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CRUISE REPORT

TOCS K9702

January 26-March 1 1997

TOCS CRUISE REPORT NO.8

JAMSTEC

CONTENTS

1. Cruise Summary 1.01–03

2. List of Instruments 2.01

3. Observation Sites 3.01

4. CTD Casts
   - 4.1 CTD Sites 4.01
   - 4.2 CTD Casts Table 4.02–03
   - 4.3 CTD Profiles 4.04–23
   - 4.4 CTD Sections 4.24–29
   - 4.5 Bottle Salinity 4.30–31
   - 4.6 Dissolved Oxygen Measurement 4.32–59

5. Meteorological Measurements
   - 5.1 Radiosonde Observation 5.01–11
   - 5.2 Boundary Layer Measurements 5.12–18
     - (a) Wind Profiler
     - (b) RASS
     - (c) SABL
     - (d) Tethered Operation
   - 5.3 Surface Meteorological Measurements 5.19–29
     - (a) Manual Measurement
     - (b) BNL instrumentation

6. Shipboard ADCP 6.01

7. ADCP Moorings 7.01–29

8. TAO Moorings 8.01–07

9. CO_2 Measurments 9.01–05

10. Summary Report 10.01–02

11. Participants List 11.01–03

Appendices
- A–1 Time Table
- A–2 GMS Images
- A–3 Trouble Report of CTD system (in Japanese)

1. Cruise Summary

Ship	:	R/V KAIYO
Chief Investigator	:	Kentaro Ando (Japan Marine Science and Technology Center)
Cruise Code	:	K9702
Project Title	:	Tropical Ocean Climate Study
Period	:	January 26, 1997 – February 28, 1997
Ports of call	:	Majuro, Republic of Marshall Islands Truk (Chuuk), Federated States of Micronesia Koror, Republic of Palau
Institutions	:	JAMSTEC NME(Nippon Marine Enterprise), PMEL(Pacific Marine Environmental Laboratory) NCAR(National Center for Atmospheric Research), BNL(Brookhaven National Laboratory), BPPT(Badan Pengkajian dan Penerapan Technologi)

Purpose :

The purpose of this cruise is to observe the physical oceanographic and atmospheric conditions in and over the tropical western Pacific for better understanding of the air-sea interaction and its relation to the ENSO(El Nino/Southern Oscillation) and global climate change.

Observation Summary :

The TOCS (Tropical Ocean Climate Study) group in Japan Marine Science and Technology Center (JAMSTEC) and Badan Pengkajian dan Penerapan Technologi (BPPT) of Indonesia conducted 59 CTD/DO (Conductivity, Temperature and Depth/ Desolved Oxygen) casts, current measurement by shipboard ADCP and 176 upper air soudings by radiosonde. The subsurface 0N165E ADCP mooring line was newly deployed in this cruise to measure the time series of current velocity profile, and the subsurface 0N147E and 0N142E ADCP mooring lines were recovered and deployed to continue measurement during this cruise. Currently, 7 ADCPs are moored in the survey area (0N165E, 0N156E, 0N147E, 0N142E, 0N138E, 2S142E, 2.5S142E).

The TAO project group in Pacific Marine Environmental Laboratory (PMEL/NOAA) and the TOCS group in JAMSTEC conducted 1 recovery/deployment of surface current buoy (PROTEUS) at 0N165E, 1 recovery/deployment of subsurface ADCP buoy at 0N165E, 5 repairs, 5 recoveries, 5 deployments of ATLAS buoys.

The National Center for Atmospheric Research (NCAR) and Brookhaven National Laboratory (BNL) conducted the surface meteorological measurement and upper air soundings by RASS, SABL, windprofiler and PRP during the cruise as the cooperative work with JAMSTEC. The combined analysis from these data may lead to a new knowledge about the uncertainty on the atmospheric boundary layer.

Preliminary Results :

The preliminary data from this cruise shows that the sea surface temperature was higher in the eastern area (more than 29.5C at 147E, 165E and 156E) than the western area (less than 29.5C at 142E and 138E, see Section 4.4). The surface salinity was also higher in the eastern sections (about 34.8 at 165E, 34.6 at 156E) and lower in the western sections (34.0−34.5 in almost cases, see Section 4). Especially, fresh water area can be found near the equator in the western sections from 138E to 147E.

The surface wind shows easterlies in the eastern area (165E−156E) and westeries in the western area (147E−138E), suggesting the exsistence of atmospheric convergence between two areas. The westerly wind in the western area sometimes showed more than 10 m/s (see Section 5), and such phenomena would relate to the wind−forced eastward surface current. The current data from the moored ADCP recovered at 0N147E shows that the quite strong eastward current more than 1.5 m/s down to 120m depth dominated in the last December, and the eastward current at 50 m depth has continued after the December westerly wind burst until the recovery (see Section 7). During the period of this cruise, the surface current by shipboard ADCP also shows eastward in the western part of the survey area.

From the CTD data, strong salinity stratification were often found in many casts in the surface isothermal layer, which is higher salinity in the lower layer and fresher in the upper layer, and mixed layer depth was shallow (less than 50 m). The lower salintiy in the upper layer may be caused by the heavy raifall in this area. During this cruise, we often observed the heavy rainfall and squall lines. The other important factor to the salinity stratification is the lateral advection of salinity. The surface salinity changed from 34.8 at 165E to 34.2 147E, suggesting the advection effect will be large. The surface current from shipboard ADCP (not shown here) also showed strong shear flows of surface wind forced eastward current and subsurface westward South Equatorial Current in the surface isothermal layer, suggesting the high salinity advection from east and the low salinity advection from west.

Acknowledgement :

We would like to express our special thanks to Captain Hyodo and his crew members of R/V Kaiyo. Without their excellent support, we will never success this cruise.

2. List of Instruments

(1) CTD (Conductivity-Temperature-Depth profiler)

- SBE9-11 plus system, Sea Bird Electronics, Inc., USA

CTD Station No. C01～C12

CTD Fish for 10500m(TOCS Group)

(Primary) T-sensor SN1462   (Secondary) T-sensor SN1465

C-sensor SN1045   C-sensor SN1174

P-sensor SN41223

DO-sensor SN130311

St. No. C13～C28

CTD Fish for 6800m(Tomography Group)

T-sensor SN1465   C-sensor SN1174

P-sensor SN41396   DO-sensor SN130311

St. No. C29～C61

CTD Fish for 6800m(TOCS Group)

T-sensor SN1465   C-sensor SN1174

P-sensor SN43435   DO-sensor SN130311

(2) Shipboard ADCP (Acoustic Doppler Current Profiler)

VM-75, RD Instruments, USA

(75khz, 16m bin length, Normal range 560m starting 30m depth)

(3) Atmospheric Sounding

- Radio Sonde System, DigiCORA MW11, VAISALA, Finland
- Wind Profiler With RASS, LAPS3000, Radian, USA
- Scanning Aerosol Backscatter Lider, CFR200Laser, Big Sky Laser Tech., USA
- Portable Radiation Package

P-sensor, PTA427, VAISALA, Finland

T & Hum sensor, HMP35, VAISARA, Finland

Wind Sensor, 05103, RM Young, USA

Pyrenometer/Pyranometer, LI200S, EPPLY, USA

RainGauge, ORG-115A-DA, Scientific Technology Inc., USA

(4) Dissolved Oxygen

- TOA Portable Dissolved Oxygen Meter Model DO-25A
- Metrohn Model 726DMS Titrino/ 10ml of titration vessel
- Pt. Electrode/ 6.0401.100
- SBE13, Sea Bird Electoronics, Inc., USA

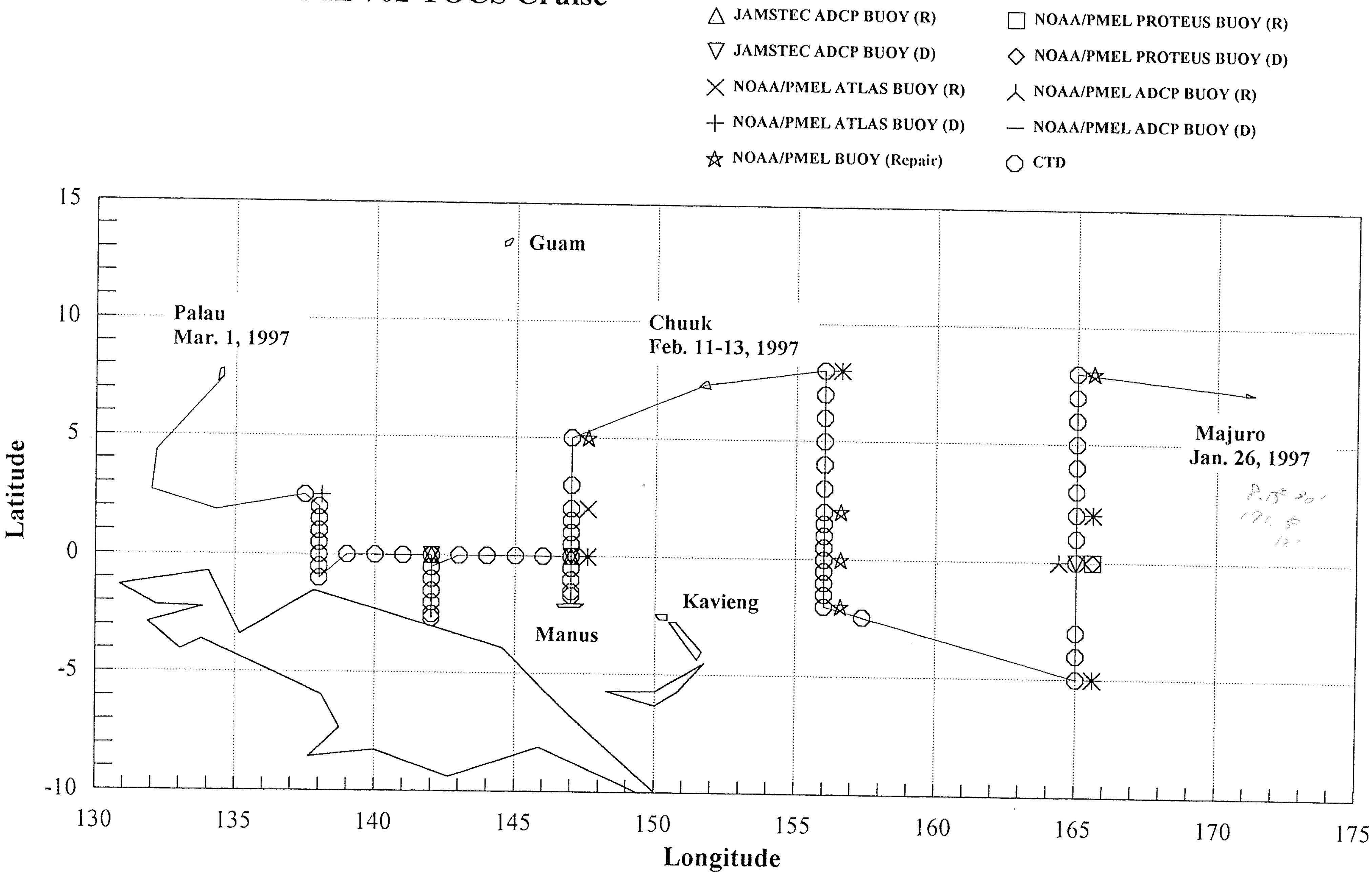
(5) Bottom Salinity

- Guildline Autosal Model8400B

(6) PCO_2 and TCO_2

- The MRI CO_2 Measuring System
- The MRI Coulometric TCO_2 Measuring System

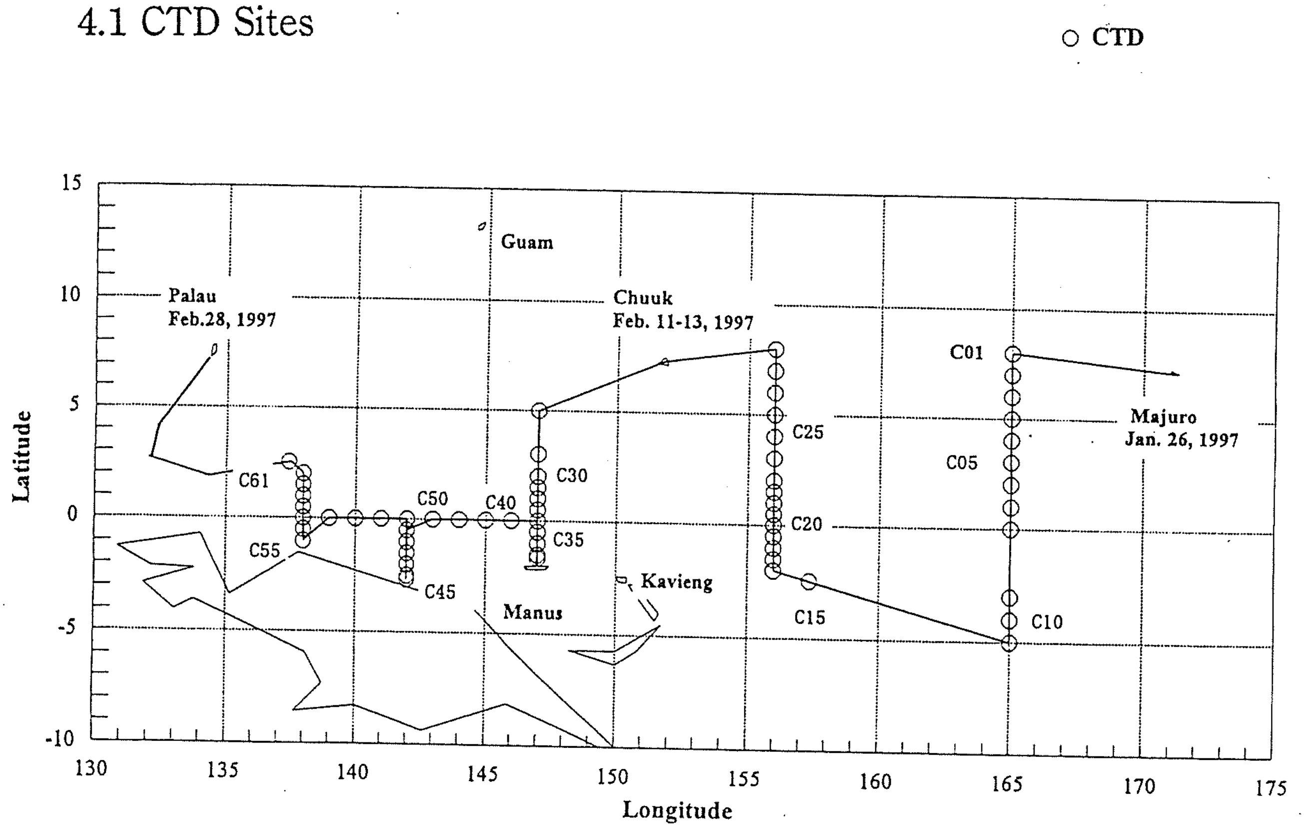
3. Observation Sites K9702 TOCS Cruise



4. CTD casts

During this cruise, we encountered several troubles in operating our CTD as is described in Appendix−3. These were caused by 1) CTD fish trouble, which might be related with short or cut of signal line in the sea cable, and 2) water sampler trouble. Through these troubles, we were forced to change CTD fishs for three times. We could use the same set of sensors (T,C and DO) during this cruise, however, we must have changed pressure sensors for this reason. Please refer to section 2 for sensor exchange information during this cruise.

4.1 CTD Sites



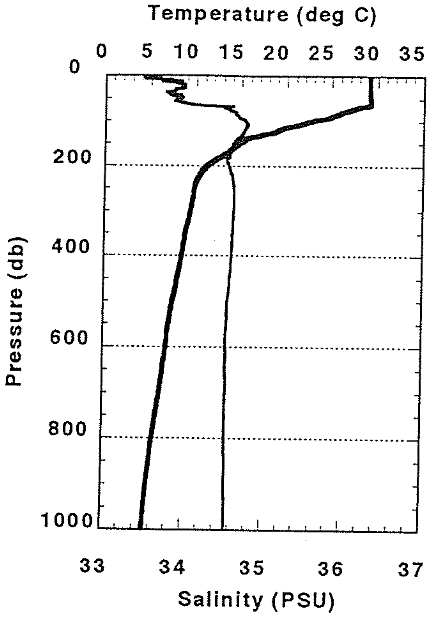
4.2 CTD Cast Table

St.	Date	Time(GMT)	Latitude	Longitude
C01	27 Jan.'97	20:15	08° 00.390'N	165° 00.805'E
C02	28 Jan.'97	02:49	07° 00.018'N	165° 00.007'E
C03	28 Jan.'97	09:20	06° 00.062'N	165° 00.080'E
C04	28 Jan.'97	15:12	05° 04.114'N	164° 59.976'E
C05	28 Jan.'97	23:40	04° 05.388'N	164° 59.876'E
C06	29 Jan.'97	14:40	02° 59.959'N	165° 00.129'E
C07	30 Jan.'97	02:43	01° 58.803'N	164° 57.890'E
C08	30 Jan.'97	08:40	01° 00.184'N	165° 00.048'E
C09	01 Feb.'97	06:43	00° 01.002'S	165° 01.051'E
C10	02 Feb.'97	00:44	02° 59.985'S	165° 00.072'E
C11	02 Feb.'97	08:10	03° 59.980'S	164° 59.993'E
C12	03 Feb.'97	02:15	04° 58.832'S	165° 11.707'E
C13	04 Feb.'97	21:05	02° 27.343'S	157° 23.336'E
C14	04 Feb.'97	05:53	02° 01.371'S	156° 00.011'E
C15	05 Feb.'97	09:25	01° 30.352'S	156° 00.071'E
C16	05 Feb.'97	12:46	01° 00.026'S	156° 00.084'E
C17	05 Feb.'97	16:18	00° 29.900'S	156° 00.032'E
C18	05 Feb.'97	22:10	00° 01.049'S	156° 08.820'E
C19	06 Feb.'97	03:16	00° 30.022'N	155° 59.892'E
C20	06 Feb.'97	07:34	00° 59.874'N	155° 59.906'E
C21	06 Feb.'97	10:50	01° 29.947'N	156° 00.003'E
C22	06 Feb.'97	21:43	02° 02.626'N	156° 00.308'E
C23	07 Feb.'97	07:05	02° 59.997'N	155° 59.886'E
C24	07 Feb.'97	12:43	03° 59.970'N	155° 59.990'E
C25	07 Feb.'97	18:33	05° 00.019'N	156° 00.085'E
C26	08 Feb.'97	00:05	05° 59.970'N	156° 00.018'E
C27	08 Feb.'97	06:23	07° 01.461'N	156° 00.261'E
C28	09 Feb.'97	02:03	08° 00.537'N	155° 59.945'E
C29	15 Feb.'97	02:54	04° 58.127'N	147° 02.192'E
C30	15 Feb.'97	17:25	03° 00.047'N	146° 59.987'E
C31	16 Feb.'97	03:10	01° 59.785'N	146° 59.965'E
C32	16 Feb.'97	06:35	01° 30.024'N	146° 59.999'E
C33	16 Feb.'97	09:52	00° 59.992'N	146° 59.942'E
C34	17 Feb.'97	03:54	00° 00.994'N	146° 59.328'E
C35	17 Feb.'97	07:52	00° 30.022'N	146° 59.949'E
C36	17 Feb.'97	14:19	00° 30.029'S	147° 00.050'E
C37	17 Feb.'97	17:50	00° 51.884'S	147° 59.891'E
C38	17 Feb.'97	21:21	01° 29.925'S	146° 59.888'E
C39	17 Feb.'97	23:06	01° 39.993'S	146° 59.941'E
C40	19 Feb.'97	06:58	00° 00.070'S	146° 00.158'E
C41	19 Feb.'97	12:30	00° 00.001'S	145° 00.155'E
C42	19 Feb.'97	19:50	00° 00.038'S	144° 00.119'E
C43	20 Feb.'97	02:20	00° 00.030'N	143° 00.063'E
C44	20 Feb.'97	09:59	00° 29.930'S	142° 00.422'E
C45	20 Feb.'97	13:26	01° 00.057'S	142° 00.325'E

St.	Date	Time(GMT)	Latitude	Longitude
C46	20 Feb.'97	17:01	01° 30.001'S	142° 00.030'E
C47	20 Feb.'97	19:57	01° 55.008'S	142° 00.104'E
C48	20 Feb.'97	23:51	02° 30.774'S	142° 00.032'E
C49	21 Feb.'97	01:30	02° 39.801'S	142° 00.020'E
C50	22 Feb.'97	00:32	00° 00.667'N	141° 58.486'E
C51	22 Feb.'97	06:37	00° 00.042'S	141° 00.076'E
C52	22 Feb.'97	13:14	00° 00.006'N	140° 00.144'E
C53	22 Feb.'97	20:00	00° 00.002'N	139° 00.099'E
C54	23 Feb.'97	05:09	00° 59.948'S	138° 00.211'E
C55	23 Feb.'97	08:49	00° 30.151'S	138° 00.117'E
C56	23 Feb.'97	12:29	00° 00.295'S	138° 00.094'E
C57	23 Feb.'97	16:07	00° 30.010'N	137° 59.938'E
C58	23 Feb.'97	19:47	00° 59.911'N	137° 59.970'E
C59	23 Feb.'97	23:16	01° 30.040'N	137° 59.965'E
C60	24 Feb.'97	02:50	01° 59.957'N	138° 00.012'E
C61	25 Feb.'97	00:45	02° 27.397'N	137° 25.010'E

4.3 CTD Profiles

ST.C01 (08-00.39N, 165-00.81E)



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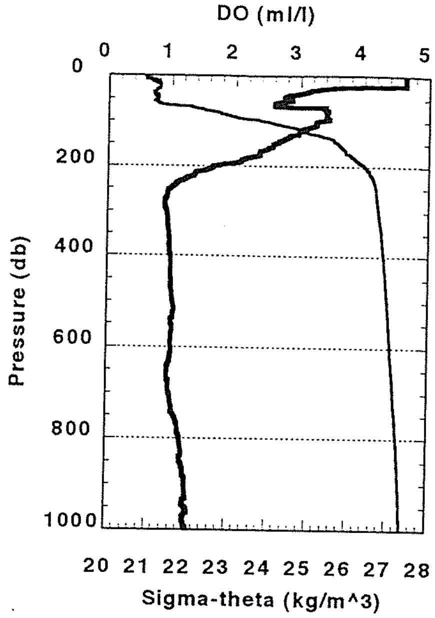
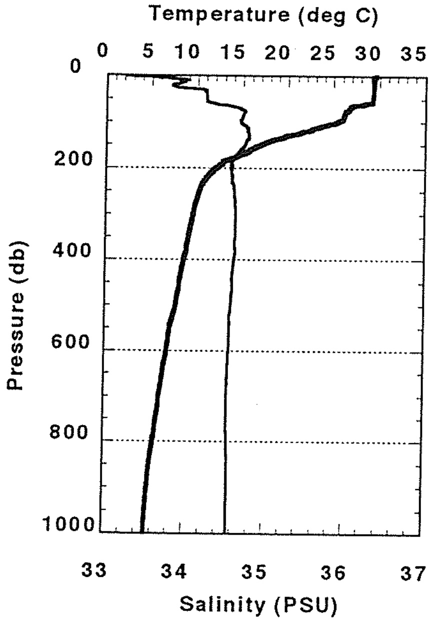
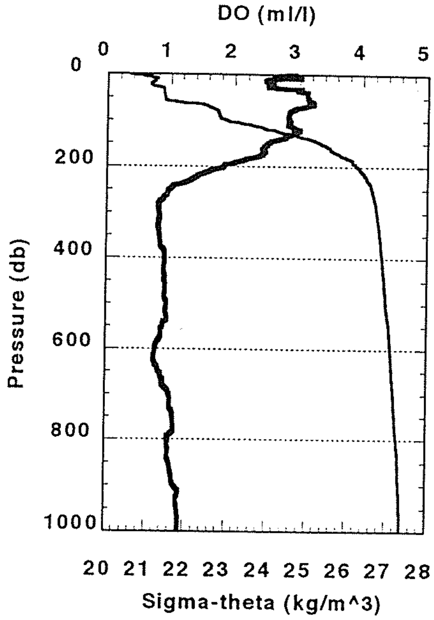


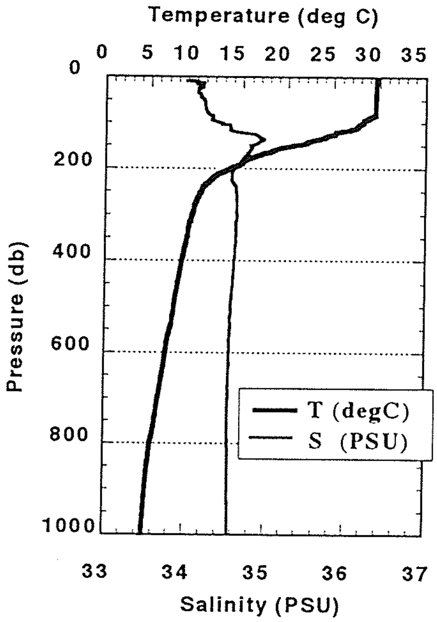
ST.C02 (07-00.02N, 165-00.01E)



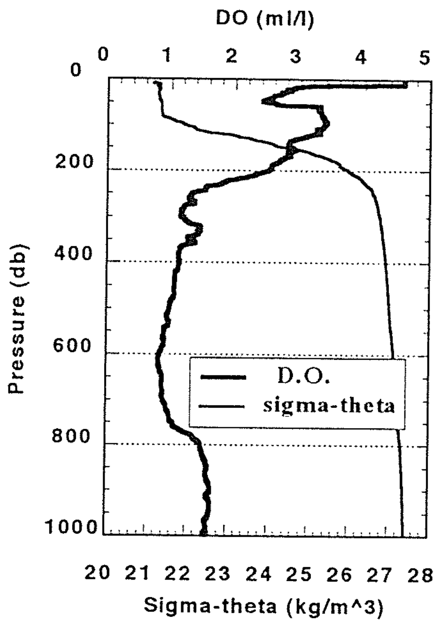
ST.C02 (07-00.02N, 165-00.01E)



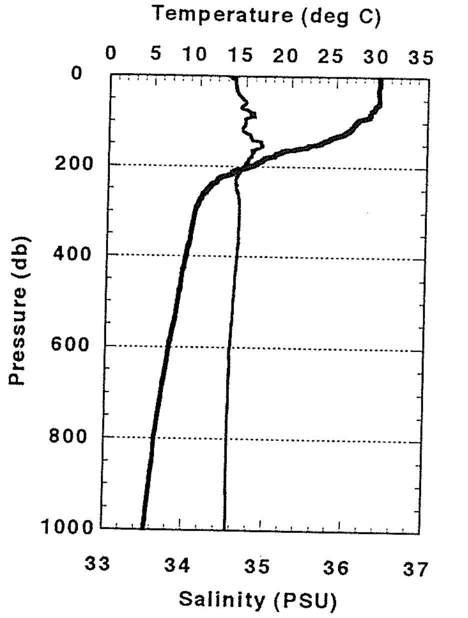
ST.C03 (06-00.62N, 165-00.08E)



ST.C03 (06-00.62N, 165-00.08E)



ST.C04 (05-04.11N, 164-59.98E)



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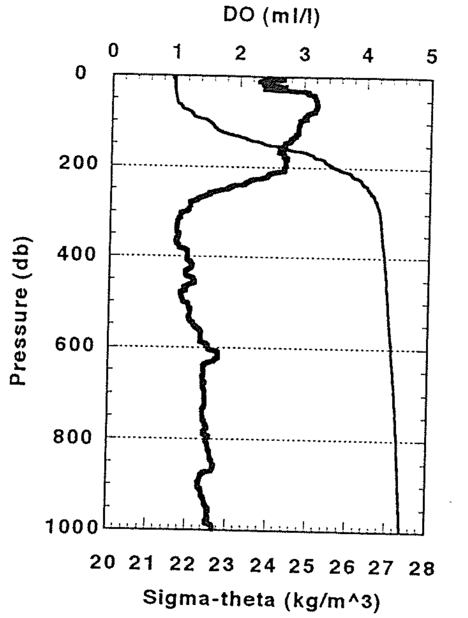
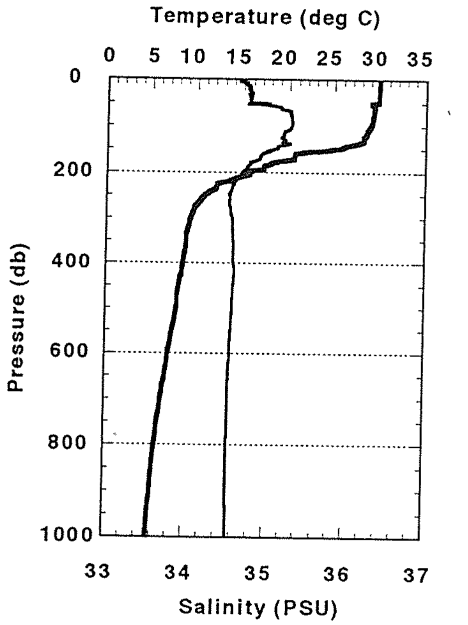


ST.C05 (04-05.39N, 164-59.88E)



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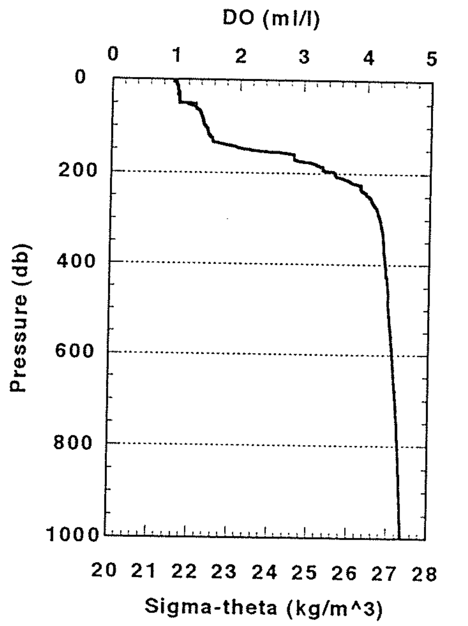
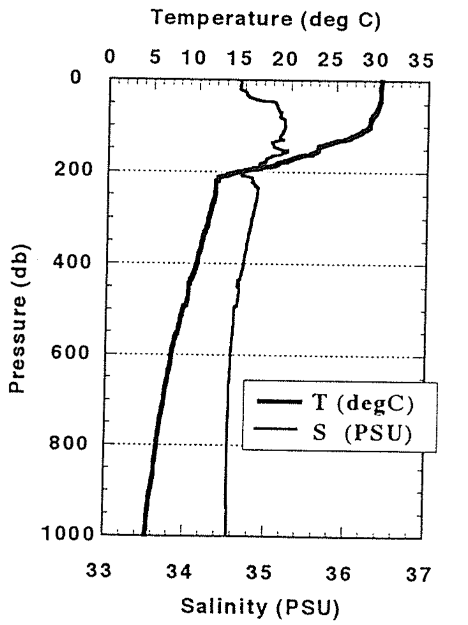


ST.C06 (02-59.96N, 165-00.13E)



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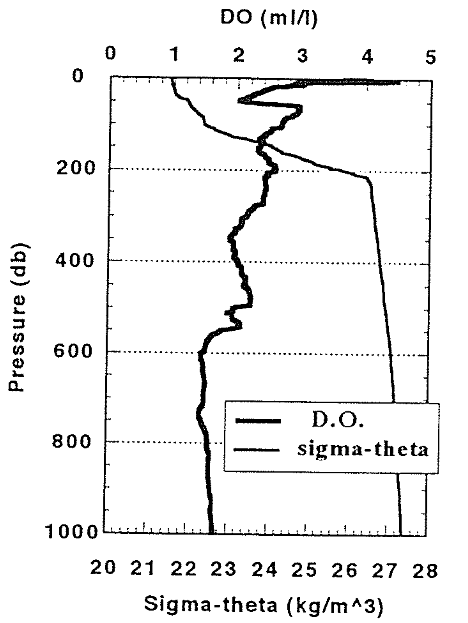
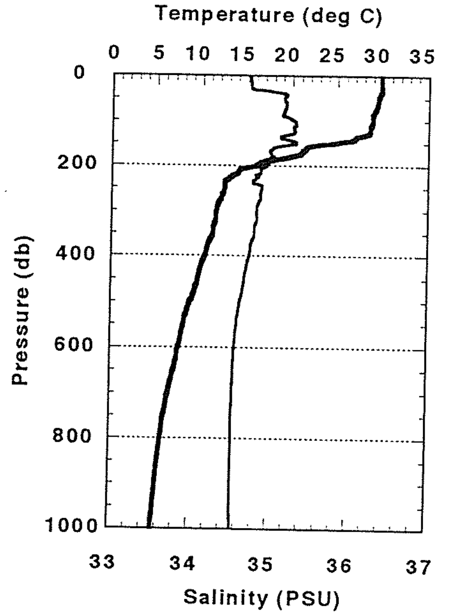
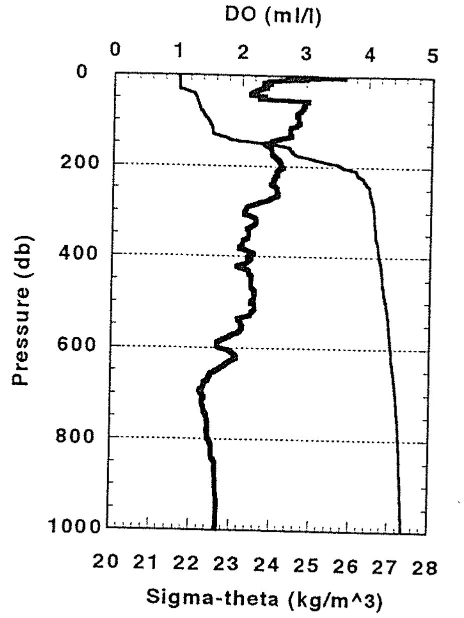


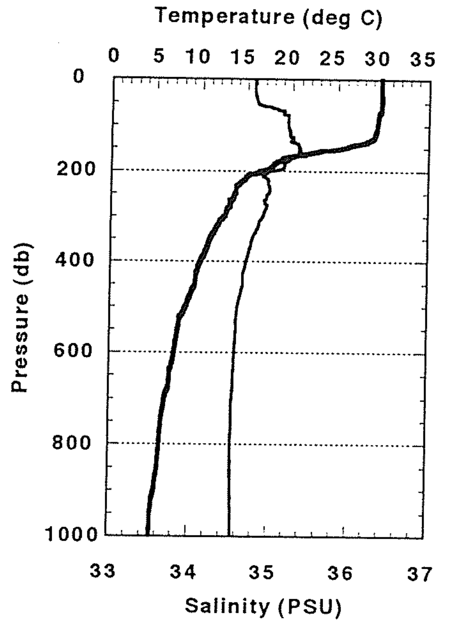
ST.C07 (01-58.80N, 164-57.89E)



ST.C07 (01-58.80N, 164-57.89E)



ST.C08 (01-00,18N, 165-00.05E)



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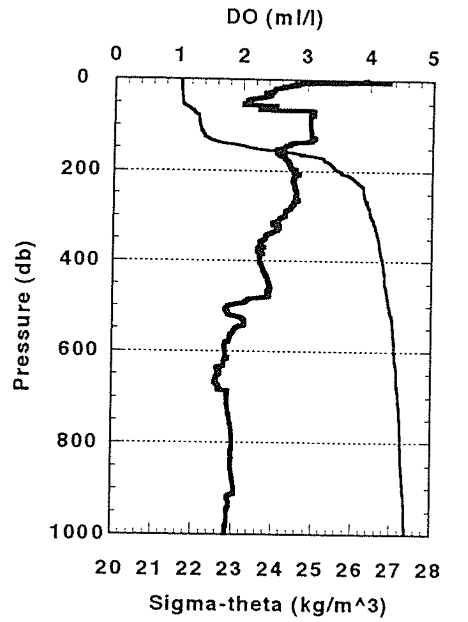

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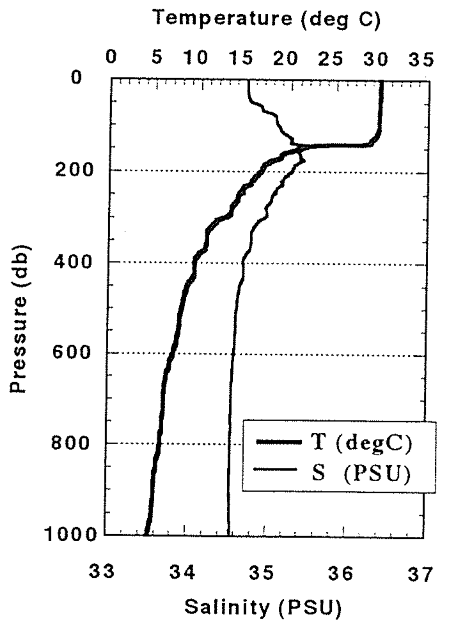
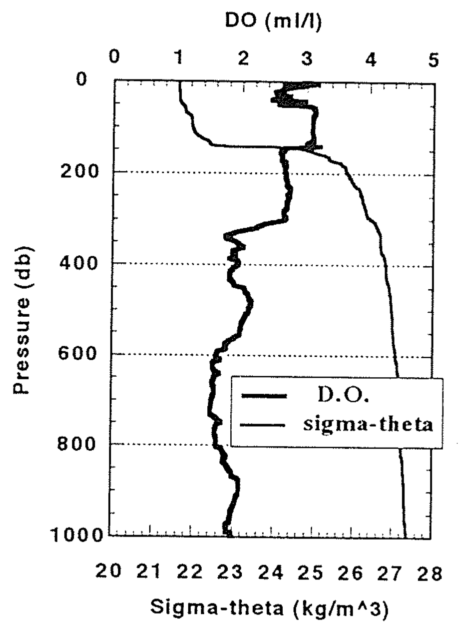
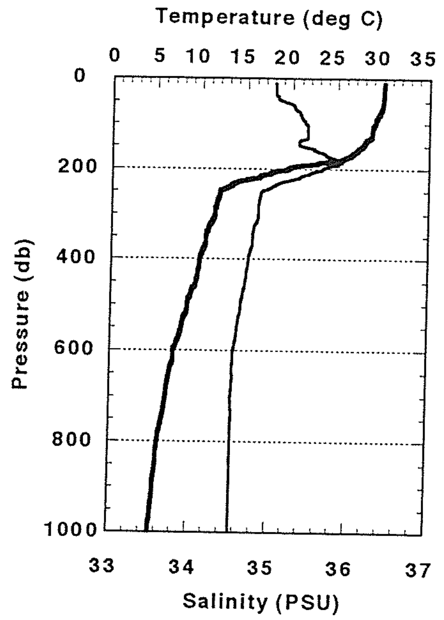


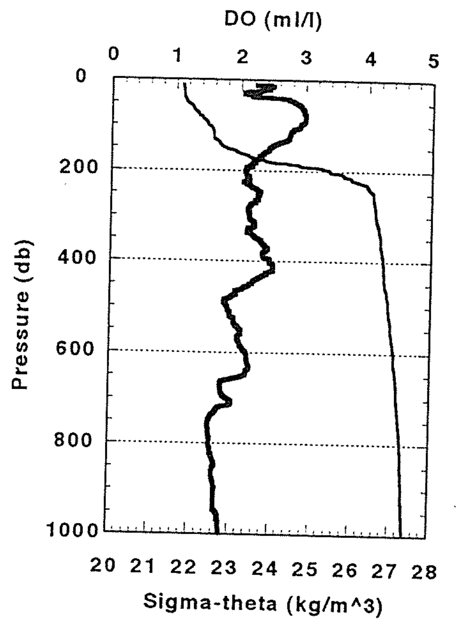
ST.C09 (00-01.00S, 165-01.05E)



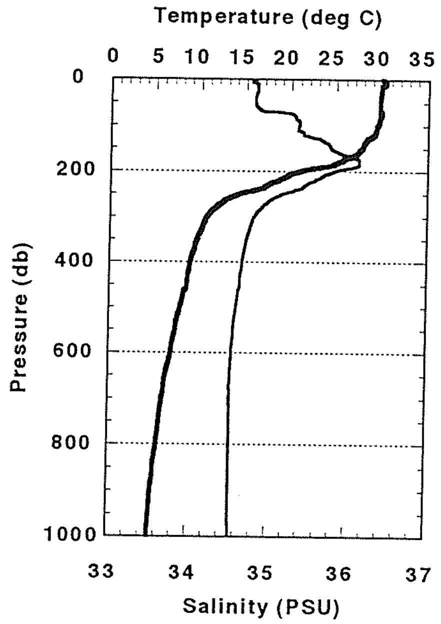
ST.C10 (02-59.99S, 165-00.07E)



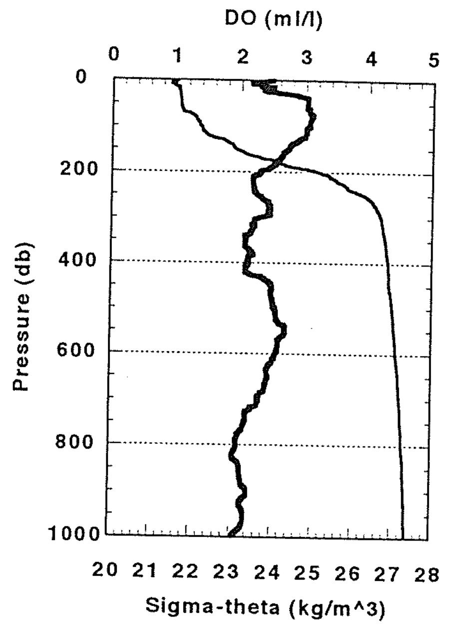
ST.C10 (02-59.99S, 165-00.07E)



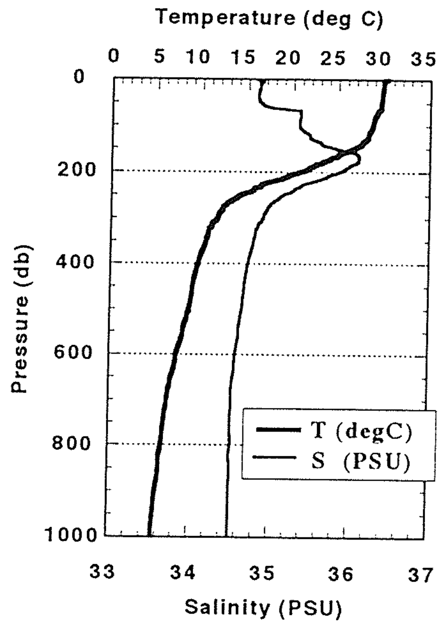
ST.C11 (03-59.98S, 164-59.99E)



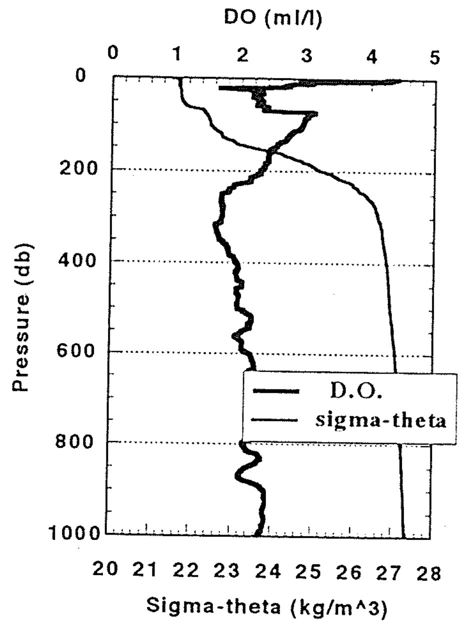
ST.C11 (03-59.98S, 164-59.99E)



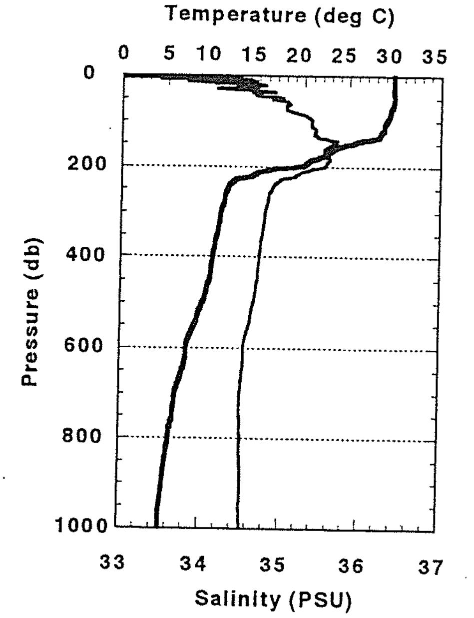
ST.C12 (04-58.83S, 165-11.71E)



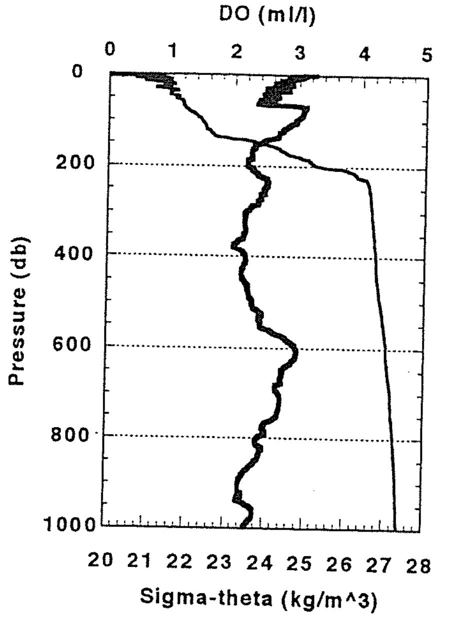
ST.C12 (04-58.83S, 165-11.71E)



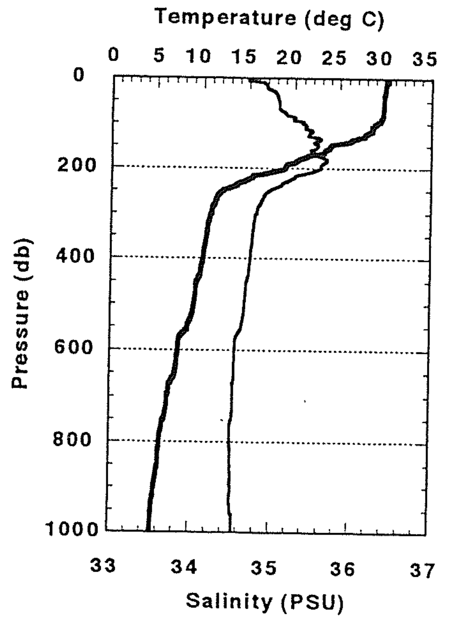
ST.C13 (02-27.34S, 157-23.34E)



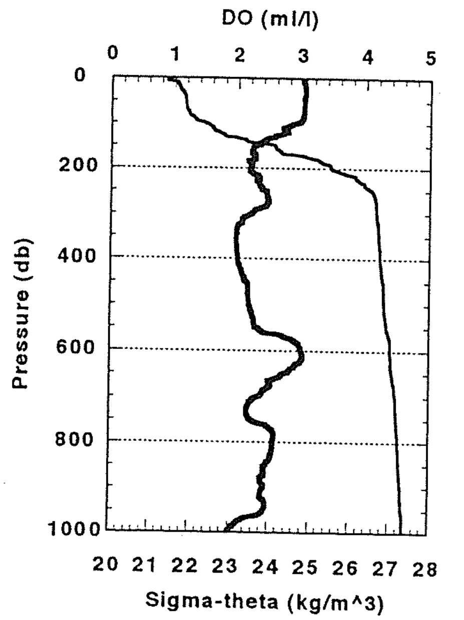
ST.C13 (02-27.34S, 157-23.34E)



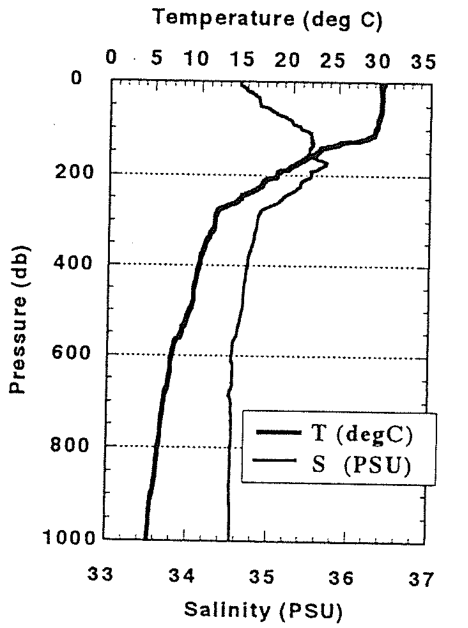
ST.C14 (02-1.371S, 156-0.011E)



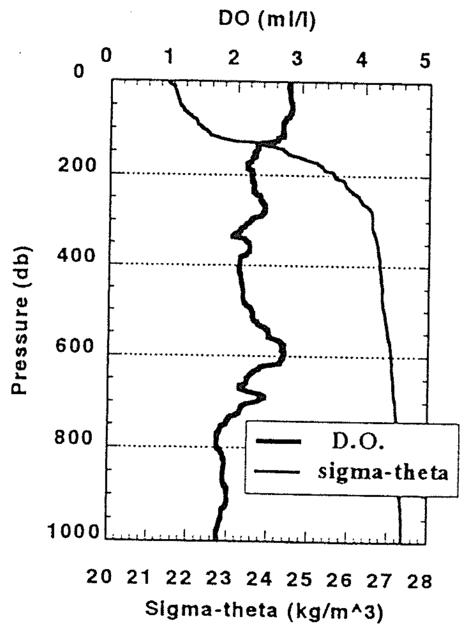
ST.C14 (02-1.371S, 156-0.011E)



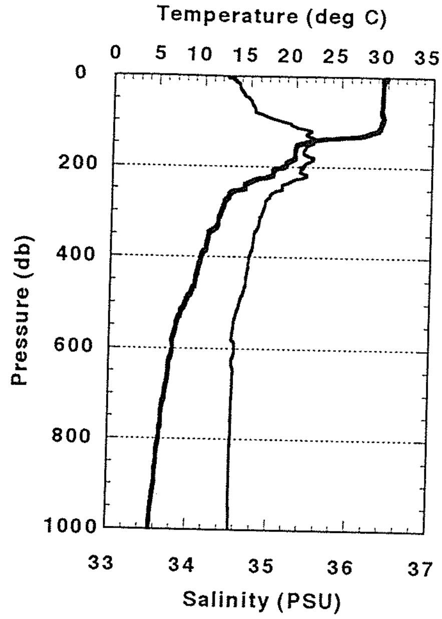
ST.C15 (01-30.352S, 156-00.71E)



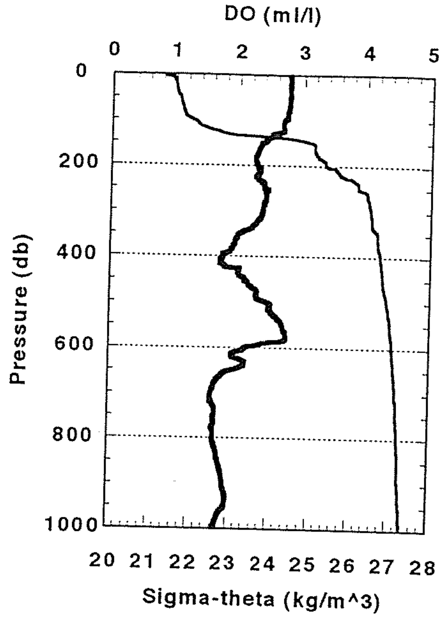
ST.C15 (01-30.352S, 156-00.71E)



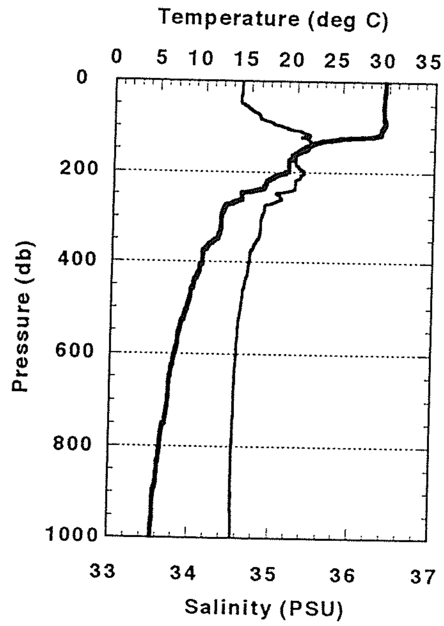
ST.C16 (01-0.026S, 156-0.084E)



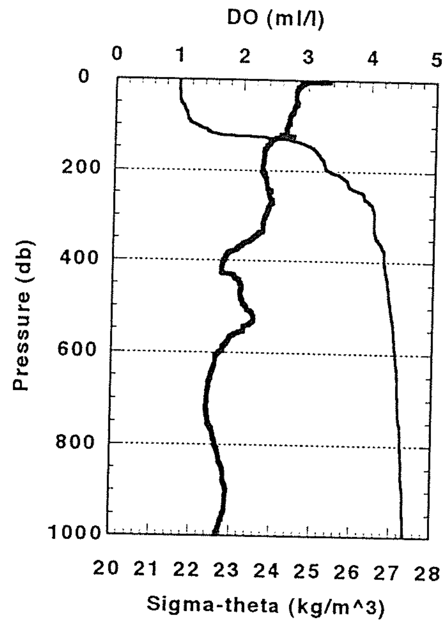
ST.C16 (01-0.026S, 156-0.084E)



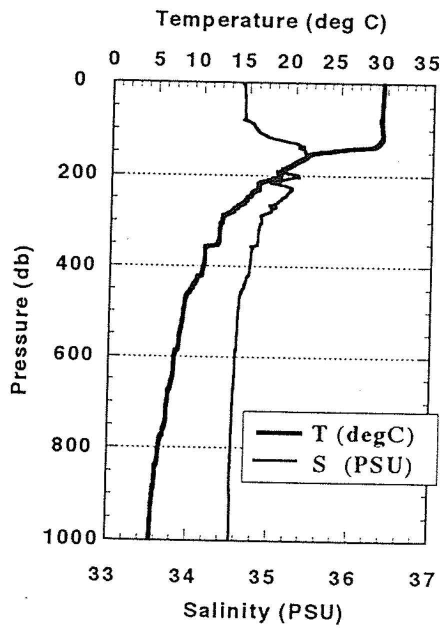
ST.C17 (00-29.900S, 156-0.032E)



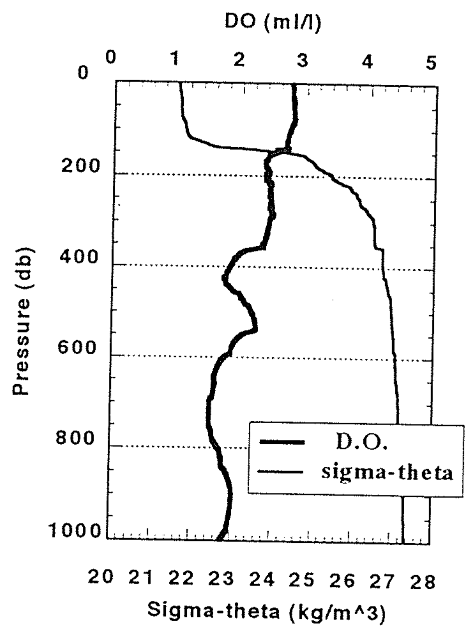
ST.C17(00-29.900S, 156-0.032E)



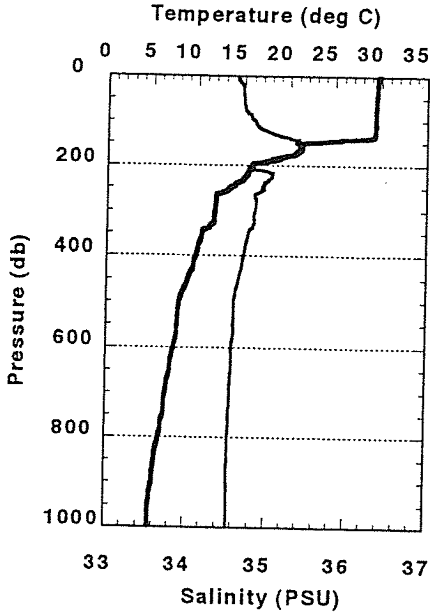
ST.C18(00-01.049S, 156-08.820E)



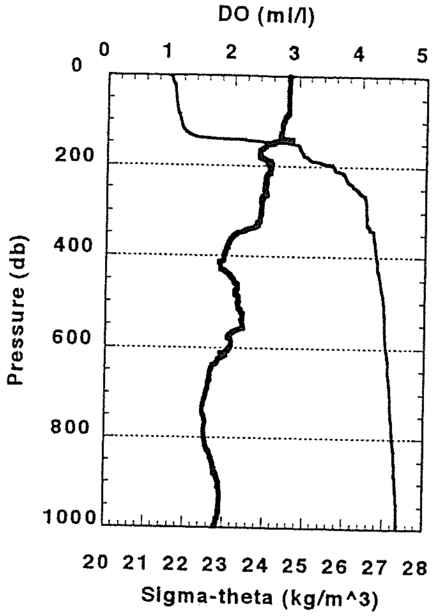
ST.C18 (00-01.049S, 156-08.820E



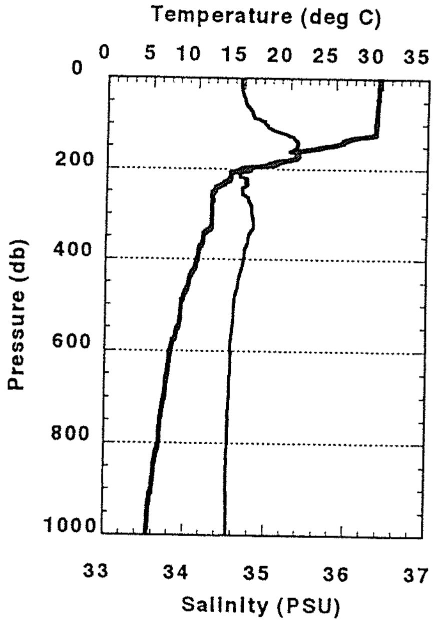
ST.C19 (00-30.022N, 155-59.892E



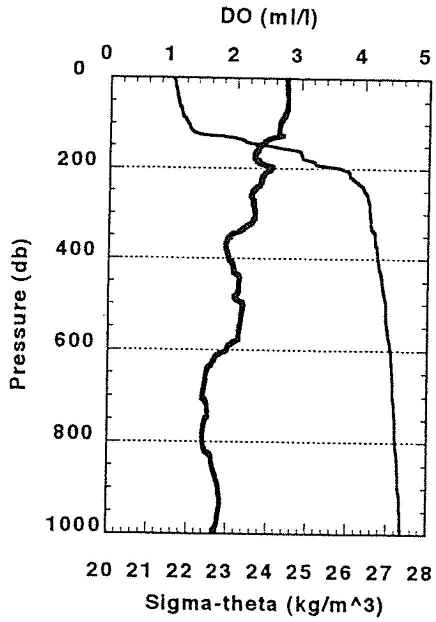
ST.C19 (00-30.022N, 155-59.892E



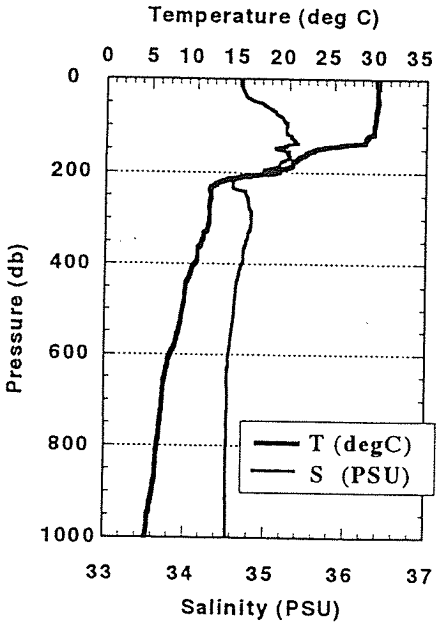
ST.C20 (00-59.874N, 155-59.906E



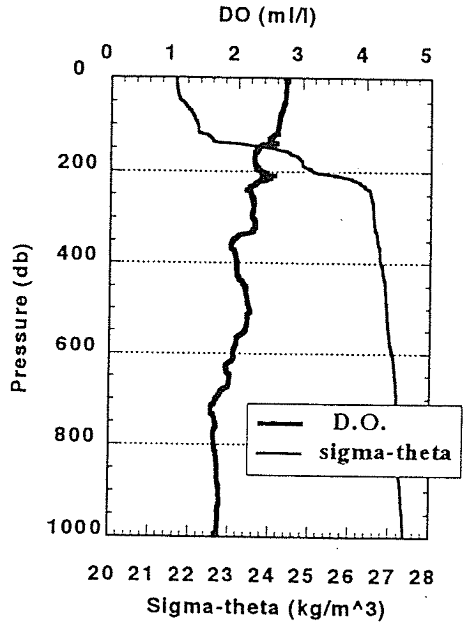
ST.C20 (00-59.874N, 155-59.906E



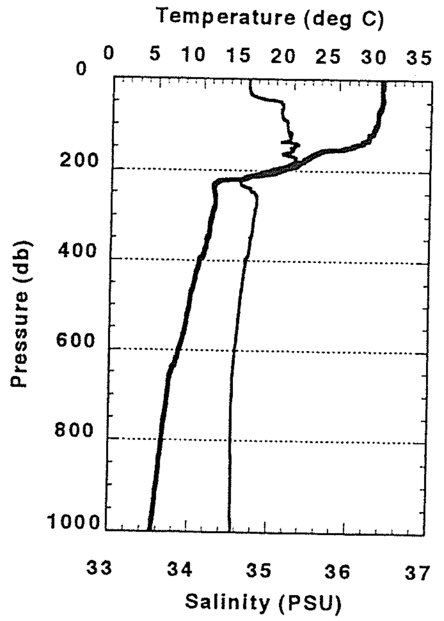
ST.C21 (01-29.947N, 156-00.003E



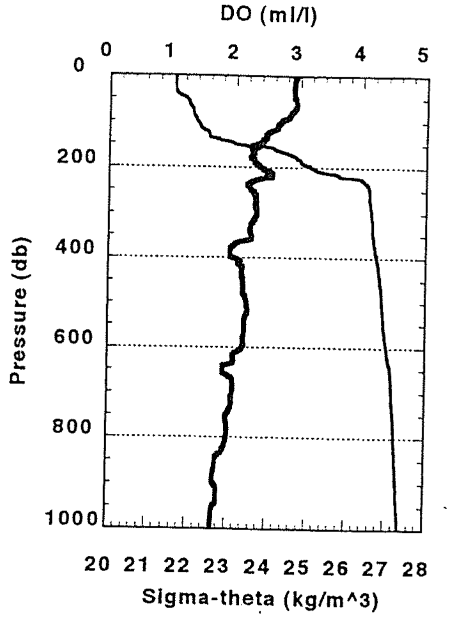
ST.C21 (01-29.947N, 156-00.003E



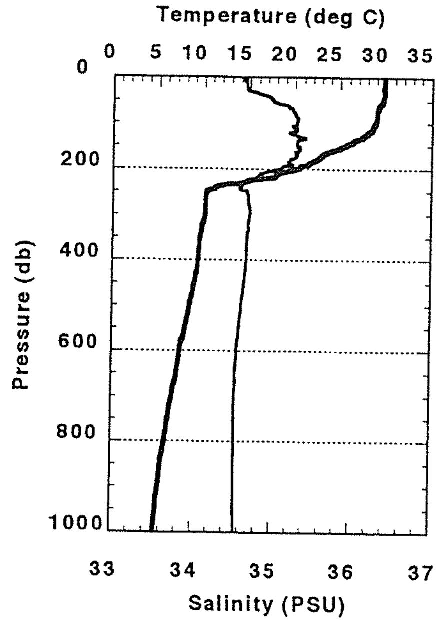
ST.C22(02-02.626N, 156-00.308E)



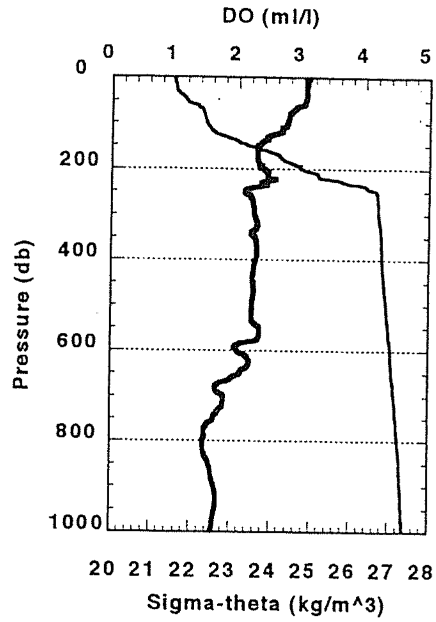
ST.C22 (02-02.626N, 156-00.308E)



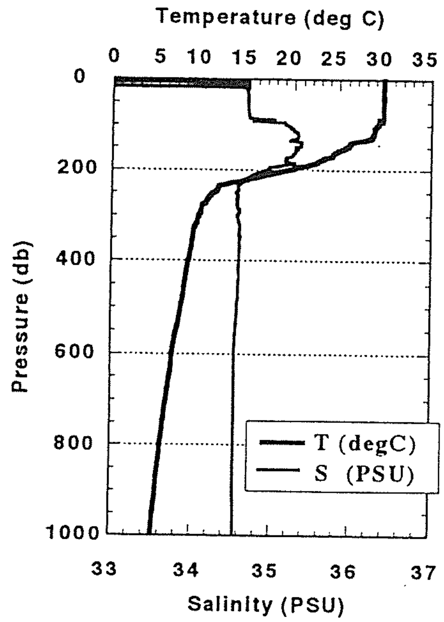
ST.C23(02-59.997N, 155-59.886E)



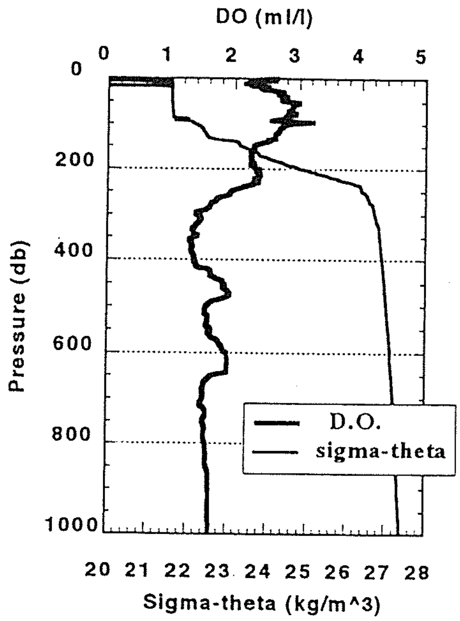
ST.C23 (02-59.997N, 155-59.886E)



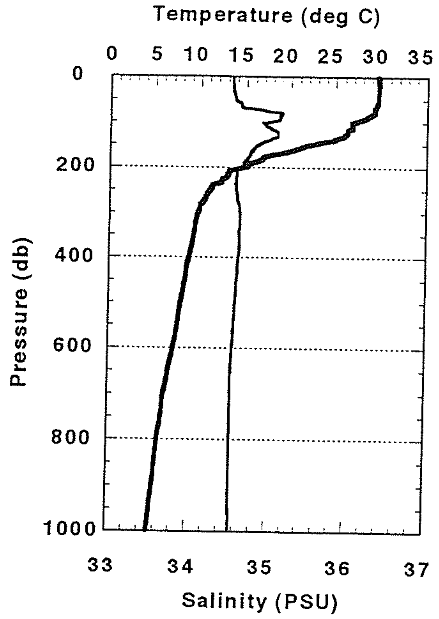
ST.C24 (03-59.970N, 155-59.990E)



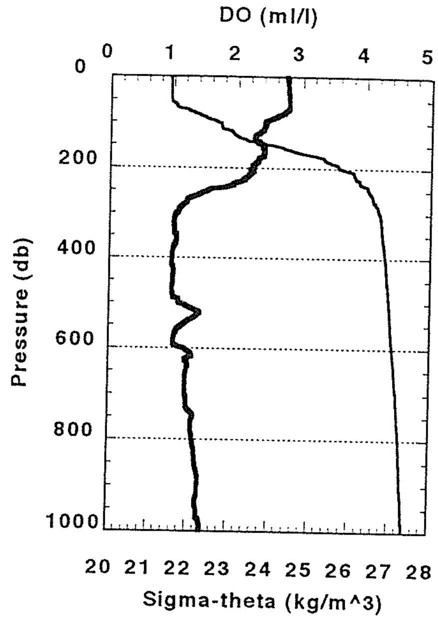
ST.C24(03-59.970N, 155-59.990E)



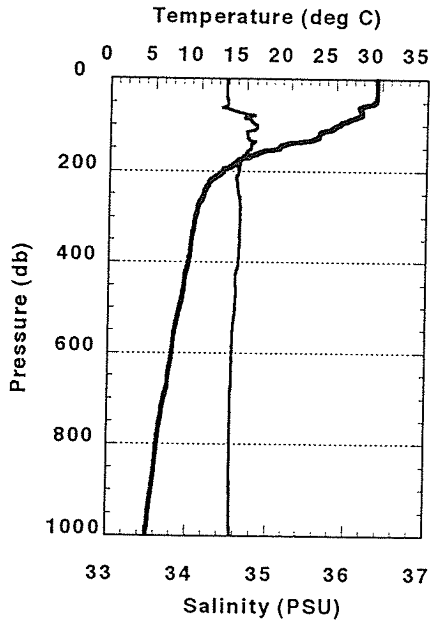
ST.C25 (05-00.019N, 156-00.085E)



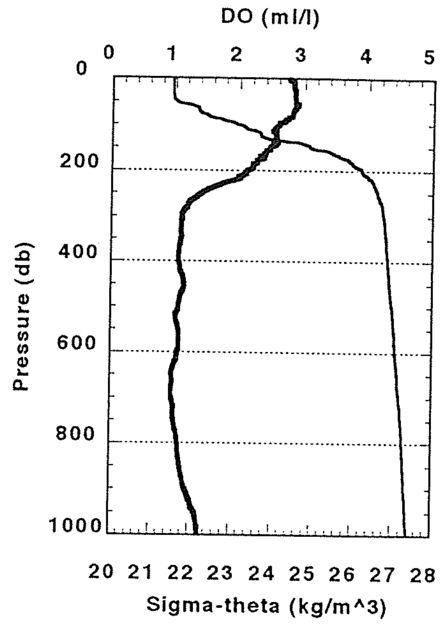
ST.C25(05-00.019N, 156-00.085E)



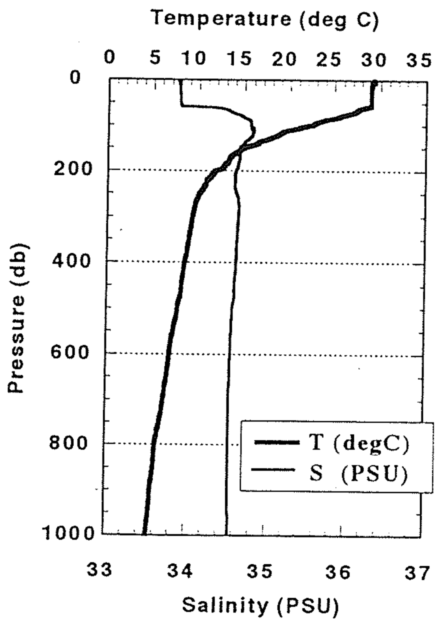
ST.C26 (05-59.970N, 156-00.018E



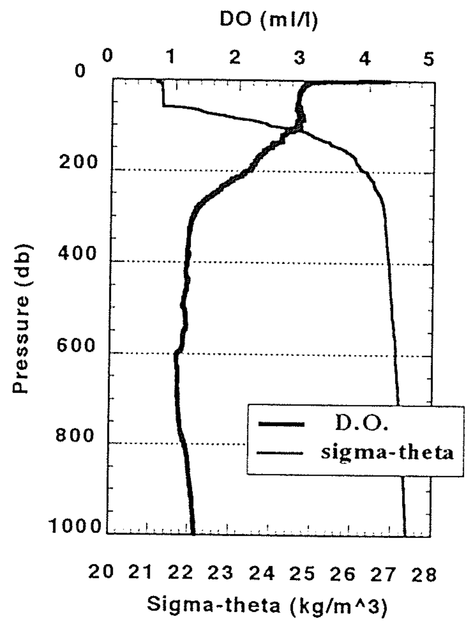
ST.C26 (05-59.970N, 156-00.018E



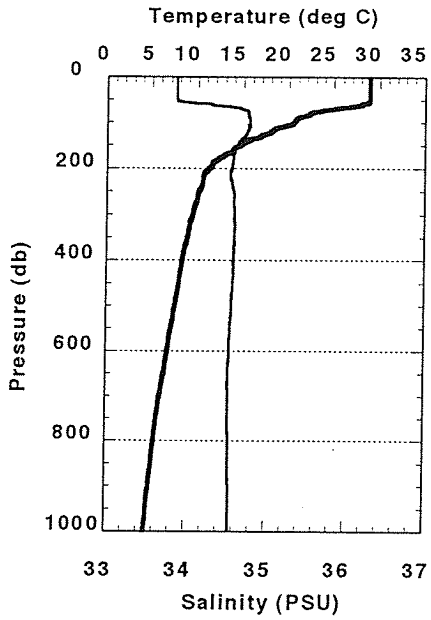
ST.C27 (07-01.461N, 156-00.261E)



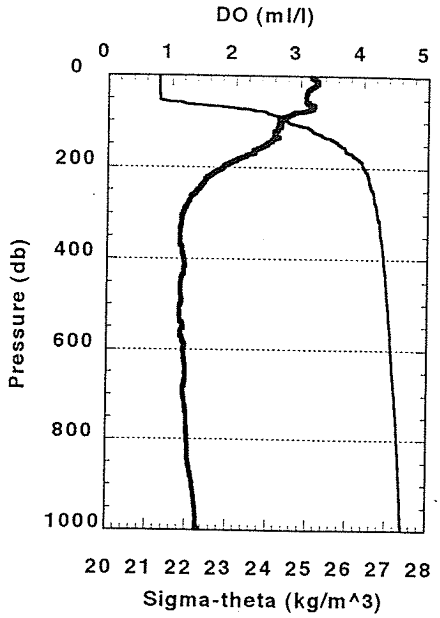
ST.C27(07-01.461N, 156-00.261E)



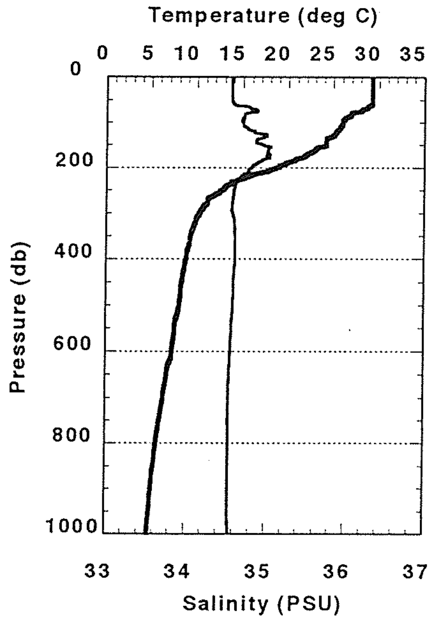
ST.C28 (08-00.537N, 155-59.945E



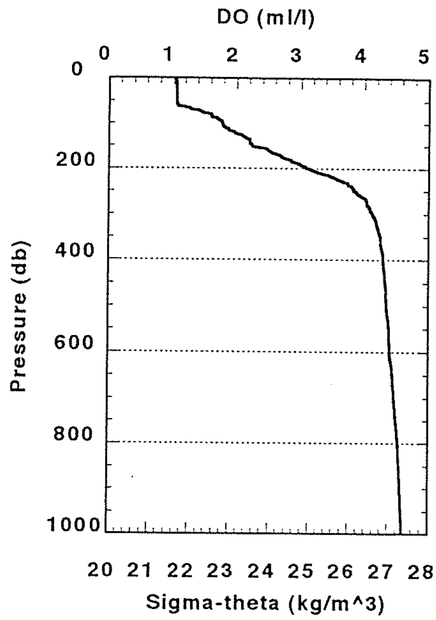
ST.C28 (08-00.537N, 155-59.945E



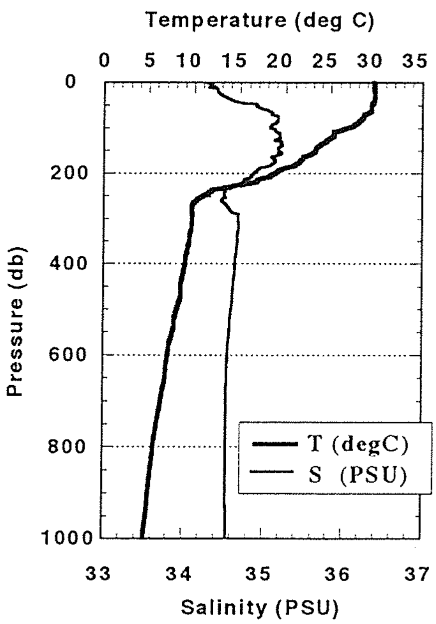
ST.C29 (04-58.127N, 147-02.192E



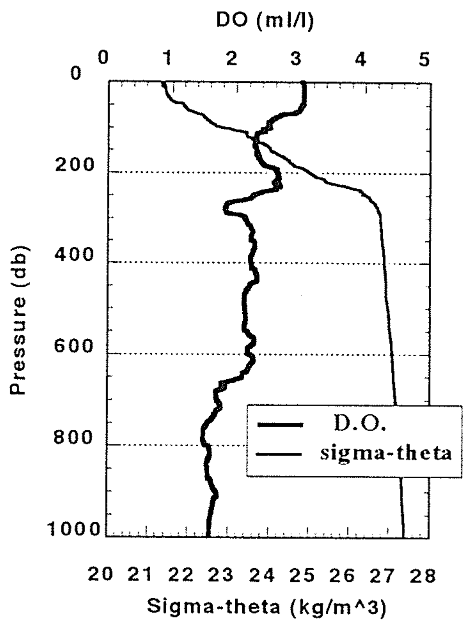
ST.C29 (04-58.127N, 147-02.192E)



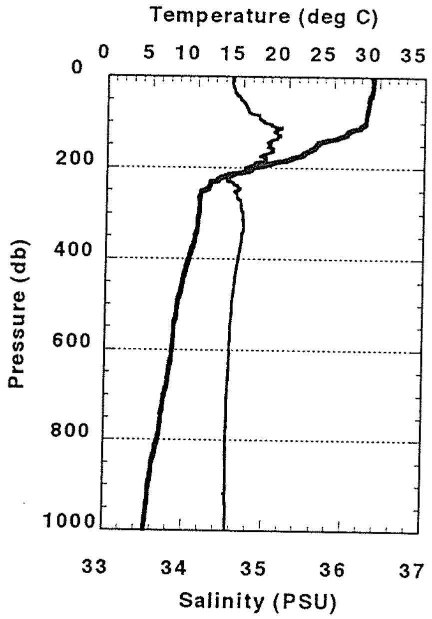
ST.C30 (03-00.047N, 146-59.987E)



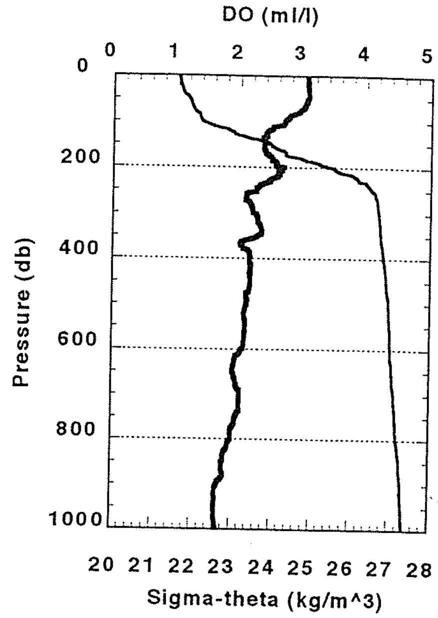
ST.C30(03-00.047N, 146-59.987E)



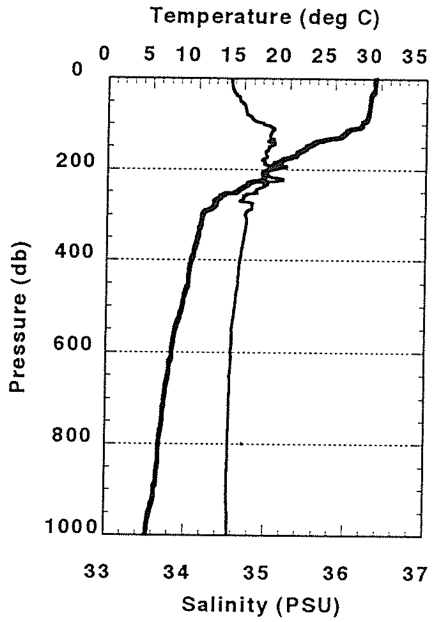
ST.C31 (01-59.785N, 146-59.965E



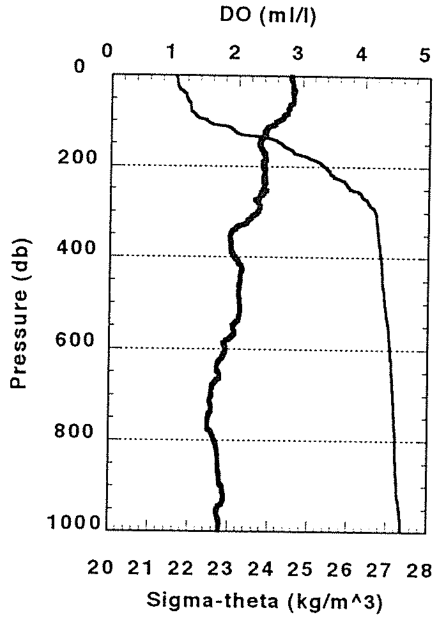
ST.C31 (01-59.785N, 146-59.965E)



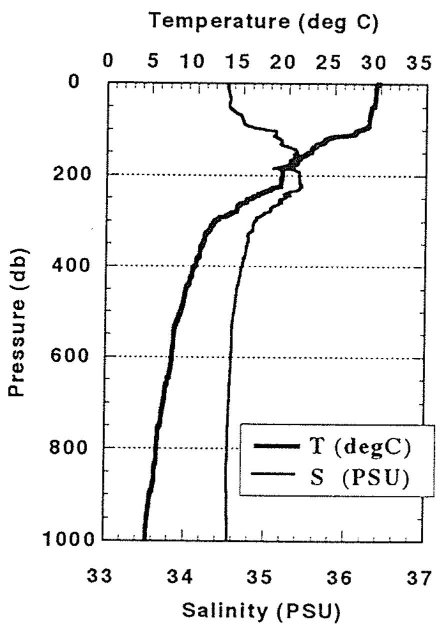
ST.C32 (01-30.024N, 146-59.999E



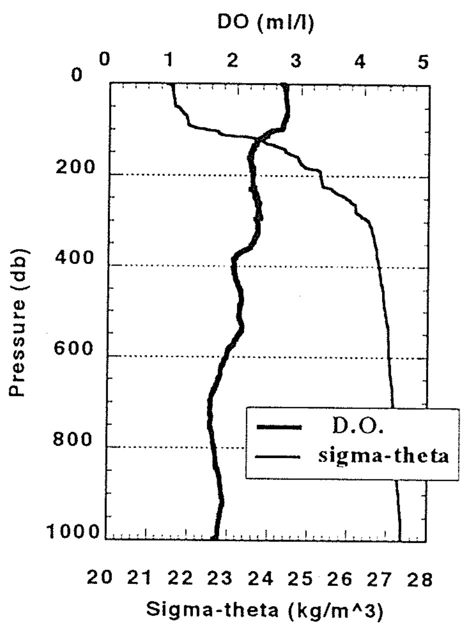
ST.C32 (01-30.024N, 146-59.999E)



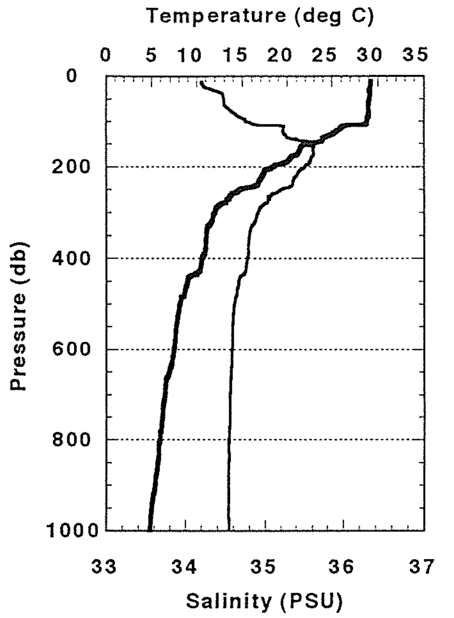
ST.C33 (00-59.992N, 146-59.942E)



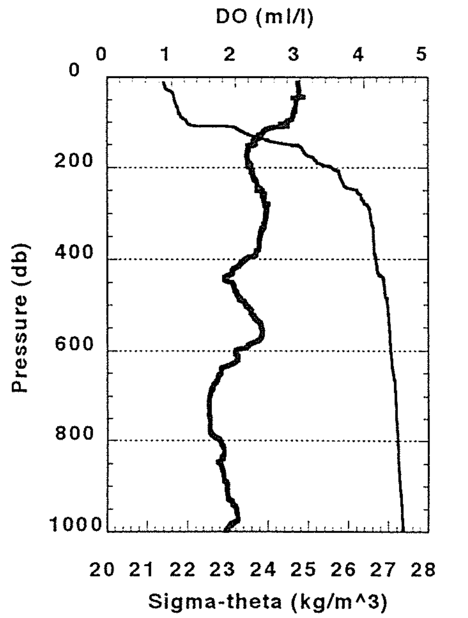
ST.C33(00-59.992N, 146-59.942E)



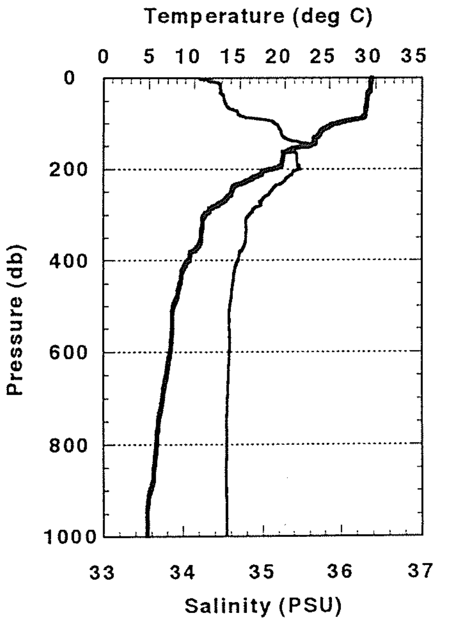
ST.C34 (00-00.994N, 146-59.328E)



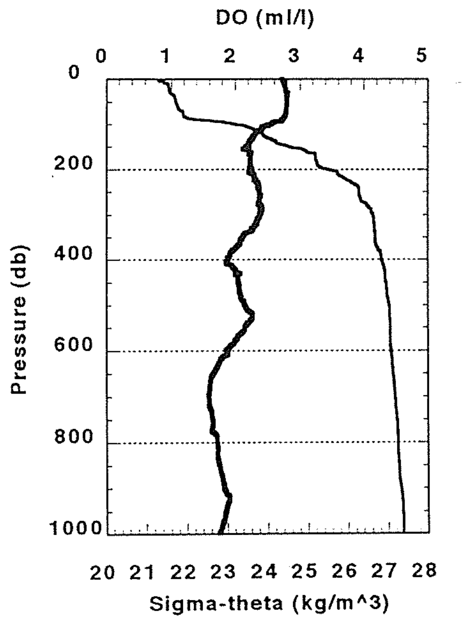
ST.C34 (00-00.994N, 146-59.328E



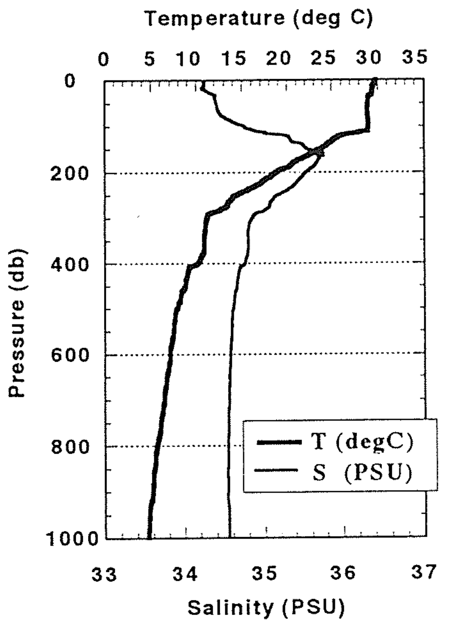
ST.C35 (00-30.022N, 146-59.949E)



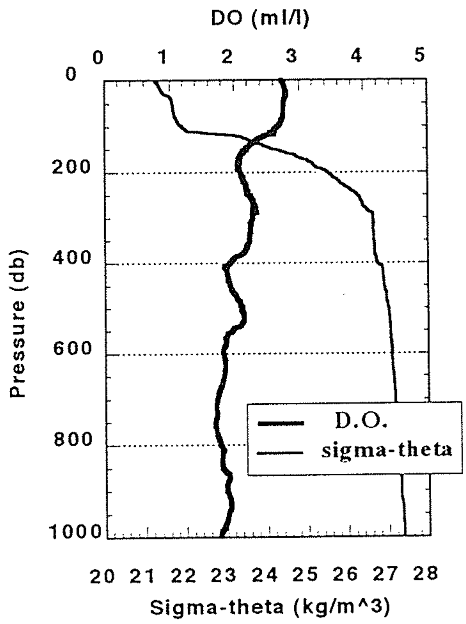
ST.C35 (00-30.022N, 146-59.949E



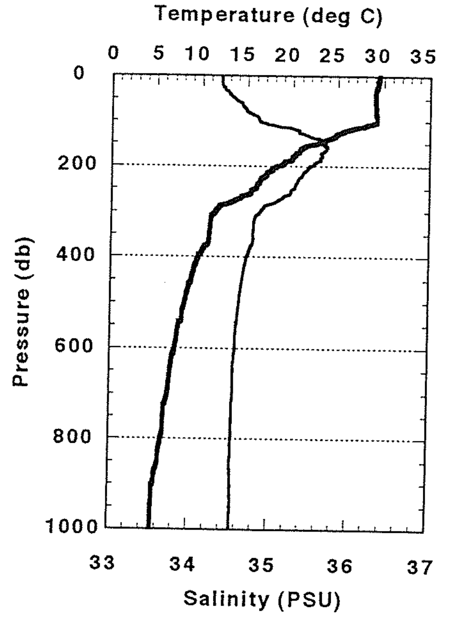
ST.C36 (00-30.029N, 147-00.050E)



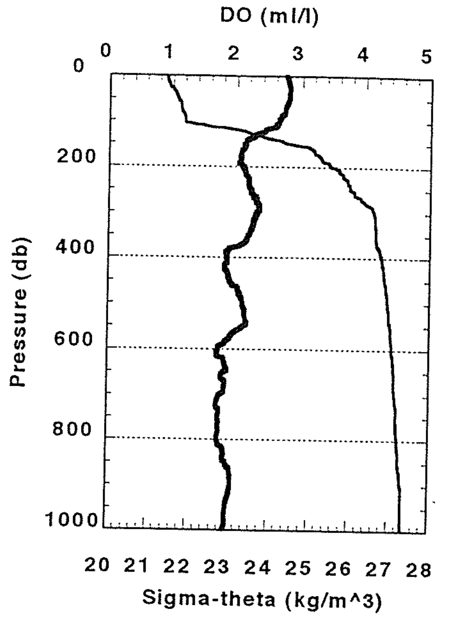
ST.C36(00-30.029N, 147-00.050E)



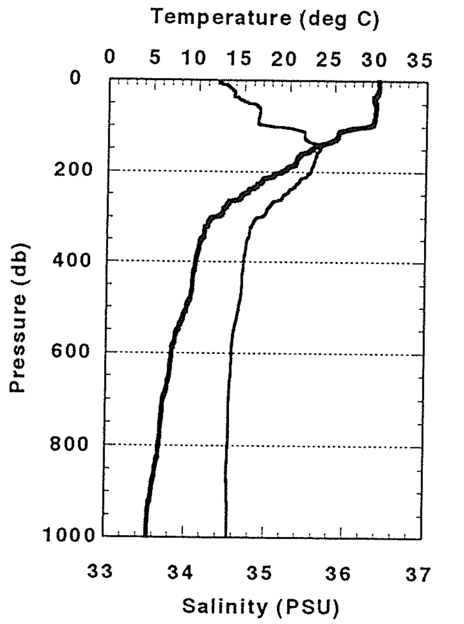
ST.C37 (00-59.884N, 147-59.891E)



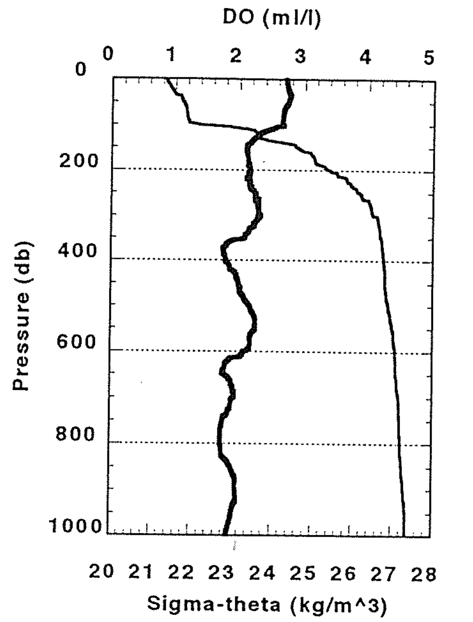
ST.C37 (00-59.884N, 147-59.891E



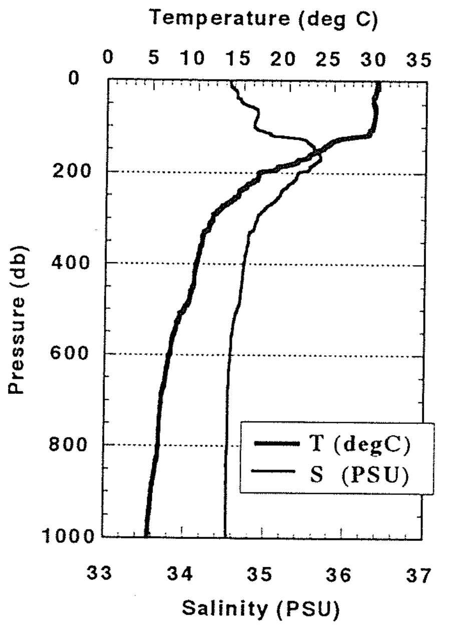
ST.C38 (01-29.925N, 146-59.888E)



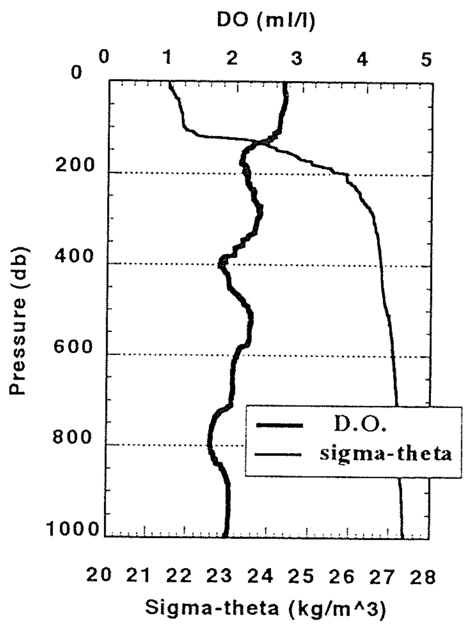
ST.C38 (01-29.925N, 146-59.888E)



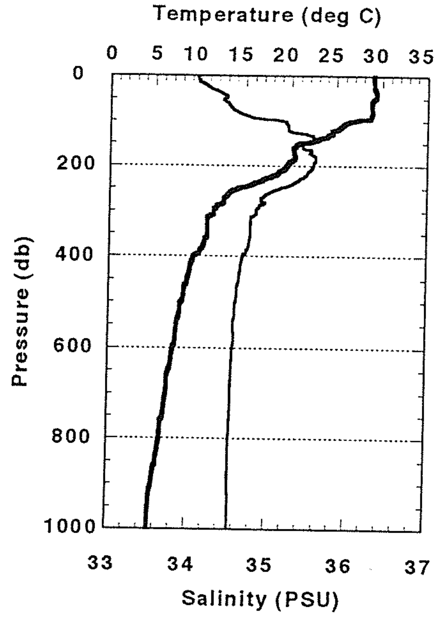
ST.C39 (01-39.993N, 146-59.941E)



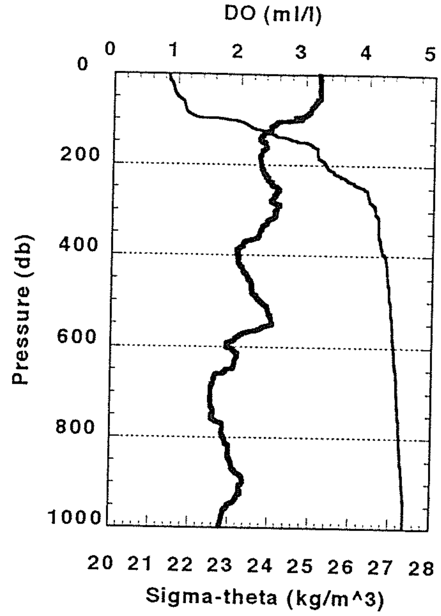
ST.C39(01-39.993N, 146-59.941E)



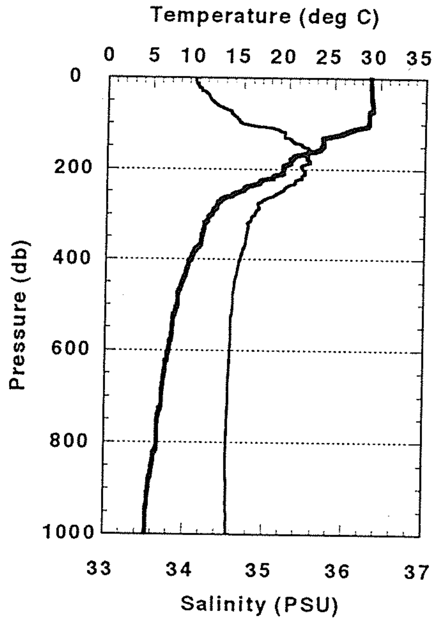
ST.C40 (00-00.070S, 146-00.158E)



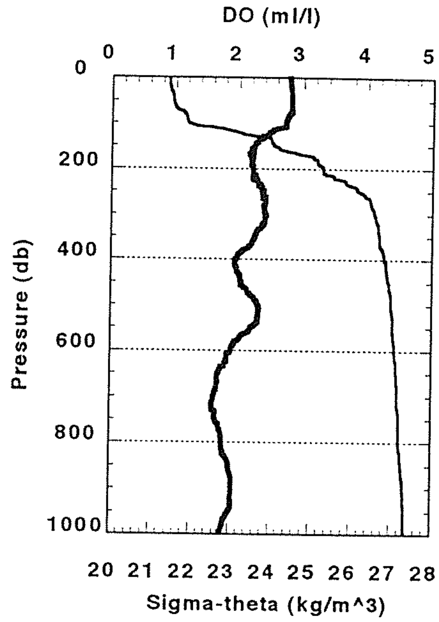
ST.C40 (00-00.070S, 146-00.158E)



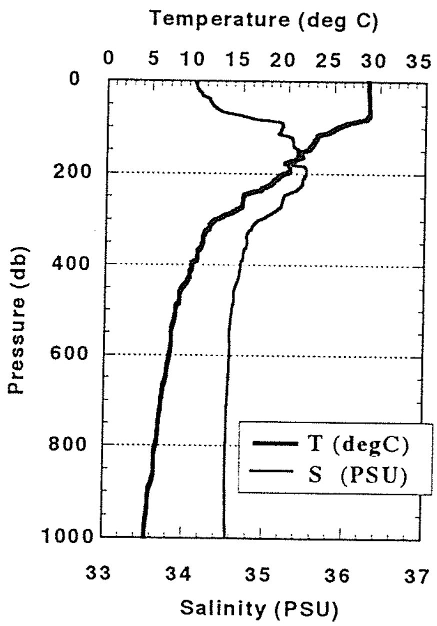
ST.C41 (00-00.001S, 145-00.155E)



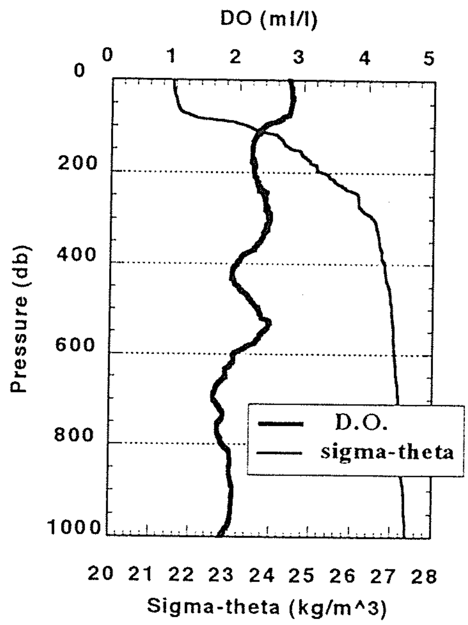
ST.C41 (00-00.001S, 145-00.155E)



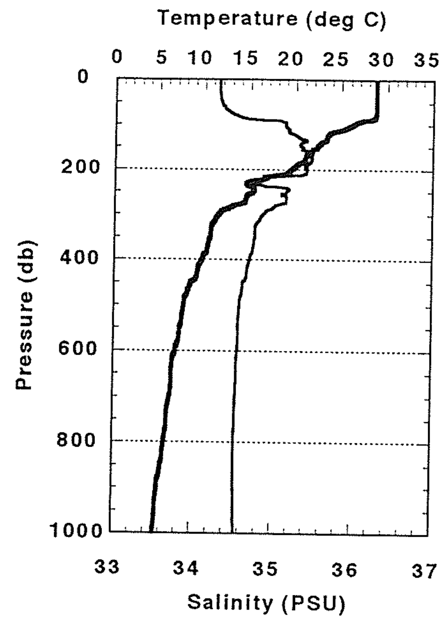
ST.C42 (00-00.038S, 144-00.119E)



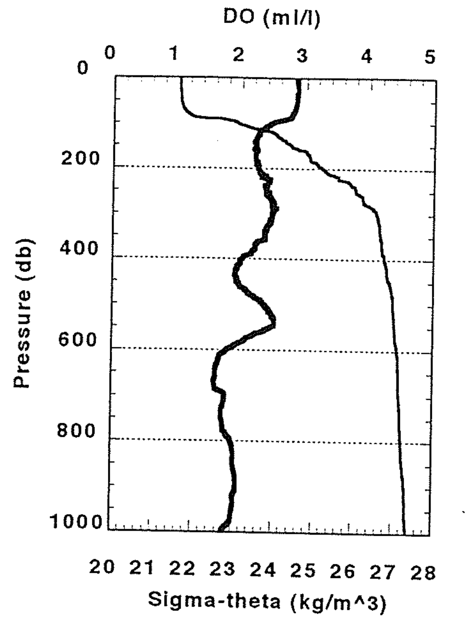
ST.C42(00-00.038S, 144-00.119E)



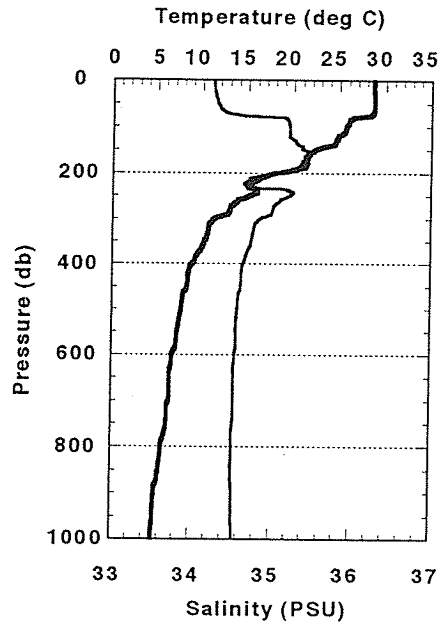
ST.C43 (00-00.030N, 143-00.063E)



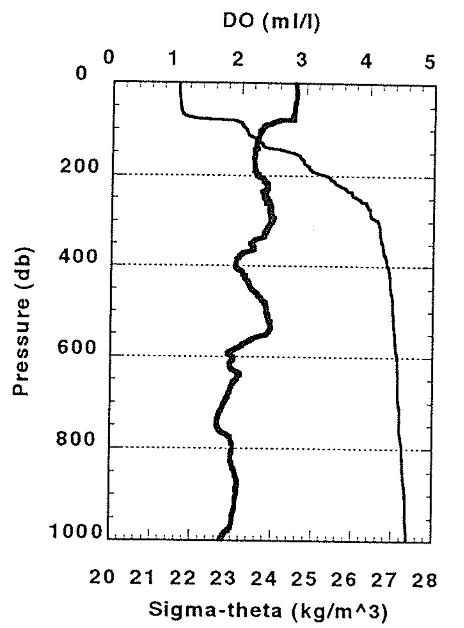
ST.C43(00-00.030N, 143-00.063E)



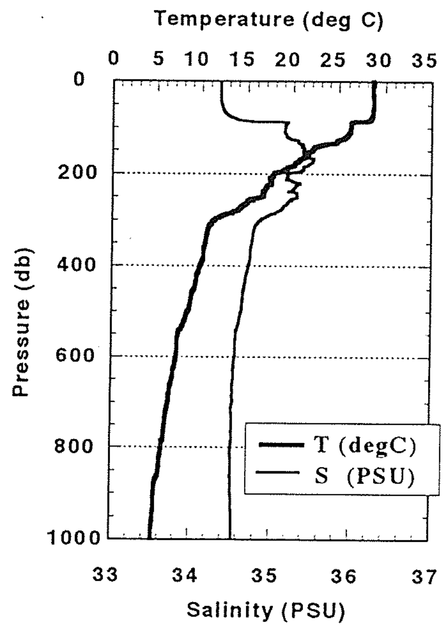
ST.C44 (00-29.930S, 142-00.422E)



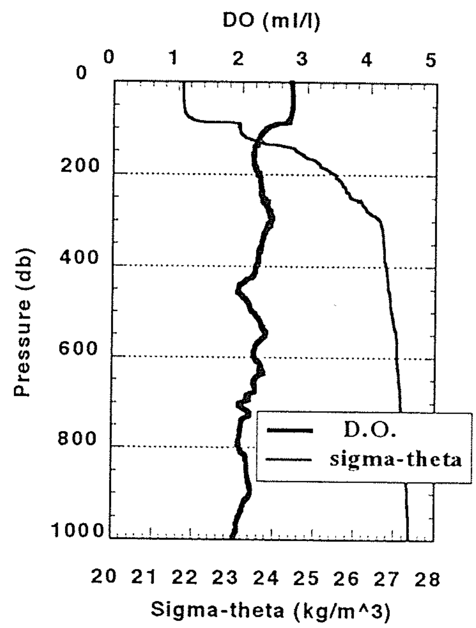
ST.C44(00-29.930S, 142-00.422E)



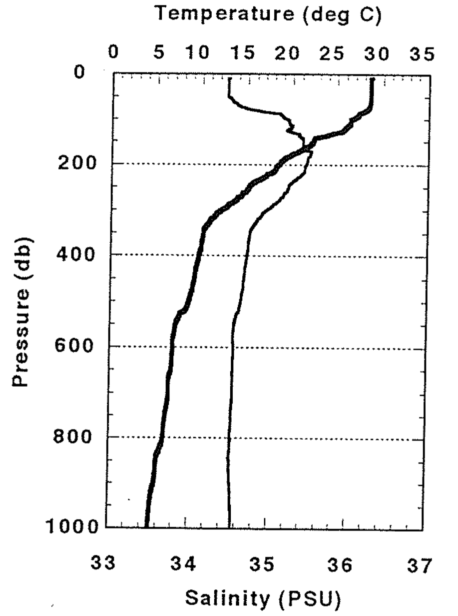
ST.C45 (01-00.057S, 142-00.325E)



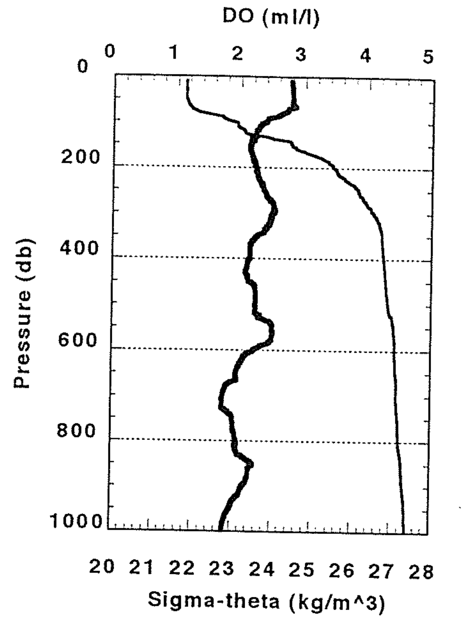
ST.C45(01-00.057S, 142-00.325E)



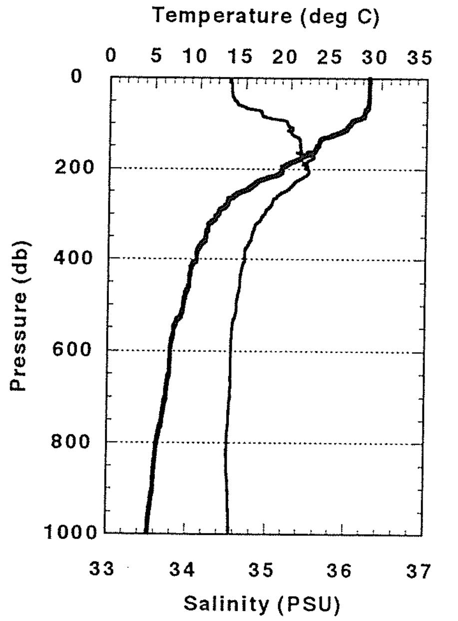
ST.C46 (01-30.001S, 142-00.030E)



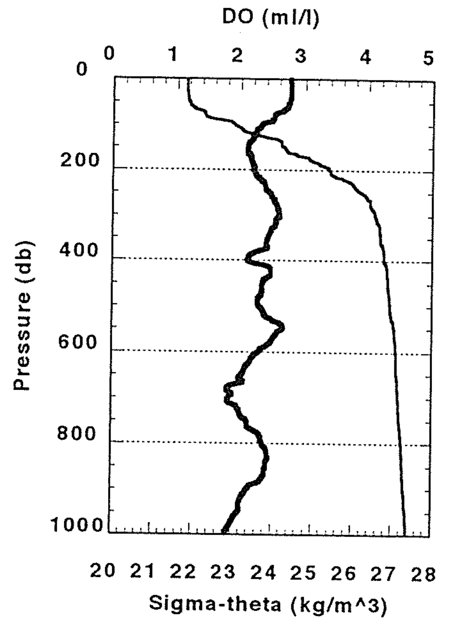
ST.C46(01-30.001S, 142-00.030E)



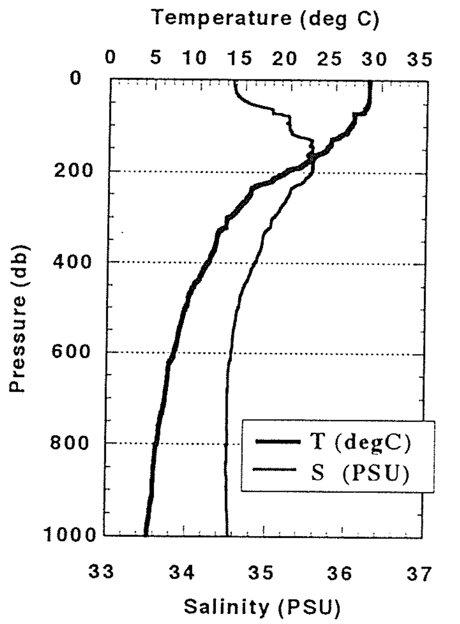
ST.C47 (01-55.008S, 142-00.104E)



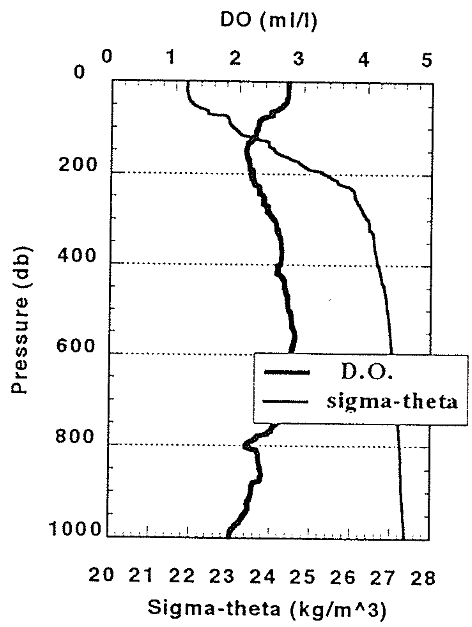
ST.C47(01-55.008S, 142-00.104E)



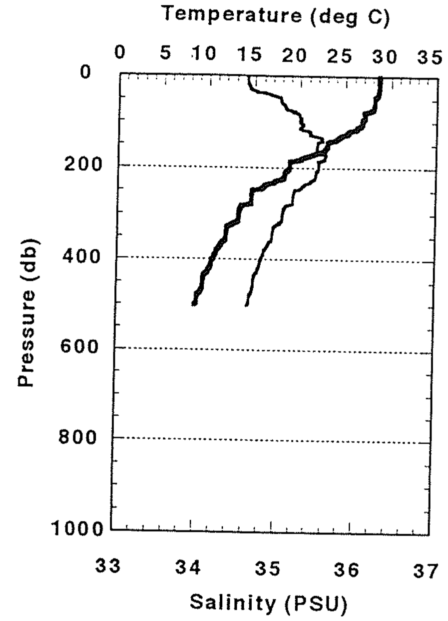
ST.C48 (02-30.774S, 142-00.032E)



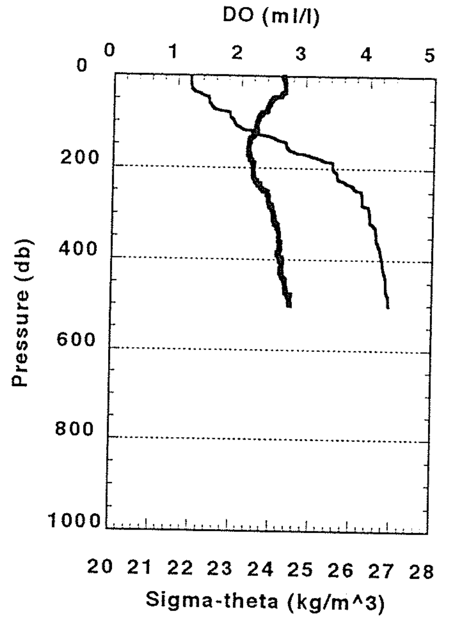
ST.C48(02-30.774S, 142-00.032E)



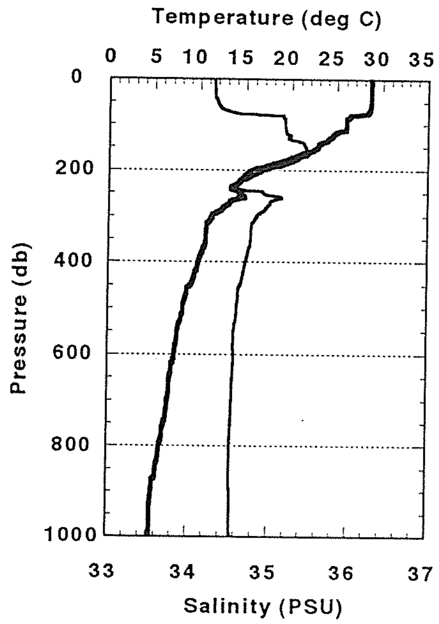
ST.C49 (02-39.801S, 142-00.020E)



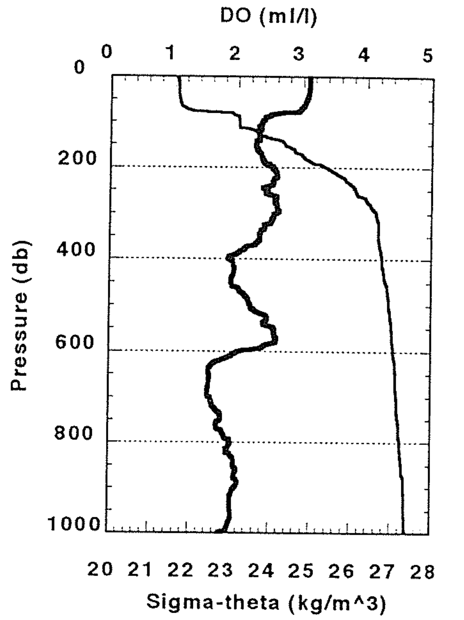
ST.C49(02-39.801S, 142-00.020E)



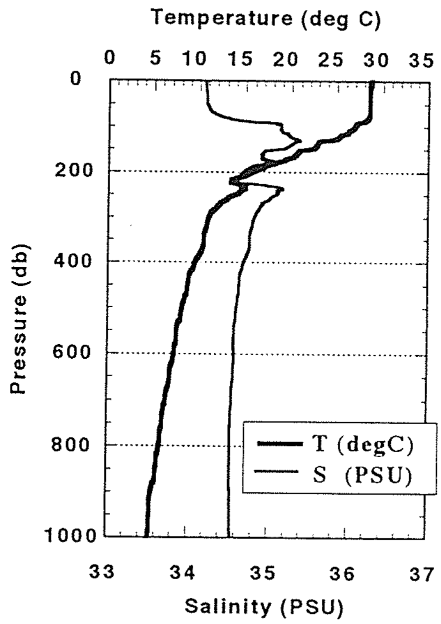
ST.C50 (00-00.667N, 141-58.486E)



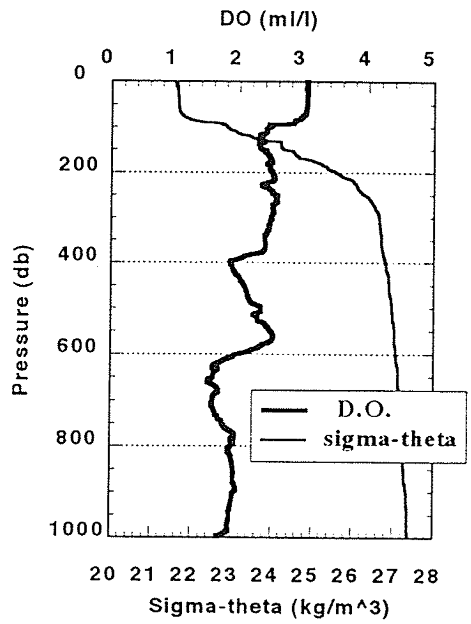
ST.C50(00-00.667N, 141-58.486E)



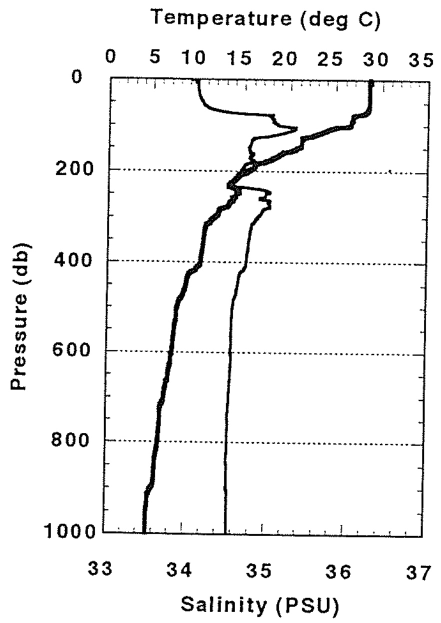
ST.C51 (00-00.042S, 141-00.076E)



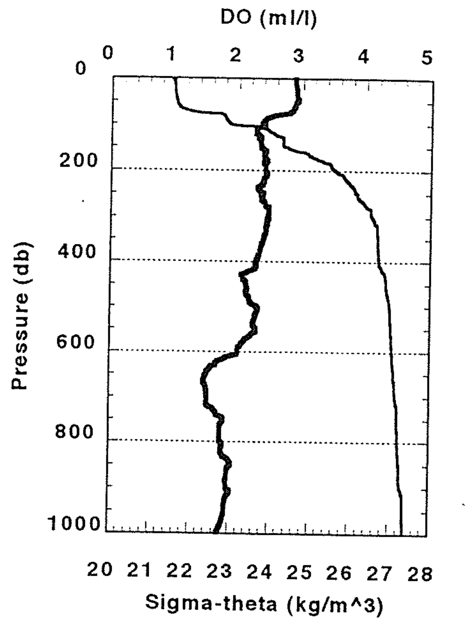
ST.C51(00-00.042S, 141-00.076E)



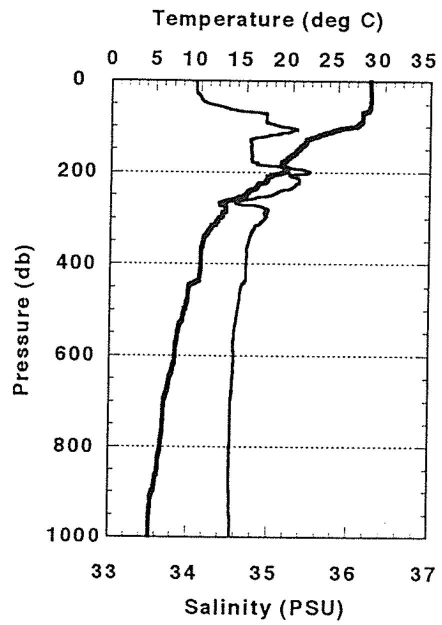
ST.C52 (00-00.006N, 140-00.144E)



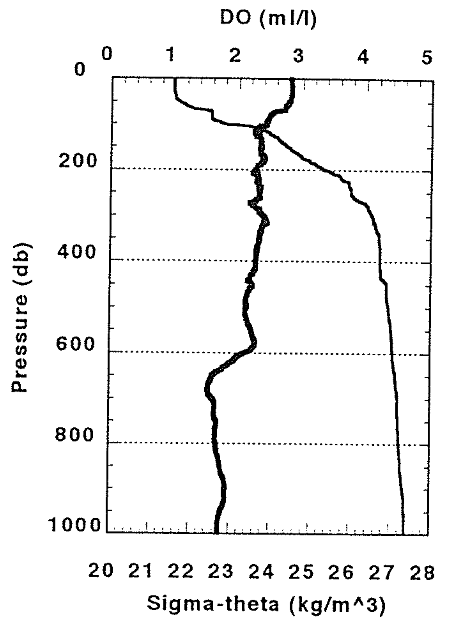
ST.C52(00-00.006N, 140-00.144E)



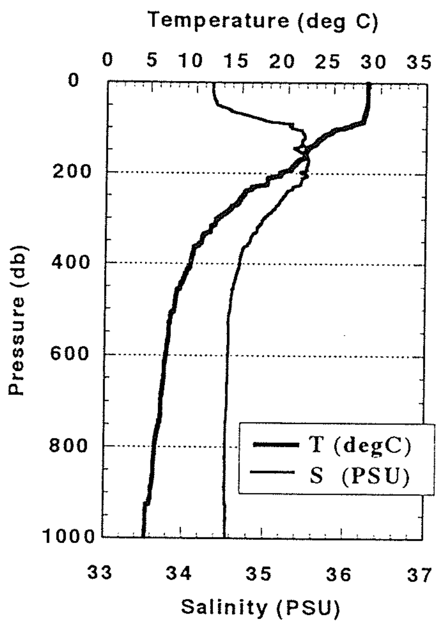
ST.C53 (00-00.002N, 139-00.099E)



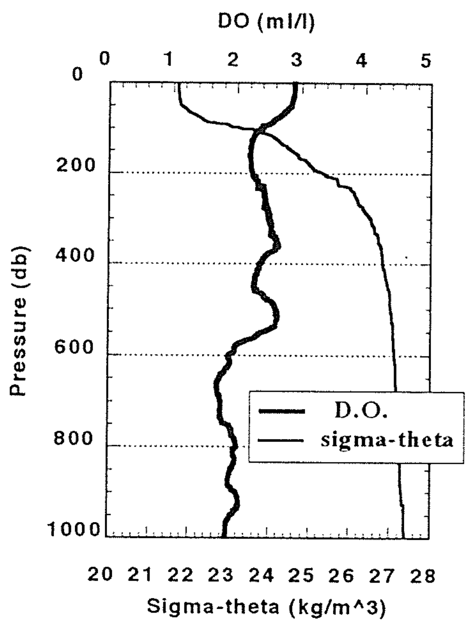
ST.C53(00-00.002N, 139-00.099E)



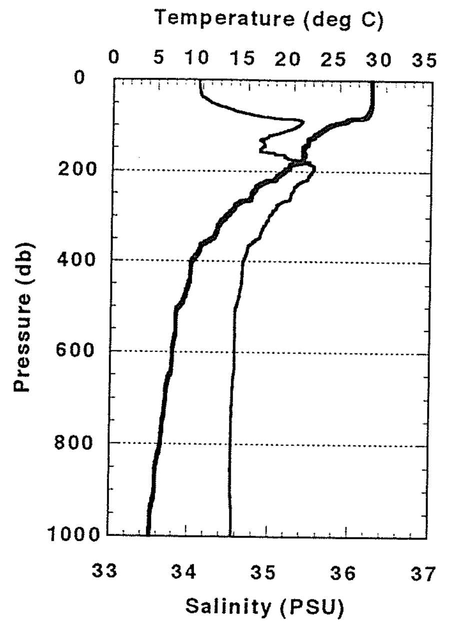
ST.C54 (00-59.948S, 138-00.211E)



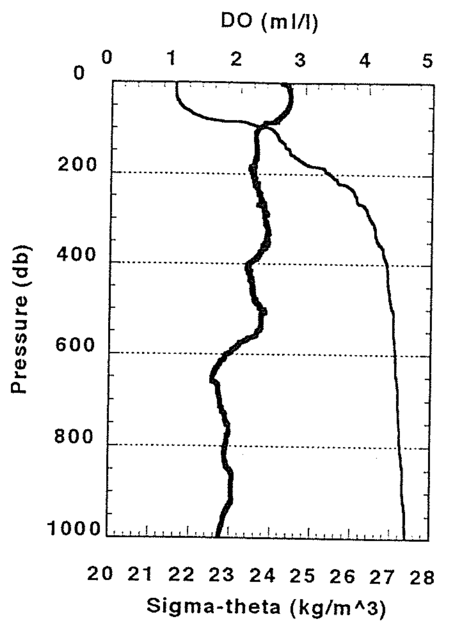
ST.C54(00-59.948S, 138-00.211E)



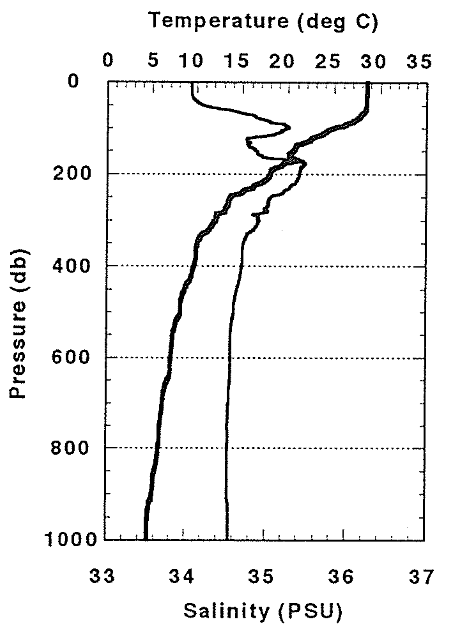
ST.C55 (00-30.151S, 138-00.117E)



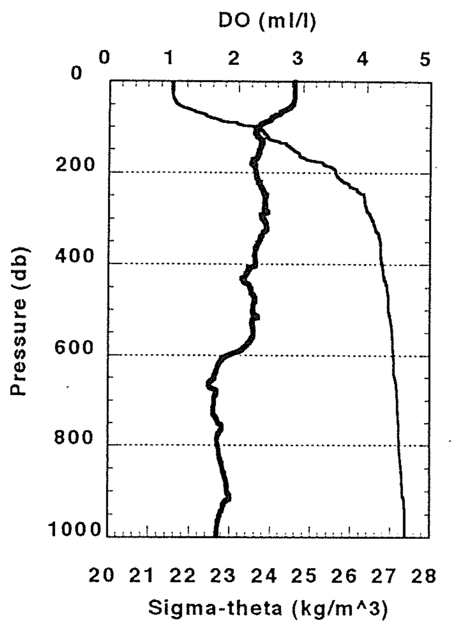
ST.C55(00-30.151S, 138-00.117E)



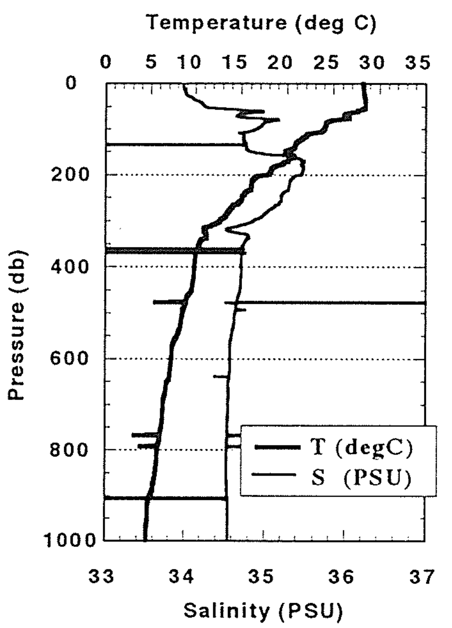
ST.C56 (00-00.295S, 138-00.094E)



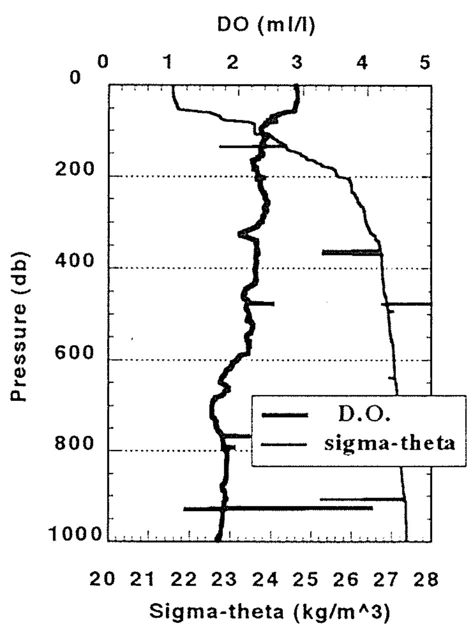
ST.C56(00-00.295S, 138-00.094E)

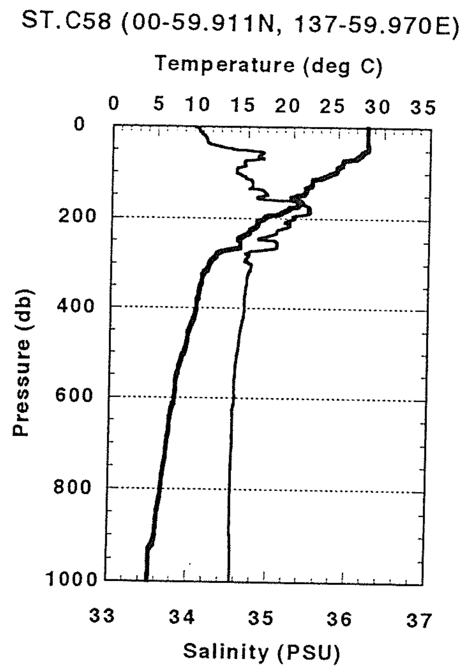


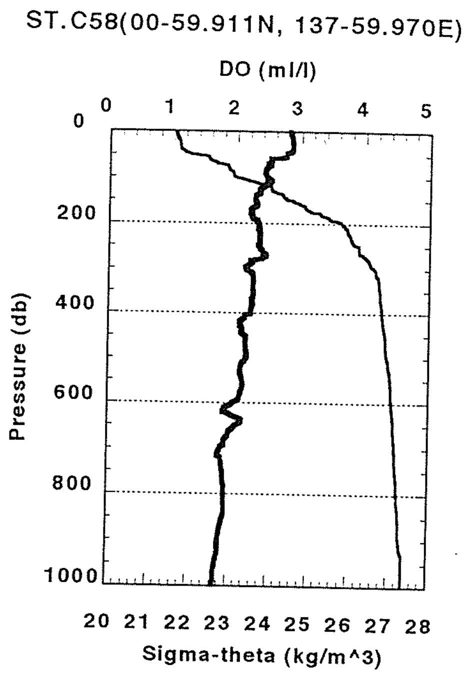
ST.C57 (00-30.010N, 137-59.938E)

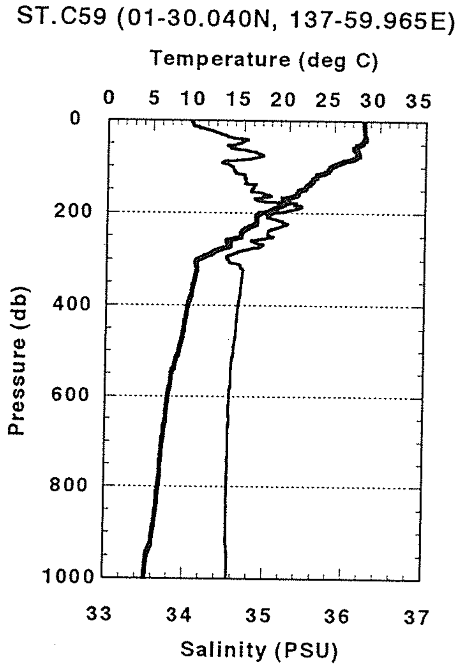


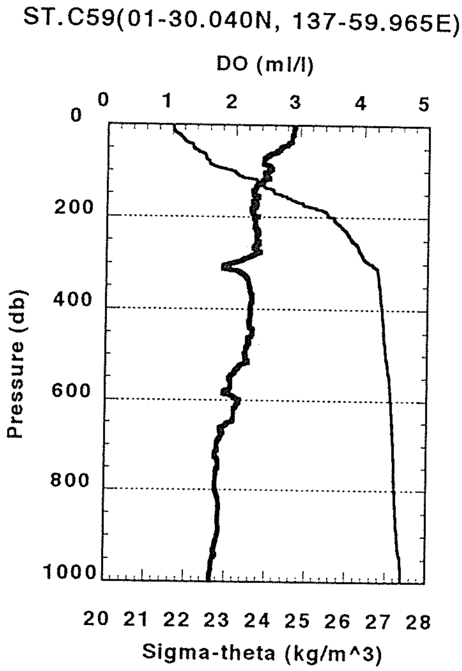
ST.C57(00-30.010N, 137-59.938E)

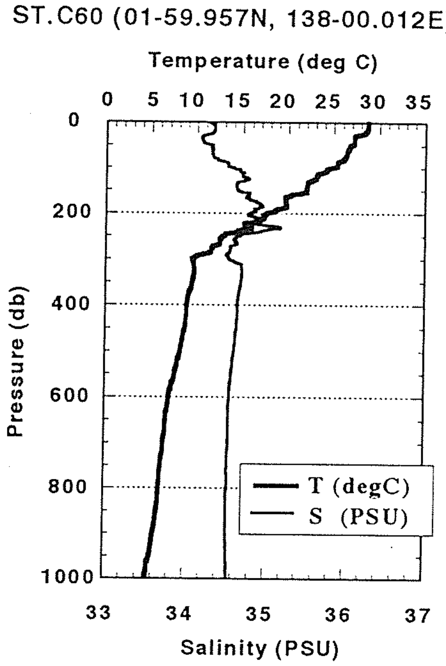


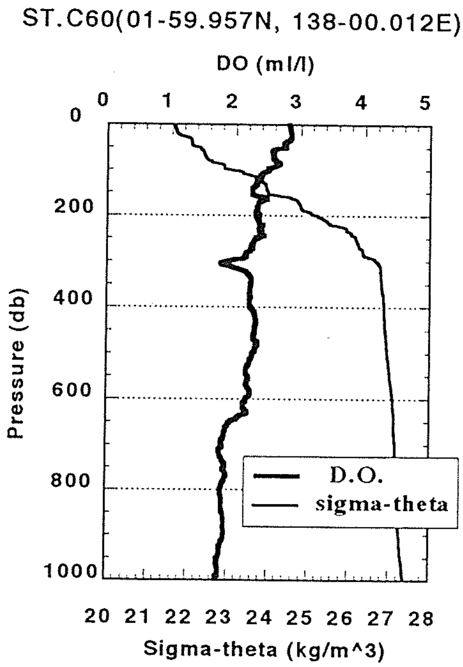

ST.C58 (00-59.911N, 137-59.970E)
Temperature (deg C)
0 5 10 15 20 25 30 35
Pressure (db)
0 200 400 600 800 1000
33 34 35 36 37
Salinity (PSU)


ST.C58(00-59.911N, 137-59.970E)
DO (ml/l)
0 1 2 3 4 5
Pressure (db)
0 200 400 600 800 1000
20 21 22 23 24 25 26 27 28
Sigma-theta (kg/m^3)

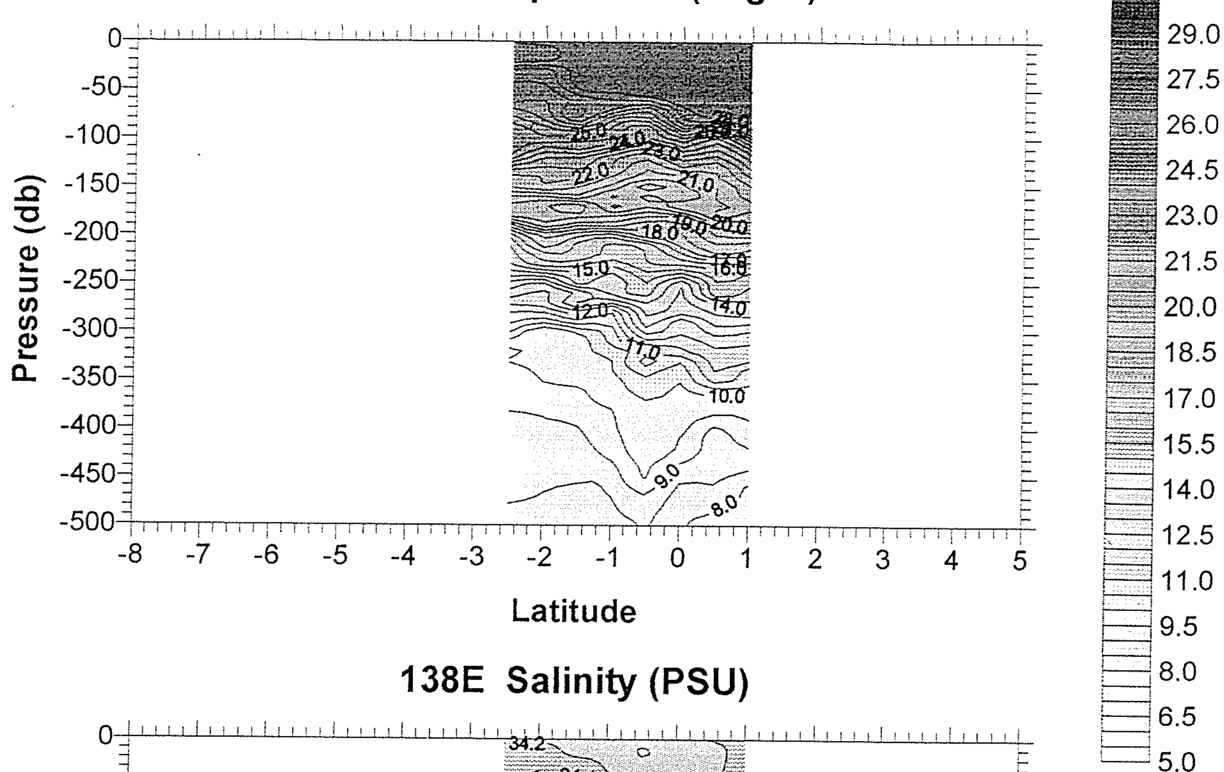

ST.C59 (01-30.040N, 137-59.965E)
Temperature (deg C)
0 5 10 15 20 25 30 35
Pressure (db)
0 200 400 600 800 1000
33 34 35 36 37
Salinity (PSU)


ST.C59(01-30.040N, 137-59.965E)
DO (ml/l)
0 1 2 3 4 5
Pressure (db)
0 200 400 600 800 1000
20 21 22 23 24 25 26 27 28
Sigma-theta (kg/m^3)

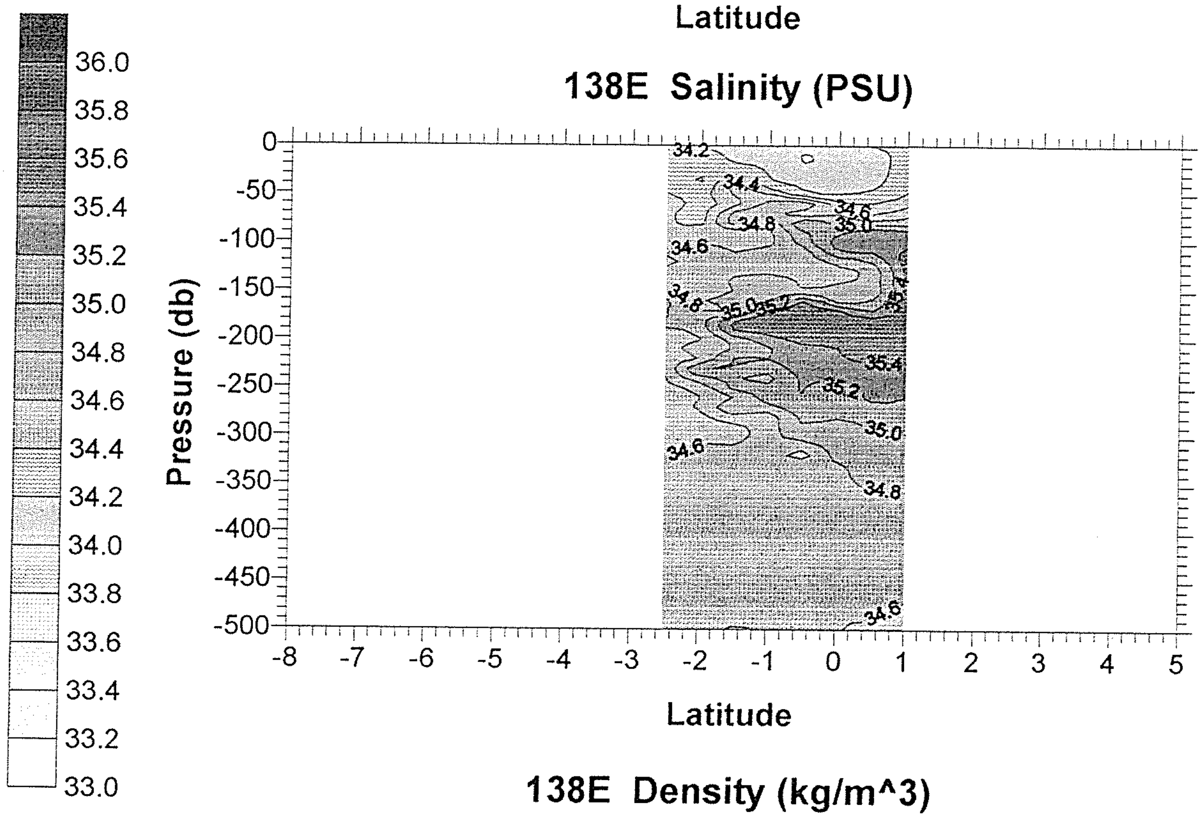

ST.C60 (01-59.957N, 138-00.012E)
Temperature (deg C)
0 5 10 15 20 25 30 35
Pressure (db)
0 200 400 600 800 1000
T (degC)
S (PSU)
33 34 35 36 37
Salinity (PSU)


ST.C60(01-59.957N, 138-00.012E)
DO (ml/l)
0 1 2 3 4 5
Pressure (db)
0 200 400 600 800 1000
D.O.
sigma-theta
20 21 22 23 24 25 26 27 28
Sigma-theta (kg/m^3)

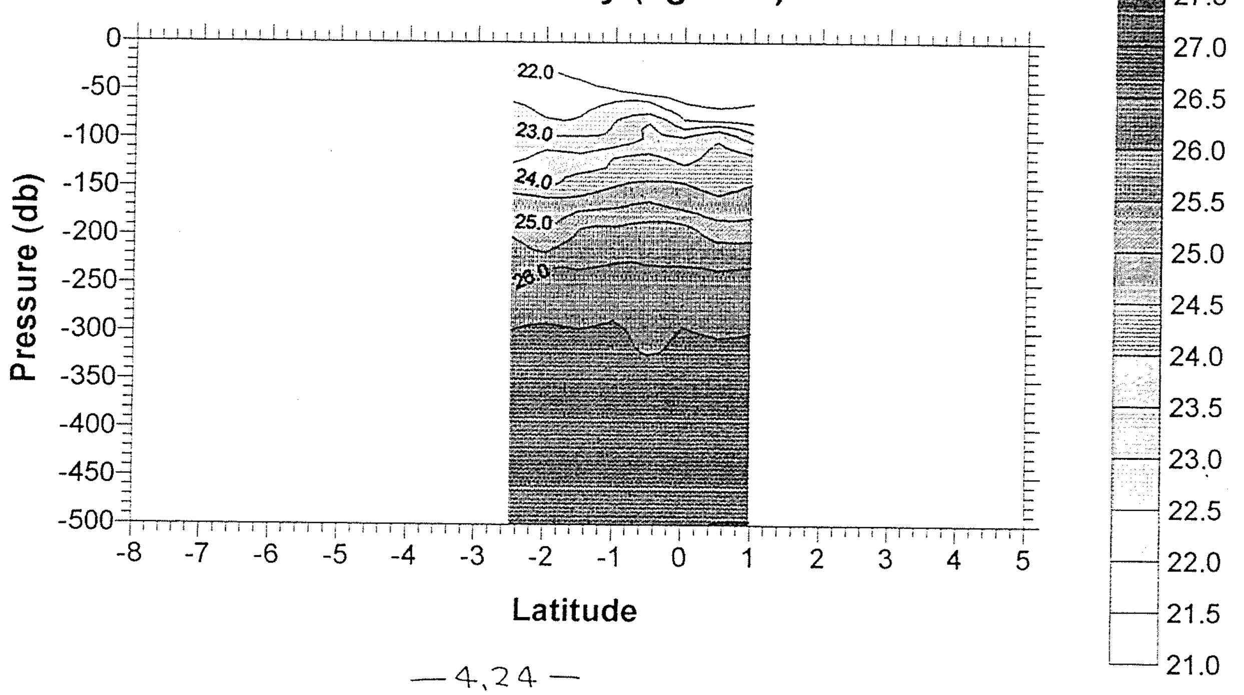
138E Temperature (deg-C)



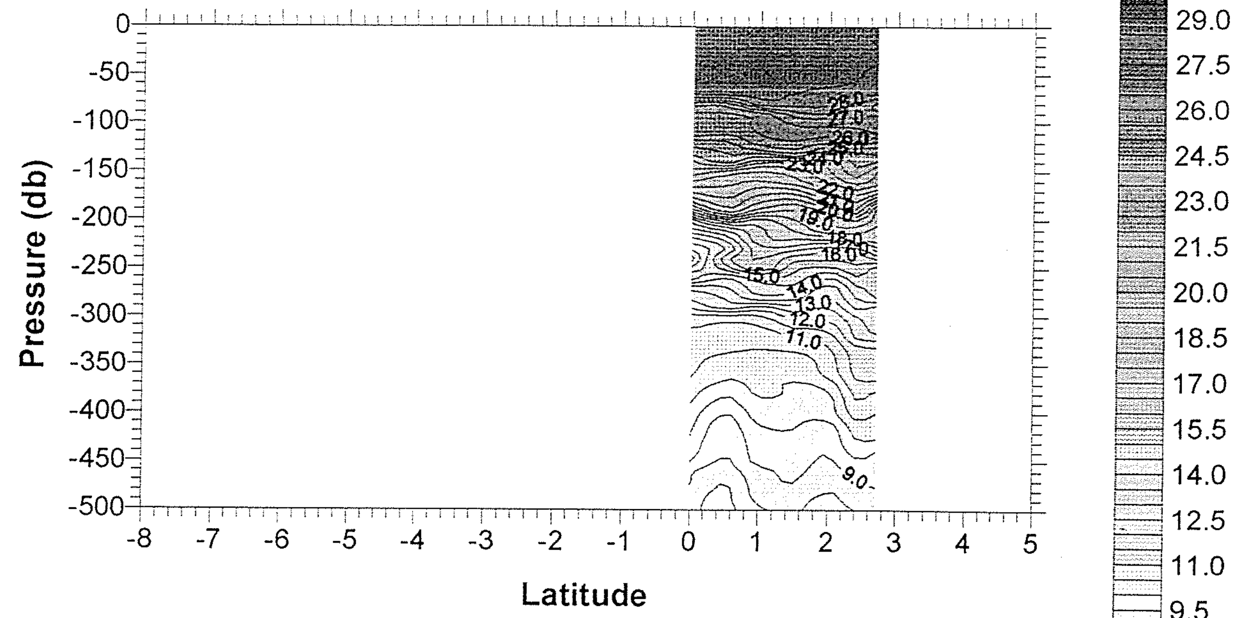
138E Salinity (PSU)



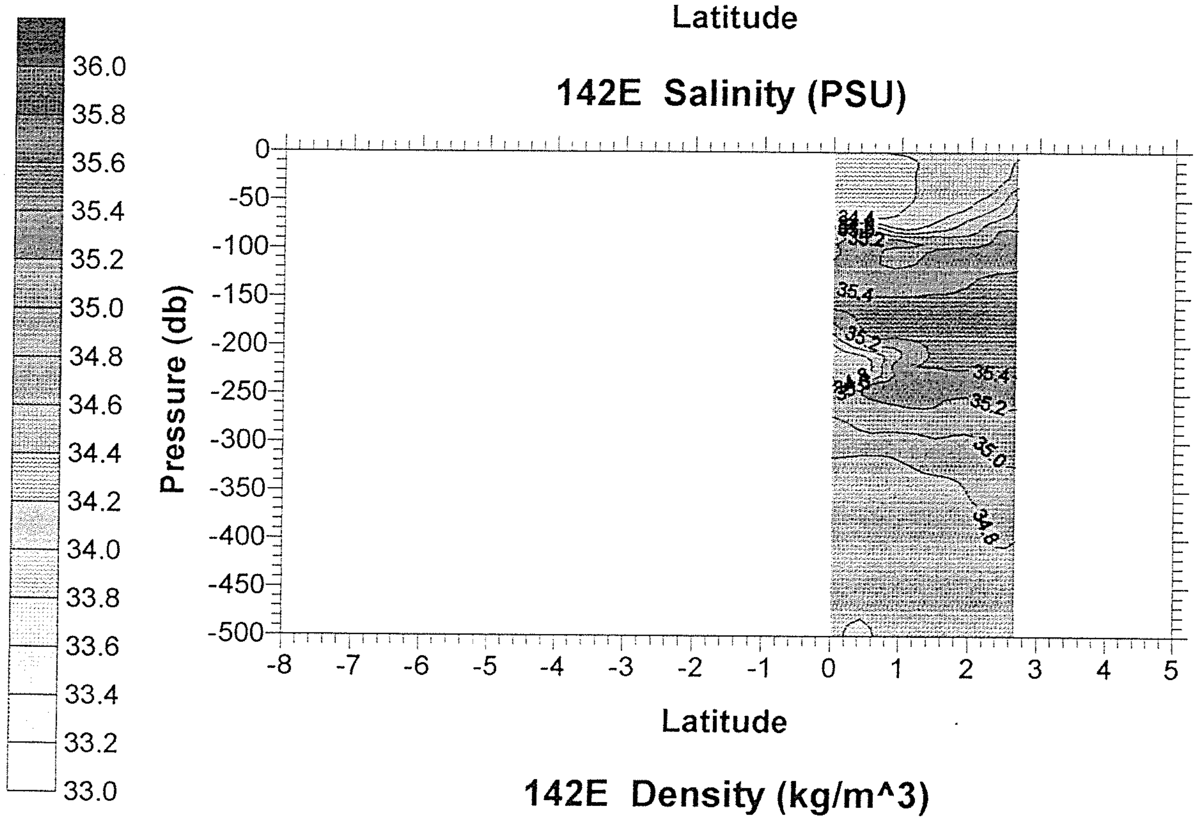
138E Density (kg/m^3)



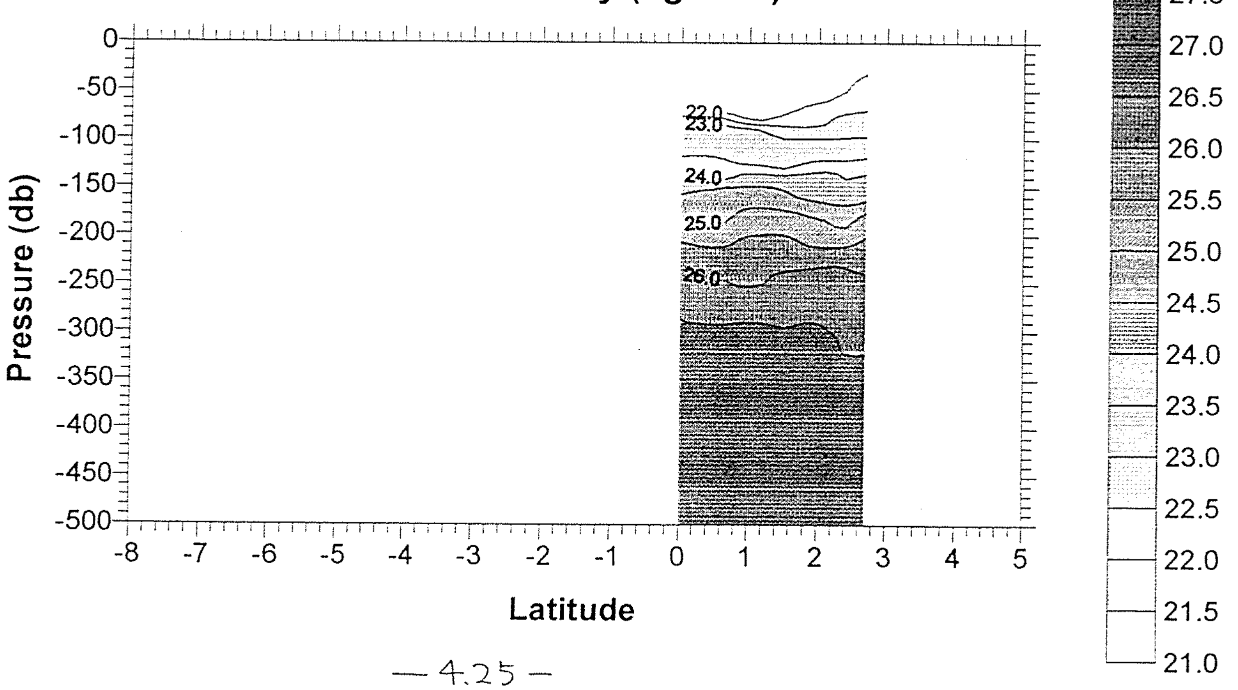
142E Temperature (deg-C)

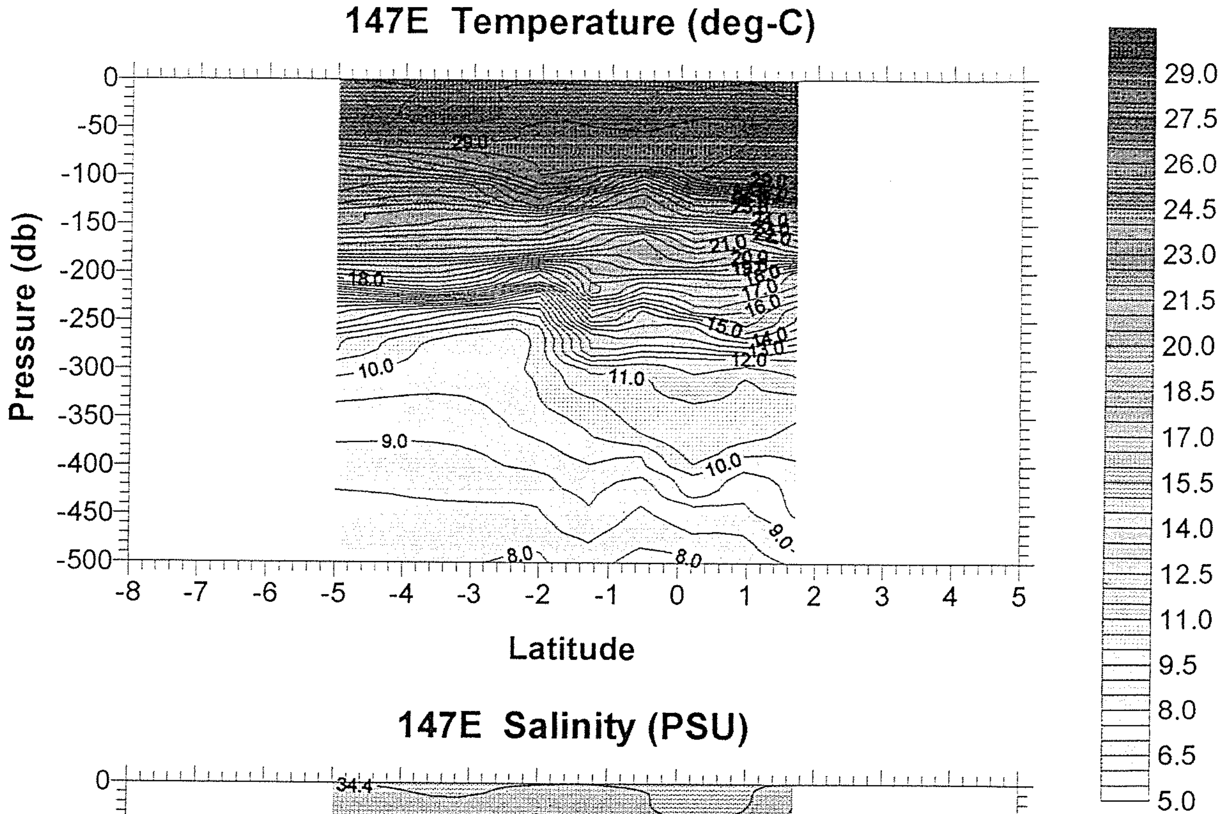


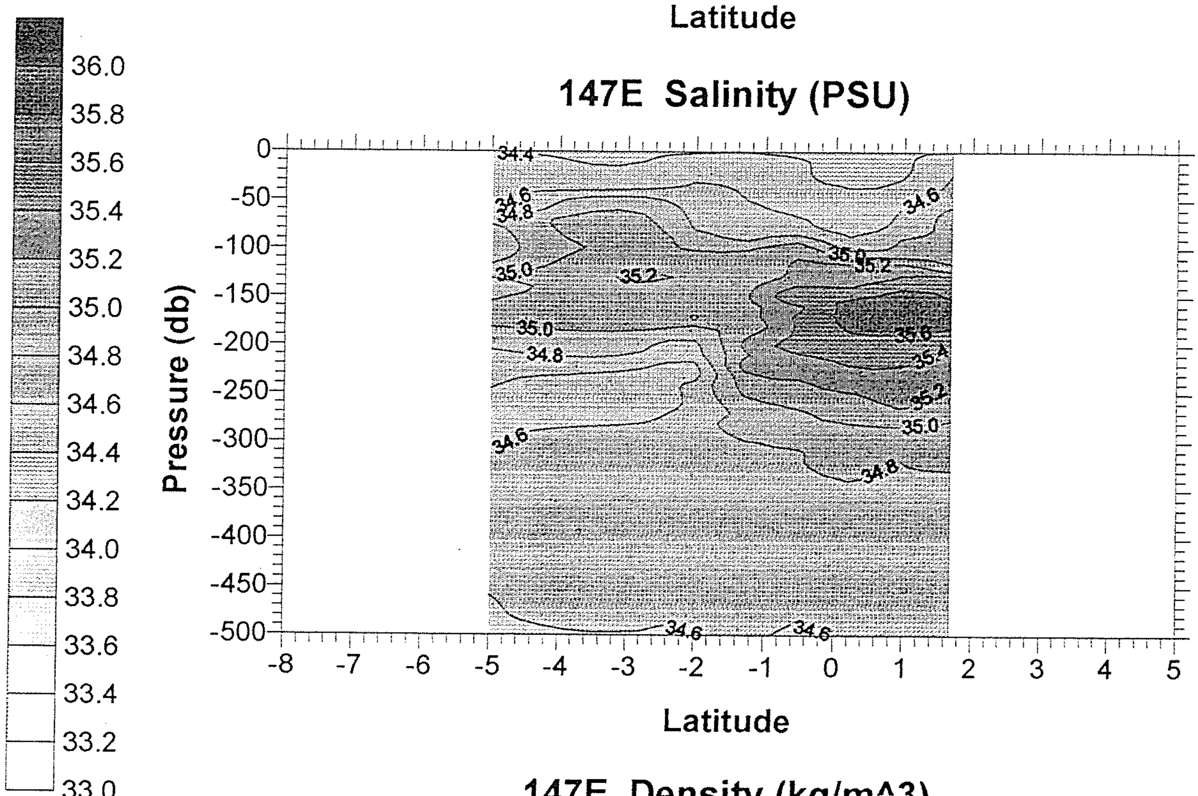
142E Salinity (PSU)

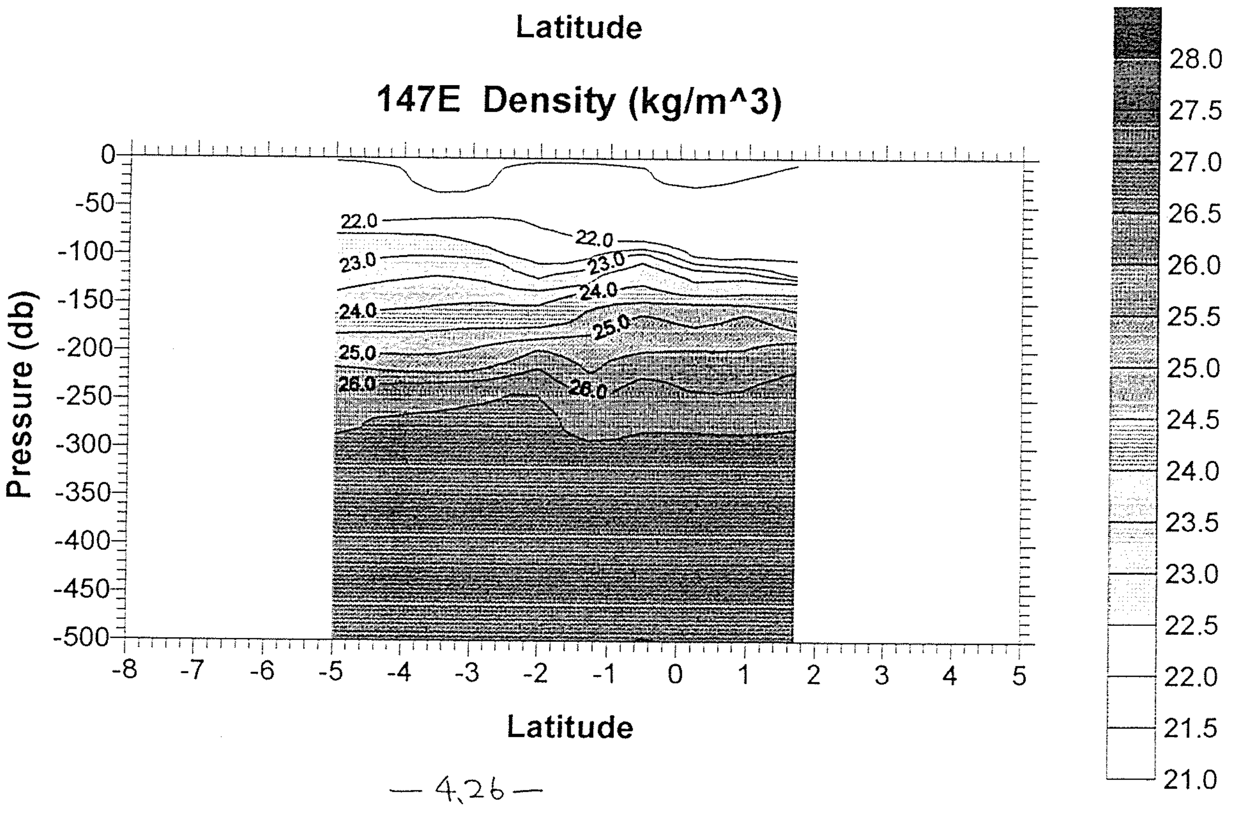


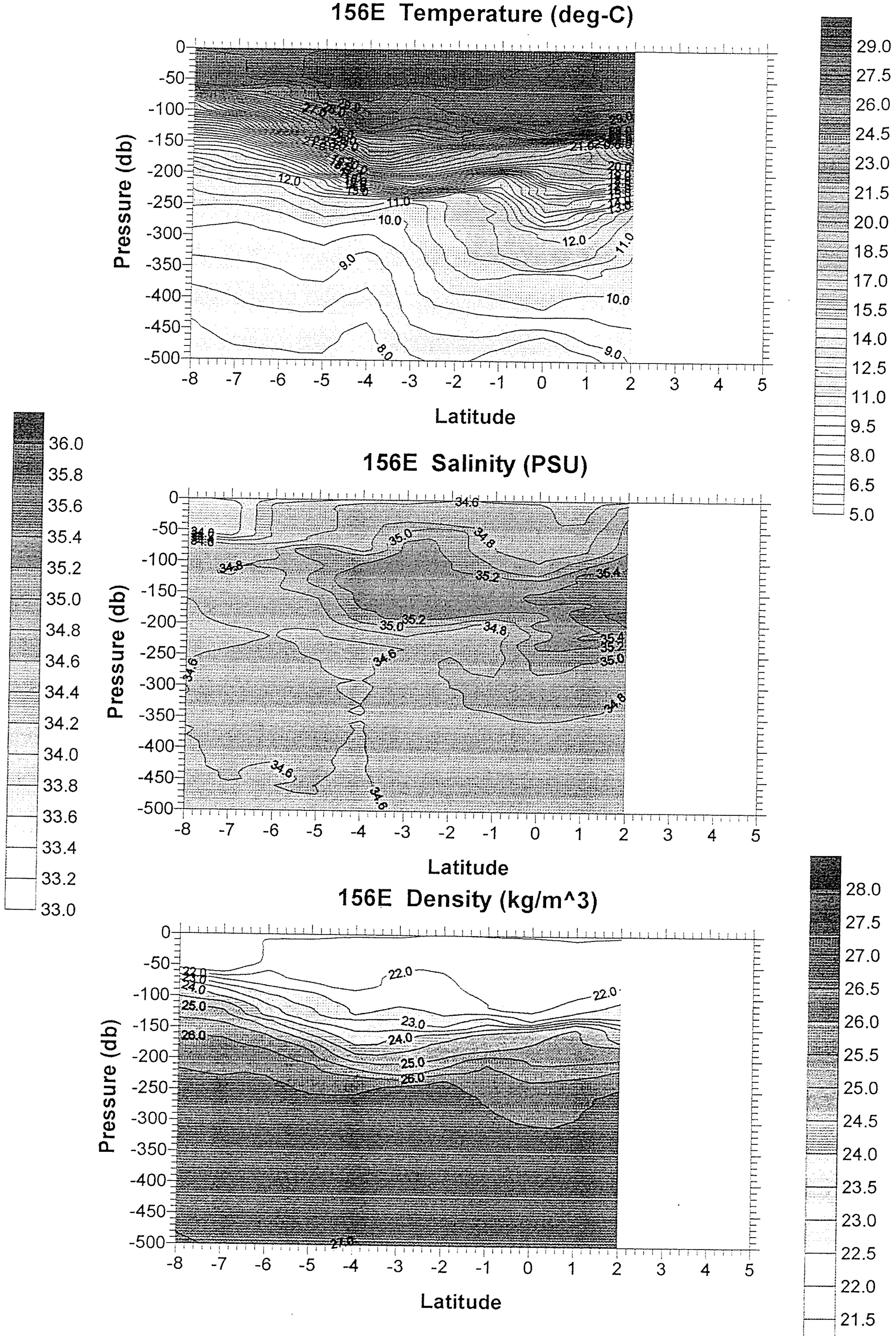
142E Density (kg/m^3)



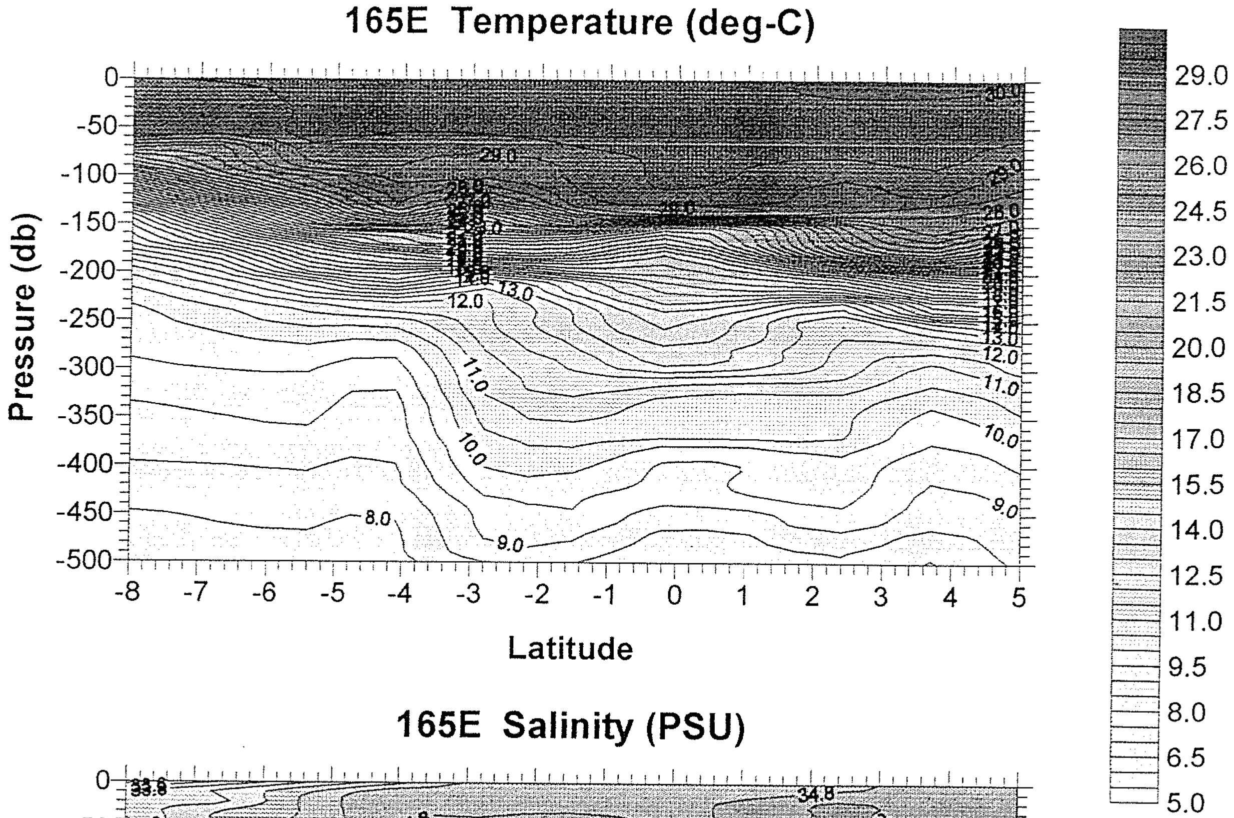

147E Temperature (deg-C)
Pressure (db)
Latitude
29.0
27.5
26.0
24.5
23.0
21.5
20.0
18.5
17.0
15.5
14.0
12.5
11.0
9.5
8.0
6.5
5.0

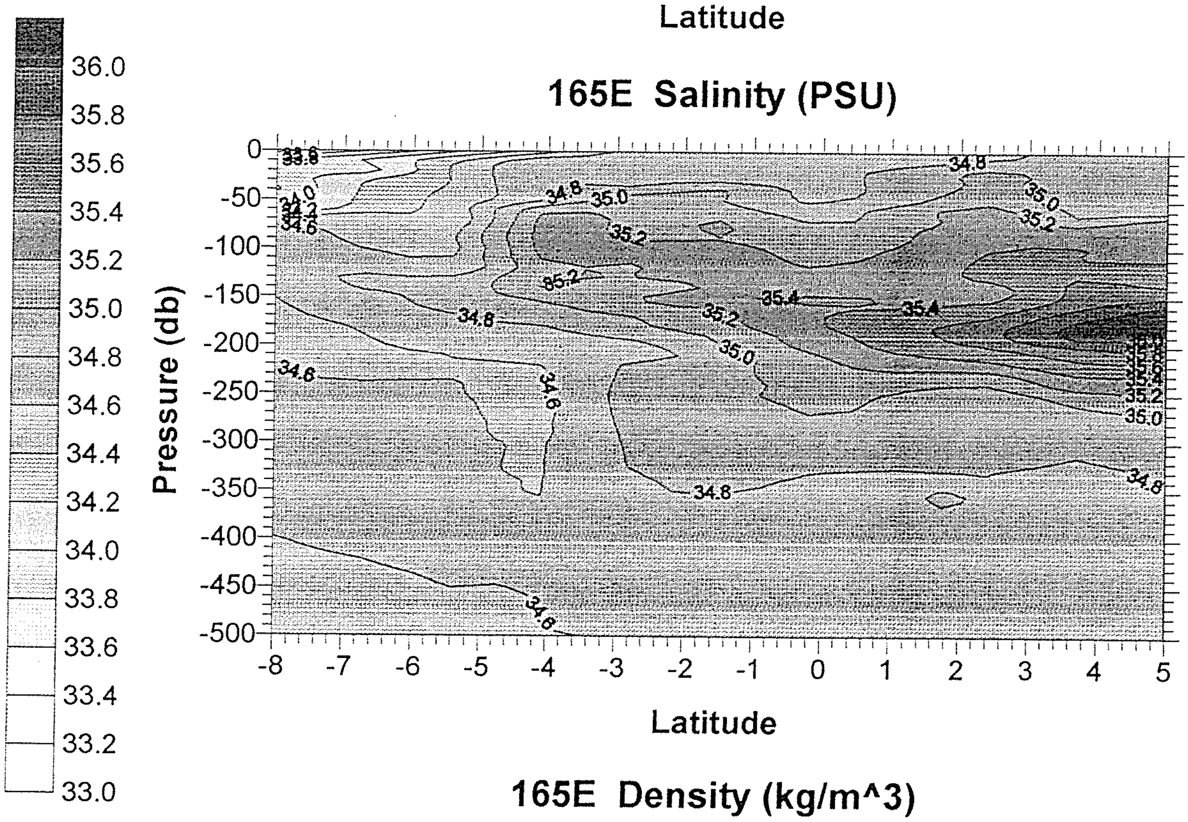

147E Salinity (PSU)
Pressure (db)
Latitude
36.0
35.8
35.6
35.4
35.2
35.0
34.8
34.6
34.4
34.2
34.0
33.8
33.6
33.4
33.2
33.0

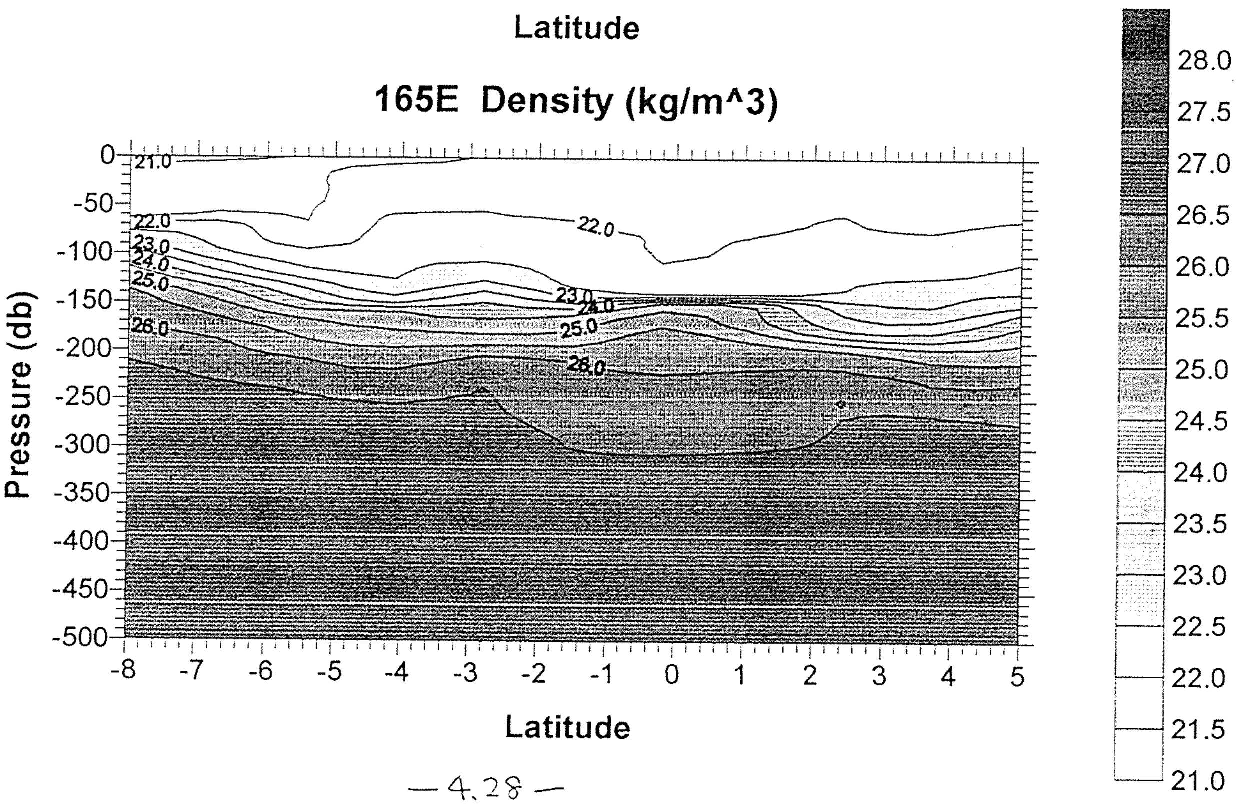

147E Density (kg/m^3)
Pressure (db)
Latitude
28.0
27.5
27.0
26.5
26.0
25.5
25.0
24.5
24.0
23.5
23.0
22.5
22.0
21.5
21.0



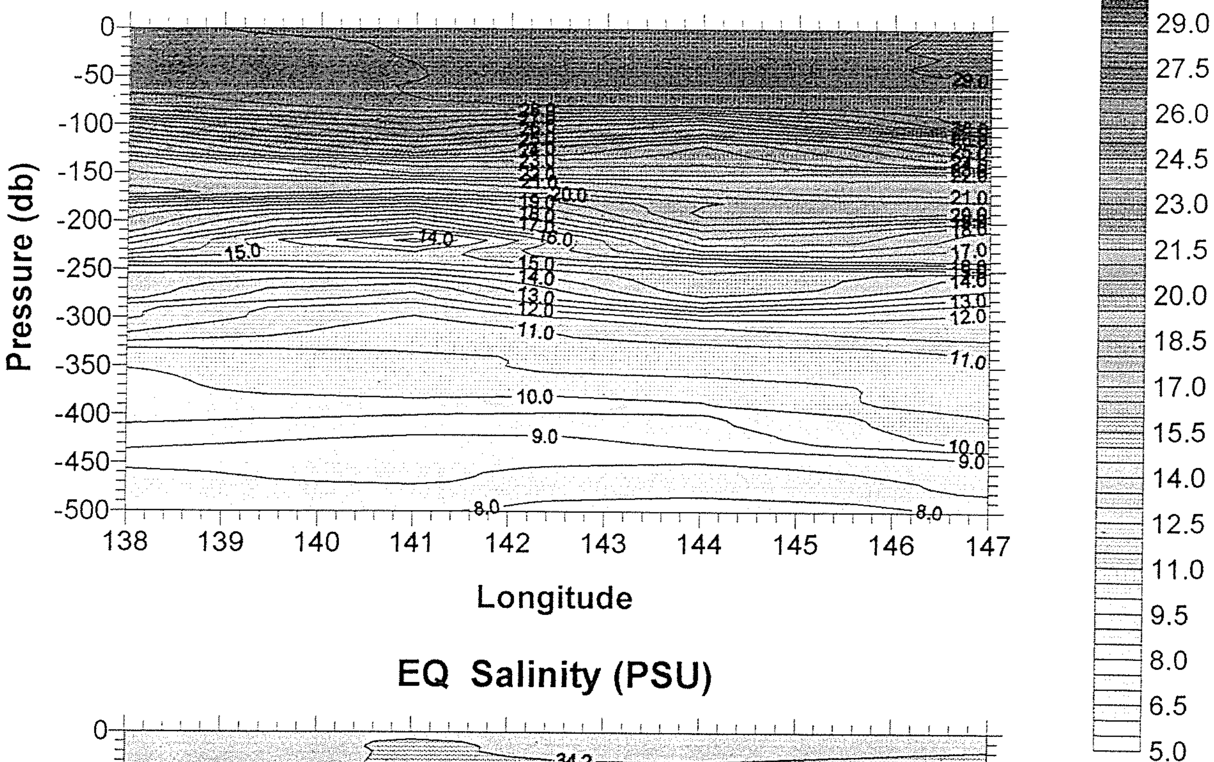
156E Temperature (deg-C)
Pressure (db)
Latitude
156E Salinity (PSU)
Pressure (db)
Latitude
156E Density (kg/m^3)
Pressure (db)
Latitude


165E Temperature (deg-C)
Pressure (db)
Latitude

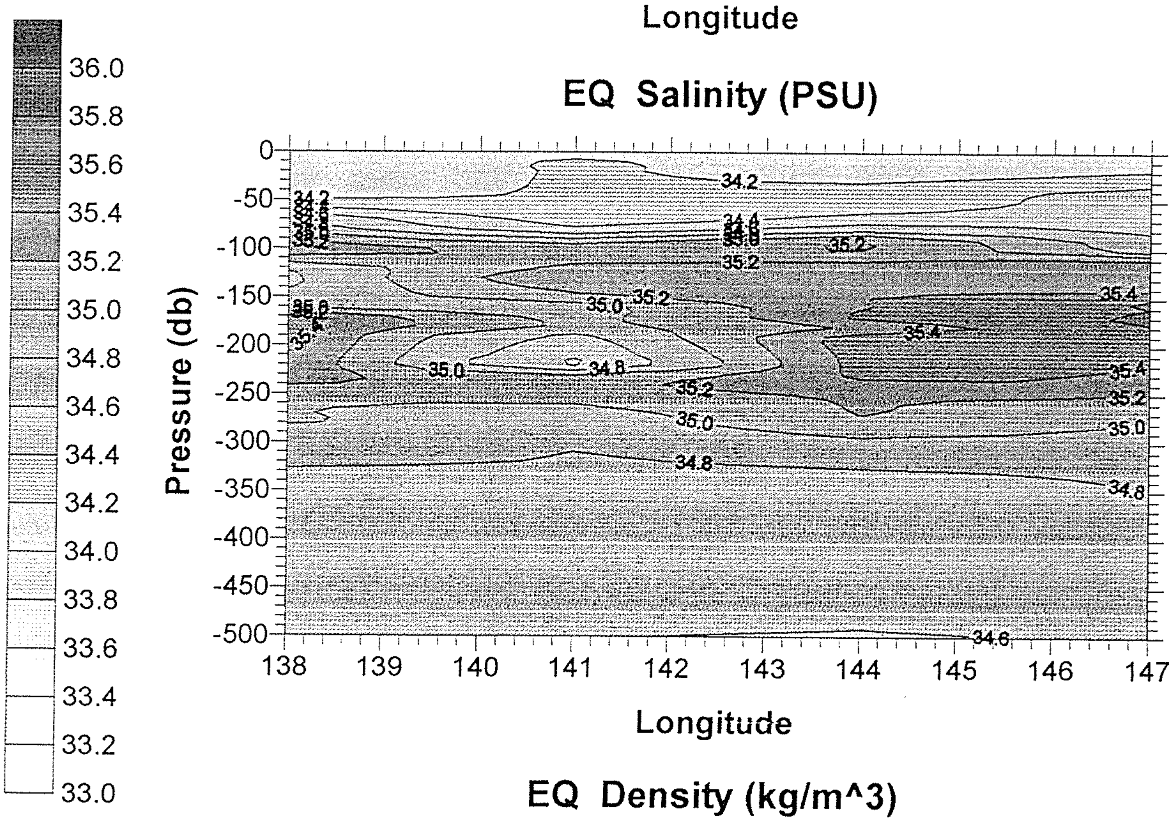

165E Salinity (PSU)
Pressure (db)
Latitude


165E Density (kg/m^3)
Pressure (db)
Latitude

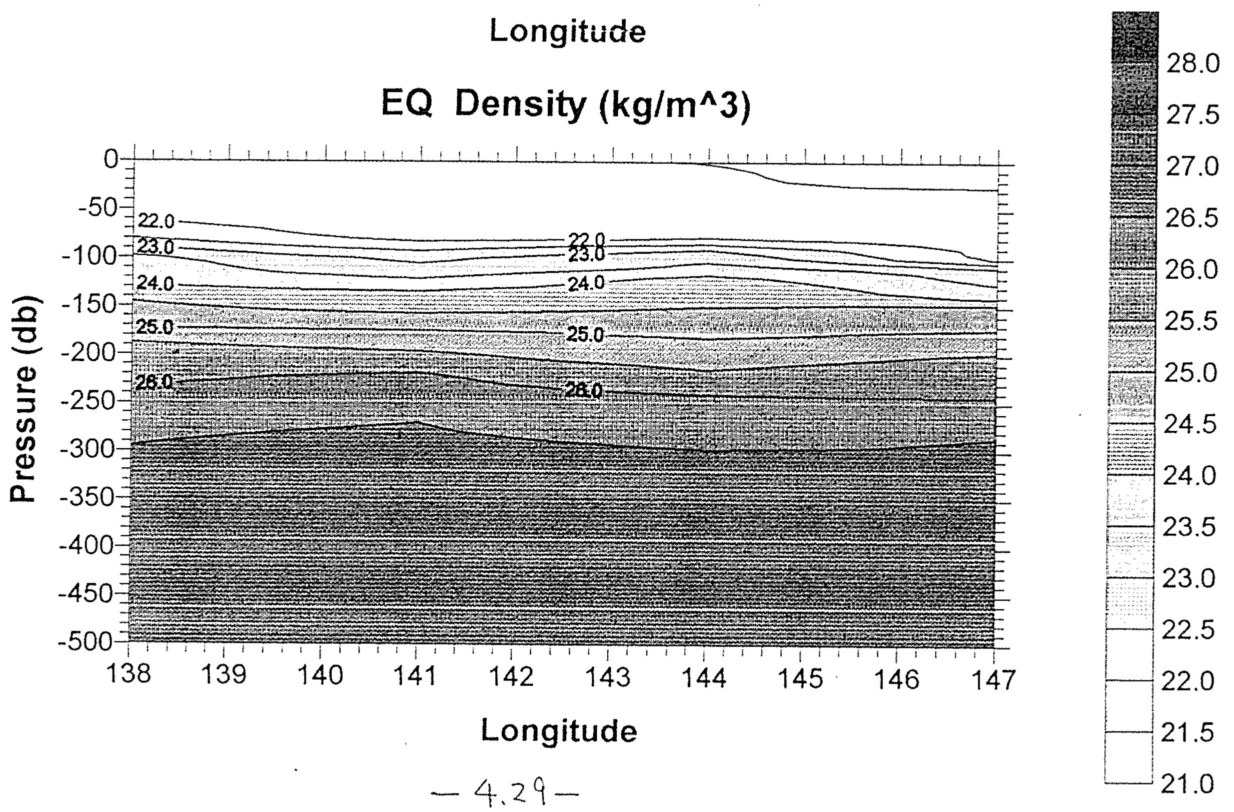
EQ Temperature (deg-C)



EQ Salinity (PSU)



EQ Density (kg/m^3)



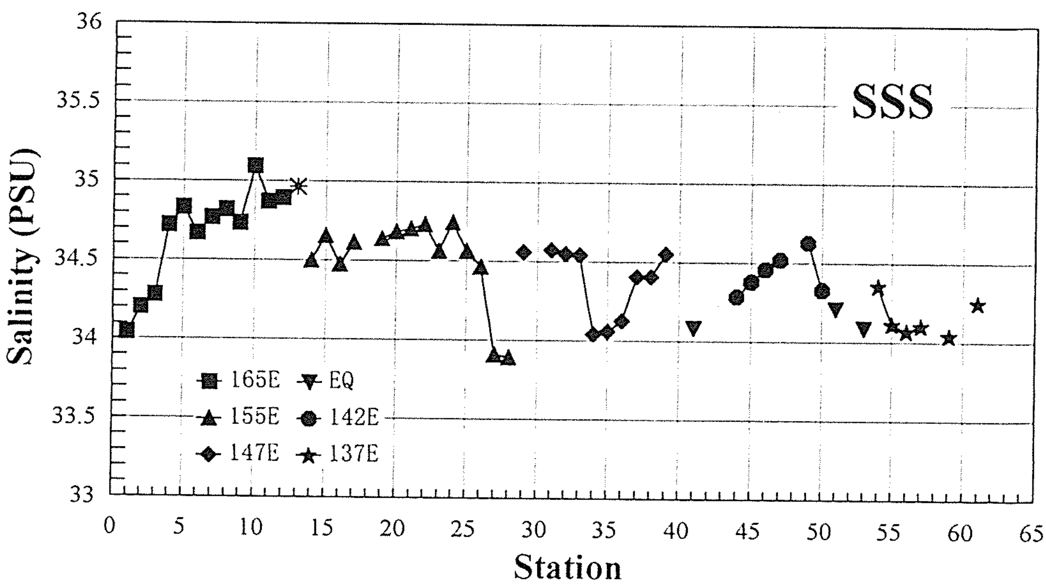
4.5 Bottle Salinity

Surface Salinity

Station #	Salinity (PSU)	
1	34.040	
2	34.200	
3	34.280	
4	34.720	
5	34.835	
6	34.670	rain
7	34.770	
8	34.820	
9	34.735	
10	35.095	
11	34.870	
12	34.895	
13	34.965	
14	34.500	
15	34.655	
16	34.475	
17	34.615	
18	———	rain
19	34.640	
20	34.685	
21	34.705	
22	34.730	
23	34.565	
24	34.745	
25	34.565	
26	34.465	
27	33.910	
28	33.895	

precision : 5/1000

Station #	Salinity (PSU)	
29	34.560	
30	———	rain
31	34.575	
32	34.550	
33	34.545	
34	34.045	
35	34.060	
36	34.130	
37	34.410	
38	34.410	
39	34.555	
40	———	
41	34.085	
42	———	
43	———	
44	34.285	
45	34.380	
46	34.460	
47	34.520	rain
48	———	rain
49	34.630	
50	34.330	
51	34.210	
52	———	rain
53	34.090	
54	34.355	
55	34.115	
56	34.070	
57	34.105	
58	———	rain
59	34.045	
60	———	rain
61	34.250	

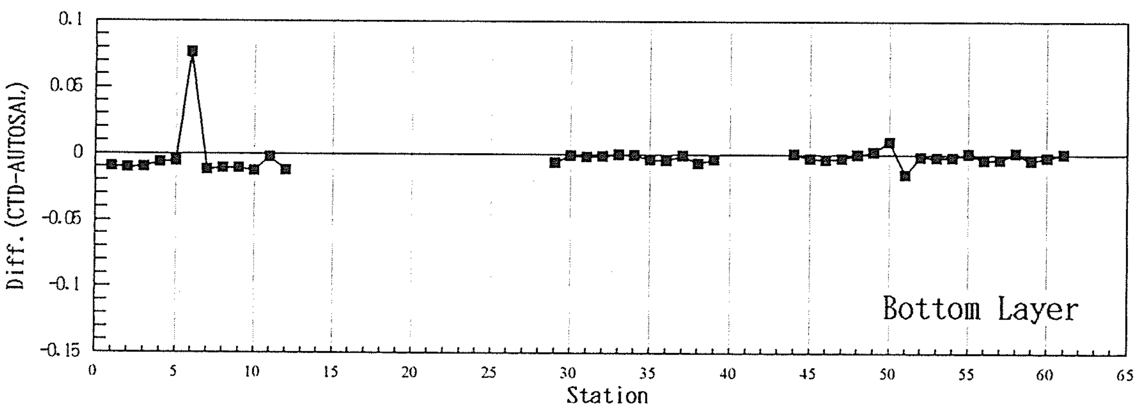


Bottom Layer

Station #	Pressure (db)	Salinity (PSU) CTD	Salinity (PSU) AUTOSAL	Difference (CTD-AUTOSAL)	
1	800.470	34.536	34.545	-0.0094	
2	1002.101	34.555	34.565	-0.0101	
3	1002.562	34.560	34.570	-0.0097	
4	1002.706	34.554	34.560	-0.0063	
5	1002.461	34.550	34.555	-0.0052	
6	1002.053	34.552	34.475	0.0767	rain
7	1001.330	34.548	34.560	-0.0119	
8	998.174	34.550	34.560	-0.0104	
9	1002.251	34.549	34.560	-0.0106	
10	1000.025	34.543	34.555	-0.0125	
11	1003.537	34.543	34.545	-0.0022	
12	1001.483	34.523	34.535	-0.0122	
13	—	—	—	—	
14	—	—	—	—	
15	—	—	—	—	
16	—	—	—	—	
17	—	—	—	—	
18	—	—	—	—	
19	—	—	—	—	
20	—	—	—	—	
21	—	—	—	—	
22	—	—	—	—	
23	—	—	—	—	
24	—	—	—	—	
25	—	—	—	—	
26	—	—	—	—	
27	—	—	—	—	
28	—	—	—	—	

precision : 5/1000

Station #	Pressure (db)	Salinity (PSU) CTD	Salinity (PSU) AUTOSAL	Difference (CTD-AUTOSAL)	
29	1000.505	34.549	34.555	-0.0063	
30	999.560	34.554	34.555	-0.0010	
31	1003.446	34.553	34.555	-0.0019	
32	1002.445	34.549	34.550	-0.0013	
33	1002.150	34.550	34.550	-0.0003	
34	1000.626	34.545	34.545	-0.0005	
35	1000.518	34.546		34.5462	
36	1003.023	34.546	34.550	-0.0044	
37	999.525	34.539	34.540	-0.0007	
38	1002.603	34.543	34.550	-0.0066	reak
39	1002.260	34.541	34.545	-0.0036	
40	—	—	—	—	
41	—	—	—	—	
42	—	—	—	—	
43	—	—	—	—	
44	1004.070	34.550	34.550	0.0004	
45	1003.196	34.547	34.550	-0.0029	
46	1000.709	34.551	34.555	-0.0039	
47	1002.035	34.547	34.550	-0.0029	rain
48	1003.526	34.550	34.550	0.0000	
49	500.776	34.642	34.640	0.0021	
50	1003.283	34.549	34.540	0.0094	
51	801.483	34.535	34.550	-0.0151	
52	1002.650	34.548	34.550	-0.0019	
53	1002.542	34.548	34.550	-0.0022	
54	1001.240	34.548	34.550	-0.0020	
55	1003.280	34.551	34.550	0.0007	
56	1002.378	34.551	34.555	-0.0042	
57	1000.466	34.551	34.555	-0.0036	
58	1004.342	34.551	34.550	0.0011	
59	1004.076	34.550	34.555	-0.0046	
60	1001.852	34.553	34.555	-0.0022	
61	1003.172	34.545	34.545	0.0002	



4.6 Dissolved Oxygen Measurement

K.Komine and M.Aihara
Sanyo Techno Marine, Inc.,Japan

Objectives:

Measurement of dissolved oxygen using D.O.meter with correction of the Winkler titration.
Comparison of D.O.meter data corrected by the Winkler titration with CTD D.O. data.

Instruments:

D.O.meter ;TOA Portable Dissolved Oxygen Meter Model DO−25A
Titrator ;Metrohm Model 716 DMS Totrino/ 10ml of titration vessel
Ditector ;Pt Electrode/ 6.0401.100
Software ;Data acquisition/ Metrohm,METRODATA/ 6.6040.100

Methods :

The samples for D.O.meter were collected from 5−liter Niskin water samplers into 100ml D.O. glassbottles. In each cast several samples for the Winkler titration were collected into caribrated BOD flasks (ca, 180 ml) (see Green and Carritt 1966). During sampling, 3−bottles−volume of sample water was overflowed and sampling water temperature was measured.

After the sampling D.O.meter with salinity correction. Before measurement, the D.O.meter was ajusted to 0−100% (see TOA D.O.meter operation manual).

The samples for the titration method were analyzed within 2 hours. Before the measurement, the D.O. values were obtained by Metrohm piston buret of 10ml with Pt Erectrode using Whole bottle titration in the laboratory controlled temperature (ca, 22° c)

The vaules of the D.O.meter were corrected with calibration factors. The factors were linear regression line based on the Winkler titration value vs D.O.meter Value.

The standerdizations have been done every day before the sample titration.

We refered to the WHP Oparations and Methods (Culberson,1991).

Reproducibility:

(1) D.O.meter Value

121 pairs of samples were analyzed as replicates taken same Niskin bottle. Difference of replicates samples were an average of 0.007 ml/ l, and standard deviation(2 sigma) of 0.018 ml/ l (0.39% of D.O.maximum in this cruise).

(2) Winkler Titration Value

In the same way, 97 pairs of samples were analyzed. Difference was an average of 0.005 ml/ l, and standared deviation (2 sigma) of 0.009 ml/ l (0.19% of D.O. maximum in this cruse).

Results :

(1) D.O.meter Values Correction

Linear regression line was obtained by 343 pairs of D.O.meter−Winkler data.(Fig.4.6.1) All D.O.meter data were corrected by this formula, and corrected D.O. data were Shown in Table.4.6.1

Formula : $Y = 0.102 + 0.989 \times X$ (n = 335)

R = 0.999

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

(2) CTD−D.O. Sensor Value correction

Polinominary regression line were obtained by 558,536 pairs of CTD−D.O. Sensor− corrected D.O.data. (Fig.4.6.2, Fig.4.6.3) In this cruise CTD−D.O. Sensor's tune was wrong, compare CTD upcast,down cast. Niskin water samplers usually collected sea water when CTD was upcast.

Fomula : $Y = 0.082 + 1.203 \times X + 0.094 \times X^2$ (n = 558)

R = 0.970

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

Fomula : $Y = -0.063 + 1.123 \times X + 0.109 \times X^2$ (n = 536)

R = 0.930

Y : Corrected D.O. Value (ml/ l)   X : CTD−D.O. Sensor Downcast Value (ml/ l)

(3) Contour

Contour in Fig.4.6.3 were made from corrected dissolved oxygen data in Table.4.6.1

Equator Line : Stn 56,53,52,51,50,43,42,41,40,34,18

165E Line : Stn 1,2,3,4,5,6,7,8,9,10,11,12

147E Line : Stn 29,30,31,32,33,34,35,36,37,38,39

142E Line : Stn 50,49,48,47,46,45,44

138E Line : Stn 61,60,59,58,57,56,55,54

(4) Vertical plofiles

Vertical plofiles in Fig.4.6.4. were made from corrected D.O. data in Table.4.6.1

(5) Comparison of CTD D.O. Sensor and corrected D.O.data

In Fig.4.6.4, upcasting and downcasting compared with corrected D.O. data. Root mean squares for each depth were also calucurated and shown Table.4.6.2.

(6) Comments

D.O. consentrations largely decreased from 4.4 ml/ l to 3.2 ml/ l near 100db depth along the equator.

Below the 200db depth, the D.O. values in the hemisphere are much lower than that in the southern hemisphere.

References :

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

Culberson,C.H.,G.Knapp,R.T.Williams and F.Zemlyak (1991) A comparison of methods for the ditermination of dissolved oxygen in sea water (WHPO 91−2),Woods Hole.

Green,E.J. and D.E.Carritt (1966) An Improved Iodine Determination Flask for Whole−bottle Titrations, Analyst, 91, 207−208.

Horibe,Y.,Y.Kodama and K.Shigehara (1972) Errors in sampling procedure for the determination of dissolved oxygen by Winkler method,J. Oceanogr. Soc, Jpn., 28, 203−206.

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

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

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

Experiment on the starting time to sample water for D.O. measurment.

Objective:

How many minutes we can't wait on deck until we start sampling ?

Methods:

(1) 3bottles were used to sample waters at 4layers(50,300,500,1000db).

(2) Soon, sampled from the lowest number bottle for each 4layers. After 30,60minutes , we sampled water from the first bottle and the next number bottle.

(3) We kept Niskin's air hole open. For 20 minutes to sample water for D.O. under high air temperature(34 ° c).

(4) These samples were measured by D.O.meter.

Results:

Comparison of D.O. and , AOU(Apparent Oxygen Utilization) versis time when another Niskin was opened were shown Fig.4.6.5(1).

(1) This shows that the trand of D.O. and AOU don't indicated significant change on the starting time to sample.

(2) D.O. little bit increase for 0.09 ml/l, AOU decrease for 0.11 ml/l.

This tendency is also fond in the samplers from the same Niskin bottles.

The data from the 300db and 1000db, were grate changed, because of the leak.

The results shows, if water isn't leaked from bottles, D.O. can be preserved at least about an hour.

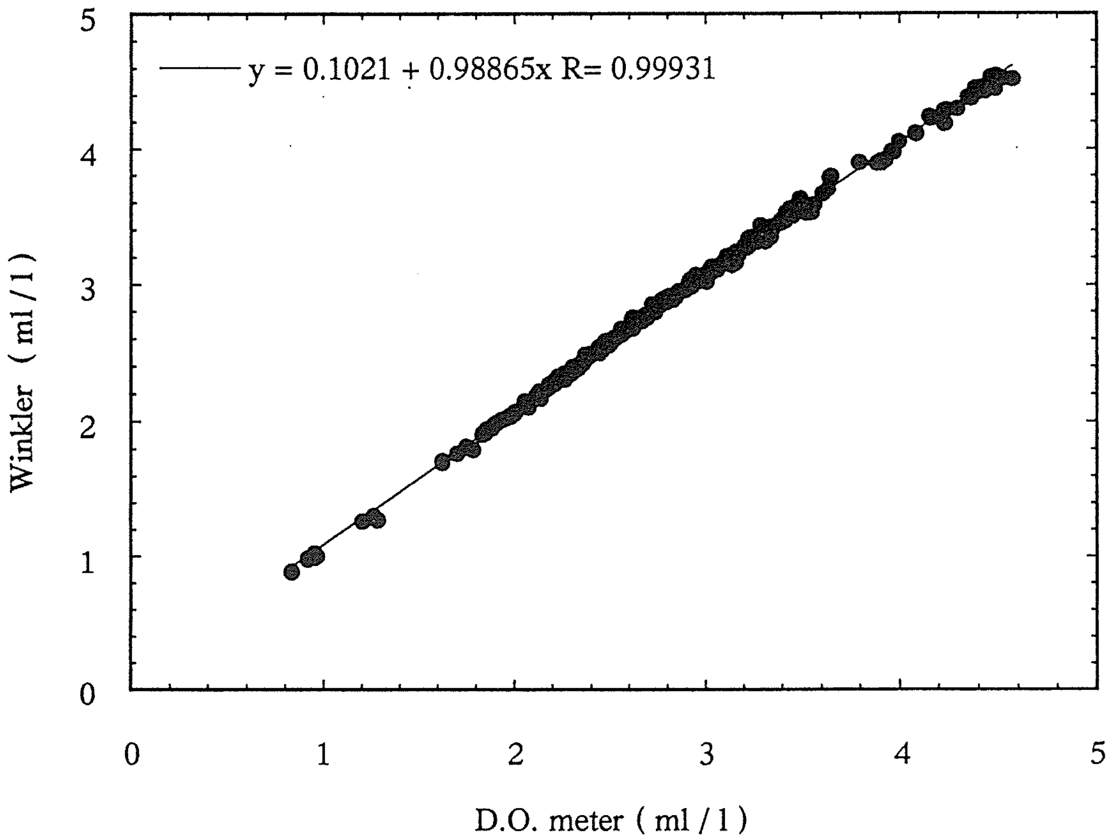


Fig.4.6.1 D.O. meter - Winkler

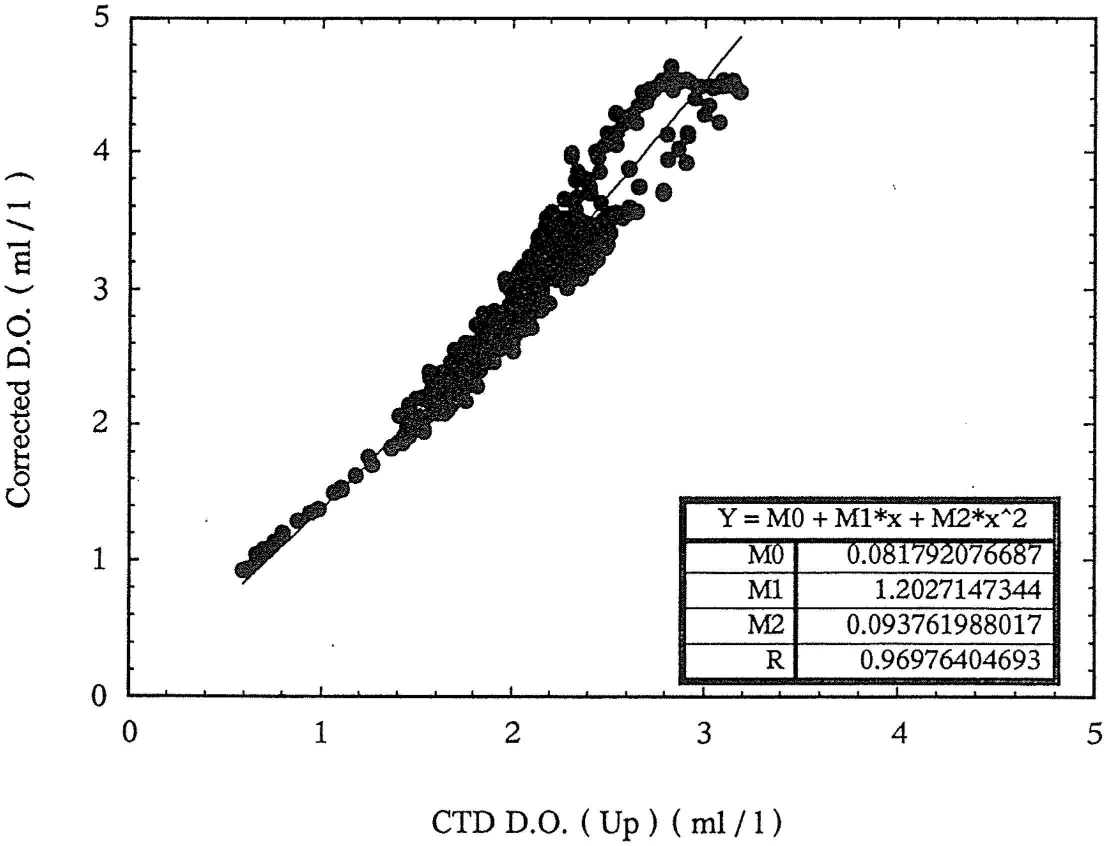


Fig.4.6.2 (1) CTD D.O.(Up) - Corrected D.O.

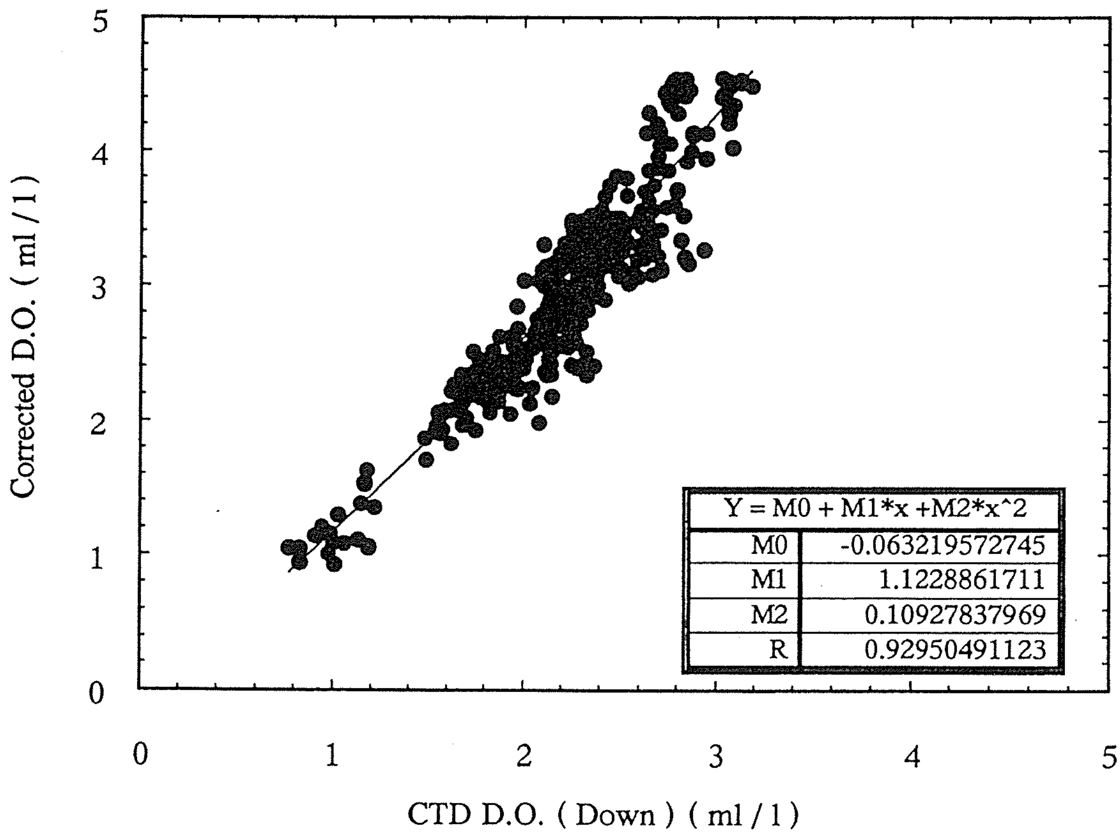


Fig.4.6.2 (2) CTD D.O.(Down) - Corrected D.O.

Equator Line

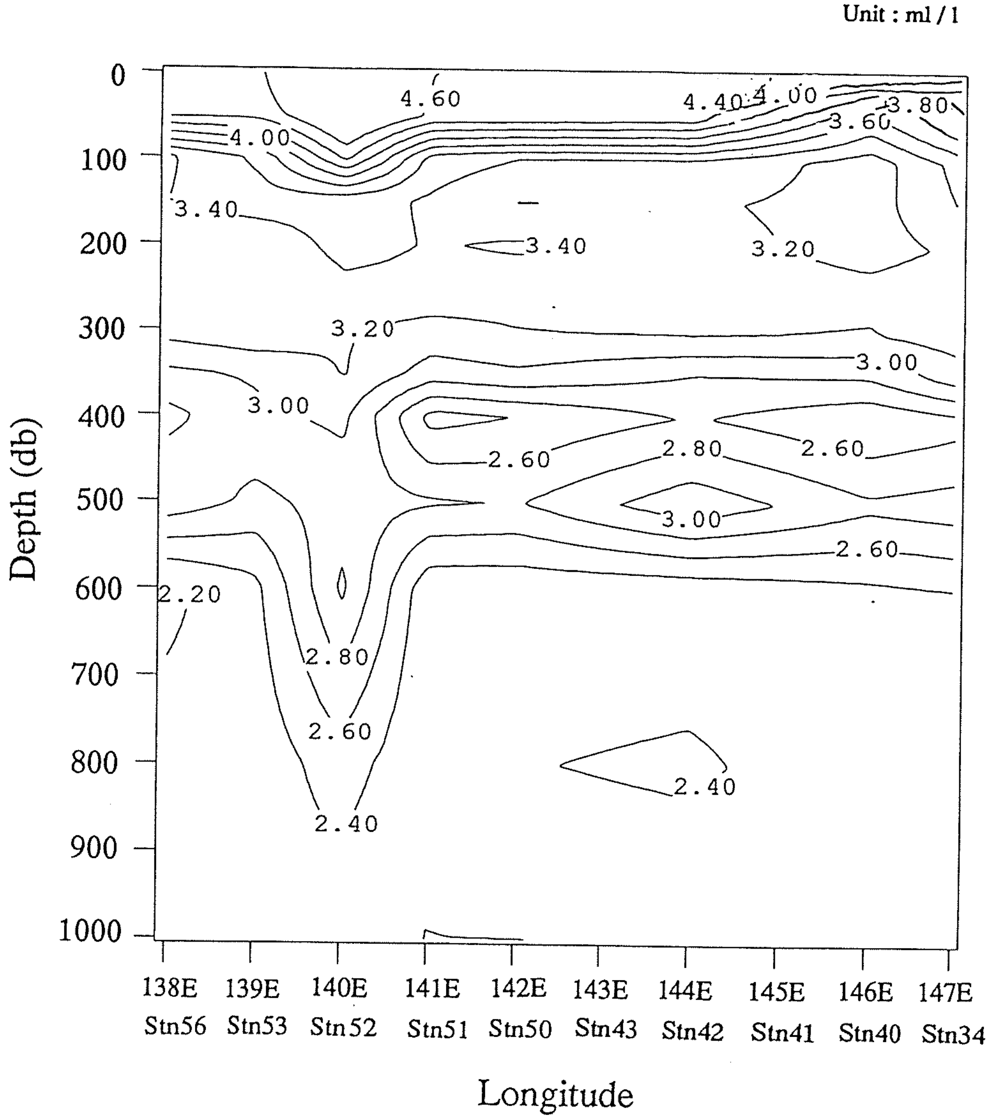


Fig.4.6.3 (1) Dissolved Oxygen Contour

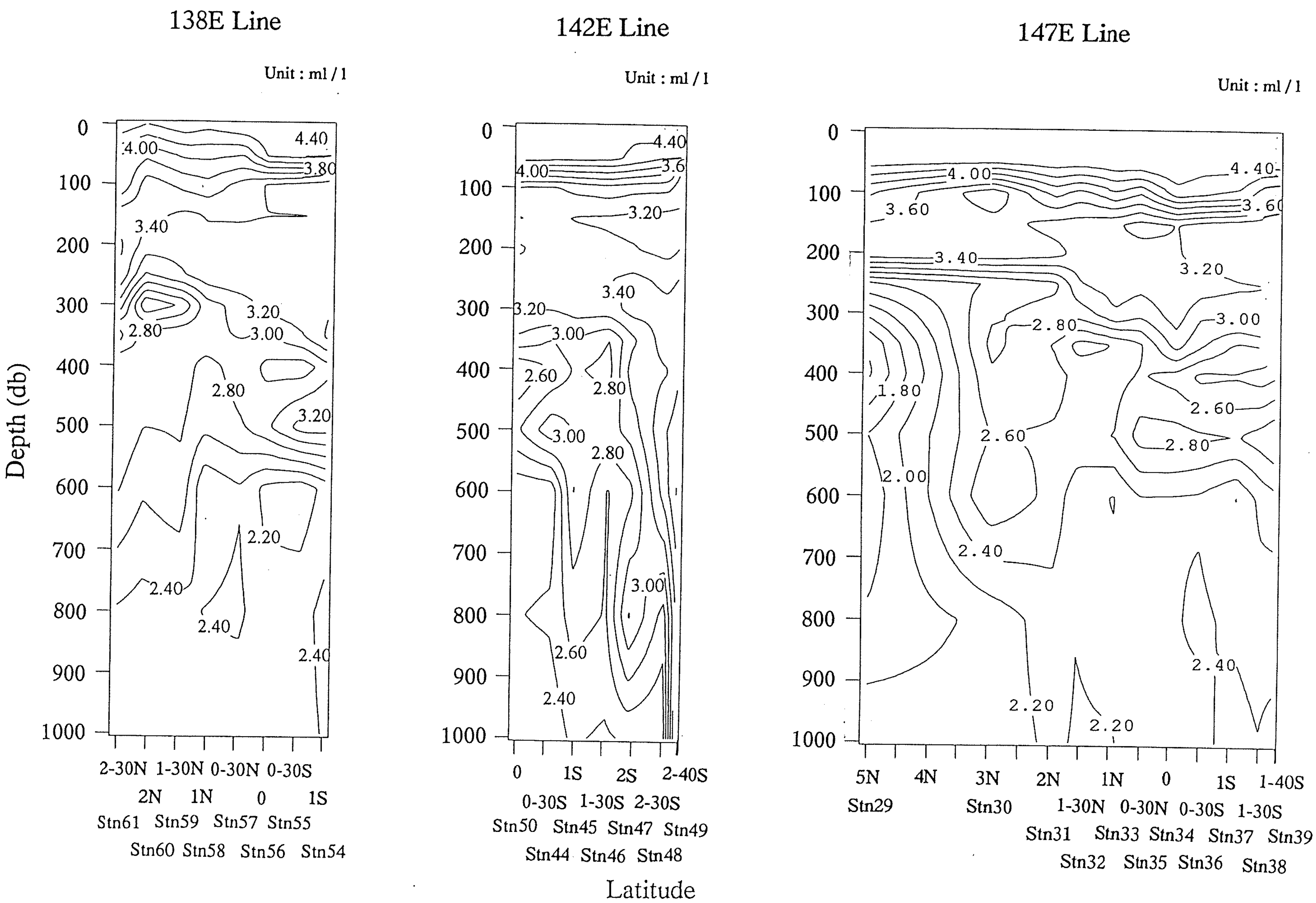


Fig.4.6.3 (2) Dissolved Oxygen Contour

165E Line

Unit : ml / l

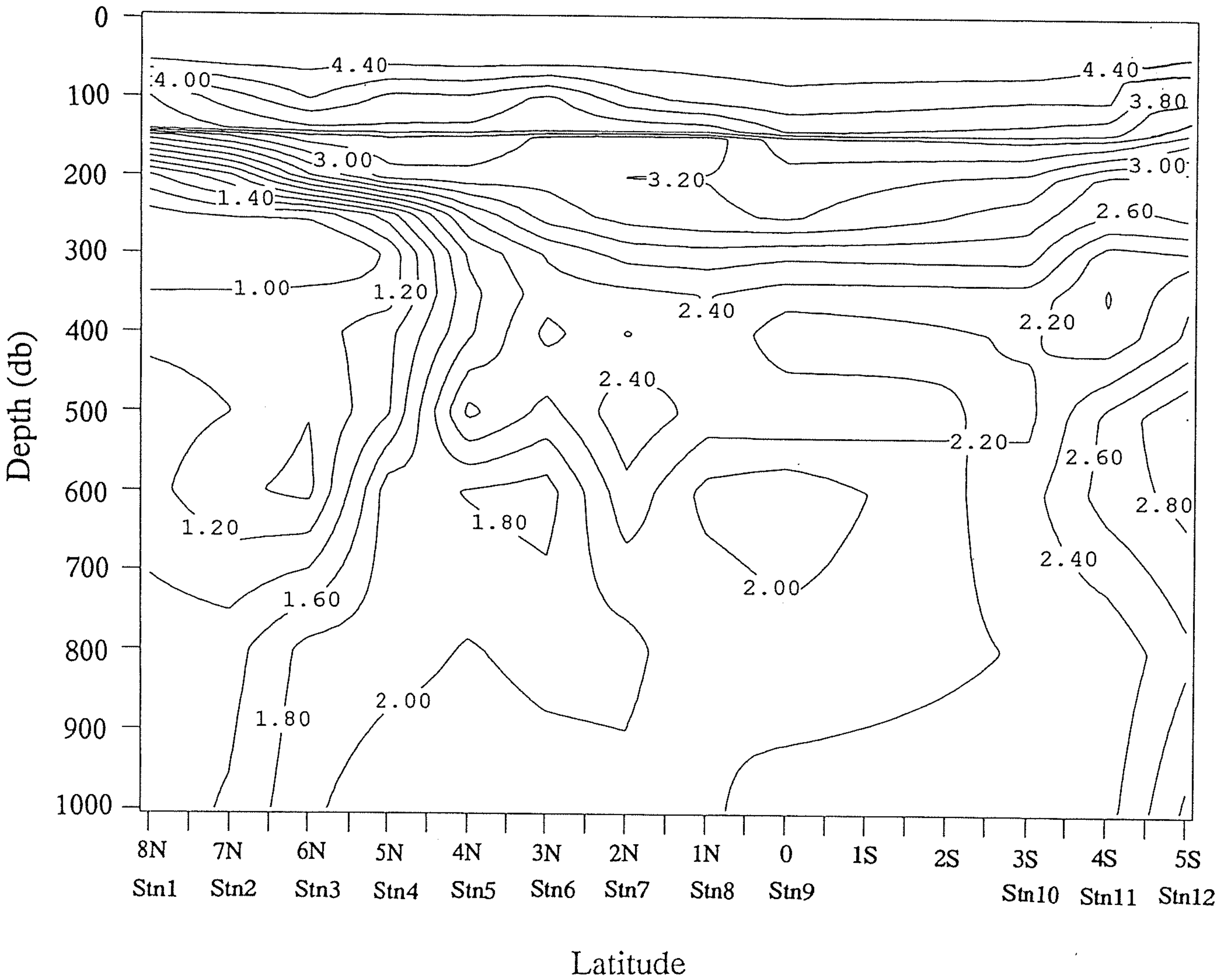


Fig.4.6.3 (3) Dissolved Oxygen Contour

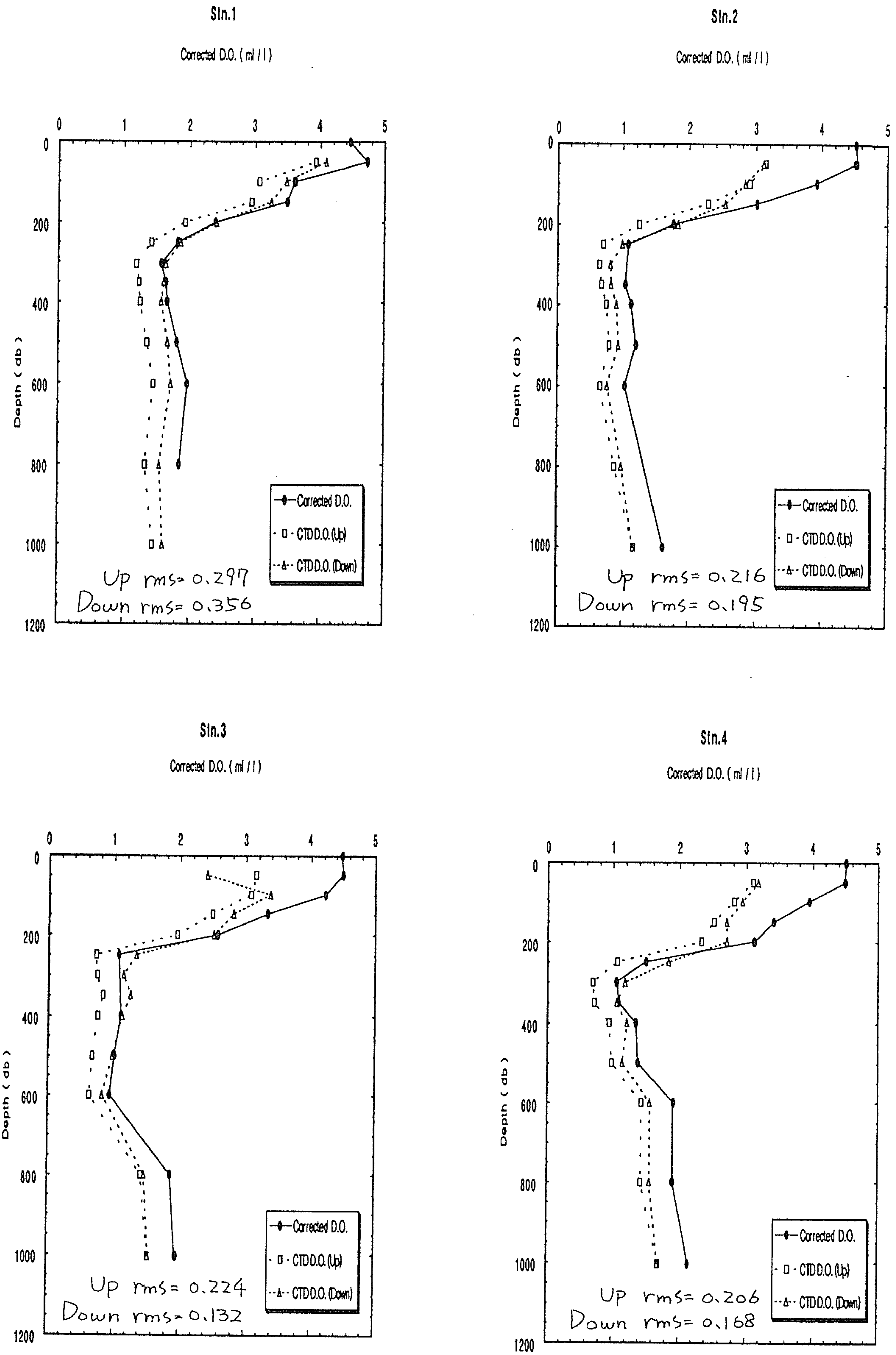


Fig.4.6.4 (1) Vertical plofiles

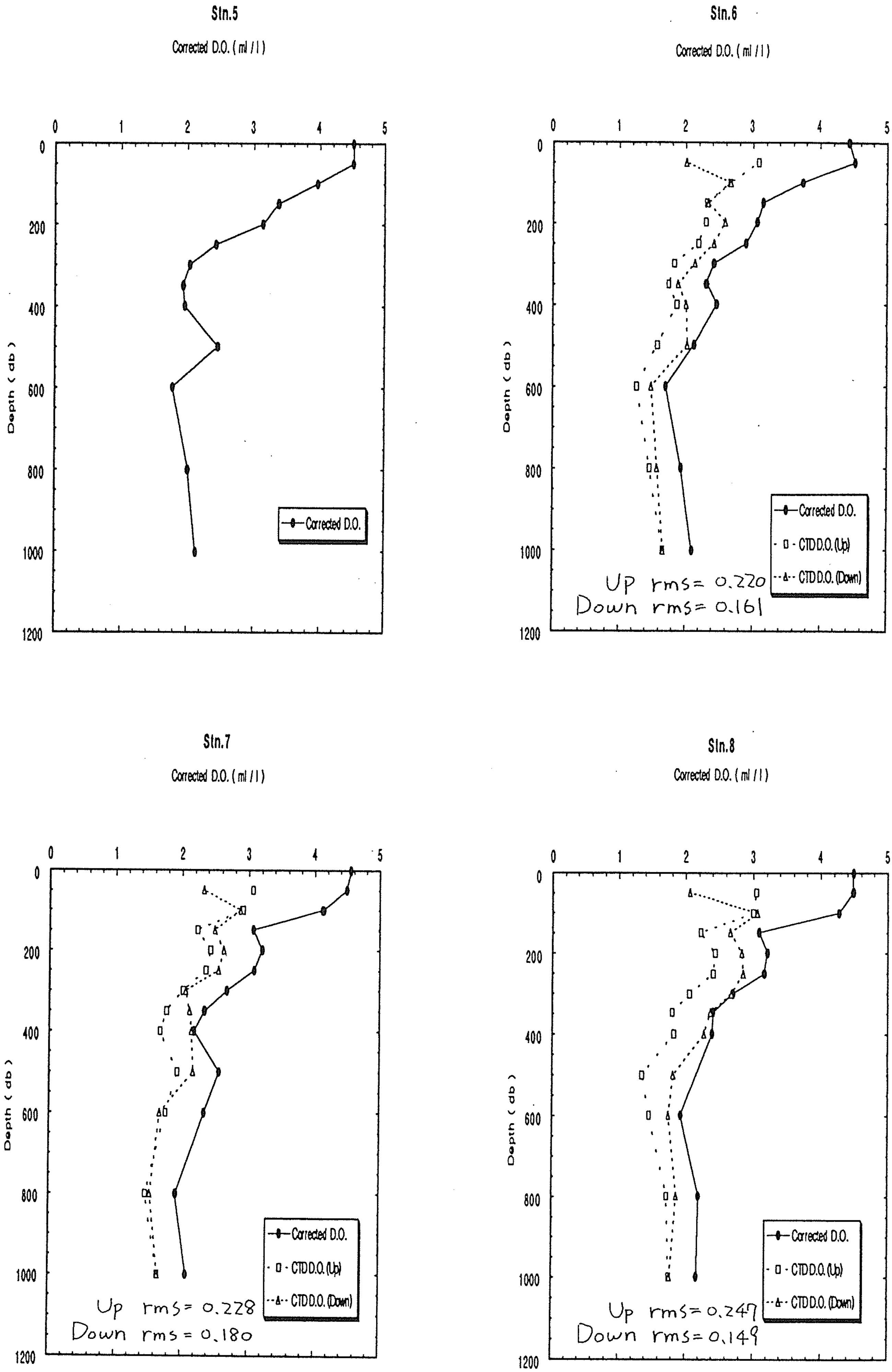


Fig.4.6.4 (2) Vertical plofiles

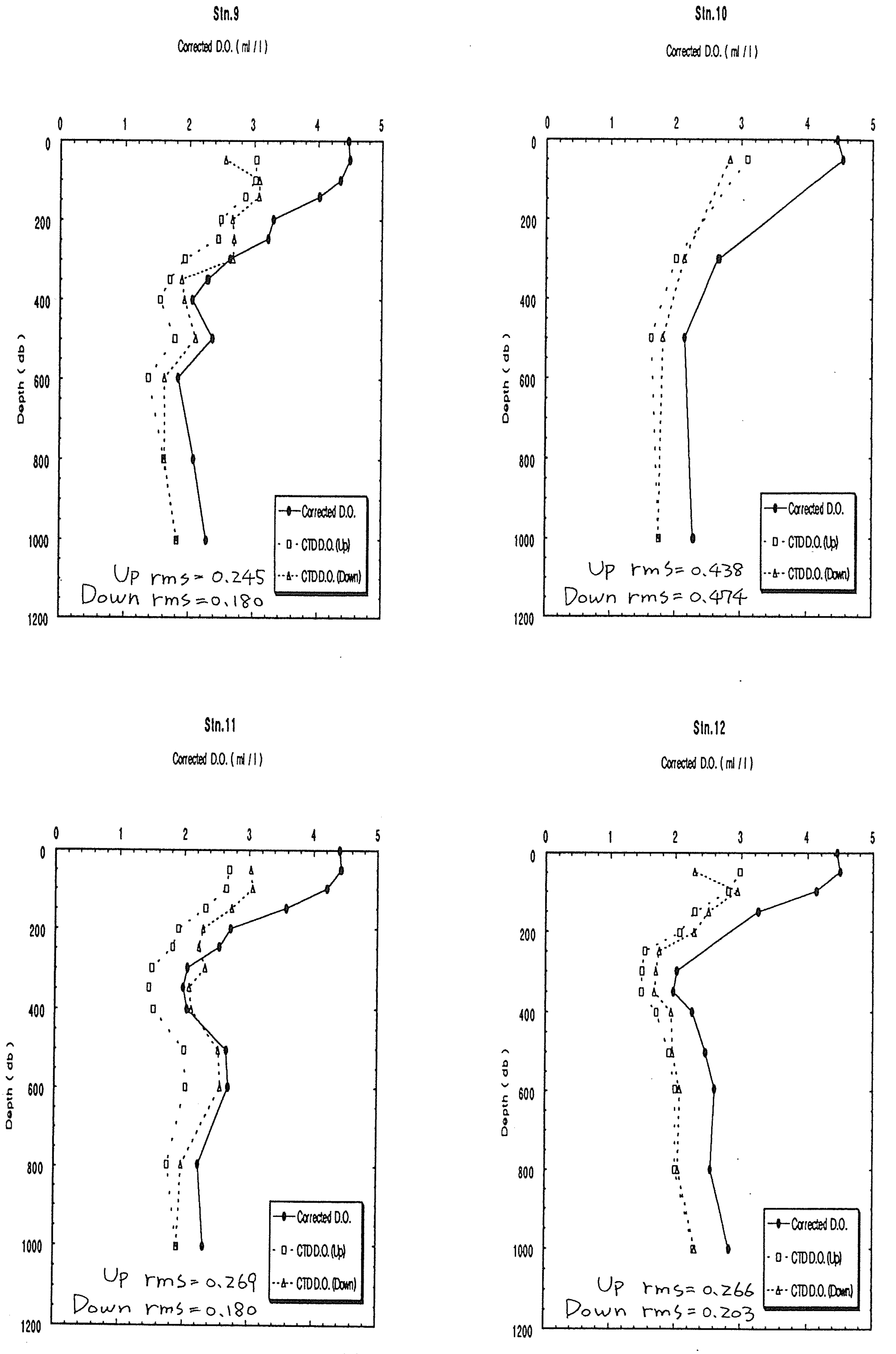


Fig.4.6.4 (3) Vertical plofiles

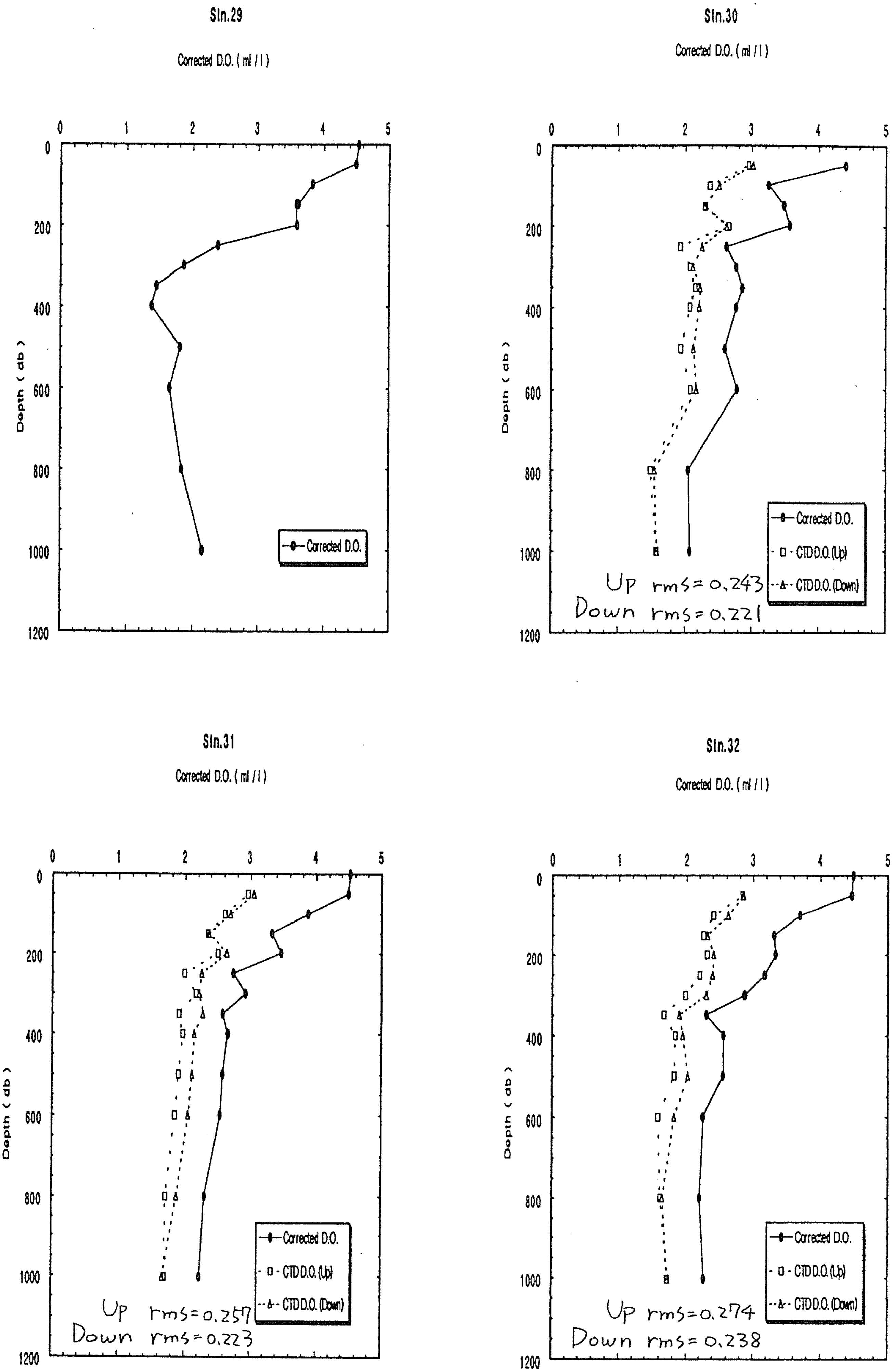
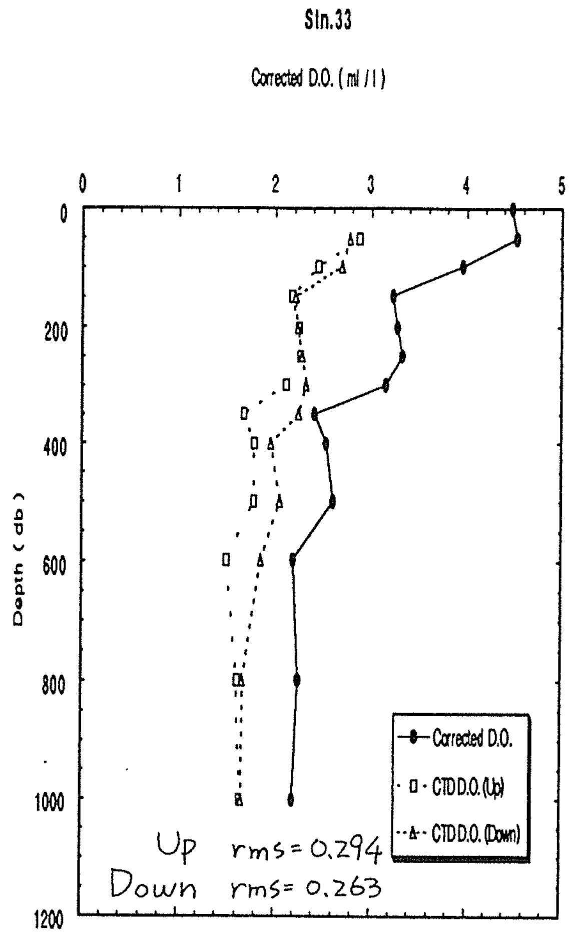
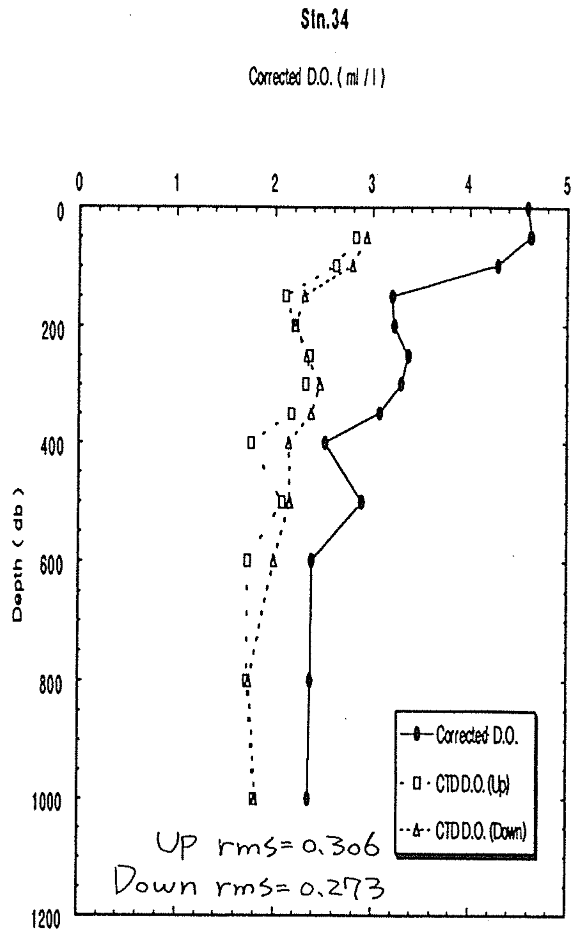
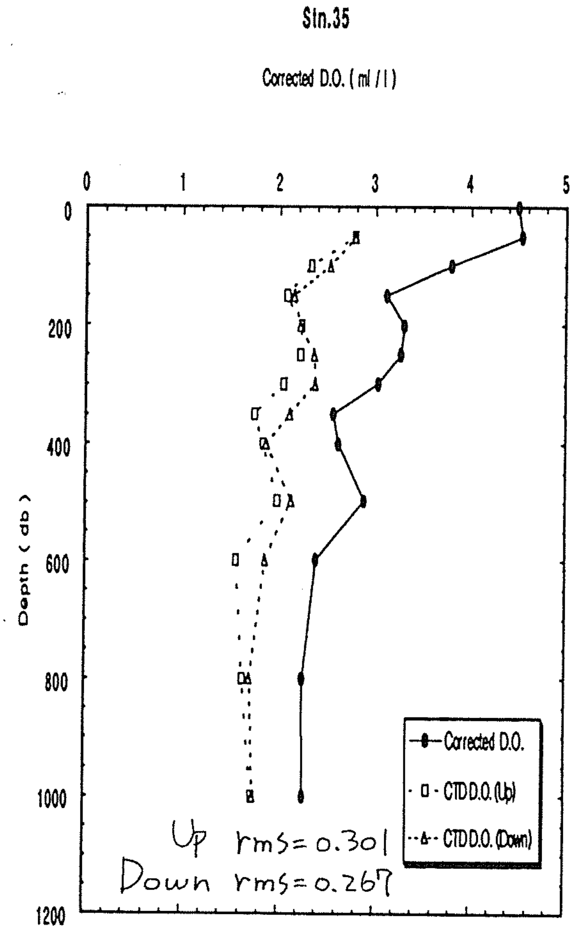


Fig.4.6.4 (4) Vertical plofiles







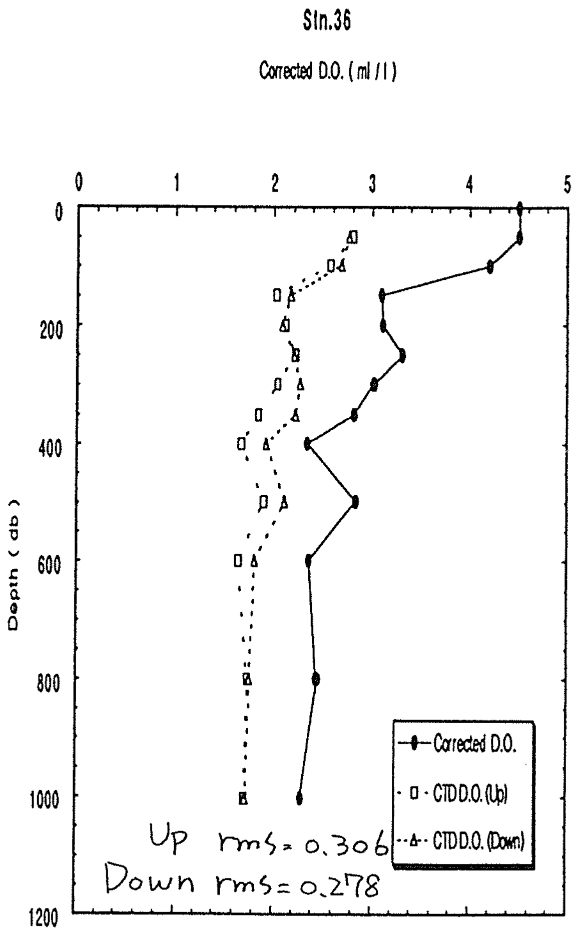
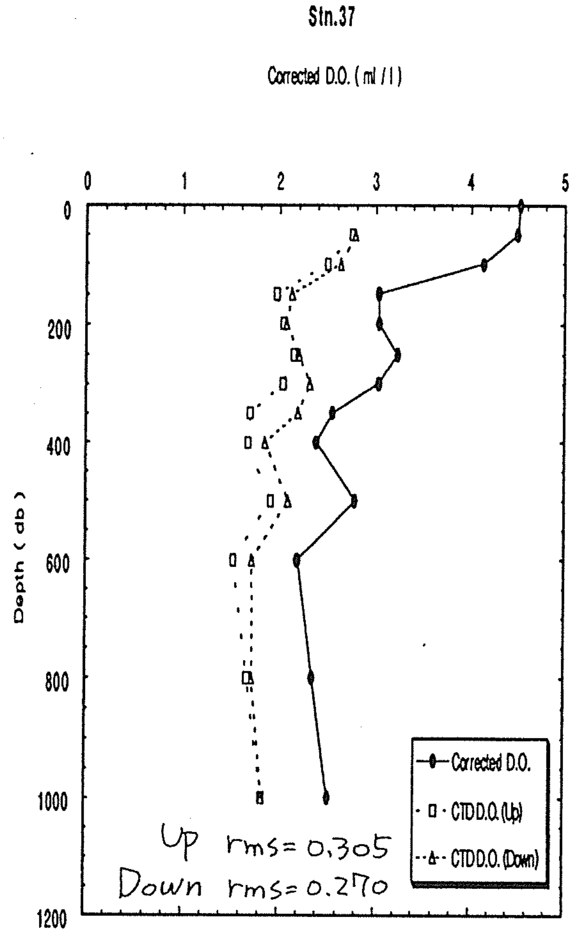
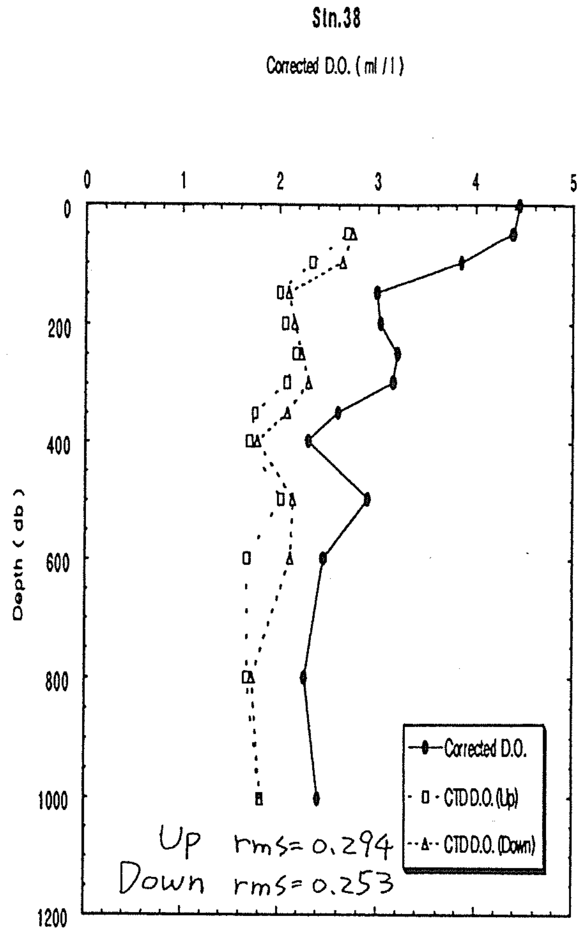
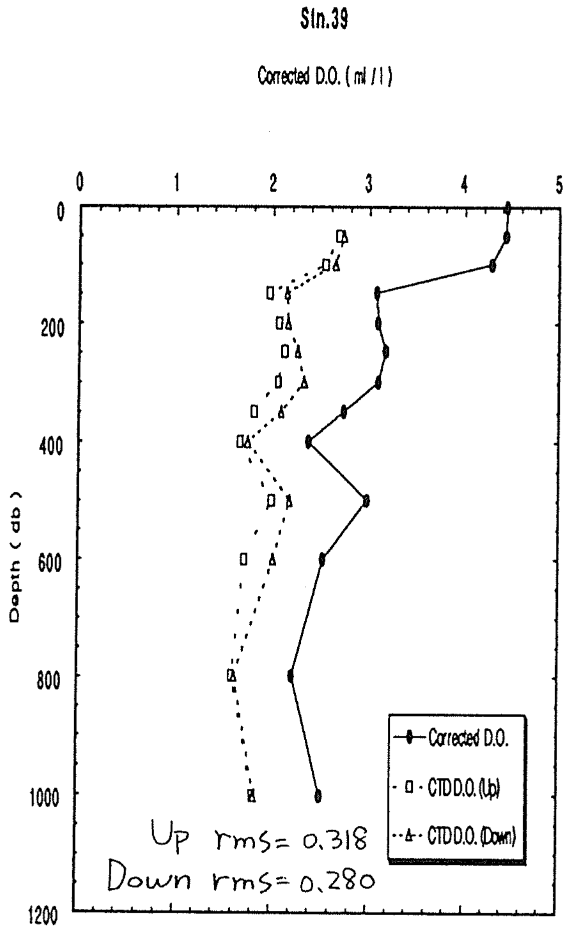


Fig.4.6.4 (5) Vertical plofiles







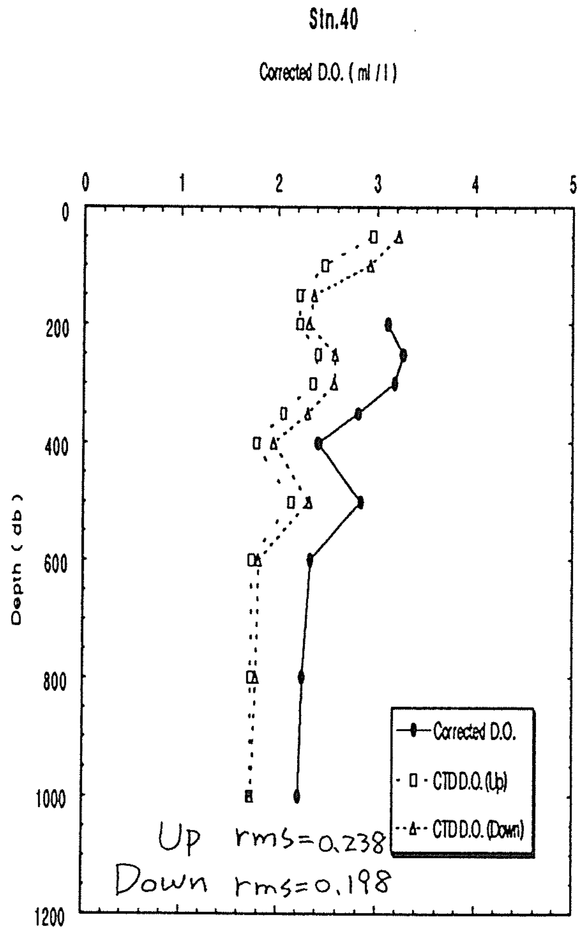
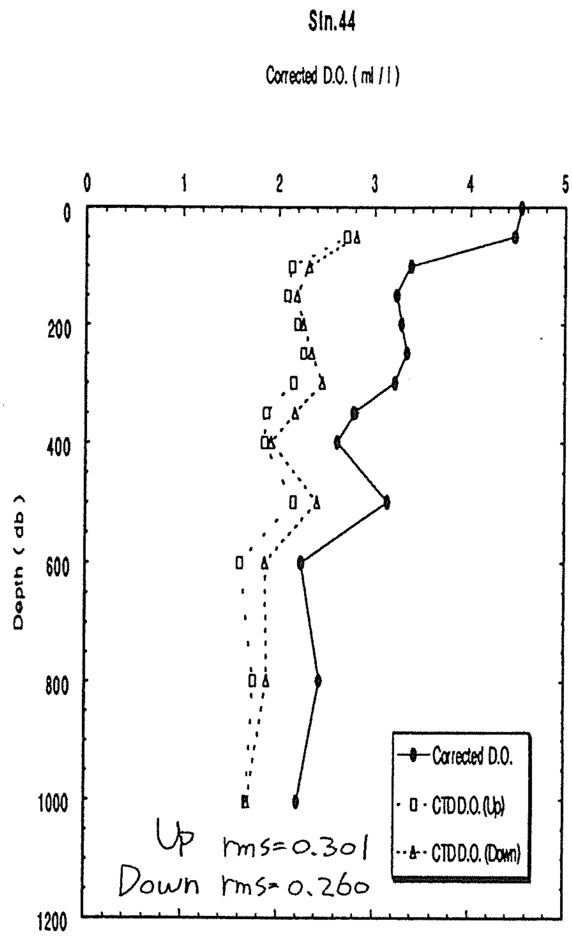
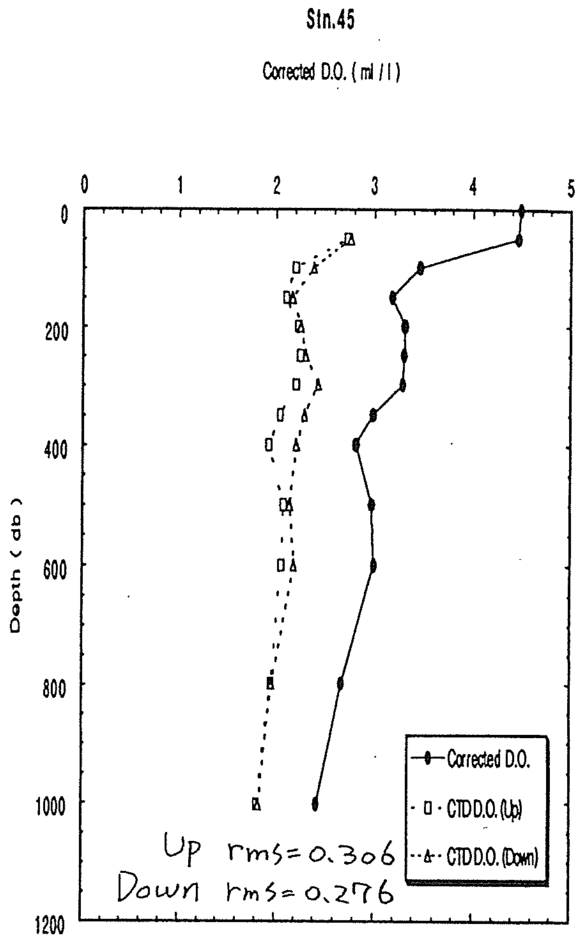
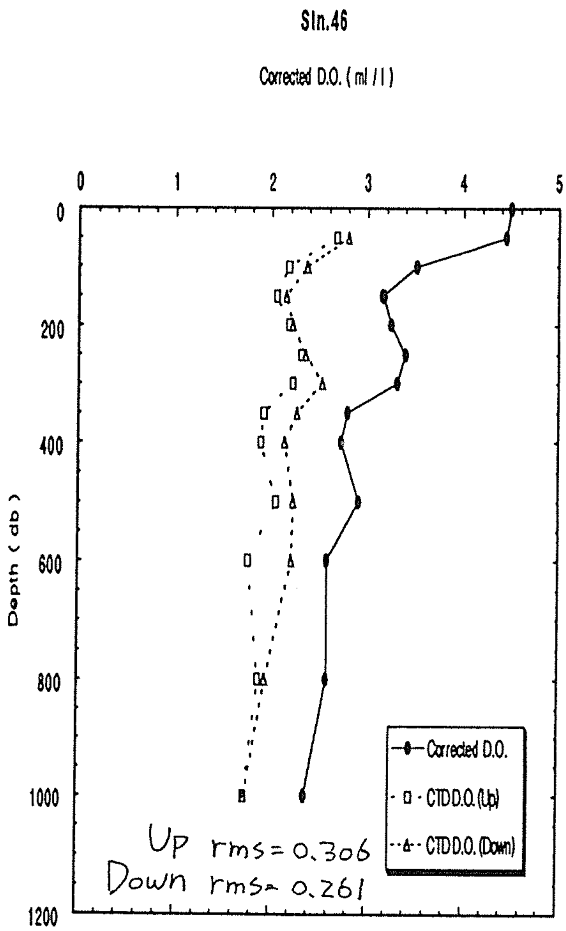


Fig.4.6.4 (6) Vertical plofiles







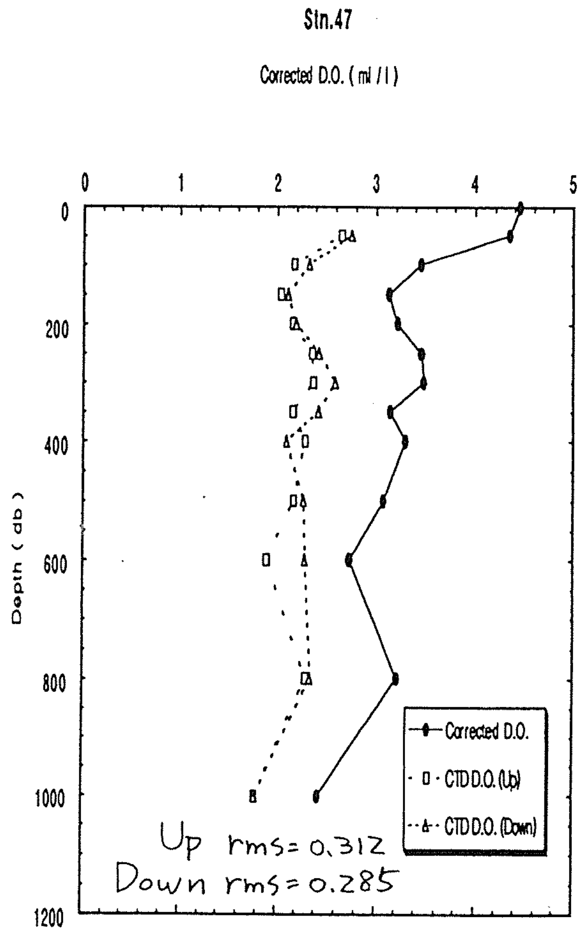


Fig.4.6.4 (7) Vertical plofiles

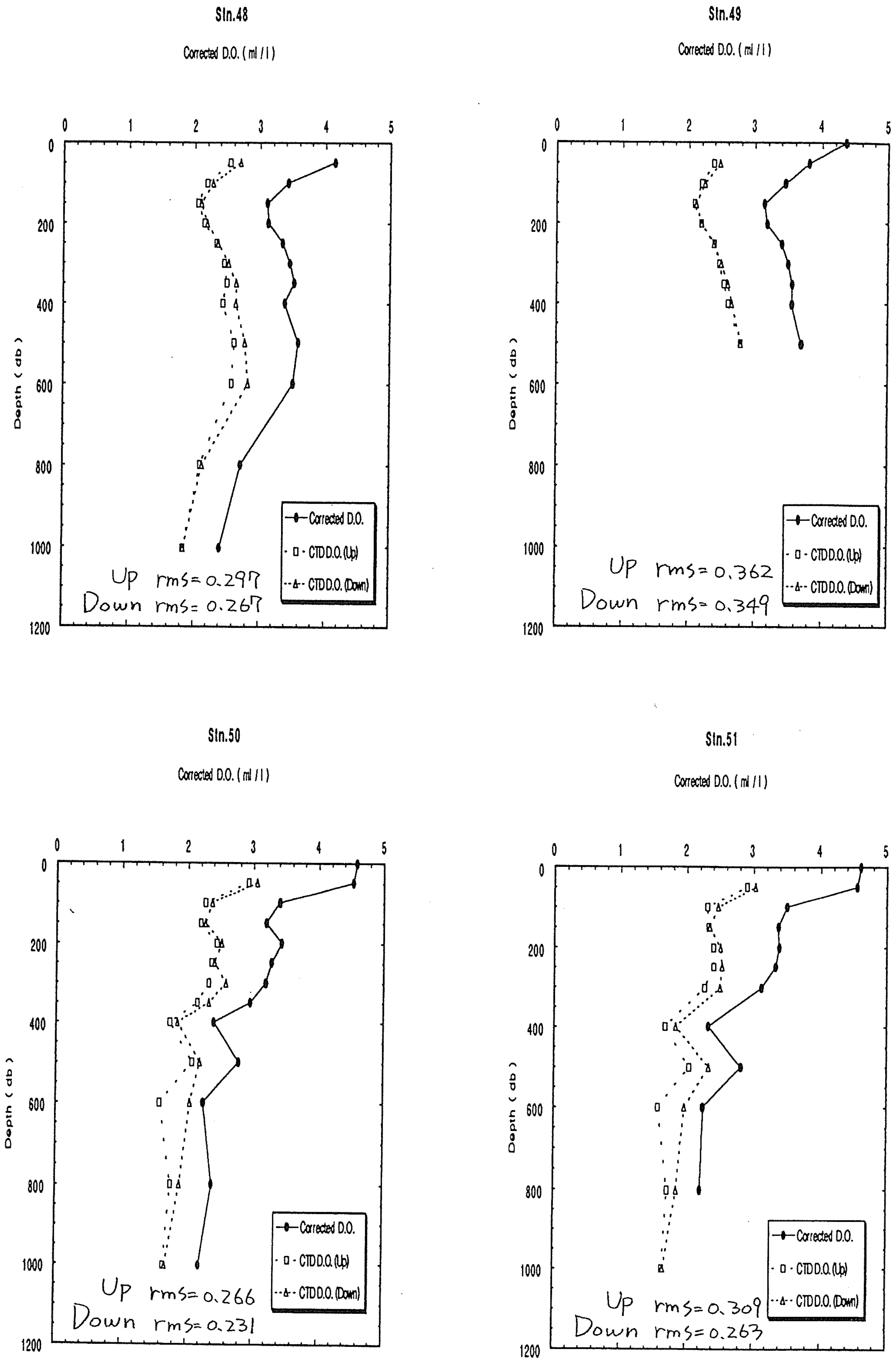


Fig.4.6.4 (8) Vertical plofiles

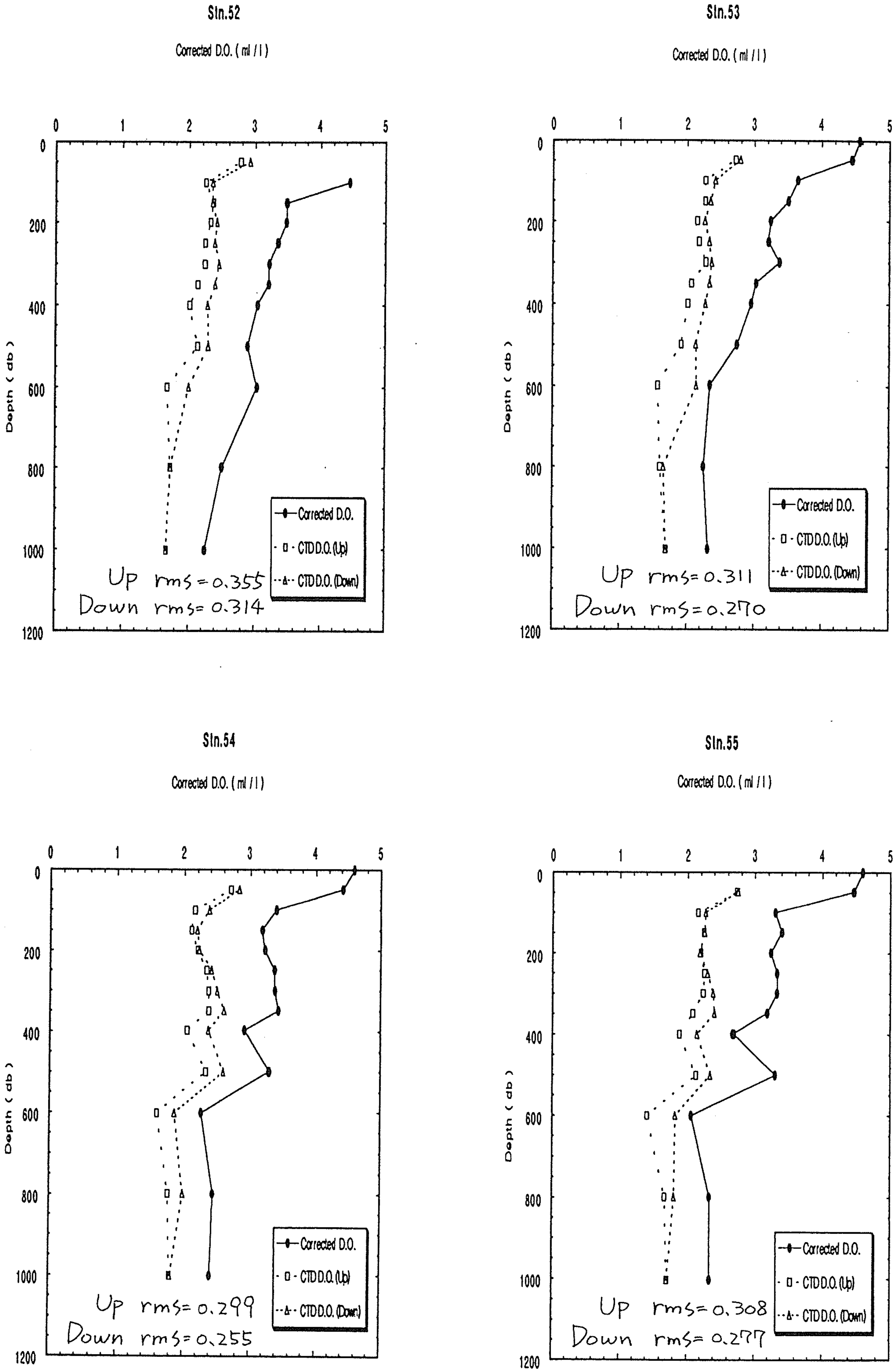
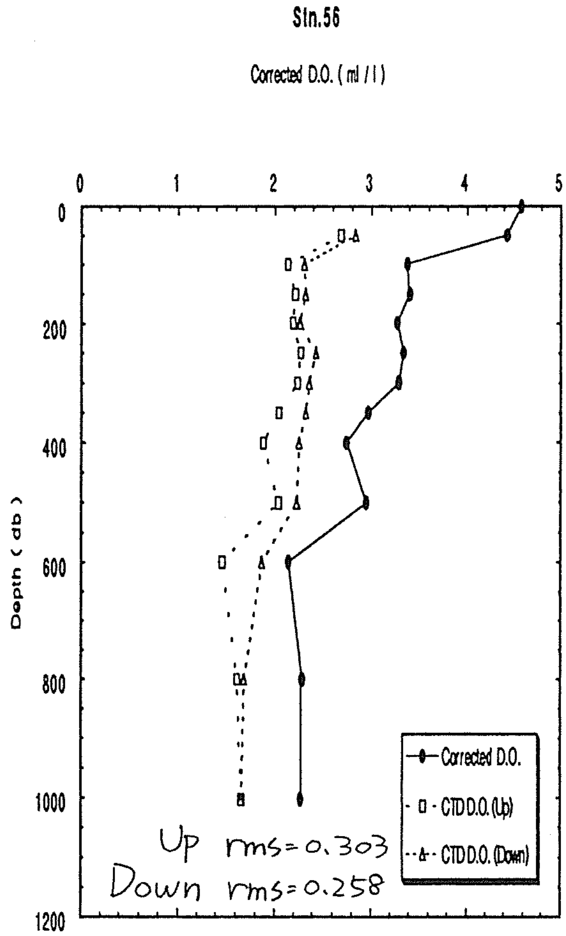
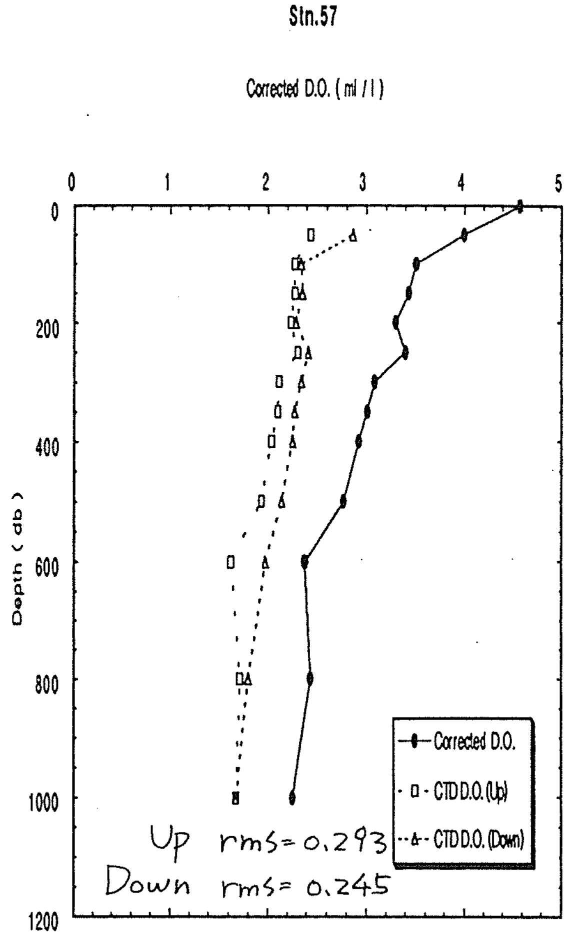
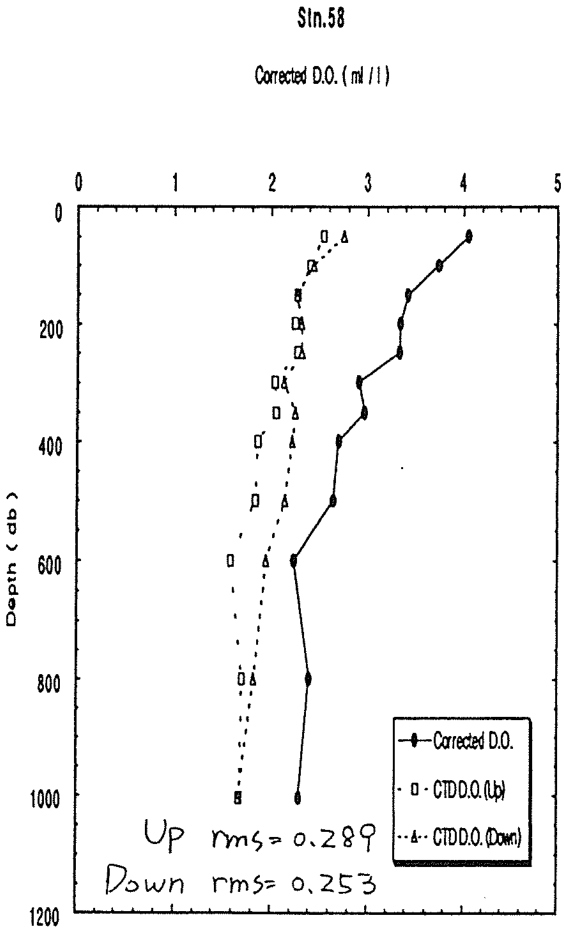


Fig.4.6.4 (9) Vertical plofiles







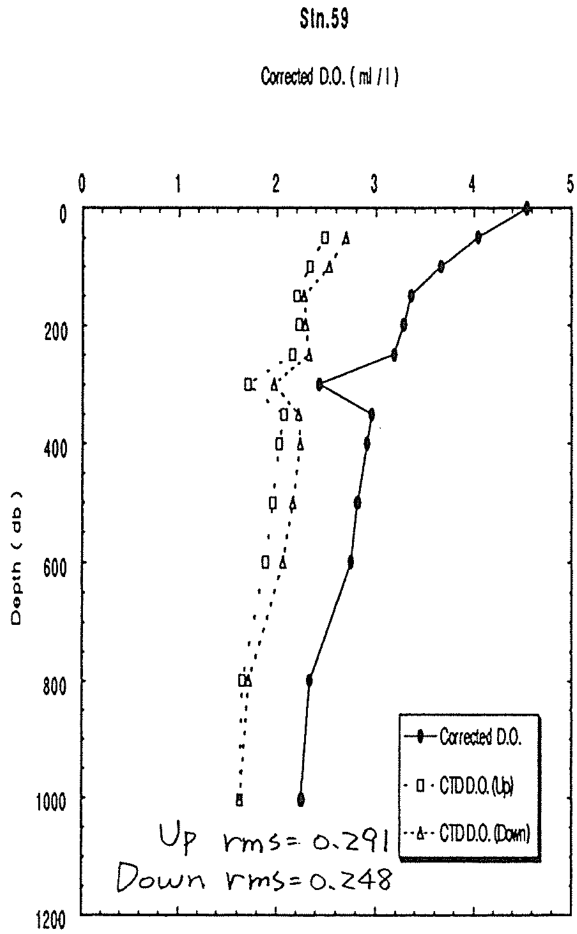
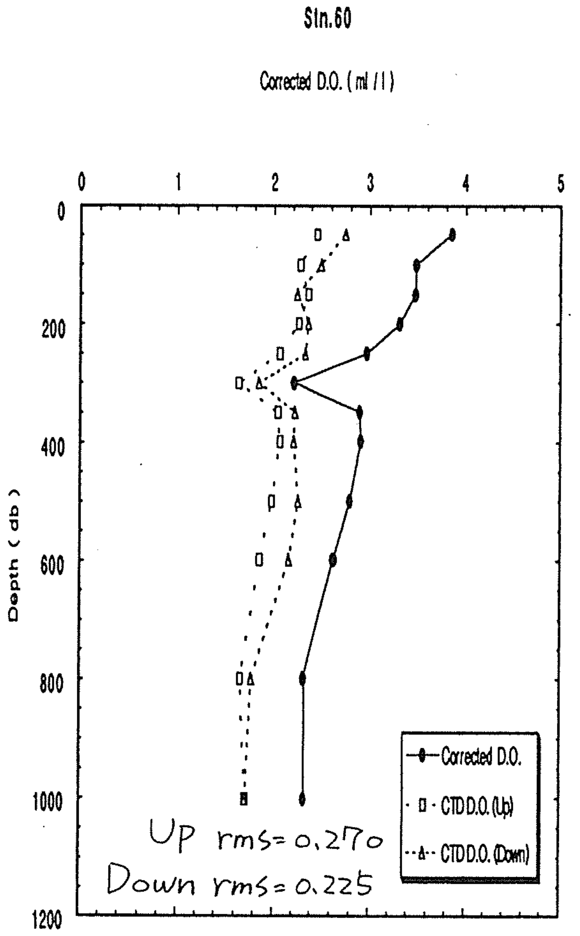


Fig.4.6.4 (10) Vertical plofiles



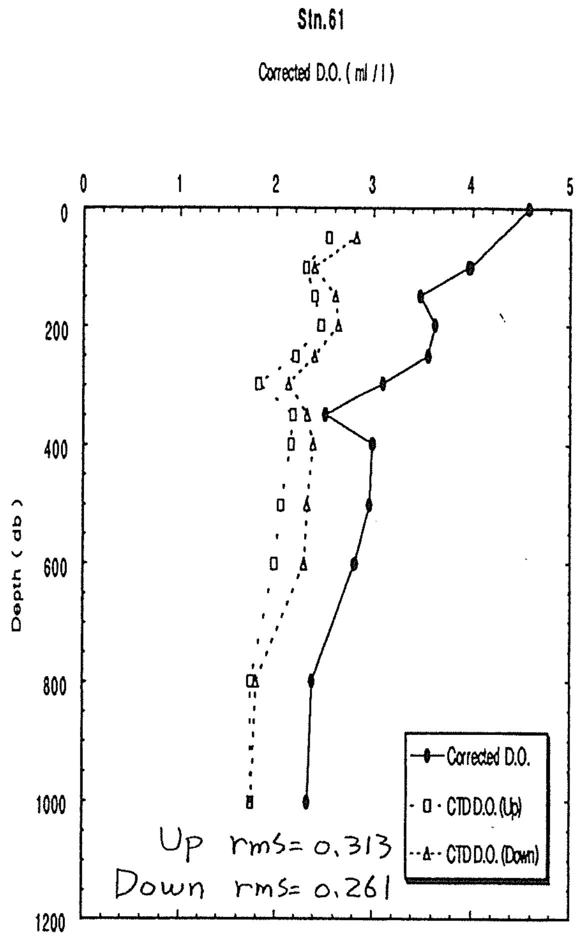


Fig.4.6.4 (11) Vertical plofiles

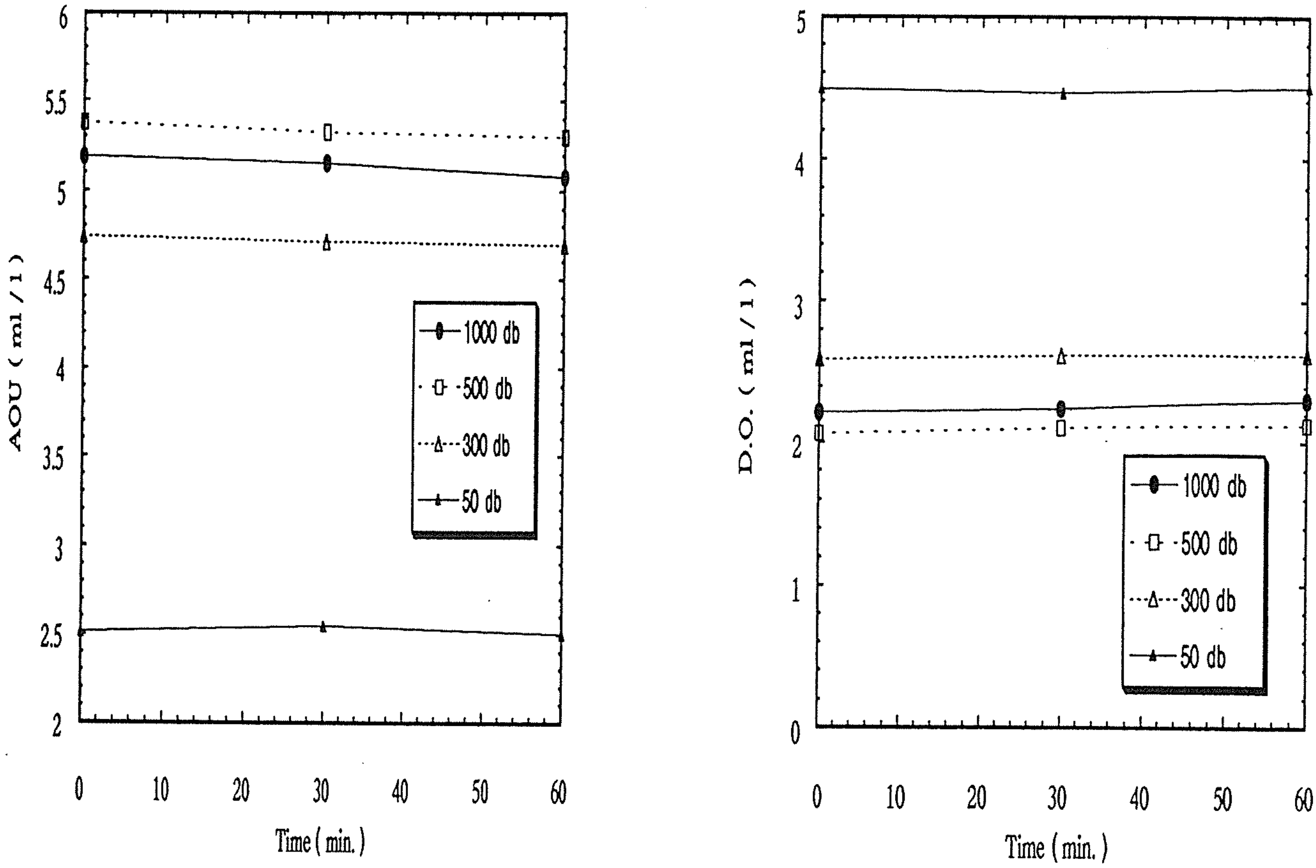


Fig.4.6.5 Experiment dn the starting time to sample water for measurment.
(1) Difference of starting time

Fig.4.6.5 (2) Sampling for Same Niskin

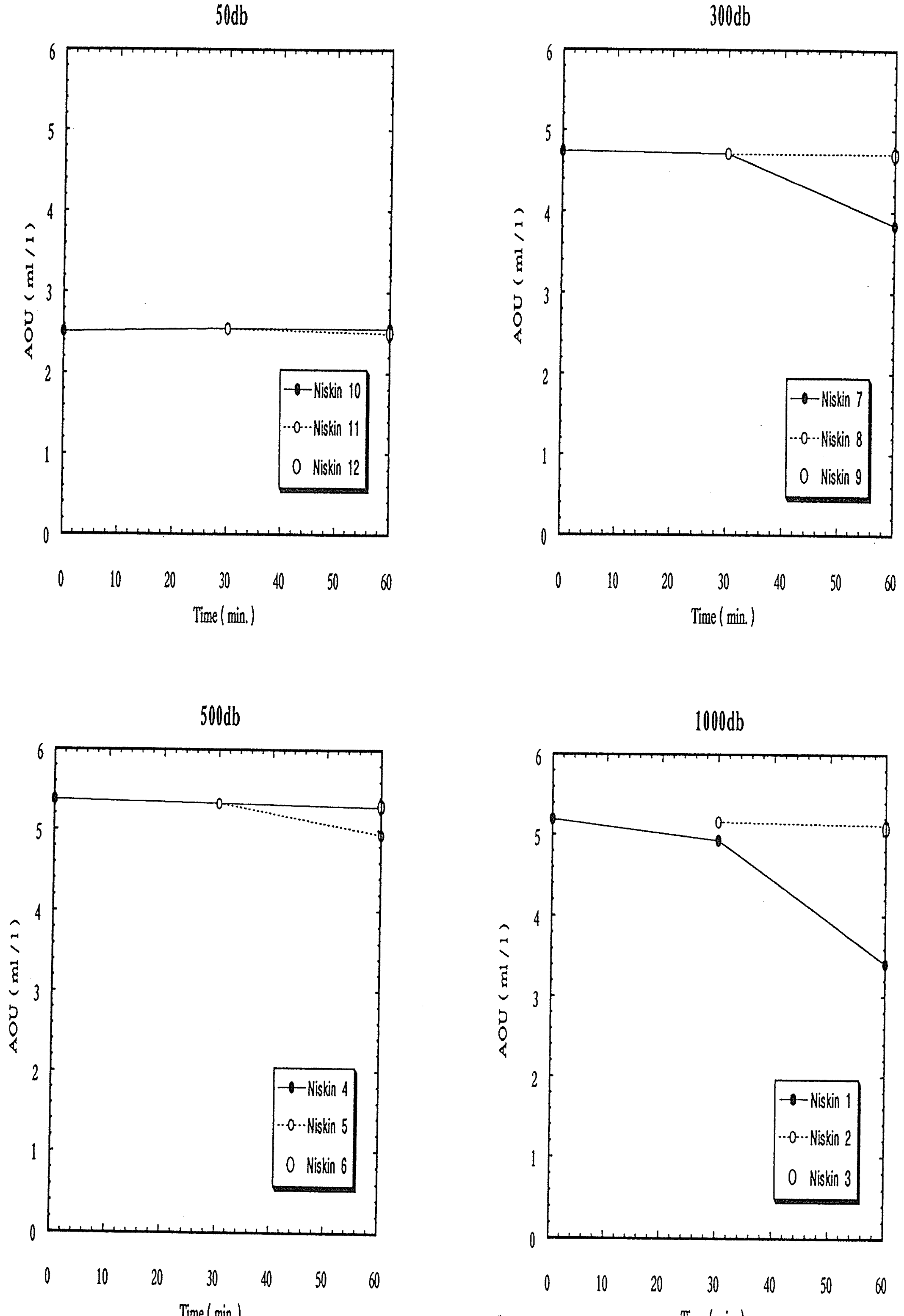


Fig.4.6.5 (2) Sampling for Same Niskin

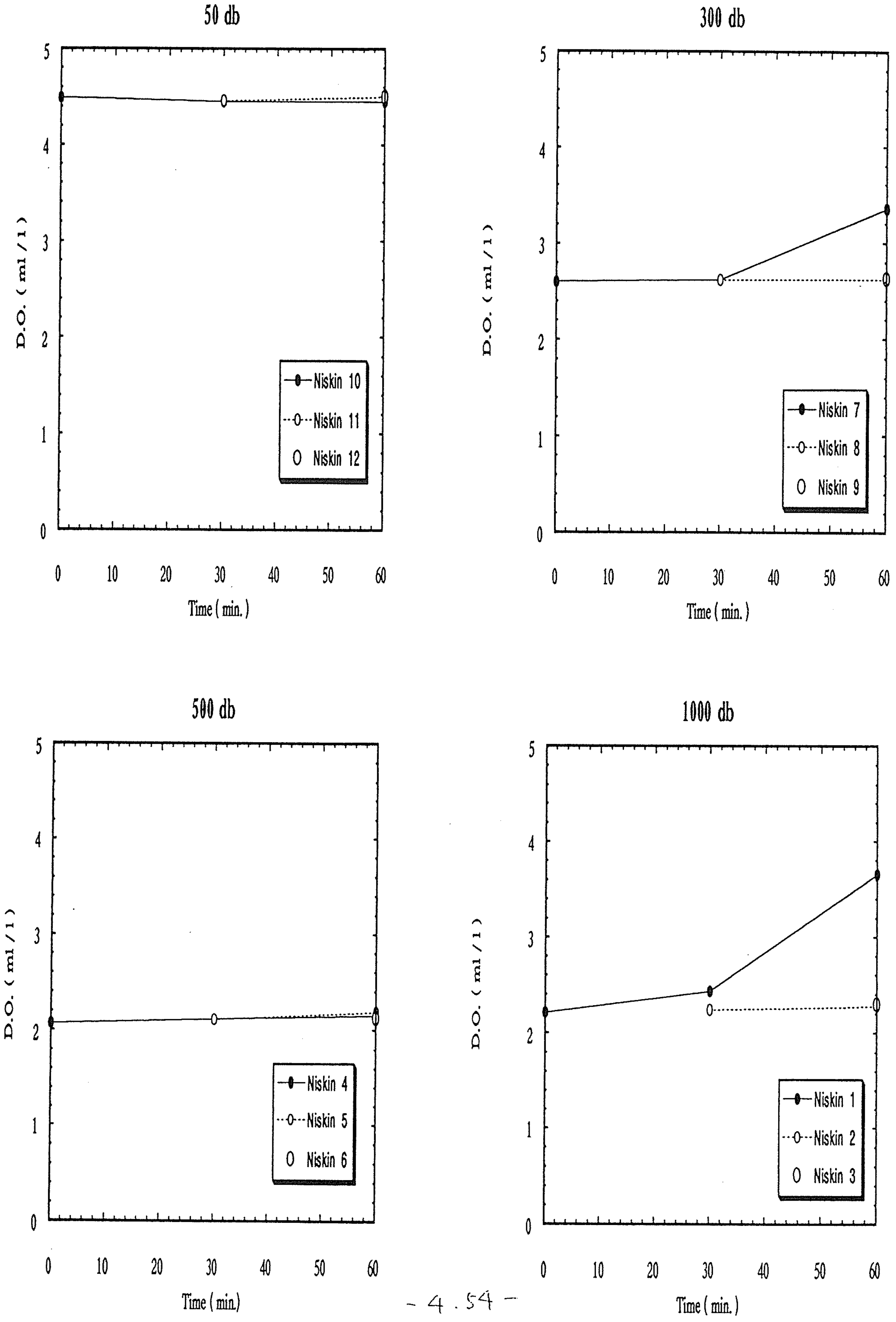


Table.4.6.1 (1) Corrected D.O. data

Stn. 8N	1 165E	Stn. 7N	2 165E	Stn. 6N	3 165E	Stn. 5N	4 165E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.41	0	4.52	0	4.48	0	4.50
49	4.45	49	4.52	49	4.49	49	4.49
100	n.d.	99	3.92	99	4.22	99	3.94
149	n.d.	148	3.02	147	3.33	149	3.41
200	n.d.	200	1.76	200	2.58	199	3.12
249	0.93	250	1.08	250	1.07	249	1.50
299	n.d.	300	n.d.	299	n.d.	300	1.05
348	n.d.	349	1.04	348	n.d.	349	1.08
400	1.15	400	1.13	399	1.11	399	1.35
501	1.29	499	1.20	500	1.01	499	1.38
599	n.d.	601	1.04	599	0.94	599	1.92
800	1.53	800	n.d.	799	1.87	799	1.91
1000	n.d.	1002	1.62	1003	1.96	1003	2.14

Stn. 4N	5 165E	Stn. 3N	6 165E	Stn. 2N	7 165E	Stn. 1N	8 165E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.51	0	4.43	0	4.55	0	4.48
50	4.51	49	4.51	50	4.48	48	4.48
100	3.96	100	3.74	101	4.13	101	4.28
148	3.37	149	3.15	149	3.07	148	3.09
200	3.14	198	3.06	200	3.20	200	3.21
250	2.43	250	2.90	250	3.09	250	3.16
300	2.04	299	2.42	300	2.67	301	2.70
351	1.94	350	2.31	350	2.34	347	2.41
400	1.96	400	2.46	400	2.19	400	2.39
500	2.46	498	2.13	500	2.56	500	n.d.
599	1.78	599	1.71	600	2.34	599	1.93
800	2.02	800	1.94	800	1.92	798	2.20
1002	2.14	1002	2.10	1001	2.08	998	2.17

Stn. 0	9 165E	Stn. 3S	10 165E	Stn. 4S	11 165E	Stn. 5S	12 165-10E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.47	0	4.46	0	4.41	0	4.44
49	4.49	51	4.54	51	4.43	49	4.49
101	4.34	100	n.d.	100	4.21	100	4.13
142	4.02	150	n.d.	150	3.58	151	3.25
199	3.31	200	n.d.	201	2.72	203	n.d.
247	3.22	250	n.d.	248	2.55	249	n.d.
298	2.64	300	2.67	300	2.05	300	2.03
350	2.29	350	n.d.	348	1.98	351	1.97
400	2.05	400	n.d.	401	2.05	401	2.26
500	2.37	500	2.14	500	2.66	500	2.46
597	1.83	600	n.d.	598	2.69	595	2.61
800	2.08	800	n.d.	795	2.23	800	2.55
1002	2.28	1000	2.29	1004	2.32	1001	2.84

Stn. 2-30S	13 157-20E	Stn. 2S	14 156E	Stn. 1-30S	15 156E	Stn. 1S	16 156E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	n.d.	0	4.39	0	4.46	0	4.39
50	n.d.	50	n.d.	50	n.d.	50	n.d.
100	n.d.	100	n.d.	100	n.d.	100	n.d.
150	n.d.	150	n.d.	150	n.d.	150	n.d.
200	n.d.	200	n.d.	200	n.d.	200	n.d.
250	n.d.	250	n.d.	250	n.d.	250	n.d.
300	n.d.	300	n.d.	300	n.d.	300	n.d.
350	n.d.	350	n.d.	350	n.d.	350	n.d.
400	n.d.	400	n.d.	400	n.d.	400	n.d.
500	n.d.	500	n.d.	500	n.d.	500	n.d.
600	n.d.	600	n.d.	600	n.d.	600	n.d.
800	n.d.	800	n.d.	800	n.d.	800	n.d.
1000	n.d.	1000	n.d.	1000	n.d.	1000	n.d.

n.d.=NO DATA

Table.4.6.1 (2) Corrected D.O. data

Stn.	17	Stn.	18	Stn.	19	Stn.	20
0-30S	156E	0	156-10E	0-30N	156E	1N	156E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.48	0	n.d.	0	4.46	0	4.42
50	n.d.	50	n.d.	50	n.d.	50	n.d.
100	n.d.	100	n.d.	100	n.d.	100	n.d.
150	n.d.	150	n.d.	150	n.d.	150	n.d.
200	n.d.	200	n.d.	200	n.d.	200	n.d.
250	n.d.	250	n.d.	250	n.d.	250	n.d.
300	n.d.	300	n.d.	300	n.d.	300	n.d.
350	n.d.	350	n.d.	350	n.d.	350	n.d.
400	n.d.	400	n.d.	400	n.d.	400	n.d.
500	n.d.	500	n.d.	500	n.d.	500	n.d.
600	n.d.	600	n.d.	600	n.d.	600	n.d.
800	n.d.	800	n.d.	800	n.d.	800	n.d.
1000	n.d.	1000	n.d.	1000	n.d.	1000	n.d.

Stn.	21	Stn.	22	Stn.	23	Stn.	24
1-30N	156E	2N	156E	3N	156E	4N	156E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.43	0	4.47	0	4.43	0	4.48
50	n.d.	50	n.d.	50	n.d.	50	n.d.
100	n.d.	100	n.d.	100	n.d.	100	n.d.
150	n.d.	150	n.d.	150	n.d.	150	n.d.
200	n.d.	200	n.d.	200	n.d.	200	n.d.
250	n.d.	250	n.d.	250	n.d.	250	n.d.
300	n.d.	300	n.d.	300	n.d.	300	n.d.
350	n.d.	350	n.d.	350	n.d.	350	n.d.
400	n.d.	400	n.d.	400	n.d.	400	n.d.
500	n.d.	500	n.d.	500	n.d.	500	n.d.
600	n.d.	600	n.d.	600	n.d.	600	n.d.
800	n.d.	800	n.d.	800	n.d.	800	n.d.
1000	n.d.	1000	n.d.	1000	n.d.	1000	n.d.

Stn.	25	Stn.	26	Stn.	27	Stn.	28
5N	156E	6N	156E	7N	156E	8N	156E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.51	0	4.51	0	4.51	0	4.56
50	n.d.	50	n.d.	50	n.d.	50	n.d.
100	n.d.	100	n.d.	100	n.d.	100	n.d.
150	n.d.	150	n.d.	150	n.d.	150	n.d.
200	n.d.	200	n.d.	200	n.d.	200	n.d.
250	n.d.	250	n.d.	250	n.d.	250	n.d.
300	n.d.	300	n.d.	300	n.d.	300	n.d.
350	n.d.	350	n.d.	350	n.d.	350	n.d.
400	n.d.	400	n.d.	400	n.d.	400	n.d.
500	n.d.	500	n.d.	500	n.d.	500	n.d.
600	n.d.	600	n.d.	600	n.d.	600	n.d.
800	n.d.	800	n.d.	800	n.d.	800	n.d.
1000	n.d.	1000	n.d.	1000	n.d.	1000	n.d.

Stn.	29	Stn.	30	Stn.	31	Stn.	32
5N	147E	3N	147E	2N	147E	1-30N	147E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.53	0	n.d.	0	4.52	0	4.48
49	4.49	49	4.40	50	4.49	50	4.46
99	3.83	100	3.25	101	3.87	99	3.69
148	3.60	150	3.48	150	3.33	151	3.31
201	3.59	199	3.56	200	3.47	198	3.33
251	2.39	250	2.62	251	2.74	250	3.17
300	1.87	300	2.77	301	2.93	300	2.87
350	1.44	351	2.86	350	2.58	348	2.30
399	1.37	399	2.77	399	2.66	400	2.55
500	1.80	500	2.60	499	2.58	498	2.55
600	1.65	599	2.78	600	2.54	600	2.26
800	1.83	800	2.06	801	2.30	799	2.21
1001	2.15	1000	2.08	1003	2.23	1002	2.28

n.d.=NO DATA

Table.4.6.1 (3) Corrected D.O. data

Stn.	33	Stn.	34	Stn.	35	Stn.	36
1N	147E	0	147E	0-30N	147E	0-30S	147E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.48	0	4.59	0	4.50	0	4.50
51	4.53	50	4.63	51	4.54	50	4.50
99	3.96	99	4.28	101	3.79	99	4.21
149	3.22	150	3.20	151	3.12	149	3.10
201	3.27	200	3.22	202	3.30	201	3.11
249	3.33	251	3.37	250	3.26	250	3.31
299	3.15	300	3.30	300	3.03	299	3.02
350	2.41	350	3.08	350	2.57	351	2.82
401	2.53	401	2.52	400	2.62	399	2.34
499	2.61	502	2.90	498	2.89	499	2.84
598	2.19	600	2.39	600	2.39	599	2.37
799	2.25	801	2.37	800	2.26	799	2.45
1002	2.20	1001	2.35	1001	2.27	1003	2.29

Stn.	37	Stn.	38	Stn.	39	Stn.	40
1S	148E	1-30S	147E	1-40S	147E	0	146E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.52	0	4.45	0	4.45	0	n.d.
50	4.50	50	4.38	50	4.43	50	n.d.
101	4.14	98	3.85	100	4.29	101	n.d.
150	3.03	149	3.00	149	3.08	151	n.d.
199	3.04	199	3.03	200	3.09	200	3.12
251	3.23	249	3.20	247	3.17	252	3.27
300	3.03	298	3.16	299	3.10	301	3.18
350	2.55	350	2.61	349	2.74	351	2.82
401	2.39	399	2.30	399	2.38	401	2.42
501	2.79	499	2.91	499	2.99	502	2.84
601	2.20	599	2.46	600	2.53	601	2.34
801	2.35	800	2.28	799	2.22	799	2.26
1000	2.52	1003	2.41	1002	2.51	1001	2.23

Stn.	41	Stn.	42	Stn.	43	Stn.	44
0	145E	0	144E	0	143E	0-30S	142E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.55	0	4.56	0	4.55	0	4.54
50	n.d.	50	n.d.	50	n.d.	50	4.47
100	n.d.	100	n.d.	100	n.d.	100	3.38
150	n.d.	150	n.d.	150	n.d.	150	3.23
200	n.d.	200	n.d.	200	n.d.	200	3.29
250	n.d.	250	n.d.	250	n.d.	249	3.35
300	n.d.	300	n.d.	300	n.d.	300	3.22
350	n.d.	350	n.d.	350	n.d.	350	2.80
400	n.d.	400	n.d.	400	n.d.	399	2.62
500	n.d.	500	n.d.	500	n.d.	499	3.15
600	n.d.	600	n.d.	600	n.d.	600	2.25
800	n.d.	800	n.d.	800	n.d.	799	2.44
1000	n.d.	1000	n.d.	1000	n.d.	1004	2.21

Stn.	45	Stn.	46	Stn.	47	Stn.	48
1S	142E	1-30S	142E	2S	142E	2-30S	142E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.48	0	4.50	0	4.46	0	n.d.
50	4.46	50	4.45	49	4.34	49	4.14
99	3.46	101	3.51	99	3.45	100	3.43
150	3.18	150	3.16	150	3.13	149	3.11
200	3.31	199	3.24	199	3.22	200	3.13
250	3.31	250	3.40	250	3.46	249	3.35
299	3.29	299	3.31	299	3.48	300	3.46
349	3.00	351	2.80	349	3.15	349	3.53
400	2.83	400	2.73	399	3.30	400	3.38
500	2.98	500	2.92	499	3.08	498	3.59
600	3.00	600	2.59	599	2.74	599	3.51
799	2.68	800	2.59	799	3.22	799	2.72
1003	2.43	1001	2.37	1002	2.43	1004	2.41

n.d.=NO DATA

Table.4.6.1 (4) Corrected D.O. data

Stn.	49	Stn.	50	Stn.	51	Stn.	52
2-40S	142E	0	142E	0	141E	0	140E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.36	0	4.58	0	4.60	0	n.d.
51	3.80	48	4.52	50	4.55	49	n.d.
101	3.46	100	3.40	100	3.50	102	4.45
151	3.15	149	3.20	150	3.37	151	3.49
200	3.18	199	3.43	200	3.38	200	3.48
250	3.40	249	3.28	249	3.33	250	3.35
300	3.50	301	3.19	302	3.13	301	3.22
351	3.56	350	2.96	350	n.d.	350	3.21
400	3.55	400	2.41	399	2.32	400	3.04
501	3.70	498	2.79	500	2.82	501	2.89
600	n.d.	600	2.25	600	2.25	600	3.04
800	n.d.	799	2.39	801	2.21	800	2.51
1000	n.d.	1003	2.20	1000	n.d.	1003	2.25

Stn.	53	Stn.	54	Stn.	55	Stn.	56
0	139E	1S	138E	0-30S	138E	0	138E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.56	0	4.59	0	4.59	0	4.58
48	4.45	49	4.41	48	4.46	50	4.43
100	3.65	100	3.40	100	3.31	100	3.38
151	3.51	150	3.18	149	3.40	151	3.40
200	3.24	200	3.22	199	3.24	199	3.27
250	3.21	249	3.37	250	3.33	250	3.34
300	3.38	301	3.38	299	3.33	300	3.29
350	3.03	350	3.43	348	3.18	350	2.97
400	2.96	397	2.92	400	2.68	401	2.75
499	2.75	500	3.29	501	3.31	500	2.95
598	2.34	601	2.27	600	2.06	600	2.14
801	2.25	799	2.45	799	2.33	800	2.29
1003	2.32	1001	2.41	1003	2.34	1002	2.28

Stn.	57	Stn.	58	Stn.	59	Stn.	60
0-30N	138E	1N	138E	1-30N	138E	2N	138E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
0	4.58	0	n.d.	0	4.55	0	n.d.
51	4.00	49	4.05	49	4.05	49	3.85
100	3.51	100	3.74	100	3.67	101	3.49
150	3.43	150	3.42	150	3.35	151	3.48
200	3.30	199	3.34	199	3.28	200	3.31
250	3.40	249	3.33	250	3.18	251	2.97
299	3.09	299	2.91	300	2.43	301	2.22
350	3.01	350	2.97	351	2.96	349	2.90
400	2.93	399	2.70	401	2.91	399	2.91
499	2.77	500	2.65	500	2.82	500	2.80
601	2.38	600	2.24	599	2.75	599	2.63
799	2.44	799	2.40	799	2.34	799	2.32
1000	2.26	1004	2.30	1004	2.26	1002	2.32

Stn.	61
2-30N	137-30E
Depth(db)	D.O.(ml/l)
0	4.57
50	n.d.
101	3.97
150	3.48
200	3.62
252	3.56
298	3.10
351	2.51
399	3.00
502	2.97
602	2.82
800	2.38
1003	2.33

n.d.=NO DATA

Table.4.6.2 Root mean squares for each depth

Corrected D.O. - CTD

Niskin No.	Depth (db)	rms CTD (Up)	rms CTD (Down)
1	1000	0.092	0.091
2	800	0.102	0.090
3	600	0.119	0.076
4	500	0.127	0.099
5	400	0.119	0.089
6	350	0.137	0.096
7	300	0.150	0.118
8	250	0.153	0.136
9	200	0.161	0.145
10	150	0.175	0.158
11	100	0.224	0.201
12	50	0.262	0.279

5. Meteorological Measurements

5.1 Radiosonde Observation

In order to promote our understanding on the air-sea interaction over the warm water pool, atmospheric sounding was carried out using VAISALA DigiCORA MW 11 semi-automatic radiosonde system. The system consists of Main processor(MW11), Local VLF antenna(CAS11B/CAA21), UHF telemetry antenna(RB21), Microdisk recorder(MF12), Balloon launcher(ASAP), and Radiosonde(RS80-15N).

We launched the radiosonde every 6 hours at 00,06,12,18Z on January 28,29 and February 14. Especially, to investigate the diurnal cycle, we launched every 3 hours at 00,03,06,09,12,15,18,21Z from January 30 to February 9 and from February 15 to February 24. In total, 176 sondes were launched during this cruise.

[Preliminary results]

Table 5-1 shows information such as time, position, and other surface meteorological parameters for each launch. Launch sites are plotted in Fig.5-1-1. In Fig.5-1-2, the skew-T with wind profile are shown at every 00Z sounding. Time series of surface(50hPa mean) mixing ratio, potential temperature, CAPE, and CIN are shown in Fig.5-1-3.

Some preliminary results are :

(1) Easterlies were dominant in the whole troposhere in the first leg Majuro-Chuuk.

(2) Strong westerlies in the lower level(～600hPa) can be found in the west of 142°E line(or after February 19).

(3) Dry layers can be found at (a) 900-700hPa (Figs.5-1-1f,l,m), (b) 650-500hPa (Figs.5-1-1a,b,d,g,h,l), and (c) 400-200hPa (Figs.5-1-1a,b,f,g,h,l,m). Layer (a) corresponds to "trade wind layer", and (b) to "melting layer", but at present case (c) is not identified.

(4) On the other hand, these dry layers cannot be found in the west of 147°E line (or after February 15).

[Remark]

Since we must consider the problem of "sensor arm heating and launches from air-conditioned container", we launched the balloons taking some steps as follows.

1. Swithed off the air conditioner in the container about 20 min. before launch.
2. Opened the window and the door of the launcher room to ventilate well.
3. When we did "ground check", we used humidity calibrator(Type:VAPORPAK H-31, Digilog Instruments). Calibrator's humidity was set to 70%.
   (cf. Previously, VAISALA ground check device was used, whose humidity was assumed "0%".)
4. Before launch, we kept the launcher outside about 5 min. to acclimate. We confirmed that sondes showed close values to the outside temperature(±0.5°C) and relative humidity(±3%).
   Besides, in this step 4, we did not open the hatch to prevent from sensor arm heating during daytime operation.

Table 5-1 Radio Sonde Launch Log Sites

No.	UTC YYMMDDTT	Position lat.	Long.	Surface Press. (hP)	Temp. (deg-C)	RH (%)	W.D. (deg)	W.S. (m/s)	Max Altitude (hPa)	(m)	Cloud Amount	Type
01	97012800	07 42 N	165 01 E	1009.6	28.0	78	167	2.5	37.4	22,213	9	Cu,Ac,Ci
02	97012806	06 45 N	165 01 E	1006.2	28.5	77	015	3.7	Unknown		3	Cu,Ci
03	97012812	05 48 N	165 00 E	1009.3	28.3	82	040	4.3	45.5	21,050	2	Cu
04	97012818	04 57 N	165 00 E	1006.4	28.4	76	000	6.5	29.9	23,634	2	Cu,Cb
05	97012900	04 00 N	165 00 E	1008.4	30.8	65	005	8.5	24.6	24,900	3	Cu
06	97012906	02 59 N	165 00 E	1004.5	28.8	75	000	5.0	38.0	22,162	10	Ns
07	97012912	02 00 N	164 59 E	1006.8	25.3	92	060	3.0	47.8	20,761	4	Ns
08	97012918	01 59 N	164 56 E	1004.4	27.5	78	080	5.0	28.9	23,852	10	Sc,Ac
09	97013000	02 00 N	164 56 E	1006.5	28.3	76	070	9.0	25.0	24,873	9	Cu,Sc
10	97013003	01 59 N	164 58 E	1004.5	27.4	86	098	9.6	28.9	23,940	10	Cu,Sc
11	97013006	01 35 N	165 00 E	1004.2	27.4	79	140	5.2	30.4	23,588	10	Ns,Cs,Ci
12	97013009	01 02 N	165 00 E	1005.5	27.4	80	195	5.1	40.2	21,783	8	Sc
13	97013012	00 40 N	165 07 E	1006.6	27.9	83	205	4.9	87.4	17,282	10	Sc
14	97013015	00 08 N	165 18 E	1005.3	27.8	80	200	7.7	30.5	23,528	10	Cu,Sc
15	97013018	00 02 N	165 07 E	1006.7	24.7	85	080	2.0	601.5	4,351	10	Ns
16	97013021	00 00 S	165 02 E	1006.9	26.8	71	170	3.5	38.8	22,041	10	Cu,Sc
17	97013100	00 00 N	165 01 E	1008.5	27.4	81	220	1.5	27.0	24,353	10	Cu,Sc
18	97013103	00 00 N	165 11 E	1006.0	31.8	56	213	2.3	29.0	23,818	10	Cu,Sc
19	97013106	00 00 S	165 13 E	1005.7	28.2	73	300	2.1	35.0	22,665	10	Sc,Cu,As
20	97013109	00 01 S	165 10 E	1008.7	24.8	79	090	5.0	831.6	1,684	10	Ns
21	97013112	00 00 N	165 08 E	1009.3	26.4	84	070	6.0	34.9	22,677	10	Sc
22	97013115	00 00 N	165 06 E	1006.2	26.8	78	185	5.0	35.4	22,557	2	Sc
23	97013118	00 01 N	165 06 E	1005.7	27.2	85	195	6.5	28.2	23,971	3	Cu
24	97013121	00 02 S	165 07 E	1007.0	27.7	75	130	5.5	25.0	24,820	1	Ac,Ci
25	97020100	00 02 S	165 07 E	1007.7	29.5	74	090	6.5	27.8	24,151	2	Cu,Ac
26	97020103	00 00 N	164 58 E	1005.3	31.0	68	100	6.9	66.8	18,884	6	Cu,Ac
27	97020106	00 00 S	165 02 E	1005.5	29.1	75	090	5.5	29.8	23,754	5	Cu,Ci
28	97020109	00 08 S	165 01 E	1006.2	28.2	83	110	5.0	40.4	21,726	2	Cu,Cs
29	97020112	00 44 S	165 00 E	1008.0	28.7	76	100	7.5	42.4	21,431	3	Cb,Cu,Si
30	97020115	01 00 S	165 00 E	1006.7	28.8	76	100	5.8	26.3	24,422	1	Cu
31	97020118	01 27 S	165 00 E	1006.0	28.8	74	105	7.2	30.3	23,517	2	Cu
32	97020121	02 02 S	165 00 E	1007.0	29.1	77	120	5.5	25.4	24,682	1	Cu,Ac
33	97020200	02 35 S	165 00 E	1007.9	29.8	65	080	5.0	34.6	22,719	2	Ac,Cu,Ci
34	97020203	03 00 S	165 00 E	1005.3	29.6	70	080	6.2	39.8	21,818	6	Ac,Cu,Ci
35	97020206	03 30 S	165 00 E	1005.0	29.1	68	115	3.3	25.2	24,669	2	Cu,Cb
36	97020209	04 00 S	165 00 E	1006.5	29.6	66	045	3.0	29.0	23,827	1	As
37	97020212	04 21 S	165 04 E	1007.8	29.5	66	025	6.0	34.9	22,674	4	Sc
38	97020215	04 52 S	165 10 E	1005.7	29.3	74	020	5.8	33.7	22,863	3	Cu,Sc
39	97020218	04 59 S	165 08 E	1005.3	29.0	75	000	5.0	Unknown		2	Cb,Cu
40	97020221	05 01 S	165 12 E	1006.0	29.2	73	020	5.5	24.2	25,005	1-	Ac,Ci
41	97020300	05 00 S	165 12 E	1007.9	28.7	79	020	6.0	31.5	23,321	5	Cu
42	97020303	04 59 S	165 12 E	1005.2	31.4	68	101	4.2	30.4	23,528	5	Cu
43	97020306	04 53 S	164 46 E	1004.2	29.2	72	015	5.9	35.9	22,489	0+	Cu
44	97020309	04 42 S	164 09 E	1006.0	29.4	72	010	4.6	60.5	19,361	1	Cs
45	97020312	04 36 S	163 46 E	1007.9	29.1	74	030	5.0	37.2	22,299	0+	
46	97020315	04 24 S	163 10 E	1005.7	29.1	78	055	4.2	31.0	23,418	2	Cu
47	97020318	04 13 S	162 36 E	1005.0	29.2	77	030	3.3	28.8	23,875	1	Cu
48	97020321	04 01 S	162 02 E	1006.0	29.3	71	060	5.7	27.2	24,317	0+	Ci,Cu
49	97020400	03 50 S	161 37 E	1006.8	31.7	65	055	6.0	Unknown		7	Cu,Ac
50	97020403	03 41 S	161 04 E	1004.5	30.6	66	070	4.3	37.0	22,281	7	Cu,Ac

51	97020406	03	29	S	160	26	E	1003.7	30.6	67	070	3.3	32.9	23,059	3	Ac,Cs,Cu
52	97020409	03	17	S	159	52	E	1006.2	30.0	75	090	2.8	48.6	20,624	4	Cb
53	97020412	03	05	S	159	17	E	1009.1	28.8	78	120	4.0	32.9	23,099	3	Cb,Cu
54	97020415	02	54	S	158	43	E	1005.7	28.4	76	315	3.4	27.4	24,268	1	Ac
55	97020418	02	42	S	158	05	E	1004.9	28.1	87	280	3.5	23.3	25,228	1	Cu
56	97020421	02	32	S	157	34	E	1005.9	28.3	78	350	2.2	22.6	25,473	2	Ci,Cu
57	97020500	02	23	S	157	09	E	1006.9	29.0	74	265	4.0	27.8	24,173	1	Cu
58	97020503	02	02	S	156	35	E	1005.4	30.3	70	340	2.5	24.1	25,053	3	Cu
59	97020506	02	00	S	156	00	E	1004.2	30.1	70	305	1.6	23.8	25,163	7	Cu,Ci,Cb
60	97020509	01	43	S	156	00	E	1006.2	29.2	71	350	4.0	22.5	25,501	2	Cu
61	97020512	01	17	S	156	00	E	1008.3	29.1	71	020	4.5	25.3	24,781	1	Sc
62	97020515	00	53	S	156	01	E	1006.8	26.7	82	175	8.3	69.9	18,525	10	Ns
63	97020518	00	28	S	156	01	E	1005.5	27.9	78	340	4.3	27.3	24,226	9	Sc
64	97020521	00	02	S	156	09	E	1007.0	28.0	79	090	2.5	24.1	25,068	10	Sc
65	97020600	00	02	S	156	10	E	1008.2	27.2	86	180	4.5	21.9	25,750	10	Sc,Cu
66	97020603	00	17	N	155	58	E	1005.2	27.7	79	255	3.7	30.3	23,601	3	Sc
67	97020606	00	33	N	156	00	E	1004.2	28.6	77	300	2.0	20.5	26,098	8	Sc,Cu
68	97020609	01	00	N	156	00	E	1005.5	28.2	80	250	2.5	26.2	24,525	8	Cu,Ac,Cb
69	97020612	01	30	N	156	00	E	1009.0	27.9	84	005	4.5	27.4	24,296	10-	St,Sc
70	97020615	01	53	N	156	00	E	1006.4	27.9	78	035	4.1	30.6	23,540	2	As
71	97020618	01	58	N	155	59	E	1004.7	27.4	82	070	4.0	23.4	25,239	4	Cu, Sc
72	97020621	02	01	N	156	01	E	1005.7	27.5	83	120	2.5	23.4	25,289	5	Cu,Sc
73	97020700	02	09	N	156	00	E	1008.4	29.4	74	120	3.0	34.8	22,753	2	Cu,Sc
74	97020703	02	45	N	156	00	E	1005.7	29.8	72	160	5.9	35.6	22,597	4	Cu,Sc
75	97020706	02	45	N	156	00	E	1005.0	29.8	66	190	3.8	23.7	25,150	9	Cu,Ci,Cc
76	97020709	03	06	N	156	00	E	1006.3	25.5	85	190	9.8	68.6	18,660	10	Sc,St,Cb
77	97020712	03	44	N	156	00	E	1008.1	26.7	83	090	4.5	31.4	23,373	10-	Sc,St
78	97020715	04	10	N	156	00	E	1006.6	27.5	75	140	5.7	34.0	22,854	2	Cu,Sc
79	97020718	04	45	N	156	00	E	1004.5	27.5	79	115	4.3	29.6	23,750	3	Sc
80	97020721	05	11	N	156	00	E	1005.6	27.7	78	110	1.6	24.8	24,866	8	Ac,Cu,Ci
81	97020800	05	47	N	156	00	E	1006.9	27.9	78	050	3.0	23.0	25,347	7	Cu,Sc
82	97020803	06	10	N	156	00	E	1005.7	29.5	52	010	5.3	29.3	23,810	3	Cu
83	97020806	06	48	N	156	00	E	1003.9	28.1	78	030	4.2	23.0	25,313	10-	Cu,Sc
84	97020809	07	15	N	156	00	E	1005.3	28.0	79	055	6.5	30.3	23,562	3	Cb,Cu,As
85	97020812	07	57	N	156	00	E	1007.2	26.9	81	060	9.0	34.5	22,782	10	St
86	97020815	07	57	N	155	58	E	1006.5	27.0	81	060	7.2	32.9	23,077	3	Sc
87	97020818	07	58	N	155	57	E	1004.4	27.6	80	040	10.0	31.4	23,345	2	Sc
88	97020821	07	59	N	156	00	E	1005.2	27.8	74	060	12.0	23.9	25,126	1	Cu,Ci
89	97020900	08	00	N	156	01	E	1007.2	28.3	71	045	12.0	29.1	23,870	5	Cu,Ci
90	97020903	08	00	N	156	00	E	1005.3	28.3	71	045	14.0	24.2	25,022	1	Cu
91	97020906	07	50	N	155	27	E	1006.6	28.4	74	050	10.7	23.1	25,362	8	Sc,Cu
92	97021400	07	05	N	151	23	E	1006.3	28.8	69	060	13.5	24.4	25,067	10-	Ac,Ci
93	97021406	06	21	N	150	54	E	1003.5	28.7	75	073	9.2	27.6	24,161	9+	Ac,Cu,As
94	97021412	05	40	N	149	55	E	1005.4	29.3	76	075	11.5	33.9	22,917	10	Ac,As
95	97021418	05	16	N	148	49	E	1003.2	28.3	76	061	12.0	30.8	23,506	5	Sc
96	97021500	04	58	N	147	33	E	1006.2	25.5	89	080	7.0	578.4	4,694	10-	St,Sc
97	97021503	04	57	N	147	03	E	1003.5	27.1	80	040	14.0	27.3	24,281	4	Cu,Ac,Ci
98	97021506	04	56	N	147	03	E	1002.0	28.7	79	050	12.0	23.7	25,214	9	Cu,Ac
99	97021509	04	36	N	147	02	E	1003.9	28.4	79	060	10.9	28.2	24,076	7	As,Ac,Cu
100	97021512	04	03	N	147	01	E	1005.2	26.6	88	090	11.5	84.4	17,522	10	Cb
101	97021515	03	33	N	147	00	E	1005.0	28.5	79	070	9.4	35.8	22,501	3	Cu,Sc
102	97021518	03	01	N	147	00	E	1003.4	24.9	91	060	5.2	463.1	6,443	10	Cb
103	97021521	02	39	N	147	00	E	1004.0	27.2	87	060	7.5	34.7	22,781	10	Cu,Sc
104	97021600	02	06	N	147	00	E	1005.8	27.4	85	080	2.5	27.8	24,285	10-	Cu,Sc

105	97021603	02	00	N	147	01	E	1003.6	27.9	84	020	2.0	29.5	23,877	10	Cu,Ac
106	97021606	01	48	N	147	00	E	1002.1	26.3	90	263	5.4	57.4	13,149	10	Cu
107	97021609	01	18	N	147	00	E	1003.0	26.9	88	015	5.0	57.5	19,683	8	Sc,Cu,Cb
108	97021612	00	54	N	147	00	E	1004.8	26.7	90	050	9.5	37.4	22,327	7	Cb,Sc
109	97021615	00	03	N	146	58	E	1004.7	26.9	83	005	0.5	30.0	23,710	10-	Cu,Sc,Cb
110	97021618	00	03	N	146	59	E	1002.9	25.0	96	140	3.5	567.1	4,546	10	Ns
111	97021621	00	00	N	146	57	E	1003.9	26.3	89	330	2.0	27.2	22,392	10	Cu,Cb,Sc
112	97021700	00	03	N	146	56	E	1006.2	27.2	84	015	1.0	24.2	25,184	10	Cu,Sc,Ac,Cb
113	97021703	00	01	S	147	01	E	1004.0	27.8	80	310	1.0	24.1	25,087	5	Cu,Ci
114	97021706	00	01	S	147	00	E	1001.9	27.4	83	320	2.0	28.3	24,113	5	Cu,Ac
115	97021709	00	30	N	147	00	E	1003.5	27.3	86	040	2.0	57.6	19,671	4	Ac,As,Cu
116	97021712	00	00	N	147	00	E	1004.9	27.5	84	calm	0.0	57.1	19,756	6	Cu,Sc,Cb
117	97021715	00	31	S	147	00	E	1004.1	26.9	88	240	4.0	26.9	24,421	9	Cu,Ci
118	97021718	00	54	S	147	00	E	1002.1	26.1	87	280	2.2	32.0	23,288	3	Sc,Cu
119	97021721	01	17	S	147	00	E	1003.0	27.0	82	330	4.0	25.9	24,672	9	Cu,As,Ci
120	97021800	01	40	S	147	00	E	1005.3	27.9	80	310	4.0	27.7	24,267	7	Cu,Ac,Cb
121	97021803	01	40	S	147	20	E	1003.8	27.3	82	350	7.8	21.6	25,874	5	Cu,Ci
122	97021806	01	40	S	147	24	E	1002.1	25.9	88	260	8.0	20.8	26,057	9	Cb,Ci,Ac
123	97021809	01	39	S	147	03	E	1003.3	26.7	83	270	11.0	74.3	18,216	10	As,Sc,Cb
124	97021812	01	16	S	146	56	E	1004.9	27.0	82	300	6.5	32.6	23,195	9	Sc,Cb,Ac
125	97021815	00	40	S	146	54	E	1004.5	26.7	86	295	5.7	35.2	22,720	10	Sc
126	97021818	00	06	S	146	53	E	1002.1	26.7	87	350	5.0	34.8	22,773	3	Sc,Ac,Cu
127	97021821	00	00	S	146	53	E	1003.1	27.2	84	350	5.0	90.3	17,126	10	Cu,Cb,Ac
128	97021900	00	01	S	146	54	E	1005.1	27.3	84	020	5.5	25.9	24,749	9	Cu,Ac
129	97021903	00	01	S	146	50	E	1003.5	24.7	95	045	7.1	27.9	24,227	10	unknown
130	97021906	00	00	S	146	18	E	1002.4	25.3	92	006	6.2	45.7	21,083	10	unknown
131	97021909	00	01	S	145	56	E	1004.8	25.9	88	060	7.0	65.2	18,977	10	St,Cu,Cb,Sc
132	97021912	00	00	S	145	24	E	1006.2	25.0	89	270	10.2	102.1	16,480	10	St
133	97021915	00	00	S	144	58	E	1006.0	26.1	84	320	3.2	78.0	18,242	10	St,Sc
134	97021918	00	00	S	144	27	E	1004.2	26.2	85	292	10.8	29.4	23,843	10	Sc,St
135	97021921	00	00	S	144	00	E	1004.4	26.3	87	295	14.0	26.7	24,504	10	Cu,Sc
136	97022000	00	00	S	143	33	E	1006.1	27.9	80	290	8.5	30.4	23,582	10	Ac
137	97022003	00	00	S	143	00	E	1005.1	29.0	77	275	13.0	34.9	22,767	10	Ac,Cu
138	97022006	00	01	S	142	38	E	1002.8	28.3	77	275	15.0	50.9	20,431	9	Ac,As,Cu
139	97022009	00	18	S	142	14	E	1003.9	28.2	80	290	11.1	31.9	23,302	10-	Cu,Ac
140	97022012	00	35	S	142	00	E	1005.8	28.2	82	330	8.5	53.8	20,114	10	St,Sc,Cu
141	97022015	01	00	S	142	01	E	1005.9	28.3	78	296	12.1	36.8	22,456	10	Cu,Ac
142	97022018	01	30	S	142	00	E	1003.4	28.2	81	315	12.0	37.0	22,380	10	Cu,Ac
143	97022021	01	55	S	142	00	E	1004.1	26.3	86	315	10.5	32.7	23,188	10	Cu,Ac
144	97022100	02	24	S	142	00	E	1006.6	26.6	87	290	8.5	569.1	4,819	10	St,Ac
145	97022103	02	40	S	142	00	E	1003.7	26.8	87	306	10.0	25.3	24,844	10	Cu,Ac
146	97022106	02	23	S	142	00	E	1000.8	27.8	88	282	12.8	37.4	22,317	9	As.Ac.Cu
147	97022109	01	50	S	142	00	E	1002.6	27.9	80	310	10.5	46.1	20,988	10	AS,Cu
148	97022112	01	15	S	142	01	E	1004.4	28.4	79	315	11.0	34.2	22,925	9	As
149	97022115	00	45	S	142	00	E	1004.4	28.2	81	356	11.2	30.8	23,579	10	As
150	97022118	00	12	S	141	57	E	1002.4	28.0	83	341	10.8	26.2	24,592	10	Cs,Cc
151	97022121	00	01	S	142	01	E	1003.2	28.0	81	010	7.0	32.4	23,227	10	As,Cs
152	97022200	00	01	S	142	01	E	1005.4	28.2	80	020	4.5	24.1	25,174	1	Ac,Cs
153	97022203	00	00	S	141	47	E	1002.8	28.2	82	030	5.4	27.5	24,311	1	Cu,Ac,Ci
154	97022206	00	00	S	141	14	E	1001.4	29.5	79	270	3.0	24.8	24,927	8	Cu,Ac
155	97022209	00	00	S	140	51	E	1002.2	26.8	87	260	10.8	66.0	18,891	9	Ac,As,Cu
156	97022212	00	00	S	140	20	E	1003.3	27.5	81	030	3.5	61.0	19,353	10	Ac,Ns
157	97022215	00	00	N	139	59	E	1003.3	26.0	94	039	8.4	43.2	21,440	10	Sc
158	97022218	00	00	S	139	29	E	1001.7	25.7	96	318	4.3	33.9	22,927	10	Sc

159	97022221	00	00	S	139	00	E	1002.0	27.2	88	250	9.0	68.3	18,709	10	Cu,As
160	97022300	00	18	S	138	44	E	1004.1	27.4	83	245	9.5	21.7	25,984	5	Cu,Ac
161	97022303	00	41	S	138	21	E	1003.1	27.0	89	250	12.1	24.5	25,140	10	Cu,Ac
162	97022306	01	00	S	138	00	E	1001.5	27.7	82	280	13.0	28.3	24,145	8	Cu,Ac,As,Ci
163	97022309	00	35	S	138	00	E	1001.8	27.2	78	275	9.8	24.8	24,971	8	Sc,Cu,Ac
164	97022312	00	14	S	138	00	E	1003.0	27.4	84	280	9.5	29.6	23,810	9	Cu,Ac
165	97022315	00	10	N	138	00	E	1004.0	27.2	70	345	9.2	239.2	11,288	9	Cu,Ac
166	97022318	00	32	N	138	00	E	1002.6	26.8	88	343	8.1	29.6	23,809	7	Cu,Ac
167	97022321	01	00	N	138	00	E	1003.2	26.1	91	000	7.5	34.4	22,866	10	Cu,As
168	97022400	01	30	N	138	00	E	1005.8	27.0	79	000	5.0	41.0	21,806	10-	Sc,Cu
169	97022403	01	58	N	138	00	E	1005.1	25.4	87	290	2.0	578.7	4,676	10	St,Cs
170	97022406	02	12	N	137	43	E	1002.8	24.9	93	270	11.5	621.6	4,074	10	St
171	97022409	02	26	N	137	24	E	1003.0	26.0	88	328	11.8	272.1	10,381	10	St
172	97022412	02	30	N	137	24	E	1004.9	26.8	87	310	8.0	81.7	17,673	10-	Sc,St
173	97022415	02	30	N	137	22	E	1005.7	27.1	84	280	9.0	26.4	24,618	9	Ac
174	97022418	02	28	N	137	20	E	1004.3	27.2	79	280	8.0	24.6	25,029	4	Ac,Ci
175	97022421	02	26	N	137	25	E	1004.7	27.5	81	275	8.2	25.7	24,775	6	Cu,Ac,Ci
176	97022500	02	26	N	137	28	E	1005.9	27.7	79	265	11.0	27.2	24,440	5	Cu,Ac,Ci

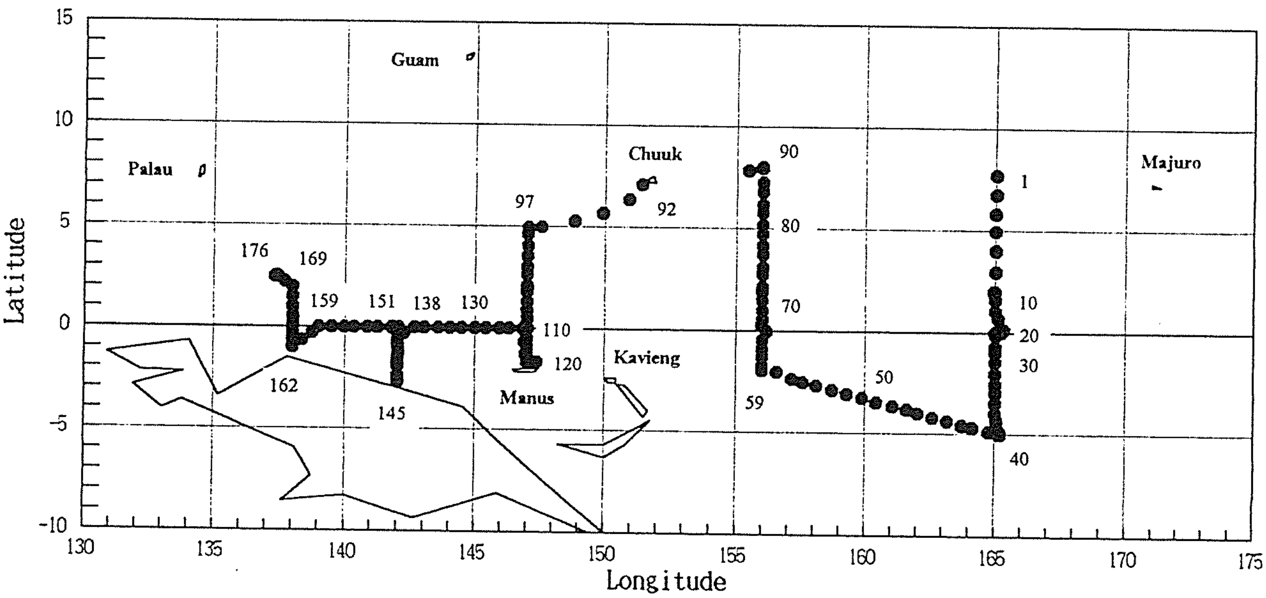


Fig.5-1-1 Launch sites

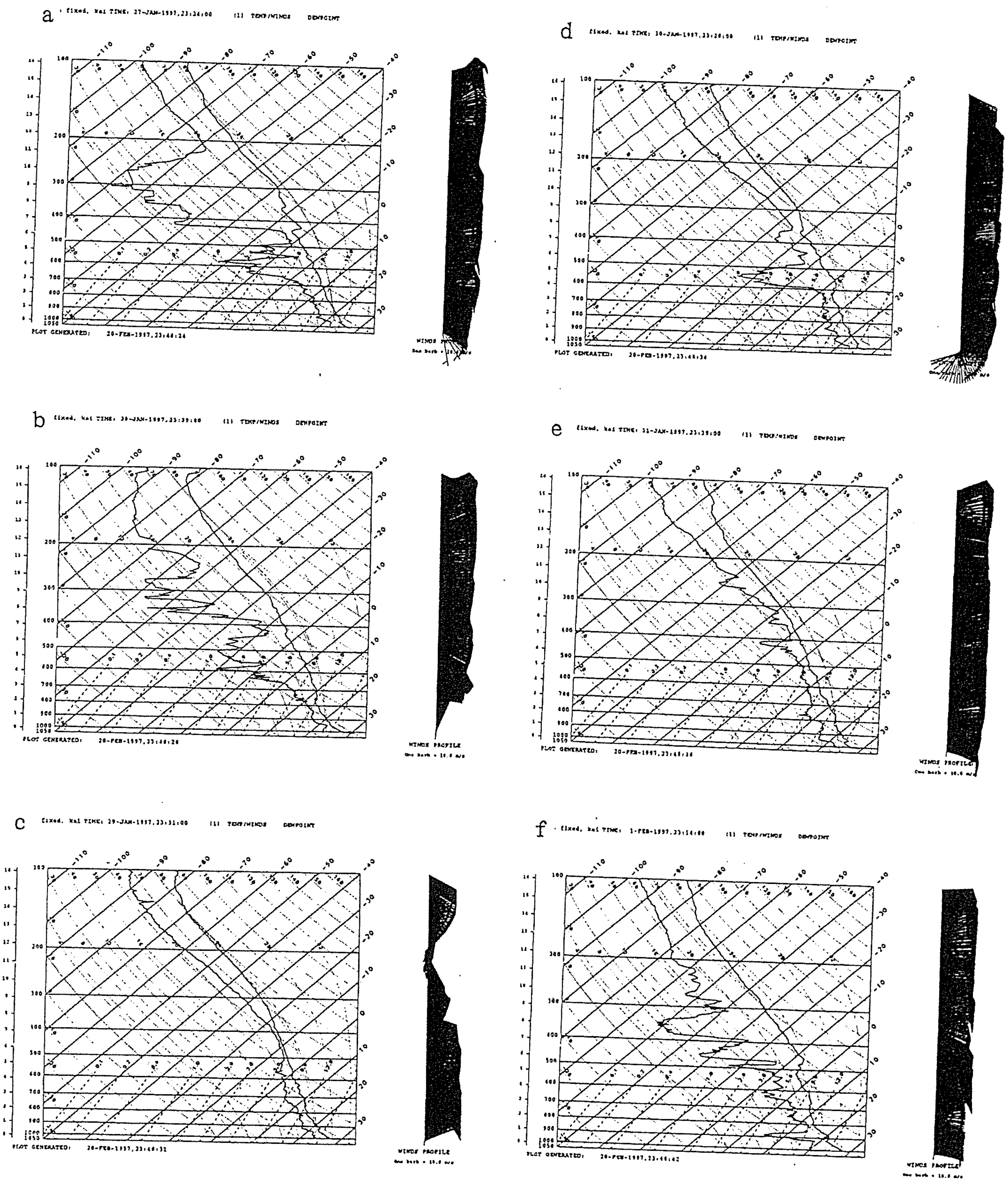


Fig. 5-1-2 Skew-T diagrams and wind profiles.

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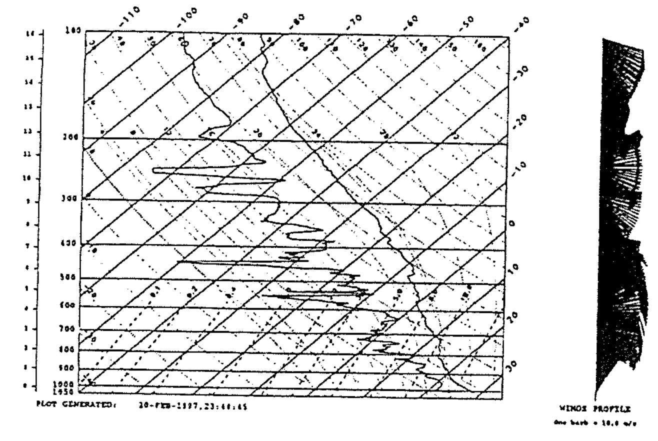

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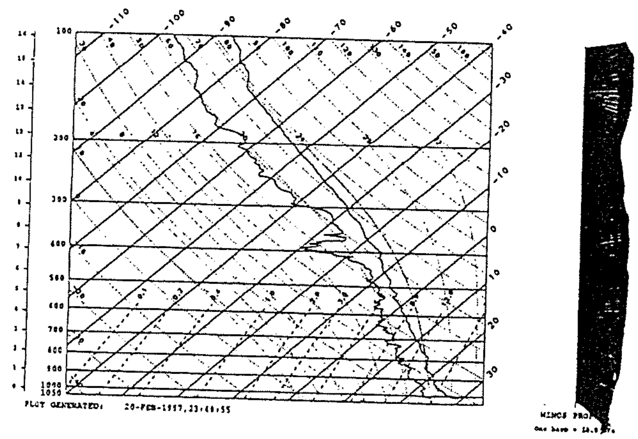

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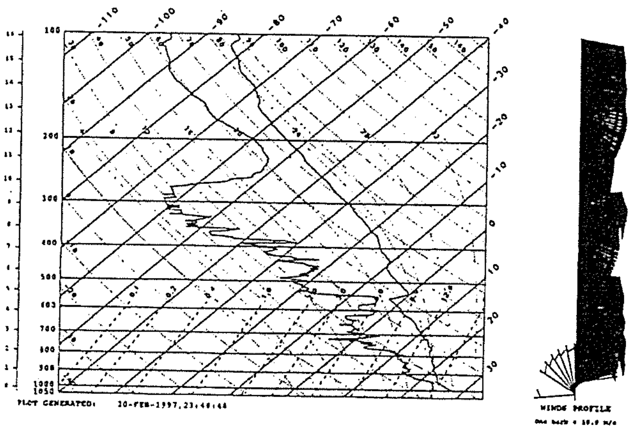

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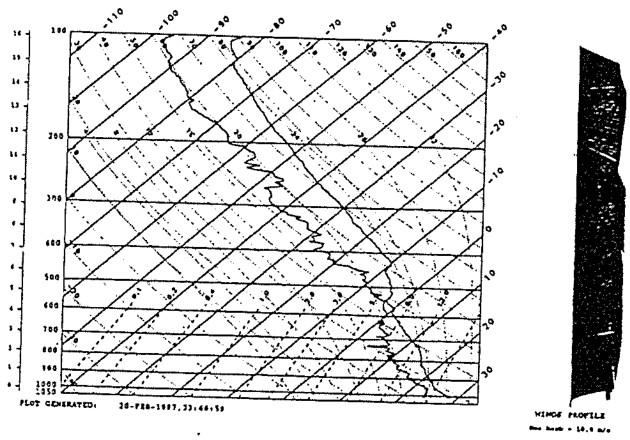

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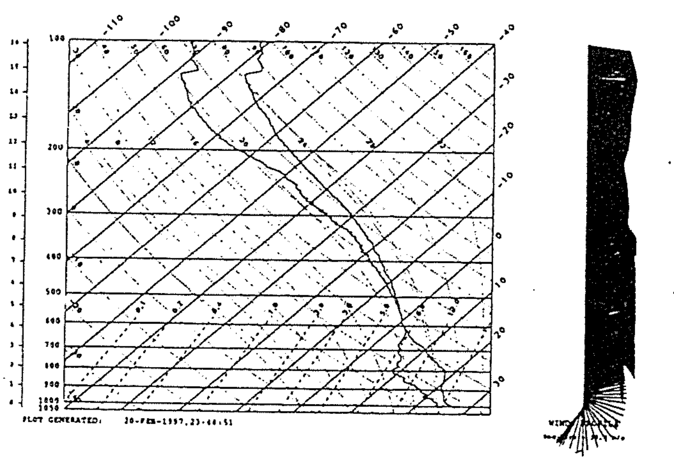

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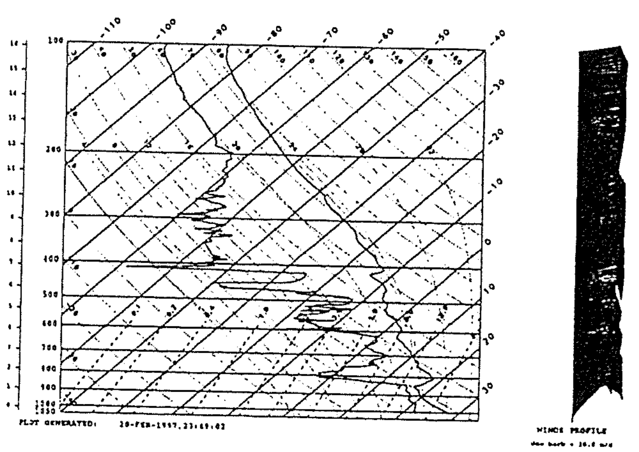

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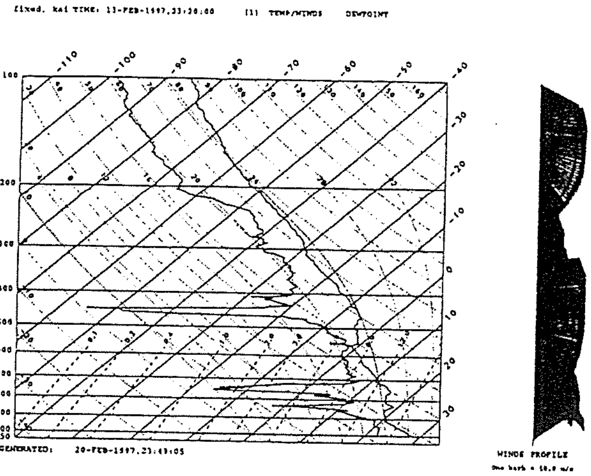
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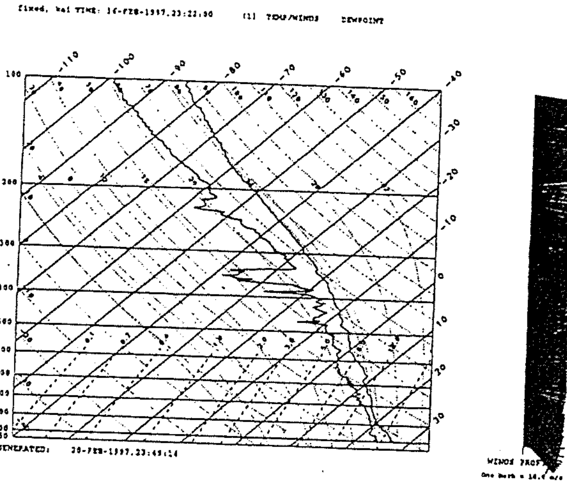
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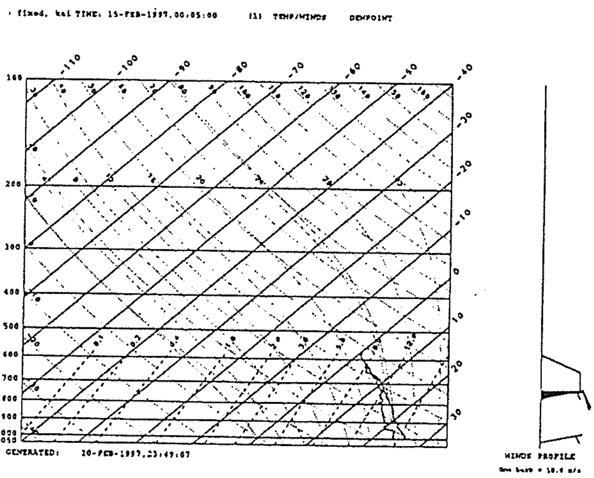
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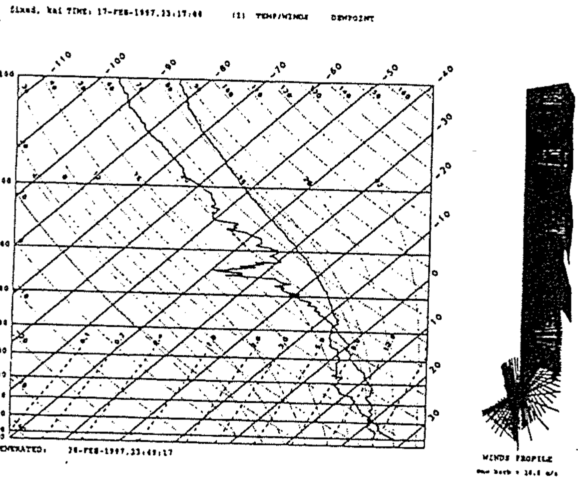
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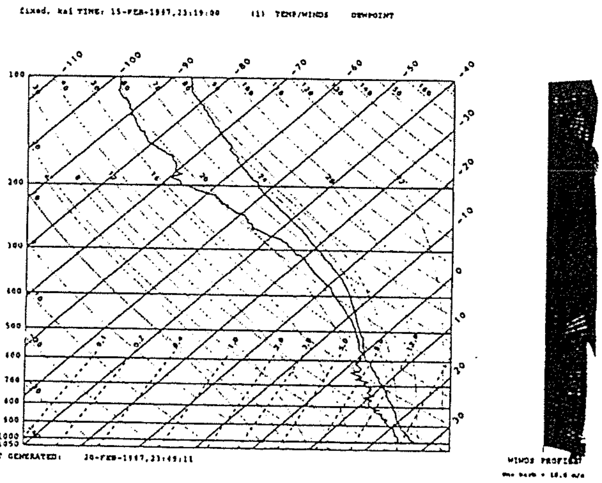
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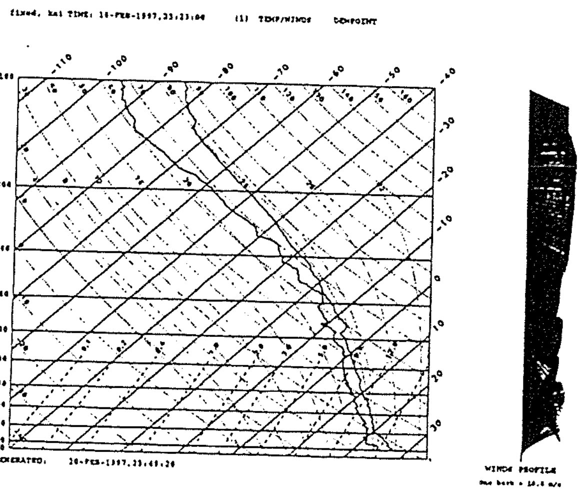
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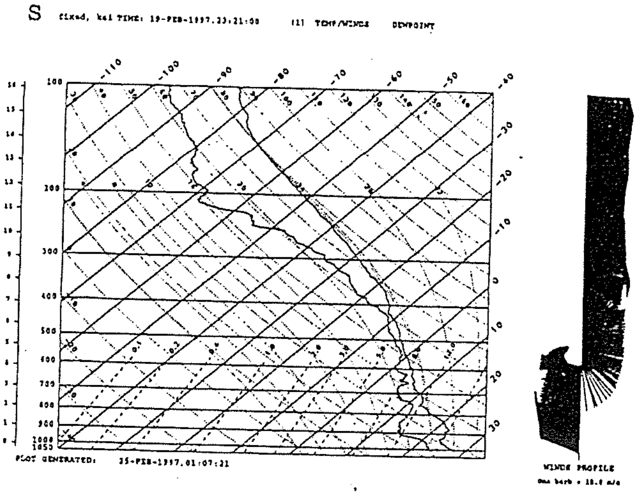

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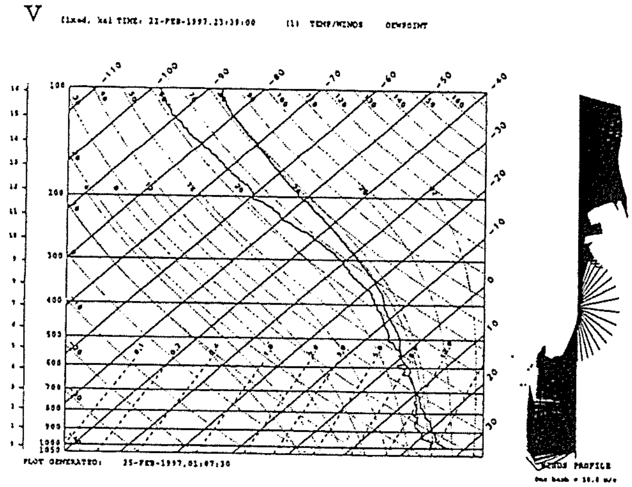

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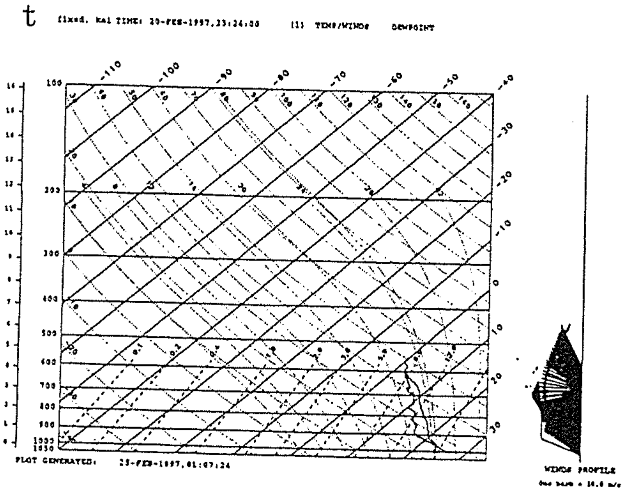

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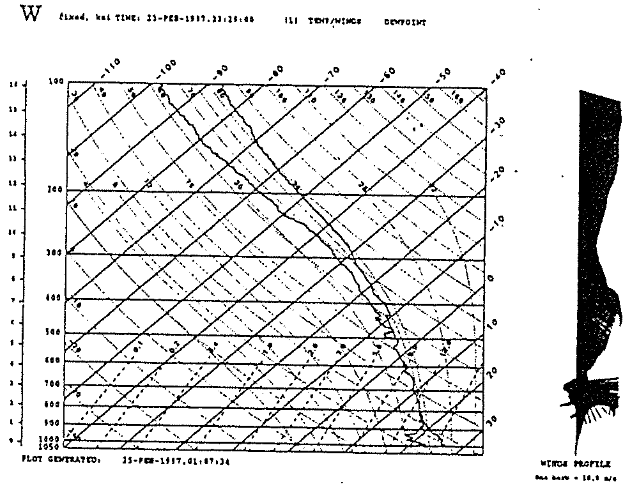
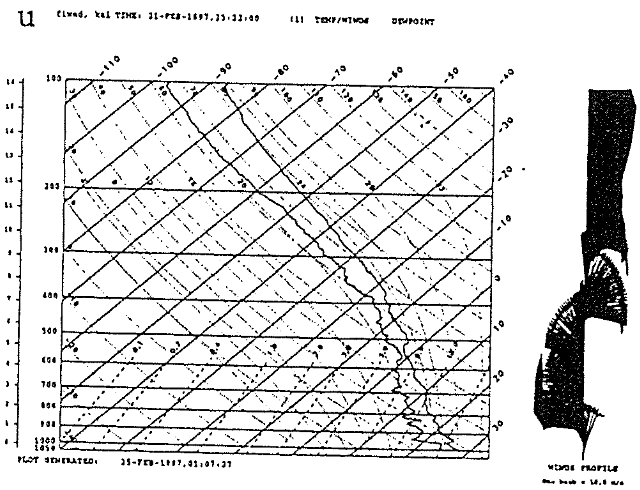
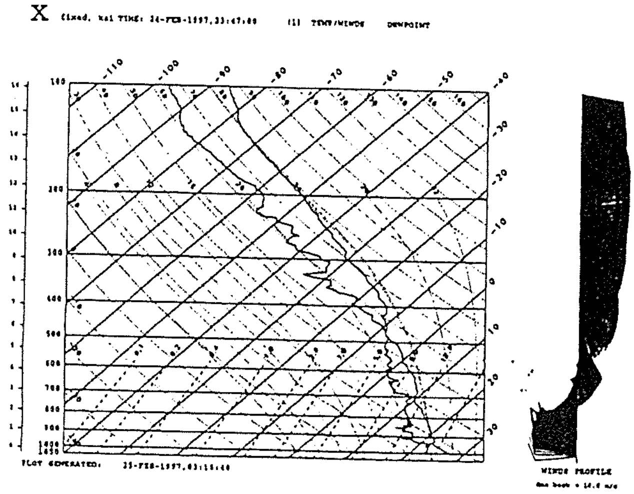


u



x



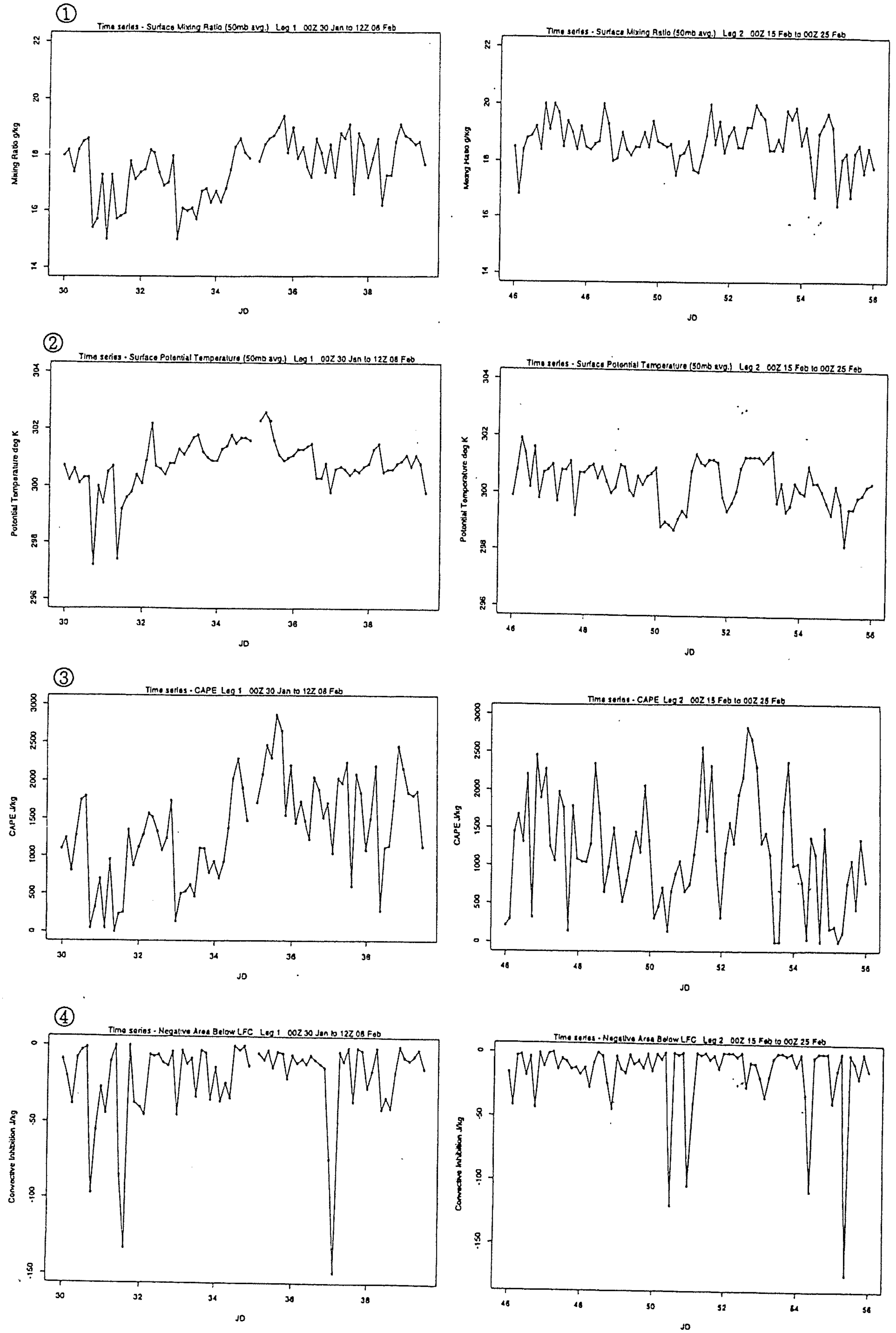
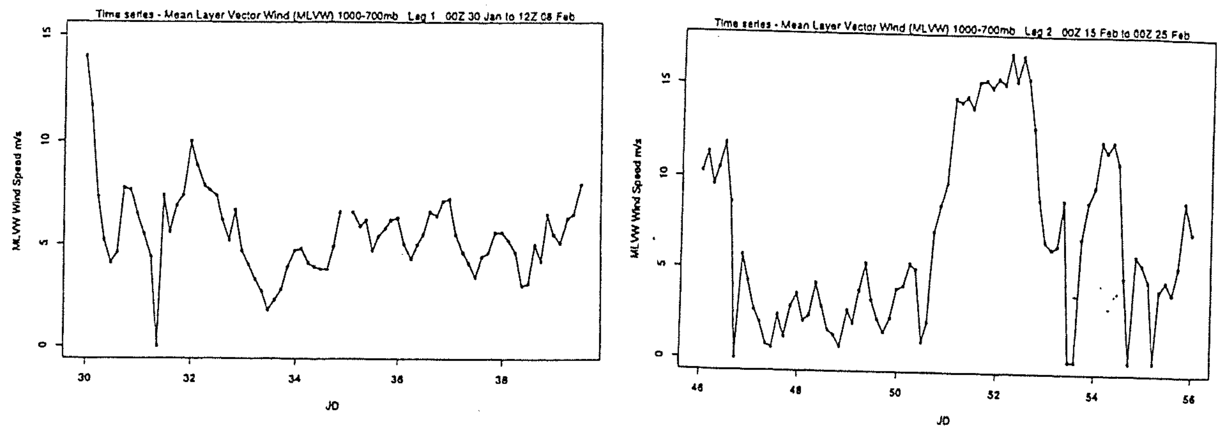
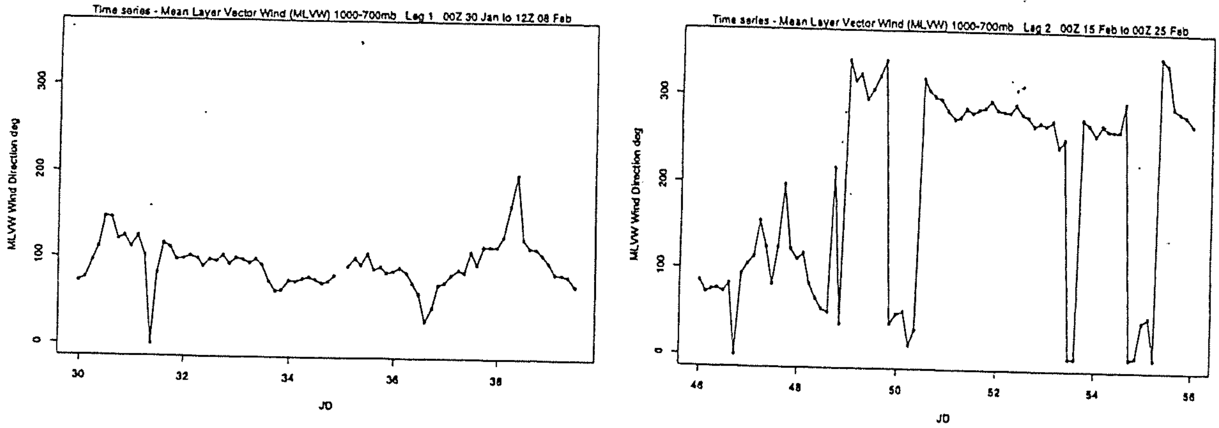


Fig. 5-1-3 Time series of ① surface mixing ratio, ② surface potential temperature, ③ CAPE, ④ CIN, ⑤ 1000-700hPa mean wind speed, and ⑥ 1000-700hPa mean wind direction.

⑤


Time series - Mean Layer Vector Wind (MLVW) 1000-700mb Leg 1 00Z 30 Jan to 12Z 08 Feb
MLVW Wind Speed m/s
JD
Time series - Mean Layer Vector Wind (MLVW) 1000-700mb Leg 2 00Z 15 Feb to 00Z 25 Feb
MLVW Wind Speed m/s
JD

⑥


Time series - Mean Layer Vector Wind (MLVW) 1000-700mb Leg 1 00Z 30 Jan to 12Z 08 Feb
MLVW Wind Direction deg
JD
Time series - Mean Layer Vector Wind (MLVW) 1000-700mb Leg 2 00Z 15 Feb to 00Z 25 Feb
MLVW Wind Direction deg
JD

5.2 Boundary Layer Measurements

(a) Wind Profiler

The profiler was used to make low level wind measurements during the TOCS cruise.

After some adjustments in the radar parameters, a configuration was set and used for remainder of the trip. The configuration used gave a maximum coverage 5km using 105m range gates.

The typical height coverage obtained during the project was only to between 2.0 and 3.0km. At times coverage did extend to 5km. Those times were in periods of high winds and rain.

The comparison of profiler winds to sounding winds was good, with both direction and speed agreeing reasonably close. There were times when low level profiler winds were not good. During these periods the winds were affected by sea clutter to a varying extent. The vertical extent of that sea clutter was dependent on the low level wind strength and sea state. In the worst cases (winds in excess of 12-15m/s and 3+ meter seas), the clutter could affect wind data as high as 1.0km but this only occurred for a few short periods. Most of the time affects of clutter, if present, were limited to the first 400m.

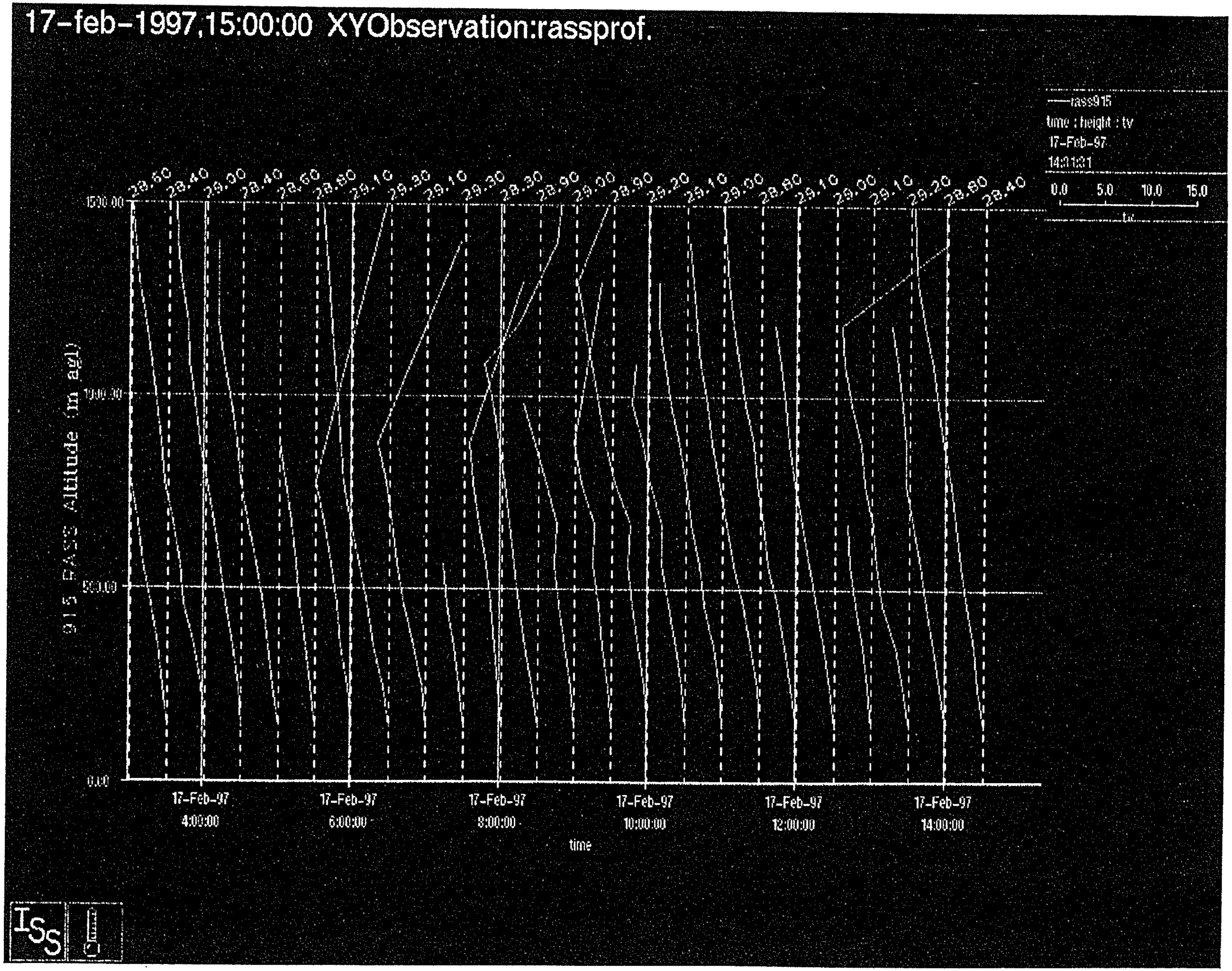
When there is sea clutter the resultant consensus winds are reported much lower in force than they actually are. This is because the clutter produces a return with a large spectral width centered on zero that masks the true wind and results in a reduced wind speed value.

(b) RASS

The Radio Acoustic Sounding System(RASS) measures the virtual temperature profile of the lower boundary layer. The RASS coverage is typically limited to the first 1000 meters. However, that coverage can be limited by high winds.

The RASS operation was good during the effort. The virtual temperature profiles obtained from the RASS agreed remarkably well with virtual temperature values calculated from radiosonde data. The agreement was to within 0.5 degrees or better. Often the two measuremnets agreed almost exactly.

The only negative regarding the RASS was in reduced height coverage during high wind periods. During these periods, the RASS coverage was sometimes reduced as low as 400m or less. During other periods the coverage was much better. In periods without high wind the coverage went to 1.0km and sometimes higher.


17-feb-1997,15:00:00 XYObservation:rassprof.
rass915
time : height : tv
17-Feb-97
0.0 5.0 10.0 15.0
tv
915 RASS Altitude (m agl)
1500.00
1000.00
500.00
0.00
28.60 28.40 29.00 28.40 28.60 28.80 29.10 29.30 29.10 29.30 28.30 28.90 29.00 28.90 29.20 29.10 29.00 28.80 29.10 29.00 29.10 29.20 28.80 28.40
17-Feb-97 4:00:00
17-Feb-97 6:00:00
17-Feb-97 8:00:00
17-Feb-97 10:00:00
17-Feb-97 12:00:00
17-Feb-97 14:00:00
time

(c) SABL

GOALS :

High resolution measurements by the Scanning Aerosol Backscatter Lidar (SABL) will monitor the atmospheric mixed layer changes and the formation of non-precipitating clouds. SABL has excellent resolution, (scale of several meters), operates at two frequencies and can see thin tropical cirrus. These measurements will allow scientists to investigate whether cloud shading during a variety of conditions is important for causing the SST to vary. SABL measurements will allow the corrected humidity fields to be compared against cloud base measurements as a further check on sonde humidity accuracies.

SABL OPERATIONS :

SABL was operated every day of the cruise, 24 hours a day, except when rainfall was heavy or maintenance was required. There were no major problems encountered during the cruise.

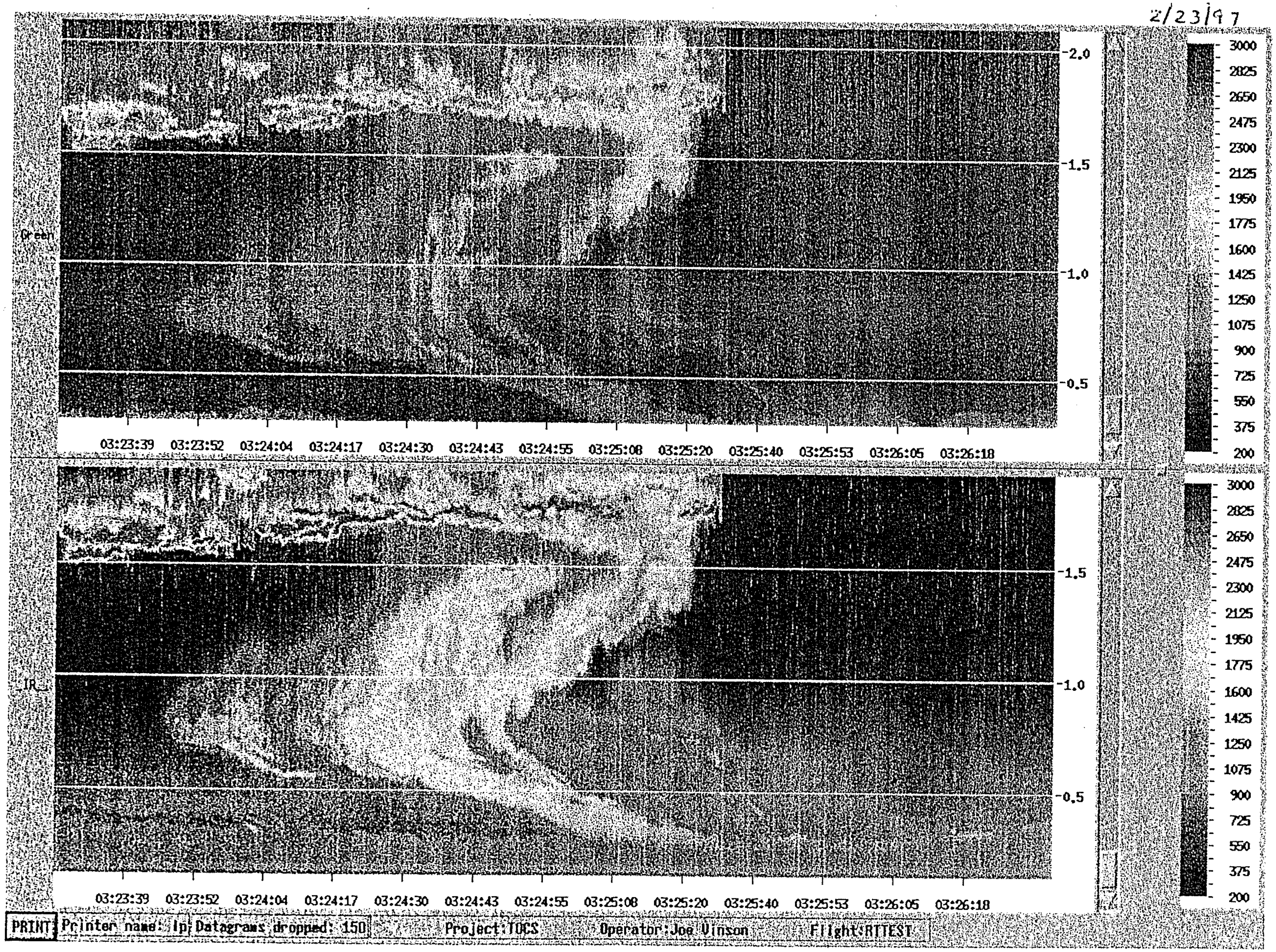
DATA :

Data was archived on 8mm exabyte tape. Each tape covered a period of approximately 20 hours. Thirty tapes were recorded during the cruise, for a total of 150,000 magebytes of data.

A backup copy of these tapes was created. A series of lidar display snap-shots (post-script images) were created and stored on tape.

A data and a cruise log book are also available.

2/23/97



Green
-2.0
-1.5
-1.0
-0.5
3000
2825
2650
2475
2300
2125
1950
1775
1600
1425
1250
1075
900
725
550
375
200
03:23:39 03:23:52 03:24:04 03:24:17 03:24:30 03:24:43 03:24:55 03:25:08 03:25:20 03:25:40 03:25:53 03:26:05 03:26:18
IR
-1.5
-1.0
-0.5
3000
2825
2650
2475
2300
2125
1950
1775
1600
1425
1250
1075
900
725
550
375
200
03:23:39 03:23:52 03:24:04 03:24:17 03:24:30 03:24:43 03:24:55 03:25:08 03:25:20 03:25:40 03:25:53 03:26:05 03:26:18
PRINT
Printer name: lp
Datagrams dropped: 150
Project:TOCS
Operator:Joe Vinson
Flight:RTTEST

(d) Tethered Operations

Radiosondes were flown both on a kite and on tethered balloons during the TOCS cruise with some success. These tethering systems were used in an attempt to get a good measure of the lower boundary layer mixing ratio. Project plans called for tethered measurements between 100 and 400 meters. Due to operational constraints, we fell about 120 meters short of the upper value.

During the second leg of the cruise, we successfully tethered a balloon and radiosonde and also successfully flew a radisonde on a kite. There were seven tethered balloon flights and two kite flights.

Varying heights were achived in these flights. The heights obtained seemed to depend mostly on wind speed and wind direction relative to the moving ship.

The heights above sea level obtained ranged from 90m to over 275m.

Table 5-2 Observation sites of tethered sonde(leg 2)

Date	Period(LCT,-10h=UTC)	Position
Feb.16	14:40 - 15:15	(01°52N, 147°00E)-(01°46N, 147°00E)
Feb.17	10:25 - 11:14	(00°00S, 146°51E)-(00°00S, 146°58E)
Feb.17	15:15 - 15:40	(00°01N, 146°59E)-(00°06N, 146°59E)
Feb.18	10:17 - 13:33	(01°40S, 147°03E)-(01°40S, 147°30E)
Feb.18	14:00 - 14:15	(01°40S, 147°30E)-(01°40S, 147°28E)
Feb.18	14:30 - 15:15	(01°40S, 147°27E)-(01°40S, 147°23E)
Feb.22	11:23 - 12:40	(00°01N, 141°58E)-(00°00N, 141°44E)
Feb.22	12:58 - 15:00	(00°00N, 141°40E)-(00°00N, 141°17E)
Feb.22	15:27 - 16:24	(00°00S, 141°12E)-(00°00S, 141°02E)

Remark

In the first leg(Majuro-Chuuk), we also measured boundary layer using tethered sonde as stationary observation.

Table 5-3 Observation sites of tethered sonde(leg 1)

Date	Period(LCT,-11h=UTC)	Position
Feb.06	14:50 - 16:02	(00°30N, 155°59E)
Feb.07	15:27 - 16:28	(02°45N, 156°00E)
Feb.08	11:14 - 12:05	(06°00N, 156°00E)

5.3 Surface Meteorological Measurements

(a) Manual Measurement

We observed some surface meteorological parameters (pressure, dry bulb temperature, wet bulb temperature, dewpoint temperature, sea surface temperature, relative humidity, wind speed/direction, cloud amount and weather) every 3 hours from Majuro to Palau via Chuuk. The surface data were measured by using aneroid barometer, shipboard wind speed/direction meter, asman psychrometer, and in–take method. Those parameters were recorded by officers and crews of R/V KAIYO according to the Ship's Weather Observation Reports.

Fig.5–3–1 and Table 5–3–1 show results of the observation.

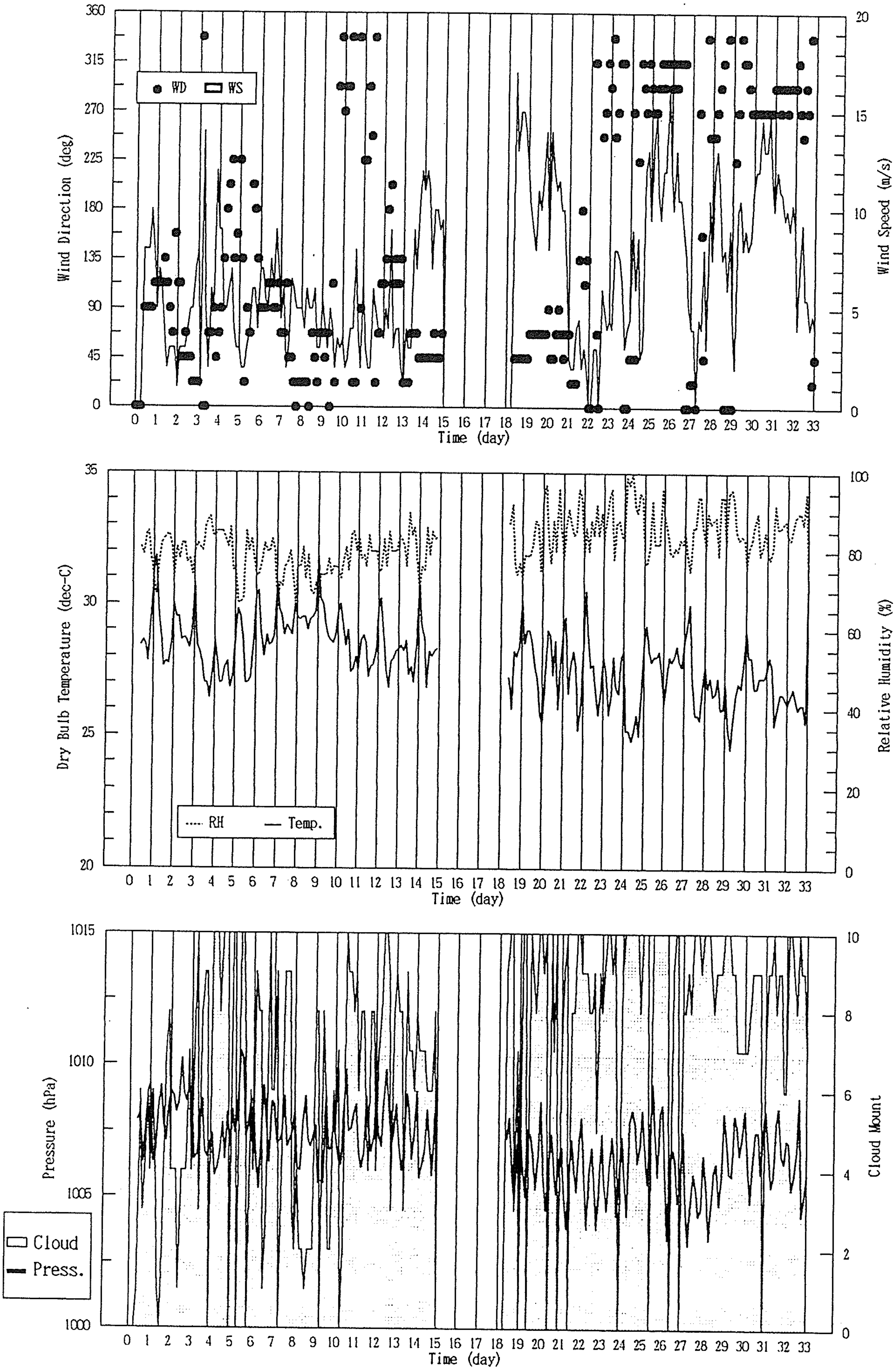


Fig 5-3-1 Surface Meteorological Mesurements

Table 5-3-1 Surface Meteorological Mesurements

Time UTC		Ship's T.		Position lat.	Long.	W.D. (16)	W.S. (m/s)	Weather	Press. (hP)	Dry Temp. (deg-C)	Wet Temp. (deg-C)	SST (deg-C)	Dew P.T. (deg-C)	RH (%)	Cloud Amount
97 JAN 26	0	JAN 26	12												
	3		15												
	6		18	Majuro											
	9		21	7 13 N	170 32 E	E	8.0	b	1007.9	28.4	25.6	28	24.6	81	1
	12	27	0	7 11 N	169 58 E	E	8.0	bc	1008.2	28.6	25.6	28	24.5	79	6
	15		3	7 9 N	169 23 E	E	8.0	bc	1006.3	28.4	26.2	29	25.4	84	3
	18		6	7 8 N	168 50 E	E	10.0	bc	1007.6	27.8	25.8	29	25.3	85	4
	21		9	7 16 N	168 17 E	ESE	8.0	bc	1009.0	29.4	26.1	29	25.0	78	6
27	0		12	7 23 N	167 43 E	ESE	5.0	bc	1009.3	31.2	27.0	29	25.6	73	4
	3		15	7 31 N	167 10 E	ESE	7.0	bc	1006.3	31.8	27.0	29	25.4	69	6
	6		18	7 38 N	166 37 E	ESE	6.0	bc	1006.8	29.7	26.3	29	25.7	77	4
	9		21	7 46 N	166 6 E	SE	4.0	b	1008.4	28.9	26.3	29	25.5	82	1
	12	28	0	7 53 N	165 35 E	ESE	2.0	bc	1009.2	27.6	25.2	29	24.3	83	unknown
	15		3	8 0 N	165 4 E	E	3.0	bc	1007.8	27.8	25.6	28	24.8	84	3
	18		6	8 0 N	164 59 E	ENE	3.0	bc	1007.1	27.7	25.5	28	24.6	84	7
	21		10	8 2 N	165 1 E	SSE	3.0	c	1008.5	28.5	25.8	29	25.1	81	8
28	0		13	7 32 N	165 1 E	ESE	1.0	bc	1009.0	30.0	26.7	29	25.6	73	4
	3		15	7 0 N	165 0 E	ESE	3.0	bc	1008.8	29.5	26.8	29	25.9	81	4
	6		18	6 38 N	165 1 E	NE	3.0	bc	1008.2	29.5	26.3	29	25.5	78	4
	9		22	6 2 N	165 60 E	ENE	3.0	b	1008.6	28.6	26.1	29	25.1	82	1
Time Corr.	12	29	0	5 38 N	165 0 E	NE	4.0	bc	1010.2	28.7	26.1	29	25.2	82	4
	15		4	5 4 N	165 0 E	NE	5.0	bc	1008.9	28.6	25.4	29	24.2	77	4
	18		7	4 51 N	165 0 E	NNE	5.0	bc	1008.6	28.3	25.2	29	23.7	78	4
	21		10	4 16 N	164 60 E	NNE	7.0	bc	1009.2	29.0	25.3	29	24.3	74	7
29	0		13	3 55 N	164 60 E	NNE	8.0	bc	1008.7	30.8	27.8	29	26.8	80	4
	3		15	3 20 N	165 0 E	NNW	1.0	bc	1006.4	28.4	25.8	29	24.9	82	7
	6		18	2 57 N	164 60 E	N	14.0	q	1006.6	28.2	25.5	29	24.6	81	10
	9		22	2 23 N	164 59 E	N	5.0	bc	1007.5	27.8	25.0	29	23.9	80	3
	12	30	1	2 1 N	164 58 E	ENE	2.0	c	1008.7	27.0	25.2	29	24.6	86	8
	15		4	2 0 N	164 57 E	ENE	6.0	c	1006.7	27.0	25.5	29	25.0	88	9
	18		7	2 60 N	164 56 E	E	5.0	c	1006.5	26.4	25.0	29	24.5	89	9
	21		10	2 0 N	164 59 E	NE	12.0	o	1007.0	27.3	25.2	29	24.1	84	unknown
30	0		13	1 60 N	164 56 E	ENE	9.0	o	1007.4	28.6	26.3	29	25.5	84	10
	3		15	1 59 N	164 58 E	E	9.0	o	1005.8	28.0	26.0	29	25.3	85	10
	6		18	1 29 N	164 59 E	SE	5.0	o	1006.1	27.0	25.0	29	24.3	85	10
	9		22	1 0 N	165 0 E	S	5.0	c	1006.7	27.0	25.0	29	24.3	85	8
	12	31	1	0 32 N	165 9 E	SSW	6.0	o	1007.8	27.6	25.2	29	24.3	83	10
	15		4	0 0 N	165 18 E	SW	7.0	o	1006.4	27.8	25.2	29	24.3	81	10
	18		7	0 2 N	165 5 E	SE	4.0	o	1008.2	26.8	25.0	29	24.3	86	10
	21		10	0 0 N	164 60 E	SSE	3.0	o	1006.9	27.2	23.8	29	22.9	75	unknown
31	0		13	0 1 S	165 5 E	SW	3.0	o	1008.3	28.6	25.2	29	23.9	76	10
	3		15	0 0 N	165 15 E	SE	2.0	o	1007.4	29.8	24.8	29	22.9	67	10
	6		18	0 0 N	165 11 E	NNE	2.0	o	1008.1	29.5	24.5	29	22.6	67	unknown
	9		22	0 1 S	165 9 E	E	3.0	o	1010.5	28.7	24.0	29	22.3	68	10
	12	1	1	0 1 N	165 7 E	ENE	4.0	o	1010.2	27.0	25.0	29	24.3	85	10
	15		4	0 1 N	165 6 E	SSW	6.0	bc	1007.3	27.0	24.2	29	23.1	80	7
	18		7	0 1 N	165 6 E	S	6.0	o	1007.6	27.2	25.0	29	24.3	83	unknown
	21		10	0 2 S	165 7 E	SE	4.0	bc	1008.6	28.7	25.5	29	24.4	78	6
FEB 1	0		13	0 2 S	165 7 E	E	7.0	bc	1008.7	30.3	26.4	29	25.1	74	4
	3		15	0 0 N	165 59 E	E	7.0	c	1006.5	30.5	26.5	29	25.2	74	9
	6		18	0 1 S	165 1 E	E	5.5	c	1005.3	28.8	25.6	29	24.3	77	8
	9		22	0 19 S	165 0 E	ESE	5.0	c	1007.3	28.0	25.5	29	24.6	82	8
	12	2	1	0 54 S	165 0 E	ESE	7.5	b	1009.2	28.8	26.0	29	25.0	80	1
	15		4	1 2 S	165 0 E	E	6.0	bc	1007.7	28.4	25.6	29	24.6	80	3
	18		7	1 37 S	165 0 E	E	9.0	q	1006.3	28.5	26.1	29	25.0	83	10
	21		10	2 12 S	164 60 E	ESE	7.0	bc	1008.6	28.8	26.0	29	25.0	80	6
2	0		13	2 44 S	164 60 E	ENE	4.5	bc	1008.5	30.8	25.4	30	23.5	65	6
	3		15	3 5 S	165 0 E	ENE	6.0	c	1007.0	29.8	26.0	30	24.7	72	9
	6		18	3 38 S	164 60 E	ESE	2.0	c	1007.1	29.5	25.2	30	23.5	71	unknown
	9		22	4 1 S	165 0 E	NE	3.0	bc	1007.4	28.8	25.5	30	24.3	76	4
	12	3	1	4 29 S	165 6 E	NE	6.5	c	1008.8	29.2	25.8	29	24.6	77	9
	15		4	4 57 S	165 11 E	NNE	6.0	c	1006.9	29.0	25.2	29	23.8	80	9
	18		7	4 60 S	165 9 E	N	5.0	c	1007.2	28.8	25.3	30	24.3	75	9
	21		10	4 60 S	165 12 E	NNE	5.0	bc	1007.5	30.0	25.0	30	23.9	67	3
3	0		13	4 60 S	165 12 E	NNE	5.0	b	1008.2	29.5	26.0	29	24.8	76	2
	3		15	4 59 S	165 11 E	NNE	4.0	bc	1006.1	29.4	26.0	30	24.8	76	4
	6		18	4 50 S	164 37 E	NNE	6.0	b	1006.0	29.5	26.8	30	26.2	81	2
	9		22	4 40 S	164 1 E	N	5.0	b	1007.7	29.5	25.5	30	24.1	73	2

	12	4 1	4 33 S	163 37 E	ENE	5.0	b	1008.8	29.0	26.0	30	25.0	79	1
	15	4	4 21 S	163 2 E	NE	6.0	b	1007.2	29.4	25.0	30	23.4	70	2
	18	7	4 9 S	162 27 E	NNE	3.0	b	1006.9	29.5	24.8	30	23.4	69	2
	21	10	3 57 S	161 51 E	ENE	3.0	b	1007.3	29.7	25.6	30	24.1	72	2
	4 0	13	3 47 S	161 27 E	ENE	5.5	c	1007.7	31.8	26.6	29	24.8	67	8
	3	15	3 37 S	160 52 E	NE	4.0	c	1005.5	30.2	26.4	30	25.1	74	8
	6	18	3 25 S	160 17 E	ENE	3.0	c	1005.6	30.0	26.2	30	24.6	74	unknown
	9	22	3 14 S	159 42 E	N	5.0	c	1005.5	29.2	25.4	30	24.3	74	8
	12	5 1	3 1 S	159 9 E	ESE	4.0	bc	1008.9	28.7	25.6	30	24.5	78	6
	15	4	2 51 S	158 33 E	NNE	2.0	b	1006.8	28.6	24.8	29	23.4	74	2
	18	7	2 39 S	157 58 E	WNW	3.5	b	1006.8	28.5	25.2	29	23.7	76	2
	21	10	2 28 S	157 23 E	NNW	3.0	bc	1007.8	28.8	25.5	29	24.3	76	6
	5 0	13	2 19 S	156 57 E	W	3.5	bc	1007.2	29.7	26.0	29	24.7	75	5
	3	15	2 7 S	156 24 E	WNW	2.0	bc	1006.4	30.0	26.0	29	24.6	73	7
	6	18	1 60 S	155 60 E	WNW	2.5	bc	1006.2	29.2	26.0	29	25.0	78	unknown
	9	22	1 34 S	156 0 E	NNW	4.0	b	1008.1	28.4	25.8	29	25.1	81	2
	12	6 1	1 8 S	156 0 E	NNE	4.0	o	1009.8	29.0	25.4	29	24.2	75	10
	15	4	0 44 S	155 60 E	NNE	8.0	c	1007.5	27.4	25.2	29	24.4	84	9
	18	7	0 20 S	156 3 E	NNW	4.0	c	1007.6	27.5	25.5	29	24.8	85	9
	21	10	0 0 S	156 8 E	E	2.0	c	1008.2	28.0	25.3	29	24.6	80	8
	6 0	13	0 0 S	156 1 E	SW	6.5	c	1008.5	27.5	25.4	29	24.7	84	9
	3	15	0 28 N	156 0 E	SW	3.0	bc	1006.7	28.6	25.4	29	24.2	78	6
	6	18	0 42 N	155 60 E	WNW	2.0	c	1006.1	28.8	25.8	29	25.0	79	8
	9	22	1 9 N	156 0 E	WSW	2.0	c	1006.7	28.5	25.2	29	23.7	76	8
	12	7 1	1 35 N	156 0 E	NNW	6.0	bc	1008.8	27.2	25.0	29	24.2	84	5
	15	4	1 59 N	156 0 E	NNE	5.0	bc	1007.5	27.6	24.8	29	23.8	80	4
	18	7	1 59 N	155 58 E	ENE	4.0	c	1006.7	27.7	25.0	29	24.1	80	8
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	7 0	13	2 21 N	156 0 E	ESE	3.5	bc	1008.8	29.8	26.2	29	25.0	75	4
	3	15	2 45 N	156 1 E	SE	5.0	bc	1007.3	30.2	26.6	29	25.4	75	7
	6	18	2 49 N	155 60 E	S	4.0	c	1006.9	28.8	26.3	29	25.7	83	8
	9	22	3 16 N	156 0 E	SSW	9.0	q	1008.6	27.5	24.2	29	22.7	76	10
	12	8 1	3 52 N	156 0 E	ESE	3.0	o	1009.8	26.8	24.8	29	24.1	85	10
	15	4	4 20 N	155 60 E	SE	4.0	c	1008.3	27.8	25.0	29	24.0	80	9
	18	7	4 55 N	156 0 E	ESE	4.0	bc	1006.9	27.9	25.2	29	23.9	80	3
	21	10	5 22 N	156 60 E	SE	2.0	c	1007.6	28.2	25.3	29	24.6	80	8
	8 0	13	5 60 N	156 0 E	NNE	1.0	c	1008.5	28.3	26.0	29	25.2	84	9
	3	15	6 21 N	156 0 E	NNE	4.0	c	1006.9	28.4	26.0	29	25.1	83	8
	6	18	6 58 N	156 0 E	NNE	3.0	c	1006.0	28.2	25.6	29	24.7	81	8
	9	22	7 25 N	155 60 E	ENE	3.0	bc	1006.7	28.6	25.2	29	23.7	76	3
	12	9 1	7 57 N	155 60 E	ENE	9.0	c	1008.9	27.3	26.0	28	25.6	90	9
	15	4	7 57 N	155 57 E	ENE	7.0	bc	1008.3	27.6	25.4	28	24.6	84	7
	18	7	7 58 N	155 56 E	NE	10.0	bc	1006.4	27.0	25.1	28	24.3	86	7
	21	10	8 0 N	156 0 E	NE	12.0	bc	1007.5	28.5	25.4	28	24.4	77	6
	9 0	13	7 60 N	155 57 E	NE	11.0	c	1009.0	30.8	26.2	28	24.6	70	8
	3	15	7 59 N	155 58 E	NE	12.0	bc	1005.7	29.2	25.6	28	24.5	76	7
	6	18	7 50 N	155 22 E	NE	11.0	bc	1006.2	28.7	25.2	28	23.7	75	7
	9	22	7 43 N	154 46 E	NE	7.0	bc	1006.8	26.8	25.0	28	24.3	86	7
Time Corr.	12	10 1	7 40 N	154 8 E	ENE	10.0	bc	1008.3	28.2	25.2	28	24.1	79	6
	15	5	7 37 N	153 32 E	NE	10.0	bc	1006.9	28.0	26.0	28	25.3	85	6
	18	8	7 34 N	152 56 E	NE	9.0	bc	1005.8	28.2	26.0	28	25.2	83	6
	21	11	7 32 N	152 20 E	ENE	9.5	c	1008.2	28.3	26.2	28	25.1	84	8
	10 0	14	Chuuk											
	3	17												
	6	20												
	9	23												
	12	11 2												
	15	5												
	18	8												
	21	11												
	11 0	14												
	3	17												
	6	20												
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	21	11												
	12 0	14												
	3	17												
	6	20												
	9	23												
	12	13 2												

	15		5												
	18		8												
	21		11												
13	0		14												
	3		17												
	6		20												
	9		23	7 44 N	151 38 E	NE	17.0	c	1007.2	27.2	25.6	28	25.0	87	9
	12	14	2	7 19 N	151 16 E	NE	13.0	q	1008.0	26.0	25.0	28	24.6	92	10
	15		5	7 4 N	151 15 E	NE	15.0	o	1005.8	28.2	25.0	28	23.8	77	10
	18		8	7 8 N	151 23 E	NE	15.0	bc	1004.8	28.0	24.4	28	23.1	74	3
	21		11	7 3 N	151 21 E	NE	14.0	c	1006.7	28.4	25.2	28	23.7	77	7
14	0		14	6 60 N	151 17 E	NE	12.0	c	1008.1	30.1	26.2	28	25.4	73	unknown
	3		17	6 35 N	151 2 E	ENE	10.2	o	1006.3	28.5	25.5	28	24.4	79	10
	6		20	6 6 N	150 46 E	ENE	9.0	o	1005.0	29.0	26.0	28	25.0	79	10
	9		23	5 48 N	150 18 E	ENE	8.0	o	1007.6	29.0	25.9	29	25.0	79	unknown
	12	15	2	5 37 N	149 45 E	ENE	11.0	o	1007.3	28.4	25.8	29	24.9	82	10
	15		5	5 24 N	149 13 E	ENE	10.0	c	1006.6	27.6	26.0	29	25.5	88	9
	18		8	5 13 N	148 40 E	ENE	12.0	c	1005.3	27.2	25.6	29	25.1	87	8
	21		11	5 2 N	148 6 E	ENE	14.0	q	1006.6	25.8	25.2	29	24.3	75	10
15	0		14	4 58 N	147 31 E	E	8.0	r	1008.6	25.5	24.6	29	24.2	94	10
	3		17	4 58 N	147 2 E	NE	14.0	c	1005.9	27.2	26.8	29	26.6	97	9
	6		20	4 57 N	147 2 E	NE	12.0	o	1004.5	29.0	26.5	29	25.7	82	10
	9		23	4 28 N	147 0 E	ENE	11.0	o	1006.0	28.8	26.6	29	25.7	77	unknown
	12	16	2	3 57 N	146 59 E	E	11.5	r	1007.4	27.3	25.8	29	25.3	88	10
	15		5	3 25 N	146 59 E	ENE	10.0	bc	1006.3	28.6	25.8	29	24.8	80	7
	18		8	3 0 N	147 0 E	NE	10.0	o	1005.1	26.0	25.5	29	25.3	96	10
	21		11	2 31 N	146 59 E	ENE	7.0	o	1006.2	27.9	25.8	29	25.3	85	unknown
16	0		14	1 60 N	146 60 E	ENE	2.5	bc	1006.9	28.9	26.8	29	26.2	78	7
	3		17	2 0 N	147 0 E	NNE	2.0	c	1005.2	29.5	27.5	29	26.9	86	9
	6		20	1 36 N	146 60 E	NNE	2.0	r	1003.8	26.6	25.4	29	25.0	91	10
	9		23	1 10 N	146 60 E	NNE	4.0	o	1005.6	27.7	26.0	29	25.5	87	unknown
	12	17	2	0 46 N	147 1 E	SE	4.5	c	1007.2	28.2	25.8	29	25.3	84	8
	15		5	0 12 N	146 58 E	S	2.0	c	1006.0	27.6	25.6	29	24.9	85	8
	18		8	0 3 N	146 59 E	ESE	3.0	r	1005.2	25.2	24.6	29	24.4	96	10
	21		11	0 2 N	146 57 E	SE	2.0	o	1007.2	26.0	25.2	29	24.8	94	10
17	0		14	0 2 N	146 53 E	calm	0.0	c	1008.0	28.4	25.4	29	24.3	79	9
	3		17	0 0 N	147 1 E	calm	0.0	c	1005.7	30.5	28.5	29	27.9	86	9
	6		20	0 9 N	146 60 E	NW	3.0	c	1003.8	28.6	25.8	29	24.8	80	9
	9		23	0 27 N	146 59 E	ENE	3.0	c	1005.8	27.6	26.0	29	25.5	88	8
	12	18	2	0 9 S	146 60 E	calm	0.0	c	1006.9	27.7	25.5	29	24.7	84	8
	15		5	0 30 S	146 60 E	WSW	6.0	c	1005.7	26.5	25.5	29	25.2	92	9
	18		8	0 60 S	146 60 E	W	5.0	bc	1003.8	25.8	24.6	29	24.2	84	5
	21		11	1 27 S	146 60 E	NW	4.0	c	1005.6	26.8	25.5	29	25.0	90	9
18	0		14	1 40 S	147 1 E	WNW	4.5	c	1007.4	28.0	25.7	29	24.9	83	8
	3		17	1 40 S	147 26 E	NNW	4.0	c	1005.5	27.4	25.8	29	25.3	88	9
	6		20	1 40 S	147 20 E	WSW	8.0	r	1004.5	25.8	25.0	29	24.7	94	10
	9		23	1 38 S	146 56 E	W	8.0	o	1006.0	26.4	25.8	29	25.8	96	10
	12	19	2	1 5 S	146 54 E	NW	7.5	c	1007.3	28.0	25.0	29	23.9	78	9
	15 AUG		5	0 31 S	146 53 E	NW	6.0	r	1006.3	26.8	25.2	29	24.7	87	10
	18		8	0 2 S	146 53 E	N	3.0	bc	1004.3	26.6	25.0	29	24.5	88	6
	21		11	0 0 N	146 53 E	N	4.0	o	1005.6	28.0	25.8	29	25.3	84	unknown
19	0		14	0 1 S	146 56 E	NE	4.5	c	1007.3	28.2	25.8	29	25.3	83	9
	3		17	0 0 S	146 42 E	W	9.0	r	1005.7	25.2	25.0	29	24.9	99	10
	6		20	0 0 S	146 9 E	NE	6.0	r	1004.3	25.2	24.8	29	24.6	97	10
	9		23	0 0 S	145 47 E	SW	8.6	q	1007.8	24.8	24.8	28	25.0	100	10
	12	20	2	0 0 S	145 15 E	NW	2.5	r	1008.3	25.2	24.0	28	23.5	92	10
	15		5	0 0 S	144 50 E	WNW	3.0	r	1007.8	25.8	24.6	28	24.2	90	10
	18		8	0 0 S	144 18 E	W	12.0	r	1006.3	25.0	24.4	28	24.2	95	10
	21		11	0 0 S	143 55 E	NW	13.0	c	1007.0	26.8	26.0	28	25.7	94	8
20	0		14	0 0 N	143 23 E	WNW	9.5	o	1008.3	28.6	25.4	28	24.4	77	10
	3		17	0 0 S	142 59 E	W	13.0	o	1006.7	29.2	25.8	28	24.7	77	10
	6		20	0 4 S	142 32 E	W	15.0	o	1005.5	28.2	25.6	28	24.7	81	10
	9		23	0 24 S	142 7 E	WNW	11.0	o	1007.0	27.8	26.8	28	26.7	93	unknown
	12	21	2	0 45 S	142 0 E	NW	9.5	o	1009.3	28.0	25.4	28	24.5	82	10
	15		5	1 8 S	142 1 E	WNW	12.0	o	1007.5	28.0	25.4	28	24.5	82	10
	18		8	1 33 S	142 0 E	NW	12.0	o	1005.8	28.2	25.6	28	24.7	82	10
	21		11	1 58 S	141 60 E	NW	16.0	q	1008.2	27.4	26.8	28	26.8	96	10
21	0		14	2 31 S	142 0 E	WNW	12.0	r	1008.5	26.2	24.9	28	24.4	89	10
	3		17	2 34 S	142 0 E	NW	10.0	r	1006.3	27.0	25.2	28	24.6	86	10
	6		20	2 15 S	142 0 E	WNW	13.0	o	1003.4	28.0	25.2	28	24.2	80	10
	9		23	1 42 S	142 0 E	NW	10.5	o	1006.3	27.8	25.8	28	25.3	79	unknown
	12	22	2	1 9 S	142 0 E	NW	10.5	c	1006.8	28.0	25.4	28	24.5	81	9
	15		5	0 36 S	141 60 E	NW	9.0	o	1006.3	28.4	25.6	28	24.6	80	10

		18		8	0 4 S	141 55 E	N	8.0	o	1004.8	27.8	25.6	28	24.8	83	10
		21		11	0 1 S	142 1 E	N	5.0	o	1005.4	27.6	26.0	28	25.5	82	unknown
	22	0		14	0 0 N	141 58 E	NNE	4.0	c	1007.5	28.6	25.6	28	24.5	85	8
		3		17	0 0 N	141 40 E	NNE	4.0	c	1004.9	29.0	26.0	28	25.0	79	8
		6		20	0 0 S	141 6 E	calm	0.0	c	1003.2	30.0	26.4	28	25.2	75	9
		9		23	0 0 S	140 44 E	W	4.5	c	1004.8	27.0	25.2	28	24.3	86	8
		12	23	2	0 0 N	140 12 E	SSE	4.0	r	1005.9	25.8	25.2	28	25.0	86	10
		15		5	0 0 S	139 51 E	NE	8.0	r	1005.3	25.8	25.0	28	24.7	94	10
		18		8	0 0 S	139 20 E	NNW	3.0	r	1004.3	25.6	24.8	28	24.5	94	10
		21		11	0 1 S	138 59 E	WSW	10.5	c	1004.6	26.9	25.0	28	25.0	86	9
	23	0		14	0 24 S	138 37 E	WSW	7.5	o	1006.6	27.6	25.0	28	24.1	81	10
		3		17	0 46 S	138 15 E	WSW	12.0	r	1005.5	26.8	25.6	28	25.2	90	10
		6		20	0 60 S	138 0 E	W	13.0	o	1003.4	27.2	25.6	28	25.1	87	10
		9		23	0 30 S	138 0 E	WNW	11.0	c	1004.7	26.5	25.0	28	24.5	88	9
		12	24	2	0 4 S	138 0 E	NW	7.5	c	1006.0	26.6	25.2	28	24.7	89	8
		15		5	0 19 N	137 60 E	N	8.0	c	1006.3	27.2	25.4	28	24.8	79	9
		18		8	0 41 N	137 60 E	NNW	6.0	c	1004.7	26.0	25.2	27	24.9	94	9
		21		11	1 5 N	137 60 E	N	9.0	c	1005.8	26.0	25.2	28	24.6	94	9
	24	0		14	1 30 N	138 0 E	N	4.5	o	1008.2	27.0	24.6	28	23.7	82	10
		3		17	2 0 N	138 0 E	SW	2.0	r	1007.3	25.4	24.8	28	24.6	95	10
		6		20	2 17 N	137 37 E	W	10.0	r	1005.9	24.5	24.0	28	23.8	96	10
		9		23	2 29 N	137 22 E	NNW	10.5	c	1005.8	25.5	24.6	28	24.0	93	9
		12	25	2	2 30 N	137 23 E	NW	8.0	c	1008.1	26.6	24.6	28	23.9	85	9
		15		5	2 30 N	137 21 E	NW	9.0	c	1007.7	27.0	24.6	28	23.3	83	7
		18		8	2 27 N	137 19 E	WNW	8.0	c	1006.6	26.8	24.6	28	23.8	84	7
		21		11	2 26 N	137 28 E	W	8.5	c	1007.3	27.8	25.6	28	24.6	83	7
	25	0		14	2 27 N	137 26 E	W	11.0	bc	1008.3	29.0	25.6	28	24.4	76	7
		3		17	2 24 N	137 20 E	W	12.0	bc	1006.5	28.0	25.4	28	24.5	81	7
		6		20	1 60 N	137 4 E	W	12.0	c	1004.8	28.0	25.6	28	24.7	83	8
		9		23	1 37 N	136 46 E	W	14.6	c	1006.2	26.8	25.2	27	24.3	87	9
		12	26	2	1 29 N	136 14 E	W	13.0	c	1007.5	26.8	24.6	28	23.8	90	9
		15		5	1 20 N	135 43 E	W	13.0	c	1007.5	27.2	24.4	28	23.4	79	9
		18		8	1 9 N	135 13 E	W	15.0	c	1005.9	27.2	24.6	28	23.7	81	9
		21		11	0 55 N	134 44 E	W	11.5	o	1007.5	27.2	25.2	28	24.3	85	unknown
	26	0		14	1 5 N	134 20 E	WNW	10.0	bc	1008.3	27.5	24.7	28	23.6	80	7
		3		17	1 17 N	134 4 E	WNW	12.0	c	1006.9	28.0	25.0	28	23.9	78	9
		6		20	1 36 N	133 38 E	W	11.0	c	1005.4	27.6	25.0	27	24.1	81	9
		9		23	1 54 N	133 12 E	WNW	10.8	o	1005.8	25.4	24.4	27	24.1	92	10
Time Corr.		12	27	2	2 13 N	132 46 E	WNW	9.5	c	1007.8	26.0	24.1	27	24.7	86	8
		15		5	2 31 N	132 18 E	W	10.0	c	1008.4	26.6	24.8	27	24.2	86	9
		18		8	2 52 N	131 59 E	WNW	9.0	c	1006.6	26.6	25.0	27	24.5	87	9
		21		11	3 25 N	132 7 E	WNW	10.3	bc	1006.3	26.4	24.8	27	24.5	88	6
	27	0		14	3 58 N	132 11 E	WNW	9.0	bc	1007.2	26.2	24.0	27	23.1	84	6
		3		17	4 31 N	132 21 E	NW	4.0	o	1007.1	26.5	24.2	27	23.3	83	10
		6		20	5 1 N	132 42 E	W	7.0	o	1005.3	26.8	25.0	26	24.4	86	10
		9		23	5 30 N	133 4 E	WSW	9.3	c	1005.8	26.4	25.0	26	24.5	89	9
		12	28	2	6 0 N	133 24 E	WNW	5.5	c	1006.8	26.0	24.8	26	24.4	90	8
		15		5	6 30 N	133 42 E	W	5.5	o	1008.8	26.2	25.0	26	24.6	90	10
		18		8	6 58 N	133 59 E	NNW	4.0	c	1004.3	26.2	24.6	26	24.1	87	9
		21		11	7 29 N	134 15 E	NNE	4.7	c	1005.1	25.5	24.8	26	24.8	95	9
	28	0		14	7 39 N	134 25 E	NE	4.0	bc	1005.9	31.0	26.4	26	unknown	72	7

*wether b : Fine (cloud 0 to 2)
bc : Fine but cloudy (cloud 3 to 7)
c : Cloudy (cloud 8 to 10)
o : Overcast (cloud 10)
r : Rain
q : Squalls

(b) BNL Instrumentation

1 System Overview

A system overview of the instrumentation (Fig. 10) shows three major sensor groups all connecting to a central processing site in the ship laboratory. The three main components to the system are (a) wind and navigation subsystem, (b) radiation and meteorology subsystem, and (c) fast-rotating shadowband radiometer subsystem. A fourth subsystem is the GOES telemetry data collection package (DCP). The subsystems all communicate with the central computer over EIA422 serial lines. Power and serial lines are run separately (Fig. 11). A considerable effort was made to ensure solid grounding and no ground loops. Each remote computer system was grounded directly to the ship structure.

In the laboratory, the data logging PC operates an eight-channel serial switch with EIA422-to-EIA232 conversion. Any of the inputs can be selected for data collection. A universal power supply (UPS), power distribution box, and mass storage device (ZIP drive) complete the arrangement. Data analysis and processing was accomplished with a separate Macintosh computer, zip drive, and color printer.

The system shown in figures 10 and 11 changed soon after the beginning of the cruise when the ship's powerful radar apparently disabled the eight-channel serial switch. (Grounding and surge protection are art forms and not totally predictable!) As a result, two small Soltec 422/232 converter boxes were adapted and data were collected by manually plugging in different subsystems.

2 Portable Radiation Package

The Portable Radiation Package (PRP) (see photo in Fig. 6) is comprised of an **Eppley PSP sensor** for global shortwave insolation, an **Eppley PIR sensor** for downwelling longwave radiation and a fast-rotating shadowband radiometer of special design for making direct/diffuse broadband shortwave radiation measurements from moving platforms.

All sensors outputs are recorded by a Zeno Model 3200 data logger (Fig. 12). The data logger samples all input analog variables at a one-sec rate then computes one-minute averages. A large capacity memory allows the logger to collect up to several weeks of data.

In addition to the radiation sensors, the following meteorological sensors were sampled: **temperature, relative humidity, and barometer**. The pitch and roll of the ship was recorded with two **x-y tilt sensors** mounted on the radiation sensor plate.

The Fast-Rotating shadowband radiometer (FRSR) is a stand-alone subsystem that has its own computer, serial interface, and power connections (Fig.13). The principal of the FRSR is described in several places (Reynolds, 1996; Reynolds and Smith, 1996). In short, the RSR arm rotates in a full circle with a period of approximately five seconds. By combining a fast silicon-cell detector, 20

Hz sampling, and special shadow-detecting software, the arm shadow can be detected regardless of the azimuth or tilt of the device.

This version of the FRSR used a Si sensor from International Light, the SED033/F/W sensor. This is a much improved sensor over the LiCor sensor used in previous excursions. The IL senor passband is flat over the 400-1000 nm short-wave band (Fig. 14) and compares nicely with the Eppley PSP. Note the Licor sensor is strongly attenuated in the blue (400 nm) and hence the diffuse measurements from the LiCor are much harder to interpret. After calibration (Sec. 4) the FRSR compares extremely well with the PSP.

3 Wind-Navigation System

The wind and navigation subsystem (Fig. 7 and 15) was a separate subsystem so it could be placed in an exposed place on the ship. The computer interfaced with a Navico flux-gate compass with serial output, a Trimble Model Lassen-SK8 miniature OEM GPS receiver, and an R.M. Young marine-grade wind monitor.

The wind monitor was oriented on the ship with its south lubber line facing the bow. The reason for this was that the direction-measuring potentiometer has a dead zone directly at the north position on the wind monitor. If it was deployed in the logical way, facing the bow, the sensor would spend much of its time in the dead zone. We add 180° to the measurements during processing.

4 GOES Platform

The GOES platform shown in figure 10 was included to evaluate the performance of the unit operating from a ship in the far west Pacific where the satellite elevation is extremely small, almost at the horizon. No data was transmitted over this unit. The data collection platform (DCP) sent only its default "No Data" message on an hourly basis. These transmissions were monitored at BNL for accuracy and reliability.

The GOES platform configuration (Fig. 16) had both a +12 vdc power input and a serial EIA422 connection. The plan was to send occasional messages over GOES (GOES-grams), but this was abandoned after the loss of the serial-switch. All available hardware was tied up in data collection.

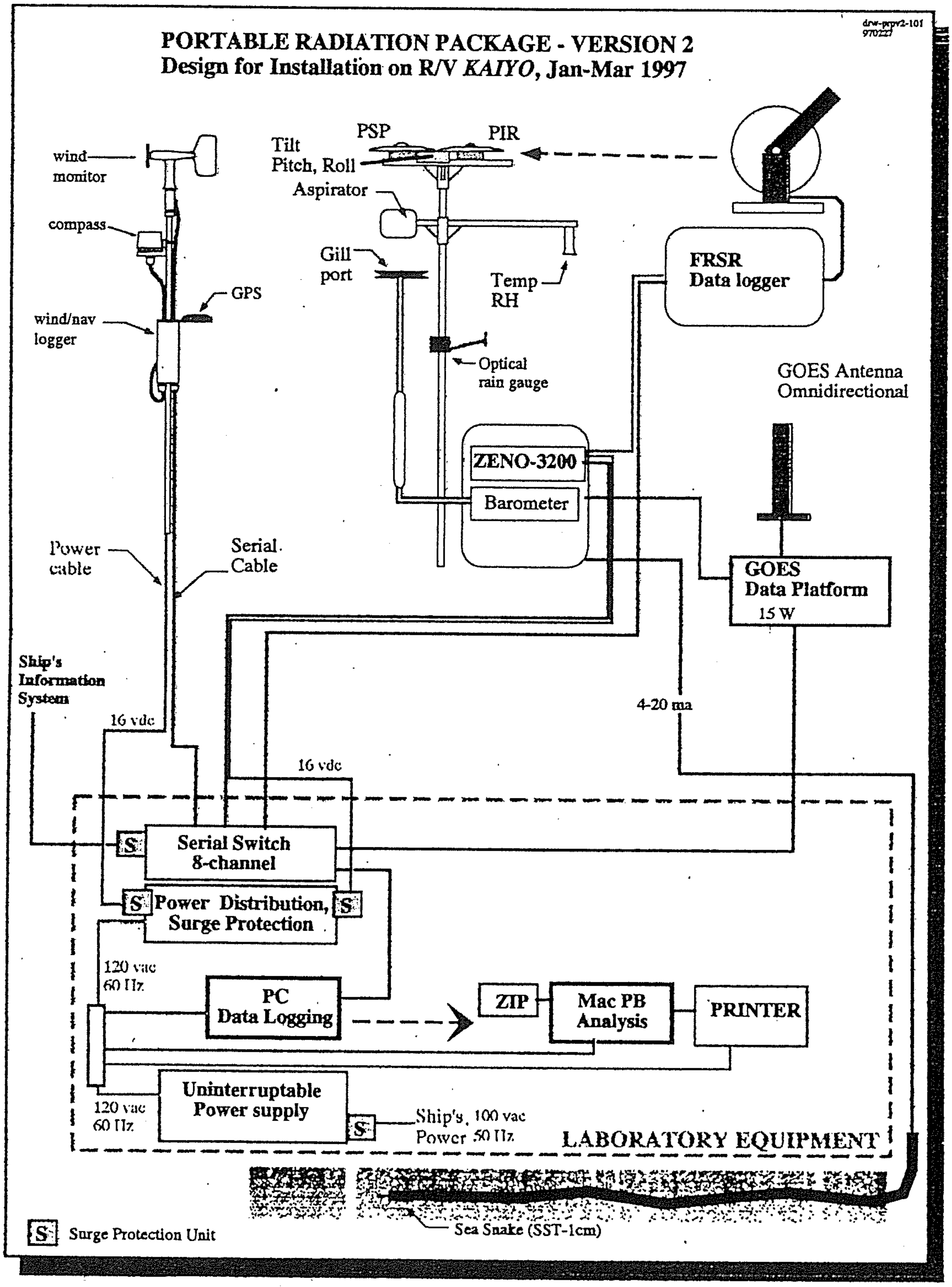
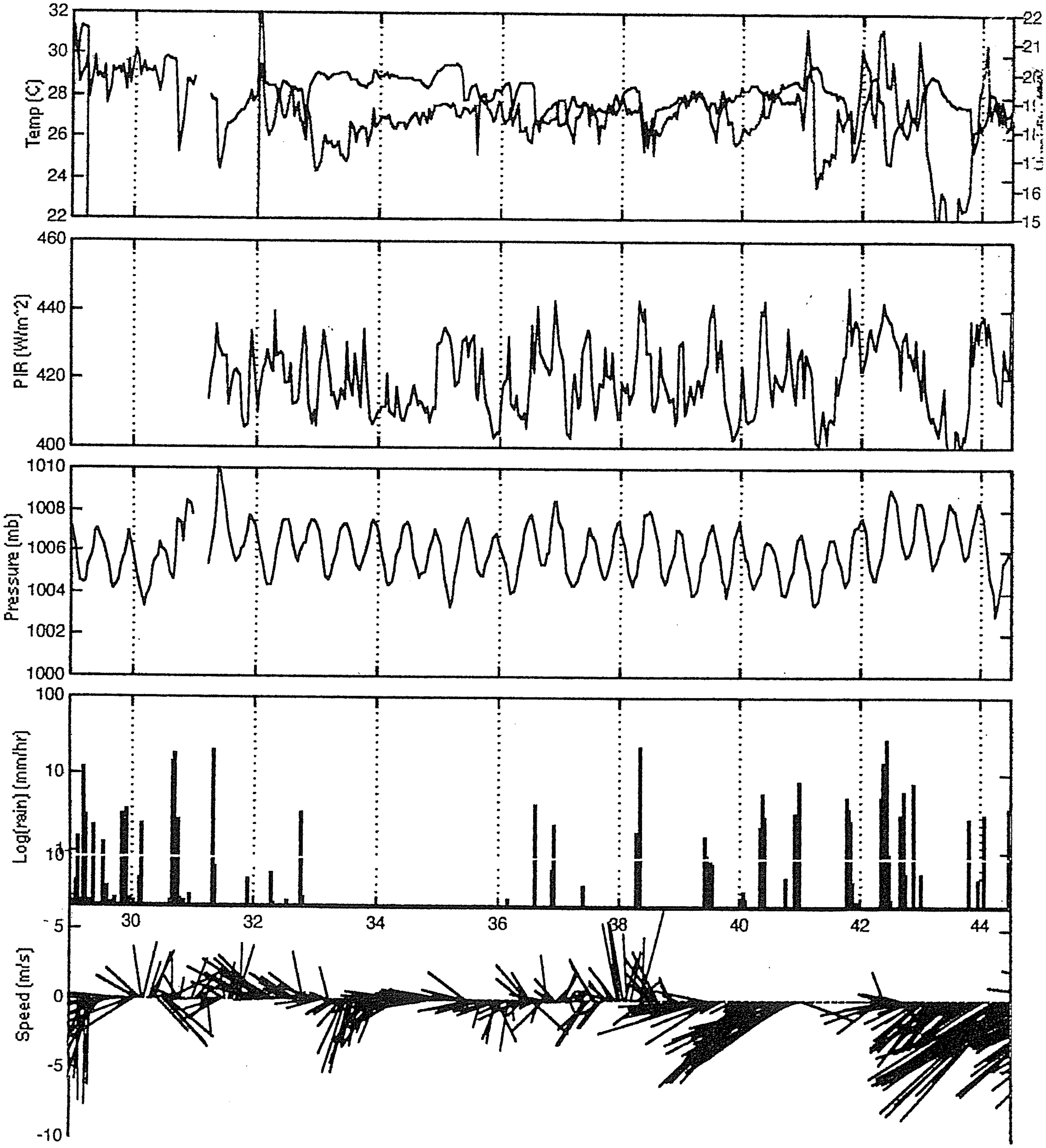
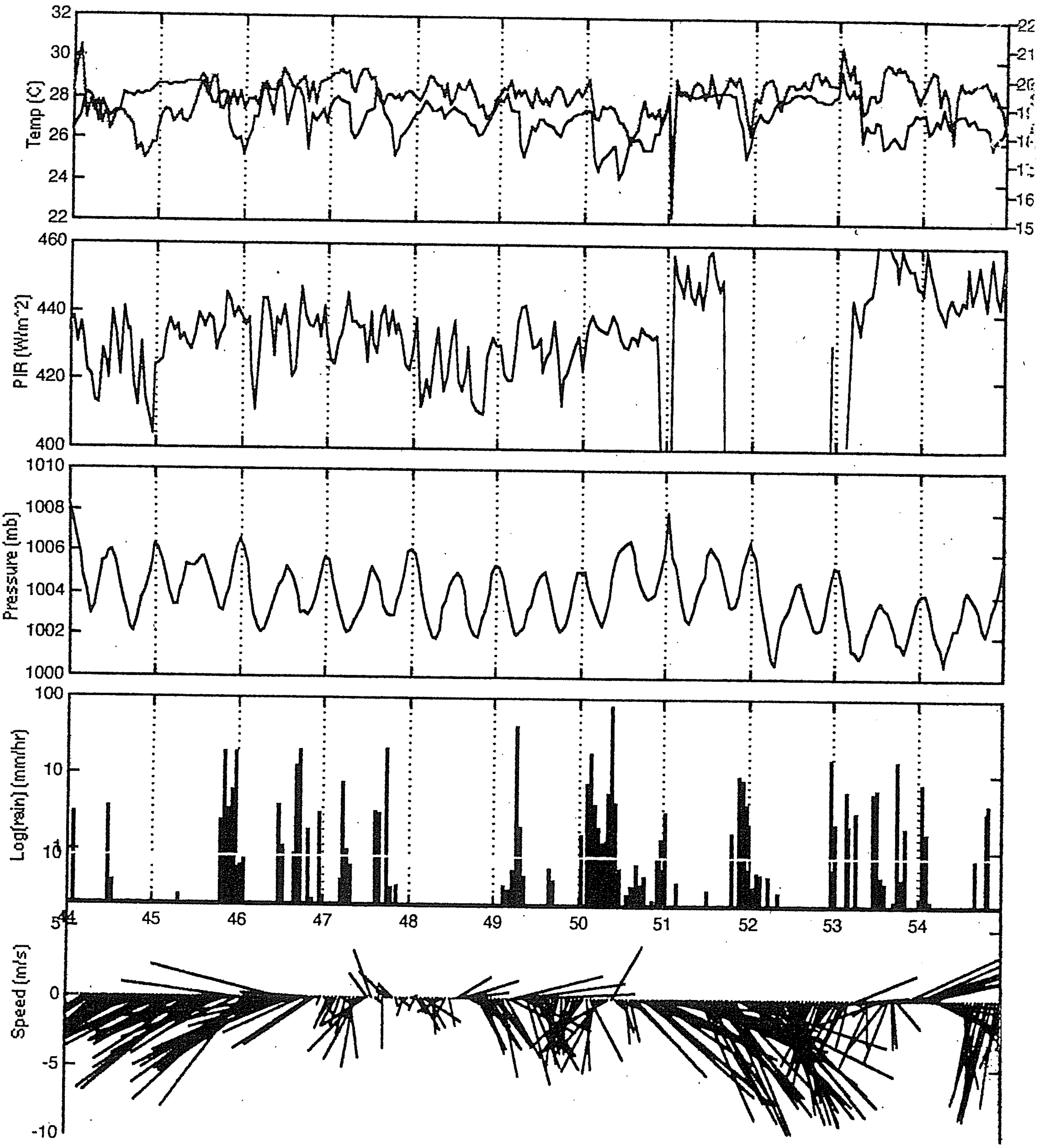


Figure 10: Sketch of the complete JUSTOS mean meteorology flux system. (prpv2-1)


Temp (C)
32
30
28
26
24
22
22
21
16
15
PIR (W/m^2)
460
440
420
400
Pressure (mb)
1010
1008
1006
1004
1002
1000
Log(rain) (mm/hr)
100
10
Speed (m/s)
5
0
-5
-10
30
32
34
36
38
40
42
44


Temp (C)
PIR (W/m^2)
Pressure (mb)
Log(rain) (mm/hr)
Speed (m/s)
44
45
46
47
48
49
50
51
52
53
54

6. Shipboard ADCP

R/V Kaiyo mounts the VM (Vessel–Mounted)–NB (Narrow–Band) ADCP (Acoustic Doppler Current Profiler) manufactured by RD Instrument. The serial number of transducer is 501 of the frequency 77 KHz and the 30 degree beam angle. The ADCP was set as listed below.

Depth Cell Length : 16 m
No. of Depth Cell : 64
Average Time : 300 sec
Tilt misalignment : 0.0
Pitch offset : 0.0
Roll offset : 0.0
Compass offset : 261.7

7. JAMSTEC ADCP MOORING

To get the knowledge of physical process in the western equatorial pacific. In this cruise (K97-02) , we recovered two subsurface ADCP (Acoustic Doppler Current Profiler) moorings at (0 ° N,147° E) and (0° N,142° E), and deployed three ADCP moorings at (0 ° N,165° E) ,(0 ° N,147° E) and (0° N,142° E).

Each mooring was equipped with ADCP with Syntatic Float , one CTD SBE16 at just below the ADCP. Two Benthos Acoustic Releases with glass balls used to release ADCP buoy from sinker on the recovery.

Instrument:

1) ADCP

Distance to first bin:17.5m
Pings per ensemble:16
Time per ping:2.00s
Bin length:8.00m
Sampling Interval:3600s

Recovered ADCP
- Serial Number:1222 (Mooring No.960212-00N147E)
- Serial Number:1223 (Mooring No.960217-00N142E)

Deployed ADCP
- Serial Number:1224 (Mooring No.970131-00N165E)
- Serial Number:1155 (Mooring No.970219-00N147E)
- Serial Number:1154 (Mooring No.970222-00N142E)

2) CTD

SBE-16
Sampling Interval:1800s

Recovered CTD
- Serial Number:1281 (Mooring No.960212-00N147E)
- Serial Number:1277 (Mooring No.960217-00N142E)

Deployed CTD
- Serial Number:1288 (Mooring No.970131-00N165E)
- Serial Number:1275 (Mooring No.970219-00N147E)
- Serial Number:1276 (Mooring No.970222-00N142E)

Deployment:

Three ADCP moorings were deployed at (0° N,165° E), (0° N,147° E) and(0° N,142° E) . The moorings were planed to make the ADCP buoy placed at about 290m. When we deployed, we added two glass balls at (0° N,147° E) and(0° N,142° E) . And then, we adjusted length of the nylon rope at (0° N,147° E). Because the bottom depth of points were deeper than that of our plan. After we dropped the sinker, we monitored depth of the acoustic releaser (Fig.7-1~3). The descent rate was about 2.7m/sec. After the mooring lated, we calibrated each position of the mooring.

Results of calibration

- Mooring No.970131-00N165E
  Lat: 0° 00.01N Long:165° 17.836E
- Mooring No.970219-00N147E
  Lat: 0° 00.325N Long:146° 52.423E
- Mooring No.970222-00N142E
  Lat: 0° 00.216N Long:141° 58.128E

Recovery:

We recovered two ADCP moorings which were deployed on Feb.1996 (K96-01). After we released the sinker, we monitored depth of the acoustic releaser (Fig.7-1~3). The ascending rate was about 1.4m/sec.

After the recovery, we uploaded ADCP and CTD data into a computer, then raw data were converted into ASCII code. Results are shown in the figures on following pages. Fig.7-4,5 shows CTD depth, temperature and salinity data. Fig.7-6~11 shows the velocity data (eastward and northward component) at 50, 120 and 200m depth.

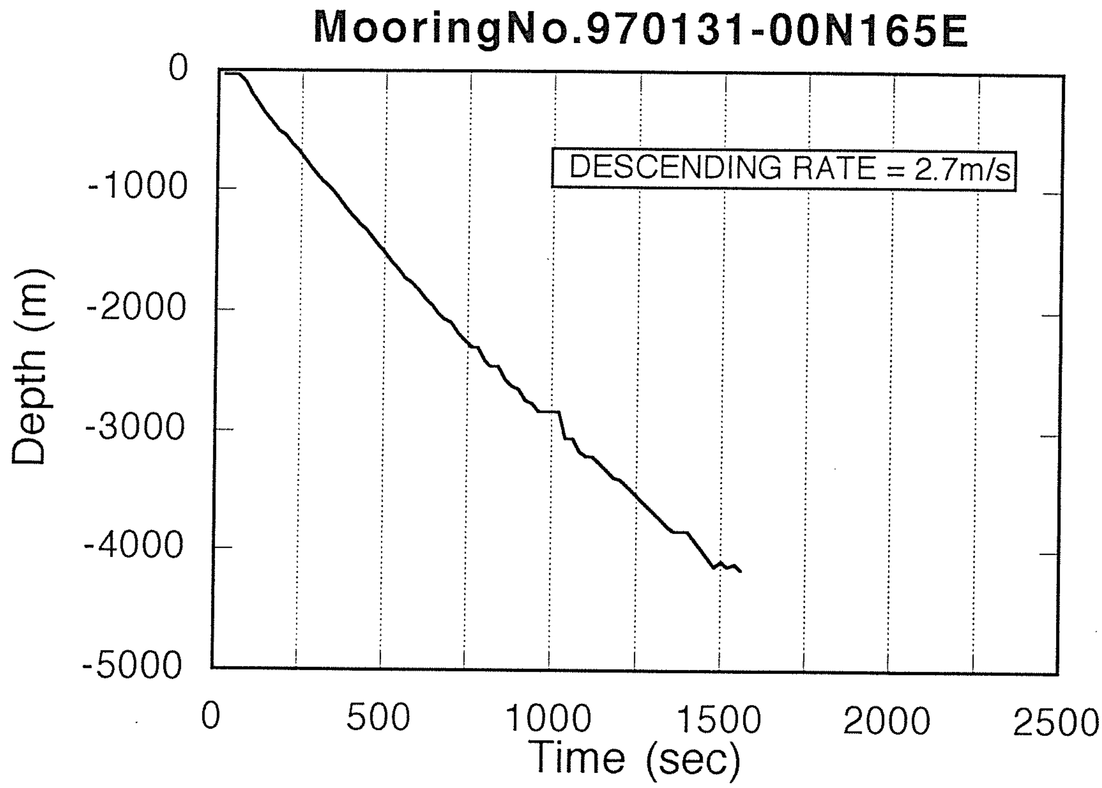
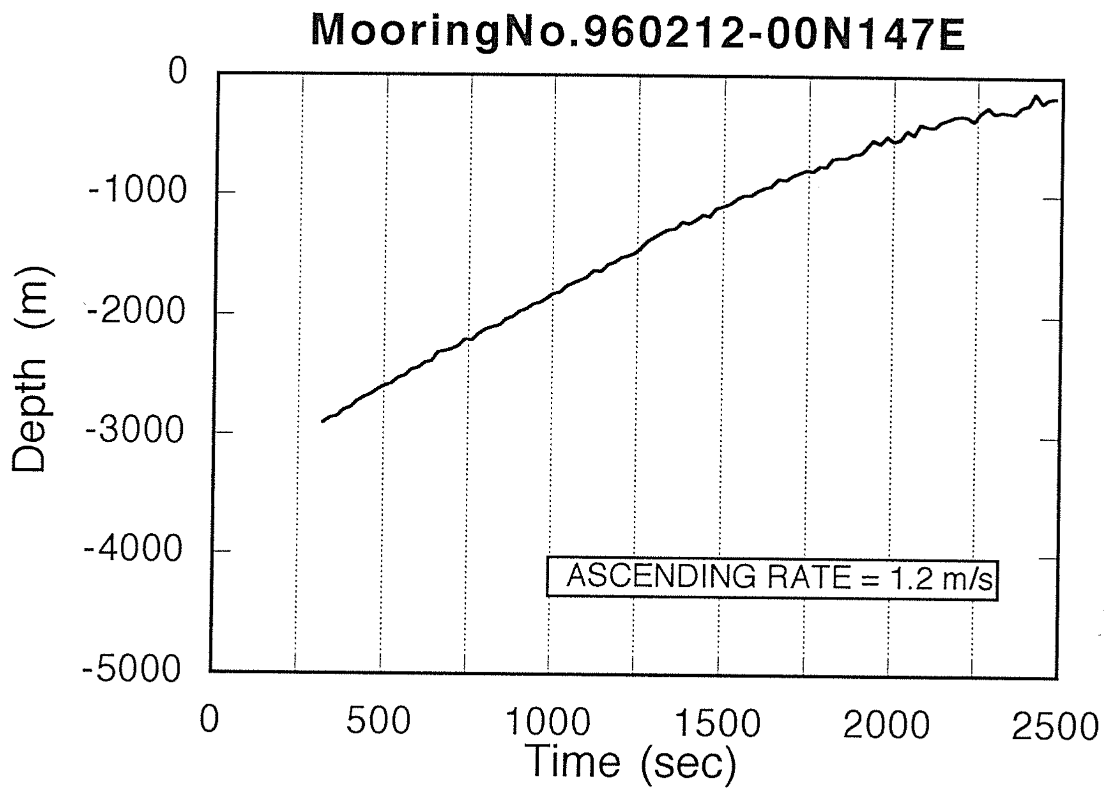


Fig. 7-1 Releaser Depth Monitor



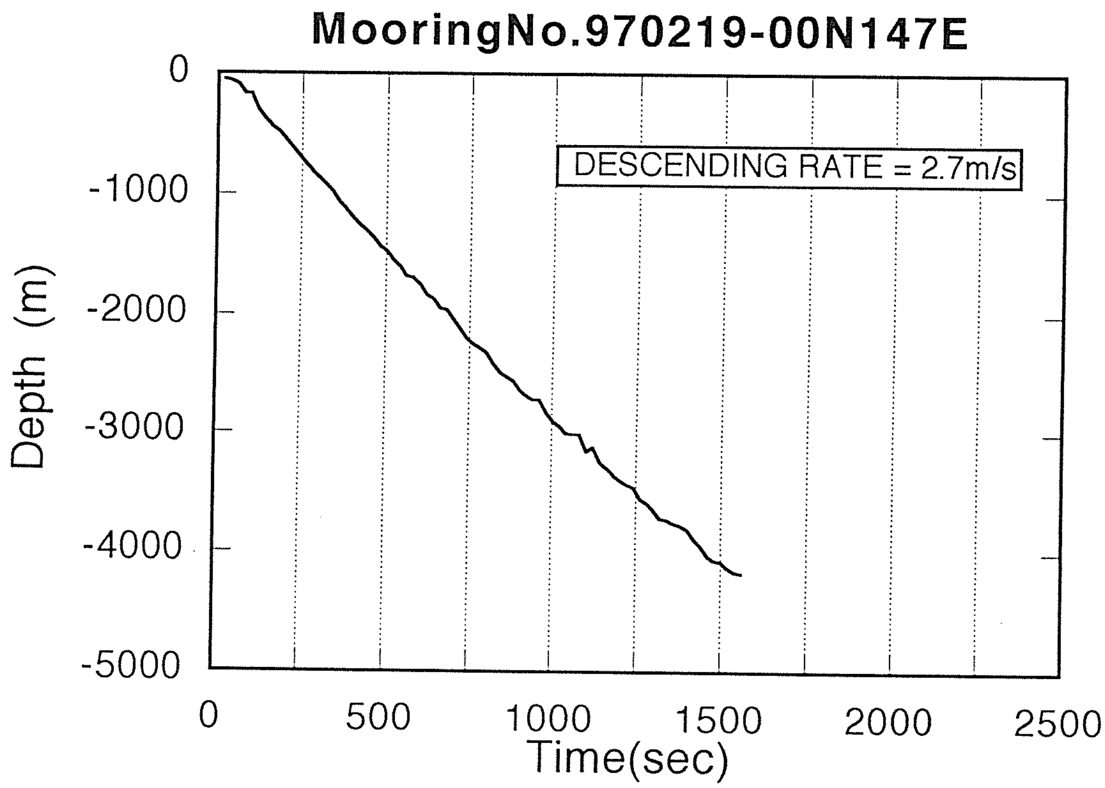
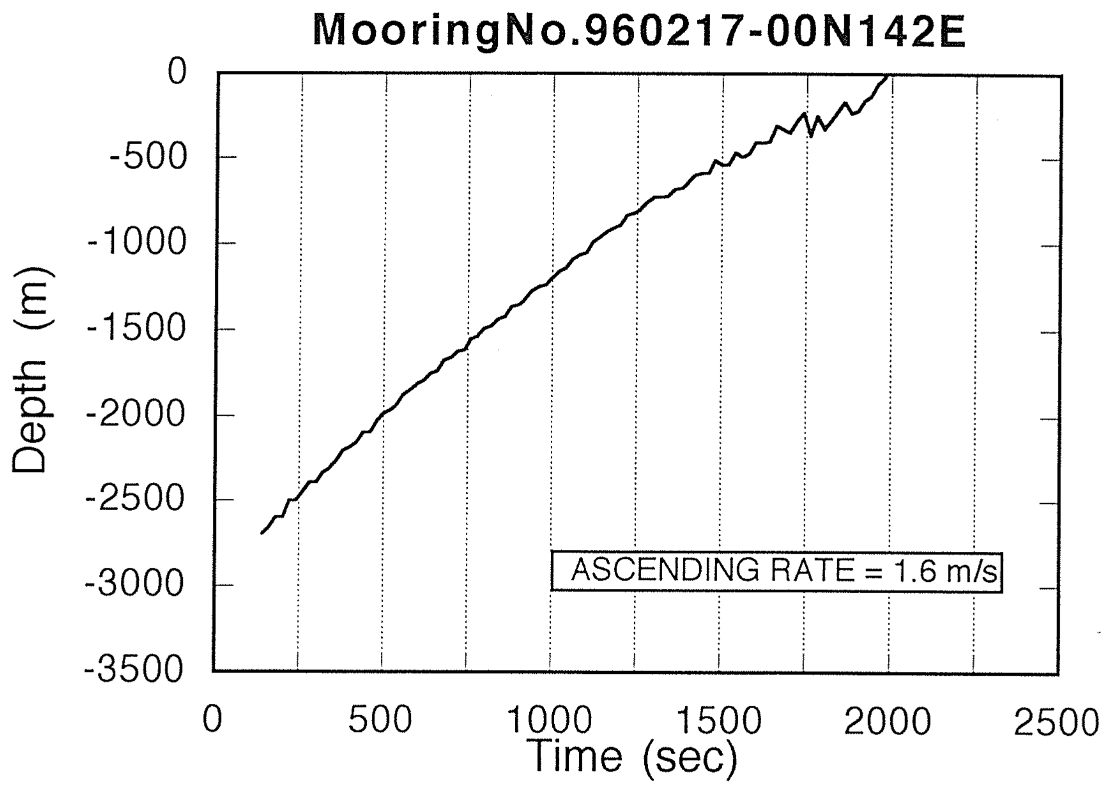


Fig. 7-2 Releaser Depth Monitor



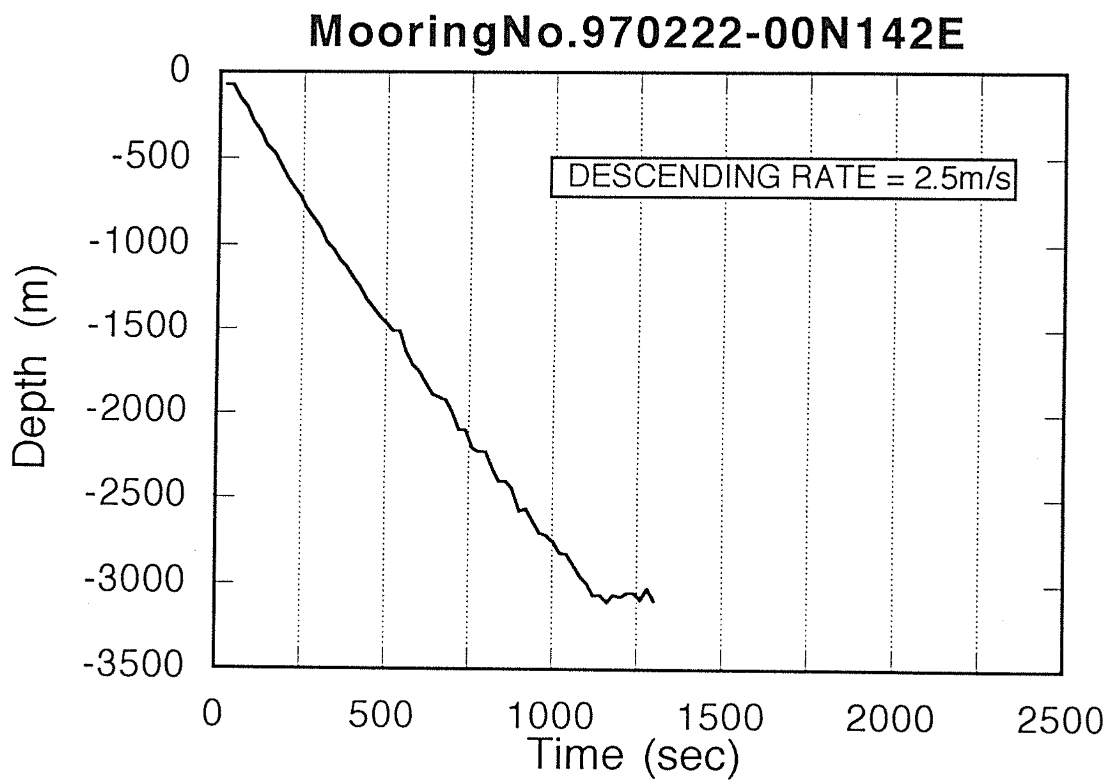


Fig. 7-3 Releaser Depth Monitor

MooringNo.960212-00N147E

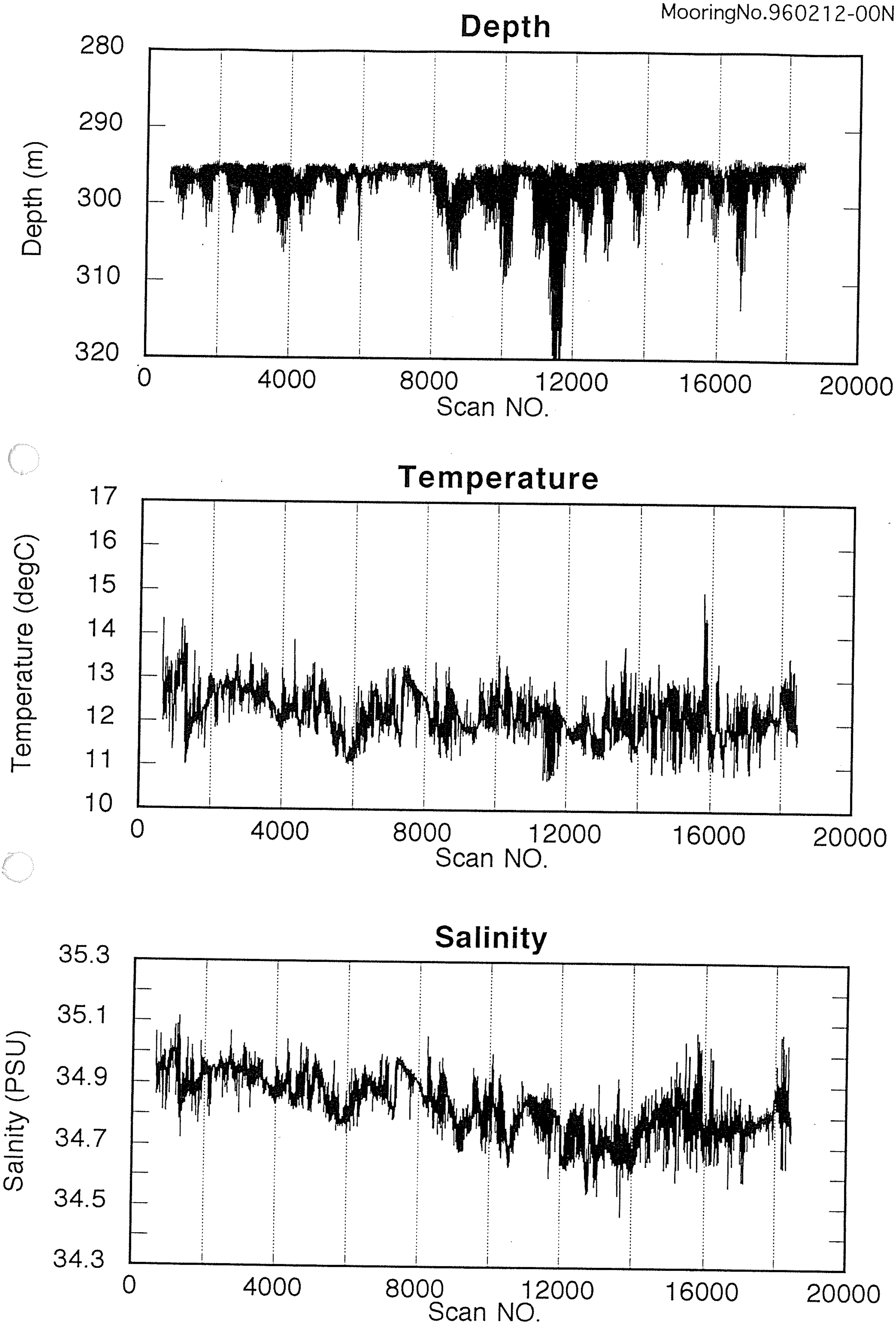


Fig. 7-4 Time Series of Depth, Temperature, Salinity

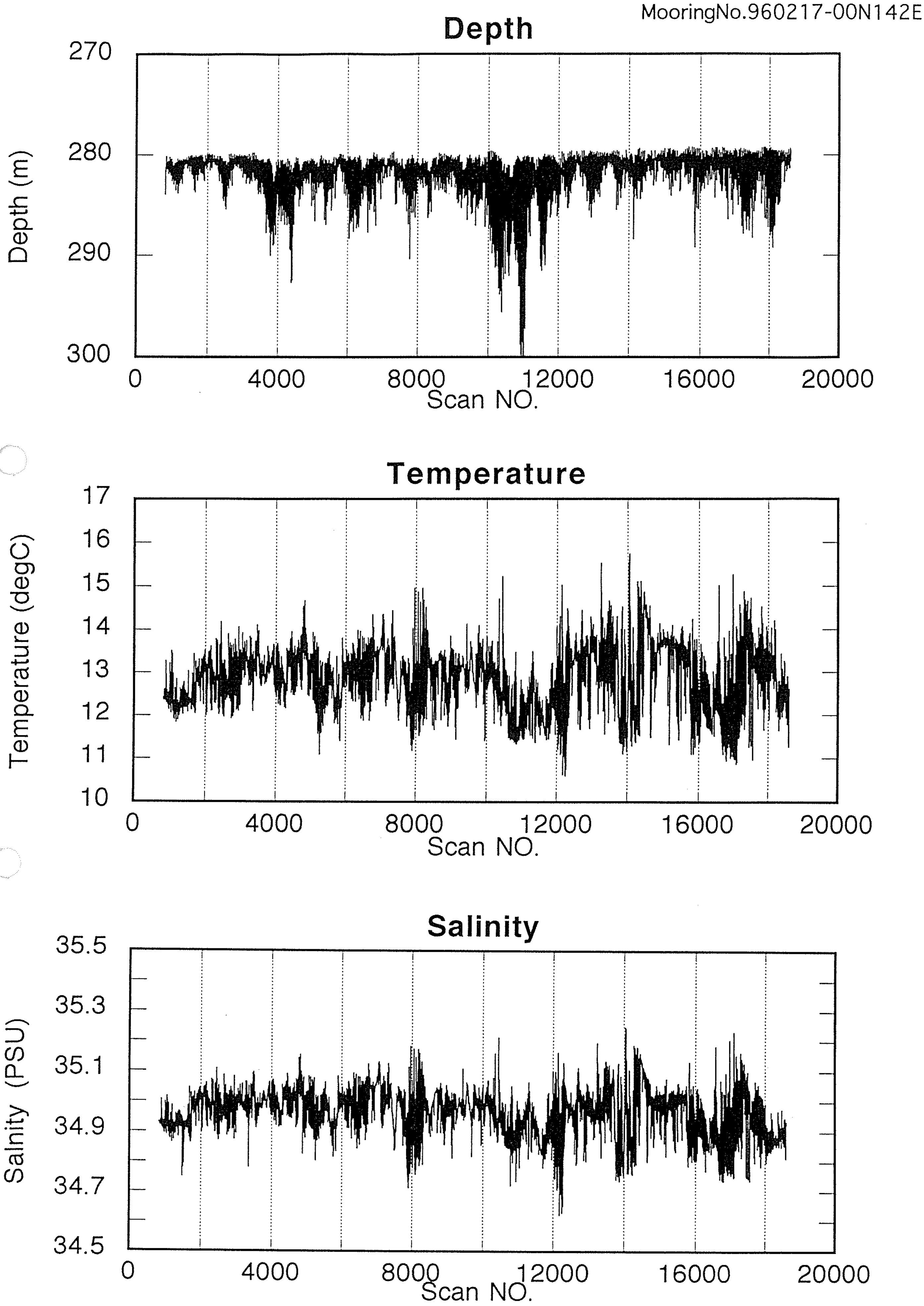
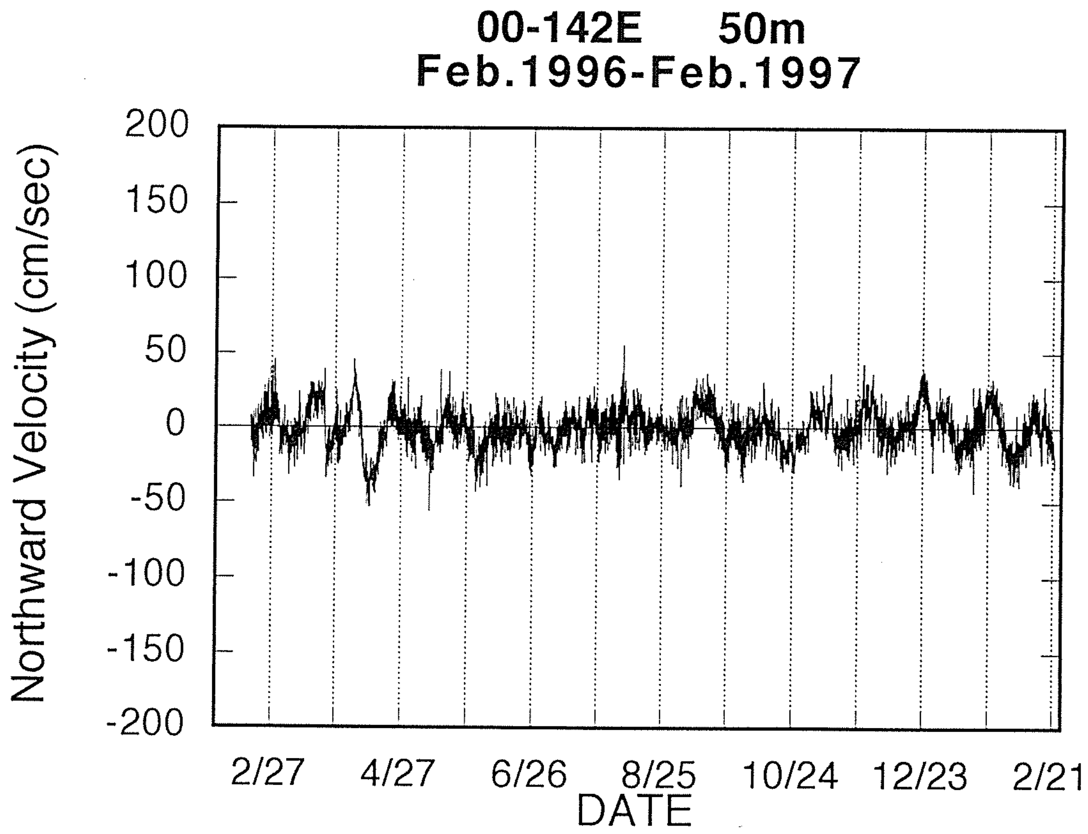


Fig. 7-5 Time Series of Depth, Temperature, Salinity



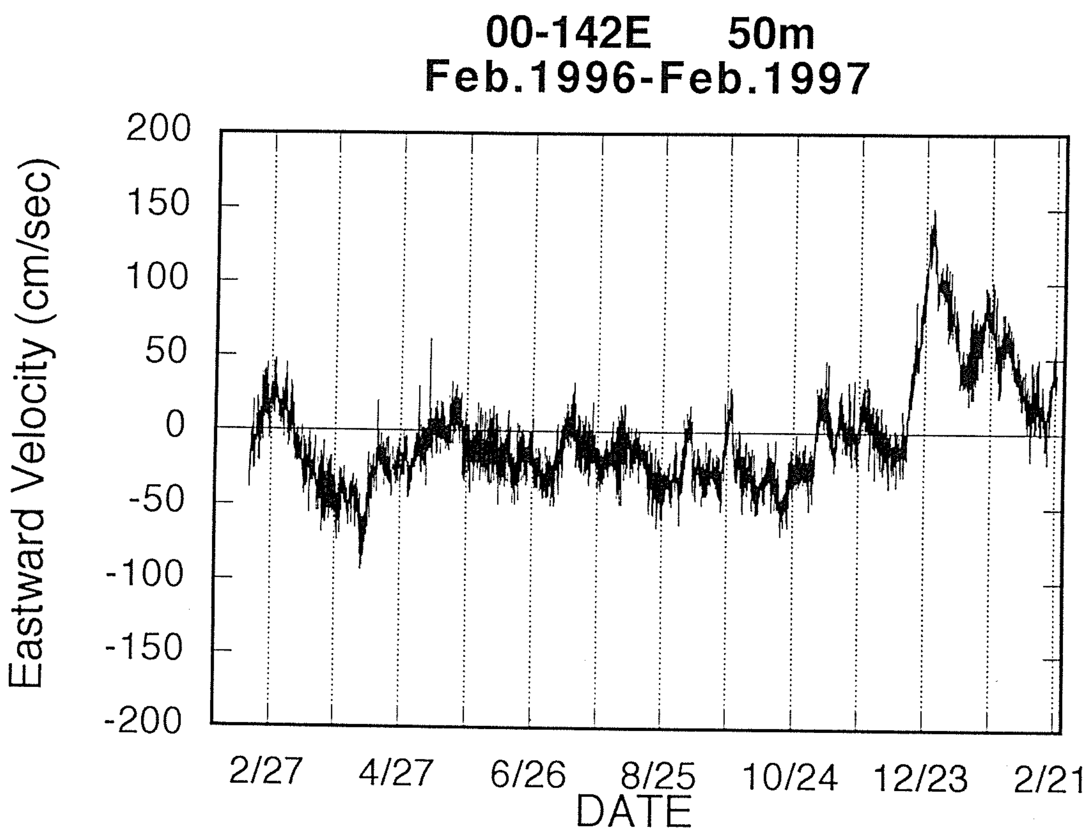
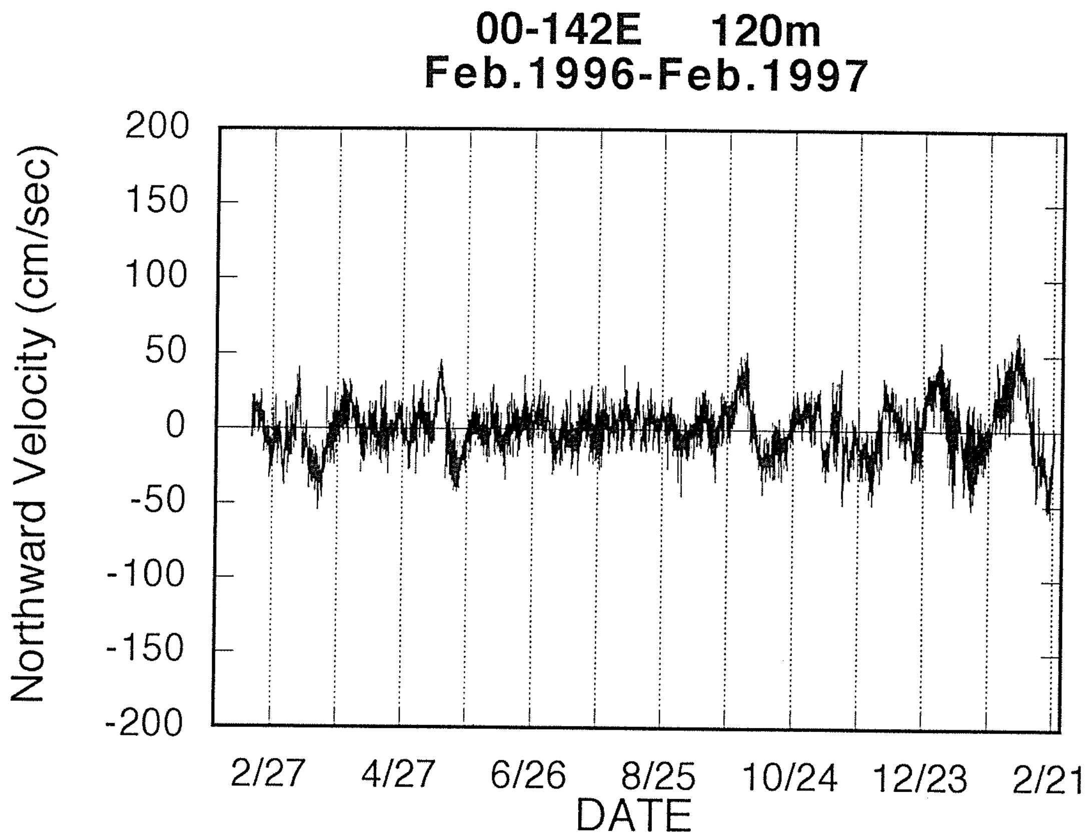


Fig. 7-6 Time Series of Velocity



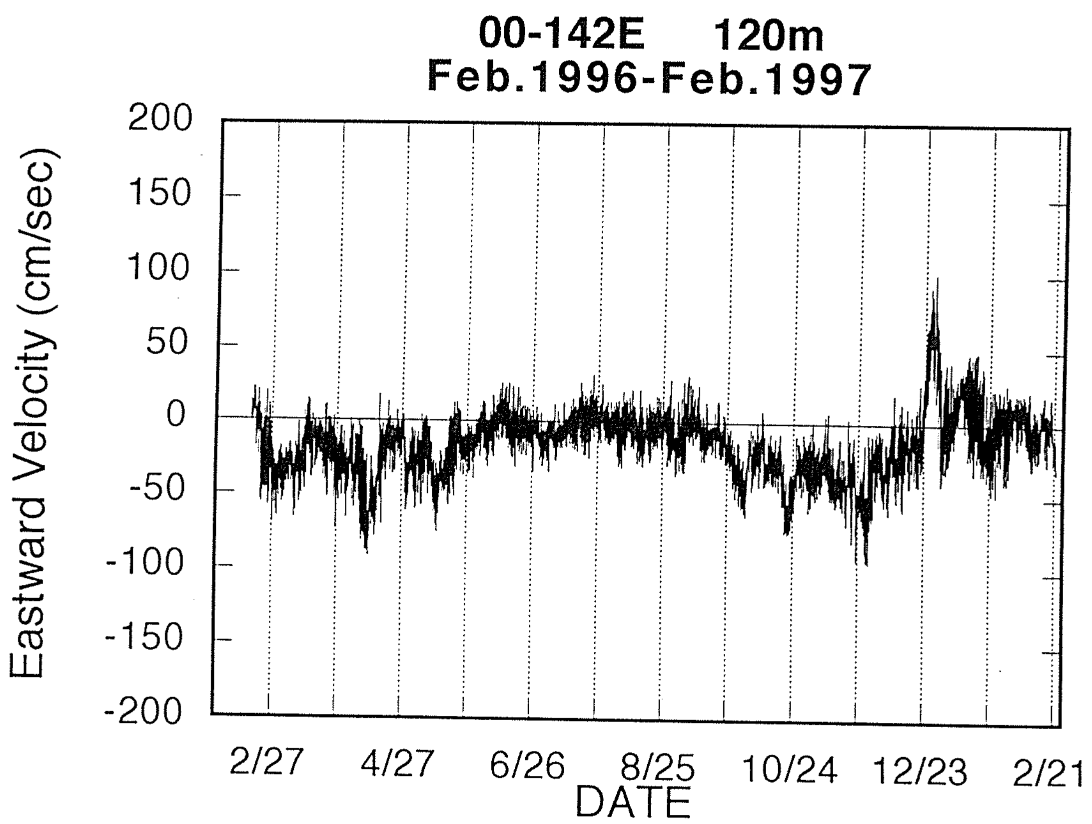
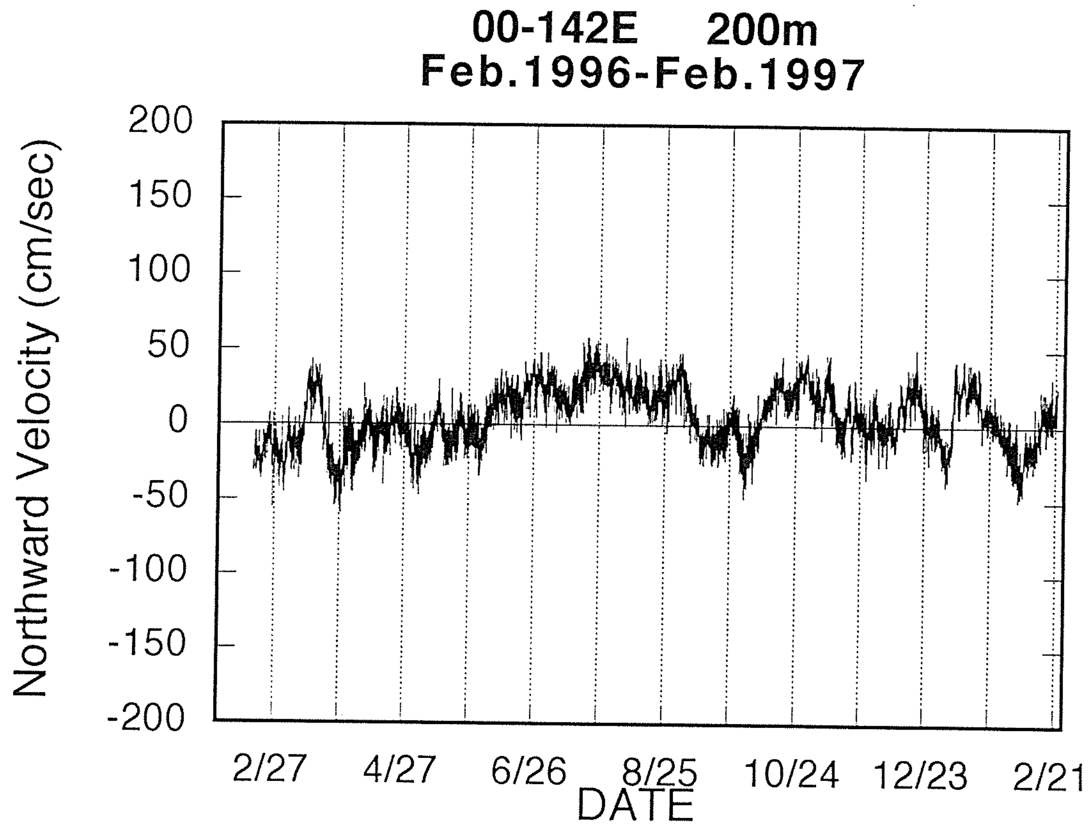


Fig. 7-7 Time Series of Velocity



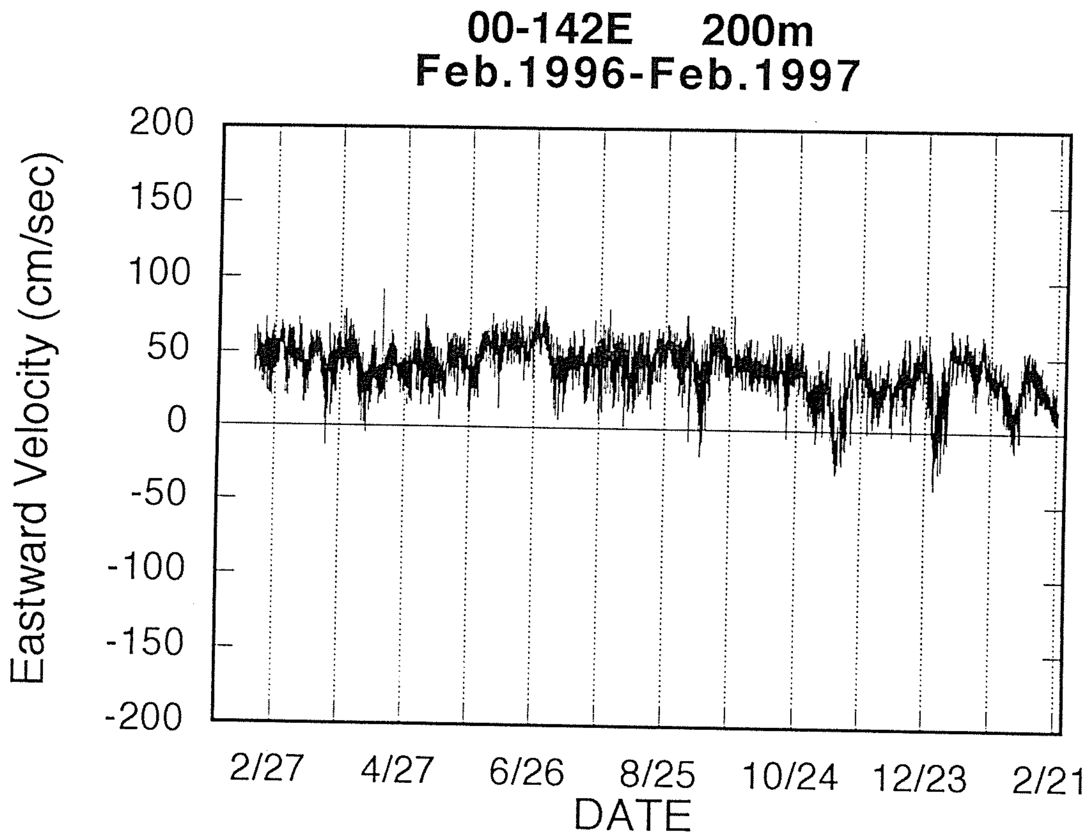
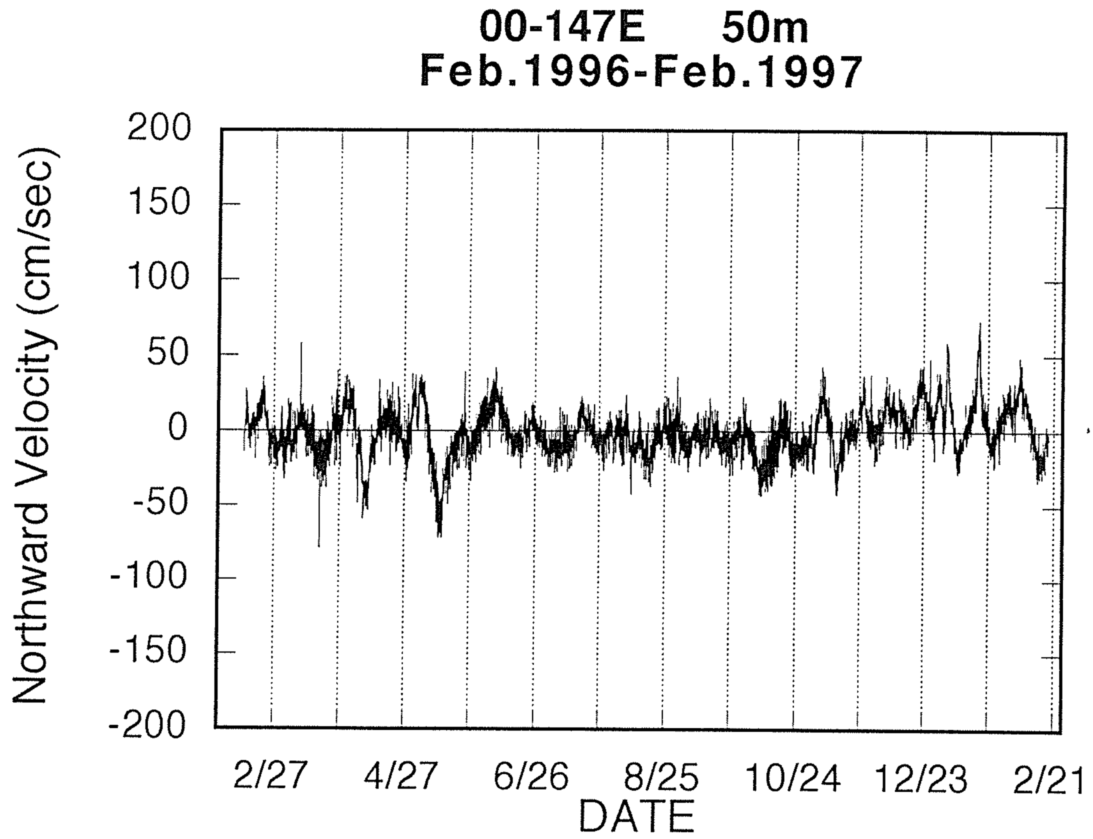


Fig. 7-8 Time Series of Velocity



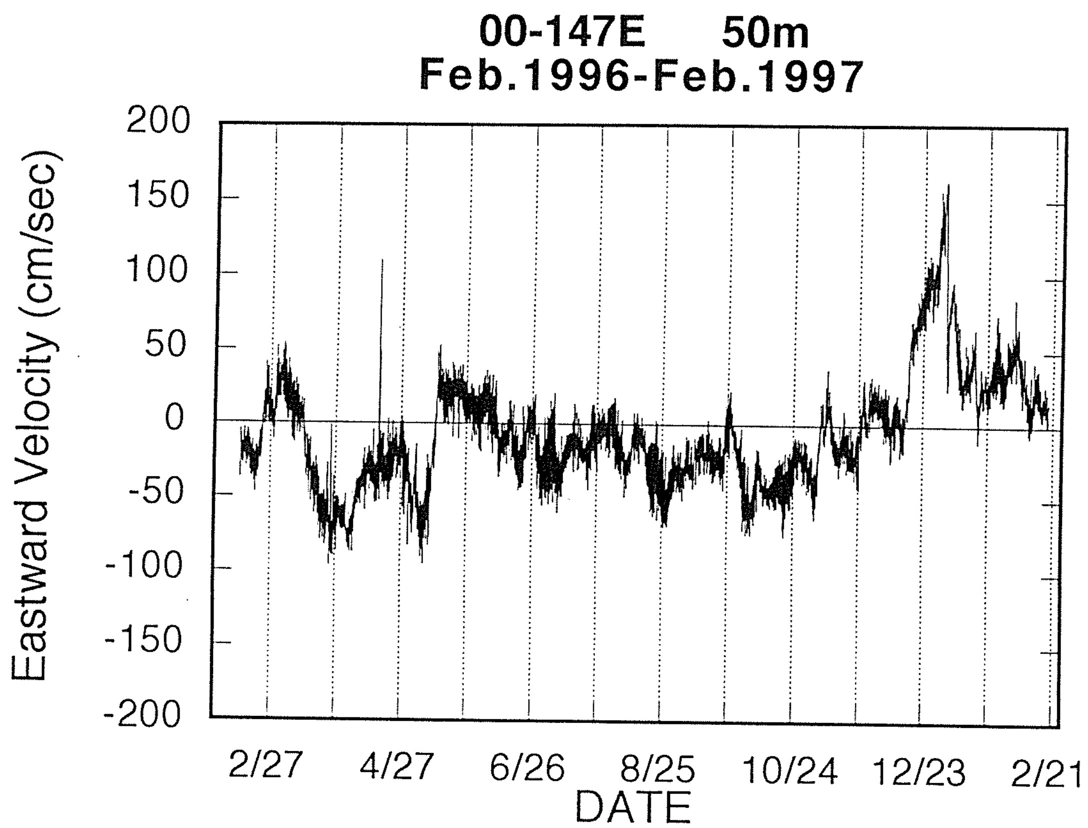
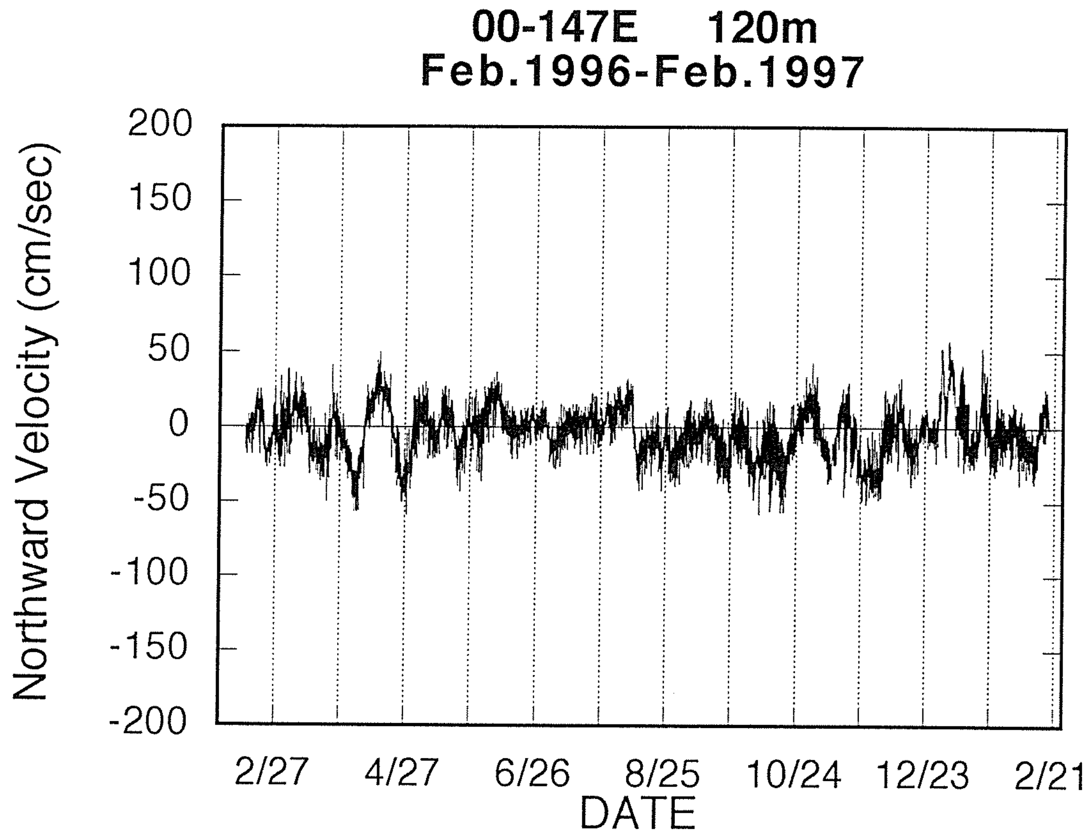


Fig. 7-9 Time Series of Velocity



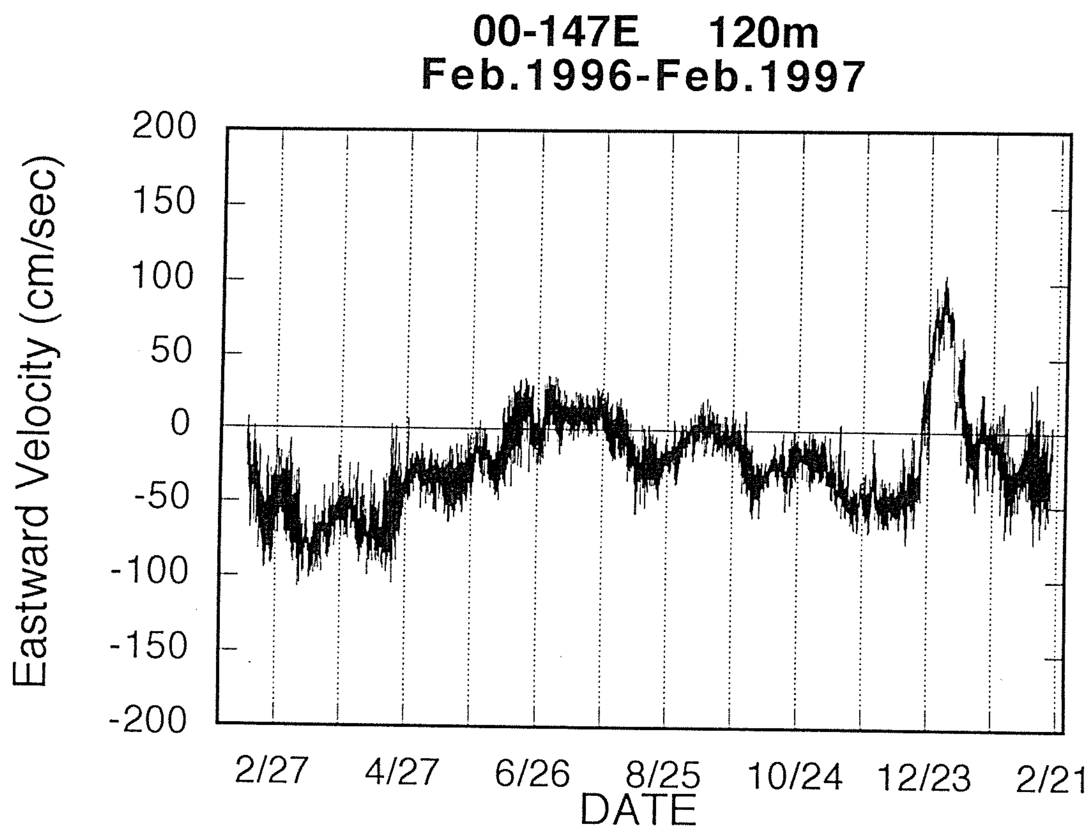
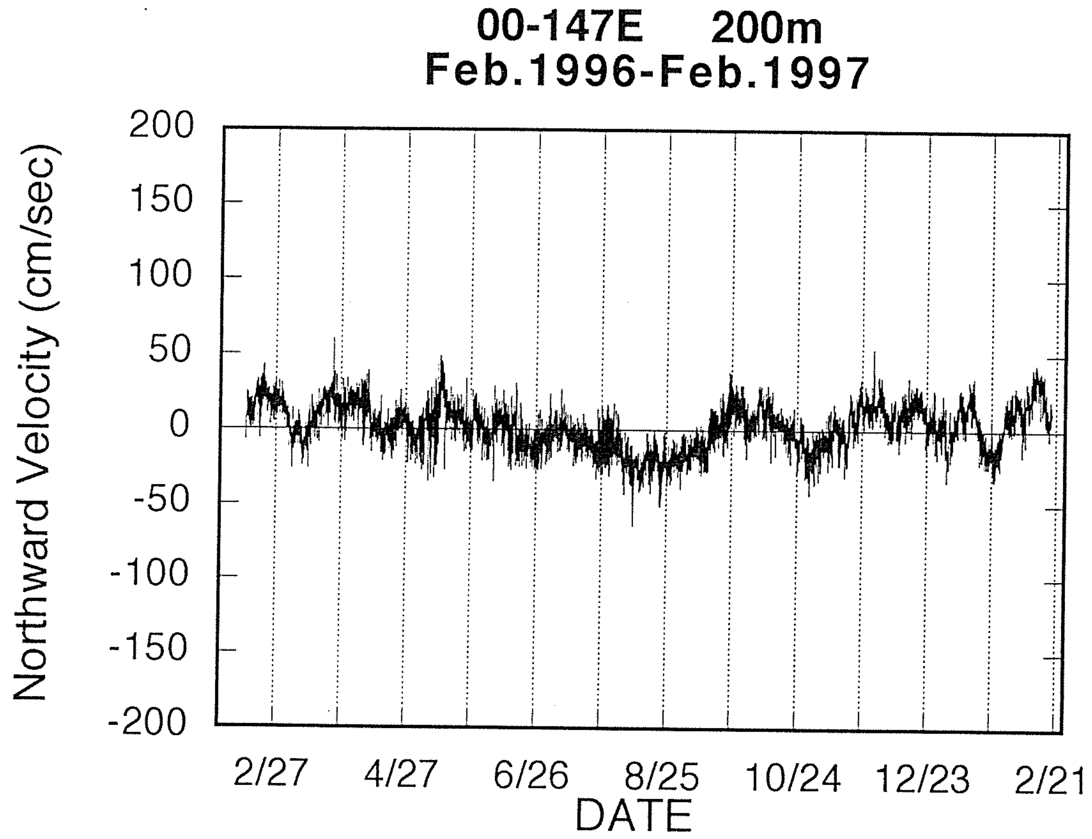


Fig. 7-10 Time Series of Velocity



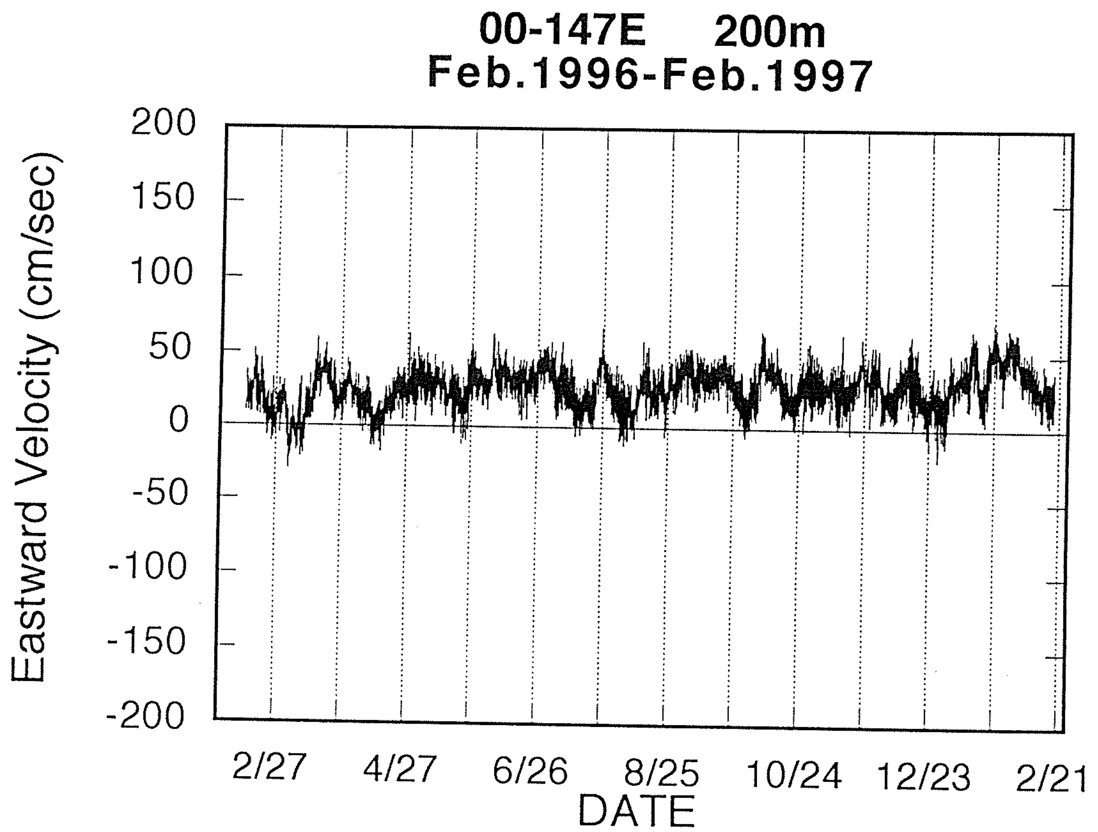


Fig. 7-11 Time Series of Velocity

MooringNo.970131-00N165E
ADCP S/N 1224
97021224.CMD

WP 00016
WD 111110000
WN 040
WS 0800
WF 0800
WM 4
TP 00:02.00
WV 480
BP 000
TE 01:00:00.00
EZ 1111111
ET 1000
ES 35
ED 3000
EX 11111
EC 1500
CF 11101
WW 12
TF 970131000000

MooringNo.970219-00N147E
ADCP S/N 1155
97021155.CMD

WP 00016
WD 111110000
WN 040
WS 0800
WF 0800
WM 4
TP 00:02.00
WV 480
BP 000
TE 01:00:00.00
EZ 1111111
ET 1000
ES 35
ED 3000
EX 11111
EC 1500
CF 11101
WW 12
TF 970216000000

MooringNo.970222-00N142E
ADCP S/N 1154
97021154.CMD

WP 00016
WD 111110000
WN 040
WS 0800
WF 0800
WM 4
TP 00:02.00
WV 480
BP 000
TE 01:00:00.00
EZ 1111111
ET 1000
ES 35
ED 3000
EX 11111
EC 1500
CF 11101
WW 12
TF 970220000000

DEPLOYMENT & RECOVERY

MOORING No. 97~~02~~0131-00N165E

PROJECT	TOCS	TIME	UTC
AREA	熱帯赤道	RECORDER (D)	T. Katayama
POSITION	00° - 165° E	(R)	
DEPTH	4380 m		
PERIOD	1997. 1. 31 ~	NAVIGATION SYSTEM :	WGS 84
No.of DAYS			

LENGTH : 4101 m DEPTH of BUOY : 279 m BUOYANCY : 1800 kg

ACOUSTIC RELEASER

TYPE	BENTHOS (上)	TYPE	BENTHOS (下)
S/N	663	S/N	694
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	13.5 kHz	TRANSMIT F.	14.5 kHz
ENABLE C.	C	ENABLE C.	G
RELEASE C.	B	RELEASE C.	F
BATTERY	2 years	BATTERY	2 years
TEST on DECK	O.K.	TEST on DECK	O.K.

DEPLOYMENT

DATE 1/31 02:34 ~ 03:48 SHIP KAIYO CRUSE No. K97-02

WEATHER ○ CONDITIONS 波高 1.7m DIR. of WIND 170° VEL. of WIND 2.0 m/s

DEPTH 4380 m DEPTH of A.R. 4273 m DESCEND. RATE 2.7 m/s BUOY 02 : 34

POS. of STRT 00° 00.015 N, 165° 14.204 E HOR.RANGE m

POS. of DEP. 00° 00.003 N, 165° 17.716 E SINKER 03 : 48 DISAPPEAR. :

POS. of MOORING 00° 00.01 N, 165° 17.836 E LANDING 04 : 13

NOTE

- ガラスブイは、ガラス玉・チェーン・シャックル共新しい物を使用、チェーンはピンクでスプレー。
- ナイロン長 150m.

SSBL	TIME	S / R	DEPTH
	03:48		29.4 m
	03:53		74.5
	03:58		1721
	04:03		2565
	04:07		3212
	04:13		4135

RECOVERY

DATE SHIP CRUSE No.

WEATHER CONDITIONS DIR. of WIND VEL. of WIND

START of RELEASE : FINISH of RELEASE :

POS. of DISCOVERY ° ° ASCENDING RATE m/s

DIRECTION ° DISTANCE m

NOTE

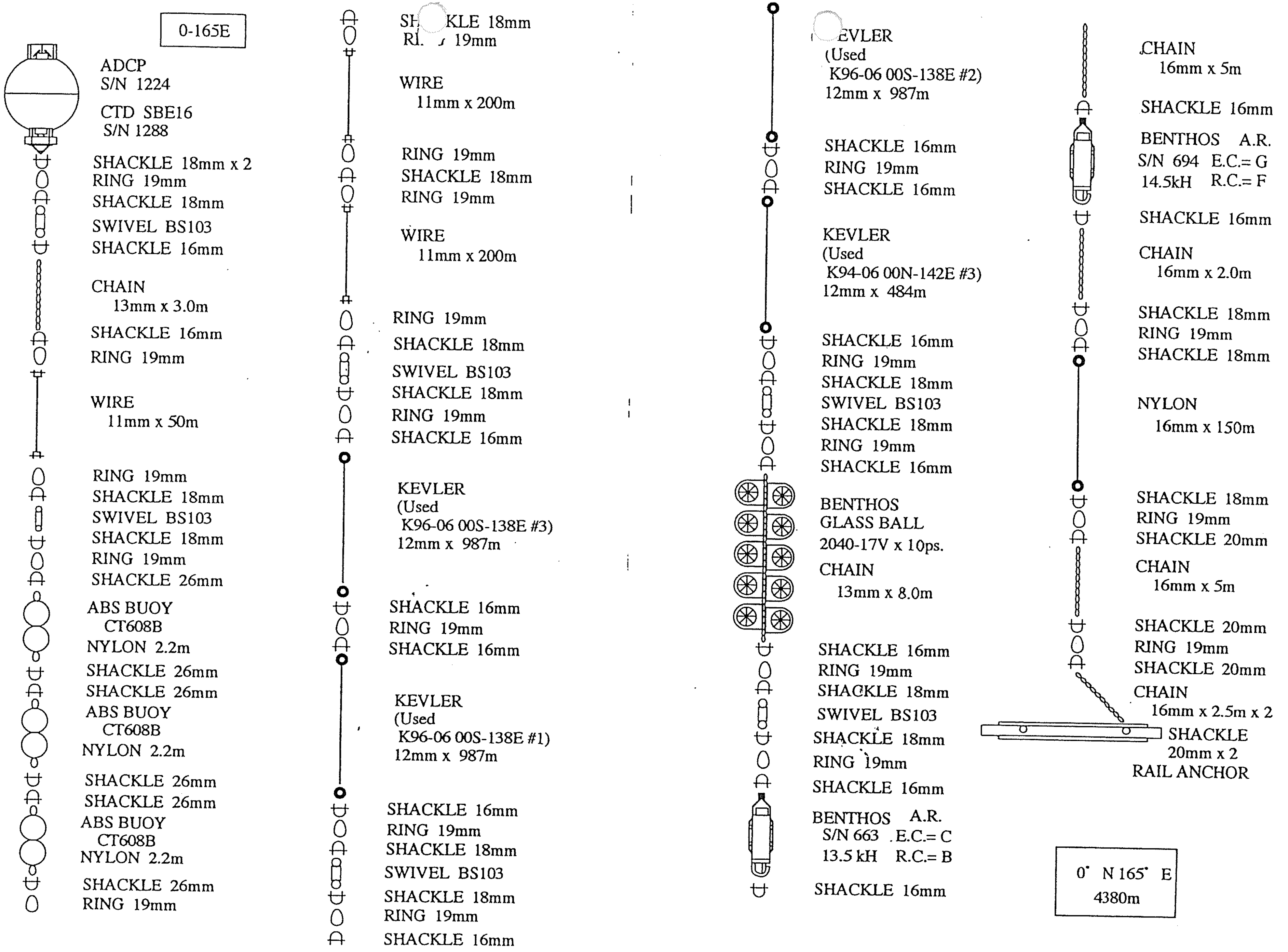
SSBL	TIME	S / R	DEPTH

TIME RECORD

MOORING NO. 970131-00N165E

		DEPLOYMENT		RECOVERY (Date)	
		Start: 02:32 Finish: 03:48		Start: Finish:	
ITEM	S/N etc	TIME	MEMO	TIME	MEMO
ADCP	1224	02:34	With CTD 1288		
WIRE	50m	02:35			
ABS BUOY	×2	02:38			
〃	×2	02:38			
〃	×2	02:38			
WIRE	200m	02:40~02:44			
〃	200m	02:45~02:49			
KEVLER	987m	02:51~02:57	(赤) K9606回収 0-138Ⓑ		
〃	987m	02:58~03:05	(赤) K9606回収 0-138Ⓒ		
〃	987m	03:07~03:14	(赤) K9606回収 0-138Ⓐ		
〃	484m	03:30~03:35	(赤) K9606回収 0-142Ⓒ		
GLASS BALL	×10	03:37	New. [illegible]		
A.R.	663	03:37			
A.R.	694	03:38			
NYLON	150m	03:38~03:44			
SYNKER	×1	03:48	1.8 ton		

ガラス玉は新規のものを使用.


0-165E
ADCP
S/N 1224
CTD SBE16
S/N 1288
SHACKLE 18mm x 2
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 16mm
CHAIN
13mm x 3.0m
SHACKLE 16mm
RING 19mm
WIRE
11mm x 50m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 00S-138E #3)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 00S-138E #1)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 00S-138E #2)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K94-06 00N-142E #3)
12mm x 484m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS
GLASS BALL
2040-17V x 10ps.
CHAIN
13mm x 8.0m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS A.R.
S/N 663 E.C.= C
13.5 kH R.C.= B
SHACKLE 16mm
CHAIN
16mm x 5m
SHACKLE 16mm
BENTHOS A.R.
S/N 694 E.C.= G
14.5kH R.C.= F
SHACKLE 16mm
CHAIN
16mm x 2.0m
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
NYLON
16mm x 150m
SHACKLE 18mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 5m
SHACKLE 20mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 2.5m x 2
SHACKLE
20mm x 2
RAIL ANCHOR
0° N 165° E
4380m

DEPLOYMENT & RECOVERY

MOORING No. 970219-00147E

PROJECT	TOCS	TIME	UTC
AREA	熱帯赤道	RECORDER (D)	Katayama
POSITION	0°S 147°E	(R)	
DEPTH	4345m		
PERIOD	19. Feb. 1997 ~	NAVIGATION SYSTEM :	WGS 84
No.of DAYS			

LENGTH : 4115 m DEPTH of BUOY : 290 m BUOYANCY : 1,800 kg

ACOUSTIC RELEASER

TYPE	BENTHOS (upper)	TYPE	BENTHOS (bottom)
S/N	634	S/N	690
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	14.5 kHz	TRANSMIT F.	13.5 kHz
ENABLE C.	F	ENABLE C.	C
RELEASE C.	E	RELEASE C.	B
BATTERY	2 years	BATTERY	2 years
TEST on DECK	O.K.	TEST on DECK	O.K.

DEPLOYMENT

DATE 1997.2.18 SHIP KAIYO CRUSE No. K9702

WEATHER C CONDITIONS うねり NE 1.8m DIR. of WIND 030° VEL. of WIND 4.5 m/s

DEPTH ~~3350~~ 4342 m DEPTH of A.R. m DESCEND. RATE 2.7 m/s BUOY 23 : 50

POS. of STRT 0° 00.662S 146° 56.130E HOR.RANGE m

POS. of DEP. 0° 00.344S 146° 52.422E SINKER 01 : 25 DISAPPEAR. :

POS. of MOORING 0° 00.325S 146° 52.423E LANDING :

NOTE 投入したガラスブイは、
ガラス玉、チェーン、シャックル共に新しい物を使用.
ガラス玉は10コ→12コへ変更.
ナイロン長 117m → 150m.

SSBL	TIME	S/R	DEPTH
	01:26		41.5 m
	01:31		861.3
	01:36		1744.2
	01:41		2639.9
	01:46		3393.2
	01:51		4119.1

RECOVERY

DATE SHIP CRUSE No.

WEATHER CONDITIONS DIR. of WIND VEL. of WIND

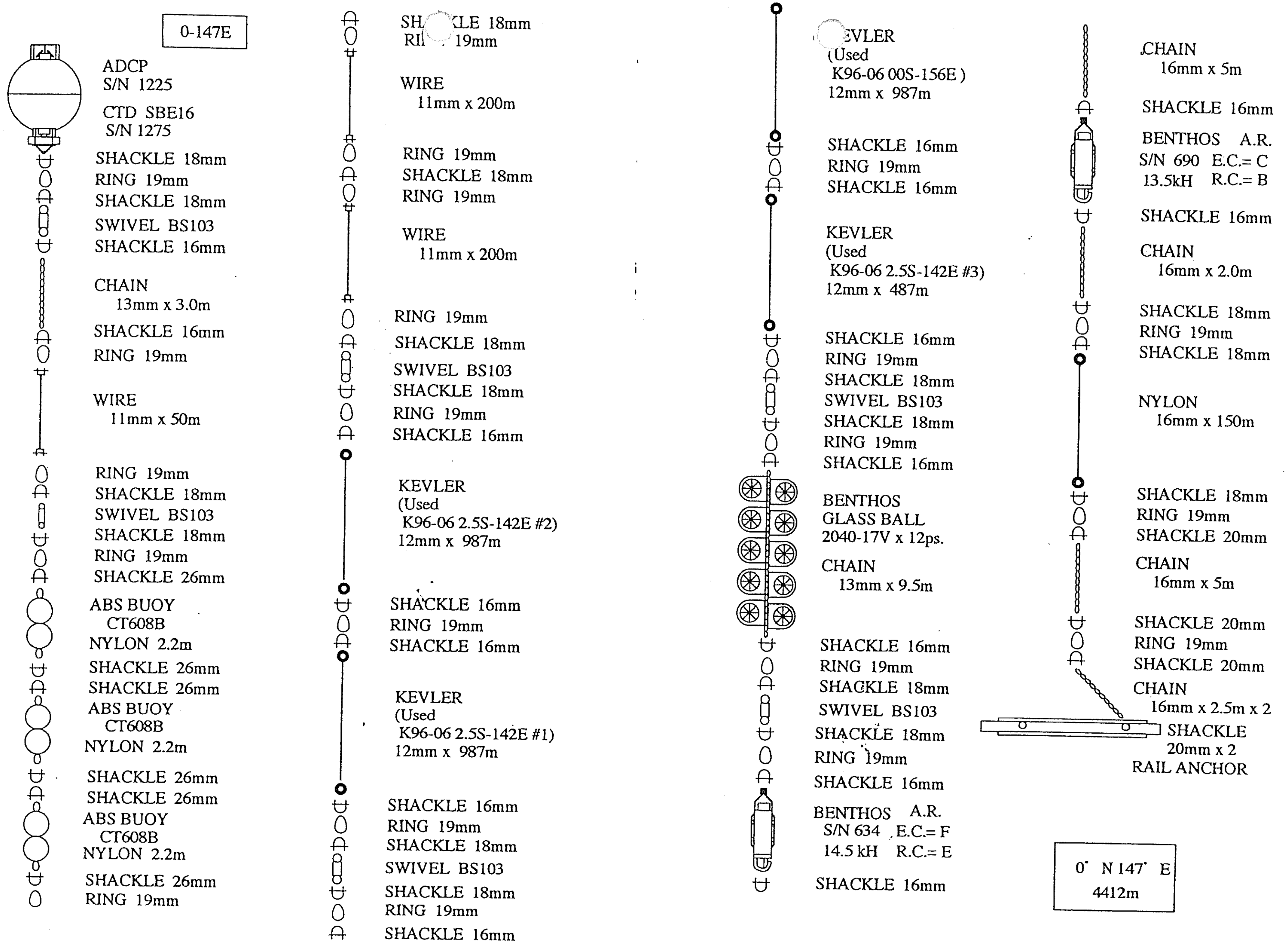
START of RELEASE : FINISH of RELEASE :

POS. of DISCOVERY ° ° ASCENDING RATE m/s

DIRECTION ° DISTANCE m

NOTE

SSBL	TIME	S/R	DEPTH


0-147E
ADCP
S/N 1225
CTD SBE16
S/N 1275
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 16mm
CHAIN
13mm x 3.0m
SHACKLE 16mm
RING 19mm
WIRE
11mm x 50m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
RING 19mm
SH LE 18mm
RI 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 2.5S-142E #2)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 2.5S-142E #1)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
EVLER
(Used
K96-06 00S-156E)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 2.5S-142E #3)
12mm x 487m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS
GLASS BALL
2040-17V x 12ps.
CHAIN
13mm x 9.5m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS A.R.
S/N 634 E.C.= F
14.5 kH R.C.= E
SHACKLE 16mm
CHAIN
16mm x 5m
SHACKLE 16mm
BENTHOS A.R.
S/N 690 E.C.= C
13.5kH R.C.= B
SHACKLE 16mm
CHAIN
16mm x 2.0m
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
NYLON
16mm x 150m
SHACKLE 18mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 5m
SHACKLE 20mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 2.5m x 2
SHACKLE
20mm x 2
RAIL ANCHOR
0° N 147° E
4412m

TIME RECORD

MOORING NO. 9702-00147E

		DEPLOYMENT		RECOVERY (Date)	
		Start: 23:50 Finish: 01:25		Start: Finish:	
ITEM	S/N etc	TIME	MEMO	TIME	MEMO
ADCP	1155	23:50	With CTD 1275		
WIRE	50m	23:50~23:51			
ABS BUOY	×2	23:53			
〃	〃	23:53			
〃	〃	23:53			
WIRE	200m	23:56~00:00			
〃	〃	00:03~00:05			
KEVLER	987m	00:09~00:18	K9606 2.5S-142E 回収 #2		
〃	〃	00:19~00:25	K9606 2.5S-142E 回収 #1		
〃	〃	00:26~00:34	K9606 0-156E 回収		
〃	487m	00:36~00:39	K9606 2S-142E 回収 #3		
GLASS BALL	×12	00:45~00:47	NEW		
A.R.	634	00:47			
〃	690	00:47			
NYLON	150m	01:17~01:25	約20分(1マイル)航走.		
SYNKER		01:25	1.8Ton		

・ガラス玉は新しいのを使用.
ピンクのスプレーでカラーリング.

・ナイロンロープ 117m → 150m

DEPLOYMENT & RECOVERY

MOORING No. 960212 - 00N147E

PROJECT	TOCS	TIME	UTC
AREA	熱帯赤道	RECORDER (D)	M. FUJISAKI
POSITION	00°N 147°E	(R)	T. Katayama
DEPTH			

PERIOD 1996.02.12 ～ 1997.02.18 NAVIGATION SYSTEM : WGS84

No.of DAYS

LENGTH : 4189.5 m DEPTH of BUOY : 294.6 m BUOYANCY : kg

ACOUSTIC RELEASER

TYPE (上)	865A-DB-13	TYPE (F)	865A-DB-13
S/N	632	S/N	693
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	14.0 kHz	TRANSMIT F.	14.5 kHz
ENABLE C.	D	ENABLE C.	F
RELEASE C.	C	RELEASE C.	E
BATTERY	2 YEARS	BATTERY	2 YEARS
TEST on DECK	OK	TEST on DECK	OK

DEPLOYMENT

DATE 1996.02.12 21:51～23:23 SHIP KAIYO CRUSE No. K96-01

WEATHER C CONDITIONS 3 DIR. of WIND NNE VEL. of WIND 4m

DEPTH 4345 m DEPTH of A.R. m DESCEND. RATE m/s BUOY :

POS. of STRT 00° 01.273S 146° 50.749E HOR.RANGE m

POS. of DEP. 00° 00.412N 146° 53.029E SINKER 23 : 23 DISAPPEAR. :

POS. of MOORING 00° 00.571 N 146° 52.860E LANDING 23 : 49

NOTE

SN693のA.R.の反応よりもSN632の方が良かったため追跡はSN632で行った。

ATLAS設置ポイント(00° 00.02N, 146° 59.861E)より約7マイル西に設置。

SSBL	TIME	S/R	DEPTH

RECOVERY

DATE 1997.02.18 21:40～~~22~~ 23:04 SHIP KAIYO CRUSE No. K9702

WEATHER 0 CONDITIONS 0 DIR. of WIND N VEL. of WIND 5 m/s

START of RELEASE 20 : 30 FINISH of RELEASE 20 : 30

POS. of DISCOVERY 00° 00.140S 146° 52.513E ASCENDING RATE 1.2 m/s

DIRECTION 021° DISTANCE 0.52マイル m

NOTE

SSBL	TIME	S/R	DEPTH
	20:40		2904.0
	20:51		1962.5
	21:01		1106.5
	21:11		390.2
	21:18		167.2

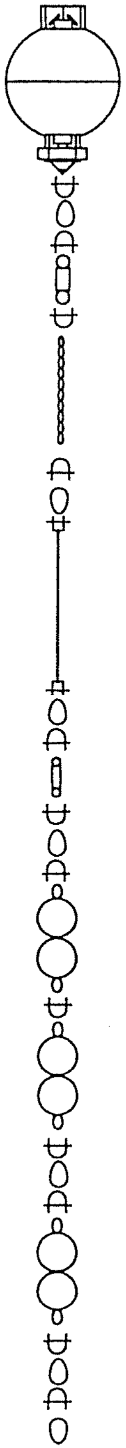
TIME RECORD

MOORING NO. 96 1212-00N147E

		DEPLOYMENT		RECOVERY (Date: 1997.02.18)	
		START : 21:51 FINISH : 23:23		START : 21:40 FINISH : 0904	
ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ADCP	1222	21:53		21:40	
CTD	1281	21:53	ADCPブイで取り付け	21:40	
WIRE ROPE	50m	21:54~21:55		21:41~21:42	
ABS BUOY	2連	21:56		21:49	
〃	2連	21:56		21:49	
〃	2連	21:56		21:49	
WIRE ROPE	200m	[illegible]~21:59		21:50~21:58	
〃	200m	22:03~22:06		21:59~~~20~~ 22:12	
KEVLER ROPE	1010m	22:10~22:25		22:13~22:18	
〃	1010m	22:27~22:42		22:20~22:35	
〃	1010m	22:44~22:57		22:37~22:51	
〃	500m	22:59~23:07		22:53~23:01	
Benthos Glass Ball	10	23:11		23:03	
A.R.	632	23:11		23:04	
〃	639	23:12		23:04	
NYLON ROPE	40m	23:16~23:17			
ANCHOR		23:23			

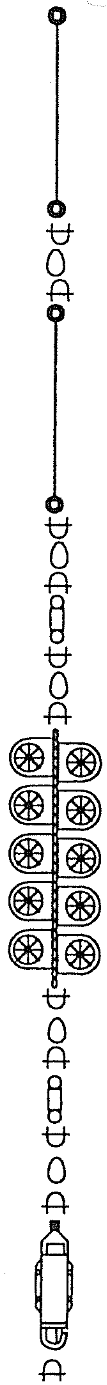
NYLON
基本設定 160m → 40mで設置

0 - 147E

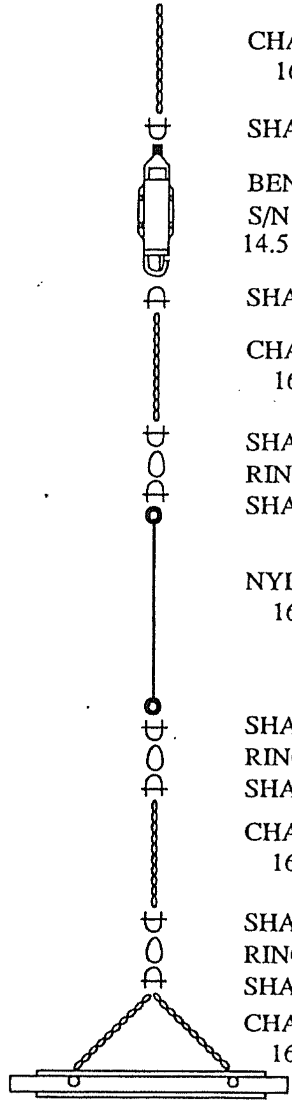


ADCP
S/N 1222 白
CTD SBE16
S/N 1281 青
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 16mm
CHAIN
13mm x 3.0m
SHACKLE 16mm
RING 19mm
WIRE
11mm x 50m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON
SHACKLE 26mm
ABS BUOY
CT608B
NYLON
SHACKLE 26mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON
SHACKLE 26mm
RING 19mm
SHACKLE 18mm
RING 19mm

WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 1010m
灰
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 1010m
黄緑
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm



KEVLER
12mm x 1010m
茶
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 505m
赤
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS
GLASS BALL
2040-17V x 10ps.
CHAIN
13mm x 8m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS A.R. 水
S/N 632 E.C.=D
14.0 kH R.C.=C
SHACKLE 16mm



CHAIN
16mm x 5m
SHACKLE 16mm
BENTHOS A.R. 灰
S/N 693 E.C.=F
14.5 kH R.C.=E
SHACKLE 16mm
CHAIN
16mm x 2.0m
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
NYLON
16mm x 40m
SHACKLE 18mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 5m
SHACKLE 20mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 2.5m x 2
RAIL ANCHOR

0° 147° E
4345m

DEPLOYMENT & RECOVERY

MOORING No. 970222 - 00N142 E

PROJECT	TOCS	TIME	UTC
AREA	熱帯赤道	RECORDER (D)	T. Katayama
POSITION	00° - 142° E	(R)	
DEPTH	3380 m		
PERIOD	1997. 2. 22 ~	NAVIGATION SYSTEM :	WGS 84
No.of DAYS			

LENGTH : 3100 m DEPTH of BUOY : 280 m BUOYANCY : 1800 kg

ACOUSTIC RELEASER

TYPE	BENTHOS (上)	TYPE	BENTHOS (下)
S/N	662	S/N	692
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	13.5 kHz	TRANSMIT F.	14.0 kHz
ENABLE C.	B	ENABLE C.	E
RELEASE C.	A	RELEASE C.	D
BATTERY	2 years	BATTERY	2 years
TEST on DECK	O.K.	TEST on DECK	O.K.

DEPLOYMENT

DATE 2/21 23:18 ~ 2/22 00:14 SHIP KAIYO CRUSE No. K97-02

WEATHER ○ CONDITIONS 波高 1.5m DIR. of WIND NNE VEL. of WIND 4.5 m/s

DEPTH 3384 m DEPTH of A.R. m DESCEND. RATE 2.5 m/s BUOY 23 : 19

POS. of STRT 00° 00.103N, 141° 59.840 E HOR.RANGE m

POS. of DEP. 00° 00.379N, 141° 59.025 E SINKER 00 : 14 DISAPPEAR. :

POS. of MOORING 00° 00.216N, 141° 58.128 E LANDING :

NOTE

- シンタティックフロートブイは 0-147E で回収した物を使用.
- ガラスブイは 0-147E で回収した物を, チェーン (ピンクでスプレー) シャックルを交換して使用. チェーンは 1.5m 追加して, ガラス玉は 10個から 12個へ増やした.
- A.R. 692 の ENABLE TIME を 16時間から 2時間へ変更.
- ナイロン長 140m

SSBL	TIME	S / R	DEPTH
	00:15		28.4 m
	00:20		847.5
	00:25		1711.4
	00:30		2448.4
	00:35		3061.0
	00:40		3082.3

RECOVERY

DATE SHIP CRUSE No.

WEATHER CONDITIONS DIR. of WIND VEL. of WIND

START of RELEASE : FINISH of RELEASE :

POS. of DISCOVERY ° ° ASCENDING RATE m/s

DIRECTION ° DISTANCE m

NOTE

SSBL	TIME	S / R	DEPTH

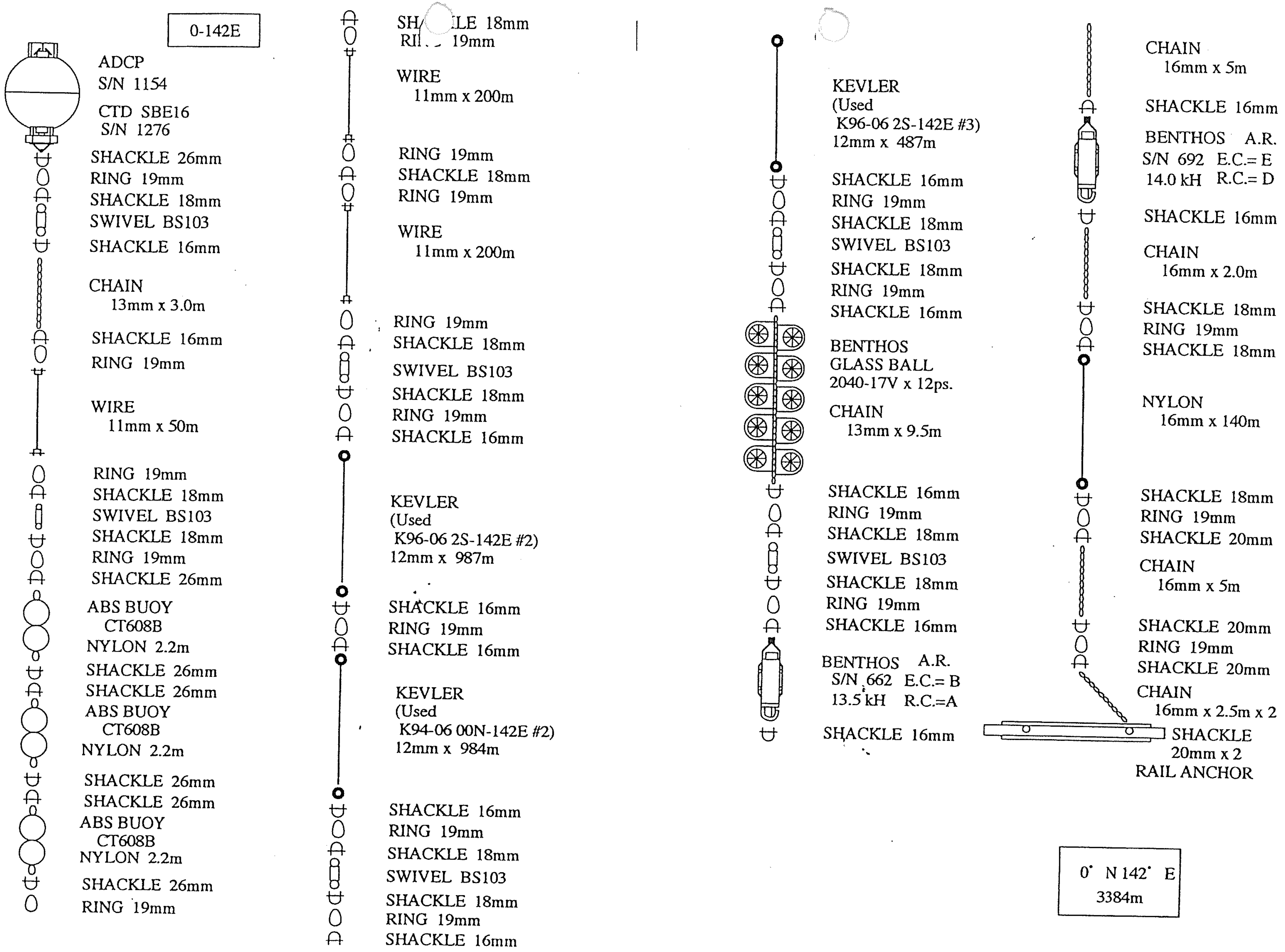
TIME RECORD

MOORING NO. 970222-00N147E

		DEPLOYMENT Start : 23:18 (2/21) Finish: 00:14 (2/22)		RECOVERY (Date) Start : Finish:	
ITEM	S/N etc	TIME	MEMO	TIME	MEMO
ADCP	1154	23:18	With CTD S/N 1295		
WIRE	50m	23:15~23:19	ワイヤーから投入開始		
ABS BUOY	×2	23:22			
〃	〃	23:22			
〃	〃	23:22			
WIRE	200m	23:27~23:28			
〃	200m	23:30~23:37			
KEVLER	987m	23:38~23:45	K9607 2S-142E #2 回収		
〃	988m	23:47~23:53			
〃	427m	23:55~00:00	K9607 2S-142E #3 回収		
GLASS BALL	×12	00:05	チェーンを ロング New		
A.R.	662	00:06			
〃	692	00:07			
NYRON	140m	00:07~00:11			
SINKER	1.8ton	00:14			

・ガラスブイはO-147Eで回収したものを、チェーン シャックルを交換して使用。ガラス玉 10コ→12コへ

・A.R. 692のENABLETIMEを16hr→2hrへ


0-142E
ADCP
S/N 1154
CTD SBE16
S/N 1276
SHACKLE 26mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 16mm
CHAIN
13mm x 3.0m
SHACKLE 16mm
RING 19mm
WIRE
11mm x 50m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 2.2m
SHACKLE 26mm
RING 19mm
SH LE 18mm
RI 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 2S-142E #2)
12mm x 987m
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K94-06 00N-142E #2)
12mm x 984m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
(Used
K96-06 2S-142E #3)
12mm x 487m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS
GLASS BALL
2040-17V x 12ps.
CHAIN
13mm x 9.5m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS A.R.
S/N 662 E.C.= B
13.5 kH R.C.=A
SHACKLE 16mm
CHAIN
16mm x 5m
SHACKLE 16mm
BENTHOS A.R.
S/N 692 E.C.= E
14.0 kH R.C.= D
SHACKLE 16mm
CHAIN
16mm x 2.0m
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
NYLON
16mm x 140m
SHACKLE 18mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 5m
SHACKLE 20mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 2.5m x 2
SHACKLE
20mm x 2
RAIL ANCHOR
0° N 142° E
3384m

DEPLOYMENT & RECOVERY

MOORING No. 960217 - 00N 142E

PROJECT	TOCS	TIME	UTC
AREA	Western Pacific	RECORDER (D)	M. FUJISAKI
POSITION	00°N 142°E	(R)	T. Katayama
DEPTH	3394m		
PERIOD	1996.02.17 ~ 1997.02.17	NAVIGATION SYSTEM :	WGS 84
No.of DAYS			

LENGTH : 3101 m DEPTH of BUOY : 293 m BUOYANCY : 1800 kg

ACOUSTIC RELEASER

TYPE (上)	865A - DB-13	TYPE (下)	865A - DB-13
S/N	630	S/N	691
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	13.5 kHz	TRANSMIT F.	14.0 kHz
ENABLE C.	B	ENABLE C.	D
RELEASE C.	A	RELEASE C.	C
BATTERY	2 YEAR	BATTERY	2 YEAR
TEST on DECK	OK	TEST on DECK	OK

DEPLOYMENT

DATE 1996.02.17 01:02 ~ 02:04 SHIP KAIYO CRUSE No. K96-01

WEATHER C CONDITIONS 3 DIR. of WIND 270° VEL. of WIND 6.0m/sec

DEPTH 3380 m DEPTH of A.R. 3215 m DESCEND. RATE m/s BUOY 01 : 02

POS. of STRT 00°00.033S 142°02.782E HOR.RANGE m

POS. of DEP. 00°00.032S 142°00.309E SINKER 02:04 DISAPPEAR. :

POS. of MOORING 00°00.073S 142°00.240E LANDING 02:24

NOTE
- ガラス玉は同ポイントで回収したものを使用
  チェーンは交換せず。インシュロック交換。
- ナイロンロープ
  170m → 158m

SSBL	TIME	S/R	DEPTH

RECOVERY

DATE 1997.02.17 21:30 ~ 22:37 SHIP KAIYO CRUSE No. K97-02

WEATHER b CONDITIONS 0 DIR. of WIND NNE VEL. of WIND 6 m/s

START of RELEASE 20 : 28 FINISH of RELEASE 20 : 28

POS. of DISCOVERY 00°00.625S, 142°00.00.653E ASCENDING RATE 1.6 m/s

DIRECTION 310° DISTANCE 760 m (0.41マイル)

NOTE
ENABLE : 20:28
RELEASE 20:28
SYNTATIC 浮上 20:31
ガラス玉 浮上 21:04

SSBL	TIME	S/R	DEPTH
	~~21~~ 20:31		2878.3
	20:36		2306.3
	20:41		1749.2
	20:46		1267.7
	20:51		~~818.8~~
	21:02		62.6

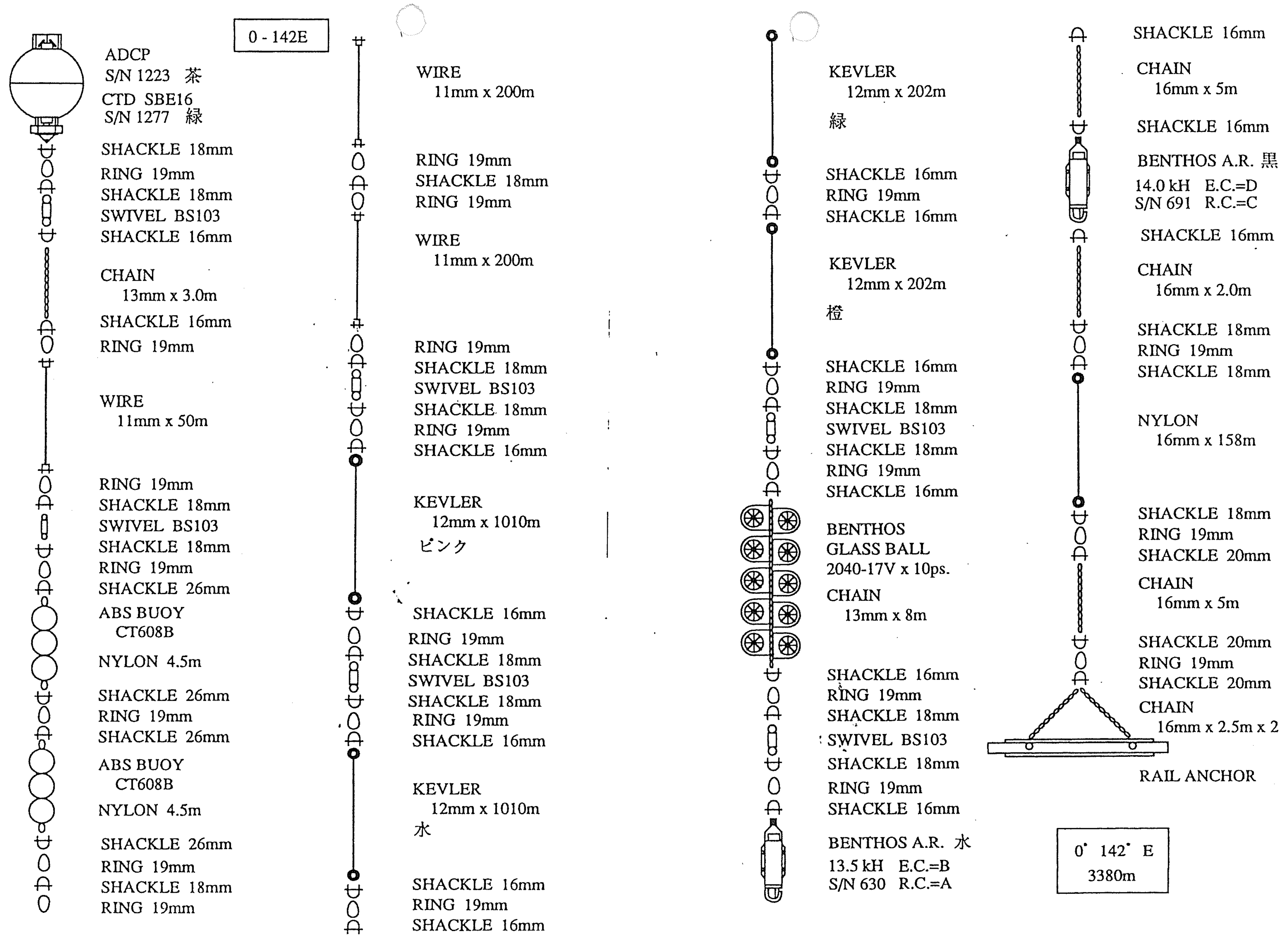
TIME RECORD

MOORING NO. 960219-CON1425

	DEPLOYMENT		RECOVERY (Date: 1997. 2. [illegible])	
	START : 01:02 FINISH : 02:04 UTC		START : 21:28 FINISH : 22:37	

ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ADCP	1223	01:02		21:30	
CTD	1277	01:02		21:30	
WIRE ROPE	50m	01:02~01:04		21:38	
ABS BUOY	3ps.	01:05		21:37	
〃	3ps.	01:05		21:37	
WIRE ROPE	200m	01:06~01:09		21:40~21:48	
〃	200m	01:11~01:17		21:49~21:58	
KEVLER ROPE	1010m	01:19~01:31		21:59~22:07	
〃	1010m	01:34~01:42		22:09~22:25	
〃	200m	01:44~01:48		22:28~22:31	[illegible]回収
〃	200m	01:49~01:53		22:32~22:35	
Glass Ball	10ps.	01:54		22:37	
A. R.	630	01:55		22:37	
〃	691	01:55		22:37	
NYLON ROPE	158m	01:56~01:58			
ANCHOR		02:04			

ナイロンロープ
170m → 158m



0 - 142E
ADCP
S/N 1223 茶
CTD SBE16
S/N 1277 緑
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 16mm
CHAIN
13mm x 3.0m
SHACKLE 16mm
RING 19mm
WIRE
11mm x 50m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 4.5m
SHACKLE 26mm
RING 19mm
SHACKLE 26mm
ABS BUOY
CT608B
NYLON 4.5m
SHACKLE 26mm
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
RING 19mm
WIRE
11mm x 200m
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 1010m
ピンク
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 1010m
水
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 202m
緑
SHACKLE 16mm
RING 19mm
SHACKLE 16mm
KEVLER
12mm x 202m
橙
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS
GLASS BALL
2040-17V x 10ps.
CHAIN
13mm x 8m
SHACKLE 16mm
RING 19mm
SHACKLE 18mm
SWIVEL BS103
SHACKLE 18mm
RING 19mm
SHACKLE 16mm
BENTHOS A.R. 水
13.5 kH E.C.=B
S/N 630 R.C.=A
SHACKLE 16mm
CHAIN
16mm x 5m
SHACKLE 16mm
BENTHOS A.R. 黒
14.0 kH E.C.=D
S/N 691 R.C.=C
SHACKLE 16mm
CHAIN
16mm x 2.0m
SHACKLE 18mm
RING 19mm
SHACKLE 18mm
NYLON
16mm x 158m
SHACKLE 18mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 5m
SHACKLE 20mm
RING 19mm
SHACKLE 20mm
CHAIN
16mm x 2.5m x 2
RAIL ANCHOR
0° 142° E
3380m

8. TROPICAL ARRAY of the OCEAN (TAO) MOORINGS

by

NOAA's Pacific Marine Environmental Laboratory (PMEL), Seattle, Washington, USA
PMEL Participants: Dave Zimmerman and Steve Smith

Introduction:

Tropical Ocean Climate Study (TOCS) Cruise # K-97-02, included the servicing of 14 TAO mooring sites of the Western Equatorial Pacific along the 165E, 156E, 147E, and 137E meridians. Work performed was done in a joint cooperation between NOAA's PMEL and JAMSTEC aboard the Research Vessel KAIYO, which departed Majuro, Republic of the Marshall Islands, on January 26, 1997, with a mid-cruise stop in Chuuk, Federated States of Micronesia on February 10th, and ending in Koror, Republic of Palau on February 28th.

The Tropical Array of the Ocean consists of 67 ATLAS and Current Meter mooring sites across the Equatorial Pacific from 137^{o} East to 95^{o} West longitude in the band of latitude between 8^{o} North and 8^{o} South. The ATLAS (Automated Temperature-Line Acquisition System) consists of a Surface buoy measuring winds, air temperature, humidity, and sea surface temperature, and a ten-sensor subsurface temperature cable down to 500m. There are also seven Current Meter Moorings positioned along the equator, including three surface buoy type with in-line mechanical current meters and four subsurface type with Acoustic Doppler Current Profilers (ADCPs). All surface buoy moorings transmit data in near real-time via the ARGOS satellite system.

PMEL's Tropical Ocean Global Atmosphere (TOGA) TAO Project, headed by Dr. Michael McPhaden, utilizes the array in its focus of research to understand the coupled behavior of the ocean-atmosphere system in the tropical Pacific and its relation to interannual climate change and the phenomenon known as El Nino.

Summary of Cruise Work:

The ship departed Majuro January 26th and transited westward to 8N,165E, servicing the ATLAS moorings on a southward track along the 165E Meridian. This included the surface buoy and subsurface ADCP current meter moorings at the equator, as well as the recovery of a Next Generation ATLAS mooring at 5S, 165E. The Next Generation ATLAS mooring consists of individual inductively-coupled subsurface temperature, conductivity, and pressure sensors in place of the temperature cable. The surface Current Meter Mooring also includes rain and radiation sensing instrumentation. From 5S, 165E the ship transited directly to 2S, 156E.

Rain gauges were serviced at 2S, the Equator, and 2N along the ships northward track along 156E, which also included radiation instrumentation at the Equator. Work ended at 8N where the buoy was found vandalized, missing its tower. The ship then headed westward to inport at the island of Chuuk on February 10th.

The ship departed Chuuk on February 13th to begin a transit to 7N, 147E, but was delayed because of high winds and seas. The ship returned to the protective lee of the island of Chuuk until noon the next day before continuing on to commence work at 5N, 147E. Work was completed at three mooring sites, including a recovery-only at 2N, 147E. A ban on further deployments at this site was decided upon prior to the cruise because of persistent vandalism resulting in the loss of data and equipment. The buoy recovered there was missing its wind sensor and badly damaged.

The ship made its way westward, and after completing JAMSTEC CTD and mooring work enroute, arrived at 2N,137E on February 24th. The mooring at this site stopped transmitting in September of 1996, and its status was unknown. It's release was located, but the buoy was not found on the surface and presumed lost, so a new mooring was deployed to replace it. This was the last site completed because seas too rough for operations of the KAIYO forced cancellation of scheduled work at 5N and 7N, 137E.

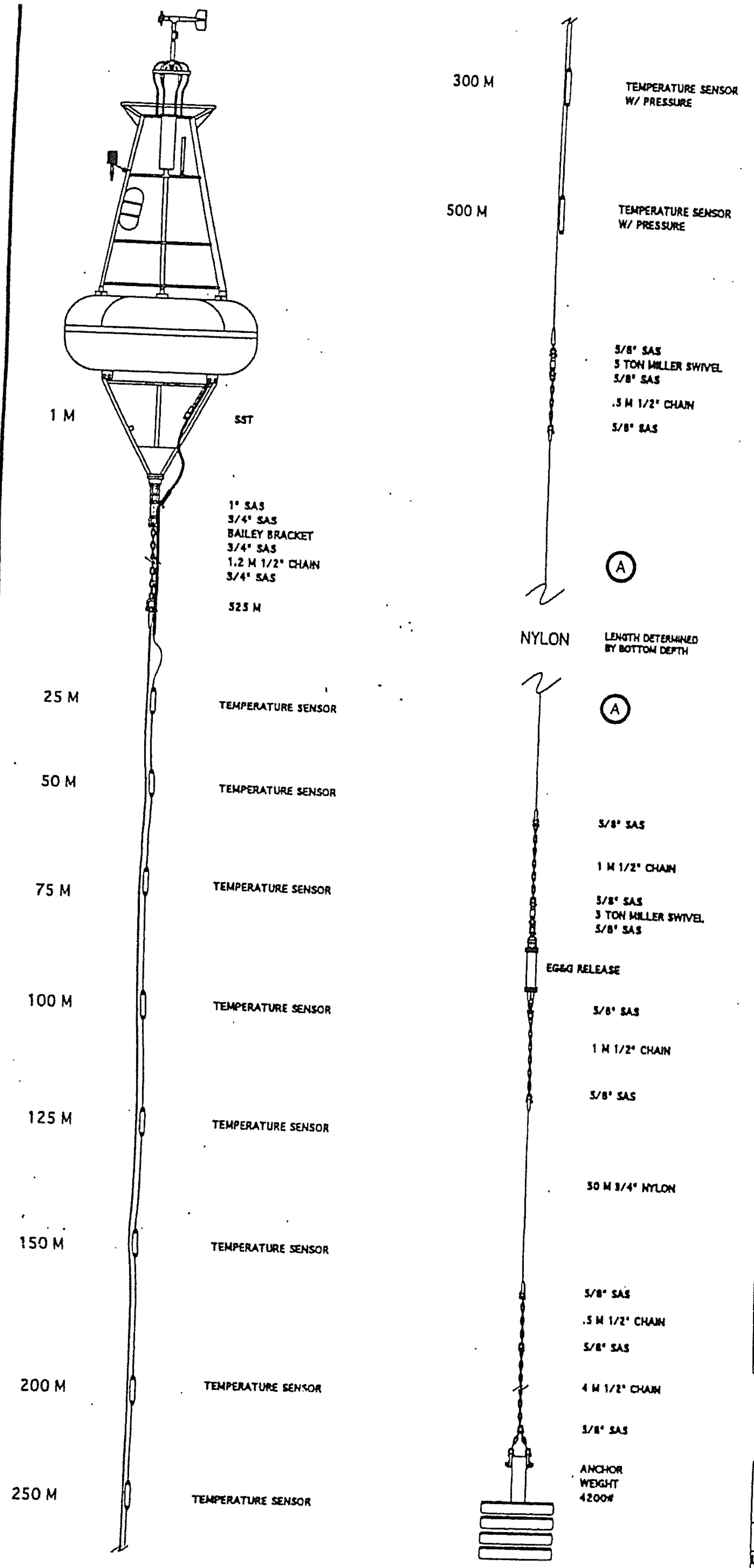
A total of 4 standard ATLAS moorings were recovered, 5 deployed, 2 visited and inspected, 5 repaired, 1 surface buoy Current Meter Mooring was recovered and deployed, 1 subsurface ADCP mooring was recovered and re-deployed, and 1 ATLAS Next Generation Mooring was recovered. Rain and radiation measurements were maintained on the Equator at 156E and 165E, plus three 1m buoy-mounted Seacat conductivity/temperature recorders were recovered and deployed at 2N, the Equator, and 5N, 165E. Refer to Table 1 for a complete list of mooring operations.

Acknowledgments:

Thanks to the skill and professionalism of Captain Hyodo and the crew of the KAIYO, TAO mooring operations were a great success during TOCS cruise K-97-02. Data received at PMEL indicates that all deployed moorings have remained anchored on site, and along with repaired moorings, are all transmitting good data. Thanks also to Chief Scientist Kentaro Ando for his hard work, dedication, and assistance that resulted in a very successful cruise.

Table 1 - SUMMARY OF TAO MOORING OPERATIONS, TOCS K-97-02

SITE	DATE	BUOY #	LAT	LONG	TYPE	OPERATION
8N, 165E	27 Jan 97	ET-397	8°-0.4'N	165°-0.7'E	Std ATLAS	REPAIR Tube Swap
5N, 165E	28 Jan 97	ET-396	5°-2.9'N	164°-59.7'E	Std ATLAS	VISIT
2N, 165E	29 Jan 97	ET-375	1°-59.6'N	164°-58.6'E	Std ATLAS	RECOVER
2N, 165E	30 Jan 97	ET-432	1°-59.9'N	164°-57.8'E	Std ATLAS	DEPLOY
EQ, 165E	30 Jan 97	WA-01B	0°-0.4'S	165°-05.3'E	Subsurface ADCP	RECOVER
EQ, 165E	31 Jan 97	WA-01C	0°-0.01'S	165°-11.9'E	Subsurface ADCP	DEPLOY
EQ, 165E	31 Jan 97	WM-02	0°-0.2'N	164°-59.4'E	Surface Current Meter	RECOVER
EQ, 165E	1 Feb 97	WM-03	0°-0.05'N	165°-01.4'E	Surface Current Meter	DEPLOY
5S, 165E	2 Feb 97	PM-012	4°-59.8'S	165°-12.3'E	NextGen ATLAS	RECOVER
5S,165E	3 Feb 97	ET-433	5°-0.01'S	165°-12.2'E	Std ATLAS	DEPLOY
2S, 156E	5 Feb 97	ET-400	1°-59.9'S	155°-59.8'E	Std ATLAS	REPAIR Rain Gauge
EQ, 156E	5 Feb 97	ET-402	0°-0.04'N	156°-08.5'E	Std ATLAS	REPAIR Rain Gauge
2N, 156E	6 Feb 97	ET-403	2°-01.6'N	156°-0.53'E	Std ATLAS	REPAIR Rain Gauge
5N, 156E	7 Feb 97	ET-405	5°-0.0'N	156°-4.4'E	Std ATLAS	VISIT
8N, 156E	8 Feb 97	ET-376	7°-59.5'N	156°-0.4'E	Std ATLAS	RECOVER
8N, 156E	9 Feb 97	ET-435	7°-59.9'N	155°-59.2'E	Std ATLAS	DEPLOY
5N, 147E	15 Feb 97	ET-398	4°-57.1'N	147°-2.2'E	Std ATLAS	REPAIR Wind Sensor
2N, 147E	16 Feb 97	ET-378	1°-59.9'N	146°-59.9'E	Std ATLAS	RECOVER
EQ, 147E	16 Feb 97	ET-377	0°-01.9'N	146°-56.4'E	Std ATLAS	RECOVER
EQ, 147E	17 Feb 97	ET-438	0°-0.01'N	146°-59.7'E	Std ATLAS	DEPLOY
2N, 137E	25 Feb 97	ET-439	2°-26.4'N	137°-25.6'E	Std ATLAS	DEPLOY



SURFACE INSTRUMENTS	
INST	SER#
TUBE	
RMYOUNG	
ROTRONICS	
EPPLEY	
SST	

MOORING REQUIREMENTS

.985 SCOPE

TOTAL LENGTH OF WIRE, HARDWARE, INCLUDING 30M PIECE OF NYLON= 588 M

FIST GRIP SPACING, EASTERN PACIFIC

SPACING	DEPTH
1.5 M	0-50 M
2.5 M	50-175 M
5 M	175-300 M
10 M*	300-500 M

* ALTERNATE WITH PANDUITS

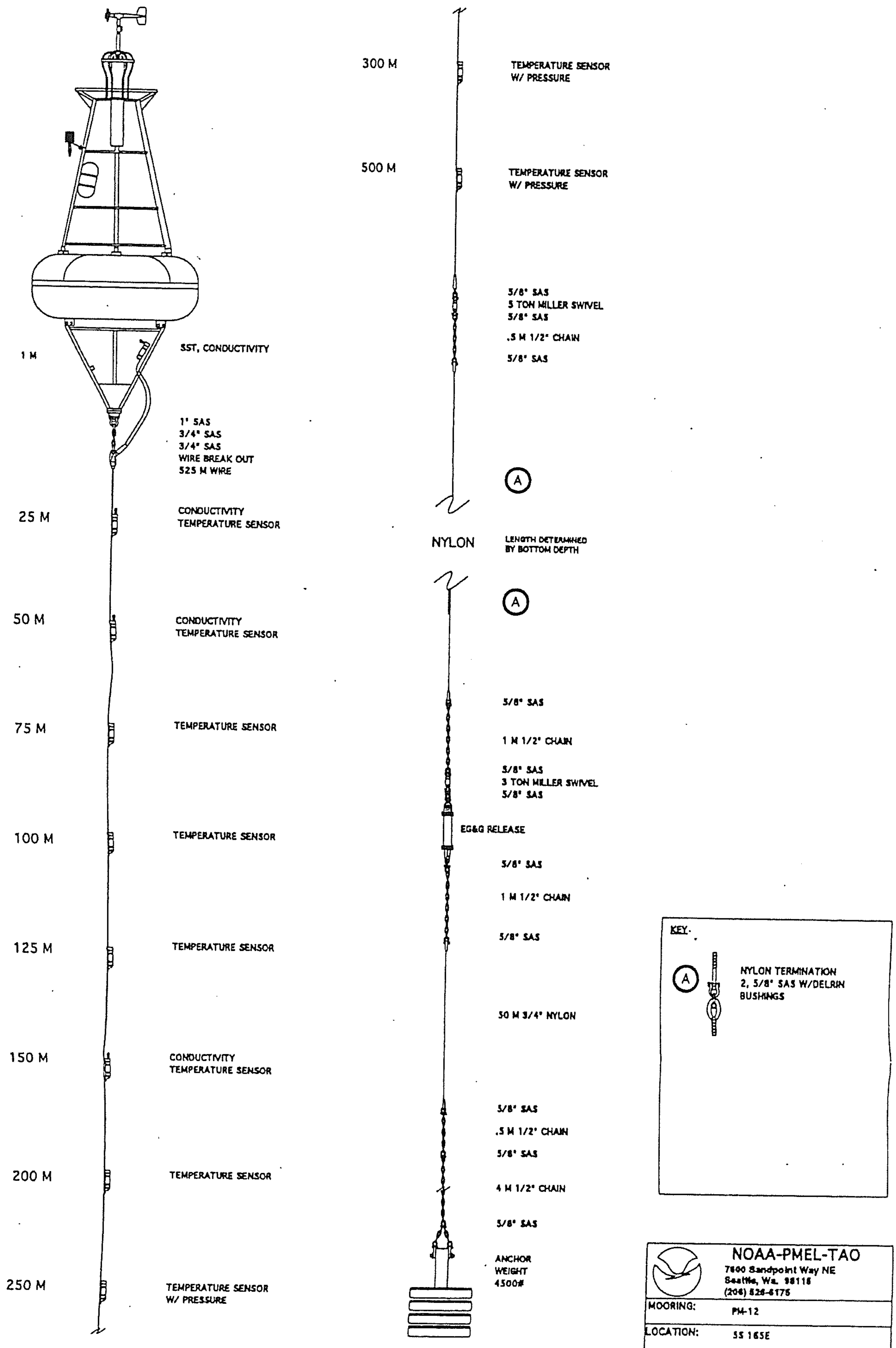
KEY

A — NYLON TERMINATION 2, 5/8" SAS W/DELRIN BUSHINGS

NOAA-PMEL-TAO
7600 SAND POINT WAY NE
SEATTLE, WA 98115
(206) 526-6178

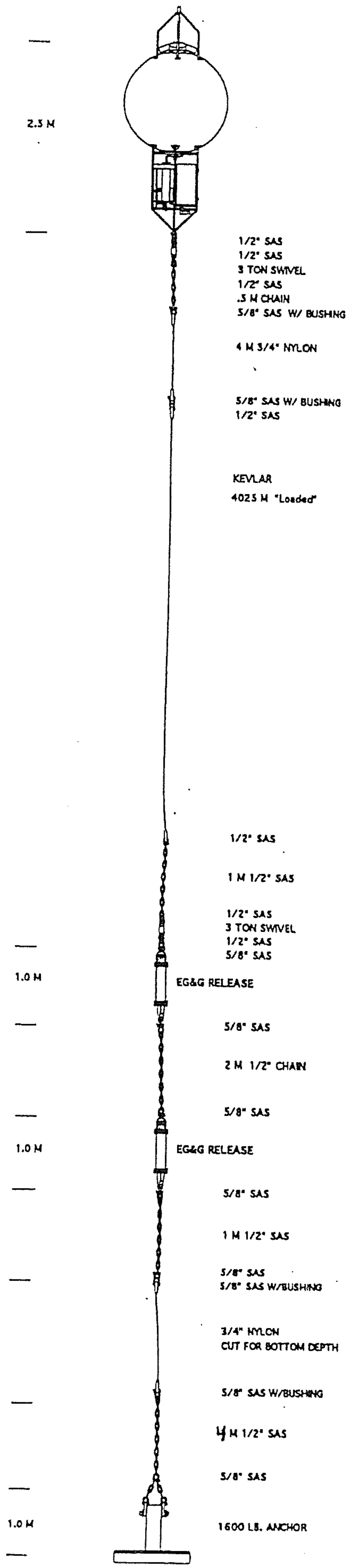
MOORING:	STANDARD ATLAS, WESTERN PACIFIC
LOCATION:	
DRAWN BY: A. LOPEZ	DATE: 14 NOV 96
APPROVED BY:	DATE:

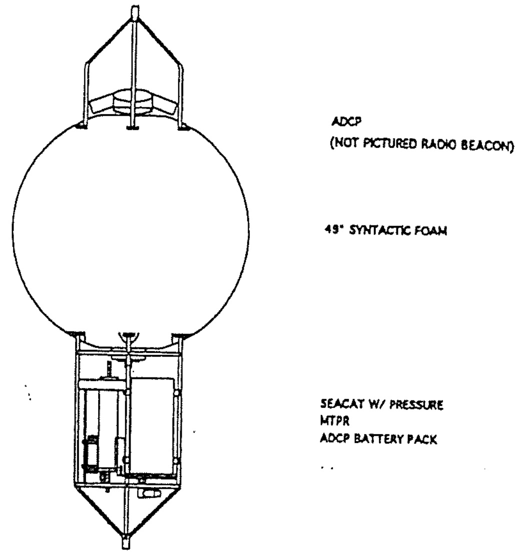
Standard ATLAS



New Generation ATLAS

NOAA-PMEL-TAO 7600 Sandpoint Way NE Seattle, Wa. 98115 (206) 526-6175	
MOORING:	PM-12
LOCATION:	5S 165E
DRAWN BY: AS	DATE: 12/10/96
APPROVED BY:	DATE:



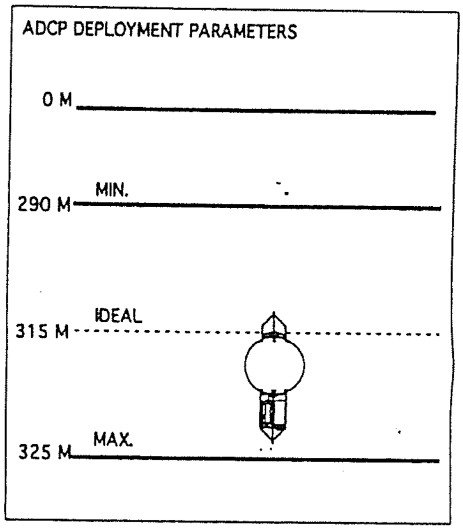


MOORING INFORMATION:

BOTTOM DEPTH (TO BE DETERMINED AT DROP SITE)
Target Bottom Depth is 4380 M

REQUIRED ADCP DEPTH 315 M

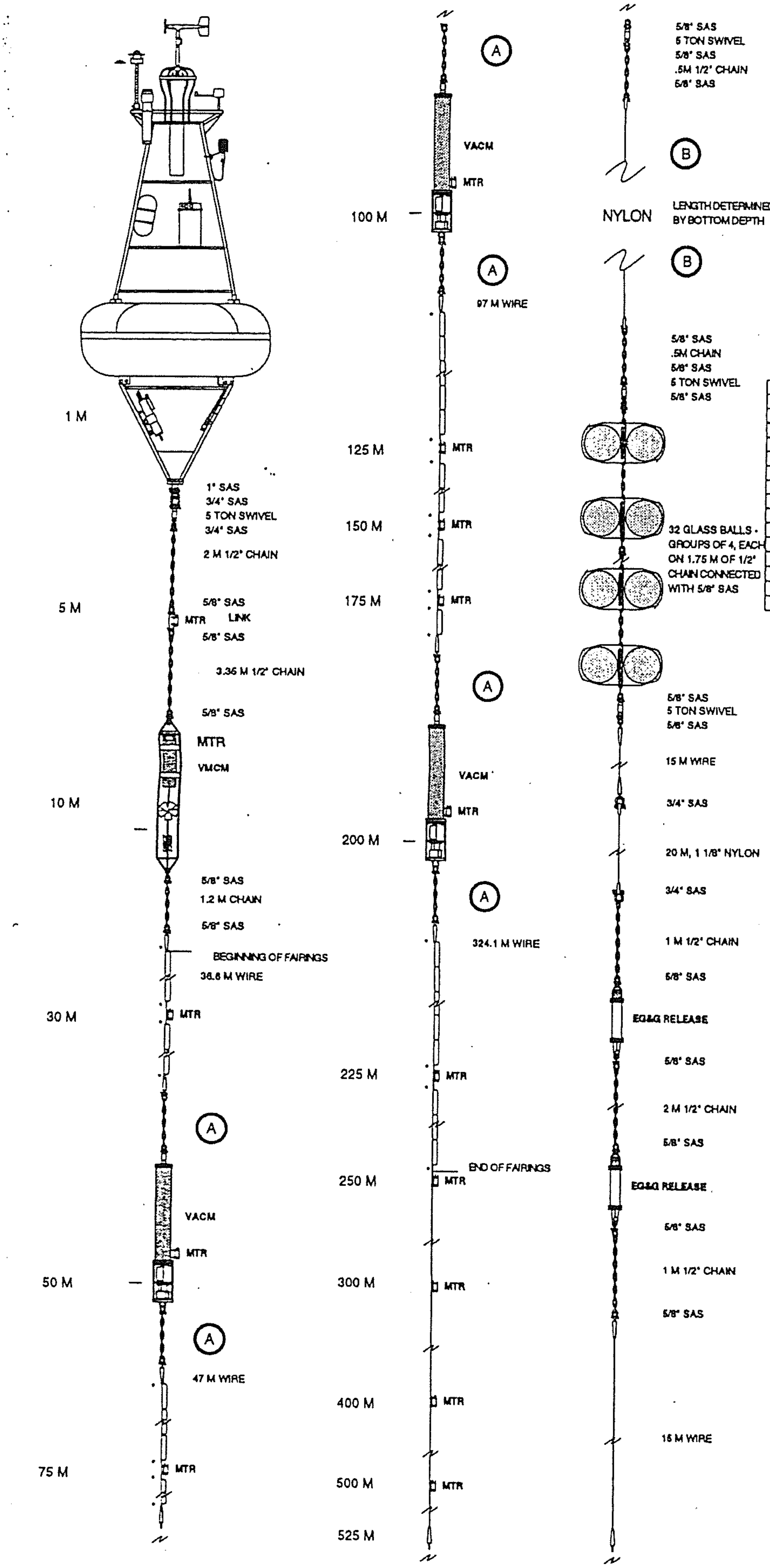
Loaded Kevlar length 4025 M

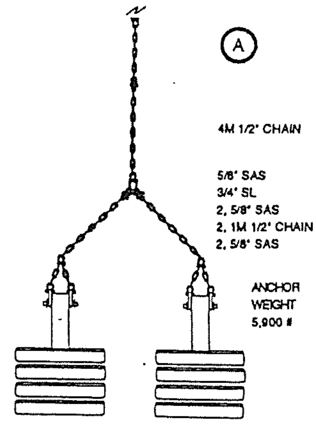


Subsurface ADCP

NOAA-PMEL-TAO
7600 Sandpoint Way NE
Seattle, Wa. 98115
(206) 526-6175

MOORING:	WA-02
LOCATION:	0, 165 E
DRAWN BY: AS	DATE: 11/DEC/96
APPROVED BY:	DATE:





LENGTH	MEASURE	MARK	COLOR	NOTES
324.1 M			YELLOW	
			WHITE	
			YELLOW	
			YELLOW	END FAIRING
			YELLOW	
			WHITE	
			WHITE	END FAIRING
			WHITE	
			YELLOW	
			WHITE	CUT
				CUT
				CUT
				CUT
				CUT

SURFACE INSTRUMENTS	
INST	SER#
AMP	
RMYOUNG	
ROTRONICS	
EPPLEY	
SST	
STI	

KEY

(A) 5/8" SAS, .5M 1/2" CH.
5/8" SAS,

(B) NYLON TERMINATION
2, 5/8" SAS W/ DELRIN
BUSHINGS

• KEEPERS

NOAA-PMEL-TAO 7600 Sandpoint Way NE Seattle, Wa. 98115 (206) 526-6175	
MOORING:	WM-03
LOCATION:	0, 165 E
DRAWN BY: A. LOPEZ	DATE:
APPROVED BY:	DATE: 5 NOV 96

Surface Currentmeter Buoy (PROTEUS)

9. CO_2 measurements

9.1 Patial pressure of CO_2 in the atmosphere and ocean

(1) Tittle

Distribution of atmospheric and oceanic CO_2 in the equatorial Pacific during January - February, 1997.

(2) Scientists

H. Yoshikawa[1)], M. Ishii[1)], Y.Ishida[2)]

[1)]Geochemical Research Department
Meteorological Research Institute (MRI)
Nagamine 1-1, Tukuba, Ibaraki, 305 JAPAN

[2)]Department of Ocean Carbon Flux Study
Kansai Environmental Engineering Center Co.LTD. (KEEC)
2-3-39, Nakazakinishi, Kitaku, Osaka, 530 JAPAN

(3) Objective

Atmospheric CO_2, known as a greenhouse gas, has been increasing due to the emission of anthropogenic CO_2. It has increased approximately 25% in comparison with the pre-industrial era (280 ppm). In order to predict the level of atmospheric CO_2 in the future, it is necessary to understand the present inventory among global carbon reservoirs: atmosphere, biosphere and ocean.

CO_2 exchange between the atmosphere and ocean plays an important role in determining the level of atmospheric CO_2. The difference in partial pressure of CO_2 between the ocean and the atmosphere (delta pCO_2) is the driving force for air/sea CO_2 exchange. Central equatorial Pacific acts as a source for atmospheric CO_2, but time and spatial distribution of delta pCO_2 is not enough to elucidate the interannual variation in CO_2 outflux. During this cruise, measurements of pCO_2 were made to study the interannual change CO_2 outflux in the equatorial Pacific regions.

(4) Method

Measurements of the CO_2 concentration in the background air and the equilibrated with surface seawater were made using the MRI CO_2 measuring system. Air sample was taken from the top of the bridge into the 2nd laboratory. Sea water was continuously taken from the bottom of the ship and then was introduced into the MRI equilibrator at the 2nd laboratory.

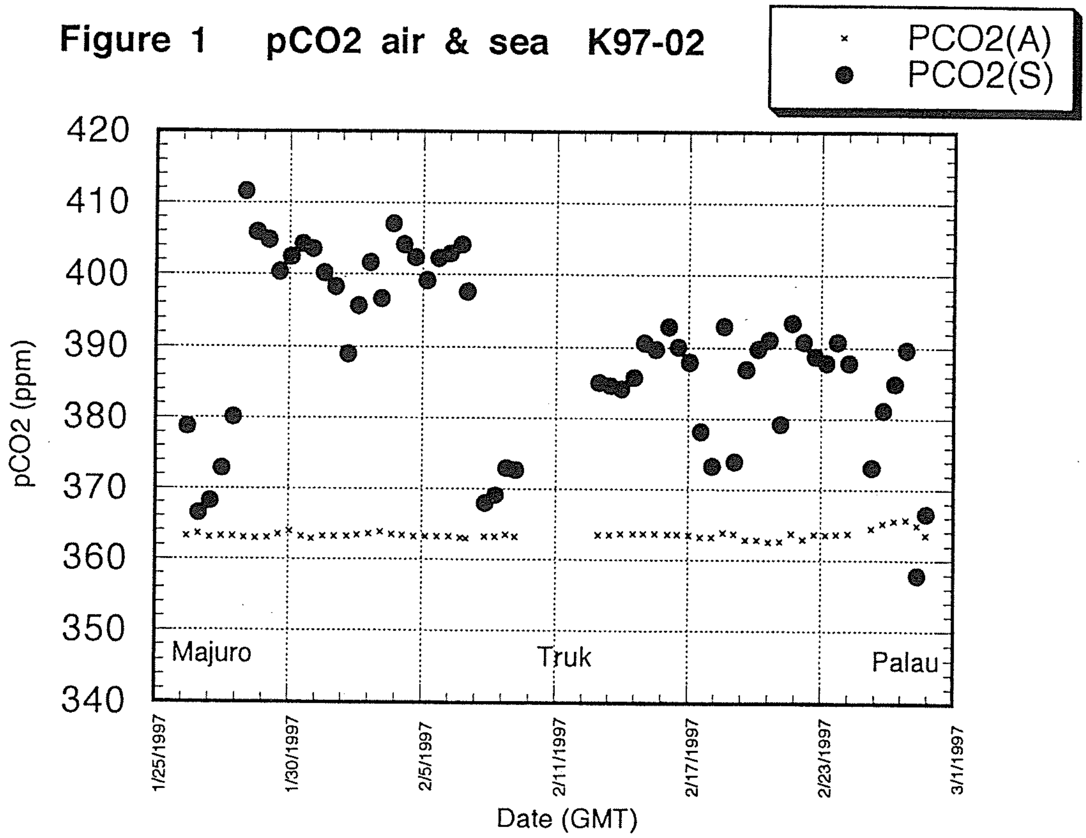
(5) Equipment

We used a non-dispersive infrared gas analyzer (BINOS 4, Germany) to determine the CO_2 concentration. CO_2 concentration will be published based on the WMO X85 mole fraction scale after this cruise. For this reason, measurements in this report are tentative. Four CO_2 calibration gases will be re-analayzed at our laboratory after this cruise to evaluate a concentration drift.

(6) Result

Figure 1 show geographical distributions of pCO_2 in air and surface seawater from Majuro to Truk and from Truk to Palau. Only two measurements in a day were tentatively calculated from the data set for every 90 minutes.

Figure 1 pCO2 air & sea K97-02



9. 2 Total inorganic carbon in the ocean

(1) Tittle

Spatial variation of the total inorganic carbon in the equatorial Pacific during January - February, 1997.

(2) Scientists

M. Ishii[1)], H. Yoshikawa[1)] and Y. Ishida[2)]
[1)]Geochemical Research Department
Meteorological Research Institute (MRI)
Nagamine 1-1, Tukuba, Ibaraki, 305 JAPAN
[2)]Department of Ocean Carbon Flux Study
Kansai Environmental Engineering Center Co.LTD. (KEEC)
2-3-39, Nakazakinishi, Kitaku, Osaka, 530 JAPAN

(3) Objective

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 surface seawater in the equatorial Pacific exhibits pronounced spatial and temporal variabilities as a result of the strong upwelling, biological activities, air-sea CO_2 exchange, etc. Coupling with pCO2(sea) data, we are aiming at describing the carbonate system in this region and clarify the factors those are responsible for its variation.

(4) Method

Surface seawater was pumped up continuously from the bottom of the ship and the portion of it was introduced (1L/min) into the MRI coulometric TCO_2 measuring system at the 2nd laboratory. TCO_2 and seawater temperature were automatically measured once every an hour.

TCO_2 in the standard seawater and CO_2 content in the standard gas (1%CO_2 in air ; Nippon Sanso,CO.) were also determined occasionally to calibrate system.

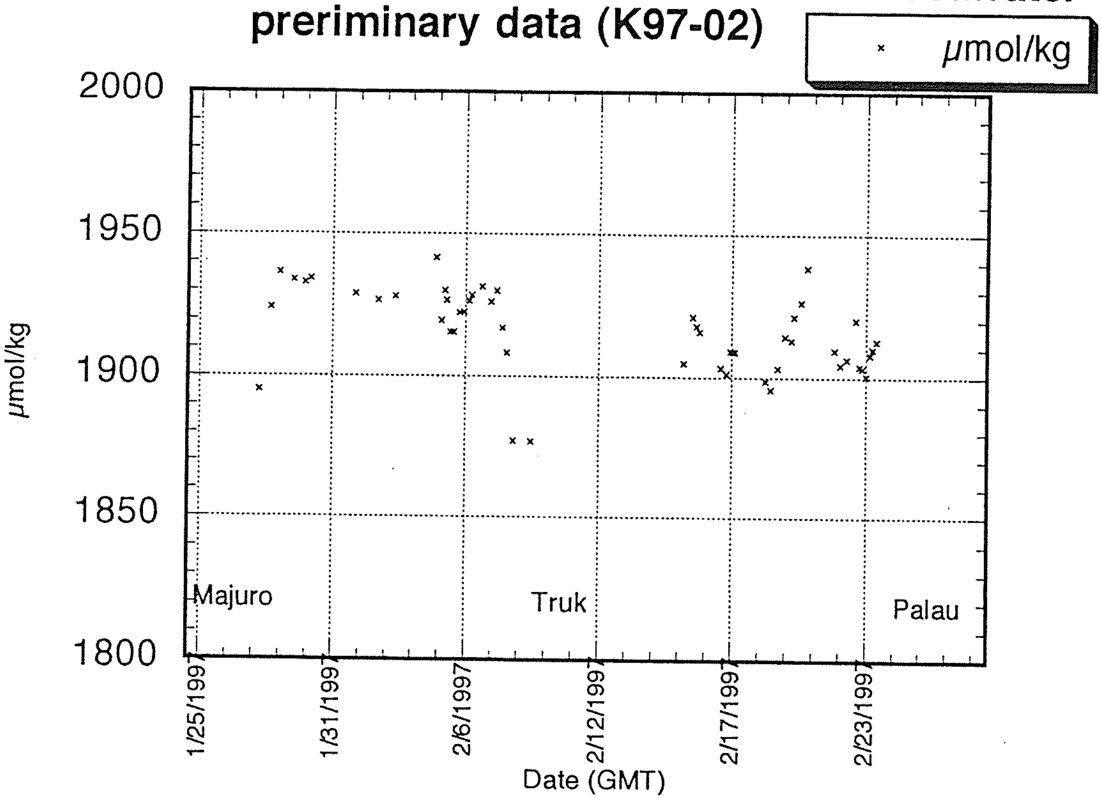
(5) Equipment

For the determination of the CO_2 amount, we used CO_2 coulometer (Model 5011 UIC Inc., USA). CO_2 extraction from the seawater and determination of its amount were automatically operated.

(6) Result

Data analysis including background correction, efficiency change correction, and seawater density calculation have not been made completely during this cruise. Figure 1 shows tentative TCO_2 measurements in the surface seawater at each CTD stations from Majuro to Truk and from Truk to Palau.

Figure 1 Distribution of TCO2 in surface seawater preriminary data (K97-02)



10. SUMMARY REPORT
TOCS K9702
by

Djoko HARTOYO and Ali ALKATIRI
BPPT Participants

Firstly, I would like to thank to Japan Marine Science and Technology Center for invited to joint on TOCS K9702 cruise. This TOCS Cruise based on Jamstec and BPPT implementing Arrangement for FY 1996/1997.

We have onboard at Chuuk (Truk), so We jointed only on Leg II. Departed from Truk at February 13th, 1997 and ended at Palau at February 28th, 1997.

During leg II, Two recoveries and deployments of JAMSTEC Subsurface ADCP buoys have been done successfully at 0, 147 E and 0, 142 E.

33 Stations CTD casting (from CTD st. 29 to 61) were done during leg II. Using CTD SBE 9 plus for 6.800 meter, water samplers were collected in 5 liter niskin bottles for dissolve oxigen measurment triggered with GO (general oceanic) water sampling system. The bottles performed extremely well, with no apparent leaks. All triggers functioned normally except at station 40 that 3 bottles could not trigger. During repairmen at station 41, 42, and 43 no water samples on CTD cast until Mr. Ando could repaired the GO rosette, exactly the GO system is very simple instrument. We also heard that some troubles occurred in Leg I from Majuro to Truk, The CTD SBE 9 Plus for 10.500 meter was broken and the winch wire was cut nearly 4.000 meter length.

Two ATLAS mooring at (2 N, 147 E), (0, 147 E) were recovered and deployed at (0, 147 E), (2.4 N, 137 E) , repaired Atlas at 5 N, 147 E, Unfortunately bad weather occurred just the end of cruise before we could deployed more two ATLAS buoys at 5 N, 137 E and 7 N, 138 E. Captain Hyodo decided to escape from rough sea around Palau.

In this cruise several meteorological measurements were done , i.e. Radio Sonde observations, Boundary layer measurements (SABL, RASS, Wind profiler) and Surface meteorological measurements (Manual measurement, PRP) also kite operations.

We will be get very important data set from several TOCS cruises and will be compared and connected to another data from our cruise using Baruna Jaya Research Vessel such as Arlindo mixing Program at 1993, 1994 and Arlindo Circulation 1996, 1998 (Arlindo = Indonesia Throughflow) as joint cruise with Lamont Doherty Observation Laboratory (LDEO, New York University), the location of this cruise in Eastern Part of Indonesia such as Banda Sea, Makasar Strait, Maluku Sea, This location is just southern of TOCS location. We also have JADE program as joint program with Lodyc Institution at France, that interest with exiting water property from Indonesia seas to Hindia Ocean so We observed at Ombai strait (between Alor and Timor islands) using ADCP and current meter mooring. Also the important data coming from WOCE program observed at P8S line with two cruises in winter 1994 and summer 1996.

Finally, We would like to appreciate to all our colleagues for working together, especially to Mr. Kentaro Ando as chief scientist for his dedicate on this cruise, Also to Captain Hyodo and crews.

11. Participants List

Kentaro Ando	Japan Marine Science and Technology Center (JAMSTEC) 2-15, Natsushima, Yokosuka, Kanagawa, 237Japan Tel +81-468-66-3811
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Mitsuru Hayashi	NME
Akihiro Sakou	NME
Masayuki Fujisaki	NME
Nobuharu Komai	NME
Takeshi Katayama	NME
Satoru Kanda	NME
Keiko Komine	Sanyo Techno Marine Co. Ltd(STM) 1-3-7, Horidome-cho, Nihonbashi, Chuo-ku, Tokyo, 103 Japan Tel +81-3-3666-3264
Masashi Aihara	STM
Yasuo Ishida	Kansai Environmental Engineering Center Co. ltd. (KEEC) 2-3-39, Nakazakinishi, Kitaku, Osaka, 530Japan Tel +81-6-372-7171
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Isbandi Andriyanto	Indonesia Navy/Hydrography JI. Pantai Kuta V/1 Jakarta Indonesia Tel +62-21-684810

David Zimmerman	Pacific Marine Environmental Laboratory(PMEL) 7600 Sand Point Way Northeast Seatle, Washington 98115 USA Tel +1-206-526-6728
Stephen Smith	PMEL
Charles Martin	National Center for Atomospheric Reserch(NCAR) 3450 Mitchell Lane, Boulder, Colorado 80301, USA Tel +1-303-4978749
Erik Miller	NCAR
Joseph Vinson	NCAR
Robert Reynolds	BrookHaven National Laboratory Bldg. 318, Upton. NY 11973, USA Tel +1-516-344-7836
Scott Smith	BNL

R/V Kaiyo Crew Members

Captain	Hiroshi Hyoudou
Chief Officer	Hajime Oda
Second Officer	Yoshiyuki Mizui
Jr.Second Officer	Isao Maeda
Third Officer	Masakatsu Yamada
Chief Engineer	Toshihiro Kimura
First Engineer	Youichi Kikuchi
Second Engineer	Mitsuhiro Ueki
Third Engineer	Kazuhito Yoshiura
Chief Radio Officer	Hideyuki Akama
Second Radio Oficer	Satoshi Watase
Boatswain	Norio Nagatani
Able Seaman	Yoshiaki Shirai
Able Seaman	Yasuyoshi Kyuki
Able Seaman	Yoshimasa Azechi
Able Seaman	Kazumi Ogasawara
Able Seaman	Shuji Takuno
Able Seaman	Yousuke Chida
Able Seaman	Takashi Kiyohara
No.1 Oiler	Akira Kajitani
Oiler	Kiyoshi Yawata
Oiler	Kouichi Kobori
Oiler	Junji Mouri
Oiler	Yoshinori Kawai
Chief Steward	Kiyotoshi Teranishi
Steward	Yoshitarou Tamiya
Steward	Jihei Nakatsuka
Steward	Isamu Kashima
Steward	Isao Matsumoto

A p p e n d i c e s

A1. Time table

A2. GMS IR Images

A3. Report of CTD troubles
(in Japanese)

A1. Time Table of TOCS K9702 Cruise

Jan.24 (Fri) Local Time(-12h=UTC) Fine | Rain
08:15-14:30 Loading the gear of PMEL, NCAR, and BNL

Jan.25 (Sat) Local Time(-12h=UTC) Fine
Set up each measurement systems

Jan.26 (Sun) Local Time(-12h=UTC) Fine
16:00 Depart Majuro

Jan.27 (Mon) Local Time(-12h=UTC) Fine
09:00-09:25 Guidance for safety ship life
09:30-09:45 Boat Drill
10:00-11:50 Meeting for observation
13:00-13:15 Test on the influence onto the ship life of RASS
13:30-15:00 ATLAS Assembly
14:09 Start Precipitation measurement
16:45 Kompira-san
19:00-19:10 Test of RASS(2nd)
21:00 Start surface meteorological measurement(every 3h)
24:00 Time adjustment (24:00 → 23:00)

Jan.28 (Tue) Local Time(-11h=UTC) Fine
06:15-06:45 ATLAS Repair (08°00N, 165°00E)
07:15-08:05 CTD-01 (08°00N, 165°01E) Start CTD observation
10:25-12:10 RS-001 (07°42N, 165°01E) Start Radiosonde observation
13:00 Start RASS observation (every 30 min.)
13:49-14:46 CTD-02 (07°00N, 165°00E)
16:27-17:35 RS-002 (06°45N, 165°00E)
20:23-21:01 CTD-03 (06°00N, 165°00E)
22:22-23:59 RS-003 (05°48N, 165°00E)

Jan.29 (Wed) Local Time(-11h=UTC) Fine | Rain
02:03-02:54 CTD-04 (05°04N, 165°00E)
04:25-06:05 RS-004 (04°57N, 165°00E)
09:52-10:27 CTD-05 (04°00N, 165°00E)
10:39-12:21 RS-005 (04°00N, 165°00E)
15:48-16:28 CTD-06 (03°00N, 165°00E)
16:40-18:05 RS-006 (03°00N, 165°00E)
22:25-00:00 RS-007 (02°00N, 165°00E)

Jan.30 (Thu) Local Time(-11h=UTC) Rain | Cloudy
04:21-06:10 RS-008 (02°00N, 165°00E)
06:02-09:08 ATLAS Recovery
10:28-12:17 ATLAS Deployment (01°59.94N, 164°57.78E)
10:31-12:31 RS-009 (02°00N, 164°56E)
13:30-15:01 RS-010 (01°59N, 164°58E)
13:38-14:19 CTD-07 (01°59N, 164°59E)
16:40-18:00 RS-011 (01°35N, 165°00E)
19:30-21:15 RS-012 (01°02N, 165°00E)
22:25-00:18 RS-013 (00°40N, 165°07E)

Jan.31 (Fri) Local Time(-11h=UTC) Cloudy／Rain
01:21-03:10 RS-014 (00°07N, 165°18E)
04:23-04:47 RS-015 (00°02N, 165°07E)
06:00-12:30 PMEL Subsurface ADCP mooring Recovery
07:21-09:18 RS-016 (00°00S, 165°02E)
10:20-12:18 RS-017 (00°00N, 165°01E)
13:30-15:20 RS-018 (00°00N, 165°11E)
13:34-15:13 JAMSTEC Subsurface ADCP mooring Deployment
15:44-18:50 PMEL Subsurface ADCP mooring Deployment
16:40-18:20 RS-019 (00°00N, 165°13E)
19:49-20:05 RS-020 (00°01S, 165°10E)
22:25-00:05 RS-021 (00°00N, 165°08E)

Feb.01 (Sat) Local Time(-11h=UTC) Fine | Rain
01:20-02:57 RS-022 (00°00N, 165°06E)
03:19-05:04 RS-023 (00°01N, 165°06E)
07:17-09:00 RS-024 (00°03S, 165°07E)
08:01-11:37 PROTEUS Recovery
10:39-12:29 RS-025 (00°03S, 165°07E)
13:29-15:20 RS-026 (00°00N, 164°58E)
13:34-17:08 PROTEUS Deployment (00°00.05N, 165°01.44E)
17:00-18:35 RS-027 (00°00S, 165°02E)
17:45-18:23 CTD-09 (00°01S, 165°01E)
19:25-21:00 RS-028 (00°08S, 165°01E)
22:19-00:05 RS-029 (00°44S, 165°00E)

Feb.02 (Sun) Local Time(-11h=UTC) Fine
01:18-03:03 RS-030 (01°00S, 165°00E)
04:17-06:00 RS-031 (01°27S, 165°00E)
07:12-09:05 RS-032 (02°02S, 165°00E)
08:04-12:00 CTD Winch Repair
10:14-11:50 RS-033 (02°35S, 165°00E)
12:44-13:26 CTD-10 (03°00S, 165°00E)
13:25-15:20 RS-034 (03°00S, 165°01E)
16:27-18:59 RS-035 (03°30S, 165°00E)
19:09-19:50 CTD-11 (04°00S, 165°00E)
19:25-21:11 RS-036 (04°00S, 165°00E)
22:16-00:10 RS-037 (04°21S, 165°04E)

Feb.03 (Mon) Local Time(-11h=UTC) Fine
01:24-03:02 RS-038 (04°52S, 165°10E)
04:24-06:15 RS-039 (04°59S, 165°08E)
07:10-09:05 RS-040 (05°01S, 165°12E)
07:38-09:30 ATLAS Recovery
10:15-12:18 ATLAS Deployment (05°00.01S, 165°12.26E) 2520m
10:27-12:10 RS-041 (05°00S, 165°12E)
13:16-14:00 CTD-12 (05°00S, 165°00E)
13:27-15:07 RS-042 (04°59S, 165°12E)
16:44-18:35 RS-043 (04°53S, 164°46E)
19:30-21:10 RS-044 (04°42S, 164°09E)
20:00-21:30 CTD Repair
22:21-00:11 RS-045 (04°36S, 163°46E)

Feb.04 (Tue) Local Time(-11h=UTC) Fine
01:30-03:15 RS-046 (04°24S, 163°11E)
04:19-06:05 RS-047 (04°13S, 162°36E)
07:20-09:10 RS-048 (04°01S, 162°02E)
08:00-09:15 Kite operation test
09:30-12:00 CTD Repair
10:36-10:37 RS-049 (03°50S, 161°37E)
13:00-16:00 CTD Repair
13:25-15:05 RS-050 (03°41S, 161°04E)
16:52-18:40 RS-051 (03°29S, 160°26E)
19:24-21:14 RS-052 (03°17S, 159°52E)
22:29-00:14 RS-053 (03°05S, 159°17E)

Feb.05 (Wed) Local Time(-11h=UTC) Fine
01:22-03:18 RS-054 (02°54S, 158°43E)
04:35-06:15 RS-055 (02°42S, 158°05E)
07:17-11:05 RS-056 (02°32S, 157°34E)
08:05-08:40 CTD-13 (02°27S, 157°23E) with no water sample
10:27-12:20 RS-057 (02°23S, 157°09E)
13:25-15:07 RS-058 (02°12S, 156°35E)
16:18-16:33 ATLAS Repair (01°59.93S, 155°59.81E) 1760m
16:49-18:59 RS-059 (02°00S, 156°00E)
16:53-17:27 CTD-14 (02°01S, 156°00E)
19:26-21:16 RS-060 (01°43S, 156°00E)
20:24-20:59 CTD-15 (01°30S, 156°00E)
22:23-00:10 RS-061 (01°17S, 156°00E)
23:46-00:20 CTD-16 (01°00S, 156°00E)

Feb.06 (Thu) Local Time(-11h=UTC) Cloudy | Rain／Fine
01:23-03:10 RS-062 (00°53S, 156°01E)
03:19-03:53 CTD-17 (00°30S, 156°00E)
04:39-06:20 RS-063 (00°28S, 156°01E)
07:20-09:13 RS-064 (00°02S, 156°09E)
08:03-08:45 ATLAS Repair (00°00.229S, 156°08.342E)
09:12-09:41 CTD-18 (00°01S, 156°09E)
09:40-10:10 Kite operation (01°01.035S, 156°08.950E)
10:20-12:04 RS-065 (00°02S, 156°10E)
13:24-15:04 RS-066 (00°07N, 155°58E)
14:17-14:46 CTD-19 (00°30N, 156°00E)
14:50-16:02 Balloon operation (00°29.909N, 155°59.479E)
16:52-18:38 RS-067 (00°33N, 156°00E)
18:32-19:08 CTD-20 (01°00N, 156°00E)
19:30-21:14 RS-068 (01°00N, 156°00E)
21:51-22:25 CTD-21 (01°30N, 156°00E)
22:34-00:10 RS-069 (01°30N, 156°00E)

Feb.07 (Fri) Local Time(-11h=UTC) Fine／Rain
01:32-03:38 RS-070 (01°53N, 156°00E)
04:20-05:51 RS-071 (01°58N, 155°59E)
07:23-09:03 RS-072 (02°01N, 156°01E)

08:02-08:28	ATLAS Repair (02°01.8N, 156°00.3E) 2599m
08:43-09:11	CTD-21 (02°02N, 156°00E)
10:29-12:18	RS-073 (02°09N, 156°00E)
12:58-15:20	Calibration manuever for wind sensor and shipboard ADCP
12:58	(02°44.987N, 155°59.999E)
13:31	(02°45.026N, 156°06.000E)
13:36	(02°44.967N, 156°06.000E)
14:07	(02°44.990N, 156°00.000E)
14:12	(02°45.000N, 155°59.976E)
14:42	(02°51.000N, 156°00.006E)
14:48	(02°50.883N, 156°00.011E)
15:20	(02°45.000N, 156°00.001E)
13:28-15:18	RS-074 (02°45N, 156°00E)
15:27-16:28	Balloon operation (02°44.990N, 156°00.035E)
16:40-18:30	RS-075 (02°45N, 156°00E)
18:03-18:33	CTD-22 (03°00N, 156°00E)
19:43-21:30	RS-076 (03°06N, 156°00E)
22:30-00:10	RS-077 (03°44N, 156°00E)
23:45-00:11	CTD-23 (04°00N, 156°00E)

Feb.08 (Sat)	Local Time(-11h=UTC) Fine
01:27-03:05	RS-078 (04°10N, 156°00E)
04:24-06:15	RS-079 (04°45N, 156°00E)
05:32-06:07	CTD-25 (05°00N, 156°00E)
07:20-09:15	RS-080 (05°11N, 156°00E)
10:21-12:01	RS-081 (05°47N, 156°00E)
11:06-11:35	CTD-26 (06°00N, 156°00E)
11:14-12:05	Balloon operation (06°00.03N, 155°59.98E)
13:27-15:20	RS-082 (06°10N, 156°00E)
16:42-18:28	RS-083 (06°48N, 156°00E)
17:23-17:51	CTD-27 (07°00N, 156°00E)
19:27-21:14	RS-084 (07°15N, 156°00E)
22:53-00:33	RS-085 (07°57N, 156°00E)

Feb.09 (Sun)	Local Time(-11h=UTC) Fine
01:22-03:04	RS-086 (07°57N, 155°58E)
04:19-06:15	RS-087 (07°58N, 155°57E)
06:37-09:58	ATLAS Recovery
07:13-09:05	RS-088 (07°59N, 156°00E)
10:33-12:23	RS-089 (08°00N, 156°01E)
10:45-12:36	ATLAS Deployment (07°59.86N, 155°59.22E) 4831m
13:01-13:30	CTD-28 (08°00.489N, 155°59.933)
13:10-13:20	Kite operation - Failure because of strong wind
13:25-15:25	RS-090 (08°00N, 156°00E)
17:06-19:00	RS-091 (07°50N, 155°32E)
24:00	Time adjustment (24:00 → 23:00)

Feb.10 (Mon)	Local Time(-10h=UTC) Rain/Fine
09:00-09:30	Cleaning the working room
11:30	Arrive Truk

Feb.11 (Tue) Local Time(-10h=UTC) Rain/Fine/Rain
08:30-11:00 Gas Bottle Exchange
CTD Replacement
10:00-18:15 Fueling

Feb.12 (Wed) Local Time(-10h=UTC) Fine
day off
Some passengers disembarked

Feb.13 (Thu) Local Time(-10h=UTC) Cloudy/Rain/Fine/Rain
15:00 Depart Truk

Feb.14 (Fri) Local Time(-10h=UTC) Fine
09:20-11:15 RS-092 (07°05N, 151°23E)
10:00-11:00 Meeting for the second leg
11:00-13:30 Assemble Subsurface ADCP buoy
15:35-17:15 RS-093 (06°12N, 150°54E)
21:24-22:53 RS-094 (05°40N, 149°55E)

Feb.15 (Sat) Local Time(-10h=UTC) Rain/Fine/Cloudy/Rain
03:24-05:18 RS-095 (05°16N, 148°49E)
10:05-10:26 RS-096 (04°58N, 147°33E)
12:56-14:27 RS-097 (04°57N, 147°03E)
12:54-13:37 CTD-29 (04°48N, 147°02E)
14:30-15:15 Kite operation test
15:50-16:10 ATLAS Repair (04°57.119N, 147°02.217E)
15:47-17:37 RS-098 (04°56N, 147°03E)
18:25-20:15 RS-099 (04°36N, 147°02E)
21:34-22:37 RS-100 (04°03N, 147°01E)

Feb.16 (Sun) Local Time(-10h=UTC) Cloudy/Rain
00:24-02:18 RS-101 (03°33N, 147°00E)
03:24-04:00 RS-102 (03°01N, 147°00E)
03:25-04:18 CTD-30 (03°00N, 147°00E)
06:24-07:40 RS-103 (02°39N, 147°00E)
09:19-11:10 RS-104 (02°06N, 147°00E)
10:00-12:48 ATLAS Recovery (01°59.89N, 146°59.93E)
12:39-14:21 RS-105 (02°00N, 147°01E)
13:09-13:51 CTD-31 (02°00N, 147°00E)
14:40-15:15 Kite and Balloon operation
(01°51.753N, 147°00.123E)-(01°46.183N, 147°00.050E)
15:24-16:18 RS-106 (01°48N, 147°00E)
18:31-19:54 RS-107 (01°18N, 147°00E)
19:53-20:34 CTD-33 (01°00N, 147°00E)
21:25-23:15 RS-108 (00°54N, 147°00E)

Feb.17 (Mon) Local Time(-10h=UTC) Fine
00:23-02:17 RS-109 (00°01N, 146°58E)
03:25-04:00 RS-110 (00°03N, 146°59E)
06:21-08:17 RS-111 (00°00N, 146°57E)
07:00-09:33 ATLAS Recovery
09:22-11:18 RS-112 (00°03N, 146°56E)

10:25-11:14 Balloon operation
(00°00.034S, 146°50.651E)-(00°00.008S, 146°58.041E)
12:02-14:25 ATLAS Deployment (00°00.03S, 146°59.63E)
12:36-14:26 RS-113 (00°00S, 147°01E)
13:54-14:37 CTD-34 (00°01N, 146°59E)
15:15-15:40 Balloon operation
(00°01.276N, 146°59.268E)-(00°05.521N, 146°59.380E)
15:24-17:14 RS-114 (00°00S, 147°00E)
17:52-18:37 CTD-35 (00°30N, 147°00E)
18:29-19:47 RS-115 (00°30N, 147°00E)
21:21-22:47 RS-116 (00°00N, 147°00E)

Feb.18 (Tue) Local Time(-10h=UTC) Fine/Rain
00:20-01:02 CTD-36 (00°30S, 147°00E)
00:26-02:18 RS-117 (00°30S, 147°00E)
03:19-05:08 RS-118 (00°54S, 147°00E)
03:50-04:32 CTD-37 (01°00S, 147°00E)
06:20-08:15 RS-119 (01°17S, 147°00E)
07:23-08:04 CTD-38 (01°30S, 147°00E)
09:08-09:48 CTD-39 (01°40S, 147°00E)
09:17-11:10 RS-120 (01°40S, 147°00E)
10:17-13:33 Balloon operation
(01°40.052S, 147°03.328E)-(01°40.076S, 147°29.595E)
12:35-14:25 RS-121 (01°40S, 147°20E)
14:00-14:15 Balloon operation
(01°39.978S, 147°29.570E)-(01°39.897S, 147°28.144E)
14:30-15:15 Kite operation
(01°39.865S, 147°26.782E)-(01°39.785S, 147°23.136E)
15:26-17:16 RS-122 (01°40S, 147°24E)
18:26-20:16 RS-123 (01°39S, 147°03E)
18:52-18:58 Kite operation - Failure
21:15-23:05 RS-124 (01°16S, 146°56E)

Feb.19 (Wed) Local Time(-10h=UTC) Cloudy/Rain
00:23-02:20 RS-125 (00°40S, 146°54E)
03:23-05:02 RS-126 (00°06S, 146°53E)
06:20-07:23 RS-127 (00°00S, 146°53E)
06:27-09:04 Subsurface ADCP buoy Recovery
09:23-11:05 RS-128 (00°01S, 146°54E)
09:48-11:25 Subsurface ADCP buoy Deployment
11:52 Calibration → (00°00.325S, 146°52.423E)
12:45-14:27 RS-129 (00°00S, 146°50E)
15:45-17:26 RS-130 (00°00S, 146°18E)
17:00-17:43 CTD-40 (00°00S, 146°00E)
18:25-20:00 RS-131 (00°01S, 145°56E)
21:20-23:05 RS-132 (00°00S, 145°24E)
23:28-23:55 CTD-41 (00°00N, 145°00E)

Feb.20 (Thu) Local Time(-10h=UTC) Cloudy
00:27-02:13 RS-133 (00°00S, 144°58E)
03:21-04:50 RS-134 (00°00S, 144°27E)
05:51-06:21 CTD-42 (00°00S, 144°00E)

06:20-08:15 RS-135 (00°00S, 144°00E)
09:21-11:11 RS-136 (00°00S, 143°32E)
12:18-12:56 CTD-43 (00°00N, 143°00E)
12:50-14:28 RS-137 (00°00S, 143°00E)
15:40-17:30 RS-138 (00°01S, 142°37E)
17:40-18:30 Repair Water Sampler
18:21-20:00 RS-139 (00°18S, 142°14E)
20:00-20:38 CTD-44 (00°30S, 142°00E)
21:21-23:11 RS-140 (00°35S, 142°00E)
23:26-00:08 CTD-45 (01°00S, 142°00E)

Feb.21 (Fri) Local Time(-10h=UTC) Rain/Cloudy
00:23-02:00 RS-141 (01°00S, 142°00E)
02:59-03:40 CTD-46 (01°30S, 142°00E)
03:24-05:05 RS-142 (01°30S, 142°00E)
05:58-06:39 CTD-47 (01°55S, 142°00E)
06:24-08:14 RS-143 (01°55S, 142°00E)
09:25-09:48 RS-144 (02°24S, 142°00E)
09:52-10:30 CTD-48 (02°30S, 142°00E)
11:30-12:00 CTD-49 (02°40S, 142°00E)
12:45-14:35 RS-145 (02°40S, 142°00E)
15:00-16:30 Assemble Subsurface ADCP buoy
15:35-17:25 RS-146 (02°23S, 142°00E)
18:25-20:11 RS-147 (01°50S, 142°00E)
21:34-23:24 RS-148 (01°15S, 142°01E)

Feb.22 (Sat) Local Time(-10h=UTC) Fine
00:21-02:03 RS-149 (00°45S, 142°00E)
03:25-05:07 RS-150 (00°12S, 141°57E)
06:25-08:15 RS-151 (00°01S, 142°01E)
06:25-08:39 Subsurface ADCP buoy Recovery
09:16-10:14 Subsurface ADCP buoy Deployment
Calibration → (00°00.158S, 141°58.295E) 3384m
09:23-11:13 RS-152 (00°01S, 142°01E)
10:33-11:14 CTD-50 (00°01N, 141°58E)
11:23-16:24 Balloon operation
(00°01.280N, 141°57.648E) → (00°00.214S, 141°01.519E)
12:40-14:13 RS-153 (00°00S, 141°47E)
15:36-17:22 RS-154 (00°00S, 141°13E)
16:37-17:24 CTD-51 (00°00S, 141°00E)
18:28-20:18 RS-155 (00°00S, 140°51E)
21:25-22:55 RS-156 (00°00S, 140°20E)
23:14-00:01 CTD-52 (00°00N, 140°00E)

Feb.23 (Sun) Local Time(-10h=UTC) Cloudy | Rain
00:28-02:00 RS-157 (00°00N, 139°59E)
03:18-05:00 RS-158 (00°00S, 139°29E)
06:02-06:44 CTD-53 (00°00S, 139°00E)
06:23-08:13 RS-159 (00°00S, 139°00E)
09:40-11:17 RS-160 (00°00S, 138°44E)
12:52-14:42 RS-161 (00°41S, 138°21E)
15:10-15:52 CTD-54 (01°00S, 138°00E)

15:38-17:28	RS-162 (01°00S, 138°00E)	
18:33-20:15	RS-163 (00°35S, 138°00E)	
18:50-19:36	CTD-55 (00°30S, 138°00E)	
21:22-23:01	RS-164 (00°14S, 138°00E)	
22:28-23:08	CTD-56 (00°00S, 138°00E)	

Feb.24 (Mon) Local Time(-10h=UTC) Cloudy／Rain

00:24-01:10	RS-165 (00°10N, 138°00E)
02:08-02:50	CTD-57 (00°30N, 138°00E)
03:19-05:10	RS-166 (00°32N, 138°00E)
05:48-06:28	CTD-58 (01°00N, 138°00E)
06:20-08:10	RS-167 (01°00N, 138°00E)
09:17-09:58	CTD-59 (01°30N, 138°00E)
09:29-11:19	RS-168 (01°30N, 138°00E)
12:44-13:08	RS-169 (01°58N, 138°00E)
12:51-13:31	CTD-60 (02°00N, 138°00E)
15:29-15:58	RS-170 (02°12N, 137°43E)
17:30-19:40	Search ATLAS
18:16-19:04	RS-171 (02°26N, 137°24E)
21:20-23:10	RS-172 (02°30N, 137°24E)

Feb.25 (Tue) Local Time(-10h=UTC) Fine

00:21-02:10	RS-173 (02°30N, 137°22E)
03:20-05:08	RS-174 (02°28N, 137°20E)
06:23-08:10	RS-175 (02°26N, 137°25E)
06:30-07:50	Search ATLAS
08:30-10:21	ATLAS Deployment (02°26.29N, 137°25.66E) 4489m
09:47-11:37	RS-176 (02°26N, 137°28E)
10:47-11:31	CTD-61 (02°28N, 137°24E)

Feb.26 (Wed) Local Time(-10h=UTC) Fine

	Cruise for Palau escaping from rough sea
24:00	Time adjustment (24:00 → 23:00)

Feb.27 (Thu) Local Time(-09h=UTC) Fine

	Cruise for Palau
09:00-11:30	Packing measurement systems

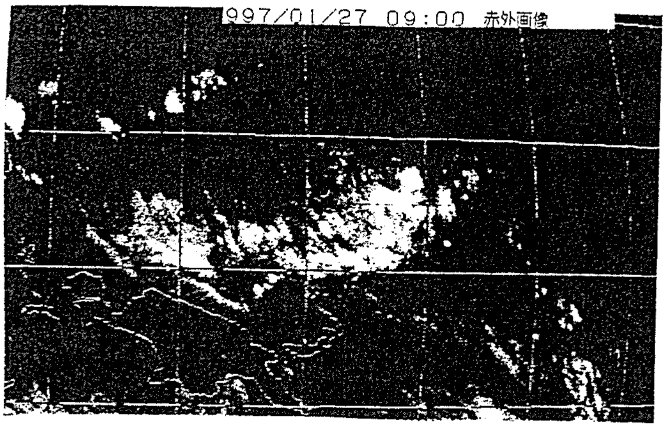
Feb.28 (Fri) Local Time(-09h=UTC) Fine

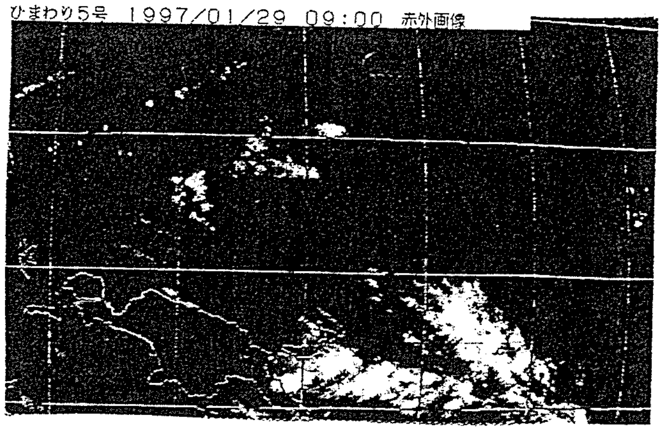
12:00	Arrive Palau

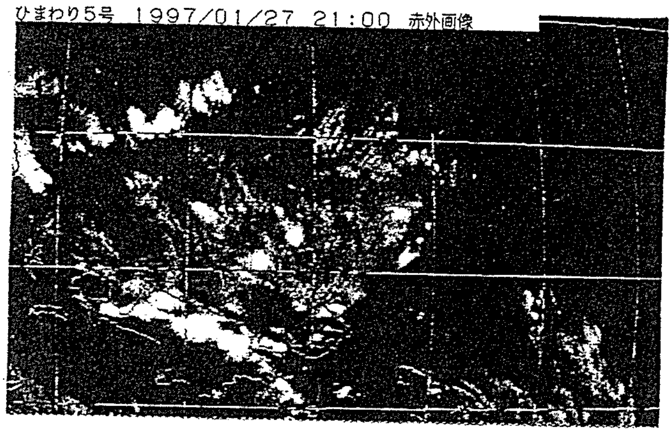
Mar.01 (Sat) Local Time(-09h=UTC) Fine

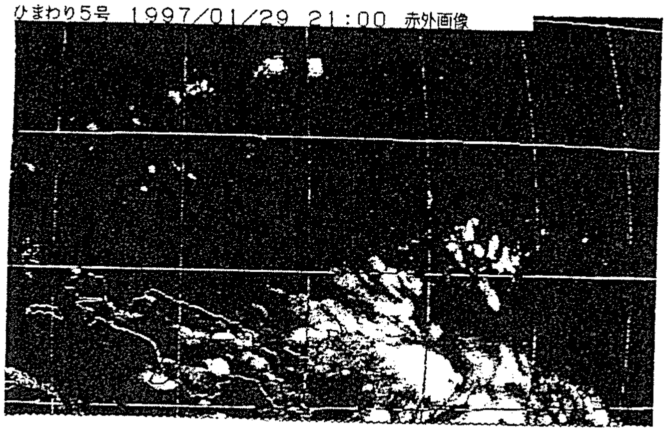
08:00-12:00	Unloading the gear of PMEL, NCAR, and BNL

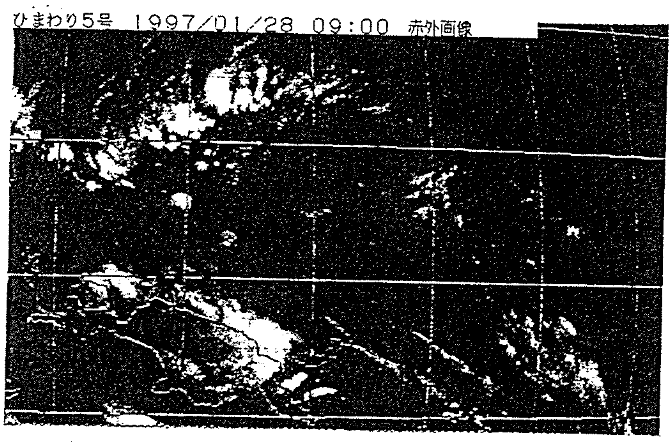
A2. GMS IR Images

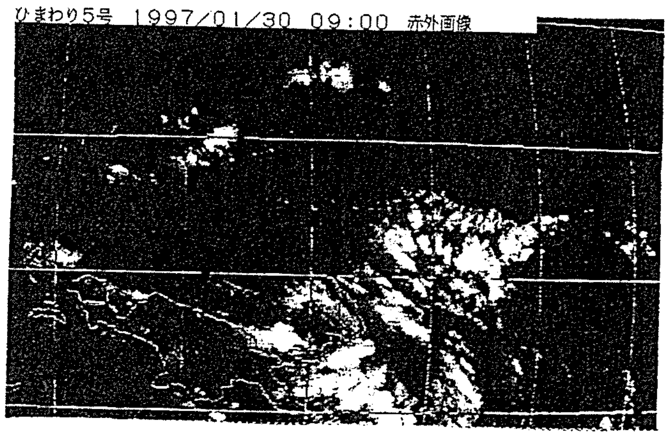


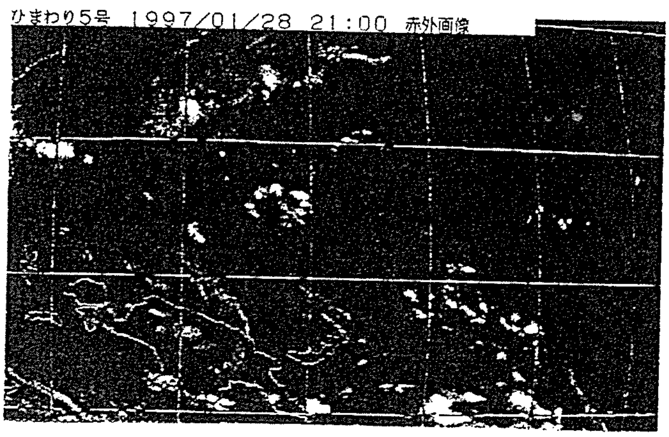


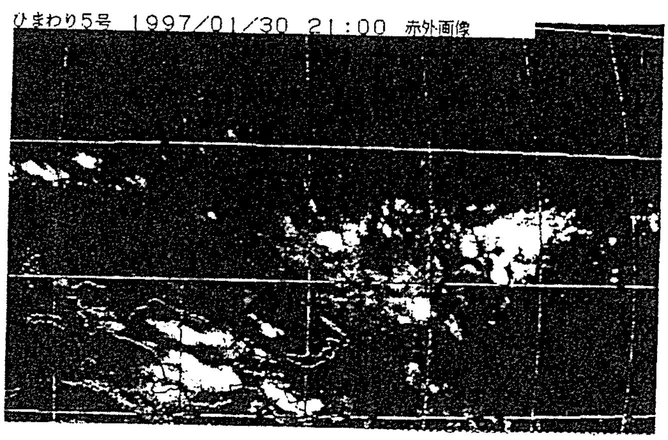












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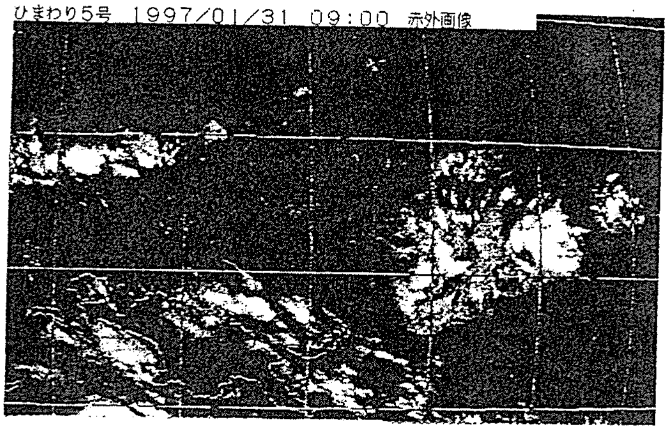
ひまわり5号 1997/01/31 09:00 赤外画像



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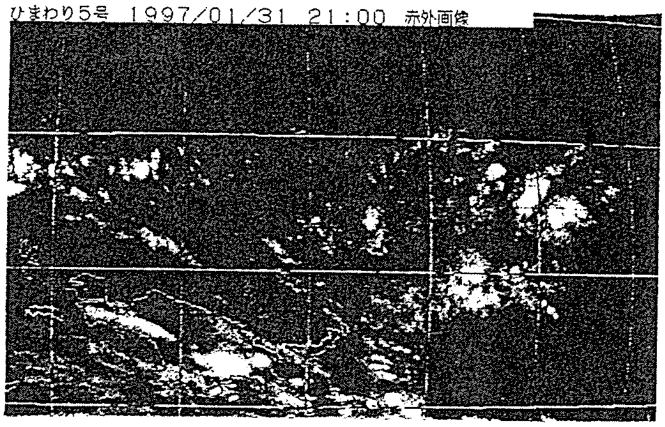

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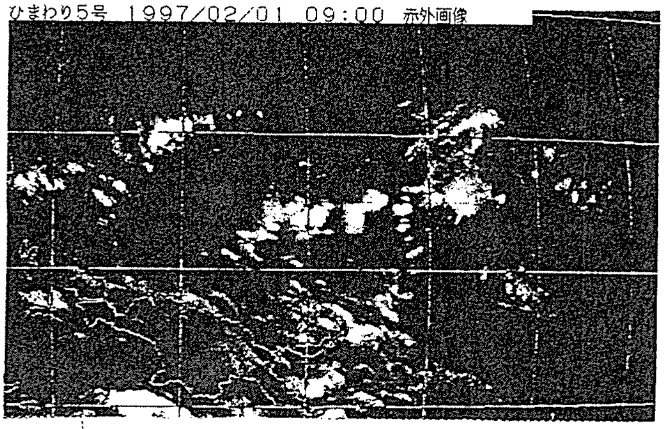

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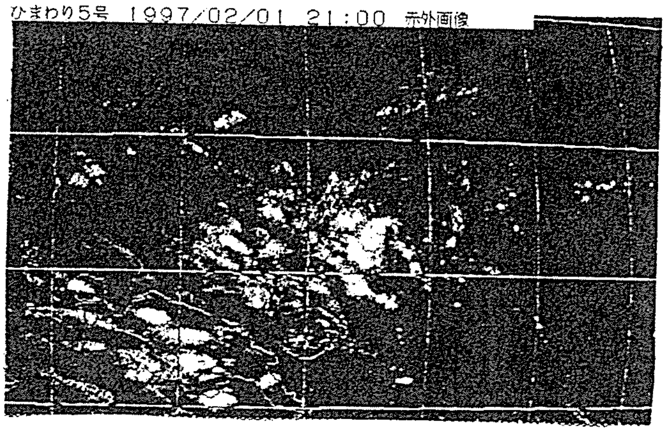

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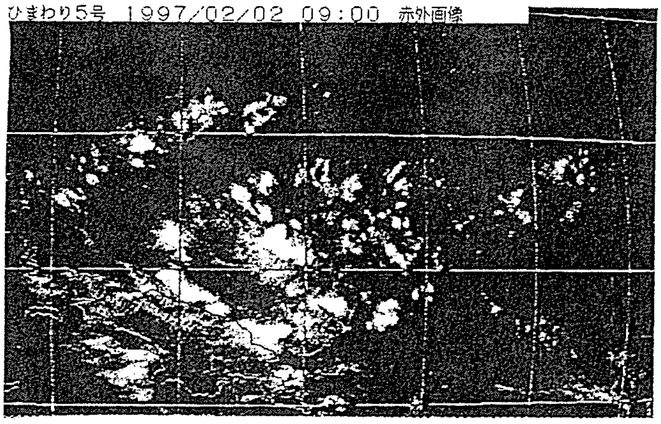

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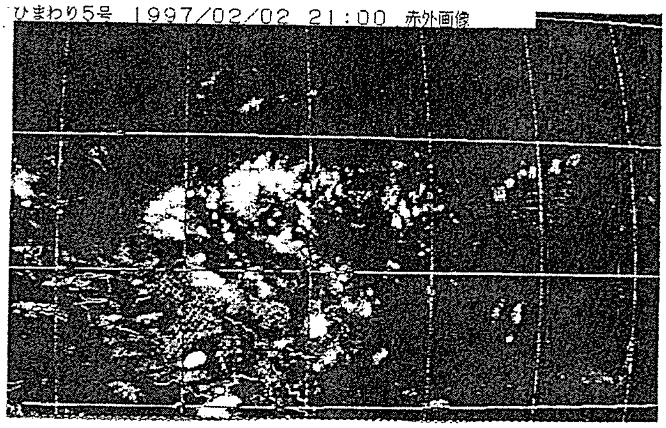

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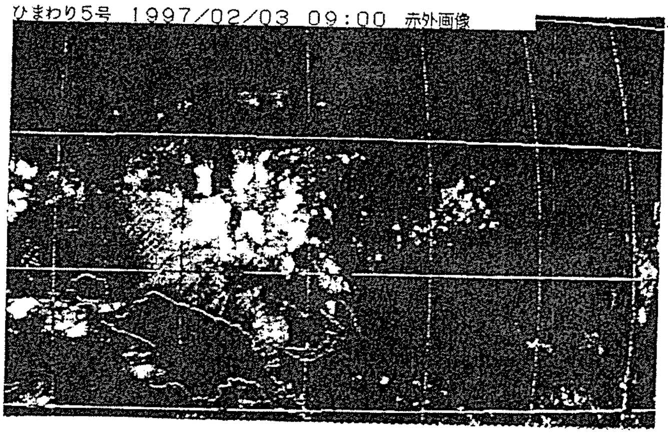

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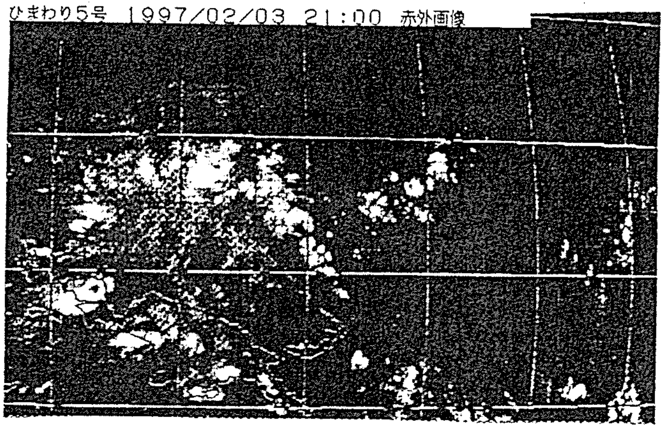

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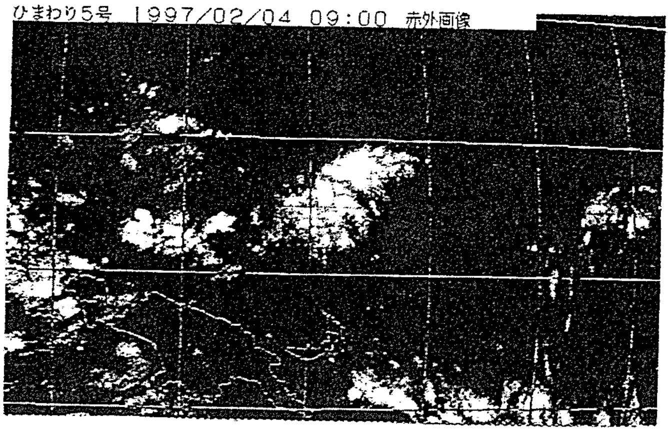

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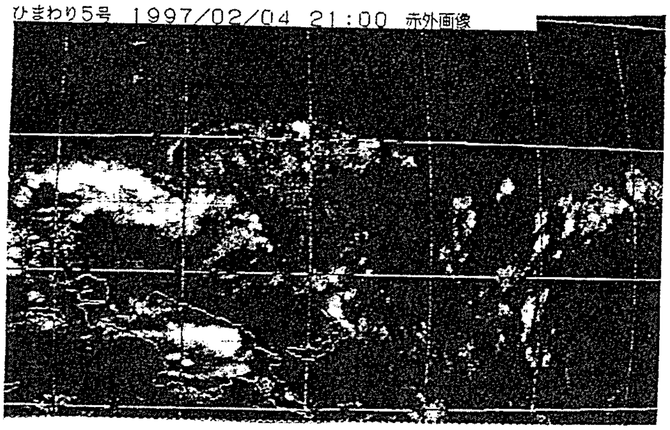

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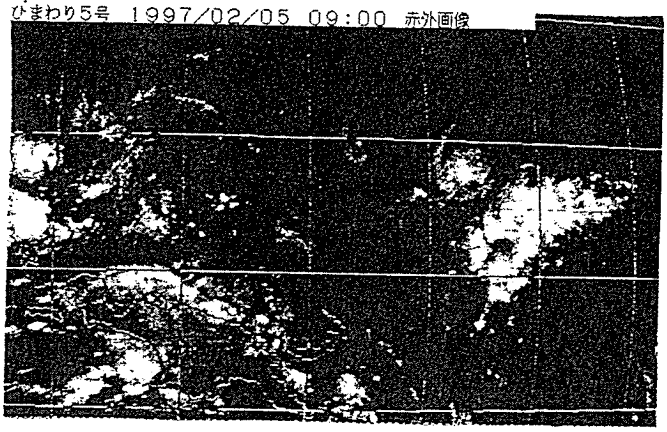

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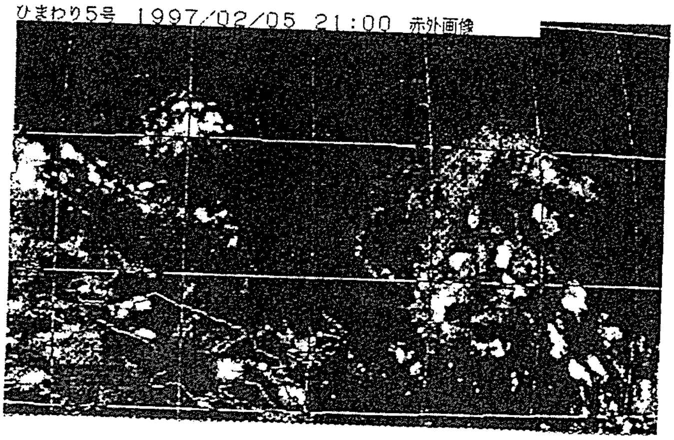

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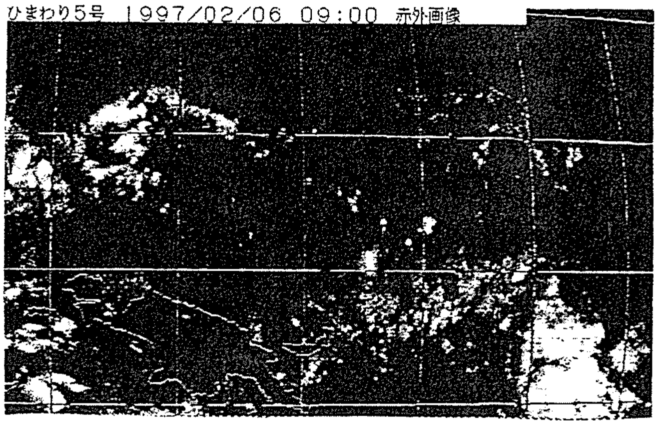

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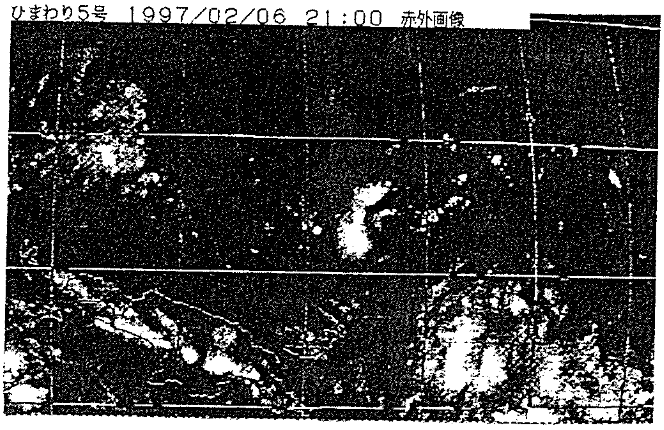

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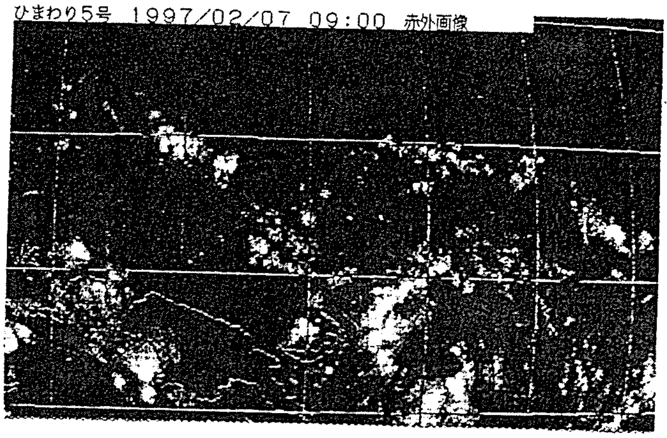

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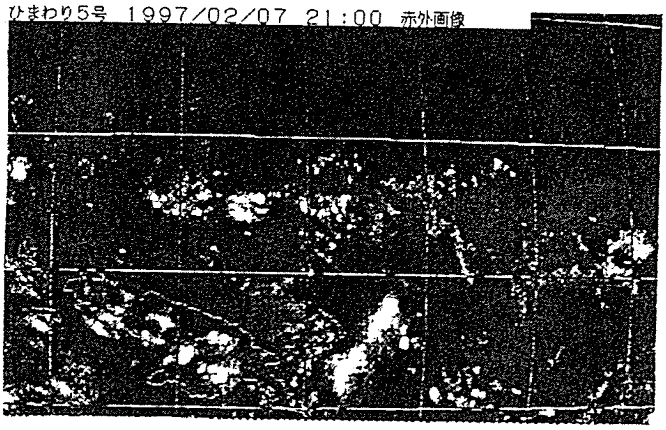
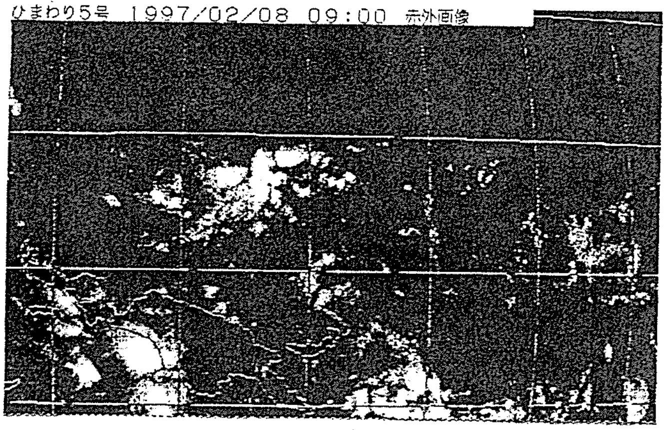
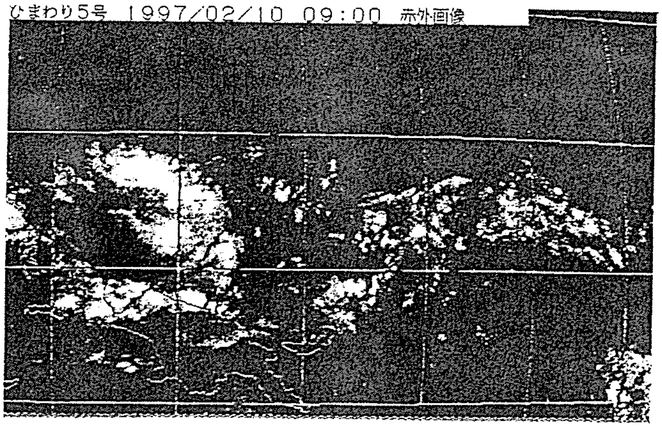


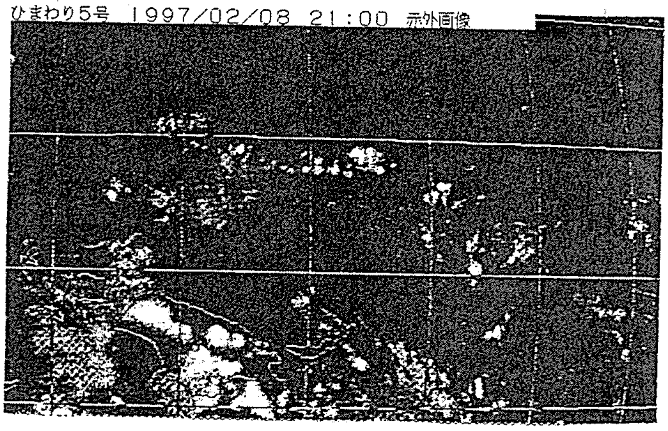
ひまわり5号 1997/02/08 09:00 赤外画像



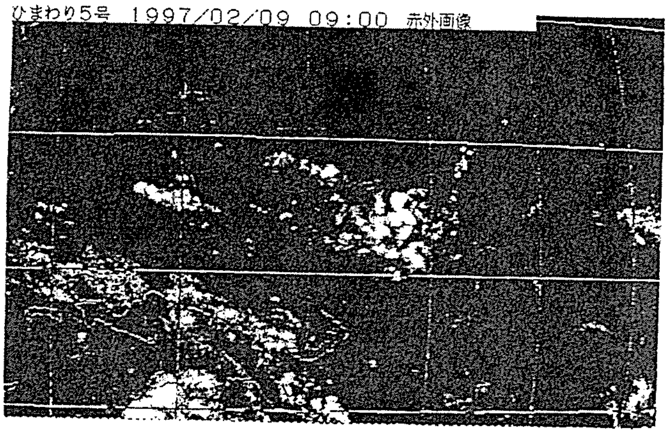
ひまわり5号 1997/02/10 09:00 赤外画像



ひまわり5号 1997/02/08 21:00 赤外画像



ひまわり5号 1997/02/09 09:00 赤外画像



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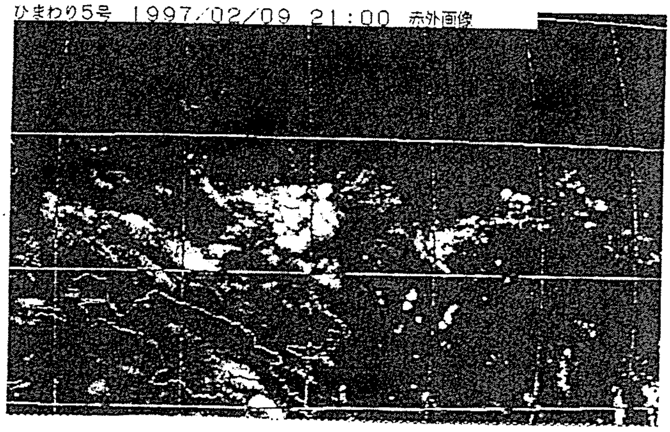
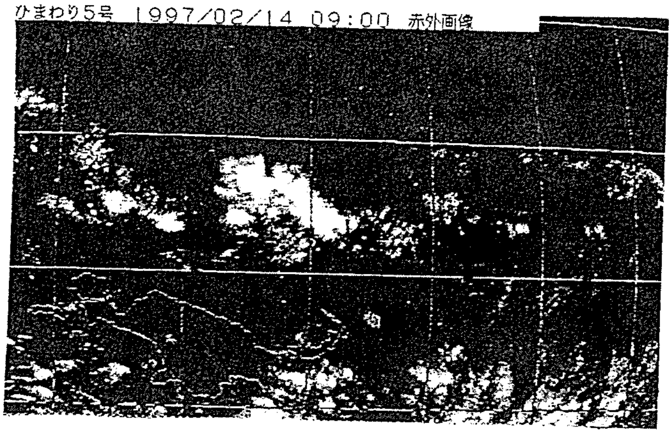


ひまわり5号 1997/02/14 09:00 赤外画像



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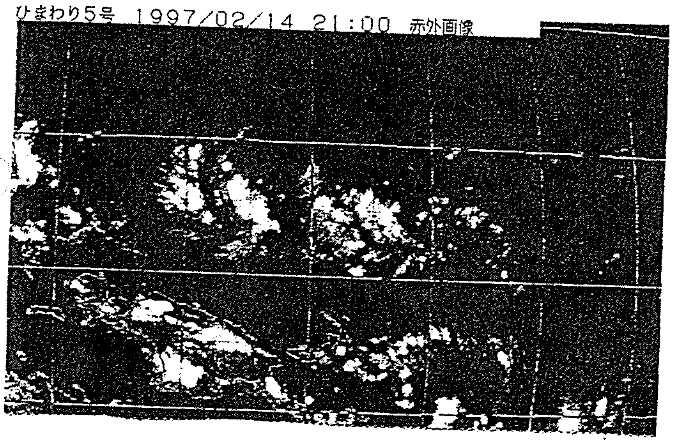

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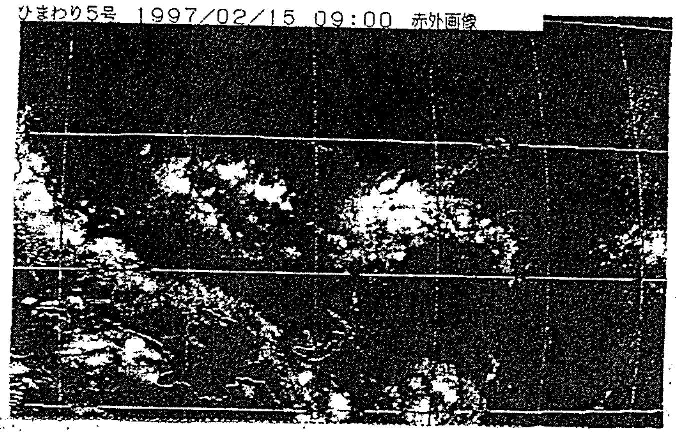

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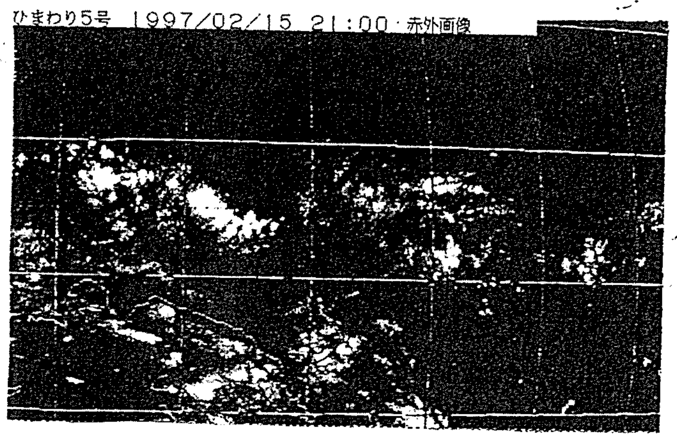

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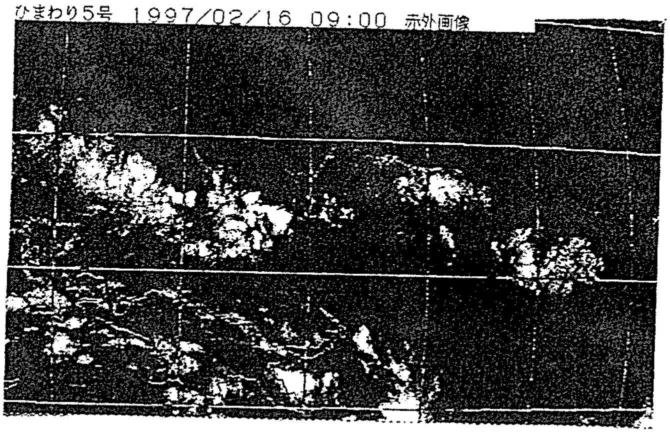

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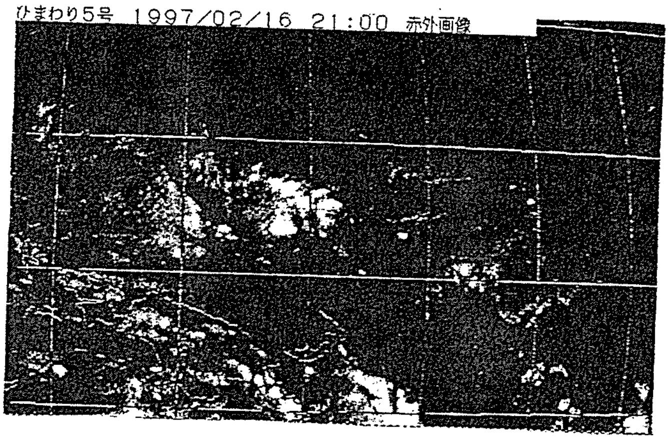
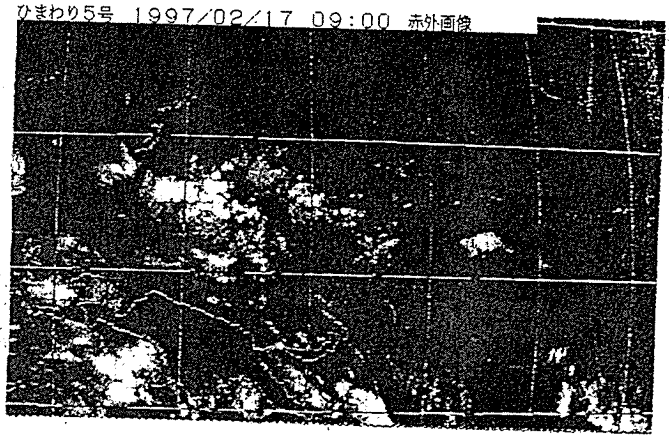
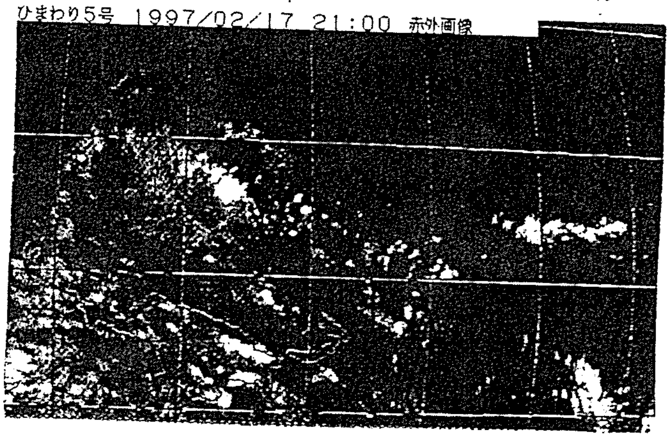


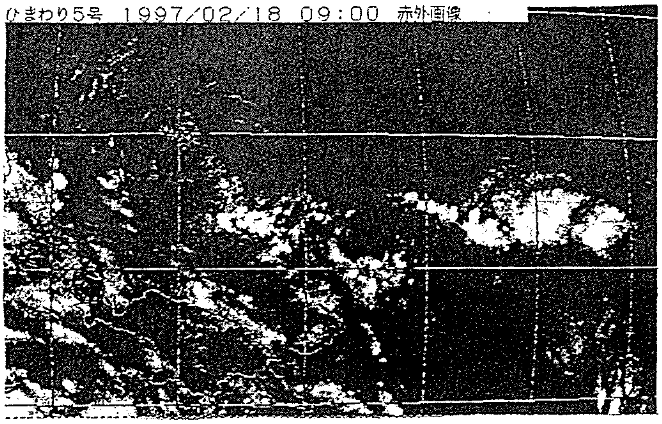
ひまわり5号 1997/02/17 09:00 赤外画像



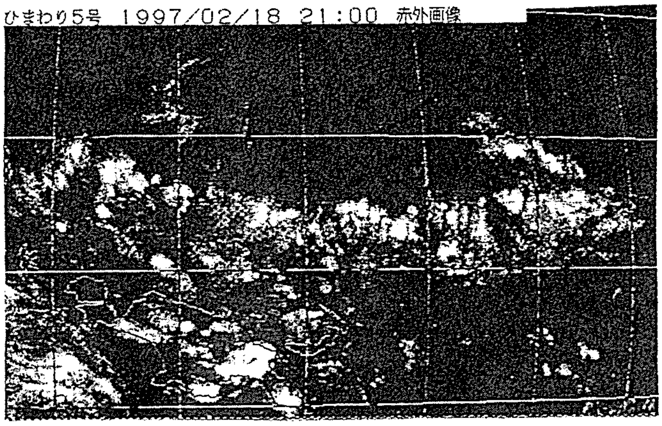
ひまわり5号 1997/02/17 21:00 赤外画像



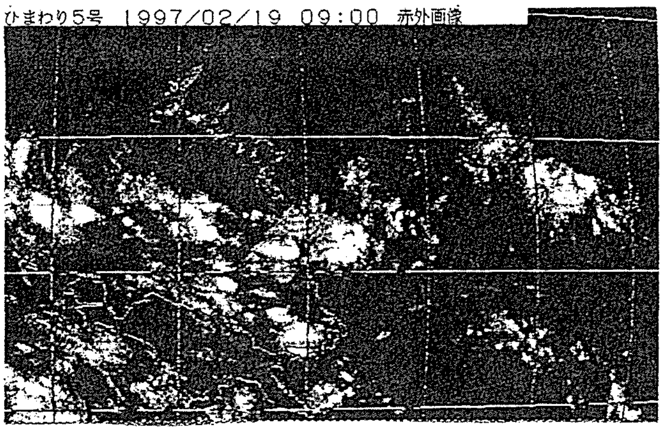
ひまわり5号 1997/02/18 09:00 赤外画像



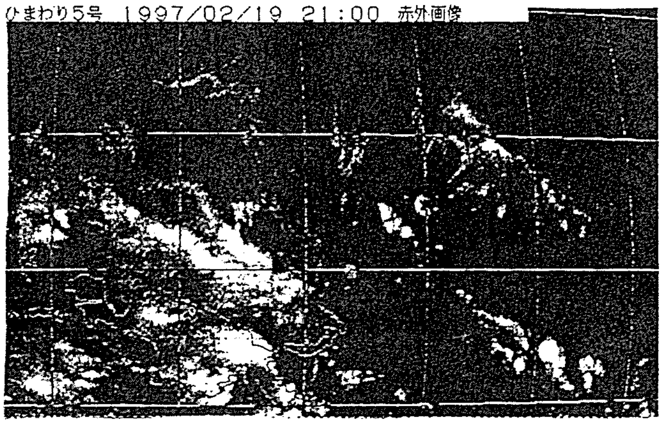
ひまわり5号 1997/02/18 21:00 赤外画像



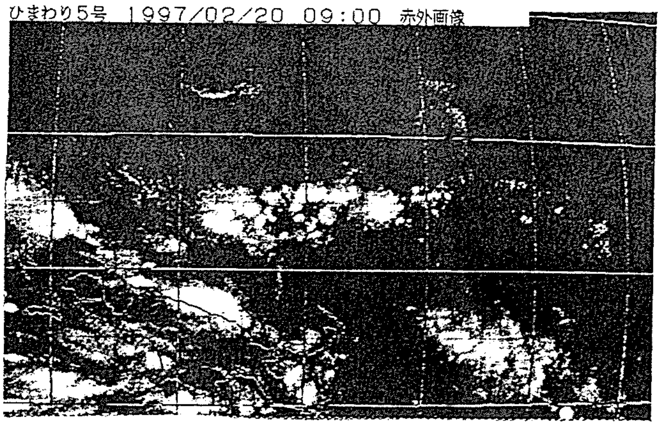
ひまわり5号 1997/02/19 09:00 赤外画像



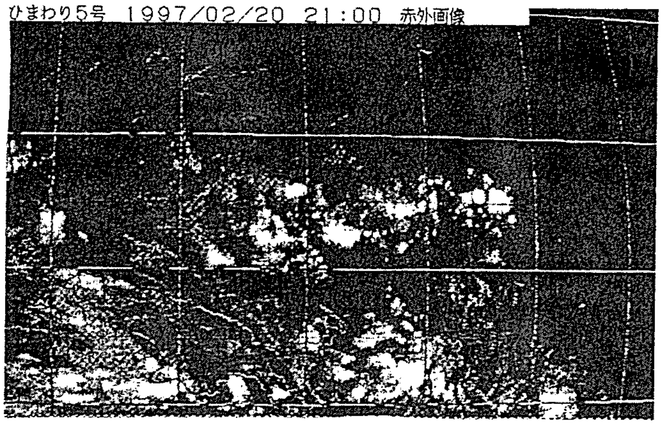
ひまわり5号 1997/02/19 21:00 赤外画像



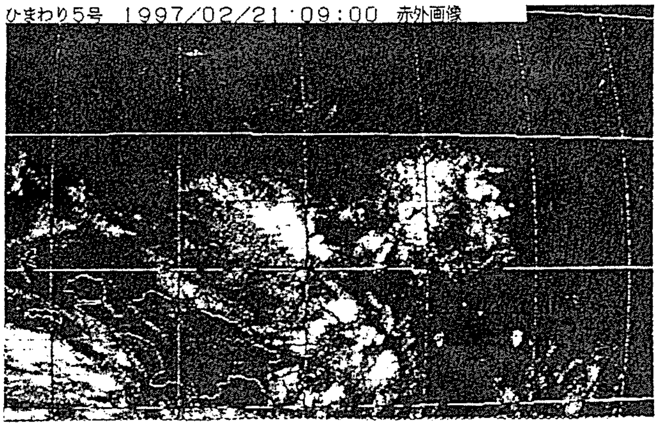
ひまわり5号 1997/02/20 09:00 赤外画像



ひまわり5号 1997/02/20 21:00 赤外画像



ひまわり5号 1997/02/21 09:00 赤外画像



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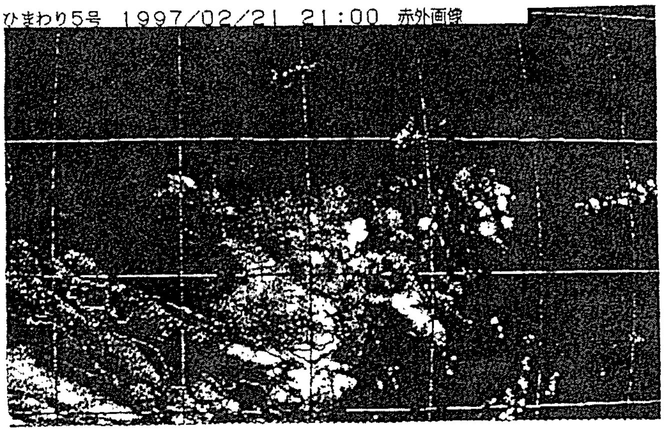
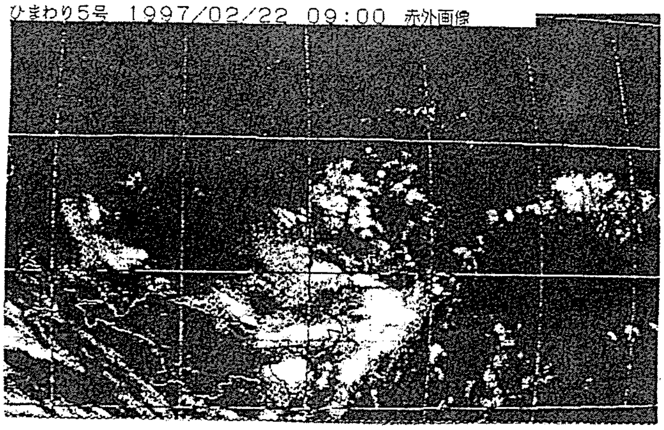
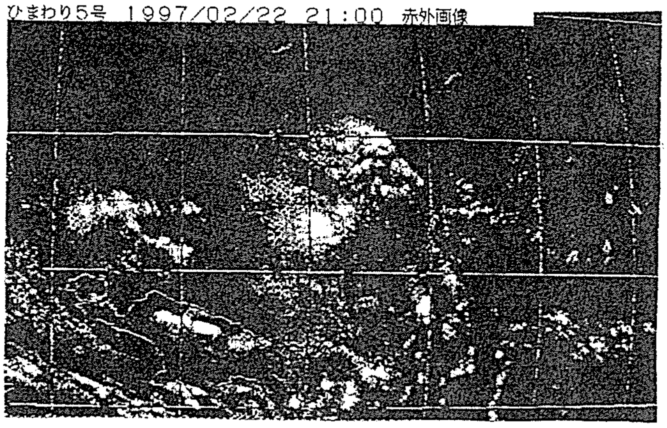
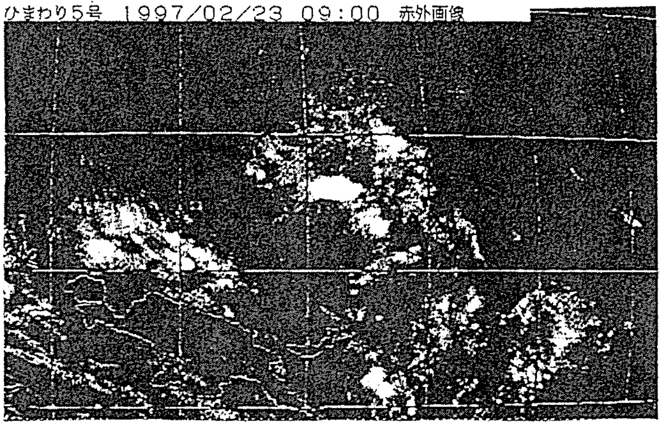




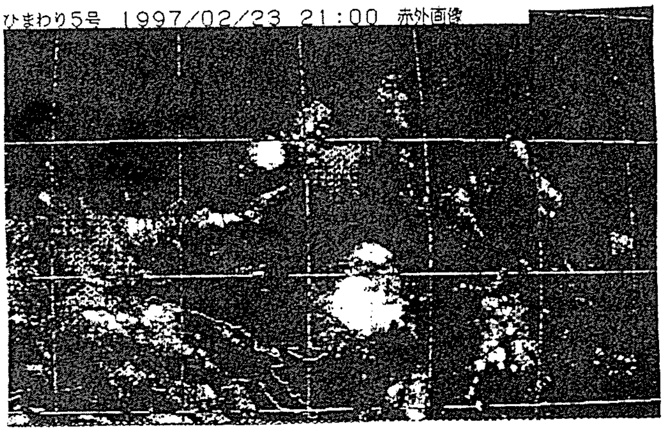
ひまわり5号 1997/02/22 09:00 赤外画像



ひまわり5号 1997/02/22 21:00 赤外画像



ひまわり5号 1997/02/23 09:00 赤外画像



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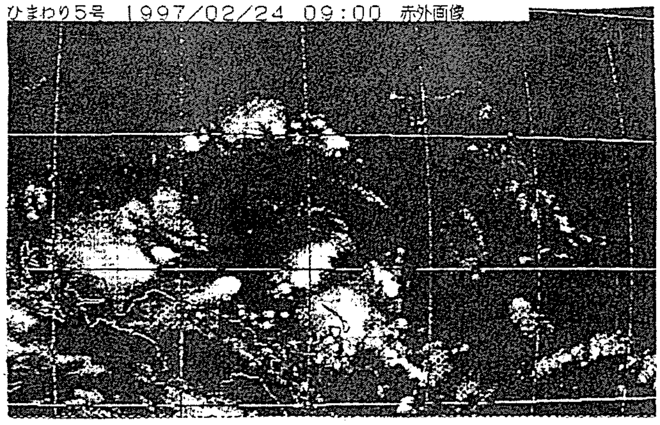
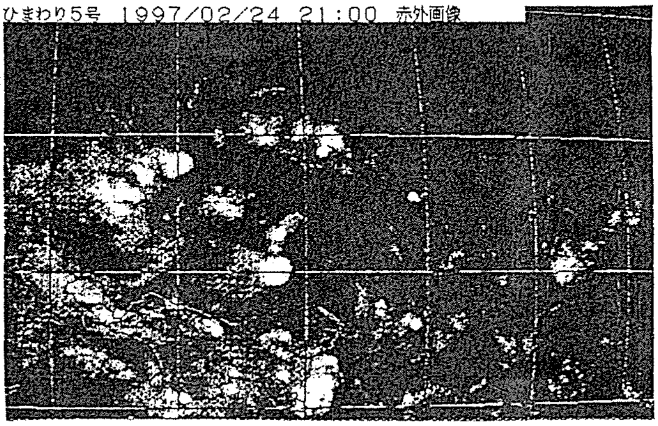
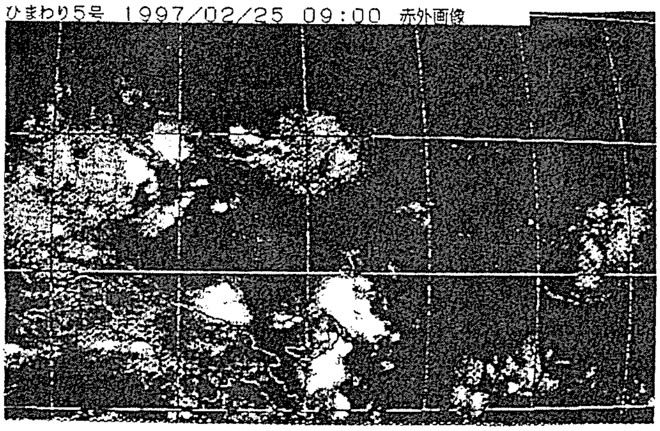


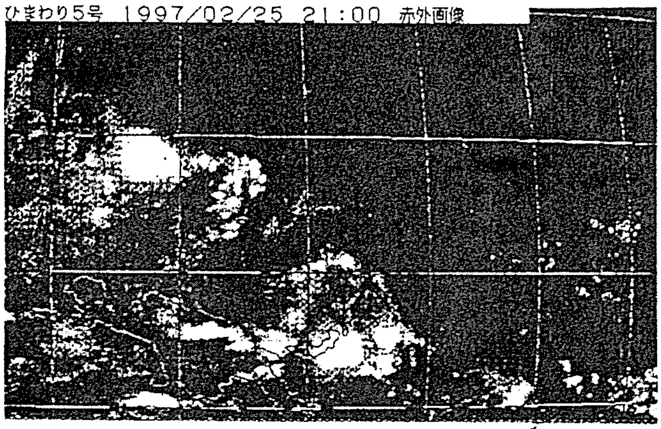
ひまわり5号 1997/02/24 09:00 赤外画像



ひまわり5号 1997/02/24 21:00 赤外画像



ひまわり5号 1997/02/25 09:00 赤外画像



ひまわり5号 1997/02/25 21:00 赤外画像

Appendix 3.　ＣＴＤ・採水システム故障レポート

今航海では以下に記すCTD・採水器関連のトラブルが発生した。
（１）CTDシステムの故障。
（２）代用CTD（トモグラフィーグループ所有）の採水未対応による採水の中断。
（３）D.O.センサー用ケーブルとアルチメーター用ケーブルの取り違え。
（４）ロゼット採水器の駆動系トラブル。

まず、測点Ｃ10においてCTD～船上局間のデータ通信が不能となったため、各部の導通テストを行った。その結果、8000mウインチに巻いてある同軸ケーブルそのものに断線が起きたものと判断して対応した。復旧作業は適宜ケーブルを繰り出して、導通が復活するまで切断を数回繰り替えした。切断したケーブル長は4900mであった。

データ通信が不能になった原因として、当初はケーブル内での断線と判断したが、実際のところ断線ではなくショートしていた可能性が高い。ケーブル切断前の抵抗値は、105Ωを示し、切断していく毎に抵抗値は減少していった。つまり、測定した抵抗値は正常な値で元々導通はあり、このことから断線ではないと考えられる。

今回の復旧作業で問題となる点は、テスターの設定が、４０Ω以上は「導通無し」になっていたこと。この設定により導通があったにも関わらず「導通無し」と判断し、ショートしているか否かを確認しなかった点である。

ケーブルトラブル復旧後、測点Ｃ13においてCTD本体および船上局に原因不明の故障が発生し、船上での修復が不可能であったため、トモグラフィーグループ所有のCTDを代用した。しかしロゼット採水器やカローセル採水器を接続して採水を行う場合には、専用のインターフェースとモデムがCTD内に内蔵されていなければならないが、このCTDには両方とも装備されていないことが判明し、以降の採水は断念せざるをえなかった。

レグ１終了後にチュークで、急遽空輸してもらったCTDなどを受け取って、作動確認を行った。しかしレグ２の最初の測点Ｃ２９でD.O.値が正常な値を示さないためケーブルの確認を行ったところ、日本から届いたケーブルがアルチメーター用のケーブルであることが判明した。よって、次測点Ｃ３０からレグ１で使用していたケーブルに交換し直し、観測を行った。
D.O.センサー用のケーブルとアルチメーター用のケーブルの外観は全く同じであり、相違があることに気が付かずまとめて保管していたことが原因である。

測点Ｃ40において、ロゼット採水器の駆動部にトラブルが発生し、一時採水ができなくなった。原因は、採水器内部にあるステッピングモーターを固定しているねじが緩んだためにモーターが下がってしまい、ニスキンボトルの蓋を閉めるピンに動力が伝わらず、蓋が閉じなかった。処置としてロゼットを分解し、モーターを定位置に戻し、ねじを締め直すことで解決した。また、ロゼット内部はシリコンオイルで満たされているが、今回はメーカー指定のオイルが船上にはなかったため、絶縁オイルを代用した。

中断していた採水は、測点Ｃ44から再開された。しかしその後の採水では、採水器から採水信号は送信されるものの、１・２本蓋が閉まらない場合が何回かあった。この原因は未だ不明である。

今航海後の事後処理期間に於いて、メーカー指定のシリコンオイルに交換すること、また蓋が時々閉まらないその原因の究明が必要である。

今後の課題としては、単に予備として持ってくるのではなく、通常使用するセンサーと同様、正常に作動することを確認し、何かあった場合は、予備として機能させなければならない。

備考

8000mウインチケーブル切断記録

Time	切断ケーブル長(m)	電気抵抗(Ω)	備考
08:05	0	105	作業開始
08:10	200		ｱｰﾏｰﾄﾞ内部まで錆発生
08:29	1427	70	
08:40	2000	63	08:47 ｹｰﾌﾞﾙ根本とｽﾘｯﾌﾟﾘﾝｸﾞ間導通試験（通有り）
09:10	3000	50	
09:20	4900		

DATE 2 Feb.'97

採水器のコントロールについて

採水器作動条件

採水器	条　　　件
GO社製ロゼット採水器（1015）	・SBE11plusとSBE9plusのモデムファームウエアバージョンが一致していること ・バージョンは、1.0以上 ・SBE9plus内部に1015ロゼットインターフェースが入っている ・SBE11plusモデムインターフェースボードのDIPスイッチの設定がoff,on,on,on ・1015内部スイッチがノーマルまたはリバースにより9plusと接続ケーブルが異なるので確認する リバース時：３ピンピグティルのピンはそれぞれ同じ番号のものと導通がある ノーマル時：１、２ピンが交差している（極性が反転） 1015インターフェースが組み込まれている9pulsではデッキユニットのチャージボタンを押すとJT4（トップエンドキャップ３ピンバルクヘッド）Pin1,2間に約70Vの電圧がある
SBE32ｶﾛｰｾﾙ採水器	・SBE11plusとSBE9plusのモデムファームウエアバージョンが一致していること ・バージョンは、2.0以上 ・SBE11plusモデムインターフェースボードのDIPスイッチの設定がon,on,on,on

ロゼット採水器の内部オイルについて

メーカー指定オイル

・20エボスのシリコンオイル

今回、内部オイル不足分を補ったオイル

・コスモ　高圧絶縁オイル

K8CA04D0K0　　T6-K-1