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MR98-K01

Preliminary Cruise Report

Feb. 1998

Japan Marine Science and Technology Center

Contents

1. Preface

MR98-K01 Cruise Chief Scientists
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Japan Marine Science and Technology Center

This volume includes the preliminary report of the MR98-K01 cruise. The cruise was carried out by using the R/V Mirai from Oct. 30, 1998 to Dec. 16. Prior to this cruise, JAMSTEC had series of shakedown cruises for this newly remodeled vessel. The MR98-K01 cruise is the first cruise with scientists from universities and national research institutes as well as JAMSTEC scientists on board.

Goals of the cruise were to study the biogeochemistry of northwestern North Pacific. More specifically, we planed (1)to assess the spatial and temporal variation of flux of CO_2, (2) to clarify the mechanisms to control the biological pump and its role in the carbon cycle, (3) to clarify transportation processes of dissolved materials in conjunction with the formation of intermediate water, and (4) to evaluate the fluxes of carbon and other materials carried by particulate matter to the interior of the deep ocean, and their spatial and temporal variation.

The cruise had two legs. We had planed to survey the northern part (>42°N) of the area for the first leg and the southern part (<45°N) for the second leg. However, bad weather prevented us to complete the planed sampling in the northern area. Even though Mirai is supposed to be able to sustain a rough sea (and it did), sampling gears could not withstand violent wave motion and strong wind, and/or it was too dangerous to handle them. We were forced to change our sampling plan. For the second leg, we visited the majority of the planed stations, where samplings were carried out.

Although the sampling was hampered especially during the first leg due to the bad weather, which we anticipated, we have collected a lot of samples and data. We really appreciate captain Akamine, chief officer Hashimoto and crew members for their hard works. They showed the professional skill even after long working hours under difficult conditions. Without their help, the cruise would have never been so fruitful.

2. Outline of MR98-K01

2.1 Cruise summary

Makio Honda

Japan Marine Science and Technology Center

Objective of this cruise was the acquisition of biogeochemical data and the verification of biogeochemical material's cycle in the northwestern North Pacific in winter season when enough oceanographic data has not been obtained before. We planed to visit nine stations located in higher than 42°N during the first leg. (October 30 - November 22) and sixteen stations lower that 40°N during the second leg. (November 24 - December 16).

Institutions and universities which participated this cruise are as follows:

Japan Marine Science and Technology center (JAMSTEC)
National Institute of Environmental Science (NIES)
National Institute for Resources and Environment (NIRE)
Japan Meteorological Agency (JMA)
Hokkaido University
Tokyo University
Nagoya University
(*Technical support*)
Marine Works Japan Ltd. (MWJ)
Global Ocean Development, Inc. (GODI)

Unfortunately, we were in trouble for the strong wind and the big wave, especially during the first leg., (Fig. 1) and, therefore, could not visit some stations and not conducted scheduled observations perfectly (Fig. 2) even if our research vessel "MIRAI" with well-trained crews is one of the biggest ocean R/V in the world. However, we succeeded to carried out various kind of observation and obtain valuable data in winter season in the northwestern North Pacific thanks to enthusiastic efforts of cruise participants and crews.

Beside of the meteorological observation, conducted observation and analysis were as follows (Institutions in the parentheses are in charge for each observation):

(1) Hydrocasting

At approximately nineteen stations, we conducted water sampling with RMS (Rosette Multi-bottle array water sampling system) with CTD (SBE 9 plus). These sea water were or will be used for the following analysis:

DO, nutrients (JAMSTEC, NIES)
Carbonate chemistry: pH, TCO_2, TALK, ^{13}C, ^{14}C (JAMSTEC, NIES)
Pigments (JAMSTEC, Nagoya Univ. Hokkaido Univ., NIES)
Trace metal (JAMSTEC)
Trace gas: DMS, CFCs, N_2, Ar (Hokkaido Univ.)
Radionuclides (JAMSTEC, NIRE)

Fig. 3 shows the vertical profile in pH (sea water scale at 25°C) at each station (uncorrected). The pH profiles at station KNOT (solid circles and solid squares) and station 1 (open circles) have convex shapes toward the sea surface, which is indicative of that the intensity of upwelling at both stations located in higher than 42°N are relatively higher than those at the other stations. At station KNOT, pH profile observed in November (solid circles) showed the clear minimum around 250 m. However, this clear minimum disappeared on the pH profile observed in December (solid squares) and the surface mixed layer became thicker. Judging from this difference, it can be said the winter season (from the oceanographic point of view) had come during the second leg.. Ongoing analysis for the above chemical components will show more clear picture concerning the biogeochemistry this area in winter season.

(2) Underway measurements (JAMSTEC, NIES)

Along the cruise truck, pCO_2, TCO_2, nutrients, and salinity, temperature in the surface sea water were continuously measured by an automated system installed on R/V "MIRAI".

(3) Sea floor sediment coring (NIRE)

Sea floor sediment and sea water above the sea floor was collected at station KNOT (40°N, 165°E) by a multiple core sampler. Radionuclides and nutrients in the sediment and pore water will be measured at the laboratory.

(4) Drifting sediment trap experiment (JAMSTEC, NIRE, NIES, Nagoya Univ., Hokkaido Univ)

In order to collect settling particulate matters in the shallow water, drifting sediment trap experiments were conducted at station KNOT (44°N, 155°E) and 20 (40°N, 165°E). Sediment trap mooring system with 20 sets of "Knauer type trap" was drifted for few days. Thanks to the GPS buoy system, the drifting speed and direction

of the mooring system was monitored during the experiment and the mooring system was recovered successfully. Fig. 4 show the preliminary result for vertical profiles in the total mass flux. The total flux decreased with increased depth and its decrease is drastic above 100 m. Some of collected sample was filtered and the others were stored in the refrigerator on board. These samples will be distributed to the trap group and, in future, organic and inorganic carbon, opal, carbonate, carbon and nitrogen stable isotopes, radionuclides, and zoo-plankton in the sample will be measured.

(5) Atmospheric observation (JAMSTEC, Tokyo Univ.)

Aerosol over the ocean were collected with the air sampler installed on the flying bridge, and its particle size and concentrations of organic carbon and inorganic carbon were measured on board. Aerosol filter and rainwater samples will be analyzed for major inorganic ions (Na^+, Ca^{2+}, NH^{4+}, SO_4^{2-}, NO_3^- and MSA) by ion chromatography.

(6) Primary productivity (NIES, Nagoya Univ.) and bio-optical measurement for ocean color remote sensing (Hokkaido Univ.)

Using ^{13}C as a tracer, *in situ* and *in vitro* incubation experiments were carried out at station KNOT and station 20. ^{13}C uptaked by phytoplankton will be measured by mass spectrometry and primary productivity in winter season in this area will be presented.

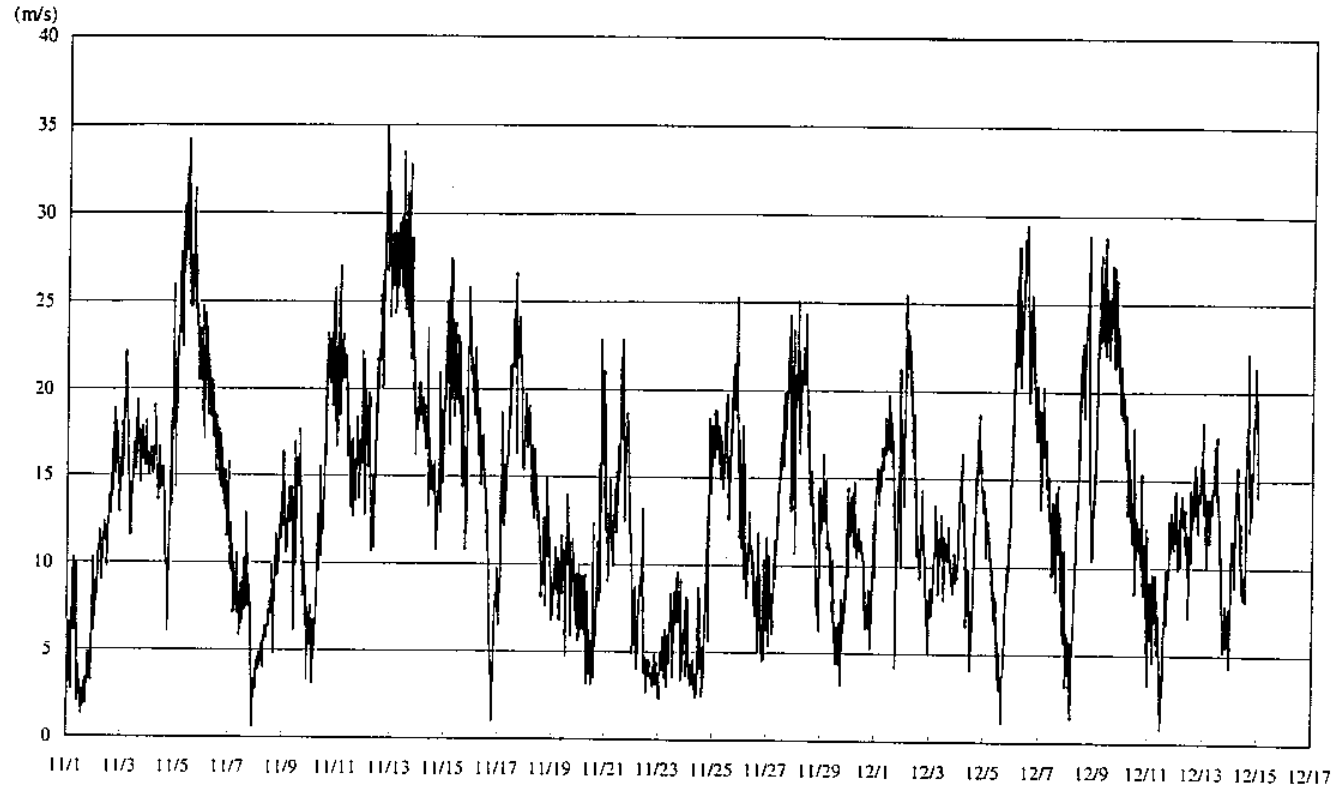
In addition, the underwater spectral downward irradiance and upward radiance were measured in order to validate and develop bio-optical algorithm for new series ocean color sensors such as Sea WiFS and GLI.

(7) XBT / XCP, CTP-ALACE float (JMA)

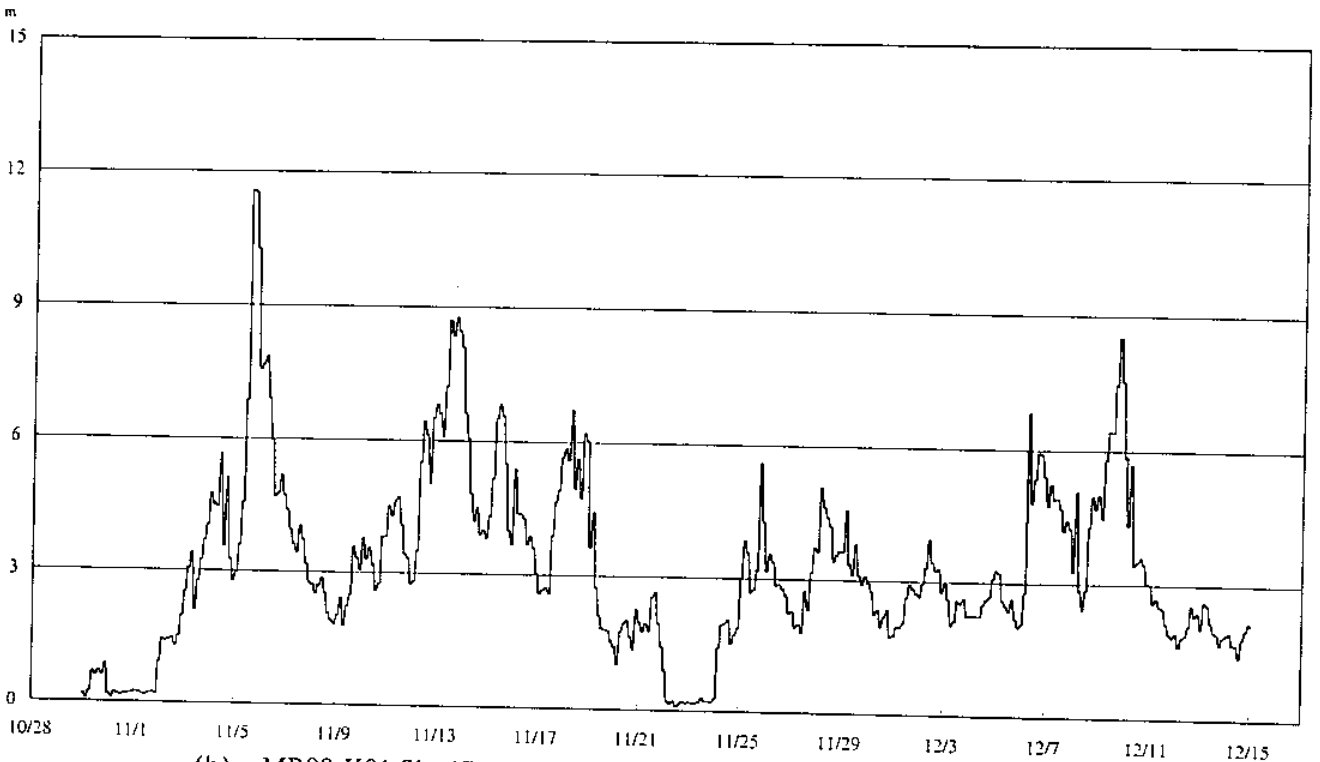
In order to investigate the structure and variation of sub-surface temperature and current in the subarctic circulation area focusing on the formation, advection, and diffusion of the North Pacific Intermediate Water (NPIW), XBT / XCP, and CTP-ALACE float were deployed along the cruise truck. Fig. 5 show some vertical sections in temperature.

(8) Geological survey and Doppler radar observation (JAMSTEC, Hokkaido Univ.)

In addition to the biogeochemical and physical oceanographic observations, geological survey such as magnetic field, gravity and sea floor topography observation, and cloud observation by Doppler radar were also carried out.

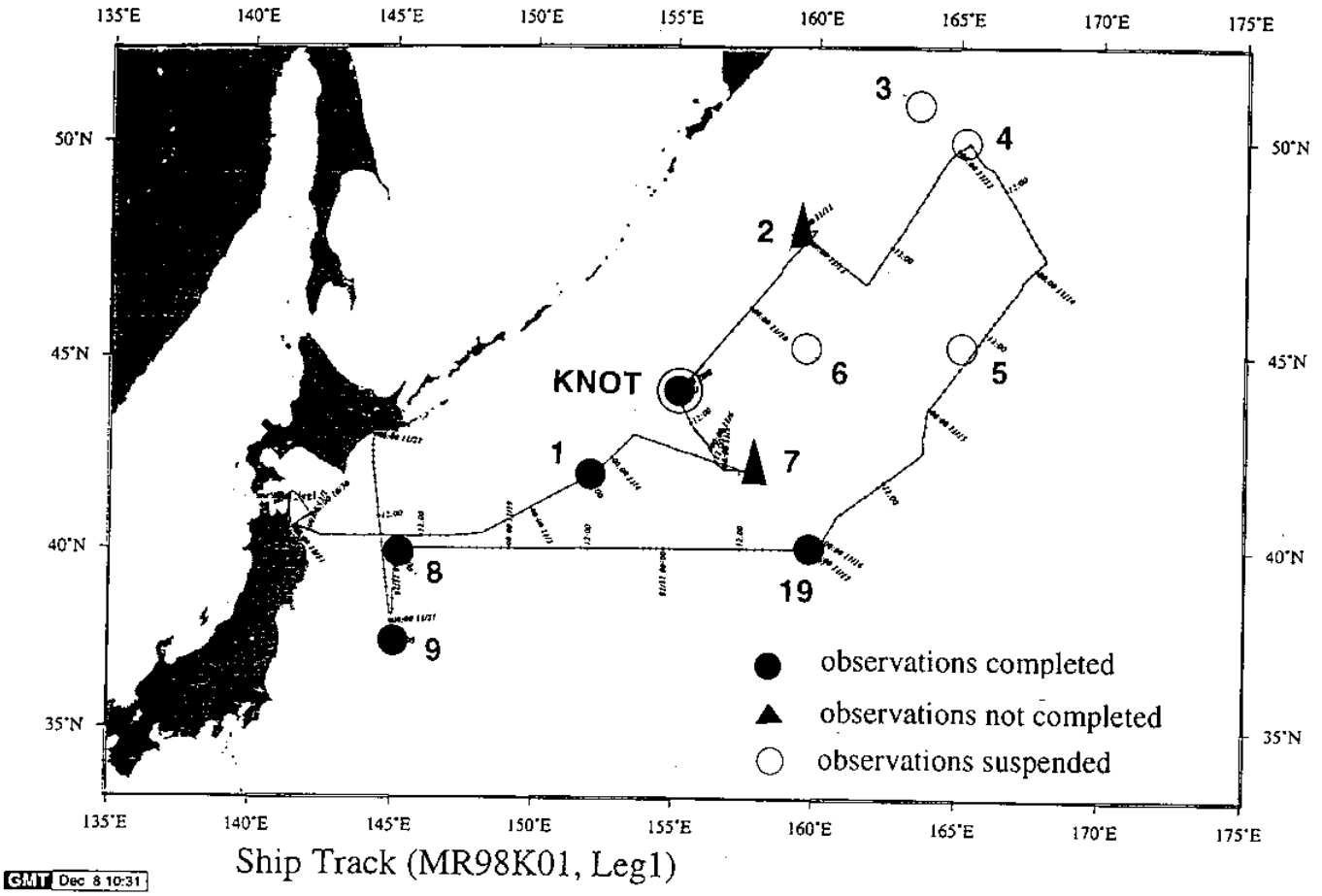


(a) MR98-K01 10 minute Average Wind Speed(m/s) measured at every hour (UTC)

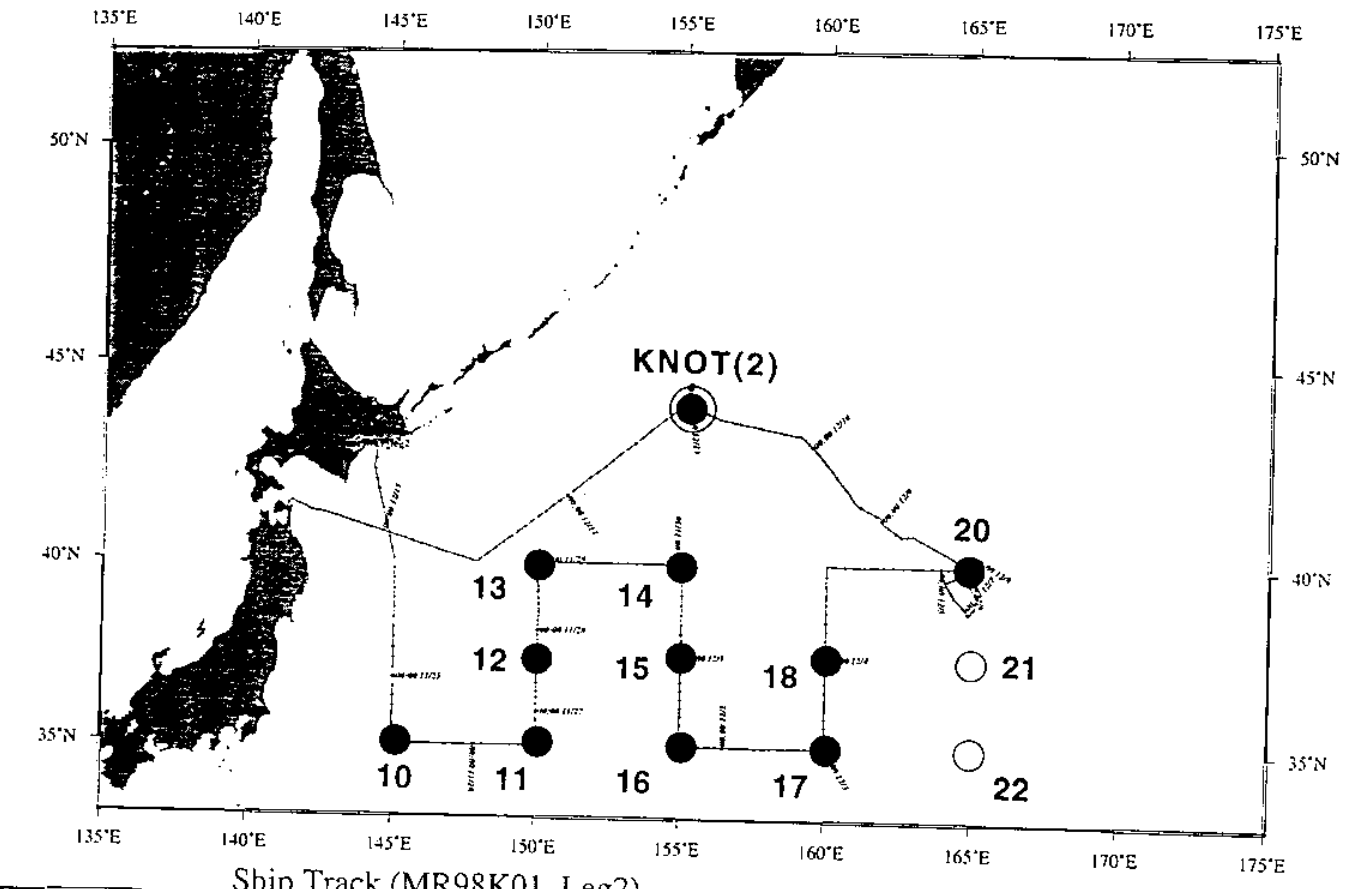


(b) MR98-K01 Significant Wave Height(m) measured first20 minute at every 3 hours(UTC)
(0200,0500,0800,1100,1400,1700,2000,2300)

Fig. 1 Wind speed (a) and wave height (b)



Ship Track (MR98K01, Leg1)



Ship Track (MR98K01, Leg2)

Fig. 2 Cruise truck and stations

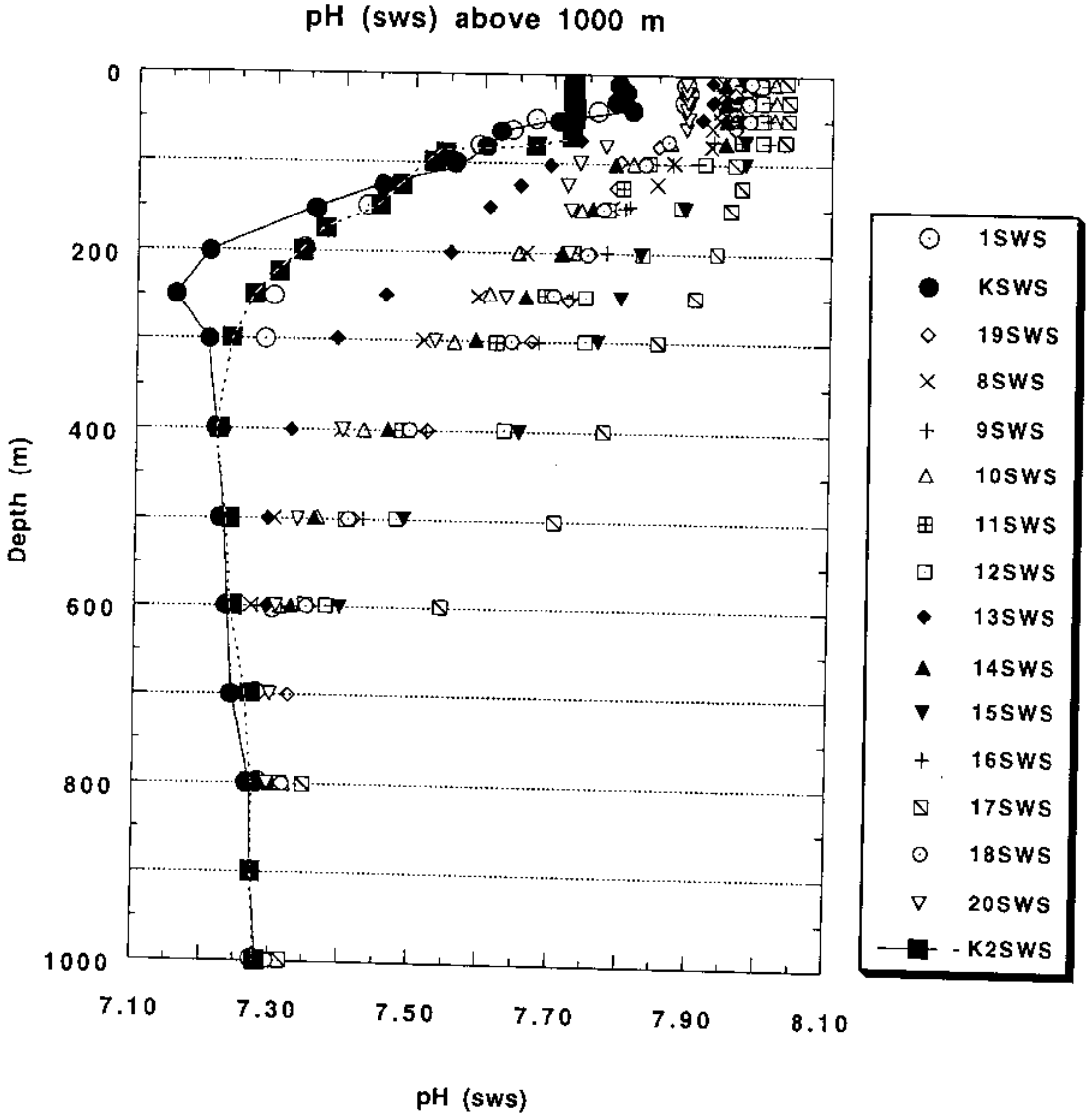


Fig. 3 Vertical profiles in pH (seawater scale at 25°C)

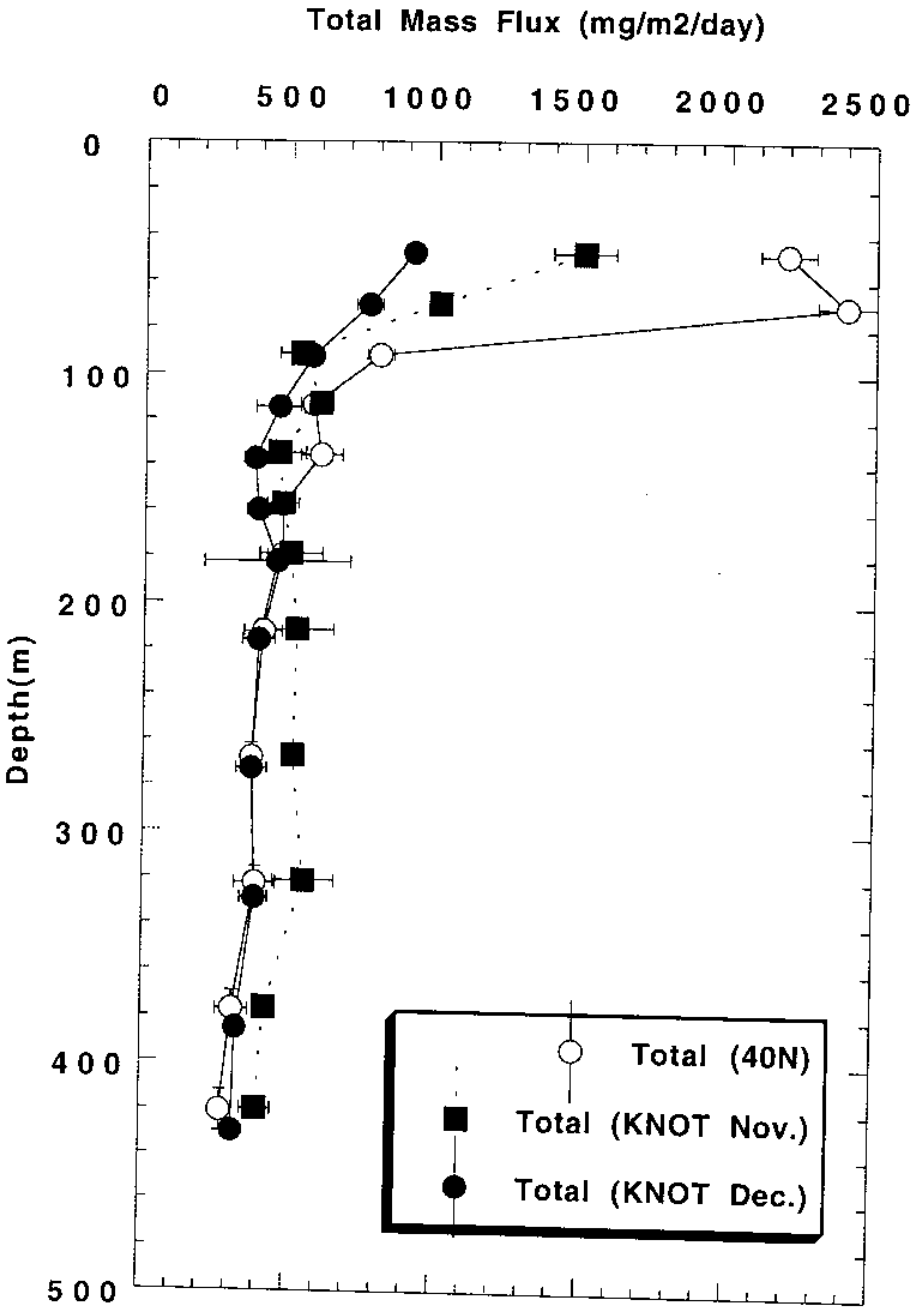
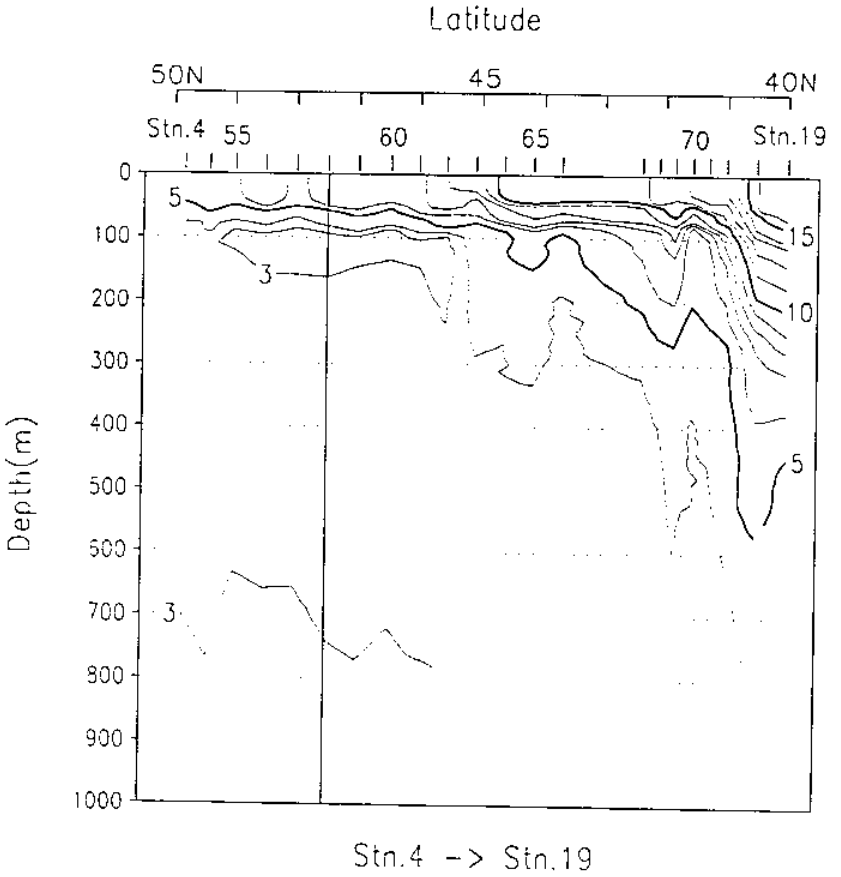
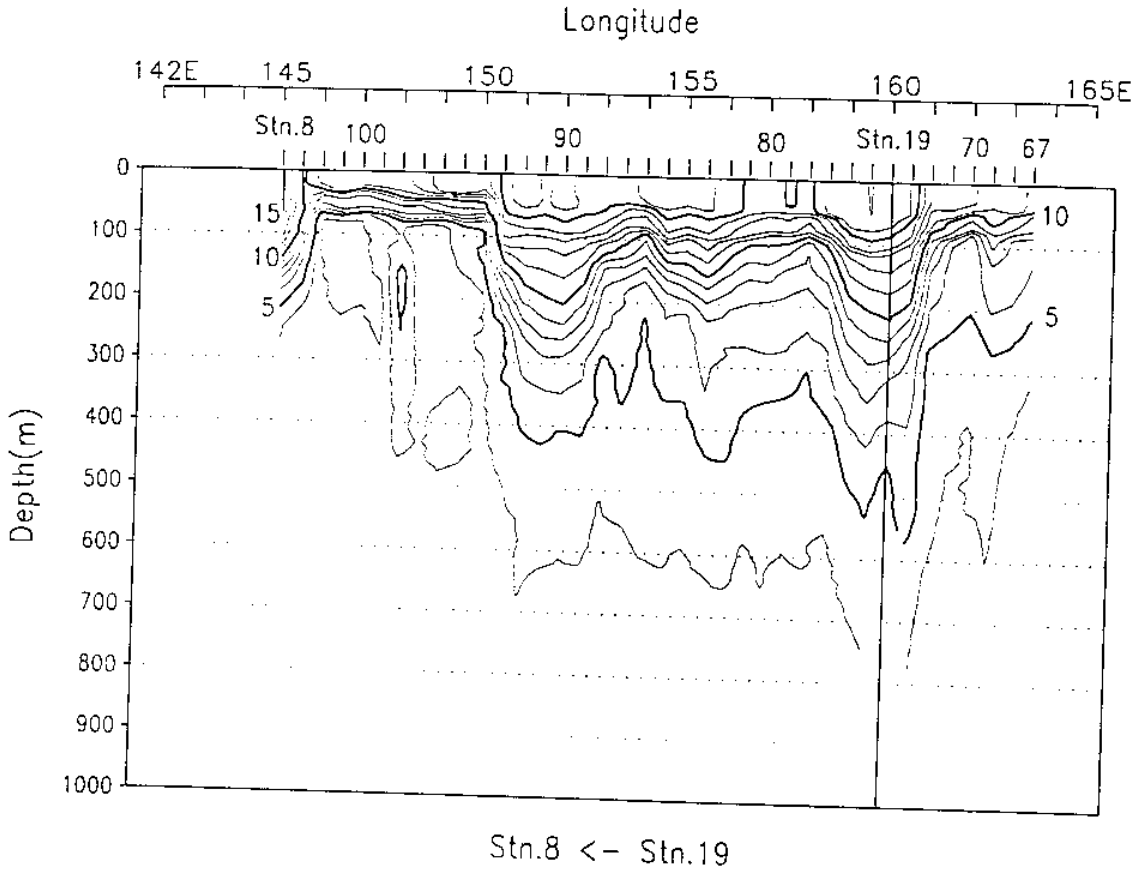


Fig. 4 Vertical profiles in total mass flux observed by drifting sediment trap



(a) 50°N - 40°N



(b) 165°E - 145°E along 40°N

Fig. 5 vertical sections in temperature observed by XBT

2. 2. Cruise Log and cruise track

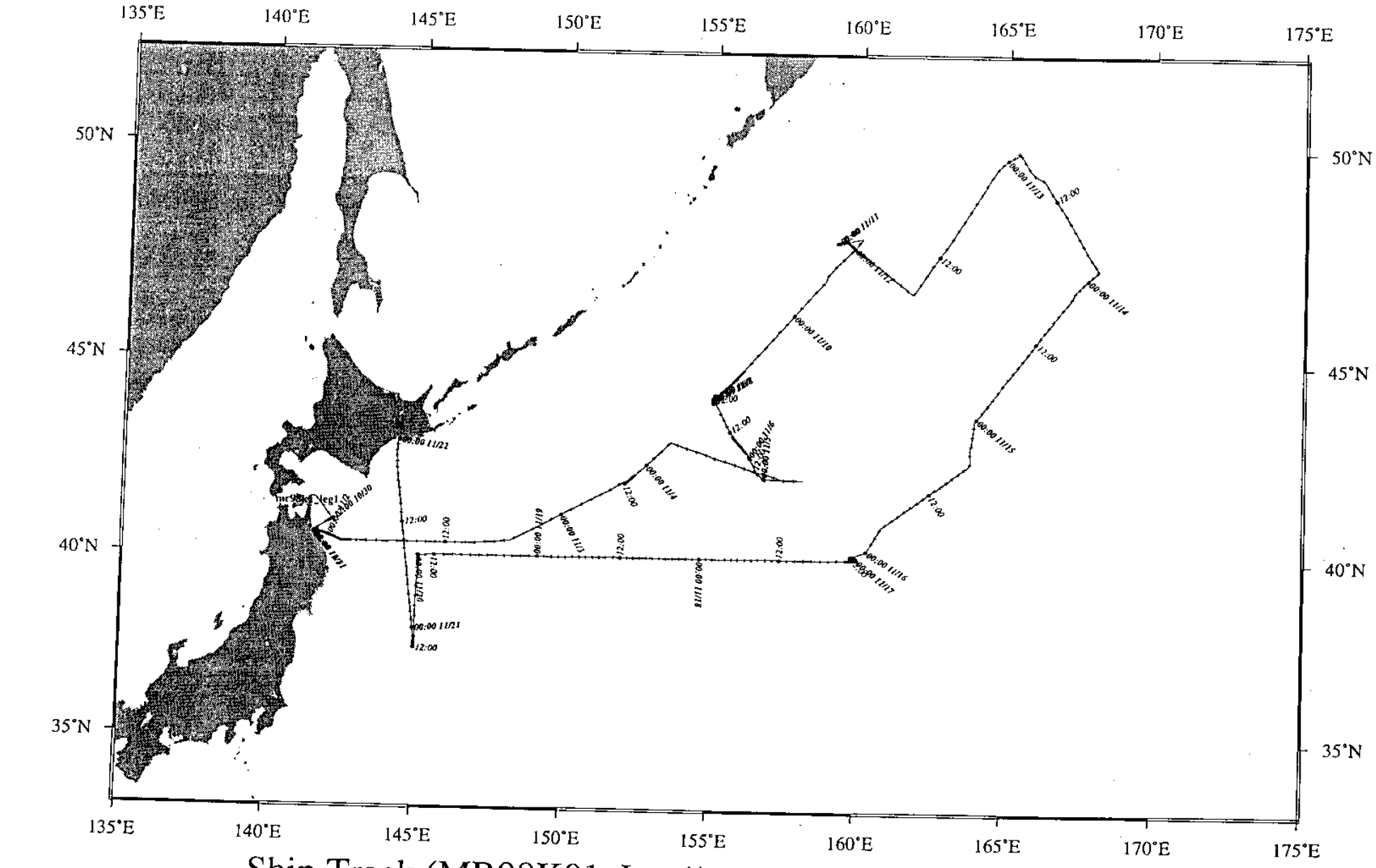
Date	Ship's Time	Site No.	Position Lat.	Long.	Events	Noon Weather
10/30	15:00		41-30.1N	141.14.5E	Departed Sekinehama	Cloud
10/31	09:00		41-40.5N	141-59.5E	Arrived Hachinohe	Cloud
11/1	07:00		40-30.0N	142-59.5E	Left Hachinohe	Cloud
					18 cast of XBT observation	
11/3	15:00	1	41-54.8N	151-49.8E	Arrived Stn.1	Cloud
	15:46	1	42-00.0N	152-00.2N	CTP-ALACE deployed	
	18:21	1	41-58.1N	152-01.2E	1 Cast of Large-CTD/RMS	
11/4	03:02	1	41-57.8N	152-59.9E	4 Cast of Small-CTD/RMS	Fine
	06:00	1	41-56.2N	152-01.5E	Left Station 1	
					11 cast of XBT observation	
11/5	02:00	7	42-05.0N	158-07.0E	arrived Station 7	Rain
	08:02	7	41-59.3N	157-49.9E	1 Cast of Large-CTD/RMS	
	12:00	7	41-59.5N	157-50.6E	Left Stn.7	
					6 cast of XBT observation	
11/7	05:00	knot	43-59.9N	155-00.1E	arrived Stn. Knot	Cloudy
	09:03	knot	43-59.6N	154-58.4E	plankton net	
	10:00	knot	43-59.7N	154-57.3E	optical measurement	
	11:55	knot	43-59.4N	154-57.3E	drafting Sediment Trop deployed	
	13:55	knot	43-59.8N	154-56.1E	1 Cast Small-CTD/RMS	
	19:50	knot	43-59.4N	154-59.1E	1 Cast Large-CTD/RMS	
11/8	01:54	knot	43-59.1N	154-56.1E	hydrocast primary production	Fine
	04:06	knot	43-59.4N	154-58.4E	in situ incubation deployed	
	05:46	knot	44-00.1N	154-53.6E	1 Cast Large-CTD/RMS	
	10:29	knot	44-02.8N	154-53.8E	1 Cast Small-CTD/RMS	
	11:28	knot	44-03.0N	154-55.9E	3 Cast Large-CTD/RMS	
	18:05	knot	44-02.4N	154-58.4E	in situ incubation recoverd	
	19:00	knot	44-02.4N	154-58.2E	plankton net	
11/9	05:00	knot	43-59.9N	154-59.7E	multiple core sampling	Cloud
	09:25	knot	44-02.3N	154-53.8E	3 Cast of Small-CTD/RMS	
	11:50	knot	43-59.7N	154-57.3E	optical measurement	
	13:17	knot	44-13.5N	155-04.3E	drafting Sediment Trop recoverd	
	15:25	knot	44-03.2N	154-59.2E	3 Cast of Small-CTD/RMS	
	22:00	knot	44-03.2N	154-59.3E	left Stn. Knot	
					10 cast of XBT observation	
11/10	18:30	2	47-53.9N	159-53.9E	arrived Stn.2	Cloud
	22:55	2	48-00.3N	160-00.7E	1 Cast of Large-CTD/RMS	
11/12	04:19	2	47-55.7N	159-28.7E	1 Cast of Small-CTD/RMS	Cloud
	05:48	2	47-55.4N	159-29.0E	1 Cast of Large-CTD/RMS	
	08:00	2	47-53.8N	159-30.4E	left Stn.2	

Date	Ship's Time	Site No.	Position Lat.	Position Long.	Events	Noon Weather
					10 cast of XBT observation	
11/13	12:00	4	49-57.6N	165-21.5E	arrived Stn 4	Cloudy
	13:30	4	49-57.5N	165-20.0E	left Stn.4	
					22 cast of XBT observation	
11/16	14:00	19	39-59.5N	159-59.9E	arrived Stn.19	Cloudy
	23:54	19	39-59.5N	160-00.4E	1 Cast of Small-CTD/RMS	
11/17	04:33	19	39-59.4N	159-59.2E	1 Cast of Large-CTD/RMS	Cloudy
	09:31	19	40-01.3N	159-58.3E	1 Cast of Small-CTD/RMS	
	10:47	19	40-00.6N	159-59.2E	1 Cast of Large-CTD/RMS	
	11:30	19	40-01.1N	159-58.7E	left Stn. 19	
					30 cast of XBT observation	
11/19	23:00	8	39-59.8N	145-01.3E	arrived Stn.8	
	23:35	8	39-59.9N	145-01.1E	1 Cast of Large-CTD/RMS	
11/20	04:08	8	39-59.9N	145-01.9E	1 Cast of Small-CTD/RMS	Fine
	08:32	8	39-59.7N	145-02.7E	1 Cast of Large-CTD/RMS	
	09:52	8	39-59.5N	145-03.0E	1 Cast of Small-CTD/RMS	
	10:40	8	39-59.2N	145-03.2E	1 Cast of Large-CTD/RMS	
	11:37	8	39-58.9N	145-03.6E	optical measurement	
	12:00	8	39-57.3N	145-04.2E	left Stn.8	
					5 cast of XBT observation	
11/20	21:00	9	37-29.4N	144-59.9E	arrived Stn.9	Cloud
	21:10	9	37-28.3N	144-59.9E	1 Cast Small-CTD/RMS	
11/21	00:51	9	37-28.8N	144-58.9E	1 Cast Large-CTD/RMS	Cloud
	06:30	9	37-27.8N	144-57.4E	left Stn.9	
					7 cast of XBT observation	
11/22	10:00		42-58.7N	144-22.4E	arrived Kusiro	Fine
11/24	09:00		42-58.7N	144-22.4E	departed Kushiro	Fine
					10 cast of XBT observation	
11/25	16:00	10	35-00.4N	145-00.4N	arrived Stn.10	Fine
	16:17	10	34-59.7N	145-00.0E	1 Cast of Small-CTD/RMS	
	18:50	10	34-59.5N	145-00.1E	1 Cast of Large-CTD/RMS	
	21:55	10	35-00.2N	144-59.8E	1 Cast of Small-CTD/RMS	
	22:50	10	34-59.99N	144-59.7E	1 Cast of Large-CTD/RMS	
	24:00	10	35-00.2N	145-05.0E	left Stn. 10	
					9 cast of XBT observation	
11/26	16:00	11	35-00.0N	150-00.0E	arrived Stn.11	Cloudy

Date	Ship's Time	Site No.	Position Lat.	Position Long.	Events	Noon Weather
11/26	16:05	11	35-00.0N	150.00.0E	1 Cast of Large-CTD/RMS	Rain
	21:28	11	35-02.8N	150-00.2E	1 Cast of Small-CTD/RMS	
	22:41	11	35-03.4N	150-01.4E	1 Cast of Large-CTD/RMS	
	23:45	11	35-04.4N	150-01.4E	2 Cast of Small-CTD/RMS	
11/27	05:00	11	35-03.7N	150-03.4E	left Stn.11	Fine
					4 cast of XBT observation	
11/27	10:55		36-20.4N	149-59.9E	optical measurement	
11/27	16:00	12	37-27.9N	159-00.6E	arrived Stn.12	Fine
	16:21	12	37-29.8N	149-56.8E	1 Cast of Small-CTD/RMS	
	23:25	12	37-30.1N	149-56.8E	1 Cast of Large-CTD/RMS	
11/28	02:46	12	37-29.3N	149-56.5E	1 Cast of Small-CTD/RMS	Cloud
	03:30	12	37-29.6N	149-56.8E	left Stn.12	
					4 cast of XBT observation	
11/29	04:00	13	39-59.9N	150-00.0E	arrived Stn.13	Fine
	06:18	13	40-03.0N	150-00.0E	1 Cast of Small-CTD/RMS	
	09:53	13	40-02.8N	149-59.2E	optical measurement	
	10:36	13	40-02.9N	149-59.2E	1 Cast of Small-CTD/RMS	
	11:20	13	40-02.5N	149-58.9E	MNB surbey	
	14:13	13	40-02.9N	149-59.0E	1 Cast of Large-CTD/RMS	
	18:00	13	40-04.3N	149-56.3E	left Stn.13	
					9 cast of XBT observation	
11/30	09:30	14	40-00.0N	154-59.1E	arrived Stn.14	Fine
	10:09	14	39-59.9N	155-00.0E	1 Cast of Large-CTD/RMS	
	12:46	14	39-59.9N	155-00.5E	1 Cast of Small-CTD/RMS	
	13:15	14	39-59.8N	155-00.4E	optical measurement	
	13:58	14	39-58.6N	155-00.5E	1 Cast of Large-CTD/RMS	
	17:00	14	39-57.0N	155-00.1E	left Stn.14	
					4 cast of XBT observation	
12/1	04:00	15	37-29.8N	155-00.0E	arrived Stn.15	Cloud
	04:21	15	37-29.8N	155-00.0E	1 Cast of Small-CTD/RMS	
	06:55	15	37-30.2N	155-00.0E	1 Cast of Large-CTD/RMS	
	09:20	15	37-30.3N	155-00.1E	1 Cast of Small-CTD/RMS	
	09:52	15	37-30.3N	155-00.3E	optical measurement	
	10:00	15	37-30.3N	155-00.3E	left Stn.15	
					4 cast of XBT observation	
12/1	20:30	16	35-00.6N	155-00.0E	arrived Stn.16	Cloudy
	21:02	16	35-00.0N	154-59.8E	1 Cast of Large-CTD/RMS	
	23:49	16	34-59.9N	154-59.6E	1 Cast of Small-CTD/RMS	
12/2	0:45	16	35-00.1N	154-59.9E	1 Cast of Large-CTD/RMS	Cloudy

Date	Ship's Time	Site No.	Position Lat.	Position Long.	Events	Noon Weather
12/2	1:49	16	35-00.1N	155-00.2E	1 Cast of Small-CTD/RMS	Cloud
	03:30	16	35-00.2N	150-03.4E	left Stn.16	
					11 cast of XBT observation	
12/3	0:00	17	35-00.0N	160-03.2E	arrived Stn.17	Fine
	08:42	17	34-59.4N	160-01.4E	optical measurement	
	09:09	17	34-59.3N	160-01.8E	1 Cast of Small-CTD/RMS	
	12:52	17	34-59.6N	160-00.4E	1 Cast of Large-CTD/RMS	
	16:03	17	34-59.1N	160-02.5E	1 Cast of Small-CTD/RMS	
	17:12	17	34-59.3N	160-03.0E	1 Cast of Large-CTD/RMS	
	18:00	17	34-59.0N	160-03.4N	left Stn.17	
					4 cast of XBT observation	
12/4	05:00	18	37-29.9N	160-00.0N	arrived Stn.18	Cloud
	05:20	18	34-30.0N	160-00.0E	1 Cast of Small-CTD/RMS	
	07:36	18	37-30.1N	159-59.4E	1 Cast of Large-CTD/RMS	
	10:03	18	37-30.1N	159-58.9E	1 Cast of Small-CTD/RMS	
	10:33	18	37-29.9N	159-58.9E	optical measurement	
	11:00	18	37-31.3N	159-58.7E	left Stn.18	
					14 cast of XBT observation	
12/5	09:58		39-59.7N	164-08.7E	optical measurement	Fine
12/5	13:00	20	40-00.1N	165-00.2E	arrived Stn.20	
	13:00	20	40-00.1N	160-00.1E	drafting Sediment Trop deployed	
	14:07	20	40-00.8N	164-59.6E	1 Cast of Small-CTD/RMS	
	15:09	20	40-00.9N	164-59.2E	1 Cast of Large-CTD/RMS	
	19:15	20	40-03.5N	164-57.9E	1 Cast of Small-CTD/RMS	
	22:39	20	40-03.6N	164-57.4E	1 Cast of Large-CTD/RMS	
12/6	01:55	20	40-00.1N	164-59.4E	water sampling	Rain
	04:00	20	40-00.0N	165-00.1E	in situ incubation deployed	
	11:07	20	40-00.0N	165-00.0E	in situ incubation recover	
	12:00	20	40-03.0N	164-54.3E	left Stn.20	
					1 cast of XBT observation	
12/8	04:30	20	40-15.5N	164-56.0E	arrived Stn.20	Cloud
	09:37	20	40-20.0N	164-59.4E	optical measurement	
	10:30	20	40-21.8N	164-57.8E	drafting Sediment Trop recoverd	
	13:09	20	39-59.5N	165-00.1E	1 Cast of Large-CTD/RMS	
	16:52	20	40-00.1N	164-59.5E	plankton net	
	18:13	20	40-00.5N	164-57.7E	1 Cast of Large-CTD/RMS	
	21:00	20	39-57.7N	164-56.2E	left Stn.20	
					9 cast of XBT observation	
					4 cast of XCTD observation	

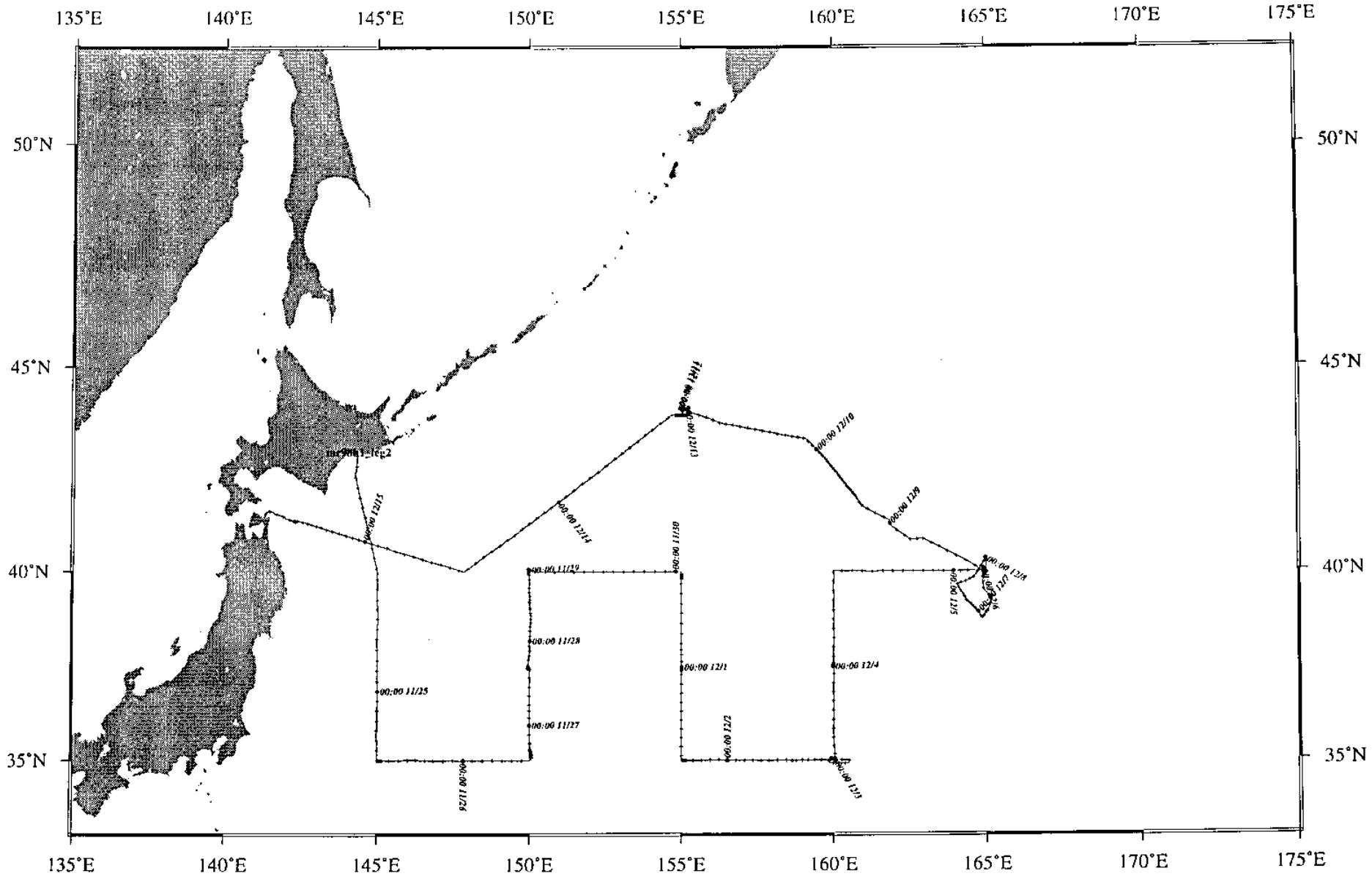
Date	Ship's Time	Site No.	Position Lat.	Position Long.	Events	Noon Weather
12/11	05:00	knot	43-59.5N	155-01.7E	arrived Stn.knot	Fine
	07:16	knot	44-00.3N	154-59.5E	1 Cast of Large-CTD/RMS	
	08:18	knot	44-00.6N	155-00.0E	drafting Sediment Trop deployed	
	09:37	knot	44-00.0N	154-59.9E	plankton net	
	10:37	knot	44-00.4N	155-00.4E	optical measurement	
	11:07	knot	44-00.5N	155-00.4E	1 Cast of Large-CTD/RMS	
	14:47	knot	44-00.7N	155-01.1E	1 Cast of Small-CTD/RMS	
	18:05	knot	43-59.0N	155-02.3E	1 Cast of Large-CTD/RMS	
	18:56	knot	43-59.0N	155-01.9E	1 Cast of Small-CTD/RMS	
	19:38	knot	43-59.0N	155-02.4E	2 Cast of Large-CTD/RMS	
12/12	01:25	knot	43-59.1N	155-01.7E	hydrocast primary nproduction	Cloud
	09:59	knot	43-59.6N	155-01.7E	optical measurement	
	13:02	knot	44-00.0N	154-59.9E	2 Cast of Small-CTD/RMS	
12/13	0257	knot	44-02.3N	155-08.8E	hydrocast primary production	Fine
	05:32	knot	44-01.1N	155-12.6E	in situ incubation	
	08:00	knot	44-02.8N	155-13.0E	drafting Sediment Trop recoverd	
	09:48	knot	43-59.5N	155-14.6N	optical measurement	
	15:00	knot	44-00.0N	155-14.4E	in situ incubation deployment	
	18:30				left Stn.knot	
					9 cast of XBT observation	
					4 cast of XCTD observation	
12/16	08:00				arraved Sekinehama	



Ship Track (MR98K01, Leg1)

Mercator Projection

on board report



Ship Track (MR98K01, Leg2)

GMT Dec 16 09:56

Mercator Projection

on board report

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Naoto MORIOKA	GODI	3-65 Oppamahigashi-cho Yokosuka 237-0063, Japan

3. Observation

3. 1 Meteorological Observation

1 Personnel

Naoto Morioka (G.O.D.I.)

2 Parameters

Shipís time:	Same as JST (UTC+9 hours) throughout the cruise
Press:	Atmospheric pressure calibrated to the sea surface level [hPa]
Air Temp:	Atmospheric temperature [°C]
Dew Temp:	Dew point temperature [°C]
Humid:	Relative Humidity [%]
Precpt:	Precipitation [mm]
W.D.:	10 minute averaged wind direction at the time [degree]
W.S.:	10 minute averaged wind speed at the time [m/s]
Seatmp:	Sea surface temperature [°C]
Wv.Ht:	Significant wave height measured first20 minutes at every 3 hours (0200, 0500, 0800, 1100, 1400, 1700, 2000, 2300UTC)
Wv.PD:	Period of Wv.HT [sec]

3 Method

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

Anemometer	:KE-500	Koshin Denki, Japan
Themometer	:FT	Koshin Denki, Japan
Dew point meter	:DW-1	Koshin Denki, Japan
Barometer	:F-451	Yokogawa, Japan
Rain gauge	:50202	Young, U.S.A.
Optical Rain Gauge	:ORG-11DR	SCTI, U.S.A.
Radiometer	:MS-801(short wave)	Eiko Seiki ,Japan
	:MS-200(long wave)	Eiko Seiki ,Japan
Wave height meter	:WM-2	Tsurumiseiki, Japan

4. Preliminary Resuls

Table (3)-1.1 and Fig(3)-1.1　2 show the results of obserbation.

5. Data archive

Surface meteorogical data will be submitted to the DMO(Data Management Office), Jamstec and will be under their control. Six-second averaged data and 10-minute averaged data are contained in the 3.5 M/O disk.

Table (3)-1.1 Surface Meteorological Observation

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
10	30	06	10	30	15	40-26N	141-20E	o	1016.4	15.6	4.5	48.0	0.0	103	1.4	18.7	0.2	6
		09			18	41-01N	141-59E	o	1016.7	15.6	5.9	52.0	0.0	293	4.8	18.5	0.7	9
		12			21	40-48E	142-13E	o	1016.2	15.8	5.4	50.0	0.0	341	1.6	18.3	0.5	8
		15		31	00	40-51E	142-09E	o	1014.5	15.5	6.3	54.0	0.0	79	1.6	18.3	0.7	8
		18			03	40-53N	142-10E	o	1013.0	15.7	6.6	55.0	0.0	63	2.7	18.3	0.6	8
		21			06	40-47N	141-53E	o	1012.5	15.9	6.8	55.0	0.0	95	3.8	18.5	0.8	14
	31	00			09	40-33N	141-29E	o	1013.2	12.7	9.2	79.0	0.0	78	1.6	18.4	0.1	6
		03			12	40-33N	141-29E	c	1012.2	15.7	10.0	69.0	0.0	64	3.3	18.4	0.1	7
		06			15	40-33N	141-29E	bc	1012.0	17.0	10.5	66.0	0.0	97	8.8	18.5	0.2	5
		09			18	40-33N	141-29E	bc	1012.4	14.3	8.6	69.0	0.0	109	3.8	18.4	0.1	6
		12			21	40-33N	141-29E	c	1013.4	12.5	8.8	78.0	0.0	110	1.6	18.3	0.1	4
		15	11	1	00	40-33N	141-29E	c	1011.5	11.4	9.0	85.0	0.0	115	2.8	18.0	0.2	7
		18			03	40-33N	141-29E	bc	1010.7	13.6	10.0	79.0	0.0	103	3.9	17.7	0.2	7
		21			06	40-33N	141-29E	r	1009.7	14.1	9.3	73.0	0.1	157	2.7	17.4	0.2	9
11	1	00			09	40-33N	141-29E	r	1011.5	13.1	11.2	88.0	3.3	13	1.5	17.3	0.2	10
		03			12	40-33N	141-29E	c	1010.4	14.3	12.8	91.0	0.4	176	2.7	17.1	0.2	9
		06			15	40-33N	141-29E	bc	1012.2	14.7	3.8	48.0	0.0	332	5.7	17.2	0.2	6
		09			18	40-33N	141-29E	bc	1016.6	9.9	0.4	52.0	0.1	349	1.7	17.3	0.1	6
		12			21	40-33N	141-29E	bc	1018.8	7.8	0.2	57.0	0.0	339	1.8	17.1	0.1	6
		15		2	24	40-33N	141-29E	bc	1019.6	6.5	1.2	69.0	0.1	110	0.9	16.7	0.2	7
		18			03	40-33N	141-29E	bc	1019.5	4.6	1.2	79.0	0.0	183	2.5	16.1	0.2	8
		21			06	40-33N	141-29E	bc	1019.5	3.6	0.3	79.0	0.0	202	2.4	15.4	0.1	7
	2	00			09			bc	1019.5	11.6	0.5	46.0	0.0	204	4.1	15.1	0.9	7
		03			12	40-20N	142-56E	bc	1018.0	13.1	3.8	53.0	0.0	180	8.0	15.3	1.4	12
		06			15	40-19N	143-59E	c	1016.5	13.6	6.8	64.0	0.0	180	9.8	15.7	1.4	11
		09			18	40-20N	145-00E	r	1016.1	13.9	8.4	70.0	0.1	155	11.0	14.6	1.4	12
		12			21	40-19N	145-58E	o	1015.0	12.8	10.0	83.0	1.3	140	11.2	13.7	1.4	10
		15		3	00	40-20N	146-58E	o	1010.5	14.6	13.1	91.0	0.4	144	12.2	14.3	1.2	6
		18			03	40-23N	147-58E	o	1007.2	16.0	15.2	95.0	1.1	176	16.6	15.6	1.5	6
		21			06	40-43N	148-56E	r	1008.9	17.5	14.7	84.0	0.5	247	12.1	15.0	1.9	10
	3	00			09	42-25N	152-44E	c	1009.5	15.9	12.5	81.0	0.0	257	13.3	15.1	2.5	13
		03			12	41-31N	150-52E	c	1009.0	15.8	7.7	58.0	0.0	282	16.9	15.1	3.0	18
		06			15	41-54N	151-49E	bc	1010.6	12.7	6.2	65.0	0.0	295	13.2	15.1	3.4	20
		09			18	41-59N	152-00E	bc	1013.0	11.7	4.4	61.0	0.1	275	11.9	13.3	2.1	6
		12			21	41-57N	152-01E	bc	1014.6	11.2	4.1	62.0	0.0	294	13.4	12.8	2.7	6
		15		4	00	41-58E	151-59E	bc	1014.9	10.7	0.9	51.0	0.0	287	15.1	12.8	3.2	7
		18			03	41-57N	151-59E	bc	1016.0	10.6	1.5	53.0	0.0	275	14.6	13.5	3.7	8
		21			06	41-56N	152-01E	bc	1017.2	10.6	1.3	53.0	0.0	283	13.6	13.7	4.0	9
	4	00			09			bc	1016.7	11.4	2.7	55.0	0.0	265	14.2	12.5	4.7	18
		03			12	42-57N	153-29E	bc	1014.4	11.9	4.8	62.0	0.0	254	13.5	11.0	4.5	18
		06			15	42-47N	154-27E	bc	1014.0	12.8	6.6	66.0	0.0	266	15.8	17.0	4.4	19
		09			18	42-32N	156-26E	bc	1013.7	13.6	7.6	67.0	0.2	258	11.9	14.5	5.6	21
		12			21	42-18N	156-26E	bc	1012.6	13.8	7.4	65.0	0.2	235	12.7	14.6	3.5	19
		15		5	00	42-05N	157-26E	bc	1011.0	14.1	8.2	68.0	0.1	236	10.3	15.1	5.1	19
		18			03	42-03N	158-03E	o	1007.1	13.9	9.4	74.0	0.1	197	5.8	14.8	3.2	8
		21			06	41-59N	157-55E	r	1001.7	14.0	11.9	87.0	0.5	174	11.0	14.8	2.7	9
	5	00			09	42-15N	156-30E	r	995.0	14.1	12.6	91.0	0.5	183	14.4	14.5	2.9	8
		03			12	41-59N	157-50E	bc	993.1	14.2	6.3	59.0	0.1	269	20.1	14.5	3.5	7
		06			15	42-05N	157-43E	c	991.5	11.9	4.2	59.0	0.2	270	21.6	14.6	4.5	8
		09			18	42-09N	157-35E	c	989.6	9.7	4.8	72.0	0.2	265	25.3	15.1	6.8	11
		12			21	42-09N	157-27E	r	986.3	9.5	5.1	74.0	0.6	270	25.6	15.0	11.5	13
		15		6	00	42-04N	157-17E	o	988.2	9.6	5.2	74.0	0.6	309	22.1	15.1	11.5	14

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
11	5	18	11	6	03	42-02N	157-04E	c	996.3	9.4	4.0	69.0	0.0	345	21.2	15.5	10.2	14
		21			06	42-05N	156-48E	c	1003.5	9.0	3.4	68.0	0.2	346	17.7	15.6	7.5	12
	6	00			09	42-15N	156-30E	c	1010.1	8.2	2.2	66.0	0.1	343	17.9	15.2	7.6	11
		03			12	42-31N	156-20E	c	1011.0	6.6	1.8	71.0	0.1	324	17.5	13.1	7.8	11
		06			15	42-40N	156-14E	c	1013.5	6.9	1.1	67.0	0.1	337	16.9	13.4	6.9	11
		09			18	42-57N	155-56E	c	1017.7	6.4	-0.4	62.0	0.1	326	13.9	13.5	5.9	11
		12			21	43-18N	155-34E	c	1020.4	6.4	-3.6	49.0	0.0	341	12.3	13.4	4.6	10
		15		7	00	43-45N	155-15E	bc	1021.8	6.1	-3.5	50.0	0.2	339	12.9	12.3	4.7	10
		18			03	43-55N	155-05E	o	1022.5	6.2	-2.8	52.0	0.0	325	13.0	10.5	5.1	9
		21			06	44-01N	154-58E	o	1024.0	5.6	-2.7	55.0	0.1	335	12.5	8.8	4.7	10
	7	00			09	43-59N	154-58E	o	1024.7	6.2	-2.7	53.0	0.0	323	10.8	9.0	4.3	10
		03			12	43-59N	154-57E	o	1023.3	6.1	0.5	68.0	0.0	304	9.3	8.7	3.9	10
		06			15	43-59N	154-56E	o	1023.2	6.0	-2.5	55.0	0.0	295	6.9	8.3	3.6	11
		09			18	44-00N	154-58E	o	1023.0	6.1	-2.5	54.0	0.1	271	5.6	8.6	3.4	11
		12			21	43-59N	154-59E	o	1021.7	6.0	-2.9	53.0	0.2	260	5.6	8.6	4.0	12
		15		8	00	43-59N	154-58E	o	1019.8	6.0	-1.7	58.0	0.1	231	6.9	8.9	3.7	11
		18			03	43-59N	154-56E	o	1017.1	6.6	0.5	65.0	0.0	216	7.1	8.8	3.1	10
		21			06	44-00N	154-53E	o	1015.3	7.3	1.5	67.0	0.0	259	0.8	8.8	2.7	11
	8	00			09	44-01N	154-53E	o	1014.1	7.8	2.8	71.0	0.0	121	2.3	8.8	2.7	12
		03			12	44-03N	154-54E	bc	1011.6	8.3	4.0	74.0	0.1	125	3.4	8.9	2.5	11
		06			15	44-02N	154-57E	c	1010.1	8.8	4.2	73.0	0.1	140	4.0	8.9	2.7	11
		09			18	44-02N	154-58E	c	1009.3	8.6	3.9	72.0	0.0	151	5.1	8.9	2.8	11
		12			21	44-02N	154-57E	c	1009.4	8.8	4.4	74.0	0.0	155	5.6	8.8	2.5	12
		15		9	00	44-04N	154-57E	r	1007.7	8.4	5.0	79.0	0.4	166	5.6	8.9	2.0	11
		18			03	44-07N	154-58E	r	1005.8	9.0	7.9	93.0	0.5	165	9.2	8.9	1.9	12
		21			06	43-59N	154-59E	o	1005.3	9.2	8.6	96.0	1.2	256	10.0	8.8	1.8	9
	9	00			09	44-00N	154-59E	o	1006.8	7.2	6.3	94.0	0.1	261	12.5	9.0	2.0	9
		03			12	44-02N	154-57E	o	1006.5	8.4	6.2	86.0	0.0	237	9.3	9.1	2.4	9
		06			15	44-05N	154-58E	o	1005.5	9.7	7.8	88.0	0.1	210	11.2	8.9	1.7	7
		09			18	44-02N	154-59E	r	1004.7	10.1	8.8	92.0	0.5	277	6.4	8.8	2.2	8
		12			21	44-02N	154-59E	r	1003.5	10.1	9.4	96.0	2.6	210	11.0	8.9	2.5	9
		15		10	00	44-24N	155-29E	o	1000.5	11.0	10.1	94.0	0.0	195	14.2	9.7	3.5	18
		18			03	45-00N	156-15E	o	999.5	10.3	9.5	95.0	0.1	229	9.0	9.1	3.3	17
		21			06	45-35N	156-58E	o	997.8	8.0	7.5	96.0	0.0	302	6.9	8.4	3.0	17
	10	00			09	46-09N	157-42E	o	996.9	7.0	5.1	88.0	0.1	359	5.7	8.0	3.7	17
		03			12	46-44N	158-25E	o	992.4	6.7	1.4	69.0	0.0	343	5.5	7.7	3.2	17
		06			15	47-19N	159-04E	o	988.4	5.2	1.7	78.0	0.4	354	7.0	7.1	3.5	18
		09			18	47-53N	159-53E	r	985.8	2.9	1.1	88.0	52.8	330	12.3	6.9	3.1	15
		12			21	48-00N	160-00E	r	986.2	3.0	1.4	89.0	0.5	302	10.2	6.8	2.6	8
		15		11	00	48-00N	160-00E	o	988.5	4.6	-0.9	68.0	0.0	293	18.2	6.8	2.7	7
		18			03	47-59N	160-01E	o	990.7	3.2	-0.2	78.0	0.2	294	19.7	6.8	3.8	8
		21			06	48-00N	159-55E	o	994.0	3.5	-3.1	62.0	0.0	283	17.8	6.8	3.8	9
	11	00			09	48-05N	159-50E	c	997.8	3.1	1.3	73.0	0.3	295	16.7	6.5	4.5	9
		03			12	48-08N	159-48E	s	998.7	3.6	-3.2	61.0	0.1	273	15.7	6.5	4.2	8
		06			15	48-06N	159-46E	o	1000.9	3.6	-5.8	51.0	0.0	287	19.1	6.7	4.5	8
		09			18	48-02N	159-38E	s	1004.1	3.5	-2.9	63.0	0.0	274	13.5	6.6	4.7	9
		12			21	48-00N	159-24E	o	1005.0	4.5	-2.5	60.0	0.0	254	12.1	6.4	4.0	9
		15		12	00	47-57N	159-14E	bc	1004.5	4.9	-0.8	67.0	0.0	229	13.4	6.4	3.4	8
		18			03	47-53N	159-07E	bc	1001.6	6.1	0.3	66.0	0.0	205	13.9	6.6	3.3	8
		21			06	47-55N	159-28E	o	999.0	6.5	2.3	74.0	0.1	183	13.7	6.4	2.7	7
	12	00			09	47-46N	159-42E	r	994.2	6.1	-3.9	86.0	1.7	173	14.9	6.8	2.8	9
		3			12	47-21N	160-31E	o	987.6	7.9	6.2	89.0	0.1	180	13.8	6.9	3.5	10
		6			15	46-56N	161-18E	o	986.0	7.1	5.8	92.0	1.5	214	8.6	7.5	5.5	12

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
11	12	9	11	12	18	46-57N	161-59E	r	983.3	7.3	5.7	90.0	1.7	212	9.1	7.9	6.4	18
		12			21	47-35N	162-38E	bc	978.9	5.5	1.6	76.0	0.0	238	16.3	7.7	6.1	18
		15		13	00	48-13N	163-16E	bc	973.5	4.8	1.8	81.0	0.0	235	20.4	6.6	5.0	17
		18			03	48-50N	163-52E	o	972.6	3.4	0.7	83.0	0.1	286	25.2	6.3	6.5	18
		21			06	49-25N	164-25E	c	977.8	3.1	-3.0	65.0	0.0	278	23.8	5.9	6.8	17
	13	00			09	49-47N	164-56E	o	979.2	2.9	-4.5	58.0	0.1	264	22.3	5.8	6.6	13
		03			12	49-57N	165-21E	o	979.6	2.3	-4.3	62.0	0.0	277	22.5	5.7	6.0	10
		06			15	49-45N	165-32E	o	982.5	2.9	-5.0	56.0	0.3	277	22.6	5.7	7.2	13
		09			18	49-22N	166-08E	c	986.6	0.9	-1.2	86.0	0.0	278	22.3	5.9	8.7	16
		12			21	48-54N	166-37E	o	989.7	3.0	-2.7	66.0	0.1	275	22.7	6.1	8.3	14
		15		14	00	48-24N	167-06E	o	994.0	3.8	-1.5	68.0	0.0	275	22.7	6.3	8.7	15
		18			03	47-53N	167-32E	o	998.6	5.3	-0.7	65.0	0.0	275	22.1	6.1	8.4	14
		21			06	47-24N	167-58E	o	1002.2	6.0	3.4	84.0	0.0	250	14.1	6.2	8.0	15
	14	00			09	47-05N	167-43E	c	1000.7	7.6	4.2	79.0	0.1	239	17.8	6.5	6.6	11
		03			12	46-47N	167-16E	c	1000.1	8.0	5.2	83.0	0.0	228	15.7	6.7	6.0	11
		06			15	46-23N	166-53E	o	1001.0	8.5	6.2	85.0	0.1	231	14.8	6.7	4.8	9
		09			18	45-57N	166-25E	bc	1000.7	8.7	7.5	92.0	2.3	247	11.2	6.8	4.2	8
		12			21	45-33N	166-00E	bc	999.2	9.6	8.7	94.0	0.2	232	12.7	8.3	4.5	9
		15		15	00	45-09N	165-33E	o	996.6	10.0	8.8	93.0	0.1	243	12.1	8.3	3.8	9
		18			03	44-41N	165-03E	o	992.5	10.9	10.2	95.0	0.2	212	12.4	10.1	4.0	8
		21			06	44-12N	164-32E	o	993.5	5.4	3.6	89.0	0.0	338	15.4	11.0	3.8	9
	15	00			09	43-41N	163-59E	r	996.4	5.8	2.4	79.0	0.0	306	15.2	10.8	4.3	10
		03			12	43-02N	163-49E	c	998.5	6.1	0.0	65.0	0.2	306	18.5	9.5	5.1	11
		06			15	42-26N	163-36E	o	1002.6	5.3	0.8	73.0	0.2	304	18.9	10.6	6.5	11
		09			18	42-06N	163-00E	c	1006.6	6.3	1.1	69.0	0.0	273	15.9	11.8	6.8	10
		12			21	41-47N	162-24E	o	1008.0	7.5	0.6	62.0	0.0	297	15.6	11.6	6.5	12
		15		16	00	41-26N	161-47E	o	1010.0	8.2	1.9	65.0	0.0	275	15.6	12.5	5.5	10
		18			03	41-05N	161-09E	o	1009.5	9.7	3.7	66.0	0.0	279	10.7	12.5	4.0	9
		21			06	40-38N	160-35E	r	1006.7	13.1	9.1	76.0	0.2	237	20.3	15.8	3.6	9
	16	00			09	40-16N	160-17E	o	1006.1	15.8	11.5	76.0	0.1	251	17.5	16.7	5.3	8
		03			12	40-05N	160-06E	o	1006.6	15.9	11.5	75.0	0.0	263	16.8	16.7	4.3	8
		06			15	39-58N	159-58E	o	1009.4	14.7	10.6	77.0	0.3	286	14.1	16.7	4.3	8
		09			18	40-00N	159-53E	o	1012.7	13.6	7.1	65.0	0.1	289	14.9	16.7	4.2	8
		12			21	40-05N	159-47E	o	1014.4	12.0	5.7	65.0	0.1	289	12.3	16.7	3.6	8
		15		17	00	39-59N	160-00E	c	1015.4	11.6	4.6	62.0	0.1	309	7.2	16.7	3.8	8
		18			03	39-59N	159-59E	c	1014.9	12.3	5.8	65.0	0.0	270	1.4	16.7	3.6	9
		21			06	40-00N	159-58E	c	1014.6	13.3	9.1	76.0	0.5	154	6.0	16.7	3.0	8
	17	00			09	40-01N	159-58E	o	1012.5	15.7	14.1	90.0	0.0	173	5.0	16.6	2.5	9
		03			12	40-01N	159-52E	o	1008.9	17.1	14.4	84.0	0.2	221	14.7	16.7	2.6	8
		06			15	40-00N	159-01E	o	1006.9	17.2	14.9	86.0	0.2	209	12.3	17.1	2.7	8
		09			18	40-00N	158-10E	r	1002.8	17.1	14.7	86.0	0.0	198	15.8	15.0	2.5	8
		12			21	40-00N	157-21E	o	999.2	17.3	15.4	89.0	0.0	205	19.0	15.3	3.8	9
		15		18	00	40-00N	156-38E	r	993.7	17.0	15.8	93.0	1.1	204	21.9	14.8	4.6	9
		18			03	39-59N	155-57E	o	991.1	17.6	16.5	93.0	0.1	212	19.6	15.6	4.9	9
		21			06	39-59N	155-17E	o	992.9	17.1	15.6	91.0	0.0	252	14.5	16.3	5.6	10
	18	00			09	39-59N	154-37E	o	998.1	16.5	8.3	58.0	0.0	274	15.9	16.3	5.8	10
		03			12	39-59N	153-56E	c	1001.6	13.5	6.0	60.0	0.1	291	15.1	16.3	5.5	10
		06			15	39-59N	153-15E	c	1004.6	12.2	3.9	57.0	0.1	287	12.8	15.0	6.7	11
		09			18	39-59N	152-35E	c	1007.9	11.9	1.2	48.0	0.0	302	12.5	16.0	4.9	10
		12			21	40-00N	151-54E	c	1009.6	10.6	0.5	50.0	0.1	314	9.7	16.3	5.6	10
		15		19	00	40-00N	151-12E	o	1010.9	9.9	0.4	52.0	0.0	301	5.9	16.4	4.7	10
		18			3	40-00N	150-31E	o	1011.2	8.3	1.4	62.0	0.1	314	7.9	17.1	6.2	10
		21			6	39-59N	149-49E	o	1013.4	7.8	0.2	59.0	0.1	335	9.6	13.8	6.0	11

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
11	19	00	11	19	9	40-00N	149-05E	o	1015.4	7.1	0.5	63.0	0.0	320	5.9	13.7	3.6	9
		03			12	40-00N	148-15E	c	1014.5	6.2	0.1	65.0	0.0	335	9.2	12.4	4.4	11
		06			15	39-59N	147-26E	c	1016.0	5.9	-0.7	63.0	0.1	340	6.5	11.9	2.7	8.0
		09			18	40-00N	146-33E	c	1017.5	4.6	-0.4	70.0	0.0	336	9.4	11.8	2.1	7.0
		12			21	40-00N	145-36E	r	1018.8	3.4	-0.7	75.0	0.4	354	5.2	10.8	1.8	7.0
		15		20	00	39-59N	145-00E	s	1018.6	4.6	-1.5	65.0	0.1	318	8.9	15.3	1.7	7.0
		18			03	40-00N	145-01E	o	1018.5	2.5	0.4	86.0	2.9	17	7.1	15.9	1.7	7.0
		21			06	39-59N	145-01E	o	1018.4	3.8	0.0	77.0	0.0	18	4.9	16.3	1.5	6.0
	20	00			09	39-59N	145-02E	o	1018.9	2.9	0.3	83.0	0.1	8	5.2	16.2	1.4	6.0
		03			12	39-57N	145-04E	c	1017.5	3.7	2.5	92.0	0.0	359	5.1	15.9	1.0	6.0
		06			15	39-08N	145-01E	o	1015.9	6.7	4.1	83.0	0.3	33	6.8	19.0	1.7	14.0
		09			18	38-19N	144-59E	c	1016.4	7.7	3.8	76.0	0.0	98	3.6	17.6	1.9	14.0
		12			21	37-29N	144-59E	bc	1015.9	10.5	4.1	64.0	0.1	143	3.9	16.0	2.0	15.0
		15		21	00	37-29N	144-59E	c	1013.6	9.9	4.8	71.0	0.1	124	5.1	16.3	1.6	7.0
		18			03	37-28N	144-58E	c	1010.7	12.7	3.5	53.0	0.0	241	8.3	16.4	1.3	7.0
		21			06	37-27N	144-57E	r	1011.6	11.2	7.1	76.0	0.2	319	14.0	17.0	2.2	6.0
	21	00			09	37-59N	144-55E	c	1014.7	8.9	4.4	73.0	0.2	0	9.7	17.1	1.9	6.0
		03			12	38-40N	144-49E	c	1014.2	7.8	1.6	65.0	0.2	356	7.1	17.3	1.7	5.0
		06			15	39-24N	144-42E	o	1013.1	6.6	-2.3	53.0	0.0	328	8.2	17.2	1.9	5.0
		09			18	40-08N	144-35E	r	1013.1	3.0	-0.2	80.0	0.4	338	9.8	17.9	1.7	6.0
		12			21	40-51N	144-29E	s	1012.9	1.5	-0.4	87.0	0.5	312	13.5	12.4	2.5	7.0
		15		22	00	41-32N	144-23E	c	1012.5	1.1	-3.4	72.0	0.1	295	17.0	12.0	2.6	7.0
		18			03	42-05N	144-17E	bc	1014.1	0.3	-7.8	54.0	0.0	320	14.4	8.2	1.9	7.0
		21			06	42-33N	144-15E	bc	1016.2	1.2	-6.2	58.0	0.0	303	12.5	8.9	1.4	5.0
	22	00			09	42-57N	144-18E	bc	1019.2	1.1	-9.5	45.0	0.1	294	4.8	7.4	0.9	12.0
		03			12	42-58N	144-22E	bc	1019.6	2.9	-8.8	42.0	0.0	200	6.7	8.6	0.2	4.0
		06			15	42-58N	144-22E	bc	1020.0	3.2	-9.5	39.0	0.0	198	6.5	8.7	0.1	6.0
		09			18	42-58N	144-22E	bc	1021.5	2.8	-9.1	41.0	0.1	192	6.7	8.6	0.2	7.0
		12			21	42-58N	144-22E	bc	1022.0	1.6	-9.4	55.0	0.0	188	3.3	8.6	0.0	6.0
		15		23	00	42-58N	144-22E	bc	1021.8	5.5	-10.0	71.0	0.0	177	3.3	8.7	0.1	5.0
		18			03	42-58N	144-22E	bc	1021.9	5.2	-10.0	69.0	0.0	150	2.7	8.7	0.2	3.0
		21			06	42-58N	144-22E	bc	1022.6	3.9	-8.1	73.0	0.0	127	3.0	8.6	0.1	4.0
		00			09													
		03			12	42-58N	144-22E		1020.6	3.1	-5.2	54	0.0	129	2.5	8.6	0.1	7
		06			15	42-58N	144-22E		1019.4	1.4	-2.6	75	0.0	126	3.1	8.7	0.1	5
		09			18	42-58N	144-22E		1016.5	0.3	-1.5	87	0.2	117	2.5	8.6	0.2	7
		12			21	42-58N	144-22E		1012.6	0.1	-0.9	93	1.0	91	3.2	8.6	0.3	4
		15			00	42-58N	144-22E		1012.1	0.4	-0.8	91	3.0	338	5.0	8.6	0.2	4
		18			03	42-58N	144-22E		1013.2	0.8	-0.7	90	0.2	349	3.7	8.4	0.2	6
11	23	21	11	24	06	42-58N	144-22E	bc	1015.3	1.0	-0.8	88	0.1	236	2.7	8.5	0.2	5
	24	00			09	42-58N	144-22E	bc	1017.0	3.0	-0.4	79	0.2	246	5.7	8.4	0.2	8
		03			12	42-22N	144-15E	bc	1016.9	4.6	-1.3	65	0.1	319	3.4	7.0	1.4	10
		06			15	41-36N	144-29E	bc	1017.5	5.7	-1.8	59	0.1	294	2.7	12.4	1.9	13
		09			18	40-52N	144-44E	c	1018.2	6.5	0.7	67	0.0	346	1.6	11.8	1.9	14
		12			21	40-05N	144-58E	o	1017.1	9.1	3.3	67	0.1	125	4.7	16.6	2.0	17
		15		25	00	39-17N	145-00E	bc	1015.5	10.6	0.3	49	0.0	171	1.9	17.6	1.5	13
		18			03	38-30N	145-00E	r	1011.7	11.5	6.7	72	0.7	122	10.3	18.9	1.7	14
		21			06	37-41N	144-59E	r	1012.8	10.0	7.6	85	1.5	358	13.9	17.6	1.8	16
	25	00			09	36-51N	145-00E	bc	1015.3	12.5	5.8	64	0.0	328	15.2	18.9	3.0	19
		03			12	36-04N	144-59E	bc	1015.5	13.7	5.9	59	0.0	326	15.0	20.4	3.8	18
		06			15	35-16N	145-00E	bc	1017.1	14.5	3.5	48	0.0	325	12.4	19.8	3.5	17
		09			18	34-59N	145-00E	bc	1018.7	14.2	2.5	45	0.1	333	12.7	19.7	2.6	7
		12			21	34-59N	144-59E	bc	1018.9	14.1	6.0	58	0.2	323	14.6	19.7	2.7	7
		15		26	00	35-00N	145-04E	bc	1019.8	13.5	6.7	63	0.0	329	14.7	19.6	3.2	10

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
11	25	18	11	26	03	35-00N	146-00E	bc	1019.7	14.7	6.7	59	0.0	314	17.4	21.9	5.6	18
		21			06	34-59N	146-51E	bc	1021.4	13.7	8.2	69	0.9	293	16.1	23.4	4.2	14
	26	00			09	34-59N	147-49E	c	1021.8	12.9	8.0	72	0.7	354	8.9	19.5	3.1	15
		03			12	34-59N	148-46E	c	1020.6	13.1	7.7	70	0.0	345	9.0	18.3	3.5	16
		06			15	35-00N	149-44E	c	1020.7	13.0	6.9	66	0.2	359	5.8	18.6	3.3	15
		09			18	35-00N	149-59E	bc	1022.4	14.1	4.3	52	0.0	341	9.0	18.5	2.8	8
		12			21	35-02N	149-59E	r	1023.9	13.5	5.4	58	0.0	351	7.3	18.4	2.8	8
		15		27	00	35-04N	150-01E	c	1024.3	13.6	6.0	60	0.0	338	6.4	18.4	2.7	8
		18			03	35-03N	150-02E	bc	1024.5	13.4	5.5	59	0.0	320	5.0	18.4	2.6	7
		21			06	35-14N	150-02E	bc	1025.2	13.2	7.0	66	0.0	317	6.8	18.4	2.2	7
	27	00			09	35-55N	149-59E	bc	1026.0	13.6	5.9	60	0.1	319	4.3	18.5	2.2	7
		03			12	36-30N	149-59E	bc	1022.9	14.3	3.8	49	0.0	295	5.5	18.0	1.9	7
		06			15	37-13N	150-00E	bc	1021.3	14.2	4.5	52	0.1	253	8.1	18.3	2.0	7
		09			18	37-28N	149-58E	bc	1020.6	14.9	5.2	52	0.1	224	10.3	20.6	1.7	7
		12			21	37-30N	150-00E	bc	1018.3	15.8	8.2	61	0.0	213	14.2	20.5	2.7	12
		15		28	00	37-30N	149-57E	bc	1015.1	16.1	8.9	62	0.0	207	14.7	20.5	2.3	6
		18			03	37-29N	149-56E	bc	1011.7	17.3	12.3	73	0.2	202	17.5	20.4	3.1	7
		21			06	37-48N	149-59E	r	1009.8	14.7	13.2	90	18.0	252	12.5	21.0	3.7	10
	28	00			09	38-11N	150-00E	o	1005.3	16.4	14.6	89	0.9	202	9.1	20.5	3.6	11
		03			12	38-34N	150-01E	o	1000.1	16.9	12.3	74	0.1	260	17.4	21.4	5.0	10
		06			15	38-51N	150-02E	o	1000.3	16.9	8.3	57	0.0	278	17.5	20.8	4.6	10
		09			18	39-04N	150-00E	bc	1003.7	12.8	6.8	67	0.3	310	17.4	19.3	4.4	9
		12			21	39-16N	150-00E	bc	1008.1	8.6	2.3	65	0.0	332	14.0	18.1	4.2	9
		15		29	00	39-34N	149-59E	bc	1010.5	7.5	0.8	63	0.0	338	11.9	12.7	3.4	9
		18			03	39-55N	149-59E	bc	1013.3	6.7	-0.3	61	0.0	335	8.6	13.3	3.5	8
		21			06	40-01N	149-59E	c	1015.8	7.5	-0.9	56	0.1	285	5.3	14.2	3.6	9
	29	00			09	40-02N	149-58E	c	1017.6	7.6	0.6	62	0.0	306	9.1	14.4	3.6	9
		03			12	39-56N	149-57E	bc	1018.0	7.7	-1.1	54	0.0	317	10.9	13.3	4.5	13
		06			15	40-02N	149-58E	c	1020.5	6.8	-4.0	46	0.0	332	8.8	14.3	3.3	9
		09			18	40-04N	149-56E	bc	1022.6	5.9	-3.0	53	0.0	323	6.1	13.5	3.1	9
		12			21	39-59N	150-49E	bc	1023.1	6.3	-3.1	51	0.0	341	4.3	14.6	3.8	13
		15		30	00	40-00N	151-47E	o	1022.6	7.8	1.6	65	0.1	347	4.2	15.4	3.1	11
		18			03	40-00N	152-45E	c	1021.8	9.1	1.8	60	0.2	212	3.7	13.6	2.9	11
		21			06	40-00N	153-46E	bc	1023.0	10.0	2.7	61	0.0	260	7.1	14.7	3.1	13
	30	00			09	39-59N	154-49E	r	1023.6	9.7	3.7	66	0.6	180	9.8	14.9	2.9	11
		03			12	39-59N	155-00E	bc	1022.1	11.3	3.9	60	0.1	191	11.0	14.8	2.7	9
		06			15	39-58N	155-00E	bc	1023.1	12.2	1.9	49	0.0	241	10.8	14.8	2.2	8
		09			18	39-41N	154-59E	bc	1023.4	13.0	4.5	56	0.1	222	10.3	14.9	2.3	10
		12			21	38-55N	154-59E	bc	1024.3	13.1	5.0	58	0.0	204	9.4	15.0	1.9	10
11	30	15	12	1	00	38-07N	155-00E	bc	1024.1	13.6	4.7	55	0.0	176	5.6	17.7	2.1	10
		18			03	37-38N	154-59E	bc	1023.1	14.5	7.2	62	0.0	173	6.2	17.8	2.3	10
		21			06	37-29N	154-59E	bc	1021.7	15.6	10.4	71	0.0	160	5.6	17.7	1.7	8
12	1	00			09	37-30N	155-00E	o	1020.5	17.0	8.8	59	0.0	169	11.1	17.7	1.7	8
		03			12	37-03N	155-00E	o	1017.9	17.6	8.5	55	0.0	183	12.3	17.8	1.9	6
		06			15	36-19N	155-00E	o	1016.0	18.3	11.5	64	0.0	174	14.3	19.7	1.9	6
		09			18	35-37N	155-00E	o	1014.4	18.3	12.6	70	0.0	160	14.7	20.6	2.0	7
		12			21	35-00N	154-59E	o	1011.9	18.5	13.5	72	0.0	163	14.1	18.9	2.6	7
		15		2	00	34-59N	154-59E	r	1008.6	17.0	15.1	88	1.3	152	13.0	18.9	2.9	7
		18			03	35-00N	155-00E	r	1006.5	16.0	15.0	94	23.6	312	4.1	18.9	2.8	9
		21			06	35-00N	155-40E	o	1002.9	18.3	14.0	76	0.0	48	17.3	21.2	2.7	8
	2	00			09	35-00N	156-30E	bc	1008.7	21.3	14.9	67	0.1	326	13.1	22.3	2.6	8
		03			12	34-59N	157-20E	o	1009.7	18.9	14.7	77	0.0	350	18.9	22.2	2.9	10
		06			15	34-59N	158-09E	o	1012.3	18.7	13.5	72	0.0	0	17.3	21.4	3.3	9
		09			18	34-59N	158-46E	bc	1015.3	17.7	11.1	65	0.0	359	15.0	21.7	3.9	8

UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
12	2	12	12	2	21	35-00N	159-21E	bc	1017.4	16.8	10.4	66	0.1	23	8.6	21.3	3.4	9
		15		3	00	34-59N	160-03E	bc	1018.7	16.2	9.4	64	0.3	23	7.8	21.9	3.2	8
		18			03	34-55N	160-22E	bc	1018.7	16.0	9.0	63	0.0	27	9.3	22.0	3.3	13
		21			06	34-58N	159-51E	bc	1019.9	16.3	9.6	64	0.1	92	5.6	21.4	2.7	10
	3	00			09	34-59N	160-01E	c	1020.9	17.8	10.6	63	0.0	183	6.2	21.7	2.9	9
		03			12	34-59N	160-04E	bc	1018.4	18.6	10.5	59	0.1	188	8.1	21.8	2.6	9
		06			15	34-59N	160-01E	c	1018.5	19.5	12.2	63	0.0	196	9.8	22.3	2.0	9
		09			18	34-58N	160-03E	bc	1019.4	20.3	13.8	66	0.1	210	8.7	22.3	2.1	9
		12			21	35-36N	160-00E	o	1021.6	14.5	12.2	86	0.1	40	7.1	18.6	2.5	8
		15		4	00	36-20N	159-59E	o	1021.0	13.9	11.6	86	0.0	31	9.5	17.2	2.5	7
		18			03	37-04N	160-00E	o	1021.5	12.4	8.0	75	0.1	41	8.0	17.2	2.6	8
		21			06	37-30N	159-59E	o	1023.3	12.0	6.5	69	0.0	37	9.1	17.8	2.2	9
	4	00			09	37-30N	159-59E	r	1022.9	12.3	7.5	72	0.2	49	8.0	17.8	2.2	9
		03			12	37-45N	159-59E	o	1020.9	11.2	4.9	65	0.0	16	12.9	17.5	2.2	9
		06			15	38-30N	160-00E	o	1021.4	7.5	4.8	83	4.8	27	11.1	15.0	2.2	9
		09			18	39-14N	160-00E	r	1022.5	9.3	5.1	75	0.3	76	5.8	15.4	2.2	9
		12			21	39-58N	160-00E	o	1023.2	9.3	4.4	72	0.0	7	2.8	16.1	2.5	9
		15		5	00	39-59N	160-56E	o	1023.6	9.3	5.9	80	0.3	11	10.1	14.7	2.6	13
		18			03	40-00N	161-56E	bc	1024.5	8.5	4.6	77	0.0	0	11.9	11.8	2.6	12
		21			06	40-00N	162-56E	bc	1027.6	8.1	3.0	70	0.0	351	13.0	12.3	3.0	11
	5	00			09	40-00N	163-55E	bc	1029.3	8.9	0.7	57	0.0	335	11.0	12.5	3.2	12
		03			12	39-59N	164-44E	bc	1030.1	9.1	0.2	54	0.1	333	9.7	12.8	3.2	12
		06			15	40-00N	164-59E	bc	1031.8	9.2	-0.5	51	0.0	323	7.5	12.6	2.6	8
		09			18	40-02N	164-58E	bc	1032.8	9.3	0.3	53	0.1	320	5.9	12.7	2.4	8
		12			21	40-03N	164-57E	bc	1033.2	9.4	0.3	53	0.0	306	4.0	12.7	2.3	9
		15		6	00	40-01N	164-58E	c	1033.8	9.7	0.8	54	0.0	304	1.9	12.5	2.6	12
		18			03	40-00N	164-59E	c	1031.4	10.1	2.1	58	0.0	115	5.3	12.7	2.2	9
		21			06	40-01N	164-59E	o	1030.6	10.9	2.6	56	0.0	128	7.8	12.9	2.0	8
	6	00			09	40-03N	164-56E	r	1025.7	10.8	5.2	69	0.2	140	12.3	12.5	2.0	8
		03			12	40-03N	164-54E	r	1014.4	10.1	7.7	85	1.4	131	20.8	12.5	2.7	8
		06			15	39-32N	164-54E	r	1002.9	14.1	13.6	97	0.0	180	20.2	13.3	6.8	10
		09			18	39-26N	165-00E	o	999.1	17.3	15.2	88	0.1	229	20.4	13.6	4.8	8
		12			21	39-19N	165-07E	c	1003.7	15.2	9.5	69	0.0	270	23.1	14.5	5.3	8
		15		7	00	39-10N	165-08E	o	1007.5	13.6	10.2	80	0.1	289	18.4	15.4	5.9	9
		18			03	39-00N	165-04E	o	1010.5	13.5	6.2	61	0.0	292	18.9	15.0	5.9	10
		21			06	38-51N	164-56E	o	1015.5	12.9	7.9	72	0.2	294	14.3	15.7	5.4	10
	7	00			09	38-55N	164-44E	c	1018.1	13.4	6.7	64	0.0	300	15.5	15.3	4.7	10
		03			12	39-05N	164-32E	c	1022.8	10.4	7.2	81	0.1	344	15.7	15.4	5.2	9
		06			15	39-14N	164-21E	o	1028.0	9.4	4.7	73	0.3	358	13.4	14.3	4.9	9
	7	09			18	39-29N	164-10E	c	1031.7	8.4	2.1	65	0.0	2	12.3	13.4	4.9	10
		12			21	39-41N	164-11E	bc	1034.5	7.4	-1.6	53	0.2	343	9.1	12.9	4.6	11
		15		8	00	39-50N	164-34E	c	1033.8	6.6	-1.7	55	0.0	336	10.6	12.3	4.1	11
		18			03	40-06N	164-49E	o	1034.7	6.4	-3.7	48	0.0	332	6.8	12.3	4.4	9
		21			06	40-18N	164-57E	o	1035.7	5.7	-1.1	62	0.0	29	4.3	12.4	4.2	9
	8	00			09	40-20N	164-58E	o	1036.2	6.6	-1.1	58	0.0	331	3.9	12.3	3.2	9
		03			12	40-15N	164-59E	o	1034.2	6.8	-2.0	53	0.0	299	1.7	12.3	5.0	17
		06			15	39-59N	164-59E	o	1031.9	7.3	-1.4	54	0.0	139	5.3	12.4	2.8	9
		09			18	40-00N	164-57E	o	1027.8	8.7	3.1	68	0.0	150	11.5	12.4	2.4	9
		12			21	39-57N	164-56E	o	1022.8	10.4	8.0	85	0.7	156	16.7	12.6	2.8	11
		15		9	00	40-23N	164-02E	r	1012.1	12.4	11.3	93	0.1	173	15.9	11.9	4.2	16
		18			03	40-43N	163-12E	o	1003.1	14.0	12.8	93	0.1	201	22.5	11.9	4.9	14
		21			06	40-47N	162-31E	o	1007.6	9.4	7.5	88	1.8	312	10.1	11.2	4.6	10
	9	00			09	41-11N	161-51E	o	1008.3	11.4	5.0	65	0.0	286	12.6	10.2	5.0	16
		03			12	41-33N	161-07E	o	1007.2	10.6	3.5	61	0.1	275	19.1	10.3	4.4	12

Time UTC			Ship's Time			Position			Press	Air Temp	Dew PT	Humid	Precpt	W.D.	W.S	Seatmp	Wv.Ht	Wv.PD
MM	DD	hh	MM	DD	hh	Lat.	Long.	Weather	(hPa)	(deg-c)	(deg-c)	(%)	(mm)	(deg)	(m/s)	(deg-c)	(m)	(sec)
12	9	06	12	9	15	41-48N	160-47E	o	1008.1	9.6	2.4	61	0.1	278	19.9	11.8	5.8	9
		09			18	41-59N	160-35E	c	1008.8	8.3	2.5	67	0.2	278	20.2	11.3	6.4	9
		12			21	42-11N	160-22E	o	1008.8	7.7	-0.4	60	0.1	280	19.6	10.1	6.4	10
		15		10	00	42-23N	160-10E	c	1009.2	6.6	-2.3	53	0.2	280	21.2	9.3	7.4	10
		18			03	42-35N	159-57E	o	1009.9	5.9	-2.8	54	0.2	288	18.7	9.1	8.5	12
		21			06	42-47N	159-43E	c	1010.9	4.9	-2.9	57	0.0	290	17.6	9.1	7.5	11
	10	00			09	43-01N	159-26E	bc	1012.6	3.6	-1.5	69	0.1	297	15.2	8.6	5.8	9
		03			12	43-17N	159-01E	bc	1012.3	4.0	-2.9	61	0.0	294	14.9	9.3	4.3	9
		06			15	43-21N	158-24E	c	1014.1	3.0	-2.4	68	0.0	313	10.6	6.3	5.7	10
		09			18	43-28N	157-39E	c	1017.3	3.1	-3.9	60	0.0	300	10.2	6.0	3.4	8
		12			21	43-34N	156-55E	bc	1018.2	2.7	-4.7	59	0.0	286	10.3	6.1	3.5	9
		15		11	00	43-39N	156-15E	bc	1018.6	2.6	-5.0	57	0.1	310	9.8	5.1	3.6	9
		18			03	43-51N	155-34E	bc	1019.9	1.5	-4.3	65	0.0	269	9.2	5.5	3.4	9
		21			06	43-59N	155-00E	bc	1021.3	0.4	-3.7	74	0.0	330	6.6	5.3	3.0	9
	11	00			09	44-00N	154-57E	bc	1023.3	1.4	-4.3	66	0.2	295	6.3	5.4	3.0	9
		03			12	44-00N	155-00E	bc	1022.3	1.0	-3.7	71	0.0	297	7.6	5.4	2.5	9
		06			15	44-00N	155-01E	o	1022.7	1.0	-3.4	72	0.1	276	6.2	5.4	2.7	9
		09			18	44-00N	155-01E	o	1021.7	2.0	-6.1	55	0.1	243	5.2	5.4	2.5	9
		12			21	43-58N	155-02E	o	1019.5	2.2	-7.0	51	0.2	149	0.7	5.4	2.4	8
		15		12	00	43-59N	155-01E	o	1013.5	2.2	-5.4	57	0.2	79	7.1	5.4	2.1	8
		18			03	43-58N	155-01E	s	1012.9	1.1	-2.2	79	0.1	94	9.2	5.4	1.9	8
		21			06	44-01N	154-56E	o	1011.3	2.0	-1.7	77	0.0	52	10.0	5.4	1.8	7
	12	00			09	44-00N	154-59E	o	1011.7	2.9	-2.8	66	0.1	24	11.0	5.3	1.9	9
		03			12	43-57N	155-01E	o	1012.3	2.1	-1.9	75	0.0	344	10.7	5.3	1.6	6
		06			15	43-59N	154-59E	o	1015.3	1.9	-4.3	64	0.0	329	12.2	5.3	1.8	6
		09			18	43-59N	154-59E	s	1017.8	1.9	-6.6	53	0.1	309	9.6	5.3	1.8	7
		12			21	43-57N	154-56E	o	1018.4	1.1	-4.1	68	0.1	305	11.6	5.2	2.0	8
		15		13	00	43-56N	154-59E	s/o	1018.2	1.4	-4.9	63	0.1	280	11.9	5.3	2.5	8
		18			03	44-02N	155-08E	o	1017.6	1.4	-7.0	53	0.0	275	11.1	5.3	2.3	7
		21			06	44-01N	155-12E	o	1016.8	2.3	-5.7	56	0.0	263	12.9	5.3	2.3	8
	13	00			09	44-02N	155-13E	o	1016.9	3.2	-3.0	64	0.0	259	10.9	5.3	2.0	8
		03			12	43-58N	155-14E	bc	1014.5	4.5	-1.1	67	0.0	249	11.0	5.3	2.6	8
		06			15	43-59N	155-13E	bc	1013.7	4.3	-0.7	70	0.0	249	11.4	5.3	2.5	8
		09			18	43-51N	154-48E	bc	1012.1	4.8	1.3	78	0.0	232	13.0	5.1	2.1	7
		12			21	43-30N	154-03E	r	1010.0	5.6	2.1	78	0.0	224	14.0	5.3	1.9	7
		15		14	00	43-04N	153-17E	bc	1009.1	5.6	3.1	84	0.0	257	9.6	5.1	1.9	8
		18			03	42-38N	152-31E	c	1008.5	4.3	2.5	88	0.1	279	5.5	4.1	1.6	6
		21			06	42-12N	151-44E	c	1009.7	4.9	2.5	85	0.0	309	5.9	6.1	1.8	6
	14	00			09	41-45N	150-57E	bc	1010.5	5.9	3.8	87	0.1	259	7.4	5.6	1.9	7
		03			12	41-20N	150-13E	c	1009.2	6.7	2.4	74	0.0	257	8.6	5.9	1.9	6
		06			15	40-56N	149-30E	o	1009.5	8.7	1.8	62	0.1	270	13.1	9.1	1.6	6
		09			18	40-31N	148-45E	c	1010.1	8.7	3.9	72	0.0	240	9.9	10.3	1.6	7
		12			21	40-04N	147-57E	bc	1009.8	10.1	3.7	65	0.1	243	7.4	10.3	1.4	7
		15		15	00	40-10N	147-05E	o	1005.9	9.9	6.0	77	0.2	227	14.9	13.1	1.8	6
		18			03	40-23N	146-10E	o	1006.8	8.5	1.0	59	0.0	295	11.1	9.1	2.0	5
		21			06	40-36N	145-18E	bc	1007.6	8.3	-2.3	47	0.0	292	15.7	12.5	2.1	4

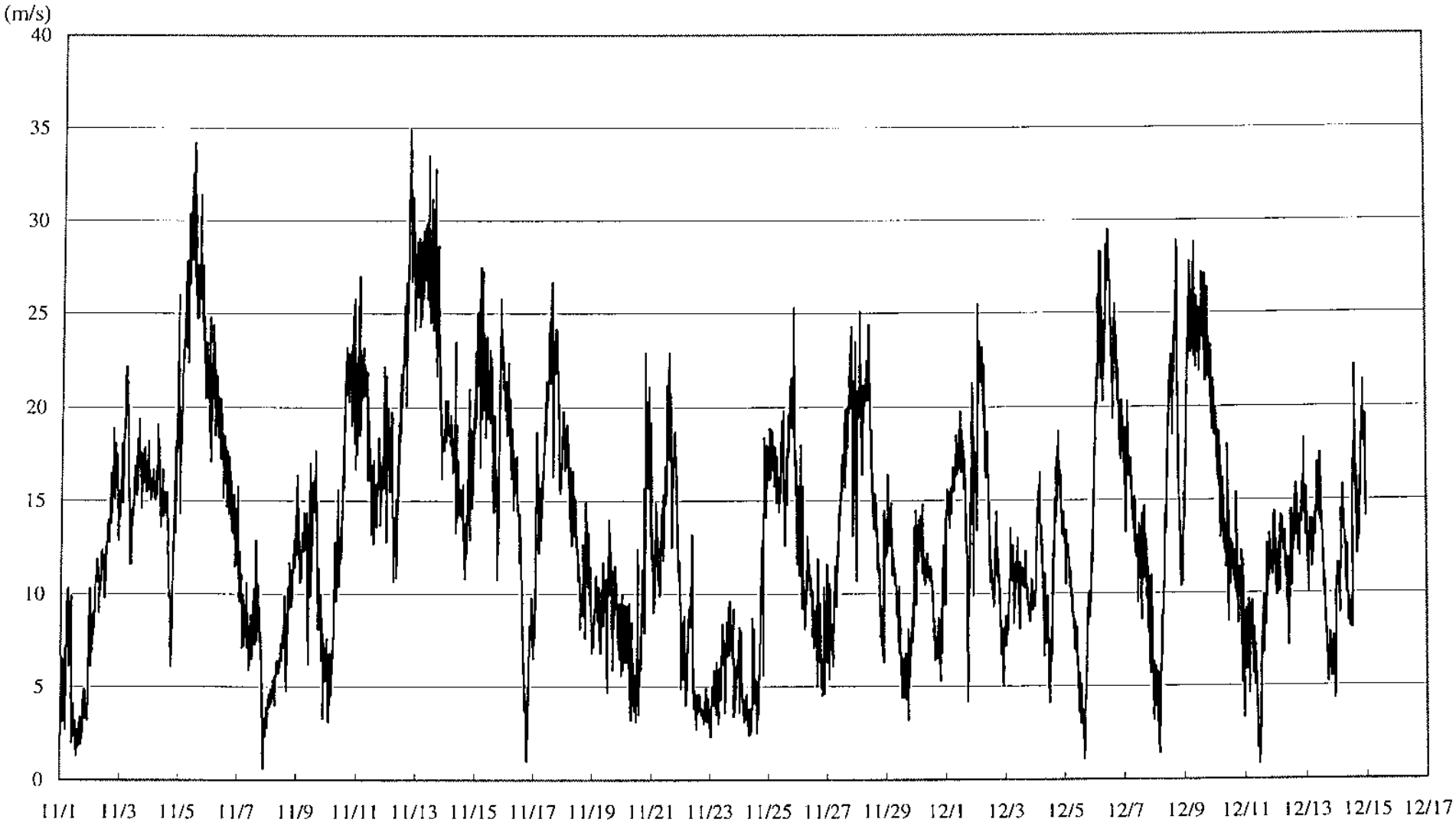

Fig-3.1-1 MR98-K01 10 minute Average Wind Speed(m/s) measured at every hour (UTC)

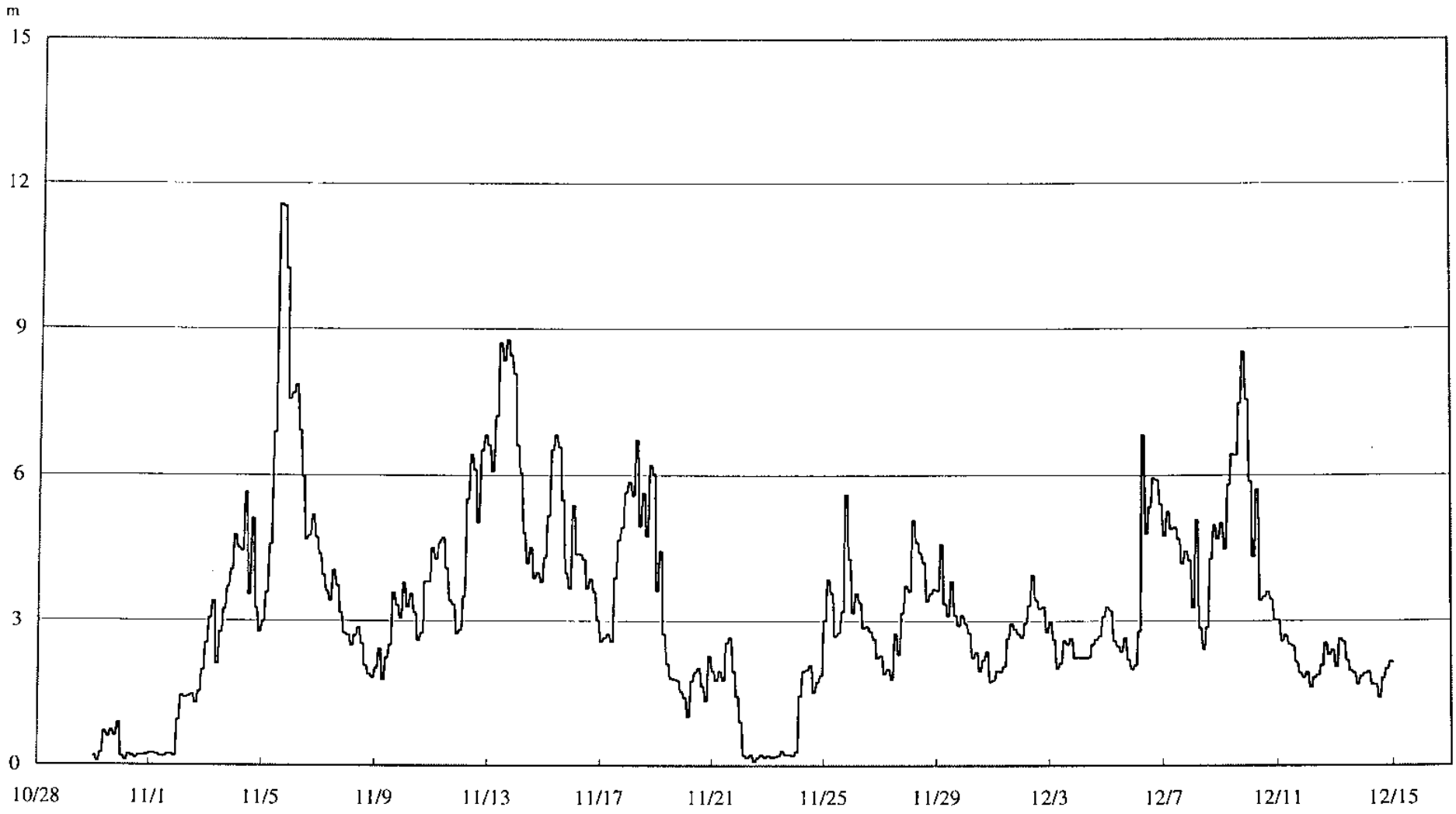

Fig-3.1-2 MR98-K01 Significant Wave Height(m) measured first20 minute at every 3 hours(UTC)
(0200,0500,0800,1100,1400,1700,2000,2300)

3. 2 Temperature and Salinity measurement and Water sampling

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1; Marine Works Japan Ltd.
2; Japan Marine Science and Technology Center

(1) Introduction

As a basic property of the water mass in the study area, temperature and salinity were measured by CTD (conductivity-temperature-depth profiler), and sea water sampling was conduced by RMS (Rosette Multi-bottle array water sampling system) in order to obtain the samples for chemical analysis. In this section, we describe as for the CTD/RMS observations in MR98-K01 cruise conducted from Nov. 02, 1998 to Dec. 12,1998 by R/V MIRAI.

(2) Measured Items

Temperature and Salinity were measured from sea surface through 50m above sea bottom, and sea waters at 36 layers (in maximum) were sampled at 20 sites shown in Figure 3-1 by using CTD/RMS. CTD/RMS water-sampling casts of 2-13 times were conduced at every station (68 casts in total) for the chemical analysis of general water properties, carbon, trace metals, radio isotope, etc..

(3) Observation Methods

(a) CTD/RMS systems

Two CTD/RMS were used during this cruise. One was the 12-litters 36-positions intelligent General Oceanic RMS (GO1016) water sampler with Sea-bird Electronics Inc. CTD (SBE9plus) for 10,500 meters, nicknamed "Large-CTD/RMS". Another one was the same CTD and RMS as Large CTD/RMS, but with 12-litters 12-positions water sampler, nicknamed "small CTD/RMS".

12-litters Niskin bottles were attached on each Rosette system, 12 bottles of which were especially used Niskin-X cleaned for the trace metal analysis. The sensors attached on each CTD were one temperature sencer, one conductivity sencer, one pressure sencer, one altimeter sencer. DO sencer especially attached Large CTD/RMS. Specification of the cencers were listed in Table 3-2-1.

(b) Operation during Observation

Large CTD/RMS was deployed and recovered from the stern of R/V MIRAI using the A-frame, and another small frame installed on starboard side, named as the Gallows, was used for Small CTD/RMS. Unfortunately, some troubles, *e.g.*, a bottle breaking during recovering of Large CTD/RMS in rough sea, abnormal exterior change

of pressure compensator of the Rosette happened during this cruise. Most of troubles were fixed during this cruise.

The CTD raw data was acquired on real time by using a 'SEASAVE' utility of a software 'SEASOFT (ver.4.226)' provided by SBE and stored on the hard disk of personal computer set in Aft wheel-house. Water samplings were made a during up cast such as date/time, station/cast/file names, location at the start/bottom/end of observation, water sampling layers and events were recorded in a CTD cast log sheet. These were summarized in 'CTD Cast List' or 'CTD Bottle List' shown in Appendex.

After a cast, the Large-CTD/RMS was lifted down from upper deck to the Water Drawing Room on 2nd deck and sea water was arawn from the bottles.

(c) CTD data processing

The CTD raw data was processed by using 'SEASOFT (ver.4.226)'. Procedure of the data processing and used utilities of 'SEASOFT' were as following.

DATCNV; Converts the binary raw data to out put one physical units. Output Items are depth, pressure, temperature, salinity, density (sigma-theta), oxygen, potential temperature. Simultaneously, this utility selects the CTD data when bottles closed to output on another file.

SPLIT; Splits the data made by DATCNV into up and down cast data.

BINAVG; Calculates the averaged data in every 1 meter.

ASCIIOUT; Converts the binary averaged data into ASCII format data.

ROSSSUM; Edits the data of water sampled to output a summary file. These data were shown in tables in Appendix ' CTD Bottle List '.

SEAPLOT; Display the vertical profiles of averaged temperature, salinity, sigma-theta and oxygen data on CRT and plot out. Plotted profiles for every Stn. are shown in Figures in following pages.

(4) Management of the CTD data

A file name of each cast consist of the cruise identification, station name, CTD/RMS type and cast number, e.g., '98K101L2' . After SPLIT utility was used, up/down identification was added. As a result of above on-board processing, 13 files was made for 1 cast (or a half cast when the system reset during a cast), such as .DAT, .CON, .HDR, .BL, .ROS, .BTL, .CNV, d**.CNV, u**.CNV, a**.ASC, u**.ASC,

d**.HDR, u**.HDR files. It is noted that these data are uncorrected, then we would like to discuss the accuracy of these data when we will analyze overall the data obtained in this study.

All of raw and processed CTD data files were copied into a 3.5 inch magnetic optical disk.

Table 3-2-1

CTD/RMS	Sensor	Model	Serial No.
Large CTD/RMS	Temperature	SBE3-04F	031359
	Conductivity	SBE4-04/O	041202
	Pressure		42410
	Oxygen	SBE13-04	130338
	Altimeter	Benthos 2110-1	0206
Small CTD/RMS	Temperature	SBE3-04F	031525
	Conductivity	SBE4-04/O	041205
	Pressure		42423
	Altimeter	Benthos 2110-1	0205

CTD Cast List in MR98-K01 cruise

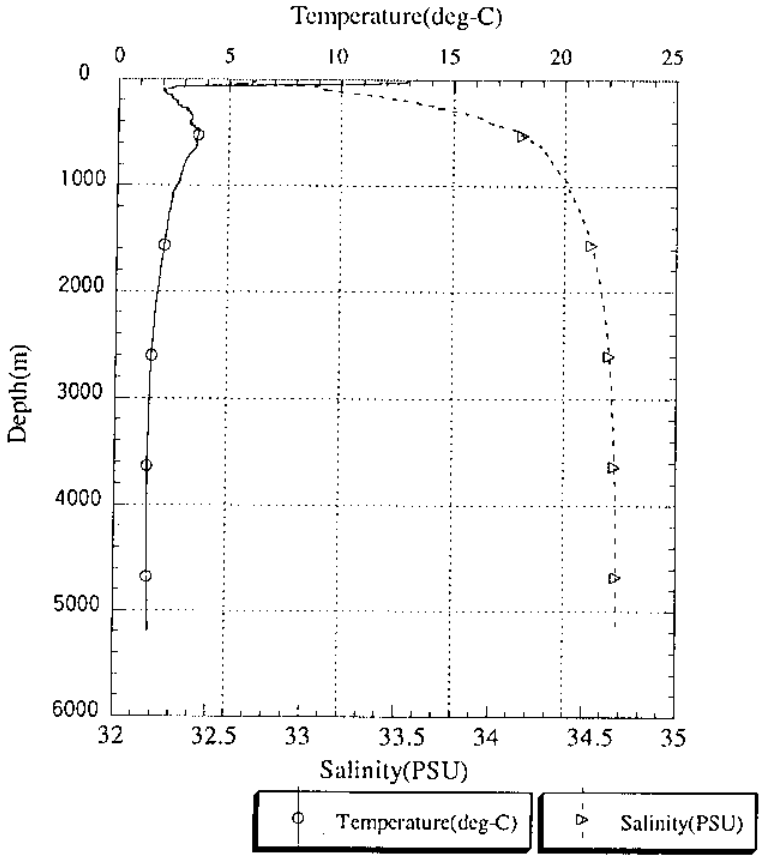
Leg.1

Stn.	Cast No.	File Name	Date	Start Time	Bottom Time	End Time	MAX Layer	Remarks
01	1	98K101L1	1998/11/03	18:24	20:28	22:52	5188	
	2	98K101S1	1998/11/03-04	23:17	00:50	02:20	5195	
	3	98K101S2	1998/11/04	03:03	03:15	03:36	600	
	4	98K101S3	1998/11/04	04:32	04:36	04:40	40	
	5	98K101S4	1998/11/04	05:16	05:19	05:21	100	
	6	98K101S5	1998/11/04	05:49	05:55	06:04	300	
07	1	98K107L1	1998/11/05	08:08	09:55	12:01	5584	
KNOT	1	98K1K1S1	1998/11/07	13:58	15:35	17:04	5286	
	2	98K1K1L1	1998/11/07	20:00	20:38	23:39	5263	
	3	98K1K1L2	1998/11/08	05:49	07:51	09:38	5292	
	4	98K1K1S2	1998/11/08	10:39		11:07	600	
	5	98K1K1L3	1998/11/08	11:30	11:40	12:03	250	
	6	98K1K1L4	1998/11/08	12:46	12:58	13:24	200	
	7	98K1K1L5	1998/11/08	14:38	16:16	18:01	5000	
	8	98K1K1S3	1998/11/09	09:25	09:54	10:20	1500	
	9	98K1K1S4	1998/11/09	10:39	10:52	11:04	500	
	10	98K1K1S5	1998/11/09	11:18	11:27	11:38	250	
	11	98K1K1S6	1998/11/09	15:28	17:07	18:49	5337	
	12	98K1K1S7	1998/11/09	20:00	20:21	20:45	1000	
	13	98K1K1S8	1998/11/09	21:42	21:49	21:59	150	
02	1	98K102L1	1998/11/10-11	22:59	23:35	00:25	600	
	2	98K102S1	1998/11/12	04:21	04:37	05:01	600	
	3	98K102L2	1998/11/12	05:51		06:48	250	
19	1	98K119L1	1998/11/17	04:32	06:40	09:18	5456	
	2	98K119L2	1998/11/17			11:16	100	
	3	98K119S1	1998/11/17-18	23:55	02:04	04:24	5471	
	4	98K119S2	1998/11/17	09:31	09:47	10:12	600	
08	1	98K108L1	1998/11/19-20	23:38	01:23	03:58	5544	
	2	98K108S1	1998/11/20	04:08	06:07	08:22	5696	
	3	98K108L2	1998/11/20	08:34	09:00	09:37	600	
	4	98K108S2	1998/11/20	09:54	10:07	10:30	600	
	5	98K108L3	1998/11/20	10:41	10:54	11:25	250	
09	1	98K109L1	1998/11/21	00:53	01:55	03:30	3000	
	2	98K108S1	1998/11/21	03:50	04:55	06:17	3000	

Leg.2

Stn.	Cast No.	File Name	Date	Start Time	Bottom Time	End Time	MAX Layer	Remarks
10	1	98K110S1	1998/11/25	16:17	17:25	18:42	3000	
	2	98K110L1	1998/11/25	18:52	20:01	21:42	3000	
	3	98K110S2	1998/11/25	21:56	22:08	22:28	250	
	4	98K110L2	1998/11/25	22:53	23:04	23:31	150	
11	1	98K111L1	1998/11/26	16:10	18:18	21:14	6053	
	2	98K111S1	1998/11/26	21:29	21:48	22:12	500	
	3	98K1111L2	1998/11/26	22:45	23:01	23:23	300	
	4	98K111S2	1998/11/26-27	23:46	03:04	04:54	5964	
12	1	98K112S1	1998/11/27	16:22	17:20	18:37	3000	
	2	98K112L1	1998/11/27	18:58				R.M.S. trouble on going down
	3	98K112L2	1998/11/27-28	23:23	01:04	02:24	3000	
	4	98K112S2	1998/11/28	02:48	02:57	03:14	400	
13	1	98K113S1	1998/11/29	06:18	08:07	09:40	5300	
	2	98K113S2	1998/11/29	10:38	10:52	11:10	500	
	3D	98K113L1	1998/11/29	14:21	15:59	15:59	5300	only down cast/system reset at bottom
	3U	98K113L2	1998/11/29	16:02	16:02	17:54	5300	only up cast
14	1	98K114L1	1998/11/30	10:17	11:17	12:32	3000	
	2	98K114S1	1998/11/30	12:46		13:06	250	
	3	98K114L2	1998/11/30	13:54	14:15	14:35	150	
	4	98K114S2	1998/11/30	14:46	15:37	16:47	3000	
15	1	98K115S1	1998/12/01	04:22	05:18	06:18	3000	
	2	98K115L1	1998/12/01	07:01	07:58	09:06	3000	
	3	98K115S2	1998/12/01	19:22	09:28	09:43	250	
16	1	98K116L1	1998/12/01	21:11	22:20	23:30	3000	
	2	98K116S1	1998/12/01-02	23:49	11:56	00:11	250	
	3	98K116L2	1998/12/02	00:53	01:02	01:25	150	
	4	98K116S2	1998/12/02	01:50	02:44	03:34	3000	
17	1D	98K117S1	1998/12/03	09:10	10:25	10:25	3445	only down cast/system reset at 3445m
	1U	98K117S2	1998/12/03	10:26	10:38	11:53	4464	only up cast
	2	98K117L1	1998/12/03	12:58	14:17	15:50	4300	
	3	98K117S3	1998/12/03	16:04	16:15	16:34	500	
	4	98K117L2	1998/12/03	17:20	17:30	17:54	300	

Stn.	Cast No.	File Name	Date	Start Time	Bottom Time	End Time	MAX Layer	Remarks
18	1	98K118S1	1998/12/04	05:21	06:16	07:14	3000	
	2	98K118L1	1998/12/04	07:43	08:44	09:47	3000	
	3	98K118S2	1998/12/04	10:05	10:10	10:25	250	
20	1	98K120S1	1998/12/05	14:08	14:21	14:39	600	
	2	98K120L1	1998/12/05	15:18	16:57	18:58	5300	
	3	98K120S2	1998/12/05	19:15	20:52	22:21	5405	
	4	98K120L2	1998/12/05	22:47	23:00	23:26	500	
	5	98K120L3	1998/12/08	13:16	14:50	16:41	5000	
	6	98K120L4	1998/12/08	18:18	18:30	18:55	250	
KNOT	1	98K1K2L1	1998/12/11	07:24	07:33	07:58	250	
	2	98K1K2S1	1998/12/11	14:48	16:22	17:50	5267	
	3	98K1K2L2	1998/12/11	11:17	12:45	14:29	5000	
	4	98K1K2L3	1998/12/11	18:10	18:19	18:40	250	
	5	98K1K2S2	1998/12/11	18:58	19:10	19:25	500	
	6	98K1K2L4	1998/12/11	19:45	19:59	20:28	500	
	7	98K1K2L5	1998/12/11-12	21:45	23:22	01:08	5100	
	8	98K1K2S3	1998/12/12	13:03	14:31	15:46	5000	
	9	98K1K2S4	1998/12/12	16:49	16:51	16:58	40	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10
15
20
25
Depth(m)
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2000
3000
4000
5000
6000
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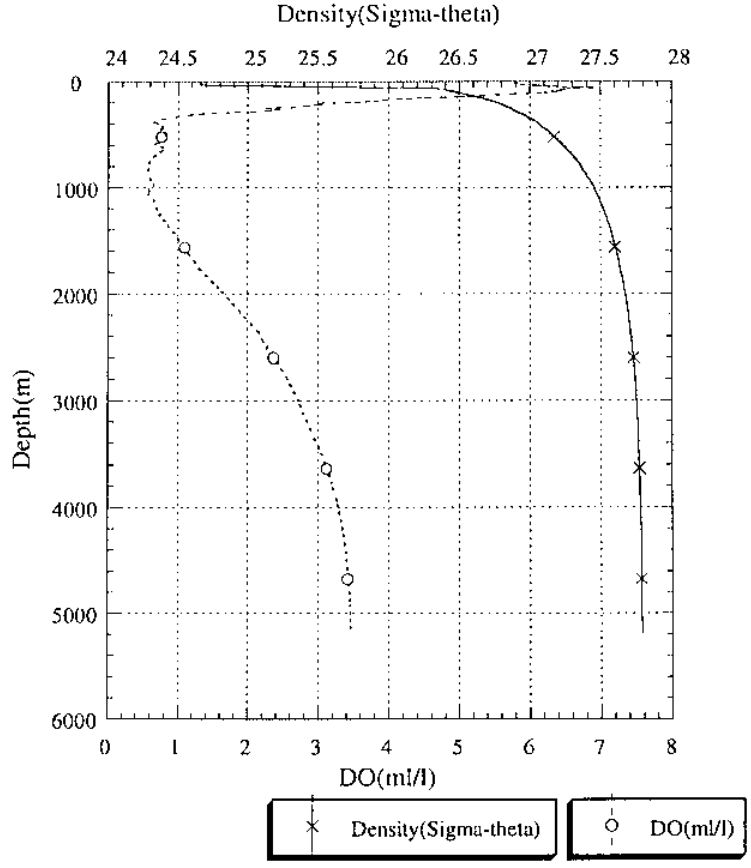
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)


Density(Sigma-theta)
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25.5
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26.5
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27.5
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Depth(m)
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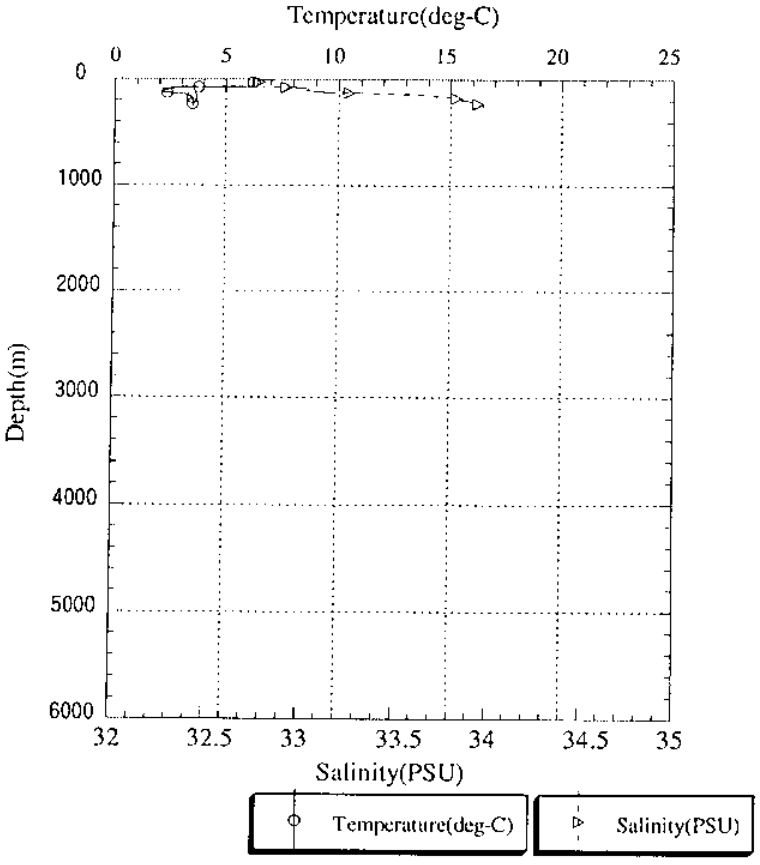
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.01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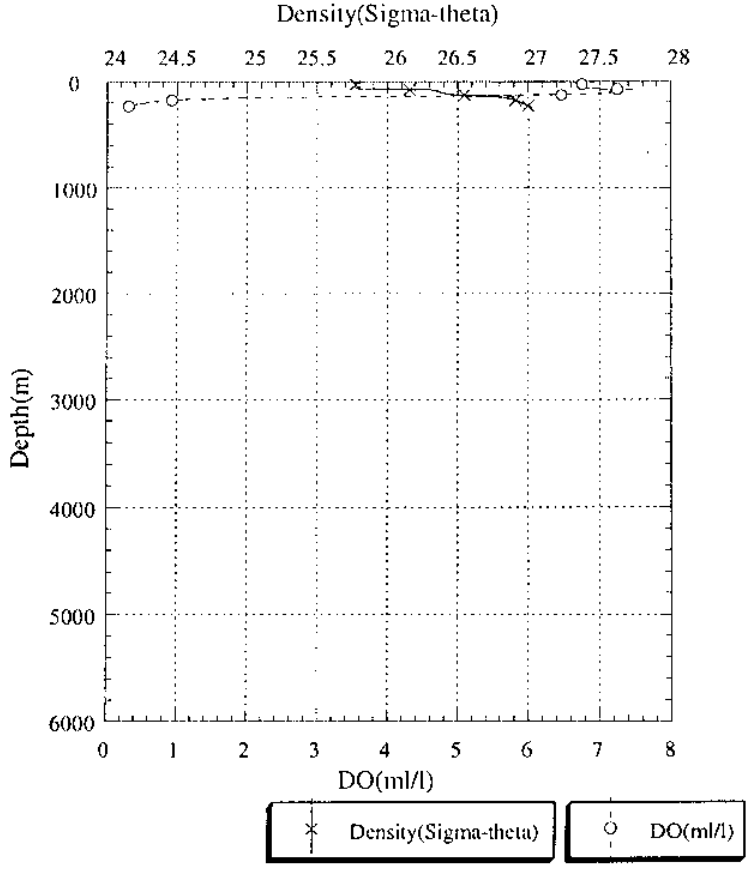
5
10
15
20
25
0
1000
2000
3000
4000
5000
6000
Depth(m)
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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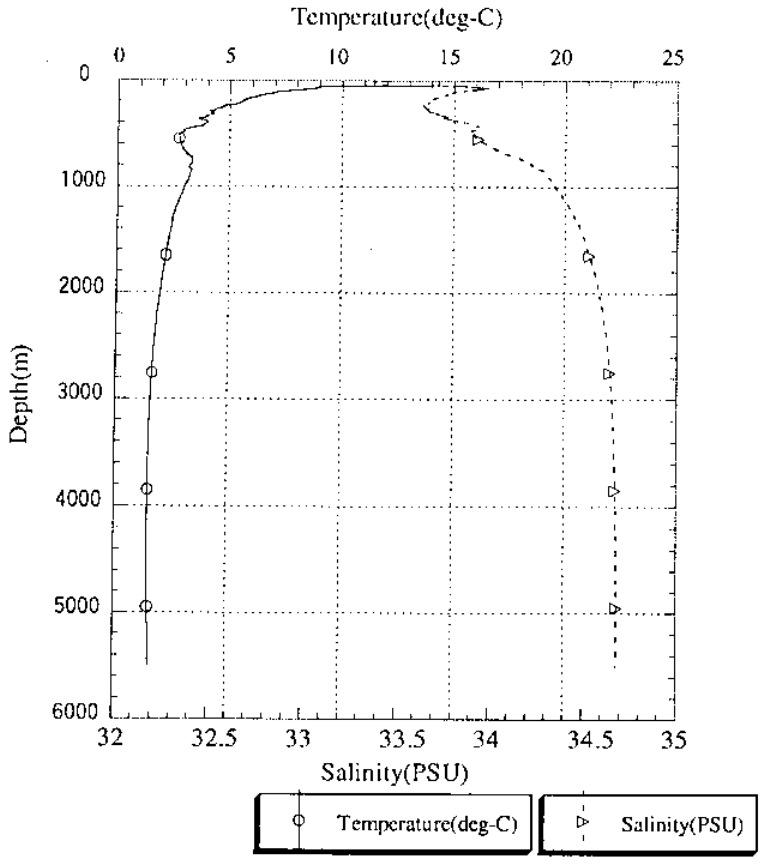
24.5
25
25.5
26
26.5
27
27.5
28
0
1000
2000
3000
4000
5000
6000
Depth(m)
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.02


Temperature(deg-C)
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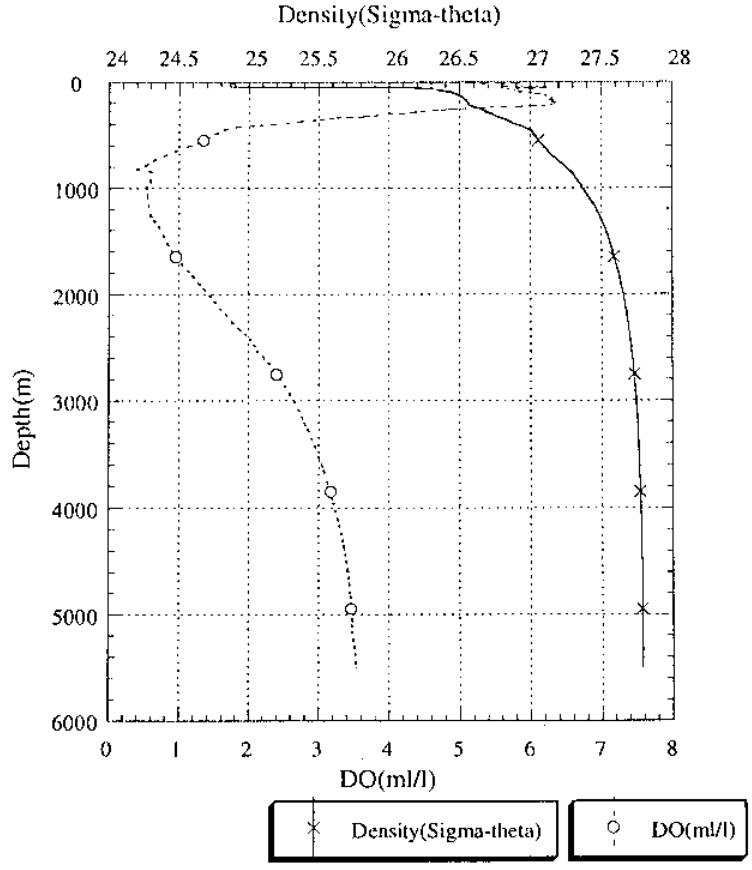
5
10
15
20
25
Depth(m)
0
1000
2000
3000
4000
5000
6000
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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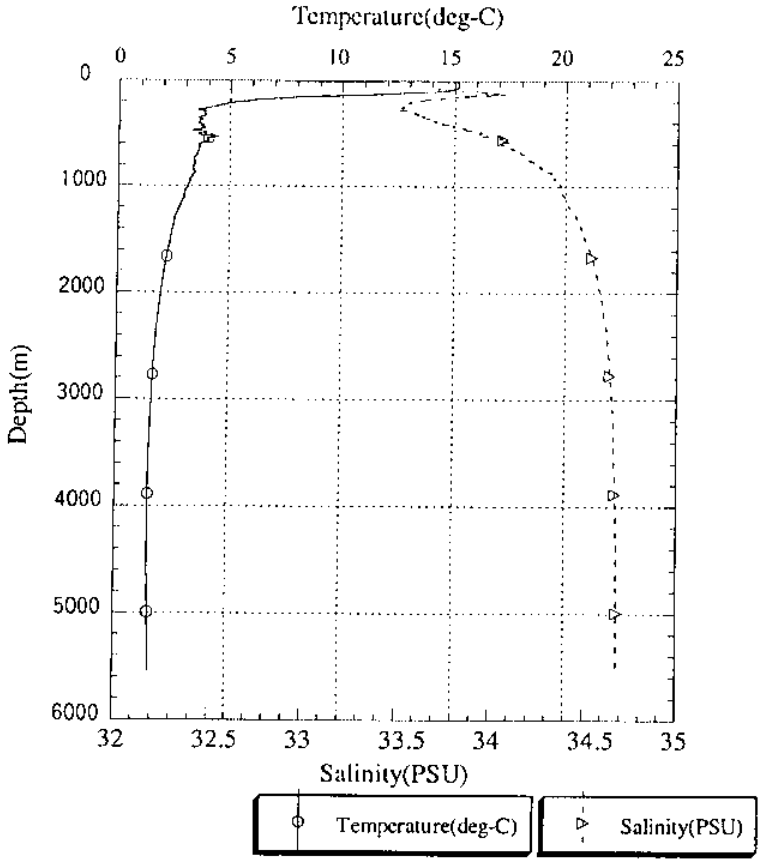
24.5
25
25.5
26
26.5
27
27.5
28
Depth(m)
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.07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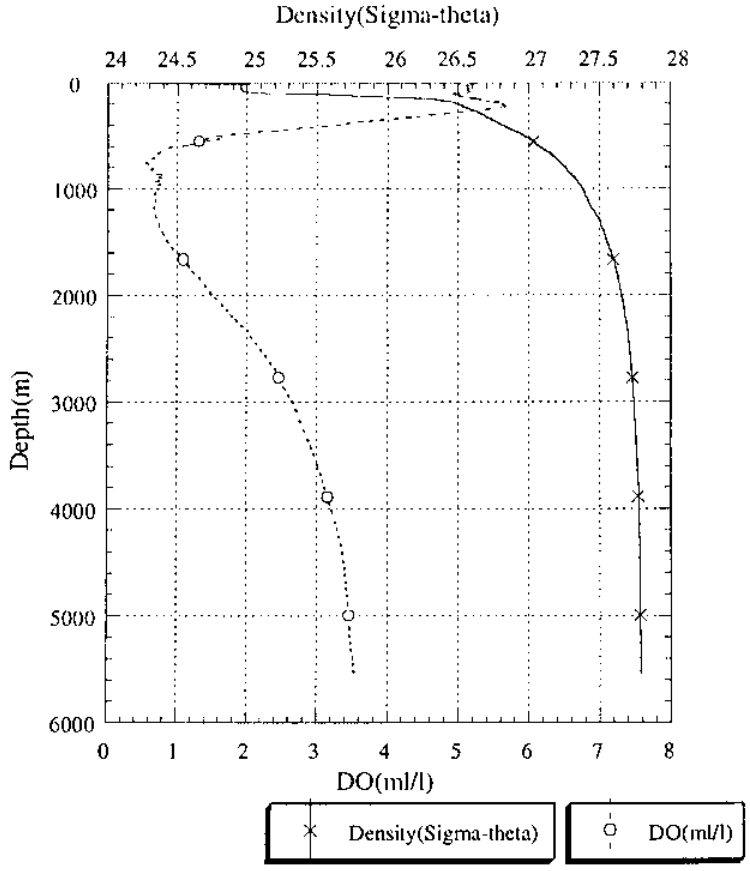
5
10
15
20
25
Depth(m)
0
1000
2000
3000
4000
5000
6000
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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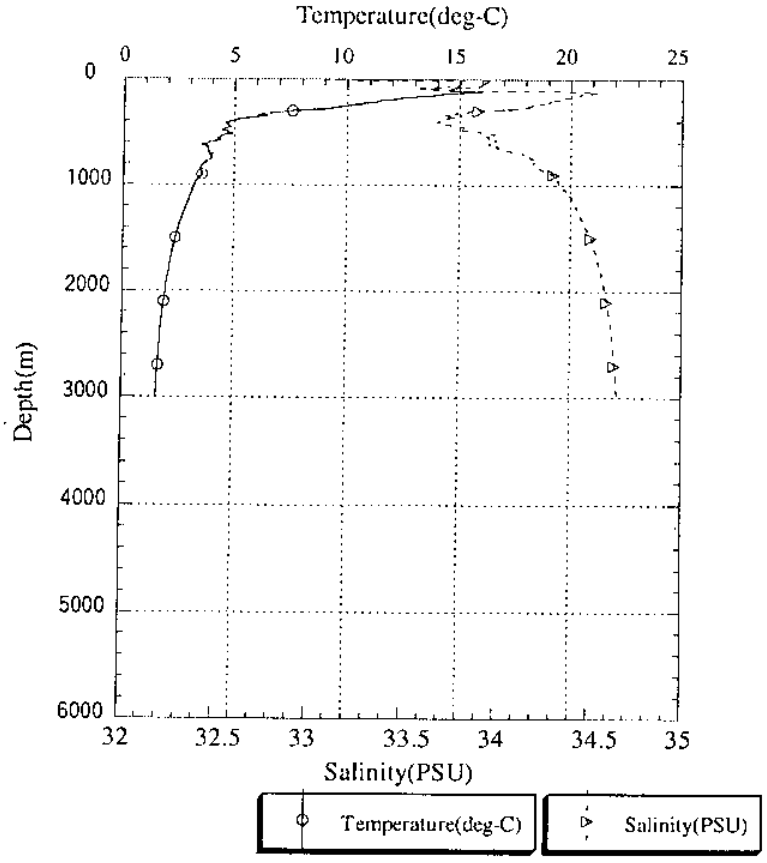
24.5
25
25.5
26
26.5
27
27.5
28
Depth(m)
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.08


Temperature(deg-C)
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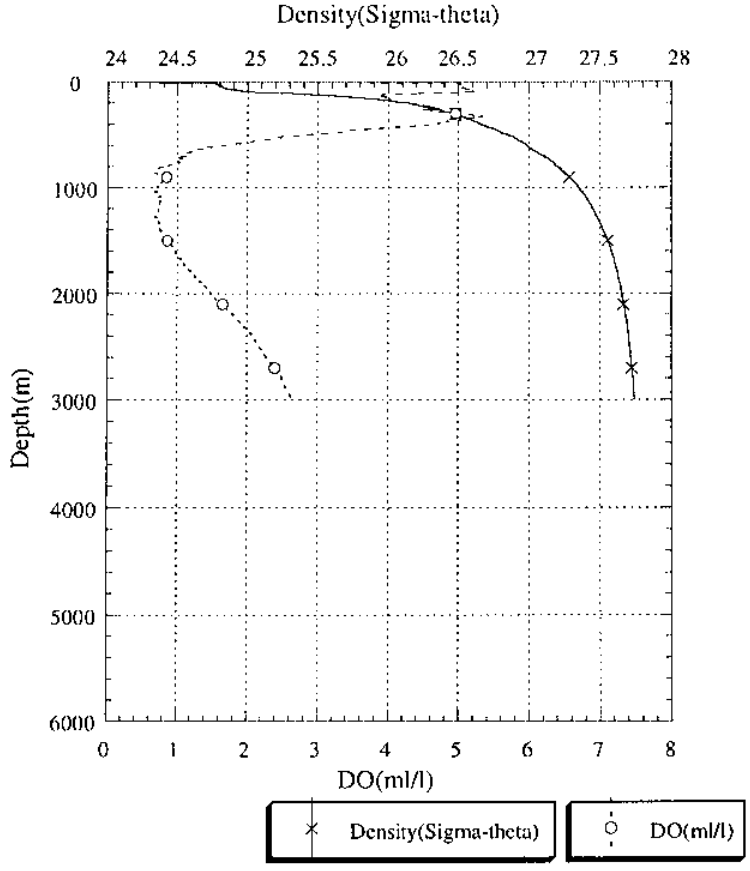
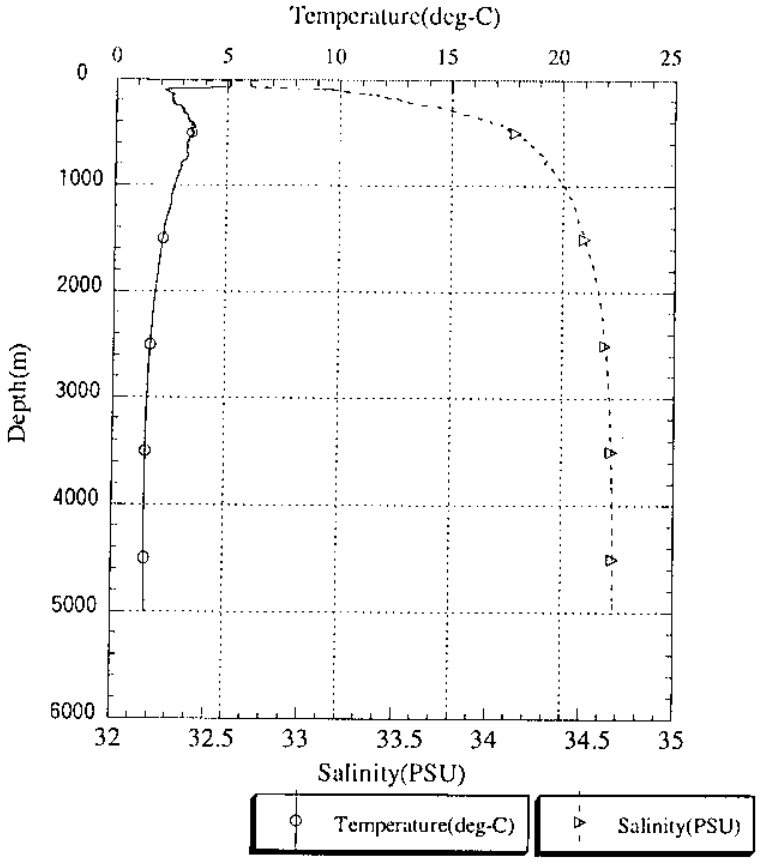
5
10
15
20
25
0
1000
2000
3000
4000
5000
6000
Depth(m)
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)


Density(Sigma-theta)
24
24.5
25
25.5
26
26.5
27
27.5
28
0
1000
2000
3000
4000
5000
6000
Depth(m)
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.09


Temperature(deg-C)
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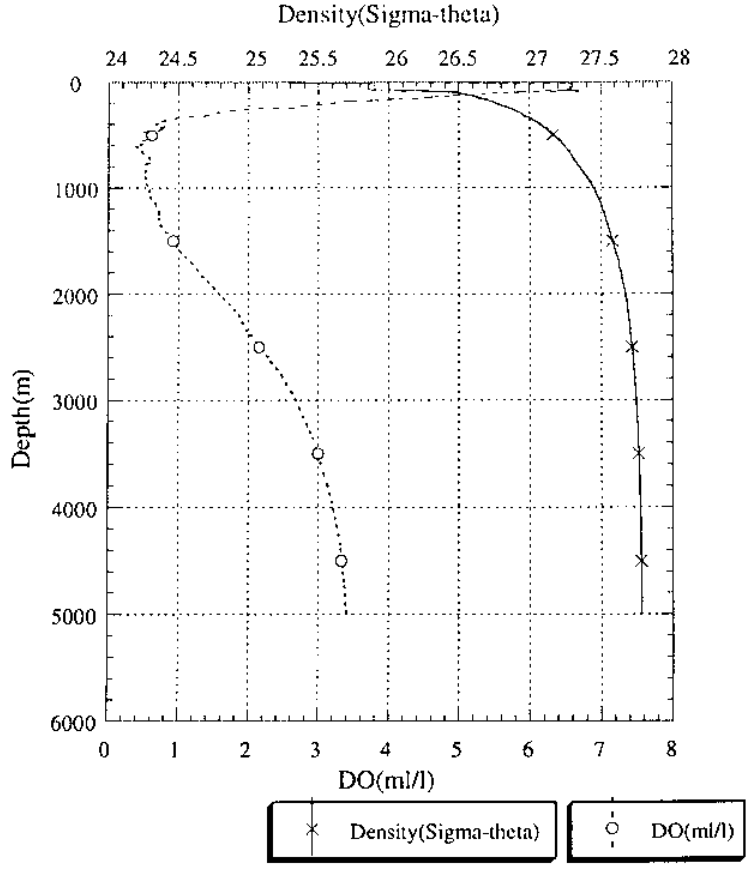
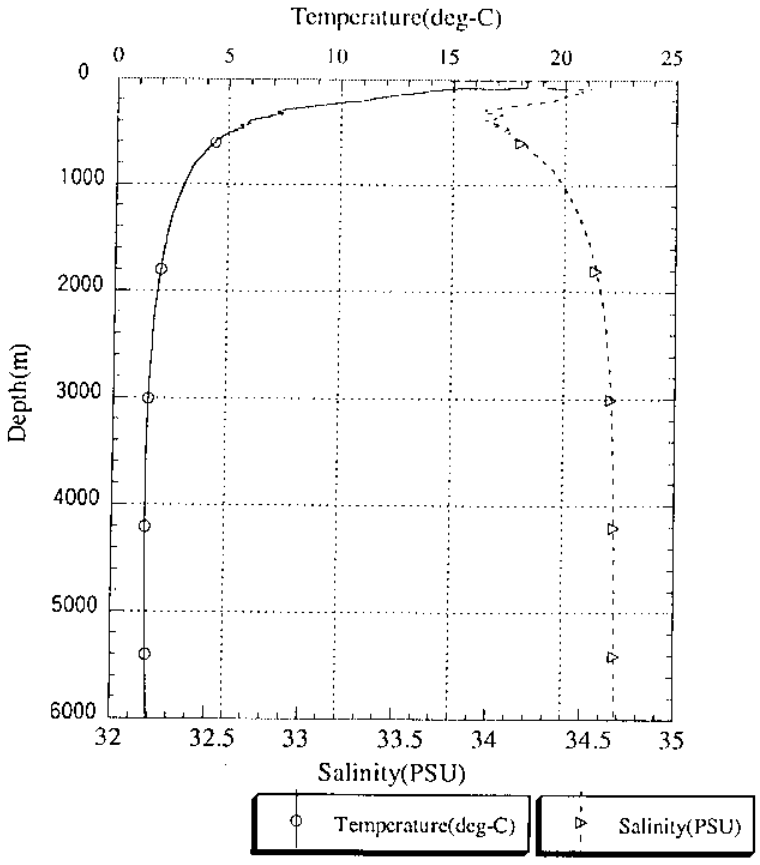
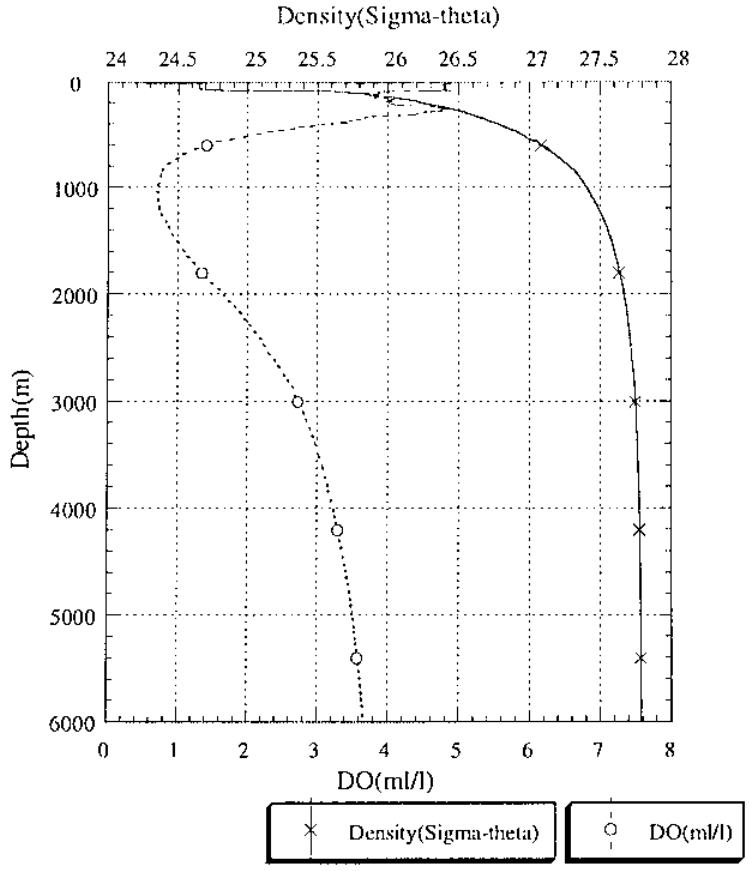
5
10
15
20
25
Depth(m)
0
1000
2000
3000
4000
5000
6000
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)

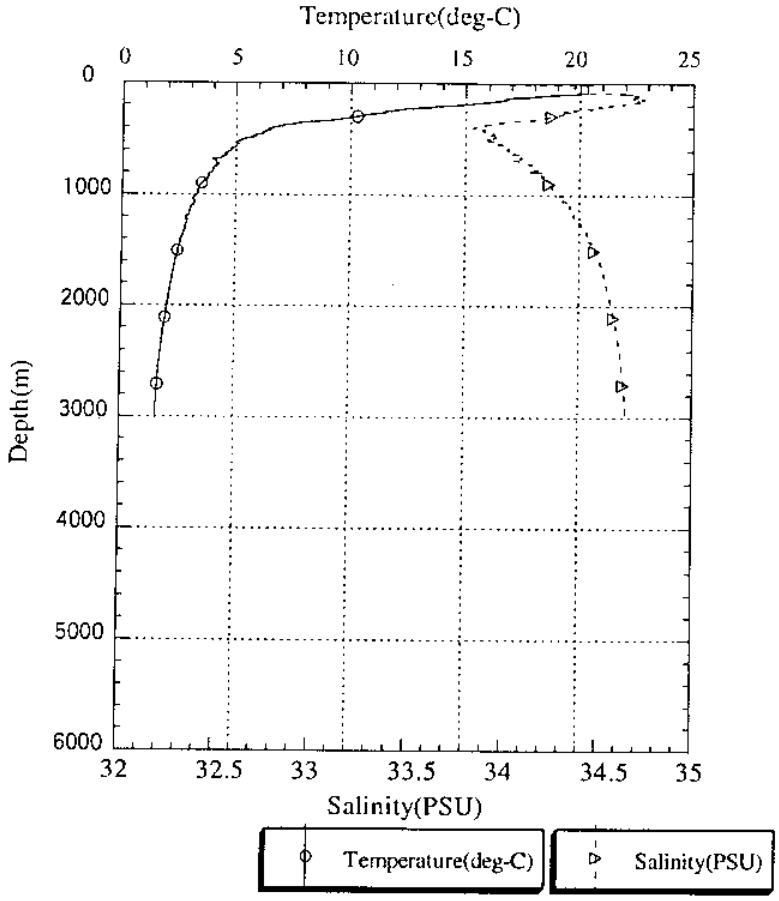

Density(Sigma-theta)
24
24.5
25
25.5
26
26.5
27
27.5
28
Depth(m)
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.10


Temperature(deg-C)
0
5
10
15
20
25
Depth(m)
0
1000
2000
3000
4000
5000
6000
32
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)


Density(Sigma-theta)
24
24.5
25
25.5
26
26.5
27
27.5
28
Depth(m)
0
1000
2000
3000
4000
5000
6000
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.11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10
15
20
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1000
2000
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4000
5000
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Depth(m)
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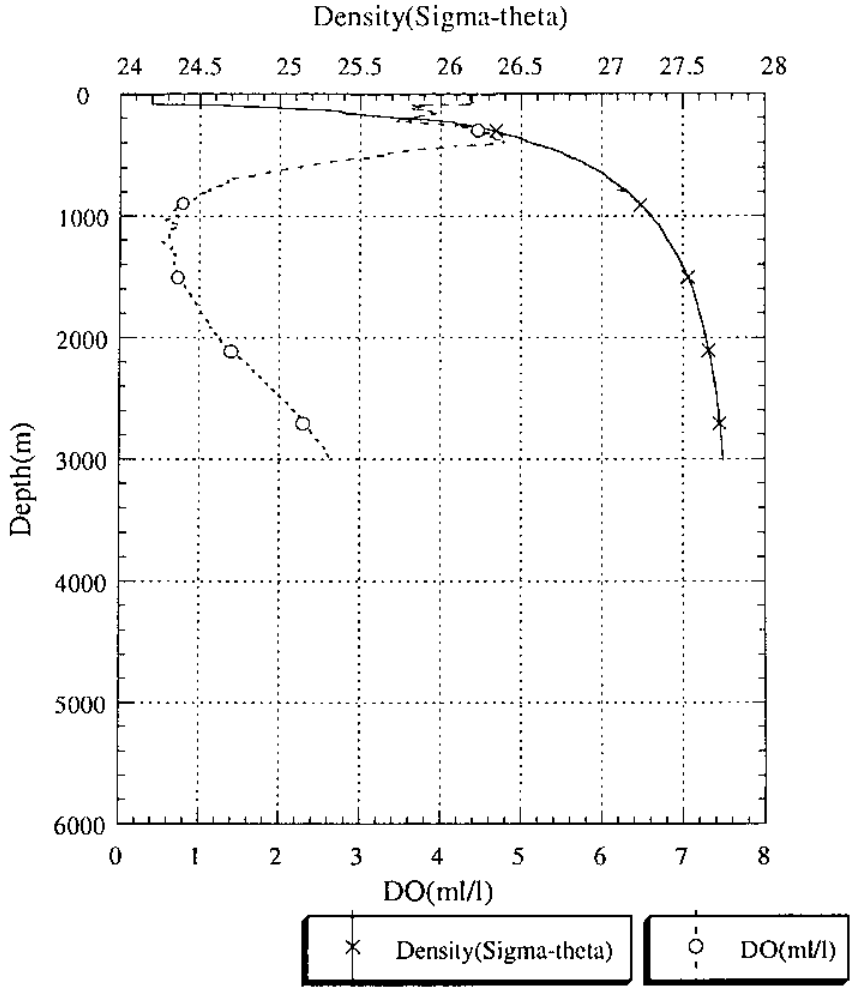
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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2000
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4000
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6000
Depth(m)
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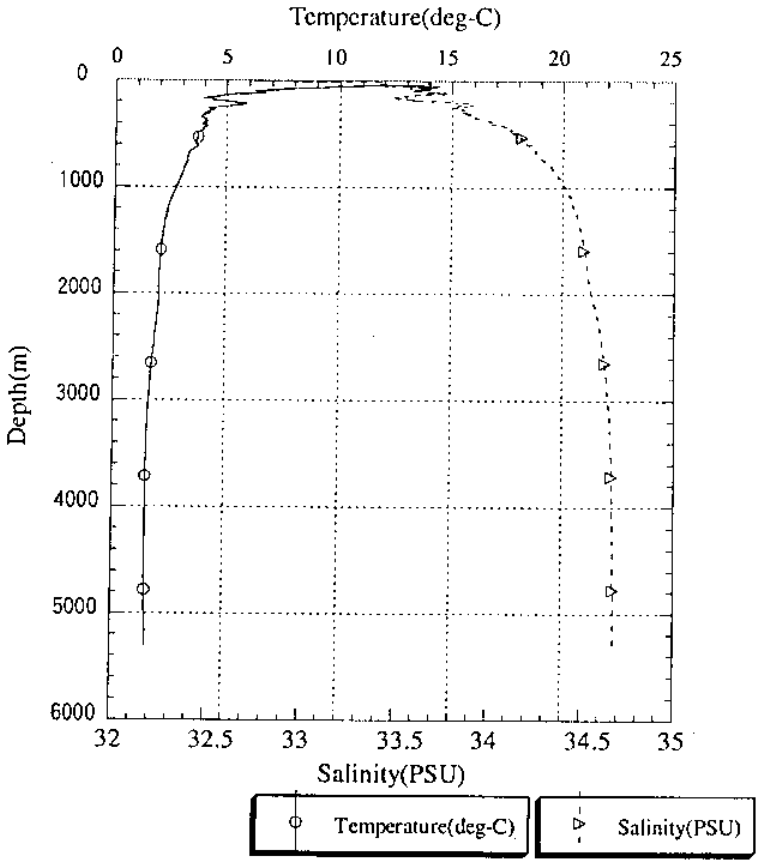
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.12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Depth(m)
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34.5
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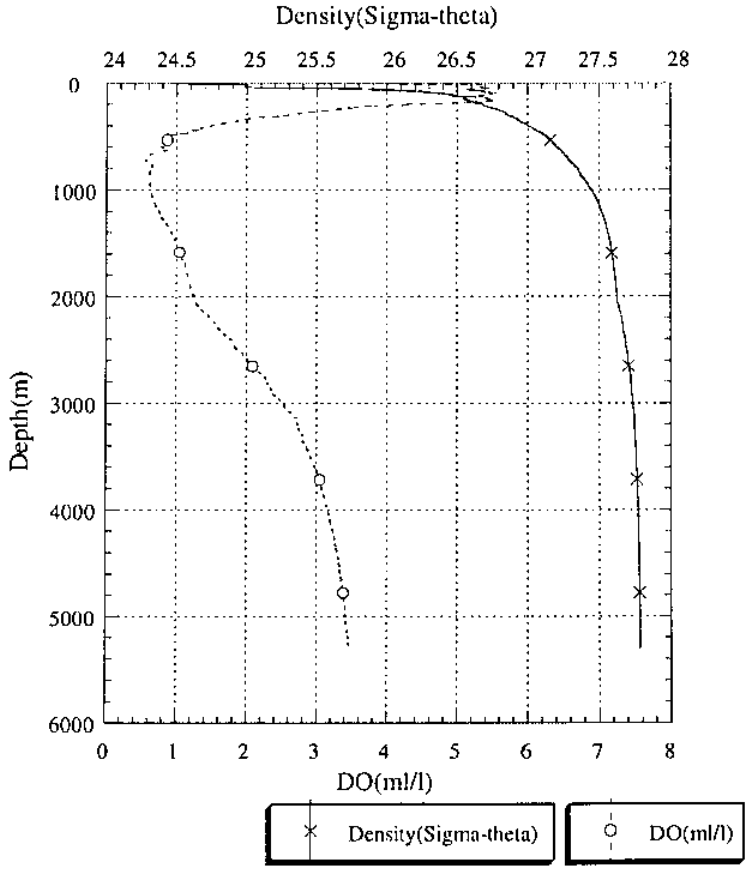
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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5000
6000
Depth(m)
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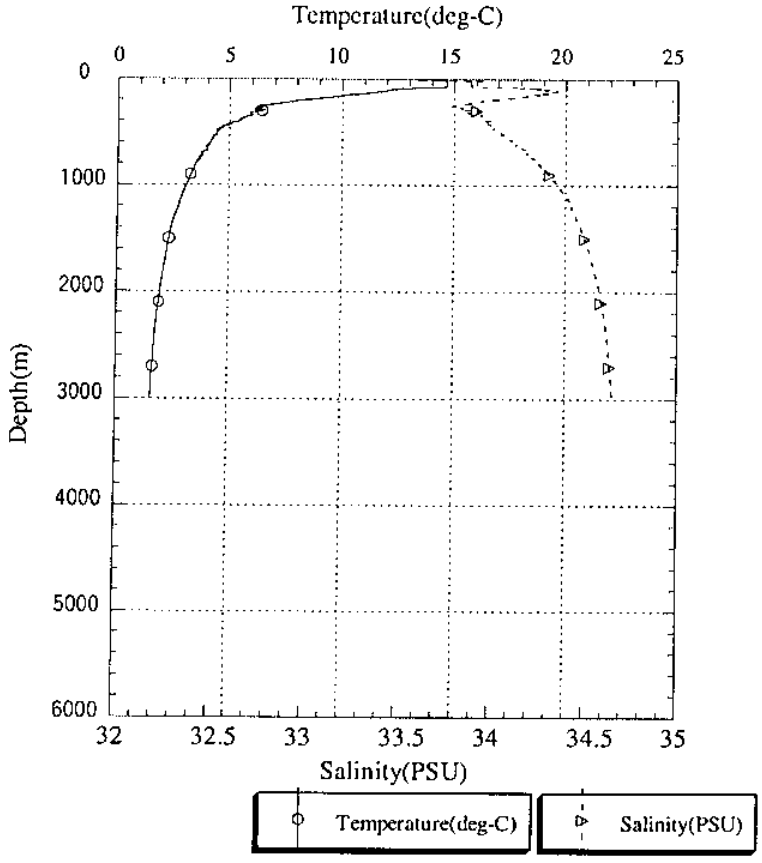
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.13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Depth(m)
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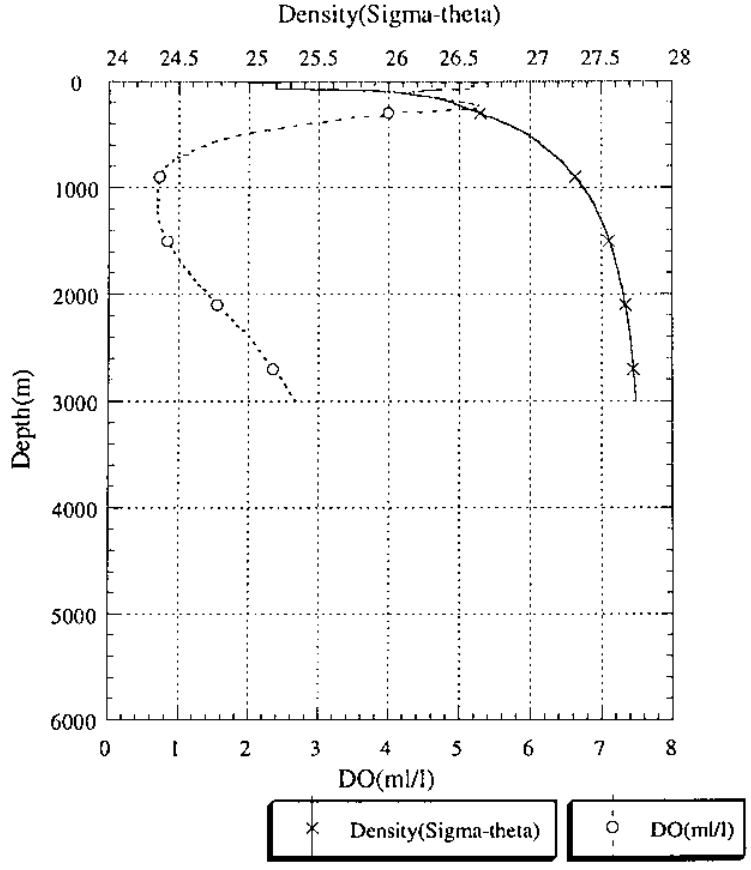
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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Depth(m)
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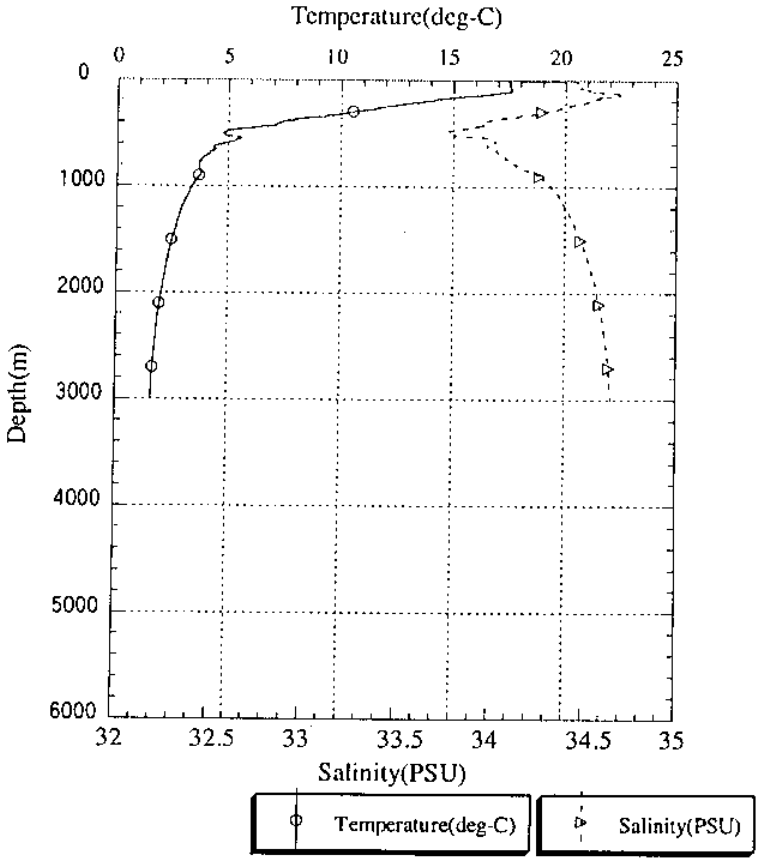
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.14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Depth(m)
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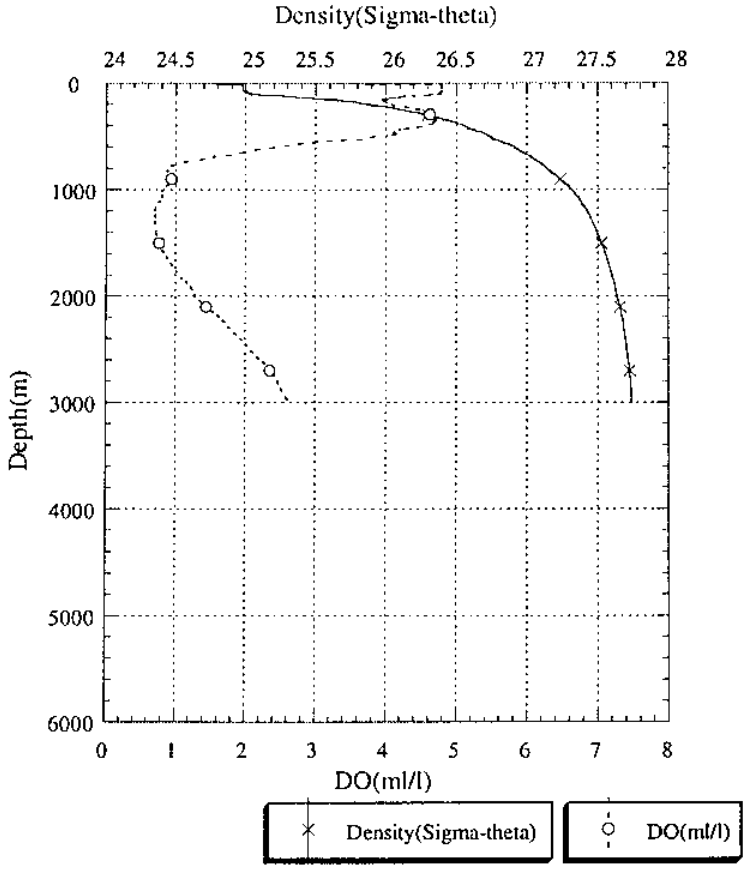
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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Depth(m)
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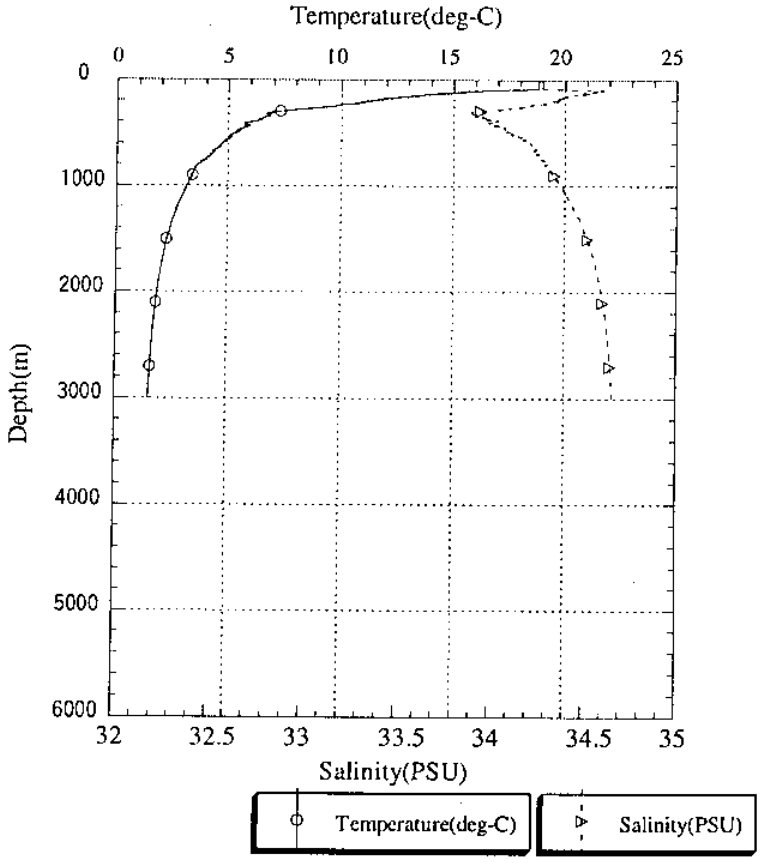
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.15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34.5
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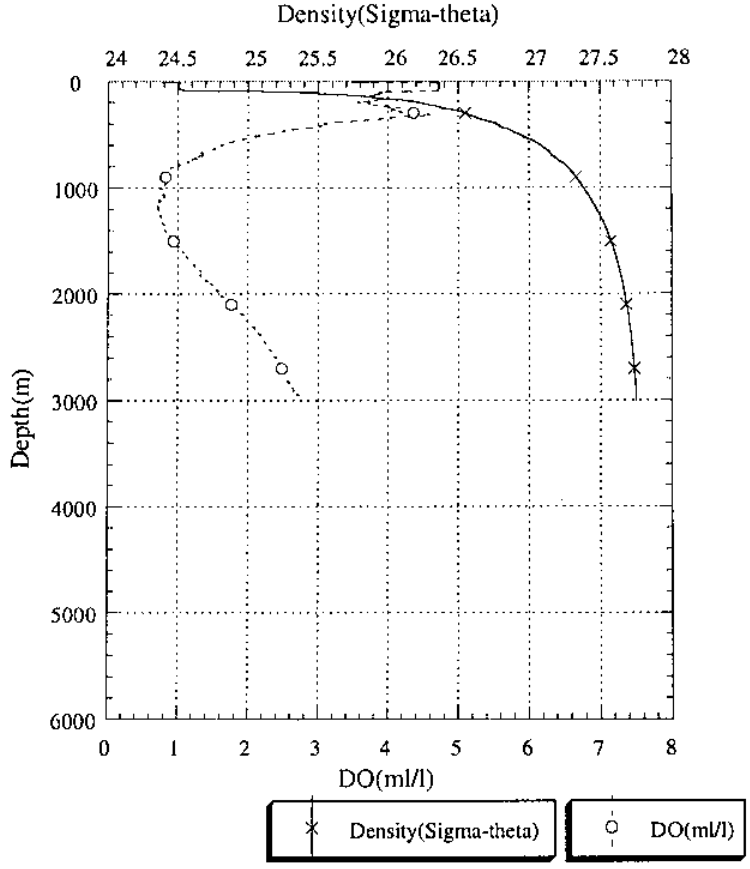
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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6000
Depth(m)
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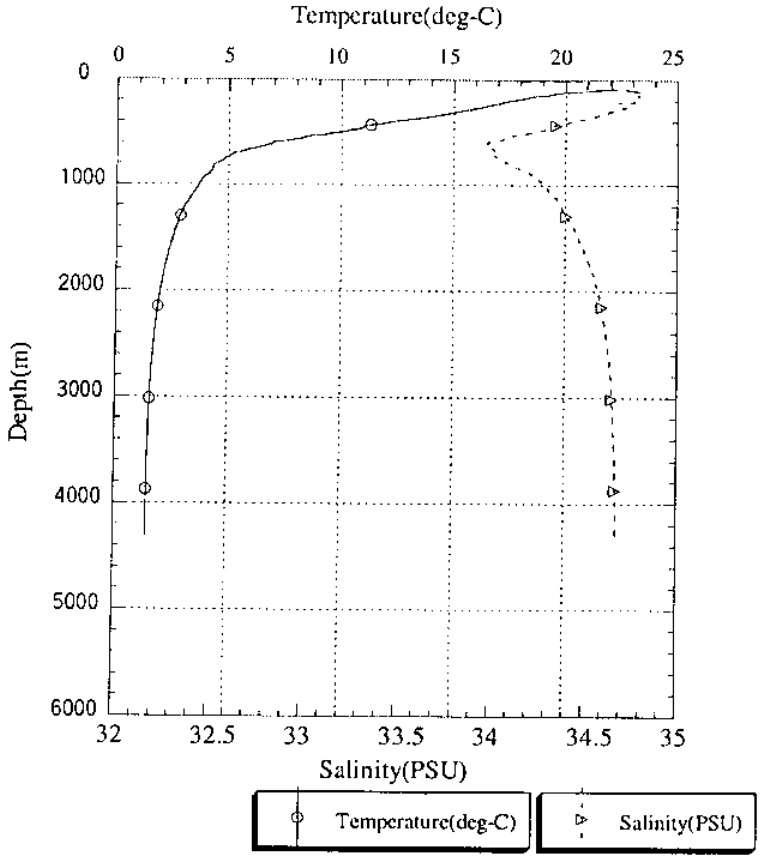
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.16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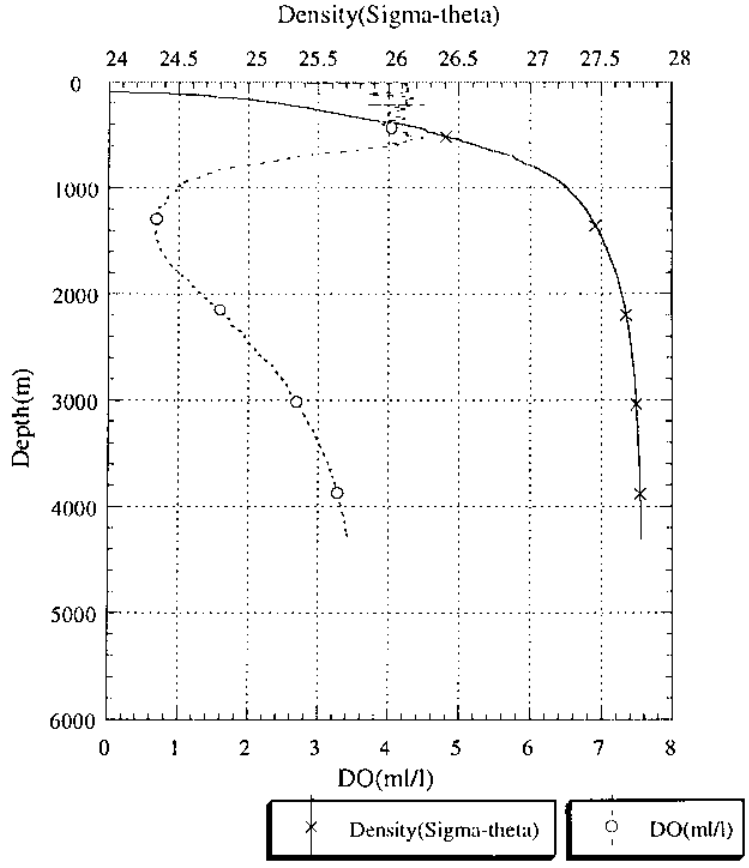
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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Depth(m)
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4000
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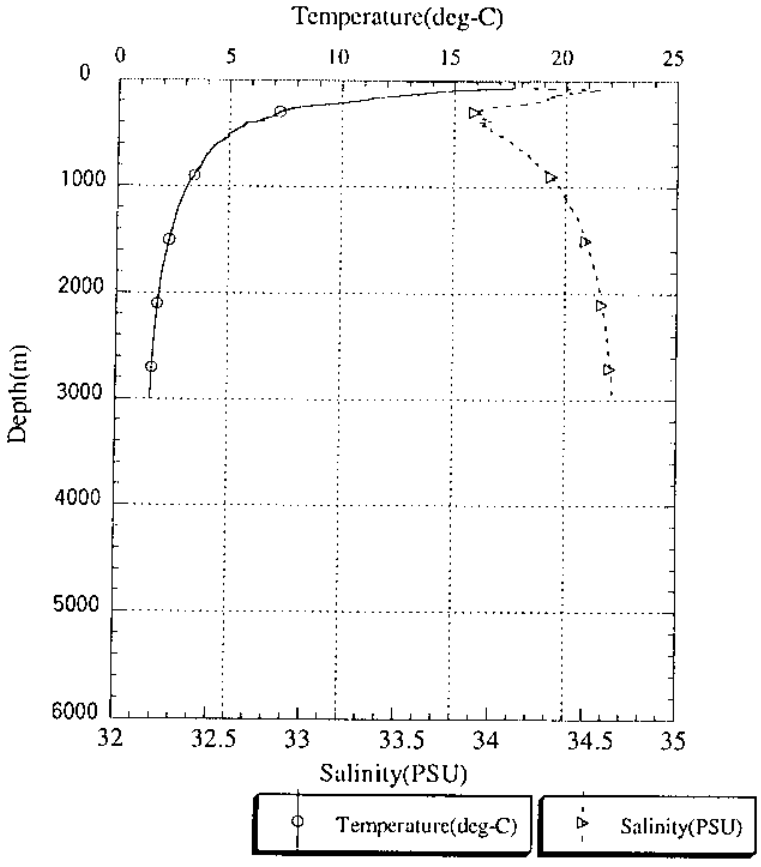
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.17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Depth(m)
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33
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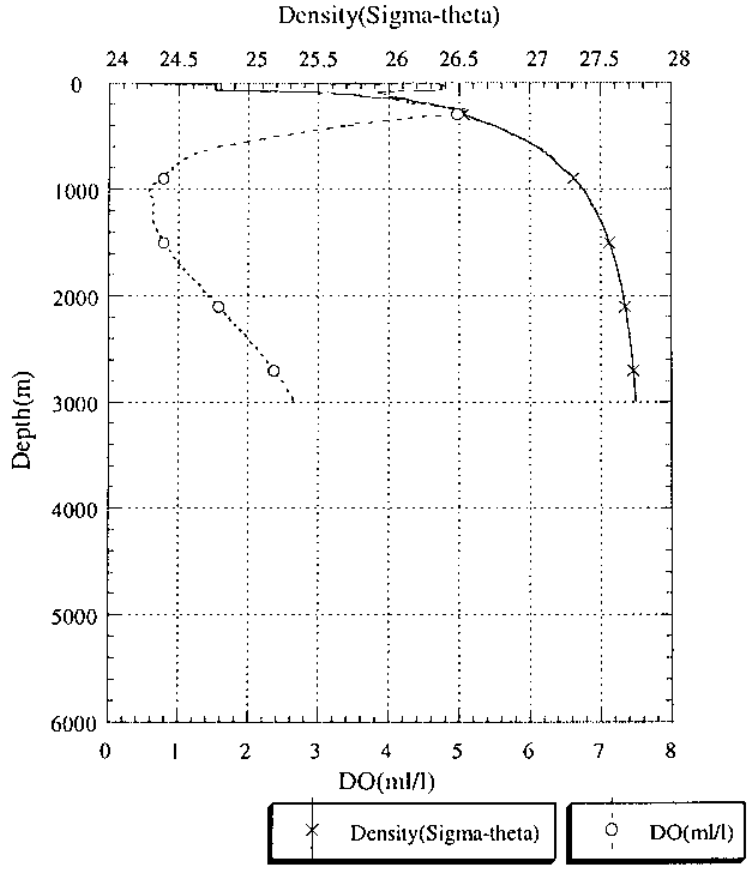
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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Depth(m)
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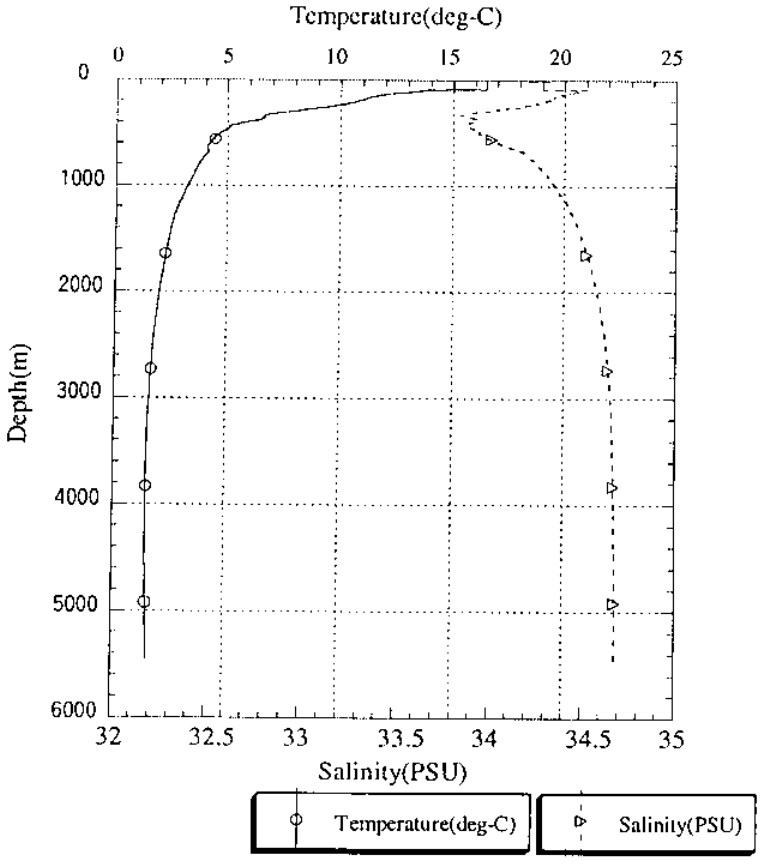
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.18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Depth(m)
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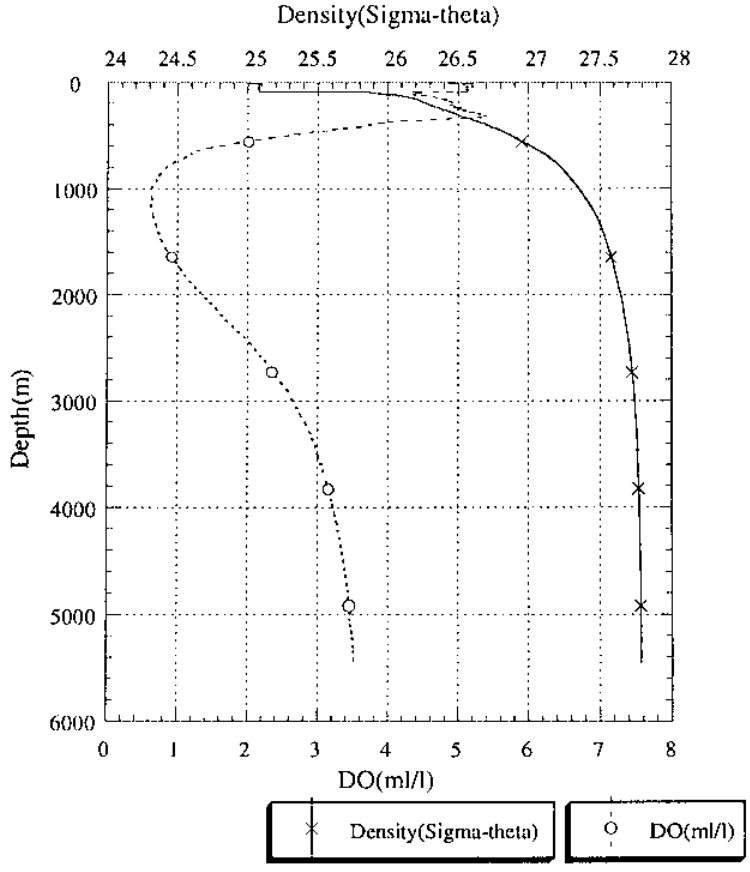
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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24.5
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27.5
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0
1000
2000
3000
4000
5000
6000
Depth(m)
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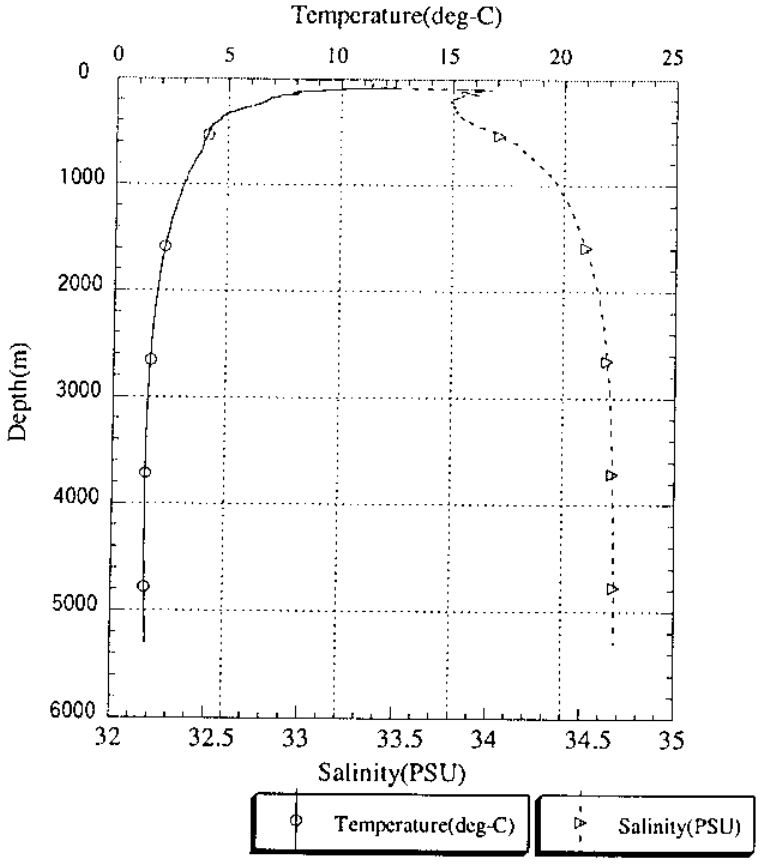
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St19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5
10
15
20
25
Depth(m)
0
1000
2000
3000
4000
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6000
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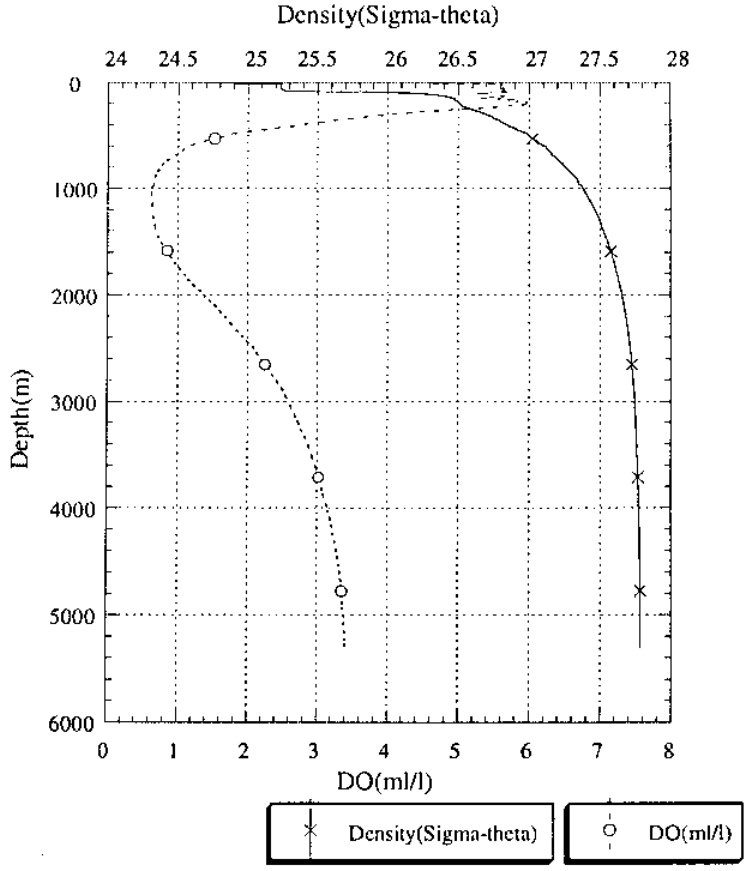
32.5
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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Depth(m)
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4000
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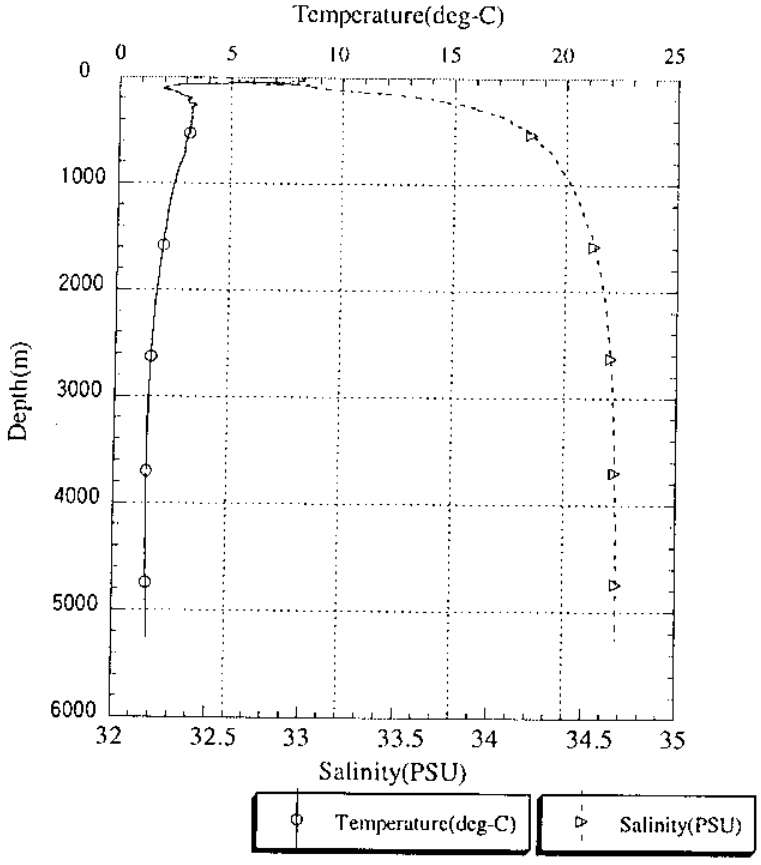
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.20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Depth(m)
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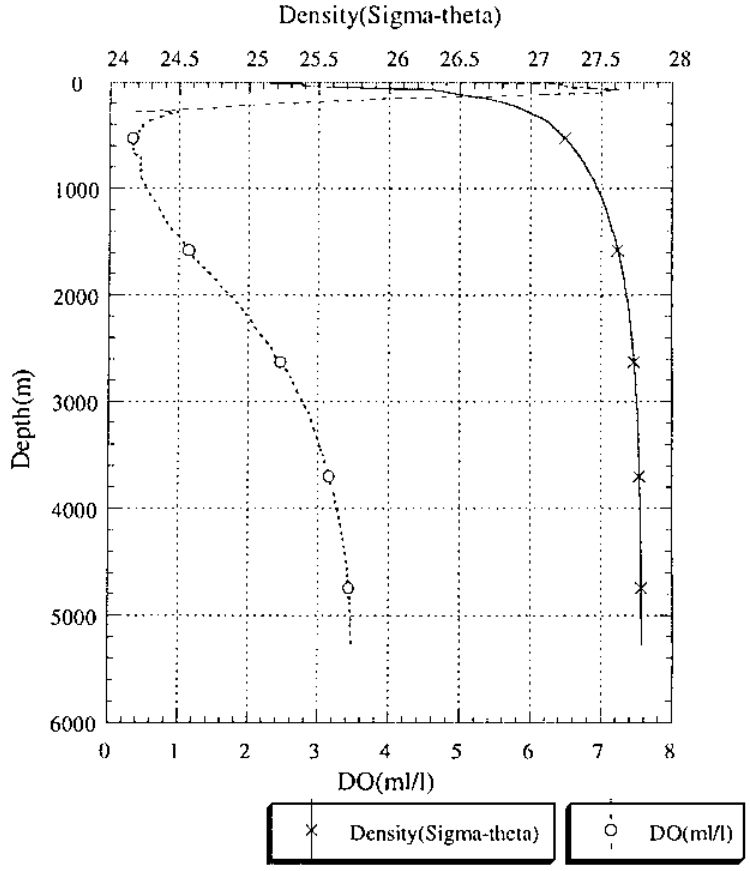
33
33.5
34
34.5
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)


Density(Sigma-theta)
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24.5
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27.5
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Depth(m)
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1000
2000
3000
4000
5000
6000
0
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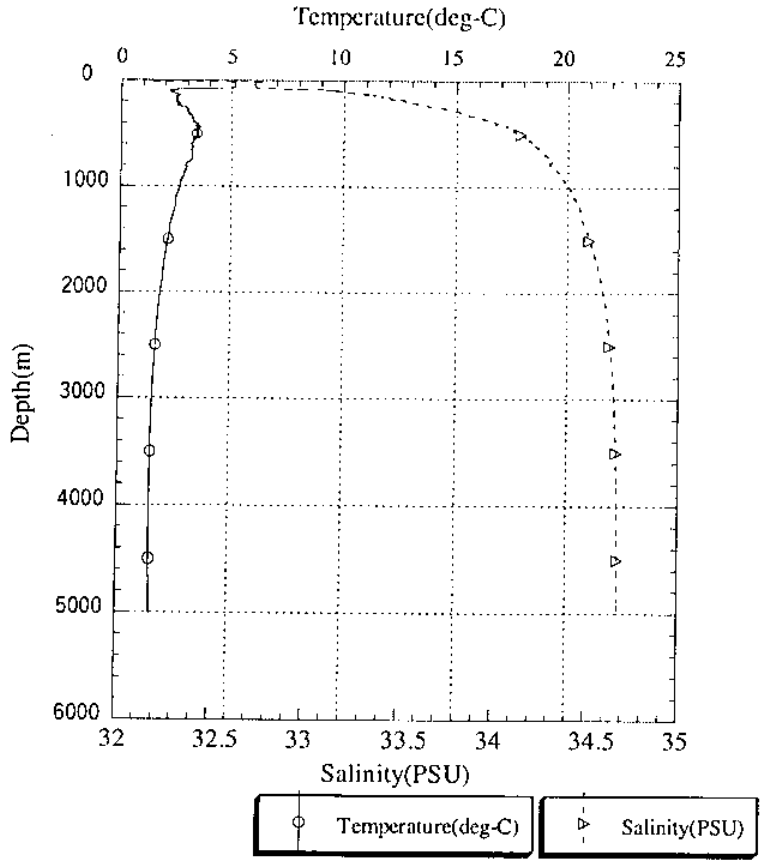
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.KNOT-1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Depth(m)
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32.5
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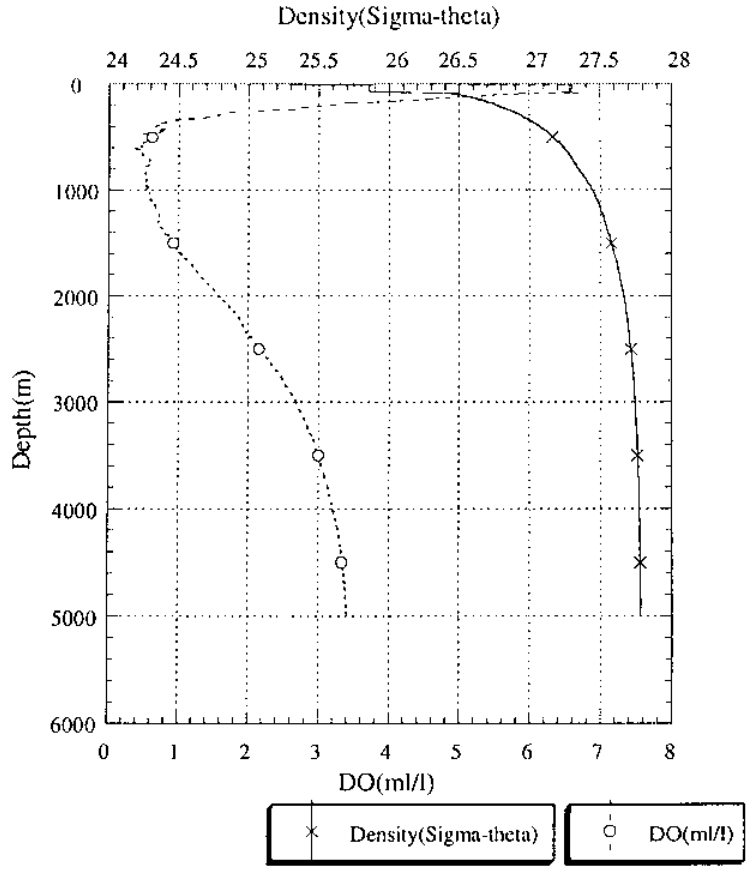
35
Salinity(PSU)
Temperature(deg-C)
Salinity(PSU)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27.5
28
1000
2000
3000
4000
5000
6000
Depth(m)
0
1
2
3
4
5
6
7
8
DO(ml/l)
Density(Sigma-theta)
DO(ml/l)

St.KNOT-2

3. 3 Do, nutrients, and salinity

3. 3. 1 Dissolved oxygen analysis

by T.Shiribiki[*1], C.Saito[*2]

*1: Marine Works Japan , Inc., *2: Japan Marine Science and Technology Center

(1) Objective

Dissolved oxygen is a major parameter for deciding the seawater characteristic on oceanography. In this cruise, the methods of dissolved oxygen determination is based on WHP Operations and Methods manual (Culberson, C.H.(1991), Dickson, A.G.(1994))

(2) Instruments and Methods

(a) Instruments and Apparatus

Glass bottle : Glass bottle for D.O. measurements consist of the ordinary BOD flask (ca.200ml) and glass stopper with long nipple, modified from the nipple presented in Green and Carritt (1966).

Dispenser : Eppendorf Comforpette 4800 / 1000 ul
OPTIFIX / 2 ml (for $MnCl_2$ & NaOH/NaI aq.)
Metrohm Model 725 Multi Dosimat / 20 ml (for KIO_3)

Titrator : Metrom Model 716 DMS Titrino / 10 ml of titration vessel
Pt Electrode / 6.0403.100 (NC)

Software : Data acquisition and endpoint evaluation / Metrohm ,METRODATA / 606013.000

(b) Methods:

Sampling and analytical methods were based on to the WHP Operations and Methods (Culberson,C.H.(1991), Dickson, A.G.(1994))

1) Sampling

Seawater samples for dissolved oxygen measurement were collected from 12 L Niskin bottles to calibrated dry glass bottles. During each sampling, 3 bottle volumes of seawater sample were overflowed to minimize contamination with atmospheric oxygen and the seawater temperature at the time of collection was measured for correction of the sample volume.

After sampling, $MnCl_2$ (aq.) 1ml and NaOH/NaI (aq.) 1ml were added into the glass bottle, which was then shook well.

2) D.O. analysis

Samples were analyzed about 0.5～3 hours after sampling. We used 2 sets of Metrohm titrators with automatic burettes and Pt electrode (Titrator 1,2). Before titration, H_2SO_4 were added to the sample after removing a glass stopper, then washing a glass stopper by deionized water well.

Before sample analysis, the standardization and D.W. blank determination have been performed at each station.

An end point of titration was determined by the potentiometric methods. The endpoint for D.O. conc.(ml/l) calculation was evaluated by the software of Metrohm , METRODATA / 606013.000 .

(c) Thiosulfate Standardization :

We used two kinds of KIO_3 standard solutions (JM981016 & JM981017 which we prepared, normality is 0.01002N respectively). JM981016 Std. solution were used at Stn.1,7,KNOT,8,9,10,11,12,13,14 and 19, JM981017 were at Stn.15,16,17,18 and 20.

The results of standardization were shown in Fig.1. The average was 1.388 ml (Titrator 1) and 1.389 ml (Titrator 2) with standard deviation of <0.002 ml, respectively.

(d) Pure water blanks :

The pure water blanks were determined in deionized water by Milli-RX12, Millipore. The results were shown in Fig.2. The average was -0.013 ml (Titrator 1) and -0.012 ml (Titrator 2) with standard deviation of <0.002 ml, respectively .

(3) Reproducibility

In this cruise, 483 samples for D.O. samples were collected. 78 pairs (16%) of total samples were analyzed as "replicates" which were collected from same Niskin bottle. These results was shown in Fig.3.

The difference of replicates samples was the average of 0.003ml/l and standard deviation (2 sigma) of 0.004ml/l (0.06% of D.O. max., 7.120ml/l in this cruise).

(4) Comparison of each standards to CSK standard solution.

Before this cruise, we compared each standards with CSK standard solution which is the commercially available standard solution prepared by Wako Pure Chemical Industries, Ltd. The results are shown in below.

Table 1. Comparison of each standards

KIO_3 Lot No.	Normality	Average titer(ml)	Standard deviation.	N	Ratio to DLG8365(CSK)
DLG 8365	0.0100	1.389	0.003	10	
JM981016	0.01002	1.391	0.001	5	1.0007
JM981017	0.01002	1.391	0.001	5	1.0007

(5) Calculation of the dissolved oxygen concentration

The concentration of dissolved oxygen, determined from whole bottle titrartions, was calculated from this equation:

$$O_2(\mathrm{mL/L}) = \frac{\dfrac{(V_x - V_{blk,dw}) \times V_{IO3} \times N_{IO3} \times 5598}{(V_{std} - V_{blk,dw})} - 1000 \times DO_{reg}}{(V_{bot} - V_{reg})}$$

Terms in this equation have the following meaning.

V_x = thiosulfate titer of sample (ml)

$V_{blk,dw}$ = thiosulfata titer of pure water blank (ml)

V_{std} = thiosulfste of standard (ml)

V_{bot} = volume sample bottle (ml) at the temperature of sampling

V_{reg} = volume of sample displaced by reagents

V_{IO3} = volume of iodate standard (ml) at temperature of standardization

DO_{reg} = absolute amount of oxygen added with reagents, 0.0027ml(measured in 1995)

O_2 = oxygen concentration in sample (mL/L)

(6) Results

Vertical profiles observed in this cruise are shown in Fig.4.

We compared the data sets of this cruise to last cruise (MR9702) at > 4000m depth in stns..KNOT(44N, 155E), 19(40N, 160E) and 20(40N, 165E), (Fig.5 and Table 2). It seems that the dissolved oxygen value in seawater seems to change upper than 3000m depth in a year.

Table 2 Comparison the data sets of this cruise to MR9702

Depth	44N155E Stn. KNOT				40N160E	Stn. 19		40N165E	Stn. 20	
(m)	MR9702	First	Second	Max-Min	MR9702	MR98K01	Diff.	MR9702	MR98K01	Diff.
4000	3.498	3.508	3.576	0.078	3.437	3.453	0.016	3.453	3.431	-0.022
4250	3.571	3.583		0.012					3.518	
4500	3.621	3.623	3.612	0.011	3.568	3.587	0.019	3.583	3.575	-0.008
4750	3.647	3.648		0.001					3.618	
5000	3.660	3.662	3.663	0.003	3.670	3.664	-0.006	3.643	3.646	0.003
B-50	3.686	3.677		-0.010	3.726	3.705	-0.021	3.648	3.659	0.011

DO(mL/L)

(7) References :

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

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

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

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

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

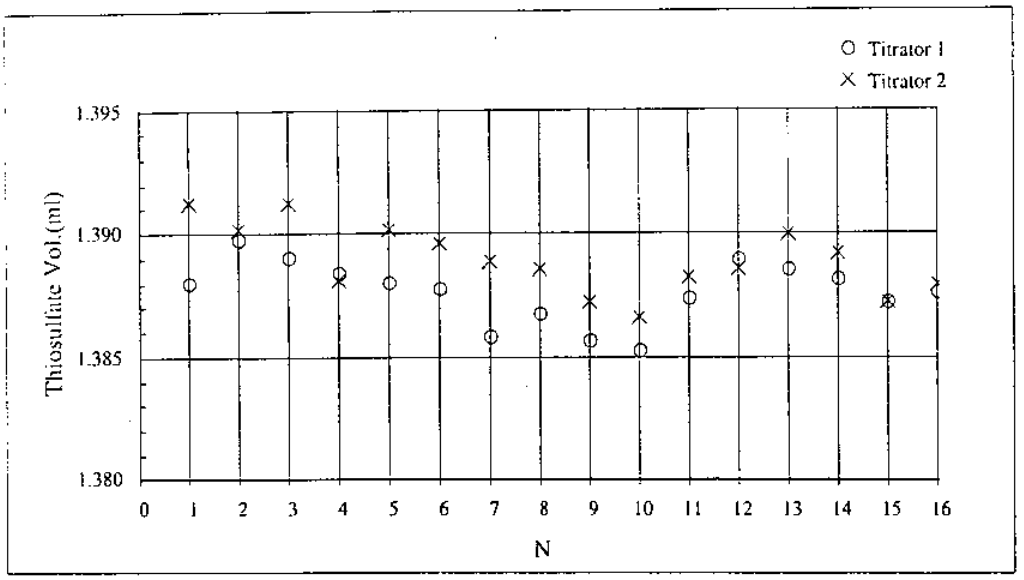


Fig.1 Results of Thiosulfate Stansrdization

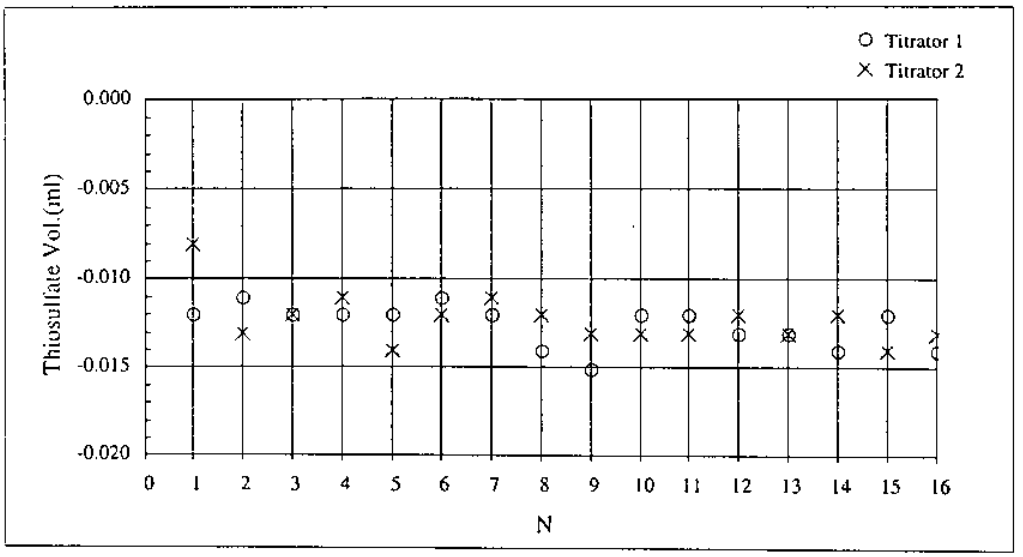


Fig.2 Results of Pure water blanks

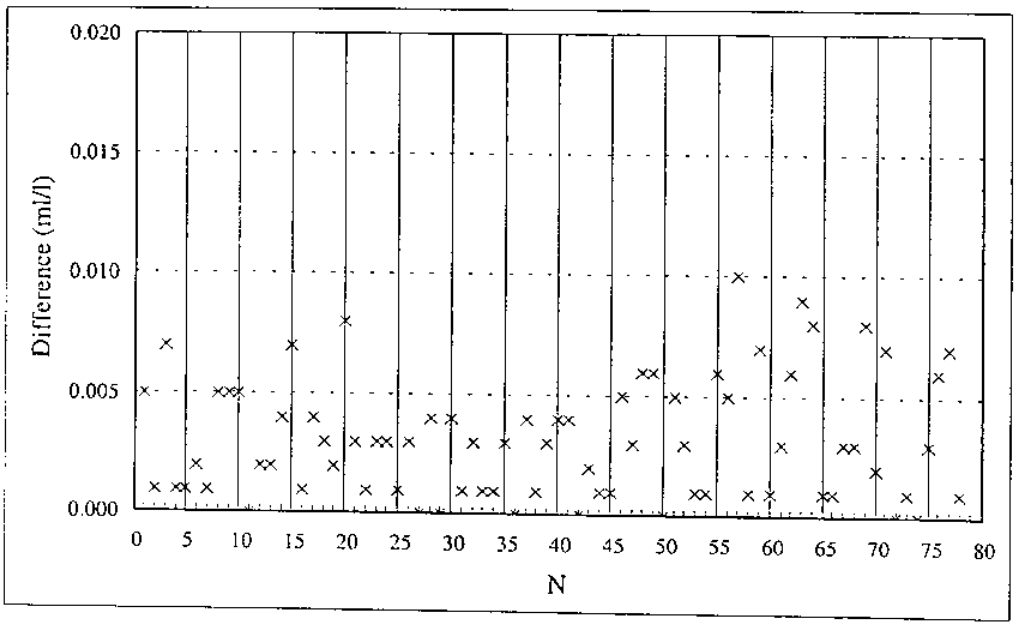
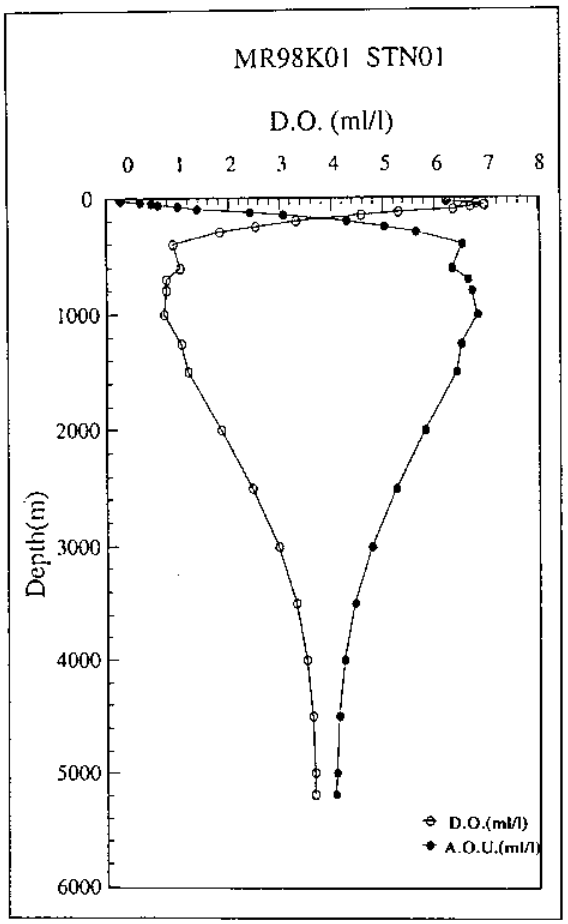
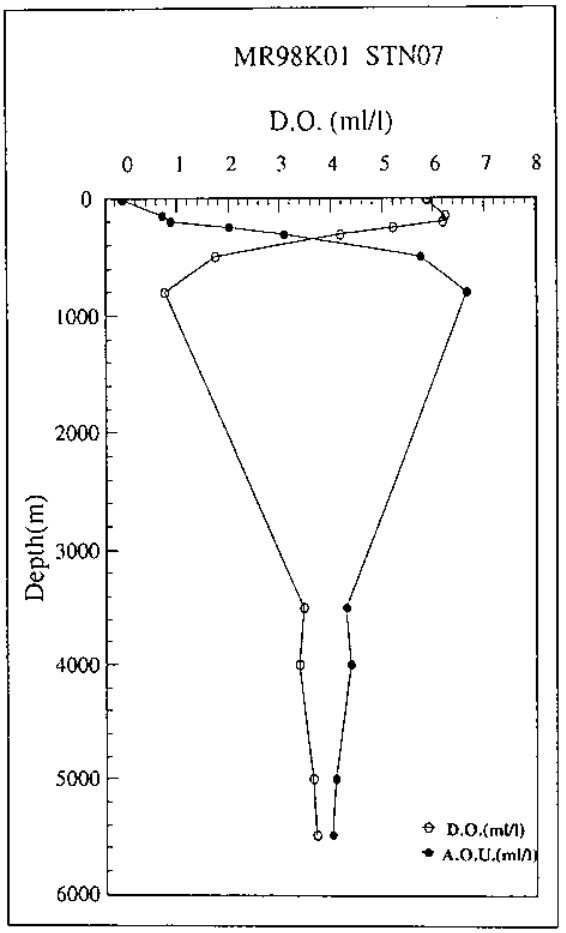
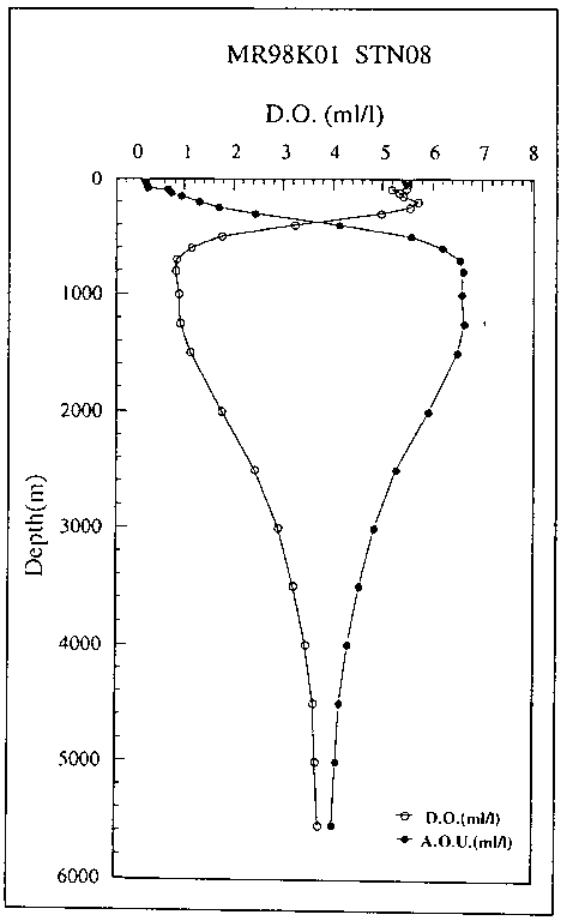


Fig.3 Difference between "Replicate" sample







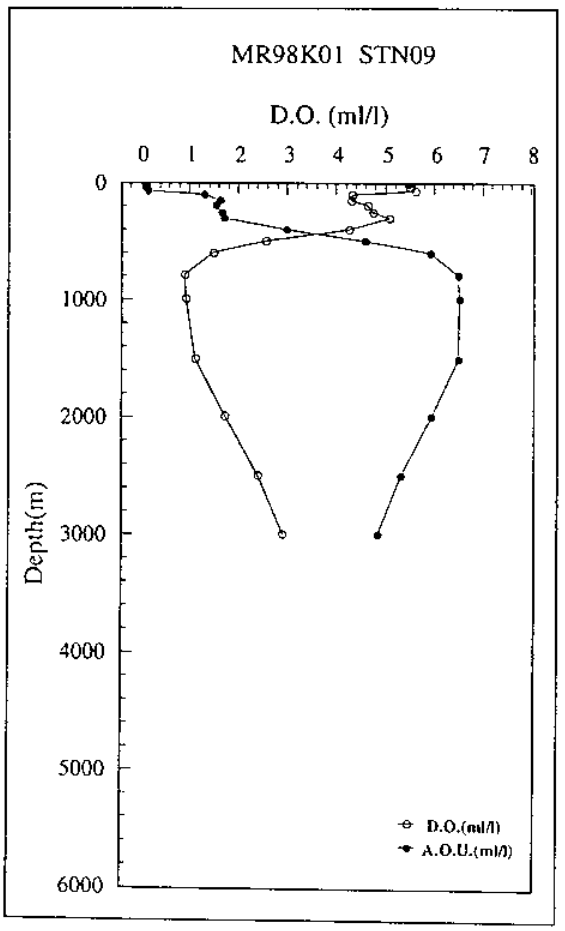


Fig.4-1 Vertical profile

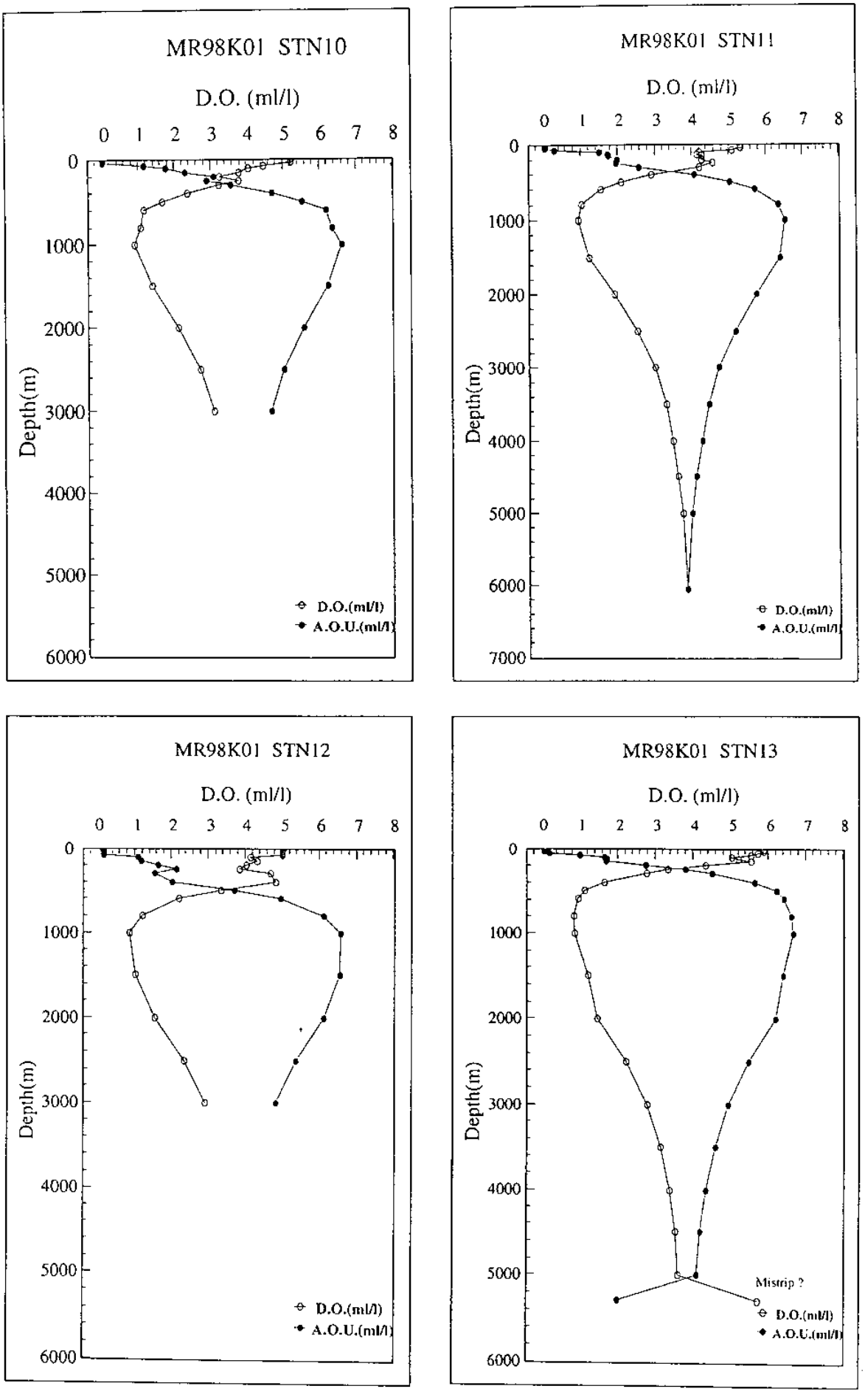


Fig.4-2 Vertical profile

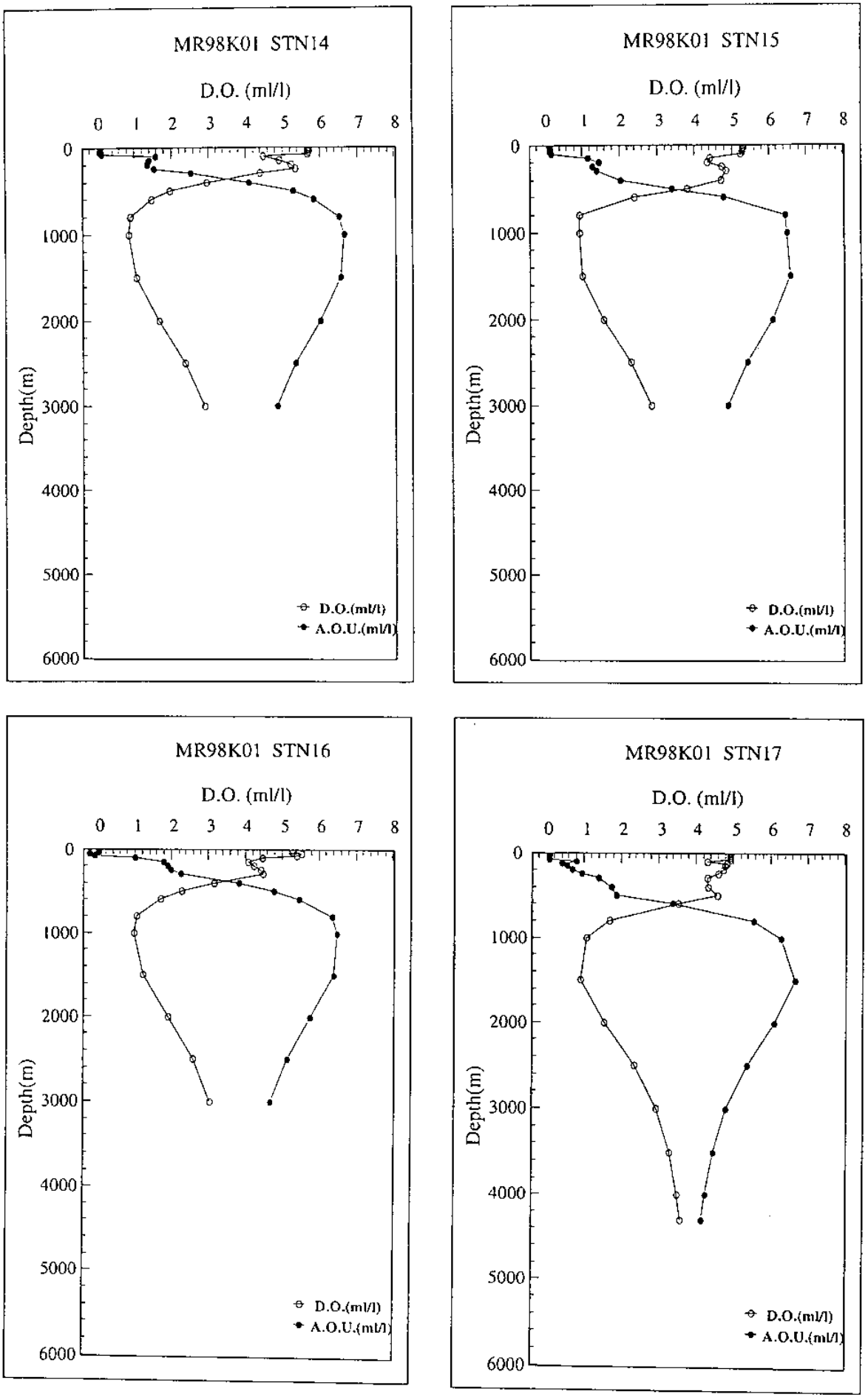
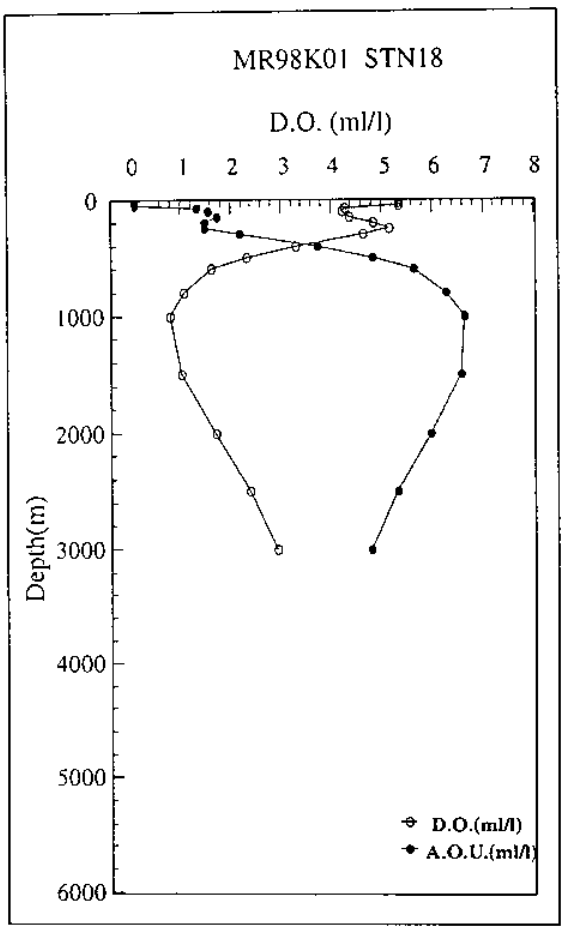
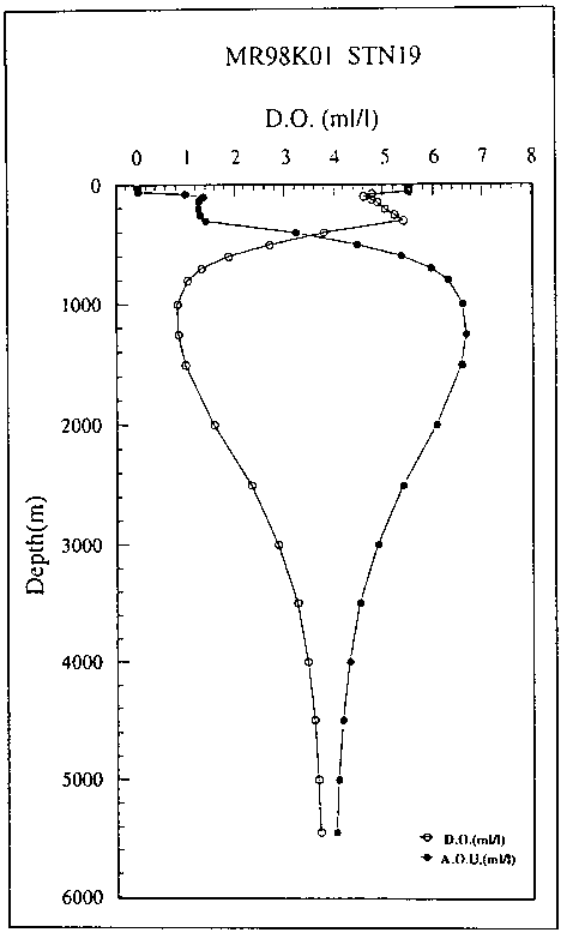


Fig.4-3 Vertical profile





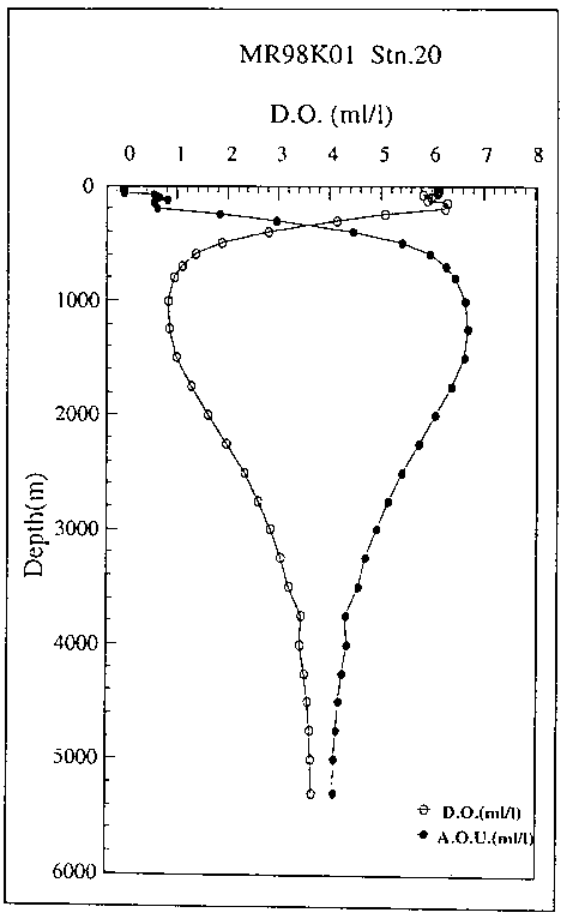


Fig.4-4 Vertical profile

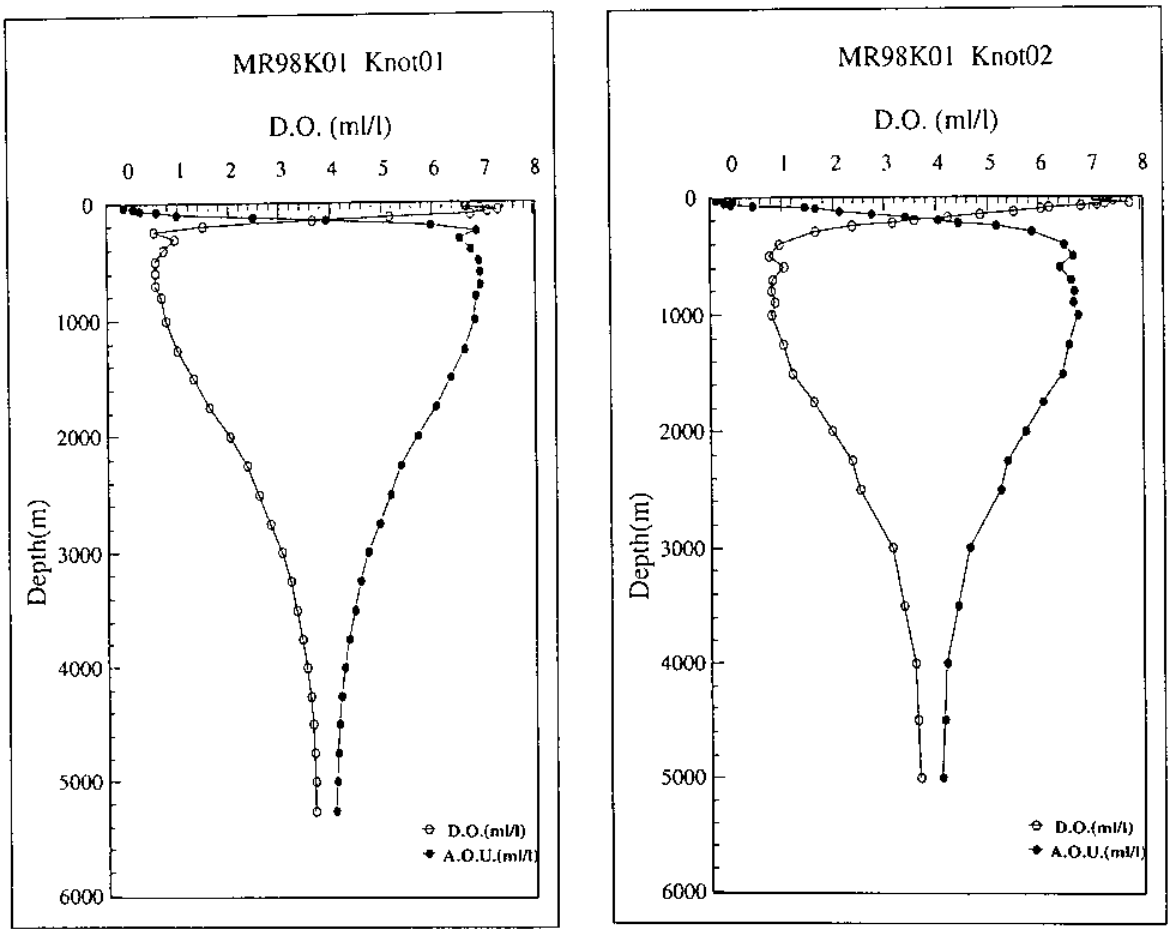


Fig.4-5 Vertical profile

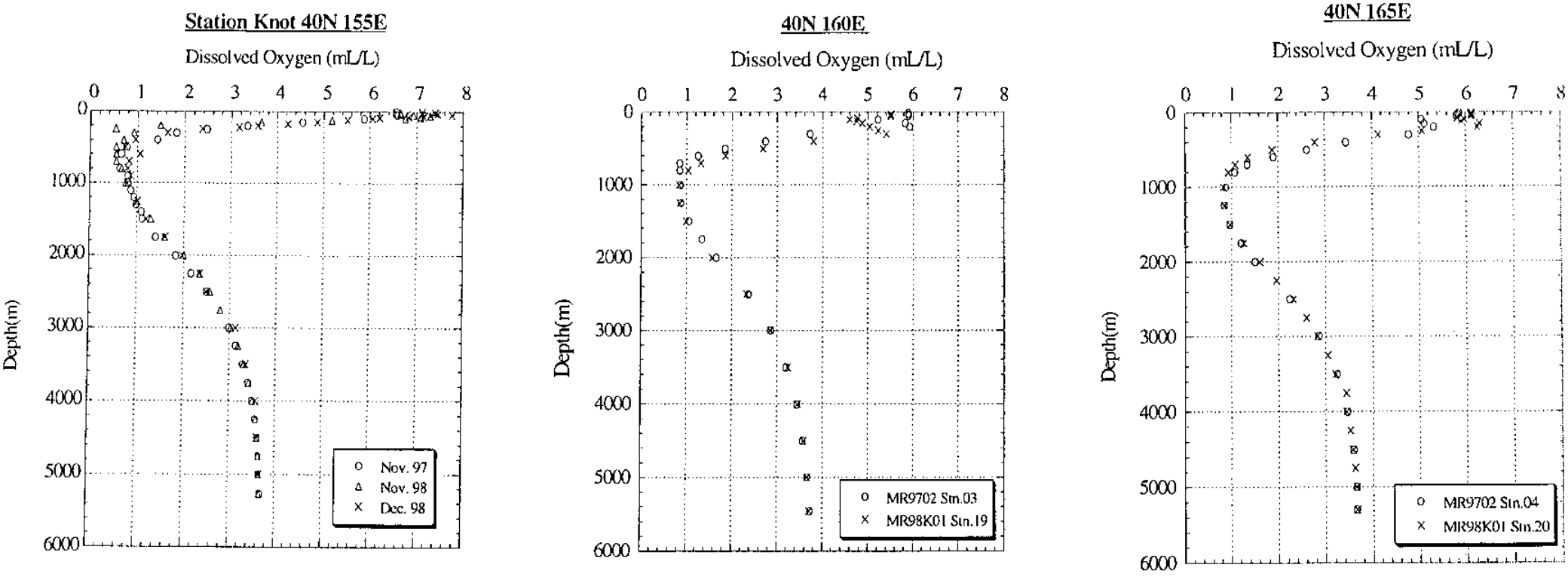


Fig.5 The difference of DO in last and this year's cruises

3.3.2 Nutrients measurements of sea water sample

Ichiro YAMAZAKI*1, Shinichiro YOKOGAWA*1 and Chizuru SAITO*2

*1: MWJ *2: JAMSTEC

(1) Objective

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. During this cruise nutrients measurements will give us the important information on the mechanism of the primary production or seawater upwelling.

(2) Instruments and Methods

The nutrients analyses were performed on BRAN+LUEBBE continuous flow analytical system Model TRAACS 800 (4 channels). The laboratory temperature was maintained between 20-25 deg C.

Nitrite: The nitrite is determined by diazitizing with sulfanilamide and coupling with N-1-naphthyl- ethylenediamine (NED) to form a colored azo dye which is measured at 550 nm using 5 cm length cell.

Nitrate: Nitrate in seawater is reduced to nitrite,which is determined by the method described above. Nitrite initially present in the sample is corrected.

Silicate: The standard AAII molybdate-ascorbic acid method was used. Tempreture of the sample was maintained at 45-50 deg C using a water bath to reduce the reproducibility problems encountered when the samples were analyzing at different temperatures. The silicomolybdate produced is measured spectrophotometrically at 630 nm using a 3 cm length cell.

Phosphate: The method by Murphy and Riley (1962) was used with separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate. Tempreture of the samples were adjusted to be 45-50 deg C using a water bath. The phospho-molybdate produced is measured at 880 nm using a 5 cm length cell.

a. Sampling Procedures

Samples were drawn into polypropylene 100 ml small mouth bottles. These were rinsed twice before filling. The samples were analyzed as soon as possible. Plastic 5ml sample cups were used for analysis.

b. Low nutrients sea water(LNSW)

Ten containers(20L) of low nutrients sea water were collected in early 1998 at equatorial Pacific and filtered with 0.45mm pore size membrane filter (Millipore HA). They are used as preparing the working standard solution.

(3) Preliminary results

a. Precision of the analysis

We have made the repeat analysis of two layers' samples at each station. One is surface layer and the other is bottom layer. At those 5 times repeat analysis range of CV (concentration average to standard deviation) were 0.12 to 3.4 % in upper layer and 0.06 to 1.4 % in bottom layer except nitrite and phosphate.

b. Distribution of nutrients

The results are shown in Appendix.

Station KNOT was the most northern station and surface nutrients concentrations were the highest at this station in this cruise. We visited station KNOT twice during this cruise, the first time was early November and second was middle December. And surface nutrients concentrations were 1.5 times higher at second time observation. On the other hand, comparing with last year's cruise data, nutrients concentration was changed upper 1000m layer at same locations. We need more time to discuss the character of northwestern North Pacific seawater.

These data are stored in MO disks in Ocean Research Department in JAMSTEC.

3.3.3 Salinity measurements

Takehiko SHIRIBIKI*1, Hirokatsu UNO*1 and Chizuru SAITO*2
*1: MWJ *2: JAMSTEC

(1) Instrument and Method

Salinity analysis was measured by a Guildline Autosal salinometer model 8400B, which was modified by addition of an Ocean Science International peristaltic-type sample intake pump and a Hewlett Packard quartz thermometer model 2804A with two 18111A quartz probes. One probes measured room temperature and the other probe measured a bath temperature. The resolution of the quartz thermometer was set to 0.001 deg C. Data of both the salinometer and the thermometer was collected simultaneously by a personal computer. A double conductivity ratio was defined as a median of 31 times readings of the salinometer. Data collection started after 5 seconds and it took about 10 seconds to collect 31 readings by a personal computer.

The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. Room temperature varied from approximately 22 deg C to 24 deg C, while a variation of a bath temperature was almost within +/- 0.004 deg C.

a. Salinity Sample Bottles

The bottles in which the salinity samples are collected and stored are 250 ml brown glass bottles with screw caps.

b. Salinity Sample Collection and Temperature Equilibration

Each bottle was rinsed twice with sample water and was filled to the shoulder of the bottle. Its cap was also thoroughly rinsed. Salinity samples were stored more than 24 hours in the same laboratory where the salinity measurement was made.

c. Standardization

Autosal model 8400B was standardized before and after sequence of measurements by use of IAPSO Standard Seawater batch P133 whose conductivity ratios were 0.99986.

d. Sub-Standard Seawater

We also used sub-standard seawater which was deep-sea water filtered by pore size of 0.45 micrometer and stored in a 20 liter cubitainer made of polyethylene and stirred for at least 24 hours before measuring. It was measured every 10 samples in order to check and correct the trend.

(2) Results

The results obtained are shown in Appendix.

These salinity data are stored in Ocean Research Department in JAMSTEC

3. 4 Carbonate chemistry

3. 4. 1 pH measurement

Makio C. Honda, Andrey Andreev, Akihiko Murata, Yuichiro Kumamoto, (JAMSTEC)
Fuyuki Shibata (MWJ)

(Theory)

The free hydrogen concentration ($[H^+]_F$) and total hydrogen ion concentration ($[H^+]$) of sea water were determined potentiometrically. These values are expressed as "$pH_{(NBS)}$" and "$pH_{(T)}$" in this study and defined as follows:

$$pH_{(NBS)} = - LOG (a * [H+]_F)$$

$$pH_{(T)} = - LOG ([H+])$$
$$= - LOG ([H+]_F + [HSO_4^-])$$

where a is the ion activity coefficient of hydrogen ion and $[HSO_4^-]$ is sulfate ion concentration.

(Methods)

Sampling

The water samples were collected in the 200 ml capacity polypropylene bottles. Special care was given to allow no air space in the samples.

Apparatus for pH measurement

Separate glass (Radiometer PHG201) and reference (Radiometer REF201) electrodes were used. The e.m.f. of the glass / reference electrode cell was measured with a pH / Ion meter (Radiometer PHM95). In order not to have sea water sample exchange CO_2 with the atmosphere during pH measurement, closed glass container with water jacket was used. The temperature during pH measurement was monitored with temperature sensor (Radiometer T901) and controlled to 25°C within 0.1°C error.

Buffer solutions

A. Buffer solution in synthetic sea water

For the electrodes calibration, 2-amino-2-hydroxyl-1, 3-propanediol ("tris") / HCl buffer and 2-amino pyridine ("amp") / HCl buffer were prepared according to Dickson and Goyet (1994).

The defined pH values of the two buffers are

$$pH_{(tris)} = (1197.0 + 3.7669S + 0.00178S^2) / T - 381.3088 - 0.011634S + 67.63163 LN(T) - 0.121538T - LOG(1-0.00106S);$$

$$pH_{(amp)} = (111.35 + 5.44875S) / T + 41.6775 - 0.015683S - 6.20815 LN(T) - LOG(1-0.00106S);$$

where T and S are absolute temperature (K) and salinity, respectively. $pH_{(tris)}$ and $pH_{(amp)}$ values at 25°C and salinity of 35 psu are 8.0893 and 6.7866, respectively.

B. NBS buffer solution

In order to determine pH values on NBS scale ($pH_{(NBS)}$) and to compare these values with $pH_{(NBS)}$ values measured in the MR97-02 cruise at Nov. 1997 and with historical pH data, following traditional buffer solutions were also prepared in this cruise.

(1) Phthalate (pH 4.005 at 25°C): 0.05 mol/l $KHC_8H_4O_4$

(2) Phosphate (pH 6.865 at 25°C): 0.025 / 0.025 mol/l KH_2PO_4 / Na_2HPO_4

pH values of above buffer solutions at different temperature were calculated with following equation and coefficients:

$$pH = A/T + B + C*T + D*T^2$$

A: Phthalate 0, Phosphate 3459.39

B: Phthalate 6.6146, Phosphate -21.0574

C: Phthalate $-1.8509*10^{-2}$, Phosphate $7.330*10^{-2}$

D: Phthalate $3.2721*10^{-5}$, Phosphate $-6.2266*10^{-5}$

Calculation

A. $pH_{(T)}$

$pH_{(T)}$ of sea water sample ($pH_{(samp)}$) was calculated from the expression

$$pH_{(samp)} = pH_{(tris)} + (E_{(tris)} - E_{(samp)}) / ER$$

where electrode response "ER" was calculated as follows:

$$ER = (E_{(amp)} - E_{(tris)}) / (pH_{(tris)} - pH_{(amp)})$$

ER value should be equal to the Nernst value as follows:

$$ER = RT\ LN(10) / F = 59.16\ mV/pH\ unit\ at\ 25\ deg\text{-}C$$

where R, T, and F are gas constant (8.3144 J/K), absolute temperature (K), and Faraday's constant (96,495 C), respectively.

However, properties of the electrode pair used in this cruise differed from the Nernst value by *ca.* 1.0 % (lower) on average. Therefore we used not the Nernst value, but ER for $pH_{(T)}$ calculation.

B. $pH_{(NBS)}$

Values of $pH_{(NBS)}$ at t °C were calculated with following equation:

$$pH_{(samp)} = pH_t^0 - E_{(samp)} / ER_{(NBS)}$$

where $ER_{(NBS)}$ is electrode response on NBS buffer solution and pH_t^0 is zero pH at T°C which is defined as the pH value at which the measured potential is zero. Unknown value of pH_t^0 and $ER_{(NBS)}$ can be calculated from measured voltage (e.m.f.s) and pH of buffer solutions at t °C.

Finally, values of $pH_{(NBS)}$ and $pH_{(T)}$ at 25°C were calculated from following equation:

$$pH_{25} = pH_t + 0.011*(t - 25)$$

(Culberson, 1968)

where pH_t is pH value at t deg-C.

(Preliminary results)

Standard deviation (2 σ) or repeatability of our pH determination (n = 66) was ± 0.003 pH.

Unfortunately, Accuracy was unknown without certified reference materials such as Dickson's CRM. We also calculated $pH_{(T)}$ with sea water based buffered solution prepared by another group (CREST team). $pH_{(T)}$ calculated with their buffer solution was approximately 0.05 pH unit higher than that calculated with our buffer solution systematically. Therefore there might be some problem in preparation of buffer solution described later.

A. $pH_{(T)}$

Fig. 1 shows vertical profiles of $pH_{(T)}$ of sea water at each stations. $pH_{(T)}$ values are listed on "CTD bottle table" in appendix. There is significant difference in $pH_{(T)}$ above 1000 m (Fig.2). $pH_{(T)}$ at stations 1 and KNOT, where are the north of 41.5 degree latitude, have the minimum around 300 - 400 m. This minimun at other stations, where is less than 40 degree latitude, appear between 600 and 1000 m. Vertical profiles at the northern stations show convex shape. In addition, $pH_{(T)}$ at the northern stations is lower than that at the southern stations. It is of interest that profiles of $pH_{(T)}$ at station KNOT show the difference between the first visit (November) and the second visit (December). When the first visit, the minimum $pH_{(T)}$ existed at 250 m and it disappeared when the second visit. In addition, it can be seen that the surface mixed layer became thicker at the second visit than at the first visit. It can be said that season changed from autumn to winter from the oceanographic point of view during our cruise.

In the future, we should consider $pH_{(T)}$ as mentioned above. The difference between $pH_{(T)}$ values and corrected $pH_{(NBS)}$ values in this cruise are approximately 0.18 pH unit and this is significantly larger than the theoretical difference with consideration of salinity (0.12 - 0.13). As mentioned before, $pH_{(T)}$ values calculated with our buffered solution are approximately 0.05 smaller than those calculated with other's buffer solution. Judging from these situation, $pH_{(T)}$ on our buffer solution (Tris and Amp) might be 0.05 pH unit lower than those of Dickson and Goyet (1994) due to less HCl addition.

After the above consideration, we will discuss carbon cycle in the northwestern north Pacific in detail with other carbonate chemical values (total dissolved inorganic carbon, total alkalinity) and other components such as nutrients and dissolved oxygen.

B. $pH_{(NBS)}$

Fig.3 shows vertical profiles of $pH_{(NBS)}$ at each station. Unlike values of $pH_{(T)}$, there is significant difference in $pH_{(NBS)}$ values below 3000 m among stations. Its difference reached by 0.06 pH unit. Table 1 shows $pH_{(NBS)}$ values below 3000 m in the northwestern North Pacific measured in November 1997 by R/V *MIRAI* and in july 1992 by Russian R/V *Akademik Vinogradov*. It can be seen that $pH_{(NBS)}$ values below 3000 m are identical at the same depth. It is unlikely that $pH_{(NBS)}$ values below 3000 m changed among stations within the restricted area and during several years. As shown in Table 2, the potentials (e.m.f.) of sea water at same depth were similar among stations. Therefore the above difference in $pH_{(SWS)}$ among stations should be

attributed to the difference of NBS buffer solutions used for each station. We made NBS buffer solution 4 times on board and stored about 1 week each time. In addition to the experimental error, the quality of high pure water ("Mili-Q" water) might be bad. The difference in the quality of buffer solution for each station must make the above difference.

Assuming that $pH_{(NBS)}$ values below 3000 m are identical at the same depth in the northwestern North Pacific and do not change since 1992, all $pH_{(NBS)}$ were recalculated with the ideal Nernst value and calculated pH_t^0 and potential of the phthalate buffer or potential phosphate. Fig.4 shows corrected $pH_{(NBS)}$ values.

We will compare $pH_{(NBS)}$ values with those in 1992 and historical values such as GEOSECS expedition focusing on $pH_{(NBS)}$ values upper 1000 m.

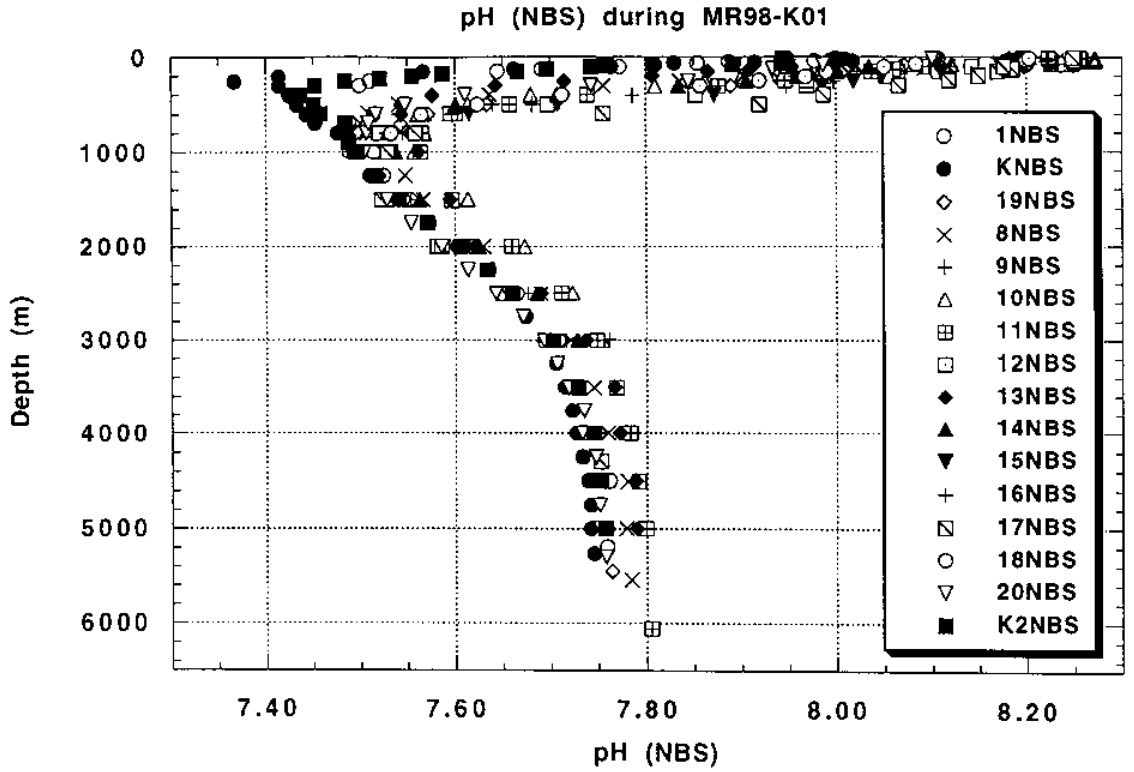


Fig. 3 $pH_{(NBS)}$ at observation sites during MR98-K01

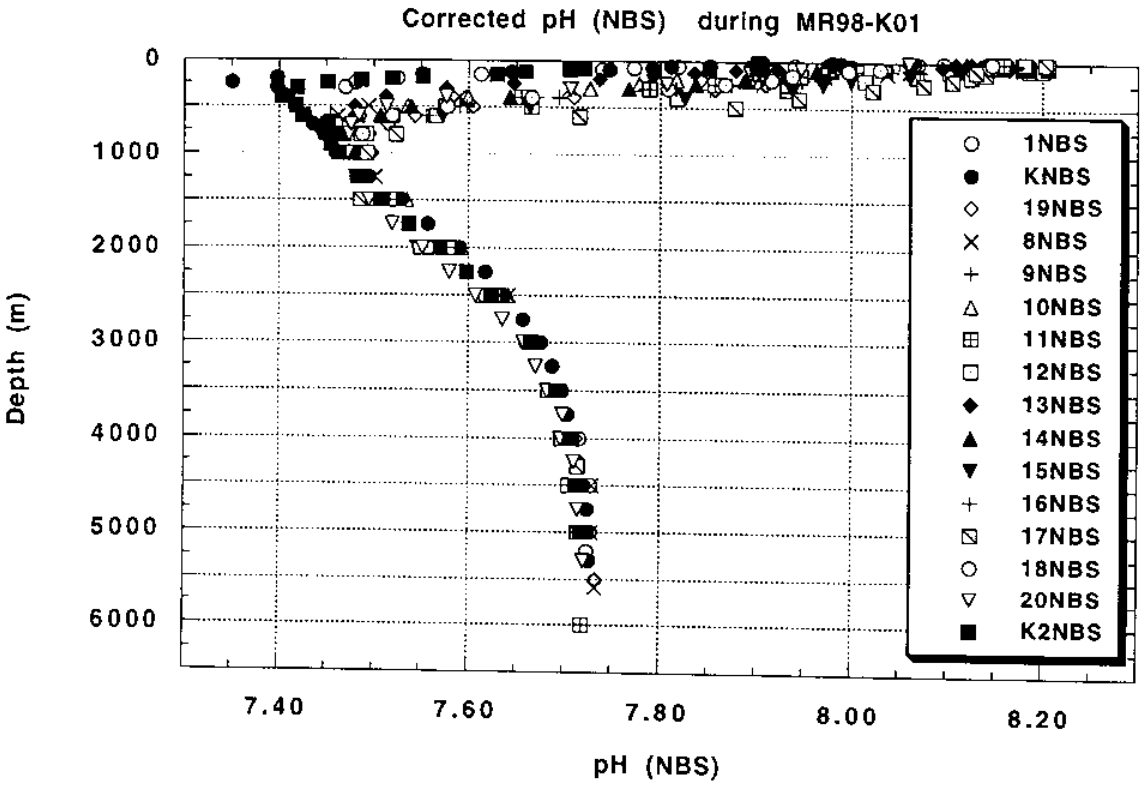


Fig. 4 corrected $pH_{(NBS)}$

Table 1 pH (NBS) values in the Northwestern Nort Pacific

	5000	4500	4000	3500	3000
MR-KNOT (44N, 155E)	7.730	7.716	7.709	7.695	7.674
MR-3 (40N, 160E)	7.722	7.718	7.706	7.692	7.664
MR-4 (40N, 165E)	7.718	7.716	7.706	7.690	7.661
MR-5 (45N, 165E)	7.721	7.717	7.706	7.689	7.663
MR-6 (50N, 165E)	7.721	7.715	7.709	7.697	7.665
MR-7 (50N, 170E)			7.714	7.689	7.661
MR-10 (35N, 170E)	7.730	7.720	7.709	7.692	7.664
MR-11 (35N, 165E)	7.719	7.712	7.703	7.687	7.663
MR-14 (35N, 155E)	7.722	7.714	7.704	7.694	7.675
AV-HS-22 (51.5N, 165E)		7.714	7.710	7.692	7.661
AV-HS-13 (45N, 160E)			7.710	7.695	
AV-HS-14 (45N, 165E)			7.712	7.698	7.671
AVERAGE	7.723	7.716	7.708	7.693	7.666
STDEV	0.005	0.002	0.003	0.003	0.005

Table 2 Potential (mv) at each depth (m)

STN	5000	4500	4000	3500	3000
1	-62.19	-62.49	-61.78	-60.78	-59.17
KNOT	-62.30	-62.10	-61.40	-61.40	-59.40
19	-62.61	-62.05	-61.63	-60.74	-59.05
8	-62.72	-62.83	-61.64	-60.76	-59.30
9					-59.20
10					-59.35
11	-61.90	-61.40	-60.90	-60.10	-59.00
12					-58.90
13	-62.24	-62.00	-61.18	-60.91	-59.20
14					-58.90
15					-58.50
16					-59.40
17		-61.90	-61.40	-60.60	-59.00
18					-58.70
20	-62.18	-61.87	-61.05	-60.04	-58.53
KNOT-2	-62.15	-61.86	-61.45	-60.54	-59.10
average	-62.29	-62.06	-61.38	-60.65	-59.04
stdev	0.26	0.41	0.29	0.41	0.28

MR: R/V MIRAI 1997 Dec
AV: R/V Akademik Vinogradov 1992 Jul. (Russia)

Table 3 pH(0), potentials of NBS buffer solutions (phtharate, phosphate)

	5000	4500	4000	3500	3000	average	stdev
pH (0)	6.670	6.667	6.671	6.667	6.668	6.668	0.002
E (4.008)	157.5	157.3	157.5	157.3	157.3	157.4	0.1
E (6.865)	-11.5	-11.7	-11.5	-11.7	-11.7	-11.6	0.1

pH (s) = 6.668 - E(s) / 59.16
6.668: pH (0)
59.16: ideal Nernst value at 25 deg-C

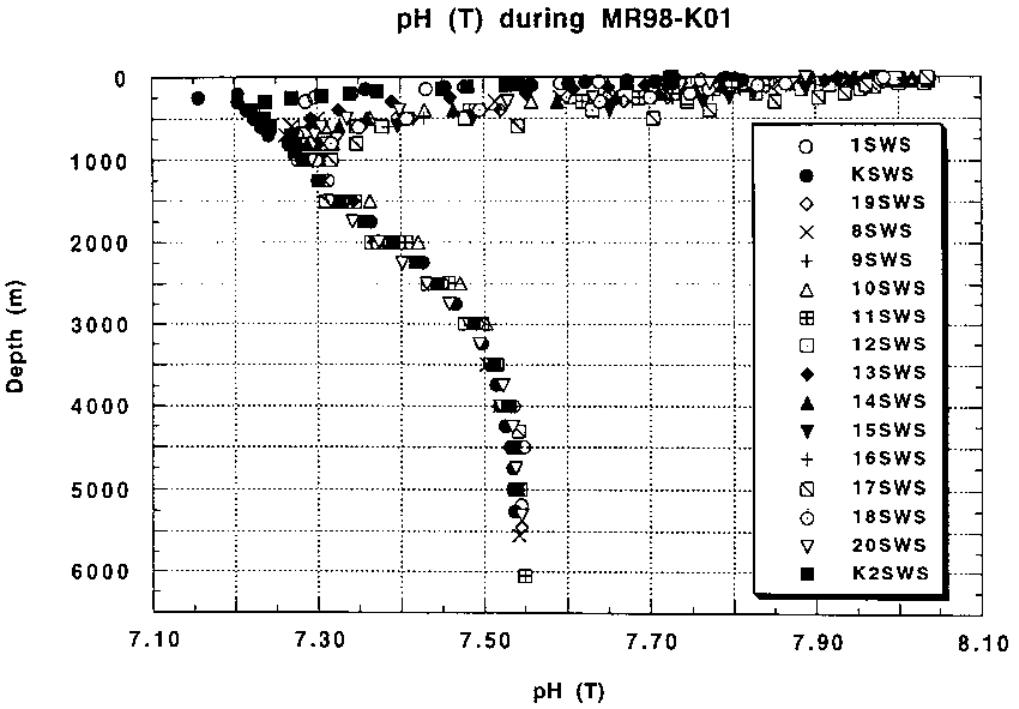


Fig. 1 $pH_{(T)}$ at observation sites during MR98-K01

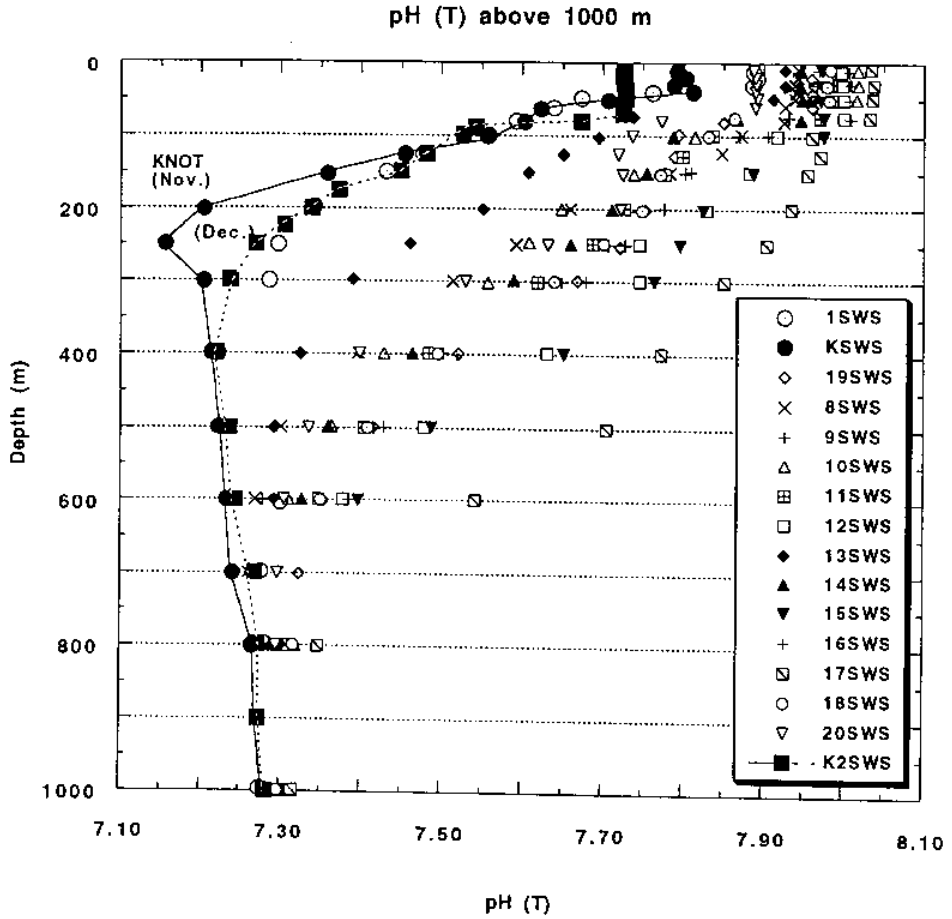


Fig.2 $pH_{(T)}$ above 1000 m

3. 4. 2 Total Dissolved Inorganic Carbon (TDIC) measurement

Yuichiro Kumamoto, Akihiko Murata, Makio Honda (JAMSTEC),
Kazuhiro Hayashi (MWJ)

Global warming caused by green house gas such as CO_2 has become much attention all over the world. In order to verify carbon cycle in the northwestern North pacific, total dissolved inorganic carbon (TDIC) was measured with analytical instruments installed on R/V MIRAI.

Concentration of TDIC in seawater collected by the hydrocasts was measured by a coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.). A volume of seawater (30 cm^3) was taken into a receptacle and 2 cm^3 of 10 percents (v/v) phosphoric acid was added. The CO_2 gas evolved was purged by CO_2 free nitrogen gas for 12 minutes at the flow rate of 80 cm^3 min.-1 and absorbed into an electrolyte solution. Acids formed by reacting with the absorbed CO_2 in the solution were titrated with hydrogen ions using the coulometer. Calibration of the coulometer was carried out using sodium carbonate solutions (0-2500 mM). The coefficient of variation of 4 (or 3) replicate determinations was approximately less than 0.2 percents for 1 sigma. All the data were referenced to the Dickson's CRM and shown in the Appendix.

3. 4. 3 Total Alkalinity (TA) measurement

Akihiko Murata, Yuichiro Kumamoto, Makio Honda (JAMSTEC),
Hideki Yamamoto (MWJ)

Global warming caused by green house gas such as CO_2 has become much attention all over the world. In order to verify carbon cycle in the northwestern North pacific, total alkalinity (TA) was measured with analytical instruments installed on R/V MIRAI.

Samples were drawn from 12 L drawn from 12 L NiskinTM bottles into 250 ml polyethylene bottles. Bottles were rinsed twice and filled from the bottom, overflowing
a volume while taking care not to entrain any bubbles. The bottles were then sealed by a screw cap with an inner cap and stored at room temperature for maximum of 24 hours prior to analysis.

The total alkalinity titration system consists of a titrator (Radiometer, TitraLabTM, TIM900) and an autoburette (Radiometer, ABU901). The titration was made by adding HCl (0.1N) to seawater past the carbonic acid point. Glass (Radiometer, REF201) and reference (Radiometer REF201) electrodes were used to measure emf. The repeatability of measured total alkalinity was 0.15 % on average. All the values reported are set to the Dickson's CRM.

3.4.4 Carbon Isotope measurement

Yuichiro Kumamoto, Makio Honda (JAMSTEC),
Kazuhiro Hayashi (MWJ)

In order to study the role of surface water and intermediate water in carbon cycle in the western North pacific, seawater was collected by the hydrocasts and the underway (continuous) sampling for radio and stable carbon isotopes of TDIC. Sampling procedures followed "Handbook of methods for the analysis of the parameters of the carbon dioxide system in sea water" (DOE, 1994). Seawater was collected in glass bottles of 250 ml rinsing these bottles with twice seawater sample. Then a head-space of 2 % of the bottle volume was left by removing seawater sample with a plastic pipette. Saturated mercuric chloride (HgCl2) of 0.05 cm^3 was added as preservative. Finally, bottles were sealed using lightly greased ground glass and the clip was secured. About 500 seawater samples were collected during this cruise. All the samples were stored in a laboratory of JAMSTEC Mutsu Branch in Mutsu City. In the laboratory, TDIC will be extracted as CO_2 and converted to graphite for measurements of stable and radio carbon isotopes, respectively.

3.5 Study of carbon system at the station KNOT

Nobuo Tsurushima[1], Fujio Shimano[2]

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2: Japan Science and Technology Corporation, c/o National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-0053, Japan

Purpose

A new ocean time series station has been established in the western sub arctic Pacific. This is one of the activities of JGOFS-Japan and JGOFS-NPTT (North Pacific Task Team). This station was named "KNOT" (Kyodo Northwest Pacific Ocean Time series; kyodo is Japanese word meaning collaborative) and located at 44°N, 155°E. The station KNOT is in the southwestern part of western subarctic gyre and the area is characterized by high biological production in spring/summer and deepening of surface mixed layer in winter season by surface cooling. The purpose of this study is to understand the seasonal variation of carbon system in the area around the KNOT.

Methods

Sampling

We collected samples for on measurements of total carbon dioxide (TC), total alkalinity (TA), pH, dissolved oxygen, $^{13}CO_2$, $O_2/N_2/Ar$, nutrients, and salinity. Water samples were collected with CTD rosette systems attached with Niskin bottles of 12 l capacity. Sample waters were drawn from Niskin samplers into individually numbered, clean bottles.

Analysis

TC and TA in seawater were determined3.5 by the methods similar to DOE (1994) with new automatic measurement system (KIMOTO ELECTRIC Co., LTD.). This system contain two devices, a device for extraction of carbon dioxide and a device for determination of TA by titration, each in a 50x60x40cm console. This system is coupled to a CO_2 coulometric detector (model 5012, supplied by UIC Coulometrics Inc.), an Autoburette (ABU901, supplied by RADIOMETER Co., LTD.), two

cooling units to maintain the sample water at constant temperature, and a personal computer. All procedures except exchange of the samples and rinsing of TA titration cell are operated automatically. Sample water for TC analyses were controlled at constant temperature (10℃). A known volume (about 30 ml) of seawater sample is dispensed into the stripping chamber and acidified with 8.5 % reagent grade phosphoric acid, converting all carbonate species to free CO_2. The evolved CO_2 is then extracted from seawater using ultra high purity nitrogen gas (99.9995 %) for 10 minutes at a rate of 200 ml/min. The CO_2 gas is absorbed by a coulometer cell solution, containing ethanolamine, dimethylsulfoxide and thymolphthalein indicator, and quantified by coulometric titration. Seawater based reference materials were prepared in Japan by the method similar to Dickson and Anderson (1998) and used for calibration. The random error was 0.1%, which was obtained from 10 replicate determinations on board the ship once a day. TA was determined by potentiometric titration. Sample water for determination of TA was controlled at constant temperature (20℃). A known volume (about 100 ml) of seawater sample is dispensed into closed titration cell containing two glass electrodes, a thermometer and a capillary tube that supplies acid from a burette. Sample seawater was titrated with 0.2 N hydrochloric acid past the carbonic acid endpoint. TA was calculated from titration data by the non-linear least-squares approach (DOE, 1994). The random error was 0.1%, which was obtained from 10 replicate determinations on board the ship once a day.

Dissolved oxygen were analyzed by Winklar method. The random error was 0.2 μmol/kg. pH were measured by glass electrode. Tris and 2-aminopyridine buffers were used for calibration.

Results

All the data of TC, TA, pH and dissolved oxygen are shown in appendix tables. Collected samples for laboratory measurement on land are also listed in appendix tables. All the data is preliminary and will be corrected.

The concentration of TC at KNOT were generally higher than that of other stations in the southern region above 1000 m. The concentration of TC in the surface mixed layer in 11 December (KNOT2) were about 50 μmol/kg higher than that in 9 November (KNOT1) and about 100 μmol/kg higher than that in summer (13 August, Hokusei maru cruise). We will discuss about the factor which cause the variability of carbon system in the surface water at KNOT and its around area, such as air-sea exchange,

biological production, horizontal advection and entrainment of deep water.

3.6 POM

Vertical distributions of C and N isotope ratios in POM and NO_3^- from water of Western North Pacific ocean.

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Natural abundance isotopic signatures can be used to find mechanisms at single organism plant and algae level as well as to trace food webs, understand palaeodiets and follow whole ecosystem cycling in the ocean.

We would like to evaluate vertical distributions of C and N natural isotope abundance in the suspended POM and Nitrate with respect to variabilities of biogeochemical processes in euphotic layer of Western North Pacific ocean.

The sample collection and storage is conducted as following.

Water samples were collected with 12L Rosette samplers from depths of 10, 30, 40, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300, 400, 500, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000m at St.KNOT 1(leg 1), 10, 30, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 250, 300, 400, 500m at St.20 and KNOT 2(leg 2). Surface water samples were collected with clean plastic bucket at above each station.

The suspended POM samples (approximately 20L) were filtered through Whatman GF/F filters pre-combusted at 450℃ for 4hr. A filter after filtration was rinsed with particle(0.2mm) free salt water (35‰ NaCl) and stored frozen (-20℃) until isotope analysis.

The Dissolved Inorganic Carbon (DIC) samples (100 ml) were poisoned with 0.1ml of saturated $HgCl_2$ solution, stored in a dark serium bottle at room temperature. The total amount of DIC and its isotope ratios will be determined following the procedure of Kroopnic (1985).

The NO_3^- samples (3L) were filtered through Whatman GF/F filters and added with 12ml of conc HCl solutions, stored in a glass bottle at room temperature.

The N isotope ratios of NO_3^- will be determined in our laboratory.

3. 7 DO^{14}C

Naomi Harada
(Ocean Research Department, JAMSTEC)

1. Introduction

DOC (Dissolved Organic Carbon) is defined as all organic matter in acidified sea water that pass through a 0.2 μm filter and is not removed during degassing. The total amount of DOC pool in the global sea water is small compared to the DIC (Dissolved Inorganic Carbon), less than 2%. The main importance of the DOC pool is not the carbon in the pool itself, but its role in the biological pump that influences the inorganic carbon concentration in the ocean surface.

The northwestern North Pacific in fall to winter season is characterized by active biological pump under high nutrient concentration in the surface water due to mixing. Therefore, the assessment of the behavior of DOC in this season and its role in oceanic carbon cycle are important.

2. Objectives

Ratios of carbon isotopes ($^{13}C/^{12}C$ and $^{14}C/^{12}C$) can give information on the origins of organic compounds and their age. The purpose of this study are to confirm a DOC UV oxidation method to measure the DO^{14}C activity in the sea water and to obtain the DOC cycling velocity in the northwestern North Pacific.

3. Sampling and sample storage

Sea water samples were taken at stn.KNOT only. About 10 litter water samples were taken at 12 water depths (10m, 30m, 60m, 100m, 200m, 400m, 600m, 800m, 1000m, 2000m, 3000m, 5000m) with the CTD rosette system. The Niskin-X bottles were cleaned by the same method as trace metal. Preservative ($HgCl_2$) was added to the water samples immediately after sampling. Each water sample was treated by two ways. A part of the sea water (*ca.* 5 litter) was filtered through a glass fiber filter (pore size 0.4-0.7 μm) under a low vacuum (>15 cmHg). About another 5 litter, no filtering was applied. Both samples were stored frozen (-20 °C) in 5 litter and 10 litter polycarbonate bottles (Nalgene), respectively. These samples will be treated on shore and the DO^{14}C activity in the samples will be measured by AMS.

3.8 Phytoplankton pigments

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Core Research for Evolutional Science and Technology

Chorophyll a and pigments separated by HPLC are measured for comparison with phytoplankton species and number. The seawater subsamples for Phytoplankton piguments collected from 12 layer (0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200m) by niskin sampler attached to CTD-RMS at station KNOT and 20. Chorophyll a samples were carried out size fraction with nuclepore filter (pore size 10, 2μm) and grass fiber filter (Whatman GF/F). In this cruise (leg. 1), Chorophyll a data and station and sampling depth are as follows.

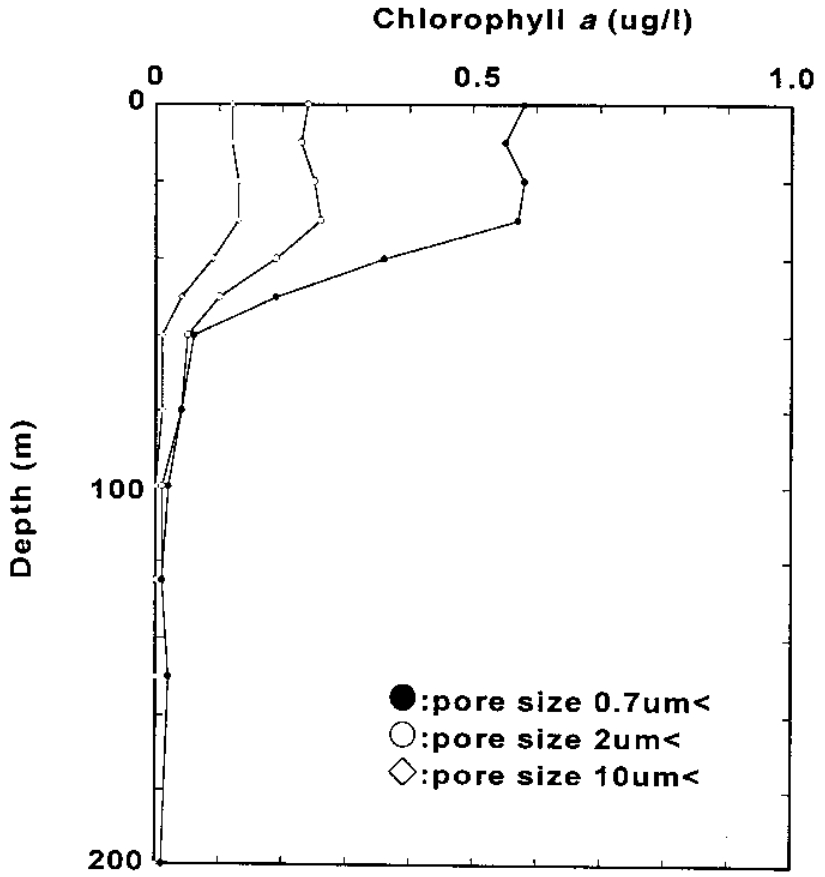

Fig. Vertical distributions of size furactionated chlorophyll a concentration at station KNOT

3. 9 Trace metal

Behavior of iron in the Northwestern North Pacific Ocean.

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Ocean Research Department
Japan Marine Science and Technology Center

(1) Introduction

Fe is one of the major elements in the earth's crust. However, its concentration in seawater is extremely low. This low concentration is attributed to the fact that solubility of thermodynamically stable Fe(III) is very low. In other wards, Fe in seawater readily hydrolyzes to form insoluble colloidal hydrous ferric oxides, settling down to the bottom. Because of this high reactivity, its residence time in the ocean is one of the shortest, which is on the order of few hundreds years in deep water and several weeks in surface water.

Usually an element with a long residence time does not respond to the sudden change of input or output. However, an element with a short residence time like Fe changes its concentration in the seawater according to the change of input or output, so that it is a very good tracer for short term phenomenon.

Fe is supplied from river and atmosphere to the ocean surface. However, because of its rapid removal from seawater, riverine dissolved Fe is readily removed within estuary, so that influence of riverine input to the open ocean surface may not be recognized. Therefore the airborne dust has been proposed as a major source of dissolved Fe to the open ocean surface. On the other hand, in deep waters other sources of dissolved Fe have been proposed as the partial release of Fe from resuspended sediment particles including colloid, and the diffusion from the pore water in the sediment.

Fe has been also known as an essential micro-nutrient for the phytoplankton growth in the ocean. Due to its extremely low solubility, however, the concentration becomes so low that phytoplankton growth is subdued where its supply is limited. Thus, the fate of Fe in seawater is closely related to the biological activity. It is very important to know the behavior of Fe in the ocean for the study of the global biogeochemical cycles of carbon and its related elements.

The Northwestern North Pacific Ocean is characterized by upwelling of deep water, high nutrients, high primary production and complicated water mass structure (i.e. intermediate water), among others. And also large aeolian input of terrigeneous material

to the area is expected. Generally, in the North Pacific the dominant source of the terrigeneous material is Asian dust. Because they can supply Fe over the surface water, they have significant impact on the phytoplankton growth. In addition, seasonal and geographical changes of these features are drastic. This complexity has prevented us from knowing exactly to what extent it plays a role in the global material cycles, which is a main goal of this project. One of the objectives of this study is to clarify the role of Fe in the phytoplankton growth in the Northwestern North Pacific. The other objective is to evaluate the transport and transformation processes of terrigeneous material and intermediate water in these regions using Fe as a tracer.

(2)Methods

Water samples were collected vertically at 17 stations using new type 12 l Niskin-X sampling bottles (General Oceanics) attached to CTD-RMS. As mentioned above, Fe in the seawater is extremely low, so we have to take special care before, while and after taking water samples. Sampling bottles with internal closing mechanism may also be prone to contamination, however this new type sampling bottle has its stainless steel spring closures mounted externally. This method of mounting the springs is ideal for applications such as trace metal analysis where the inside of the sampling bottle must be totally free of contaminants. In addition, inside the sampling bottles were coated with Teflon to avoid contamination. Teflon stopped cock, Teflon air vent screw cock and biton o-ring were also used for the bottles. Surface seawater samples were collected in low density polyethylene bottles directly hanging on a nylon rope. Sampling stations are listed in Table 1.

Water samples for total Fe (100 ml) and other trace metals (250 ml) were kept in a freezer (-20°C) immediately after sampling. Samples for dissolved Fe(III) were filtered in-line using peristaltic pumps through 25 mm diameter, 0.2 μm Nuclepore polycarbonate filters held in Teflon filter sandwiches (SAVILEX). The filtrates (100 ml) were adjusted to pH 3.2 with formic acid-ammonium format buffer solution and then were kept in a refrigerator (4°C) until the measurements. Samples for colloidal Fe(III) were adjusted to pH 3.2 with same buffer solution without filtration and were kept in a refrigerator (4°C). Two samples for calibration (1000 ml) were collected at 0 m and 10 m depths (except Sts. 1 and 2); after their filtration using same procedure, one was kept in a freezer (-20°C) and the other was kept in a refrigerator (4°C). All procedures were done in a class 100 laminar flow cabinet to avoid contamination. Treatment of samples are listed in Table 2.

Fe(III) will be measured by automated analytical method using a combination of selective column extraction and luminol-hydrogen peroxide chemiluminescence detection method.

Table 1. Sampling locations for Fe study.

Date	Station	Depth, m
11/ 4	St. 1	10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600
11/ 7	KNOT	0, 10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
11/12	St. 2	10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600
11/17	St. 19	0, 10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
11/20	St. 8	0, 10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
11/21	St. 9	0, 10, 30, 50, 75, 100, 200, 400, 600, 1000, 1500, 2000, 3000
11/25	St. 10	0, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
11/26	St. 11	0, 10, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
11/27	St. 12	0, 10, 20, 30, 40, 50, 75, 100, 125, 150, 200, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
11/29	St. 13	0, 10, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
11/30	St. 14	0, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
12/ 1	St. 15	0, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
12/ 2	St. 16	0, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
12/ 3	St. 17	0, 10, 30, 50, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4300, 3500 down cat x 2
12/ 4	St. 18	0, 10, 20, 30, 40, 50, 60, 75, 100, 125, 150, 200, 250, 300, 400, 500, 600, 800, 1000, 1250, 1500, 1750, 2000, 2500, 3000
12/ 4	St. 20	0, 10, 20, 30, 40, 60, 80, 100, 125, 150, 200, 400, 600, 800, 1000, 1250, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m
12/11	KNOT	0, 10, 20, 40, 60, 80, 100, 125, 150, 200, 300, 400, 500, 600, 800, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, B-50m

Table 2. Treatment of samples.

Volume	Measurement	Treatment
100 ml	Total Fe(III)	no treatment, frozen (-20°C)
250 ml	Other metals	no treatment, frozen (-20°C)
100 ml	Dissolved Fe(III)	filtration (0.2 μm) and pH adjustment (pH 3.2), refrigerated (4°C)
100 ml	Colloidal Fe(III)	no filtration and pH adjustment (pH 3.2), refrigerated (4°C)
1000 ml	Calibration	filtration (0.2 μm) (only 0 and 10 m), frozen (-20°C)
1000 ml	Calibration	filtration (0.2 μm) (only 0 and 10 m) , refrigerated (4°C)

3. 10 Gas

3. 10. 1 Seasonal variation of methane and halocarbons in seawater at the station KNOT

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Purpose

Ocean is the source of methane and halocarbons which are drawn much attention in the global atmospheric chemistry. In marine environment, these gases are mainly produced by the biological activity. The time series station KNOT is in the North Pacific and have a large seasonal variability of biological activity. In this study, we will discuss the factors controlling the methane and halocarbons concentrations in seawater at KNOT and estimate the flux of these gases derived from the ocean to the atmosphere.

Methods

Water samples were collected with CTD rosette systems attached with Niskin bottles of 12 l capacity. Sample waters were drawn from Niskin samplers into 30 ml and 100 ml glass bottles through the rubber tube for halocarbon and methane, respectively. The sample water were overflowed more than twice of bottle capacity. The sampling stations and numbers of samples collected in this cruise listed in Table 1 and detailed in appendix tables. These samples will be analyzed in laboratory on land by gas chromatography and gas chromatograph - mass spectrometry.

3.10.2 Dissolved CFCs (CFC-11,CFC-12) and SF_6 measurement

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(Hokkaido University)

(1)Introduction

CFCs and SF_6 are useful chemical tracers to study on the water circulation in the ocean and air-sea gas exchange. In this study, we purposed to obtain the distributions of CFCs and SF_6 near sea surface in the northern North Pacific in wintertime and to study air-sea gas exchange.

(2) Method

Sampling

Water samples were collected at 6 stations; Sta. KNOT, 8, 10, 14, 15 and 20. About 500ml sea water collected from 0m to 200m depth was transferred to a glass cylinder from 12l Niskin bottles attached to CTD-RMS system for analysis of SF_6 and CFCs. About 100ml water from 200m to 3000m depth was transferred to a glass syringe for the determination of CFCs concentration.

Analysis

Concentrations of CFCs and SF6 were determined on the board immediately. CFCs and SF_6 dissolved in the seawater were stripped and preconcentrated using purge-and-trapping system jointed with ECD-GC. This procedure is combined those by Bullister and Weiss (1988) and Law, Watson and Liddicoat (1994).

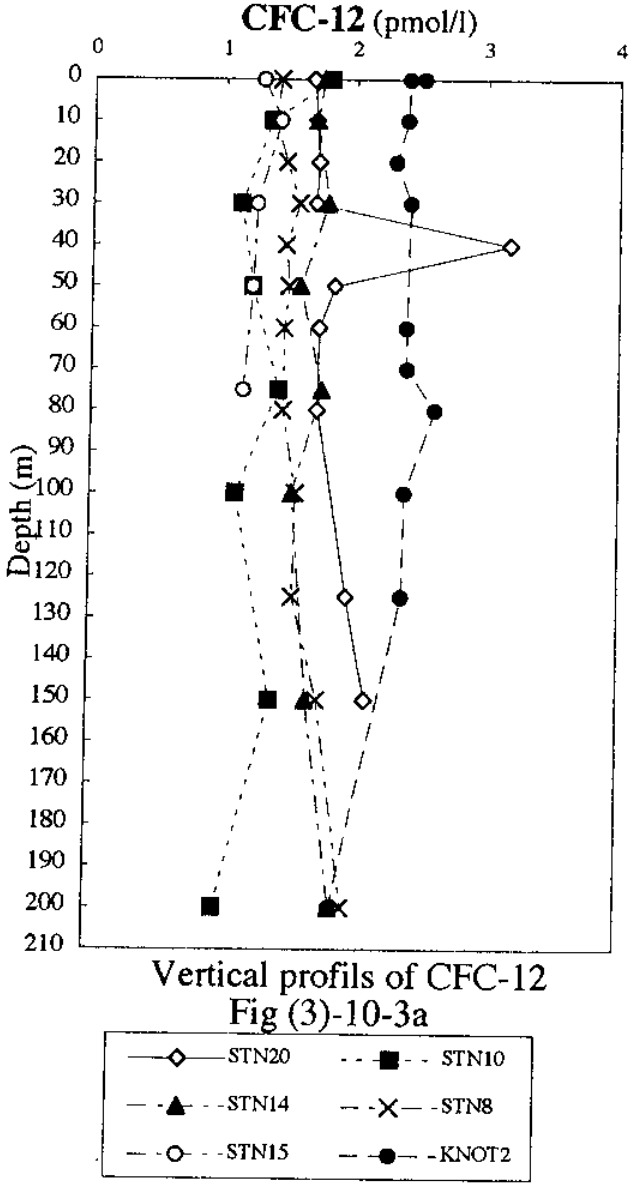
(3) Results

Vertical profiles in this cruise are shown in Fig.(3)-10-3a,b,c. We have excluded the date of CFCs (300-3000m) because of problems with the onboard analysis.

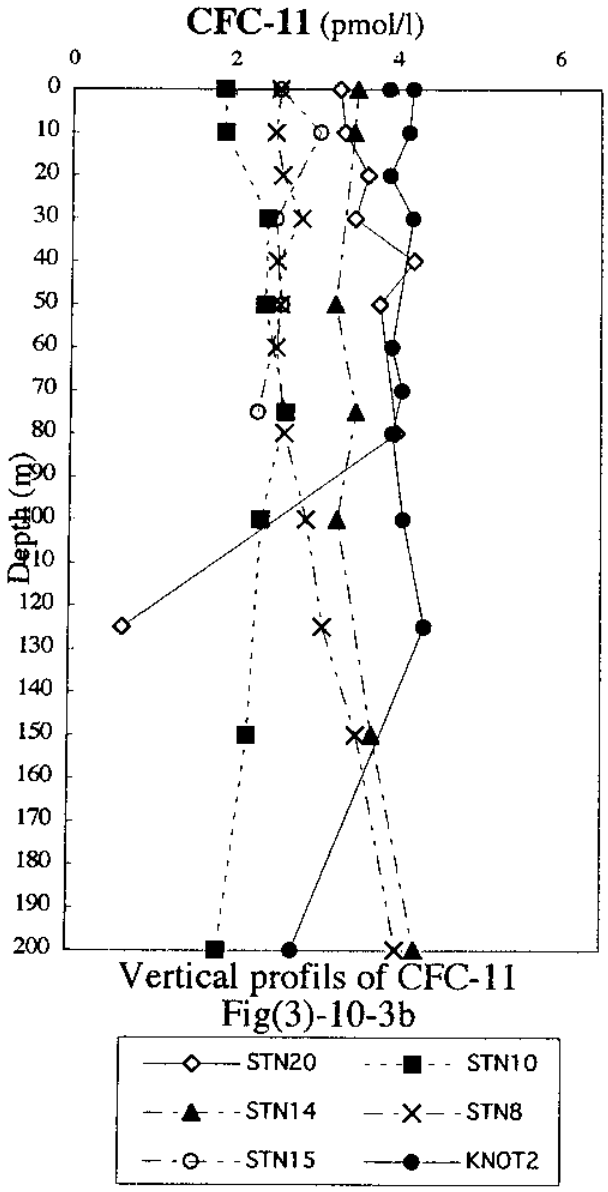
Reference

Law, C.S., A.J. Watson and M.I. Liddecoat (1994) Automated vacuum analysis of sulphur hexafluoride in sea water; determination of the atmospheric trend (1970-1993) and potential as a transient tracer, Mar.chem., 48,57-69

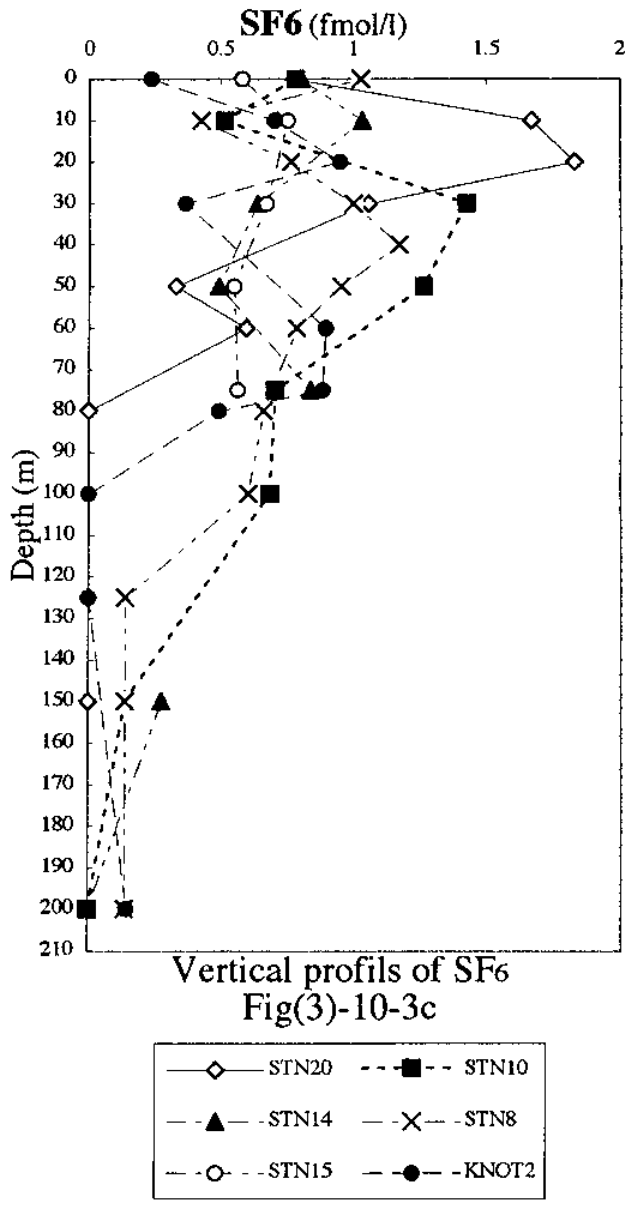
Bullister, J.L., R.F. Weiss (1988) Determination of CCl_3F and CCl_2F_2 in sea water and air, Deep-sea Res, 35,839-853



Vertical profils of CFC-12
Fig (3)-10-3a



Vertical profils of CFC-11
Fig(3)-10-3b



Vertical profils of SF6
Fig(3)-10-3c

3.11 Radionuclides

3.11.1 ^{234}Th, ^{210}Po, ^{210}Pb by JAMSTEC

Yong-Liang Yang and Hajime Kawakami
(JAMSTEC)

PURPOSE OF THE STUDY: Particle-reactive radionuclides (^{234}Th, ^{210}Po, ^{210}Pb) and their relationship with POC and PON in the northwestern North Pacific Ocean. Particularly the excessive ^{210}Po's origin will be focussed on (particle regeneration or from the shallow area sediments via North Pacific Mid-Water).

SAMPLING :

Seawater sampling for ^{210}Po and ^{210}Pb: 5 stations (Knot(1), 8, 10,14,16, 20, Knot(2)). 21 depths (10m, 20m, 30m, 40m, 50m, 60m, 75m, 100m, 150m, 200m, 300m, 400m, 500m, 600m, 700m, 800m, 900m, 1000m, 1100m, 1200m, 2000m) at each station (Knot(1) and (2)'s upper 10 depths samples were taken by Harada Koh and Narita and 50m-above-bottom samples were also taken.) and 5 liters for ^{210}Po and 5 liters for ^{210}Pb at each depth.

Seawater sampling for ^{234}Th: 9 stations (Stn 1, 2, 8,10, 11, 14, 16, 17, 20). 11 depths (10m, 20m, 30m, 40m, 50m, 60m, 75m, 100m, 150m, 200m, 300m) at each station and 20 liters for each depth.

Seawater samples were filtrated with 47mm GF/F filter on board immediately after water sampling.

CHEMICAL ANALYSES:

^{234}Th: Seperation of U, Th on board by anion exchange; Dissolved and particulate samples of Stn 1 and Stn 2 were measured by scintilation method on board. The rest of samples were seperated from U only and taken back to land-based laboratory ready for TTA extraction.

^{210}Po and ^{210}Pb: ^{210}Pb samples were acidified on borad and spiked and will be seperated and measured after ^{210}Po reaches equilibrium with ^{210}Pb (about 5 half-lives, i.e. 2 years). ^{210}Po samples were acidified and spiked and self-deposited on Ag disc on board of the ship.

DISSCUTION AND SUMMARY:

Due to the bad weather in the first leg, only three stations were taken samples. In the second leg, effiucieny was much higher. At least at 7 locations, ^{210}Po and ^{234}Th particulate and dissolved profiles can be compared. This work will help further understanding of particle dynamics of two different particle-reactive redionuclides especially ^{210}Po which may be influenced by the redox condition in the water coloum.

3. 11. 2 Time-series observation of ^{234}Th, ^{210}Po and ^{210}Pb at KNOT station

Koh Harada (National Institute for Resources and Environment)
Yoko Shibamoto (National Institute for Resources and Environment)
Hisashi Narita (Hokkaido Univ.)
Masashi Kusakabe (Japan Marine Science and Technology Center)

(Objectives)

Estimation of export production, which is particulate carbon flux from the surface mixed layer to the deeper ocean, is very important to verify the role of oceanic biological pump. Time-series observation of the export production has been desired because the biological process in the surface layer has large seasonal variation. The export production could be estimated by sediment traps deployed just under the mixed layer, however, collecting efficiency of the particulate matter by the traps may not be constant because of complicated hydrodynamics in the surface water.
Insoluble natural radionuclides are good tracers for the particulate matter.

Removal flux of the nuclides should be estimated from the concentration of the nuclide in water column and carbon flux should be estimated from the removal flux and carbon to the radionuclide ratio in the particulate matter. Therefore, ^{234}Th, ^{210}Pb and ^{210}Po in seawater were measured in this cruise.

(Methods)

Seawater samples were collected from 12 layers down to 300 m at Stn. KNOT on Nov. 8. After filtering through a GF/F filter, the filtered water sample was acidified and spikes and iron carrier were added. Neutralizing by adding ammonia water, the radionuclides were collected in iron precipitates. The precipitates were collected on cartridge filters. After some purification and separation processes using ion exchange and extraction techniques, Po was plated onto a silver disc and Th was collected in scintillation solution. Lead fraction in acid solution was kept in a plastic bottle. Beta activity from the Th fraction was counted by using an ORDELA 8100 AB liquid scintillation counter on board. Po on the silver disc was counted by using a MCA with a silicon surface barrier detector. Activity of ^{210}Pb will be measured by counting ^{210}Po activity generated in one year storage.

3.11.3 Rn measurement

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1: Graduate School of Environmental Earth Science, Hokkaido Univ.
2: National Institute for Resources and Environment
3: JAMSTEC

(1) Introduction

Rn-222(t1/2 = 3.84 days) has been used as an oceanographic tracer, for estimating diffusion coefficient of bottom water(Sarmiento et al., 1976) and gas exchange rate through sea surface(Schink et al., 1970), after Broecker (1965) described the basic handling and counting techniques. Because Rn-222 has a short half-life, its measurement must be done in a short period.

In this study, we have modified to the basic method. In order to estimate gas exchange rate in the northern North Pacific, the method is applied to determine the vertical profile distribution of Rn-222 in surface waters.

(2) Method

Sampling

Water samples were collected with 12-l Niskin bottles with CTD rosette multi sampler at St. KNOT, St. 2, St. 8, St. 20 and St. KNOT-2. The water from two 12-l Niskin bottles is allowed to flow into evacuated PVC bottles (ca. 25-l) through a quick-connect fitting on the top plate. This bottles was specially designed for radon extraction from 20-l sea water samples. In order to estimate overall precision, we collected 6 samples from same depth (550 m) at St. 17.

Rn extraction

Immediately after sampling, Rn extraction were done. We degassed three samples simultaneously circulating radon-free air at a flow rate of ca. 1l air/min by diaphragm pumps for each sample. After bubbling through the slurred sample, each gas stream passes over Soda lime, DrieriteTM(anhydrous $CaSO_4$, 10-20 mesh) and magnesium prechlorate (anhydrous reagent) to remove H_2O and CO_2. The gas streams flow into the separable trap kept at dryice-ethanol temperature. These traps are made of glass tubing(OD; 6 mm, ID; 3.5 mm) with inlet and exit Teflon needle valves, packed with active charcoal. After 60 min, pumps are

turned off. The high-purity He (99.999%) flows at a rate of ca. 1l He/min for 5 min. After passing through the trap, the helium carrier is vented to the atmosphere. When degassing is complete, the bypass valve is opened and the valves on the PVC bottles closed. The flow using high-purity He is continued more 5 min. Finally, the inlet and exit valves to all three sample traps are closed and the helium flow stopped. Those traps are removed from the radon stripping system and kept at dryice-ethanol temperature until next step.

Rn transfer

Rn-222 is transferred quantitatively to the counting cell in this step. The separable trap is connected to the transfer system with the Cajon® fitting and evacuated. After closing the valve between the trap and the Swagelock® male quick-connect (called the cell-fill valve), the counting cell connected to the quick-connect and evacuated. After opening the exit valve of the trap and the cell-fill valve, the trap heated for 30 min at 350℃ so that radon expands through the valves into the evacuated cell. Finally, any radon left in the trap is flowed into the counting cell by helium. The counting cell is removed from the system when the helium pressure reaches about 510 mm Hg. The time for flowing helium is about 100 sec. Using this system, the average time for stripping and transfer of 9 radon samples at each station is about 45 min per sample.

Ra extraction

Radium is extracted from the sea water after radon degassing is completed. Five litter sea water is passed through a column (column volume: 1.5 ml) packed with manganese-impregnated acrylic bead using micro tube pump. Flow rate is about 10 ml/min.

After all the sea water has passed through the column, the manganese bide will return to the lab for analysis. Activities of Ra-226 and its daughters will be measured by liquid alpha scintillation counter, after purification.

Rn counting, background and efficiency

The counting system used were supplied from Ludlum measurements Inc. and a Lucas-type cell from EDA Instruments Inc. The counting time for each sample is usually 360 min and run twice. The decay and growth collection for radon and the calculation of statistical

counting error is due to the equation reported by Samineto et al. (1976). The counting error is normally below 2 %.

The background of 9 different cells range from 0.08 to 0.40 cpm. This difference may be due to Pb-210 build-up in the cells.

The total efficiency is determined for the all system by measuring a 27.92 dpm standard solution prepared by gravimetoric dilution from NBS radium standard. A total efficiency was 86.0 1.5 %. This is an average value of four times run using 4 cells of all for calibration. Although no significant difference may be observed among the cells and the separable traps, the total efficiency will be determined more in future.

Results

Analytical precision

In order to estimate overall precision, we collected 5 samples from 500 m depth at St. 17. These samples should all have an identical radon content, because of each bottles fired within 5 m. Because of the separations between radium and radon were done within 5 hrs from sample collection, the effect of time correction is negligibly small for decay or growth from radium. Analysis showed a standard deviation in mean radon activity of 2.6 %. The results compare favorably with precessions obtained by best methods reported previously.

Rn-222 vertical profiles in surface water

Surface water results are corrected to the time the sample was removed from its environment. This is necessary since the radon deficiency in the surface water decay with the half-life of radon. After measuring Ra-226 in surface water in Lab, final results will be reported within 1 year.

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3. 12 Drifting sediment trap experiment

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Hisashi Narita (Hokkaido Univ.)
Tomoyuki Tanaka and Yoshihisa Mino (Nagoya Univ.)

(Objectives)

As one of tactics to verify the role of oceanic biological pump in the control of global environment, sediment trap experiments have been carried out all over the world ocean. However, sediment traps have been usually deployed in the deep sea (> 1000 m) because of complication of hydrodynamics, swimmer, and vandalism in the shallower water. Therefore these sediment traps have not given us enough information about the mechanism of biological pump in the layer between photic zone and deep sea. In addition, collecting efficiency of moored sediment traps are significantly affected by hydrodynamics. In order to solve these problem, drifting sediment trap experiments have been also conducted to collect settling particles in the shallower depth although experimental period is limited.

For the better understanding of biological pump in the Northwestern North Pacific, we conducted short-termed drifting sediment trap experiment three times at two stations in this cruise.

(Methods)

Drifting sediment trap experiments were conducted at stn. KNOT (Time-series station) and stn. 20 (sub Arctic boundary zone). Sediment trap array consisted of eight individual transparent policarbonate cylinders with baffle (collection area, ca. 0.0038 m^2: aspect ratio, 620 mm length / 75 mm width = 8.27), which were modified from Knauer et *al.* (1979) and were deployed at 20 layers from *ca.* 40 m to 400 m (Fig.1). Before deployment, each piece of sediment trap was filled with filtered surface sea water, which salinity is adjusted to *ca.* 39 PSU by addition of NaCl. Thermometer and depth sensor were attached on sediment trap array at 40m, 60m, and 390 m. These sediment traps were lowered from surface floating package including surface floating buoy, GPS buoy, radar reflector, and flash light. This moorings system drifted during *ca.* 48 hours at station KNOT and ca. 68 hours at station 20 (Table 1). During the experiment, the position of mooring system was monitored on board by GPS tracking system. Fig.2 (a), (b), (c) shows track of drifting sediment trap mooring system at

station KNOT in the first leg, and station 20 and station KNOT in the second leg. At station KNOT, it can be seen that the mooring system drifted to the northeastward, which movement was not monotonous and some turning points can be seen (Fig.2 (a)). These might be the effect of eddy. However, the mooring system drifted to the eastward when the second experiment (Fig.2 (b)).

Fig.3 (a), (b), (c) shows the variability in water depth and water temperature at 40m, 60m, and 390 m sediment trap during the experimental period. During the first experiment at station KNOT, water depth of 40 m sediment and 390 m sediment traps shifted from 44 m to 48 m, and from 415 m and 425 m, respectively. It is attributed to the extension of the nylon rope. Water temperature at 40 m ranged from 8 to 3 degree centigrade and temperature at 60 m also changed between 5 and 2.5 degree centigrade, while temperature at 390 m was constant around 3 degree. It is notable that decrease in temperature at 40 m coincided to the turning point of drifter direction (Fig.2 (a)). During the experiment at station 20, the decrease of depth by 5 m at 40 m sediment trap depth and 20 m at 390 m sediment trap took place from the middle to the end of period (Fig.3 (b)). During this period, wave height and wind velocity became higher because of low atmospheric pressure. The mooring system should be towed laterally and , therefore, sediment traps were raised.

After recovery, sediment trap samples were treated according to procedures in Fig. 4. Samples from twelve sediment trap arrays were water sieved through a 1 mm nylon screen to remove "swimmer" such as zooplankton and small fish. Samples less than 1 mm were sequentially filtered with GF/F filter or Nuclepore filter rinsing with high pure water on board, and filter papers with settling particles were frozen in the refrigerator. Some samples of remains were treated with the above procedures and some samples are freezed or stored in the refrigerator with preservative (formaline) for the former analysis.

(Future analysis)

These samples will be distributed to participants for the following various analysis.

1. Dry weight (JAMSTEC, Hokkaido Univ.)
2. Org-C, inorganic carbon, Total-N (JAMSTEC, Nagoya Univ.)
3. Carbonate, Opal (Hokkaido Univ.)
4. Stable isotopes (^{13}C, ^{15}N: Nagoya Univ.)
5. Trace elements (Al, Fe, Mn *etc.*: JAMSTEC, Hokkaido Univ.)
6. Radionuclides (^{210}Pb, ^{210}Po, ^{234}Th: NIRE)
7. Microscopic analysis (zooplankton: NIES)

Table 1 Drifting sediment trap experiment

Station	Deployment position	Deployment time	Recovery position	Recovery time (period)
KNOT (44N, 155E)	43.99N, 154.95E	98/11/07 13:14	44.22N, 155.07E	98/11/09 13:17 (48 h)
20 (40N, 165E)	40.01N, 165.00E	98/12/05 13:55	40.37N, 164.96E	98/12/08 10:30 (67.5 h)
KNOT-2 (44N, 155E)	44.02N, 154.95E	1998/12/11 9:15	44.05N, 155.22E	98/12/13 8:26 (48 h)

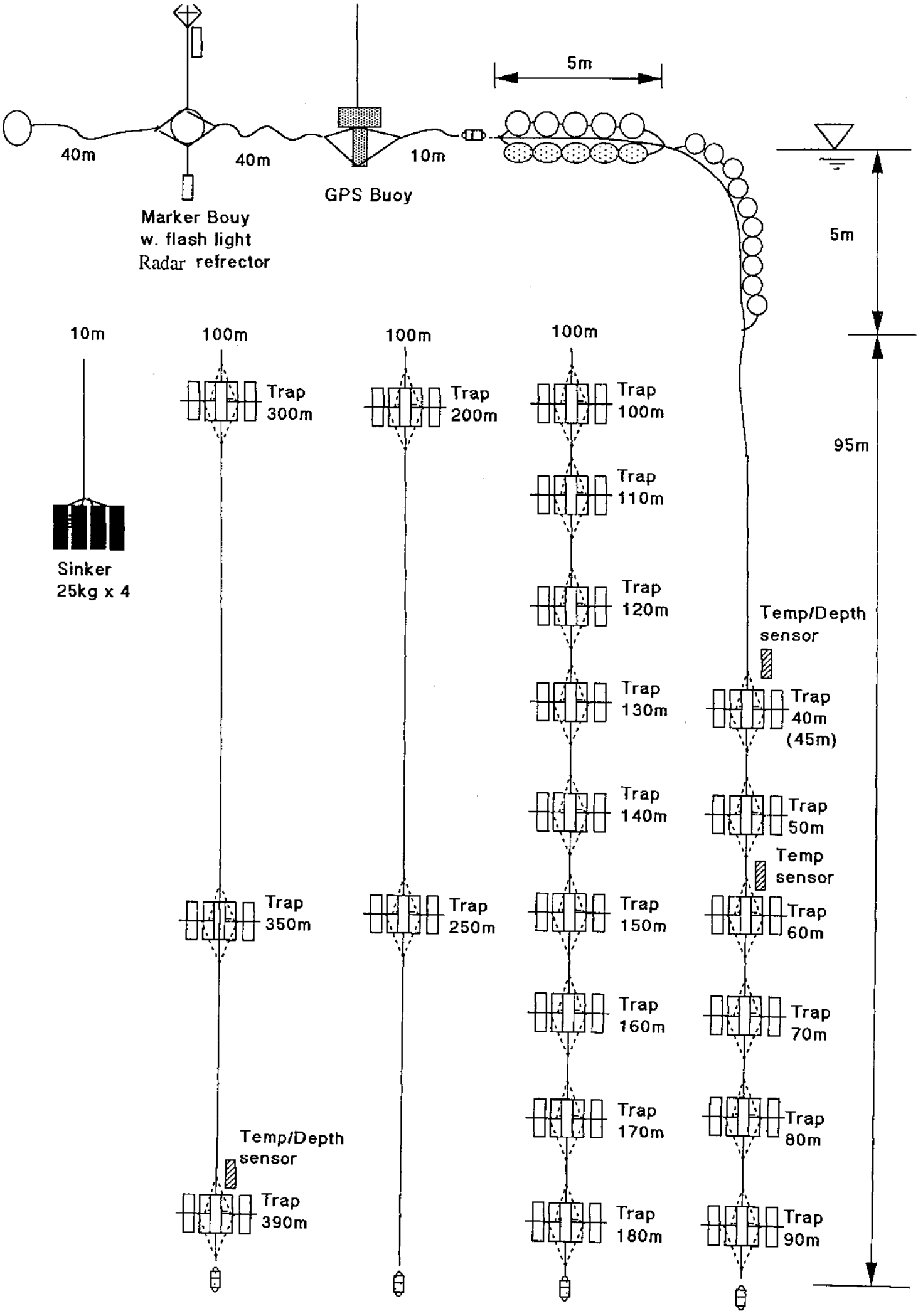

Fig.1 Drifting Sediment trap mooring system

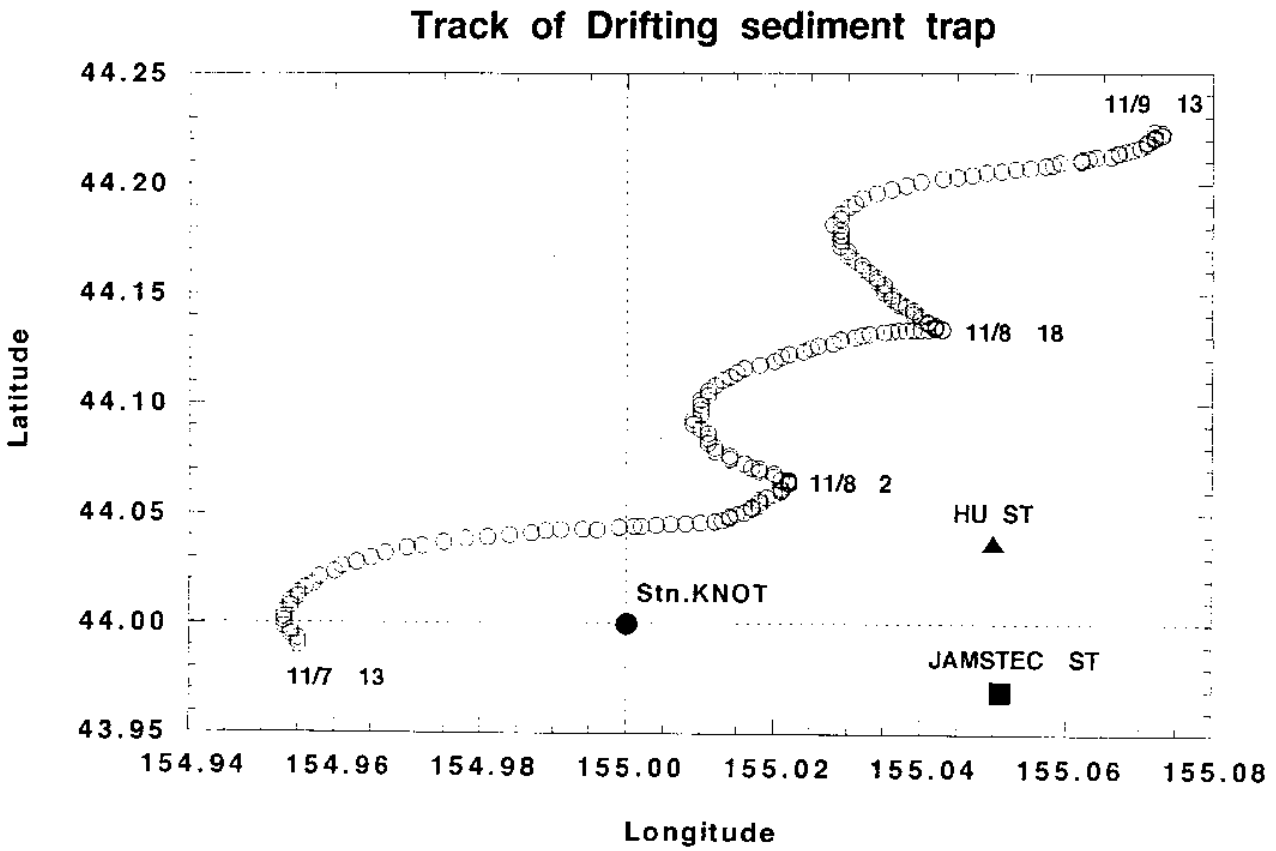

Fig.2 (a) Track of drifting sediment trap at stn. KNOT (November)

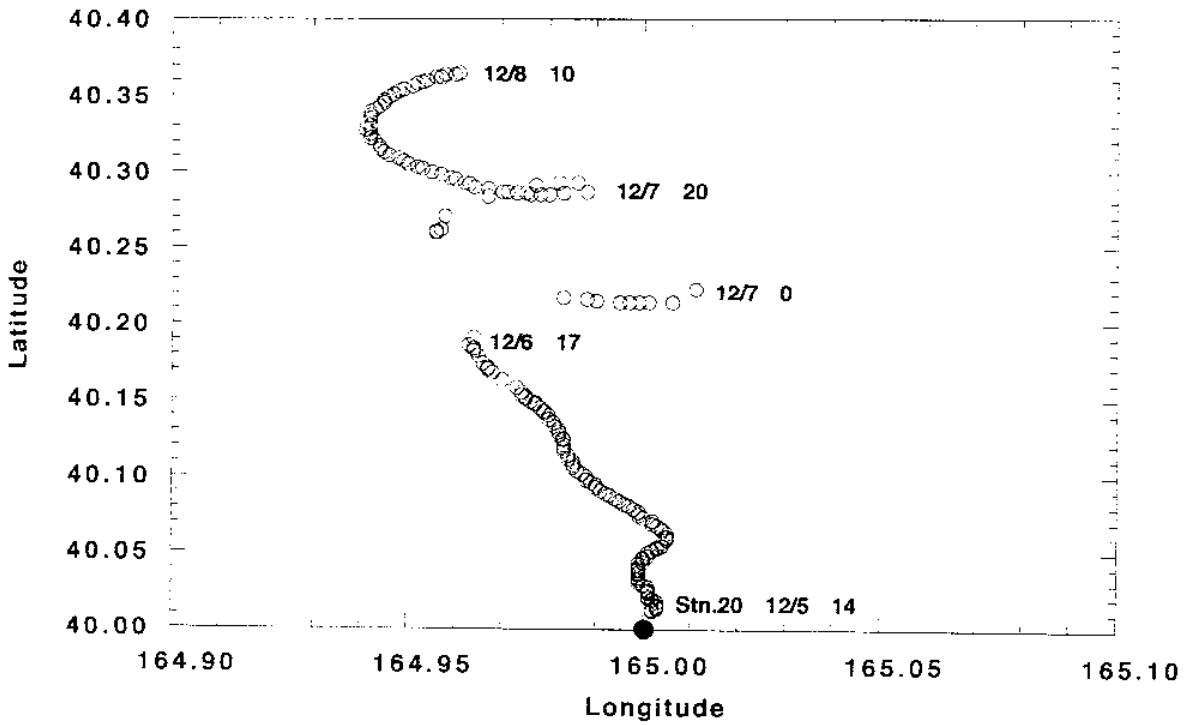

Fig.2 (b) Track of drifting sediment trap at stn. 20

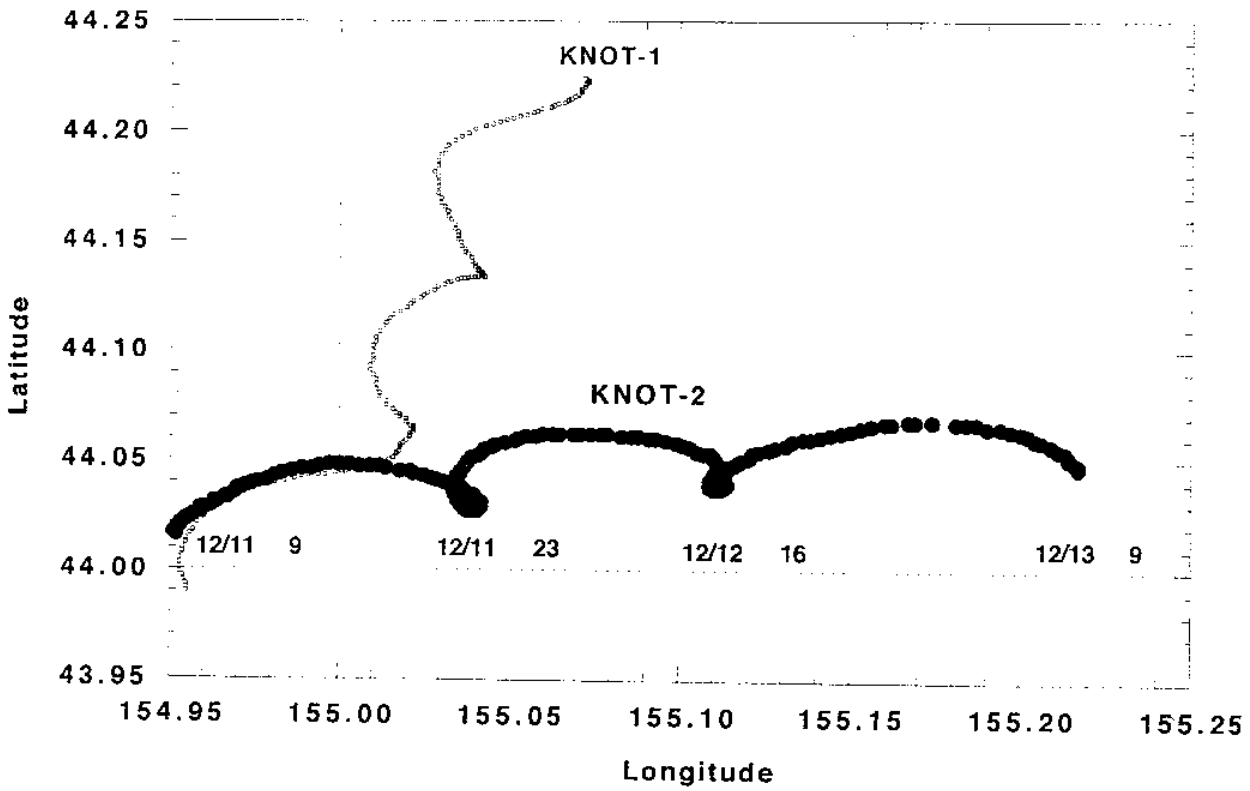

Fig.2 (c) Track of drifting sediment trap at stn. KNOT (December)

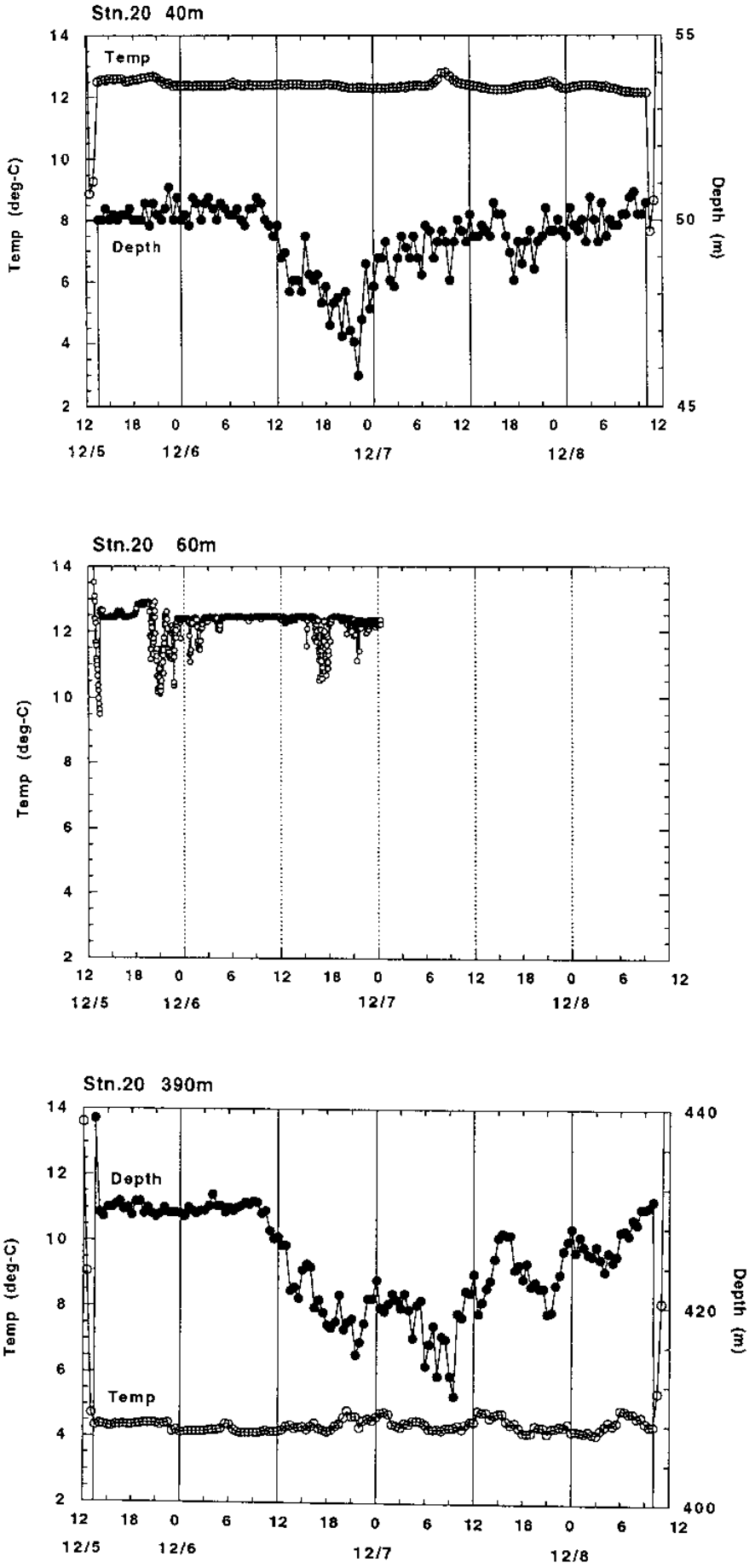

Fig.3 (b) Variability in water temperature and sediment trap depth at 40 m, 60 m, and 390 m during the experiment at stn. 20

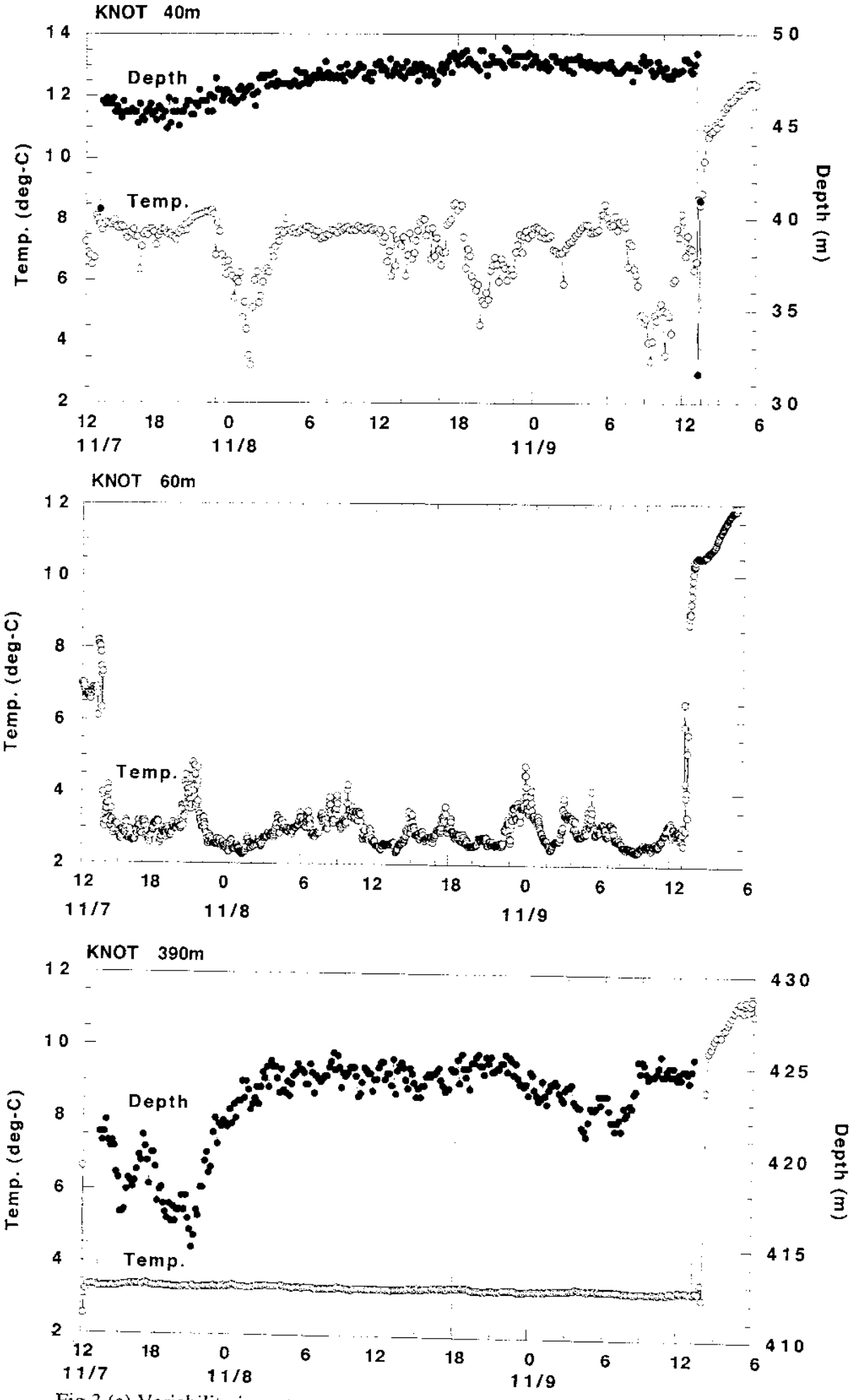

Fig.3 (a) Variability in water temperature and sediment trap depth at 40 m, 60 m, and 390 m during the first experiment at stn. KNOT in November

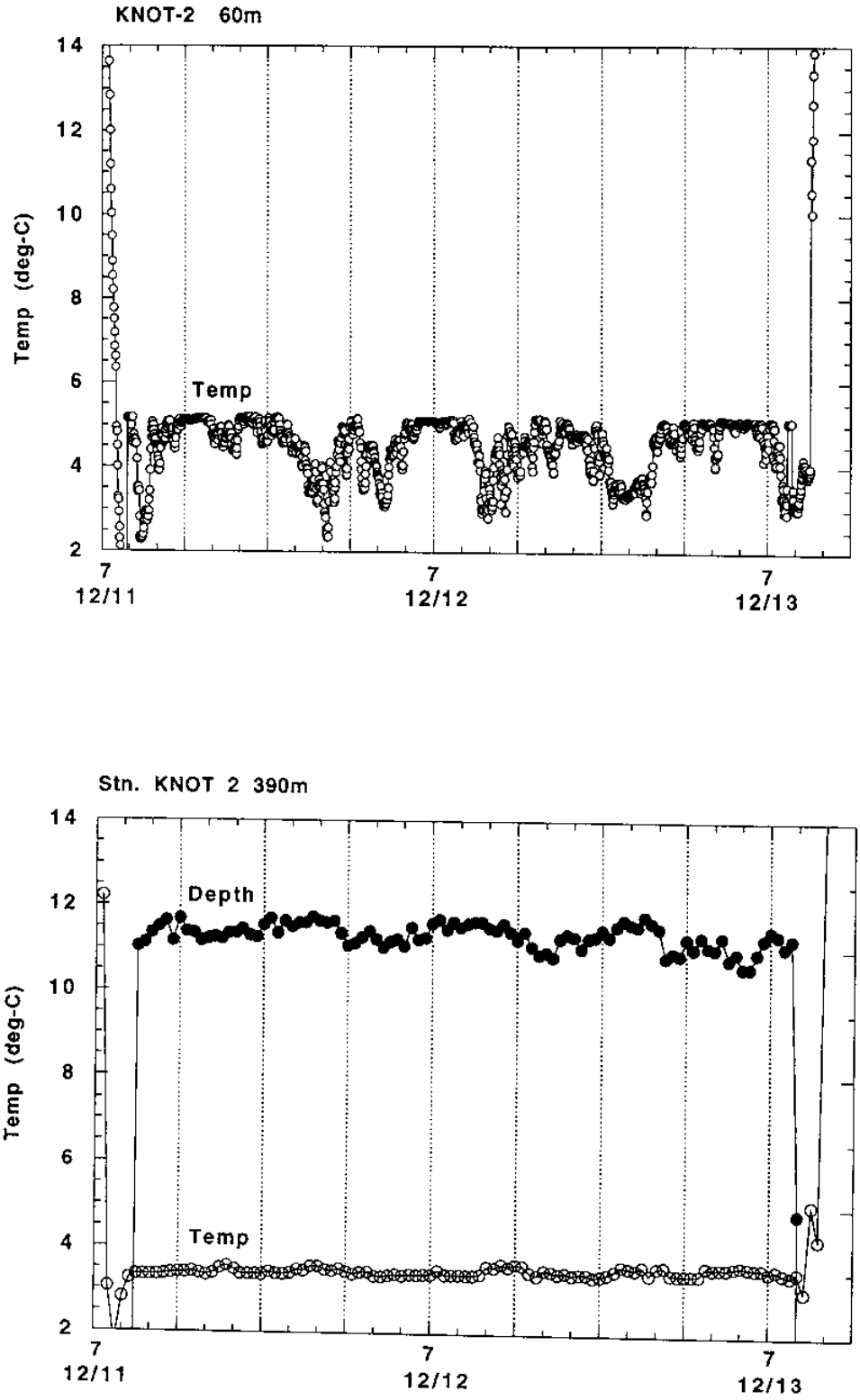

Fig.3 (c) Variability in water temperature and sediment trap depth at 60 m and 390 m during the second experiment at stn. KNOT in December

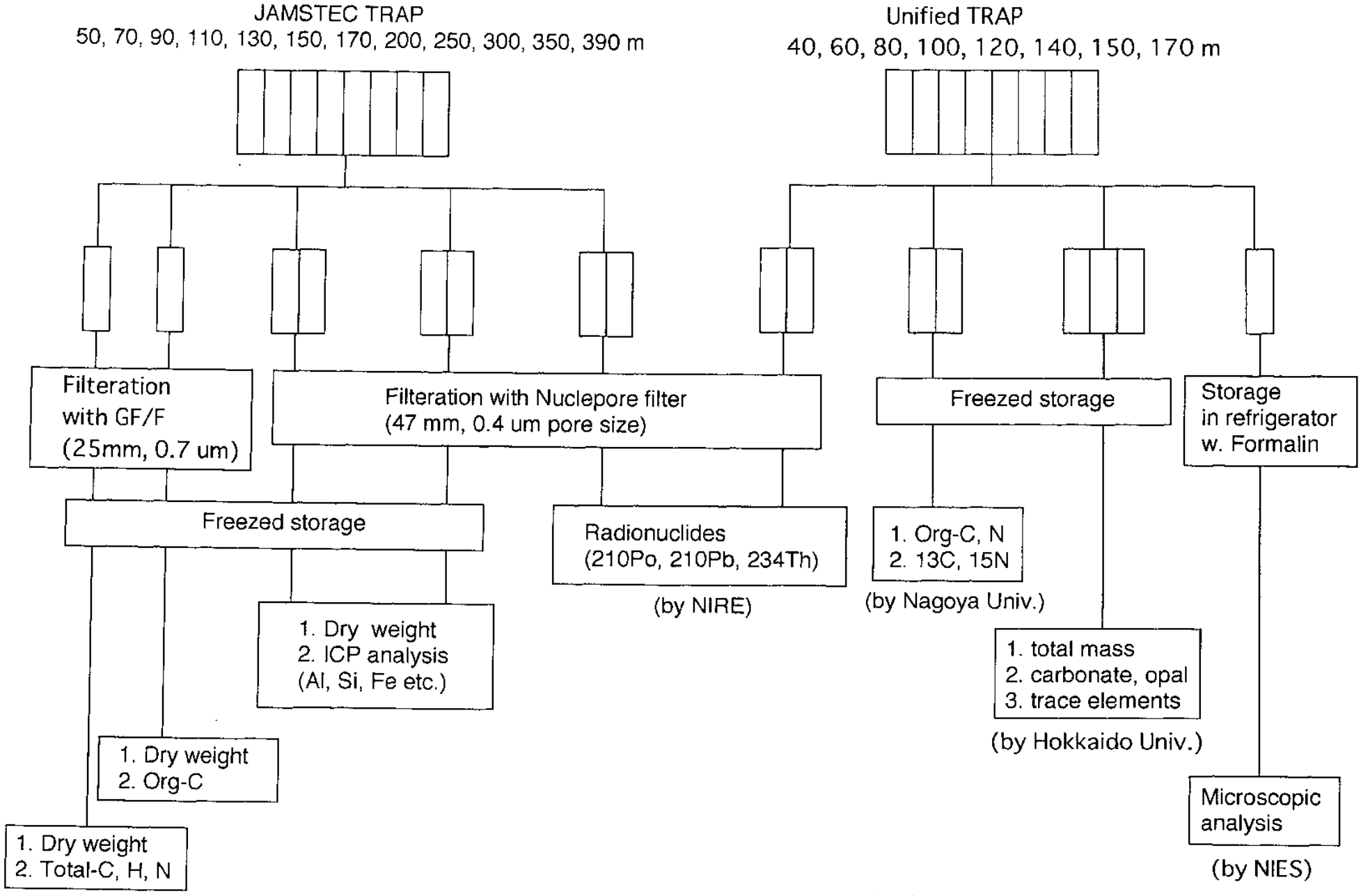

Fig.4 Procedures of sample distribution

3. 13 Primary production

3.13.1 Primary production

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In western region of North Pacific Ocean time series survey was started since June 1998. In this region it is very important to estimate primary production by phytoplankton in winter.

In this cruise, using ^{13}C as a tracer for inorganic ^{13}C uptake by phytoplankton photosynthesis, incubation experiments carried out in two types procedures(in-site and ñvivo). Water samples were collected with lever action niskin bottles attached Kevler wire from the 6 layers corresponding to 100, 34, 17, 8.5, 4, 0.9% of surface irradiance and drained into 250ml polycarbonate bottles. After addition of ^{13}C-$NaHCO_3$ those bottles were incubated for 24 h. And particle matter was filtered onto precombusted (450°C, 4h) grass fiber filter (Whatman GF/F) after incubation. Primary production will be calculated with concentration and ^{13}C atom % of particle organic carbon (POC) determined by Tracer. Incubation data and station and sampling depth are as follows.

Tabule Incubation data and station and sampling depth

Date	Station	Sampling Depth (m)
08 – 09 Nov.	KNOT	0, 7, 13, 22, 28, 50
06 – 08 Dec.	20	0, 9, 16, 25, 36, 52
12 – 13 Dec.	KNOT	0, 11, 17, 25, 36, 52

3. 13. 2

Nitrogen uptake by natural phytoplankton in western North Pacific Ocean

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In most open oceans, nitrogenous nutrients supply controls population of phytoplankton and its productivity. So it is important to estimate the rate of nitrogenous nutrients uptake by phytoplankton in order to understand regional variability of primary production. Primary production is divided in two components based on the relative uptake of ammonium(termed regenerated production) and nitrate (termed new production), and new production has been equated with export production, which has important implications with respect to the global carbon cycle.
In this cruise, we conducted 15N tracer incubation experiments to evaluate nitrate and ammonium uptake rate by phytoplankton in western North Pacific Ocean.

Water samples were collected from 6 layer depths (same as ^{13}C tracer experiments) before dawn and were immediately transferred to 500mL polycarbonate bottles after passage through a 200-um-mesh screen to exclude grazer.
For NH_4-N uptake experiments, each bottle were spiked with 0.1 uM ($^{15}NH_4$)Cl (99.7 atm%) and for NO_3-N uptake experiments, labeled $^{15}KNO_3$ (99.6 atm%) addition were varied in concert with the range in ambient concentrations to keep enrichment at ca 5%.
In situ incubations were started from dawn for 24 hr and terminated by filtration onto pre-combusted 25mm GF/F Whatman filters which were stored frozen until analyses of PN and 15N content. Uptake rates of nitrogenous nutrients were calculated by equation of Dugdale and Goering (1967).

Station and sampling depth are same as ^{13}C tracer experiments.

3. 14 Bio-optical measurements in the subarctic North Pacific Ocean for ocean color remote sensing

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Objectives

Subarctic North Pacific Ocean is one of the highest biological productivity regions in the world. The quantitative assessment of phytoplankton production in this region is very important to estimate global primary production. The recent development of satellite ocean color remote sensing and its application to the observation of the temporal and spatial variability of chlorophyll distribution over broad synoptic scales has provided us with a unique tool to study these features. However, there is some problems of in-water algorithms in this region. The solar incoming radiation in the subarctic North Pacific shows large variability seasonally by sky conditions. No or extremely low radiation reaches on the sea surface in the winter season by heavy cloud coverage and low sun angle. These radiant environment could effect the photosynthetic characteristics of phytoplankton in the areas. The bio-optical algorithms in the high latitude regions were different from the general algorithms (Mitchell, 1992). Then, the new bio-optical algorithms for the high latitude regions need to be developed as soon as possible. Especially in the winter season, there is a few bio-optical data sets in this region.

Primary objective of this study is to validate and to develop bio-optical algorithm for new series ocean color sensors, such as Sea-viewing Wide Field-of-view Sensor(SeaWiFS) and Global Imager(GLI) in the subarctic North Pacific Ocean. Therefore, we measured in-situ bio-optical parameters, including upwelled spectral radiance, downwelled spectral irradiance, phytoplankton pigments (fluorometric method), and particle absorption coefficient. Temporal and spatial distribution of chlorophyll a in this study area analyzed using SeaWiFS data which has been received on board.

3.14.1 Water samples for chlorophyll *a*, pheopigment and absorption coefficient

Water samples for chlorophyll *a* (Chl-a), pheopigment and absorption coefficient

determinations were collected using Niskin bottles attached to a rosette on the CTD. Chlorophyll samples were collected at all stations from surface to 200m depth and absorption coefficient samples were gathered at the stations from surface to 50m depth, which were carried optical measurements.

Chlorophyll samples were collected in 250ml or 1000ml bottles and filtered through a Whatman GF/F filter on board. Filtering Volume was 200ml or 500ml. Filtered samples were extracted in 8 ml of N,N-dimethylformamide, under cold and dark conditions for later analysis. Chl-a and phaeophytin were determined by the fluorometric method (Parsons et al., 1984) with a Turner Designs Fluorometer (Model:10-AU). Chl-a and pheopigment obtained by the CTD casts is shown in Table 1. We will compare of these chlorophyll data sets and SeaWiFS data sets in future study.

The absorption coefficients samples were collected in 4000ml bottles and between 1000 and 3000 ml filtered on to a 25 mm Watman GF/F glass-fiber filter under low vacuum pressure (<100 mmHg) on board.

We will measure the absorption coefficients of phytoplankton ($a$ph) and detritus (ad) using the modified glass fiber technique with methanol treatment (Kishino et al., 1985), and then we will calculate a chlorophyll normalized specific absorption spectra, a*ph to divide $a$ph by Chl-a concentration.

3.14.2 Measurements of underwater light field

The underwater spectral downward irradiance and upward radiance were measured using the underwater unit, MER-2040 (Biospherical Instrument Inc.). The measurements were carried out from the sea surface down to depth 80m or 100m depending on the water turbidity. The incident solar spectral irradiance was measured using the deck unit, MER-2041 (Biospherical Instrument Inc.). The measurements were carried out once a day near the satellite overpassing time (about 10:00 A.M. to 12:00 P.M.) during the 3 days at St Knot and 20. At other stations (Stns 8, 13, 14, 15, 17, 18, special stations (27 Nov. and 5 Dec.)) were made once a day near the satellite overpassing time (about 10:00 A.M. to 12:00 P.M.). The list of MER-2040/2041 measurement in this cruise summarized Table 2. The spectral channels of MER-2040/2041 covered the wavelength of 412, 443, 465, 490, 510, 520, 555, 565, 625, 665, 670, 683 nm and PAR (710nm for upward radiance). These channels were selected for compatible satellite ocean color sensor, SeaWiFS and GLI. Fig.1 shows spectra of the underwater downward irradiance and upward radiance obtained by MER2040 measurements at each station.

Upward and downward PAR(Photosynthetically available radiation) was determined optical depth for the in-situ primary production measurement (CREST and Nagoya Univ. group).

The vertical distribution of PAR is shown in Fig.2.

We will calculate normalized water leaving radiance (Lwn) using these bio-optical parameters and examine the relationship between in situ measured chl-a values and estimated chl-a values using the several bio-optical algorithm developed by NASA, NASDA and other reserchers. We will develop the new bio-optical algorithms for the high latitude regions and make high accuracy chl-a images in this region in future study.

Table 1. Chlorophyll a (Chl-a) and pheopigment (Pheo.) (mg/m^3) obtained by CTD casts.

St 1 cast:routine
3 Nov. 1998
41-59.9N 151-59.8E

Depth	chl-a	Pheo.
0	0.529	0.154
10	0.552	0.175
20	0.527	0.181
30	0.519	0.164
40	0.33	0.18
50	0.128	0.092
60	0.073	0.08
80	0.024	0.069
100	0.019	0.082
125	0.015	0.082
150	0.014	0.082
200	0.008	0.071

St Knot cast:routine
7 Nov. 1998
43-59.7N 154-59.0E

Depth	chl-a	Pheo.
0	0.514	0.189
10	0.527	0.176
20	0.549	0.165
30	0.509	0.156
40	0.507	0.145
50	0.194	0.09
60	0.079	0.056
80	0.038	0.052
100	0.013	0.033
125	0.008	0.035
150	0.007	0.039
200	0.004	0.026

St 19 cast:routine
17 Nov. 1998
39-59.3N 159-59.3E

Depth	chl-a	Pheo.
0	0.411	0.153
20	0.393	0.139
30	0.383	0.149
40	0.408	0.155
50	0.378	0.143
60	0.388	0.151
80	0.129	0.095
100	0.038	0.032
125	0.011	0.024
150	0.005	0.018
200	0.002	0.017

St 8 cast:routine
19 Nov. 1998
39-59.8N 145-00.5E

Depth	chl-a	Pheo.
0	0.4	0.232
10	0.411	0.238
20	0.392	0.23
30	0.474	0.227
40	0.432	0.198
50	0.402	0.237
60	0.387	0.204
80	0.357	0.215
100	0.026	0.049
125	0.01	0.037
150	0.011	0.042
200	0.008	0.04

St 9 cast:routine
21 Nov. 1998
37-29.2N 144-58.9E

Depth	chl-a	Pheo.
0	0.537	0.241
10	0.546	0.25
30	0.511	0.246
50	0.539	0.263
75	0.357	0.205
100	0.092	0.125
150	0.011	0.045
200	0.002	0.024

St 10 cast:routine
25 Nov. 1998
34-59.5N 145-00.0E

Depth	chl-a	Pheo.
0	0.907	0.308
10	0.816	0.292
30	0.877	0.267
50	0.837	0.237
75	0.072	0.081
100	0.029	0.059
150	0.005	0.03
200	0.004	0.025

St 11 cast:routine
26 Nov. 1998
35-00.0N 150-00.0E

Depth	chl-a	Pheo.
0	0.383	0.16
10	0.407	0.148
30	0.364	0.143
50	0.337	0.151
75	0.184	0.109
100	0.045	0.051
125	0.019	0.037
150	0.007	0.03
200	0.003	0.022

St 12 cast:routine
27 Nov. 1998
37-30.3N 149-59.8E

Depth	chl-a	Pheo.
0	0.502	0.218
30	0.472	0.195
50	0.506	0.193
75	0.49	0.214
100	0.471	0.224
125	0.022	0.043
150	0.003	0.021
200	0.004	0.023

St 13 cast: S2
29 Nov. 1998
40-02.9N 149-59.2E

Depth	chl-a	Pheo.
0	0.512	0.217
10	0.622	0.206
30	0.553	0.184
50	0.052	0.096
75	0.011	0.06
100	0.012	0.066
125	0.008	0.062
150	0.004	0.055
200	0.004	0.04

St 14 cast:routine
30 Nov. 1998
39-59.9N 155-00.0E

Depth	chl-a	Pheo.
0	0.427	0.172
10	0.431	0.174
30	0.4	0.17
50	0.446	0.191
75	0.399	0.172
100	0.044	0.044
150	0.007	0.021
200	0.013	0.023

St 15 cast:routine
1 Dec. 1998
37-30.1N 155-00.0E

Depth	chl-a	Pheo.
0	0.322	0.128
10	0.313	0.128
30	0.312	0.134
50	0.311	0.136
75	0.343	0.129
100	0.205	0.187
150	0.007	0.023
200	0.005	0.022

St 16 cast:routine
1 Dec. 1998
35-00.0N 154-59.8E

Depth	chl-a	Pheo.
0	0.44	0.183
10	0.39	0.154
30	0.371	0.169
50	0.389	0.15
75	0.403	0.147
100	0.051	0.075
150	0.015	0.033
200	0.004	0.03

St 17 cast:routine
3 Dec. 1998
34-59.3N 160-02.3E

Depth	chl-a	Pheo.
0	0.393	0.175
10	0.368	0.132
30	0.373	0.158
50	0.364	0.161
75	0.333	0.157
100	0.022	0.037
125	0.037	0.066
150	0.025	0.048
200	0.009	0.025

St 18 cast:routine
4 Dec. 1998
37-30.1N 159-59.3E

Depth	chl-a	Pheo.
0	0.55	0.181
10	0.542	0.169
30	0.116	0.071
50	0.043	0.042
75	0.007	0.021
100	0.005	0.017
150	0.004	0.018
200	0.002	0.026

St 20 cast:routine
5 Dec. 1998
40-00.7N 164-59.2E

Depth	chl-a	Pheo.
0	0.54	0.182
10	0.532	0.17
20	0.534	0.14
30	0.526	0.191
40	0.569	0.209
50	0.342	0.191
60	0.335	0.143
80	0.321	0.151
100	0.343	0.142
125	0.046	0.056
150	0.032	0.047
200	0.005	0.028

St Knot2 cast: L3
11 Dec. 1998
44-00.0N 155-01.8E

Depth	chl-a	Pheo.
0	0.627	0.155
10	0.679	0.204
20	0.625	0.173
30	0.62	0.138
40	0.608	0.179
50	0.641	0.152
60	0.631	0.171
80	0.497	0.166
100	0.024	0.07
150	0.014	0.069
200	0.016	0.052

Table 2. The list of MER2040/2041 measurement in this

St.	Date	Time(JST)	Latitude	Longitude
Knot	7 Nov. 98	10:03	43-59.5N	154-57.0E
Knot	9 Nov. 98	11:58	44-00.0N	155-00.0E
8	20 Nov. 98	11:47	40-00.0N	145-00.0E
special-1	27 Nov. 98	10:55	36-20.3N	149-59.9E
13	29 Nov. 98	10:10	40-02.8N	149-58.3E
14	30 Nov. 98	13:23	40-00.0N	155-00.1E
15	1 Dec. 98	9:51	37-30.3N	155-00.2E
17	3 Dec. 98	8:45	34-59.4N	160-01.3E
18	4 Dec. 98	10:34	37-29.9N	159-58.9E
special-2	5 Dec. 98	10:05	39-59.7N	164-08.7E
20	8 Dec. 98	9:45	40-20.1N	164-59.4E
Knot	11 Dec. 98	10:40	44-00.4N	155-00.0E
Knot	12 Dec. 98	10:00	43-59.5N	155-00.7E
Knot	13 Dec. 98	9:50	43-59.4N	155-14.6E

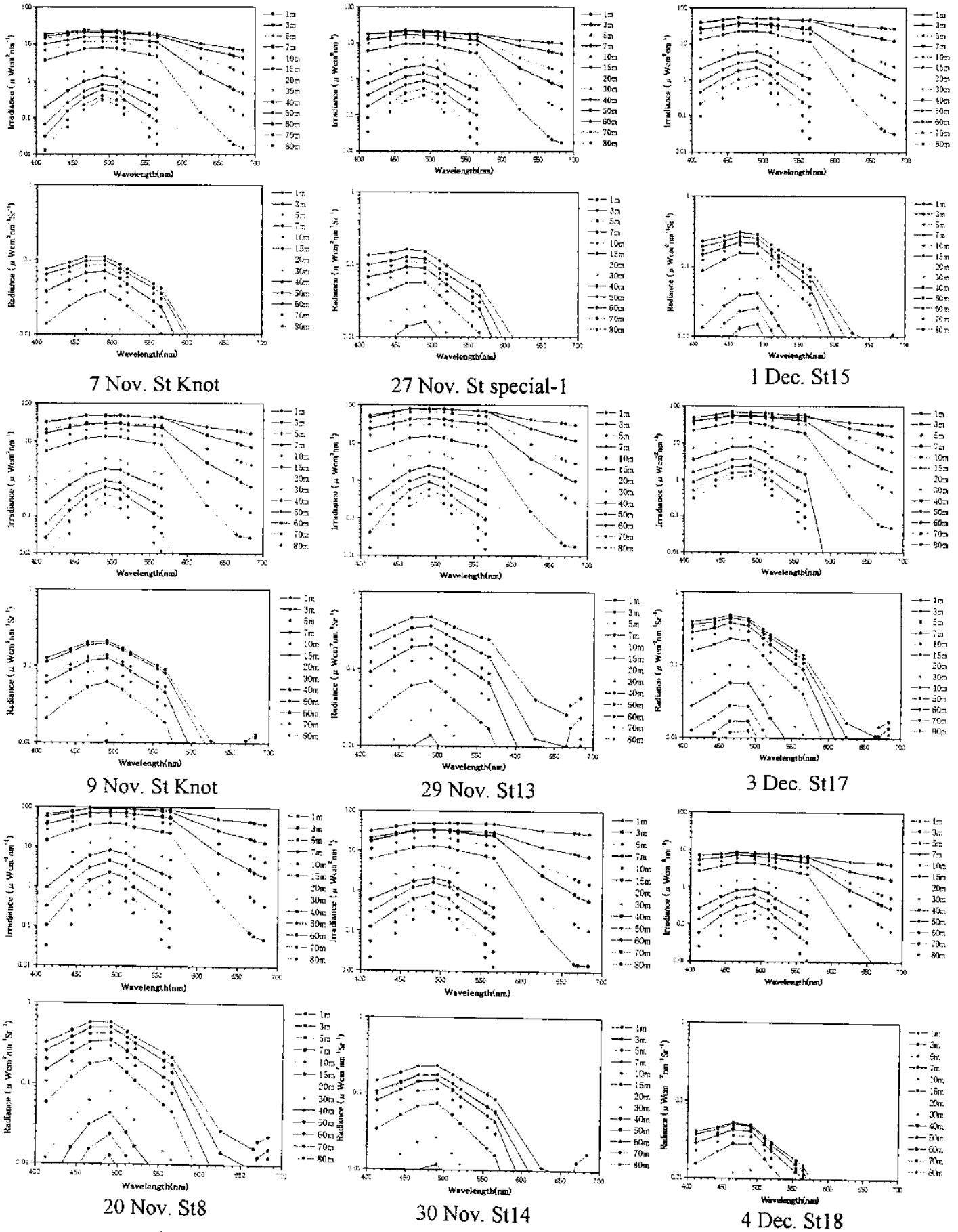
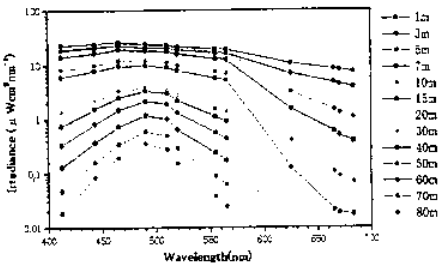
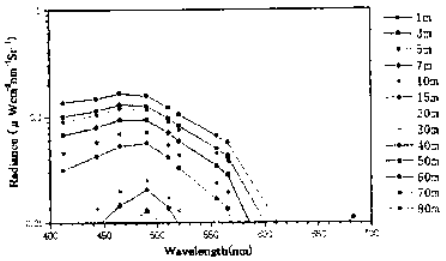
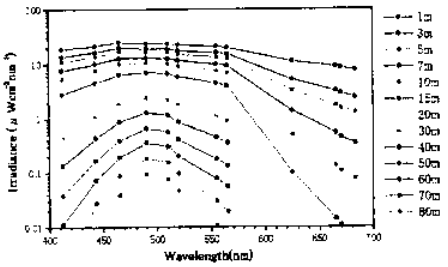


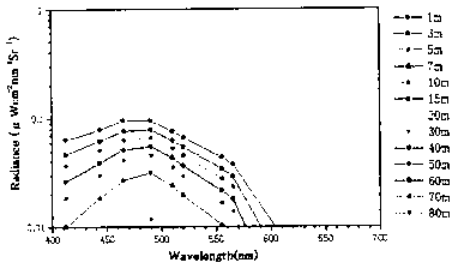
Fig. 1 Spectra of the underwater downward irradiance and upward radiance obtained by MER2040 measurements at each station.



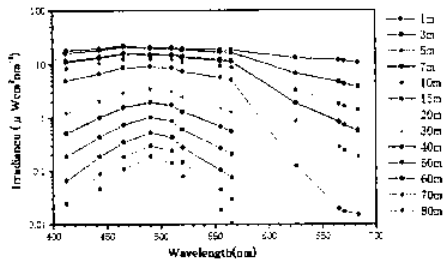


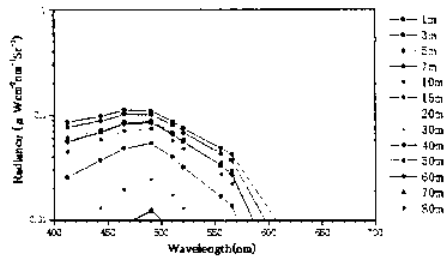
5 Dec. St special-2



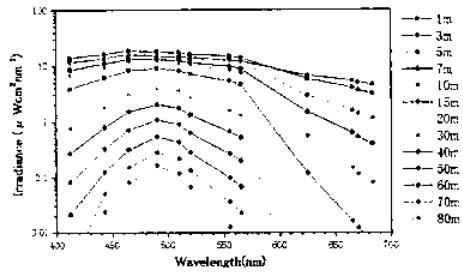


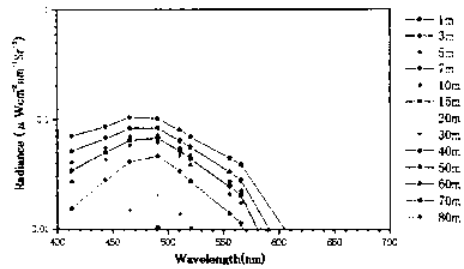
12 Dec. St Knot



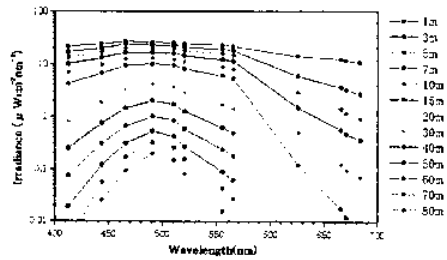


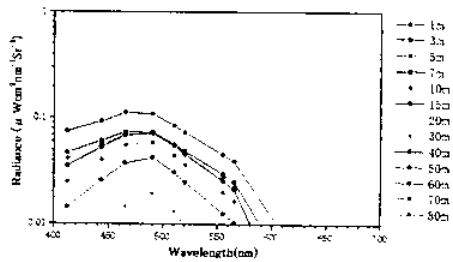
8 Dec. St20





13 Dec. St Knot





11 Dec. St Knot

Fig.1 (continued)

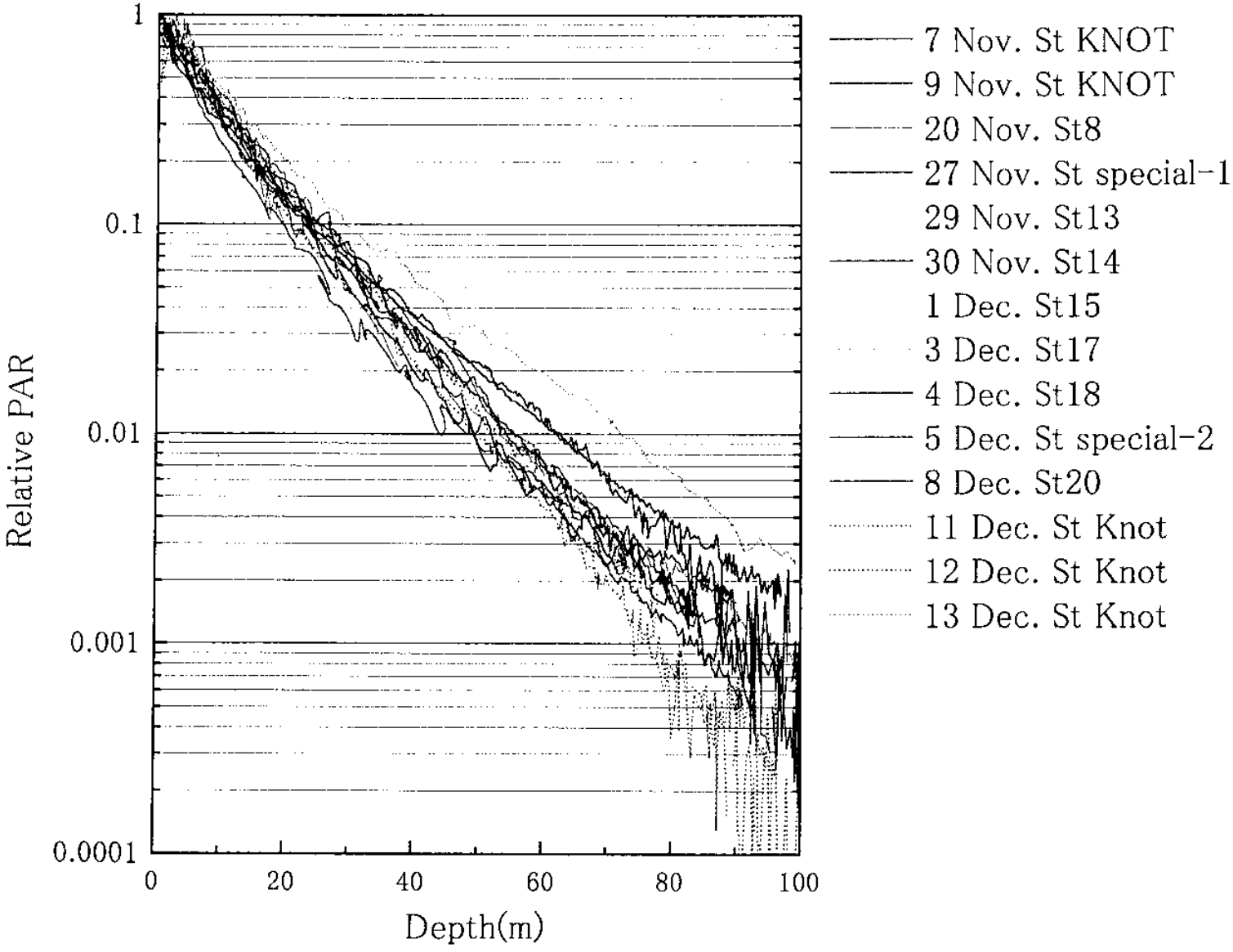


Fig.2 The vertical distribution of PAR

3.15 Plankton

K. Imai and T. Egashira
Core Research for Evolutional Science and Technology

To estimate biomass of phytoplankton and zooplankton community be necessary to define starting point of planktonic food webs. Seasonal values of plankton species and number did not have been made clear. Therefore collecting plankton samples in this cruise, winter ocean are importance. Phyto- and microzooplankton community were obtained in the seawater collected from 12 layer (0, 10, 20, 30, 40, 50, 60, 80, 100, 125, 150, 200m) by niskin sampler attached to CTD-RMS. Those samples after draining into sample bottles were fixed immediately using formalin(final conc. 1%), glutarldehyde(final conc. 1%) and rugol eosin (final conc. 3%). After this cruise samples fixed using formalin and rugol eosin will be carried out sorting and numbering with optical microscope, and samples fixed using glutarldehyde will be carried out numbering by flow cytometry. Wire out of single(NXX7; ca. 200um mesh size) and twin(XX13 and GG54; ca. 0.1 and 0.33 mm mesh size) Norpac net were respectively 200m and 150,500m. And vertical closing net(Gamaguthi net) was used making vertical hauls in 5 layers(0-50m, 50-250m, 250-500m, 500-1000m, 1000-1500m). These plankton net samples were fixed immediately by formalin (final conc. 1%) and will be counted cell number with microscope after this cruise. Sample collection data and station and sampling depth are as follows.

Tabule Plankton net sample collection data and station and sampling depth

Net	Station	Sampling time	Wire out(m)	Wire angle
NORPAC net(single)	KNOT	8 Nov. 19:49	202	9
	20	8 Dec. 17:50	204	12
	KNOT	11 Dec. 10:20	219	24
NORPAC net(twin)	KNOT	8 Nov. 19:03	152	10
	KNOT	8 Nov. 19:18	532	21
	20	8 Dec. 17:40	151	8
	20	8 Dec. 16:49	577	30
	KNOT	11 Dec. 10:05	152	10
	KNOT	11 Dec. 09:38	501	5
Closing net	KNOT	8 Nov. 20:05	0 - 50	0
	KNOT	8 Nov. 20:12	59 - 250	17
	KNOT	8 Nov. 20:28	268 - 500	13
	KNOT	8 Nov. 20:54	521 - 1000	15
	KNOT	8 Nov. 21:36	1020 - 1910	6

3.16 XBT and XCTD Observations

NAKANO Toshiya (JMA), FURUTA Toshio (GODI) and MORIOKA Naoto (GODI)

1. Title

Research on the variation of the subarctic circulation in the North Pacific.

2. Objectives

To research the structure and variation of sub-surface temperature and current in the subarctic circulation area.

To research the formation, advection and diffusion process of the North Pacific Intermediate Water (NPIW).

3. Equipment and correction

3-1 XBT observation

T.S.K (Tsurumi Seiki) MK-30N converter.

T.S.K (Tsurumi Seiki) T-7 (Deep Blue) type probe.

Depth calculation formula was as follows ;

Formula : $Z=A*T+B*T^2$

Where Z (meters) : depth

T (seconds) : elapsed time

A : 6.691

B : -0.00225

3-2 XCTD observation

T.S.K (Tsurumi Seiki) MK-100 converter.

T.S.K (Tsurumi Seiki) XCTD probe.

The coefficients of depth, temperature and conductivity calculation are installed in the probe.

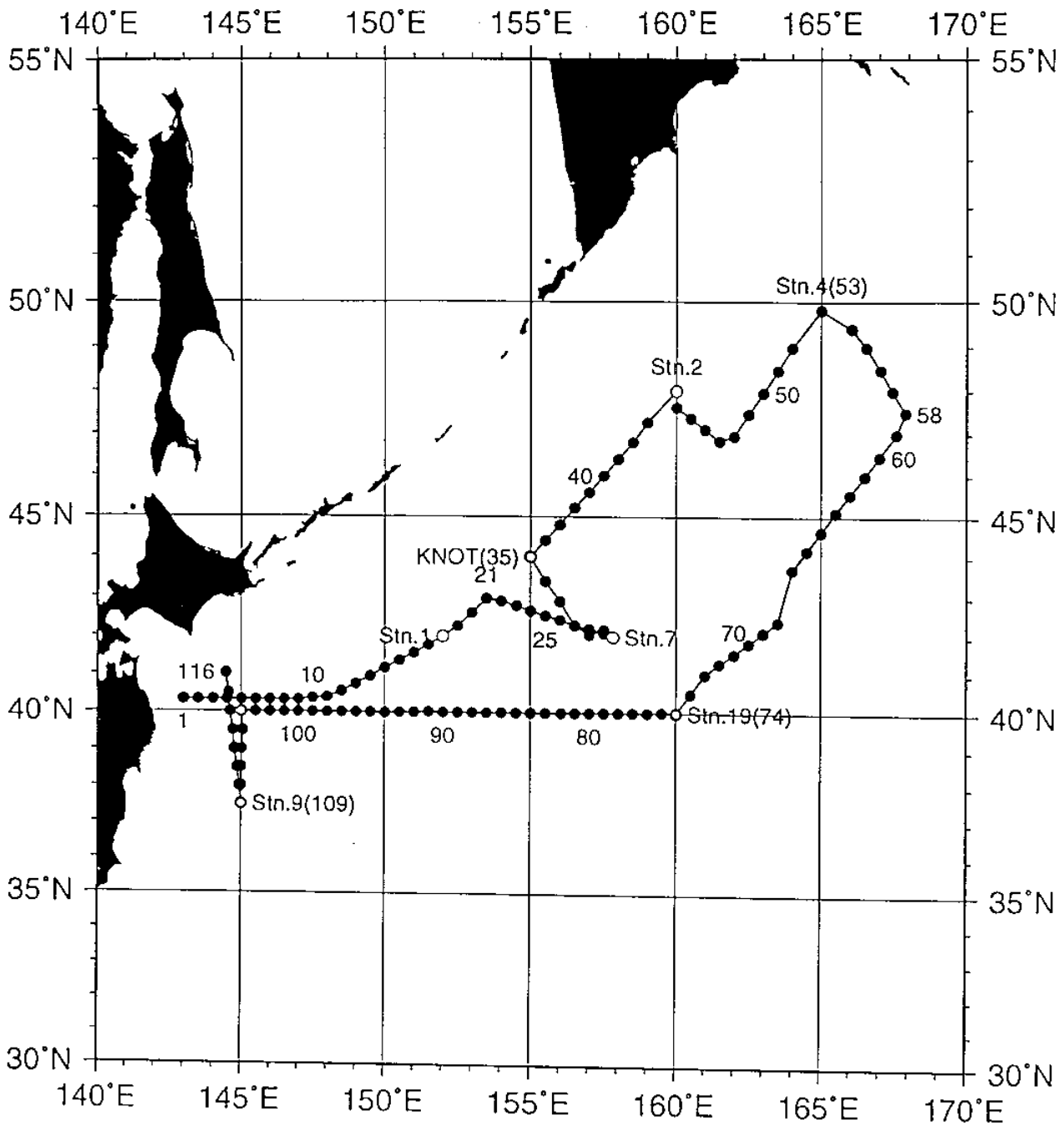
4. Summary

The lists of XBT and XCTD observation stations are shown in Table 1 and Table 2, respectively. Station location charts, vertical profiles for XBT and XCTD at selected stations and distributions of temperature follows.

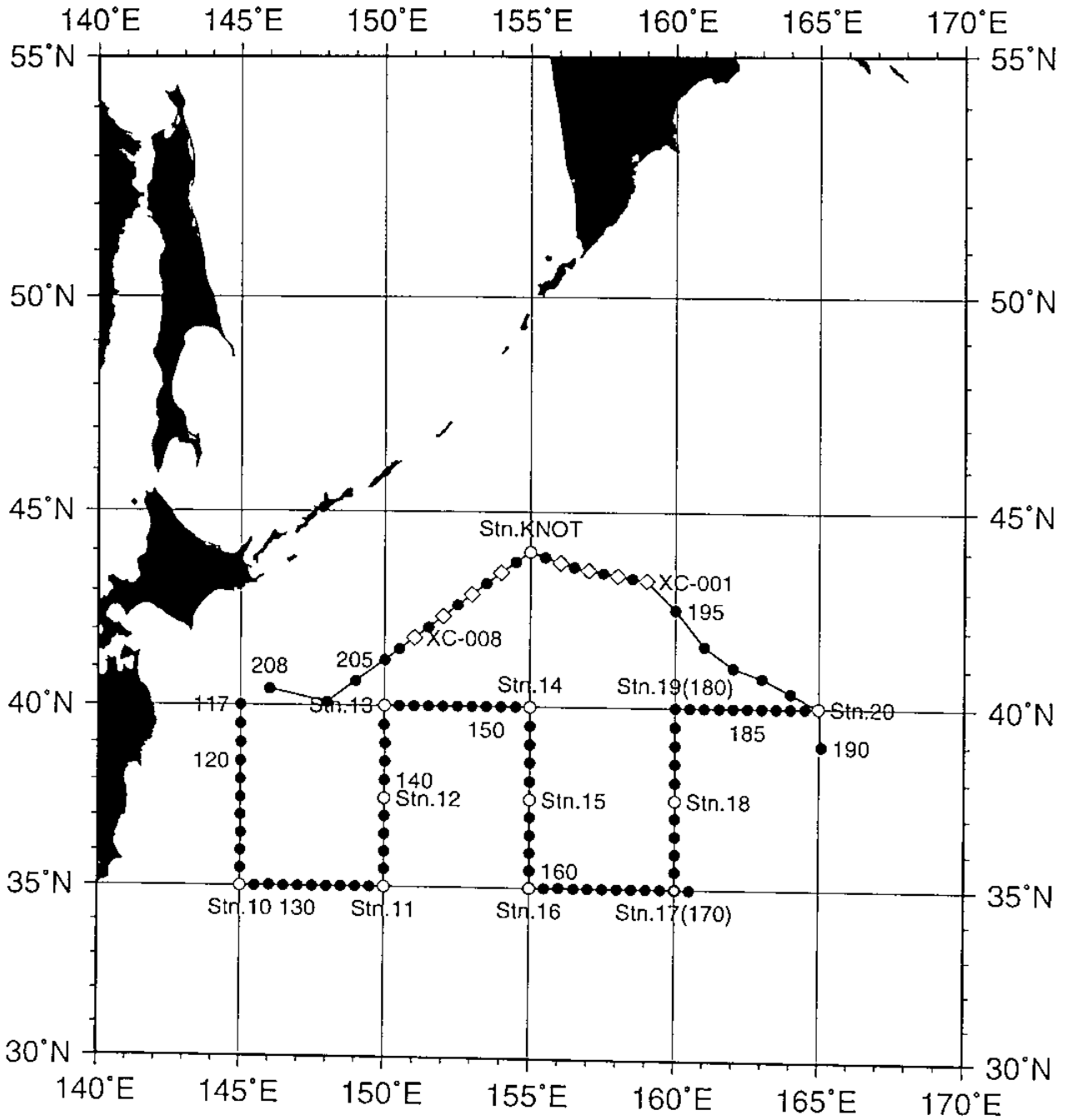
XBT and XCTD data will be submitted to the DMO (Data Management Office), JAMSTEC.

5. Acknowledgement

We thank T. TANAKA (Nagoya Univ.), Y. MINO (Nagoya Univ.), M. SASAKAWA (Univ. of Tokyo) and M. NAKAHARA (KGE) for their cooperation on these observations.



R/V MIRAI (MR98-K01 : Leg 1)



R/V MIRAI (MR98-K01 : Leg 2)

Table 1 XBT observation stations

No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
1	1998/11/02	03:09	40-20.19	143-00.25
2	1998/11/02	04:35	40-19.54	143-30.17
3	1998/11/02	06:03	40-19.61	144-00.62
4	1998/11/02	07:28	40-19.90	144-29.96
5	1998/11/02	08:59	40-20.20	144-59.99
6	1998/11/02	10:33	40-19.61	145-29.73
7	1998/11/02	12:06	40-19.78	146-00.41
8	1998/11/02	13:34	40-19.66	146-30.09
9	1998/11/02	15:04	40-20.43	146-59.91
10	1998/11/02	16:34	40-21.95	147-29.78
11	1998/11/02	18:03	40-24.00	147-59.71
12	1998/11/02	19:38	40-33.03	148-30.33
13	1998/11/02	21:12	40-45.14	148-59.95
14	1998/11/02	22:48	40-57.44	149-29.99
15	1998/11/03	00:20	41-10.09	149-59.85
16	1998/11/03	01:51	41-22.33	150-30.11
17	1998/11/03	03:21	41-34.35	150-59.83
18	1998/11/03	04:54	41-45.83	151-29.80
19	1998/11/03	23:02	42-15.19	152-29.96
20	1998/11/04	01:00	42-36.18	152-59.99
21	1998/11/04	03:02	42-57.84	153-29.99
22	1998/11/04	04:37	42-53.88	154-00.00
23	1998/11/04	06:10	42-46.84	154-30.72
24	1998/11/04	07:41	42-38.69	155-00.01
25	1998/11/04	09:11	42-31.92	155-30.09
26	1998/11/04	10:42	42-24.51	156-00.01
27	1998/11/04	12:11	42-17.31	156-30.03
28	1998/11/04	13:39	42-11.77	157-00.00
29	1998/11/04	15:09	42-05.12	157-29.98
30	1998/11/05	11:15	42-09.78	157-29.91
31	1998/11/05	18:53	42-02.59	157-00.10
32	1998/11/06	00:11	42-16.97	156-29.96
33	1998/11/06	08:29	42-54.33	156-00.11
34	1998/11/06	12:41	43-24.18	155-30.00
35	1998/11/06	20:25	44-00.51	154-59.42

No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
36	1998/11/09	15:02	44-25.28	155-29.99
37	1998/11/09	16:56	44-47.69	155-59.87
38	1998/11/09	19:01	45-12.51	156-30.00
39	1998/11/09	21:05	45-36.39	157-00.04
40	1998/11/09	23:10	45-59.95	157-29.97
41	1998/11/10	01:16	46-24.32	158-00.16
42	1998/11/10	03:18	46-47.90	158-29.95
43	1998/11/10	05:41	47-16.16	159-00.02
44	1998/11/12	01:04	47-37.37	160-00.06
45	1998/11/12	02:57	47-21.69	160-30.20
46	1998/11/12	04:51	47-06.15	161-00.20
47	1998/11/12	06:48	46-50.29	161-30.28
48	1998/11/12	09:00	46-57.49	161-59.94
49	1998/11/12	11:24	47-28.07	162-29.97
50	1998/11/12	13:39	47-56.53	163-00.14
51	1998/11/12	16:07	48-27.85	163-30.17
52	1998/11/12	18:42	48-58.68	163-59.92
53	1998/11/13	00:22	49-49.46	165-00.05
54	1998/11/13	08:39	49-24.61	166-02.57
55	1998/11/13	11:30	48-59.52	166-32.99
56	1998/11/13	14:30	48-29.82	167-02.00
57	1998/11/13	17:22	47-59.97	167-27.36
58	1998/11/13	20:26	47-30.12	167-53.45
59	1998/11/14	00:55	47-00.04	167-35.35
60	1998/11/14	05:21	46-28.27	167-00.02
61	1998/11/14	08:37	46-00.93	166-29.84
62	1998/11/14	12:01	45-33.76	165-59.98
63	1998/11/14	15:24	45-05.53	165-29.84
64	1998/11/14	18:19	44-38.20	165-00.07
65	1998/11/14	21:15	44-09.90	164-30.02
66	1998/11/14	23:57	43-42.25	164-00.07
67	1998/11/15	06:32	42-22.50	163-30.07
68	1998/11/15	09:02	42-05.95	163-00.06
69	1998/11/15	11:32	41-50.41	162-30.05
70	1998/11/15	14:02	41-33.45	162-00.01
71	1998/11/15	16:22	41-17.67	161-30.32
72	1998/11/15	18:43	41-00.52	160-59.76

No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
73	1998/11/15	21:47	40-30.57	160-29.83
74	1998/11/16	04:43	40-00.08	160-00.14
75	1998/11/17	04:21	40-00.97	159-30.01
76	1998/11/17	06:08	40-00.09	158-59.89
77	1998/11/17	07:52	40-00.03	158-30.13
78	1998/11/17	09:39	40-00.09	158-00.06
79	1998/11/17	11:29	40-00.36	157-30.04
80	1998/11/17	13:29	40-00.43	157-00.04
81	1998/11/17	15:37	40-00.39	156-29.91
82	1998/11/17	17:41	39-59.76	156-01.77
83	1998/11/17	20:02	40-00.05	155-30.16
84	1998/11/17	22:20	40-00.04	155-00.08
85	1998/11/18	00:33	39-59.78	154-30.01
86	1998/11/18	02:44	39-59.98	154-00.03
87	1998/11/18	04:57	39-59.84	153-30.04
88	1998/11/18	07:11	40-00.10	153-00.04
89	1998/11/18	09:25	39-59.82	152-29.89
90	1998/11/18	11:39	39-59.96	151-59.88
91	1998/11/18	13:47	40-00.50	151-29.86
92	1998/11/18	15:52	40-00.18	151-00.44
93	1998/11/18	18:07	40-00.26	150-29.73
94	1998/11/18	20:17	39-59.41	149-59.87
95	1998/11/18	22:23	39-59.55	149-29.93
96	1998/11/19	00:23	40-00.12	149-00.01
97	1998/11/19	02:11	40-00.14	148-29.60
98	1998/11/19	04:00	40-00.27	147-59.52
99	1998/11/19	05:49	39-59.78	147-29.80
100	1998/11/19	07:31	40-00.18	146-59.88
101	1998/11/19	09:12	40-00.37	146-29.93
102	1998/11/19	10:48	40-00.35	145-59.89
103	1998/11/19	12:22	40-00.17	145-29.98
104	1998/11/19	14:09	39-59.96	145-00.10
105	1998/11/20	04:41	39-29.92	145-03.18
106	1998/11/20	06:32	38-59.91	145-01.03
107	1998/11/20	08:23	38-30.14	145-00.16
108	1998/11/20	10:08	38-00.16	144-59.77
109	1998/11/20	11:57	37-30.00	144-59.98

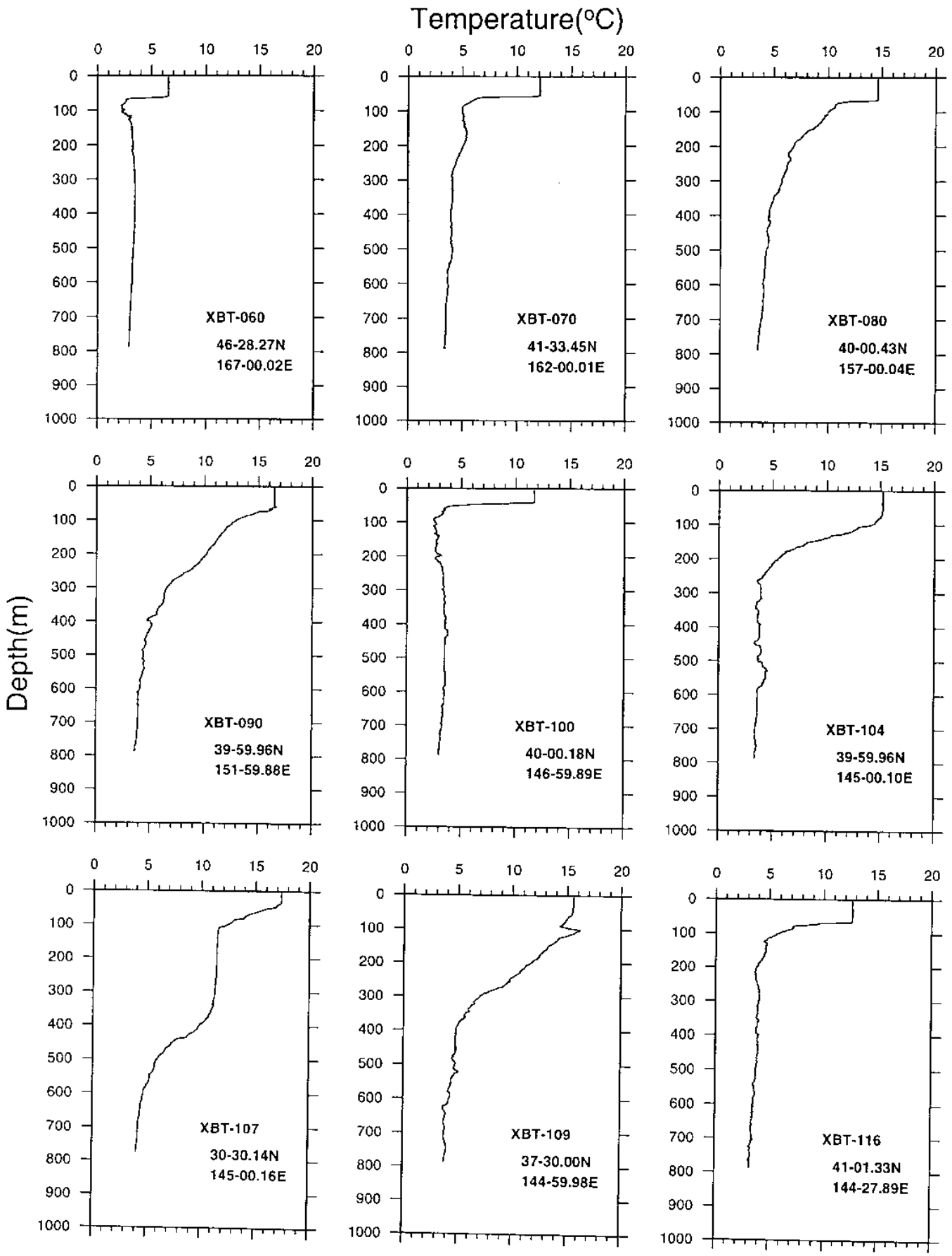
No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
110	1998/11/21	00:01	38-00.01	144-55.35
111	1998/11/21	02:15	38-29.99	144-51.21
112	1998/11/21	04:19	39-00.00	144-46.44
113	1998/11/21	06:23	39-30.11	144-41.86
114	1998/11/21	08:25	39-59.85	144-36.99
115	1998/11/21	10:30	40-30.07	144-32.92
116	1998/11/21	12:43	41-01.33	144-27.89
117	1998/11/24	12:20	40-00.01	144-59.93
118	1998/11/24	14:13	39-29.84	144-59.96
119	1998/11/24	16:08	39-00.05	145-00.69
120	1998/11/24	18:07	38-28.97	145-00.14
121	1998/11/24	19:55	37-59.87	144-59.61
122	1998/11/24	21:42	37-29.94	144-59.94
123	1998/11/24	23:30	36-59.83	145-00.39
124	1998/11/25	01:25	36-29.86	145-00.51
125	1998/11/25	03:17	36-00.04	144-59.78
126	1998/11/25	05:10	35-30.03	144-59.88
127	1998/11/25	16:18	34-59.95	145-30.05
128	1998/11/25	17:58	35-00.08	146-00.01
129	1998/11/25	19:50	35-00.11	146-30.11
130	1998/11/25	21:29	34-59.79	147-00.16
131	1998/11/25	23:03	34-59.80	147-30.00
132	1998/11/26	00:34	35-00.03	147-59.93
133	1998/11/26	02:10	34-59.84	148-30.25
134	1998/11/26	03:41	34-59.88	149-00.05
135	1998/11/26	05:16	35-00.27	149-30.48
136	1998/11/26	22:07	35-29.89	150-00.27
137	1998/11/27	00:20	35-59.99	150-00.01
138	1998/11/27	03:01	36-29.97	149-59.96
139	1998/11/27	05:05	37-00.01	149-59.81
140	1998/11/27	22:29	37-59.86	150-00.19
141	1998/11/28	02:19	38-29.98	150-00.93
142	1998/11/28	07:55	38-59.95	150-01.16
143	1998/11/28	14:16	39-29.96	149-59.05
144	1998/11/29	10:59	40-00.11	150-30.03
145	1998/11/29	12:34	39-59.81	151-00.01
146	1998/11/29	14:07	39-59.72	151-30.00

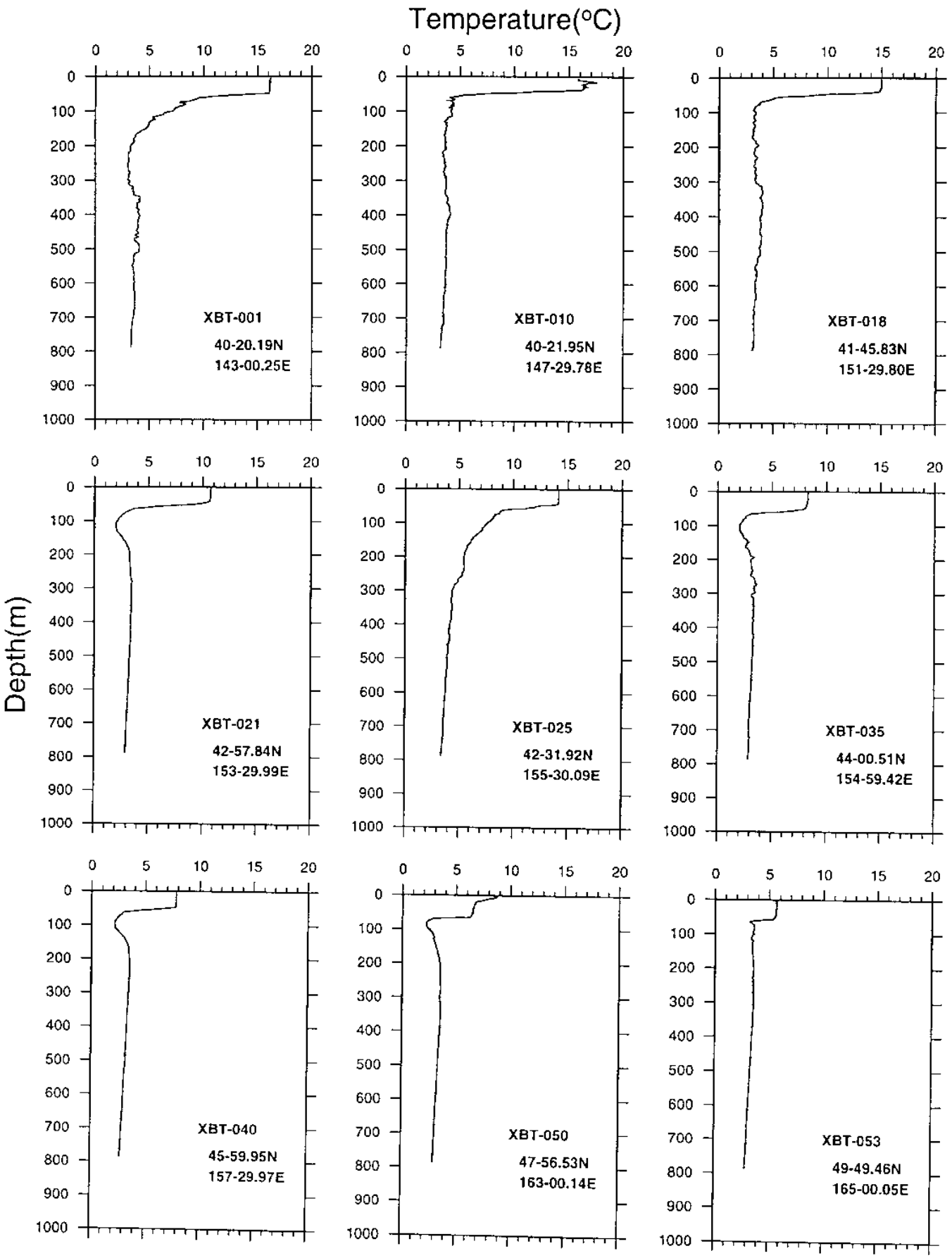
No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
147	1998/11/29	15:41	39-59.90	152-00.07
148	1998/11/29	17:13	40-00.37	152-30.06
149	1998/11/29	18:43	40-00.00	152-59.92
150	1998/11/29	20:12	40-00.21	153-30.10
151	1998/11/29	21:39	40-00.13	154-00.08
152	1998/11/29	23:07	40-00.15	154-30.23
153	1998/11/30	09:48	39-29.67	155-00.05
154	1998/11/30	11:43	38-59.86	154-59.75
155	1998/11/30	13:37	38-29.84	154-59.98
156	1998/11/30	15:47	37-59.89	155-00.33
157	1998/12/01	03:14	37-00.01	155-59.97
158	1998/12/01	05:18	36-29.97	155-00.11
159	1998/12/01	07:23	36-00.21	154-59.90
160	1998/12/01	09:30	35-30.12	154-59.89
161	1998/12/01	20:25	35-00.40	155-29.99
162	1998/12/01	22:12	35-00.73	155-59.98
163	1998/12/02	00:02	35-00.32	156-30.61
164	1998/12/02	01:47	35-00.20	156-59.92
165	1998/12/02	03:37	34-59.70	157-30.01
166	1998/12/02	05:28	34-59.73	158-00.02
167	1998/12/02	07:13	34-59.96	158-29.97
168	1998/12/02	10:17	34-59.86	159-00.02
169	1998/12/02	12:37	35-00.09	159-30.00
170	1998/12/02	14:47	35-00.01	159-59.96
171	1998/12/02	17:02	34-59.20	160-30.05
172	1998/12/03	11:31	35-30.00	160-00.46
173	1998/12/03	13:39	36-00.04	160-00.07
174	1998/12/03	15:40	36-30.04	160-00.03
175	1998/12/03	17:44	36-59.99	159-59.99
176	1998/12/04	03:57	38-00.00	159-59.87
177	1998/12/04	06:01	38-29.99	160-00.07
178	1998/12/04	08:04	38-59.99	159-59.90
179	1998/12/04	10:04	39-30.13	159-59.88
180	1998/12/04	12:07	40-00.17	160-00.13
181	1998/12/04	13:42	39-59.99	160-30.22
182	1998/12/04	15:11	39-59.78	161-00.02
183	1998/12/04	16:42	39-59.81	161-30.62

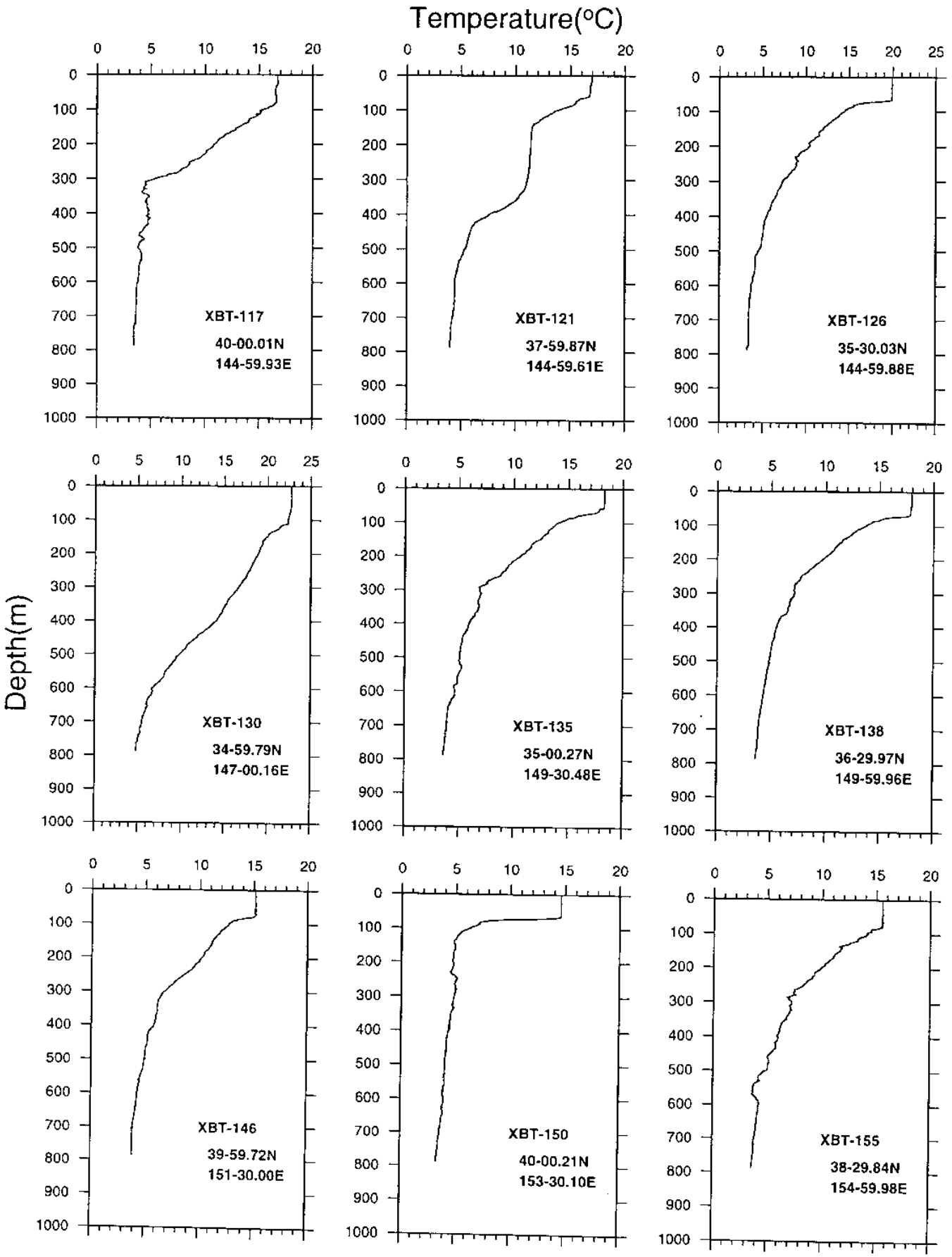
No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
184	1998/12/04	18:12	40-00.09	162-00.37
185	1998/12/04	19:41	40-00.00	162-29.99
186	1998/12/04	21:12	40-00.07	163-00.12
187	1998/12/04	22:43	40-00.09	163-29.97
188	1998/12/05	00:15	40-00.10	164-00.03
189	1998/12/05	02:20	39-59.93	164-30.03
190	1998/12/06	18:02	39-00.06	165-04.35
191	1998/12/08	15:11	40-24.20	163-59.97
192	1998/12/08	18:49	40-47.95	162-59.99
193	1998/12/08	23:22	41-04.49	162-00.04
194	1998/12/09	03:33	41-36.42	161-00.02
195	1998/12/09	17:34	42-33.29	160-00.05
196	1998/12/10	05:41	43-21.15	158-29.96
197	1998/12/10	09:42	43-29.48	157-29.95
198	1998/12/10	13:56	43-37.85	156-30.26
199	1998/12/10	18:18	43-52.32	155-30.04
200	1998/12/13	10:19	43-44.89	154-30.06
201	1998/12/13	14:15	43-11.65	153-29.93
202	1998/12/13	18:08	42-37.55	152-29.79
203	1998/12/13	21:53	42-04.15	151-30.49
204	1998/12/14	01:56	41-29.68	150-29.59
205	1998/12/14	04:00	41-12.96	149-59.88
206	1998/12/14	08:05	40-39.27	149-00.27
207	1998/12/14	11:55	40-05.07	147-59.65
208	1998/12/14	18:39	40-25.90	146-00.02

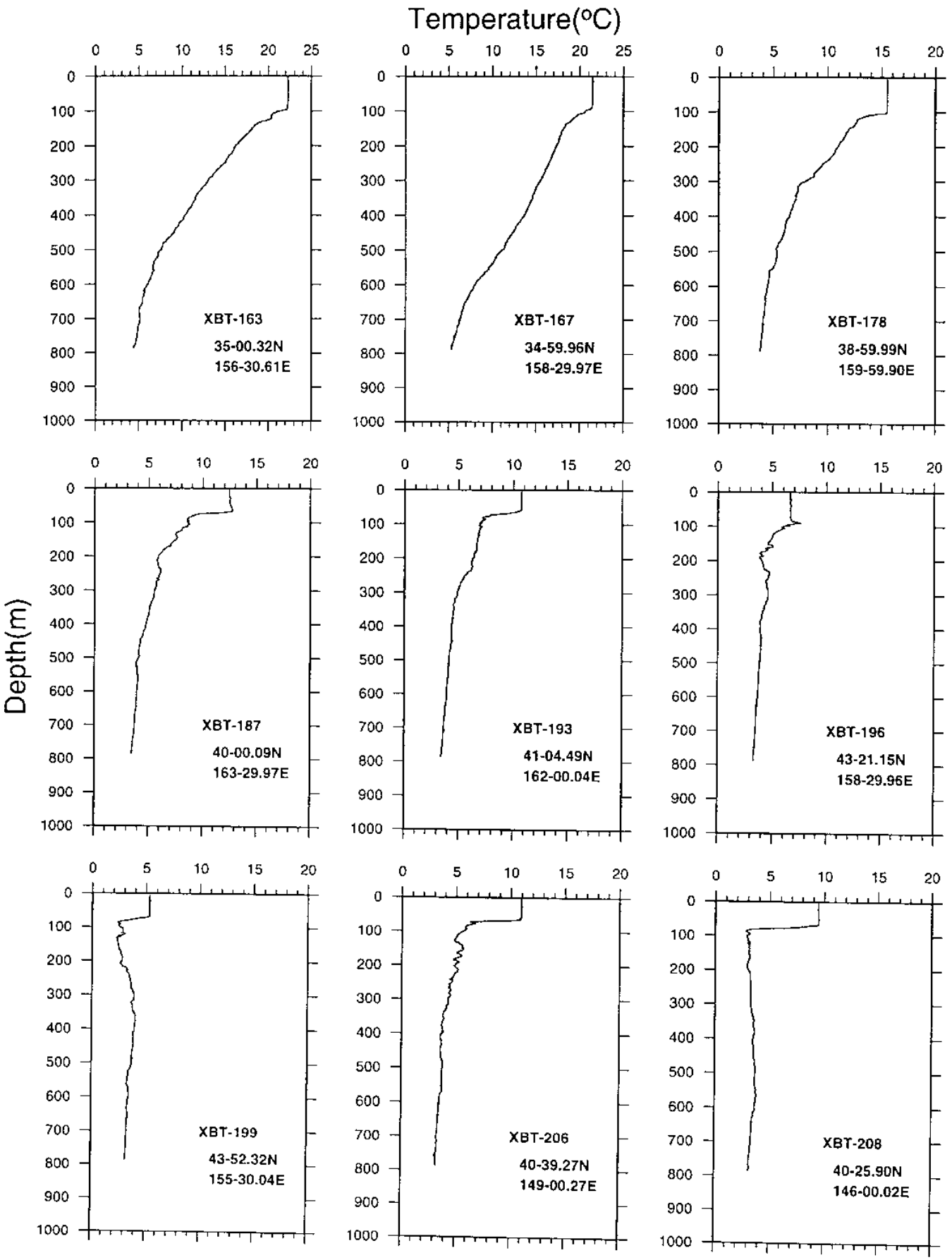
Table 2 XCTD observation stations

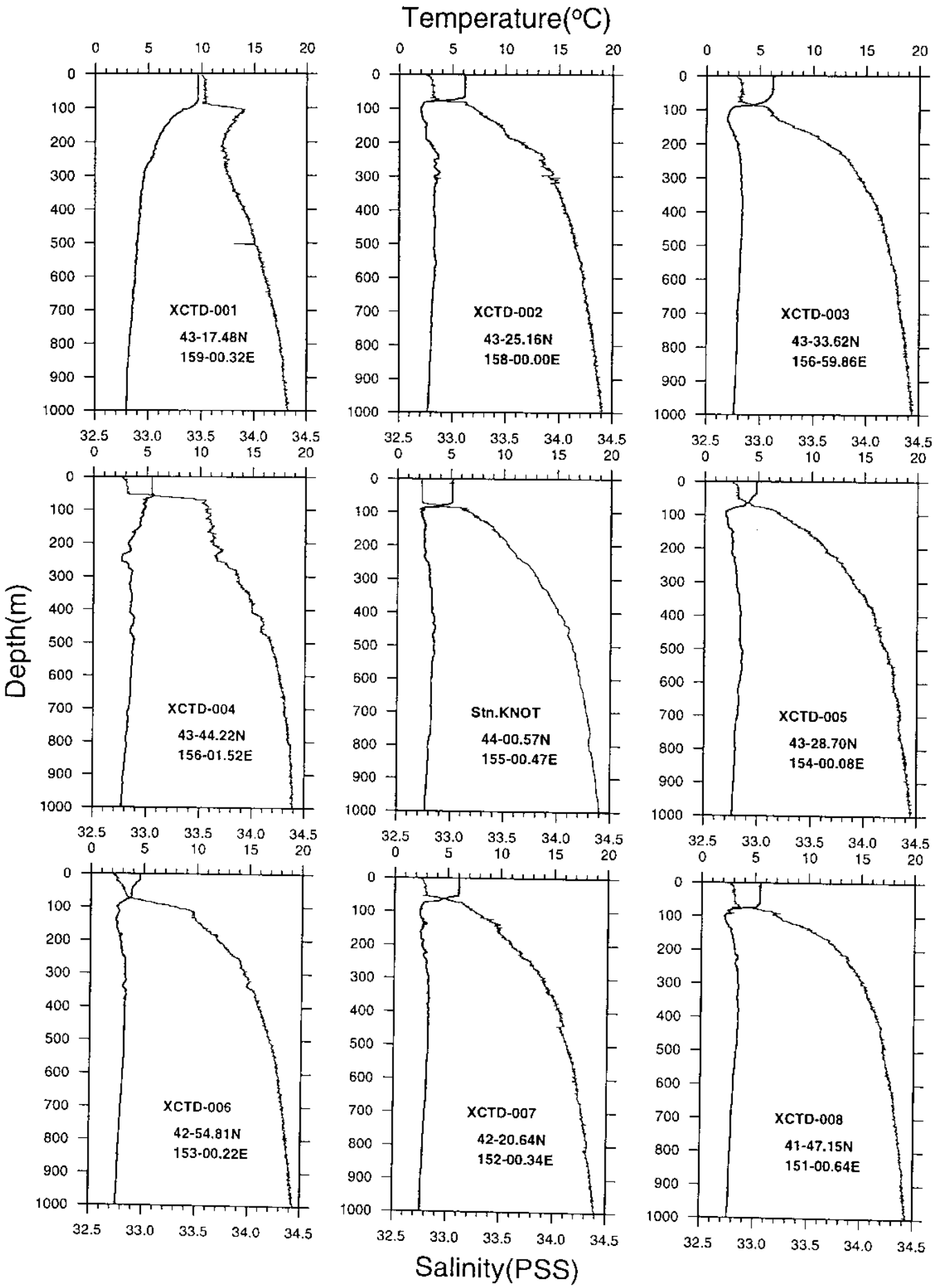
No.	Date	Time(UTC)	Latitude(N)	Longitude(E)
1	1998/12/10	03:07	43-17.48	159-00.32
2	1998/12/10	07:37	43-25.16	158-00.00
3	1998/12/10	11:46	43-33.62	156-59.86
4	1998/12/10	16:08	43-44.22	156-01.52
5	1998/12/13	12:17	43-28.70	154-00.08
6	1998/12/13	16:09	42-54.81	153-00.22
7	1998/12/13	19:58	42-20.64	152-00.34
8	1998/12/13	23:47	41-47.15	151-00.64

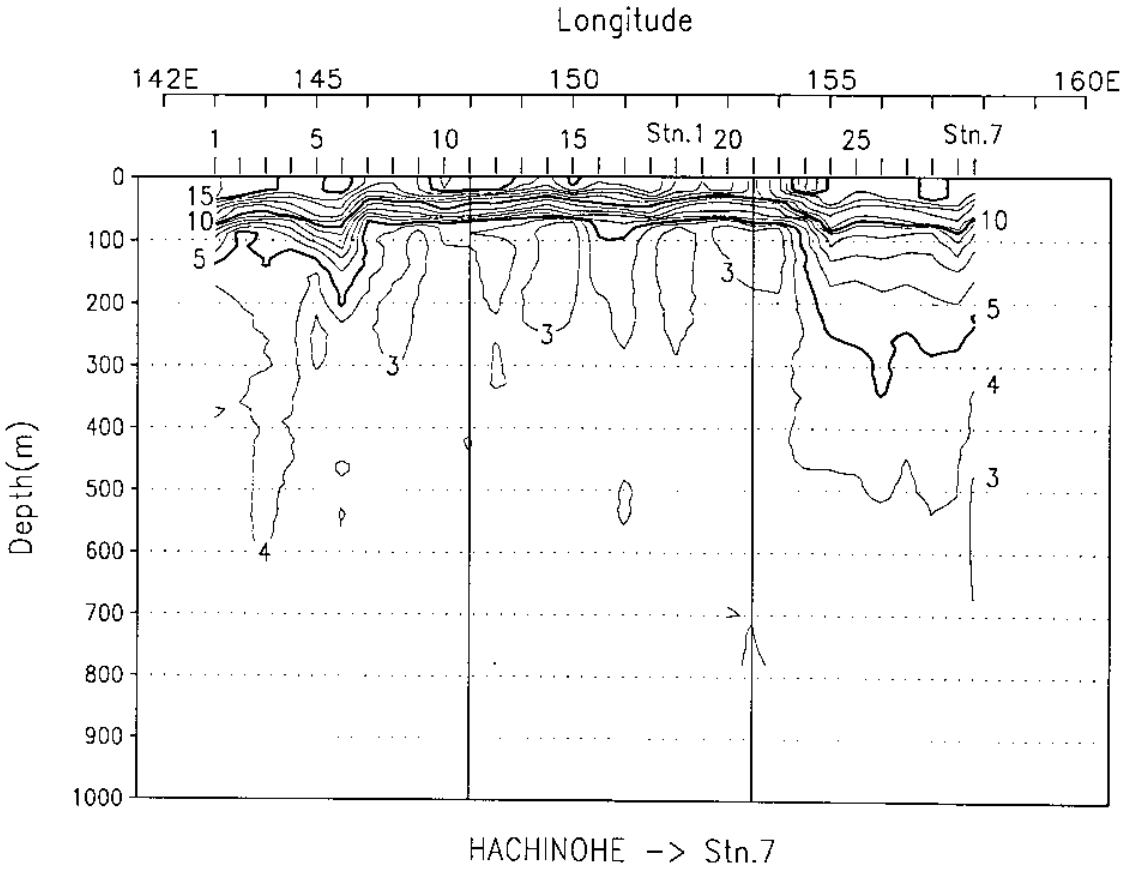

Temperature(°C)
Depth(m)
0 5 10 15 20
0 100 200 300 400 500 600 700 800 900 1000
XBT-060
46-28.27N
167-00.02E
XBT-070
41-33.45N
162-00.01E
XBT-080
40-00.43N
157-00.04E
XBT-090
39-59.96N
151-59.88E
XBT-100
40-00.18N
146-59.89E
XBT-104
39-59.96N
145-00.10E
XBT-107
30-30.14N
145-00.16E
XBT-109
37-30.00N
144-59.98E
XBT-116
41-01.33N
144-27.89E

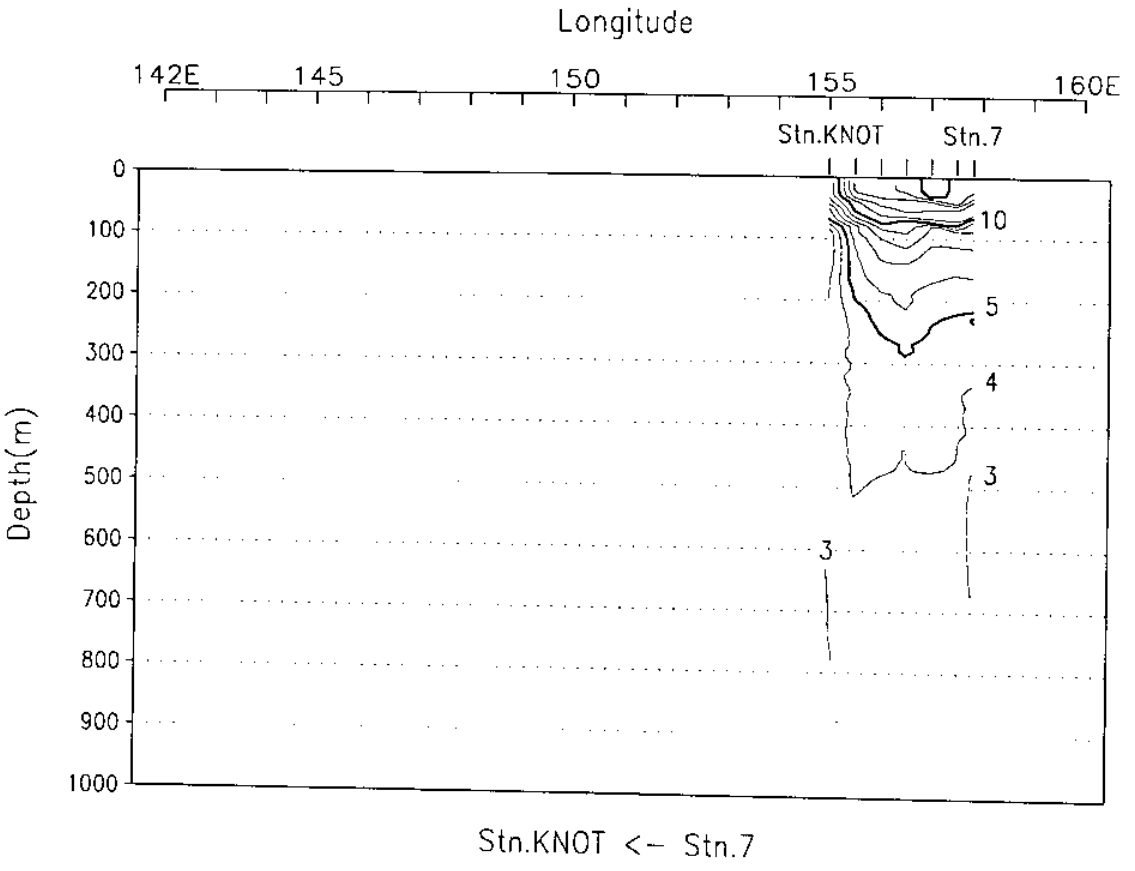

Temperature(°C)
Depth(m)
0 5 10 15 20
0 100 200 300 400 500 600 700 800 900 1000
XBT-001
40-20.19N
143-00.25E
XBT-010
40-21.95N
147-29.78E
XBT-018
41-45.83N
151-29.80E
XBT-021
42-57.84N
153-29.99E
XBT-025
42-31.92N
155-30.09E
XBT-035
44-00.51N
154-59.42E
XBT-040
45-59.95N
157-29.97E
XBT-050
47-56.53N
163-00.14E
XBT-053
49-49.46N
165-00.05E

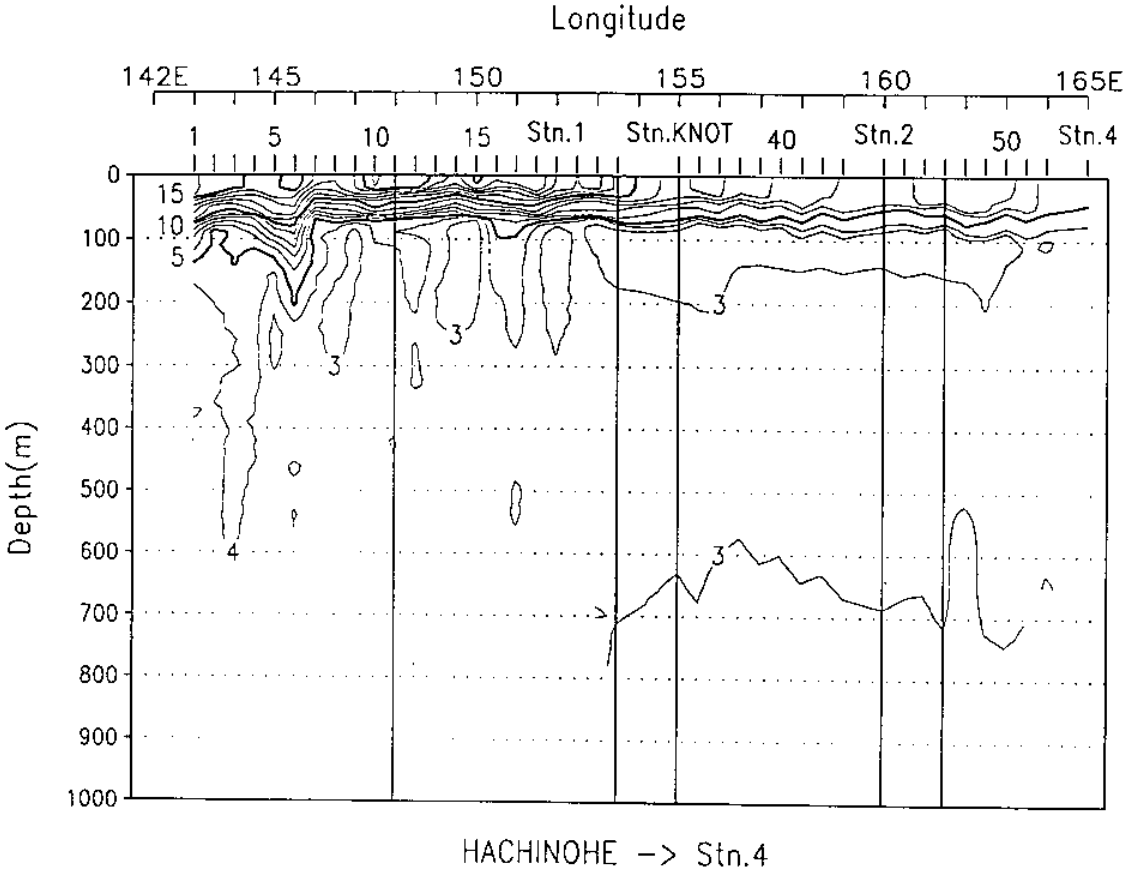

Temperature(°C)
Depth(m)
XBT-117
40-00.01N
144-59.93E
XBT-121
37-59.87N
144-59.61E
XBT-126
35-30.03N
144-59.88E
XBT-130
34-59.79N
147-00.16E
XBT-135
35-00.27N
149-30.48E
XBT-138
36-29.97N
149-59.96E
XBT-146
39-59.72N
151-30.00E
XBT-150
40-00.21N
153-30.10E
XBT-155
38-29.84N
154-59.98E

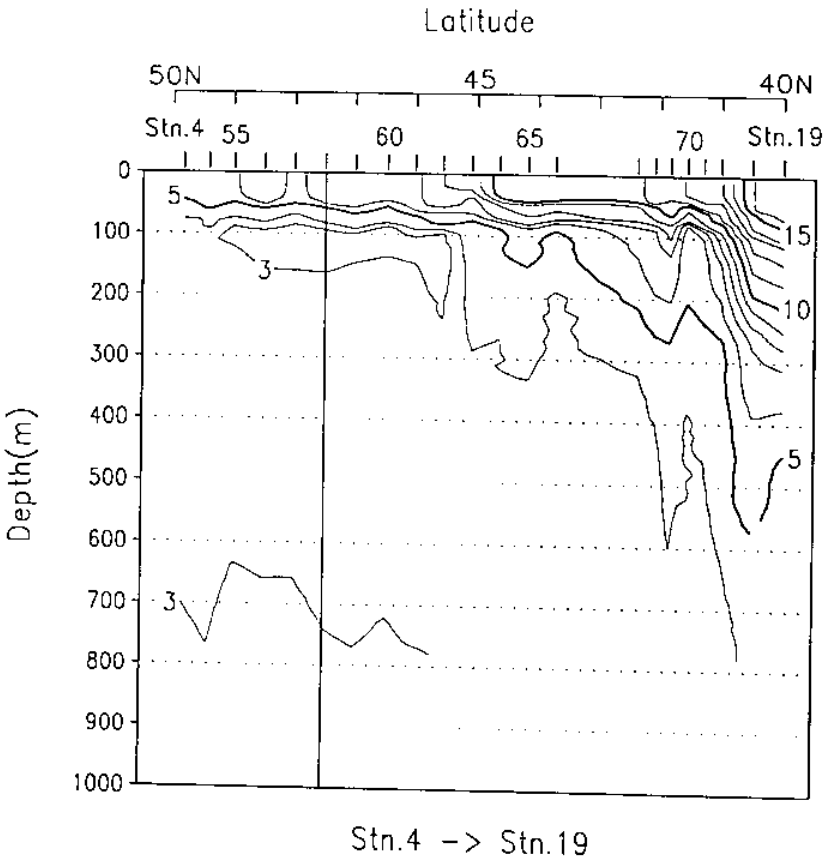

Temperature(°C)
Depth(m)
XBT-163
35-00.32N
156-30.61E
XBT-167
34-59.96N
158-29.97E
XBT-178
38-59.99N
159-59.90E
XBT-187
40-00.09N
163-29.97E
XBT-193
41-04.49N
162-00.04E
XBT-196
43-21.15N
158-29.96E
XBT-199
43-52.32N
155-30.04E
XBT-206
40-39.27N
149-00.27E
XBT-208
40-25.90N
146-00.02E

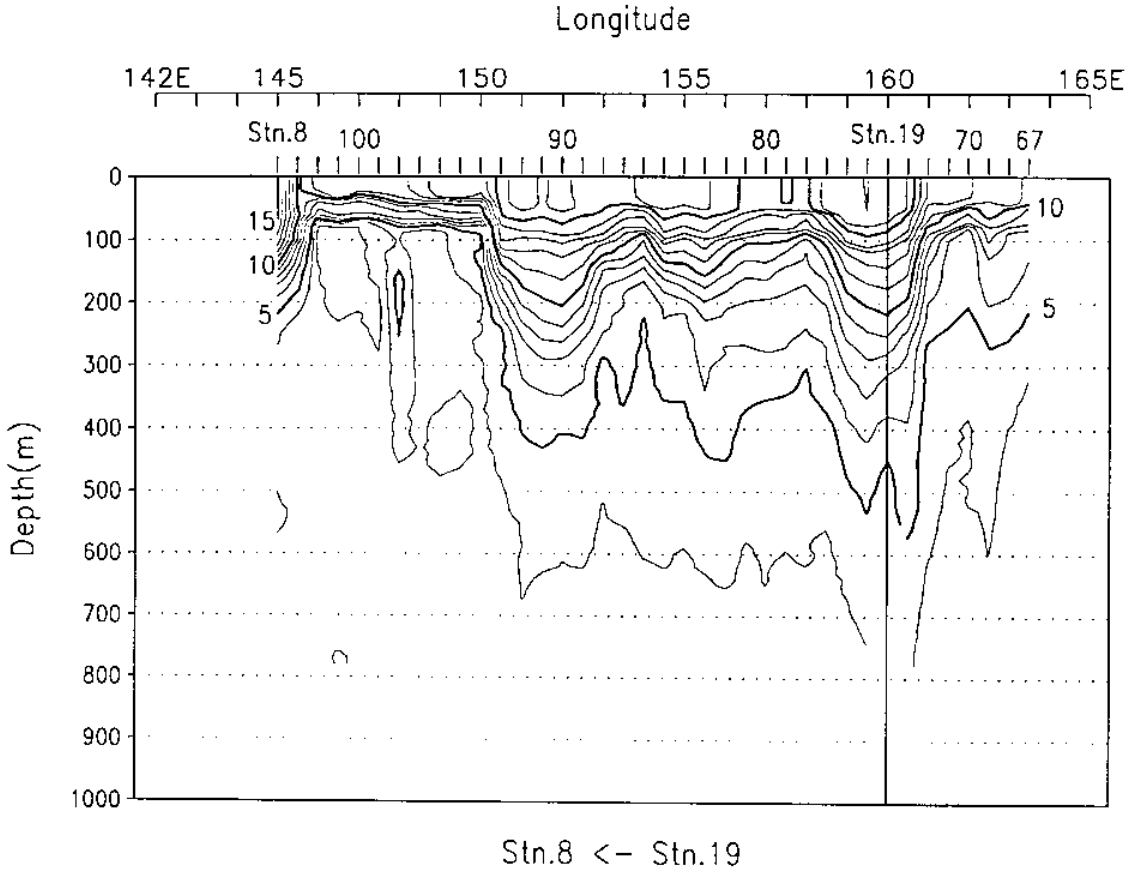

Temperature(°C)
Depth(m)
Salinity(PSS)
XCTD-001
43-17.48N
159-00.32E
XCTD-002
43-25.16N
158-00.00E
XCTD-003
43-33.62N
156-59.86E
XCTD-004
43-44.22N
156-01.52E
Stn.KNOT
44-00.57N
155-00.47E
XCTD-005
43-28.70N
154-00.08E
XCTD-006
42-54.81N
153-00.22E
XCTD-007
42-20.64N
152-00.34E
XCTD-008
41-47.15N
151-00.64E

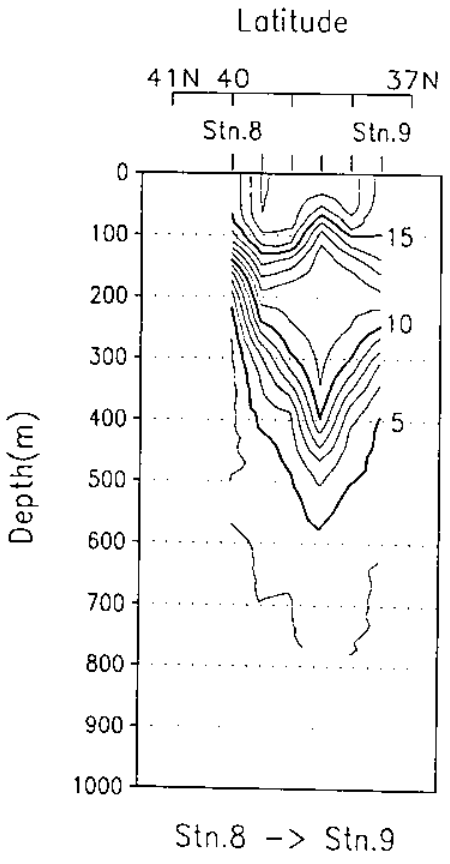

Longitude
142E
145
150
155
160E
1
5
10
15
Stn.1
20
25
Stn.7
0
100
200
300
400
500
600
700
800
900
1000
Depth(m)
15
10
5
3
4
HACHINOHE -> Stn.7

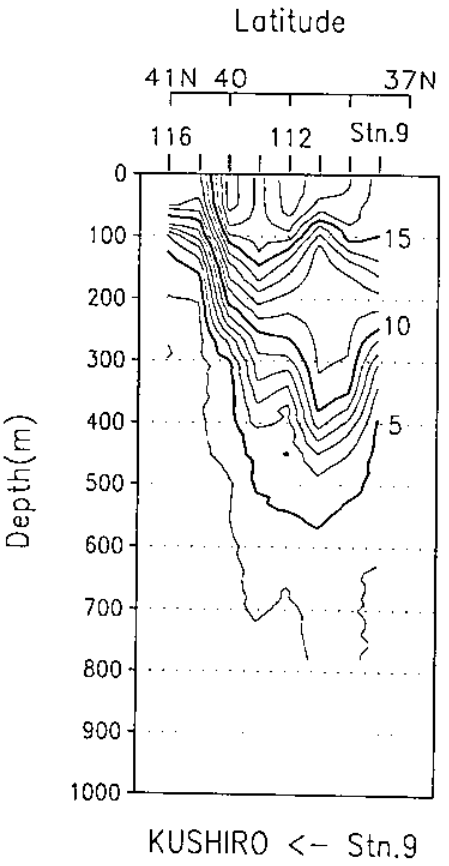

Longitude
142E
145
150
155
160E
Stn.KNOT
Stn.7
0
100
200
300
400
500
600
700
800
900
1000
Depth(m)
10
5
4
3
Stn.KNOT <- Stn.7

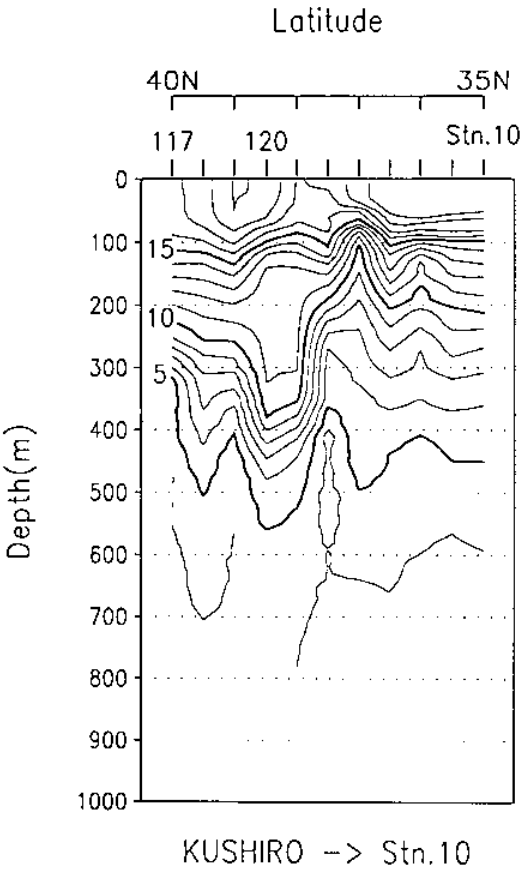

Longitude
142E
145
150
155
160
165E
1
5
10
15
Stn.1
Stn.KNOT
40
Stn.2
50
Stn.4
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
3
4
HACHINOHE -> Stn.4


Latitude
50N
45
40N
Stn.4
55
60
65
70
Stn.19
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
5
3
15
10
Stn.4 -> Stn.19

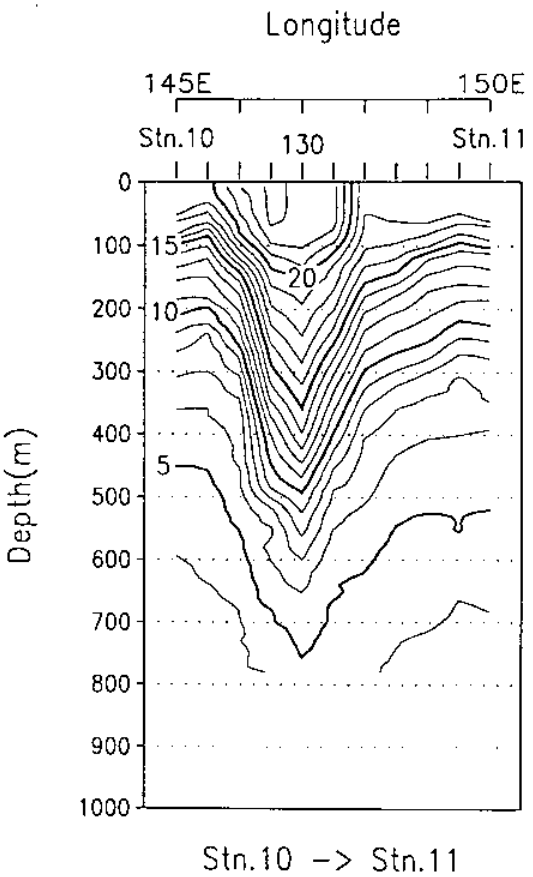

Longitude
142E
145
150
155
160
165E
Stn.8
100
90
80
Stn.19
70
67
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
10
5
Stn.8 <- Stn.19


Latitude
41N
40
37N
Stn.8
Stn.9
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
Stn.8 -> Stn.9

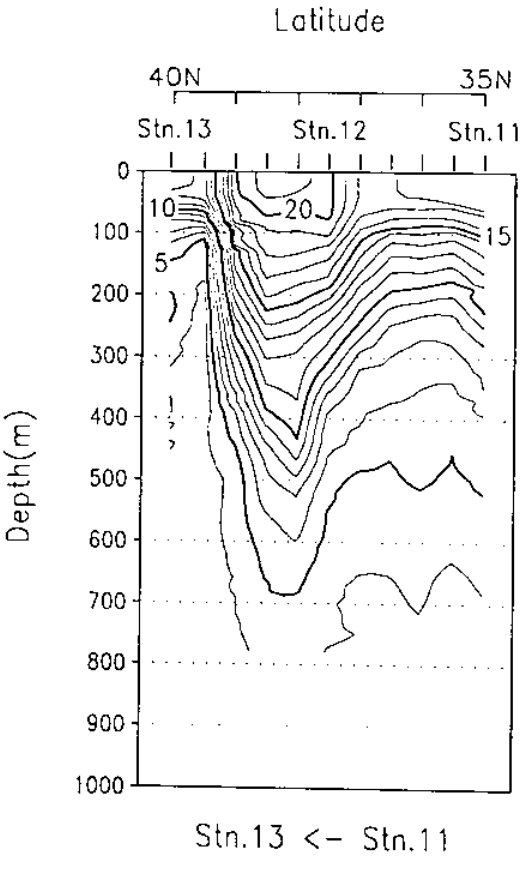

Latitude
41N
40
37N
116
112
Stn.9
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
KUSHIRO <- Stn.9



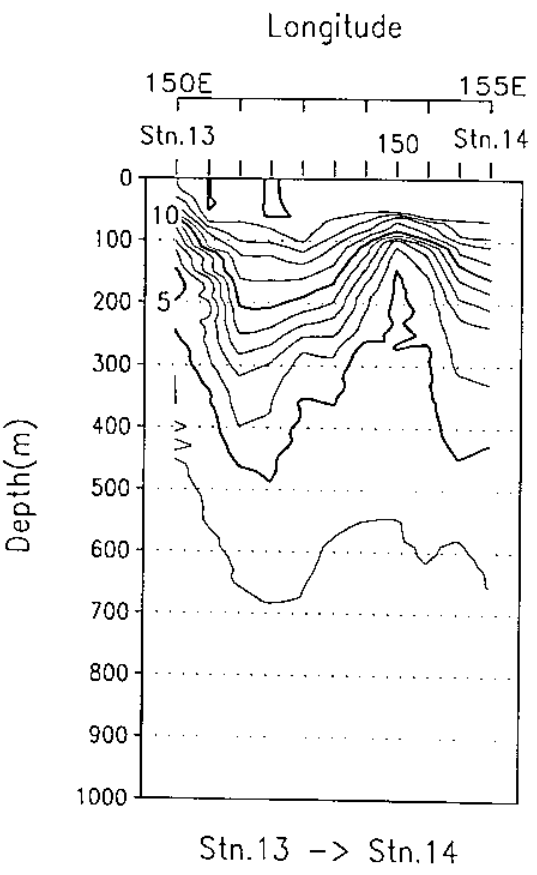
KUSHIRO -> Stn.10



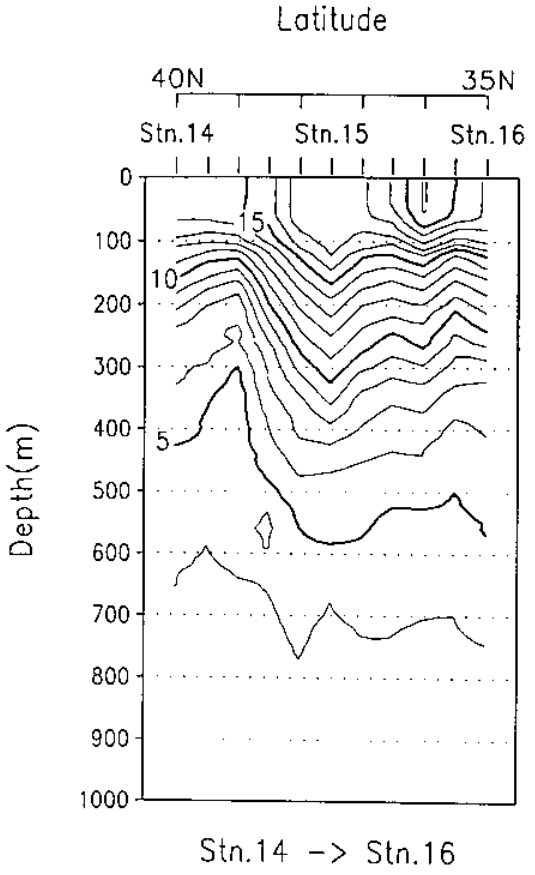
Stn.10 -> Stn.11

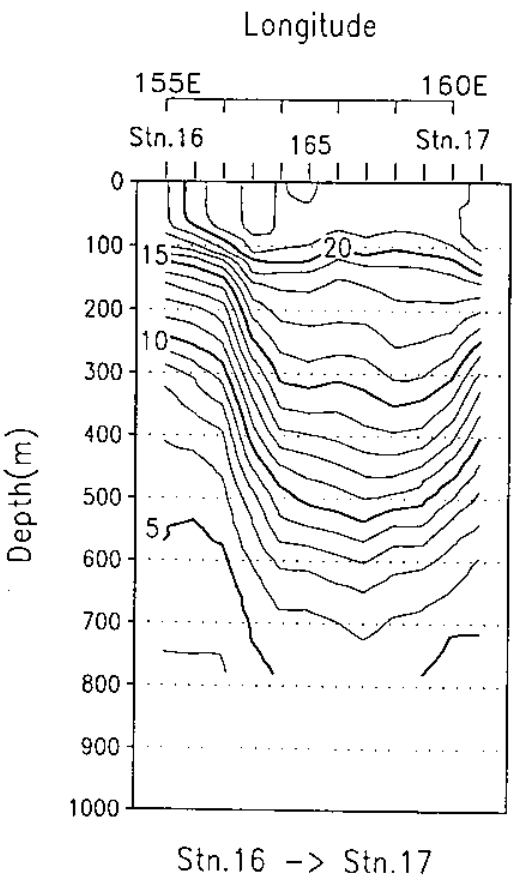


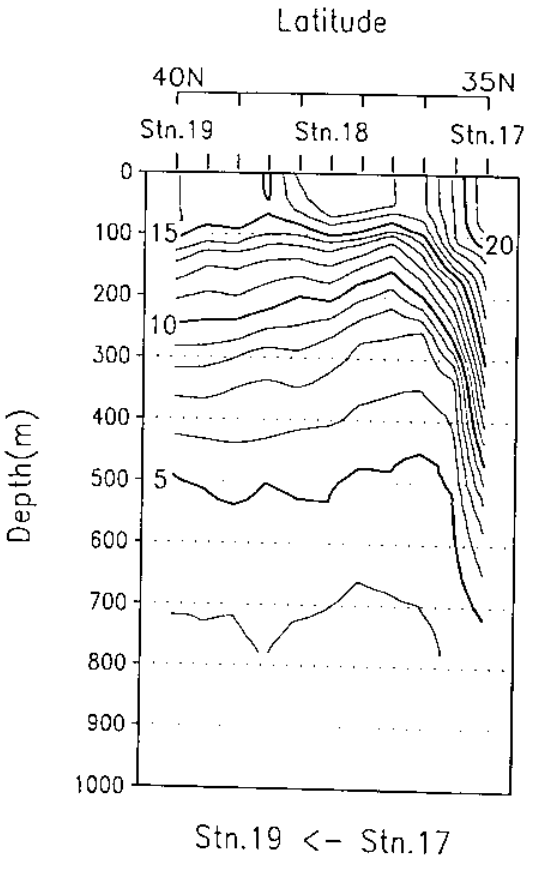
Stn.13 <- Stn.11

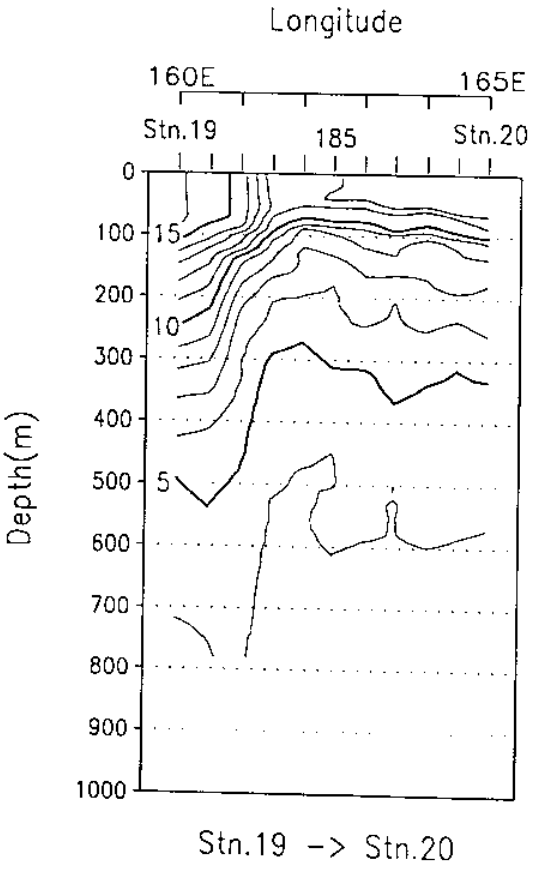


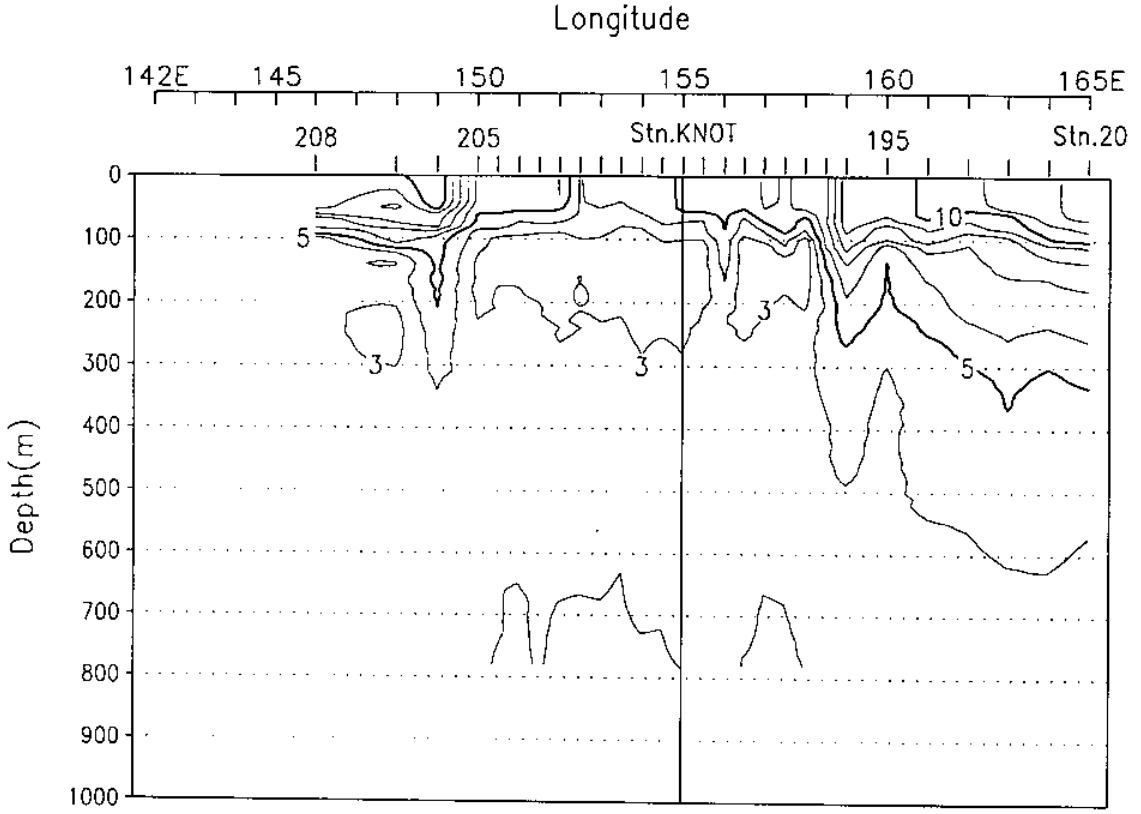
Stn.13 -> Stn.14

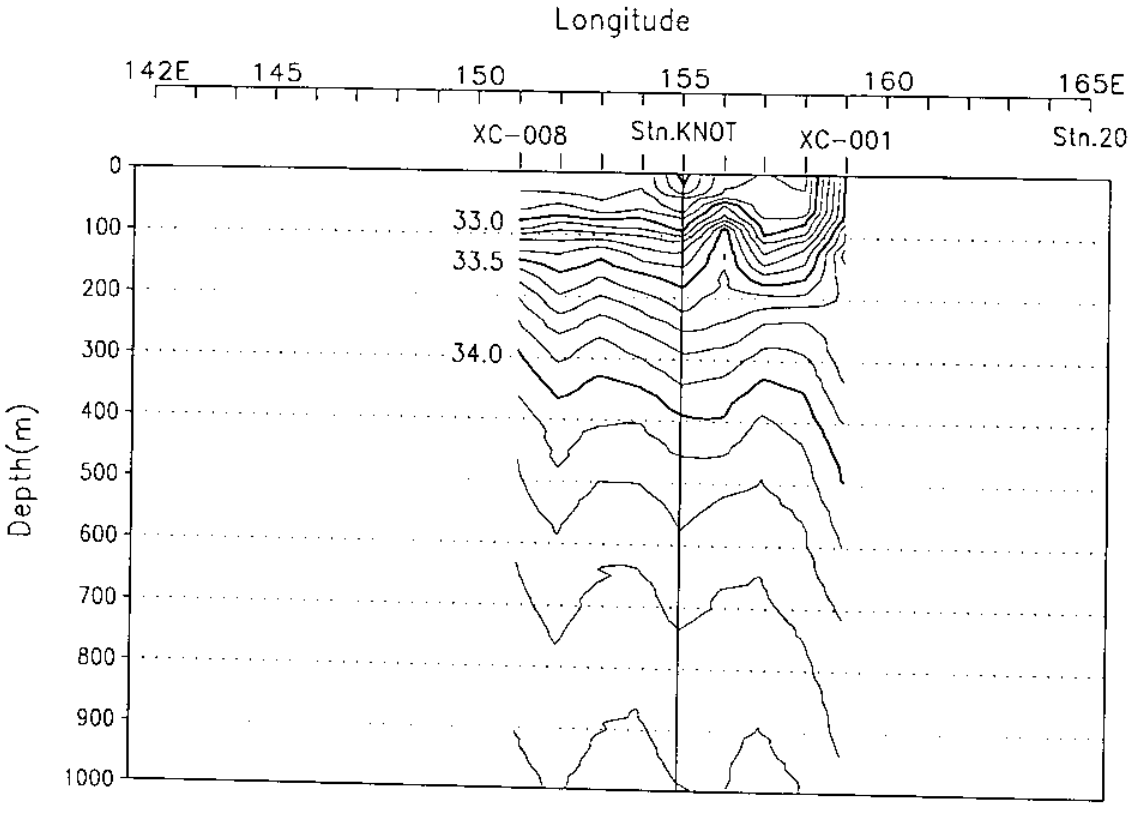

Latitude
40N
35N
Stn.14
Stn.15
Stn.16
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
Stn.14 -> Stn.16


Longitude
155E
160E
Stn.16
165
Stn.17
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
20
10
5
Stn.16 -> Stn.17


Latitude
40N
35N
Stn.19
Stn.18
Stn.17
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
20
10
5
Stn.19 <- Stn.17


Longitude
160E
165E
Stn.19
185
Stn.20
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
15
10
5
Stn.19 -> Stn.20


Longitude
142E
145
150
155
160
165E
208
205
Stn.KNOT
195
Stn.20
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
5
3
3
3
10
5
SEKINEHAMA <- Stn.KNOT <- Stn.20 (Temperature)


Longitude
142E
145
150
155
160
165E
XC-008
Stn.KNOT
XC-001
Stn.20
Depth(m)
0
100
200
300
400
500
600
700
800
900
1000
33.0
33.5
34.0
SEKINEHAMA <- Stn.KNOT <- Stn.20 (Salinity)

3. 17 ALACE

NAKANO Toshiya (JMA)

1. Title

Research on the variation of the subarctic circulation in the North Pacific.

2. Objectives

To research the structure and variation of sub-surface temperature and current in the subarctic circulation area.

To research the formation, advection and diffusion process of the North Pacific Intermediate Water (NPIW).

3. Specification

Depth	1000db
Temperature	3℃
Salinity	34.4psu
in situ density	1.032042g/cm^3
Cycle period	10days
Transmission period	24hours

	Range	Accuracy
Temperature	-2 to 32℃	±0.005℃
Conductivity	1 to 65mmho/cm	±0.005mmho/cm
Pressure	0 to 2000db	±1db

Dimension	1980mm length ◊ 165mm diameter
Weight in air	28kg

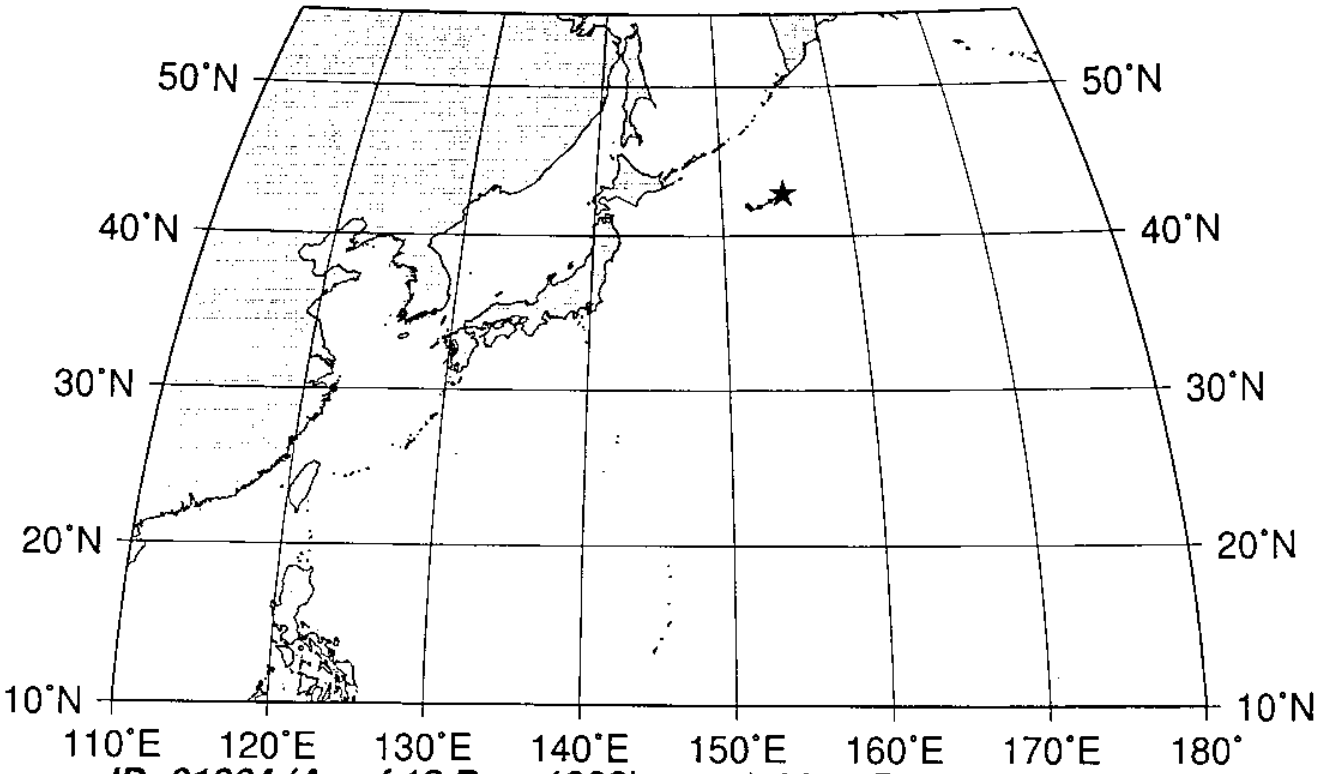
4. Summary

Deployed	1998/11/02	06:46(UTC)
	42°00.02' N	152°00.17' E
(5244m)		

Most recent location of ALACE and vertical profile of temperature and salinity follows.

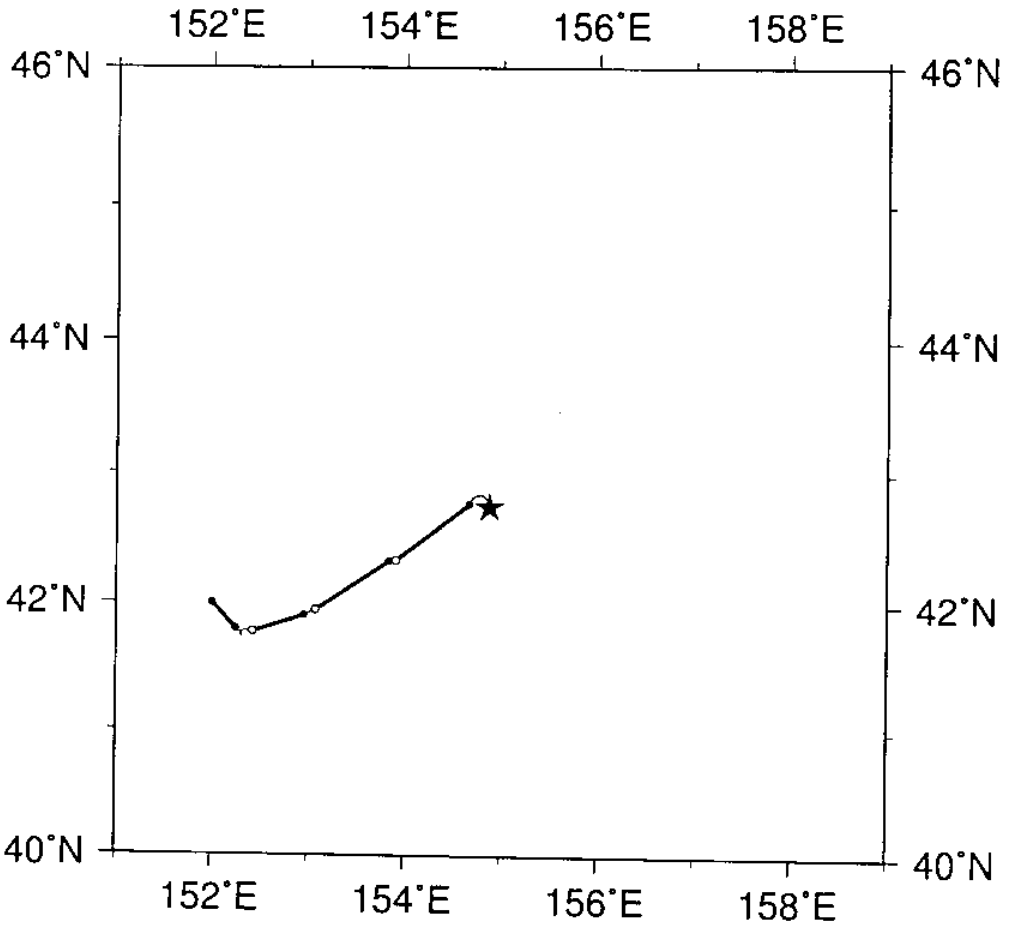
5. Acknowledgement

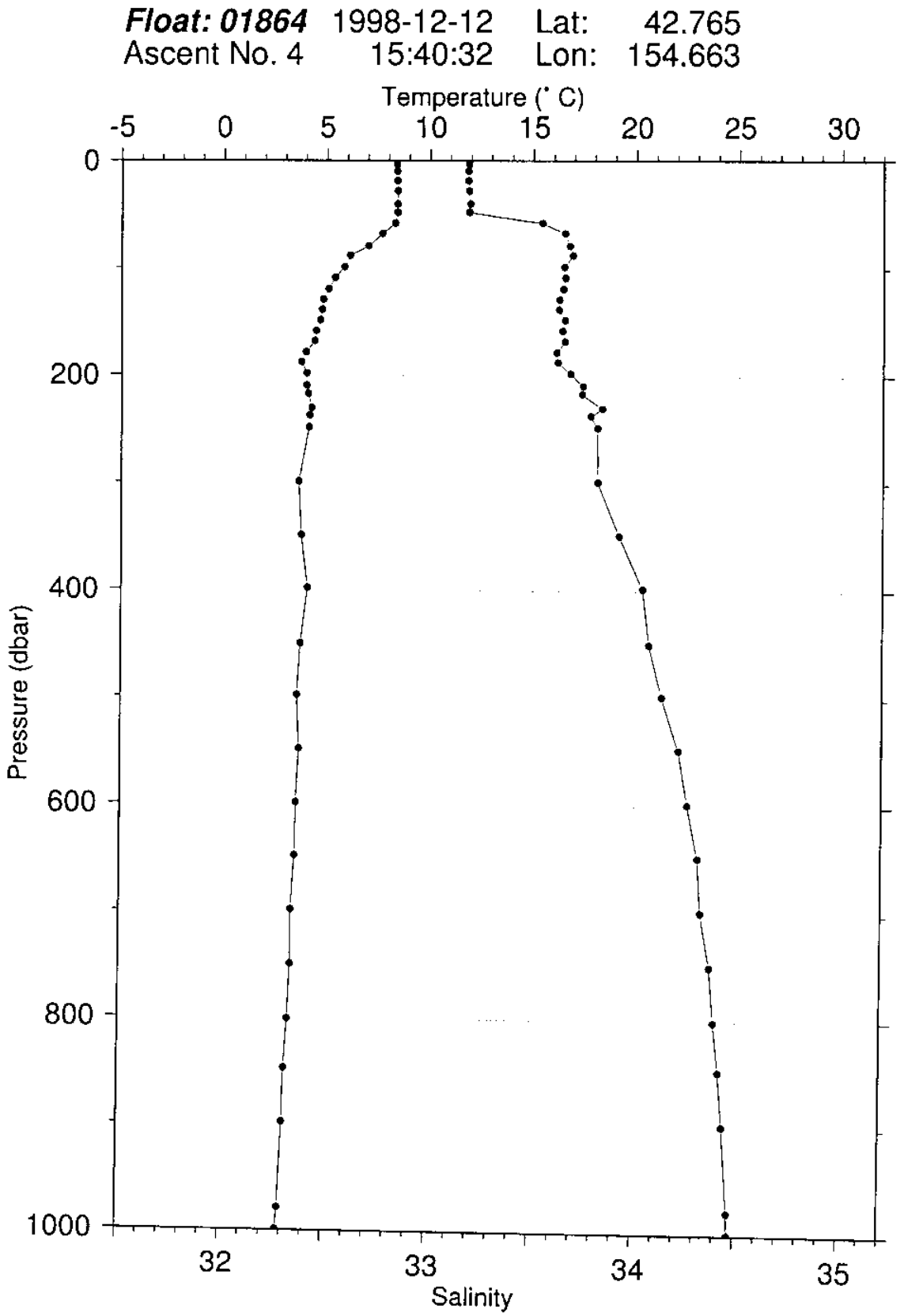
I thank Captain M. AKAMINE, the officers, and crew of R/V MIRAI for their cooperation in the fieldwork.



ID: 01864 (As of 12 Dec. 1998)
(Deployed on 3 Nov. 1998)

★:Most Recent Location of Float.




Float: 01864 1998-12-12 Lat: 42.765
Ascent No. 4 15:40:32 Lon: 154.663
Temperature (° C)
-5
0
5
10
15
20
25
30
0
200
400
600
800
1000
Pressure (dbar)
32
33
34
35
Salinity

3. 18 Atmospheric observation

3. 18. 1. Atmospheric input of iron over the Northwestern North Pacific Ocean.

Shigeto NAKABAYASHI
Ocean Research Department
Japan Marine Science and Technology Center

(1) Introduction

Fe is one of the major elements in the earth's crust. However, its concentration in seawater is extremely low. This low concentration is attributed to the fact that solubility of thermodynamically stable Fe(III) is very low. In other wards, Fe in seawater readily hydrolyzes to form insoluble colloidal hydrous ferric oxides, settling down to the bottom. Because of this high reactivity, its residence time in the ocean is one of the shortest, which is on the order of few hundreds years in deep water and several weeks in surface water.

Fe has been also known as an essential micro-nutrient for the phytoplankton growth in the ocean. Due to its extremely low solubility, however, the concentration becomes so low that phytoplankton growth is subdued where its supply is limited. Thus, the fate of Fe in seawater is closely related to the biological activity. It is very important to know the behavior of Fe in the ocean for the study of the global biogeochemical cycles of carbon and its related elements.

Fe is supplied from river and atmosphere to the ocean surface. However, because of its rapid removal from seawater, riverine dissolved Fe is readily removed within estuary, so that influence of riverine input to the open ocean surface may not be recognized. Therefore the airborne dust has been proposed as a major source of dissolved Fe to the open ocean surface.

The Northwestern North Pacific Ocean is characterized by upwelling of deep water, high nutrients, high primary production and complicated water mass structure (i.e. intermediate water), among others. And also large aeolian input of terrigeneous material to the area is expected. Generally, in the North Pacific the dominant source of the terrigeneous material is Asian dust. Because they can supply Fe over the surface water, they have significant impact on the phytoplankton growth. In addition, seasonal and geographical changes of these features are drastic. This complexity has prevented us from knowing exactly to what extent it plays a role in the global material cycles.

This study is focused on the impact of aeolian input to Fe distribution at the surface water and phytoplankton growth in the Northwestern North Pacific Ocean.

(2) Methods

40 atmospheric dust samples were collected using a high volume air sampler Model HVC-1000N (Shibata co.). The sampler was set up on the compass deck and filtered the air at the rate of about 1000 l $min.^{-1}$. Atmospheric dust samples were collected on the 0.6 μm pore size Nuclepore polycarbonate filters (203 x 253 mm) while the ship was steaming or at the stations. After the collection of dust samples, the filters were kept in a freezer until its analysis on the land-based laboratory. Samples will be measured by ICP-AES or GFAAS after acid digestion. Samples collected in this cruise are listed in Table 1.

Table 1. The list of samples.

		Start				End					Volume
	No	Date	Time	Station	Lat. (N)	Long. (E)	Date	Time	Station	Lat. (N)	Long. (E)	m^3
Leg 1 (No. 1 sampler)												
	1	11/3	9:40		41-13.7	150-08.7	11/3	15:13				307.2
	2	11/5	2:00				11/5	7:00				274.8
	3	11/8	21:00	KNOT			11/9	8:52	KNOT			711.4
	4	11/10	21:21	St. 2	48-00.4	159-59.9	11/11	8:55	St. 2	48-05.8	159-50.9	700.8
	5	11/11	9:00	St. 2	48-16.0	159-50.7	11/11	20:55	St. 2	48-01.0	159-24.6	~~417.0~~
	6	11/11	21:00	St. 2	48-01.0	159-24.6	11/12	8:50		47-46.5	159-43.0	701.9
*	7	11/12	8:55		47-46.5	159-43.0	11/12	20:55		47-35.6	162-37.9	465.9
*	8	11/16	21:23	St. 19	40-05.8	159-46.5	11/17	9:00	St. 19	40-01.4	159-58.2	695.9
	9	11/17	14:00	St. 19	40-00.5	159-18.0	11/18	8:00	St. 14	40-00.0	154-49.5	887.0
	10	11/18	8:05	St. 14	40-00.0	154-49.5	11/18	20:53		40-00.0	151-55.2	773.1
	11	11/18	20:53		40-00.0	151-55.2	11/19	8:55		40-00.0	149-05.4	729.8
	12	11/19	9:00		40-00.0	149.05.4	11/19	21:05		40.00.2	145-33.4	738.4
	13	11/19	21:10		40.00.2	145-33.4	11/20	9:10	St. 8	39-59.7	145-02.7	731.2
	14	11/20	9:10	St. 8	39-59.7	145-02.7	11/21	9:15		38-03.3	144-54.8	1423.1
	15	11/21	9:15		38-03.3	144-54.8	11/21	21:00		40-52.1	144-28.9	715.0
Leg 2 (No. 2 sampler)												
*	16	11/24	21:05		40-03.2	144-59.2	11/25	9:00		36-50.0	145-00.7	567.1
*	17	11/25	16:23	St. 10	35-00.0	145-00.2	11/25	24:00	St. 10	35-00.2	145-06.4	377.7
	18	11/26	16:40	St. 11	35-00.0	150-00.0	11/27	4:55	St. 11	35-03.7	150-03.4	596.3
	19	11/27	4:55	St. 11	35-03.7	150-03.4	11/27	16:30	St. 12	37-29.6	149-59.4	559.3
	20	11/27	16:30	St. 12	37-29.6	149-59.4	11/28	7:57	St. 12	38-04.1	150-00.0	530.0

Table 1. Continued.

		Start					End					Volume
	No	Date	Time	Station	Lat. (N)	Long. (E)	Date	Time	Station	Lat. (N)	Long. (E)	m^3
	21	11/29	7:03	St. 13	40-02.9	149-59.3	11/29	18:30	St. 13	40-02.7	150-04.2	514.0
	22	11/29	18:30	St. 13	40-02.7	150-04.2	11/30	9:30	St. 14	40-00.0	154-59.4	688.1
	23	11/30	9:30	St. 14	40-00.0	154-59.4	11/30	16:47	St. 14	40-00.0	155-00.0	313.3
*	24	11/30	16:47	St. 14	40-00.0	155-00.0	12/1	10:48	St. 15	37-21.1	155-00.3	775.1
	25	12/1	10:48	St. 15	37-21.1	155-00.3	12/1	20:43	St. 16	35-00.1	155-00.0	395.3 ?
*	26	12/2	20:43	St. 16	35-00.1	155-00.0	12/2	8:00	St. 16	35-00.7	156-15.6	381.0
*	27	12/2	21:05		35-00.2	159-23.8	12/3	8:35	St. 17	34-59.4	160-01.3	424.4
*	28	12/3	9:20	St. 17	34-59.1	160-02.1	12/3	21:10		35-39.5	160-00.0	457.3
	29	12/3	21:10		35-39.5	160-00.0	12/4	8:50	St. 18	37-30.0	159-59.3	512.4
	30	12/4	11:27	St. 18	37-37.5	160-00.0	12/4	21:00		40-00.0	160-00.1	362.0
	31	12/4	21:00		40-00.0	160-00.1	12/5	9:30		40-00.1	164-06.9	654.1
	32	12/5	15:50	St. 20	40-01.1	164-59.1	12/6	10:59	St. 20	40-05.6	164-54.2	934.6
	33	12/8	19:30	St. 20	39-59.5	164-57.9	12/9	13:15		41-41.1	160-53.4	415.2
	34	12/9	13:15		41-41.1	160-53.4	12/10	13:50		43-19.9	158-39.9	444.6
	35	12/10	13:50		43-19.9	158-39.9	12/11	8:00	KNOT	44-00.6	154-58.4	952.1
*	36	12/11	11:25	KNOT	44-00.4	155-00.5	12/12	1:55	KNOT	43-59.4	155-01.5	867.8
*	37	12/12	1:55	KNOT	43-59.4	155-01.5	12/12	9:25	KNOT	43-59.7	155-00.4	447.1
*	38	12/12	13:05	KNOT	44-00.0	155-00.0	12/13	18:05		43-51.0	154-46.2	1473.2
*	39	12/13	18:05		43-51.0	154-46.2	12/14	11:55		41-21.3	150-14.7	665.9
*	40	12/14	11:55		41-21.3	150-14.7	12/15	8:35		40-44.5	144-41.1	1035.1

* Provable contamination from research vessel.

3. 18. 2 Distrtibution and characterization of marine aerosols over the Northwestern North Pacific region

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Introduction

From an aerosol chemistry viewpoint, the importance of East Asia has been recognized during the past several decades. Especially, springtime outbreaks of the desert dust from the arid regions of the Asian continent have been studied with different approaches in the various locations on land and on shipboard. With the long-range transport of mineral aerosols over the large areas of the North Pacific, pollution aerosols (such as sulfates, nitrate, and carbonaceous particles) are carried from the east coast region of Asia to the western and the central North Pacific by the prevailing westerlies. During this transport, natural particles and anthropogenic substances are expected to interact with each other. In addition, the emission of sulfur from marine biological activity is also one of the important sources of marine aerosols over the region where primary production is generally high. Therefore, the Northwestern North Pacific region is one of the interesting areas to investigate the physical and chemical interactions and modifications among terrestrial substances, oceanic products, and anthropogenic emissions from the view of the global change on climate.

Sampling and Analysis

Aerosol samples were collected for 12-hr periods by using high-volume air-sampling system (Kimoto Co. Inc., flow rate: ~0.4 m^3 min^{-1}) with Whatman 41 filters (20x25 cm) on the compass deck. A wind sector control for the sampler was activated at the beginning of the cruise. Unfortunately, the wind vane was blown out under a severe storm during the leg 1. The sampling was carried on without the controlling system during the rest of the leg 1 and leg2.

Rain samples were also collected by using the 20-cm diameter rain collector (Shibata Co., W-102) with in-situ filtration by each rain event basis. The pH for filtrate was measured immediately after the collection. Major inorganic ions will be measured for aerosol and rain samples by ion chromatography.

Carbonaceous particles were measured for every 4 hours by using an ambient carbon particulate monitor (Rupprecht & Patashnick Co. Inc.; model 5400). The instrument was developed for measurment of both the organic and elemental fractions of carbon using a thermal analysis technique, that is, an infrared CO_2 analyzer (NDIR). A temperature of 340°C was used as the dividing point for higher volatility organic carbon from low volatility elemental carbon. In addition, temperatures of 200 and 250°C were set up to characterize the fraction of volatile organic carbons. Elemental carbon concentration was obtained from the difference between the total carbon concentration and the carbon concentration measured at 340°C.

Simultaneously, particle number distribution was measured with 5 size ranges (0.10, 0.15, 0.20, 0.30, >0.50 μm) by a particle counter (RION, model KC-18) for every 20 min. Intake tube of air for the carbon particulate monitor and particle counter was separated after removing the particles larger than 2.5 μm in diameter by PM2.5 cyclone fractionator (50% cut off efficiency for 2.5 μm particles).

Ozone concentration was measured every 12 seconds by an ozone monitor (Dylec, model 1150). Ozone in marine atmosphere is a good indicator of polluted air masses, while its concentration is not sensitive as the concentration of particle number by particle counter.

During these samplings, wind direction was occasionally not favorable due to the emission from the ship itself. Based on the meteorological data provided from the ship, the data during the out of sector had to be discarded.

Preliminary Results

Raw concentrations of carbonaceous particles and ozone were shown in figures by the legs. The data can be used for further discussions after the elimination of data during the contaminated periods.

Future Plan

Aerosol filter and rainwater samples will be analyzed for major inorganic ions (Na^+, Ca^{2+}, NH^{4+}, SO_4^{2-}, NO_3^- and MSA) by ion chromatography. After the determination of data quality, the separation of air masses will be attempted by the meteorological data observed on the ship. A dozen low-pressure systems were passed over the ship during the cruise. It may be possible to characterize the background level concentrations for each component by latitude change and the modification of aerosol chemical component with longitude, which means distance from the source region to the ship location. It is interesting to compare the data obtained during this cruise in November with different seasons over the same region.

Fig. 1 Temporal variation of particulate carbon concentration during leg 1.

Fig. 2 Temporal variation of ozone concentration during leg 1.

Fig. 3 Temporal variation of particulate number concentration during leg 1.

Fig. 4 Temporal variation of particulate carbon concentration during leg 2.

Fig. 5 Temporal variation of ozone concentration during leg 2.

Fig. 6 Temporal variation of particulate number concentration during leg 2.

Fig. 1
Leg1 Carbon concentration

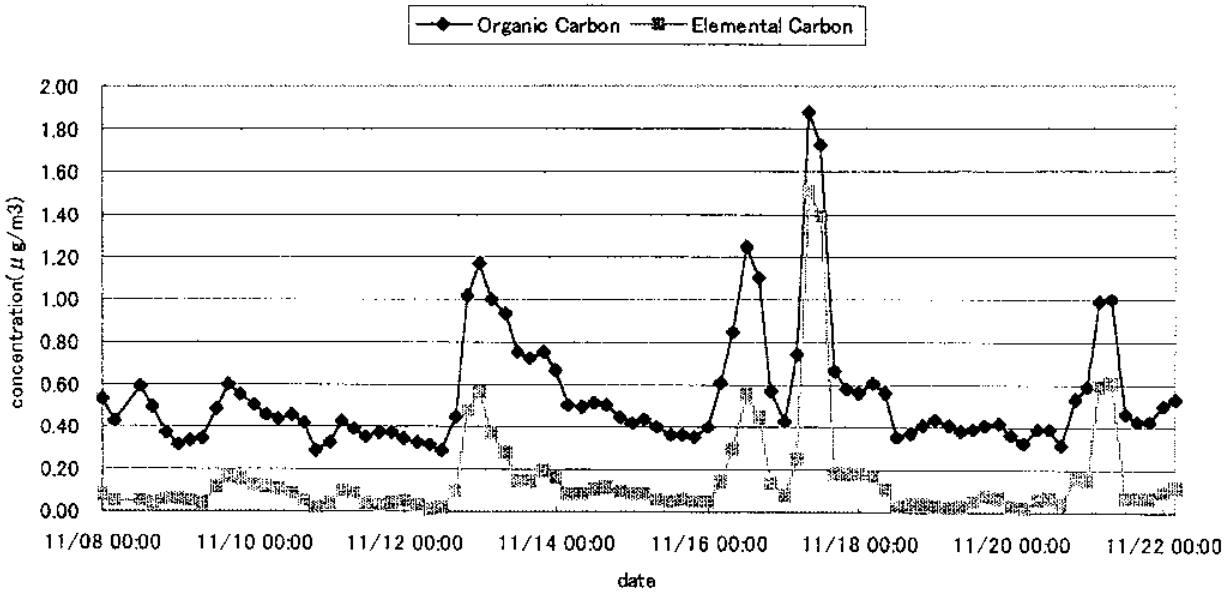


Fig. 2
Ozone concentration(Leg1)

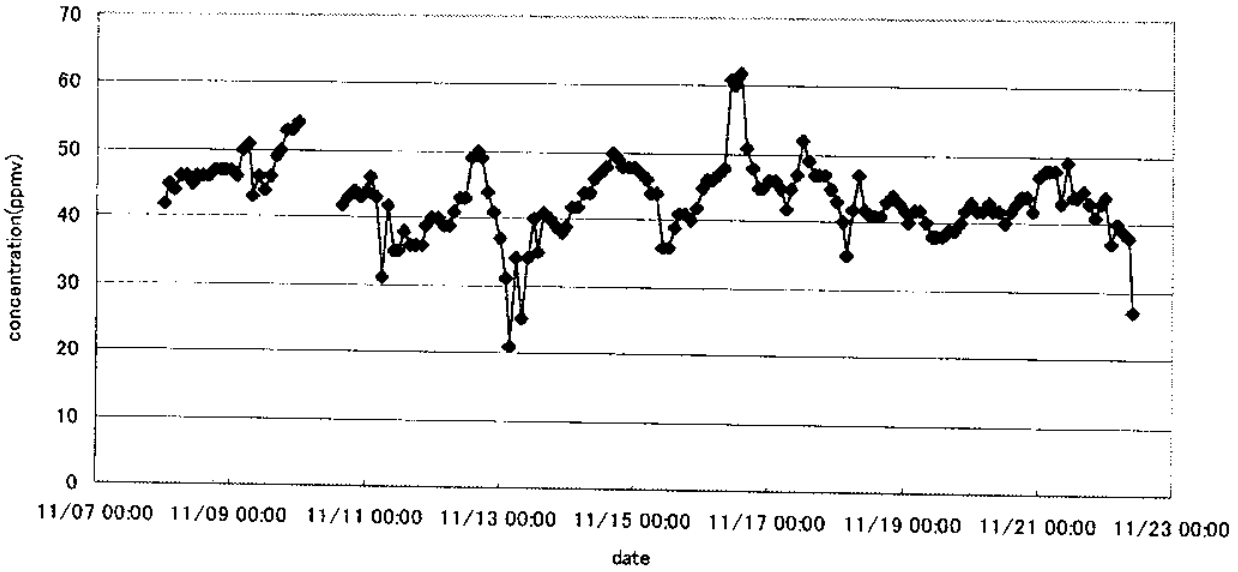


Fig. 3
Leg1 Particle Number

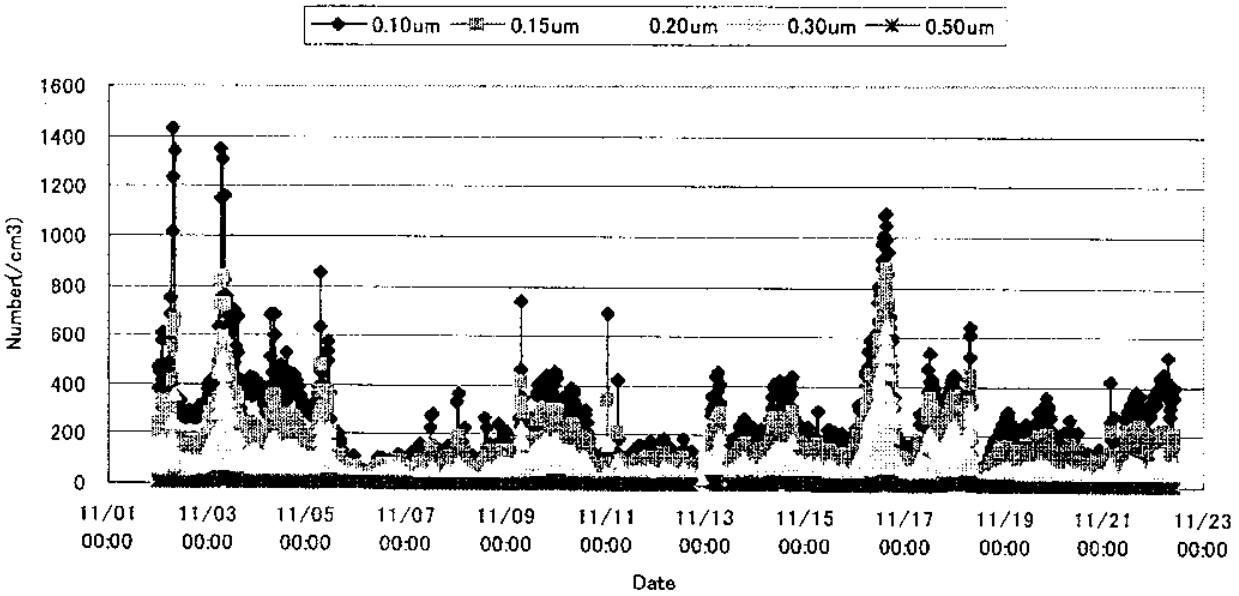


Fig. 4
Leg2 Carbon concentration

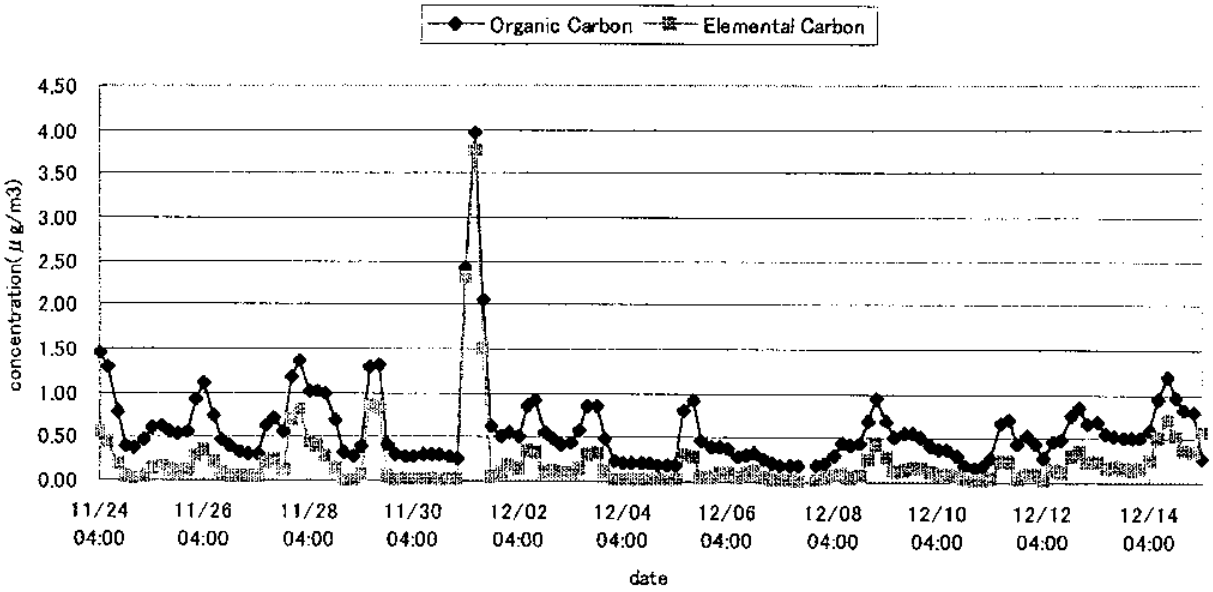


Fig. 5
Ozone concentration (Leg2)

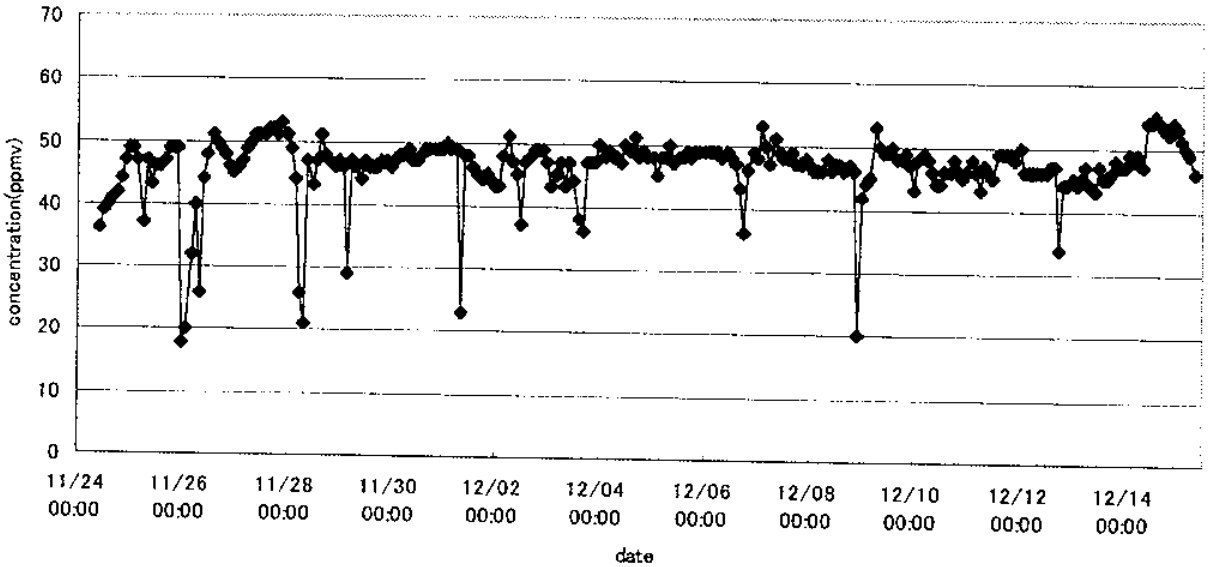
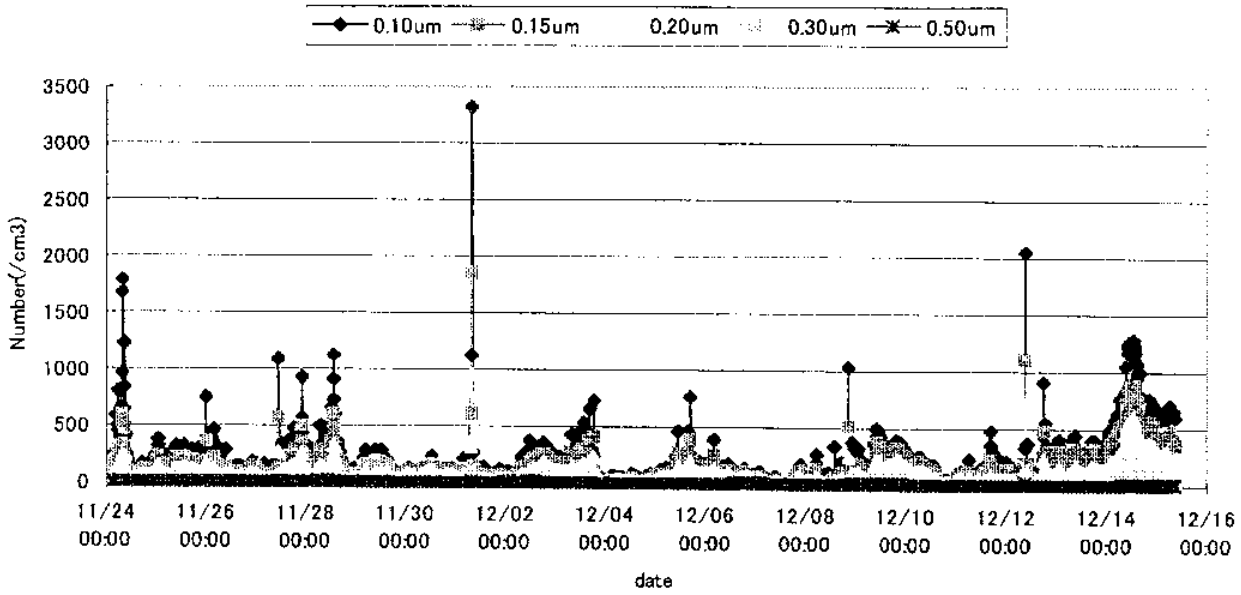


Fig. 6
Leg2 Particle Number



3. 18.3 Biogenic sulfur compounds in the marine boundary layer in the northern North Pacific.

K. Aranami and S. Tsunogai (Graduate School of Environmental Earth Science, Hokkaido University)

Introduction

Sulfate aerosol particles are a dominant component of the acid-base chemistry in the marine troposphere and are a major source of cloud condensation nuclei (CCN). In remote areas where the total particle population limits the CCN population, the number of sulfate aerosol particles acting as CCN may affect the optical properties of clouds and thus influence the radiative climate of the Earth. An understanding of the cycling of sulfur through the atmosphere, therefore, is important in order to assess the effect of anthropogenic and natural sulfur emissions on global climate change.

In this study, we report measurements of atmospheric and oceanic sulfur compounds, in order to estimate the sulfur budget in the marine boundary layer in the northern North Pacific.

Methods

Air samples were collected using 10-liter tedlar bags through a PFA tube, which was mounted on the flying bridge. About 9-liter of the sample (250ml/sec × 35min) was immediately pulled through a KI-Na_2CO_3 scrubber and a Nafion drier in order to eliminate oxidants and water vapor, and then trapped in a PFA tube packed with TenaxGR at a dry ice-ethanol temperature. The volatile sulfur compounds (i.e. DMS, CS_2, COS) collected in the trap were desorbed with near boiling water, then separated by passing through a glass column packed with ODPN (25%Chromosorb W) and quantified with a flame photometric detector.

Seawater samples at the sampling stations were collected using the Niskin bottles, the others (i.e. the surface seawater samples) using the ship's sea chest. The sample was transferred to a 100-ml glass syringe. About 50-ml of the sample was taken into a

glass vessel through a GF/F filter. The vessel was purged with helium gas to remove the sulfur compounds dissolved in the seawater. The gas was dried through a glass tube packed with K_2CO_3 and a Nafion drier, and then trapped in a PFA tube packed with TenaxGR at a dryice-ethanol temperature. The subsequent measurement procedure was the same as that for their atmospheric concentrations.

The relative standard errors of DMS, CS_2 and COS in atmosphere were $\pm 5\%$, $\pm 6\%$ and $\pm 2\%$, respectively. Those of DMS and COS in seawater were $\pm 10\%$ and $\pm 15\%$, respectively. In this cruise, the CS_2 concentrations in seawater were not detectable in almost seawater samples.

Preliminary results

I obtained continuous measurements of the sulfur compounds in atmosphere and surface seawater. With regard to DMS concentrations, I observed less 1/10 lower concentrations in atmosphere and about 1/7 lower concentrations in surface seawater than those obtained in the KH97-2 cruise during summer in the same region. The summary of the continuous measurements obtained in this MR98-K01 cruise during winter was shown as follows.

	$[DMS]_w$ (nM)	$[DMS]_a$ (ppt)	$[CS_2]_a$ (ppt)	$[COS]_a$ (ppt)	$[COS]_w$ (pM)
Av. (Nov.-Dec.)	0.73	30	28	489	75
(95%Conf.)	(0.10)	(5)	(3)	(16)	(4)
(1 σ)	(0.36)	(22)	(10)	(65)	(12)
	N=46	n=65	n=65	n=65	n=42

(Subscripts "a" and "w" refer to the air and the surface seawater samples, respectively)

I also obtained the vertical profiles (10-200m) of the sulfur compounds in seawater at every station. Measurements in detail were noted in the appendix.

Future analysis

I will estimate the seasonal variation of the sulfur budget in the marine boundary layer in the northern North Pacific using the MR98-K01 and the KH97-2 data sets.

3. 18. 4 Measurement of Carbon Dioxide in the Atmosphere

Principal Investigator
Fujio Shimano
Japan Science and Technology (JST)

Objective

The two primary objectives of the cruise were to:

(1) measure CO_2 in the atmosphere at St. KNOT.

(2) supplement a pCO_2 measurement system with a glass bottle sampling.

Method

The glass bottle sampling did outside without a long intake line, totally 1-meter, therefore the sampling could avoid contamination. Air was pumped through 1/8-inch and 1/4-inch stainless tubing from the upper deck to the glass bottle (2L). The line and the bottle were flushed for 10-miutes. The air was pumped up to the bottle until pressure gauge indicated 2.5 kgf / cm^2
analyzed using a standardized infra-red analyzer. Samples were brought to the laboratory and NDIR.

Precision

The CO_2 concentration in the atmosphere was measured using the NDIR analyzer with an estimated precision of approximately 0.05 ppm.

Sampling stations

MR98-K1 Leg1 St. KNOT 09-November-1998
MR98-K1 Leg2 St. KNOT 12-December-1998

Results

Comments

Plan

Plans for CO_2 data are to:

(1) compare pCO_2 data and bottle data

(2) supplement a pCO_2 measurement.

(3) adopt as a parameter of the CO_2 system in seawater.

3. 19 Underway measurements

3. 19. 1 Partial pressure of CO_2 (pCO_2) in the atmosphere and sea surface

Akihiko Murata, Yuichiro Kumamoto, Makio Honda (JAMSTEC)
Hideki Yamamoto (MWJ)

Concentrations of CO_2 in the atmosphere and the sea surface were measured continuously during the entire cruise by the automated system with a non-dispersive infrared (IR) analyzer (BINOSTM). It runs on half hour or two hours cycle during which four standards, an ambient air sample, and a head space sample from the equilibrator were analyzed.

The ambient air sample taken from the bow is introduced into the IR through a mass flow controller which controls the air flow rate at about 0.5 L/min, a cooling unit, a perma pure dryer, and a desiccant holder ($Mg(ClO_4)_2$).

The equilibrator has shower head space in the top through which surface water is forced at a rate of 5-8 L/min. Air in the head space is circulated with an air pump at 0.5-0.8L/min in a closed loop through two cooling units, a perma pure dryer, and the desiccant holder.

For calibration, compressed gas standards with nominal mixing ratios of 270, 330, 360, 410, ppmv (parts per million by volume) were used.

3. 19. 2 Measurement of CO_2 in the Atmosphere and in Surface Seawater.

Principal Investigator
Fujio Shimano
Japan Science and Technology (JST)

Objective

Continuous measurement of the partial pressure of CO_2 (pCO_2) in surface seawater.

The two primary objectives of the cruise were to:
(1) assess pCO_2 at the St. KNOT.
(2) measure pCO_2 during Leg1 and Leg2 of the cruise.

Method

Surface seawater is pumped up to a Tandem-style equilibrator (Kimoto Electric Co., Ltd.) and the gases were equilibrated with a headspace of the equilibrator. After equilibration the headspace gas was dried and analyzed using a standardized infra-red analyzer.

Precision

The pCO_2 in surface seawater was measured using the infra-red analyzer with an estimated precision of approximately 0.05 ppm.

Sampling stations

Measuring data included all stations of MR98-K1 Leg1 and Leg2.

Results
Attached.

Comments

The CO_2 system in seawater is described by four carbon system parameters: TA, TCO_2, pH, and either fCO_2 or pCO_2. pCO_2 has the largest dynamic range of the four parameters and is an excellent parameter to use in calculations.

This report contained tables of the following data:
Time (GMT)
Flag
Observed NDIR raw data (ppm) in equilibrator headspace
NDIR temperature
NDIR output pressure

Pressure of the laboratory

Seawater temperature of equilibrator headspace

It did not include a correction for the nonideality of CO_2, pressure, salinity and warming. The fugacity is about 0.3% to 0.4% lower than the partial pressure over the range of interest, due to the nonideality of CO_2.

Plan

Plans for pCO_2 data are to:

(1) add GPS, atmospheric pressure, seawater temperature and salinity data.

(2) correct data with salinity, pressure and warming.

(3) extract and assess data around St. KNOT.

3.19.3 Continuous monitoring of surface water

(1) Integrated monitoring of surface water

S. Yokogawa[1], T. Shiribiki[1], H. Uno[1], H. Kawakami[2] and C. Saito[2]
1: MWJ 2: JAMSTEC

This system can measure temperature, salinity, dissolved Oxygen, fluorescence and particle size of surface water continuously on real time. It is connected to shipboard LAN-system, and provides the acquired data for pCO_2 measurement system. These data were stored every minute with ship position.

1) Instruments and methods

This system was located in the sea-surface monitoring laboratory on this R/V. Surface seawater was pumped up to the laboratory through a vinyl-chloride pipe, and the flow rate was controlled some valves.

This system have five kinds of sensor, and specification of the sensors were listed below.

a) Temperature and Salinity sensor
SEACAT THEROMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.

b) Dissolved Oxygen sensor
Model: 2127, Oubisufair Laboratories Japan, INC.

c) Fluorometer
Model: 10-AU-005, TURNER DESIGNS.

d) Particle Size sensor
Model: P-05, Nippon Kaiyo LTD.

e) Flowmeter
Model: EMARG2W, Aichi Watch Electronics LTD.

2) Calibration

In order to calibrate the data from this system, seawater samples were collected from this system daily or weekly, and were determined Salinity and the concentrations of Chlorophyll a and dissolved oxygen on board. The methods measured Salinity and the concentrations of dissolved oxygen were similar to hydrocasts samples ((3)-3), and the concentrations of Chlorophyll a was indicated below.

The concentration of chlorophyll a in seawater samples is measured by fluorometric determination. The method used here utilizes the Turner fluorometer as suggested by Parsons et al. (1984).

Experimental procedure

Seawater samples (500-1000 ml) are filtered through a glass fiber filter at 1/2 atmospheric pressure. Filters are used Whatman GF/F glass fiber filters (25 mm diameter).

Chlorophyll a on the filters were extracted with 8 ml of N, N' - dimethylformamide overnight in a dark and cold (-20 °C) place. Fluorescence of the extracts are measured by Turner fluorometer (10-AU-005, TURNER DESIGNS) with a 340-500 nm bound excitation filter and a >665 nm bound emission filer. A half minuets after the measurement, the extracts were acidified with 1 or 2 drops of 1 N HCl and the second measurement was made.

The amount of chlorophyll a is calculated from the following equation;

$$\mu g \text{ chlorophyll a} / L = (fo - fa) / (FCh - Fph) * v/V$$

where fo and fa are the fluorescence before and after the acidification, respectively, FCh and Fph are the fluorescent factor of chlorophyll a and phaeophytine a, respectively, v is the volume of N, N' - dimethylformamide extract, and V is the volume of seawater.

The method is calibrated against a known concentration of chlorophyll a as determined by the spectrophotometric method (Porra et al., 1989). A precision based on replicate measurements (n=8) at the 0.3 µg/L chlorophyll a level is 1.71%.

3) Preliminary result

The non-calibrated results are shown in from Figs. (3)-19-3-1 to (3)-19-3-8. Temperature and salinity were indicated lower value at the higher latitude. On the other hand, fluorecence and the concentration of dissolved oxygen were generally higher at the higher latitude.

The data were stored in MO disk in the Ocean Research Department in JAMSTEC, and should be calibrated from the batch measurements as soon as possible after this cruise.

4) References

Parsons Timothy R, Yoshiaki Maita and Carol M Lalli. 1984. "A manual of chemical andbiological methods for seawater analysis" (Pergamon Press), pp. 101-112.

Porra R. J., W. A. Thompson and P. E. Kriedemann. 1989. Biochim. Biophys. Acta, 975, 384-394.

(2) Nutrients monitoring in sea water

Ichiro YAMAZAKI[1], Shinichiro YOKOGAWA[1] and Chizuru SAITO[2]
1: MWJ 2: JAMSTEC

1) Sea surface nutrients measurement

The distribution of nutrients of sea surface water are important to investigate the primary production. The nutrients were measured colorimetrically by BRAN + LUEBBE nutrients monitoring system. This system was located in the sea surface water monitoring laboratory on R/V Mirai. Sea surface water pumped up to laboratory, and drawn into this monitoring system continuously.

2) Preliminary result

This monitoring system was not work in this cruise because of electronic trouble, so unfortunately we couldn't get continuous sea surface nutrients data.

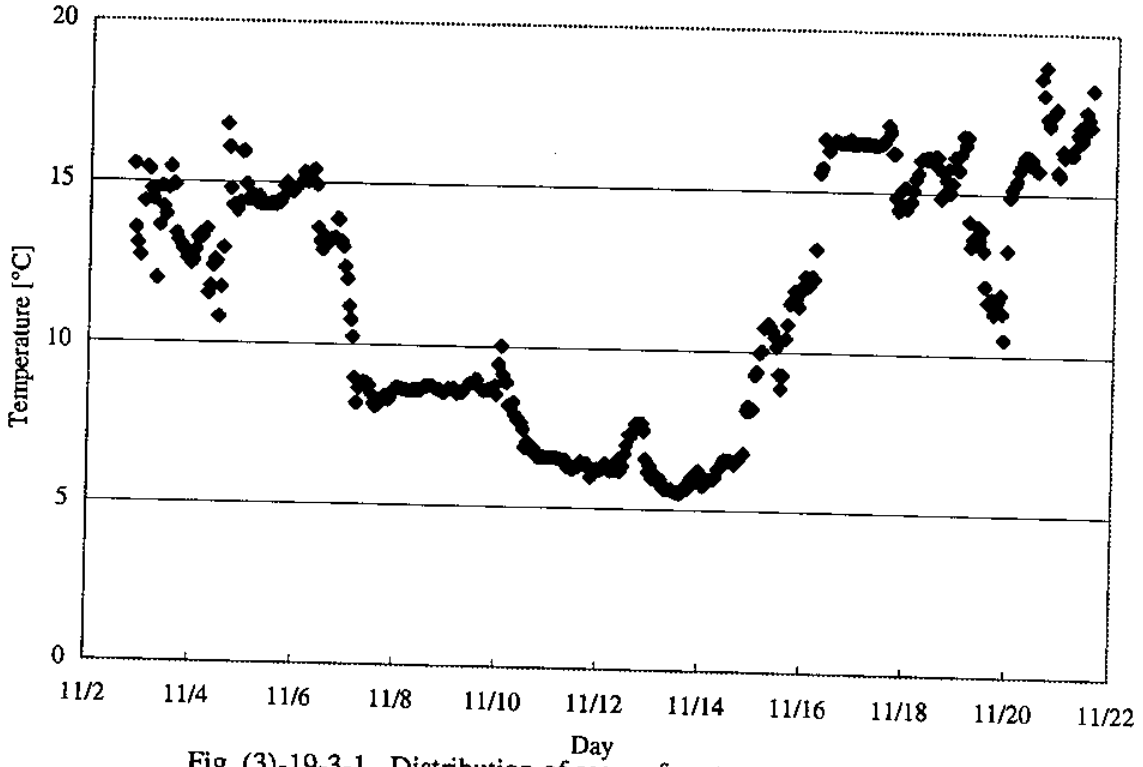


Fig. (3)-19-3-1. Distribution of sea surface temperature in Leg. 1.

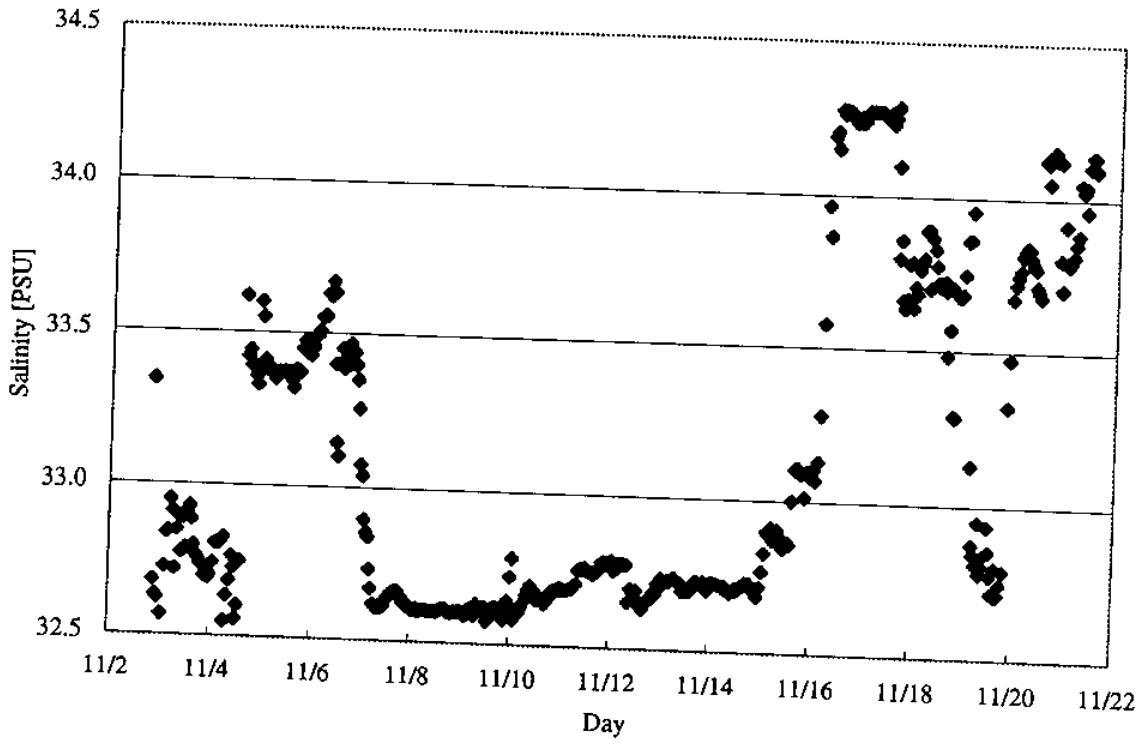


Fig. (3)-19-3-2. Distribution of sea surface salinity in Leg. 1.

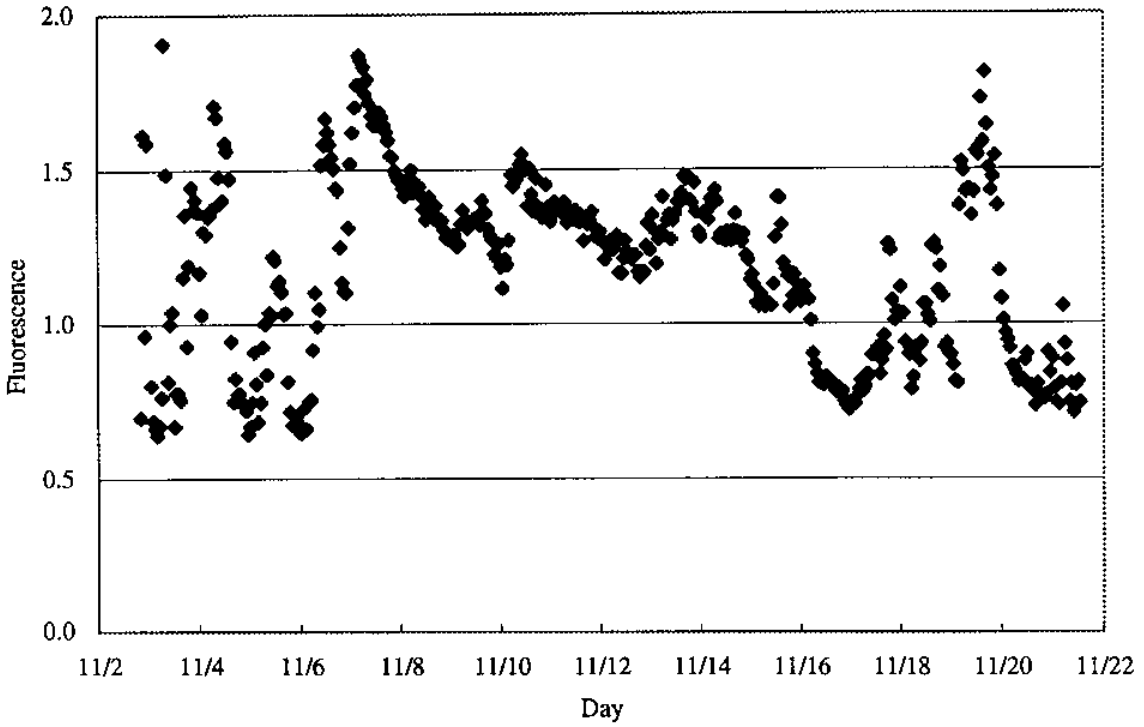


Fig. (3)-19-3-3. Distribution of sea surface fluorescence in Leg. 1.

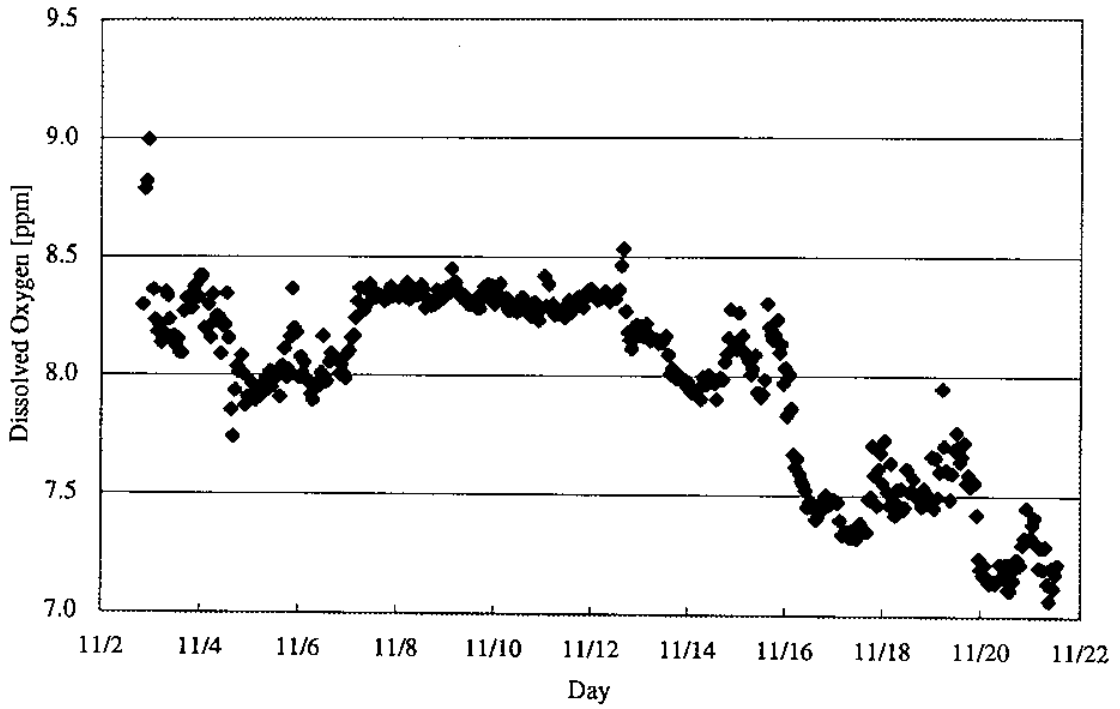


Fig. (3)-19-3-4. Distribution of sea surface Dissolved Oxygen in Leg. 1.

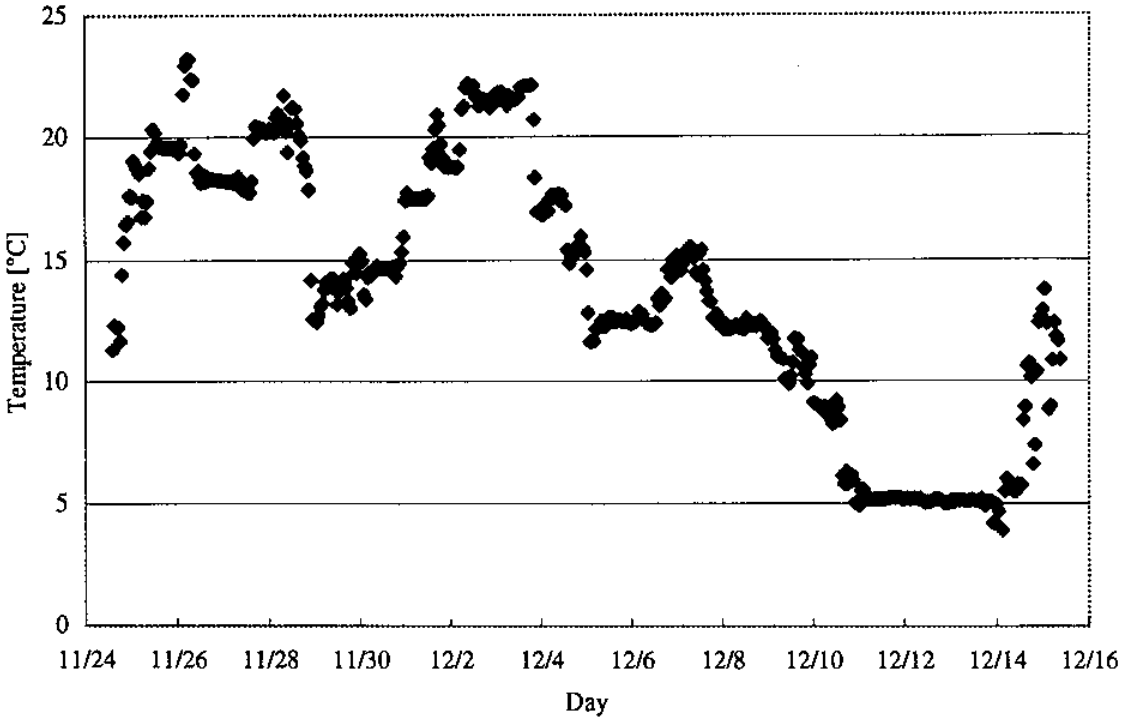


Fig. (3)-19-3-5. Distribution of sea surface temperature in Leg. 2.

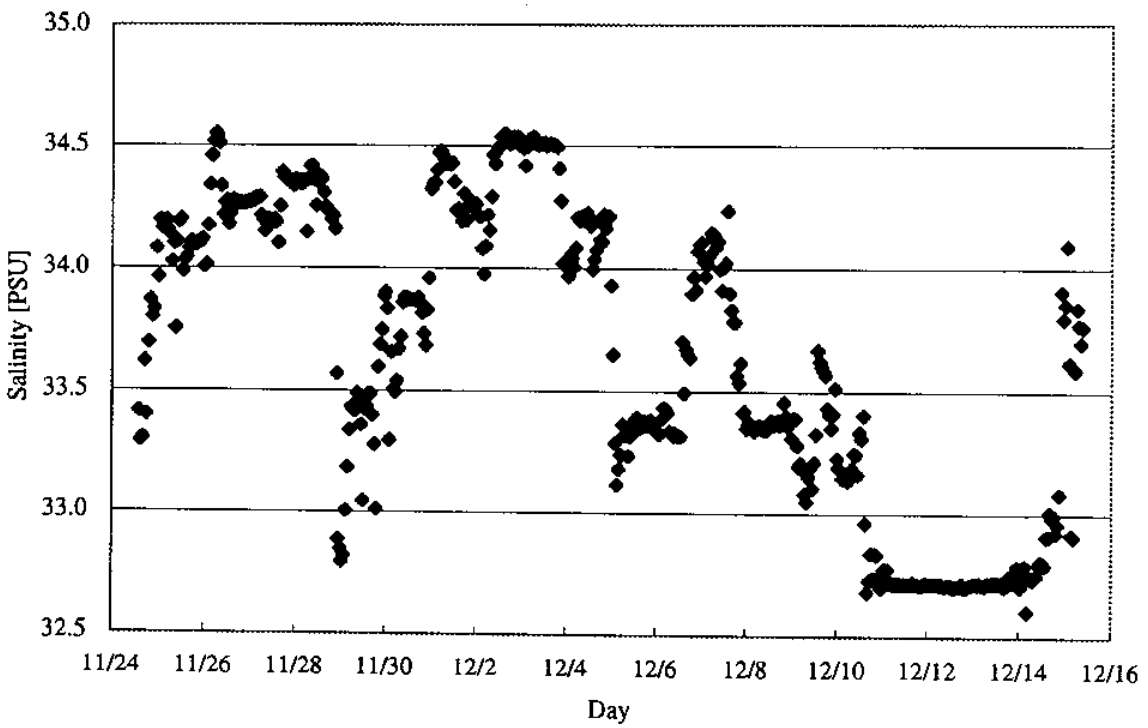


Fig. (3)-19-3-6. Distribution of sea surface salinity in Leg. 2.

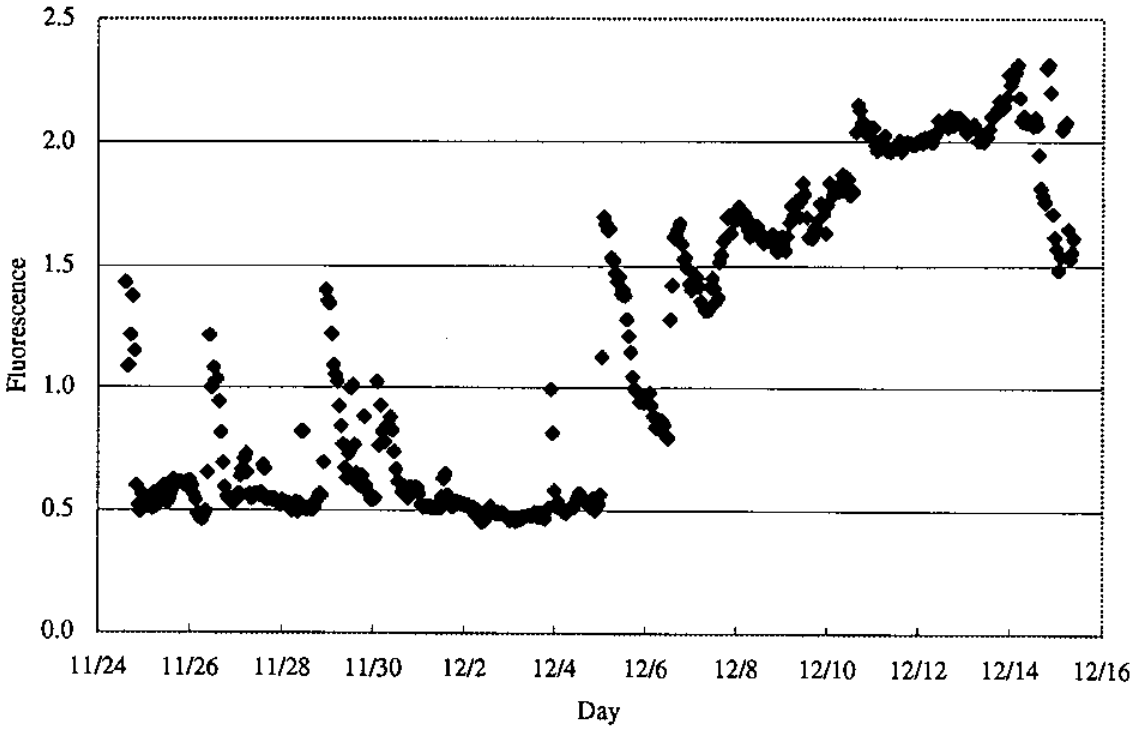


Fig. (3)-19-3-7. Distribution of sea surface fluorescence in Leg. 2.

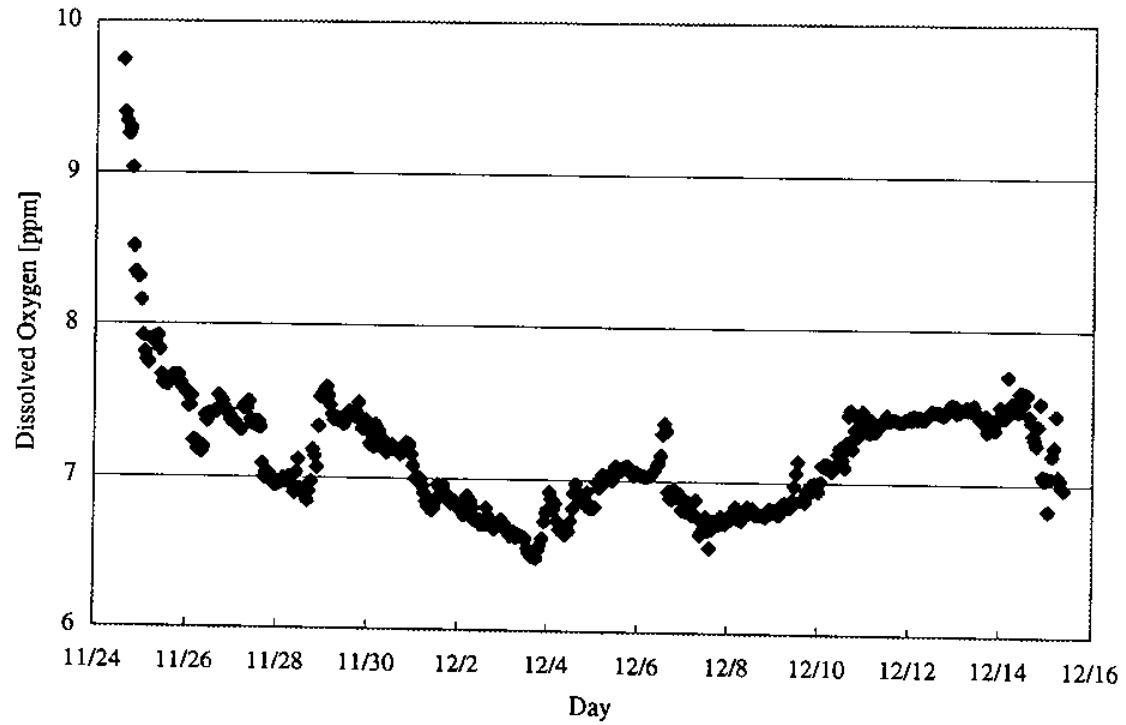


Fig. (3)-19-3-8. Distribution of sea surface Dissolved Oxygen in Leg. 2.

3. 19. 4

Geographical distribution of C and N isotope ratios in the surface of northwestern North Pacific.

TANAKA Tomoyuki and YOSHIHISA Mino
Institute for Hydrospheric-Atmospheric Sciences, Nagoya University

Objective:

Variations in C and N isotope ratios are mainly caused by biological and physical processes. Therefore, their determination could provide information on natural processes involved in C and N isotope dynamics in the ocean. These advancement of the knowledge about the isotope fractionation by primary producers are regarded as key points of C and N isotope dynamics. During this cruise , we attempt to evaluate the utilization of C and N isotopic ratios as natural tracers for understanding the geographical distribution of carbon and nitrogen dynamics in the surface waters of the northwest Pacific Ocean.

For the following analysyses, surface seawater samples from various location along the cruise track were pumped up from the ship as the ship sailed.

1. Natural abundance of ^{13}C and ^{15}N in particulate organic matter

For the determination of natural abundance of ^{13}C and ^{15}N isotopes in particulate organic matter, 15 litre surface seawater samples were filtered through a pre-conbusted Whatman GF/F filter. After filtration, the filters were rinsed with particle free salt water and frozen –20 degree until analyses.

2. Natural abundance of ^{13}C in dissolved inorganic carbon

Surface seawater samples were collected in dark serium bottle and fixed with $HgCl_2$ for later analysis in the laboratory. After estimating the dissolved inorganic carbon (DIC) concentration, natural abundance of ^{13}C and ^{15}N isotope ratio determined by a mass spectrometer.

3. Natural abundance of ^{15}N as ^{15}N-nitrate

For the determination of natural abundance of N isotopes in nitrate from the surface, 3 liters of seawater samples were filtered through a pre-combusted Whatman GF/F filter. Filtered seawater samples were stored in glass bottles with addition of conc. HCl. Natural abundance of ^{15}N as ^{15}N-nitrate will be determined with isotope ratio mass spectrometer in the laboratory.

3. 20 Sediment sampling and study on geochemical cycle on sea floor

Koh Harada (National Institute for Resources and Environment)
Yoko Shibamoto (National Institute for Resources and Environment)

(Objectives)

Water-sediment boundary is a place where biogeochemical processes actively occur. To clarify regeneration process of nutrients, balances of the nutrients at the boundary should be investigated. The fluxes of the nutrients which generated within the sediment can be estimated from the their concentration in pore water and the estimated fluxes can be compared with rain rates from the water column to the sediment surface which can be measured by sediment traps.

Sediment particles near the boundary are well mixed due to organisms at the sediment surface. This mechanism is called bioturbation. Generally speaking, abundance of the benthic organisms is related to flux of particulate organic matter from the water column and also productivity in the surface water. These suggest the bioturbation rate also have some relation with the flux of organic matter and the production in the surface water. To estimate the bioturbation rate, vertical profiles of relatively short lived radio-nuclides such as ^{234}Th, ^{210}Pb and ^{210}Po in the sediment core obtained at Stn. KNOT were investigated.

(Methods)

Sediment cores were collected at Stn. KNOT using with a Multiple Corer. Eight non-disturbed cores of which length was about 30 cm were successively collected. Immediately after recovering the corer on the deck, four of the eight cores were sliced in 3 mm thick each for the topmost ten sub-samples, 6mm thick each for the second ten samples and 12 mm thick each down to the bottom. Pore water samples were squeezed by centrifugation at 2°C using sub-samples from the two cores. Concentrations of silicate, phosphate, nitrate and nitrite were determined by an Auto Analyzer.
Sub-samples from the another two cores were kept in a freezer and brought to the laboratory of NIRE. Concentrations of ^{234}Th, ^{210}Pb and ^{210}Pb were determined by the same methods mentioned in Section 3. 11.2. Water content, concentrations of $CaCO_3$, biogenic silica and Al will be also determined.

Two non-sliced cores are saved in a refrigerator for further studies such as X-ray photograph. Another two cores were brought to Hokkaido University and

Tokai University for analyses of long lived radionuclides and metal

3. 21 Shipboard ADCP

1. Presonal

Naoto morioka (G.O.D.I.)

2. Parameters

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

(2) ECHO intensity of each depth cell [dB]

3. Methods

I measured sea water current profiles by VM-75 (RD Instruments ,Inc. USA) shipboard ADCP (Acoustic Doppler Current Profiler) throughout MR98K01 cruise from departure of Sekinehama , October 30 1998 to the arrival of Sekinehama 16 December 1998 .

Major parameters for the measurement configuration are as follows

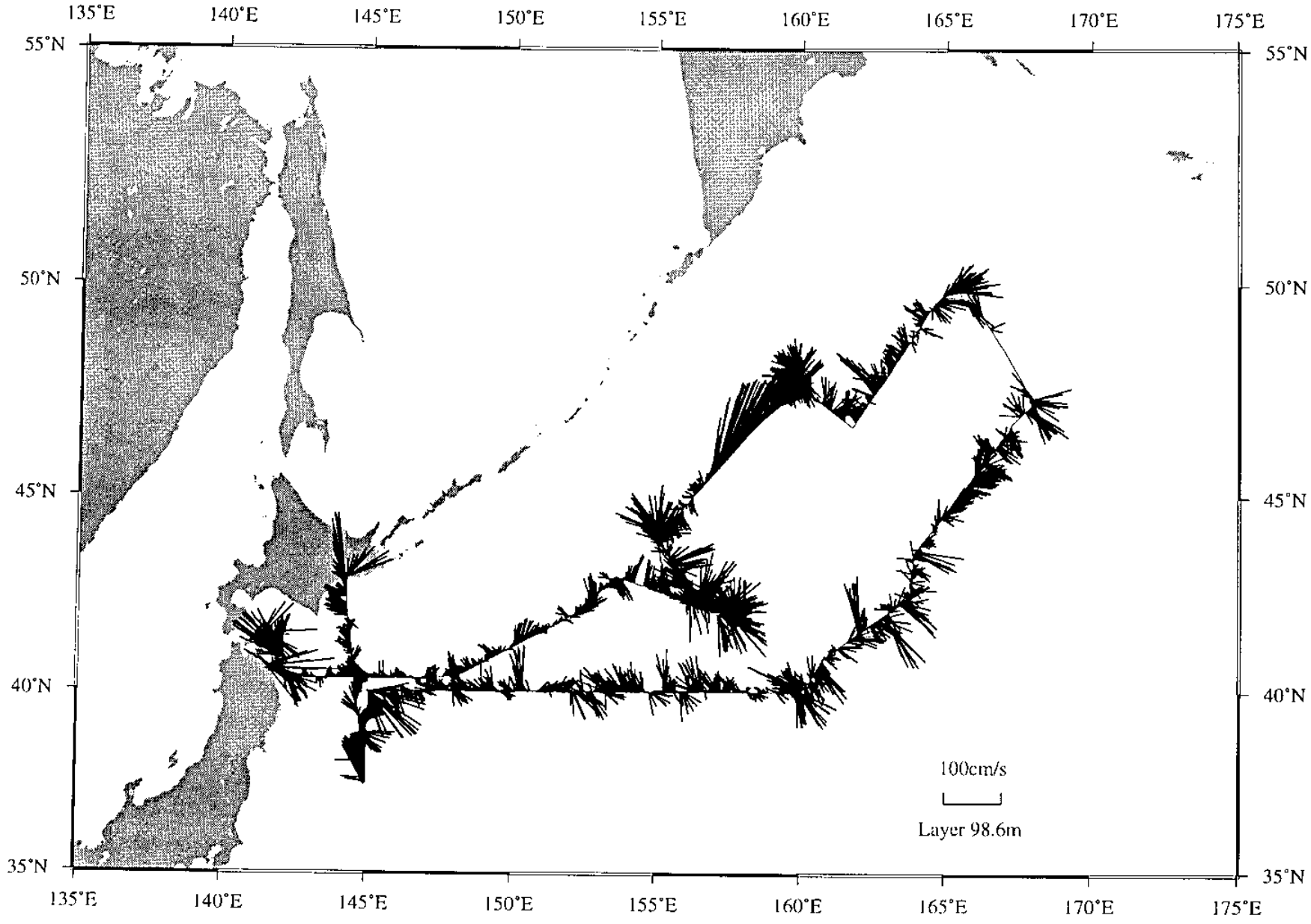
Frequency:	75KHz
Average:	every 300sec
Depth cell length:	1600cm
No. of depth cells:	40
First depth cell position:	32.6m
Last depth cell position:	656.6m
ADCP ensemble time:	51.9 s
Ping per ADCP	16

4. Preliminary results

Five-minutely vectors with 1-hour runnimg mean plotted. Fig (3)-21.1.2 shows layer 98.6 m.

5. Data archives

ADCP data will be submitted to the DMO(Data Management Office), Jamstec and will be under their control. 5-minute averaged process data , navigation data and raw data are contained in the 3.5" Modisk.



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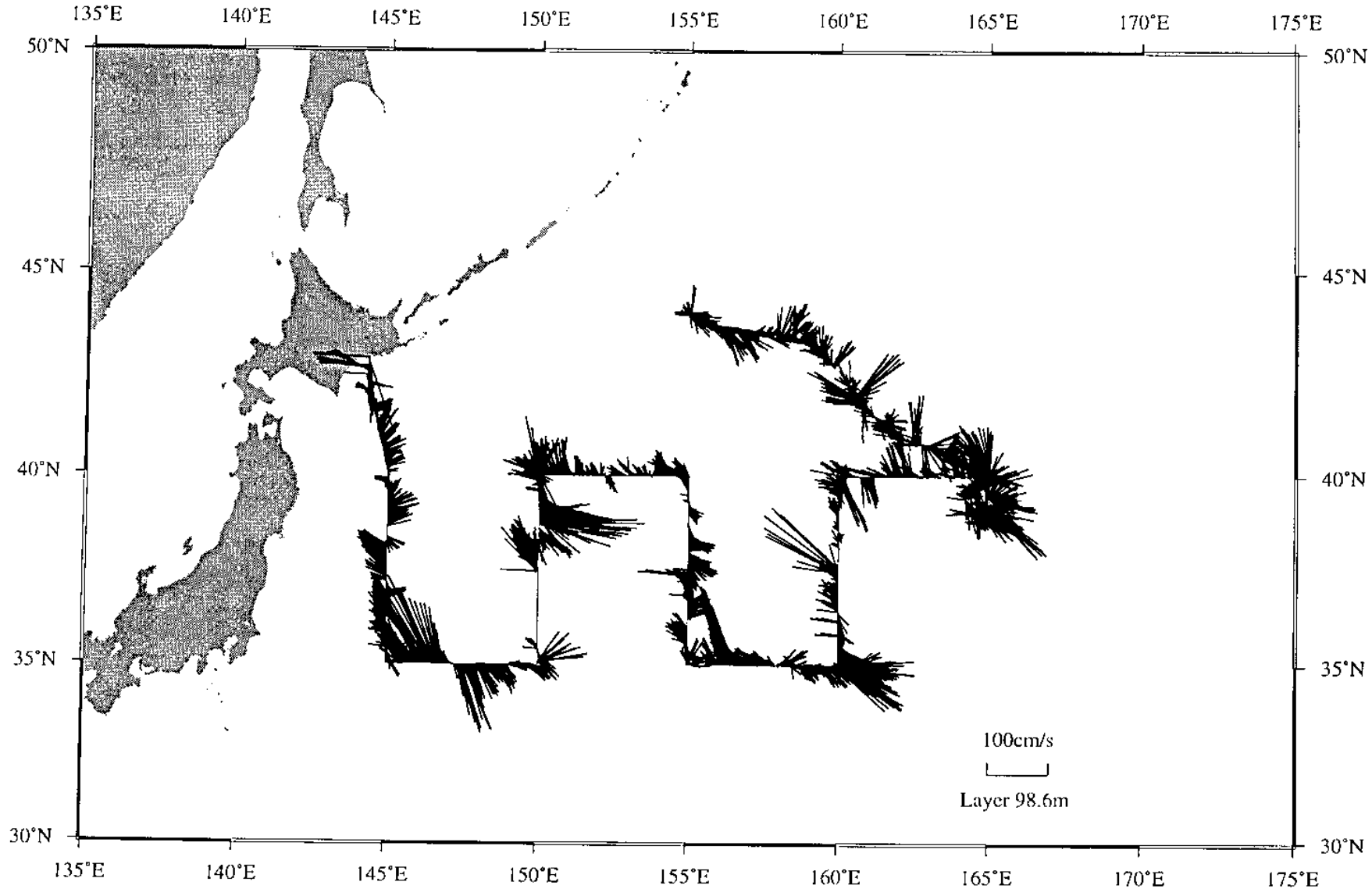
ADCP MR98K01 Leg-1

Mercator Projection

Fig. 3.21.1



ADCP MR98K01 Leg-2

Fig. 3.21.2

3.22 Geophysical Observation

Toshio Furuta, Naoto Morioka (G.O.D.I.) and Masaki Nakahara(K.G.E)

3.22.1 Sea Beam Observation

1. Objectives

(1)To obtain the continuous swath water depth for contribution of]geophysical investigation.

(2)To obtain bathymetric data for deep water sampling.

To perform the above 2 items, the Sea Beam Observation is carried out routinely along the ship tracks through the cruise. In addition to the swath survey alongthe ship tracks, the determination of water depth is performed on the CTD cast sites.

2. Instruments

A 12kHz Seabeam 2112 MultiNarrow Beam Bathymetric Survey System with 4kHz SubBotton Profiler manufactured by the Sea Beam Instruments, Inc., USA is used for measuring water depth.

3. Summary

We carried out bathymetric survey during MR98-K01 cruise. The contour maps around sites of Station13 and Station17 are made on the basis of Sea Beam data.

We observed subsurface structures using by subbottom profiling images at Station13 for the future mission of sediment sampling.

Sound velocity profiles to be used ray path correction of acoustic multibeam were provided from CTD casts near the each site and short XBT data.

The whole ship-tracks of Sea Beam observation and the contour maps of survey area as well as ship-tracks are shown in Figures (3)-22-1-1 to (3)-22-1-6.

4. Remarks

During the MR98-K01 cruise, there are a lot of day suffered from rough sea-condition, the system could not frequently get return signals from the bottom enough to data processing.

MR98-K01, Leg1, SeaBeam Track

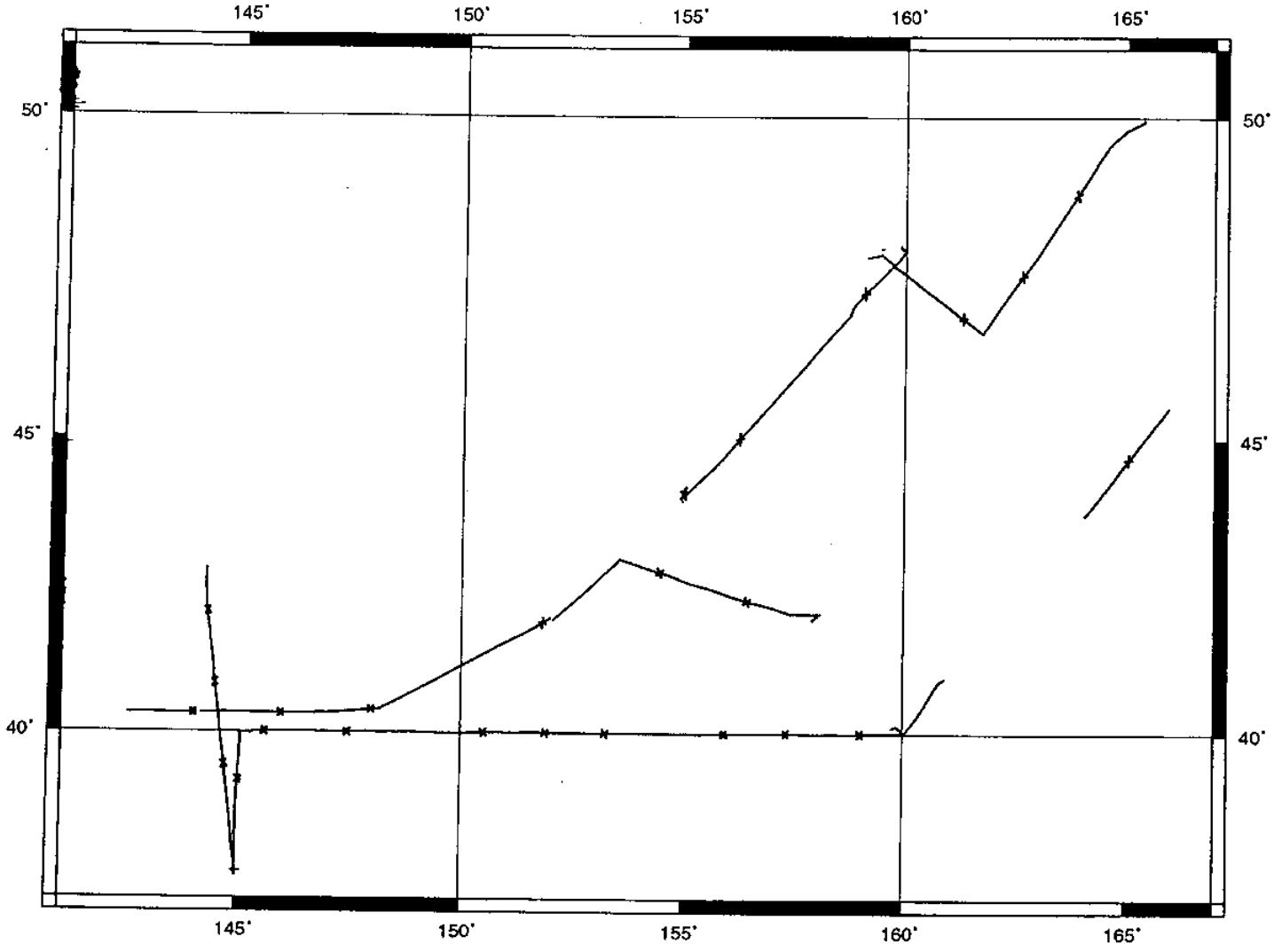


Fig. 3.22.1.1

MR98-K01, Leg 2, SeaBeam Track

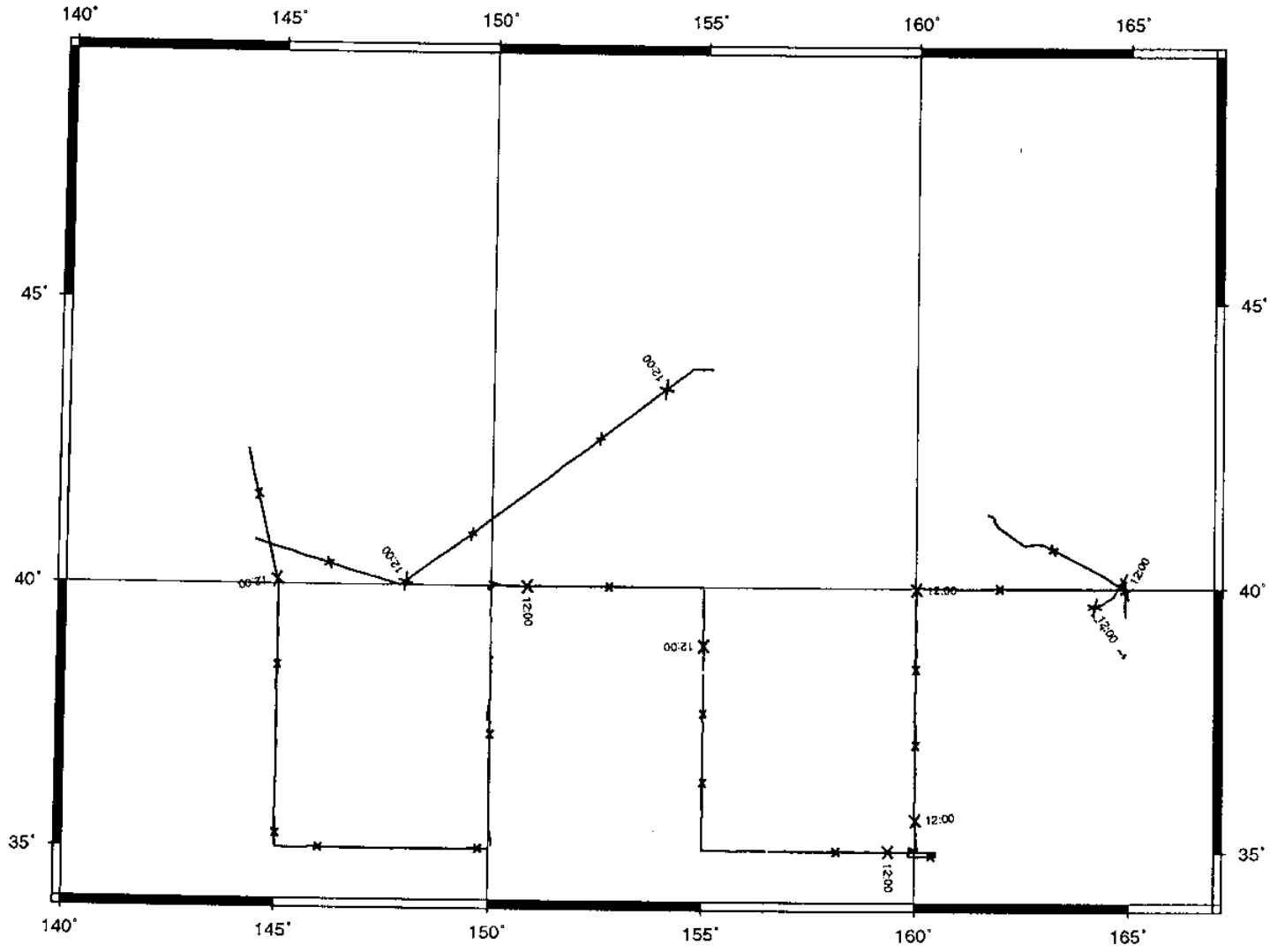


Fig. 3.22.1.2

MR98-K01, STN13

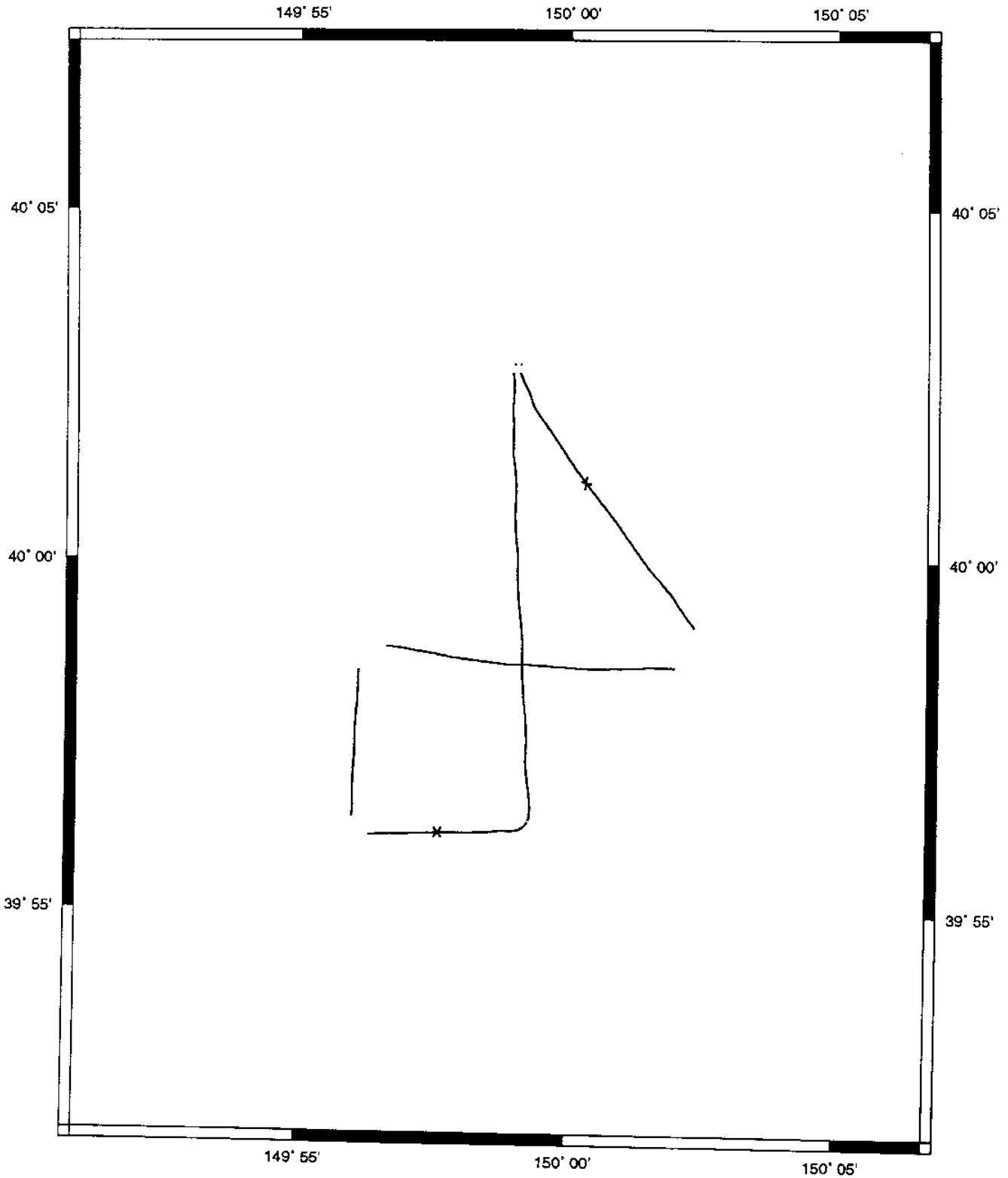


Fig. 3.22.1.3

STATION 13

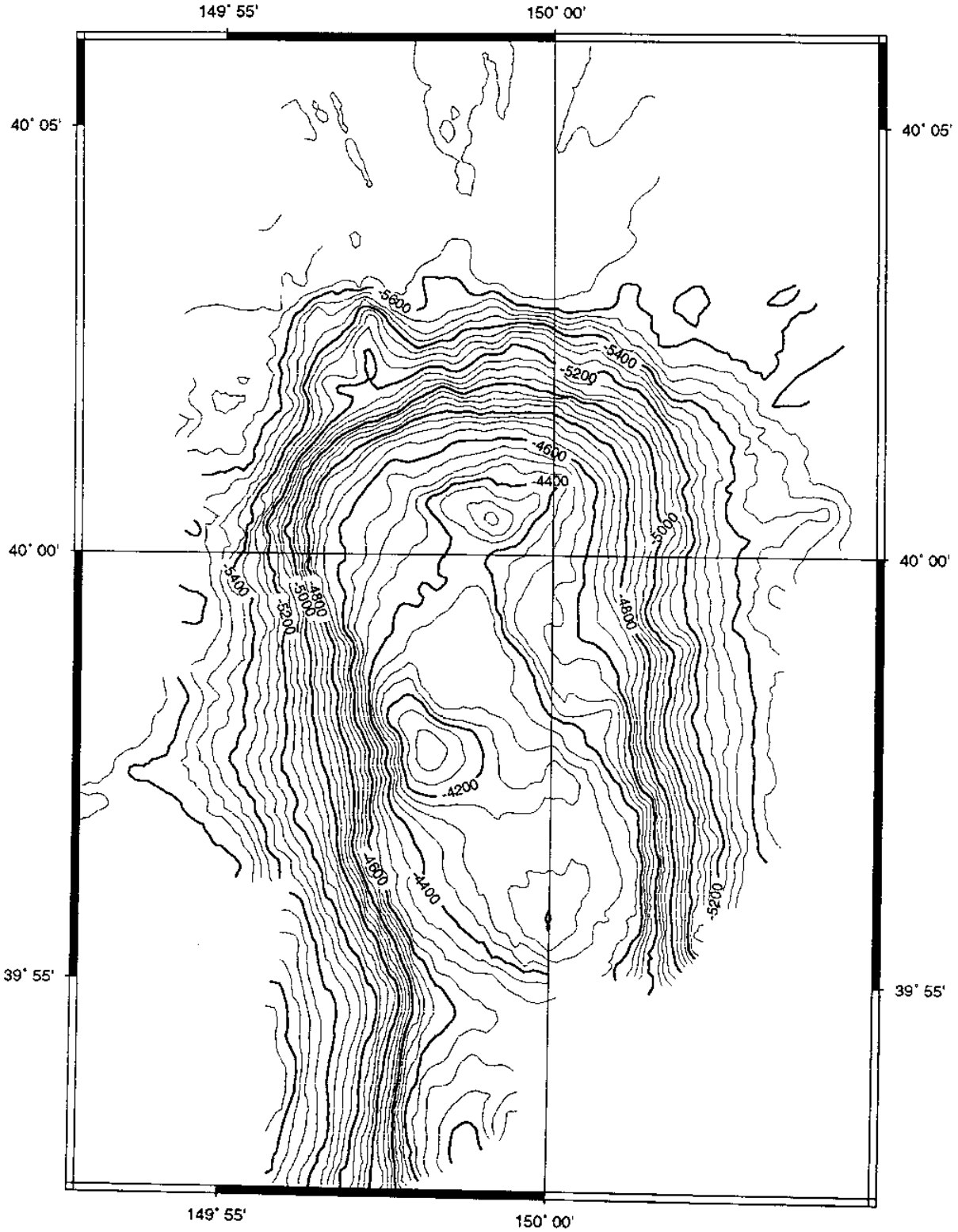


Fig. 3.22.1.4

MR98-K01, Station 17

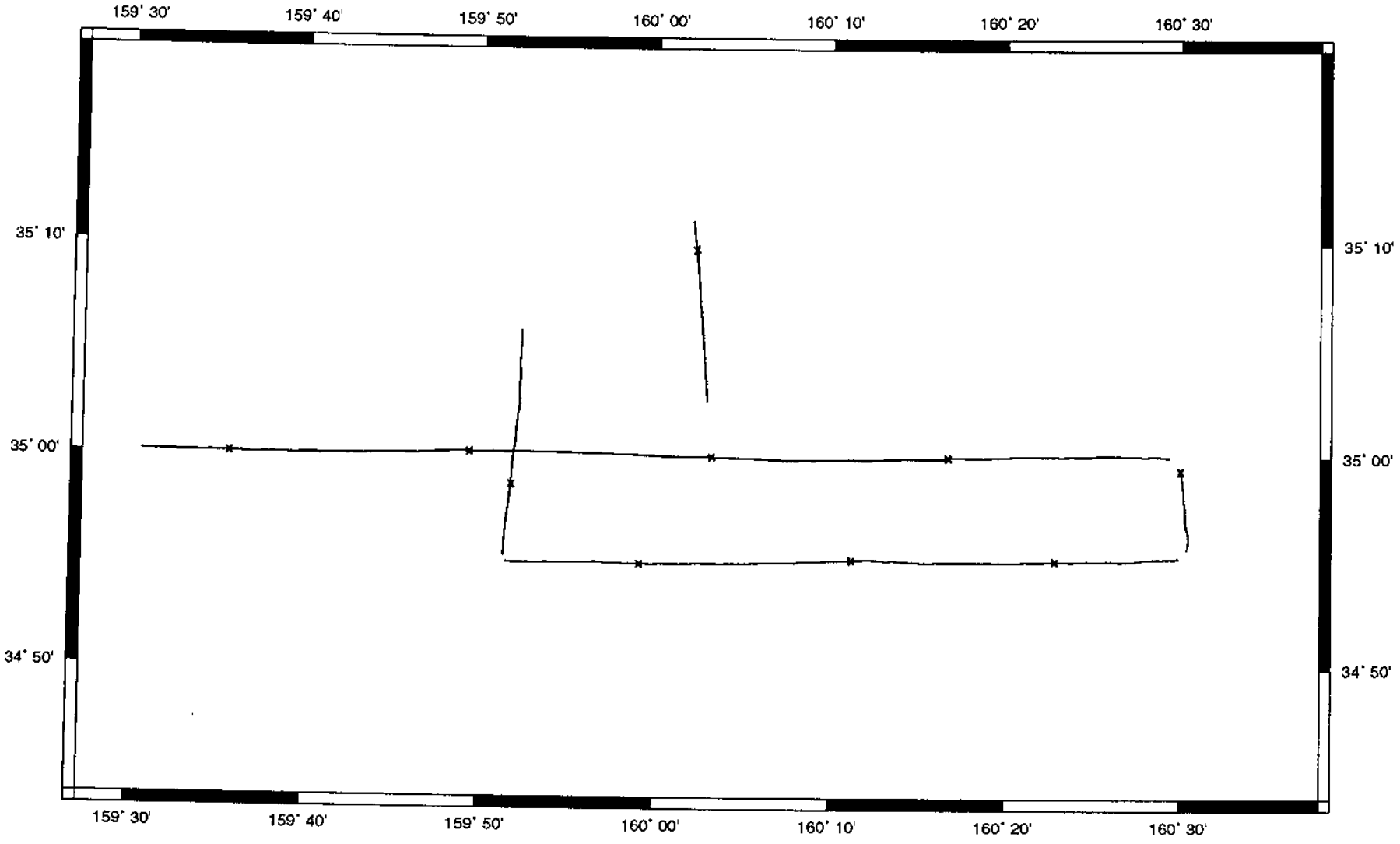


Fig. 3.22.1.5

Station 17

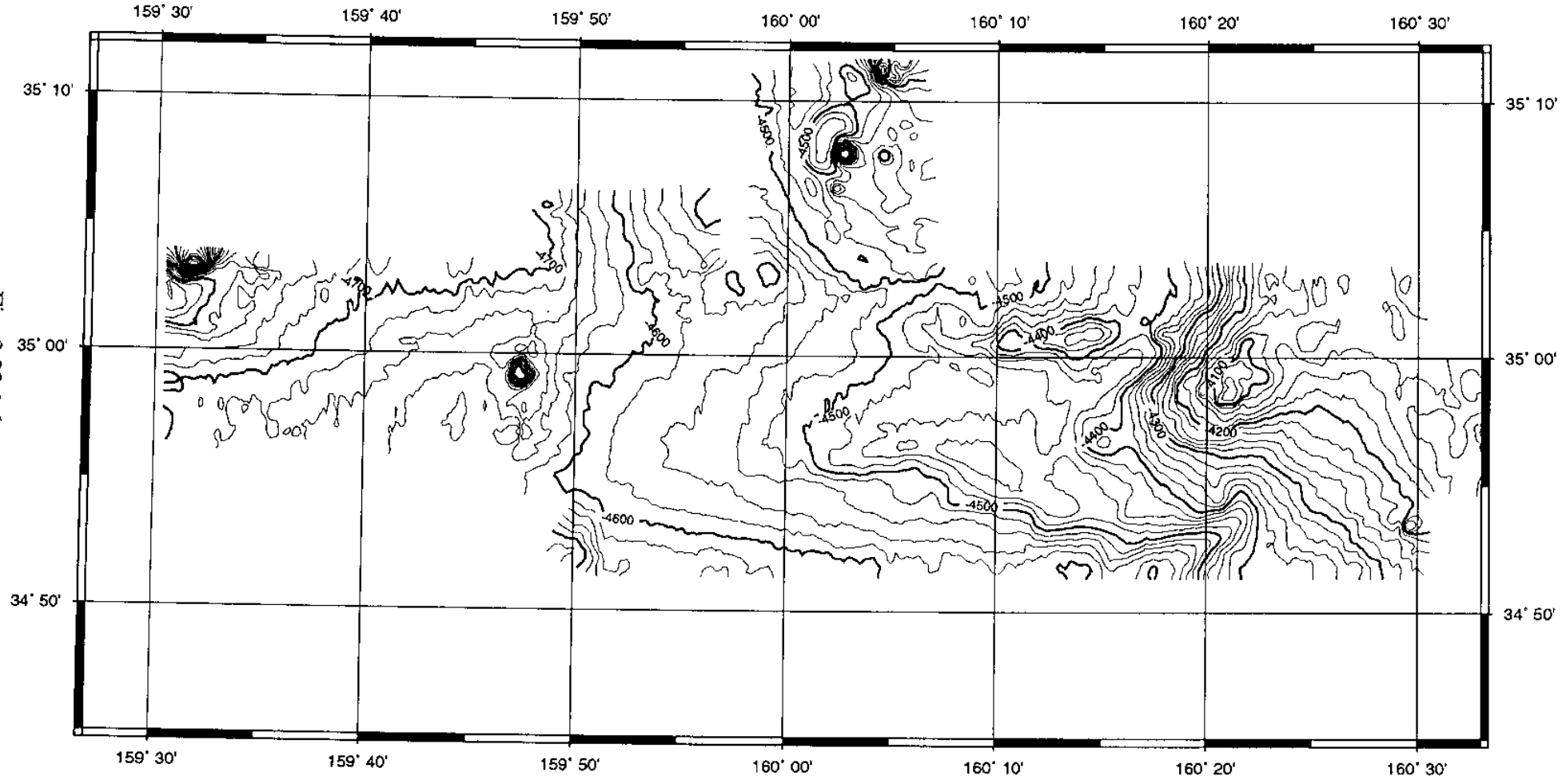


Fig. 3.22.1.6

Knot

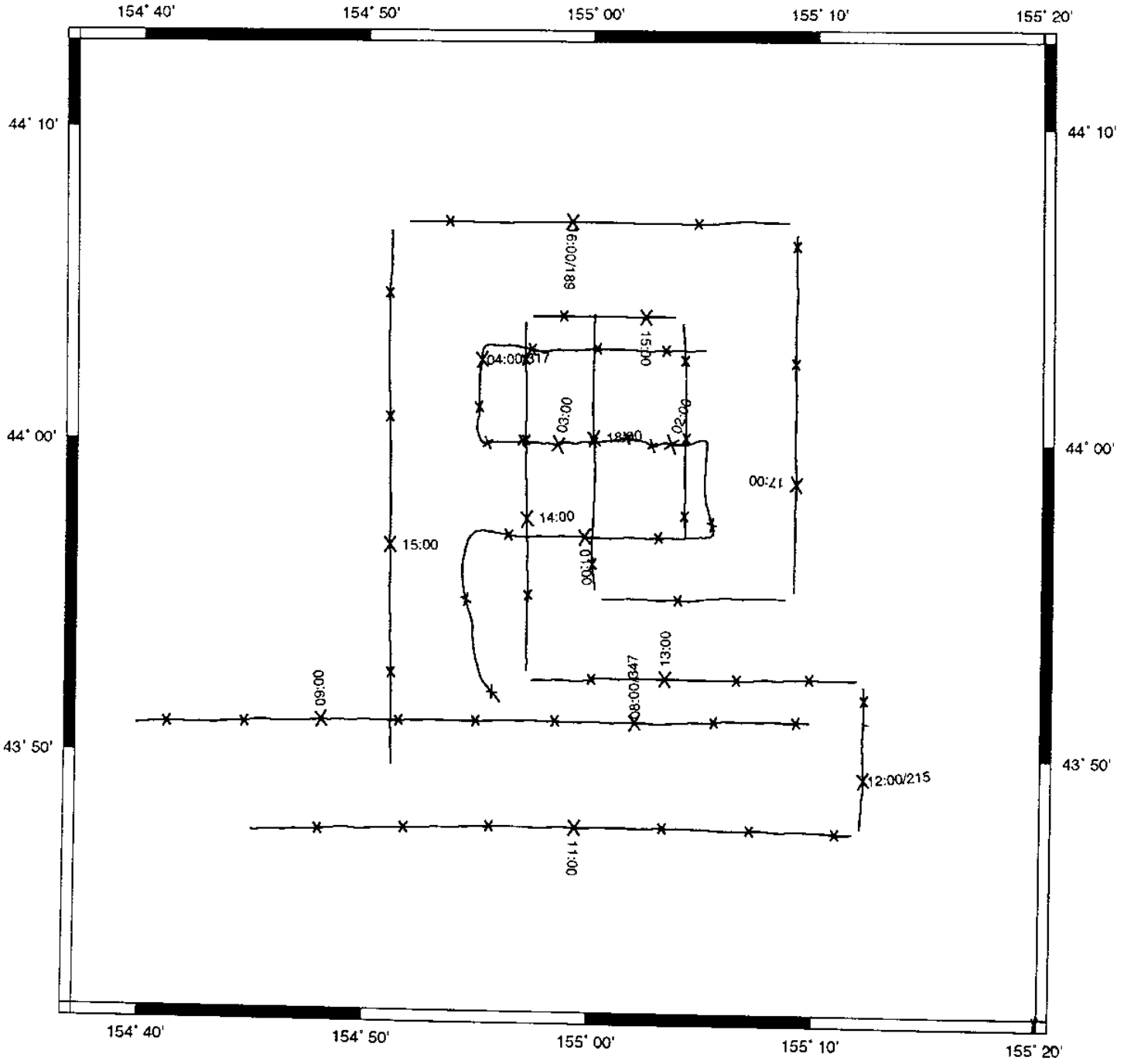


Fig. 3.22.1.7

KNOT(MR9702, MR9805, MR9806 & MR98k01)

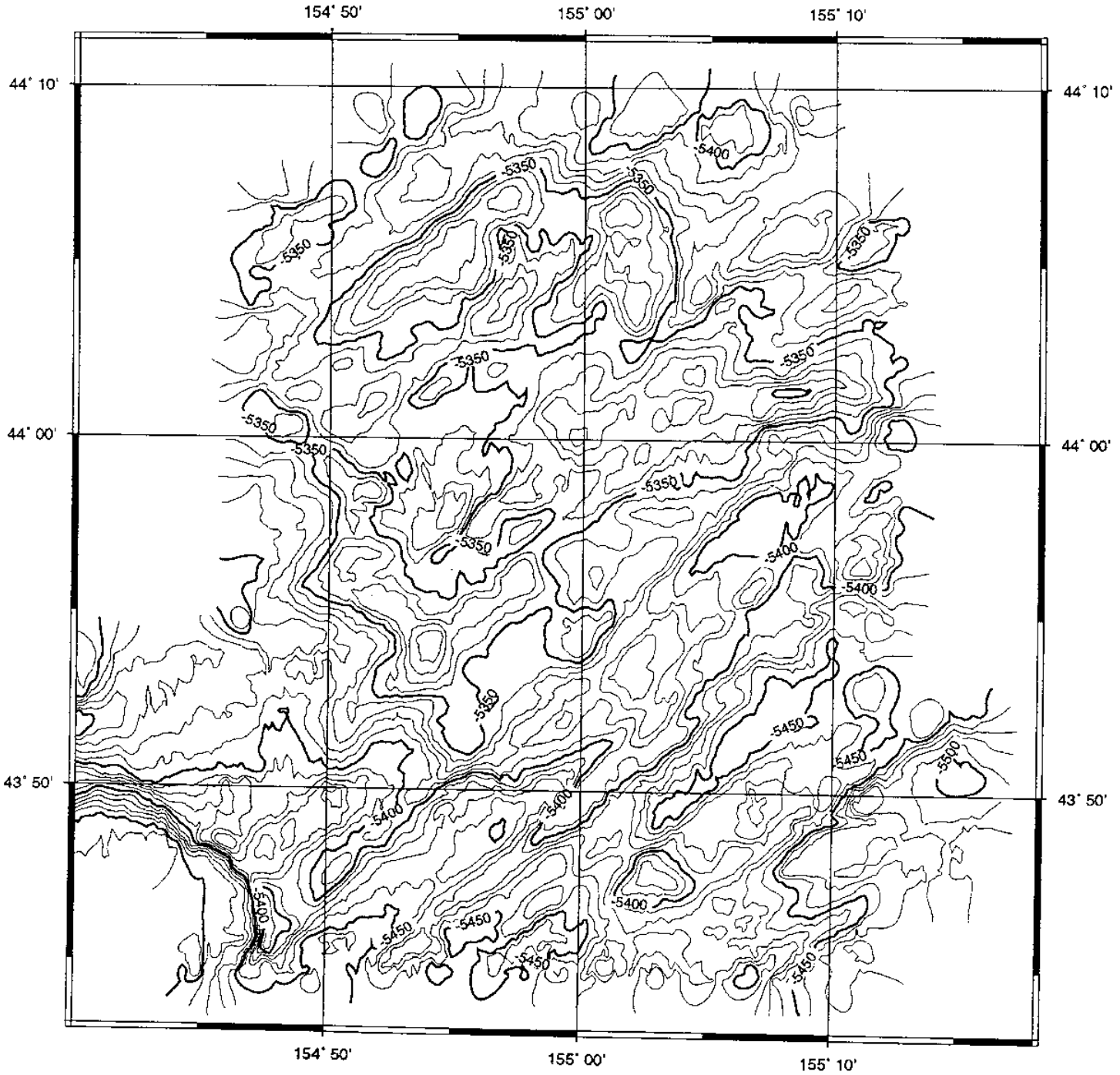


Fig. 3.22.1.8

3.22.2 Sea Surface Gravity Measurement

1. Objective

(1)To obtain the continuous gravity data for contribution of geophysical investigation.

To perform the above item ,sea surface gravity is measured relative variation of gravity values through the cruise.

2. Instruments

Gravity measurement on the sea is using by a LaCoste-Romberg gravity meter S-116. To determine of drift ration of the surface gravity sensor, we measured the gravity values at the each port using by an Automated Gravity Meter CG-3M Autogav, SCINTREX, in comparison with the surface gravity sensor.

3. Summary

We carried out gravity measurement during MR98-K01 cruise(from Sekinehama to Sekinehama). Detailed data analysis based on the measurements will be done on the shore base.

4. Remarks

We stopped gravity meter operation during rough sea-condition, the data should be evaluated at the each port to correlated with reference values at each port.

3.22.3 Surface Three component magnetometer

1.Objective

(1)To obtain the continuous three component magnetic field for contribution of geophysical investigation.

To perform the above item, the three component measurement of total geomagnetic filed is carried out through the cruise.

2. Instruments

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

3. Summary

We get three component magnetic data during MR98-K01 cruise(from Sekinehama to Sekinehama). The database contains high ratio of ship attitude is a very useful not only for geomagnetic investigation by for precise ship movement analysis.

We collected data to be eliminated the effect of hull magnetization from measured three component magnetic data at Station20 (40°N, 165°E).

4. Remarks

The system is no trouble and we get a good three component magnetic data.

3. 23 Doppler radar observation

(1) Personnel

Naoto Morioka (G.O.D.I.)

(2) Objectives

Main theme to use Doppler radar is to investigate the precipitation mechanism of convections which develop over the ocean. In addition ,rainfall map would be produced to contribute to the fresh water budget over tropical weastern Pacific Ocean.

(3) Parameters

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

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

(4) Methods

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

In the present cruise, we observe rainfall by CAPPI mode and PPI mode from 4rh November to 20th November.

Major specification of the Doppler radar is as follow

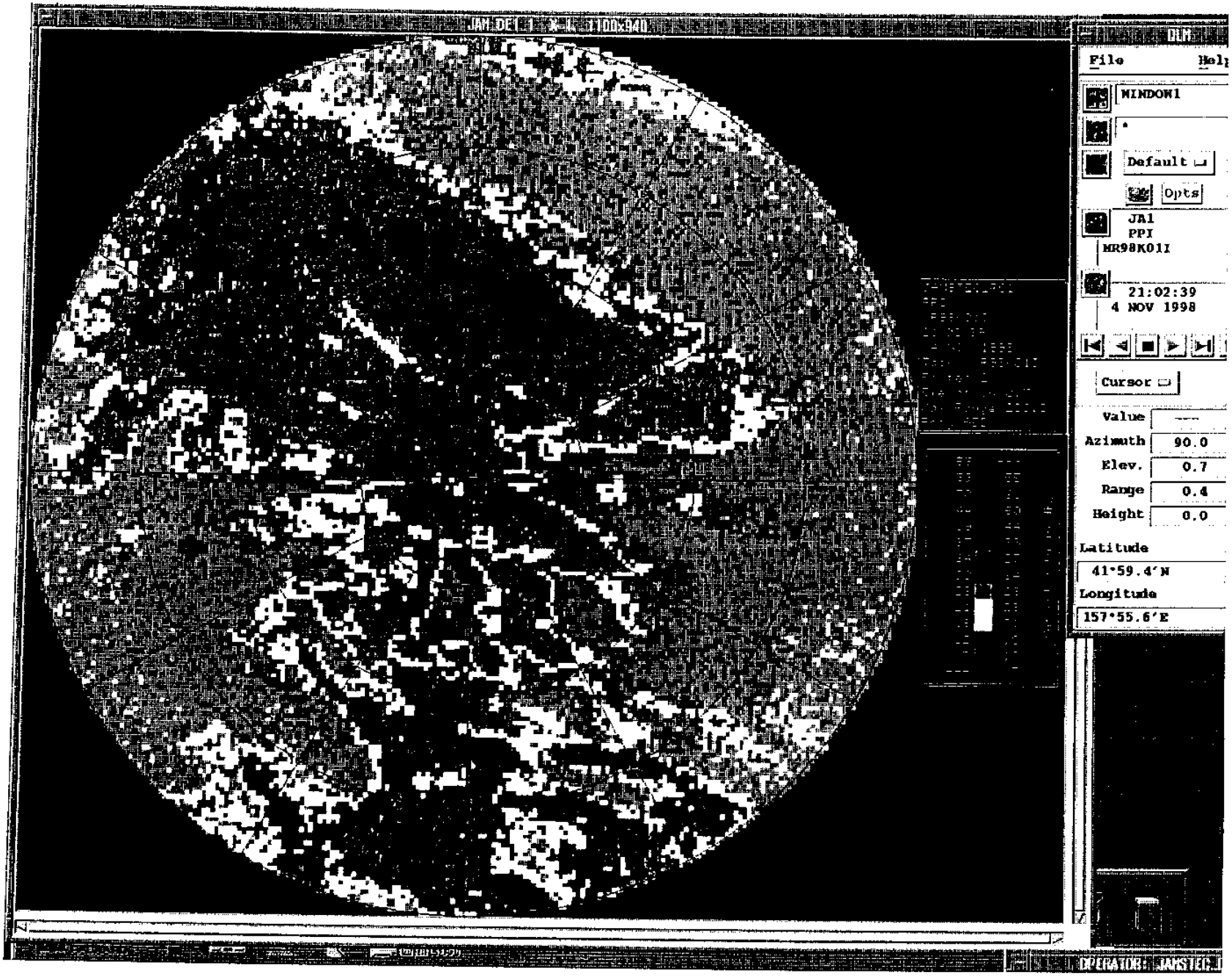
Type: :	RC-52B (Mitsybishi Electric Co. Ltd., Japan)
Frequency:	5290MHz
Beam Width:	Better than 1.5 degree
Output Power:	250kw(pep)
Signal Processor:	RVP-6 (Sigmet, Inc., USA)
Application S/W:	IRIS/Open (Sigmet, Inc., USA)
Intetial navigation unit:	DRUH (Honeywell, Inc., USA)

(5) Resault

The preliminary result is shown in in PPI radar images (Fig. 93)-23.1)

(6)Data archive

Doppler Radar data obtained in this cruise will be submitted to the DMO.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Opts
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4 NOV 1998
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Value
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Height 0.0
Latitude
41°59.4'N
Longitude
157°55.6'E

Fig. 3.23.1