.5155	—
C17	504	34.5742	34.5709	0.0033
C17	504	34.5742	34.5704	0.0038
C20	0	No data	34.5952	—
C20	1009	34.5609	34.5578	0.0031
C20	503	34.5938	34.5914	0.0024
C21	0	No data	34.5201	—
C21	1012	34.5636	34.5602	0.0034
C21	504	34.5979	34.5995	-0.0016
C21	504	34.5979	34.5955	0.0024
C24	0	No data	35.0320	—
C24	1008	34.5636	34.5615	0.0021
C24	503	34.6204	34.6184	0.0020
C25	0	No data	35.0830	—
C25	1008	34.5582	34.5555	0.0027
C25	1008	34.5582	34.5557	0.0025
C25	503	34.6315	34.6274	0.0041
C28	0	No data	35.1683	—
C28	806	34.5357	34.5348	0.0009
C28	504	34.5993	34.5974	0.0019
C29	0	No data	35.2623	—
C29	1008	34.5503	34.5471	0.0032
C29	503	34.6138	34.6093	0.0045
C32	0	No data	35.0478	—
C32	1010	34.5546	34.5523	0.0023
C32	1010	34.5546	34.5520	0.0026
C32	503	34.6370	34.6340	0.0030
C33	0	No data	34.6807	—
C33	0	No data	34.6837	—
C33	1009	34.5522	34.5533	-0.0011
C33	101	35.2160	35.2217	-0.0057
C36	0	No data	34.6368	—
C36	1008	34.5359	34.5342	0.0017

Stn	Depth (db)	CTD	Autosal	CTD-Autosal
			(PSU)	
C36	201	35.7487	35.6977	0.0510
C36	503	34.6706	34.6674	0.0032
C37	0	No data	34.4019	—
C37	50	34.4401	34.4502	-0.0101
C37	251	35.7717	35.7413	0.0304
C37	202	35.5704	35.5770	-0.0066
C38	0	No data	35.5118	—
C38	1008	34.5435	34.5411	0.0024
C38	251	35.7413	35.7379	0.0034
C38	251	35.7413	35.7440	-0.0027
C39	0	No data	35.4556	—
C39	1008	34.5534	34.5515	0.0019
C39	504	34.6207	34.6178	0.0029
C40	0	No data	35.1983	—
C40	1009	34.5565	34.5541	0.0024
C40	806	34.5388	34.5368	0.0020
C40	603	34.5617	34.5592	0.0025
C40	502	34.6145	34.6131	0.0014
C40	402	34.6867	34.6807	0.0060
C40	351	34.7269	34.7247	0.0022
C40	301	34.8255	34.8233	0.0022
C40	251	34.8791	34.8770	0.0021
C40	201	34.8434	34.8362	0.0072
C40	150	35.3815	35.4095	-0.0280
C40	100	35.3353	35.3422	-0.0069
C40	50	35.2226	35.2371	-0.0145
C41	0	No data	34.9039	—
C41	1009	34.5612	34.5566	0.0046
C41	1009	34.5612	34.5574	0.0038
C41	504	34.5912	34.5871	0.0041
C42	0	No data	34.9079	—
C42	1007	34.5594	34.5547	0.0047
C42	353	34.6335	34.6295	0.0040
C42	52	34.8975	34.8999	-0.0024

Note: Shadow column shows duplicate sample

Table 6.2.2-2 Comparison between CTD data and Autosal data

Standard CTD cast (1000m depth)

Stn. No.	Salinity (PSU)		
	CTD	AUTOSAL	Difference
C04	34.5543	34.5489	0.0054
C07	34.5603	34.5577	0.0026
C13	34.5571	34.5543	0.0028
C16	34.5545	34.5523	0.0022
C17	34.5619	34.5610	0.0009
C20	34.5609	34.5578	0.0031
C21	34.5636	34.5602	0.0034
C24	34.5636	34.5615	0.0021
C25	34.5582	34.5556	0.0026
C28	-	*No Sampling*	-
C29	34.5503	34.5471	0.0032
C32	34.5546	34.5522	0.0024
C33	34.5522	34.5533	-0.0011
C36	34.5359	34.5342	0.0017
C37	34.5435	34.5411	0.0024
C38	34.5534	34.5515	0.0019
C39	34.5565	34.5541	0.0024
C40	34.5612	34.557	0.0042
C41	34.5594	34.5547	0.0047

24hours CTD cast (500m depth)

Stn. No.	Salinity (PSU)		
	CTD	AUTOSAL	Difference
C04	34.5838	34.5792	0.0046
C07	34.6620	34.6585	0.0035
C13	34.6290	34.6247	0.0043
C16	34.5899	34.5863	0.0036
C20	34.5938	34.5914	0.0024
C24	34.6204	34.6184	0.0020
C28	34.5993	34.5974	0.0019
C32	34.6370	34.6340	0.0030
C36	34.6706	34.6674	0.0032

6.3 Dissolved Oxygen Measurement

(1) Personnel

Nobuharu Komai (MWJ) : Operation leader
Takehiko Shiribiki (MWJ)

(2) Objectives

- Measurement of dissolved oxygen (D.O.) using D.O. meter corrected by the Winkler titration method following the WHP Operations and Methods (Culberson, 1991).
- Correction for D.O. sensor of CTD

(3) Parameters

D.O. in sea water down to 1000m depth

(4) Methods

(4-1) Instruments for D.O. analysis

D.O. meter: TOA Electronics Ltd., Portable Dissolved Oxygen Meter Model 25-A
(Resolution : 0.01 mg/L)
D.O. sensor for D.O. meter: TOA Electronics Ltd., Model OE-2111
Titrator: Metrohm, Model 716 DMS Titrino/ 10ml of titration vessel
Detector: Metrohm, Pt Electrode/ 6.0408.100
Software: Data acquisition/ Metrohm, METRODATA/ 6.6040.100

(4-2) Sampling and analysis

The 12 Niskin water samplers sampled sea water during CTD upcast at each sampling stations. The water samples for D.O. meter analysis were collected from the 12-litter Niskin water samplers into 100ml D.O. glass bottles. We also collected sea surface water by a bucket sampling. In each cast, several water samples for the Winkler titration were also sampled to calibrated BOD flasks (ca, 180ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966). Three times of bottle volumes of sample water were overflowed during of each sampling. During sampling, we measured the water temperature at the time of sampling for correction of the volume of sampling bottle.

After the sampling, we analyzed D.O. with salinity correction within 30 to 60 minutes. The D.O. meter was adjusted to 0-100% before measurement at each stations (see TOA D.O. meter operation manual). The data from the D.O. meter were corrected with calibration factors. The factors were decided by linear regression based on the Winkler titration value vs. D.O. meter value.

The samples for the titration method were analyzed by Metrohm piston burette of 10ml with Pt Electrode using Whole bottle titration in the laboratory under controlled temperature (ca, 20-24 deg-C). The standardizations and blank determination have been performed every day before the sample titration. Concentration of D.O. was calculated by equation (8) of WHP Operations and Methods (Culberson, 1991). The amount of D.O. in the reagents was reported 0.0017ml at 25.5 deg-C (Murray et al., 1968). However in this cruise, we used the value (=0.0027 ml at 21 deg-C) measured at 1995 WOCE cruise. D.O. concentrations we calculated were not corrected by seawater blank.

(5) Results

(5-1) Reproducibility

a) D.O. meter value

73 pairs of samples were analyzed as replicates taken by same Niskin bottle and bucket. The average and standard deviation (2 sigma) of difference of replicate samples were 0.012 ml/l and 0.032 ml, respectively (standard deviation corresponded to 0.7% of D.O. maximum concentration (4.59 ml/l) in this cruise).

b) Winkler Titration value

We prepared a 5 liter batch of 0.07N thiosulfate solution and 0.0100N standard KIO3 solution for Winkler method. We compared our KIO3 standard to CSK standard solution which are prepared by Wako pure chemical industries, Ltd. The results show that normality of our standard may be different 0.07% from nominal normality.

40pairs of samples were analyzed as replicates taken by same Niskin bottle and bucket. The average and standard deviation (2 sigma) of difference was 0.004 ml/l and 0.008 ml/l, respectively (standard deviation corresponded to 0.17% of D.O. maximum (4.606 ml/l) in this cruise).

(5-2) Correction of D.O. meter value

Linear regression line listed below was obtained from 166 pairs of the combination of D.O. meter and Winkler data(Fig. 6.3-1). All D.O. meter data were calibrated by this formula (corrected D.O. data were shown in Table 6.3-1).

Formula: $Y = 0.037 + 1.008X$ (n = 166)

$R = 0.998$

Y: Winkler value (ml/l) X: D.O. meter value (ml/l)

(5-3) CTD-D.O. Sensor Value correction

The two kinds of calculated polynomial regression curve for upcast and downcast were obtained from 248 pairs of CTD D.O. Sensor and corrected D.O. data (Fig.6.3-2).

For upcast: $Y = 0.482 + 0.584X + 0.116X^2$ (n = 248)

$R = 0.982$

Y: Corrected D.O. Value (ml/ l) X: CTD-D.O. Sensor Upcast Value (ml/ l)

For downcast: $Y = 0.807 + 0.150X + 0.204X^2$ (n = 248)

$R = 0.971$

Y: Corrected D.O. Value (ml/ l) X: CTD-D.O. Sensor Upcast Value (ml/ l)

(5-4) Vertical profiles

Vertical profiles in this cruise are shown in Fig.6.3-3 where the data from CTD and corrected D.O. data in Table 6.3-1 were plotted.

(5-5) Contour plots

Contour plots along 156E in Fig.6.3-4 were made from corrected dissolved oxygen data in Table 6.3-1.

(5-6) Comparison of D.O. Sensor's value and corrected D.O. value

To compare D.O. Sensor's value and corrected D.O. value, we calculated Root Mean Squares (below R.M.S.) are calculated for each depths and each stations by this formula.

$$R.M.S. = \sqrt{\frac{1}{N} \sum (X_i - Y_i)^2}$$

X_i : corrected D.O. value Y_i : D.O. sensor's value

The upcast and downcast of R.M.S. values for each stations and each depths are showed in Table 6.3-2 and Table 6.3-3, respectively.

(5-7) Comments

In 156E sections, there are D.O. front from 2N to 4N. On the other hand, there are high D.O. water mass at about 600db 1S〜2S. Above 200db depth, D.O. concentrations is more than 3.00 ml/l.

Because the condition of D.O. meter was not good at C40, we thought that the D.O. value may be underestimated at 50m and surface.

(6) Data archive

The data of titration of all samples and worksheets of calculation for D.O. concentration were stored on a floppy disks. We/MWJ Chemical Team will keep the original data. All data of corrected D.O. value will be submitted to the DMO at JAMSTEC.

(7) Other remarks

Reference:

Culberson, C. H. (1991) Dissolved Oxygen, in WHP Operations Methods, Woods Hole, pp.1-15.

Culberson, C. H., G. Knapp, M. C. Stalcup, R.T. Williams and F. Zemlyak (1991) A comparison methods for the determination of dissolved Oxygen in the seawater (WHPO-91-2), Woods Hole, pp.1-15.

Green, E. J. and D. E. Carritt (1966) An improved iodine determination flask for Whole-bottle titrations, Analyst, 91, 207-208.

Kitagawa, S. and K. Taira (1993) Measurement of dissolved oxygen by an electrode method, Umi no Kagaku (in Japanese), 2, 15-18.

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

TOA Electronics Ltd. (1991) DO-25A Portable Dissolved Oxygen meter Operation Manual, Tokyo, 29.

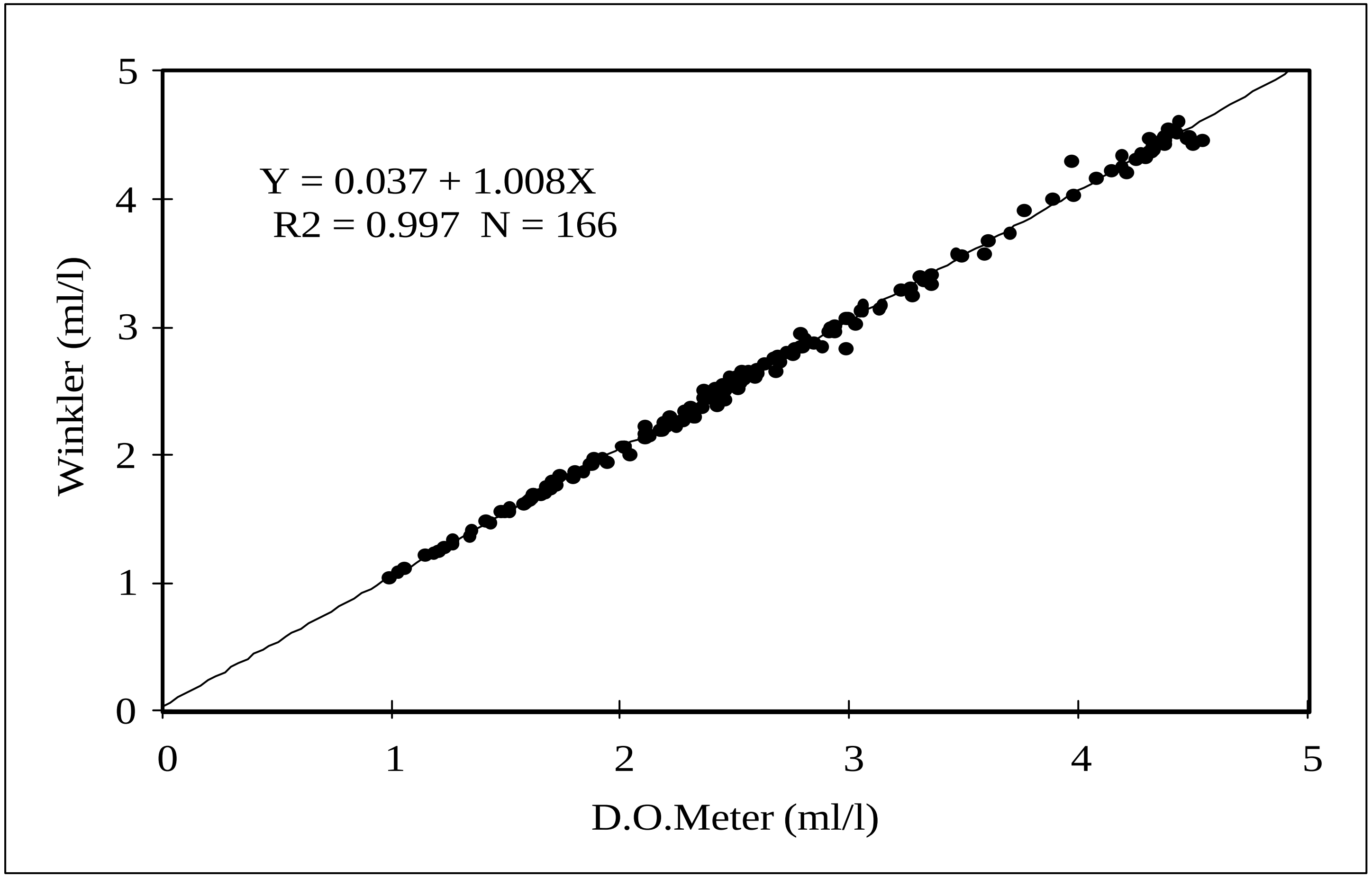
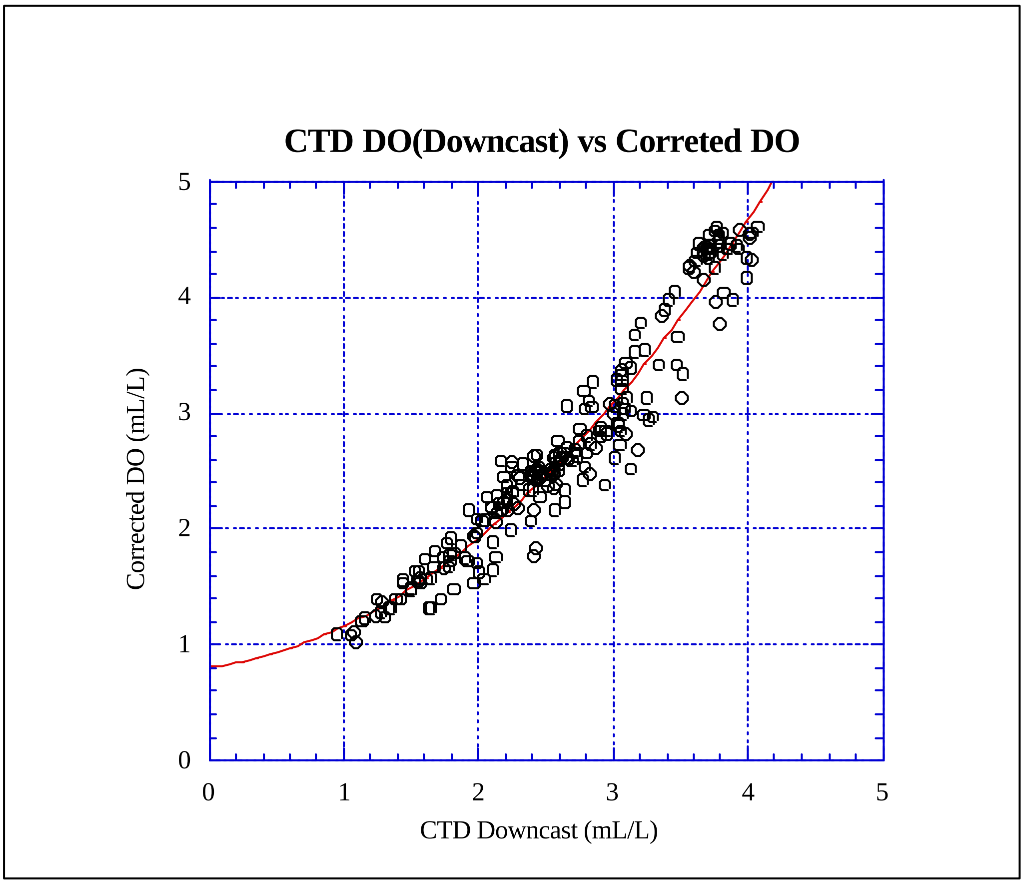


Fig 6.3-1 D.O. Meter - Winkler



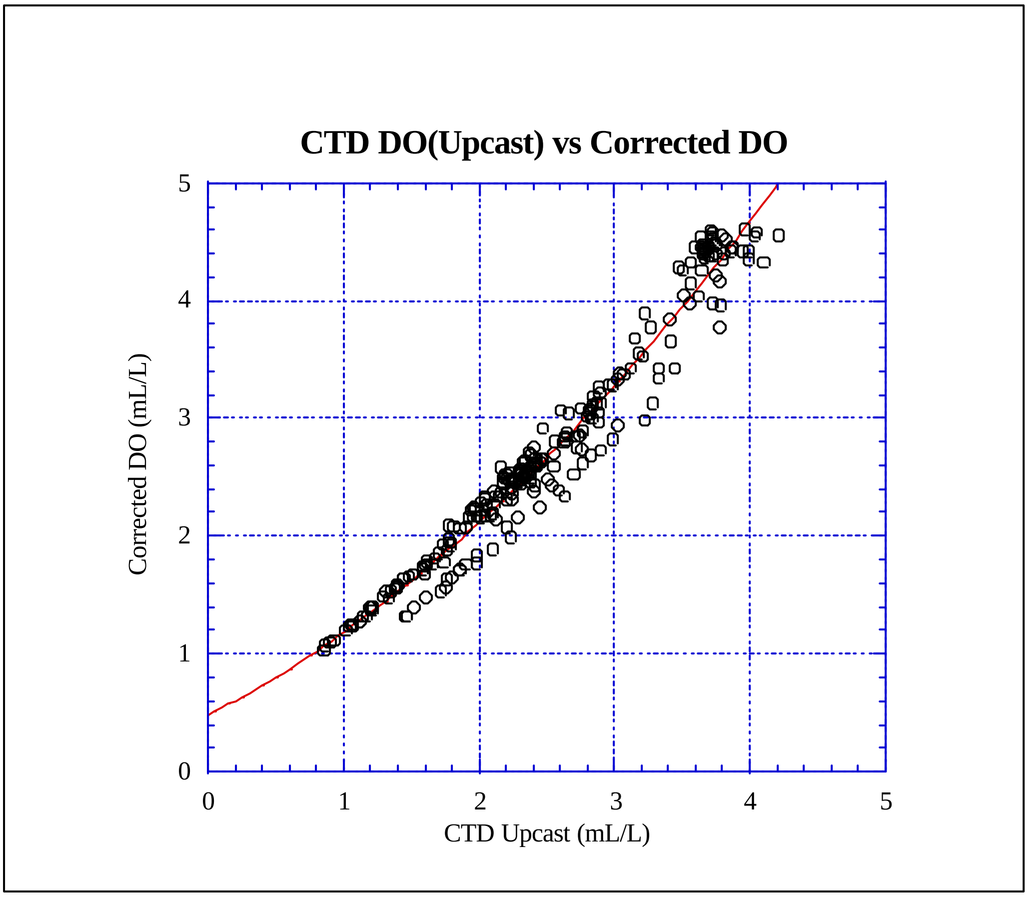
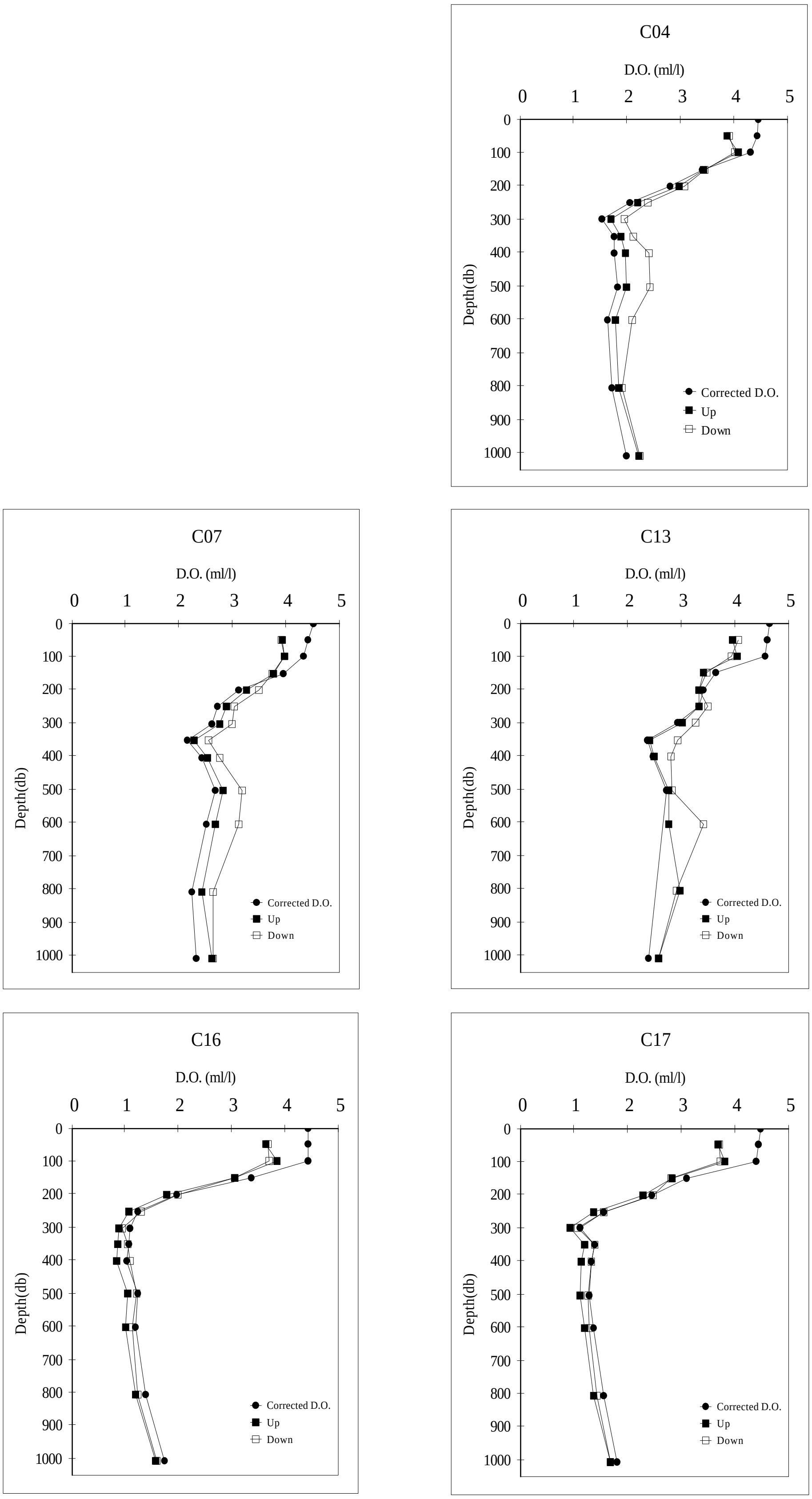
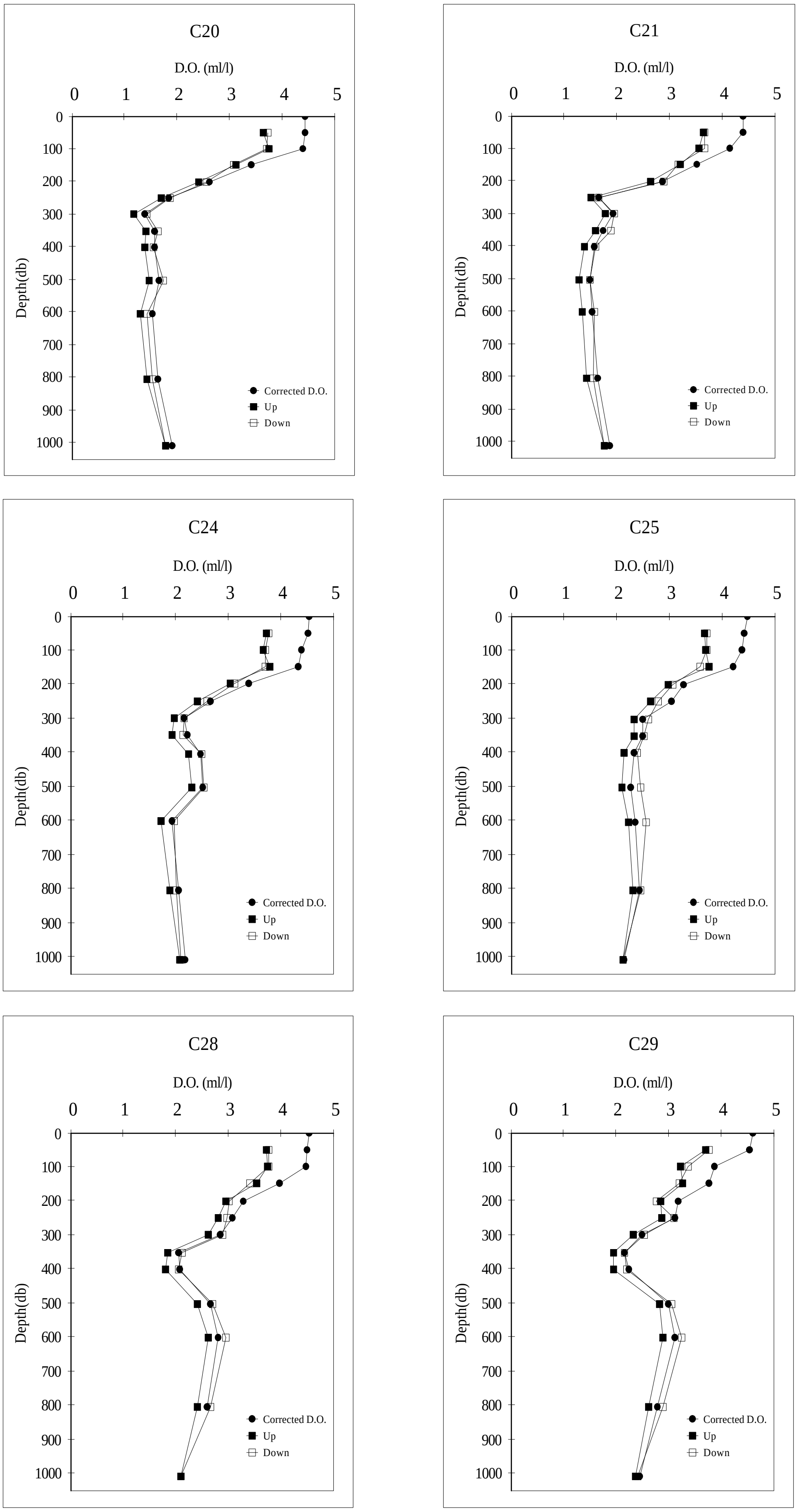


Fig 6.3-2 CTD D.O. - Corrected D.O.



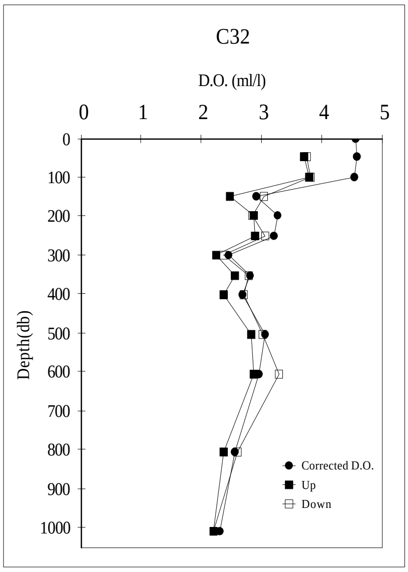
P1

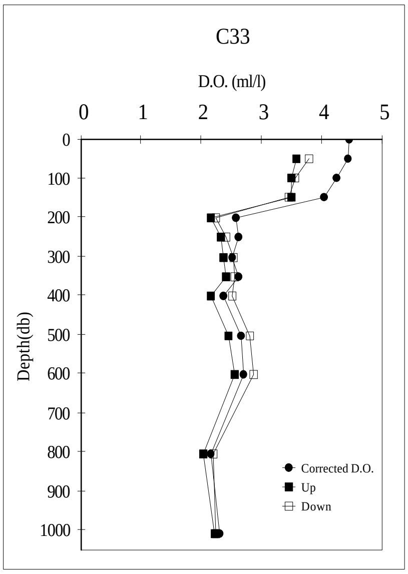
Fig.6.3-3 (1) Vertical profiles at each stations

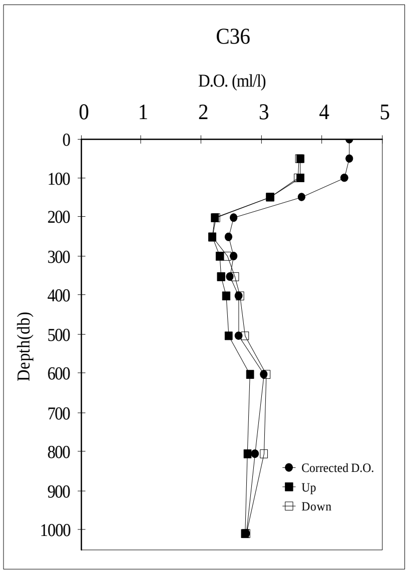


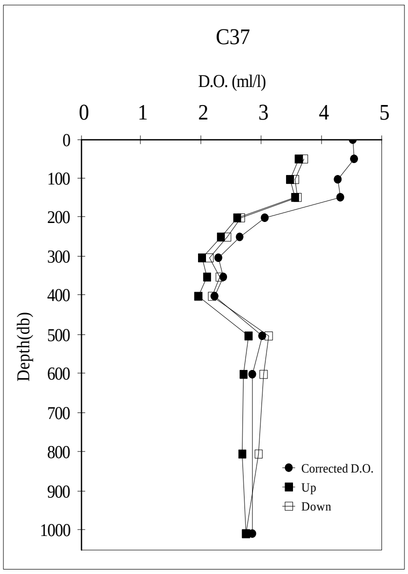
P2

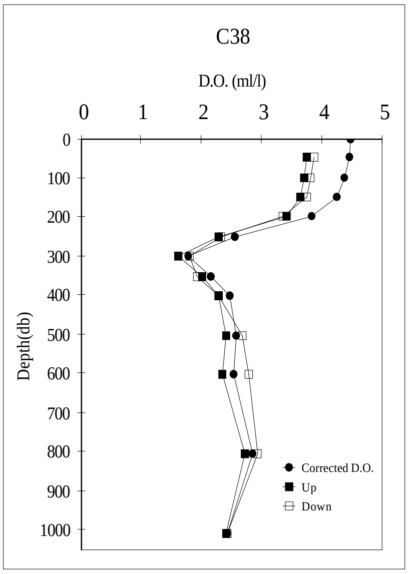
Fig.6.3-3 (2) Vertical profiles at each stations











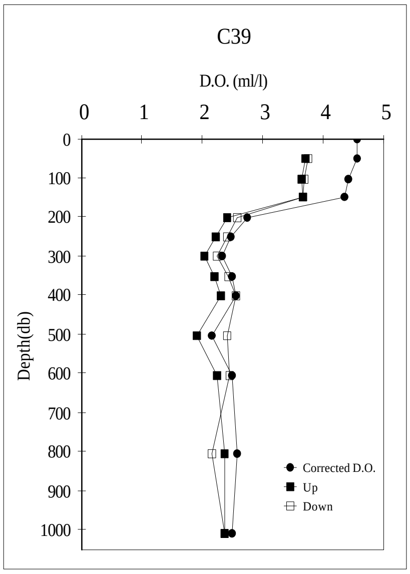
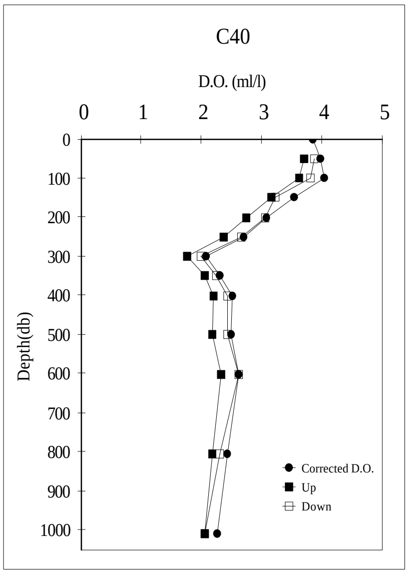
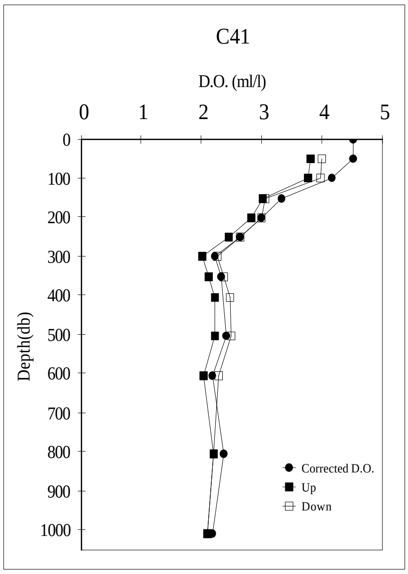


Fig.6.3-3 (3) Vertical profiles at each stations P3





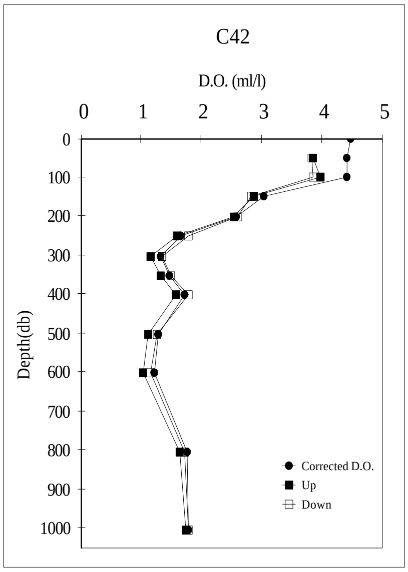


Fig.6.3-3 (4) Vertical profiles at each stations

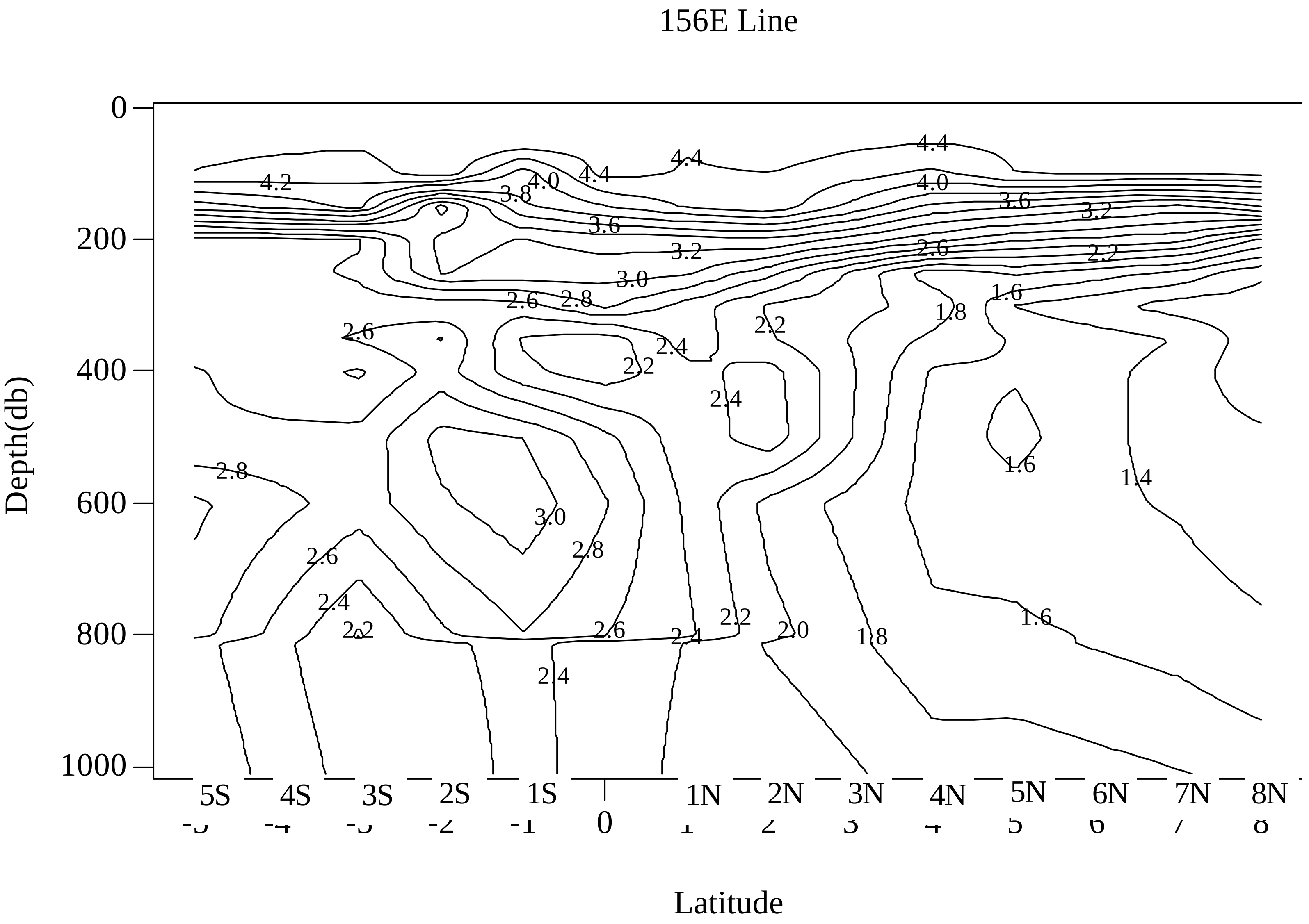


Fig 6.3-4 Contour plot of D.O. along 156E Line

Table 6.3-1 Corrected D.O. Value

C04	
04-53N	146-58E
Depth (db)	DO (ml/L)
0	4.46
51	4.45
101	4.33
152	3.42
202	2.82
252	2.07
302	1.53
353	1.76
403	1.77
504	1.84
604	1.65
807	1.72
1009	1.99

C07	
02-06N	146-57E
Depth (db)	DO (ml/L)
0	4.53
51	4.42
101	4.35
152	3.96
202	3.13
252	2.73
303	2.62
352	2.16
404	2.43
504	2.69
605	2.52
808	2.24
1009	2.34

C13	
00-03N	146-51E
Depth (db)	DO (ml/L)
0	4.66
51	4.61
101	4.58
151	3.66
202	3.42
252	3.34
302	2.94
353	2.38
403	2.48
504	2.74
605	N.D.
806	N.D.
1009	2.39

C16	
08-00N	156-02E
Depth (db)	DO (ml/L)
0	4.44
51	4.44
100	4.45
151	3.37
202	1.97
252	1.24
303	1.09
353	1.08
404	1.03
503	1.25
604	1.20
807	1.40
1008	1.74

C17	
07-00N	156-00E
Depth(db)	DO(mL/L)
0	4.48
51	4.45
100	4.40
151	3.11
202	2.46
252	1.55
302	1.11
353	1.39
402	1.32
504	1.28
604	1.37
806	1.56
1008	1.81

C20	
05-03N	155-58E
Depth (db)	DO (ml/L)
0	4.45
50	4.45
101	4.40
151	3.43
202	2.63
251	1.85
302	1.39
353	1.58
402	1.58
503	1.66
605	1.53
807	1.64
1009	1.92

C21	
04-00N	156-00E
Depth (db)	DO (ml/L)
0	4.41
51	4.41
101	4.15
151	3.53
202	2.87
252	1.67
302	1.94
353	1.75
403	1.57
504	1.49
604	1.53
806	1.64
1012	1.88

C24	
01-57N	156-00E
Depth (db)	DO (ml/L)
0	4.55
51	4.52
100	4.40
151	4.35
200	3.39
251	2.66
301	2.17
351	2.22
404	2.48
503	2.52
603	1.93
806	2.07
1008	2.18

C25	
01-00N	156-00E
Depth (db)	DO (ml/L)
0	4.49
51	4.42
101	4.38
151	4.22
202	3.28
252	3.04
303	2.51
353	2.51
403	2.34
503	2.27
605	2.36
806	2.44
1008	2.14

C28	
00-04S	156-02E
Depth(db)	DO(mL/L)
0	4.54
50	4.50
101	4.48
151	3.98
202	3.29
252	3.08
302	2.85
352	2.06
403	2.08
504	2.66
604	2.82
806	2.60
1008	N.D.

C29	
01-00S	156-00E
Depth (db)	DO (ml/L)
0	4.61
50	4.54
99	3.89
150	3.78
201	3.19
251	3.13
302	2.5
352	2.17
402	2.25
503	3.00
604	3.13
805	2.79
1008	2.45

C32	
02-00S	155-57E
Depth (db)	DO (ml/L)
0	4.57
49	4.60
101	4.56
150	2.91
200	3.27
252	3.21
301	2.46
352	2.81
403	2.69
503	3.07
605	2.97
806	2.56
1010	2.31

C33	
03-00S	156-00E
Depth (db)	DO (ml/L)
0	4.47
50	4.45
101	4.26
151	4.05
201	2.58
252	2.63
303	2.52
353	2.62
403	2.37
504	2.66
604	2.70
806	2.17
1009	2.31

C36	
05-05S	156-03E
Depth (db)	DO (ml/L)
0	4.47
51	4.47
101	4.39
151	3.68
201	2.54
252	2.45
302	2.54
352	2.48
403	2.62
503	2.63
604	3.04
806	2.89
1008	2.75

C37	
08-03S	164-49E
Depth(db)	DO(mL/L)
0	4.52
50	4.54
102	4.28
151	4.32
202	3.07
251	2.64
303	2.29
353	2.38
403	2.23
504	3.02
604	2.85
807	N.D.
1008	2.86

C38	
04-59S	165-12E
Depth (db)	DO (ml/L)
0	4.49
49	4.47
100	4.38
150	4.26
200	3.84
251	2.56
301	1.79
353	2.16
402	2.47
503	2.59
604	2.54
806	2.85
1008	2.43

C39	
01-55S	164-22E
Depth (db)	DO (ml/L)
0	4.58
50	4.57
102	4.42
151	4.36
202	2.76
252	2.47
302	2.33
353	2.49
403	2.57
504	2.16
605	2.49
807	2.59
1008	2.50

C40	
00-00S	165-01E
Depth (db)	DO (ml/L)
0	3.86
50	3.98
100	4.04
150	3.55
201	3.09
251	2.71
301	2.09
351	2.31
402	2.52
502	2.50
603	2.62
806	2.44
1009	2.27

C41	
01-59S	164-58E
Depth (db)	DO (ml/L)
0	4.52
51	4.52
101	4.17
152	3.33
201	3.00
252	2.65
302	2.22
353	2.34
404	N.D.
504	2.42
605	2.18
807	2.37
1009	2.19

C42	
05-05N	164-59E
Depth (db)	DO(mL/L)
0	4.48
52	4.42
100	4.42
151	3.05
202	2.59
251	1.67
303	1.32
353	1.47
403	1.72
503	1.28
604	1.23
807	1.76
1007	1.78

N.D. shows not sampling

Table 6.3-2 R.M.S. for each stations

Cast	RMS (ml/L)	
	Upcast	Downcast
C04	0.232	0.404
C07	0.234	0.403
C13	0.285	0.367
C16	0.336	0.326
C17	0.323	0.307
C20	0.351	0.313
C21	0.330	0.284
C24	0.402	0.356
C25	0.368	0.358
C28	0.399	0.362
C29	0.394	0.338
C32	0.421	0.364
C33	0.414	0.355
C36	0.396	0.385
C37	0.491	0.426
C38	0.382	0.341
C39	0.446	0.405
C40	0.314	0.143
C41	0.299	0.194
C42	0.238	0.245

Table 6.3-3 R.M.S. for each depth

Niskin No.	Depth(db)	Upcast	Downcast
Niskin12	50 db	0.732	0.675
Niskin11	100db	0.614	0.604
Niskin10	150db	0.430	0.440
Niskin09	200db	0.293	0.263
Niskin08	250db	0.236	0.193
Niskin07	300db	0.199	0.174
Niskin06	350db	0.197	0.199
Niskin05	400db	0.216	0.205
Niskin04	500db	0.192	0.205
Niskin03	600db	0.185	0.231
Niskin02	800db	0.172	0.181
Niskin01	1000db	0.143	0.141

6.4 Continuous surface temperature and salinity measurements

(1) Personnel

Nobuharu Komai (MWJ): Operation leader
Takehiko Shiribiki (MWJ)

(2) Objectives

To monitor continuously the physical, chemical and biological characteristic of sea surface water.

(3) Parameters

Temperature, salinity, dissolved oxygen, fluorescence, particle size of plankton in the surface water.

(4) Methods

The Continuous Sea Surface Water Monitoring System is located in the "sea surface monitoring laboratory" on R/V Mirai. It can automatically measure temperature, salinity, dissolved oxygen, fluorescence and particle size of plankton in the surface water every one minute. Measured data are saved every one minute together with time and the position of ship, and displayed in the data management PC machine. This system is connected to shipboard LAN-system and provides the acquired data for p-CO_2 measurement system, etc.

Sea surface water was continuously pumped up from the seachest of the ship at 4 meters depth to the laboratory and then flowed into the Continuous Sea Surface Water Monitoring System and p-CO_2 measurement system etc. through a steel pipe. The flow rate of surface water for the Continuous Sea Surface Water Monitoring System was controlled by some valves and passed through some sensors i.e. temperature, salinity and dissolved oxygen etc. through vinyl-chloride pipes.

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

Leg. 1 8-Feb-99 10:17 to 11-Feb-99 01:11 (From Hachinohe to Guam)
Leg. 2 15-Feb-99 04:28 to 8-Mar-99 23:53 (From Guam to Honiara)
Leg. 3 12-Mar-99 08:13 to 23-Mar-99 09:00 (From Honiara to Chuuk)

Specification and calibration date of the sensors are listed below.

(a-1) Temperature and salinity sensors

SEACAT THERMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number: 2113117-2641
Measurement range: Temperature -5 to +35 deg-C, Salinity 0 to 6.5 S/m
Accuracy: Temperature 0.01 deg-C/6month, Salinity 0.001 S/m/month
Resolution: Temperature 0.001 deg-C, Salinity 0.0001 S/m
Calibration date: 13-May-98 (mounted on 17-Oct-98 in this system)

(a-2) Ship bottom oceanographic thermometer (mounted at the back of the pump for surface water)

Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number: 2607
Measurement range: -5 to +35 deg-C
Initial Accuracy: 0.001 deg-C per year typical
Stability: 0.002 deg-C per year typical
Calibration date: 16-Jun-98 (mounted on 17-Oct-98 in this system)

b) Dissolved oxygen sensor

Model: 2127, Oubisufair Laboratories Japan INC.
Serial number: 31757

Measurement range: 0 to 14 ppm
Accuracy: ±1% at 5 deg-C of correction range
Stability: 1% per month
Calibration date: 6-Feb-99

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

d) Particle size sensor
Model: P-05, Nippon Kaiyo LTD.
Serial number: P5024
Accuracy: ±10% of range
Measurement range: 0.02681mm to 6.666mm
Reproducibility: ±5%
Stability: 5% per week

e) Flowmeter
Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 L/min
Accuracy: ±1%
Stability: ±1% per day

(5) Results

During the former cruise, it was found that salinity values obtained by this system is approximately 0.025 lower than those of the surface water which simultaneously sampled from the same location and measured by an Autosal salinometer. Therefore we sampled once a day for salinity validation from the system during this cruise. At the same time, we also sampled from the drain valve of surface water for p-CO_2 and/or the continuous dissolved inorganic carbon measurement system during Leg. 1 and 2. All samples were analyzed by an Autosal salinometer (see section 6.2) and the results were shown in table 6.4-1.

We compared salinity values of the water samples and those from SBE21 sensor of the system (Fig 6.4-1). Salinity values of the sensor were always lower than those of water samples, as well as during the former cruise, even though salinity of the sensor agreed very closely with salinity values of water samples. We calculated the Root Mean Squares (R.M.S.) for 40 samples and it was 0.0117 (one sigma). Cell electrode of conductivity sensor can be contaminated with oil, biological growths, and other foreign material, will cause low conductivity readings (SEACAT THERMOSALINOGRAPH SBE21 OPERATING MANUAL, APPLICATION NOTE No. 2D). Therefore, conductivity sensor of this system can be also contaminated with these materials.

We showed the difference of salinity values between the system and the different location (Fig 6.4-2). Calculated R.M.S. was 0.0045 (one sigma). The R.M.S. was smaller than 0.0117, therefore it was not related to the location of the conductivity sensor.

D.O. sensor of this system was calibrated just before this cruise. To estimate of accuracy of the sensor, we collected the 17 samples from the course of the system and analyzed by Winkler method (see section 6.3). The results were shown in table 6.4-2 and Fig 6.4-3. The values of D.O. sensor were always higher than the values analyzed by the Winkler method. Calculated R.M.S. was 0.255 ml/L (one sigma).

Preliminary data every 10 minutes from Hachinohe to Guam, and along 147E line, 156E line, 165E line, the equator (from 156E to 165E) are shown in Fig 6.4-4～Fig 6.4-8, respectively. They showed the respective trend of temperature, salinity, D.O. and fluorescence distributions on the ship's track. In Fig 6.4-4, there was the Kuroshio front in the vicinity of 37N. Fluorescence was getting lower southward but it was almost constant from 25N to south. D.O. was high from 24N to 31N.

Compared with three lines of 147E, 156E and 165E, the temperature was getting higher and salinity was getting lower westward. At 147E, temperature of surface water was not changed significantly but salinity, D.O., and fluorescence was changed at around 2N (Fig 6.4-5). At 156E, temperature was low from around 2S to 4N associated with equatorial upwelling caused by strong easterly winds but others were high at there (Fig 6.4-6).

At 165E, salinity was significantly changed around 5S (Fig 6.4-7). The value of salinity tends to be high, but temperature tends to be low from 5S to 2N. There was a peak of fluorescence at 1N along 165E.

Temperature, salinity, D.O. were almost constant along the equator from 156E to 165E but there were some peaks of fluorescence. (Fig 6.4-8).

(6) Data archive

All the files of raw data, Microsoft excel files of raw data, excel files divided into each 10minutes data were stored on a magnetic optical disk. All the data will be submitted to the DMO at JAMSTEC.

(7) Other remarks

The data from the particle size sensor were not reliable, because the setting of the sensor was not good. At Honiara and chuuk, the cell of conductivity sensor was filled with a 1% solution of Triton X-100 and let soak for 30 minutes to clean inside of the cell. We cleaned the flow cell of fluorometer, when R/V Mirai was at Sekinehama, Guam, Honiara and Chuuk ports.

(8) References

SEACAT THERMOSALINOGRAPH SBE21 OPERATING MANUAL, APPLICATION NOTE No. 2D, Revised January 1998

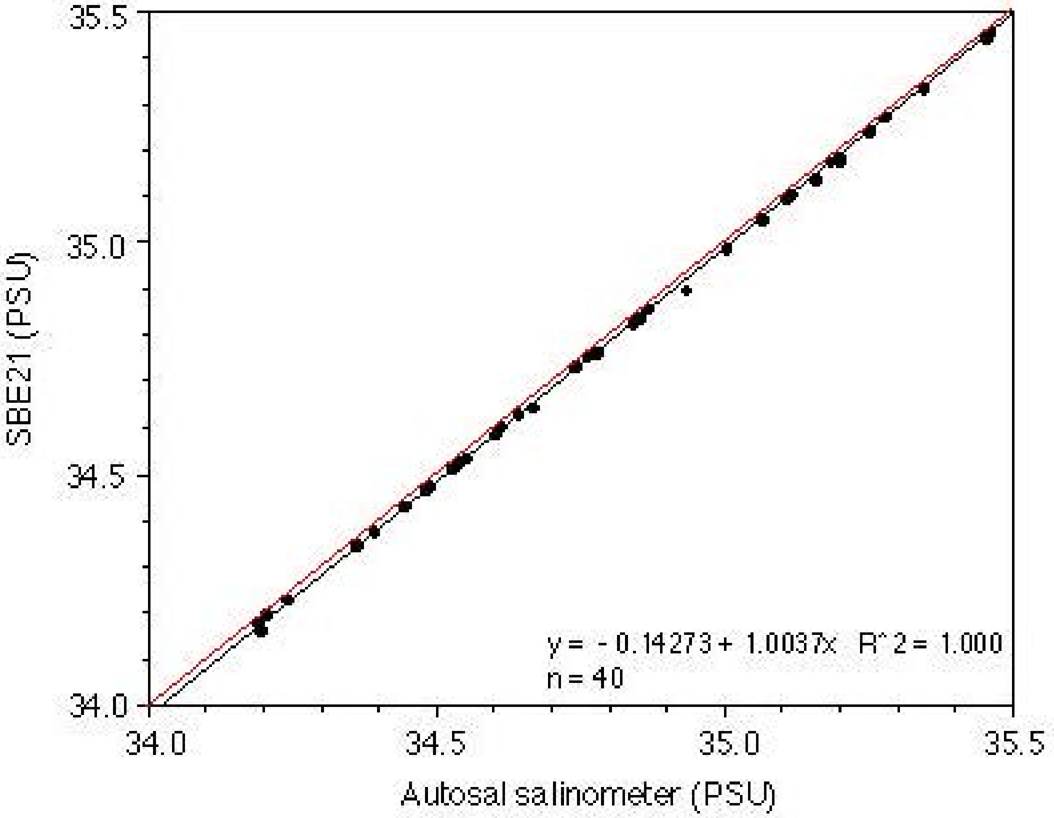


Fig 6.4-1 Comparison between the salinity values measured by SBE21 of the Sea Suraface Monitoring System and by Autosal salinometer for 40 samples.
Note: Salinity in this figure is not corrected.

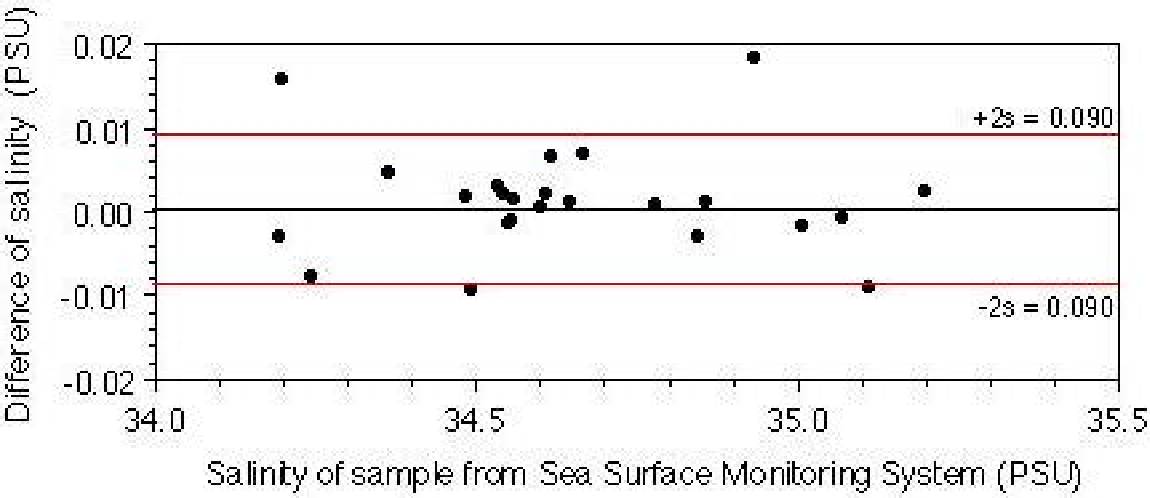


Fig 6.4-2 Difference of salinity of samples from the Sea Suraface Monitoring System and from different place at the same laboratory.
Note: Salinity in this figure is not corrected.

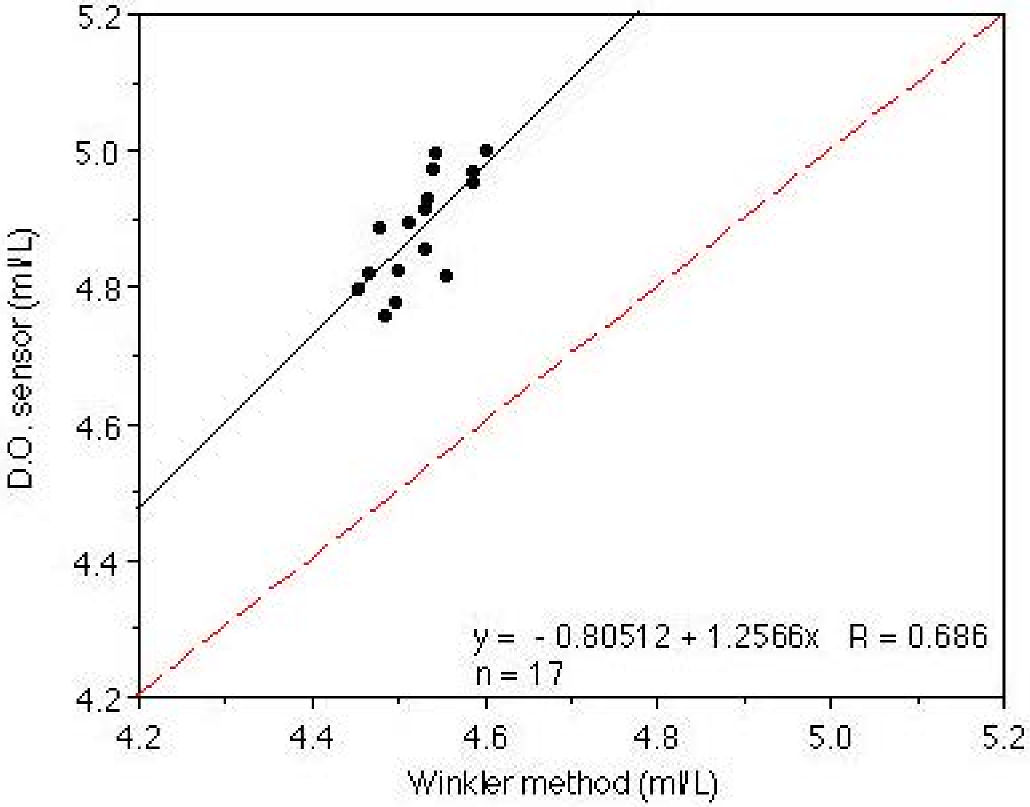


Fig 6.4-3 Comparison between the D.O. value measured by D.O. sensor of the Sea Suraface Monitoring System and by Winkler method for 17 samples obtained during MR99-K01 cruise.

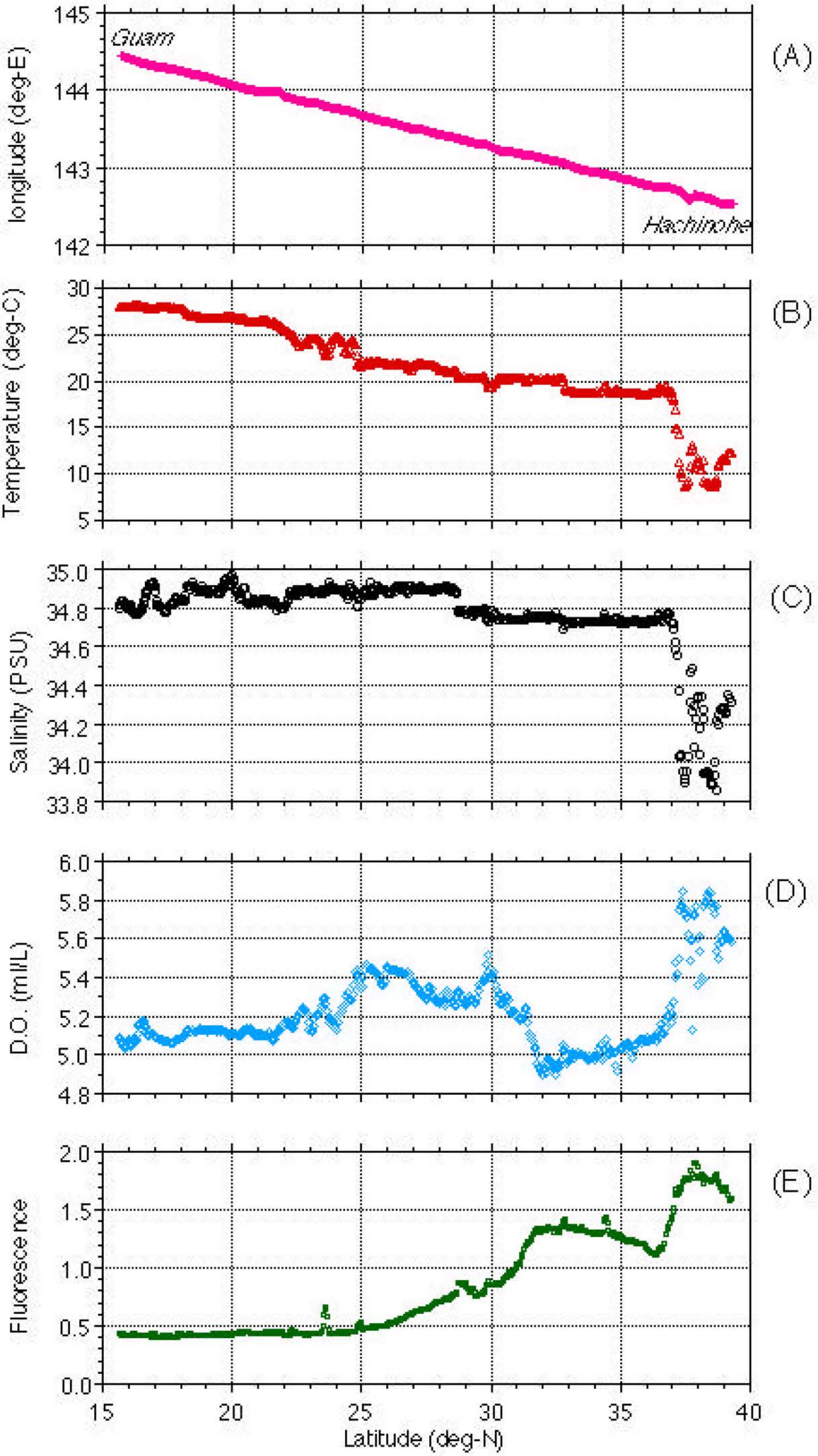


Fig 6.4-4 Ship's track (A), temperature (B), salinity (C), D.O. (D) and

(A)

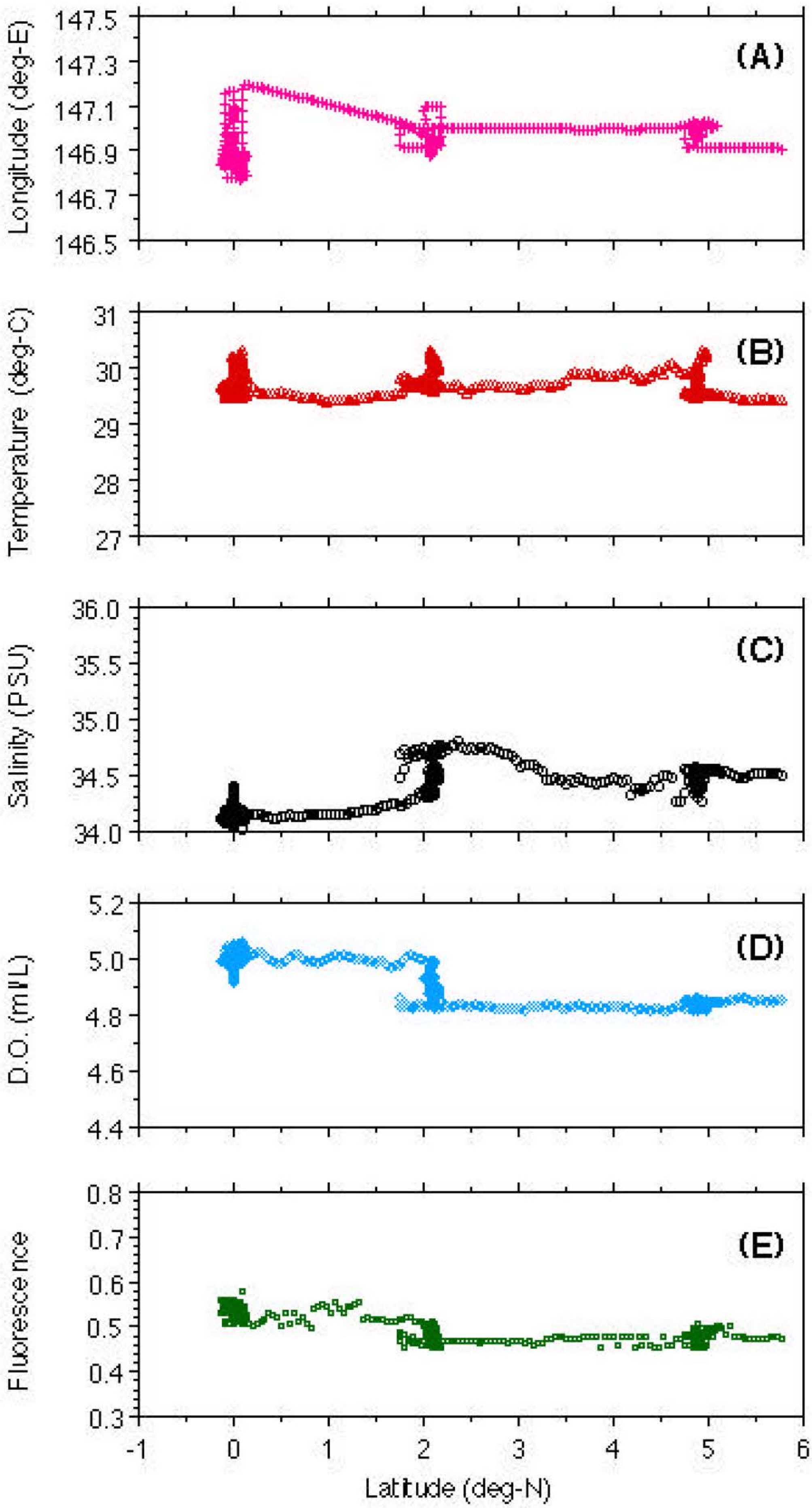


Fig 6.4-5 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water along 147E line.
Note: Salinity and D.O. in this figure is not corrected.

(A)

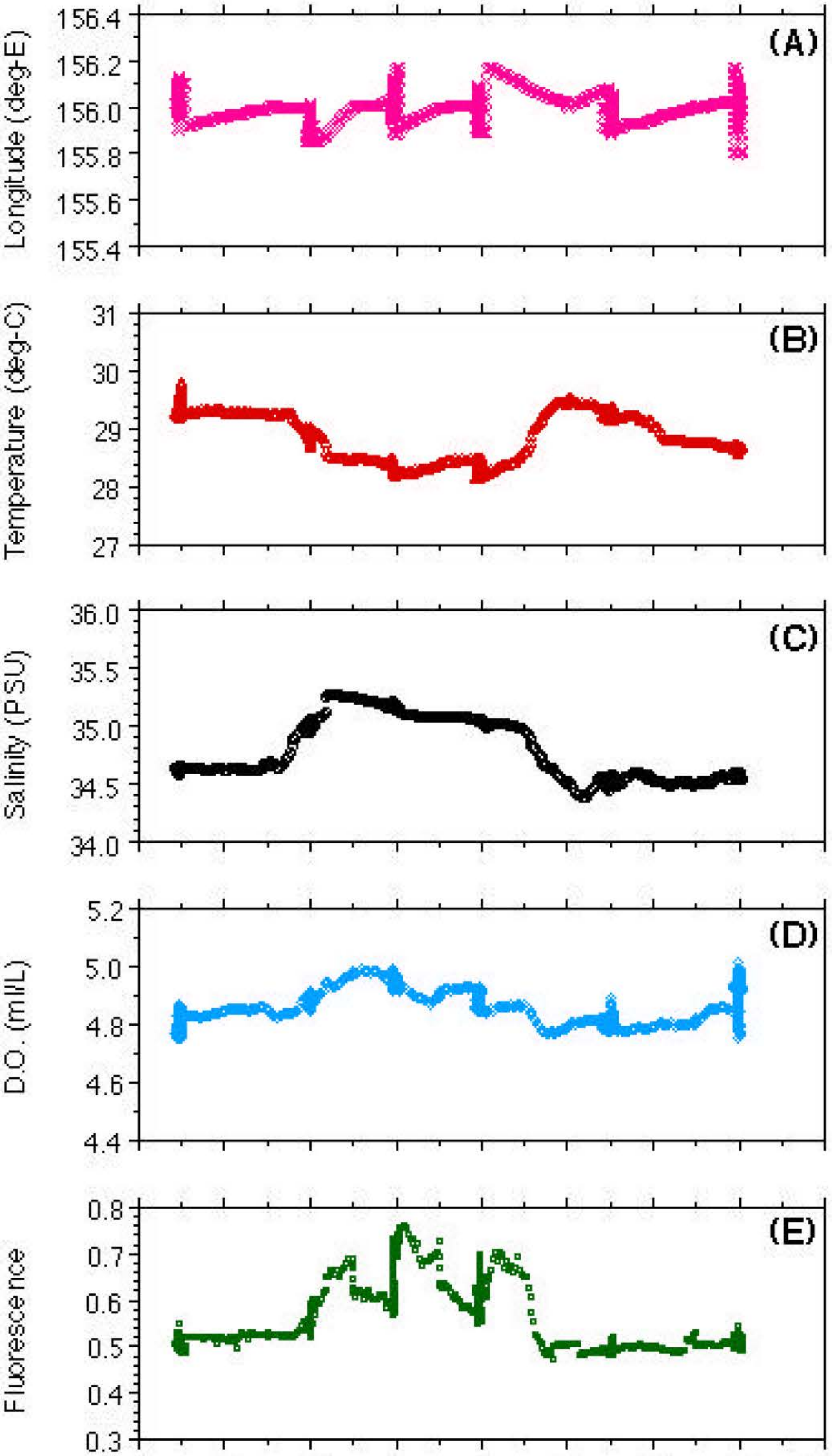


Fig 6.4-6 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water along 156E line.
Note: Salinity and D.O. in this figure is not corrected.

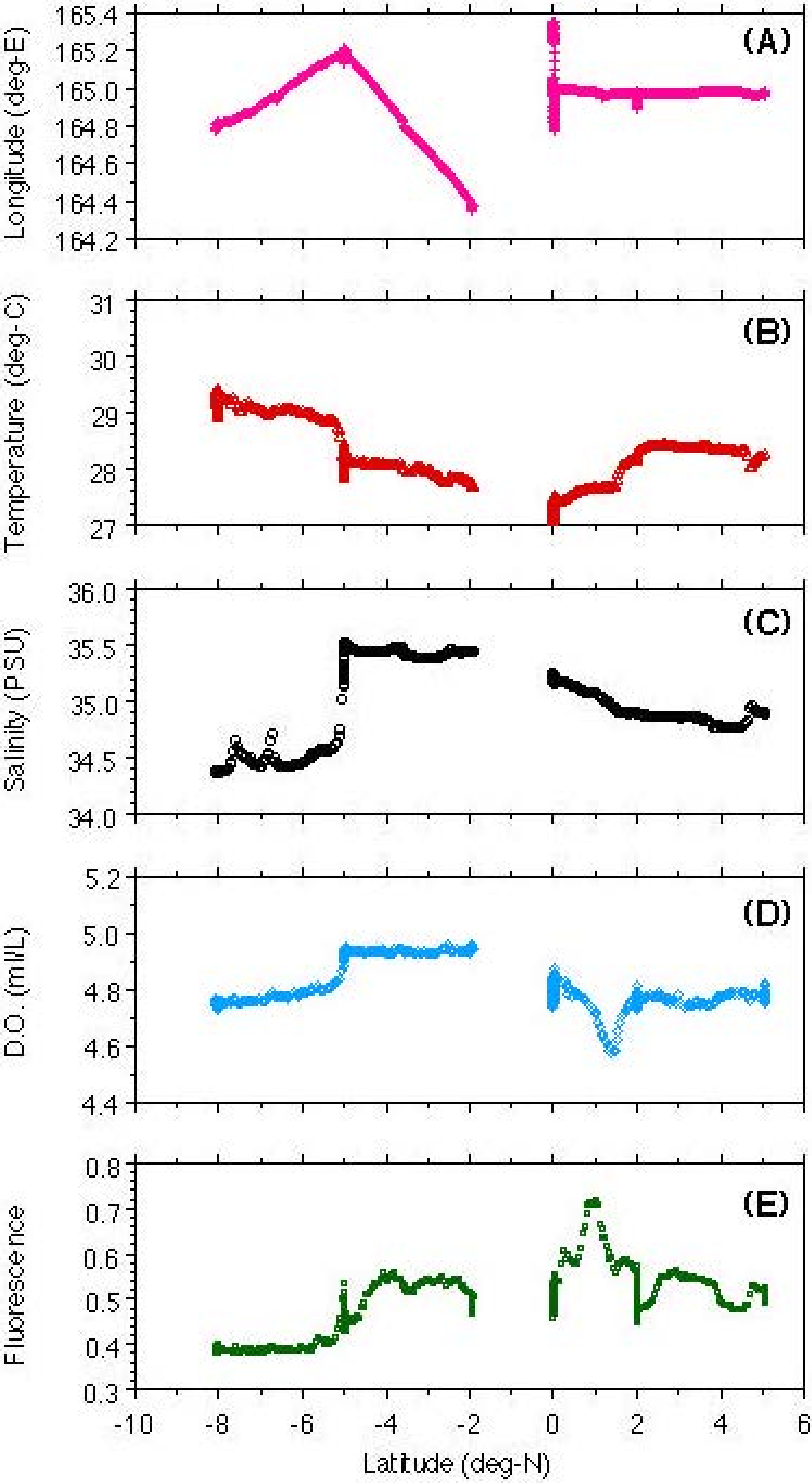


Fig 6.4-7 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water along 165E line.
Note: There is data missing from 2S to the equator. Salinity and D.O. in this figure is not corrected.

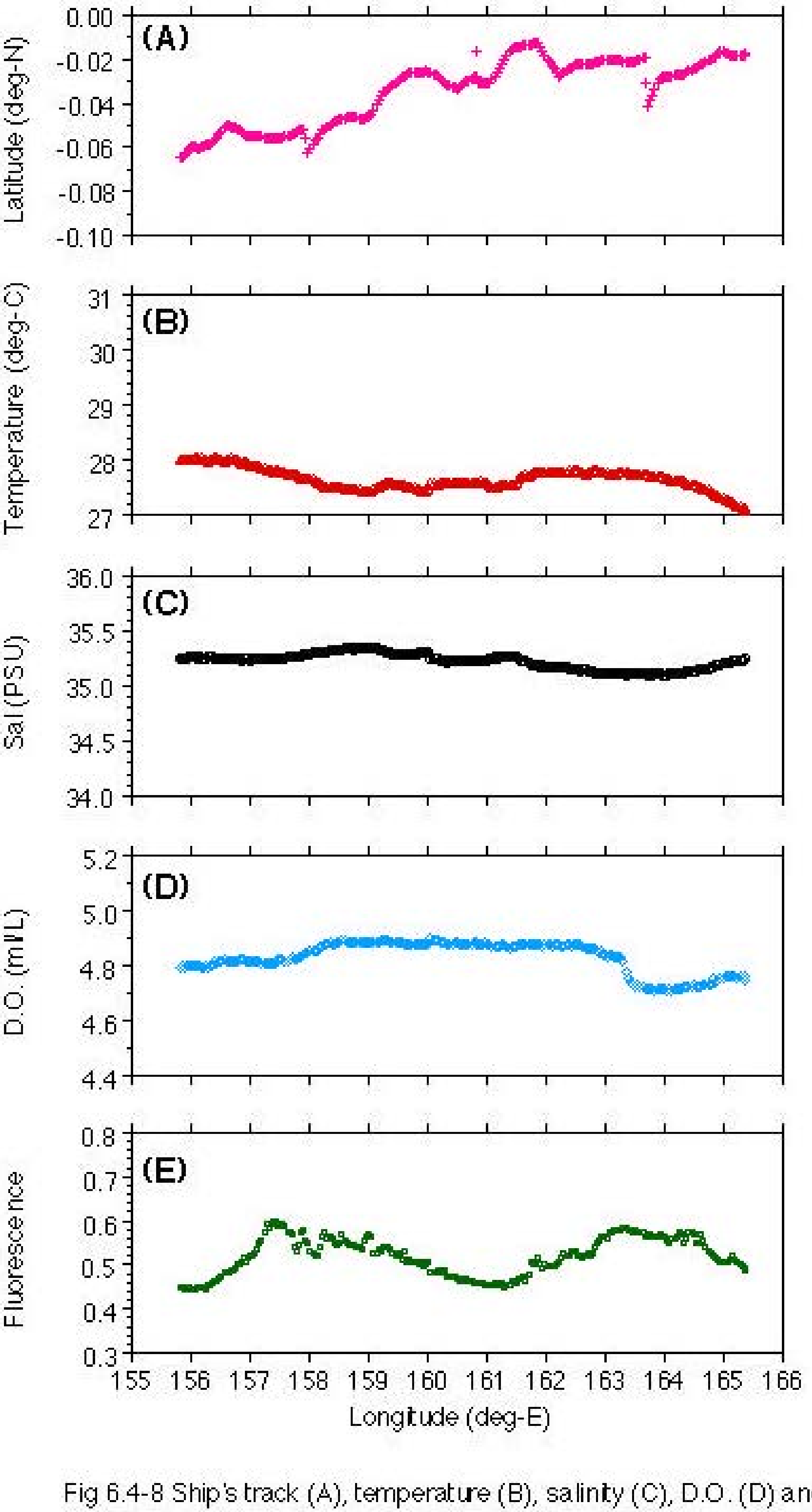


Fig 6.4-8 Ship's track (A), temperature (B), salinity (C), D.O. (D) and fluorescence (E) of suface water along the equator line.
Note: Salinity and D.O.in this figure is not corrected.

Table 6.4-1 Comparison among the salinity values based on water samples from SSMS and water samples from the other place using an Autosal salinometer, and SBE21sensor of the Sea Surface Monitoring System (SSMS).

Sampling (UTC)		Latitude	Longitude	Temp	Salinity (PSU)			Difference of Salinity (PSU)	
Date	Time			(deg-C)	SBE21	From SSMS	From Other	SBE21-SSMS	Other-SSMS
2/9/99	9:07	33-33.004N	142-57.945E	18.740	34.7312	34.7425	Not Sampling	-0.0113	—
2/10/99	9:06	27-10.902N	143-30.083E	21.860	34.8956	34.9328	34.9144	-0.0372	0.0184
2/15/99	8:47	07-42.465N	146-29.251E	28.888	34.3452	34.3635	34.3587	-0.0183	0.0048
2/16/99	7:55	04-54.383N	146-58.312E	29.662	34.4675	34.4839	34.4820	-0.0164	0.0019
2/17/99	8:32	04-58.356N	147-00.702E	30.270	34.5350	34.5514	34.5525	-0.0164	-0.0011
2/18/99	8:23	02-07.750N	146-54.795E	30.130	34.5117	34.5300	34.5267	-0.0183	0.0033
2/19/99	8:39	01-47.226N	147-01.355E	29.593	34.2269	34.2419	34.2496	-0.0150	-0.0077
2/20/99	8:13	00-04.787N	146-46.904E	29.946	34.1791	34.1921	34.1948	-0.0130	-0.0027
2/21/99	9:45	00-01.126S	146-56.084E	29.848	34.1634	34.1963	34.1803	-0.0329	0.0160
2/22/99	8:21	00-39.954N	147-28.930E	29.764	34.1741	34.1920	34.1950	-0.0179	-0.0030
2/23/99	10:25	05-23.569N	152-11.665E	29.518	34.4722	34.4890	34.4983	-0.0168	-0.0093
2/24/99	7:46	08-06.040N	155-50.126E	28.689	34.5366	34.5556	34.5539	-0.0190	0.0017
2/25/99	8:30	08-00.784N	156-02.849E	28.674	34.5869	34.6054	34.6031	-0.0185	0.0023
2/26/99	11:51	06-08.630N	155-57.287E	28.982	34.5231	34.5390	34.5369	-0.0159	0.0021
2/27/99	8:05	05-03.219N	155-59.399E	29.367	34.5364	34.5504	34.5516	-0.0140	-0.0012
2/28/99	12:20	03-17.632N	156-03.776E	29.063	34.7624	34.7779	34.7768	-0.0155	0.0011
3/1/99	7:55	01-56.658N	156-02.779E	28.408	35.0500	35.0675	35.0680	-0.0175	-0.0005
3/2/99	15:25	00-00.036S	156-09.836E	28.234	35.1384	35.1566	Not Sampling	-0.0182	—
3/3/99	8:09	00-03.653S	156-02.254E	28.384	35.1820	35.1984	35.1960	-0.0164	0.0024
3/4/99	11:18	01-41.579S	155-52.044E	28.816	35.0961	35.1079	35.1169	-0.0118	-0.0090
3/5/99	7:49	02-01.811S	155-54.704E	28.947	34.9877	35.0047	35.0062	-0.0170	-0.0015
3/6/99	10:54	03-50.856S	155-57.979E	29.293	34.6262	34.6426	34.6412	-0.0164	0.0014
3/7/99	8:16	05-03.398S	156-06.965E	29.295	34.5861	34.5996	34.5989	-0.0135	0.0007
3/8/99	6:37	05-03.193S	155-57.224E	29.584	34.6460	34.6654	34.6584	-0.0194	0.0070
3/12/99	9:26	09-19.275S	162-27.895E	29.046	34.1965	34.2025	Not Sampling	-0.0060	—
3/13/99	6:29	07-54.648S	164-48.821E	29.317	34.3758	34.3912	Not Sampling	-0.0154	—
3/14/99	9:35	04-04.512S	164-57.421E	28.101	35.4444	35.4537	Not Sampling	-0.0093	—
3/14/99	22:05	01-52.151S	164-10.924E	27.627	35.4514	35.4611	Not Sampling	-0.0097	—
3/15/99	13:52	00-54.457S	159-45.053E	27.522	35.332	35.3452	Not Sampling	-0.0132	—
3/16/99	12:29	00-04.480S	155-58.996E	27.916	35.2409	35.2505	Not Sampling	-0.0096	—
3/17/99	10:59	00-03.143S	157-49.123E	27.695	35.2722	35.2812	Not Sampling	-0.0090	—
3/18/99	11:53	00-02.281S	163-46.130E	27.695	35.108	35.1180	Not Sampling	-0.0100	—
3/19/99	8:31	00-01.408N	164-58.660E	27.422	35.1803	35.2010	Not Sampling	-0.0207	—
3/20/99	7:47	00-12.966N	164-59.688E	27.444	35.1718	35.1827	Not Sampling	-0.0109	—
3/21/99	9:58	03-02.895N	164-58.071E	28.390	34.8551	34.8668	Not Sampling	-0.0117	—
3/22/99	2:20	05-26.621N	163-18.748E	28.266	34.7517	34.7608	Not Sampling	-0.0091	—

Table 6.4-2 Comparison of D.O. values between a D.O. sensor of Sea Surface Monitoring System (SSMS) and water samples from SSMS using Winkler method.

Sampling (UTC) Date	Time	Latitude	Longitude	Salinity (PSU)	Tempature (deg-C)	D.O. Sensor (ml/L)	Winkler (ml/L)	Difference (ml/L) (Sensor - Winkler)
17-Feb-99	8:29	04-58.158N	147-00.683E	34.525	30.241	4.824	4.499	0.325
19-Feb-99	8:37	01-47.721N	147-01.292E	34.229	29.601	4.999	4.602	0.397
22-Feb-99	6:06	00-16.513N	147-04.302E	34.230	29.903	4.973	4.540	0.433
22-Feb-99	6:13	00-17.697N	147-05.542E	34.204	29.900	4.996	4.542	0.454
26-Feb-99	4:23	07-45.638N	156-01.436E	34.537	28.681	4.855	4.529	0.326
28-Feb-99	3:53	04-58.814N	156-04.457E	34.556	29.321	4.823	4.466	0.357
2-Mar-99	3:13	01-59.688N	156-01.078E	35.045	28.463	4.916	4.531	0.385
4-Mar-99	2:54	00-00.209S	156-09.614E	35.147	28.303	4.930	4.532	0.398
6-Mar-99	2:55	02-00.951S	155-59.670E	35.045	28.839	4.897	4.513	0.384
8-Mar-99	2:39	05-00.475S	156-00.468E	34.643	29.622	4.799	4.453	0.346
13-Mar-99	6:26	07-55.420S	164-48.759E	34.367	29.299	4.760	4.484	0.276
14-Mar-99	6:05	04-57.398S	165-11.034E	35.514	28.133	4.955	4.586	0.369
14-Mar-99	22:00	01-52.610S	164-12.311E	35.449	27.661	4.970	4.585	0.385
20-Mar-99	7:54	00-14.714N	164-59.657E	35.176	27.456	4.819	4.554	0.265
21-Mar-99	6:42	02-11.901N	164-58.013E	34.873	28.391	4.779	4.495	0.284
21-Mar-99	20:00	05-03.260N	164-59.222E	34.891	28.252	4.817	4.554	0.263

6.5 Shipboard ADCP

(1) Personnel

Masaki Hanyu (GODI): Operation Leader
Fumitaka Yoshiura (GODI)
Toshihiko Yano (JAMSTEC)

(2) Parameters

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

(3) Methods

We measured current profiles by VM-75 (RD Instruments, Inc. U.S.A.) shipboard ADCP (Acoustic Doppler Current Profiler) throughout MR99-K01 cruise from the departure of Hachinohe, Japan on 8 February 1999 to the arrival of Shimonoseki, Japan on 31 March 1999 via Guam, Honiara and Chuuk..

Major parameters for the measurement configuration are as follows;

Frequency :	75kHz
Average :	every 300 sec
Depth cell length :	1600 cm
No. of depth cells :	40
First depth cell position :	30.9 m
Last depth cell position :	654.9 m
ADCP ensemble time :	32.4 sec
Ping per ADCP raw data :	8

(4) Preliminary results

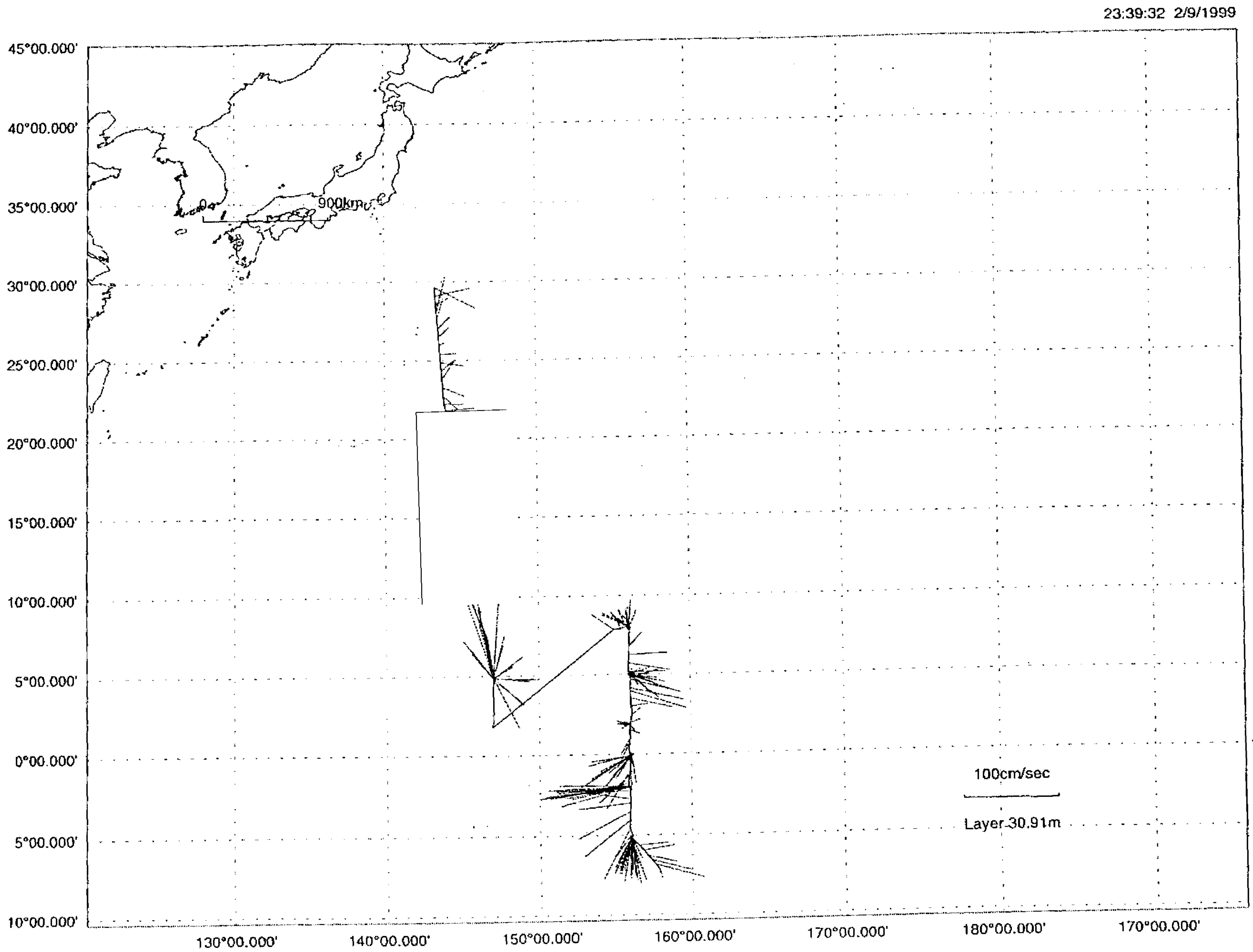
Two-hourly current vectors of 2-hour running mean averaged data are plotted for 30.9m-layer (Fig.6.5-1, Fig.6.5-2), 206.9m-layer (Fig.6.5-3, Fig.6.5-4) respectively. We could not plot whole cruise data in one sheet because of the software limitation.

(5) Remarks

(5-1) From 8 to 10 February, ADCP data was not recorded properly because of the MO disk drive error. The data of this period was not used in the preliminary results.
(5-2) From 18 to 24 February, ADCP data was processed with wrong ship's heading data because of the ship's gyro signal error. The data of this period cannot be used to derive current map.

(6) Data archives

ADCP data obtained in this cruise will be submitted to the DMO (Data Management Office), JAMSTEC and will be under their control.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15°00.000'
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900km
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130°00.000'
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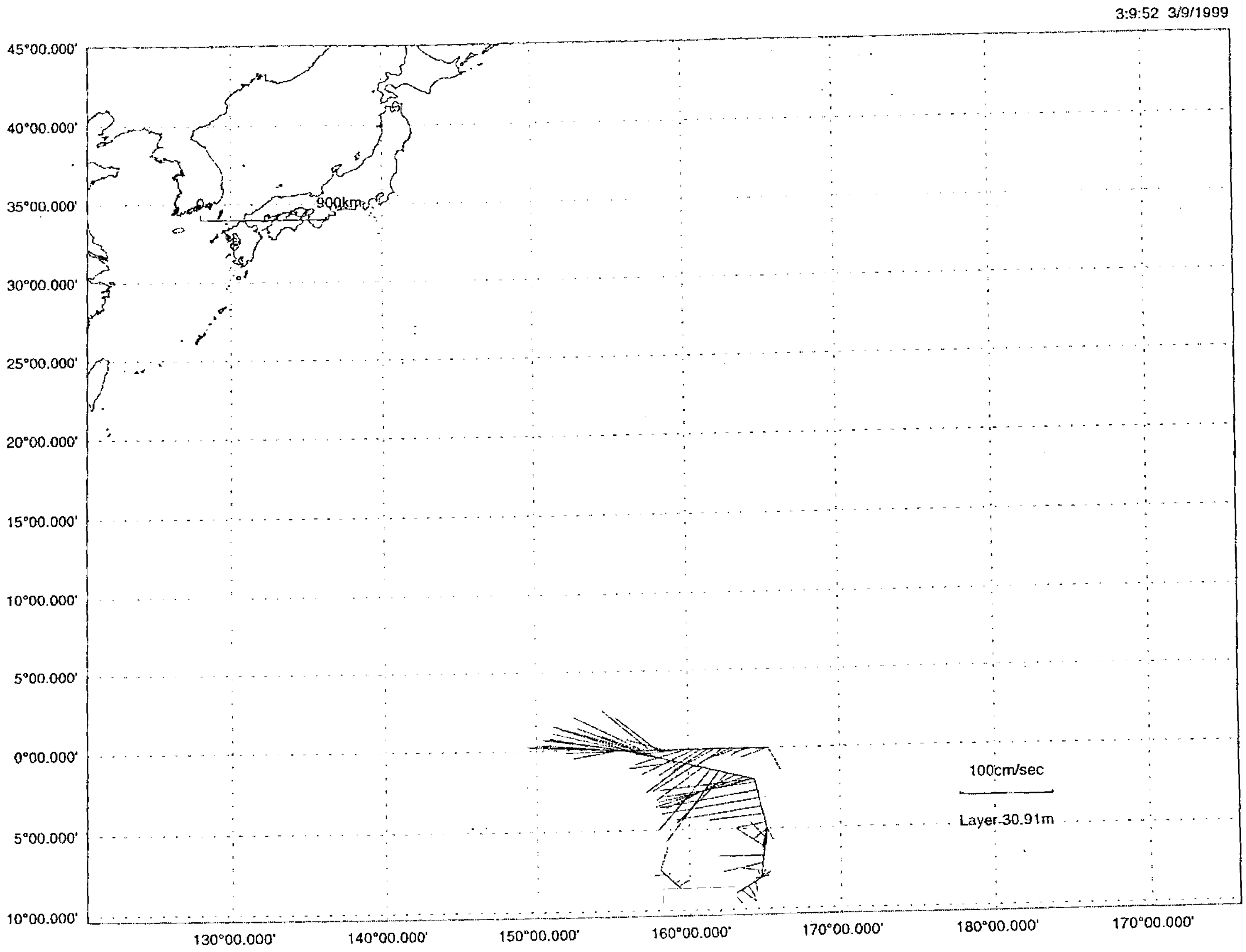
Fig.6.5-1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130°00.000'
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Fig.6.5-2

21:49:21 3/18/1999

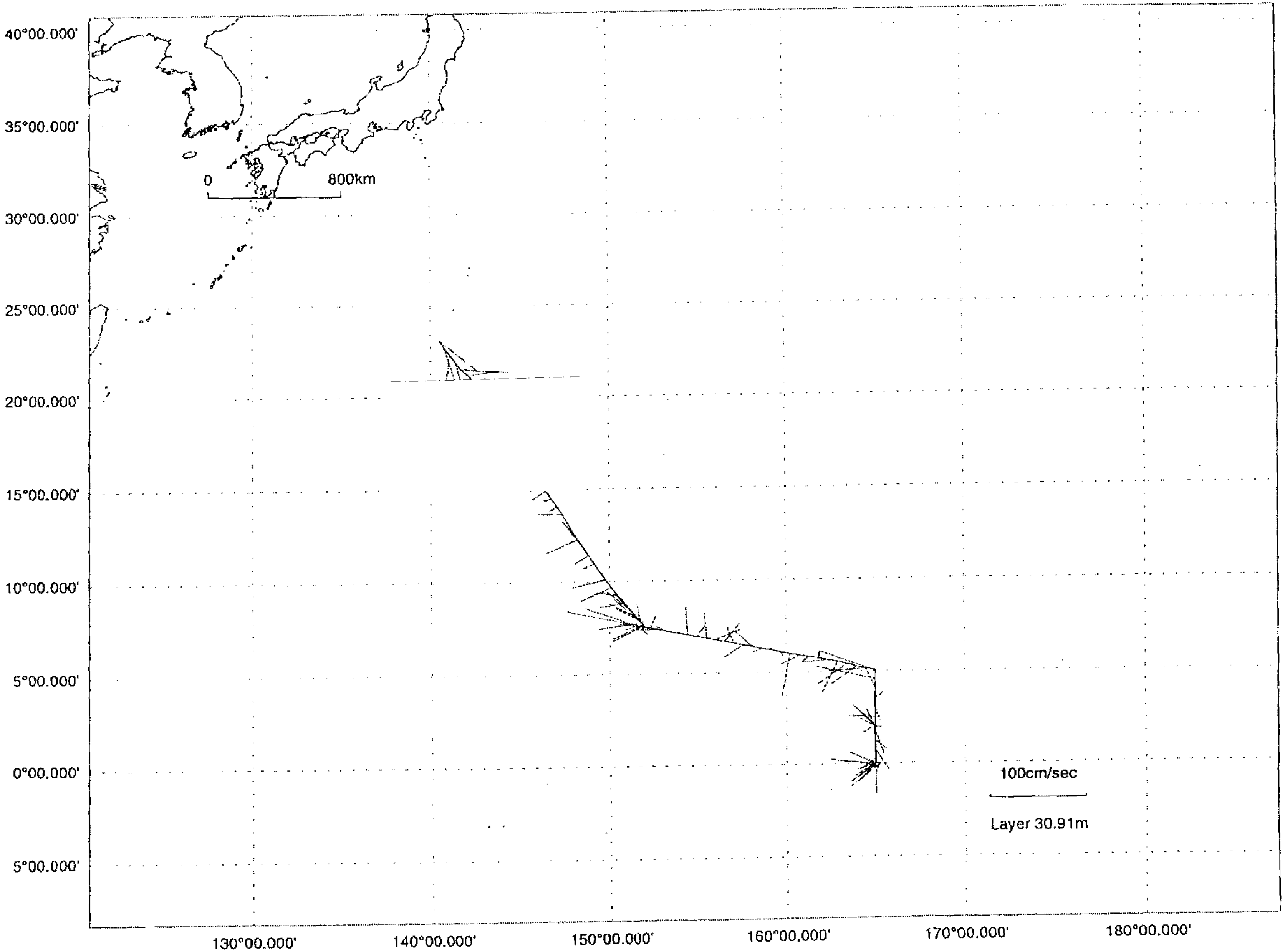

Fig.6.5-3

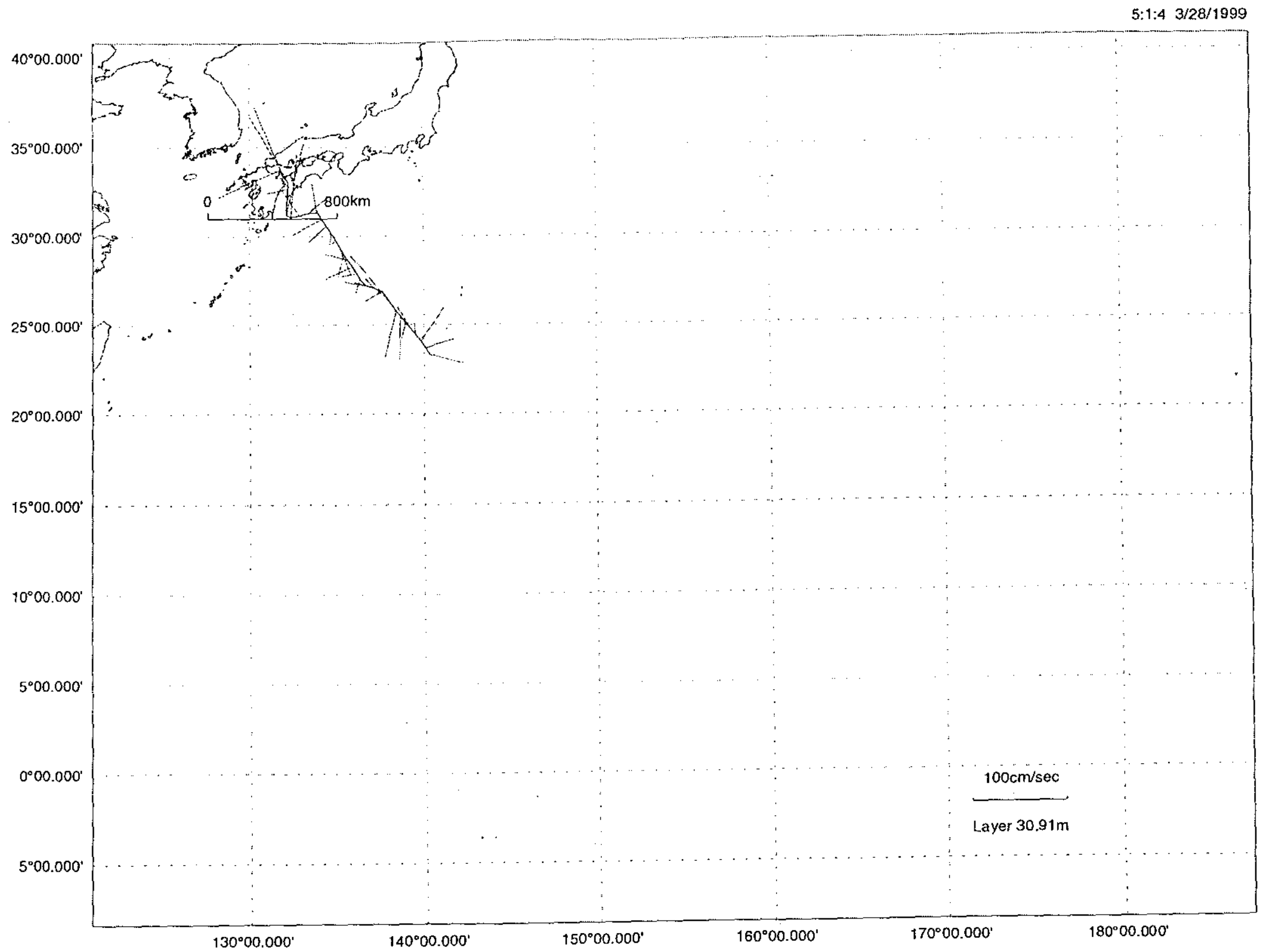
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Fig.6.5-4

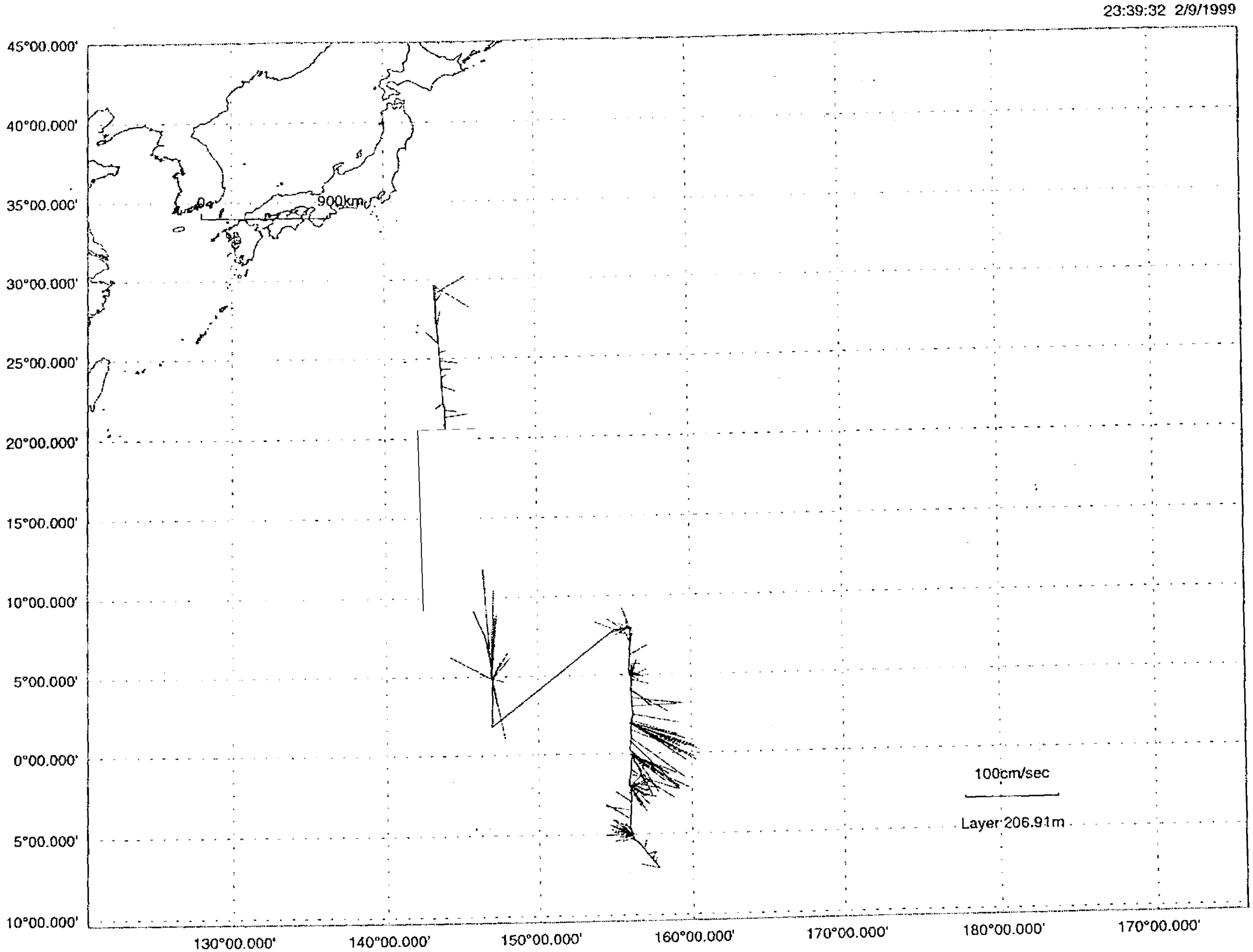
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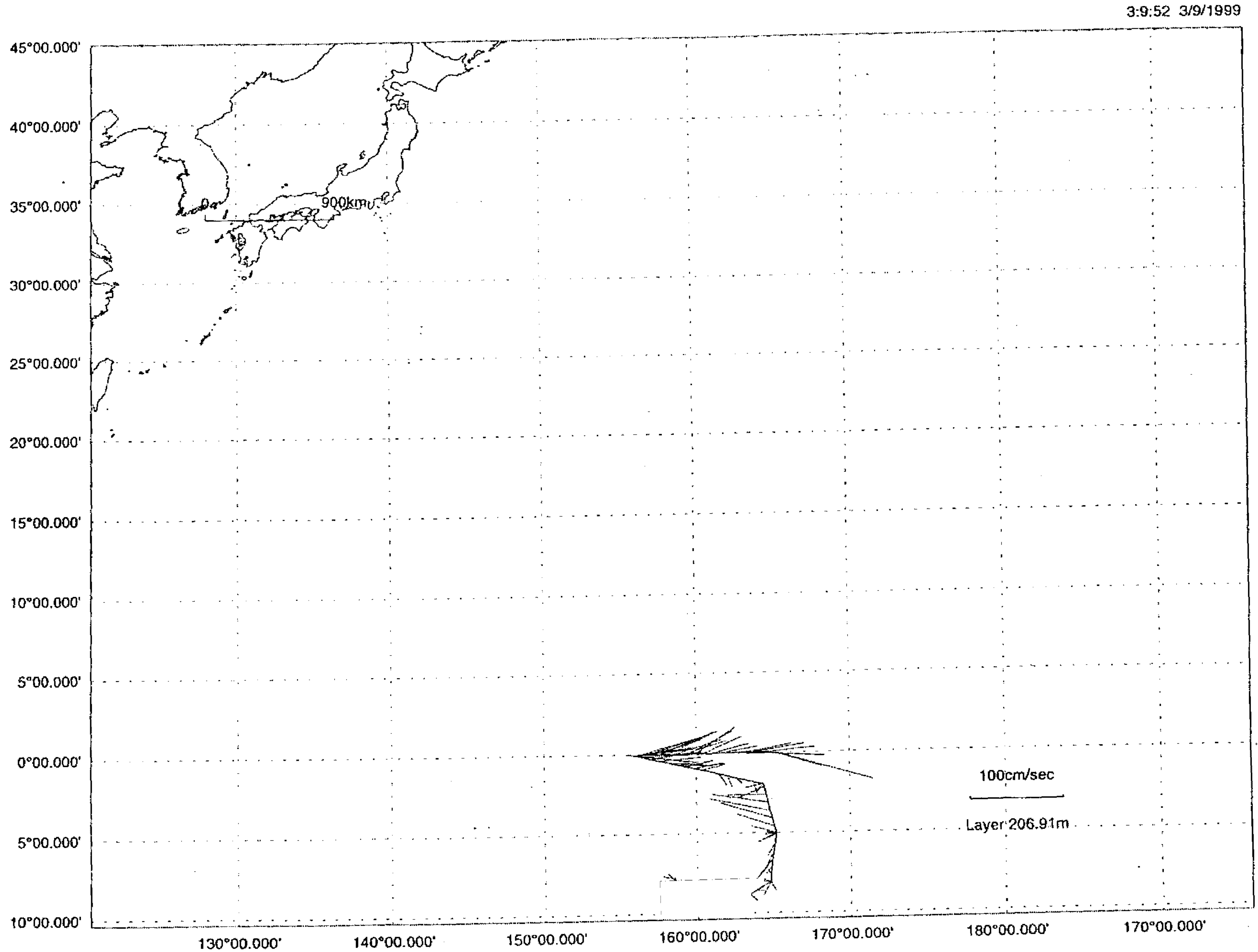
Fig.6.5-5



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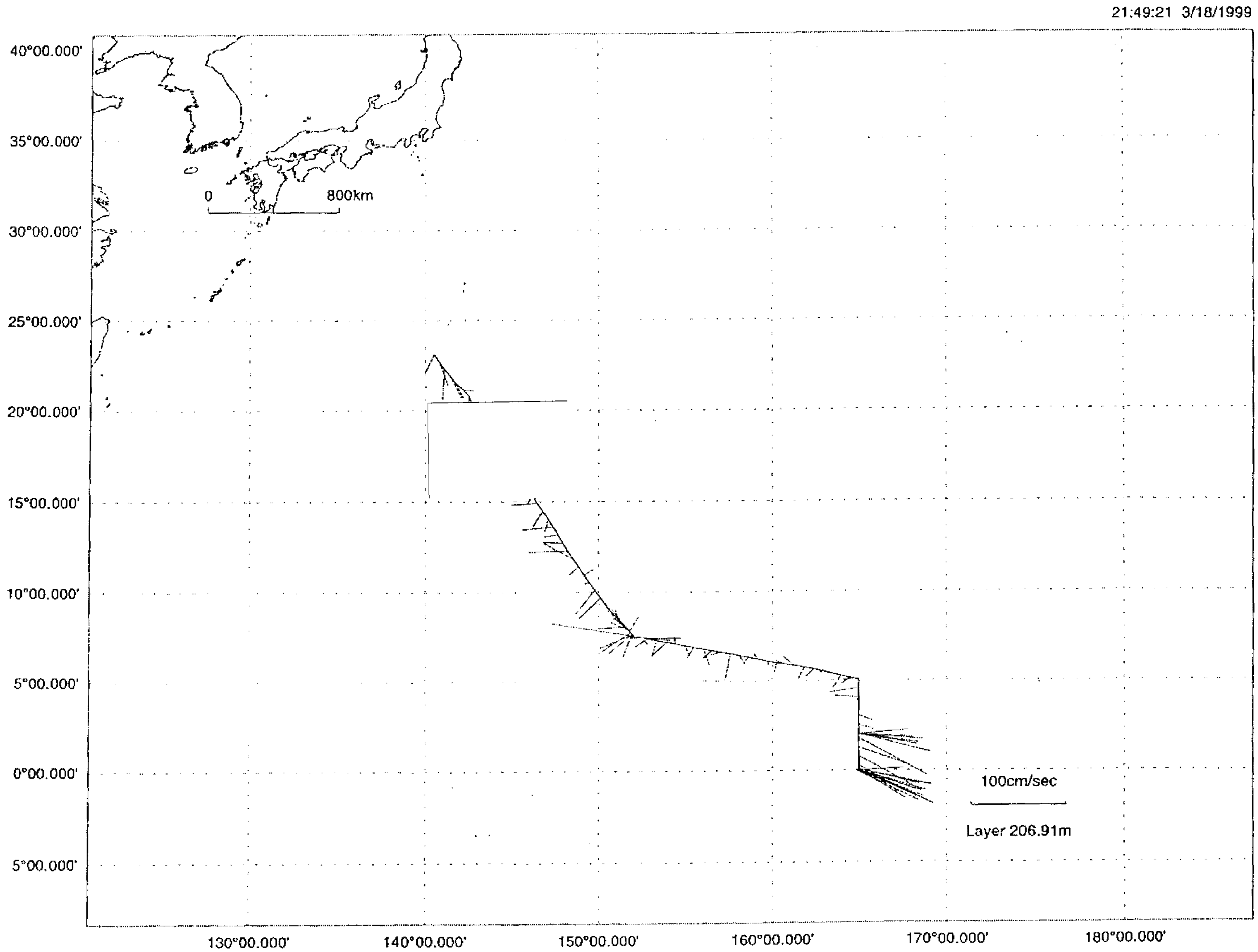
100cm/sec
Layer 206.91m

Fig.6.5-6


21:49:21 3/18/1999
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100cm/sec
Layer 206.91m
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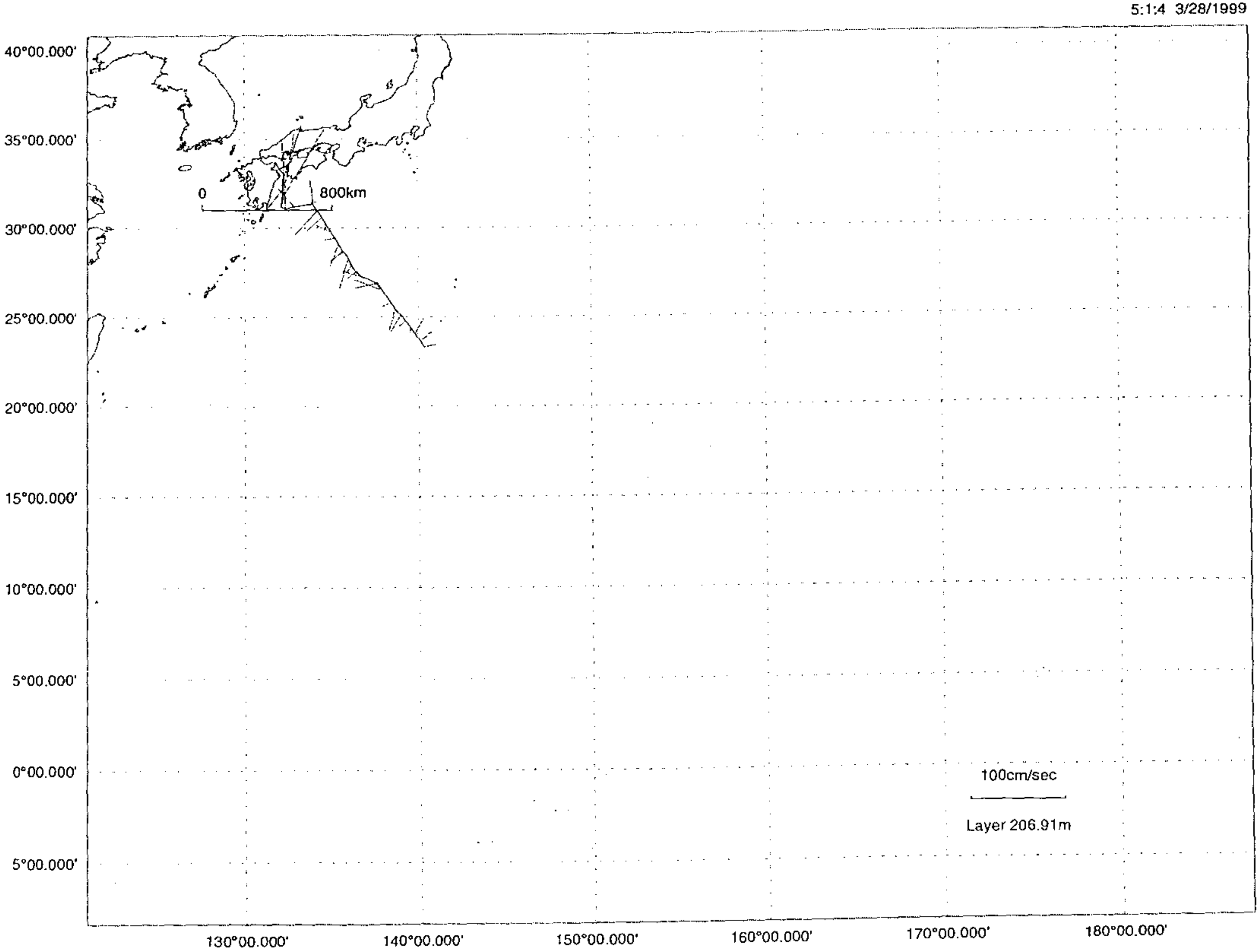
Fig.6.5-7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0
800km
100cm/sec
Layer 206.91m
130°00.000'
140°00.000'
150°00.000'
160°00.000'
170°00.000'
180°00.000'

Fig.6.5-8

6.6 Underway geophysics

6.6.1 Sea surface gravity

(1) Personnel

Toshio Furuta (GODI), Operation leader

(2) Objective

Sea Surface gravity measurement during MR99-K01 cruise using a LaCoste-Romberg gravity meter S-116 installed on the R/V Mirai from Sekinehama to Guam and Chuuk to Shimonoseki, except to EEZs of all foreign countries.

(3) System configuration

The system consists of three components, first is a sensor platform with horizontally stabilized mechanism (two axes of gyros and torque motors), second is a digital control system, and third is a cataloging PC which can record data in 3.5” optical magnetic disk(MO) at every ten second in addition with common navigation information. Data is also sent to the Mirai network server through ethernet LAN system via terminal server.

(4) Method

As system can measure only the relative variation of gravity values, the value were correlated by the absolute or known gravity values at each port (from start to finish of one cruise or leg). Moreover, measured values are corrected based on the bathymetry (free-air) and ship movement (etoveth). Consequently, the corrected gravity data should involve the information of crustal and upper mantle structures how they compensate the discrepancy from isostatic balance.

(5) Data storage:

Media: 3.5” magnetic optical disk (230MB MO)

Place: JAMSTEC Data Management Office

Annex shows the observed values at Sekinehama, Guam and Shimonoseki MHI gravity bases or reference points measured by a Scintrex gravity meter CG-3M, these values were used for correction of sea surface gravity meter at the ports.

6.6.2 Surface three component magnetometer

(1) Personnel

Toshio Furuta (GODI), Operation leader

(2) Objective

In order to continuously obtain the geomagnetic field vectors on the sea surface, a three component magnetometer is a very useful equipment. The magnetic force on the sea is affected by induction of magnetized body beneath the subbottom in addition to the earth dipole magnetic field. The magnetic measurement on the sea is, therefore, one of utilities for geophysical reconstruction of crustal structure and so on. The geomagnetic field can be divided into three components, i.e., two horizontal (x & y)and one vertical (z) moments. Three-component observation instead of total force includes much information of magnetic structure of magnetized bodies.

(3) System configuration

The system is mainly divided into three segments; sensor unit, control and cataloging unit, and gyro and vertical reference unit (VRU). The sensor unit is installed on the top of foremast, the control and cataloging unit in the dry laboratory, and the VRU also in dry lab. The gyro using this system is as same as navigation gyrocompass. A ring laser gyro in the Doppler Radar Meteorology system was used instead of normal VRU, because of high precision

(4) Method

The sensor is a three axes fluxgate magnetometer and sampling period is 8Hz. The timing of sampling is controlled by the 1pps standard clock of GPS signal. Every one second data set which consists of 310 bytes; navigation information, 8 Hz three component of magnetic forces and VRU data were recorded in the external hard disk. The data set is simultaneously fed to the Mirai network server through ethernet LAN system.

(5) Data storage:

Media: 3.5” optical magnetic disk (230MB MO)

Place: JAMSTEC Data Management Office

(6) Results

During MR99-K01 cruise, the magnetic force is continuously measured from Sekinehama to Shimonoseki except the EEZs of all foreign countries. Data obtained on the sea will be analyzed in near future. The procedure of quality control is mainly to eliminate the effect of ship’s magnetized vector condition.

6.6.3 Multi narrow beam echo sounding system

(1) Personnel

Toshio Furuta (GODI), Operation leader

(2) Objective

R/V Mirai has installed a multi narrow beam echo sounding system manufactured by SeaBeam Inc., SeaBeam 2100 system. This system utilized bathymetry mapping and subbottom profiler. The newest one can measure more than 120 degrees wider swath and available all depth of the world ocean floor.

(3) System configuration

The system consists of mainly four segments; under hull unit, controller electronic circuits, real time display unit, and post processing unit. Under hull unit has two projector alleys; one is for 12kHz and another for 4kHz with one hydrophone alley. The hydrophone alley can receive both returning acoustic signals of 12kHz and 4kHz, interleavingly. Main electronic circuits of 12kHz bathymetry and 4kHz subbottom profiler have the individual consoles in which the cpus and dsp boards process receiving signals. The real time display unit consists of three Indy workstations (W/S), two of them are for 12kHz terminal and real time display, and one for subbottom profiling controller. The system has also output devices such as graphic recorders, color printer and color plotter.

(4) Method

Gridding survey in this cruise was carried out at the four buoy deployment sites at 8° N, 5° N, 2°N and equator along 147°E, in addition to six area where the bathymetoric maps had been created during the last cruise of MR98-02. Each area is approximately 100 n.m. square or less, and depth from 5800m to 1500m. The gridding interval being one and half or twice of depth is different depending on their depths. After the gridding survey, the bathymetric data were fed to post processing W/S by ftp command. The post processing system furnished on this MNBES has two high performance W/S Indigo^2 which have “mb-system” software on the basis of the Genetic Mapping Tool (GMT) called SeaView. Consequently, measured data can easily be edited on W/S by automatically or manually to provide gridding data and map images. Finally colored map from A to E size were used to decide to buoy deployment locations.

The bathymetry data gridding on the basis of netCDF format were sent to the network server of Mirai to overprint on the navigation track display.

(5) Data storage

Media: Exabyte tape

Place: JAMSTEC Data Management Office and JODC of Japan Marine Safety Agency

(6) Results

The accuracy seems to be enough to deploy the mooring at any depth. It is, of course, required to keep high accuracy that precise correction of sound speed of the target area can be performed based on the temperature profiles of water column. During this cruise, CTD casts have done at the deployment sites or very close to the sites, we could use the CTD data to derive sound velocity. The newest system has continuously measured the surface water sound velocity in real time, because sound velocity at the hydrophone alley is a very important factor to determine the angle of acoustic ray path which affects the outer beam of wider swath. Unfortunately, the ssv meter had a trouble after half of the cruise, so we input the newest sound velocity data site by site.

Gravity Variations on each Port of R/V MIRAI, MR99-K01 Cruise

KGE,1999.3.31

Station	date	time	G_o	ih	G_c	B-O	G_{abs}	SLH	Draft	G_s
	(JST)		mgal	cm	mgal	mgal	mgal	cm	cm	mgal
Sekinehama JAMSTEC G-Base	1999.2.3	13:26:33	3903.410	46.5	3903.553		**980,368.07**			GODI measured
Sekinehama Port	1999.2.3	13:07:38	3907.158	46.0	3907.300	-3.746	980,371.82			
L & R								262	610	980,372.66
L & R	1999.2.5	9:37:00	12625.900					273	610	980,372.68
L & R	1999.2.13	9:15	10786.200					180	650	978,528.17
Sekinehama-Guam (L & R)			1839.700							1,844.51
Honiara Point Cruz (L & R)	1999.3.11	22:00	10504.300					100	615	
Shimonoseki MHI							**979,674.23**			GODI measured
Sekinehama-Shimonoseki										

Go : Observation Value og Gravity Meter, Gc : Correction of instrumental height, B-O : Gravity Base - Go, Gabs : Absolute G-Values
SLH : Sea Level Height, Gs : Absolute G-Values of Sea Gravity Meter

7. Special Observation

7.1 TRITON moorings

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC):	Principal Investigator
Koichi Takao	(MWJ):	Operation leader
Norifumi Ushijima	(JAMSTEC):	Leader of meteorological sensor validation
Masayuki Fujisaki	(MWJ):	Technical stuff
Hirokatsu Uno	(MWJ):	Technical stuff
Takeo Matsumoto	(MWJ):	Technical stuff
Fuyuki Shibata	(MWJ):	Technical stuff
Jitsuo Tanaka	(MWJ/MHI):	Electronics engineer
Takahiro Kazama	(MWJ):	Technical stuff
Tomohiro Horiuchi	(MWJ):	Technical stuff
Kimiko Nishijima	(MWJ):	Technical stuff
Takehiko Shiribiki	(MWJ):	Technical stuff
Nobuharu Komai	(MWJ):	Technical stuff

(2) Objectives

The 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 has not been well understood. Long term data sets of temperature, salinity, currents, so on are required at fixed locations. In particular, the oceanic change to the winds in the western tropical Pacific is important in that region of origin of El Nino and rain fall over the ocean is also important parameter to study El Nino and Asia-Australian Monsoon. The TRITON program aims to obtain the basic data to improve the predictions of El Nino and variations of Asia-Australian Monsoon system.

TRITON will be 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 in cooperation with France, Chinese Taipei and Japan. 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 nine TRITON buoys have been successfully deployed during this R/V Mirai cruise (MR99-K01), and it was the start of long term measurement in the western tropical Pacific Ocean for the TRITON program.

(3) Measured parameters

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

The TRITON buoys will be recovered one year after and replaced by new buoys. The recovered buoy will be maintained at JAMSTEC Mutsu-Branch where is the mother port of R/V Mirai.

(4) Locations of TRITON Buoys

Nine TRITON buoys have been successfully deployed in the EEZs of Federated States of Micronesia and Papua New Guinea using R/V Mirai. However we must recovered adrifted TRITON buoy at 0,156E. We have also observed that the ATLAS buoys at 8N,156E and 2N,156E lost their wind sensors. The ATLAS buoys will be removed from this region in this year. TAO-ATLAS array in the eastern/central Pacific and TRITON aray in the western Pacific will continuously cover the entire Pacific basin for long-term measurement of El Nino. In order to enable the sustainable measurements, we hope that relevant agencies and institutions alert continually to relevant ships operating in this area to watch the buoys.

TRITON deployed position

Nominal location	5N,147E
ID number at JAMSTEC	07001
Number on surface float	11
ARGOS PTT number	9772
Deployed date	16 February, 1999
Exact location	4 - 51.65N, 146 - 57.50E
Depth	4252 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 7 mile NNE of the TRITON buoy.

Nominal location	2N,147E
ID number at JAMSTEC	08001
Number on surface float	12
ARGOS PTT number	7960
Deployed date	18 February, 1999
Exact location	2 - 04.46N, 146 - 56.59E
Depth	4490 m

Note: There is no ATLAS.

Nominal location	0N,147E
ID number at JAMSTEC	09001
Number on surface float	13
ARGOS PTT number	7961
Deployed date	20 February, 1999
Exact location	0 - 04.51N, 146 - 51.08E
Depth	4310 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 9 mile ESE of TRITON buoy.

Nominal location	8N,156E
ID number at JAMSTEC	01002
Number on surface float	05
ARGOS PTT number	1132
Deployed date	25 February, 1999

Exact location	7 - 57.98N, 156 - 01.87E
Depth	4844 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 7 mile North of TRITON buoy.

Nominal location	5N,156E
ID number at JAMSTEC	02002
Number on surface float	06
ARGOS PTT number	3593
Deployed date	27 February, 1999
Exact location	5 - 01.15N, 155 - 58.09E
Depth	3606 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 6 mile East of TRITON buoy.

Nominal location	2N,156E
ID number at JAMSTEC	03002
Number on surface float	07
ARGOS PTT number	3594
Deployed date	1 March, 1999
Exact location	1 - 54.97N, 156 - 00.13E
Depth	2550 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 5 mile North of TRITON buoy.

Nominal location	0N,156E
ID number at JAMSTEC	04002
Number on surface float	08
ARGOS PTT number	3595
Deployed date	3 March, 1999
Exact location	0 - 05.44S, 156 - 01.95E
Depth	1957 m
Recovered date	16 March, 1999

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 9 mile ENE of TRITON buoy.

This TRITON buoy had drifted accidentally since March 12 09:00 (GMT). We recovered the drifting TRITON surface buoy on March 16 and underwater parts on March 17.

Recovered date	16 March, 1999
Recovered location	0 - 01.32S, 155 - 25.28E

Nominal location	2S,156E
ID number at JAMSTEC	05001
Number on surface float	09
ARGOS PTT number	3779
Deployed date	5 March, 1999
Exact location	2 - 01.03S, 155 - 57.24E

Depth	1754 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 4 mile ENE of TRITON buoy.

Nominal location	5S,156E
ID number at JAMSTEC	06001
Number on surface float	10
ARGOS PTT number	3780
Deployed date	7 March, 1999
Exact location	5 - 03.34S, 156 - 02.98 E
Depth	1507 m

Note: This TRITON buoy is accompanied by an ATLAS buoy which is located about 5 mile NW of TRITON buoy.

(5) Data archive

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


JAMSTEC


TRITON

7.2 Intercomparison between shipboard CTD and TRITON data

(1) Personnel

Masayuki Fujisaki (MWJ): Operation leader
Koichi Takao (MWJ)
Nobuharu Komai (MWJ)
Takehiko Shiribiki (MWJ)
Hirokatsu Uno (MWJ)
Fuyuki Shibata (MWJ)
Takeo Matsumoto (MWJ)
Tomohiro Horiuchi (MWJ)
Takahiro Kazama (MWJ)
Kimiko Nishijima (MWJ)

(2) Objectives

TRITON CTD data validation.

(3) Measured parameters

- Temperature
- Conductivity
- Pressure

(4) Methods

We used the same CTD system with general CTD observation. We conducted 3 CTD casts at each TRITON buoy site. The first cast was perfomed immediately after the deployment, the second was 12 hours after and the third was 24 hours after.

(5) Results

Temperature : There are good agreement CTD data and underwater sensors of Triton buoys at each casts.
Conductivity : There are good agreement CTD data and underwater sensors of Triton buoys at each casts.
Salinity : There are good agreement CTD data and underwater sensors of Triton buoys at each casts. The data will be examined more closely using T-S relation diagram.

(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 JAMSTEC Mutsu brunch.

7.3 Intercomparison of surface meteorology and current data between TRITON buoy and R/V Mirai

(1) Personnel

Norifumi Ushijima (JAMSTEC): Principal Investigator
Masaki Hanyu (GOJI): Shipboard measurements
Hirokatsu Uno (MWJ): Assembling meteorological sensors on albedo boom at the bow

(2) Objectives

Data of TRITON buoys is expected to improve the capability of El Nino prediction and daily weather forecast. For that purpose, it is important to provide qualified data. The shipboard meteorological observation in this report aims to obtain the data for TRITON buoy data validation. During this R/V Mirai cruise (MR99-K01), shipboard meteorological measurements were carried out for 24 hours after each deployment of TRITON buoy.

(3) Measured parameters

TRITON buoy:	wind speed, wind direction, air temperature, relative humidity, precipitation, solar radiation, atmospheric pressure, current speed, current direction.
R/V Mirai:	wind speed, wind direction, air temperature, relative humidity, precipitation, solar radiation, atmospheric pressure, current speed, current direction.

(4) Methods

Location, sampling interval and data analysis are as follows.

TRITON buoy:	•sampling interval	10min. (except precipitation) continuous (precipitation)
	•data analysis	hourly averaged (except precipitation) 1-hour total precipitation (precipitation)
Mirai: (automatic observation)	•location	albedo boom at the bow (wind vane/anemometer, thermometer, hygrometer, pyranometer) Weather observation room on the captain deck (resonator digital barometer) Top of the fore mast (wind vane/anemometer) Compass deck (thermometer, hygrometer) Top of the main mast (pyrometer) Roof top on the anti rolling system room, which is as almost same as compass deck level (rain gauge) bottom of the ship (Doppler sonar)
	•sampling interval	1 min.
	•data analysis	hourly averaged hourly total precipitation (precipitation)

(5) Results

•Wind speed

The height of wind vane on TRITON buoy was different from that at the albedo boom of R/V Mirai (TRITON buoy: 3.5m, albedo boom: 10.0m, above the sea surface). So, wind speed obtained at the albedo boom was generally larger than at TRITON buoy.

During 24-hour observations, R/V Mirai drifted and kept her head to the wind, and also to keep the ship position within 5-nautical mile from the TRITON buoy. Because of the current and wind, R/V Mirai should return to the first position by about 10 knots every 5-6 hours. Although measured wind speed would be affected by ship speed and course angle in all cases, the wind speed data at TRITON buoy showed similar values at the albedo boom at bow.

・Wind direction

In most cases, averaged difference was from 20 to 30 degrees between TRITON and the albedo boom data.

For verification of the data at albedo boom, we compared the wind direction at foremast of R/V Mirai and albedo. They showed almost the same wind direction.

・Air temperature and relative humidity

The height of thermometer and hygrometer on the TRITON buoy was different from that of thermometer and hygrometer at albedo boom (TRITON buoy: 2.2m, albedo boom: 9.8m, above the sea surface). So, air temperature and relative humidity at albedo boom were generally lower than those on TRITON buoy.

The air temperature and relative humidity on TRITON buoy showed similar time change at albedo boom. The temperature differences between TRITON and albedo data were about 0.2-0.3 degree C. There was a case of which albedo temperature was a little higher than TRITON temperature, when the wind weakened and the time was in the middle of the daytime. It may be caused by ship heating. Generally, the temperature change was small, but temperature dropped occasionally 0.5 - 2 degree C associated with rainfall.

In most case, the relative humidity on TRITON was about 2-3% higher than that at albedo boom, except 0N-156E where the albedo data was 7-8 % higher than the TRITON data. For verification of the data at albedo boom, we referred relative humidity at compass deck of R/V Mirai. They showed the almost same time change, although the data at compass deck was lower than that at the albedo boom because of height difference. The time change of relative humidity was generally small, but humidity also dropped occasionally about 5% associated with rainfall.

・Precipitation

Time change of precipitation was almost similar between the data on TRITON and R/V Mirai. But the amount of precipitation on TRITON was much smaller than that on R/V Mirai. The reason was not clear now, further investigation will be necessary.

The effect of rainfall to temperature and relative humidity was clear as above.

・Solar radiation

Solar radiation on TRITON buoy showed almost same value comparing with that at albedo boom except in the rainy periods or cloudy periods when the measurements may be affected by small scale cloud movement.

・Atmospheric pressure

The height of resonator digital barometer on TRITON buoy was different from the height of resonator digital barometer on R/V Mirai (TRITON buoy: 2.0m, captain deck: 13.4m, above the sea surface). Then the observed pressure on R/V Mirai was adjusted to the pressure at mean sea level. As a result of correction to mean sea level, the pressure on TRITON buoy showed almost same value.

・Current speed and current direction

Current speed and current direction data obtained from TRITON at 10m depth and Doppler sonar at 8 m depth on R/V Mirai were hourly averaged. The differences were small between the data on TRITON buoy and on R/V Mirai.

(6) Data archive

All data will be archived at JAMSTEC Mutsu Branch by member of TRITON Project Team.

(7) Remarks

We will carry out further analysis.

We will calculate momentum, sensible heat and latent heat fluxes to check data of wind speed, air temperature and relative humidity more precisely.

7.4 Doppler radar observation

(1) Personnel

Masaki Hanyu (GODI): Operation Leader
Fumitaka Yoshiura (GODI)
Toshihiko Yano (JAMSTEC)

(2) Objectives

The shipboard Doppler radar is to investigate the precipitation mechanism in convective clouds which develops over the ocean. In addition, rainfall map would be produced to contribute to the fresh water budget in the tropical western Pacific Ocean.

(3) Parameters

Radar reflectivity (dBZ), which usually translated into rainfall rate (mm/hr) using Z-R relation equation, is measured within 200km range as Intensity mode.

Radar reflectivity and radial velocity (m/s) of precipitation particles are measured within 100km range as Doppler mode.

(4) Methods

Doppler radar operation consists of three operational mode; PPI (Plan Position Indicator, which measure the precipitation at one angle), CAPPI (Constant Altitude PPI, which measure the precipitation at constant altitude changing radar antenna elevation), and RHI (Range Height Indicator, vertical cross section at constant azimuth).

Major specification of the Doppler radar is as follows;

Type :	RC-52B (Mitsubishi Electric Co. Ltd., Japan)
Frequency :	5290MHz
Beam Width :	Better than 1.5 degrees
Output Power :	250kW (pep)
Signal Processor :	RVP-6 (Sigmet, Inc., U.S.A.)
Application S/W :	IRIS/Open (Sigmet, Inc., U.S.A.)
Inertial navigation unit :	DRUH (Honeywell, Inc., U.S.A.)

• Radar task configuration

One sequence of Doppler radar tasks consisted of intensity mode PPI-scan and Doppler mode volume-scan. This about 7.5-minute sequence was operated continuously in the operational area except for the time of radar check..

The parameters of intensity mode PPI-scan were as follows;

Pulse Width :	2 μs
Elevation :	1 angles (0.7)
Scan Speed :	18 deg/sec
PRF :	260 Hz
Max Range :	200.0 km
Resolution :	1.0 deg
Bin Spacing :	250.0 m
Range Averaging :	None
Filter :	None
Gain Control :	Fixed

The parameters of Doppler mode volume-scan were as follows;

Pulse Width :	0.5 μs
Elevation :	18 angles (0.0 0.7 1.4 2.1 2.8 3.6 4.6 5.8 7.2 8.8 10.6 12.6 14.8 18.0 22.0 27.0 32.0 40.0)
Scan Speed :	18 deg/sec
PRF :	720/900 Hz
Max Range :	100.0 km
Resolution :	1.0 deg
Bin Spacing :	125.0 m
Range Averaging :	None
Filter :	None
Gain Control :	Fixed

・Calibration

Mean power [dBm] of the radar output was measured every operational day by Hewlett Packard 435B power meter. Transmitting pulse width and pulse repetition frequencies (PRF) were measured 6 times during the cruise using Hewlett Packard 54600B oscilloscope. Radar peak output power in dBm is;

(Peak output power) = (Measured mean power) – 10Log(Pulse width x PRF) + (coupler loss)

where (coupler loss) = 50.6 dB from the radar manufacturer

Results of radar peak output power during this cruise is shown in Fig.7.4-1.

Receiver linearity was checked 5 times during this cruise using Hewlett Packard 83732B synthesized signal generator and IRIS/Open zauto utility. Slope dB/AD were varied from 0.3233 to 0.3272 for 2μs, 0.3257 to 0.3274 for 0.5μs.

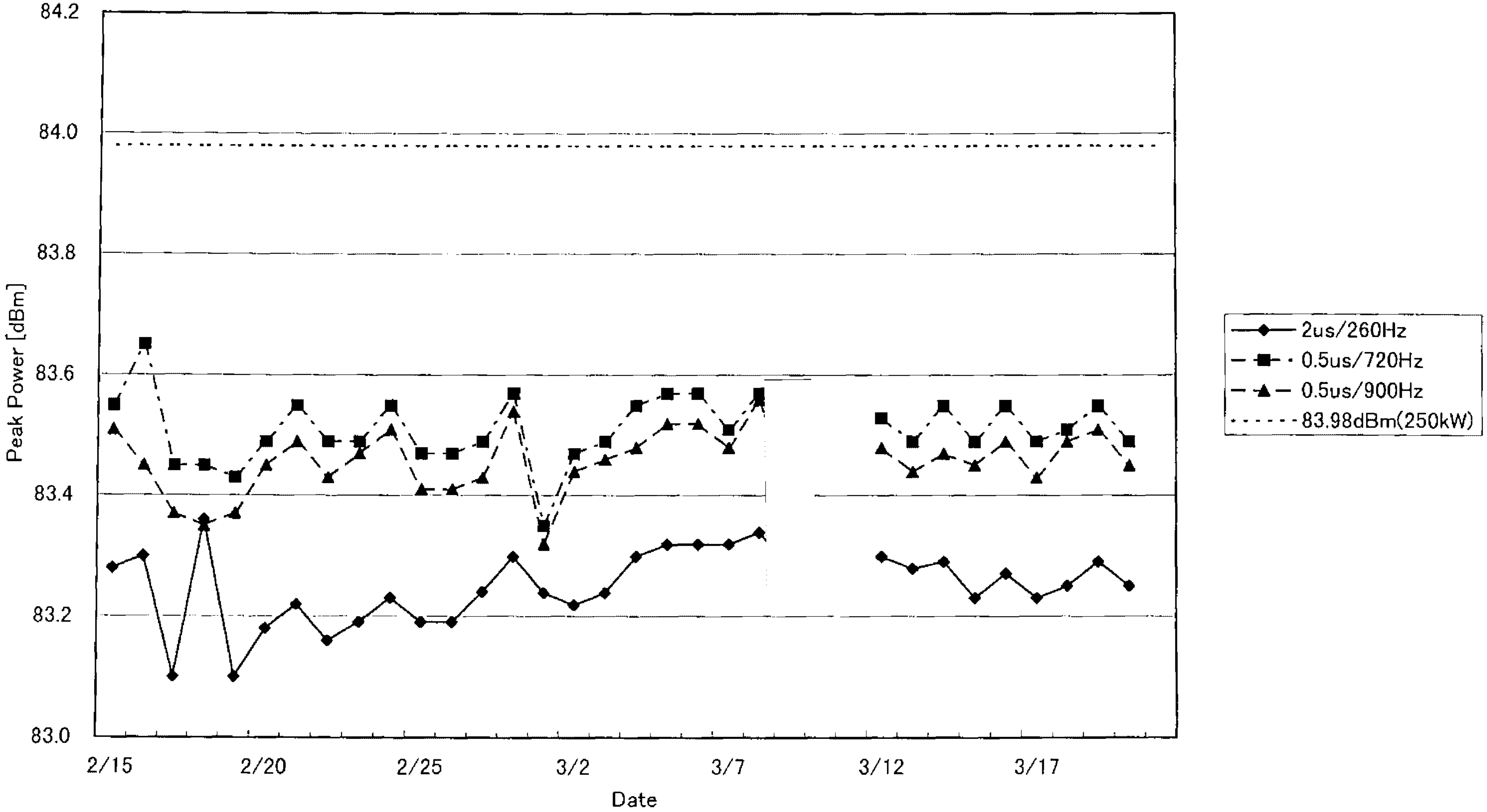
(5) Preliminary results

Examples of radar echo images are shown on the following pages.

(6) Data archives

The inventory information of the Doppler radar data obtained in this cruise will be submitted to the DMO (Data Management Office), JAMSTEC. The original data will be archived by members of the Air-Sea Interaction Project team at JAMSTEC. Contact person is Kunio Yoneyama

Fig.7.4-1 MR99-K1 Doppler Radar OBS



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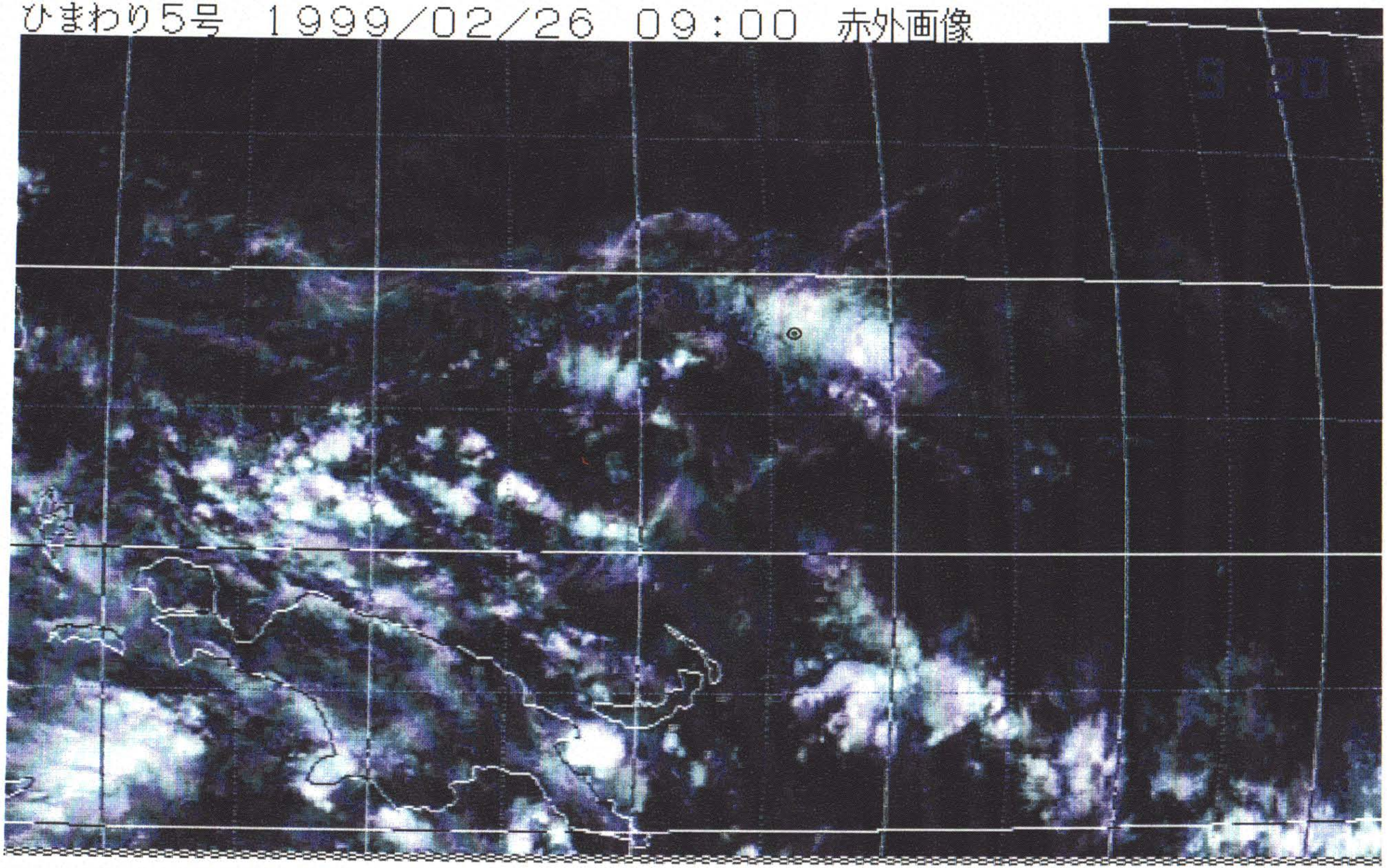

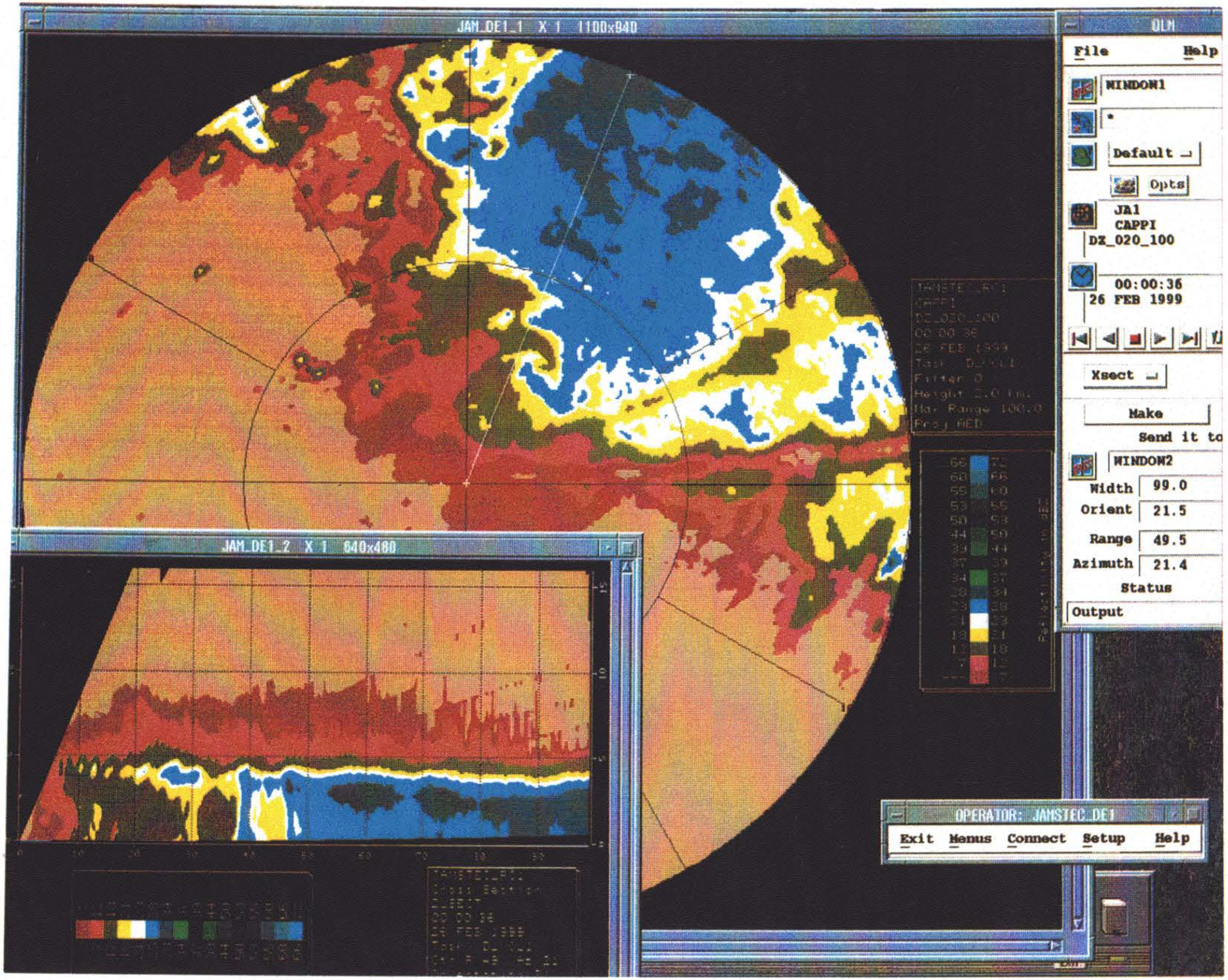
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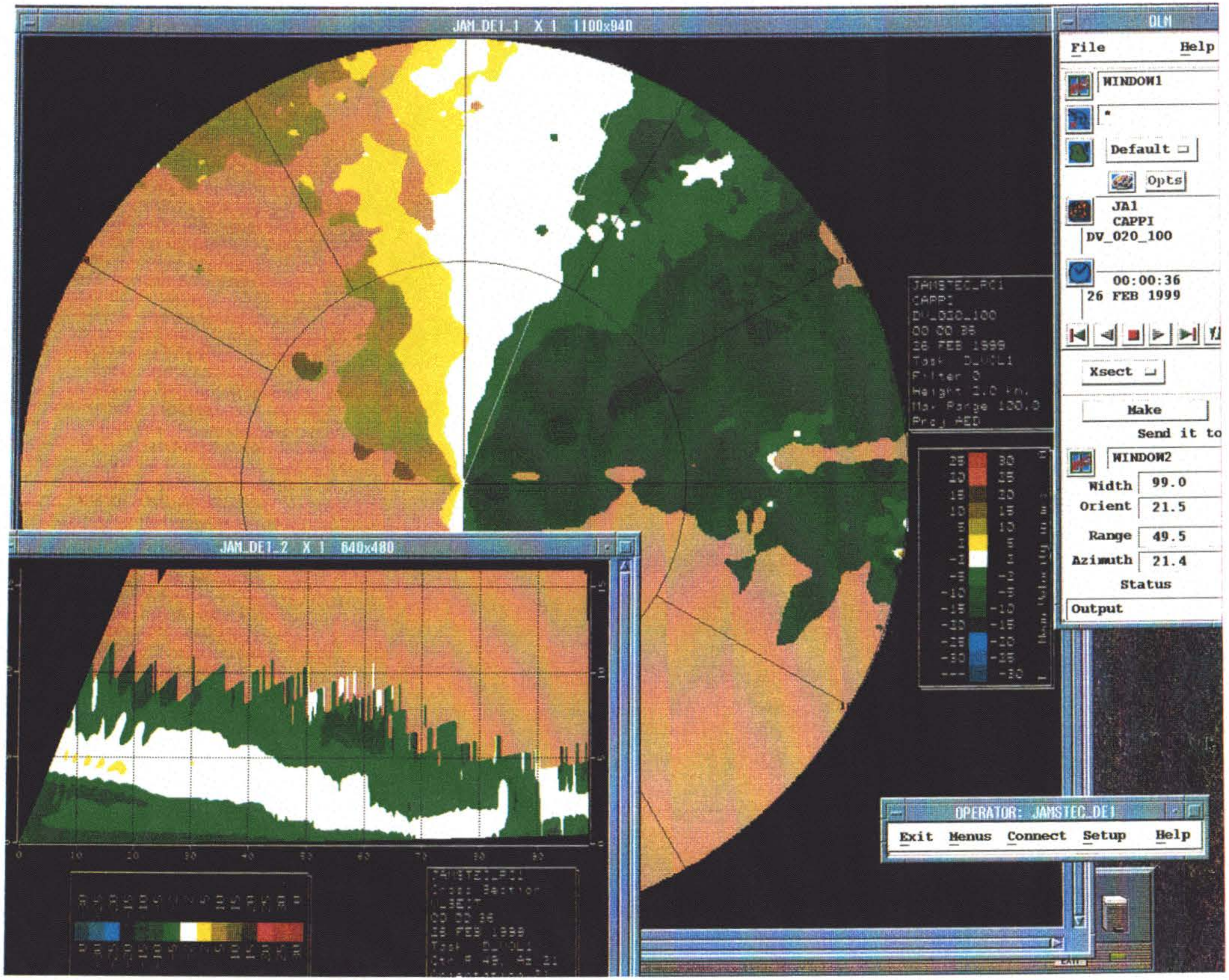

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Range 49.5
Azimuth 21.4
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OPERATOR: JAMSTEC_DEI
Exit Menus Connect Setup Help

7.5 Atmospheric and oceanic CO_2 measurements

(1) Personnel

Hisayuki Yoshikawa Inoue[1] , Masao Ishii[1] and Takashi Harimoto[2]

[1] Geochemical Research Department,
Meteorological Research Institute (MRI),

[2] Ocean environmental survey Team,
Environmental Chemistry Dept.,
Kansai Environmental Engineering Center Co.,Ltd.

(2) Objectives

Carbon dioxide (CO_2), known as a major greenhouse gas, has been increasing in the atmosphere as a result of the anthropogenic emission. Its current global mean concentration is approximately 30% larger than that in the pre-industrial era (280ppm). In order to predict the atmospheric CO_2 level in the future, it is necessary to understand the processes which are controlling the fluxes among the global carbon reservoirs: the atmosphere, the terrestrial biosphere and the ocean, as well as to estimate the present CO2 inventory among these reservoirs.

The difference in CO_2 partial pressure (pCO_2) between the sea surface and the marine boundary air (ΔpCO_2) is a driving force for the CO_2 exchange between the ocean and the atmosphere. The temporal and spatial variability of pCO_2 in surface seawater is thought to be playing an important role for the variability of the atmospheric CO_2 growth rate. The equatorial Pacific is known to act as a source of CO_2 to the atmosphere due primarily to the equatorial upwelling in the central and the eastern zones. Its flux has been reported to exhibit a significant interannual variability that is associated with the ENSO event. However, the temporal and spatial variations in ΔpCO_2 enough to deduce the interannual variation in CO_2 outflux from the whole equatorial zone has not been well documented.

Partial pressure of CO_2 in seawater is governed by the carbonate system in seawater. It is expected that total inorganic carbon (TCO_2; the sum of the concentrations of hydrate carbon dioxide, carbonic acid, bicarbonate, and carbonate) in the upper water column in the equatorial Pacific also exhibits pronounced temporal and spatial variability as a result of the changes in meteorological, ocean-physical, and biological conditions including upwelling, extension of the warm water pool, biological production, and air-sea CO_2 exchange.

(3) Parameters

pCO2: CO_2 in surface seawater and in the marine boundary air, Water temperature, pressure.
TCO2: Total inorganic carbon in surface seawater

(4) Methods

We made measurements of the CO2 concentration (mole fraction of CO2 in air; χCO2) in marine boundary air (twice every about 1.5 h) and in air equilibrated with surface seawater (five times every about 1.5 h) using the χCO2 measuring system in the surface seawater monitoring laboratory. Seawater was taken continuously from the seachest and was introduced into the MRI-shower-type equilibrator.

We used non-dispersive infrared (NDIR) gas analyzer (BINOS 4) and four CO2 standard gases (265, 311, 357, 400 ppm in Leg 1 and Leg 4 ; 311, 357, 400, 446 ppm in Leg 2 and Leg 3 ; Nippon Sanso Co.) to determine the CO2 concentration. Concentration of CO2 will be published on the basis of the WMO X85 mole fraction scale after this cruise. Corrections for the temperature-rise from the seachest to the equilibrator and drift of CO2 concentration in standard gases are also to be made. Partial pressure of CO2 will be calculated from χCO2 by taking the water vapour pressure into account.

We made underway measurement of TCO2 in surface seawater using the coulometric TCO2 measuring system in the surface seawater monitoring laboratory. Seawater was taken continuously from the seachest and was introducted into the system. A portion of the seawater (～30cm3) was taken into a pipette twice every 1.5 hrs, and its TCO2 was automatically analyzed. We also analyzed TCO2 in Reference Seawaters we prepared in MRI (batch L; 1950.2±1.6 μmol/kg and batch M; 1967.0±1.1 μmol/kg) which is traceable to the CRM provided by Dr. Dickson in Scripps Institute of Oceanography at least once during the each run of the system.

(5) Results

Data analyses have not been completed, because all data will need the calibration after this cruise. Hence we only shown the preliminary results (Fig.1 and Fig.2).

In December 1997 during the period of the strong ENSO event, the western equatorial Pacific to the west of the date-line had been covered with less-saline warm water, and CO2 partial pressure in surface seawater was comparable to that in the marine boundary air.

In this cruise, however, surface seawater in the same region was highly supersaturated with CO2 (xCO2 in surface water reached 430 ppm) due to the enhanced equatorial upwelling and the westward retreat of warm water-pool. CO2 flux from the ocean to the atmosphere from the equatorial Pacific, though not evaluated yet, is expected to be much larger than in the periods of ENSO event and may have a significant effect on the atmospheric CO2 growth-rate.

(6) Data archive

The original data will be archived at Geochemical Research Department at MRI. The data will be also submitted to the DMO at JAMSTEC within 3 years.

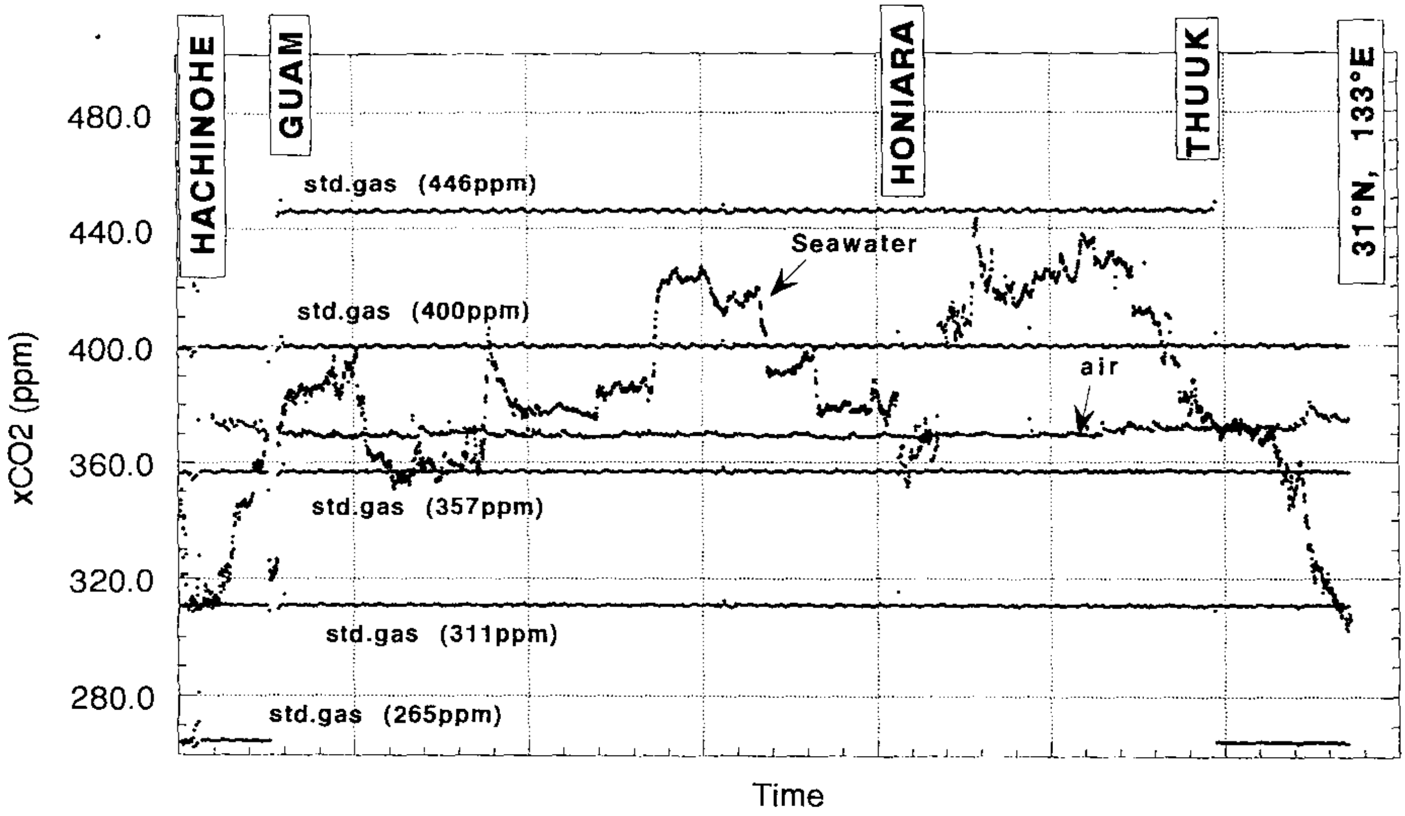

Fig. 1 Distribution of xCO_2 surface seawater and in marine boundary air (selected preliminary data)

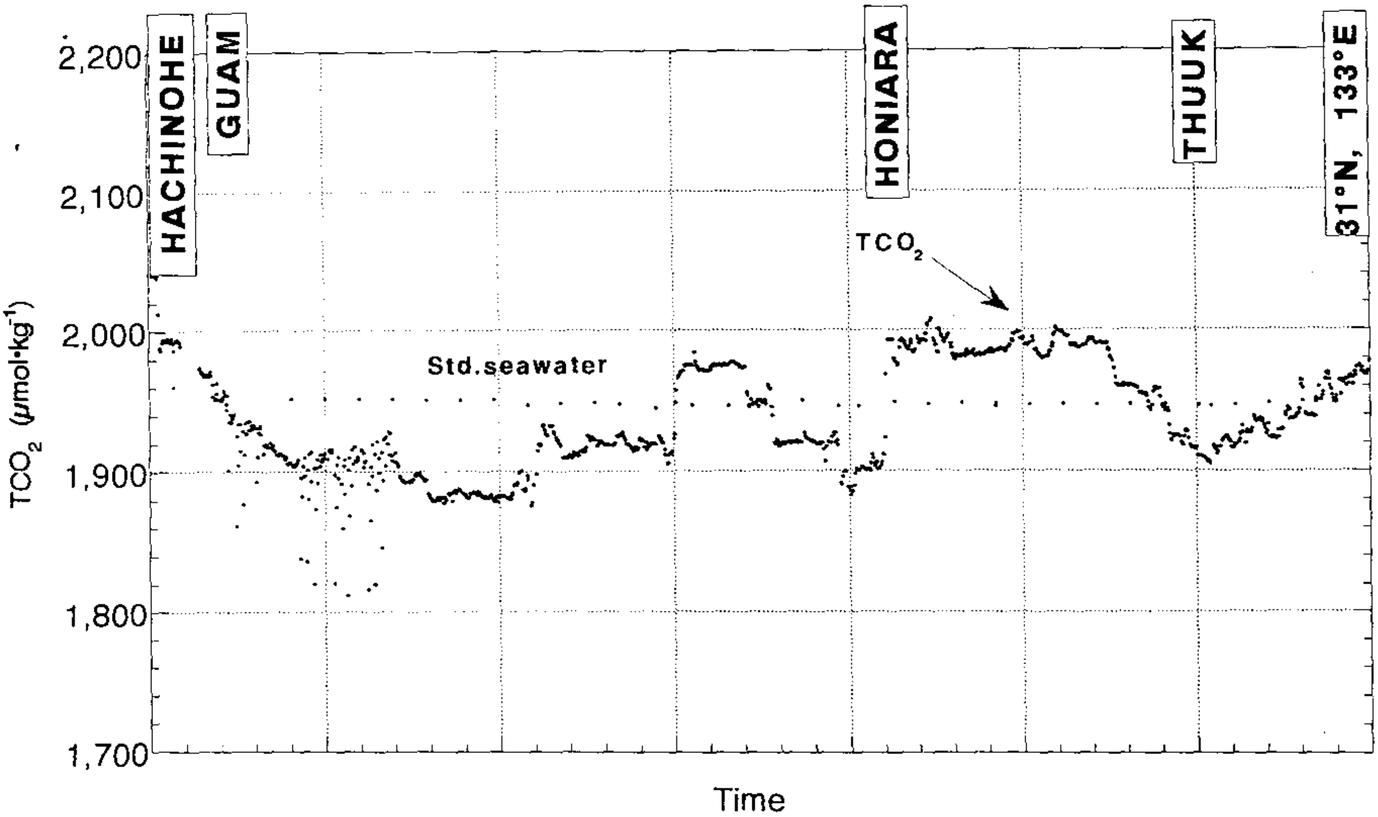

Fig. 2 Distribution of TCO_2 in surface seawater (preriminary data)

7.6 Shipborne backscattering lidar experiments in the Western Pacific region

(1) Personnel (* indicates on board personnel)

Kazuhiro Asai* (T.I.T. : Tohoku Institute of Technology)
Nobuo Sugimoto (NIES : National Institute of Environment Studies)
Ichiro Matsui* (NIES : National Institute of Environment Studies)
Isao Tamamushi* (T.I.T. : Tohoku Institute of Technology)
Tetsuya Sugata* (T.I.T. : Tohoku Institute of Technology)

(2) Objectives

The aerosols associated with human life are trapped within the PBL (Planetary Boundary Layer) located between at a few hundred meter and at around 2km. Troposphere aerosols play an important role in the meteorological situations, such as air-pollution, radiation balance and product of the clouds. The earth's radiation balance also is strongly under the influence of the quantity variation and the height distribution of clouds. Especially, cirrus clouds located in the high troposphere have been remarked for the reason that ones have a warming effect for the earth. Thus, it is important to observe the PBL, aerosols and clouds over the ocean in order to make clear the climate change and the interaction between the atmosphere and the ocean. Those observed data are also useful as the fundamental data for the spaceborne lidar developing by NASDA[1)]. The lidar observations on R/V Mirai are expected to provide the interesting and the valuable data about above mentions.

(3) Measured parameters

PBL:	height.
Troposphere aerosols :	density distribution , depolarization, backscatter coefficient.
Clouds :	height of cloud bottom, depolarization, backscatter coefficient, optical depth.

(4) Method

• lidar system.

The shipborne mie backscattering lidar transmitter is Nd:YAG laser operating at two wavelengths(1064nm and 532nm) and repetition frequency 10Hz. Backscattered signals are received by the telescope with 0.28m diameter, and separated into each wavelength by optical filters. Furthermore, these are divided into the normal and parallel component for the polarization of the transmitted signals by polarizer, and detected. For Detection, APD for 1064nm, PMT for 532nm is used, respectively. Moreover, the clinometer is introduced to measure the pitching and rolling angles, which are necessary for approximation of altitude and understanding of angle dependence of backscattering. The whole system is installed into a air-conditioned marine container equipped on the deck of R/V Mirai.

• sampling.

1 data set consists on 300 data that each contains information of the pitching angle, the rolling angle and signal data for all components. Sampling interval is 20min per 1 data set.

• monitoring.

The height to intensity (A-scope) of received signals is always monitored. The Time to Height Indication (THI) of received signals also is done.

• analysis.

Height is showed by THI. The depolarization is obtained as the parallel component to the normal one ratio. The backscatter coefficient is obtained by solving the lidar equation with the some estimated parameters.

(5) Results

It is illustrated in Fig. 1 that data profiles collected on the 25th of February 1999. Shades of color are corresponding to received signal intensity. The blanks show sleeping time of observations. High intensity layers between 0 and 1 km indicate the existence of troposphere aerosols within the PBL.

Some phenomena that high intensity layer appeared between 2 and 4 km as decrease of aerosols within the PBL are found (for example, between 12:20 and 13:20, or 16:20 and 17:00). These layers may be water vapor. Furthermore, these layers rise and change to clouds. It may be that such phenomena mean the generation of clouds. We should make the research in terms of the geophysics.

Various parameters will be made clear with taking into account of position (latitude, longitude), speed, pitching and rolling of the ship.

(6) Data archive

All data will be archived at T.I.T. and NIES.

(7) Other remarks

We will not only get the parameters of the atmosphere, but also estimate the backscatter coefficient at 2 μm, of which is the operation wavelength of spaceborne coherent Doppler lidar, using the extrapolation. Moreover, we are planning to equip in a container with the 2 μm coherent Doppler lidar.

(8) References

1. Toshikazu Itabe, Kohei Mizutani, Mitsuo Isizu and Kazuhiro Asai; Technical Digest of The 10th Coherent Laser Radar Conference (Mount Hood, Oregon, 1999)

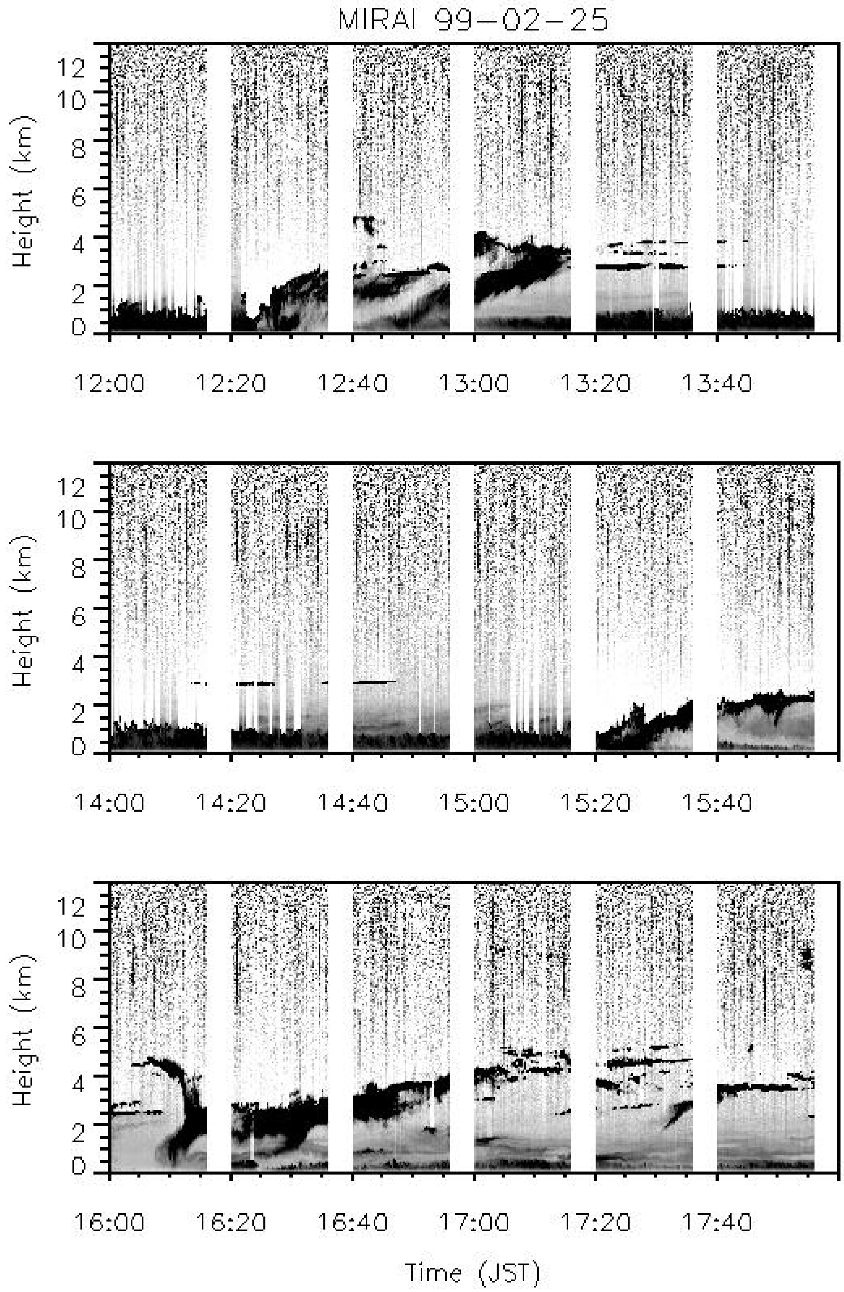

Fig.1(a) Time to height indication of the backscattered signal of troposphere aerosols and clouds obtained at 25 February 1999 between 12:00 and 18:00 JST .

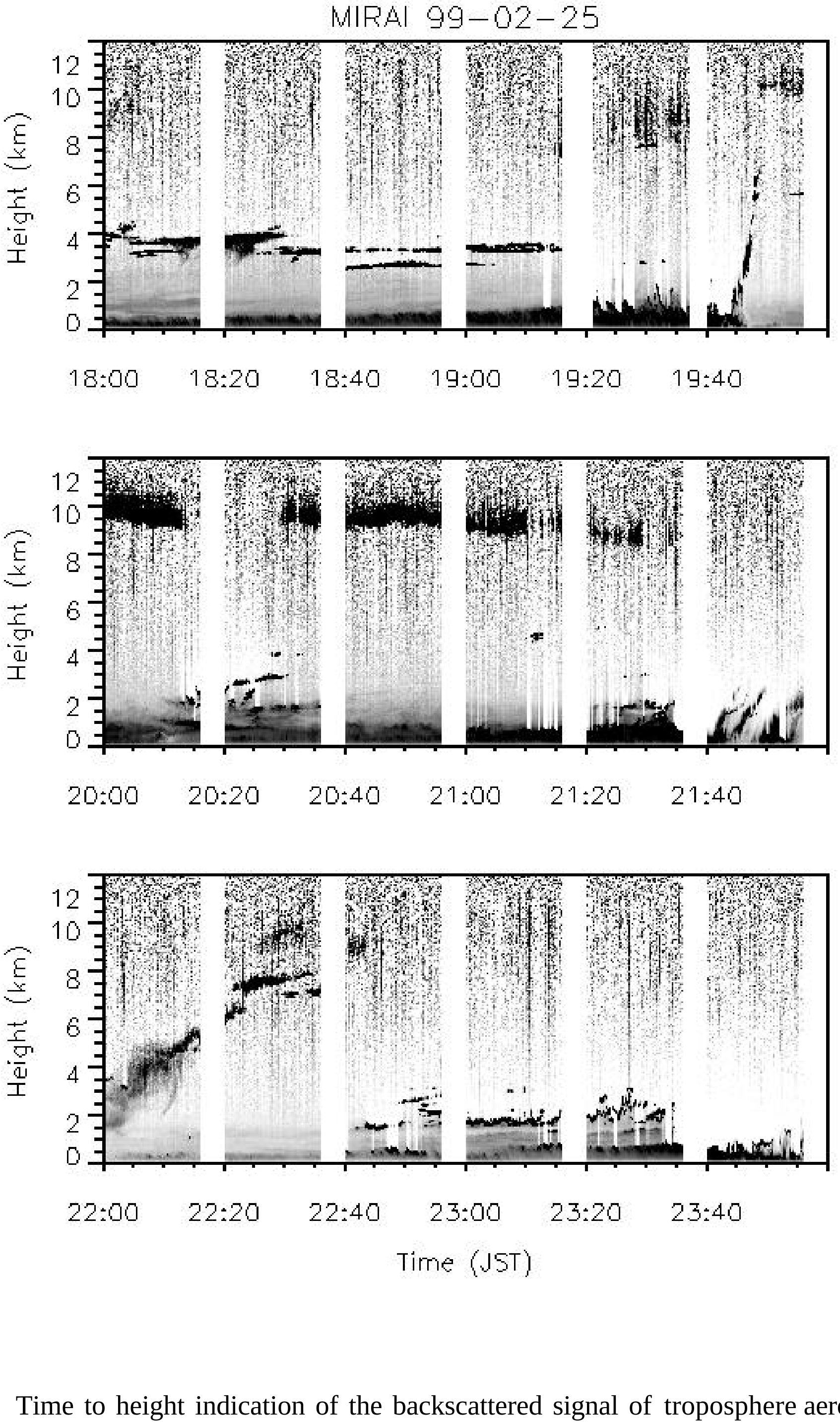

Fig.1(b) Time to height indication of the backscattered signal of troposphere aerosols and clouds obtained at 25 February 1999 between 18:00 and 24:00 JST .

7.7 Biogenic sulfur compounds, acidic and basic gases, halogen gases, and water-soluble ions in marine atmospheric aerosols

(1) Personnel

Yasushi Narita (Faculty of Sci. and Technol., Keio Univ.):
Operation leader, Measurement of gases, and collecting aerosols in the marine atmosphere

Masayuki Tajima (Faculty of Sci. and Technol., Keio Univ.):
Measurement of gases, and collecting aerosols in the marine atmosphere

(2) Objectives

It is very important to understand the amount of biogenic sulfur compounds, which is known as a cooling factor to the global climate change. Biogenic sulfur compounds (for example dimethylsulfide (DMS), dimethylsulfoniopropionate (DMSP)), as a metabolism, are released from some kind of phytoplanktons. DMS volatilizes from the seawater into the troposphere and is finally oxidized to sulfate or methansulfonic acid (MSA). Sulfate controls the green house effect by creating CCN. It was estimated that the amount of biogenic sulfur compound is about 37% of the global net. It is expected that the data set including of concentration profiles of biogenic sulfur compounds in the marine atmosphere can be improved during this R/V Mirai cruise (MR99-K01).

Aldehydes, especially formaldehyde and acetaldehyde, are responsible for photochemical reactions and are important intermediates of hydrocarbons. In the marine atmosphere without pollutants, methane and ethylene are important precursor of formaldehyde and acetaldehyde. It is known that intermediates of DMS react on formaldehyde and change into sulfate and that halogens and their radicals also react on that. It is expected that we can get the concentration levels and the behaviors of aldehydes around the middle Pacific Ocean during this cruise.

The concentration levels of acidic gases (HCl, HNO_3, SO_2) and basic gas (NH_3) are expected to be investigated in a remote area, especially a remote ocean. In an urban ambient acidic gases, especially HCl, NOx, a part of which are photooxidized to HNO_3, and SO_2, are emitted from human activities. NH_3 is emitted from human and bacteria activities. These concentration levels are known in an urban area, but unknown in a remote area, especially over the ocean. As above, SO_2 is an oxidation of biogenic sulfur compound, DMS, and shows different behavior in the marine ocean from in the urban area. So we do measure and monitor these trace gases over the ocean during this cruise .

Halogens, especially inorganic halogens, HX, and X_2, are important chemicals as radical sources. It is known that halogen is produced from methylhalogen, a sea salt, and so on. Methylhalogen volatizes from the seawater into the troposphere and is oxidized to a halogen gas (X_2), which changes a halogen radical (X) under a photochemical decomposition. In a marine atmosphere halogen radical reacts on other chemicals like a OH radical. The kinetic ratio of halogen radical's reaction with formaldehyde, for example, is as quick as that of OH radical's. So we monitor not only halogens but also acidic gases, especially HCl and HBr. During this cruise it is expected to observed the diurnal change and concentration levels of halogens.

Water-soluble ions, MSA, Cl^-, NO_3^-, SO_4^{2-}, Na^+, NH_4^+, K^+, Mg^{2+}, Ca^{2+}, and so on, are involved in a aerosol. MSA and sulfate are photochemical products of a biogenic sulfur compound, i.e., DMS in marine atmosphere. The final product ratio of MSA, which is only the DMS source, to sulfate is decided by NOx concentration. The low concentration of NOx changes DMS to MSA much more than the high concentration of that.

An "acidity", which is calculated by the following function (1), is an important parameter in order to know the aerosol acidity.

$[Acidity] = [nss\text{-}SO_4^{2-}] - [NH_4^+] - [nss\text{-}Ca^{2+}]$ (1)

*nss- non sea salt

Sulfur compounds, including biogenic and anthoropogenic ones, decline a pH of aerosols lower for the reason why they are finally oxidized to sulfate. Therefore, it is expected to investigate the ratio of MSA to sulfate, biogenic sulfur compounds to get knowledge of a part of green house effect during this cruise.

(3) Measurement parameters

Biogenic sulfur compounds:	dimethylsulfide (DMS), methylmercaptane (MeSH), and carbonilesulfide (COS)
Aldehydes:	formaldehyde (HCHO), and acetaldehyde (CH_3CHO)
Acidic and basic gases:	hydrochloric acid (HCl), nitrate (HNO_3), sulfur dioxide (SO_2), and ammonia (NH_3)
Halogen gases:	hydrochloric acid (HCl), chlorine (Cl_2), hydrogen bromide (HBr), and bromine(Br_2)
Soluble ions in aerosol:	methansulfonic acid(MSA), chloric ion(Cl^-), nitrate ion(NO_3^-), sulfate ion(SO_4^{2-}), sodium ion(Na^+), ammonium ion(NH_4^+), potassium ion(K^+), calcium ion(Ca^{2+}), and magnesium ion(Mg^{2+})

(4) Methods

Sampling interval and data analysis are as follows.

Biogenic sulfur compounds:	monitoring interval	1hr.
	data analysis	1hr.
	Gas chromatograph coupled with cold trap system	
Aldehydes:	monitoring interval	1hr.
	data analysis	1hr.
	automatic continuous measurement system (HPLC + controller) coupled with diffusion scrubber	
Acidic and Basic gases:	monitoring interval	1hr.
	data analysis	1hr.
	automatic continuous measurement system (Ion Chromatograph + controller) coupled with diffusion scrubber	
Halogen gases:	monitoring interval	1hr.
	data analysis	1hr.
	automatic continuous measurement system (Ion Chromatograph + controller) coupled with diffusion scrubber	
water-soluble ions in aerosol:	sampling interval	6hr.
	data analysis	6hr.
	32 series aerosol sampler	

(5) Data archive

We will calculate and calibrate all data of these chemicals for this R/V Mirai cruise (MR99-K01).

After calculating and calibrating these data, all of them will be archived at Environmental Chemistry Laboratory, faculty of Sci. and Technol., Keio University. Within a year, all numerical data will be submitted to the DMO at JAMSTEC.

7.8 Studies on behaviors and climate influence of atmospheric aerosol and clouds over the tropical western Pacific Ocean

(1) Personnel

On board scientists

Tatsuo Endoh	(Institute of Low Temperature Science, Hokkaido University): Associate Professor
Atsushi Ueda	(Engineering school, Hokkaido University):Graduate student of Master Course

Co-workers not on board

TamioTakamura	(Center of environmental remote sensing science, Chiba University): Professor
Sachio Ohta	(Engineering environmental resource laboratory, school of engineering, Hokkaido University): Professor
Kazuhiko Miura	(Physics Laboratory,Faculty of Science, Tokyo Science University): Lecturer
Teruyuki Nakajima	(Center of climate system research, University of Tokyo): Professor

(2) Objectives

Collection of calibration and validation data for remote sensing aerosol data.

Calculation of optical properties, i.e. optical thickness and its dependence on the wave length for the atmospheric aerosol over the ocean with observation of solar radiation using sky radiometer.

Providing more precise radiation data for estimation of radiative forcing for global climate.

(3) Measuring parameters

・Atmospheric optical characteristics

Atmospheric optical thickness, Aangstrom coefficient of wave length efficiencies,Irradiating intensity of solar, forward scattering intensity with scattering angles and wave length, GPS location of londitude and latitude, heading direction, azimuth and elevation angle, rolling and pitching.

・Concentration and size distribution of atmospheric aerosol

Aerosol number concentration with size ranges, chemical component of aerosol particles, atomic analysis of aerosol, scattering coefficient and absorping coefficient and mass distribution with size range.

・Aerosol observation module

Air temperature and relative wind speed of out door of the module and air temperature and relative humidity in the module, check of total electricity and module's weight.

(4) Methods

The instruments used in this work are shown as following. (see table 7.8.1)

- Sky Radiometer is measuring irradiating intensities of solar radiation through six different filters with the scanning angle of 0-160 degree and finally providing optical thickness, Aangstrom exponent and size distribution of atmospheric aerosols.
- Optical Particle Counter is measuring the size of large aerosol particle and counting the number concentration with visible light scattering method and providing real time series display graphically.
- Integrated Nepherometer is measuring scattering coefficient for whole angle 7-175 degree.
- Step Sampler is collecting aerosol particles in the manner of impacting onto the filter tape with a certain displacement every 12 hours automatically.
- Absorption Photometer is measuring absorption coefficient with extinction method.

・Aerosol Filtering Sampler is providing aerosol particle and some chemical components in the manner of impacting method onto the filter paper every six or eight hour distinguishing the day and night time.
・Aerosol Mass Monitor is measuring the total mass of the aerosol particles with size ranges.
・Housing Module is providing the preferred circumstance for these measuring instruments.

(5) Results

The sky radiometer has been going well owing to more silent shivering condition and circumstances provided by the R/V Mirai.

Aerosols size distribution of number concentration have been measured by the Particle Counter. The time series data obtained are displayed in real time with 5stages of size range i.e., 0.3, 0.5, 1.0, 2.0, and 5.0 micron in diameter. The performance of module was confirmed to provide good circumstances for many kind of instruments.

(6) Data archive

All data will be archived at ILTS, Hokkaido University after the quality check and submitted to JAMSTEC within 3-year.

(7) Other remarks

3 Feb.1999:	Removal of heavily accumulated snow for taking off the module
4 Feb.1999:	Carrying off the module and departure from Hokkaido University
5 Feb.1999:	Carrying in the module to the R/V Mirai, settlement arrangement of observational equipments
6 Feb.1999:	Starting of measurement partly and departure from the Sekinehama harbor
7 Feb.1999:	Entering into the port Hachinohe and departure
8 Feb.1999:	Addition of electricity, repair and arrangement of air conditioner and starting the observations
Feb.1999:	Taking out the first data from logger and continuing the measurement
Feb.1999:	Suspension of sky radiometer observation avoiding the interference before entering port
Feb.1999:	Entering port of Guam, T. Endoh dropping with first data and A. Ueda continuing the measurements
Feb.1999:	Re-starting of sky radiometer observation
4 Mar. 1999:	Examination of sequential motion of sky radiometer across the equator
Mar.1999:	Closing the observation, withdrawal of instruments and packing
11 Mar. 1999:	A. Ueda dropping with whole data at Honiara harbor
31 Mar. 1999:	Entering the harbor Shimonoseki taking out the module

(8)References

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Miura, K., S. Nakae, et al.,: Optical properties of aerosol particles over the Western Pacific Ocean, Proc. Int. Sym. Remote Sensing, 275-280, 1997.

Data inventory

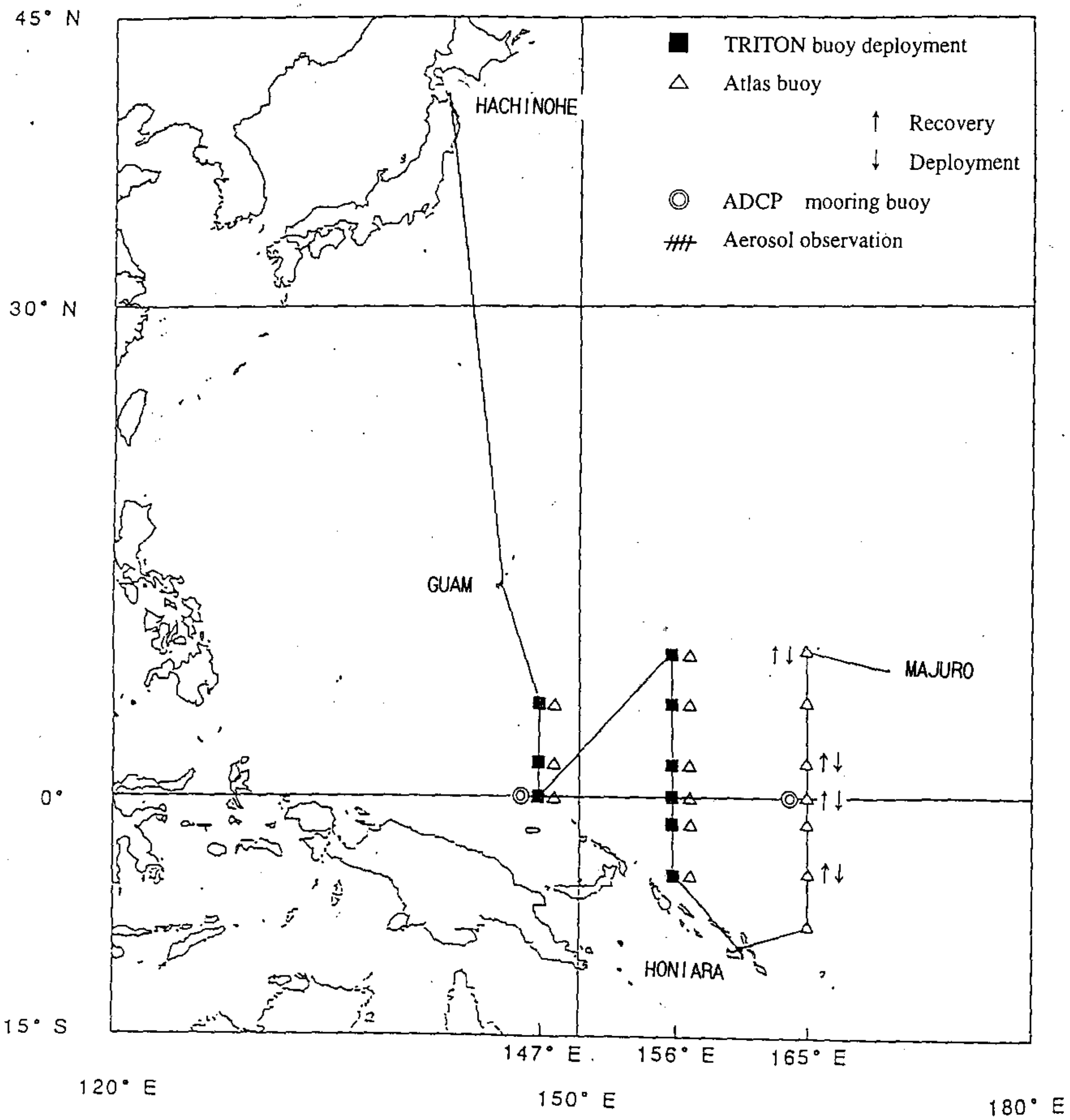
Table 7.8.1 Information of obtained data inventory

Item, No.data	Name	Instrument	Site position
<module>	Endoh	Lidar hausing	Upper deck
scattering coe.	Ueda	Nephelometer (Radiance Research , M903)	
absorption coe.	Ueda	Absorption Photometer (Radiance Research)	
Aerosol	Ueda	Laser particle Counter (Met One , Model237)	
<observation>	Endoh, Ueda		Chosa Shiki shitsu Compass deck
sky radiometer	Endoh	sky radiometer (Prede , POM-01MK2)	
particle counter	Endoh	particle counter (Rion , KC-01C)	
scattering coe.	Ueda	Nephelometer (Radiance Research , M903)	
absorption coe.	Ueda	Absorption Photometer (Radiance Research)	
Aerosol mass	Ueda	Piezo-balance dust meter Monitor (KANOMAX , model 51-1111)	

Sample inventory

Sample	rate	site	object	name	state	remarks
Aerosol	2/day	Compass Deck	analysis of atom	Ueda	land analysis	Feb 7 ～ March 8, 1999
Aerosol	2/day	Module	identify of atom	Ueda	land analysis	Feb 7 ～ March 5, 1999

Figure 7.8.1 Aerosol observation



7.9 ADCP subsurface mooring

(1) Personel

Koichi Takao	(MWJ)	
Takehiko Shiribiki	(MWJ)	
Masayuki Fujisaki	(MWJ)	
Nobuharu Komai	(MWJ)	
Hirokatsu Uno	(MWJ)	
Fuyuki Shibata	(MWJ)	
Takeo Matsumoto	(MWJ)	
Takahiro Kazama	(MWJ)	
Tomohiro Horiuchi	(MWJ)	
Kimiko Nishijima	(MWJ)	
Yoshifumi Kuroda	(JAMSTEC)	Principal investigator
Kentaro Ando	(JAMSTEC)	not onboard
Yuji Kashino	(JAMSTEC)	not onboard

(2) Objectives

The purpose is to get the knowledge of upper ocean circulation in the western equatorial pacific. In this cruise (MR99-K01), we recovered one subsurface ADCP mooring at Eq.-165E, and deployed two ADCP moorings at Eq.-147E, Eq.-165E.

(3) Parameters

- Current profiles
- Echo intensity
- Temperature and Conductivity

(4) Instrument

1) ADCP

RDI BB-ADCP

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

Recovered ADCP

- Serial Number : 1152 (Mooring No.980108-00165E)

Deployed ADCP

- Serial Number : 1222 (Mooring No.990221-00147E)
- Serial Number : 1223 (Mooring No.990319-00165E)

2) CTD

SBE-16

Sampling Interval : 1800s

Recovered CTD

・Serial Number : 1285 (Mooring No.980108-00165E)

Deployed CTD

・Serial Number : 1280 (Mooring No.990221-00147E)

・Serial Number : 1283 (Mooring No.990319-00165E)

(5) Deployment

Two ADCP mooring were deployed at Eq.-147E , Eq.-165E. The moorings were designed to moor the ADCP at about 270m. After we dropped the anchor, we monitored depth of the acoustic releaser. The descending rate was about 2.2m/sec. Each position of the mooring were showed below.

Results of calibration

・Mooring No.990221-00147E

Lat: 0° 00.00N Long: 147° 05.38E

・Mooring No.990319-00165E

Lat: 0° 00.10S Long: 165° 17.85E

(6) Recovery

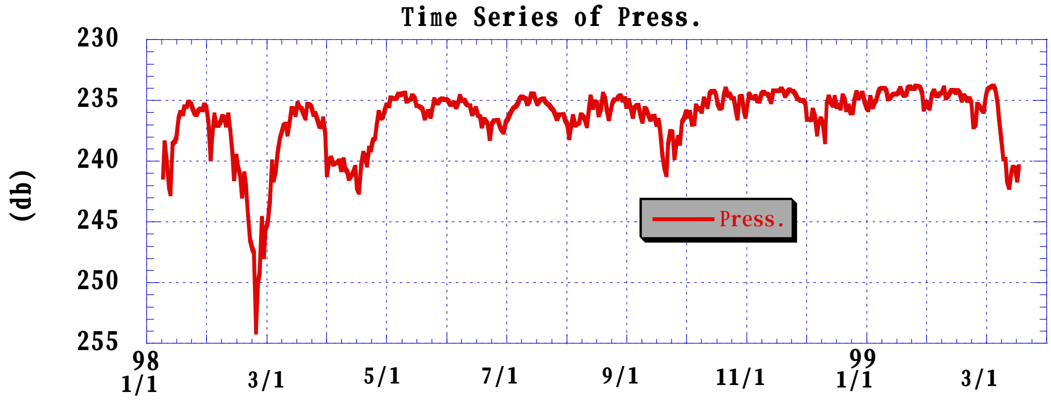
We recovered one ADCP moorings at Eq.-165E which were deployed on Jan.1998 (KY98-01). At first we were planning to recover at Eq.-147E (Mooring No.980124-00147E), too. But because of acoustic releaser trouble, we decided to give up recovering. We monitored depth of acoustic releaser after we released the anchor.

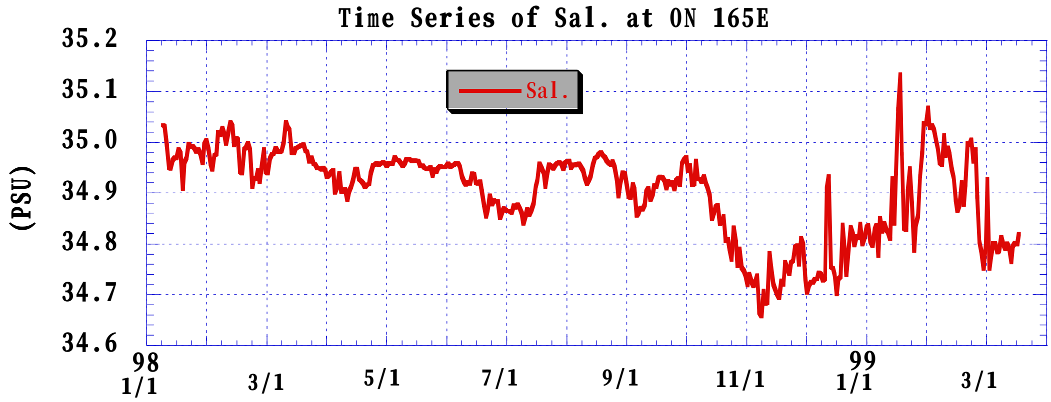
After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. Results were shown in the figures on following pages. Fig.7.9-1 shows timeseries of CTD depth, temperature, and salinity. Figure7.9-2, 3 shows the velocity data (eastward and northward component) at 50m (25bins), 100m (18bins), 150m (12bins), and 200m (6bins) depth.

(7) Data archive

The data will be created using CTD depth data. The data will be archived by member of TOCS project at JAMSTEC. The data at Eq.-147E and Eq.-165E will be submitted to TAO project office as a component of TAO current meter array after the quality check.

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


Time Series of Press.
230
235
240
245
250
255
(db)
Press.
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1


Time Series of Sal. at 0N 165E
35.2
35.1
35.0
34.9
34.8
34.7
34.6
(PSU)
Sal.
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

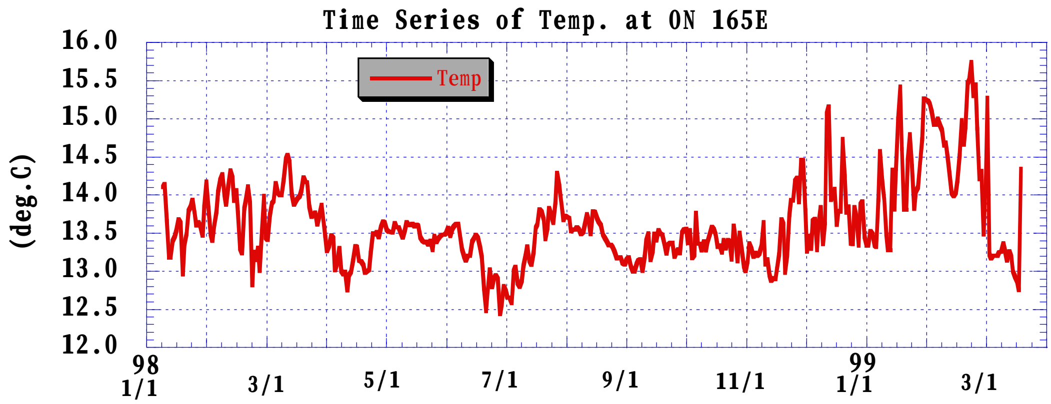
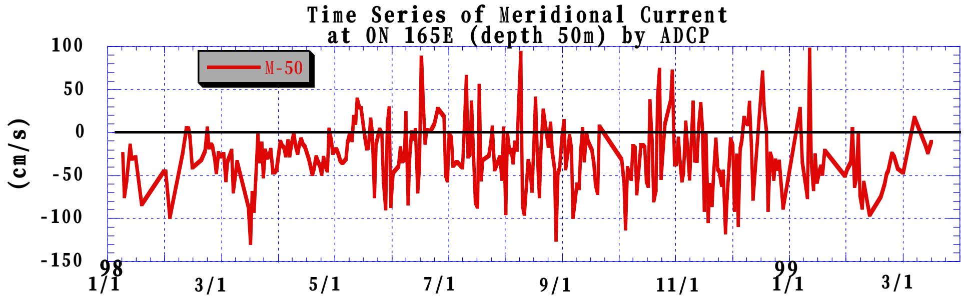
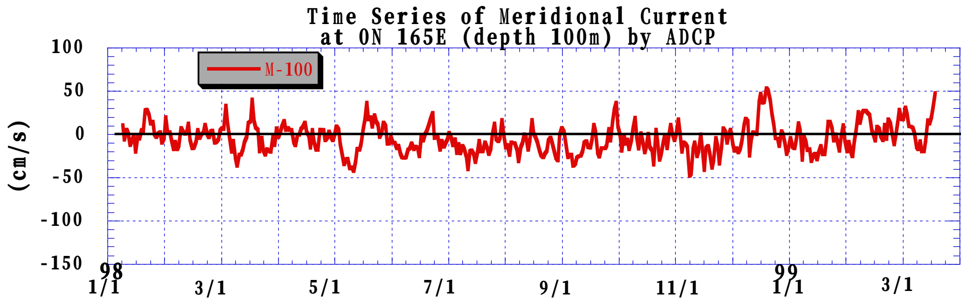
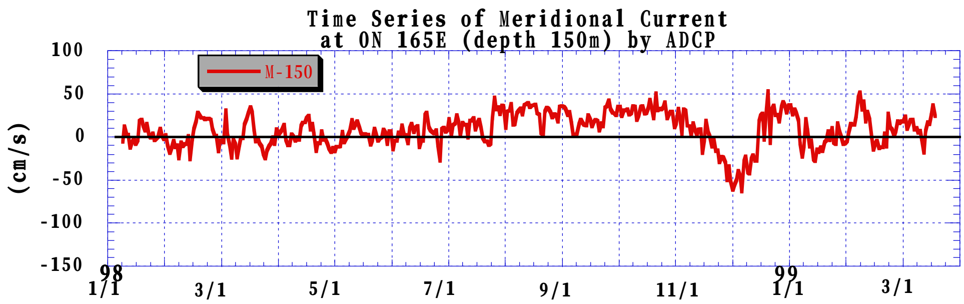

Time Series of Temp. at 0N 165E
16.0
15.5
15.0
14.5
14.0
13.5
13.0
12.5
12.0
(deg.C)
Temp
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

Fig.7.9-1


Time Series of Meridional Current
at 0N 165E (depth 50m) by ADCP
M-50
(cm/s)
100
50
0
-50
-100
-150
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1


Time Series of Meridional Current
at 0N 165E (depth 100m) by ADCP
M-100
(cm/s)
100
50
0
-50
-100
-150
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1


Time Series of Meridional Current
at 0N 165E (depth 150m) by ADCP
M-150
(cm/s)
100
50
0
-50
-100
-150
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

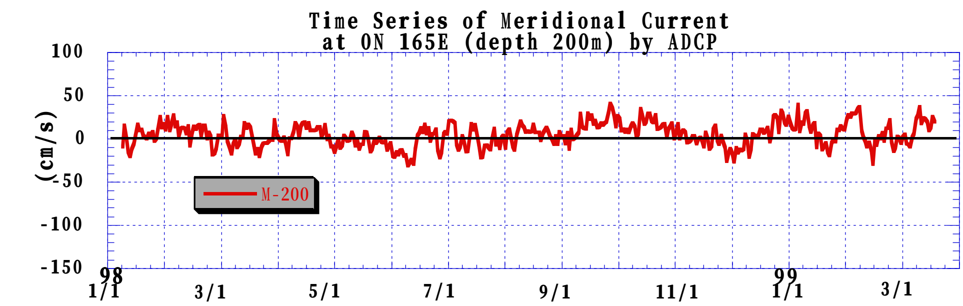
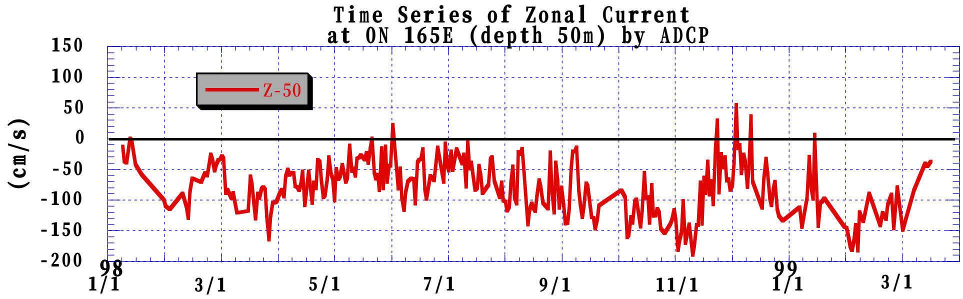
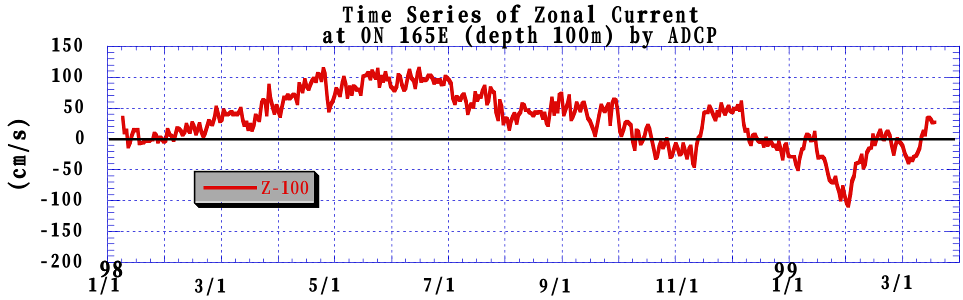
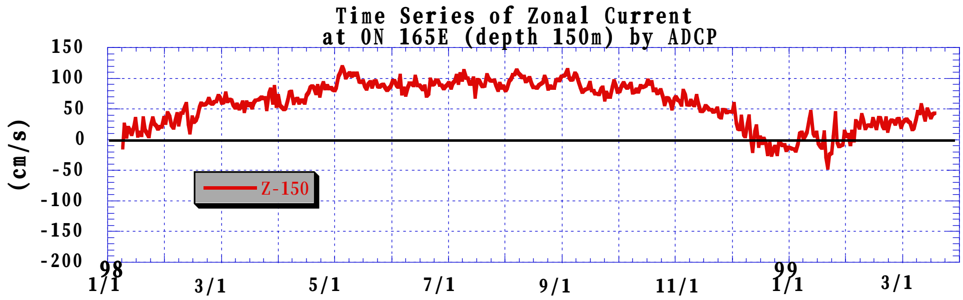

Time Series of Meridional Current
at 0N 165E (depth 200m) by ADCP
M-200
(cm/s)
100
50
0
-50
-100
-150
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

Fig.7.9-2


Time Series of Zonal Current
at 0N 165E (depth 50m) by ADCP
Z-50
(cm/s)
150
100
50
0
-50
-100
-150
-200
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1


Time Series of Zonal Current
at 0N 165E (depth 100m) by ADCP
Z-100
(cm/s)
150
100
50
0
-50
-100
-150
-200
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1


Time Series of Zonal Current
at 0N 165E (depth 150m) by ADCP
Z-150
(cm/s)
150
100
50
0
-50
-100
-150
-200
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

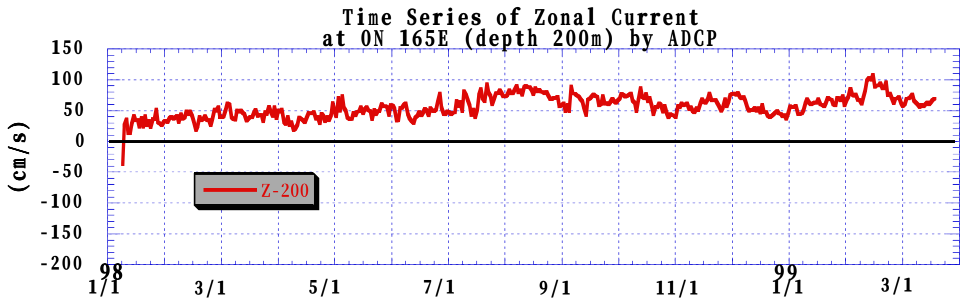

Time Series of Zonal Current
at 0N 165E (depth 200m) by ADCP
Z-200
(cm/s)
150
100
50
0
-50
-100
-150
-200
98
1/1
3/1
5/1
7/1
9/1
11/1
99
1/1
3/1

Fig.7.9-3

7.10 TAO/ATLAS mooring

(1) Personel

Andrew Shepherd (PMEL)
Mike Strick (PMEL)

(2) TAO cruise report

WP2-99-MA

(3) Ship

JAMSTEC Research Vessel Marai

(4) Cruise date

March 12 to March 24, 1999
Andrew Shepherd: March 5, to March 26, 1999
Mike Strick: February 27, to March 26, 1999

(5) Port

Honiara, Solomoon Islands to Chuuk, Federated States of Micronesia

(6) Operations

Date	Location	Depth	ID	Operation
3/12	8.03S, 164.81E	3900	PM055	Recovery
3/13	08 02.14S, 154 48.16E	3916	PM079	Deployment
3/13	5.00S, 165.20E	2527	PM34B	Recovery
3/14	04 59.98S, 165 11.7E	2516	PM080	Deployment
3/14	1.91S, 164.41E	4443	PM054	Sensor Swap
3/19	0.01N, 165.01E	4411	PM053	Recovery
3/20	00 00.43N, 165 00.68E	4415	PM081	Deployment
3/20	2.00N, 164.95E	4183	PM032B	Recovery
3/21	01 59.65N, 164 58.10E	4487	Pm082	Deployment

(7) Instrumentation failures

ATRH31905	Scheduled for 5S, 165E	Failed on setup no Relative Humidity output
T-1, 11678	Missing from 8S	Growth indicated module missing for a long time.
T-2, 11679	Missing from 8S	Module mount intact and free of growth.
T-3, 11680	Module from 8S, 165E	Module did not respond.
T-8, 11474	Module from 5S, 165E	ROM Chip dislodged from circuit board
T-1, 11482	Module from 2N, 165E	Module did not respond.
Tube 437	Tube from 0,165E	Unit on fail-safe.
MTR 4068	from 0, 165E	Invalid date/time and no data logged

(8) R/V Mirai

The ship is as good as it gets, large, spacious, clean, good food, fast, and it doesn't move much. The Japanese went out of their way to make this ship a very usable and comfortable ship for mooring work. There was unused lab space in all parts of the ship on most decks. Accommodations were spacious with everyone onboard in their own room. There were probably bunk space to carry an additional 40 scientist without feeling cramped. There are 4 hot baths onboard and a gym with a sauna. They have an INMARSAT B phone booth onboard for personal calls charged at about $2/minute.

The amount of indoor lab space is luxurious. By myself I could set up in a room the size of the computer lab on the Ka'imimoana and still have two other rooms the same size available to me. It always surprised me during the cruise when I would stumble on a room that I hadn't seen before. The day before we got in I discovered the sea-beam room with it's five different work stations, Silicon Graphics, Sun, PC based, all with multiple color printers. This room was available to anyone wishing to use it. The computer system on the ship is windows based. I hooked my laptop to the system through a PCMCIA T-base 10 connection and I could use all the shipboard printers, navigational aids the ship had.

(9) Equipment failures

The Tandy Laptop did not work from the start of the cruise. This was to be the backup computer system for the cruise. The IBM Laptop I hand carried to Honiara became our sole computer for the receive program, reading the data from the modules and setting up the tubes. During the boat ride at the repair at 2S, 165E the IBM was dunked in the water destroying it's monitor and internal power supply. I borrowed a monitor and a power supply from the Japanese and for the rest of the cruise this was the system I used for everything.. The disconcerting part of blowing out the IBM was I was in the blind with the transmissions from the buoy at 2S. I had nothing which could hook into the Telonics uplink receiver.

(10) Mooring operations

The ship is designed for mooring work and is nicely laid out for both recovery and deployment operations. The deck is very large and spacious with enough room to setup at least 6 ATLAS surface torroids for deployments with plenty of room for a recovery operation. The ship has a traction winch installed used to bring in line during recovery operations with a diameter of 1.5 meters. This allowed us to recover the nilspin on the next generation moorings without having to break the mooring below the buoy using a Yale. The A-frame is massive and articulated. As the A-frame extends outboard of the ship the top portion of the A-frame can then be moved up or down and at angles to the lines of the A-frame. A line is used from a deep-sea winch which is fairlead up the sides of the A-frame and down through the middle articulated middle of the A-frame. This line is used for picking up the buoy on recoveries and deployments. The recovery of the surface buoys with winds above 20 kts and with 3 meter wave heights without taking off the sensors. There are two additional blocks suspended from the A-frame fairlead to power capstans used to transfer loads when necessary. Cleats and davits on the ship are plentiful and can be moved around the ship using a system of deck bolts which are numerous and installed throughout the ship.

The crew is very professional and probably the best I've worked with. The captain and officers are very good ship handlers and very experienced with mooring operations. They had writeups of all the mooring operations ever done by us on other Japanese ships which they studied and used for designing the recovery and deployment operations. When it came time for our work they were well versed in what we wanted and how we wanted it done. The ship is also equipped with a Sea Beam system which provided us with excellent bathymetry at all the sites. Everyone in the mooring business should have the opportunity to sail on this ship just once. There is none better!

(11) Canceled operations

Twice during the cruise planned operations had to be canceled. During the sensor repair of the 2S, 165E mooring Kuroda received word the 0, 156E TRITON buoy was adrift. The buoy had been deployed on the previous leg 15 days prior and after 7 days started drifting.. The ship was diverted to recovery operations resulting in the cancellation of the8N. On the morning of the repair of the 5N, 165E buoy Kuroda and the captain decided the weather conditions were too bad to attempt a repair. The winds were 25 kts and the wave height was 3.2 to 3.5 meters. The main concern was the inability of the ship to recover the small boat above 3.2 meter wave heights.