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Tropical Ocean Climate Study (TOCS)

KY9901 Cruise Report

January 26, 1999 - March 2, 1999

Japan Marine Science and Technology Center

TOCS KY99-01 Cruise Report

1. Cruise Summary

Ship	: R/V KAIYO
Chief Investigator	: Yuji Kashino (JAMSTEC)
Co-Chief Investigator	: Lukiyanto (BPPT)
Cruise Code	: KY99-01
Project Title	: Tropical Ocean Climate Study
Period	: January 26, 1999 - March 1, 1999
Ports of call	: Majuro (Marshall Islands) Koror (Republic of Palau)
Institute	: JAMSTEC (Japan Marine Science and Technology Center) BPPT (Badan Pengkajian dan Penerapan Teknologi) University of Hawaii PMEL (Pacific Marine Environmental Laboratory) MWJ (Marine Work Japan Co. LTD) NME (Nippon Marine Enterprise Co. LTD) KEEC (Kansai Environmental Engineering Center Co.LTD)

Purpose: The purpose of this cruise is to observe currents, temperature, salinity etc., in the western equatorial Pacific to understand the ENSO (El Nino/Southern Oscillation) phenomena. Because El Nino is occurred with migration of the warm water pool in the western equatorial Pacific, variability of the warm water pool is focused in this study. Additionally, a sea water flow from the Pacific to the Indian Ocean in the Indonesian Seas, i.e., the Indonesian Throughflow is also focused because this flow might be related to the warm water pool variability.

Observation Summery :

(Leg 1)

Following buoy work were performed:

ADCP buoys: 0N, 142E (recovery) and 0N, 138E (recovery and deployment)

One current meter provided by Ocean Research Institute (Tokyo Univ.) was installed at 700m depth at 0N, 138E.

ATLAS buoys: 0N, 147E and 2.4N, 137.5E (recovery and deployment by PMEL)

19 CTD casts were performed until 1000m depth. At all CTD casts, only one Niskin bottle was used to get water sample for salinity measurement.

One XCTD cast was performed near the first CTD station to check its performance.

Current along the cruise track was measured by a shipboard ADCP.

CO_2 concentration in air and sea water was measured along the cruise track by KEEC.

These observation were conducted in the open sea, Marshall Islands EEZ, Papua New Guinea EEZ, Micronesia EEZ, Indonesian EEZ and Palau EEZ.

(Leg 2)

Five current meters were deployed at 5-07N, 125-40E (Philippine EEZ).

67 CTD casts and 30 XCTD casts were performed to measure temperature, salinity vertical profile.

casts of them were conducted using the Lowered ADCP by University of Hawaii to measure vertical profile of the current until 2000m depth.

Oxygen and salinity in sampled water were measured by six Niskin bottles at CTD casts

Current along the cruise track was measured by a shipboard ADCP.

CO_2 concentration in air and sea water was measured along the cruise track by KEEC.

These observation were conducted in the open sea, Palau EEZ, Philippine EEZ, and Indonesian EEZ and territorial water.

Preliminary Results (by Yuji Kashino)

During this cruise, typical La Nina has been occurring. According to the SST distribution shown in the PMEL home page at December 1998, low SST anomaly (with maximum of -4°C) was seen at the east of 160E. Actually, the South Equatorial Current was extremely strong (> 1 m/sec) due to this phenomena. Since ship speed during Leg 1 was usually exceeded than 12knot due to this strong surface westward current, weather was good and every jobs during Leg 1 did well, R/V Kaiyo arrived at Palau two days earlier.

In contrast, at the begging of Leg 2, we met some troubles. At first, because issue of the clearance for Philippine EEZ delayed and was issued on February 18, we must change course from Palau to Mindanao, from 7N to 6N. Next, Kaiyo again shifted to 5N because of swell with height of > 3m due to low pressure. Additionally, at 5N, there was an against strong current (eastward), North Equatorial Countercurrent, which kept ship speed of R/V Kaiyo slower than 9knot. Finally, lowered acoustic Doppler current profiler (LADCP) prepared by University of Hawaii did not work well after st.23.

However, everything became well after mooring deployment at the south of Mindanao (5-7N, 125-40E) in the Philippine EEZ. (Its clearance was issued just before its deployment !!) Although appearance of the pirates was anticipated in the observation area during Leg 2, they did not appear. Weather also became good after mooring deployment. Consequently, we conducted additional observations in the Maluku Sea by spending remainder ship time, which was derived due to giving up observation near the Mindanao.

In this cruise, it is first time for us (maybe for all foreign ships in the world !!) to conduct observation in the Indonesian territorial water using JAMSTEC's ship. It is also first time to deploy the mooring in the current axis of the Mindanao Current in the Philippine EEZ. Additionally, we used two new instruments for observation: XCTD and LADCP. That is, this cruise was conduced to obtain new data of the Indonesian Throughflow, and knowledge/experience of the new instruments.

Main purpose of Leg 1 cruise is to maintain the ATLAS and ADCP buoys, and we succeeded to completely achieve this purpose. We did not meet any troubles concerning the ATLAS buoys. With regard to ADCP buoys, we found that ADCP buttery at 0N, 142E was almost consumed. Its reason is still unknown and should be checked. Until their recoveries, we have been afraid that acoustic releaser by Benthos (not ADCP) would not work because of problem of consuming its buttery, but all releasers worked well, fortunately.

Data from the moored ADCPs show some interesting current fluctuations. For example, result from the ADCP at 0N, 142E at 50m depth shows that strong westward South Equatorial Current was not seen from June 1998 to December 1998, i.e., this westward flow appeared in January 1998 in this longitude. At 138E, eastward flow appeared just before this cruise.

30-day oscillation, which was reported by H. Matsuura in the cruise report of KY9801, is clearly seen in the meridional component of the moored ADCP velocity at 50m depth at both longitudes. In contrast, variability with period of about two months appeared at the thermocline depth (150m).

As mentioned above, shipboard ADCP shows that surface westward current along the equator is pretty strong with maximum speed of 1.5m/sec. This surface westward flow was observed near 5N, 137E, and the eastward North Equatorial Countercurrent around this longitude was not clear at surface. At subsurface (200m depth), retroflection of the New Guinea Coastal Undercurrent was observed around 140E and it connected with the Equatorial Undercurrent. The Northern Subsurface Countercurrent (Tsuchiya Jet) was seen at 2.5N, 137E and 165E.

Leg 2 cruise was conducted in order to observe the Indonesian Throughflow. To observe its variability, in particular, 50-day oscillation shown by Kashino et al. [in press], a mooring with five Aanderaa current meters and a SBE-19 were deployed at the current axis of the Mindanao Current, which is main source of the Indonesian Throughflow. This mooring will be recovered during TOCS 1999 autumn cruise.

Shipboard ADCP measurement gave very interested and complicate structure of the Mindanao Current in the Celebes and Maluku Seas, where is no current data by the foreign research vessel with shipboard ADCP until this cruise. The Mindanao Current bifurcated at the southeastern tip of the Mindanao: one part flows eastward as the North Equatorial Countercurrent and the other enter into the Celebes Sea. The part in the Celebes Sea seems to meander and again bifurcate. One goes to the Makkasar Strait and, the other retroflect in the Celebes Sea and return to the Pacific. Some of them. In the Maluku Sea, there is strong outflow to the Pacific, which contained vertically homogenous water originating in the Indonesian Seas.

Although LADCP did not work well after St.23 during Leg 2, its data before this station also shows interesting results. There is the northward current at 5N around 128E between 500m and 1000m depth: it might be the Mindanao Undercurrent. Unfortunately, it is difficult to confirm that this is a current or eddy since 5N is only one section measured by LADCP. Further observations are needed to conclude it.

Water mass distribution not only in the southernmost Philippine Sea but also in the Celebes Sea and Maluku Sea is obtained by CTD and XCTD. In particular, it is interesting that we observed homogenous vertical profiles in these Indonesian waters. Comparison with results by the shipboard ADCP current vector may give further interesting aspect in oceanography in this region.

Acknowledgments:

We would like to express special thanks to Captains Hasegawa (Leg 1) and Tanaka (Leg 2) and crew of R/V Kaiyo. During the cruise, technicians of Marine Work Japan Co. Ltd. And Nihon Marine Enterprise Co. Ltd., participated in this cruise and helpfully supported us.

This cruises were conducted as a joint project by Japan Marine Science and Technology Center (JAMSTEC), Japan, and Badan Pengkajian Dan Penerapan Teknologi (BPPT), Indonesia. We thank our colleagues in JAMSTEC and BPPT for their efforts in conducting this cruise. We also thank Mr. Sidik Praptakuncara, security officer of the Indonesian Navy, who pleasantly gave us the permission of the observation in the Maluku Sea, where was not planned at first.

2.List of Instruments

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

- SBE9-11 plus system,Sea Bird Electronics,Inc.,USA
  CTD Fish for 10,500m(TOCS Group)

  Primary: T-sensor SN1462
  C-sensor SN1045
  Secondary: T-sensor SN1465
  C-sensor SN1174
  P-sensor SN41223
  DO-sensor SN130311

(2) Shipboard ADCP (Acoustic Doppler Current Profiler)
VM-75,RD Instruments,USA
(75kHz,16m bin length, Normal range 560m starting 30m depth)

(4)Dissolved Oxygen

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

(5)Bottom Salinity

- Guildline Autosal Model8400B

(6)PCO_2 and TCO_2

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

3 . Participants List

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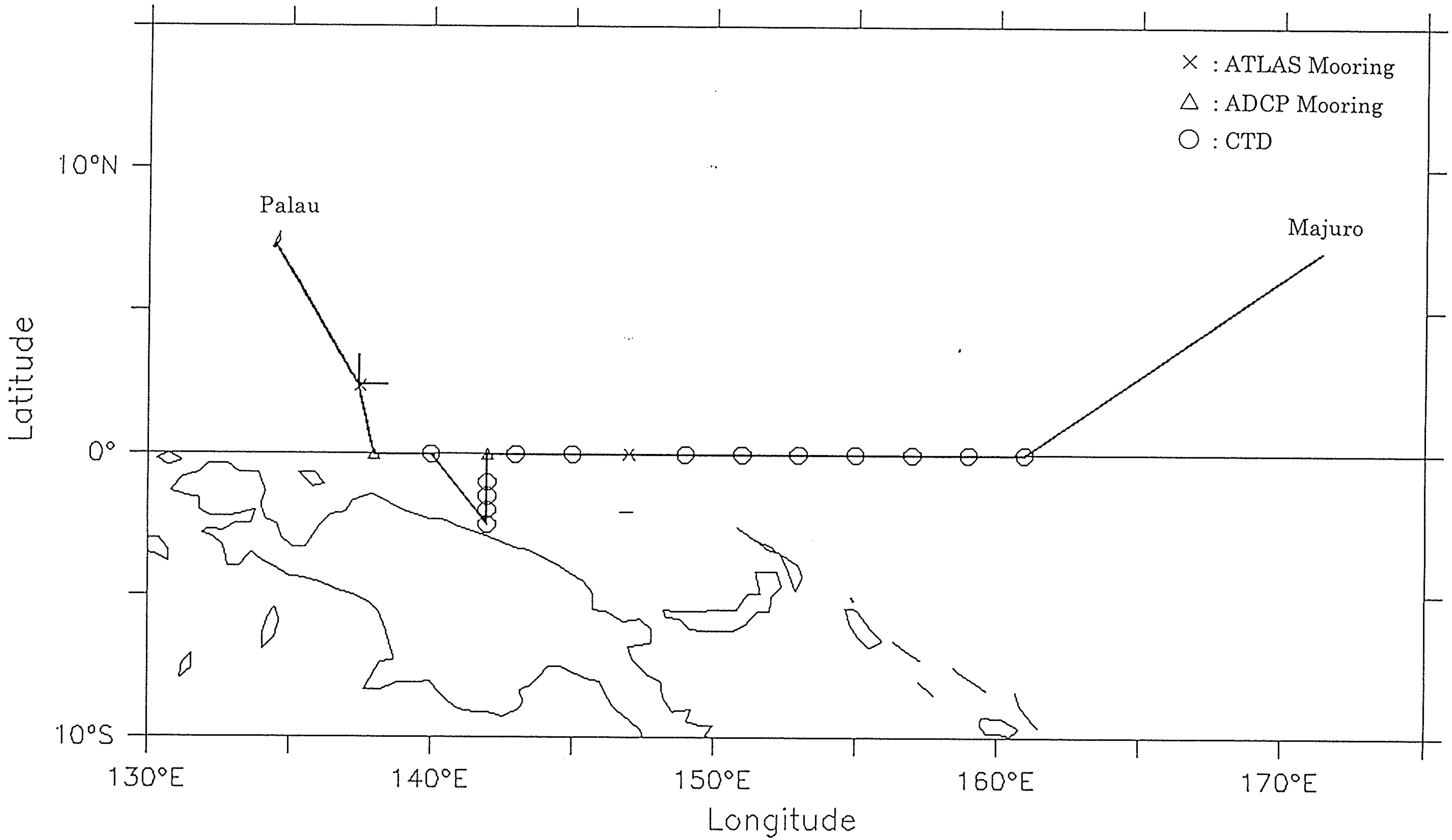
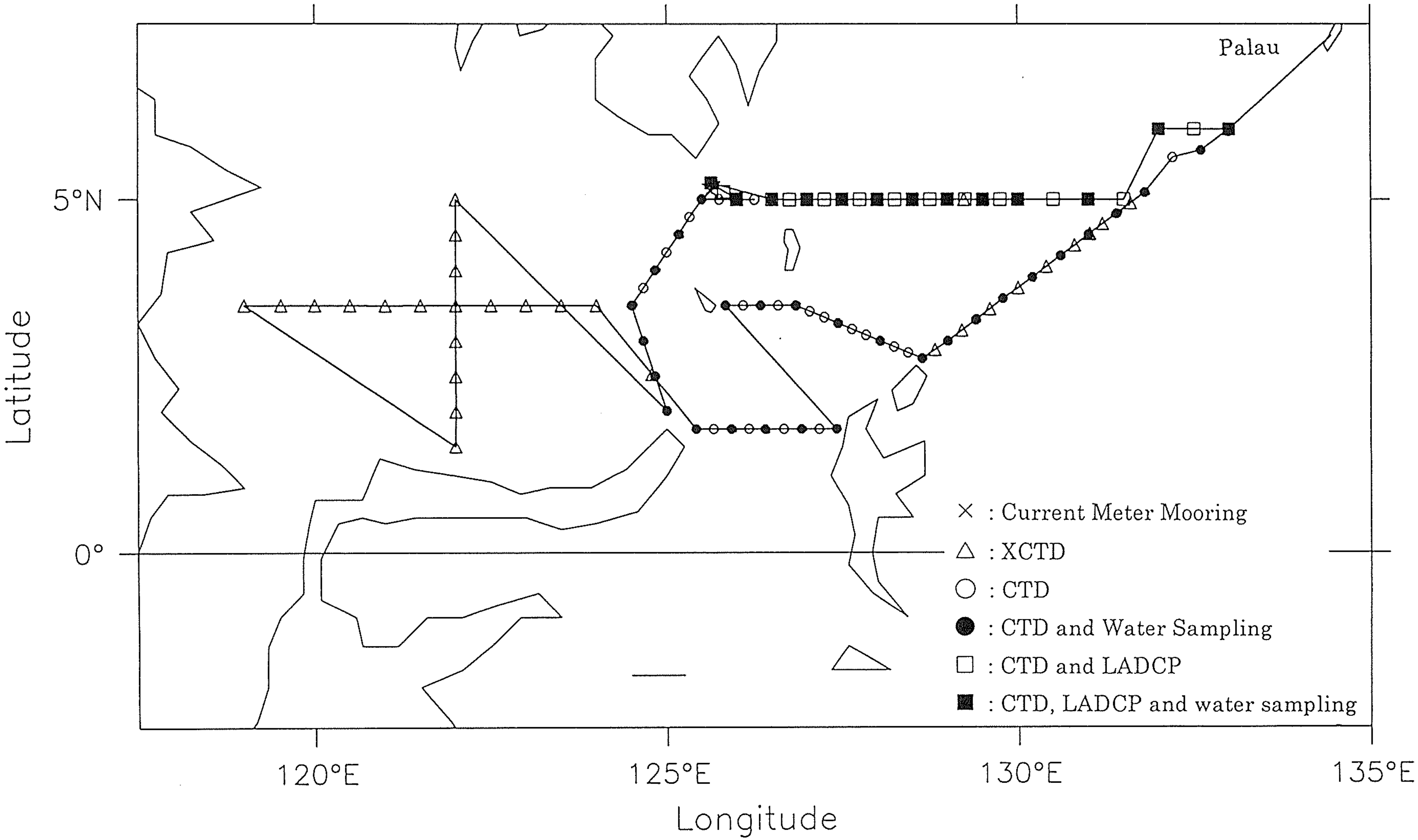
R / V KAIYO Crew Menbers

Captain	Kiyoshi Hasegawa ／ Hitoshi Tanaka
Cheif Officer	Eikou Ukekura
Second Officer	Kazunori Fujiwara
	Toshinobu Miyata
Third Officer	Akihiro Shimada
Cheif Engineer	Toshiichi Hirose
First Engineer	Yoichi Kikuchi
Second Engineer	Yoshinobu Hiratsuka
Third Engineer	Dai Yamanishi
Cheif Radio Officer	Masayuki Sasaki ／ Masahiro Aimono
Second Radio Officer	Shibuki Kuwaoka
Boatswain	Haruo Kobayashi
Able Seaman	Makio Nakamura
Able Seaman	Sakae Sasaki
Able Seaman	Yoshiaki Kawamura
Able Seaman	Hideo Isobe
Able Seaman	Keiji Shikama
Able Seaman	Hirohiko Nakagawa
No.1 Oiler	Akira Terai
Oiler	Chikara Inoue
Oiler	Makoto Kobayashi
Oiler	Kazuo Abe
Oiler	Katsuyuki Miyazaki
Cheif Steward	Kiyotoshi Teranishi
Steward	Yoshinobu Hasatani
Steward	Kyoichi Hirayama
Steward	Isao Matsumoto
Steward	Kazunori Nagano



KY9901 TOCS Leg 1



KY9901 TOCS Leg 2

4.2 CTD Cast Table

St.	Time(GMT)	Latitude	Longitude
C01	28 Jan. '99 19:47	00-00.021S	160-59.23E
C02	29 Jan. '99 06:00	00-00.41S	158-59.836E
C03	29 Jan. '99 15:16	00-00.121S	157-00.179E
C04	30 Jan. '99 02:14	00-00.106S	155-00.048E
C05	30 Jan. '99 12:03	00-00.021S	153-00.010E
C06	30 Jan. '99 21:50	00-00.139S	151-00.101E
C07	31 Jan. '99 07:45	00-00.050N	149-00.000E
C08	01 Feb. '99 04:39	00-00.284N	146-57.463E
C09	01 Feb. '99 21:56	00-00.080N	144-59.917E
C10	02 Feb. '99 08:50	00-00.065N	143-00.047E
C11	02 Feb. '99 23:30	00-00.227N	141-58.240E
C12	03 Feb. '99 02:51	00-29.802S	141-59.864E
C13	03 Feb. '99 06:05	00-59.837S	142-00.087E
C14	03 Feb. '99 09:21	01-29.857S	142-00.026E
C15	03 Feb. '99 12:33	01-59.972S	142-00.086E
C16	03 Feb. '99 15:49	02-30.159S	142-00.100E
C17	04 Feb. '99 09:56	00-00.140S	140-00.015E
C18	05 Feb. '99 03:00	00-00.745S	138-00.989E
C19	06 Feb. '99 03:54	02-26.067N	137-24.499E
C20	14 Feb. '99 14:30	05-59.933N	132-59.843E
C21	14 Feb. '99 18:32	05-59.977N	132-30.061E
C22	14 Feb. '99 22:30	06-00.007N	131-59.904E
C23	15 Feb. '99 05:33	05-00.018N	131-30.252E
C24	15 Feb. '99 10:31	04-59.995N	131-00.073E
C25	15 Feb. '99 15:19	05-00.014N	130-30.244E
C26	15 Feb. '99 19:45	05-00.061N	130-00.127E
C27	15 Feb. '99 22:37	05-00.052N	129-45.045E
C28	16 Feb. '99 01:19	04-59.955N	129-30.076E
C29	16 Feb. '99 04:08	05-00.002N	129-15.023E
C30	16 Feb. '99 06:52	05-00.044N	129-00.039E
C31	16 Feb. '99 09:37	04-59.946N	128-45.025E
C32	16 Feb. '99 12:02	04-59.943N	128-29.998E
C33	16 Feb. '99 14:40	04-59.988N	128-15.020E
C34	16 Feb. '99 17:05	04-59.930N	128-00-048E
C35	16 Feb. '99 19:42	05-00.081N	127-45-093E
C36	16 Feb. '99 22:13	05-06.015N	127-29.975E
C37	17 Feb. '99 00:43	04-59.952N	127-15.000E
C38	17 Feb. '99 03:36	04-59.990N	127-00.042E
C39	17 Feb. '99 05:16	04-59.802N	126-45.017E
C40	17 Feb. '99 07:22	05-00.048N	126-29.911E
C41	18 Feb. '99 03:59	05-13.964N	125-37.990E
C42	18 Feb. '99 06:02	05-06.906N	125-48.945E
C43	18 Feb. '99 08:07	05-00.021N	125-59.923E
C44	18 Feb. '99 10:22	04-59.972N	126-14.978E
C45	18 Feb. '99 13:24	05-00.009N	125-44.972E
C46	18 Feb. '99 15:15	05-00.143N	125-30.026E
C47	18 Feb. '99 17:24	04-45.082N	125-19.629E
C48	18 Feb. '99 19:28	04-30.121N	125-10.229E
C49	18 Feb. '99 21:49	04-14.977N	124-59.949E
C50	19 Feb. '99 00:04	03-59.925N	124-49.983E

St.	Time(GMT)	Latitude	Longitude
C51	19 Feb. '99 12:23	03-45.009N	124-40.144E
C52	19 Feb. '99 04:56	03-29.990N	124-30.033E
C53	19 Feb. '99 08:38	03-00.203N	124-39.941E
C54	19 Feb. '99 12:26	02-29.969N	124-50.019E
C55	19 Feb. '99 16:13	02-00.045N	125-00.035E
C56	24 Feb. '99 09:43	01-44.957N	125-25.102E
C57	24 Feb. '99 11:52	01-45.082N	125-40.010E
C58	24 Feb. '99 13:49	01-45.048N	125-55.058E
C59	24 Feb. '99 16:02	01-45.088N	126-10.072E
C60	24 Feb. '99 18:02	01-44.915N	126-24.009E
C61	24 Feb. '99 20:10	01-44.988N	126-39.980E
C62	24 Feb. '99 22:20	01-44.992N	126-55.093E
C63	25 Feb. '99 00:19	01-45.009N	127-10.068E
C64	25 Feb. '99 02:25	01-45.062N	127-25.016E
C65	25 Feb. '99 21:29	03-30.046N	125-50.025E
C66	25 Feb. '99 23:26	03-29.980N	126-05.137E
C67	26 Feb. '99 01:17	03-30.022N	126-20.131E
C68	26 Feb. '99 03:18	03-29.957N	126-35.102E
C69	26 Feb. '99 05:11	03-29.973N	126-50.068E
C70	26 Feb. '99 07:02	03-25.056N	127-02.048E
C71	26 Feb. '99 08:44	03-20.091N	127-14.444E
C72	26 Feb. '99 10:28	03:15.081N	127-26.079E
C73	26 Feb. '99 12:21	03-10.052N	127-38.119E
C74	26 Feb. '99 14:02	03-05.015N	127-50.089E
C75	26 Feb. '99 15:50	03-00.148N	128-02.148E
C76	26 Feb. '99 17:54	02-55.133N	128-14.062E
C77	26 Feb. '99 19:52	02-50.045N	128-26.052E
C78	26 Feb. '99 21:54	02-45.067N	128-38.032E
C79	27 Feb. '99 00:52	02-59.980N	129-00.008E
C80	27 Feb. '99 04:10	03-17.957N	129-23.968E
C81	27 Feb. '99 07:27	03-36.019N	129-47.004E
C82	27 Feb. '99 10:46	03-54.045N	130-12.156E
C83	27 Feb. '99 13:56	04-12.072N	130-36.149E
C84	27 Feb. '99 17:12	04-29.888N	130-59.941E
C85	27 Feb. '99 20:51	04-47.921N	131-36.003E
C86	28 Feb. '99 00:08	05-06.022N	131-48.088E
C87	28 Feb. '99 04:15	05-35.937N	132-12.026E
C88	28 Feb. '99 06:57	05-41.987N	132-35.922E
C89	28 Feb. '99 10:10	06-00.031N	133-00.068E

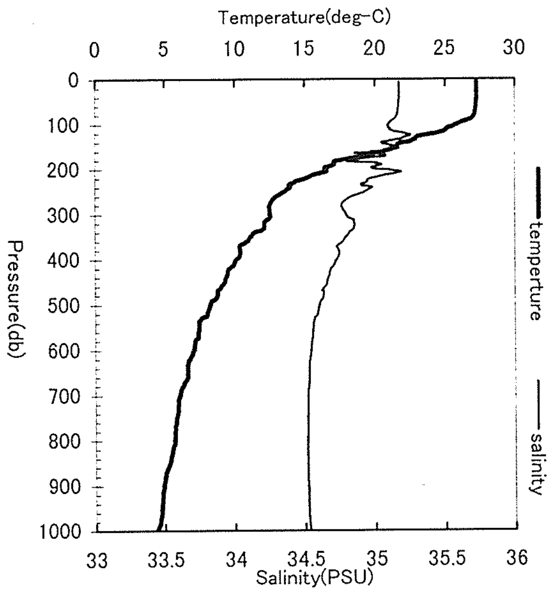
XCTD Cast Table

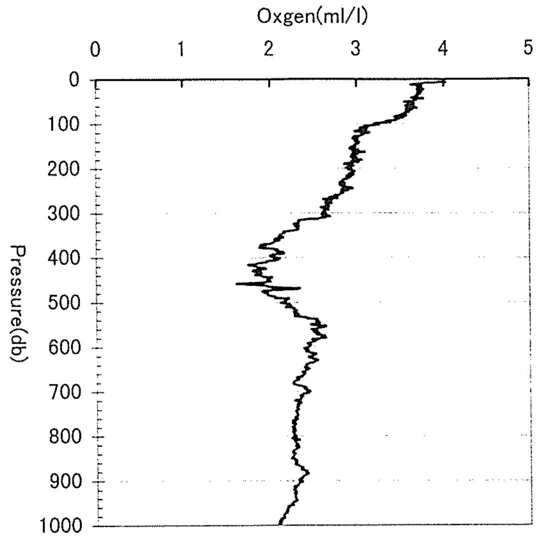
St.	Time(GMT)	Latitude	Longitude
XC01	28 Jan. '99 19:27	00-00.015S	161-00.000E
XC02	16 Feb. '99 05:13	05-00.017N	129-14.000E
XC03	20 Feb. '99 21:09	05-00.000N	121-59.999E
XC04	20 Feb. '99 23:56	04-30.000N	121-59.982E
XC05	21 Feb. '99 02:50	04-00.002N	122-00.030E
XC06	21 Feb. '99 05:39	03-30.000N	121-59.956E
XC07	21 Feb. '99 08:32	03-00.000N	121-59.978E
XC08	21 Feb. '99 11:22	02-29.998N	121-59.978E
XC09	21 Feb. '99 14:12	02-00.000N	122-00.045E
XC10	21 Feb. '99 17:03	01-30.000N	121-59.987E
XC11	22 Feb. '99 13:57	03-30.079N	119-00.006E
XC12	22 Feb. '99 17:29	03-30.001N	119-31.290E
XC13	22 Feb. '99 20:53	02-29.990N	120-00.000E
XC14	23 Feb. '99 00:11	03-30.056N	120-30.004E
XC15	23 Feb. '99 03:28	03-29.928N	121-00.000E
XC16	23 Feb. '99 06:41	03-29.998N	121-30.000E
XC17	23 Feb. '99 09:39	03-29.999N	122-00.000E
XC18	23 Feb. '99 12:26	03-29.969N	122-30.002E
XC19	23 Feb. '99 15:10	03-29.986N	123-00.000E
XC20	23 Feb. '99 17:52	03-29.984N	123-30.000E
XC21	23 Feb. '99 20:50	03-29.996N	124-00.000E
XC22	24 Feb. '99 04:03	02-31.627N	124-47.267E
XC23	26 Feb. '99 23:37	02-52.514N	128-49.005E
XC24	27 Feb. '99 02:46	03-08.992N	129-12.000E
XC25	27 Feb. '99 06:05	03-27.000N	129-36.000E
XC26	27 Feb. '99 09:25	03-45.010N	130-00.000E
XC27	27 Feb. '99 12:36	04-02.981N	130-24.000E
XC28	27 Feb. '99 15:51	04-20.996N	130-48.000E
XC29-1	27 Feb. '99 17:58	04-30.386N	131-01.291E
XC29-2	27 Feb. '99 18:08	04-30.876N	131-01.024E
XC29-3	27 Feb. '99 18:18	04-30.638N	131-01.024E
XC30	27 Feb. '99 19:29	04-38.999N	131-12.000E
XC31	27 Feb. '99 22:45	04-56.986N	131-36.003E

4.3 Profile

4.3.1 CTD Profiles

St.C01(00N,161E)





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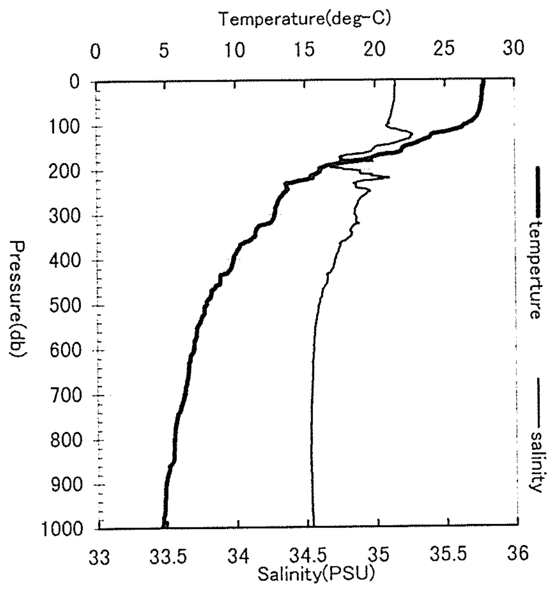

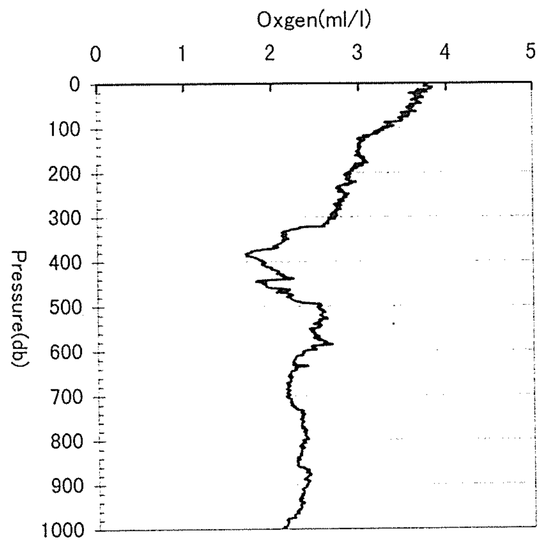

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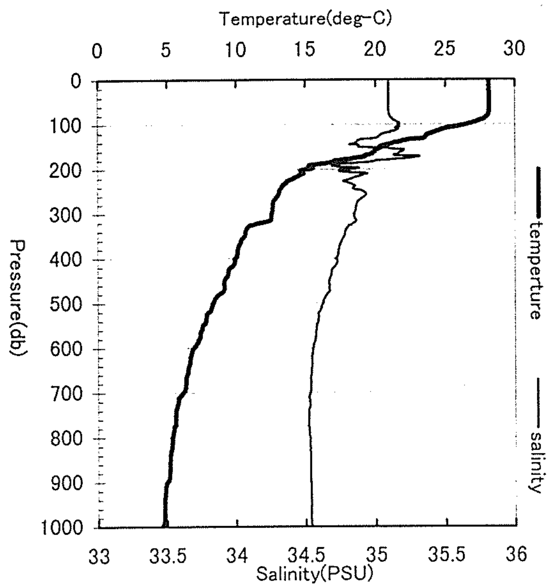

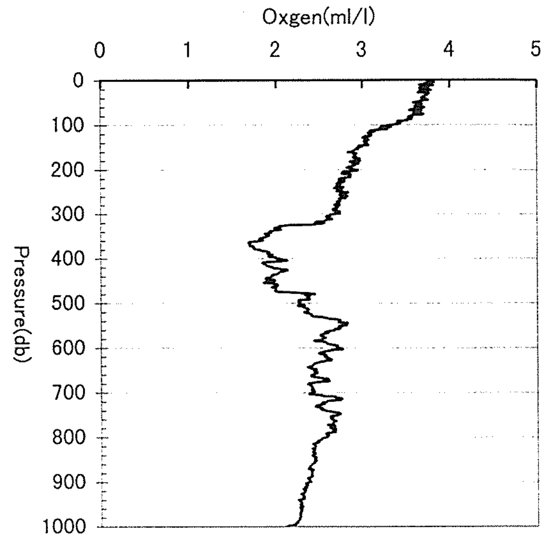

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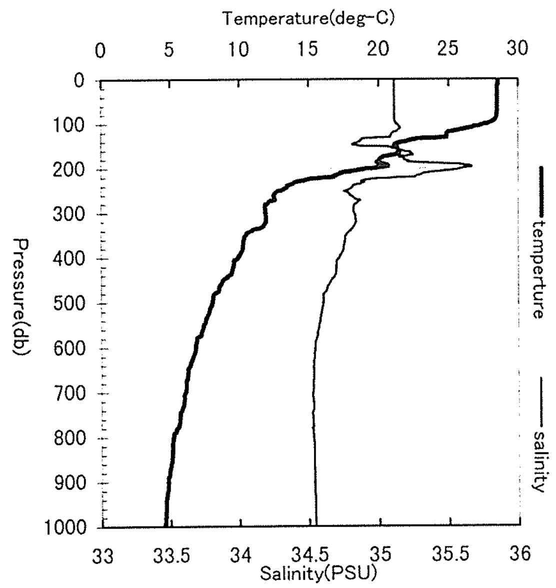
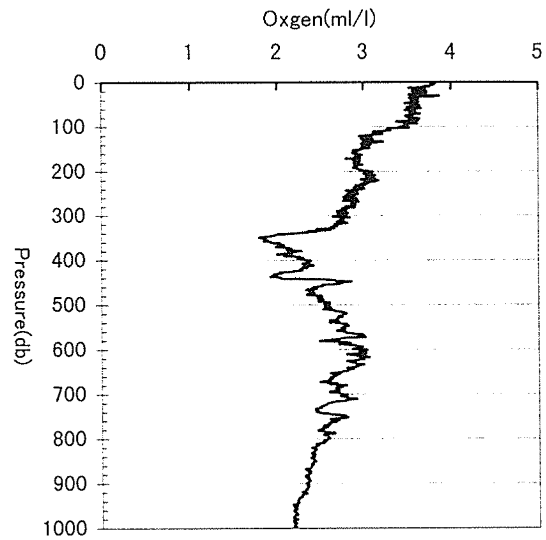
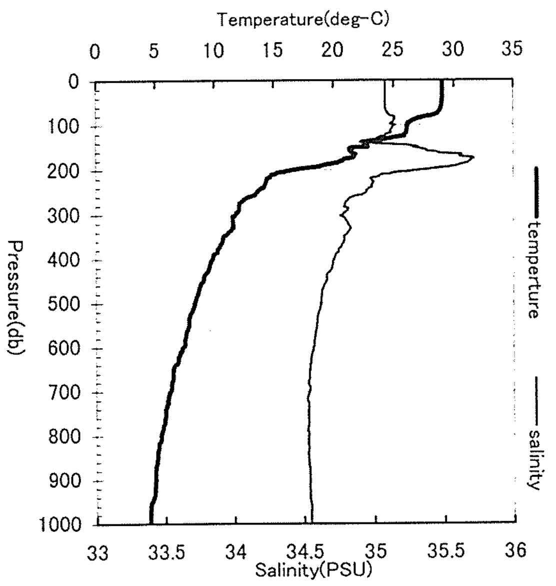
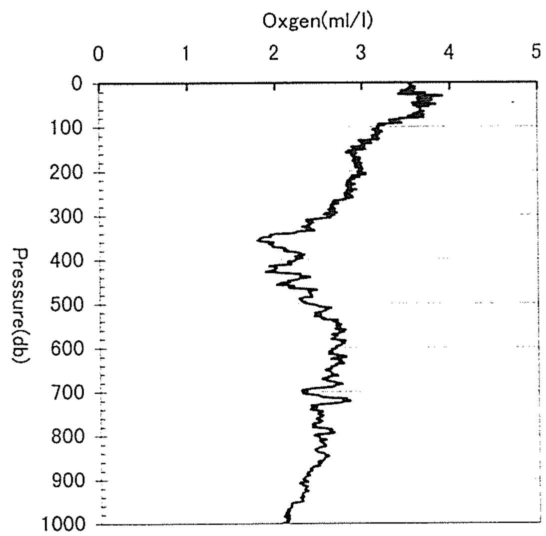


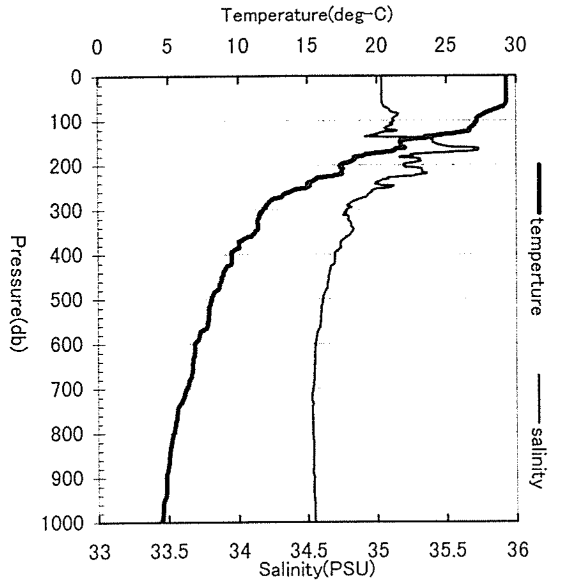


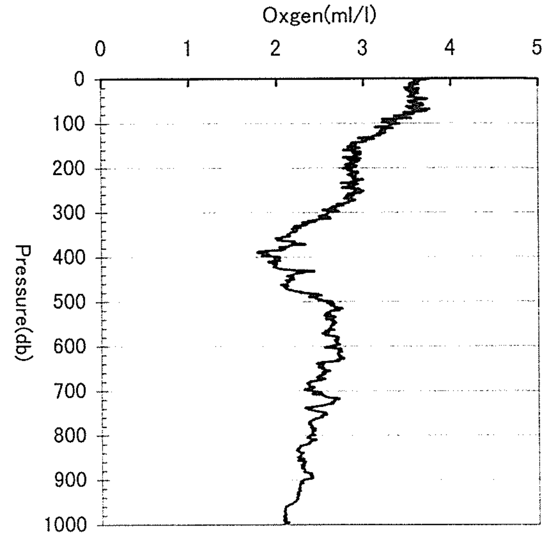
St.C05(00N,153E)



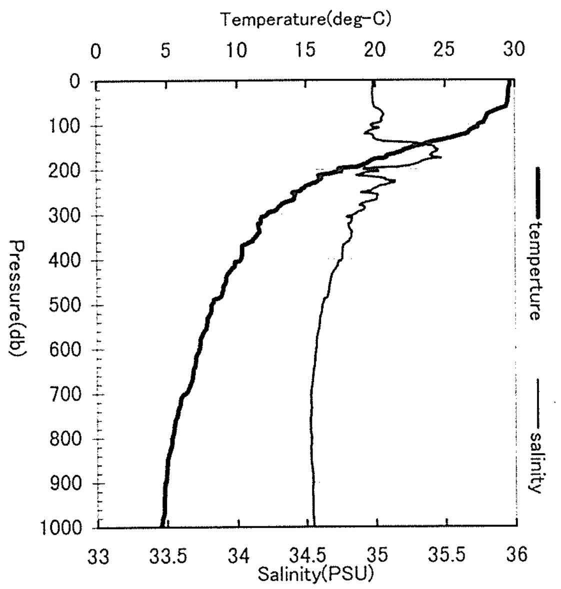


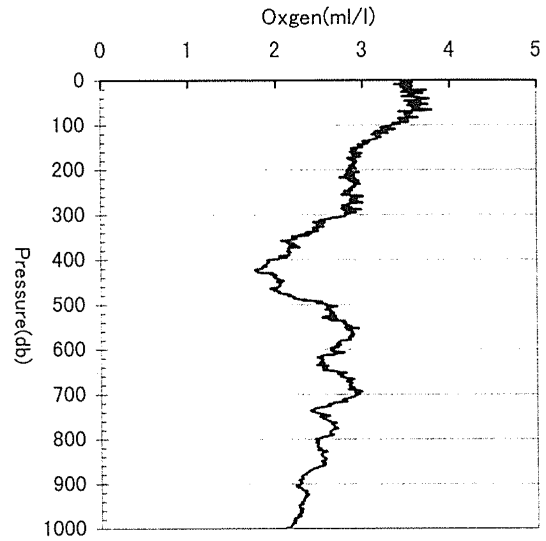
St.C06(00N,151E)



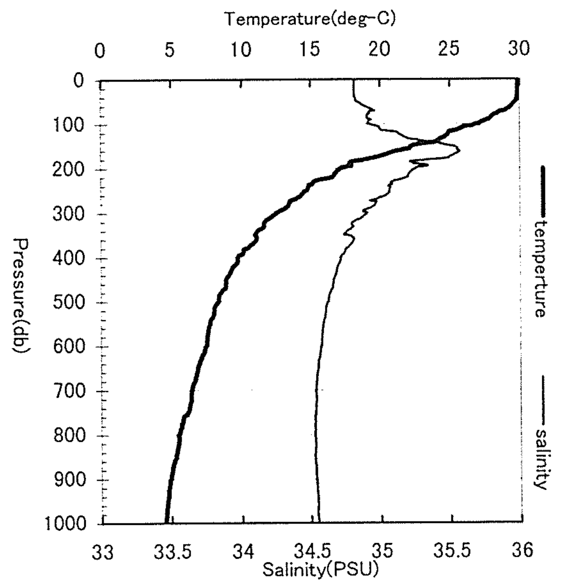


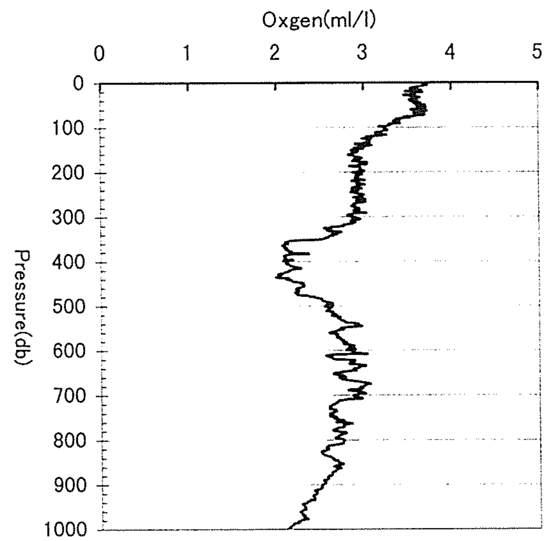
St.C07(00N,149E)



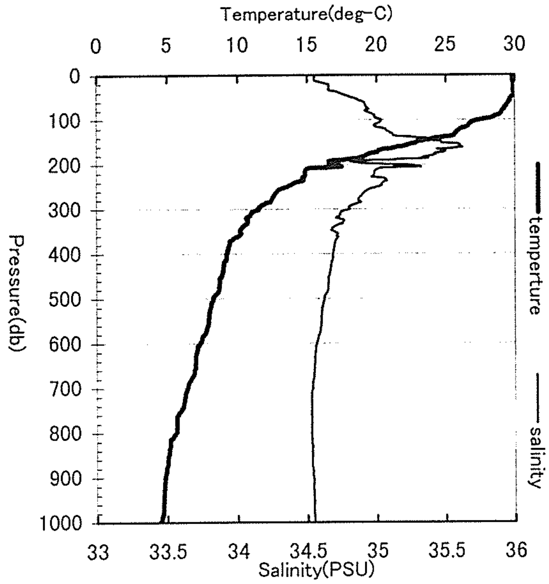


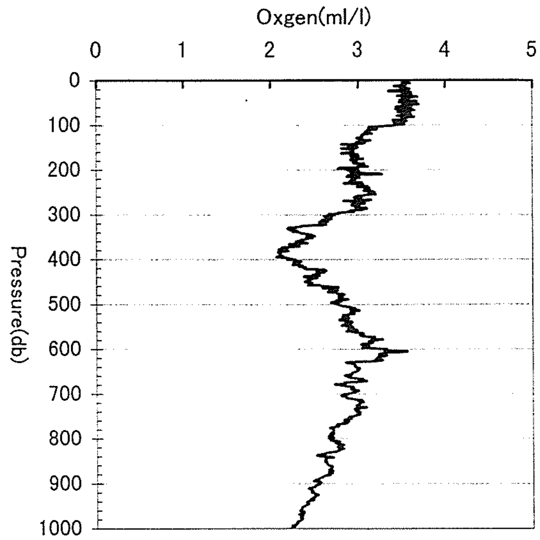
St.C08(00N,147E)



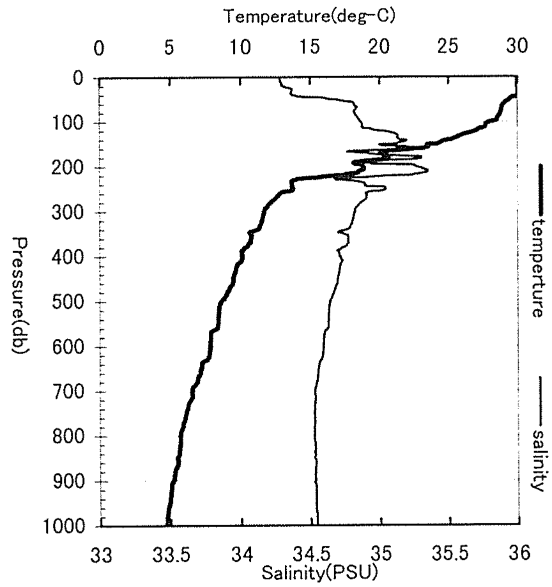


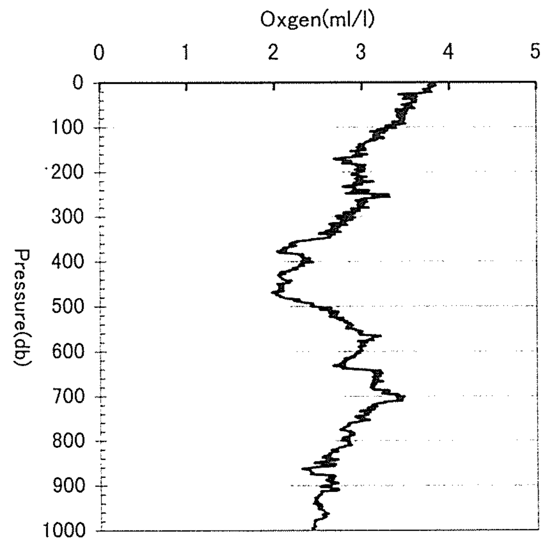
St.C09(00N,145E)



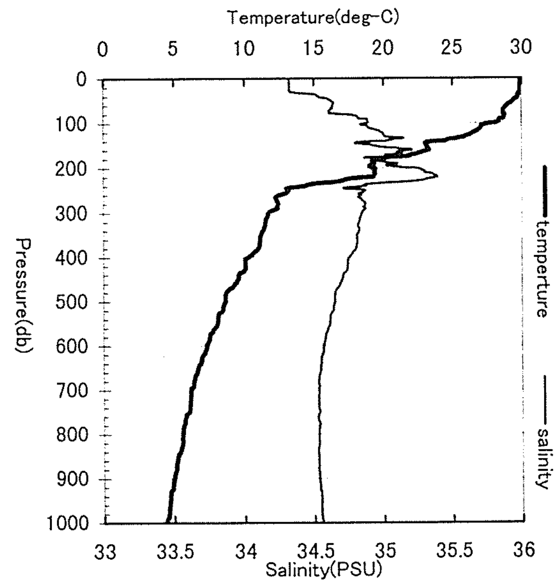


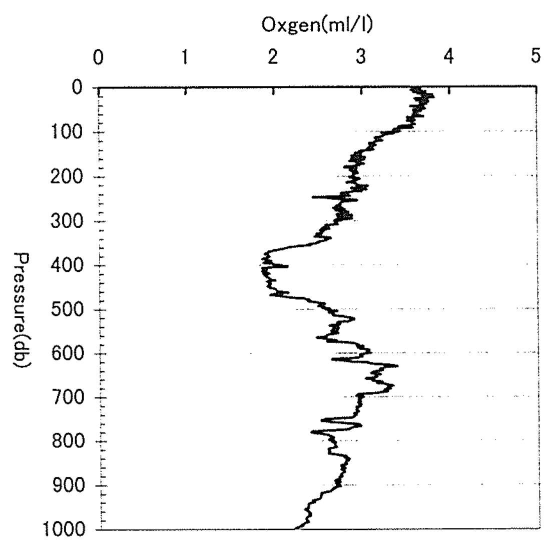
St.C10(00N,143E)



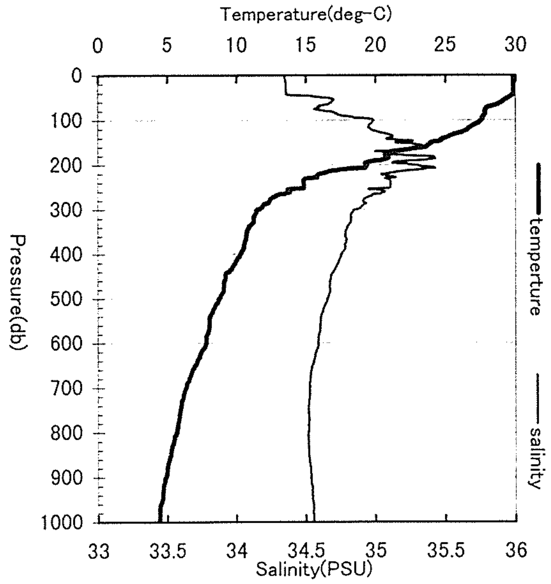


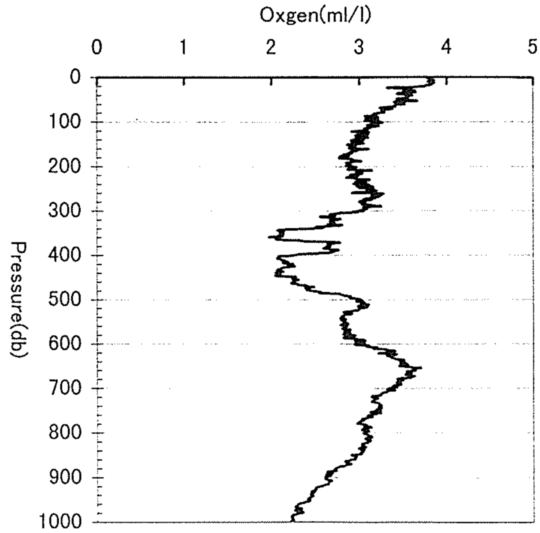
St.C11(00N,142E)



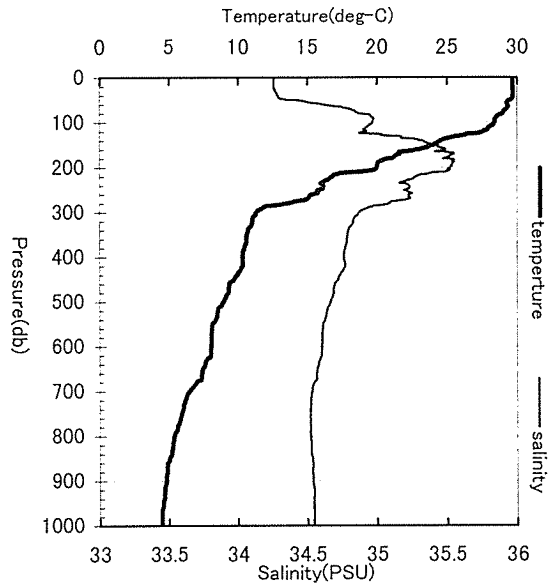


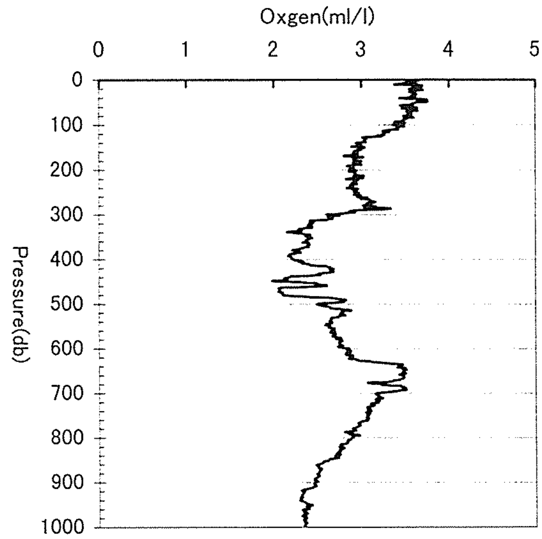
St.C12(00-30S,142E)



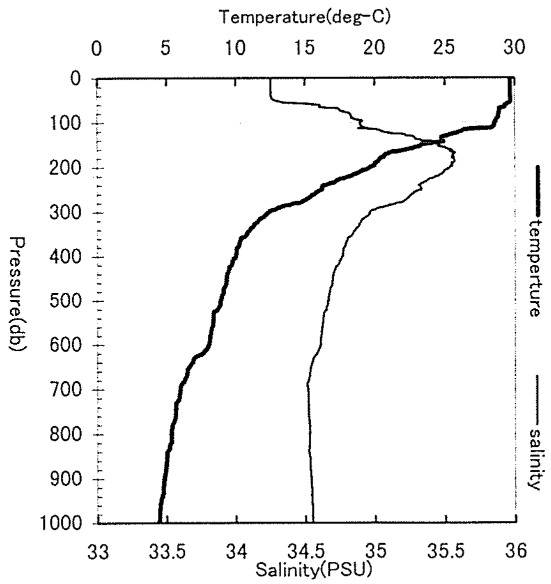


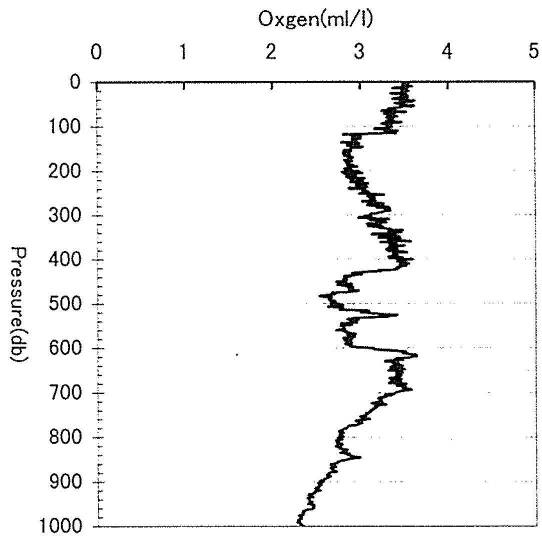
St.C13(01S,142E)



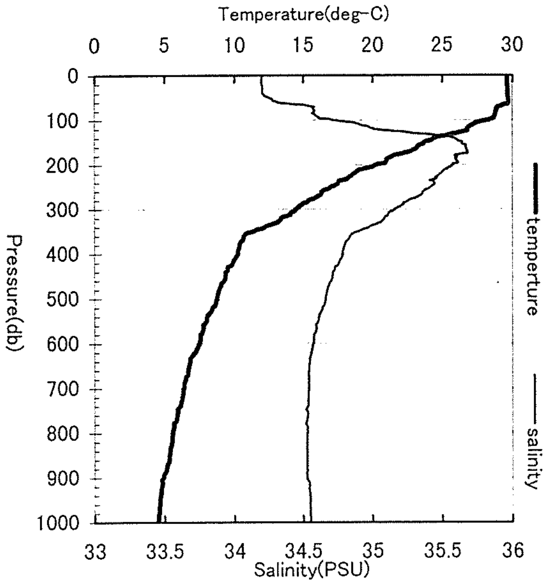


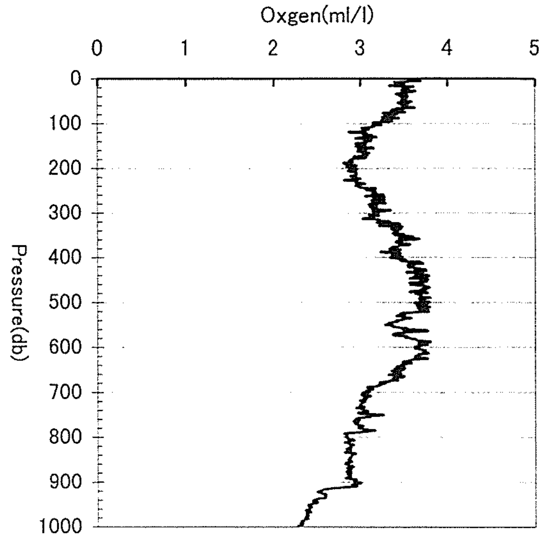
St.C14(01-30S,142E)



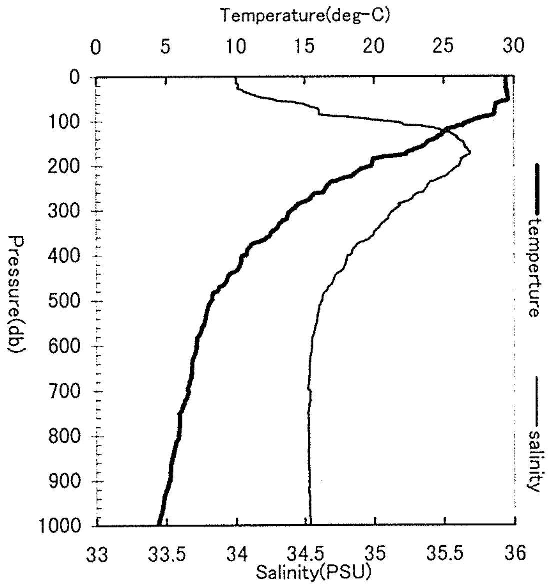


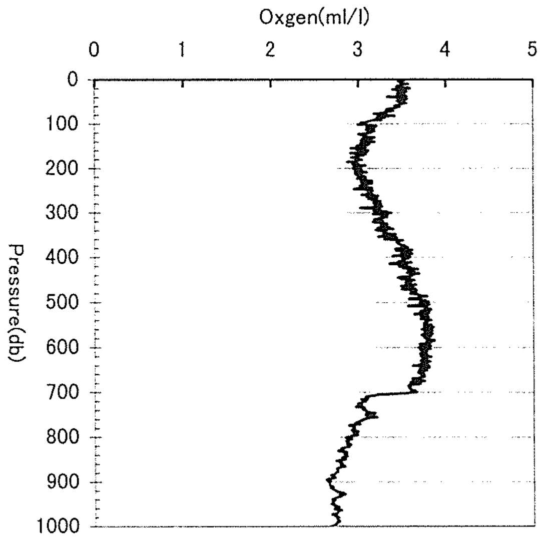
St.C15(02S,142E)



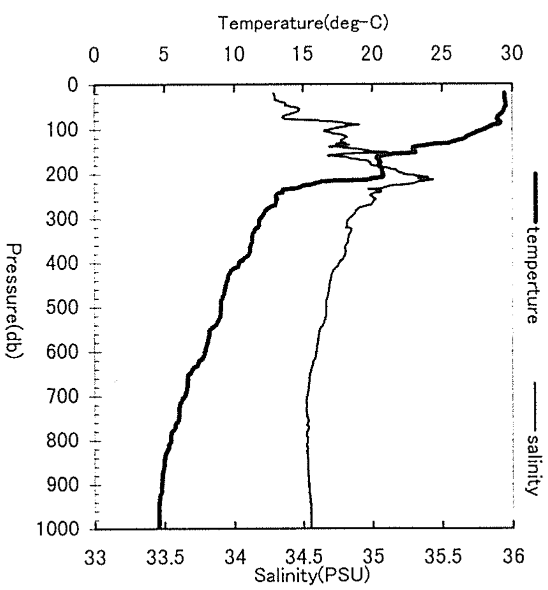


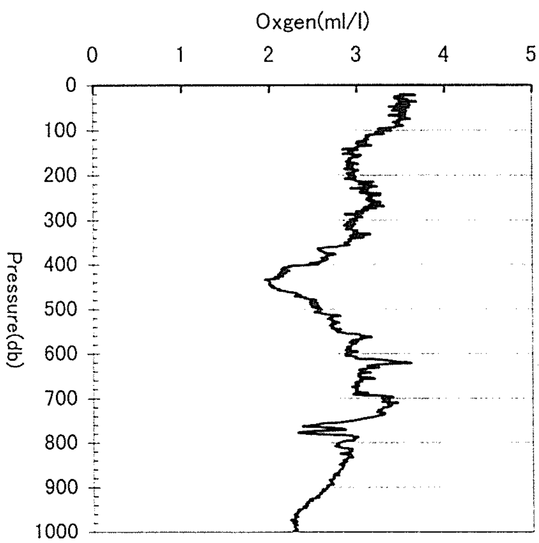
St.C16(02-30S,142E)



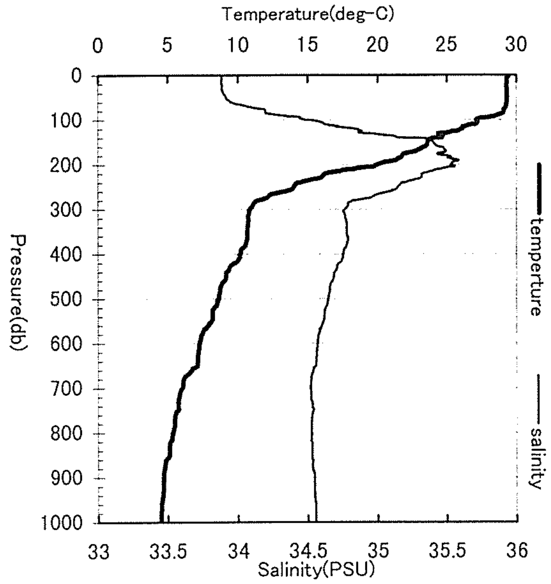


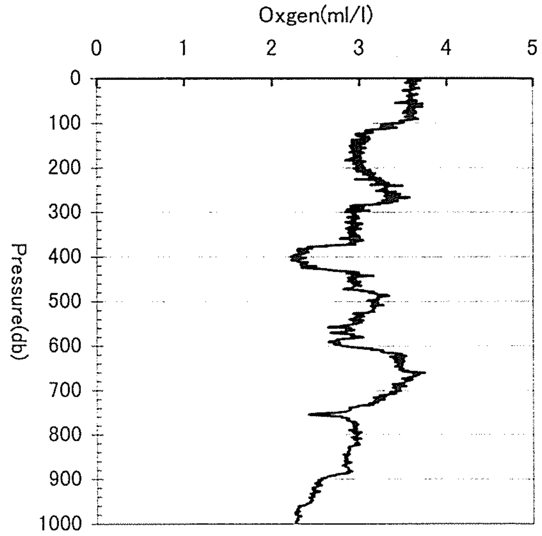
St.C17(00N,140E)



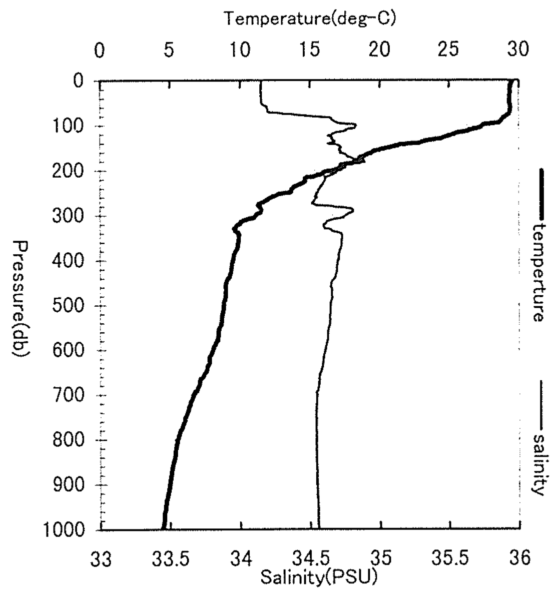


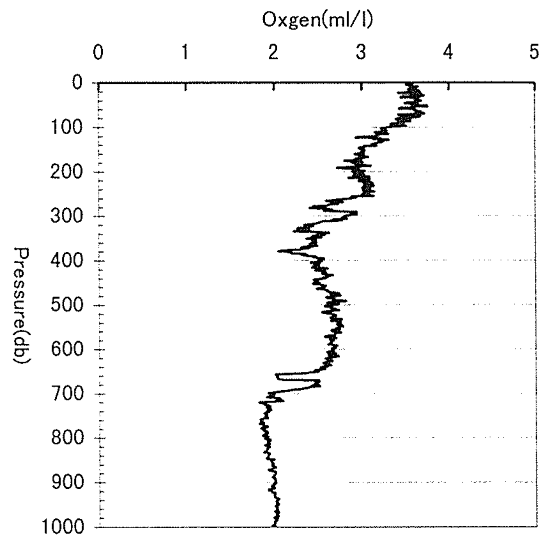
St.C18(00N,138E)



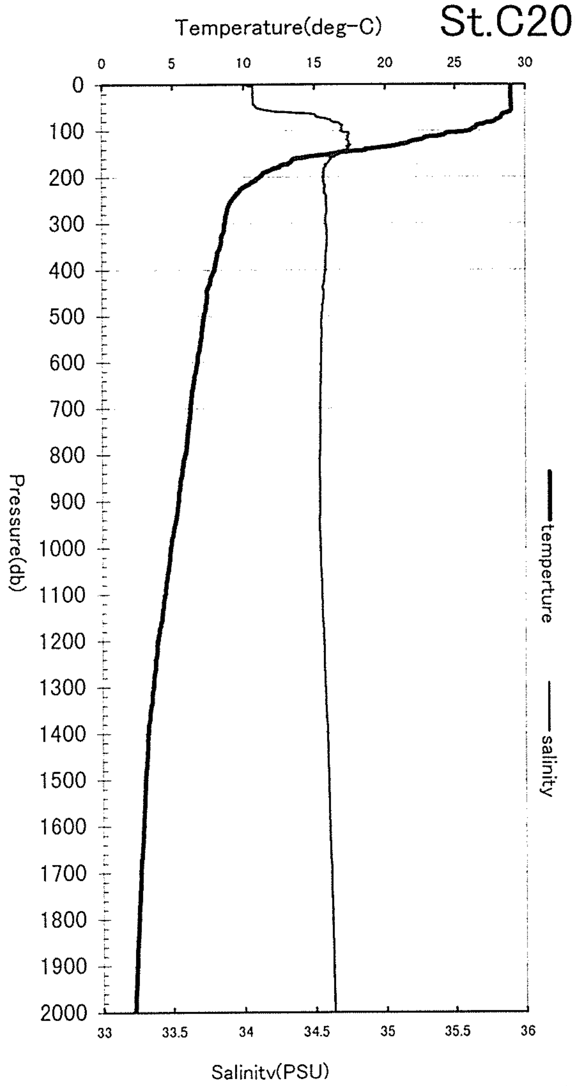


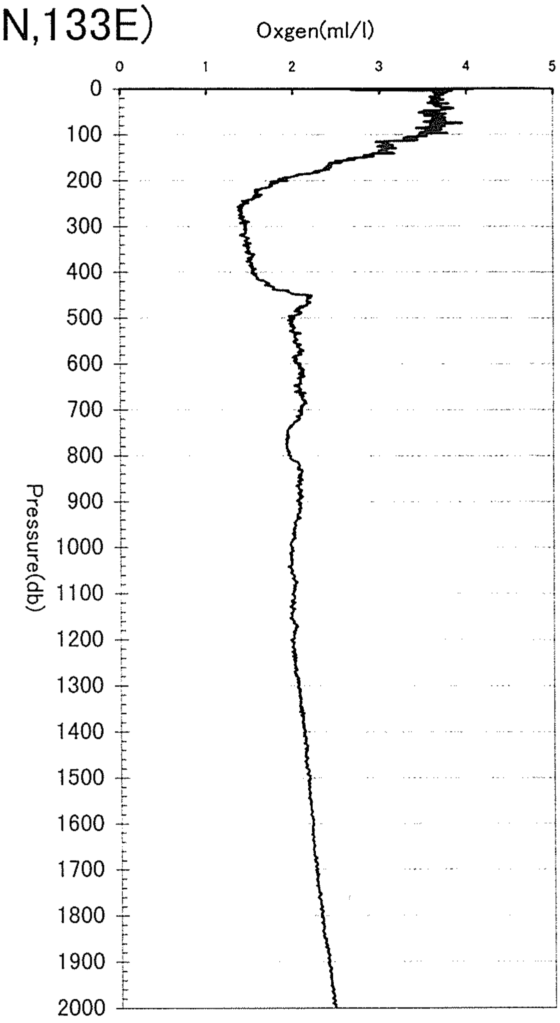
St.C19(02-30N,137-30E)



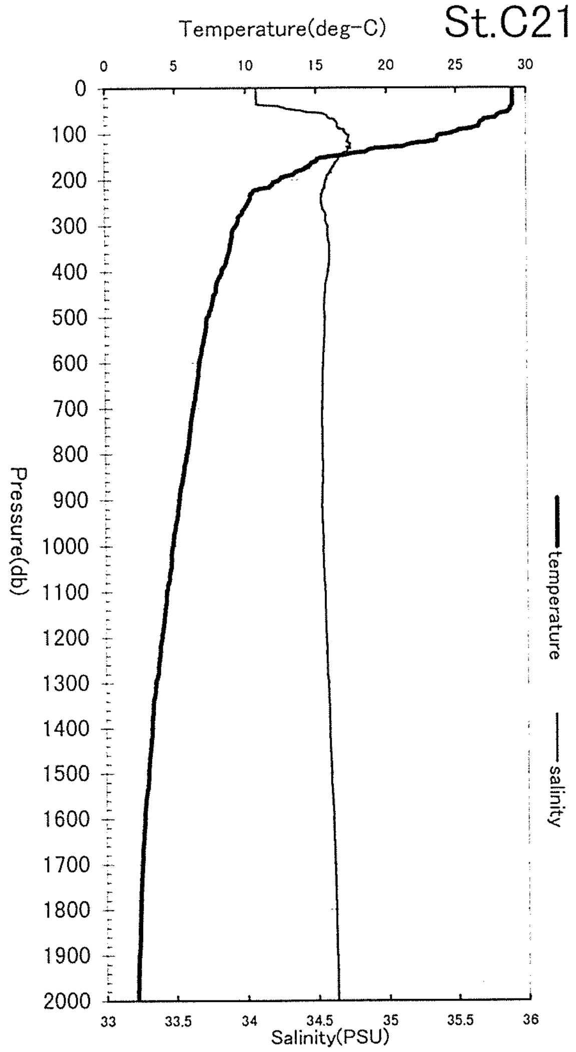


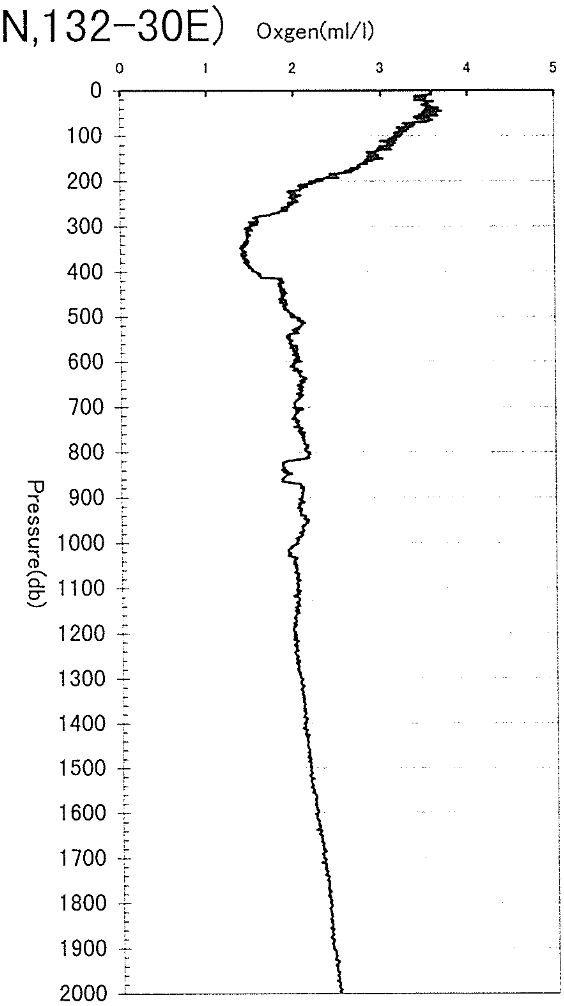
St.C20(06N,133E)



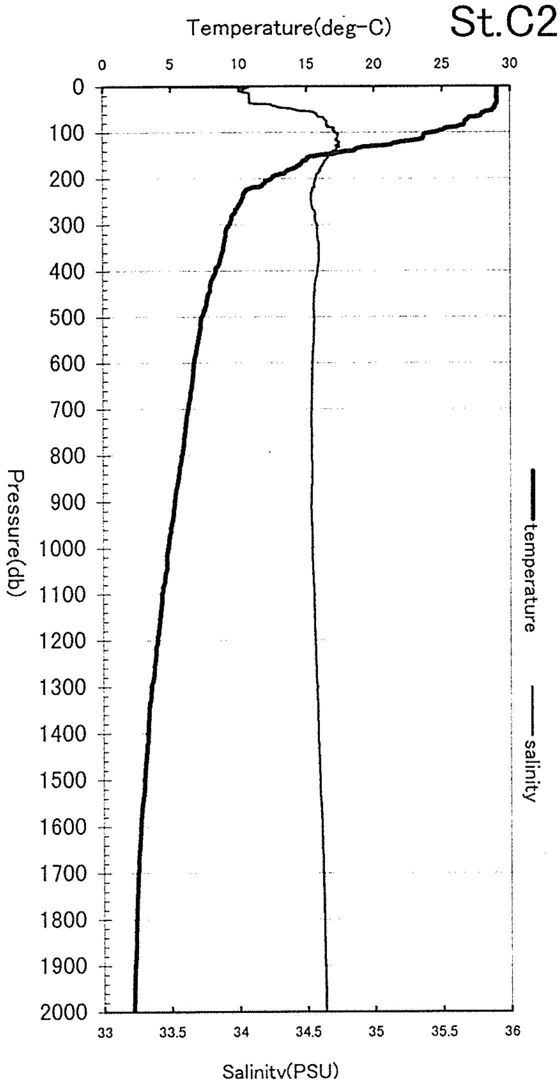


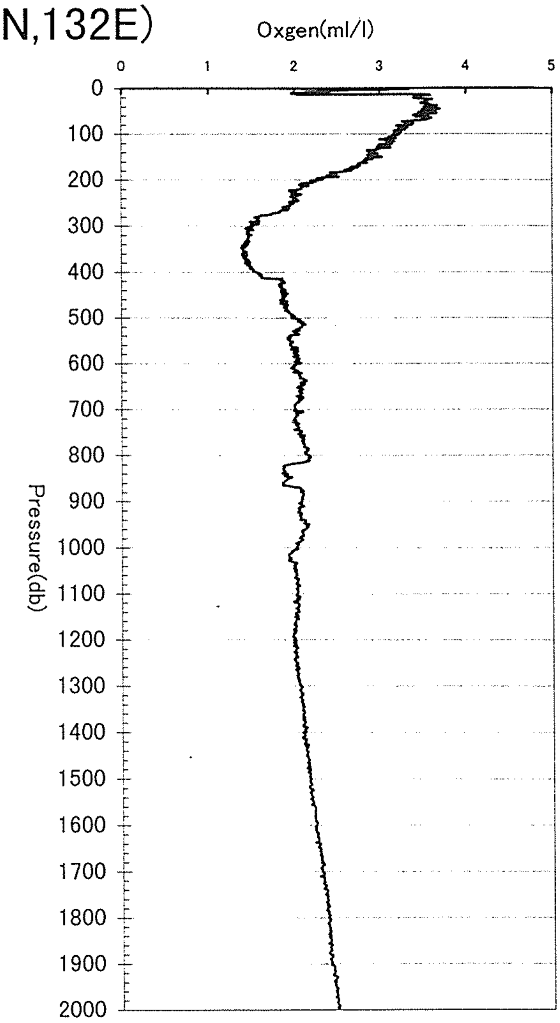
St.C21(06N,132-30E)



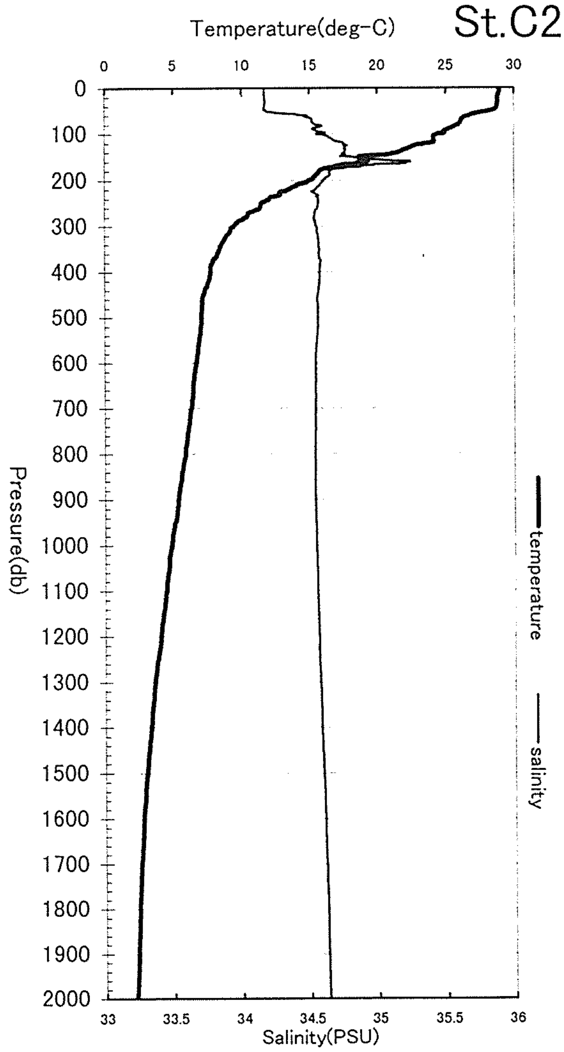


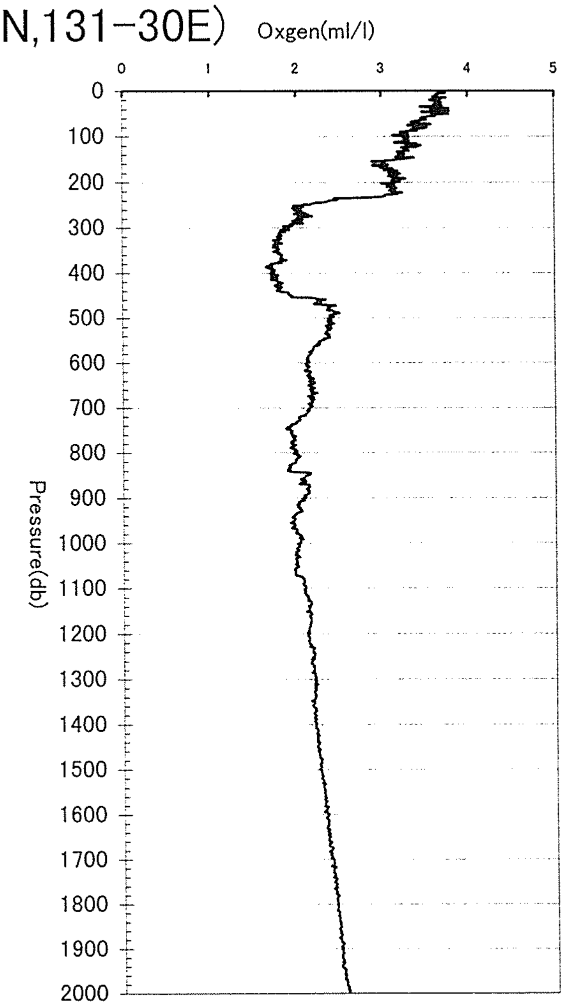
St.C22(06N,132E)



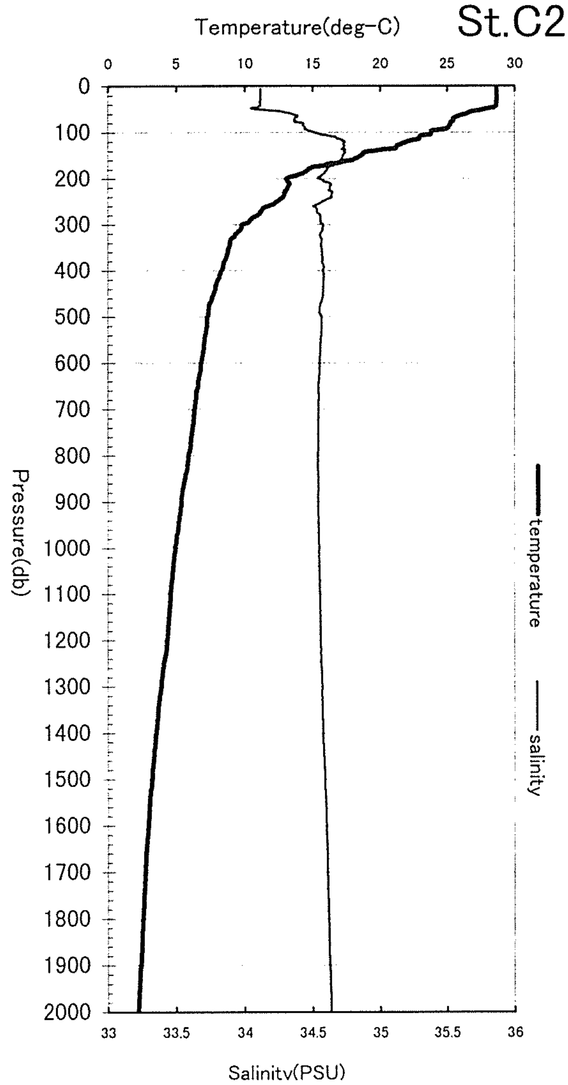


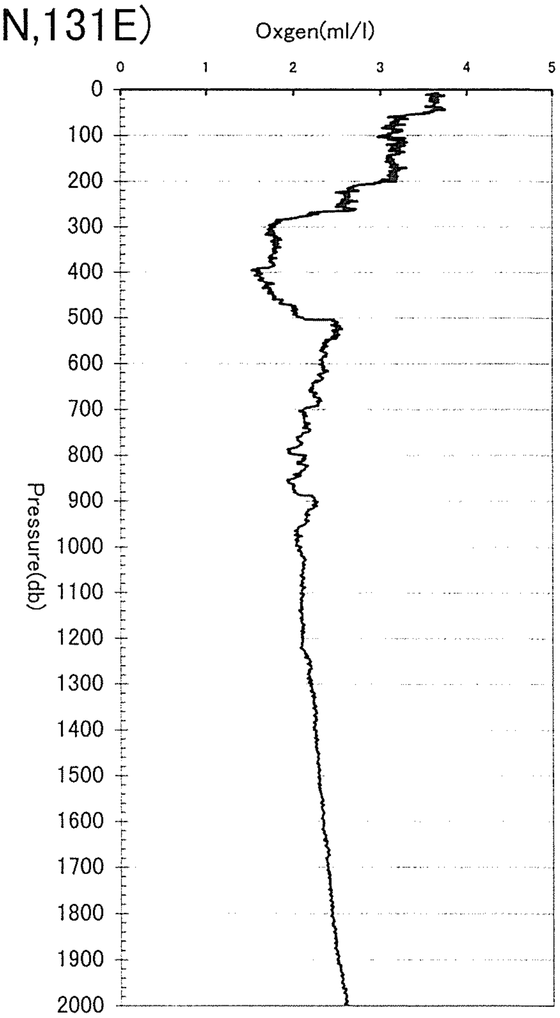
St.C23(05N,131-30E)



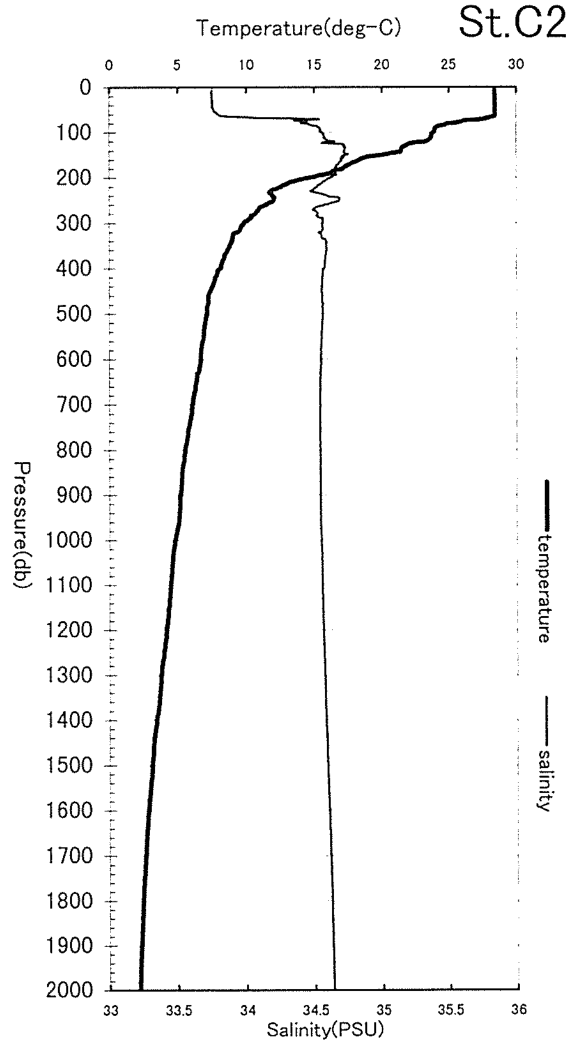


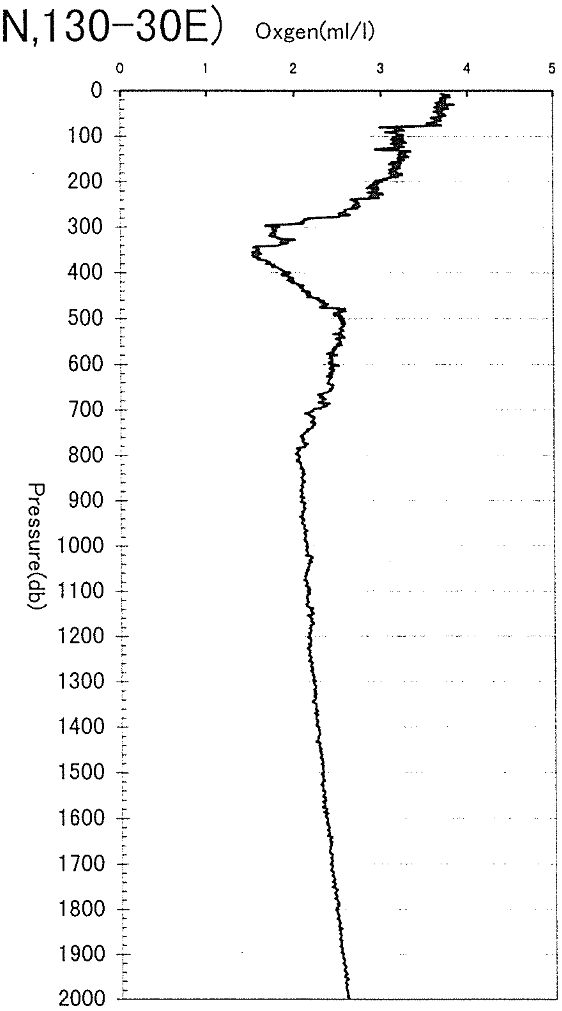
St.C24(05N,131E)



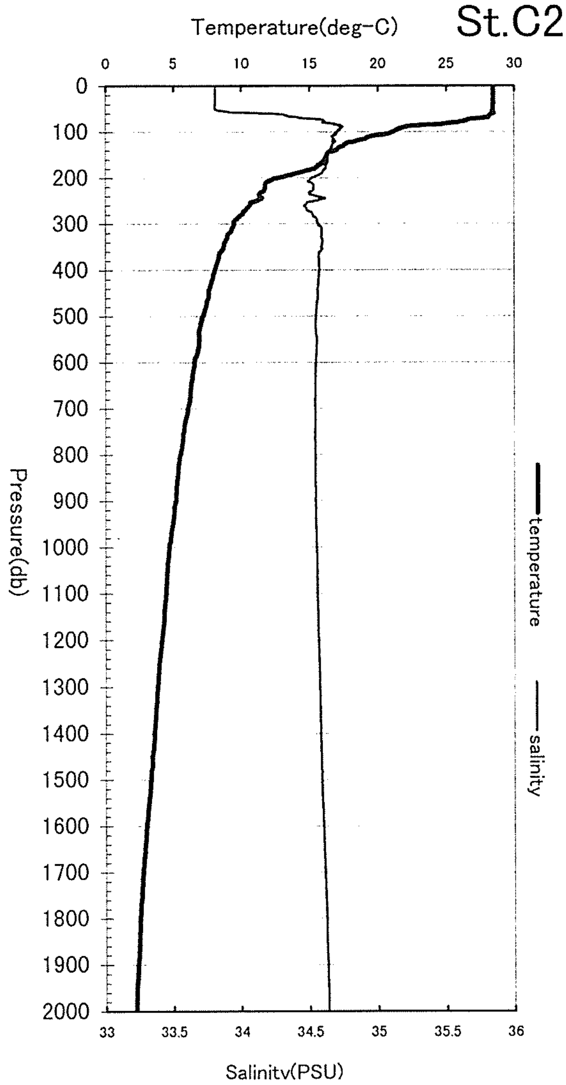


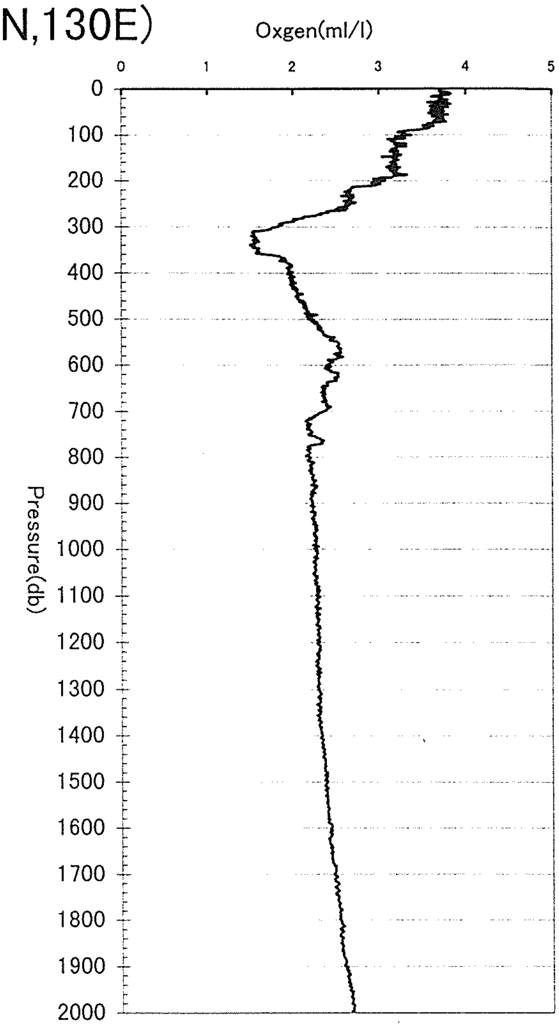
St.C25(05N,130-30E)



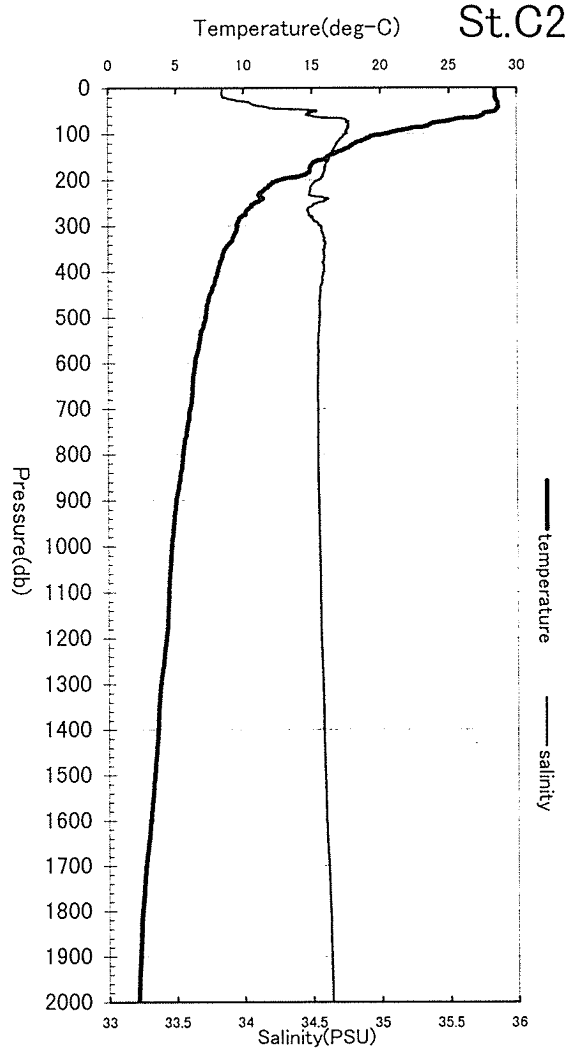


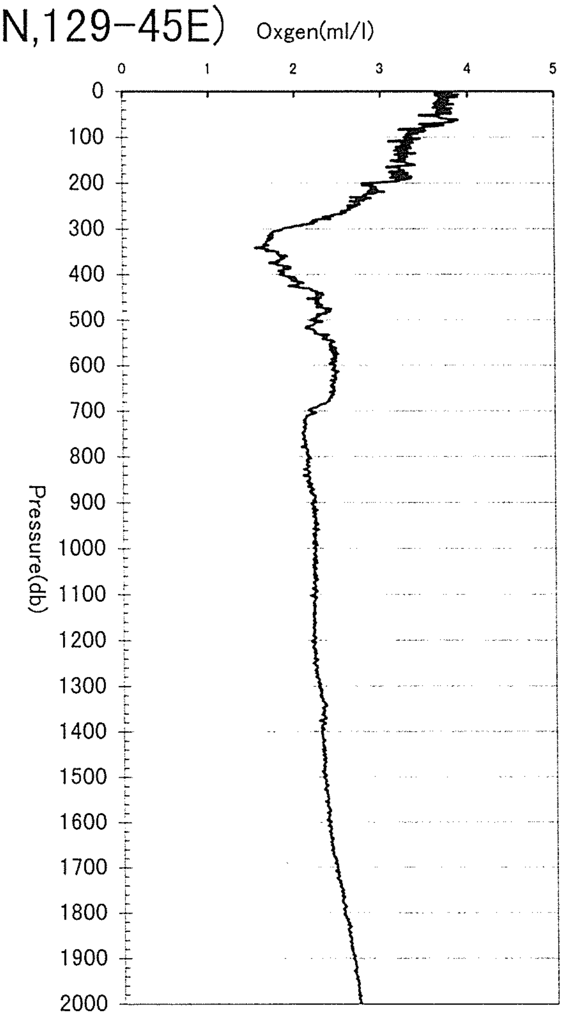
St.C26(05N,130E)



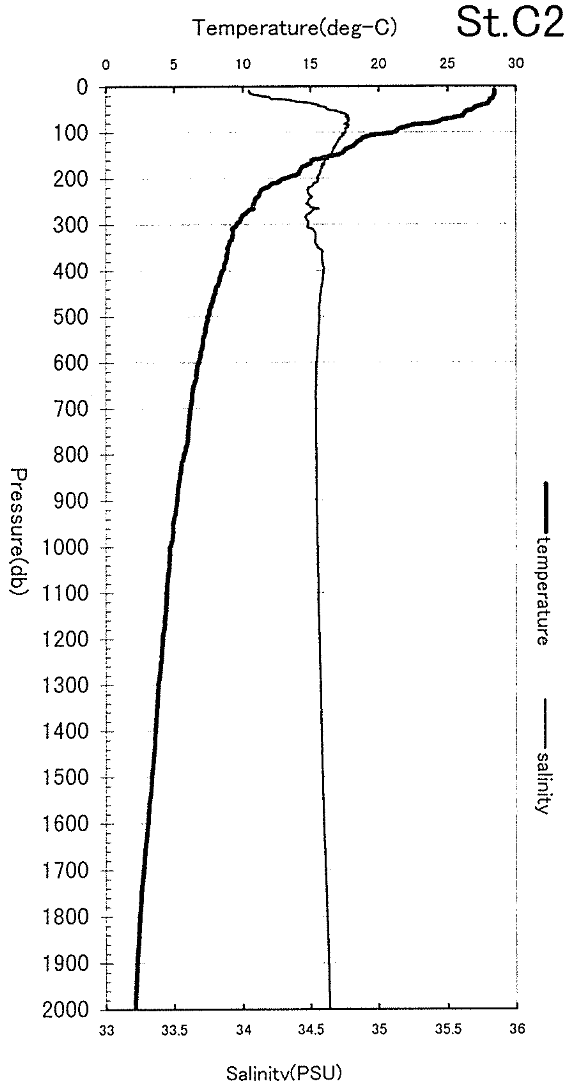


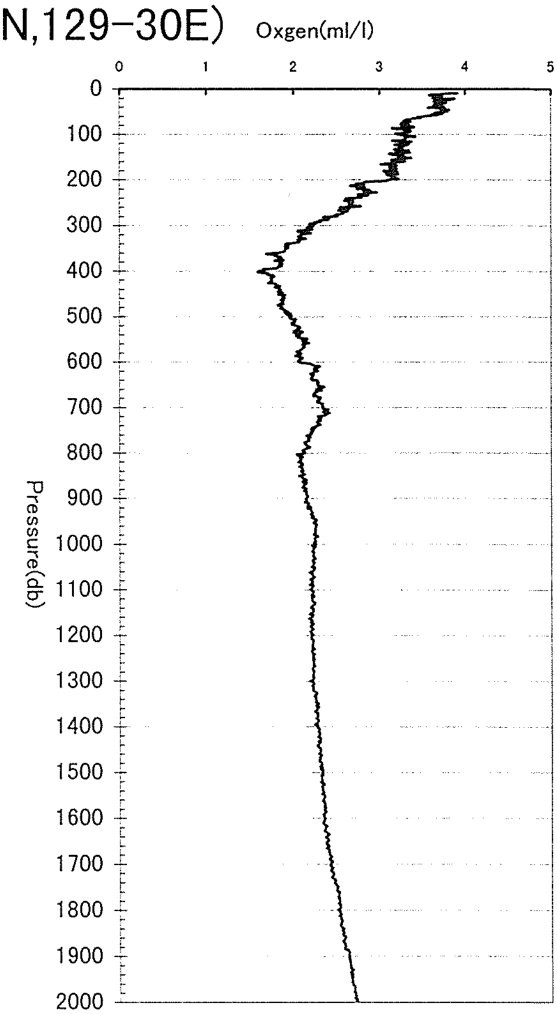
St.C27(05N,129-45E)



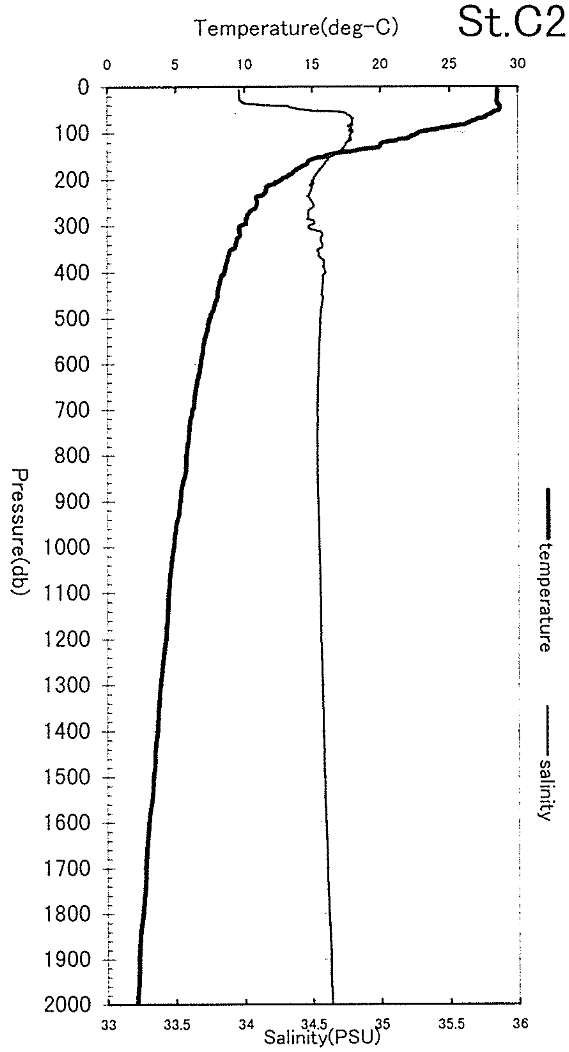


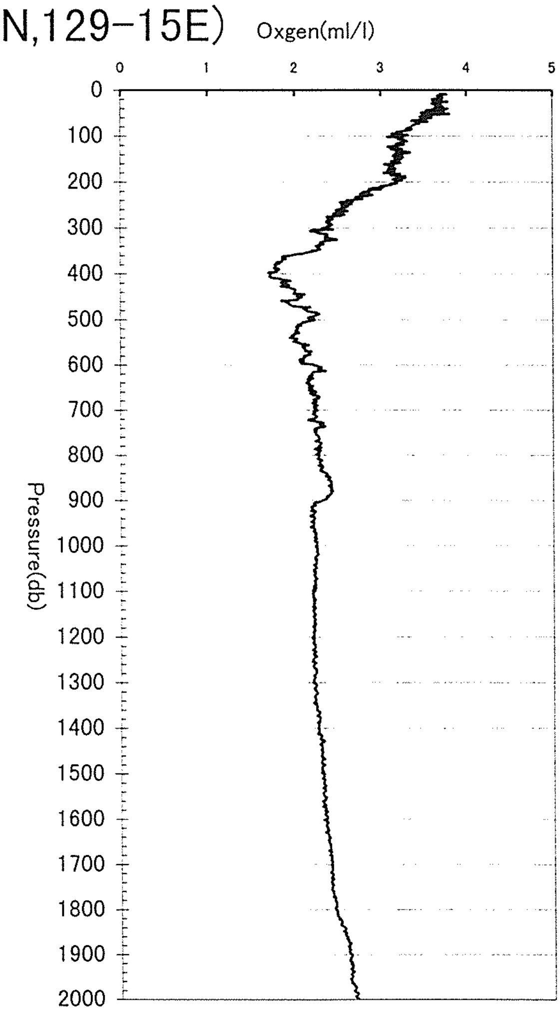
St.C28(05N,129-30E)



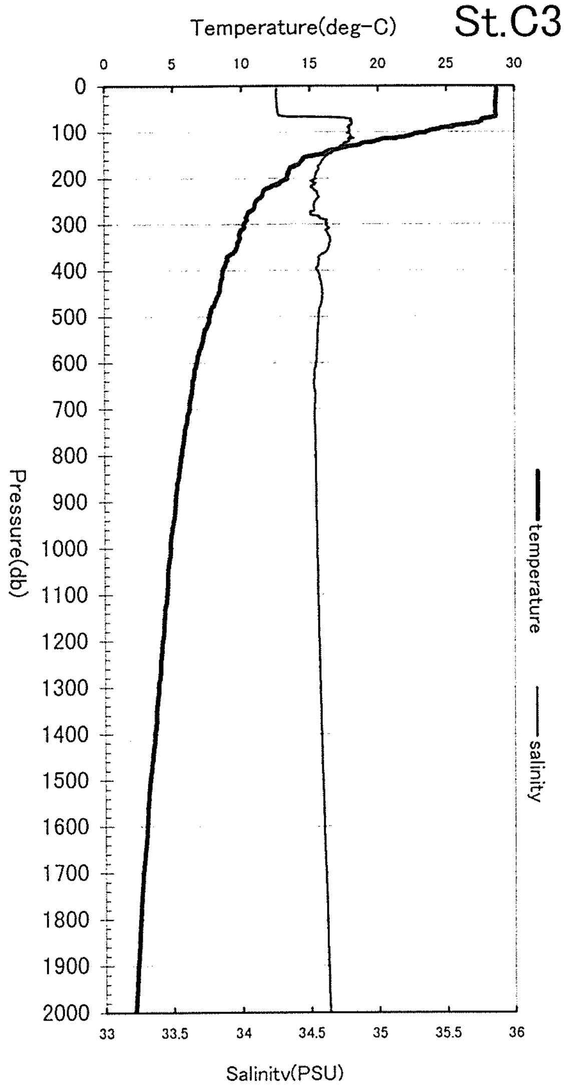


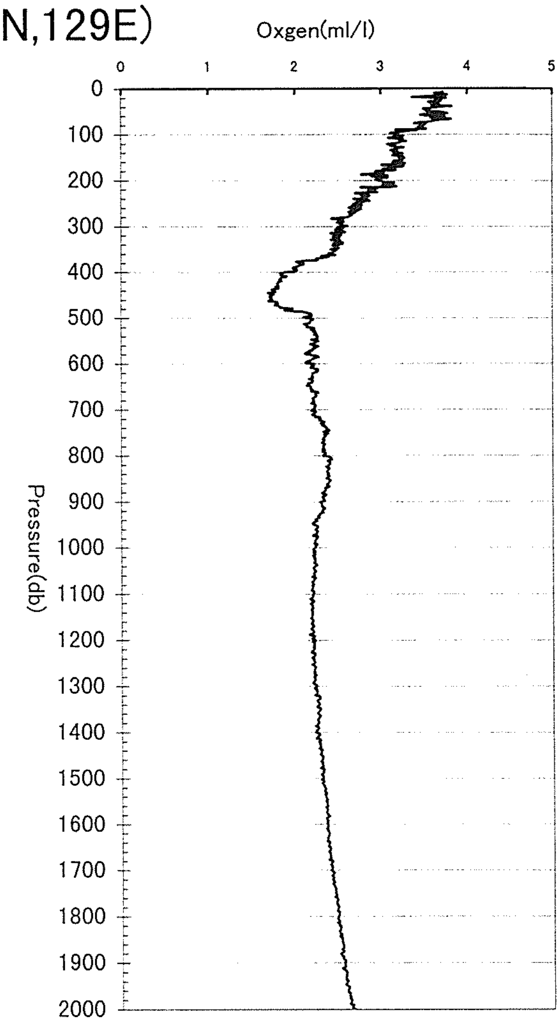
St.C29(05N,129-15E)



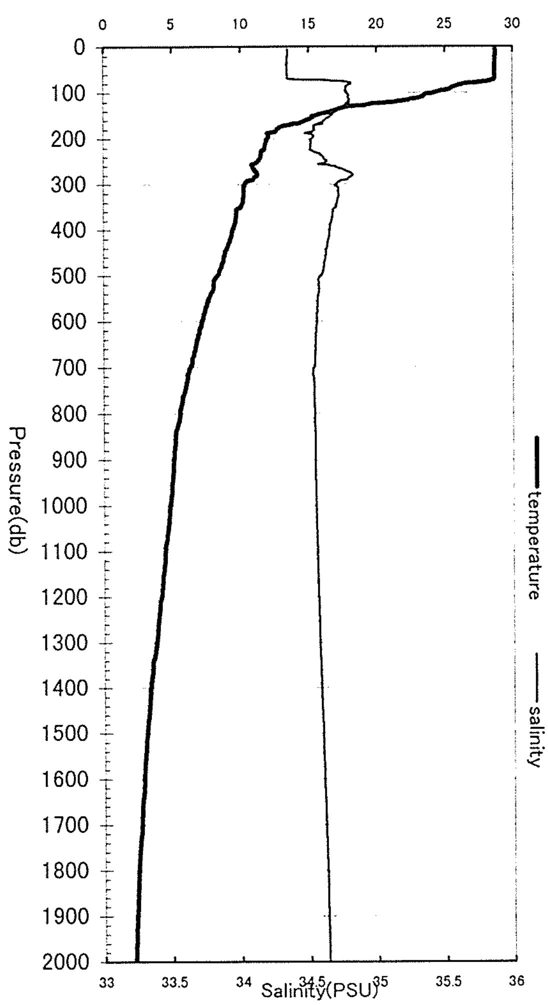


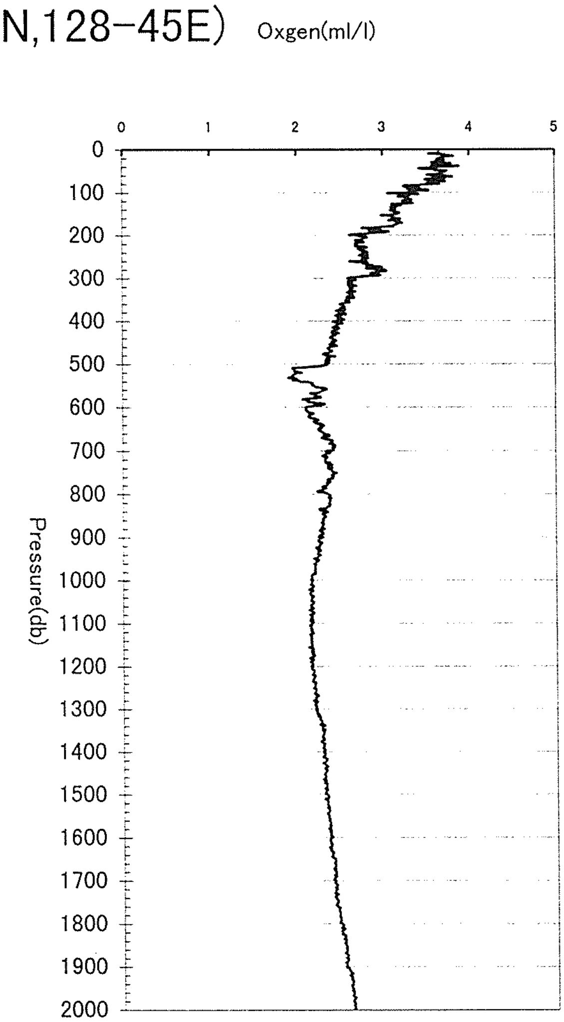
St.C30(05N,129E)



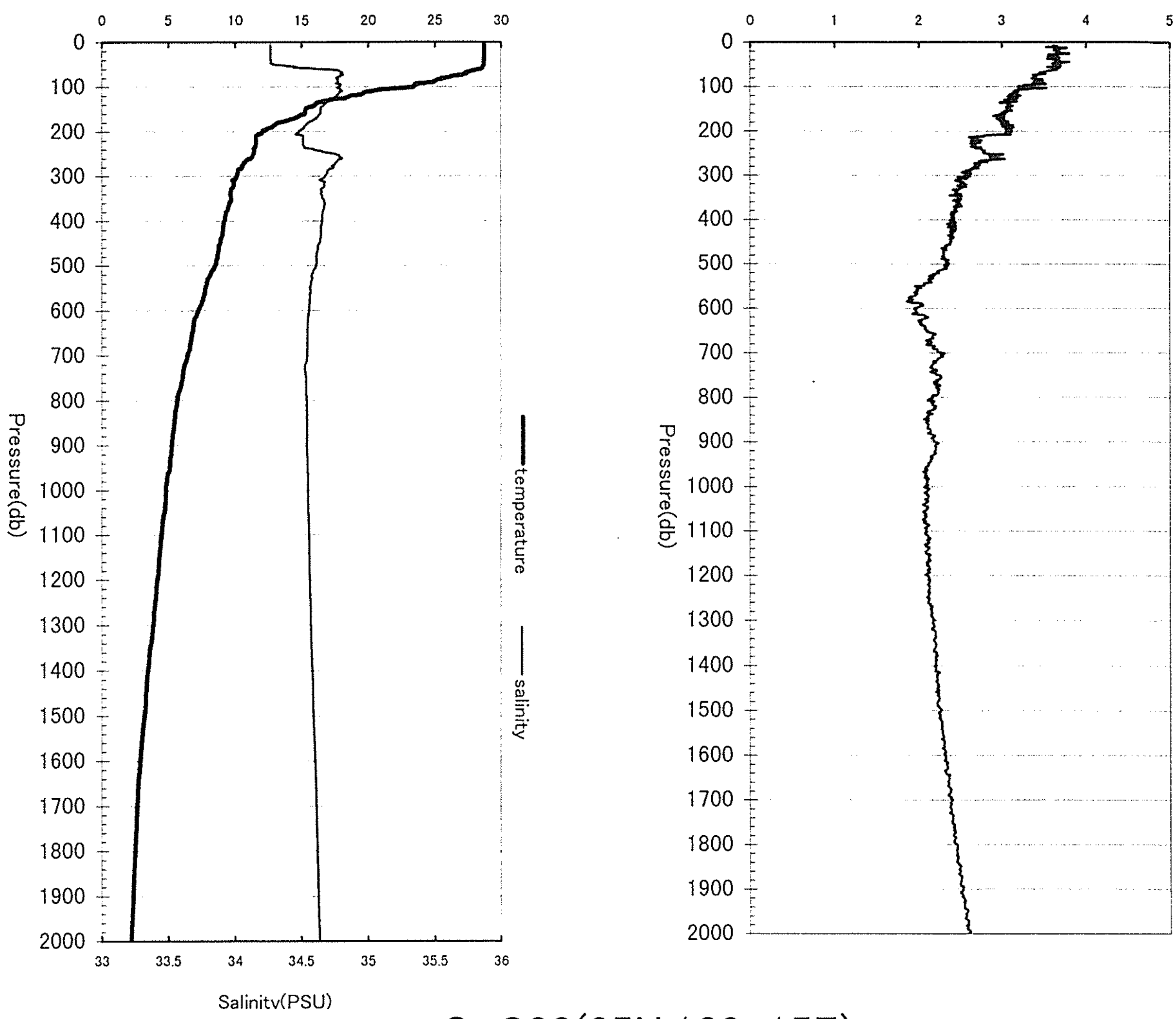


St.C31(05N,128-45E)

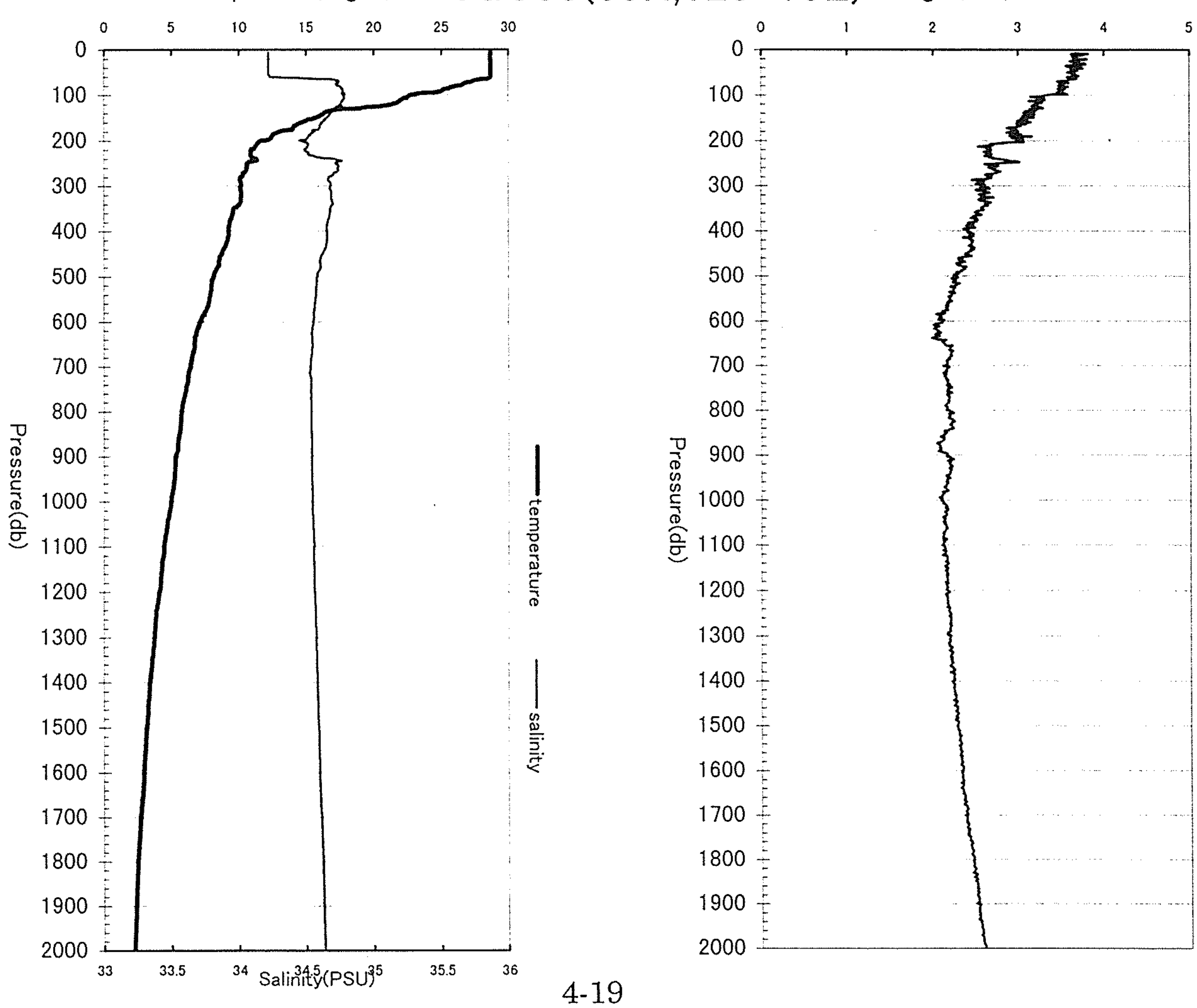




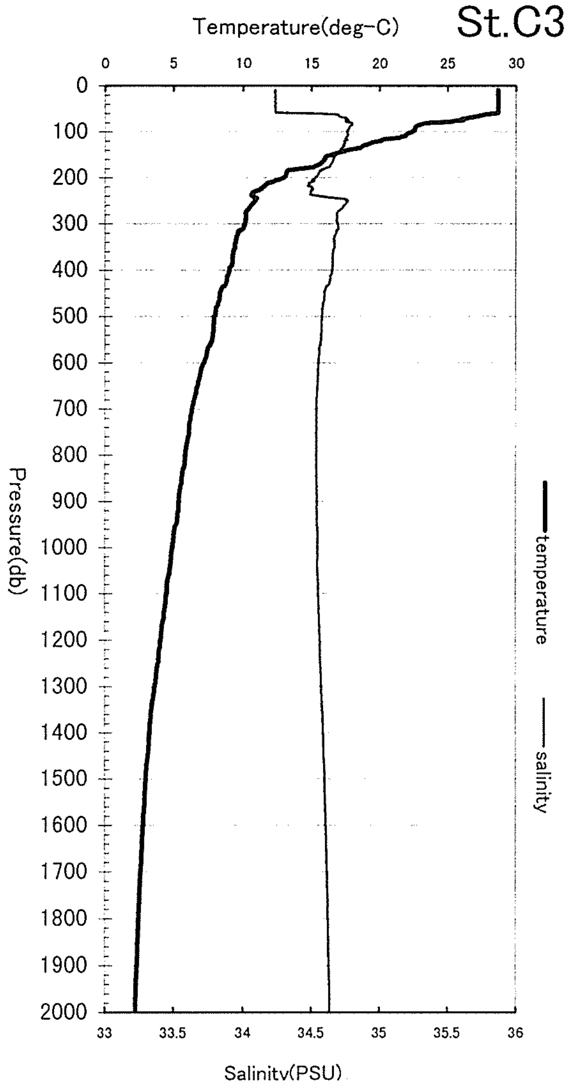
St.C32(05N,128-30E)

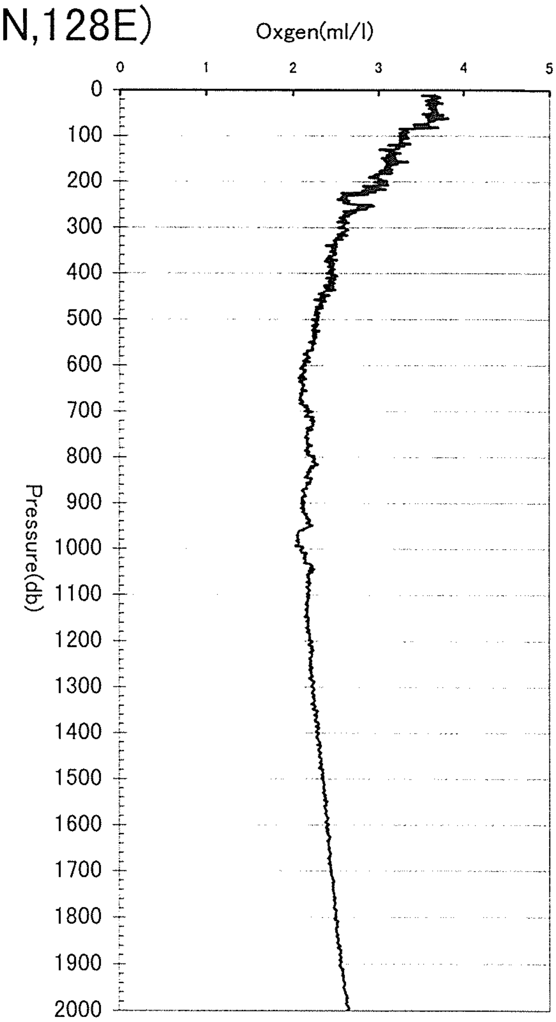


St.C33(05N,128-15E)

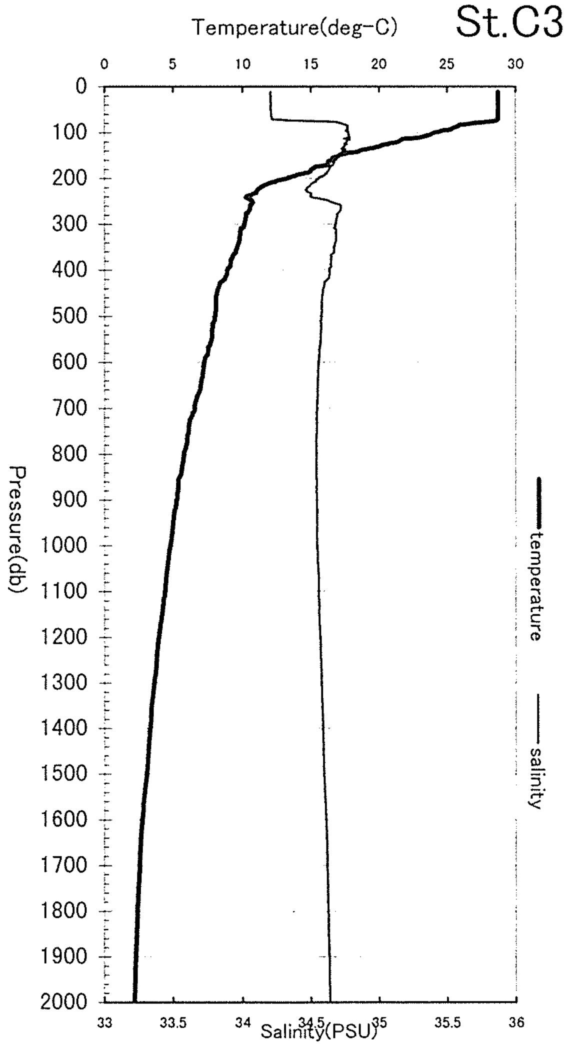


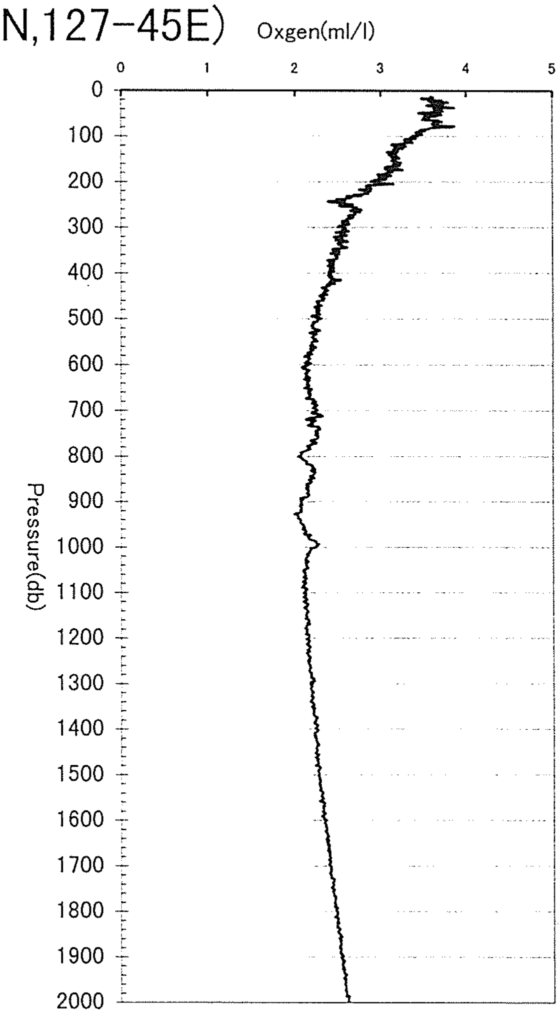
St.C34(05N,128E)

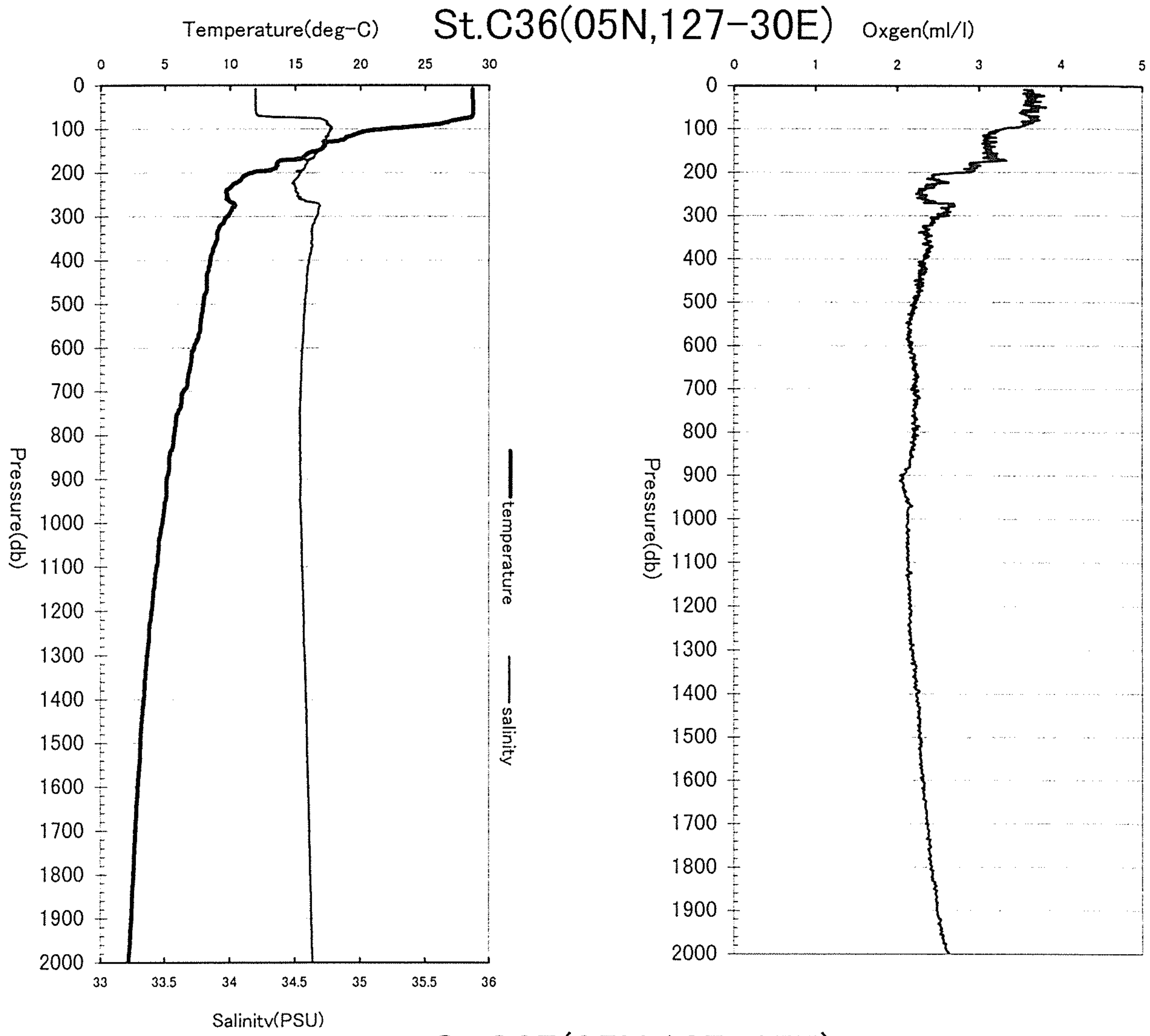


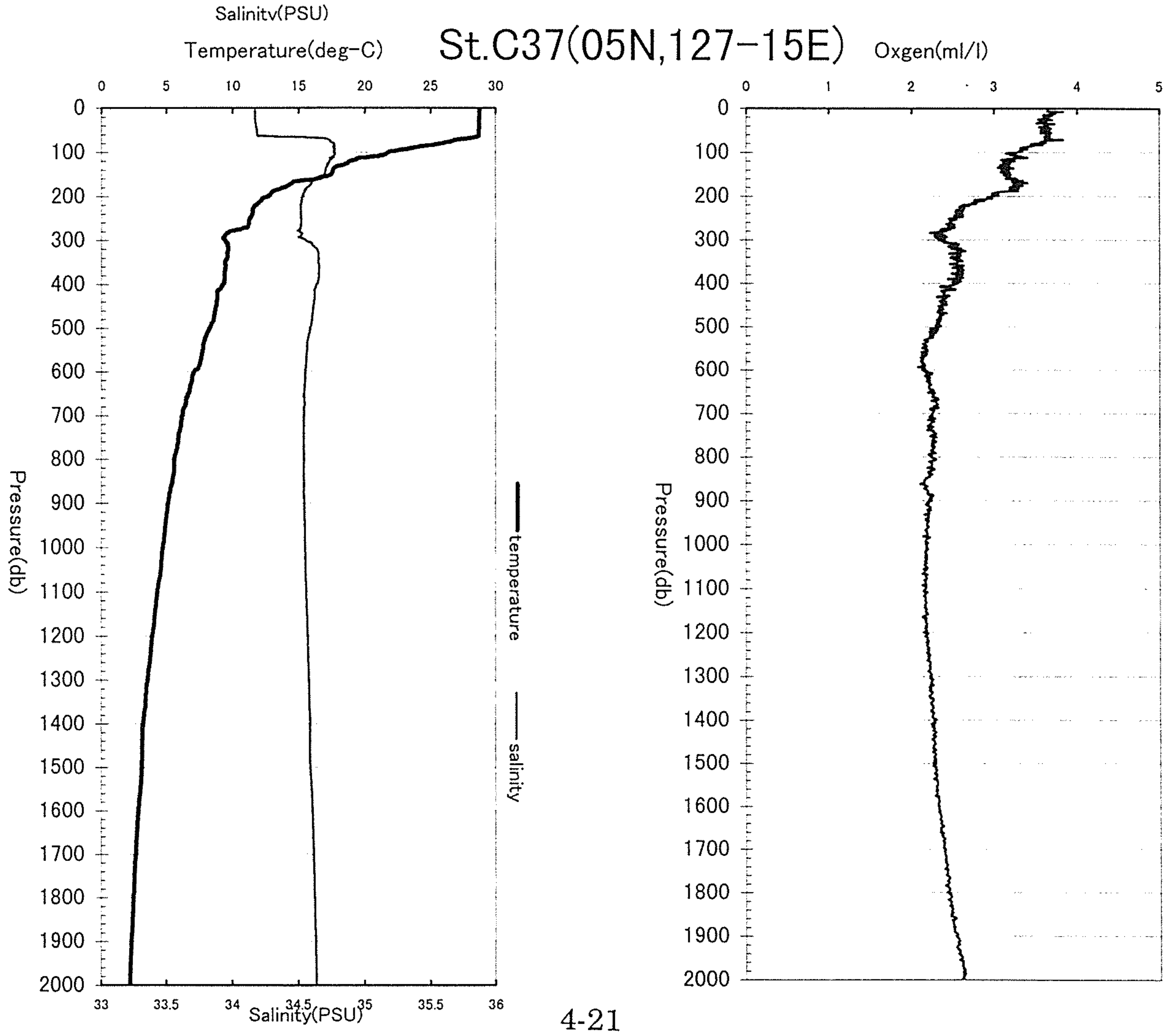


St.C35(05N,127-45E)

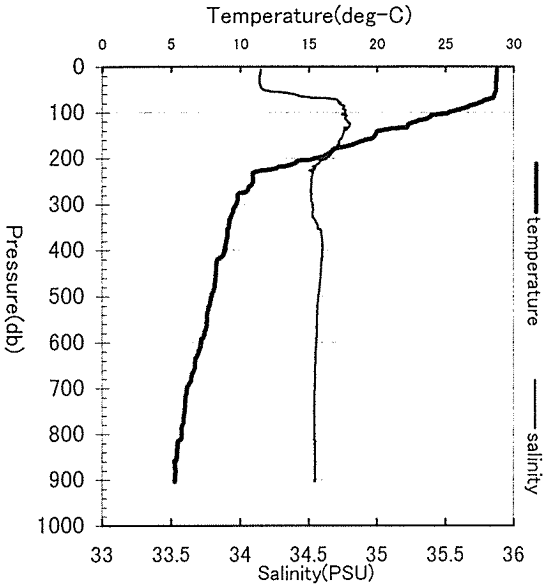


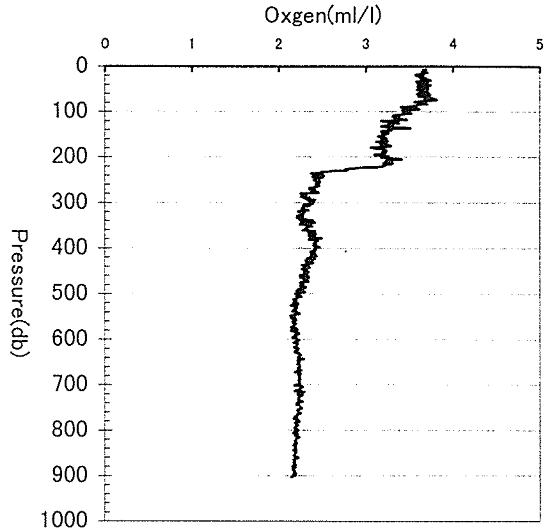



St.C36(05N,127-30E)
Temperature(deg-C)
Oxgen(ml/l)
Pressure(db)
temperature
salinity
Salinitv(PSU)

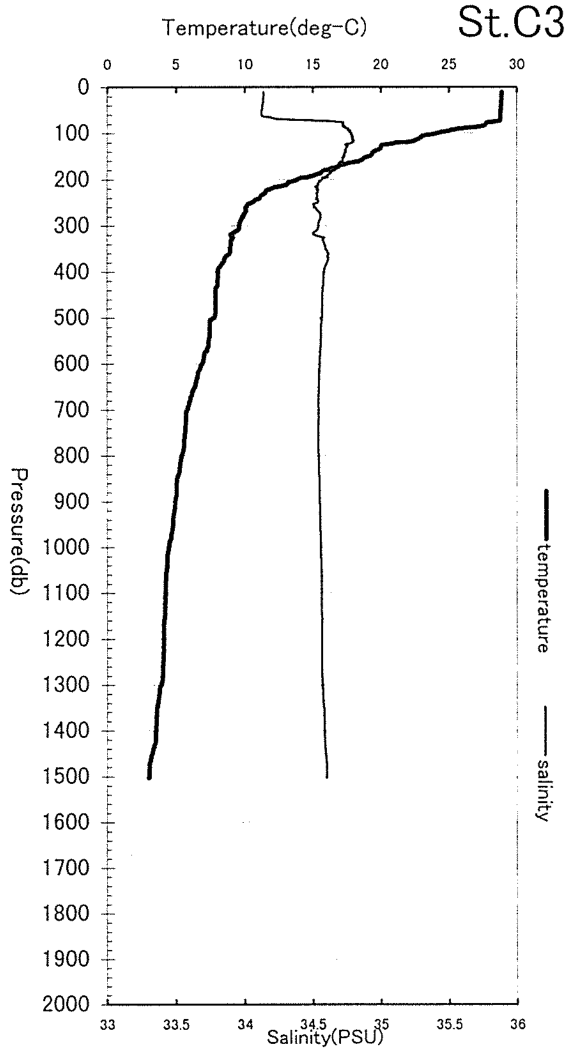

St.C37(05N,127-15E)
Temperature(deg-C)
Oxgen(ml/l)
Pressure(db)
temperature
salinity
Salinity(PSU)

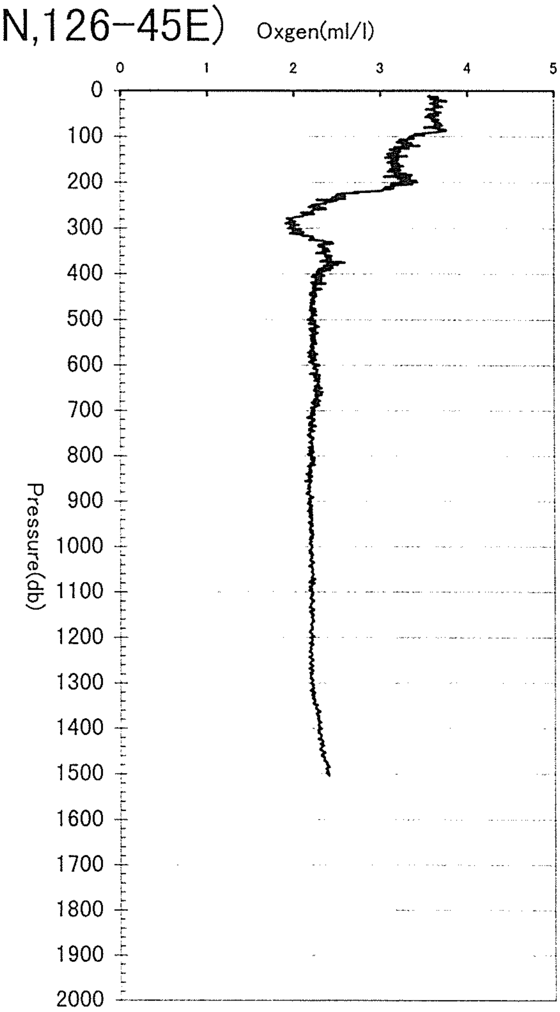
St.C38(05N,127E)



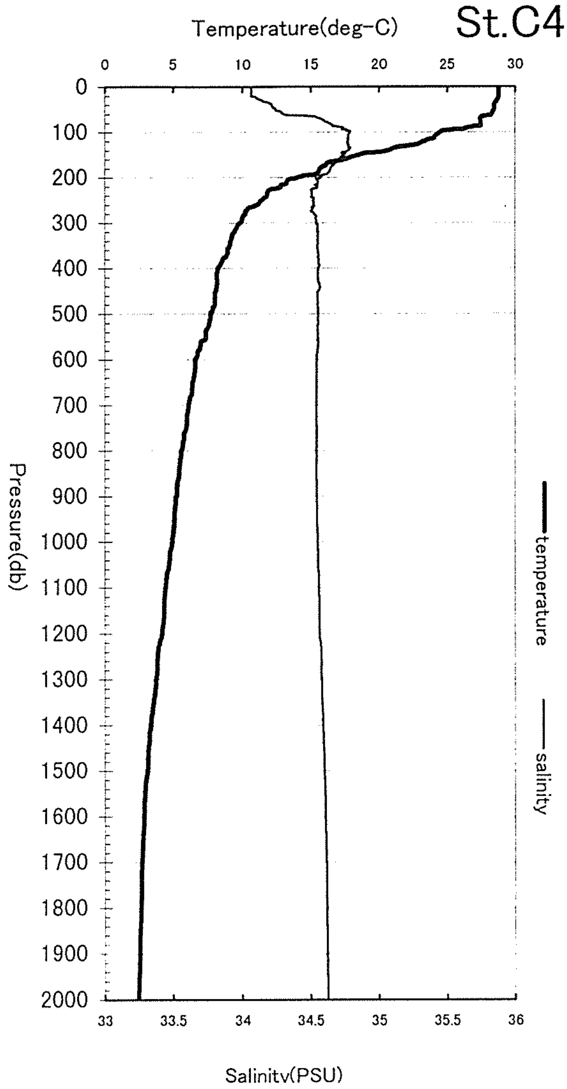


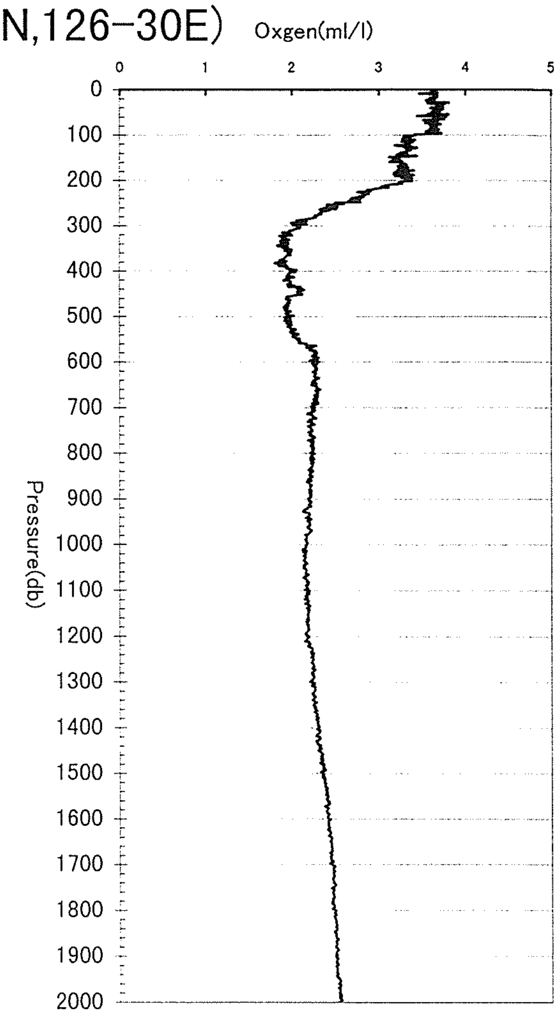
St.C39(05N,126-45E)



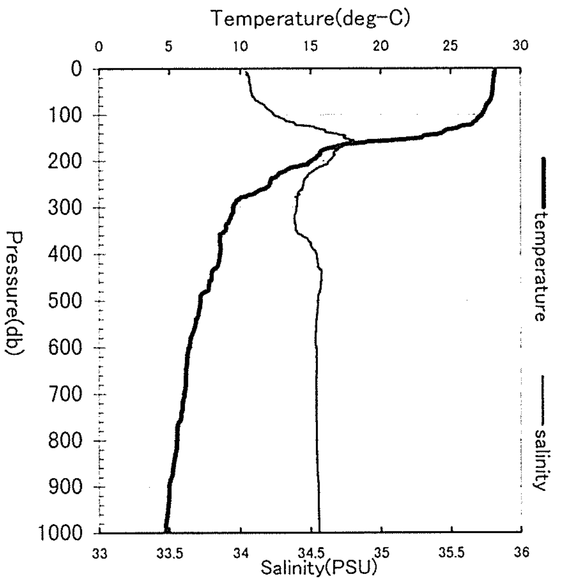


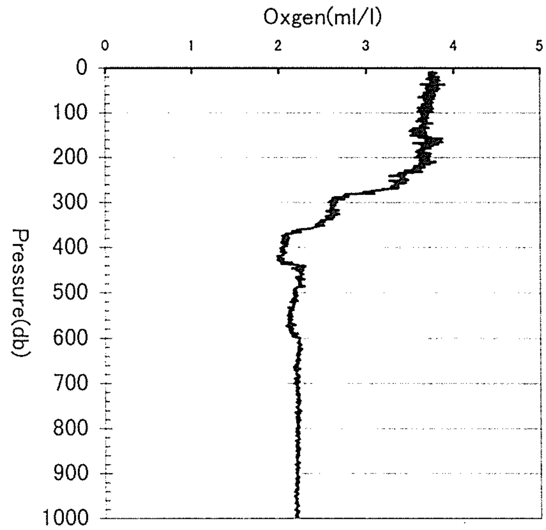
St.C40(05N,126-30E)



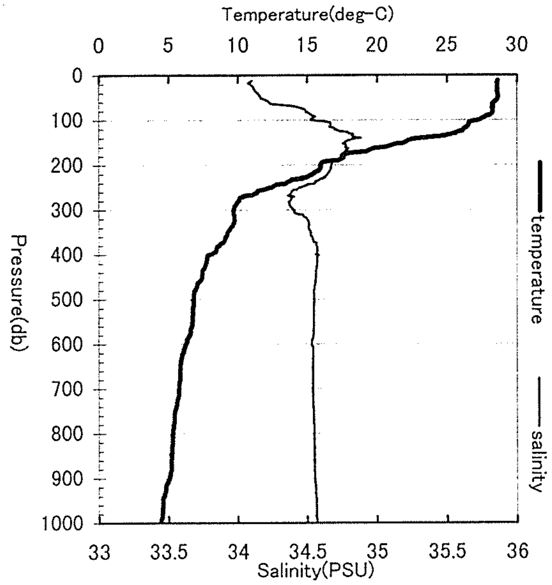


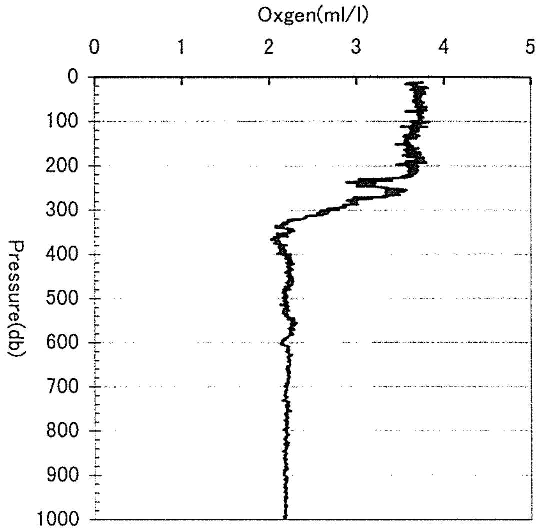
St.C41(05-14N,125-38E)



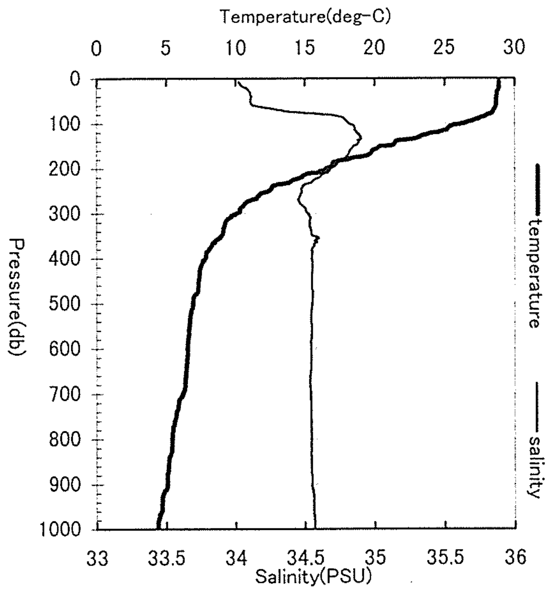


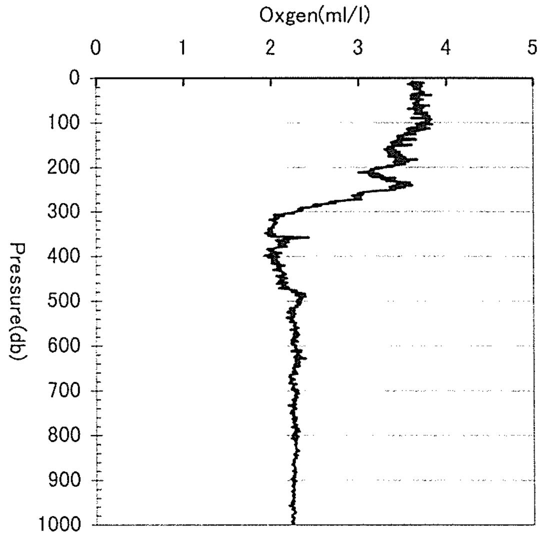
St.42(05-07N,125-49E)



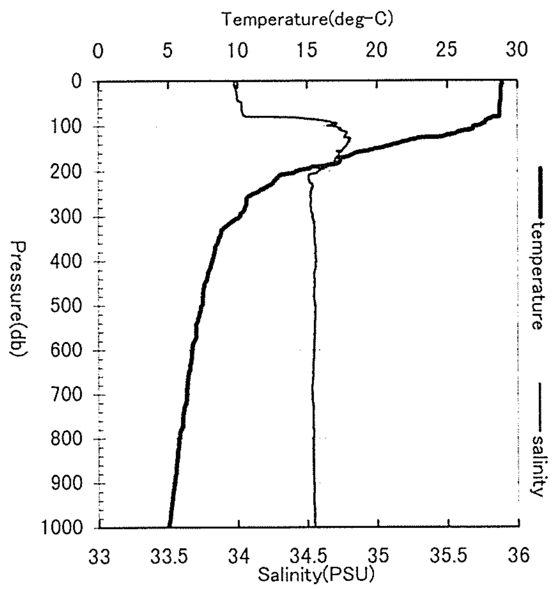


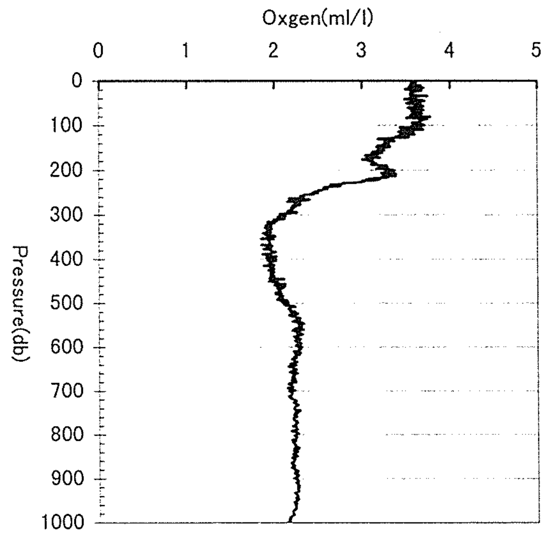
St.43(05N,126E)



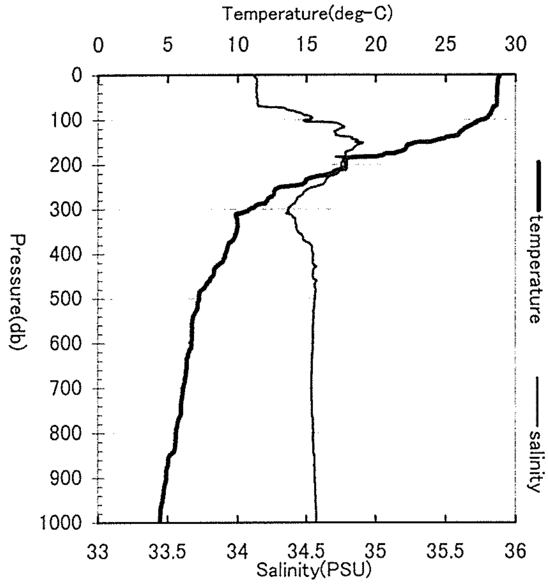


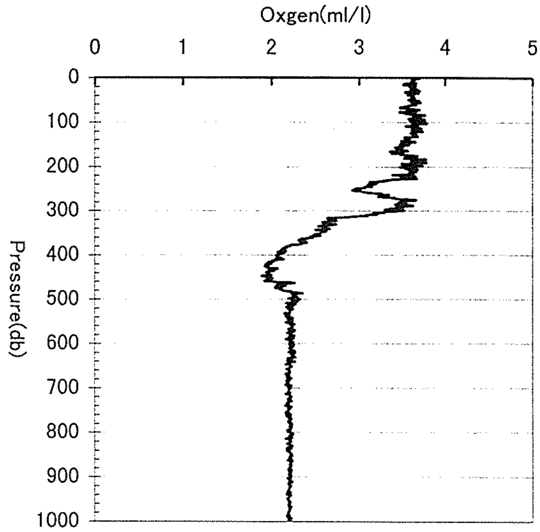
St.44(05N,126-15E)



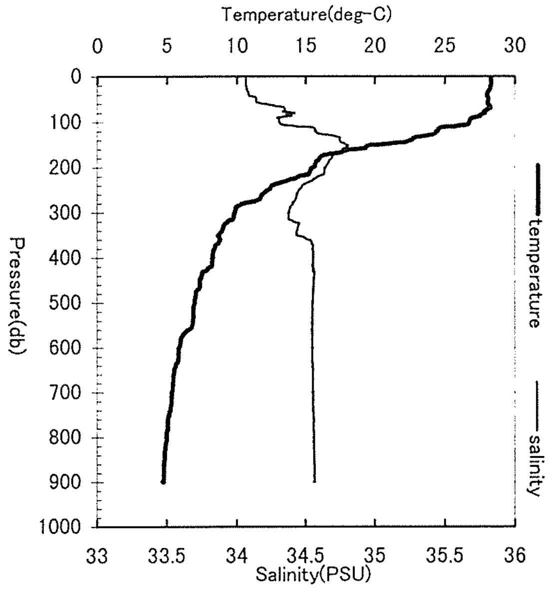


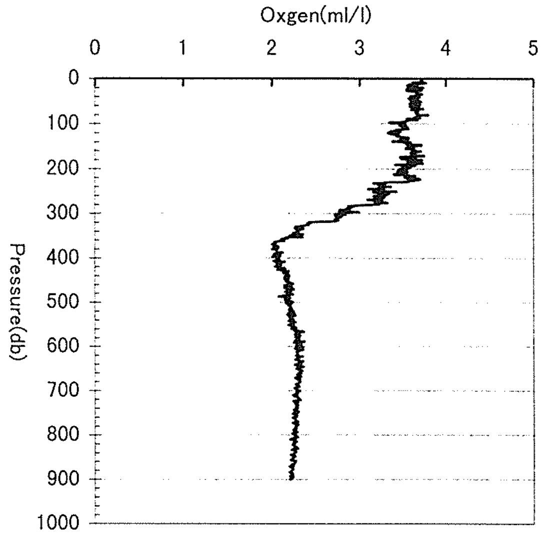
St.45(05N,125-45E)



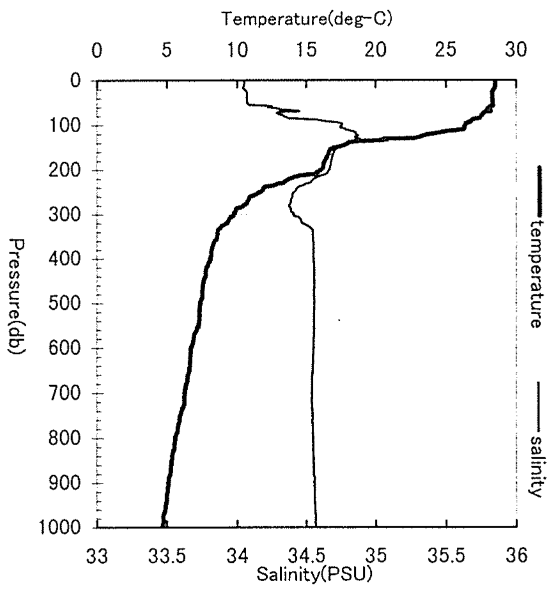


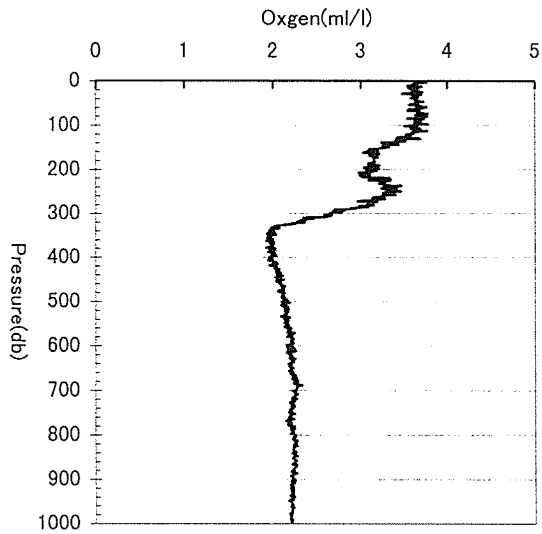
St.46(05N,125-30E)



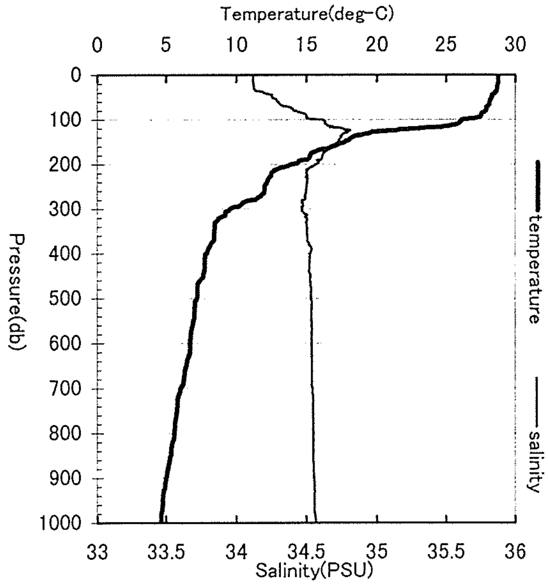


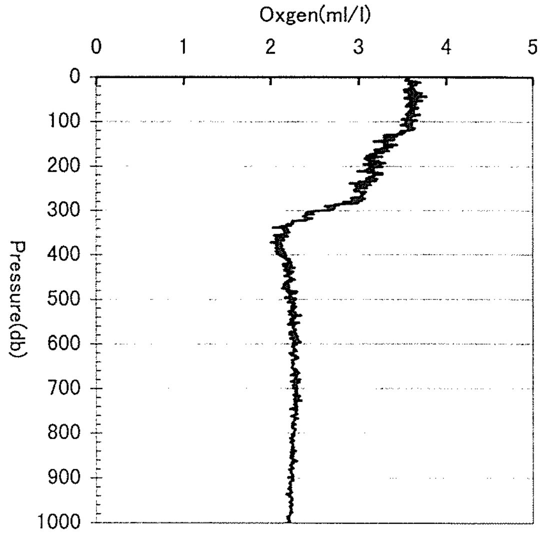
St.47(04-45N,125-20E)



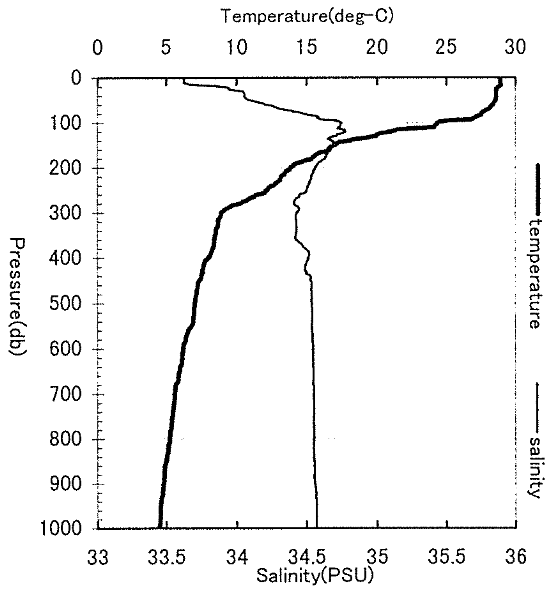


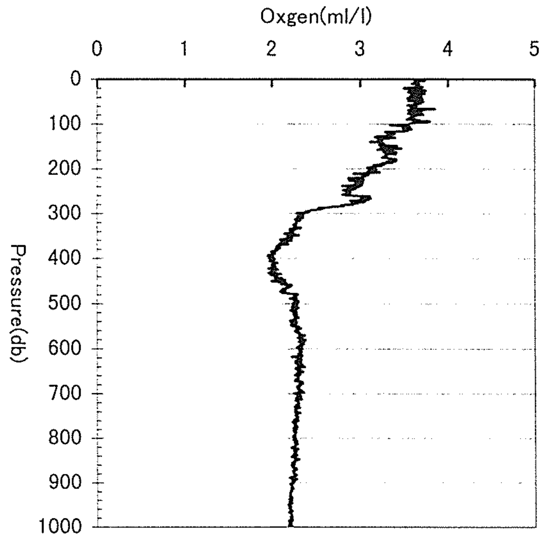
St.C48(04-30N,125-10E)



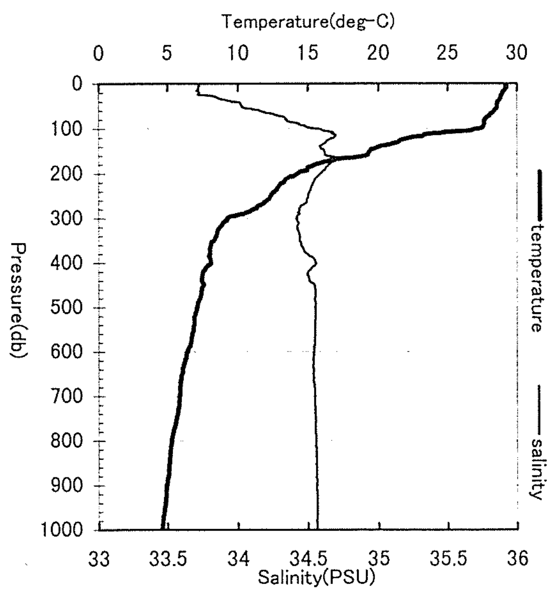


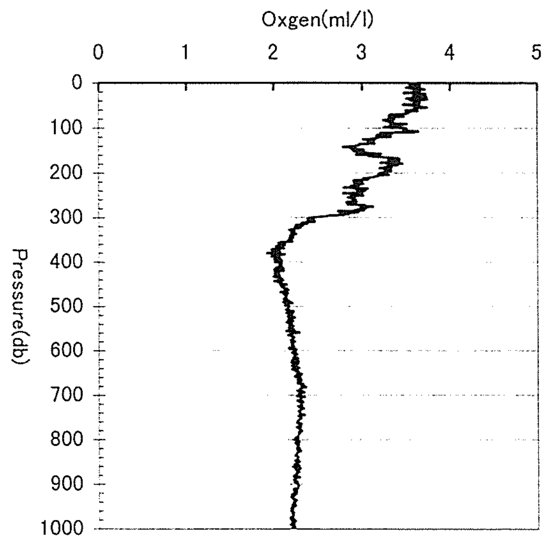
St.C49(04-15N,125E)



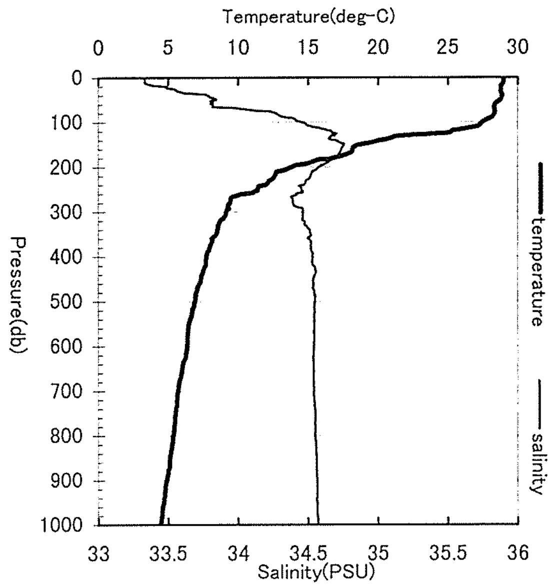


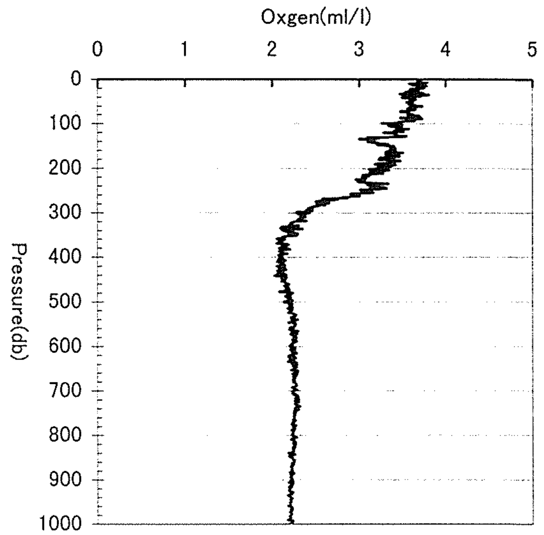
St.C50(04N,124-50E)



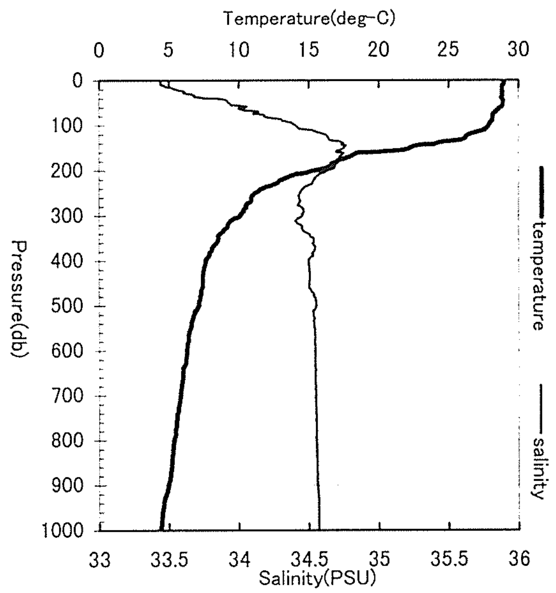


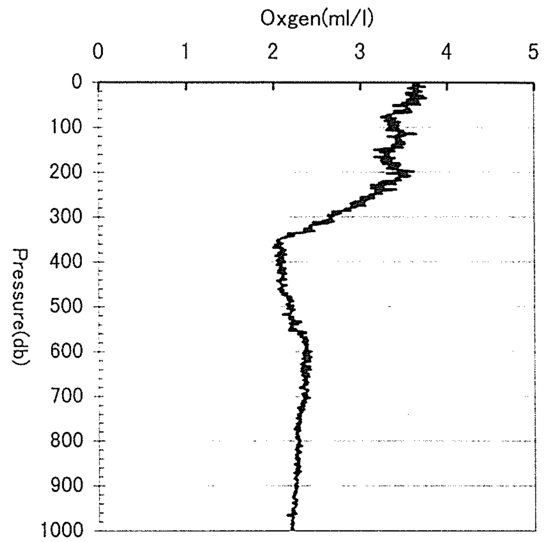
St.C51(03-45N,124-40E)



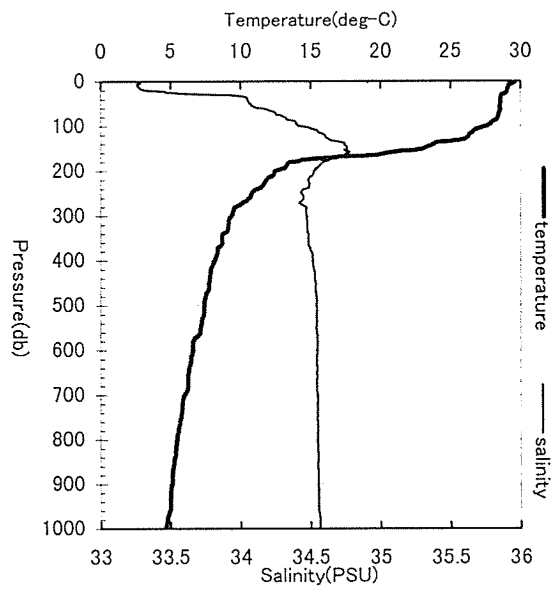


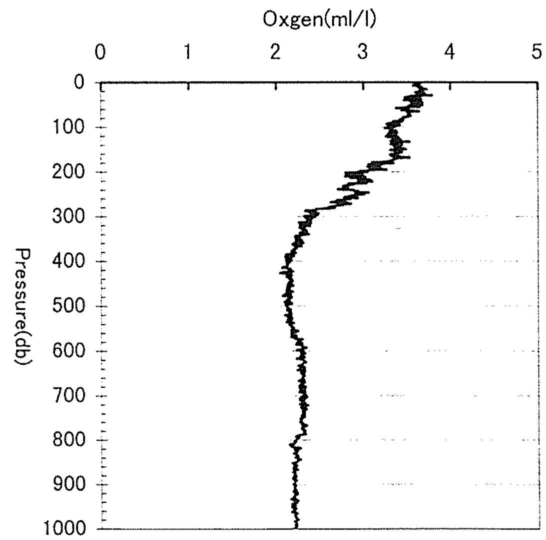
St.C52(03-30N,124-30E)



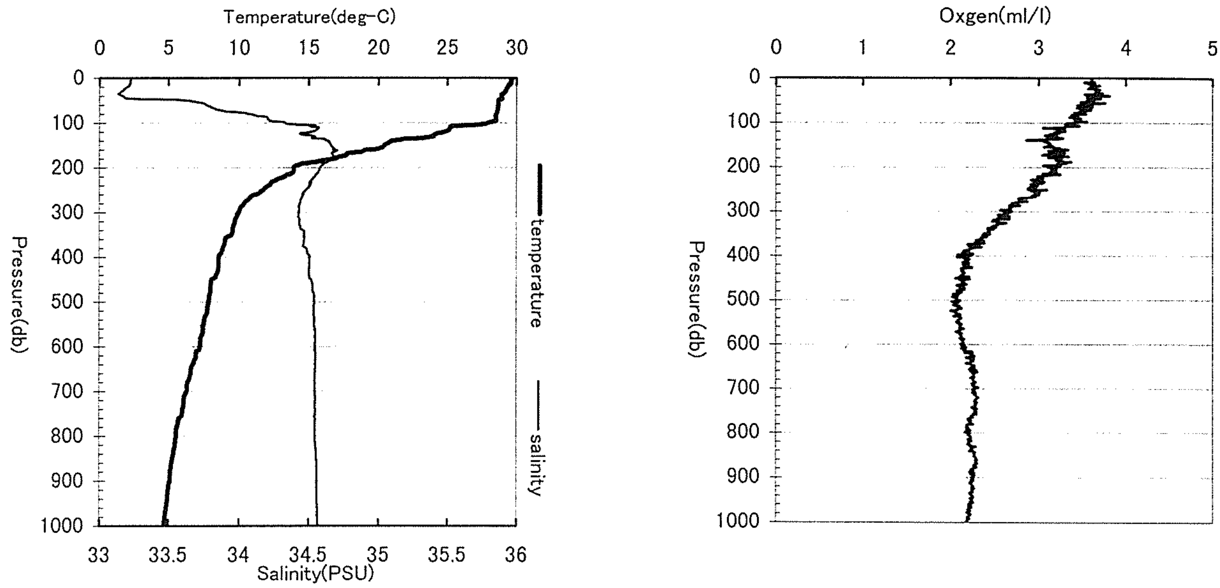


St.C53(03N,124-40E)

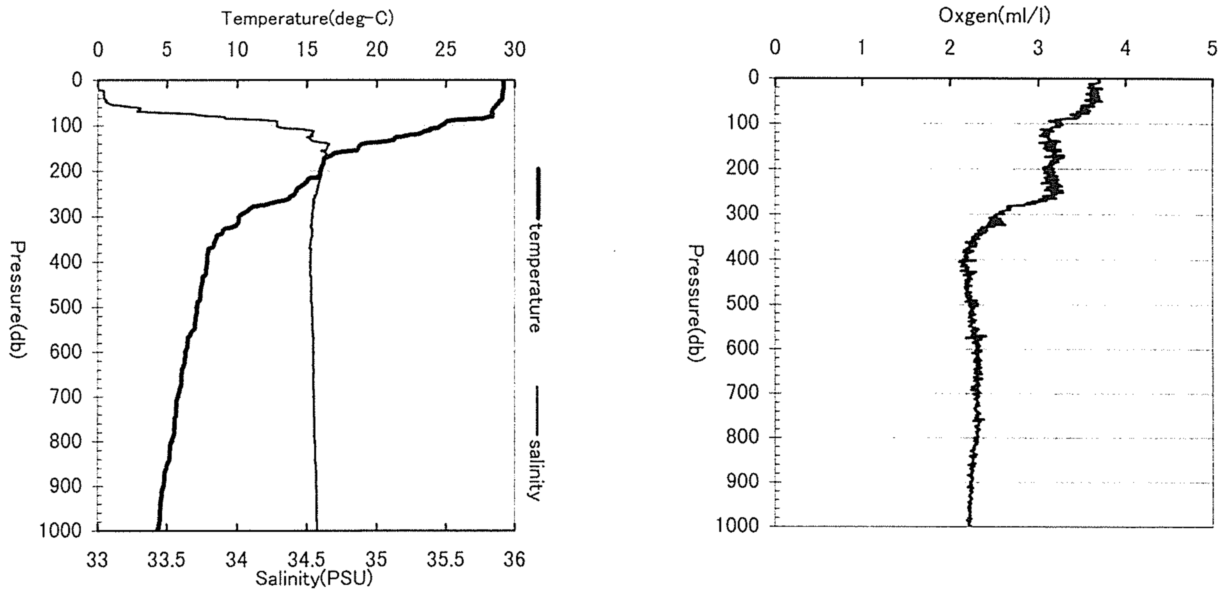




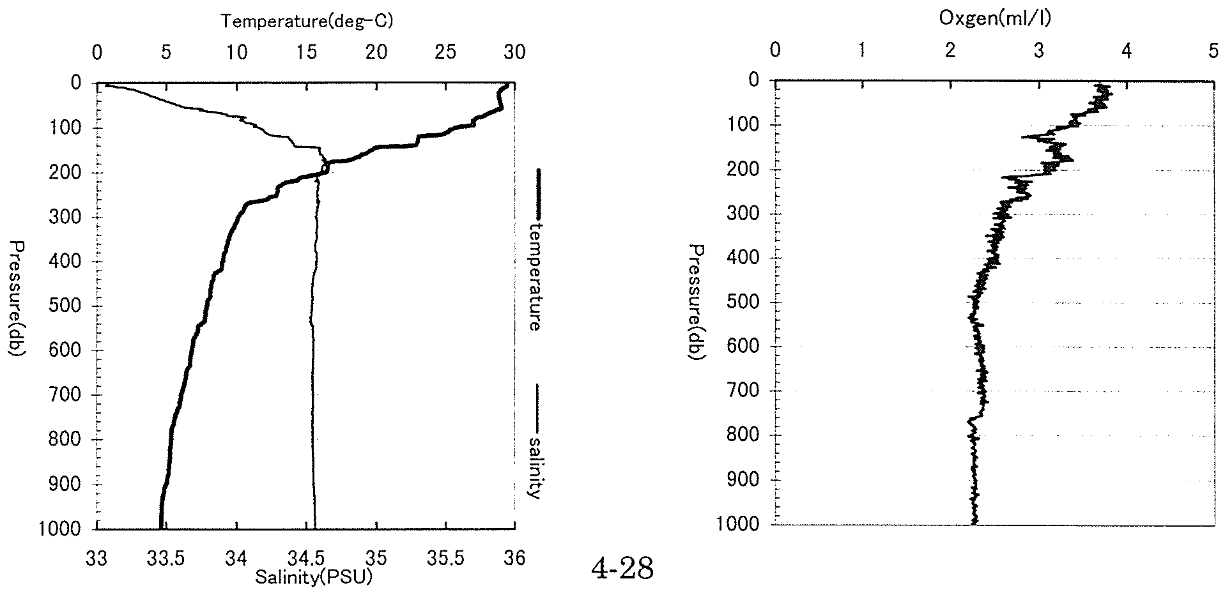
St.C54(03N,124-50E)



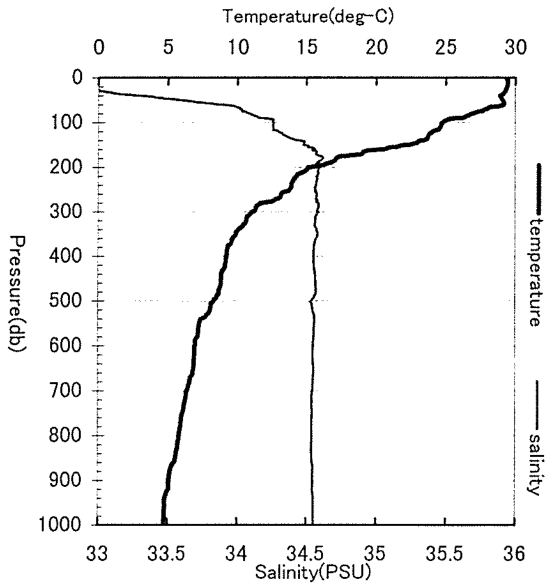
St.C55(02N,125E)

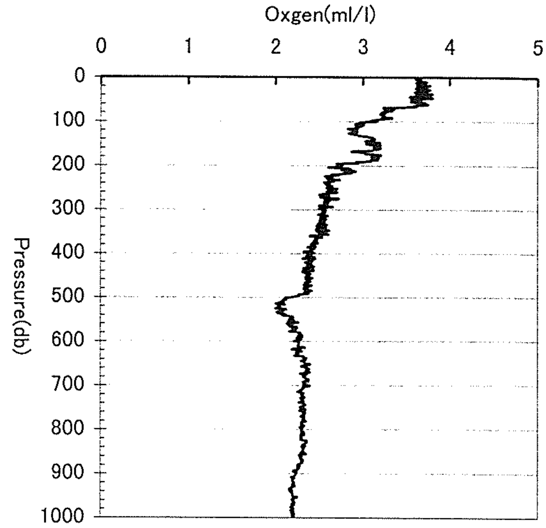


St.C56(01-45N,125-25E)

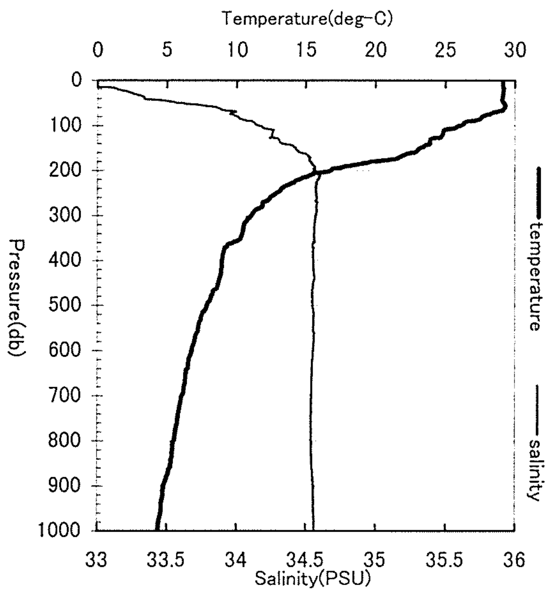


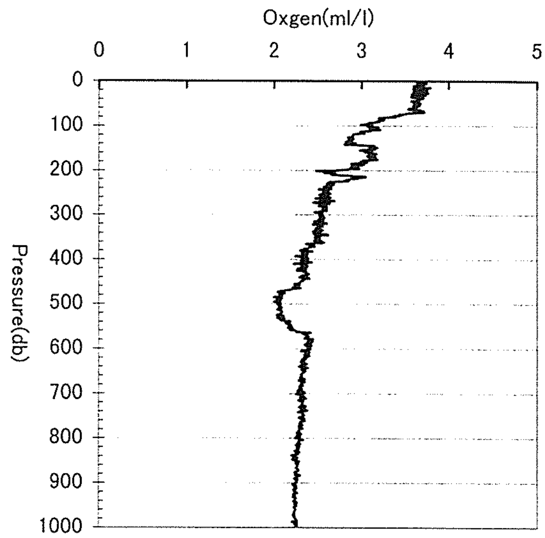
St.C57(01-45N,125-40E)



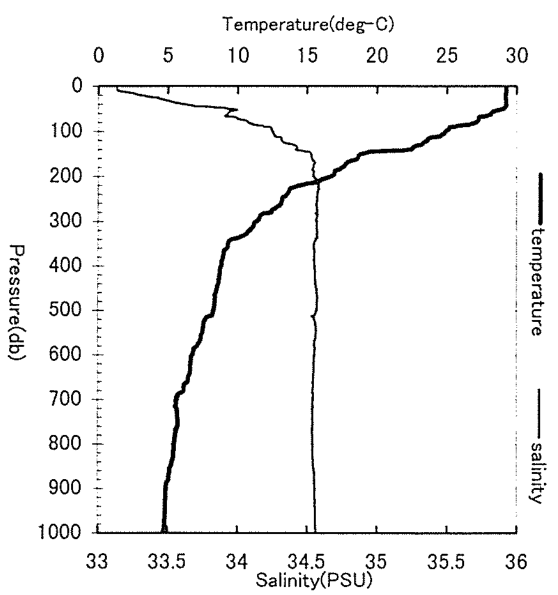


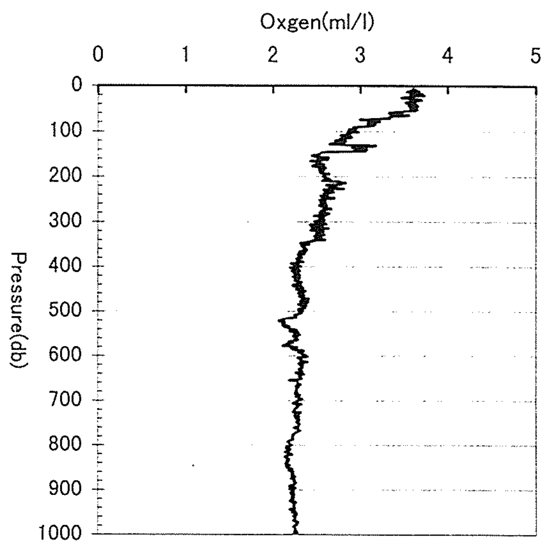
St.C58(01-45N,125-55E)



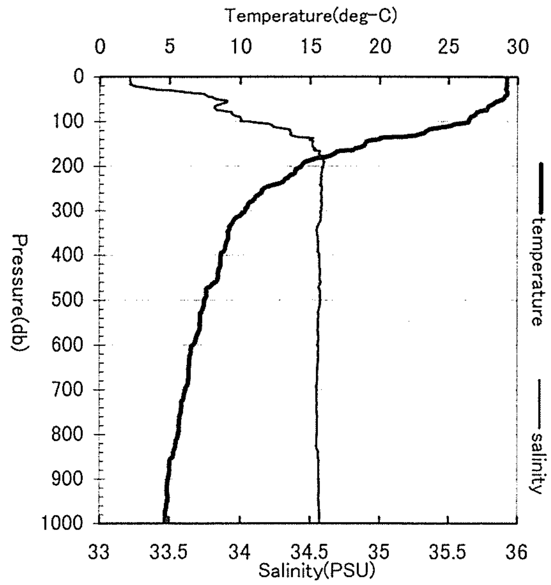


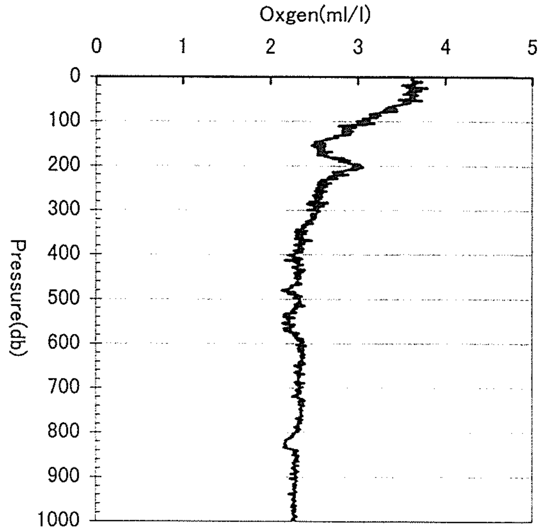
St.C59(01-45N,126-10E)



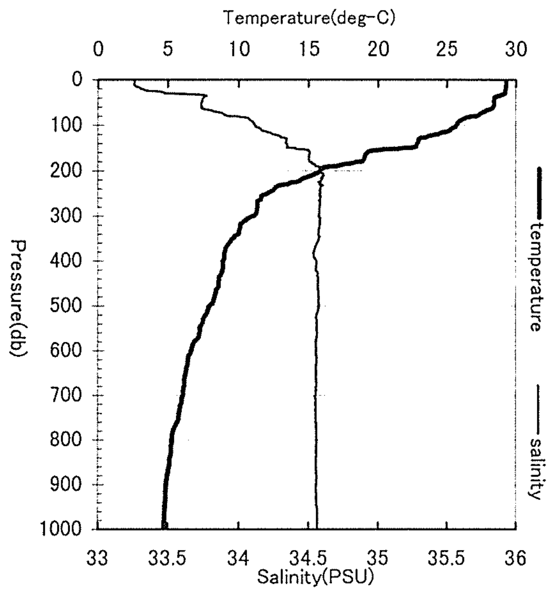


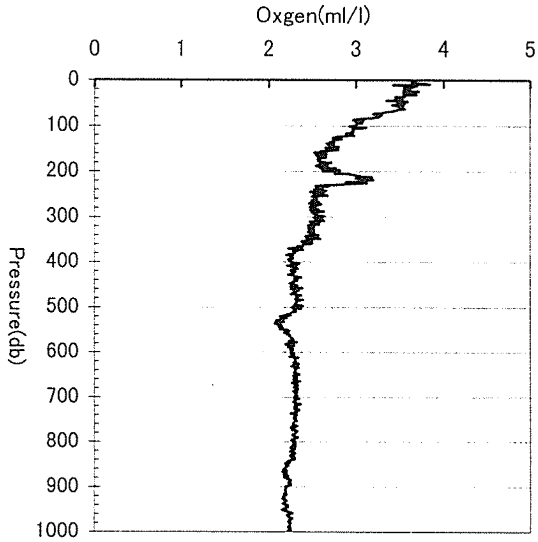
St.C60(01-45N,126-25E)



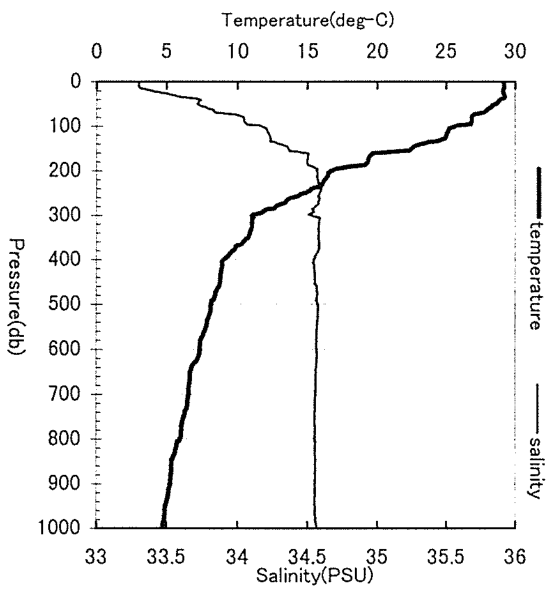


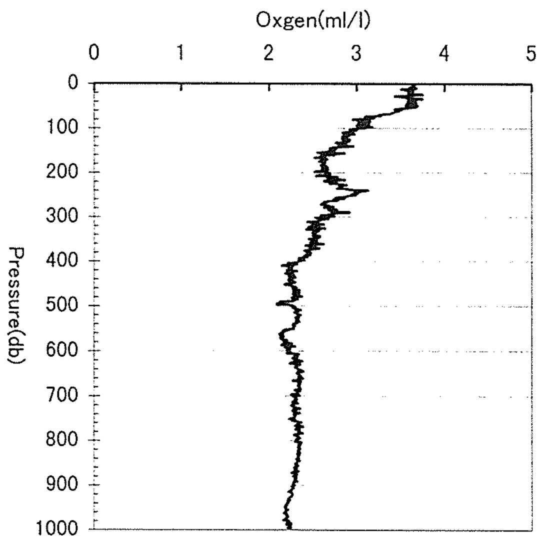
St.C61(01-45N,126-40E)



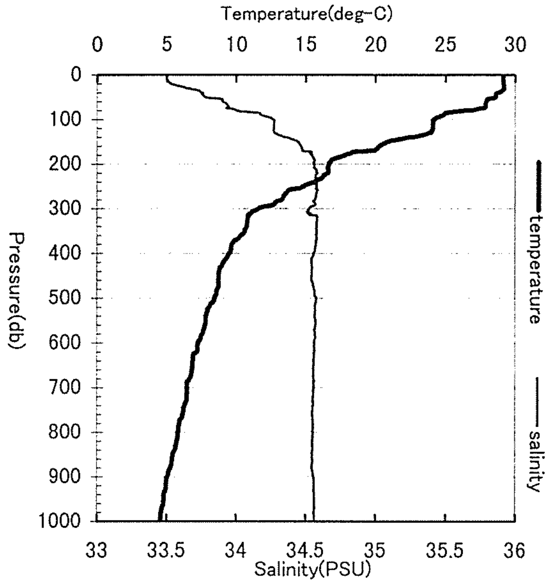


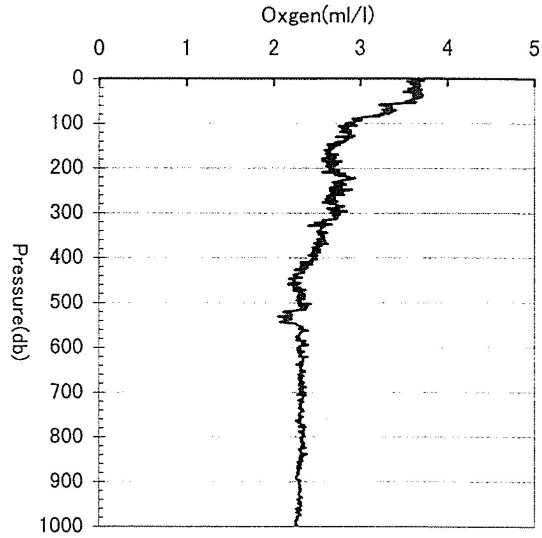
St.C62(01-45N,126-55E)



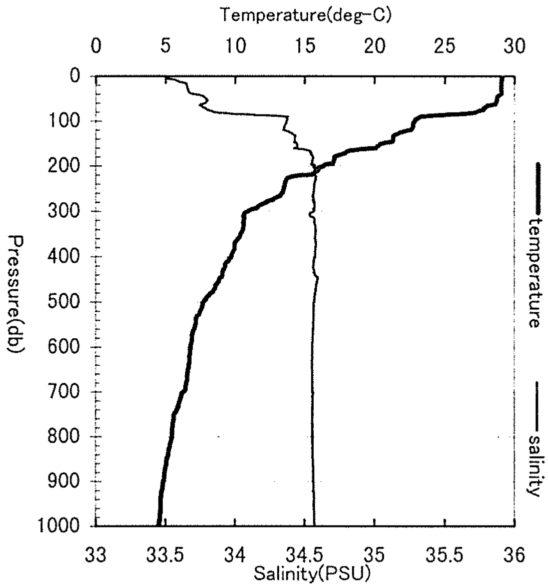


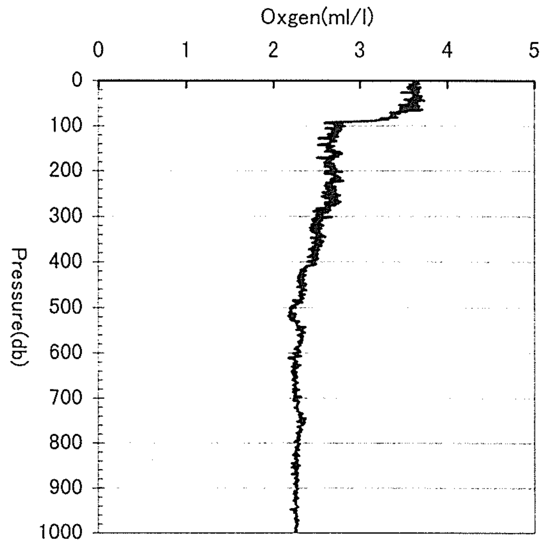
St.C63(01-45N,127-10E)



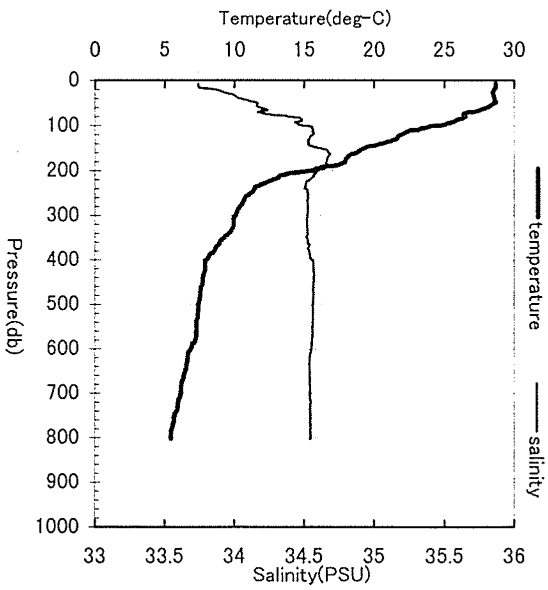


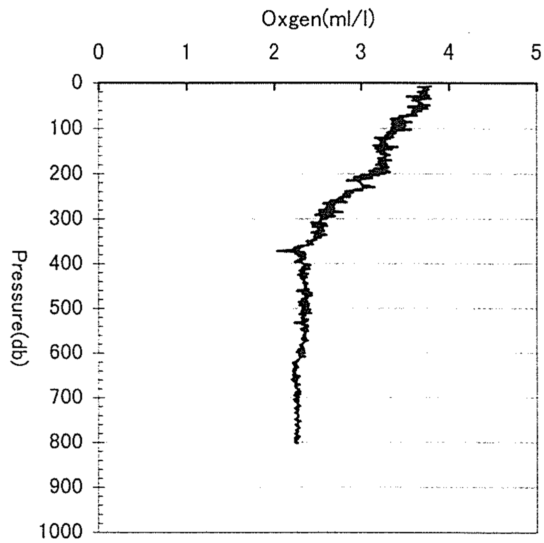
St.C64(01-45N,127-25E)



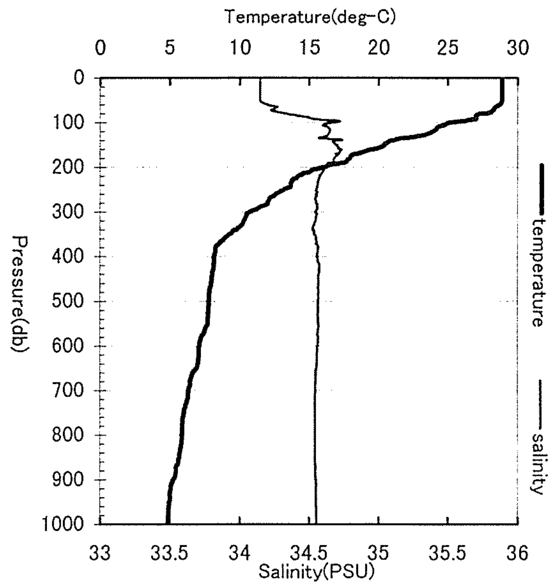


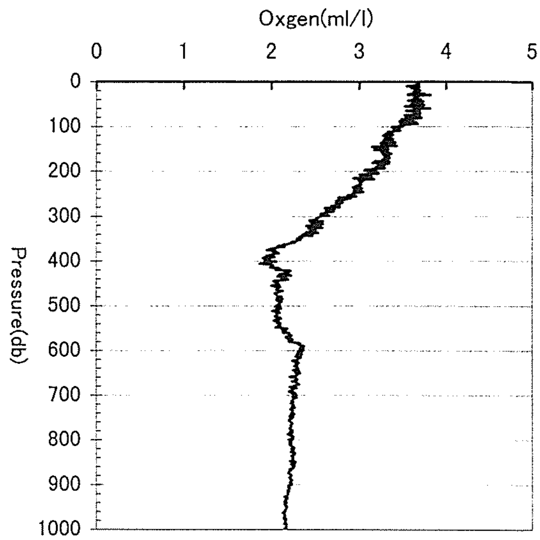
St.C65(03-30N,125-50E)



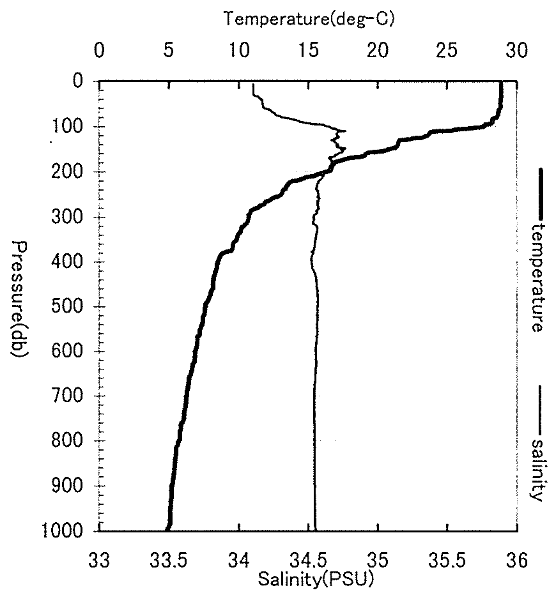


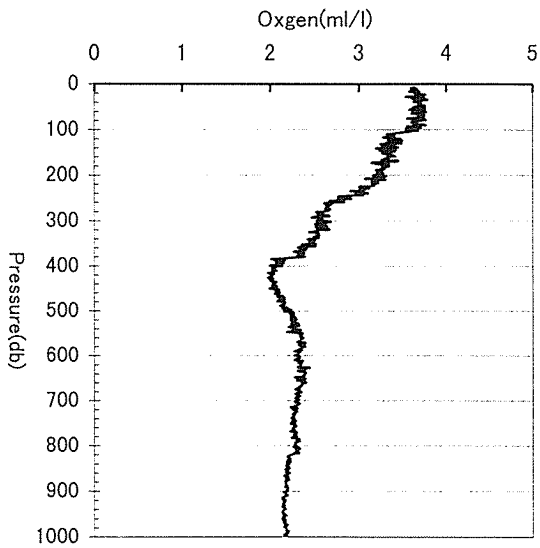
St.C66(03-30N,126-05E)



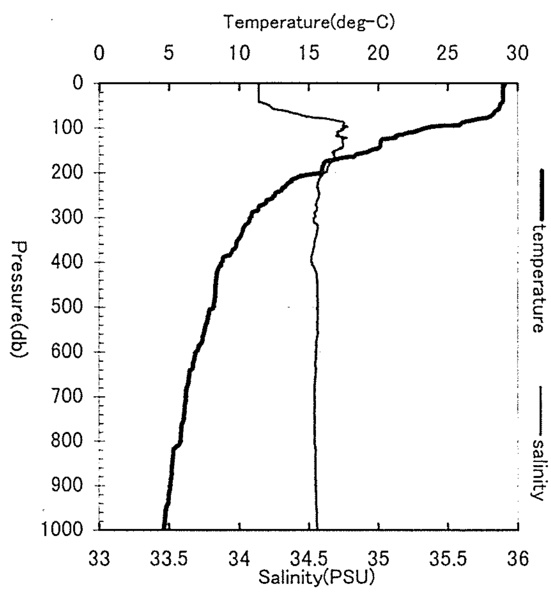


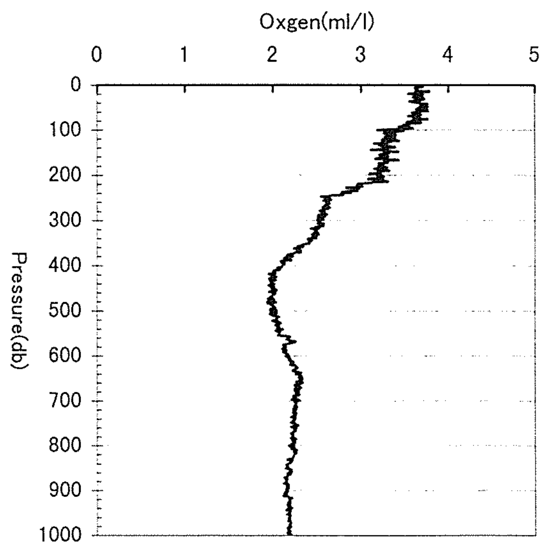
St.C67(03-30N,126-20E)



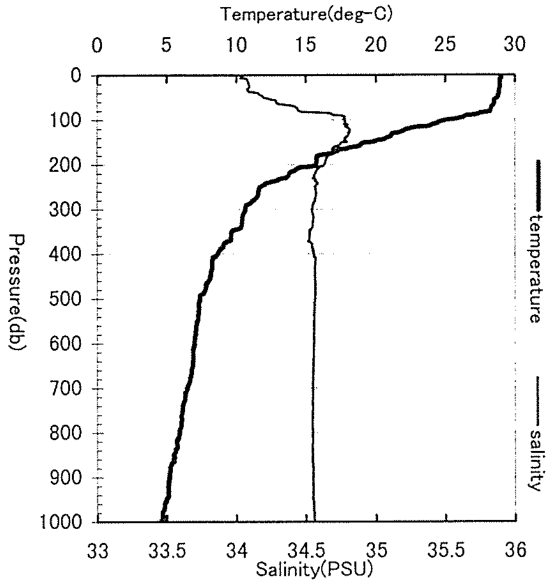


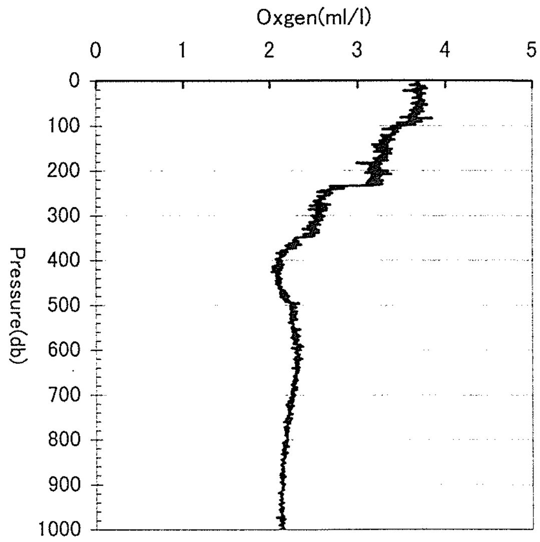
St.C68(03-30N,126-35E)



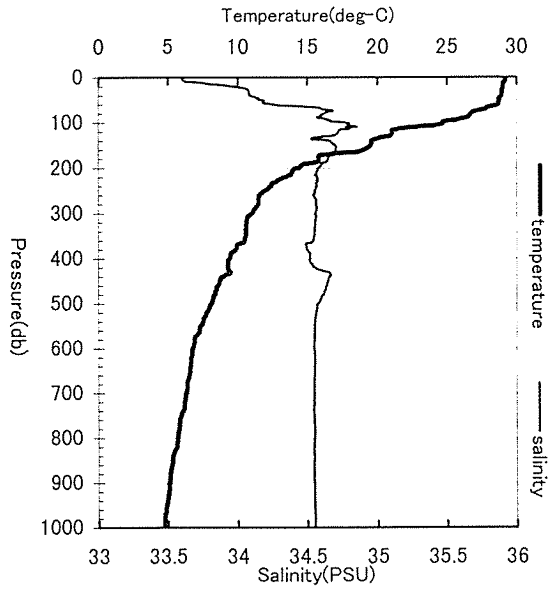


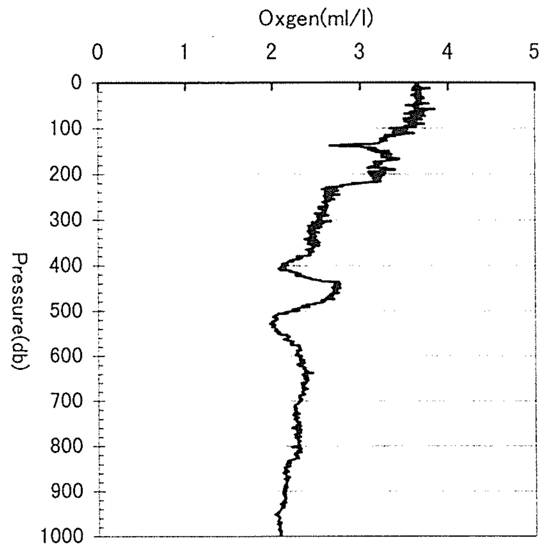
St.C69(03-30N,126-50E)



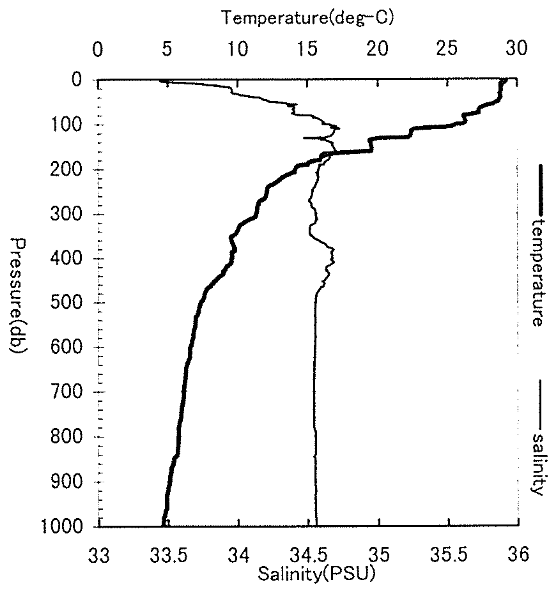


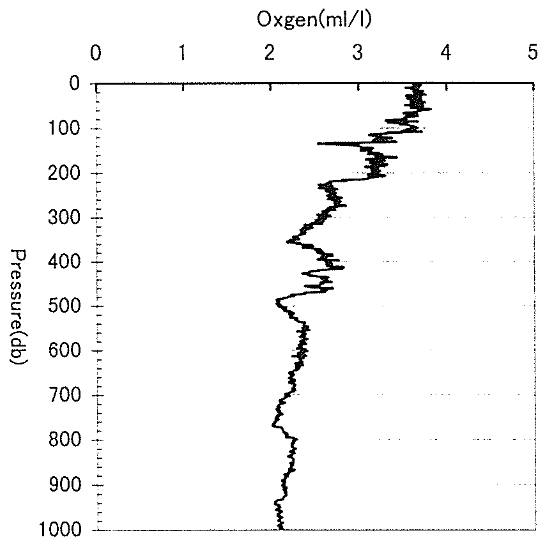
St.C70(03-25N,127-02E)



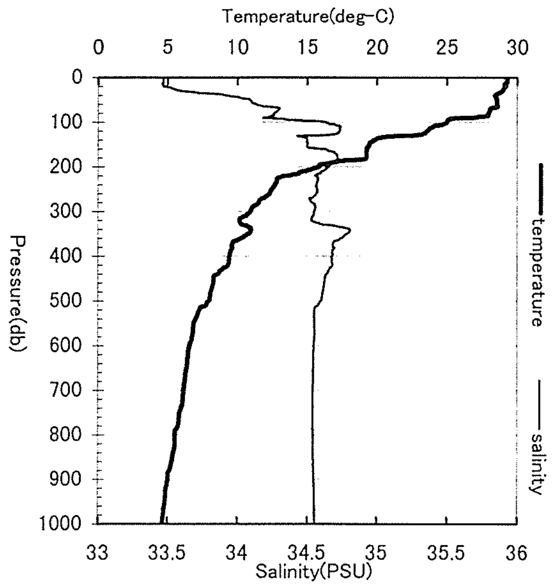


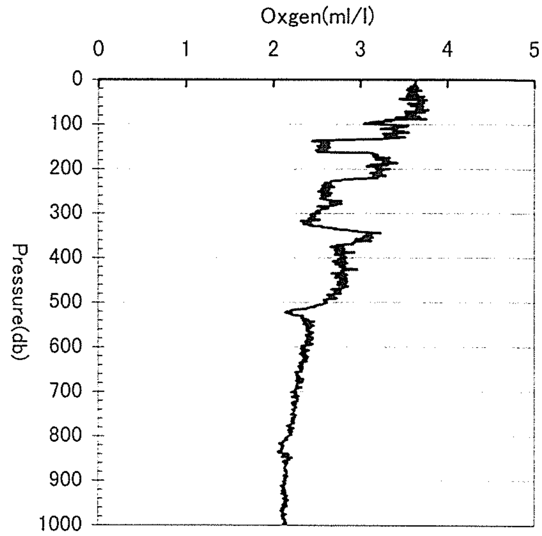
St.C71(03-20N,127-14E)



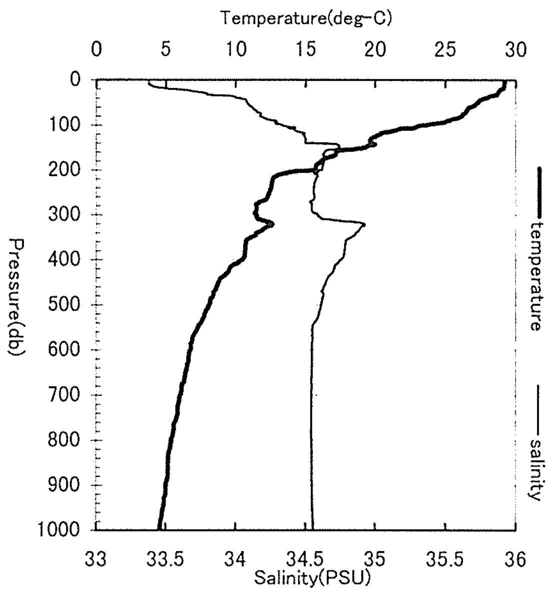


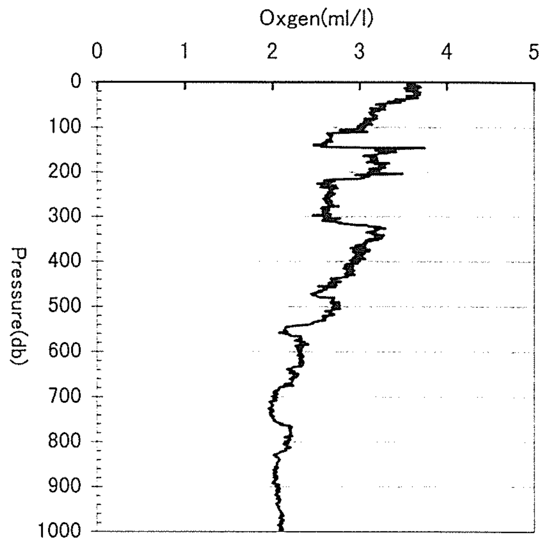
St.C72(03-15N,127-26E)



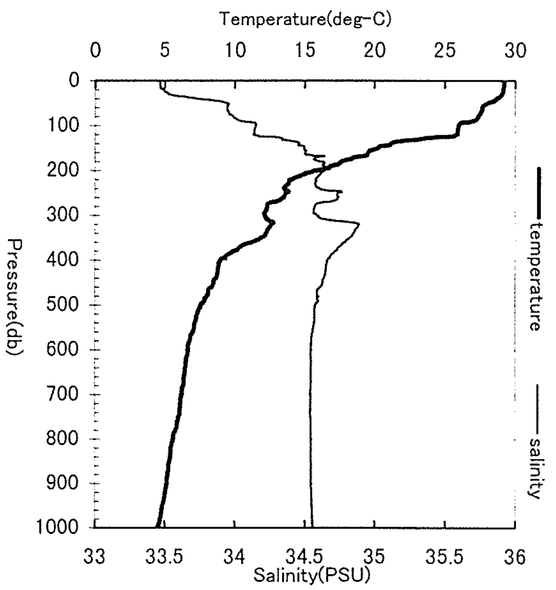


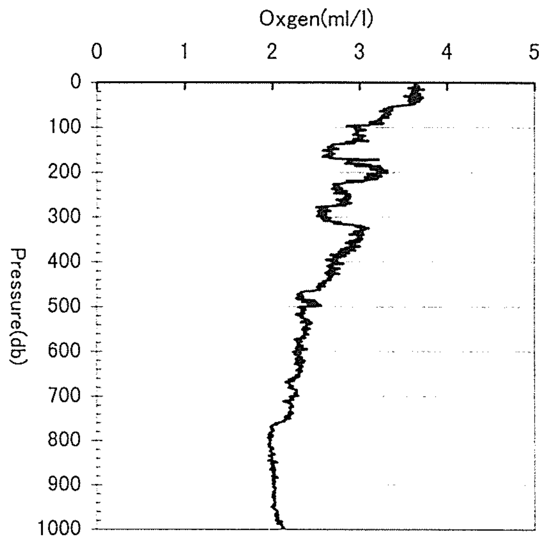
St.C73(03-10N,127-38E)



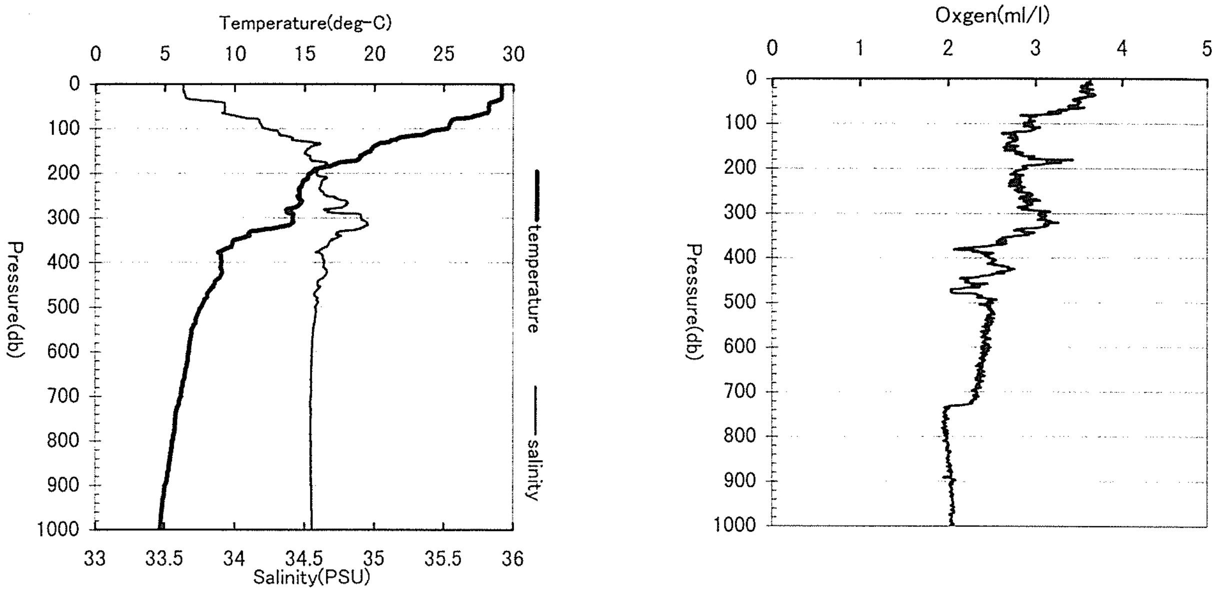


St.C74(03-05N,127-50E)

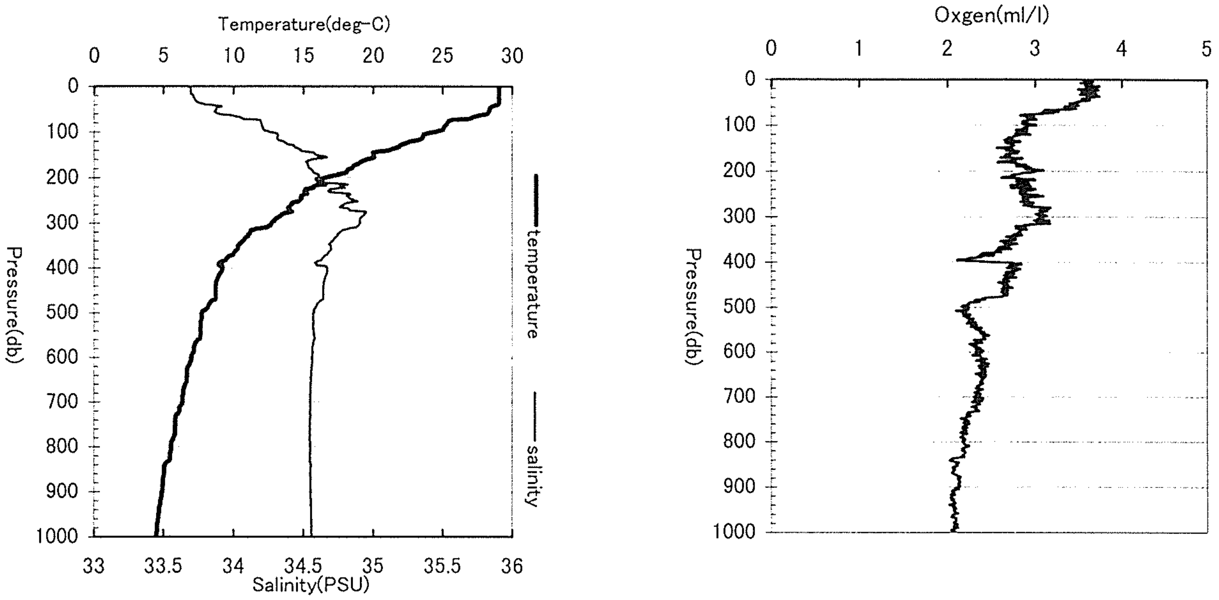




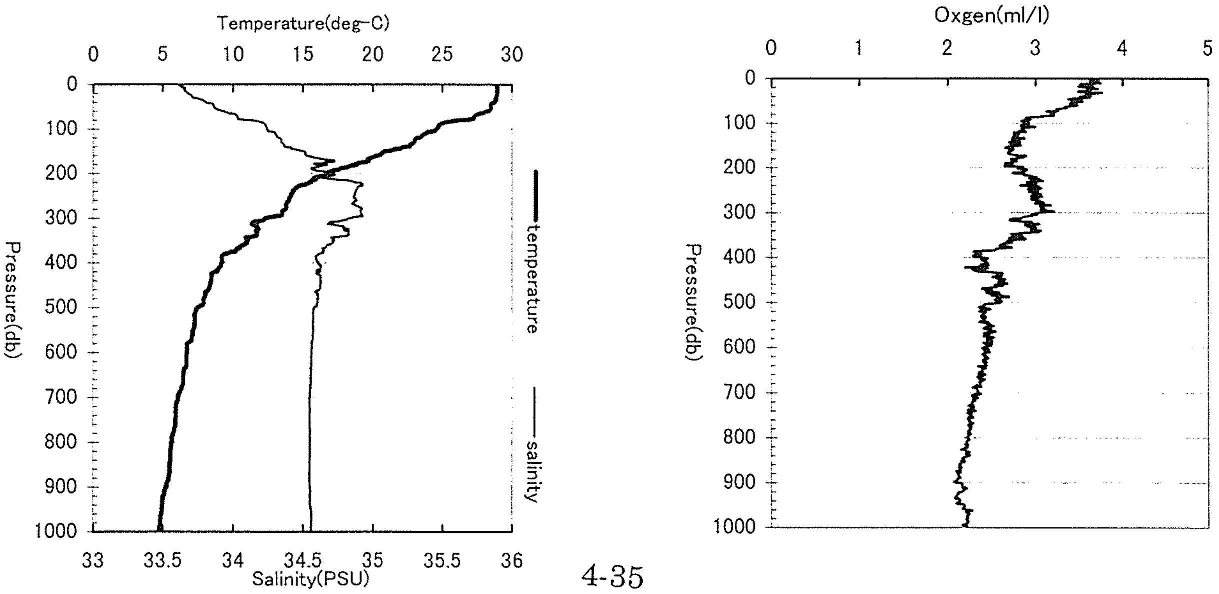
St.C75(03N,128-02E)



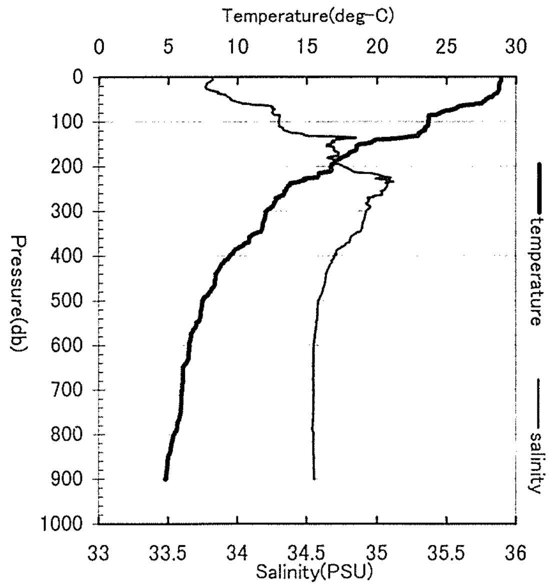
St.C76(02-55N,128-14E)

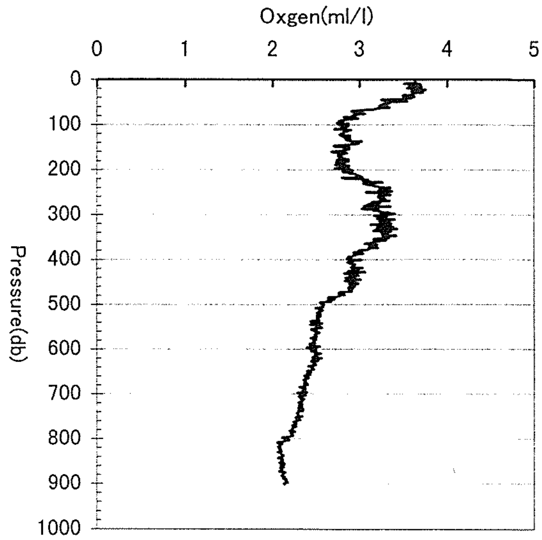


St.C77(02-50N,128-26E)

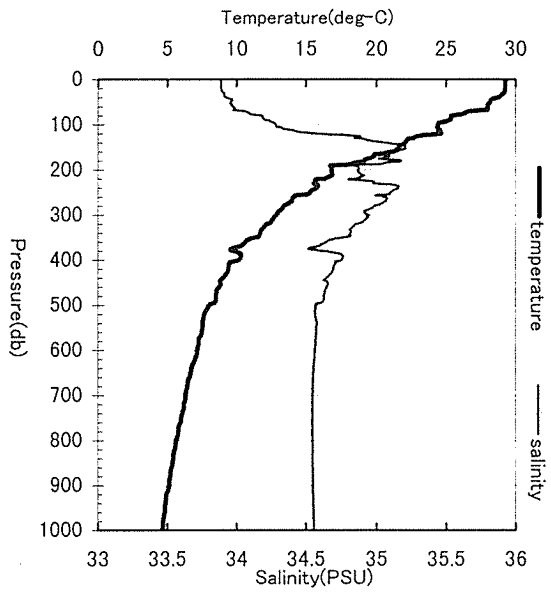


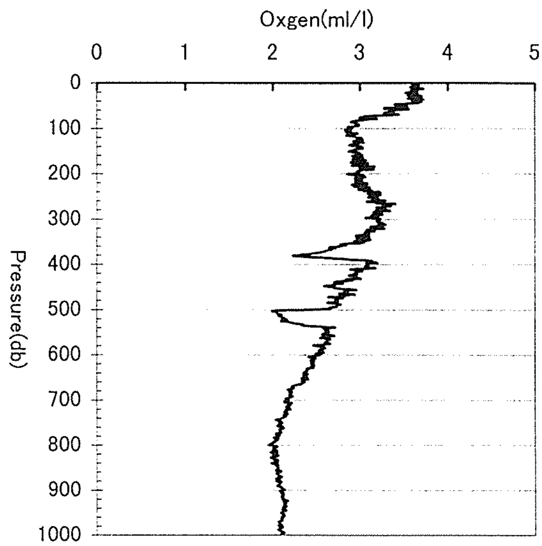
St.C78(02-45N,128-38E)



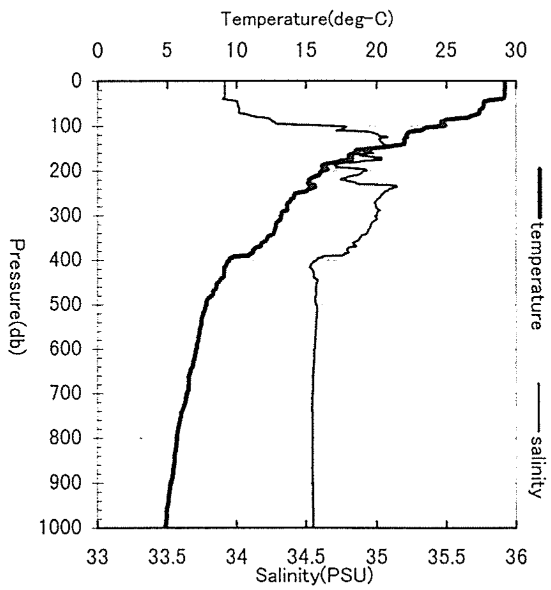


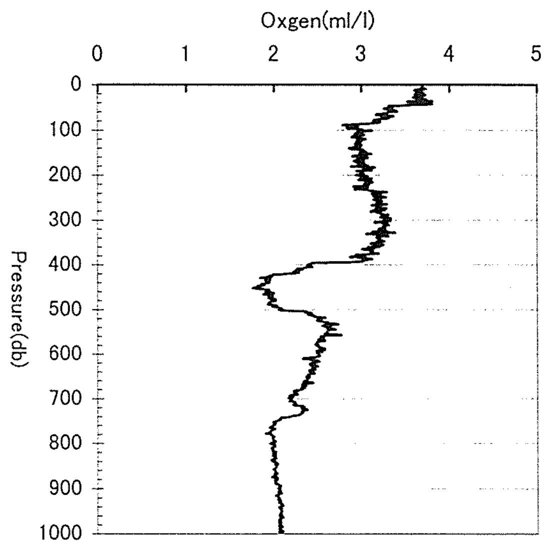
St.C79(03N,129E)



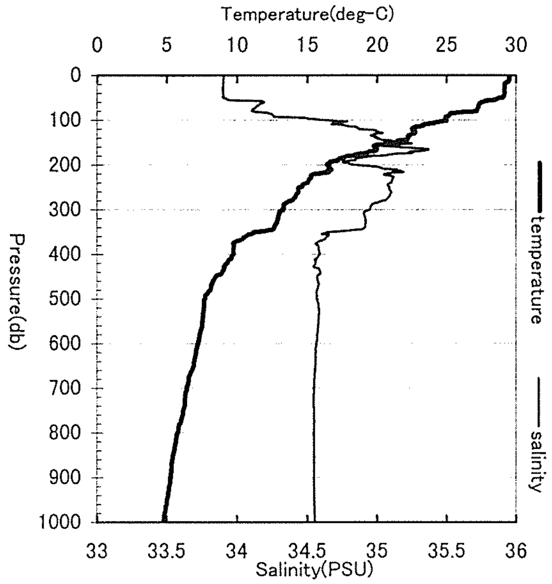


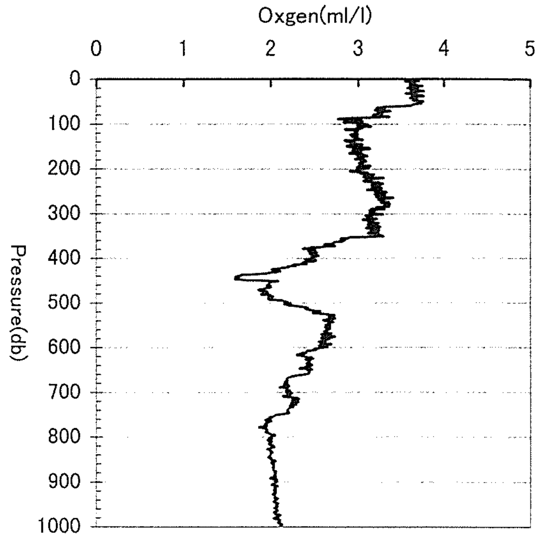
St.C80(03-18N,129-24E)





St.C81(03-36N,129-48E)





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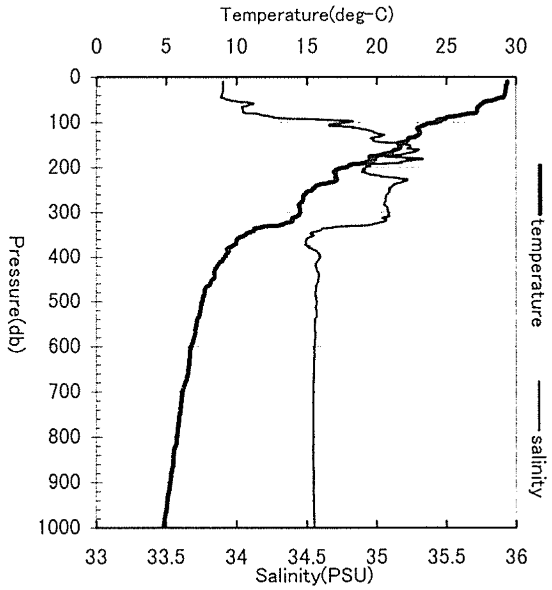

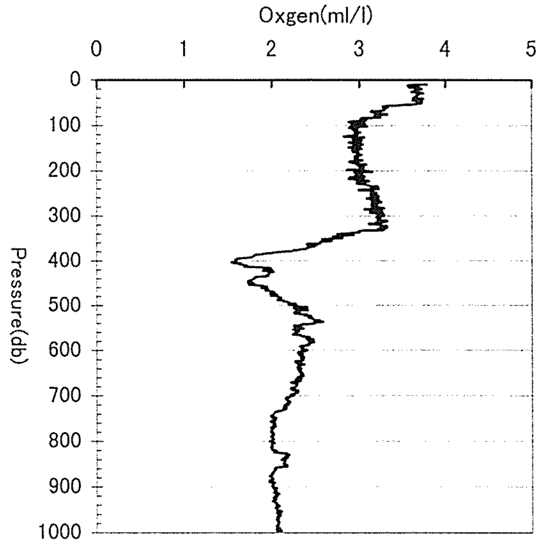

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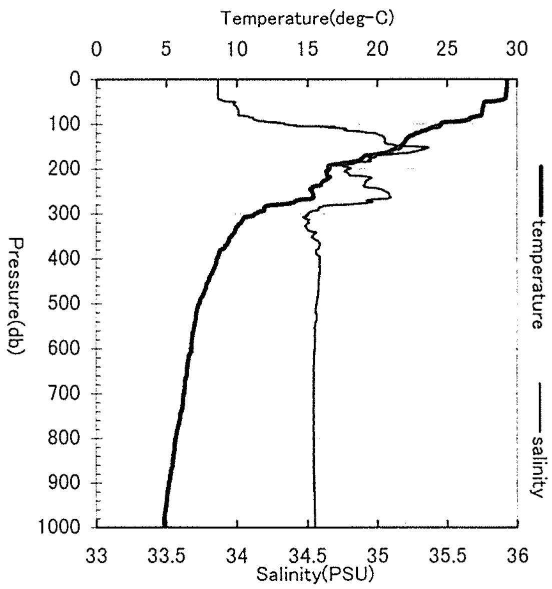
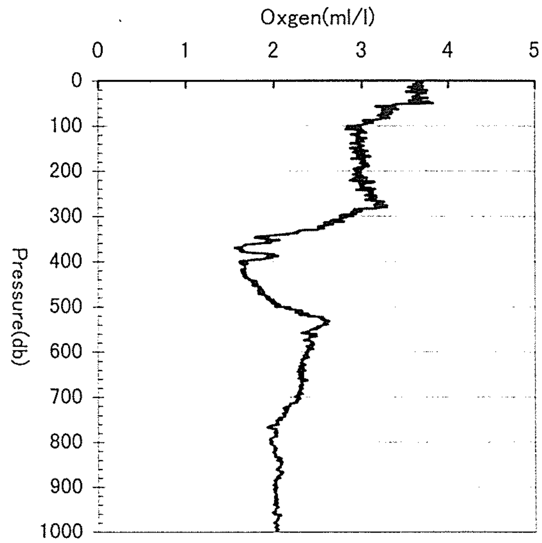
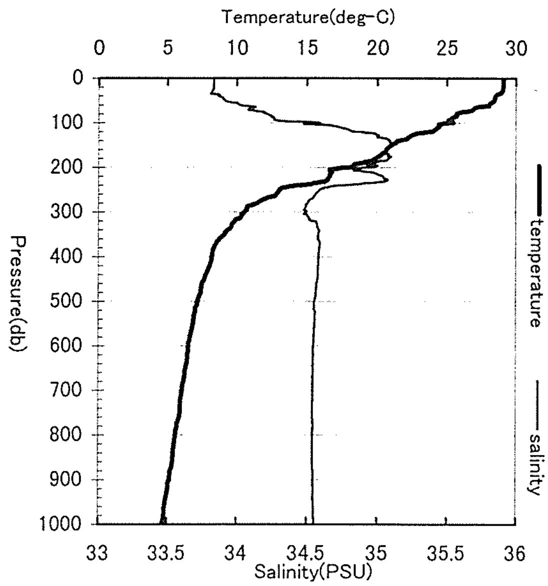
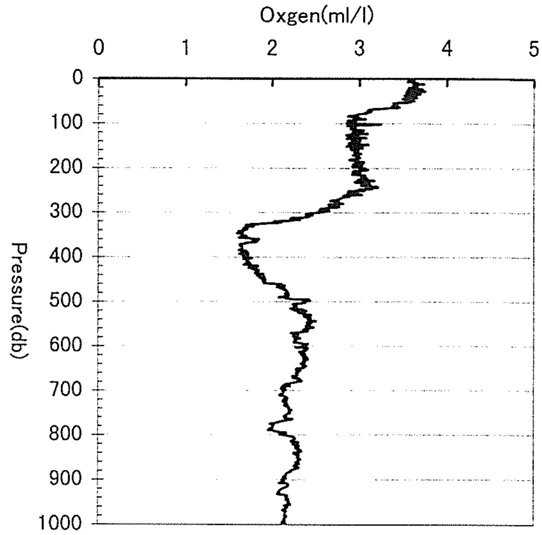


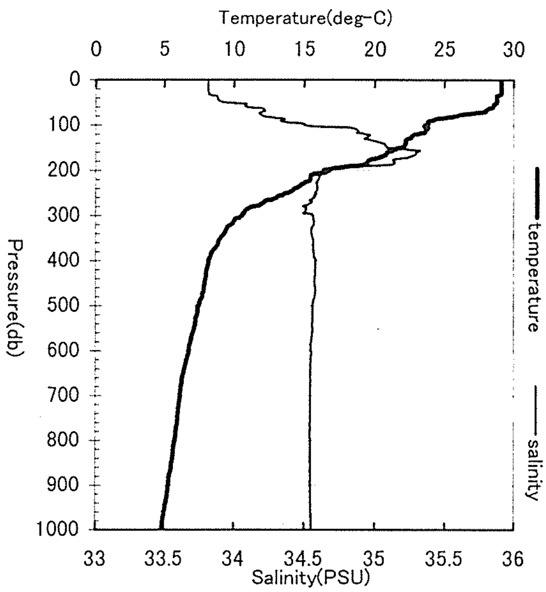


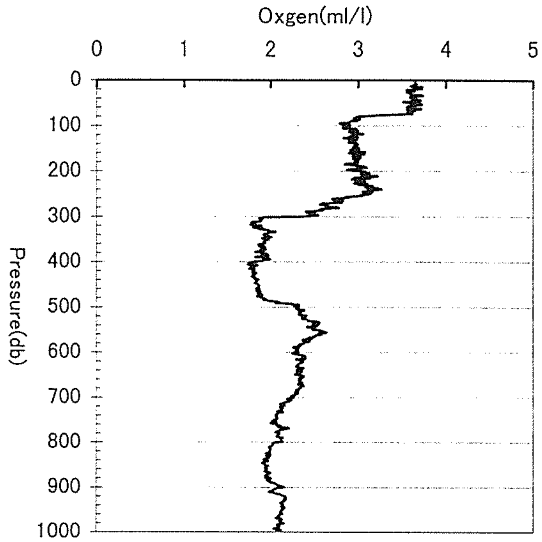
St.C84(04-30N,131E)



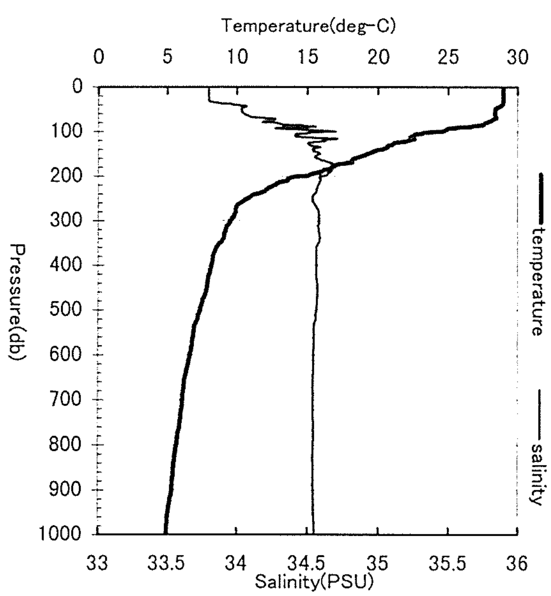


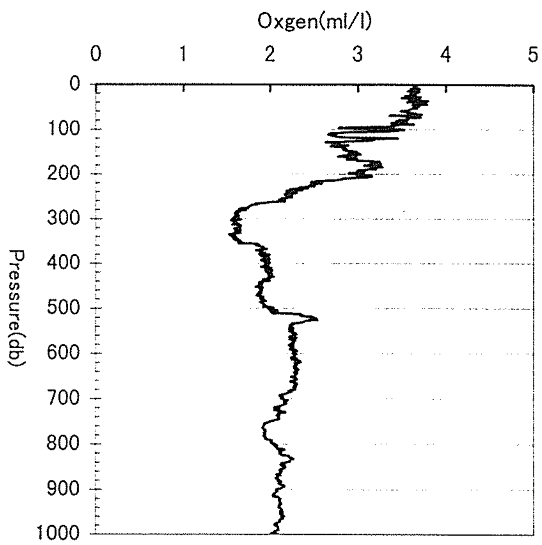
St.C85(04-48N,131-24E)



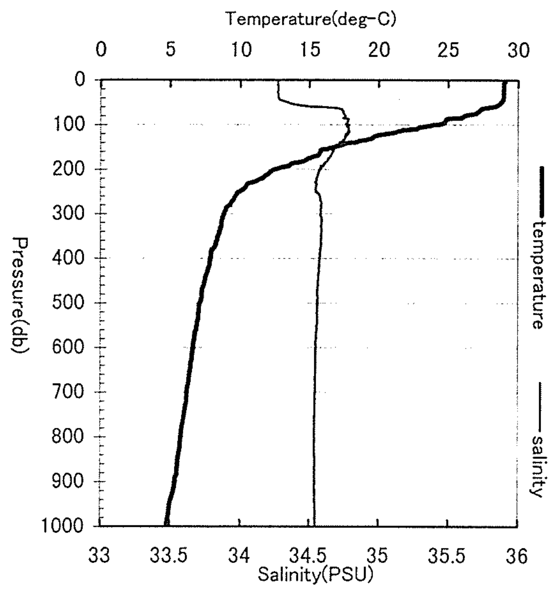


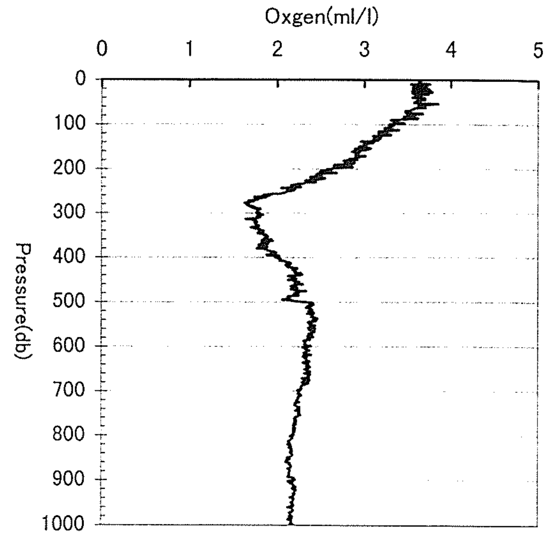
St.C86(05-06N,131-48E)





St.C87(05-36N,132-12E)





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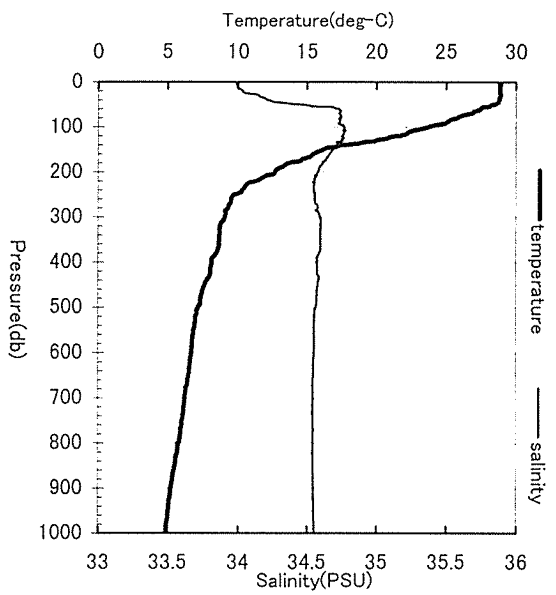
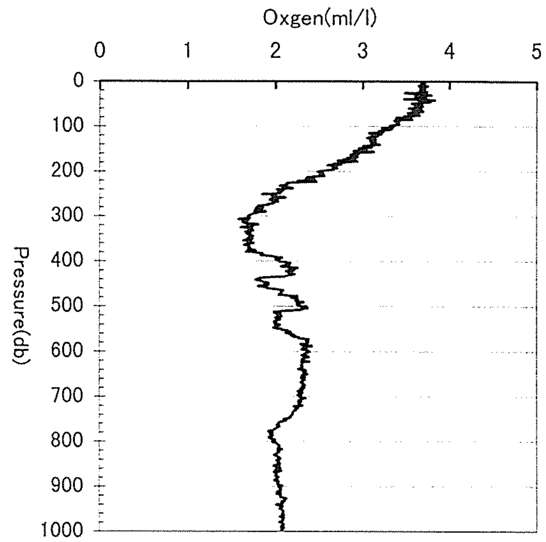
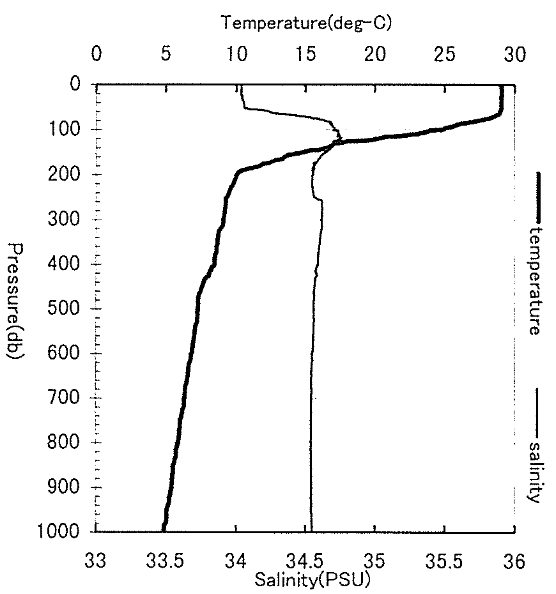
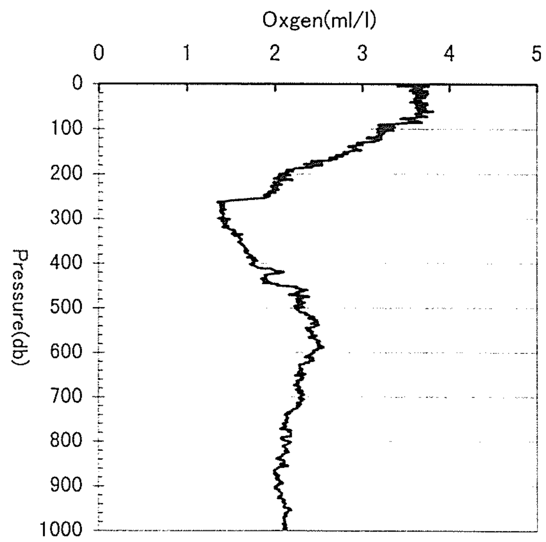




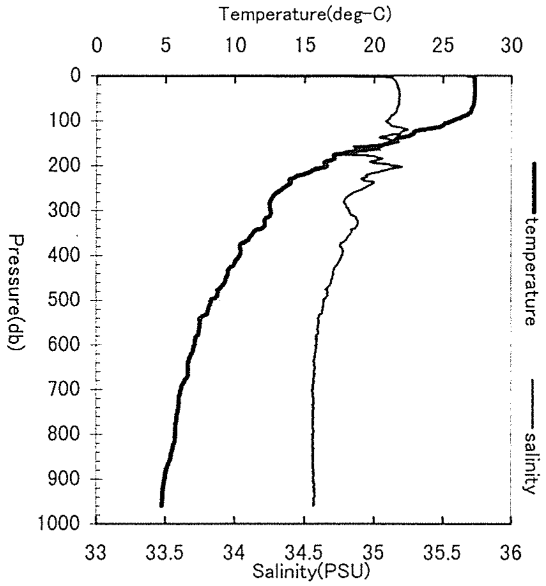
St.C89(06N,133E)



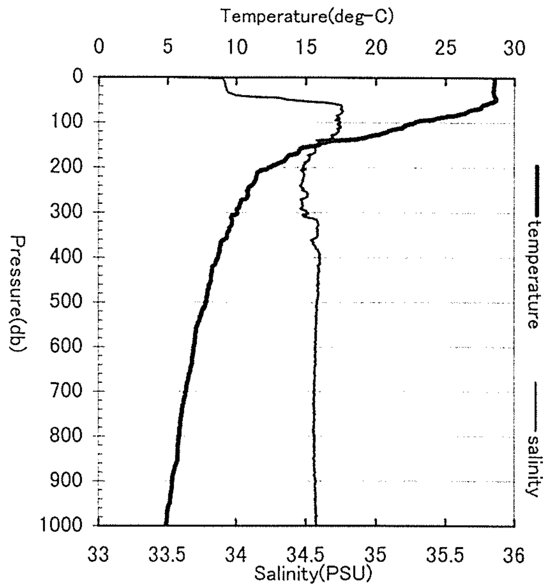


4.3.2 XCTD Profiles

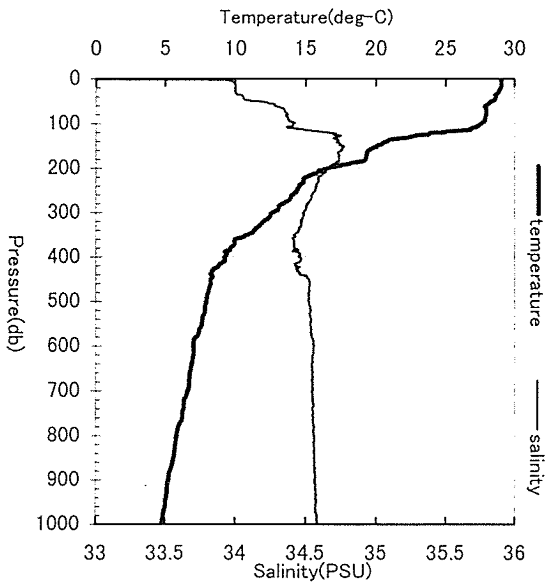
St.XC01(00N,161E)



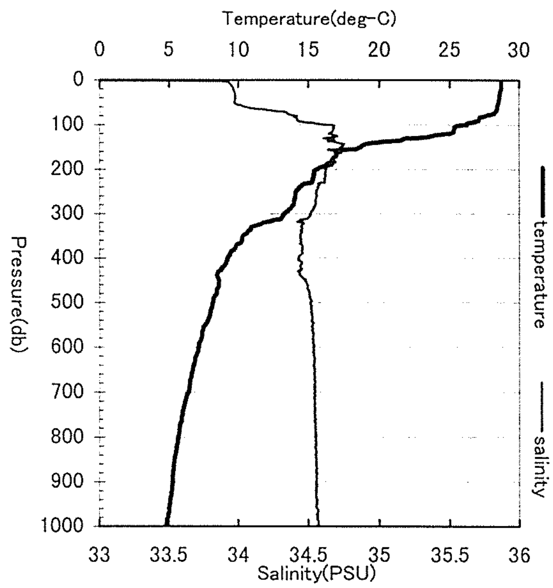
St.XC02(05N,129-14E)



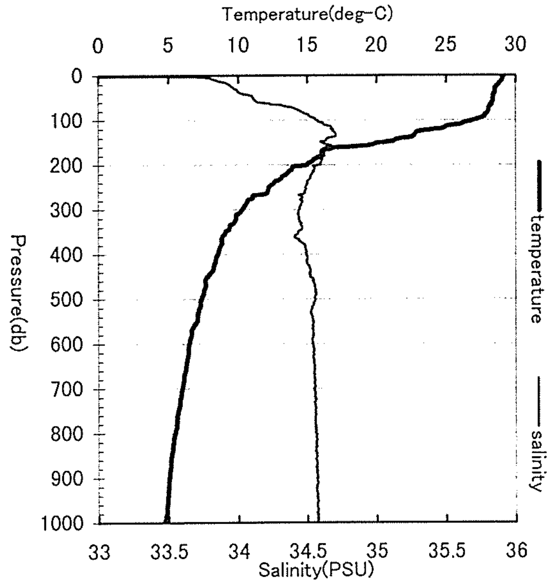
St.XC03(05N,122E)



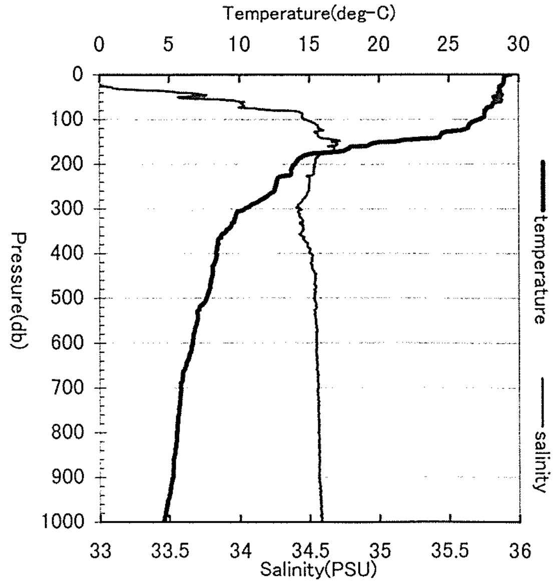
St.XC04(04-30N,122E)



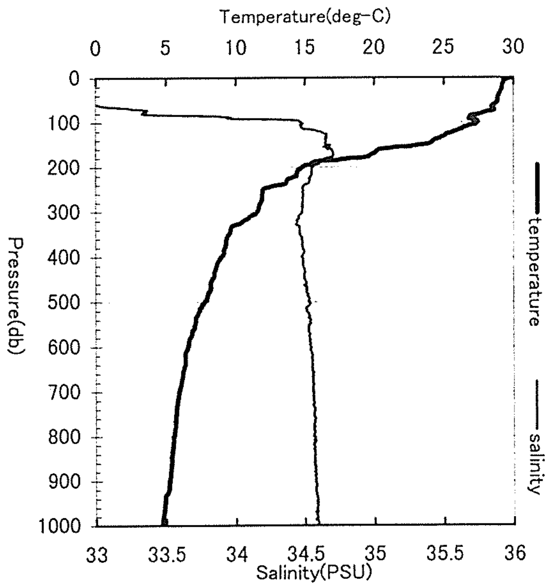
St.XC05(04N,122E)



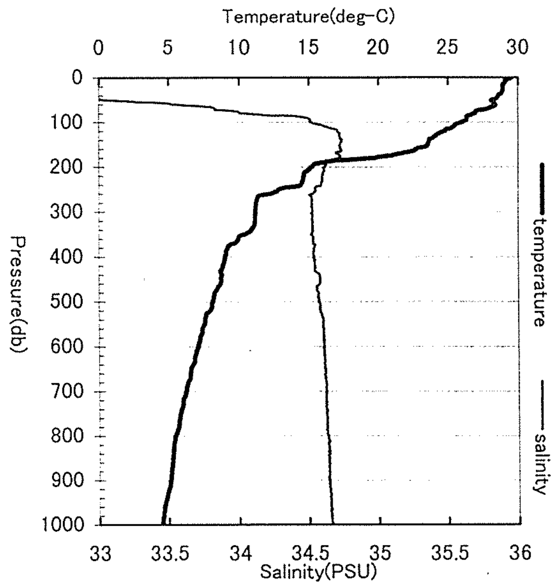
St.XC06(03-30N,122E)



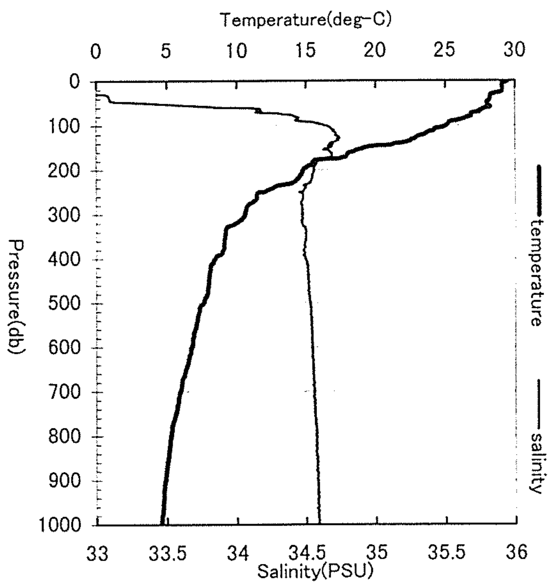
St.XC07(03N,122E)



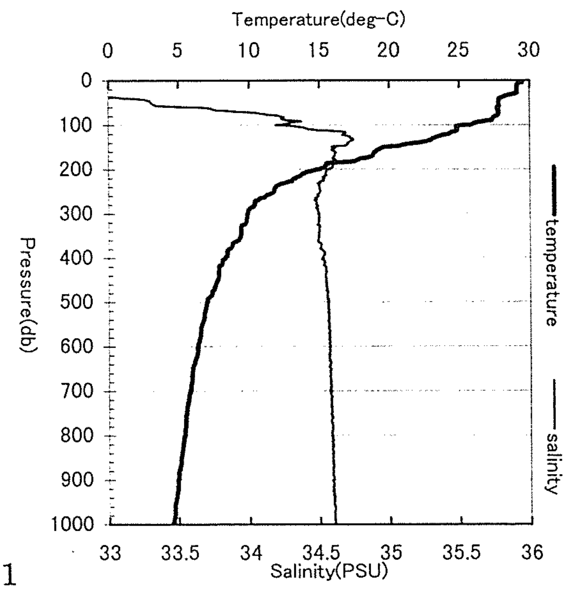
St.XC08(02-30N,122E)



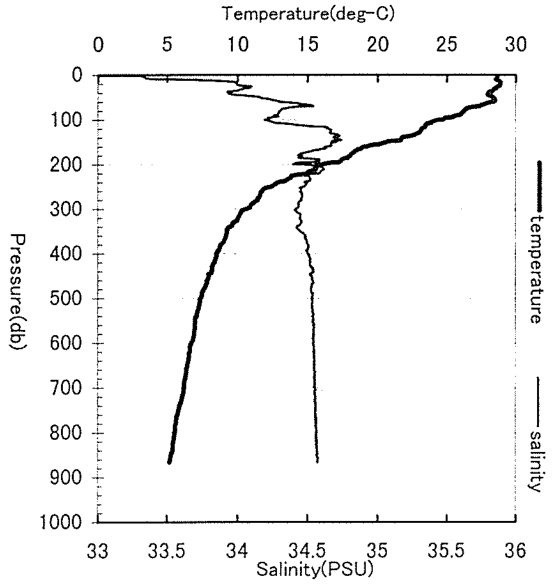
St.XC09(02N,122E)



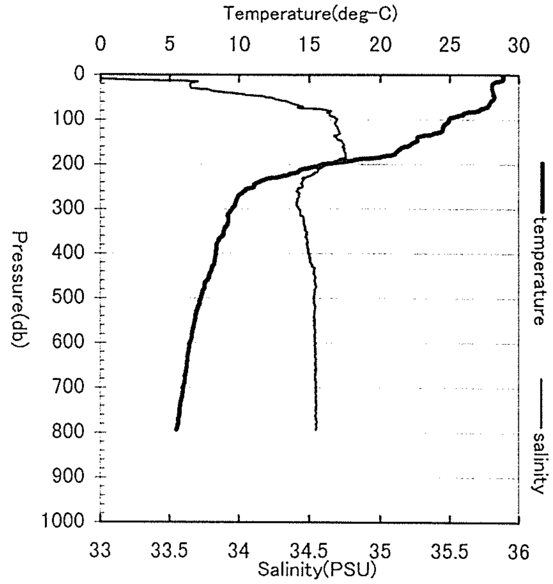
St.XC10(01-30N,122E)



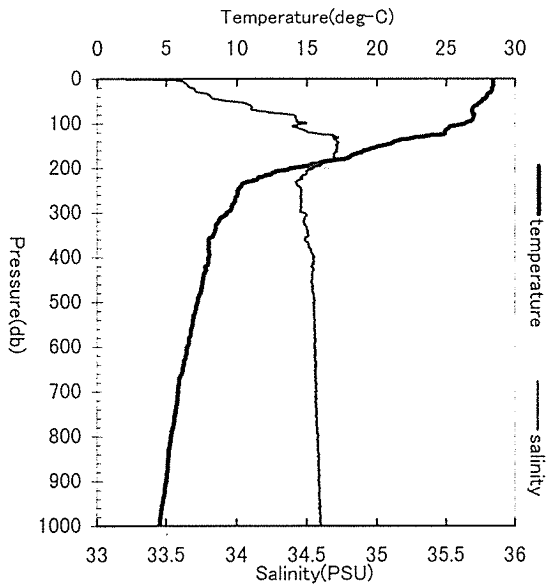
St.XC11(03-30N,119E)



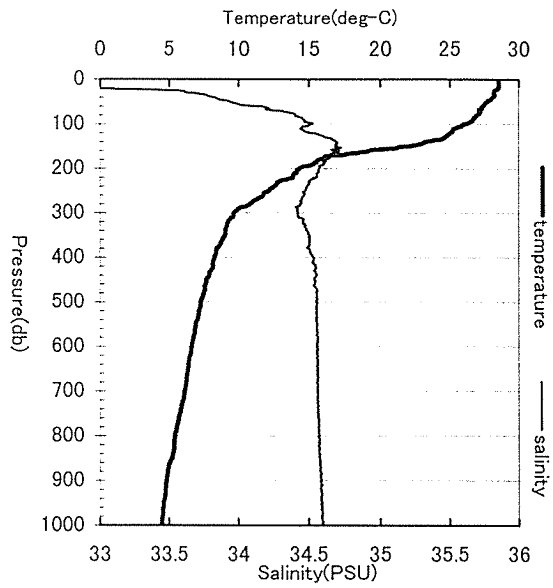
St.XC12(03-30N,119-30E)



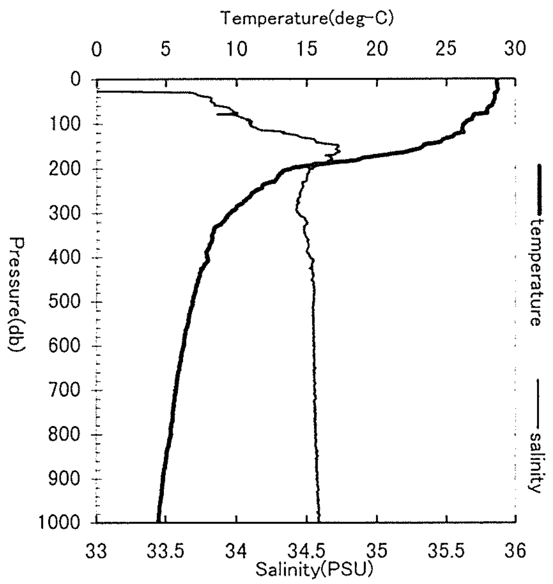
St.XC13(03-30N,120E)



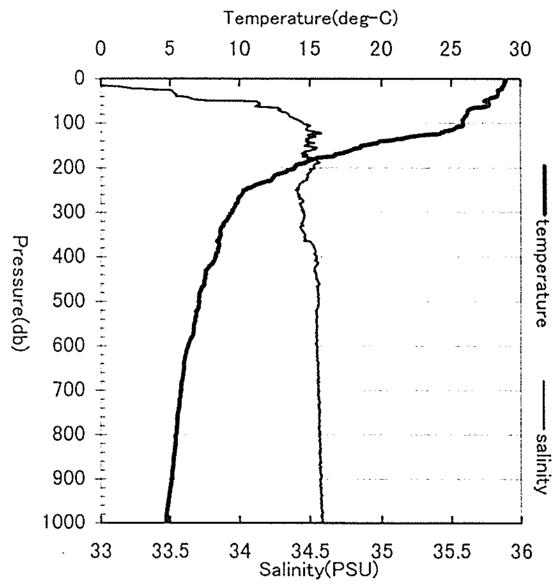
St.XC14(03-30N,120-30E)



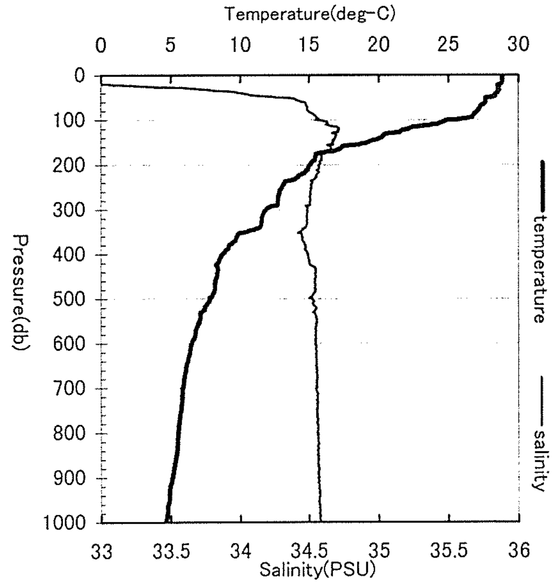
St.XC15(03-30N,121E)



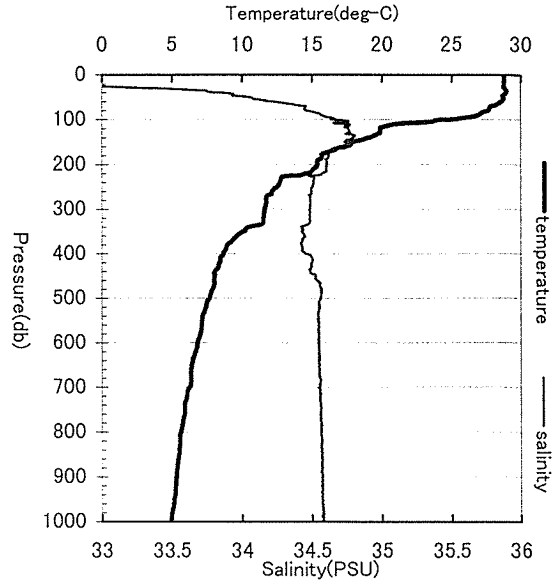
St.XC16(03-30N,121-30E)



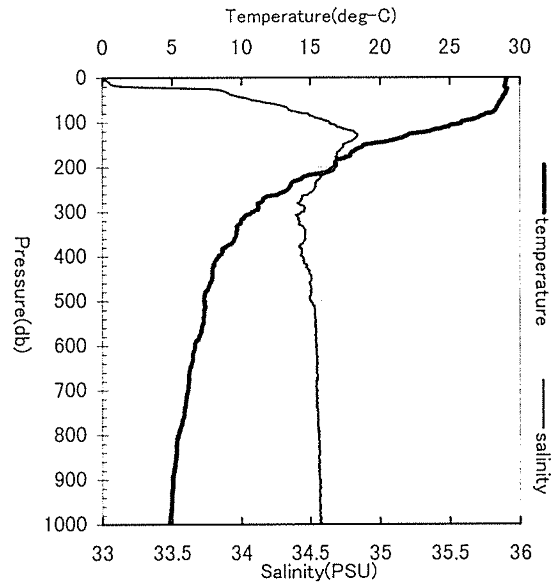
St.XC17(03-30N,122E)



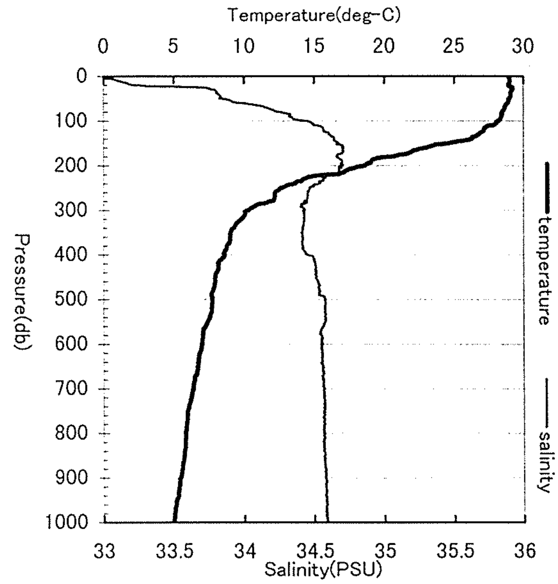
St.XC18(03-30N,122-30E)



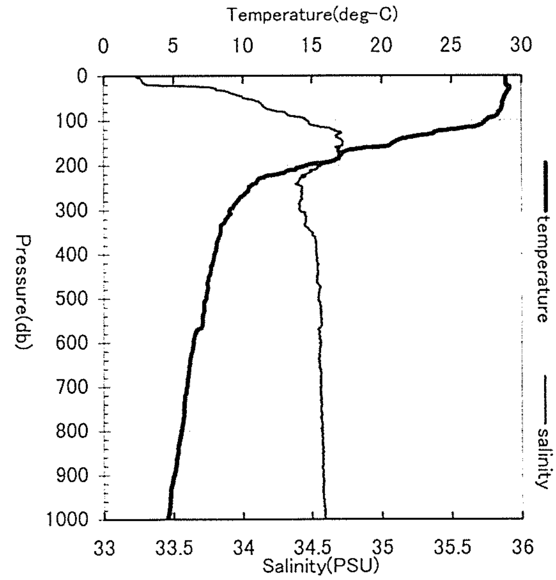
St.XC19(03-30N,123E)



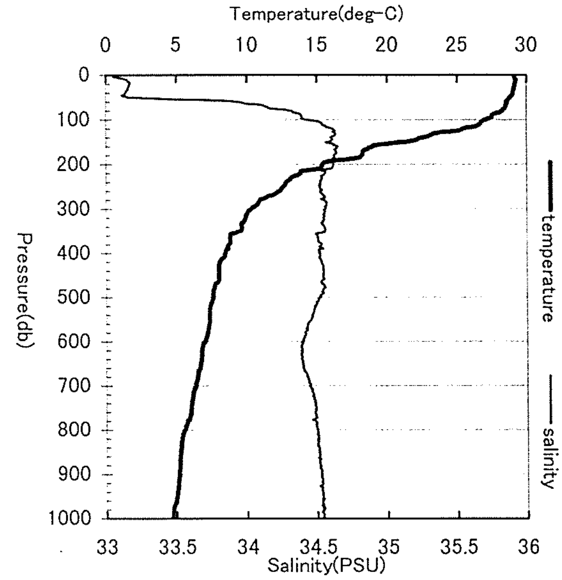
St.XC20(03-30N,123-30E)



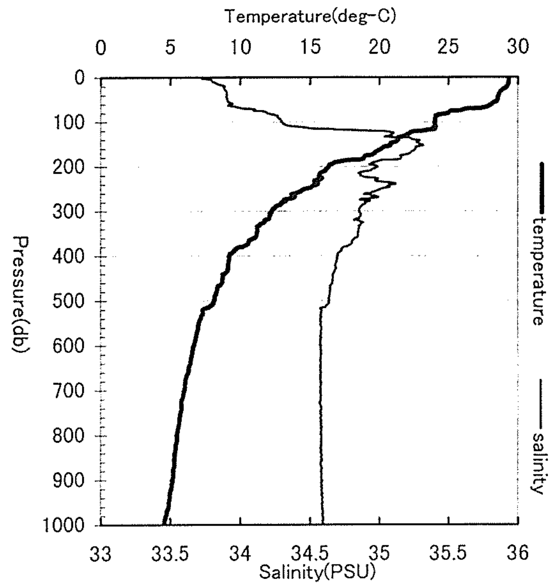
St.XC21(03-30N,124E)



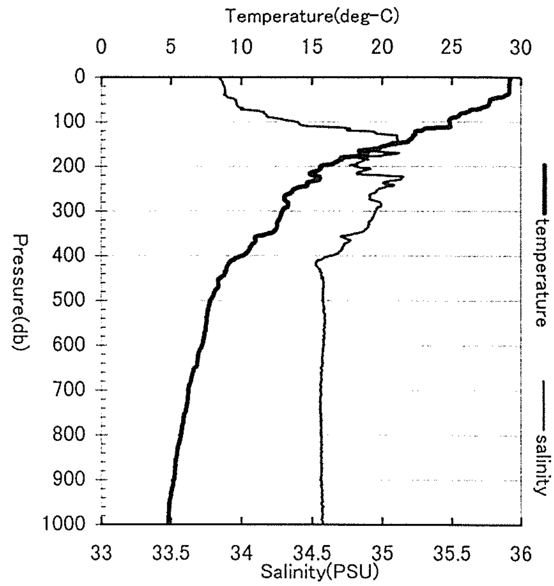
St.XC22(02-31N,124-47E)



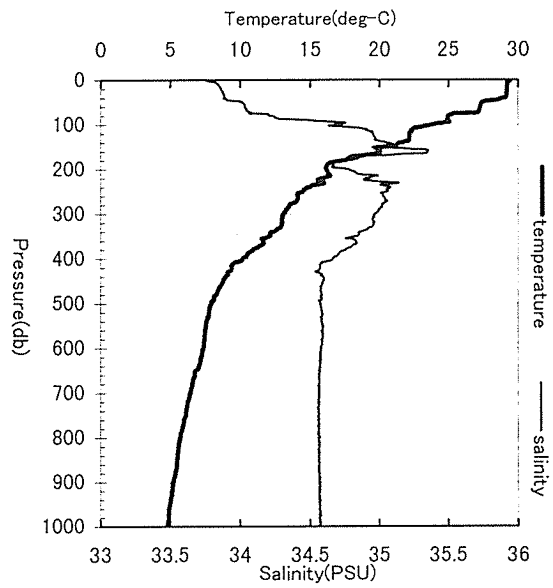
St.XC23(02-52N,128-49E)



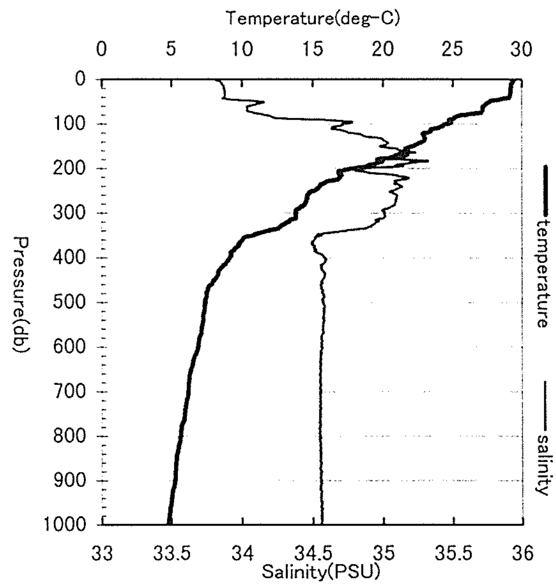
St.XC24(03-09N,129-12E)



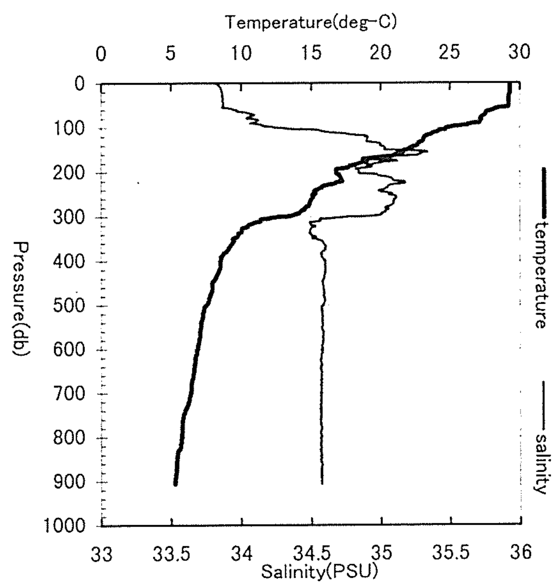
St.XC25(03-27N,129-36E)



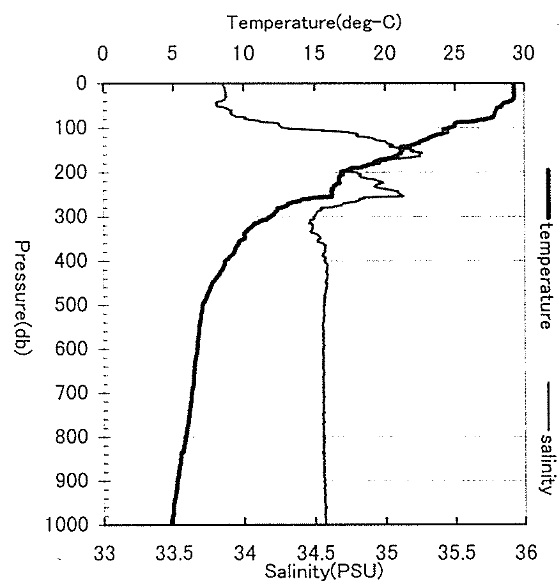
St.XC26(03-45N,130E)



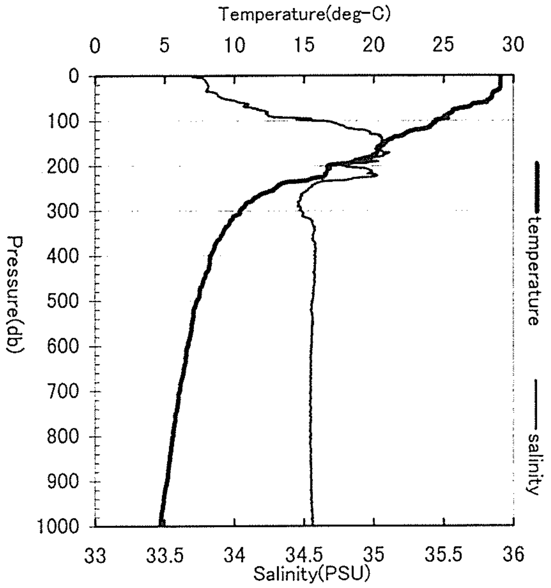
St.XC27(04-03N,130-24E)



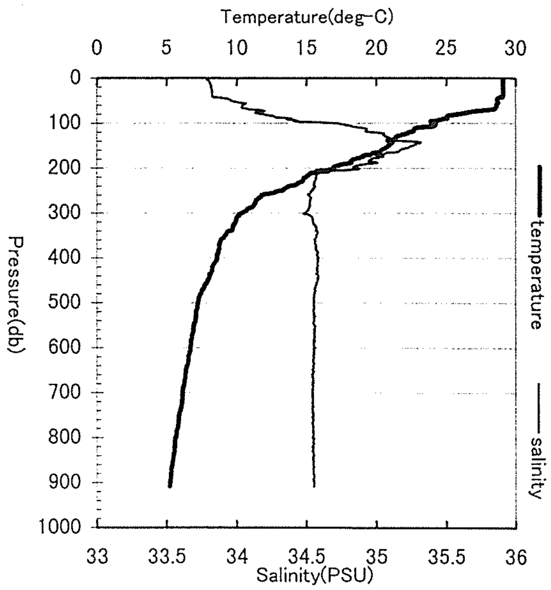
St.XC28(04-21N,130-48E)



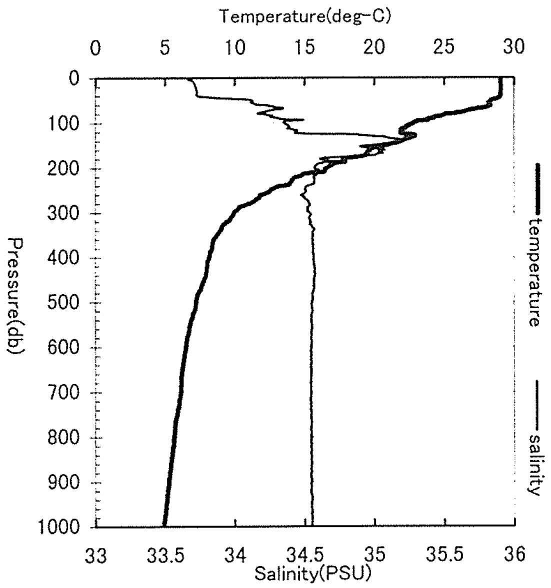
St.XC29(04-30N,131E)



St.XC30(04-39N,131-12E)



St.XC31(04-57N,131-36E)



4.3.3

Lowered ADCP

Instrumentation

Two acoustic Doppler profilers (ADP in Sontek terminology, more widely known as ADCPs) were attached to the rosette and used for lowered profiling. A 250-kHz instrument was mounted at the bottom of the rosette looking down, and a 500-kHz instrument was mounted at the top looking up. Both instruments were new from the Sontek factory; they had been tested and burned in there, but not used in the field. They were built specifically for this application, with 6000-m pressure housings and 30-degree beam angles. A similar 250-kHz unit had been used on two cruise legs of the Wakataka Maru during the past year. The Sontek ADPs use incoherent (narrow bandwidth) signal processing and feature shaded transducers for reduced sidelobes in their beam patterns. They are designed to ping at nearly the maximum possible rate as limited by the travel time to the last depth cell. The two instruments on the present cruise were the first to be built with synchronization circuits, so that one, the master, causes the other, the slave, to ping simultaneously. Synchronization reduces the ping rate, but is essential to avoid interference between the two instruments; this was demonstrated on the one occasion when we deliberately set both instruments to ping freely so as to check for interference.

Use of the 500-kHz instrument for this application was considered experimental; nothing of frequency above 300 kHz had been used previously. It was hoped that the loss of range with increasing frequency might be less than expected based on the usual simple inverse relationship; the 500 kHz has narrower beams and should be able to take advantage of smaller scatterers. The experience of this cruise, however, suggests that there is no advantage to the higher frequency; on the contrary, the reduction in range puts it at a major disadvantage to the 250.

It should be noted that the scattering levels are very low in the region of this cruise. This was expected based on prior experience such as the WOCE P10 line, where the 300-kHz LADCP produced no usable measurements below about 1000 m in the NECC region. (Scattering was still low on the equator, but sufficiently improved to permit useful deep profiles within several degrees of the equator.)

LADCP casts were numbered to correspond the the CTD file numbers; this fits in with our automated processing scheme, in which LADCP and CTD files need to be named consistently. The first CTD file, hence the first LADCP, was 20. The last was 42. Casts proceeded uneventfully until 32, when the 250 stopped pinging and then restarted itself on deck at the end of the cast. After that, unintentional stops of the 250 became generally more common (although not uniformly) until cast 37, when the transmitter failed entirely. Later inspection of the instrument showed that one or more components in the high-power amplifier section had burned out. The 500 burned out shortly thereafter, on cast 42. A full explanation of these failures will await investigation and testing by Sontek. Given the lack of heating problems during extensive burn-in testing at Sontek, and the success of a similar unit on the Wakataka Maru working latitudes north of 30°N, it seems likely that the high temperatures on deck and in the surface waters were a contributing factor. We expect the systems to be redesigned as needed to completely eliminate this problem in the future.

Lowered ADCP Methodology

To measure velocity throughout the water column at eachstation, a self-contained ADCP was mounted on the rosette;this is referred to as the lowered ADCP (LADCP). The LADCP includes a magnetic compass and a tilt sensor, so the velocity profiles can be rotated into the local east-north-up coordinate system. Because the motion of the rosette over the ground is not measured, the LADCP measurements of current relative to the instrument cannot be used directly to infer the current over the ground. Instead, the single-ping velocity profiles aredifferentiated vertically to remove the package motion (which changes only slightly between the time a ping is tranmitted and the time the backscattered return is received). The vertical shear estimates from all pings are then interpolated and averaged on a single uniform depth grid covering the whole water column. This full-depth shear profile is integrated vertically to yield a velocity profile with an unknown constant of integration; and the constant is calculated from the known displacement of the instrument between beginning and end of the cast, together with the shape of the relative velocity profile and the measured current past the instrument as a function of time during the cast. The method is explained in detail by Fischer and Visbeck (1993).

Immediately after each station the data were dumped from the LADCP to a PC via a serial line (RS-422). The profile was processed using the University of Hawaii system, a mixture of C, Matlab, and Perl programs. Velocity and shear data are automatically edited based on several criteria including signal/noise ratio (about 3 db minimum), error velocity (10 cm/s maximum), deviation of vertical velocity in a given bin from its vertical average (12.5 cm/s maximum), and deviation of individual shear estimates from a mean shear profile (2.5 standard deviations). These parameters are subject to change in later processing, but the values quoted seemed reasonable and adequate for the present data set. Additional editing can be done on the upcast, but so far has been omitted for this data set: the top two depth bins are rejected if the current, profiler vertical velocity, and profiler orientation are such that one beam may be intersecting the profiler's wake.

We have an automated routine for matching the time series of vertical velocity measured by the LADCP with the time series of vertical velocity calculated from the CTD pressure record, and then assigning the corresponding CTD-derived depths to the LADCP. (This is less important with the Sonteks, which have good pressure sensors, than with the RDI units we have used, which have no pressure sensors; nevertheless it is desirable to accurately match the velocity measurements to the CTD profile, as our procedure does.)

Accurate position fixes at the start and end of the LADCP profile are essential to the calculation of absolute velocities. We logged the PPS GPS fixes at the full 1 Hz sampling rate. The processing software accesses these files and extracts the subsets needed for each profile. Magnetic variation is needed to calculate true direction from the compass readings; we calculate the variation from a standard model of the earth's magnetic field. To date we have not, however, performed any calibration of the compass in the instrument, but have taken the compass headings at face value.

Tabular summary of LADCP casts: For each instrument, the first field is M for Master, S for Slave, or F for Free-running; the second field is the number of depth cells; the third is the pulse/blank/cell lengths in meters; and the last is G for Good, P for Partial, or B for Bad. Good simply means that data were collected normally; it does not indicate anything about the quality of the profile. Partial means there were resets, each with a 3-minute gap, while the instrument was in the water. Bad means velocity was mostly or entirely missing.

The 250 returned useful velocities for 20-32 and 35. The 500 produced good profiles only on 38 and 41, the two cases in which it was pinging at its maximum rate without interference from the 250.

CTD file	Lat	Lon	250 kHz downward	500 kHz upward	notes
20	6°00'N	133°00'E	M 20 16/4/8 G	S 20 8/10/4 G	
21	6°00'N	132°30'E	M 20 16/4/8 G	S 20 8/10/4 G	
22	6°00'N	132°00'E	M 20 16/8/8 G	S 20 8/10/4 G	increased blanking interval
23	5°00'N	131°30'E	M 20 16/8/8 G	S 20 8/10/4 G	
24	5°00'N	131°00'E	M 20 16/8/8 G	S 20 8/10/4 G	
25	5°00'N	130°30'E	M 20 16/8/8 G	S 20 8/10/4 G	
26	5°00'N	130°00'E	M 20 16/8/8 G	S 20 8/10/4 G	
27	5°00'N	129°45'E	M 20 16/8/8 G	S 20 8/10/4 G	
28	5°00'N	129°30'E	M 20 16/8/8 G	S 20 8/10/4 G	
29	5°00'N	129°15'E	M 20 16/8/8 G	S 20 8/10/4 G	
30	5°00'N	129°00'E	M 20 16/8/8 G	S 20 16/8/8 G	increased pulse on 500
31	5°00'N	128°45'E	M 20 16/8/8 G	S 20 16/8/8 G	
32	5°00'N	128°30'E	M 20 16/8/8 G	S 20 16/8/8 G	250 generated second deployment at end of cast, on deck
33	5°00'N	128°15'E	M 20 16/8/8 P	S 20 16/8/8 P	250 generated 4 deployments, 2 in water, 2 at end of cast, on deck
34	5°00'N	128°00'E	M 20 16/8/8 P	S 20 16/8/8 P	250 generated 6 deployments

CTD file	Lat	Lon	250 kHz downward	500 kHz upward	notes
35	5°00'N	127°45'E	S 20 16/8/8 G	M 20 16/8/8 G	no restarts, but 250 file is missing the end of the on-deck period.
36	5°00'N	127°30'E	S 20 16/8/8 P	M 20 16/8/8 G	250 generated 4 deployments
37	5°00'N	127°15'E	F 20 16/8/8 B	F 16 16/8/8 G*	250 generated 7 deployments; transmitter failed.
38	5°00'N	127°00'E		F 10 16/8/8 G	about 6 pings/sec
39	5°00'N	126°45'E	S 20 16/8/8 B	M 14 16/8/8 G	250 did not transmit. Use of 14 cells for the master but 20 for the slave was an error.
40	5°00'N	126°30'E	S 20 16/8/8 B	M 14 16/8/8 G	250 did not transmit
41	5°14'N	125°38'E		F 12 16/4/8 G	near mooring
42	5°07'N	125°49'E		F 12 16/4/8 B	2 segments; transmit ended on deck before launch

Additional notes follow:

500 kHz, profiles 30-36 only: amplitude was zero counts in the last cell of beams 2 and 4 only. These are the only profiles for which the 500 was the master with 20 8-m cells, 8-m blank, and 16-m pulse.

250 kHz: the 4-m blanking interval used on 21 and 22 was inadequate; the first bin is biased enough to skew the shear profile. Ignoring the first bin, or increasing the blanking interval to 8 m as in all subsequent casts, solves the problem.

Station 40: P-code fixes were not logged or were lost. They were replaced by the excellent DGPS from the Kaiyo's logging system.

Stations 33, 34: because the 250 Master was pausing, there are gaps in both the up and the down-looking instruments; these stations are not recoverable.

Station 37 is probably unrecoverable because of the extensive interference between the two free-running instruments.

500 kHz, CTD depth: the fit does not work for 33 and 34 because of the 250 master restarts. 37 is also bad, presumably because of the interference from the free-running 250. 39 looks marginal; the reason is not clear. Of the group starting with 33, only 35, 36, 38, and 41 look good enough to warrant using the CTD depth in place of the pressure depth.

Processing notes and evaluation

Processing parameters were selected based on previous experience modified by experimentation with the present data set. Profile quality was evaluated from the difference between the downcast and the upcast, and from the difference between the shipboard and lowered profiles in their regions of overlap. This comparison was done for downcast, upcast, and the blended down and upcast. Ordinarily the blend would be the best estimate, but so far we are finding the best agreement is between the downcasts and the shipboard. Therefore we are presently using the downcasts for presentation of results. The question of why the upcasts agree less well with the shipboard will be investigated; in the past, this has sometimes been caused by the wake of the package, and the problem has been reduced by use of our wake-editing algorithm. Initial experimentation indicated that this was not the case on this cruise (with its relatively small rosette package), but it remains a possible contributor. Another possible contributor is the higher winch speed on the upcast than the downcast, which might emphasize any slight biases related to mean speed.

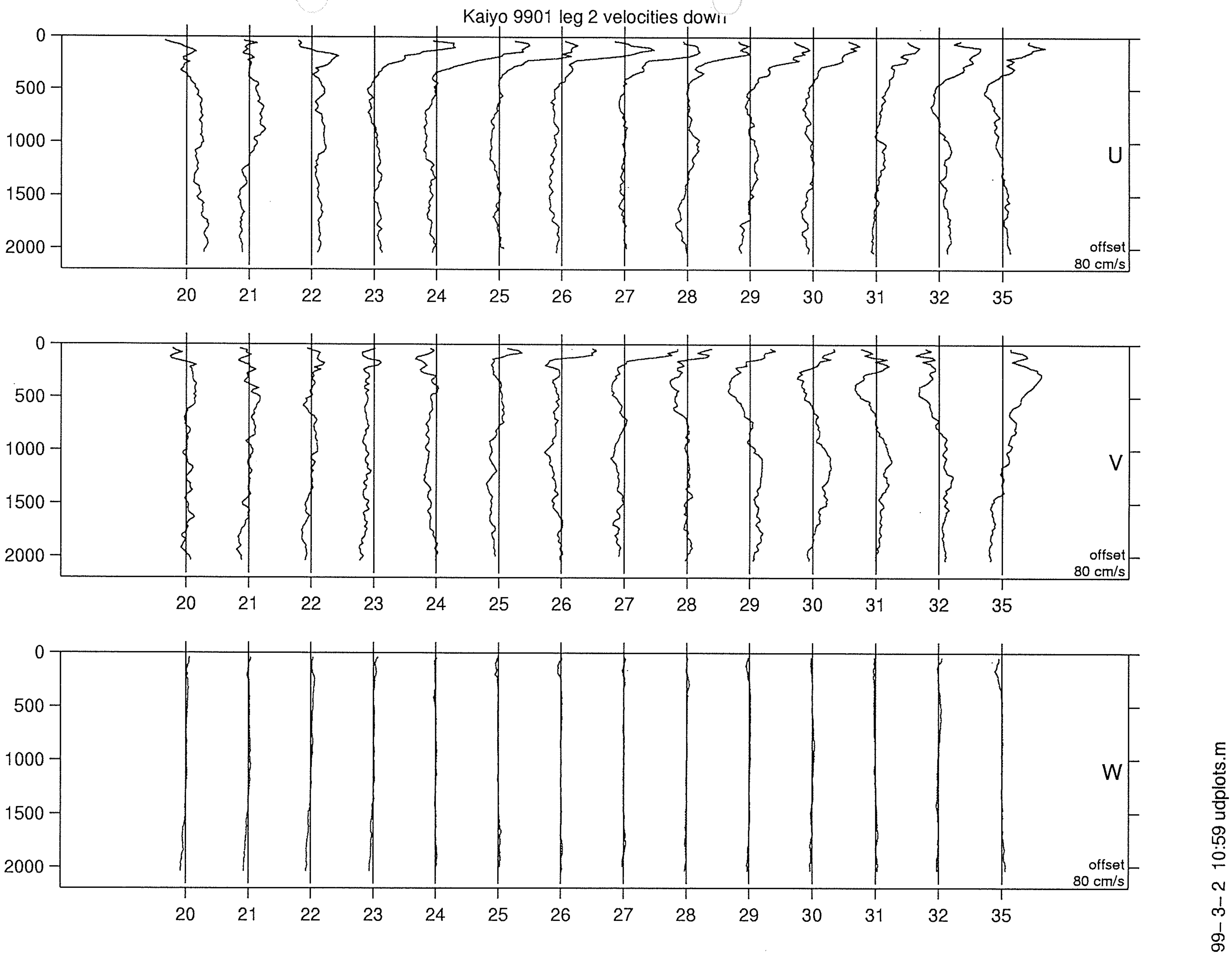
Over casts 20-32 and 35, the rms offset between the shipboard and LADCP downcasts was about 3 cm/s in each component; this offset is calculated for each profile as the mean difference over the region of overlap. It serves as an estimate of the error in the profile in the upper ocean, and should also be a reasonable estimate of the uncertainty at all depths above about 1500, where the shear estimates suffer badly from lack of scatterers.

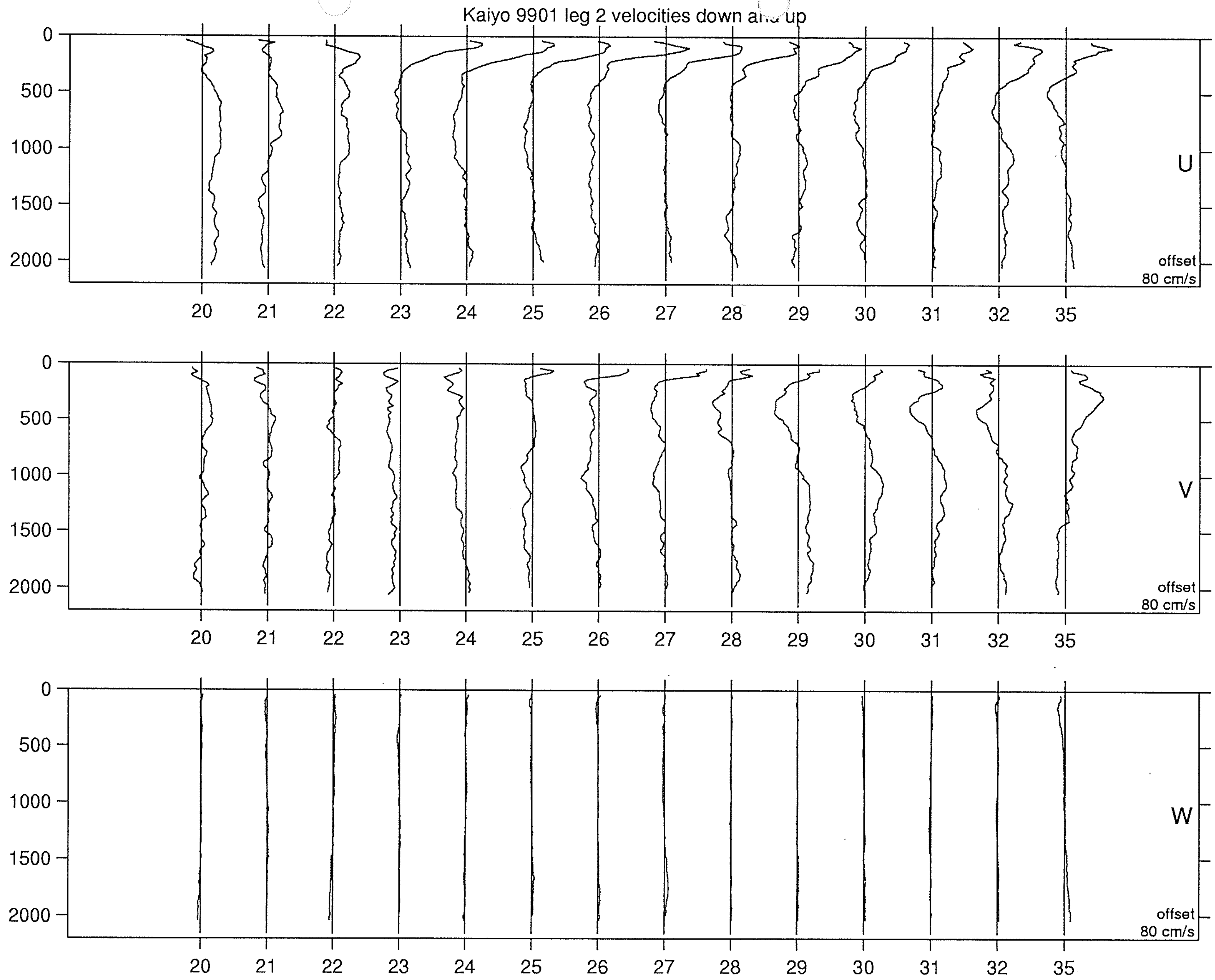
Section

Velocities from the downcasts on 20-32 and 35 are contoured with 10-cm/s intervals. Velocities below about 1500 m are considered unreliable and are not shown. From 1000 to 1500 m there is a region of northward (and somewhat eastward) flow centered on 129°E, with southwestward flow from 130° to at least 131.5° E. The transition at 131.5° may be an artifact of the shift in the cruise track from 6°N in the east to 5°N in the west. The dominant tendency on the short 6°N segment, below 500 m, is eastward. Surface currents there were extremely weak; it appears to have been exactly on the boundary between the NEC and the NECC.

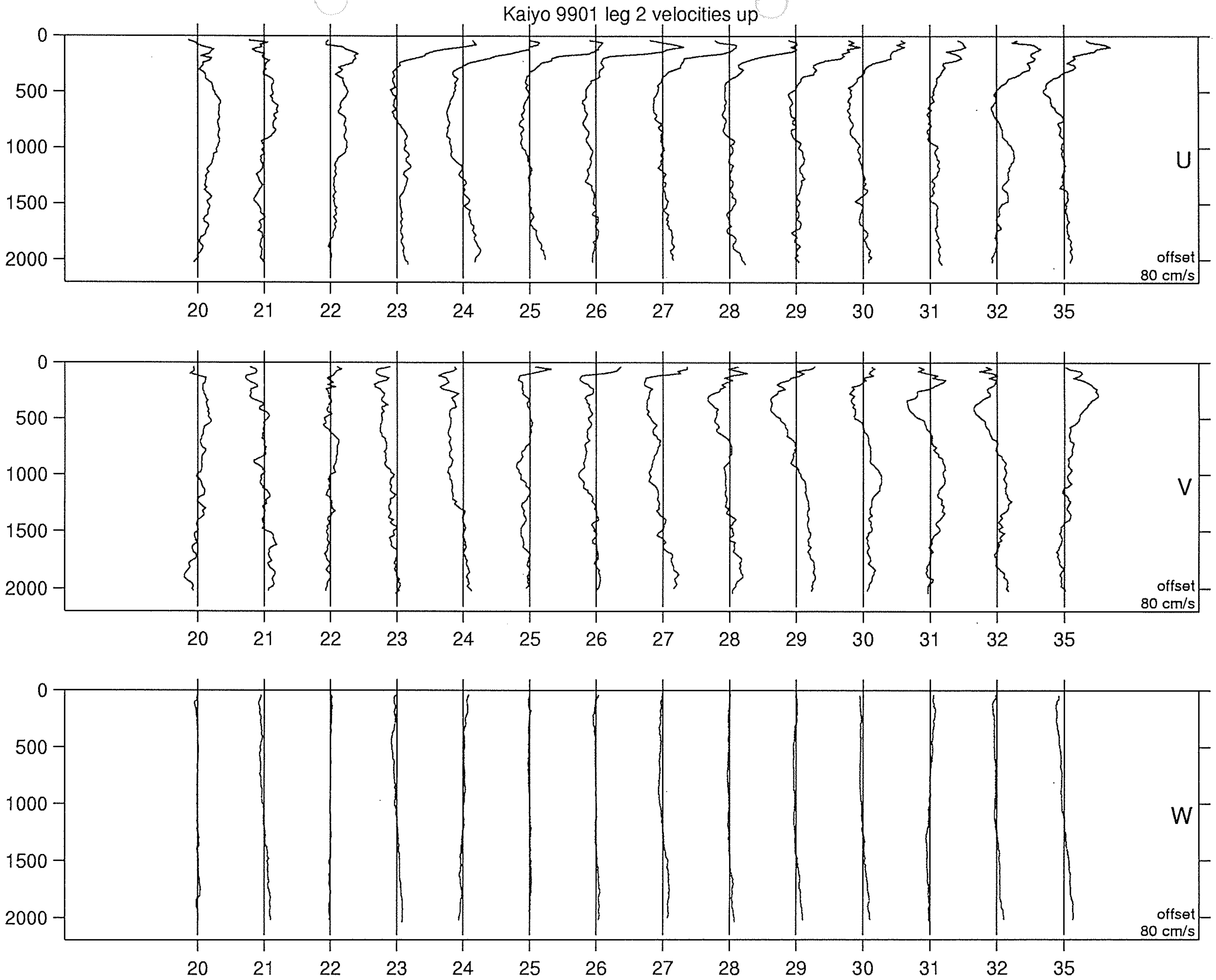
References

Fischer, J., and M. Visbeck, 1993. Deep velocity profiling with self-contained ADCPs. J. Atmos. Oceanic Technol., 10, 764-773.

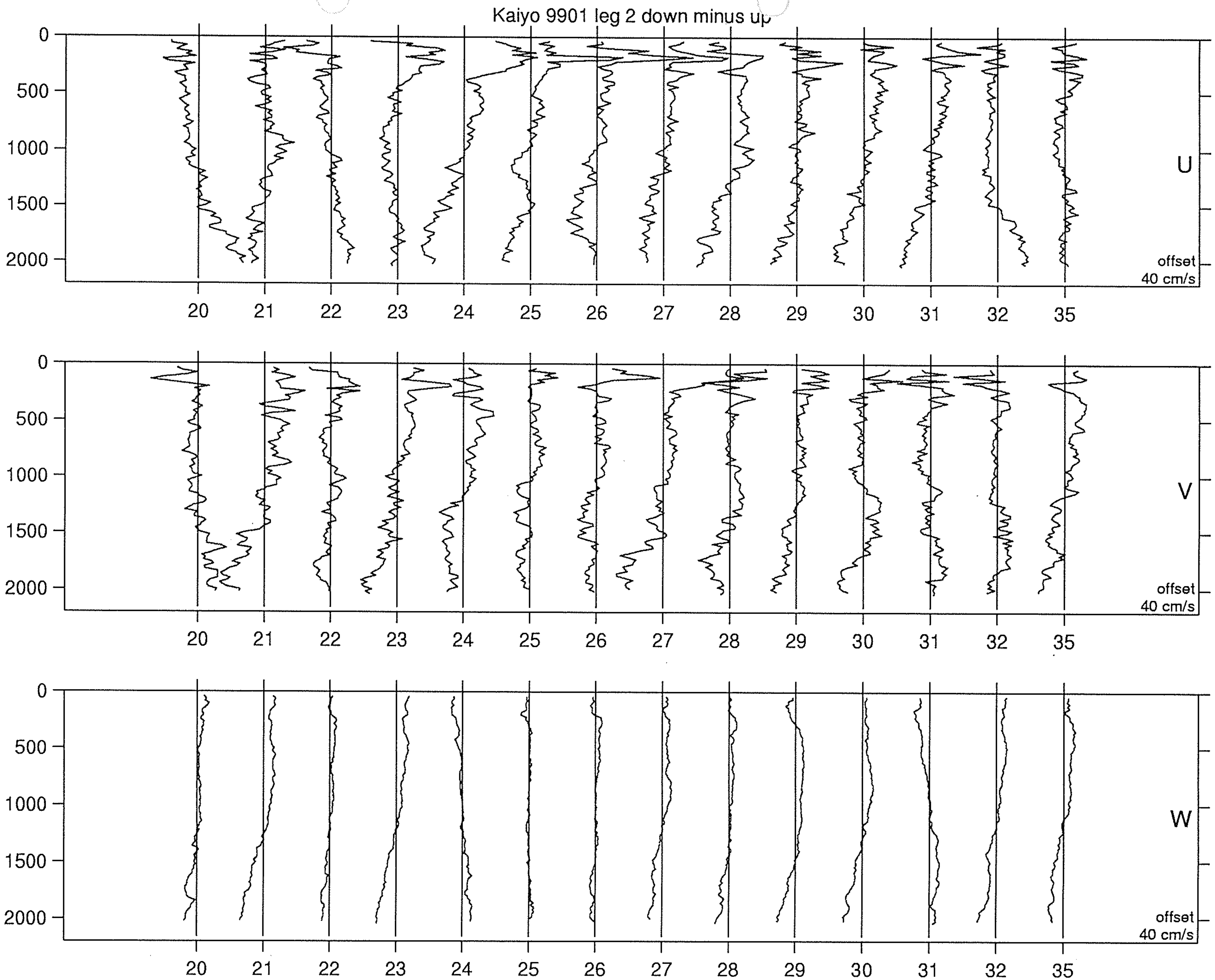

Kaiyo 9901 leg 2 velocities down
U
V
W
offset
80 cm/s
0
500
1000
1500
2000
20
21
22
23
24
25
26
27
28
29
30
31
32
35
99- 3- 2 10:59 udplots.m

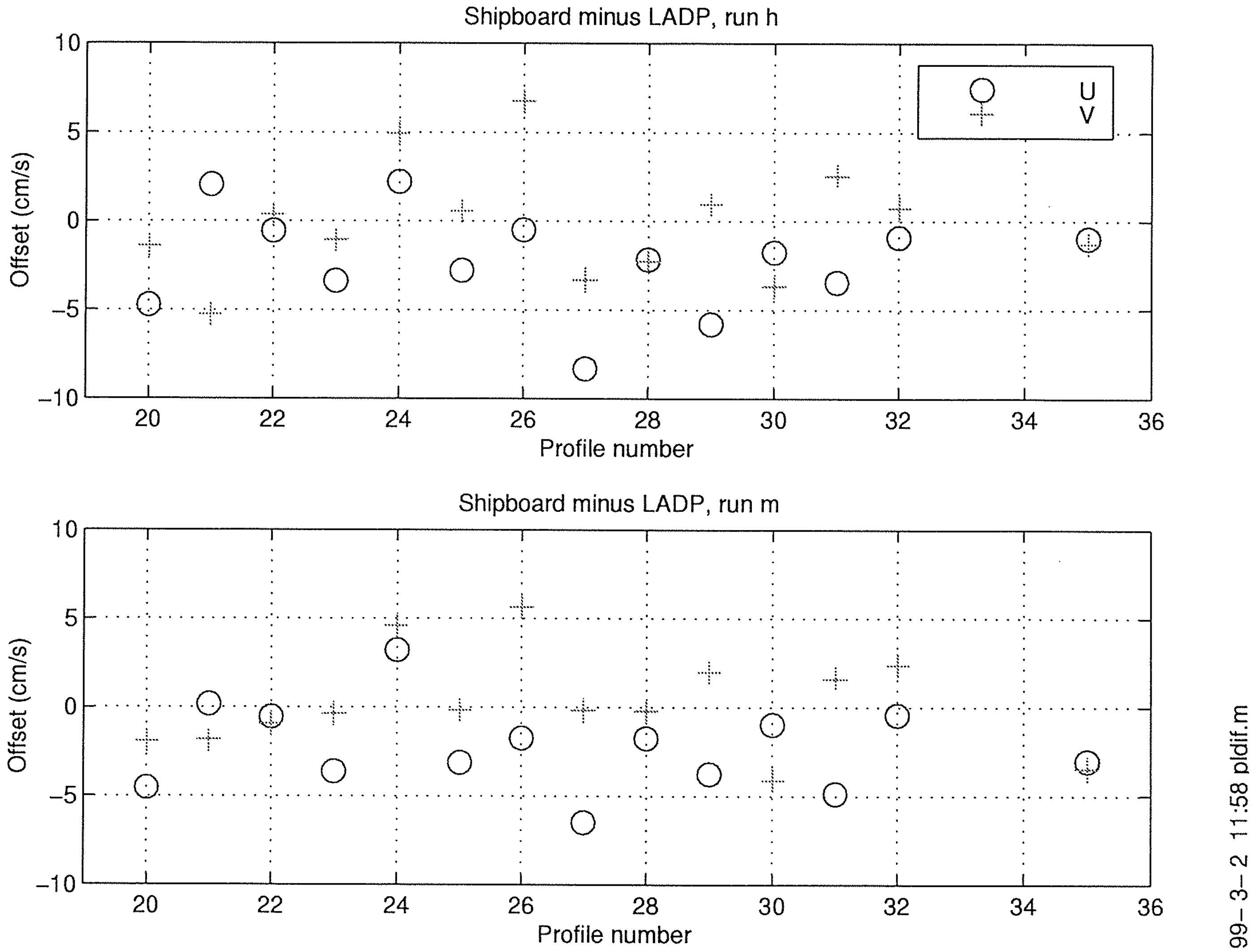


99– 3– 2 10:59 udplots.m



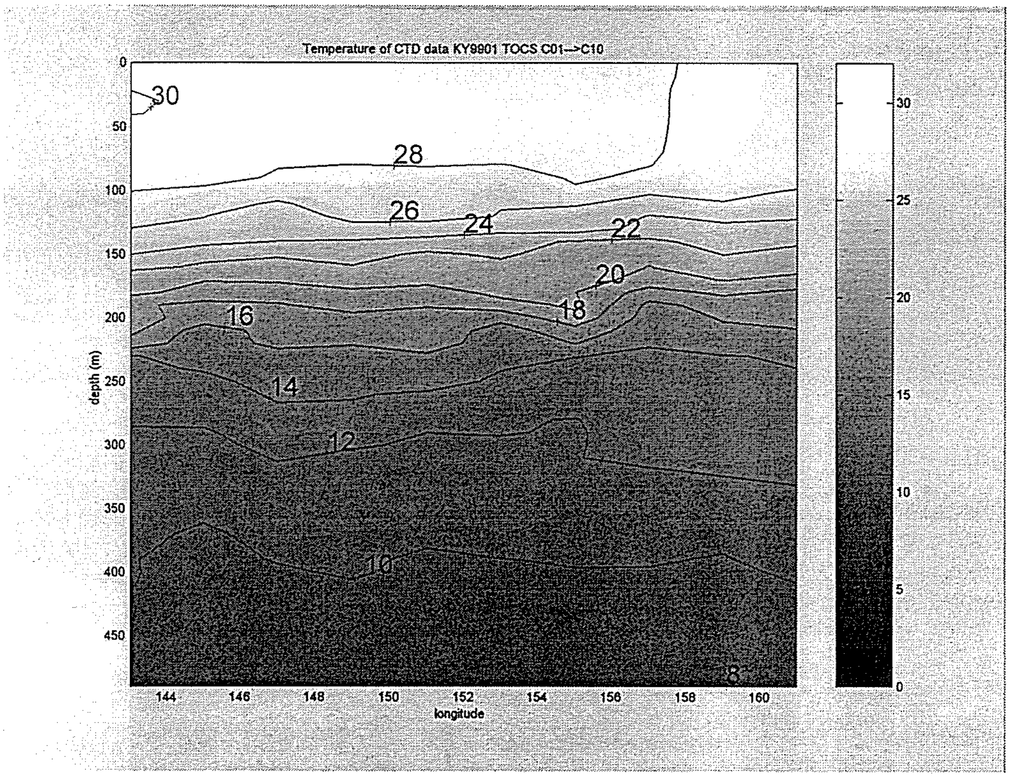
99– 3– 2 10:59 udplots.m


Kaiyo 9901 leg 2 down minus up
0
500
1000
1500
2000
U
offset
40 cm/s
20 21 22 23 24 25 26 27 28 29 30 31 32 35
V
W

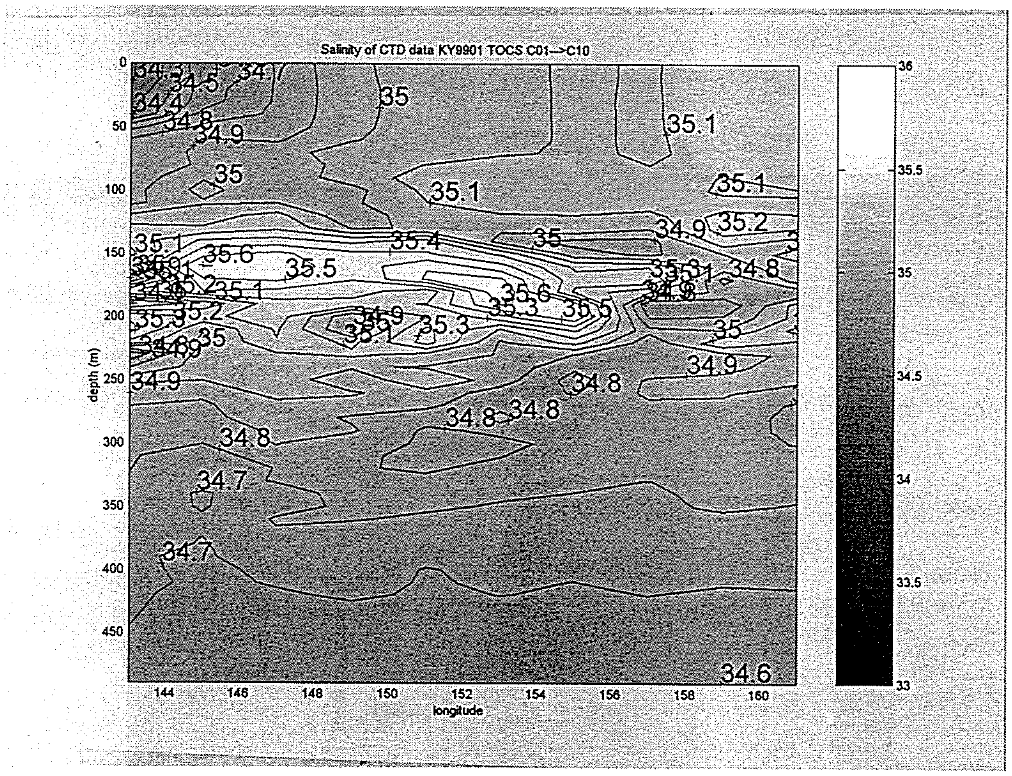


Shipboard minus LADP, run h
Offset (cm/s)
Profile number
U
V
Shipboard minus LADP, run m
Offset (cm/s)
Profile number
99– 3– 2 11:58 pldif.m

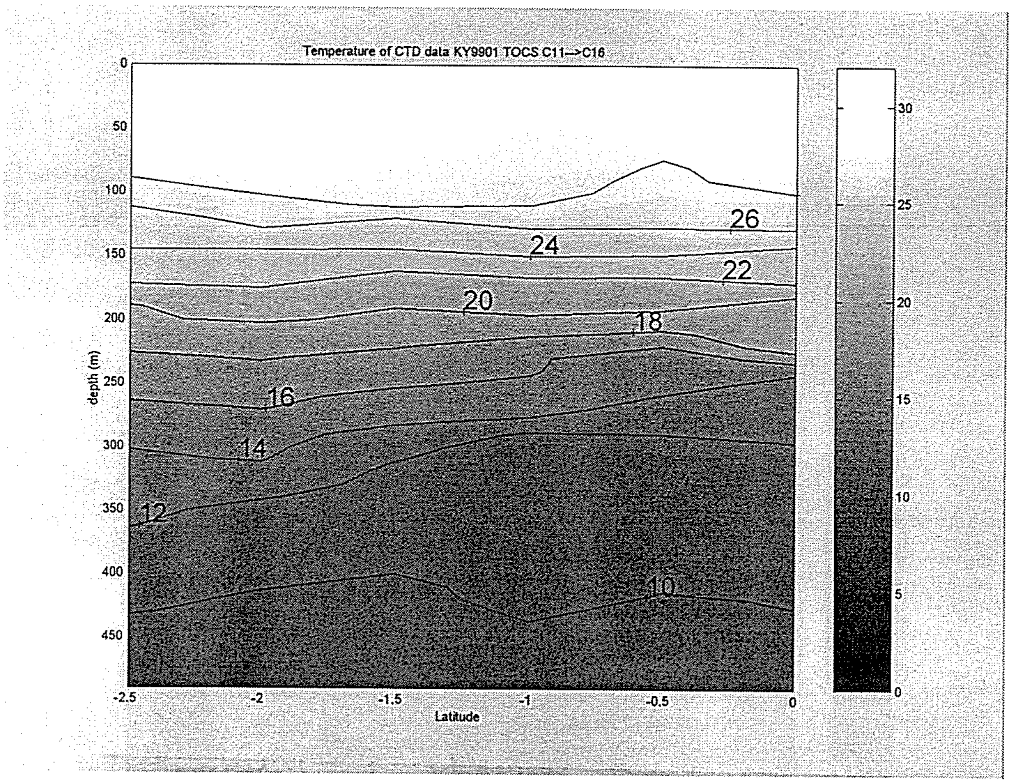
4..4 Sections 4.4.1 Temperature & Salinity



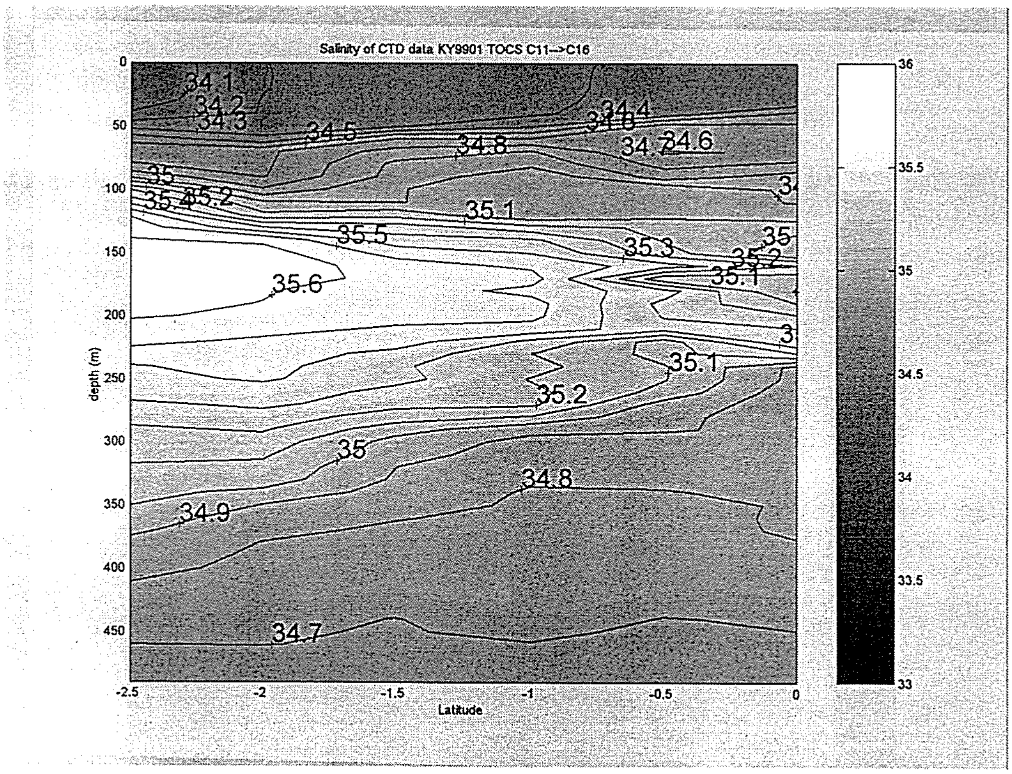
Temperature St.C01 ~ C10 (Equator)



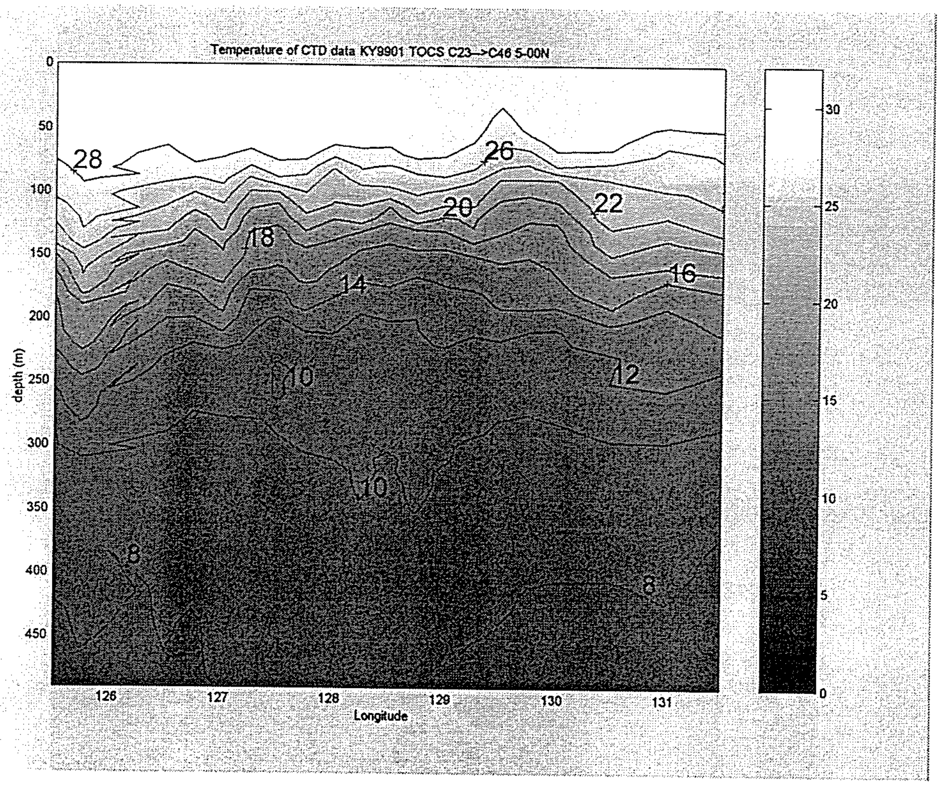
Salinity St.C01 ~ C10 (Equator)



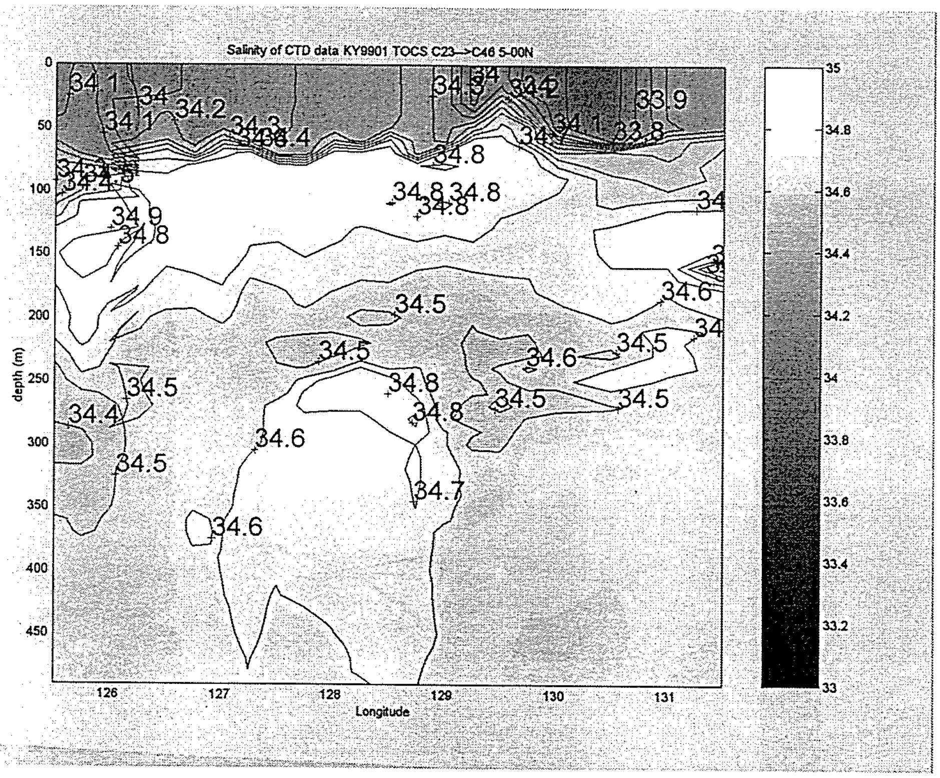
Temperature St.C11 ~ C16 (142-00E)



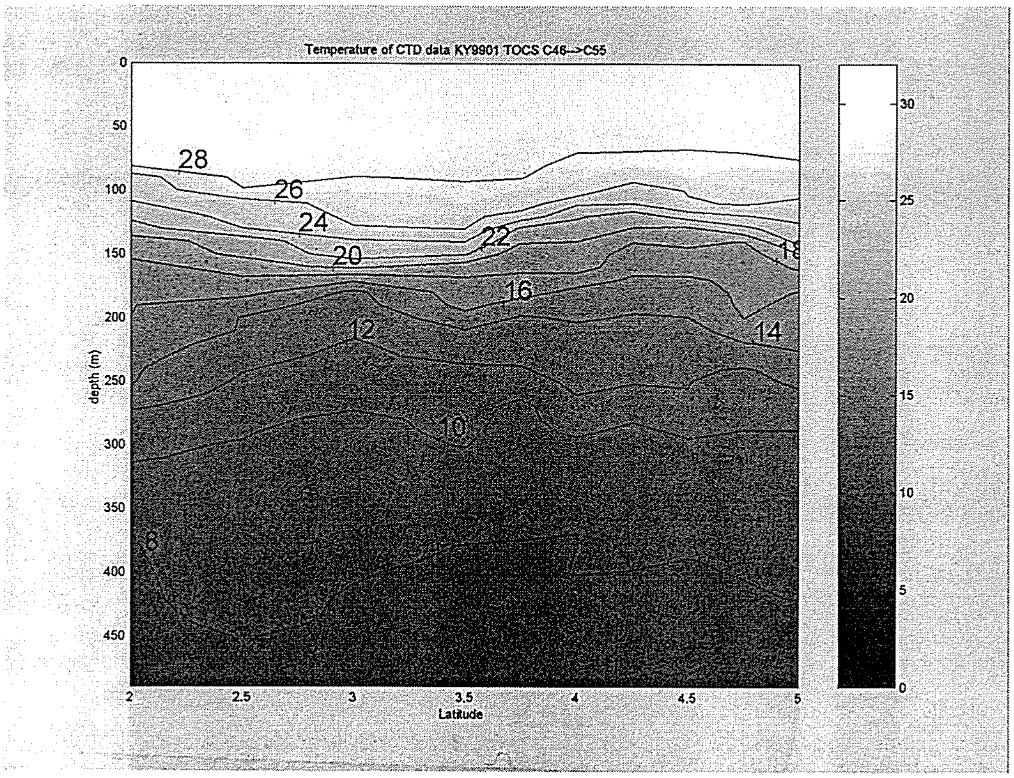
Salinity St.C11 ~ C16 (142-00E)



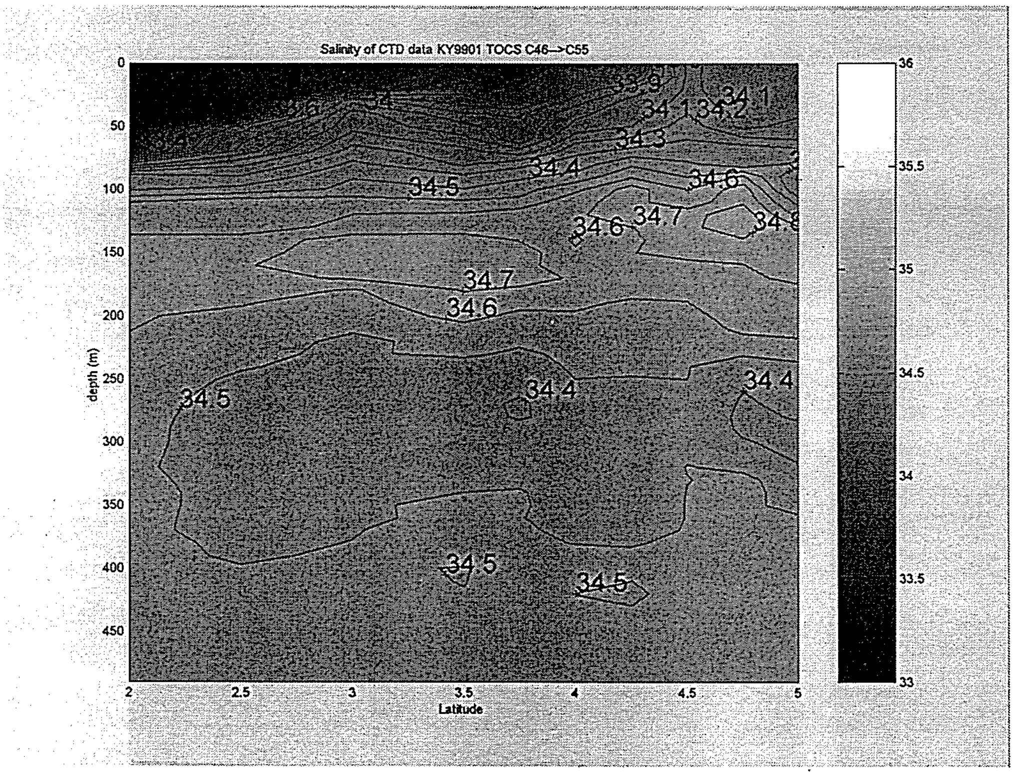
Temperature St.C23 ~ C46 (5-00N)



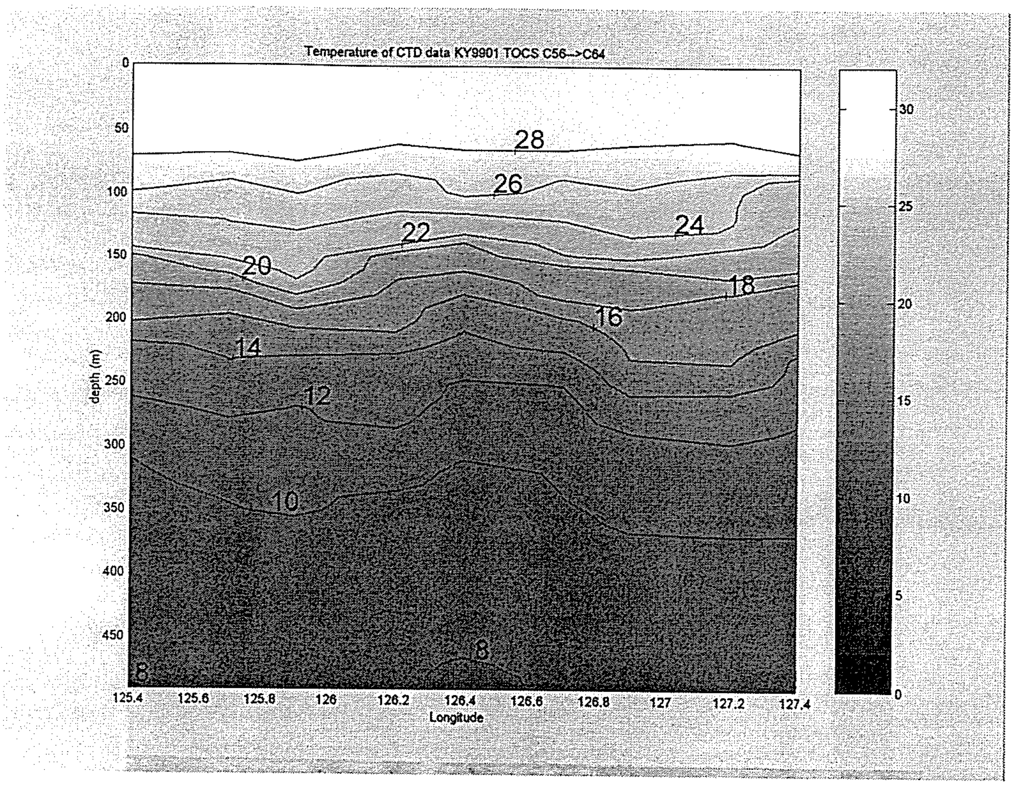
Salinity St.C23 ~ C46 (5-00N)



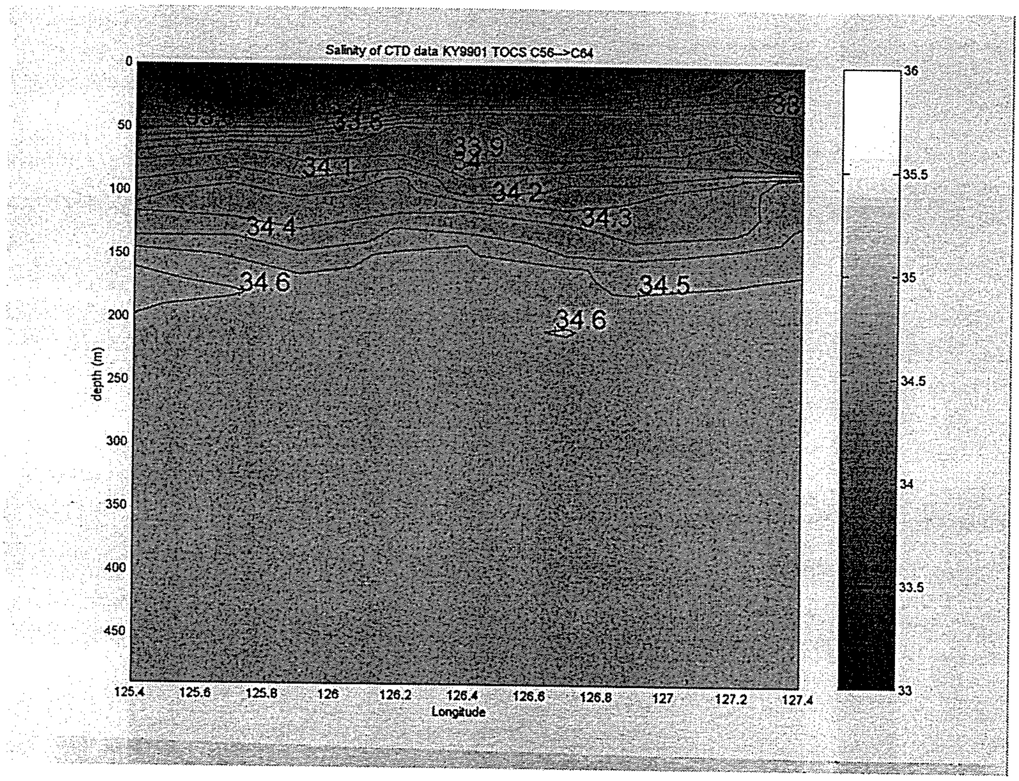
Temperature St.C46 ～ C55



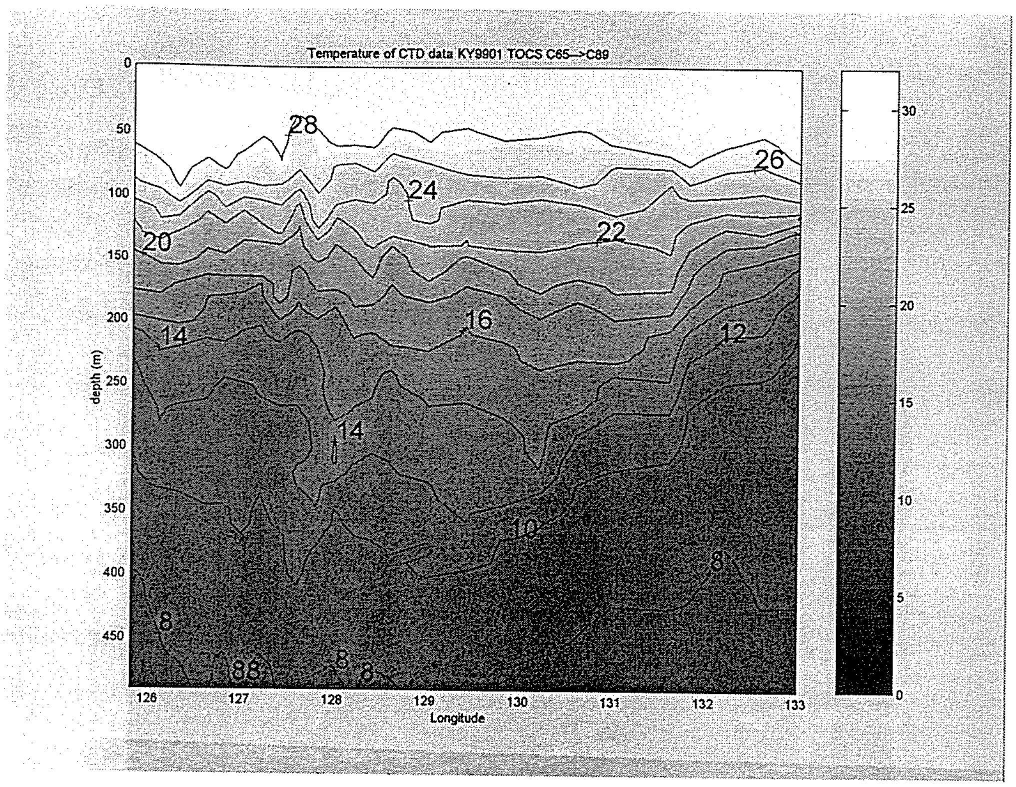
Salinity St.C46 ～ C55



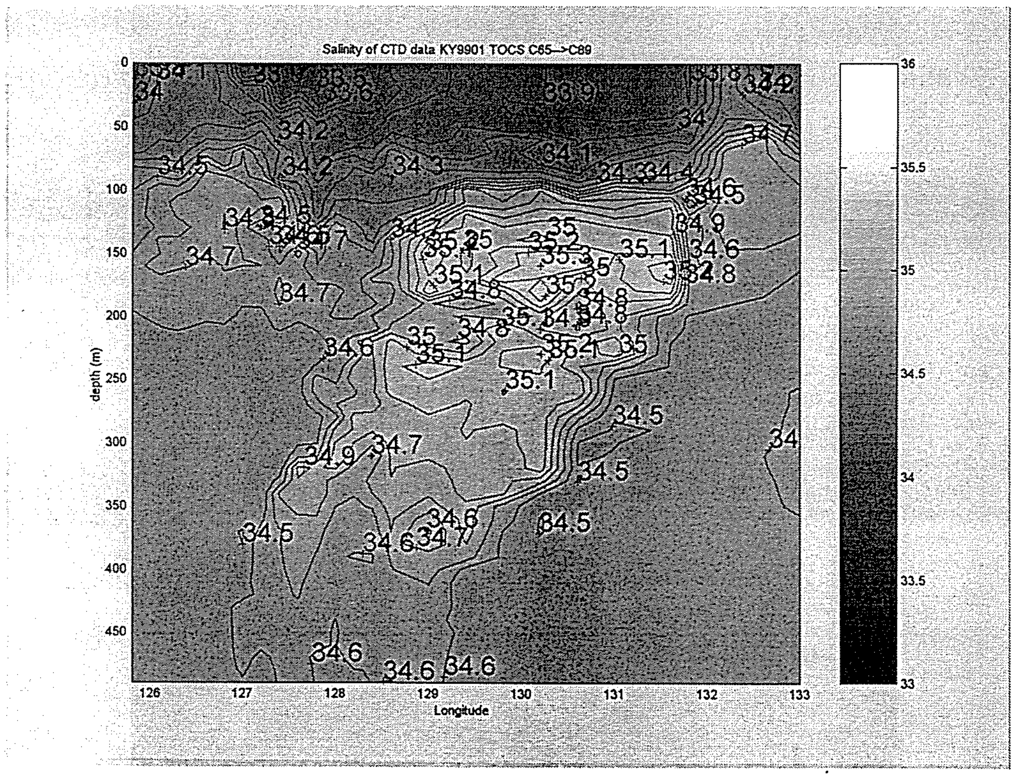
Temperature St.C56 ~ C64 (01-45N)



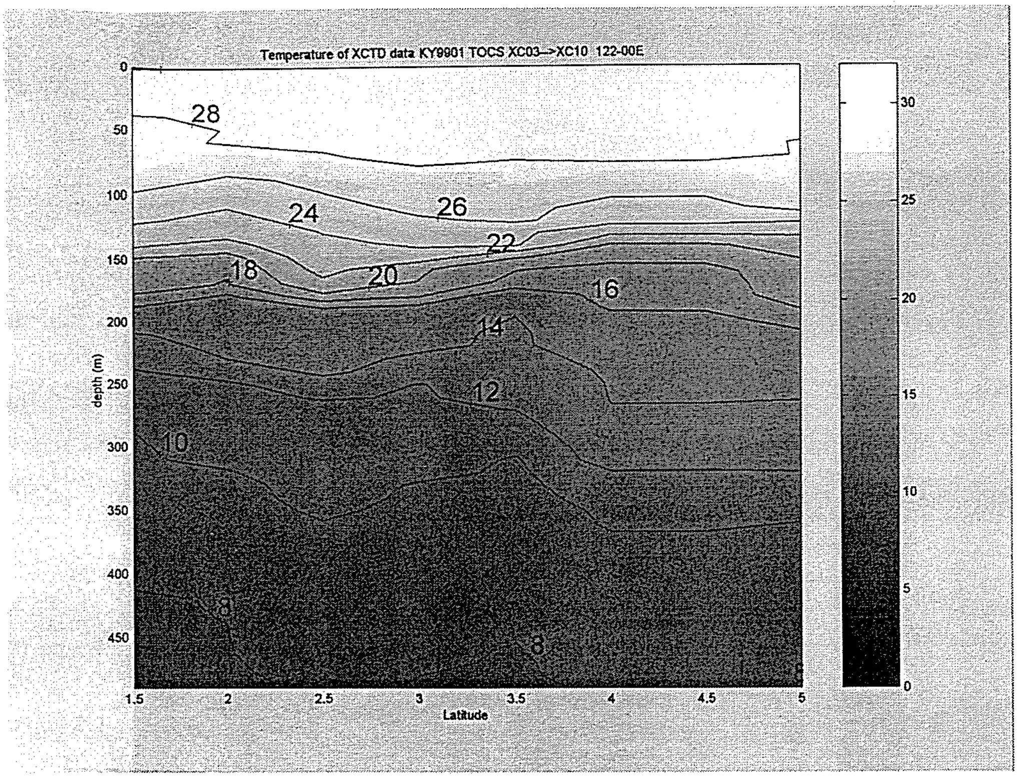
Salinity St.C56 ~ C64 (01-45N)



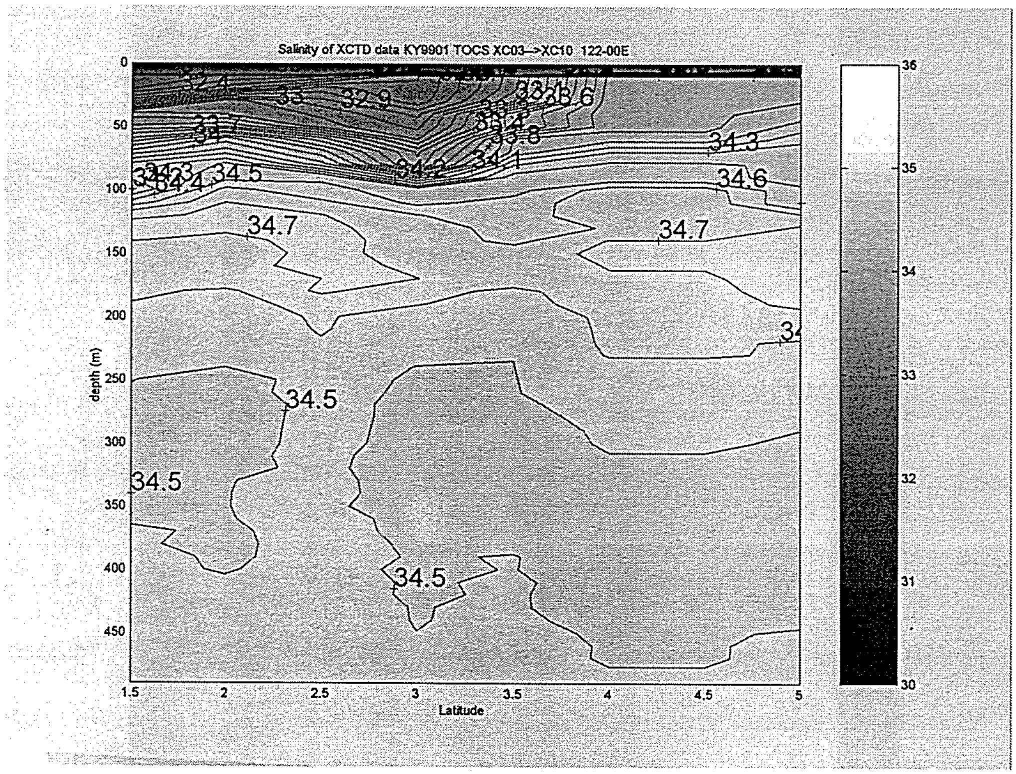
Temperature St.C65 ～ C89



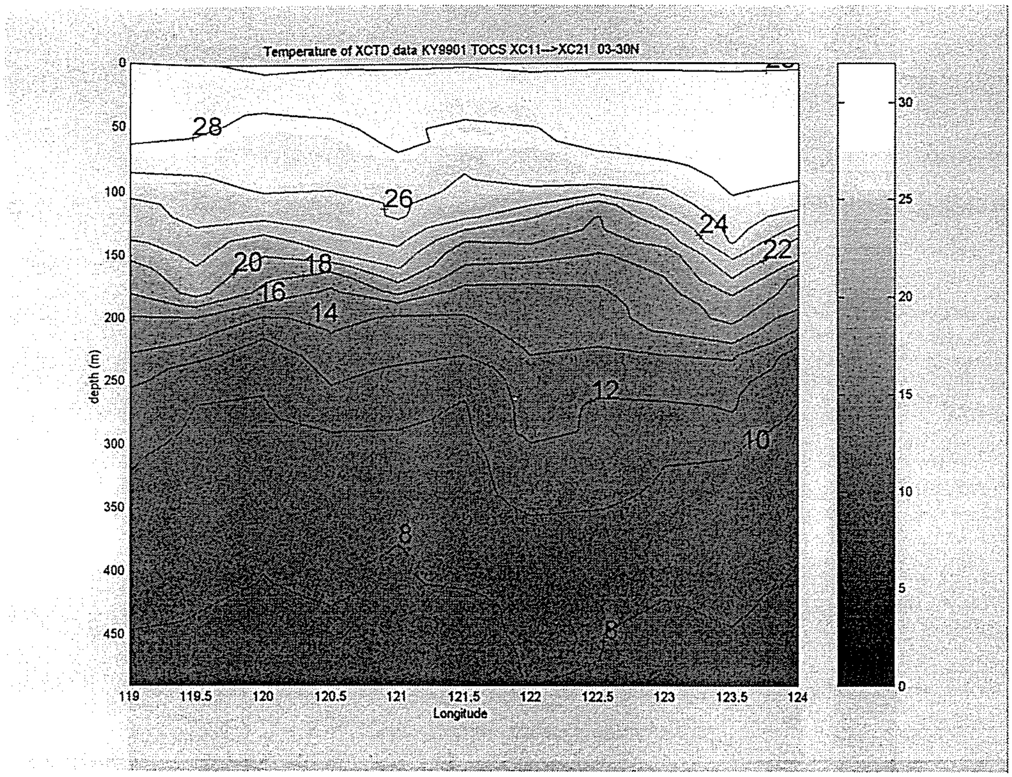
Salinity St.C65 ～ C89



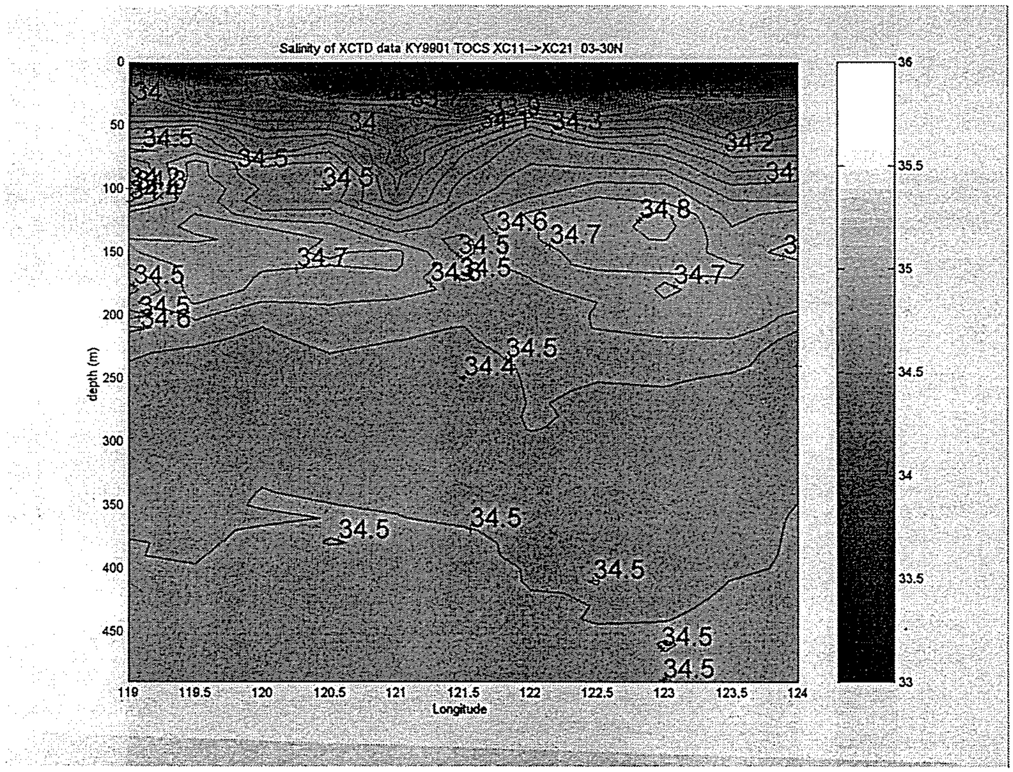
Temperature St.XC03 ~ XC10 (122-00E)



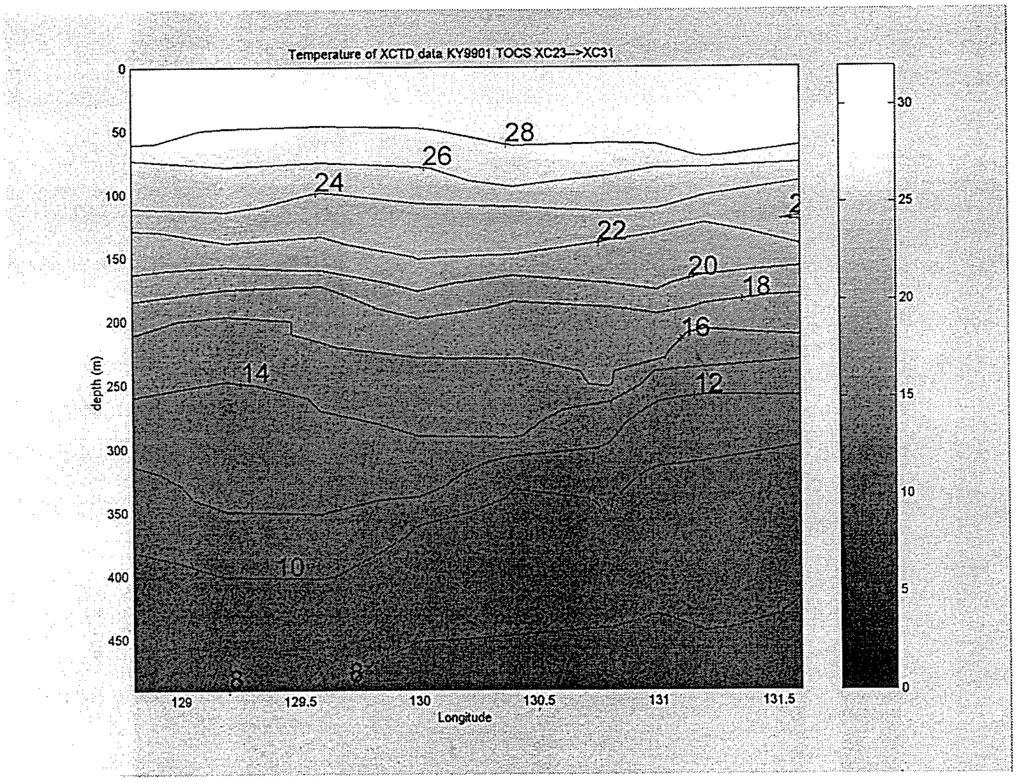
Salinity St.XC03 ~ XC10 (122-00E)



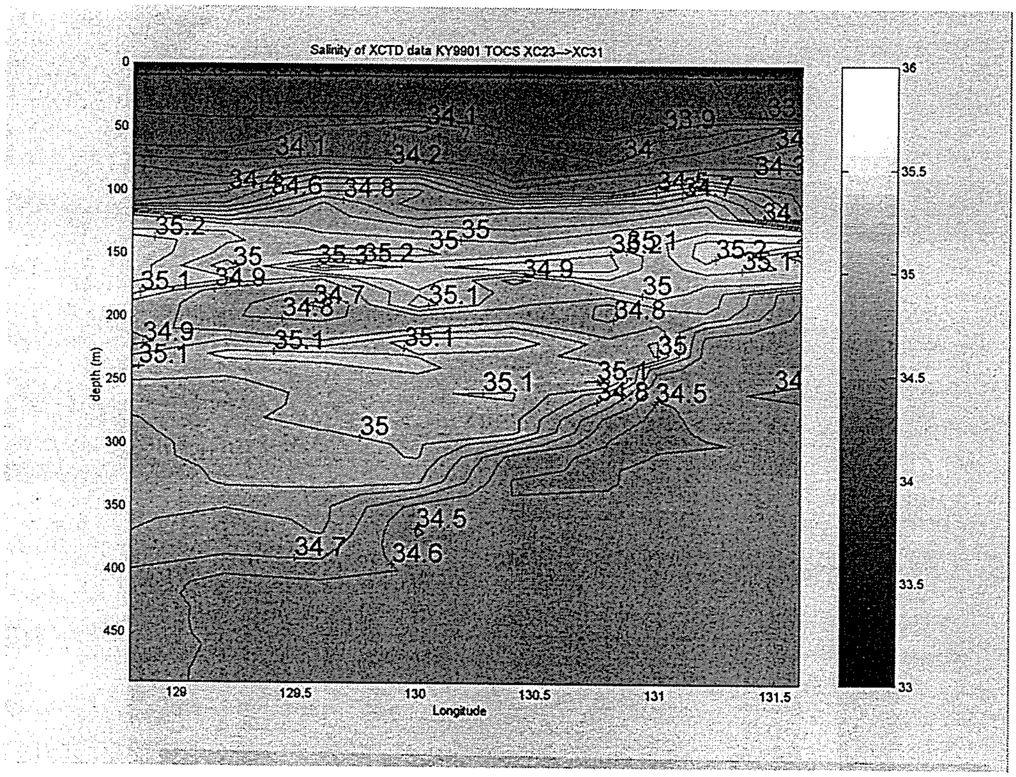
Temperature St.XC11 ~ XC22 (03-30N)



Salinity St.XC11 ~ XC22 (03-30N)

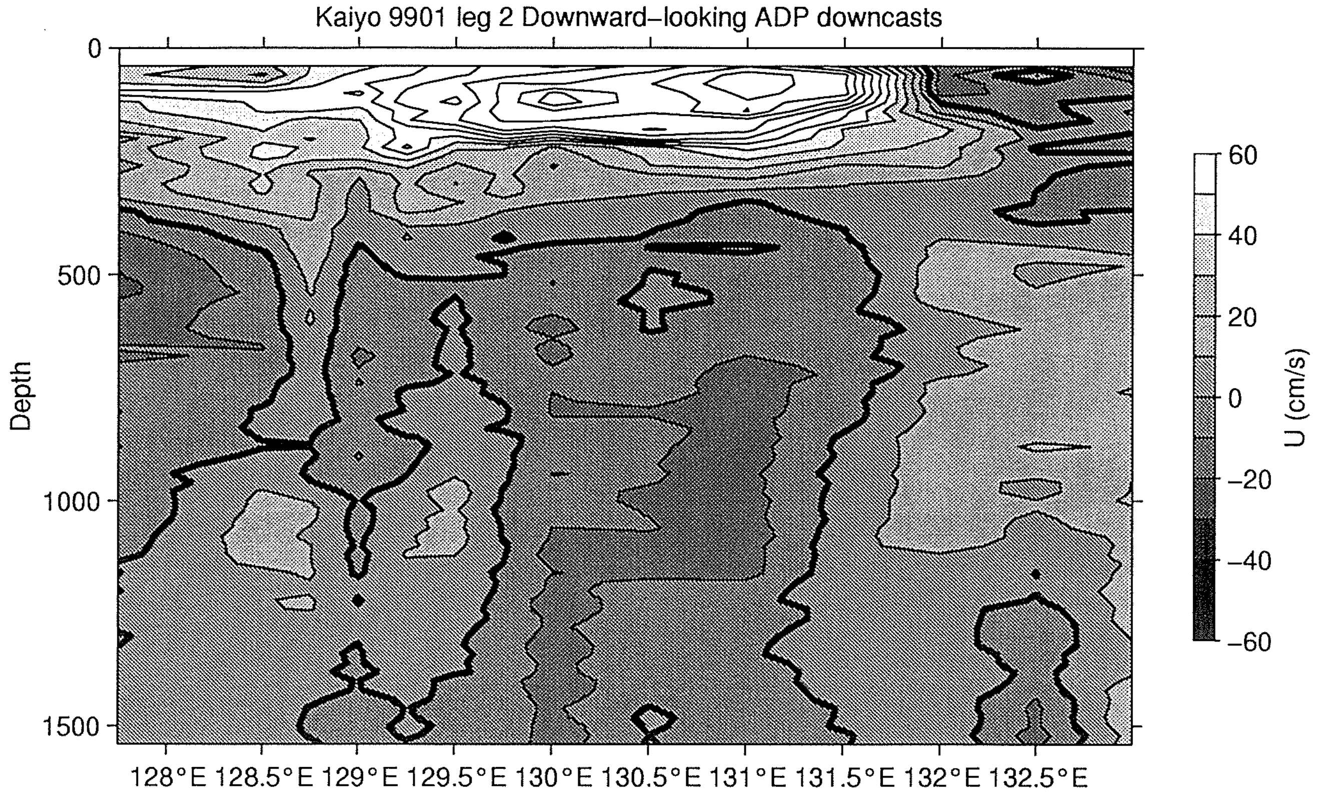


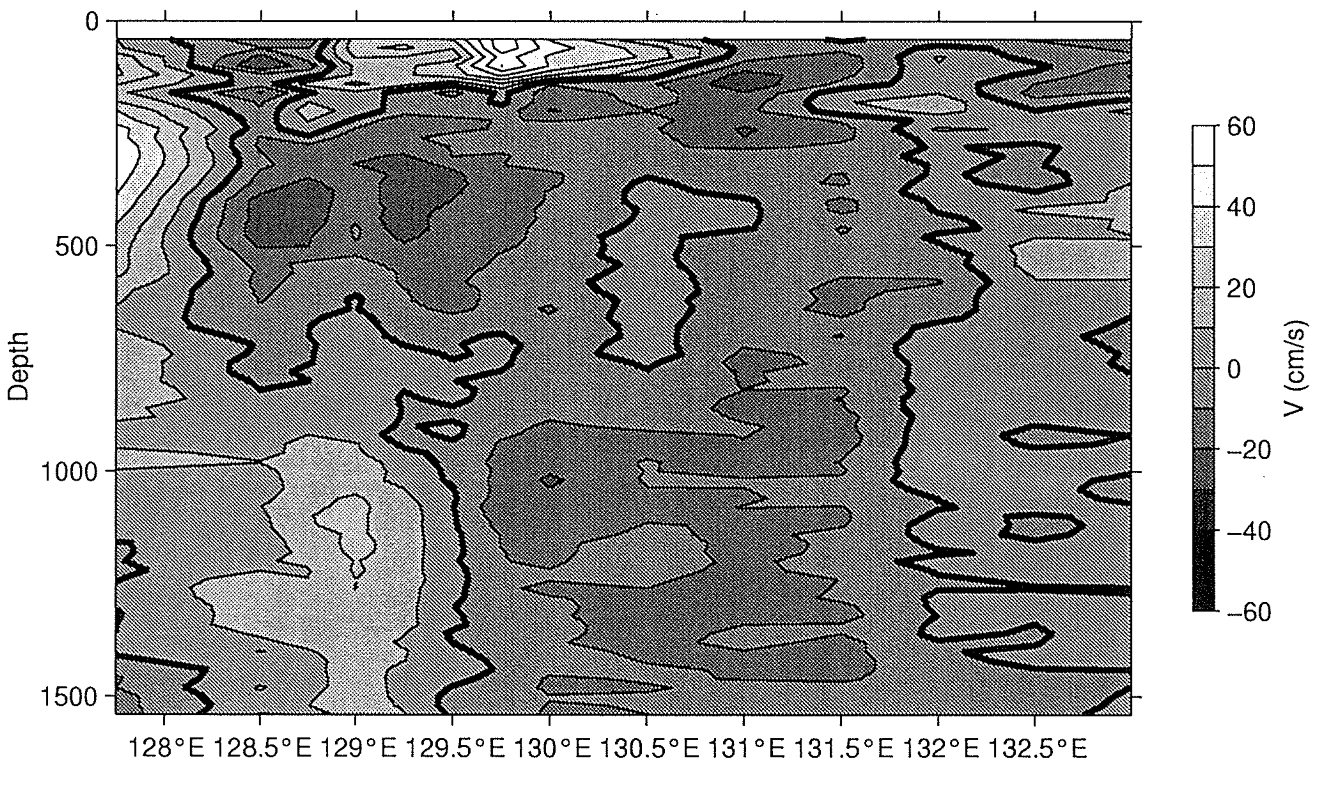
Temperature　St.XC23 ～ XC31



Salinity　St.XC23 ～ XC31

4.4.2 Current





99– 3– 2 11:22 con dn.m

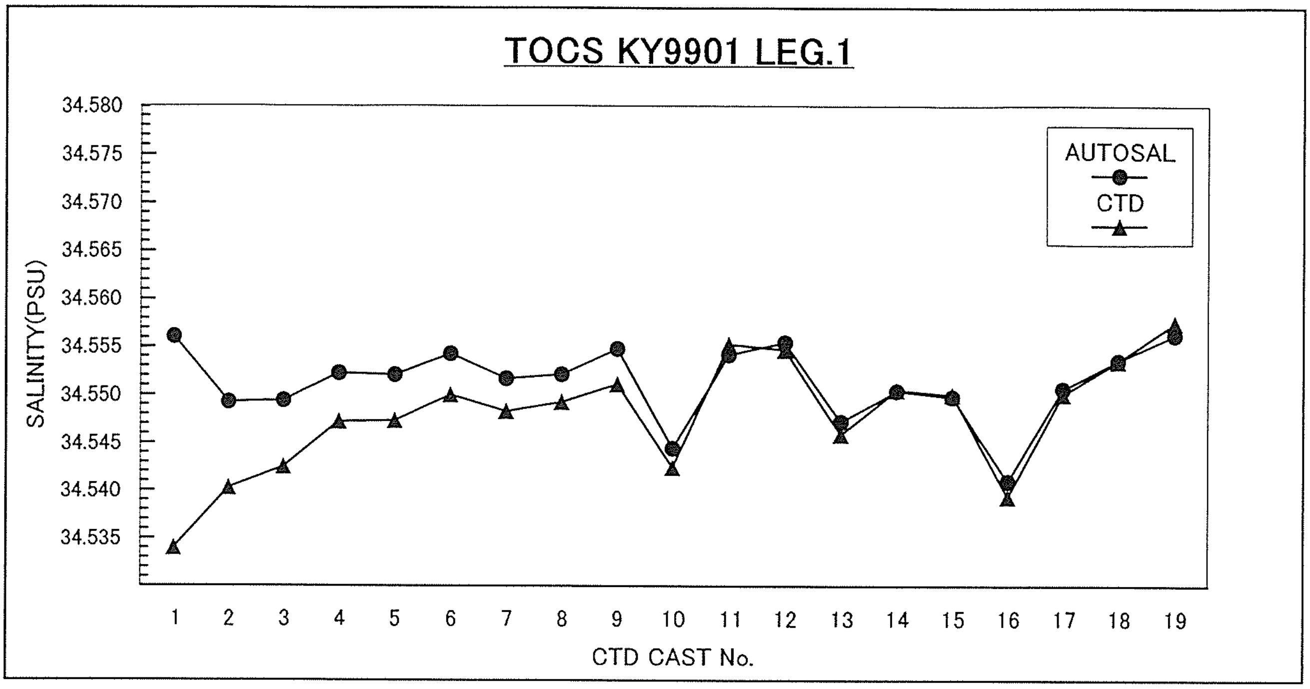
4.5 Bottle Salinity

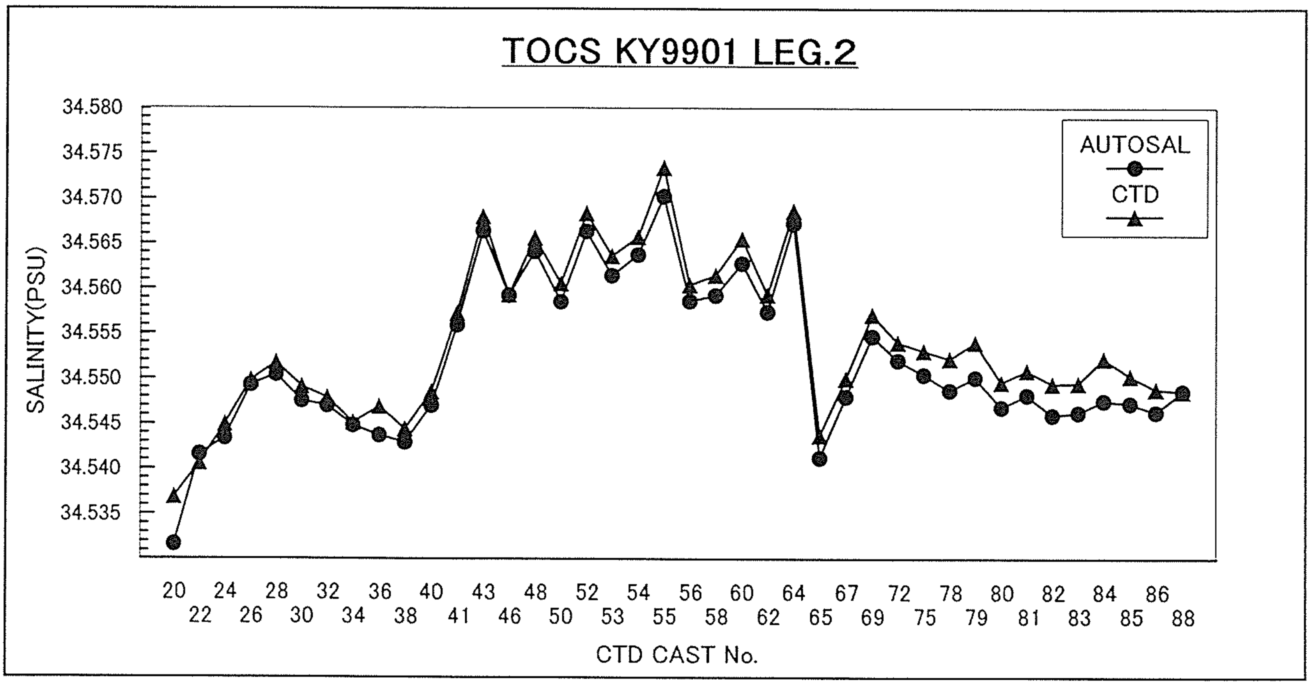
To confirm the difference the conductivity sensore of CTD from data of salinity measurements by using Guildline Autosal Salinometer model 8400B. Seawater samples were collected from the deepest layer of Niskin Sampling Bottle and were stored 250ml Phoenix brown glass bottles with screw caps.

The salinometer was operated in the airconditioned ship's laboratory at a bath temperature of 24 deg C.

It was standardized by use of IAPSO Standard Seawater batch P133 whose conductivity ratio was 0.99986.

Leg.1 - 19 samples
Leg.2 - 40 samples


TOCS KY9901 LEG.1
34.580
34.575
34.570
34.565
34.560
34.555
34.550
34.545
34.540
34.535
SALINITY(PSU)
AUTOSAL
CTD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
CTD CAST No.


TOCS KY9901 LEG.2
34.580
34.575
34.570
34.565
34.560
34.555
34.550
34.545
34.540
34.535
SALINITY(PSU)
AUTOSAL
CTD
20 24 28 32 36 40 43 48 52 54 56 60 64 67 72 78 80 82 84 86
22 26 30 34 38 41 46 50 53 55 58 62 65 69 75 79 81 83 85 88
CTD CAST No.

4.6 Dissolved Oxygen Measurement

S. Ozawa[1] and K. Kida[1]

1) :Marine Works Japan, LTD.

Objectives:

Measurement of dissolved oxygen (below D.O.) using D.O.meter corrected by the Winkler titration processed to the WHP Operations and Methods(Culberson,1991).

Comparison of D.O.meter data corrected by the Winkler titration with CTD D.O. data.

Instruments:

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

Methods :

The 12 piston Niskin water samplers (Go 1015) sampled sea water during CTD upcast.

The water samples for D.O. were sampled from the 5-liter Niskin water samplers into 100ml D.O. glass bottles. In several cast, water samples for the Winkler titration were also sampled to calibrated BOD flasks (ca, 180 ml) (see Green and Carritt 1966).

During sampling, water corresponded to three times of D.O. bottles was used to flush, then water temperature was measured during sampling.After the sampling, we analyzed D.O. with salinity correction within 30 minutes.(Before measurement, the D.O.meter was adjusted to 0-100% (see TOA D.O.meter operation manual)).

The samples for the titration method were analyzed within 2 hours. These samples were analyzedby Metrohm piston buret of 10ml with Pt Erectrode.The standerdizations have been performed every day before the sample titration.

The data from the D.O.meter were corrected with calibration factors. The factors were decided by linear regression based on the Winkler titration value vs D.O.meter Value.

Results :

(1) Correction of D.O.meter Values

Linear regression line listed below was obtained form 49 pairs of D.O.meter-Winkler data. (Fig.4.6.1)

All D.O.meter data were calibrated by this formula.(corrected D.O. data were Shown in Table 4.6.1)

$$\text{Formula : } Y = 0.5253 + 0.8202 \times X \ (n = 49)$$

$$R = 0.829$$

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

(2) CTD-D.O. Sensor Value correction

The two kinds of alculated polinominary regression curve for upcast was obtained from 233 pairs of CTD D.O.Sensor and corrected D.O.data. (Fig.4.6.2)

$$\text{For upcast : } Y = 1.2812 + 0.1606 \times X + 0.1312 \times X2 \ (n = 233)$$

$$R = 0.676$$

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

The difference of CTD D.O.Sensor and corrected D.O.data was 0.11, and standard deviation was 0.06.

(3) Contour plots

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

5 N Line : Stn C20,C22,C24,C26,C28,C30,C32,C34,C36,C38.C40.C43.C46
125 E Line : Stn C46,C48,C50,C52,C53,C54,C55
M1 Line : Stn C56,C58,C60,C62,C64
M2,M3 and PM Line : Stn C65,C67,C69,C72,C75.C78,C79,C80,C81,C82,C83, C84,C85,C86,C88

(4) Vertical profiles

All vertical profiles in this cruise are showed in Fig.4.6.4. These data were used from corrected D.O. data in Table.4.6.1

References :

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

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

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

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

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

S.Kitagawa and K.Taira (1993) Measurement of dissolved oxygen by an electrode method,

Umi no Kagaku (in Japanese), 2, 15-18.TOA Electronics Ltd. (1991) DO-25A Portable Dissolved Oxygen meter Oparation Manual,Tokyo, 29

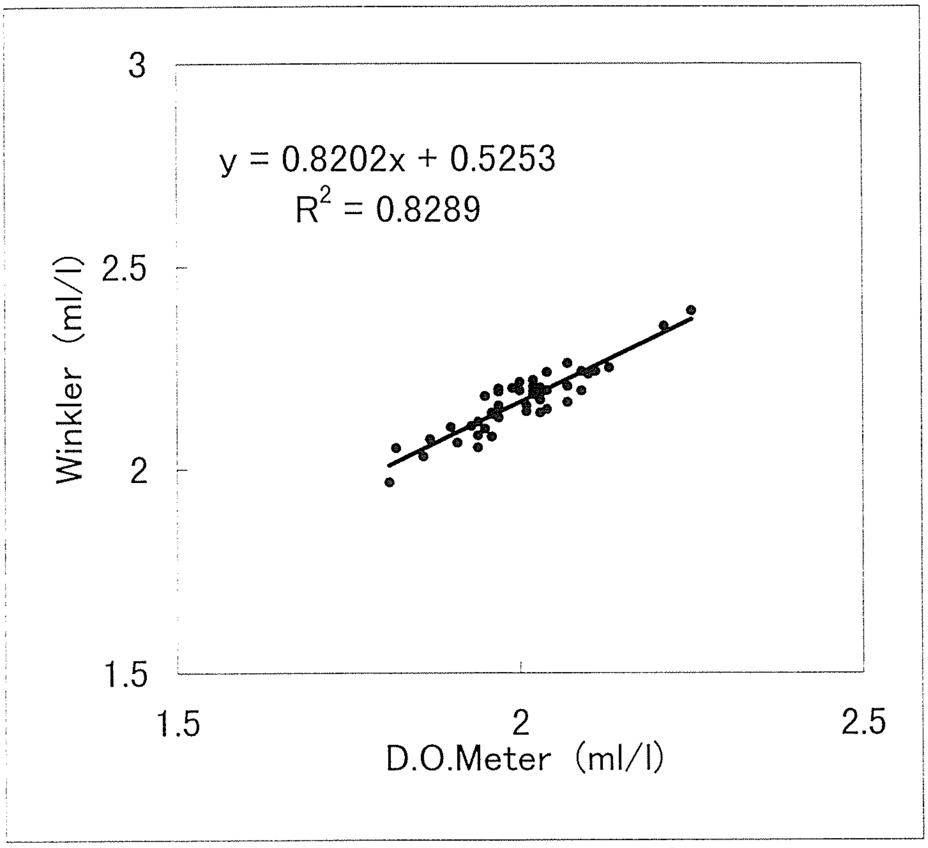


Fig 4.6.1 D.O.Meter - Winkler

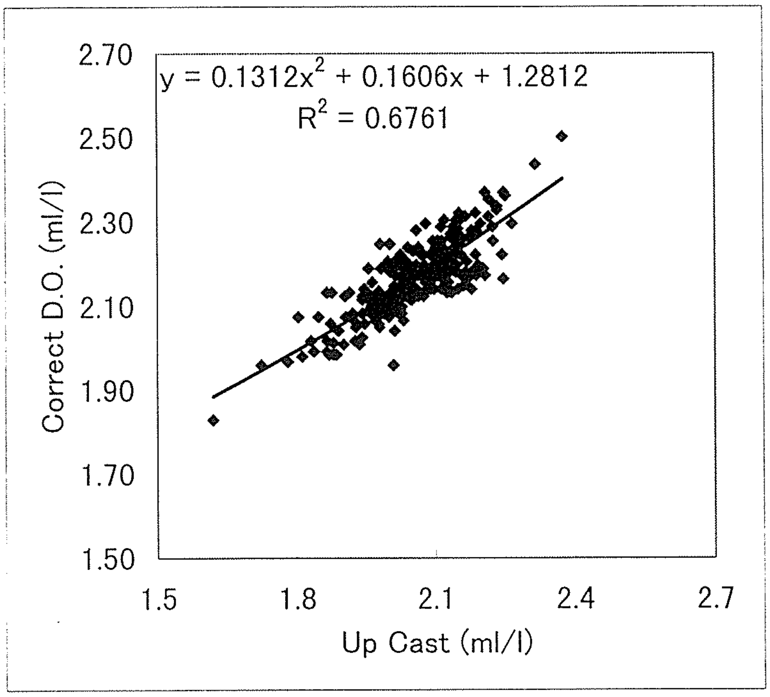


Fig 4.6.2 CTD D.O Sensor vs Corrected D.O

Table 4.6.1

Stn	C20	Stn	C22	Stn	C24	Stn	C26	Stn	C28
6-00N	133-00E	6-00N	132-00E	5-00N	131-00E	5-00N	130-00E	5-00N	129-30E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
497	2.13	500	2.13	501	2.44	497	2.07	499	1.83
		599	2.08	603	2.31	595	2.13	600	1.97
701	2.25	696	2.08	702	2.21	698	1.99	701	2.17
799	2.19	799	2.25	802	2.19	801	1.99	800	1.99
901	1.96	900	2.13	901	2.31	899	2.01	898	2.08
		1000	2.19	999	2.14	1002	2.04	1001	2.11

Stn	C30	Stn	C32	Stn	C34	Stn	C36	Stn	C38
5-00N	129-00E	5-00N	128-30E	5-00N	128-00E	5-00N	127-30E	5-00N	127-00E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
501	2.12	500	2.26	499	2.17	499	2.18	501	2.08
599	2.09	600	2.01	600	2.06	600	2.17	600	2.13
702	2.14	697	2.15	699	2.09	699	2.18	699	2.18
798	2.24	800	2.17	799	2.14	800	2.24	801	2.19
899	2.17	901	2.12	900	2.08	901	2.12	900	2.20
999	2.13	999	2.10	1000	2.08	999	2.19		

Stn	C40	Stn	C41	Stn	C43	Stn	C46	Stn	C48
5-00N	126-30E	5-14N	125-38E	5-00N	126-00E	5-00N	125-30E	4-30N	125-10E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
501	1.96	498	2.12	498	2.08	505	2.02	501	2.08
600	2.21	599	2.03	602	2.08	601	2.12	600	2.15
701	2.23	700	2.12	699	2.12	700	2.14	700	2.20
800	2.24	800	2.13	798	2.14	799	2.16	801	2.17
901	2.24	900	2.15	899	2.14	897	2.18	900	2.18
1001	2.19	1002	2.17	1001	2.17			1001	2.17

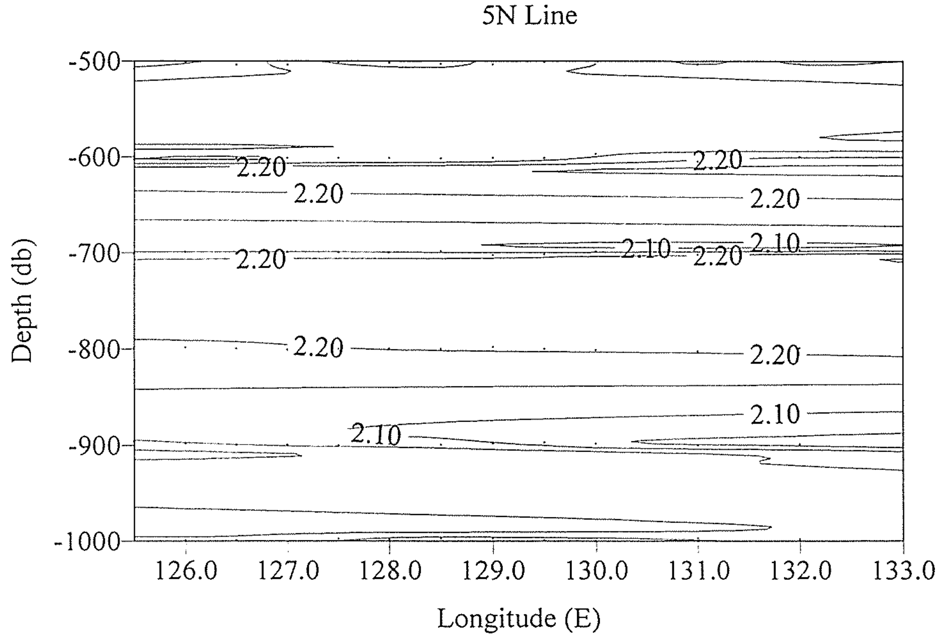
Stn	C50	Stn	C52	Stn	C53	Stn	C54	Stn	C55
4-00N	124-50E	3-30N	124-30E	3-00N	124-40E	2-30N	124-50	2-00N	125-00E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
497	2.04	500	2.08	502	2.08	502	1.81	501	2.06
599	2.09	600	2.22	601	2.18	600	1.97	600	2.14
700	2.18	700	2.24	700	2.22	701	2.12	698	2.17
800	2.16	799	2.21	800	2.18	800	2.08	799	2.18
899	2.17	899	2.21	899	2.18	901	2.15	899	2.18
1003	2.17	1002	2.19	1000	2.20	999	2.16	1002	2.19

Stn	C56	Stn	C58	Stn	C60	Stn	C62	Stn	C64
1-45N	125-25E	1-45N	125-55E	1-45N	126-24E	1-45N	126-55E	1-45N	127-25E
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
500	2.11	500	2.02	501	2.20	497	2.12	496	2.25
600	2.17	600	2.28	599	2.24	599	2.16	599	2.28
700	2.20	701	2.25	696	2.26	703	2.29	699	2.30
799	2.14	800	2.24	798	2.20	801	2.29	798	2.31
900	2.18	899	2.22	898	2.28	899	2.27	898	2.32
1003	2.22	1001	2.26	1002	2.30	998	2.29	1001	2.35

Stn	C65	Stn	C67	Stn	C69	Stn	C72	Stn	C75
3-30N	125-50E	3-30N	126-20E	3-30N	126-50E	3-15N	127-26E		
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
499	2.20	503	2.17	500	2.21	493	2.50	500	2.37
600	2.20	601	2.27	599	2.26	600	2.26	600	2.31
699	2.19	701	2.24	701	2.26	699	2.22	701	2.26
801	2.22	798	2.28	800	2.22	801	2.18	800	2.06
		898	2.20	899	2.20	902	2.17	900	2.11
		1000	2.22	1000	2.22	1004	2.18	1002	2.14

Stn	C78	Stn	C79	Stn	C80	Stn	C81	Stn	C82
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
500	2.37	501	2.26	502	2.31	503	2.30	505	2.12
599	2.34	598	2.36	599	2.34	600	2.32	600	2.22
701	2.26	699	2.12	701	2.11	698	2.15	700	2.14
798	2.12	799	2.02	803	1.99	800	1.99	799	2.01
900	2.19	900	2.12	901	2.08	899	2.08	898	2.05
		1000	2.16	1001	2.12	1002	2.14	1001	2.12

Stn	C83	Stn	C84	Stn	C85	Stn	C86	Stn	C87
Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)	Depth(db)	D.O.(ml/l)
502	2.05	499	2.22	504	2.22	498	2.33		
600	2.26	600	2.31	601	2.18	603	2.22	600	2.27
699	2.19	700	2.12	699	2.17	700	2.10	700	2.24
		799	2.22	796	2.11	799	2.15	799	2.07
901	2.07	899	2.18	897	2.10	901	2.10	900	2.10
1002	2.10	998	2.21	1005	2.14	1005	2.12	1002	2.14



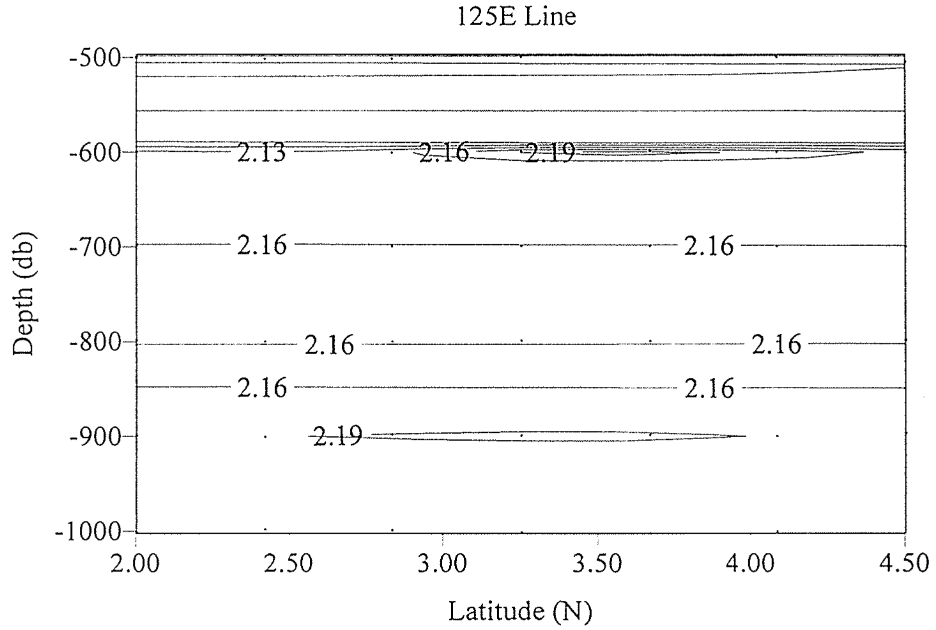
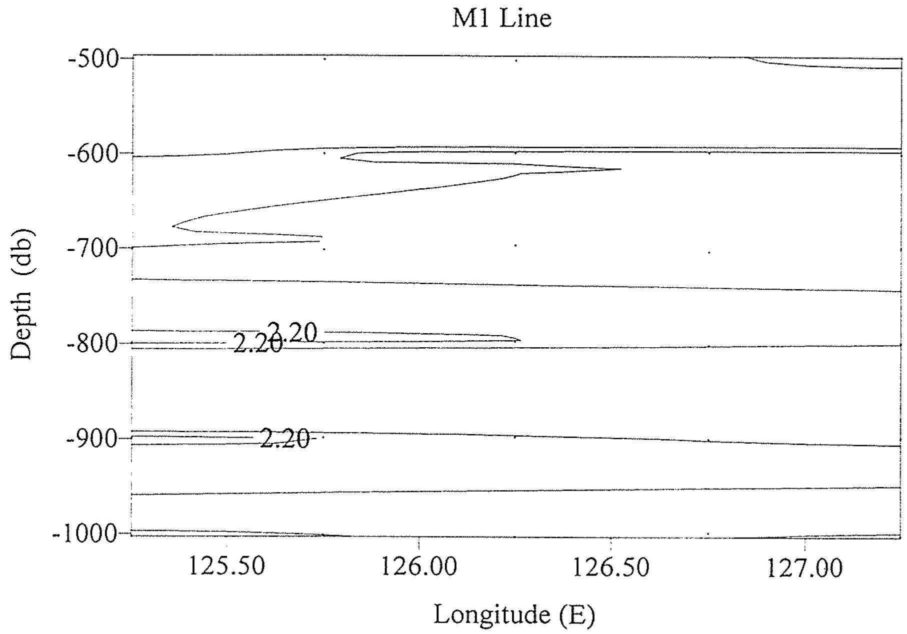


Fig4.6.3(1) Contour Plot



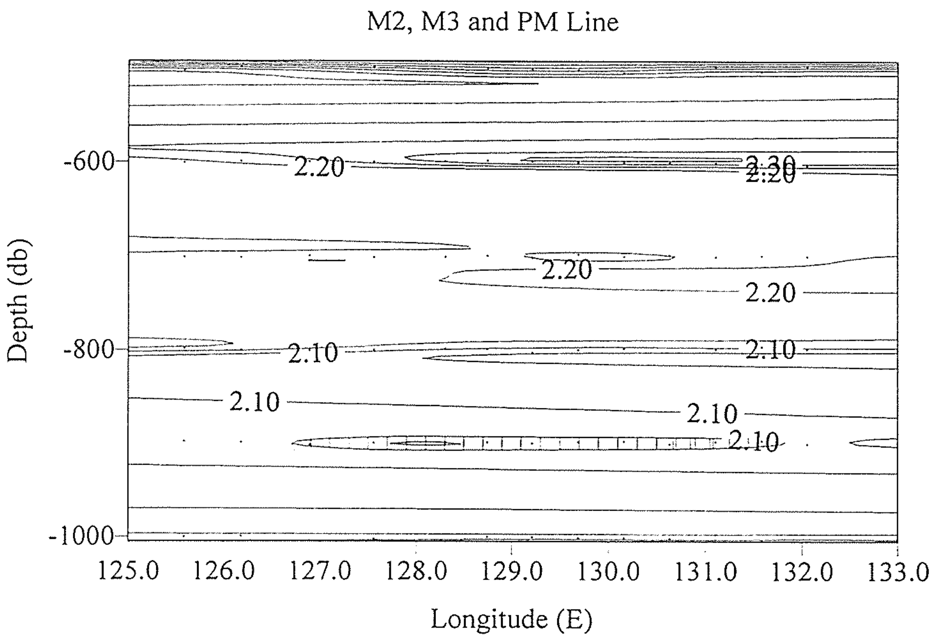


Fig4.6.3 (2) Contour Plot

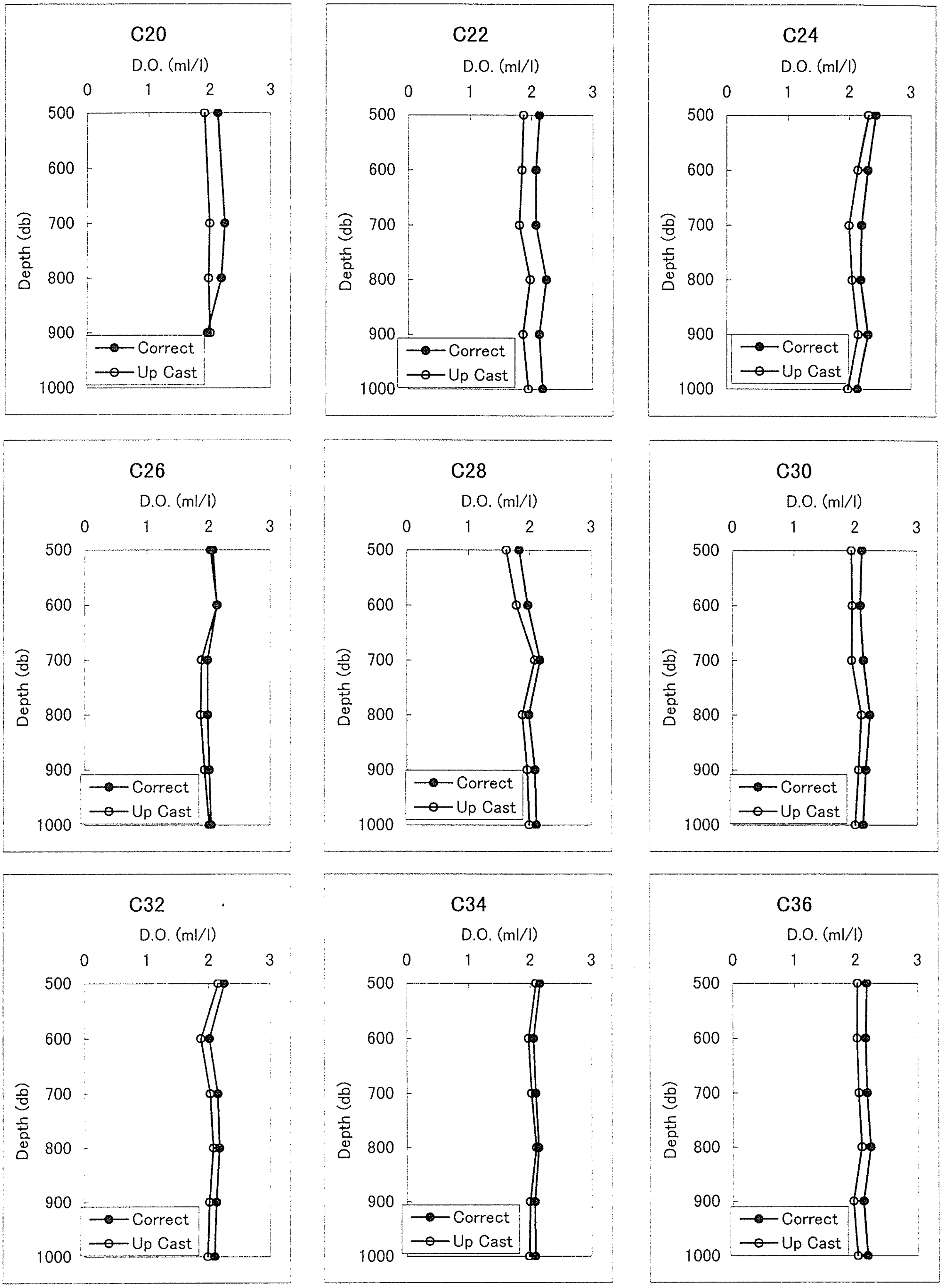


Fig4.6.4(1) Vertical Profile

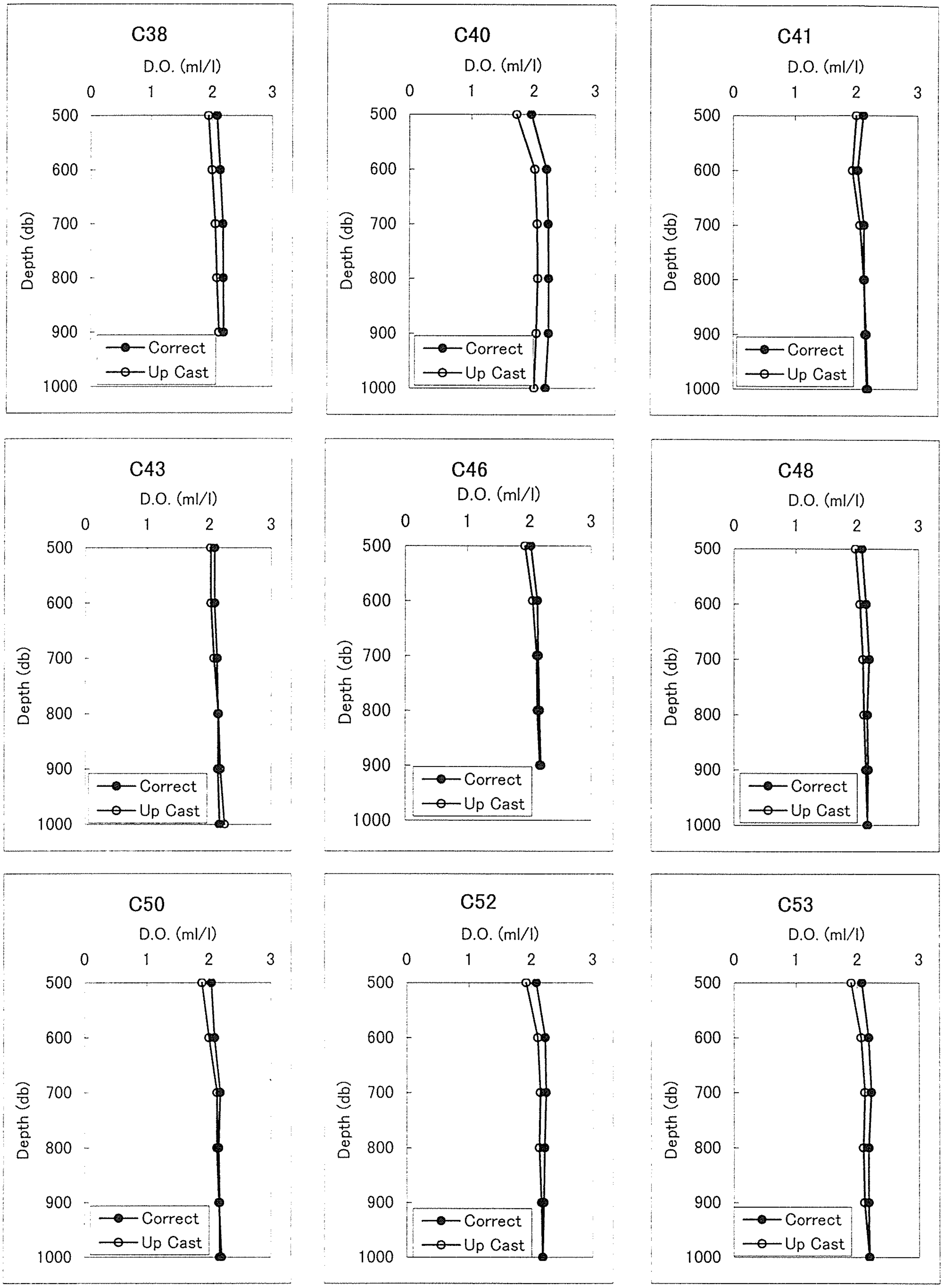


Fig4.6.4(2) Vertical Profile

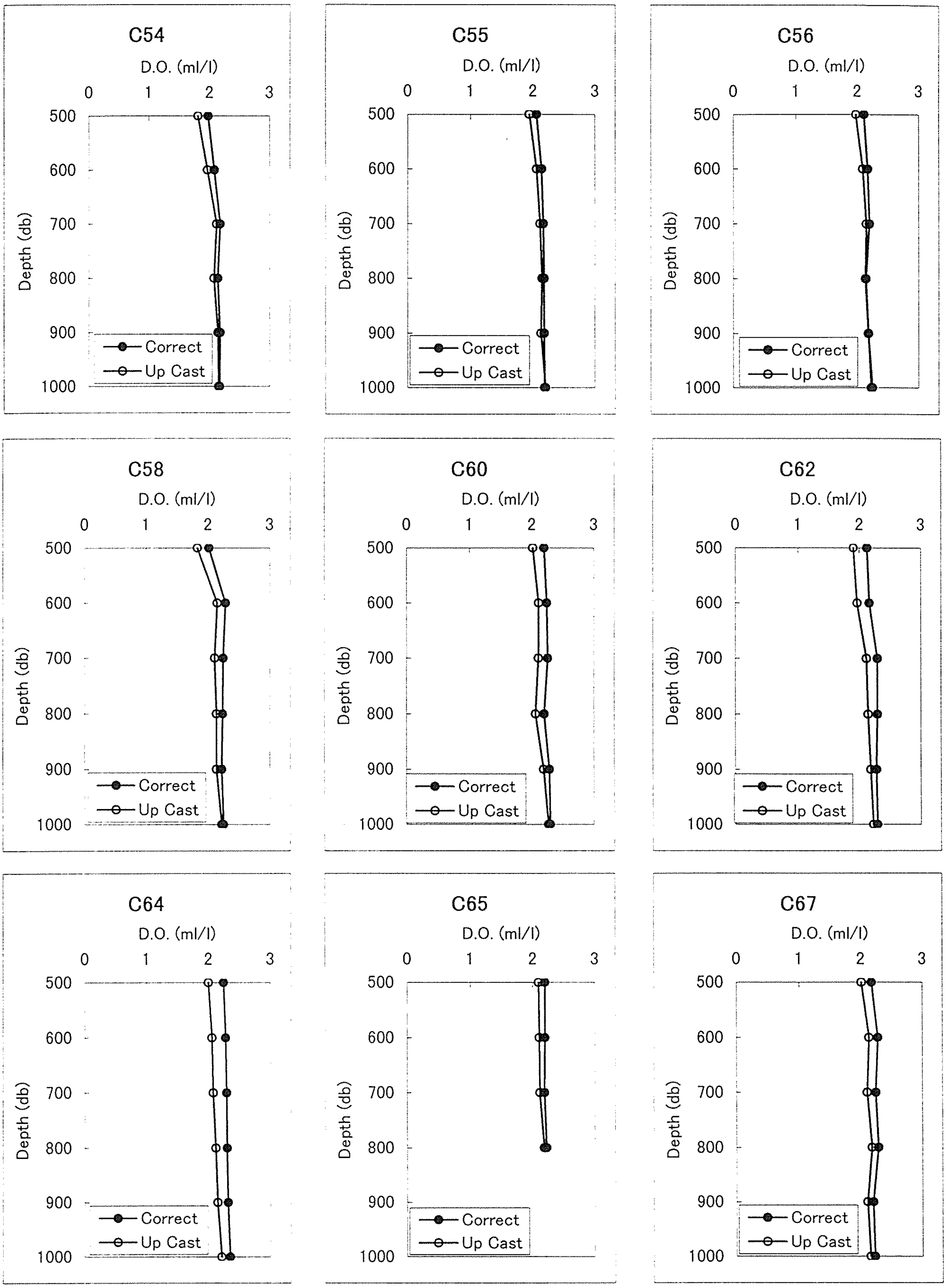


Fig4.6.4(3) Vertical Profile

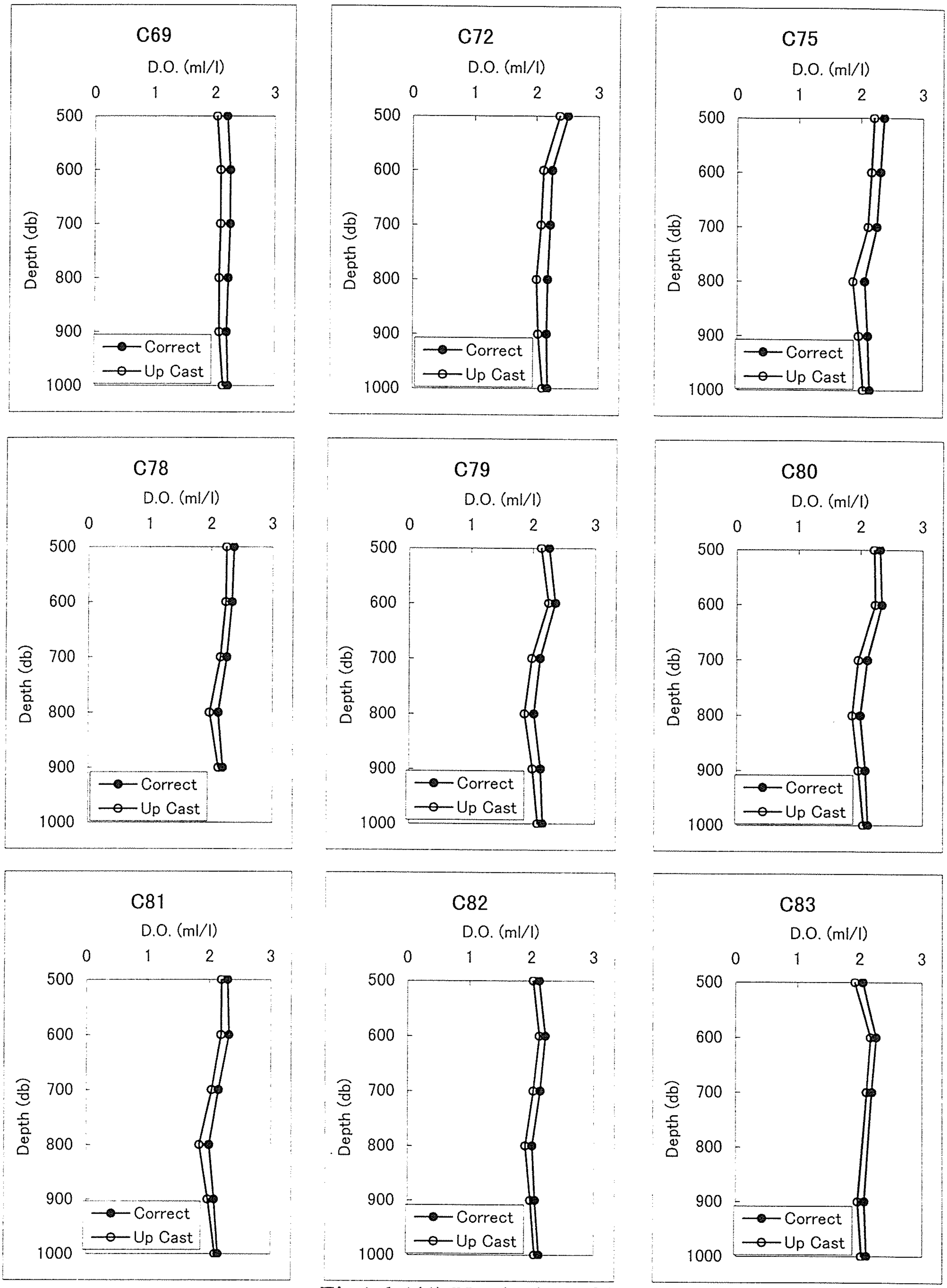


Fig4.6.4(4) Vertical Profile

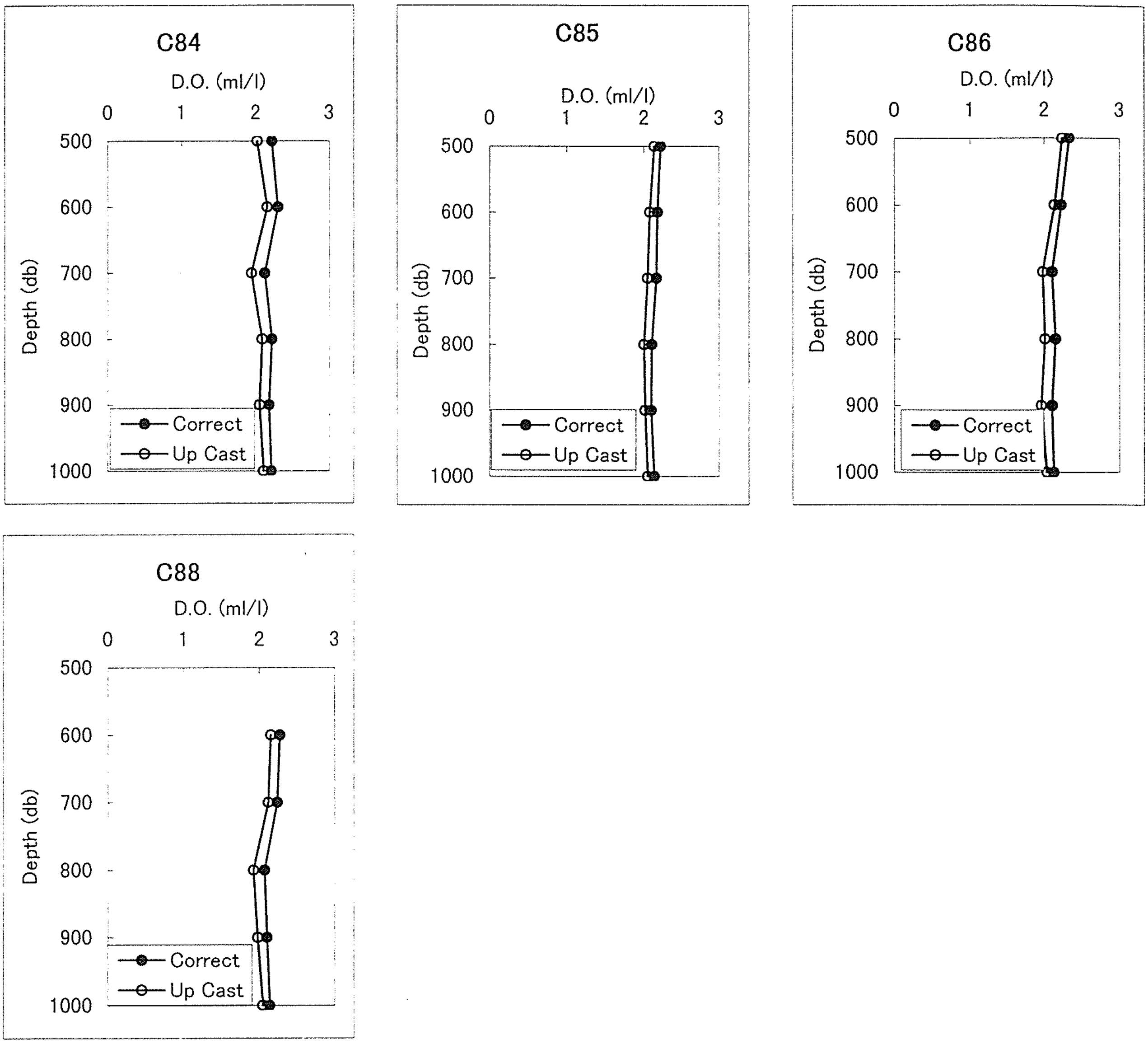


Fig4.6.4(5) Vertical Profile

5. Shipbord ADCP

R/V Kaiyo mounts the VM (Vessel-Mounted) -NB (Narrow-Band) ADCP (Acoustic Doppler Current Plofiler) manufacutured by RD Instrument. The serial number of transducer is 501 of the frequency 77KHz and the 30degreebeam angle.The ADCP was setas listed below.

Depth Cell Length : 16m

No. of Depth Cell : 64

Average Time : 300 sec

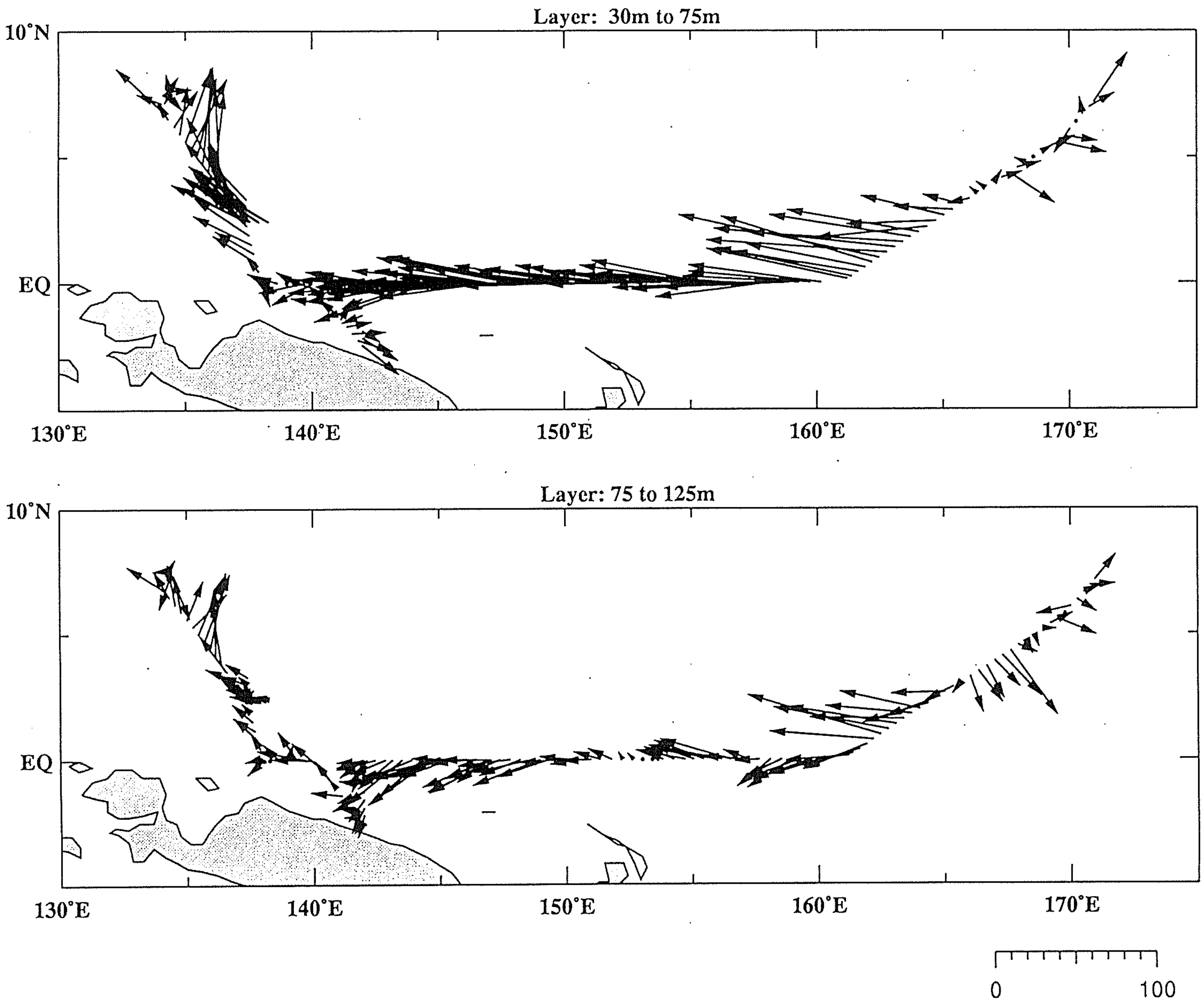
Tilt misalignment : 0.0

Pitch offset : 0.0

Roll offset : 0.0

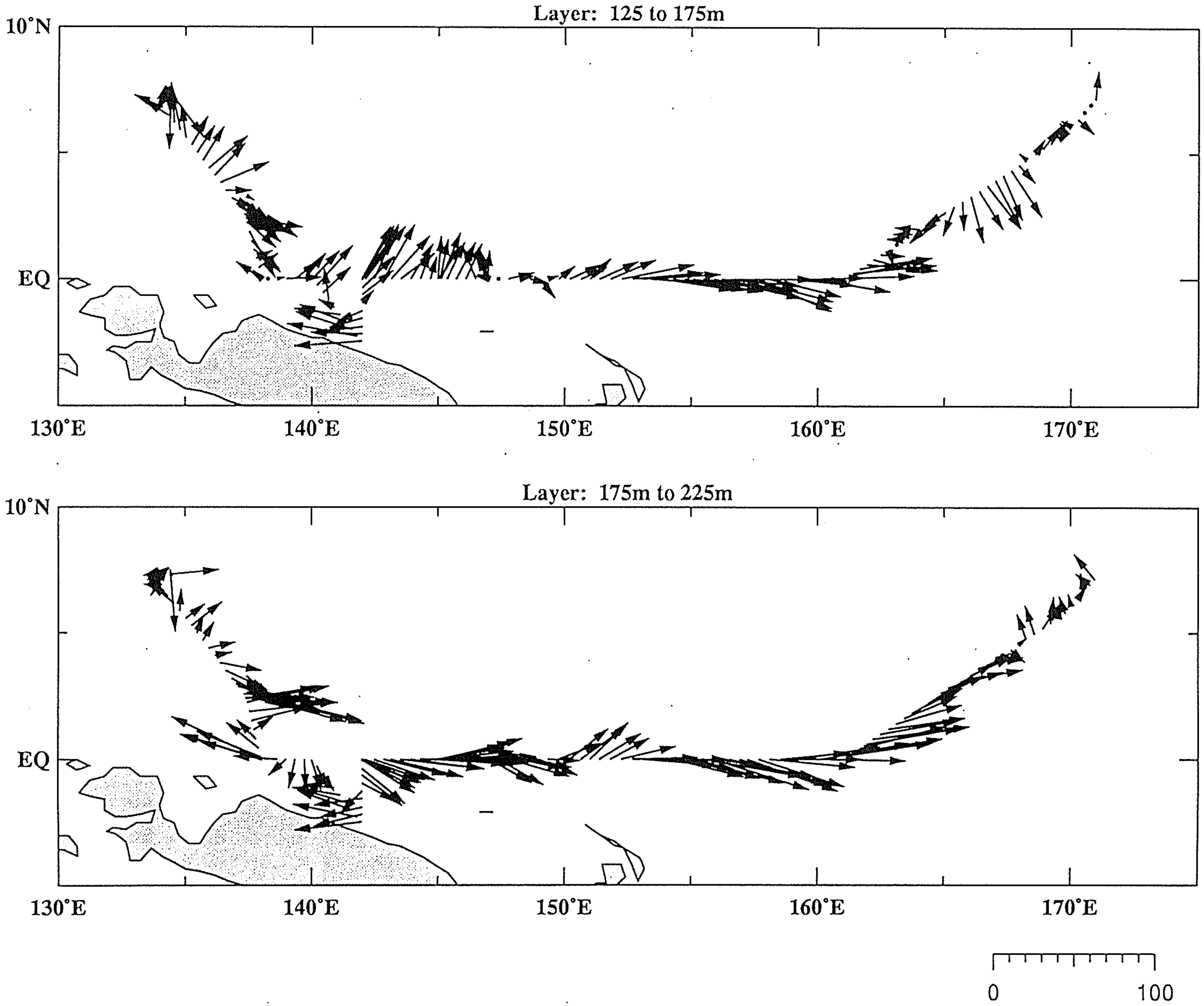
Kaiyo 9901

Jan 25 to Feb 9, 1999



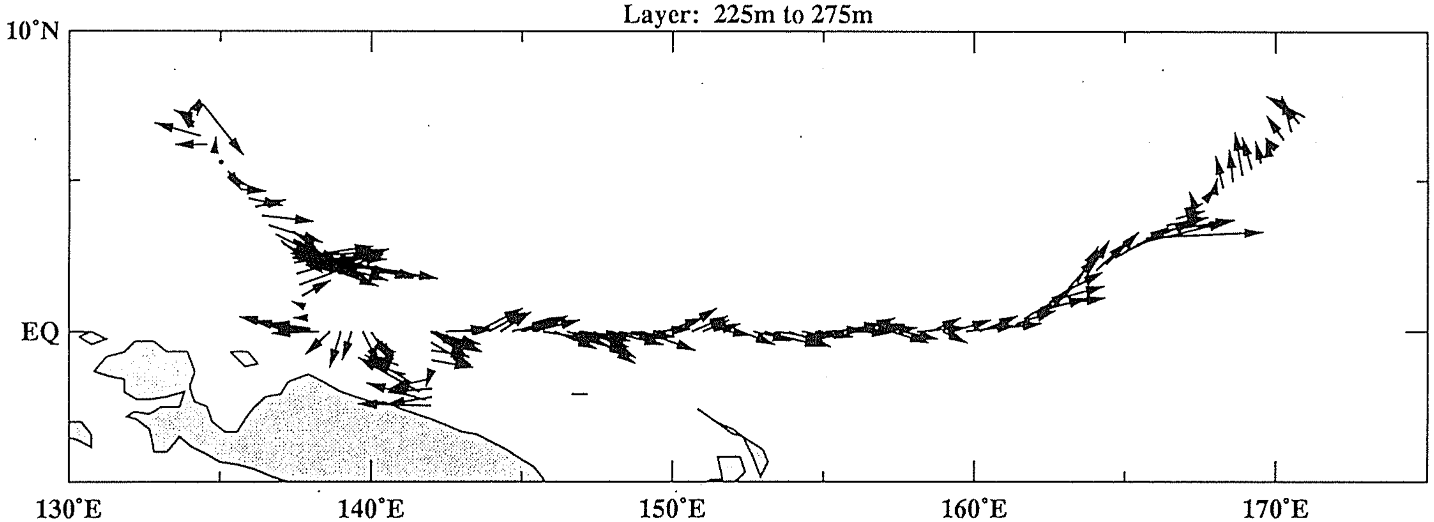
Kaiyo 9901

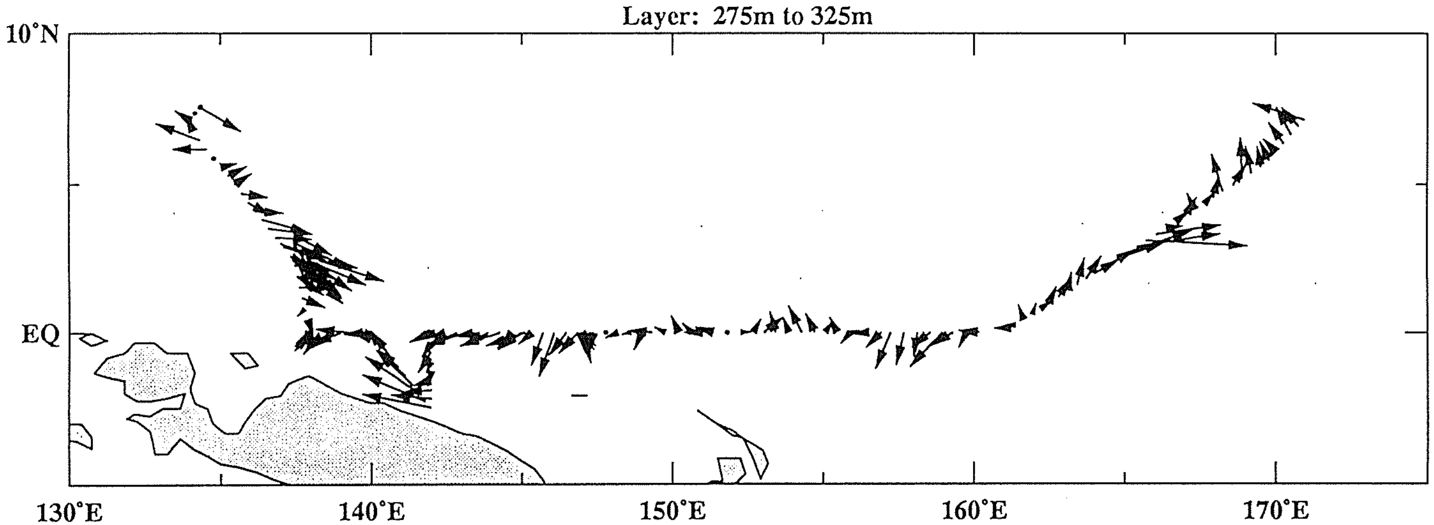
Jan 25 to Feb 9, 1999



Kaiyo 9901

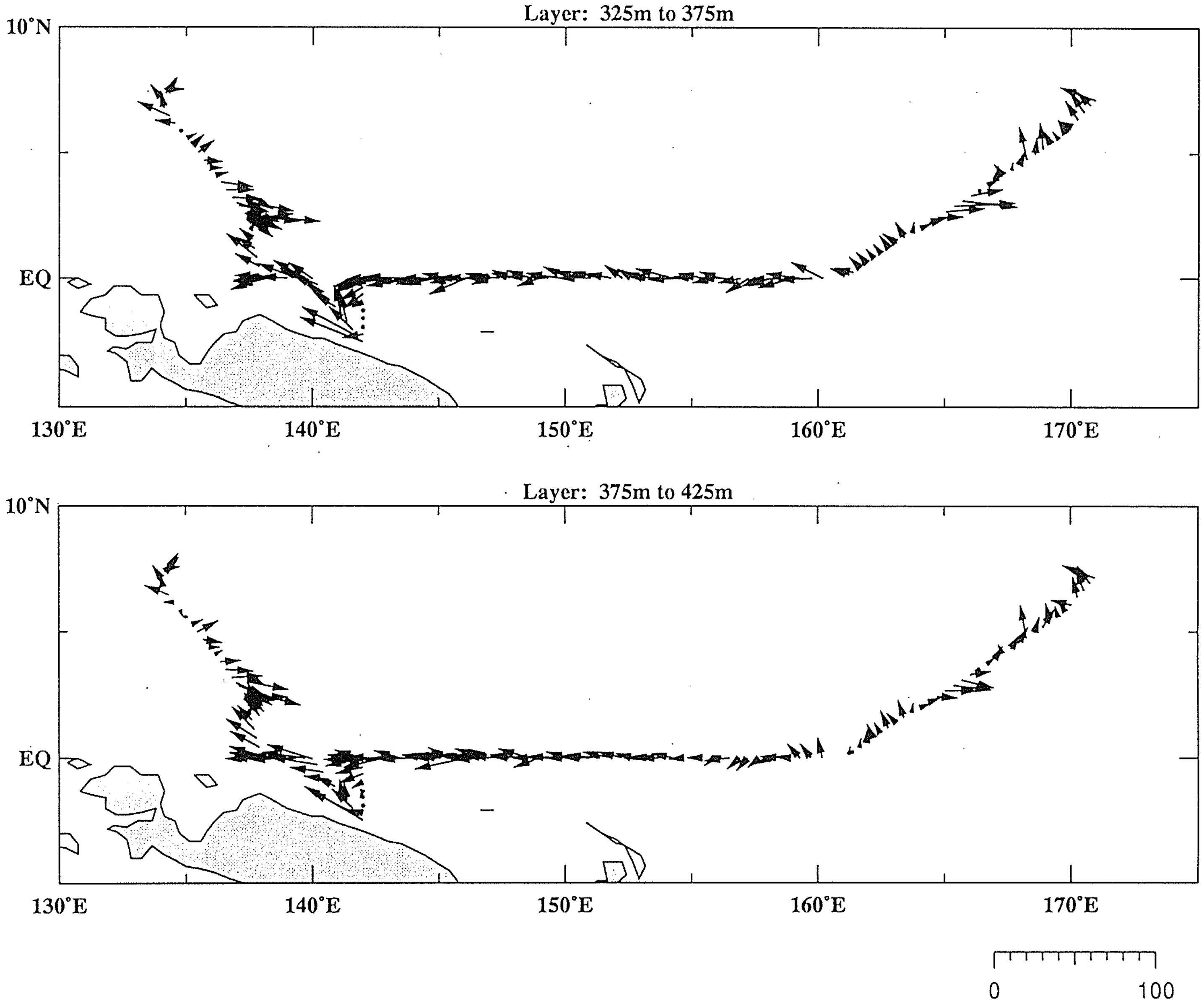
Jan 25 to Feb 9, 1999





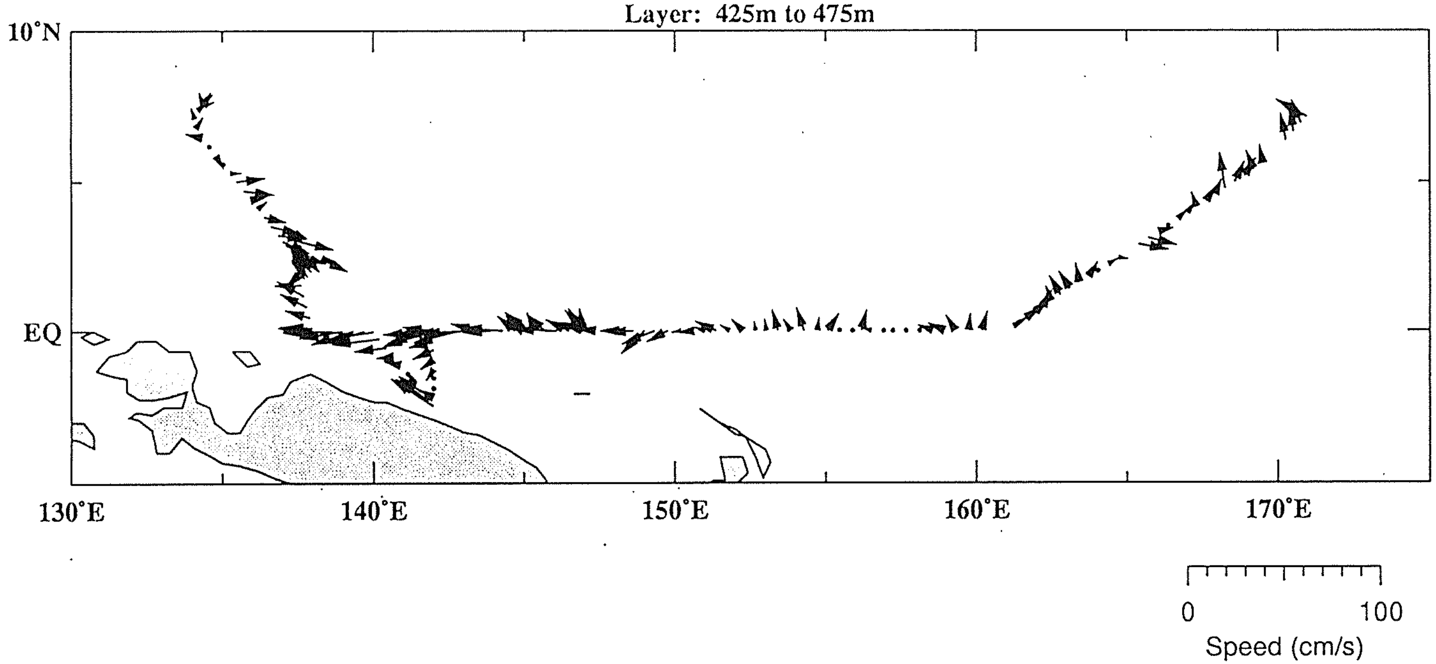
Kaiyo 9901

Jan 25 to Feb 9, 1999



Kaiyo 9901

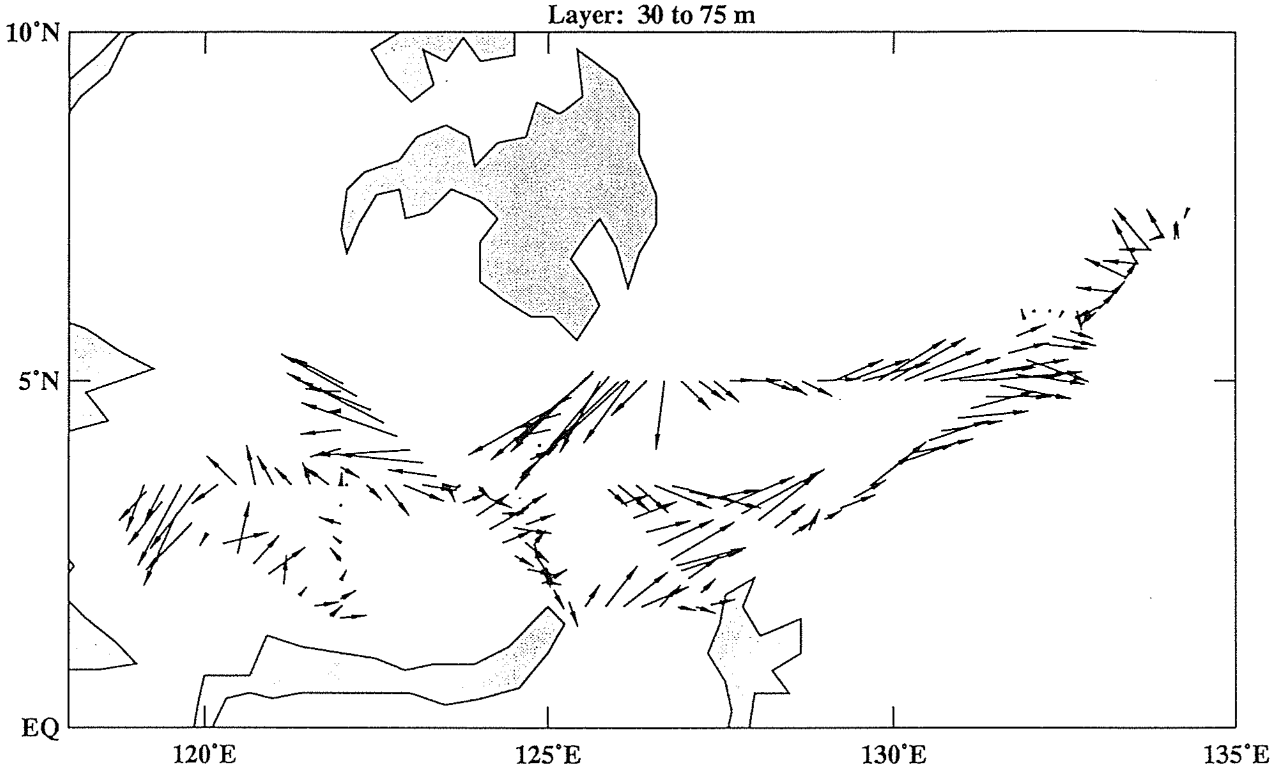
Jan 25 to Feb 9, 1999



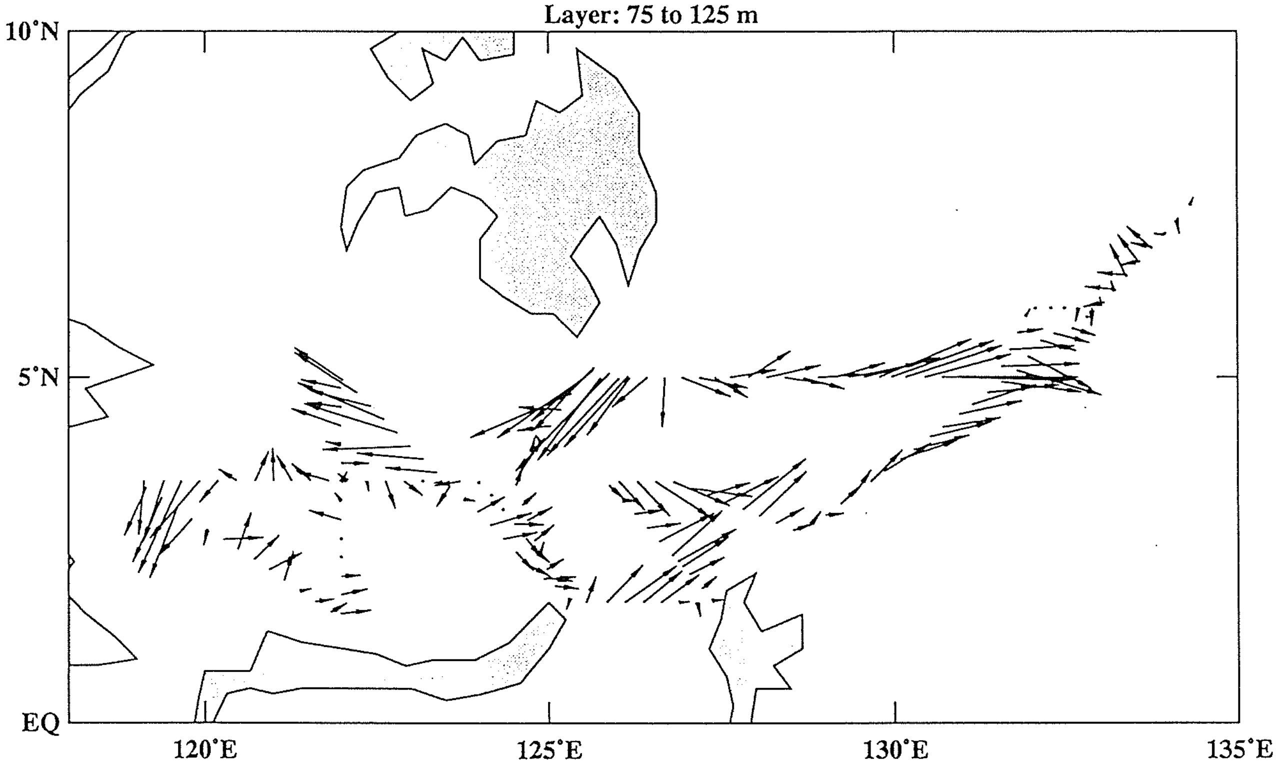
Kaiyo 9901 Leg 2

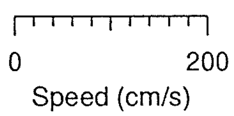
Feb 13 to March 1, 1999

Layer: 30 to 75 m



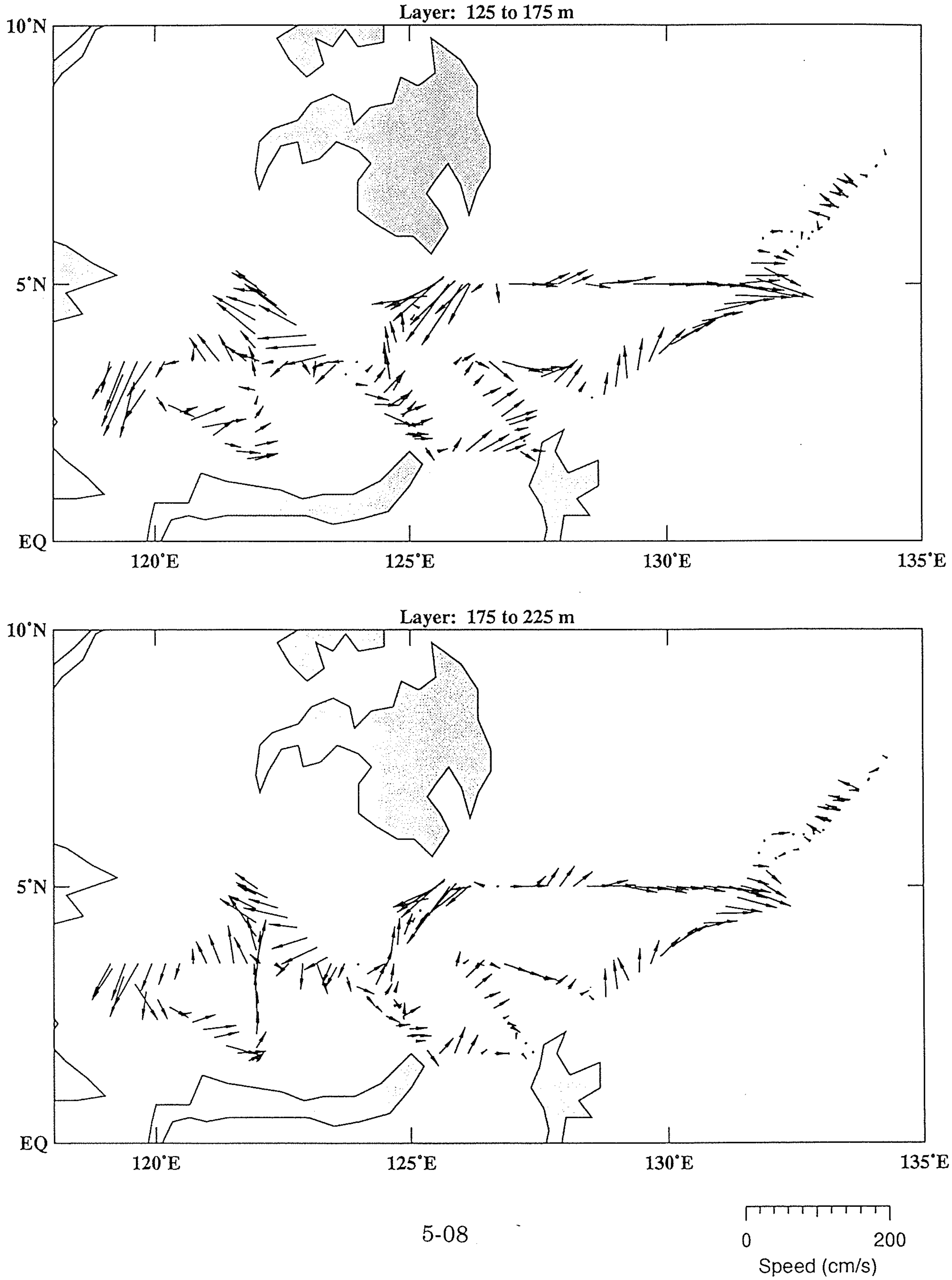
Layer: 75 to 125 m





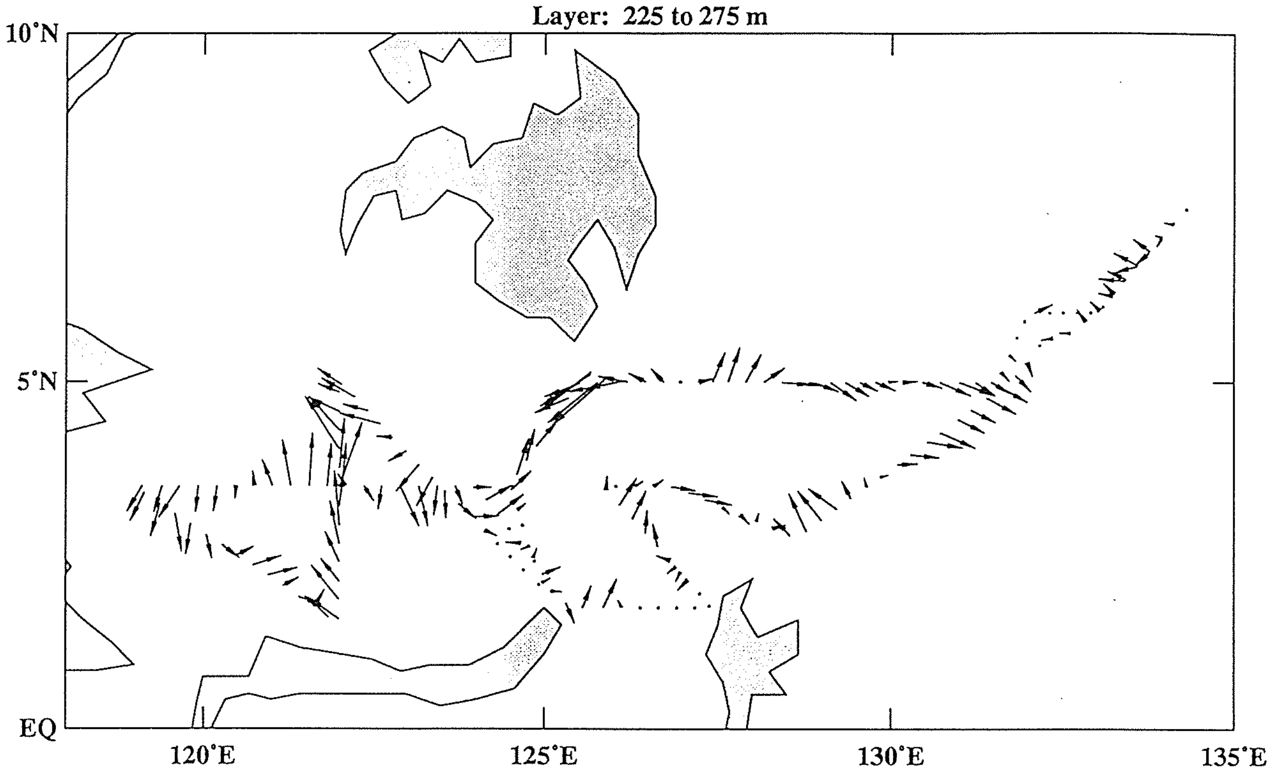
Kaiyo 9901 Leg 2

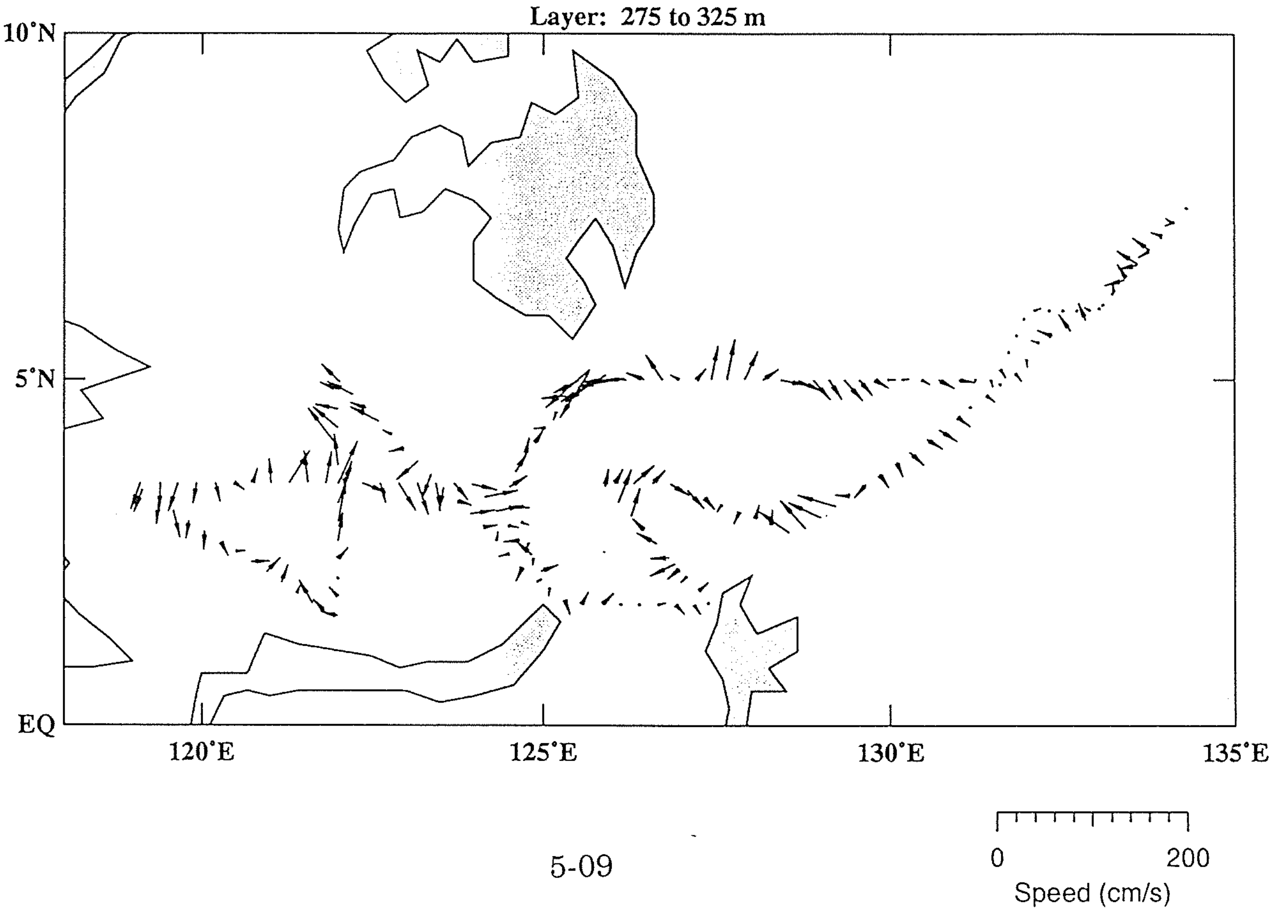
Feb 13 to March 1, 1999



Kaiyo 9901 Leg 2

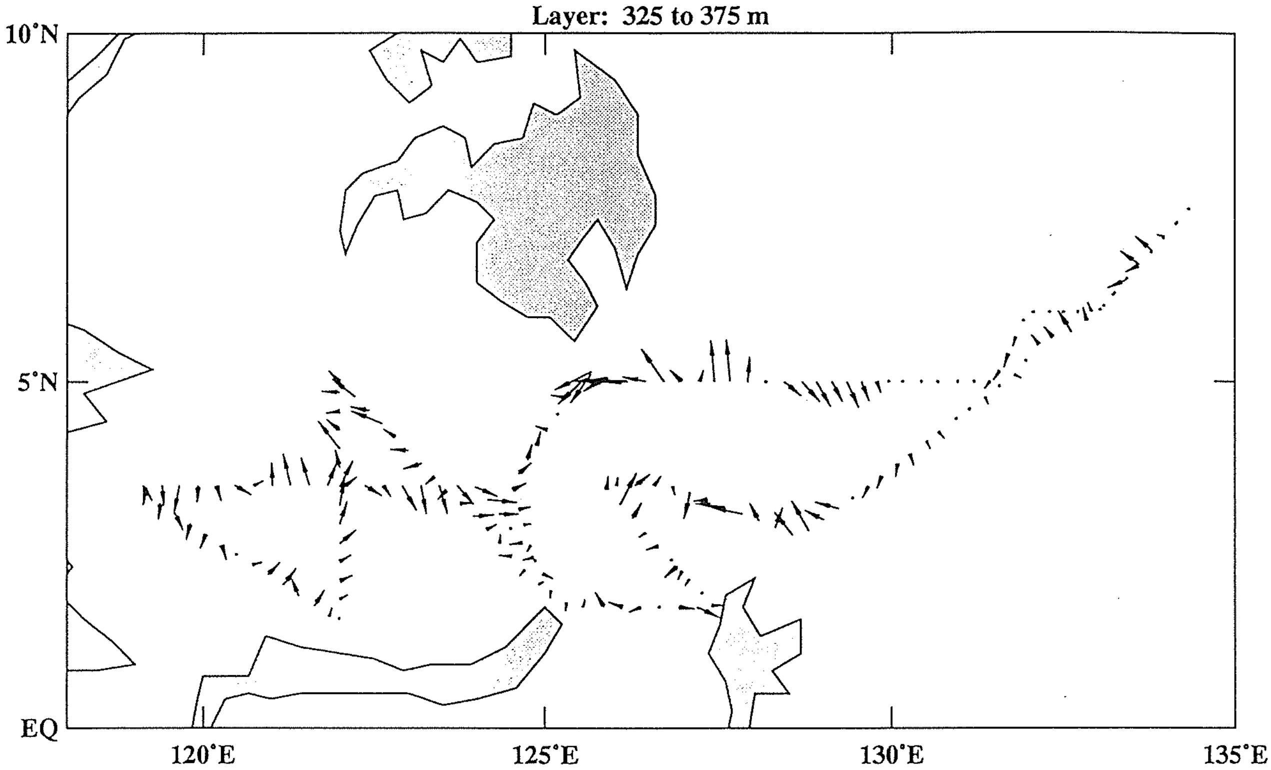
Feb 13 to March 1, 1999

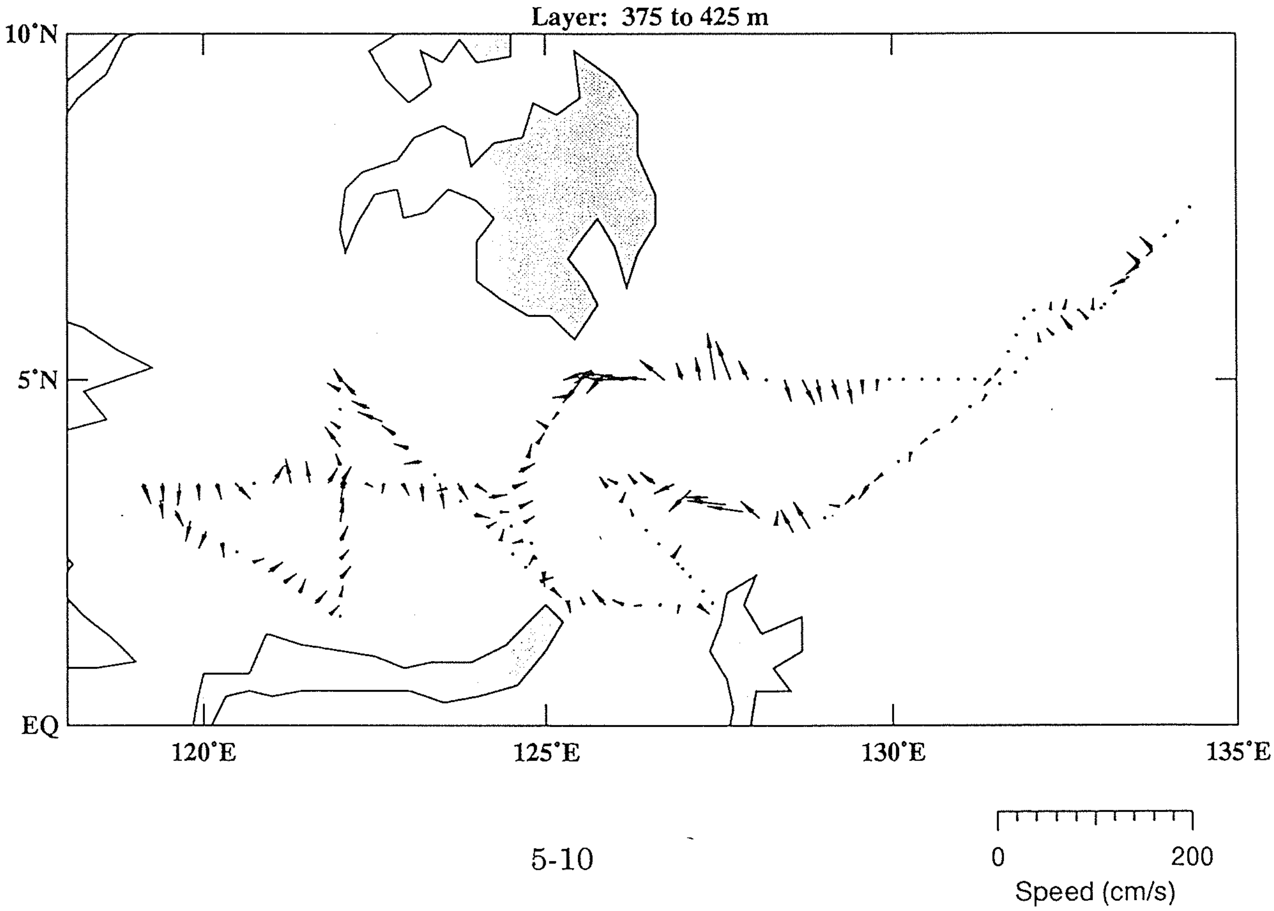




Kaiyo 9901 Leg 2

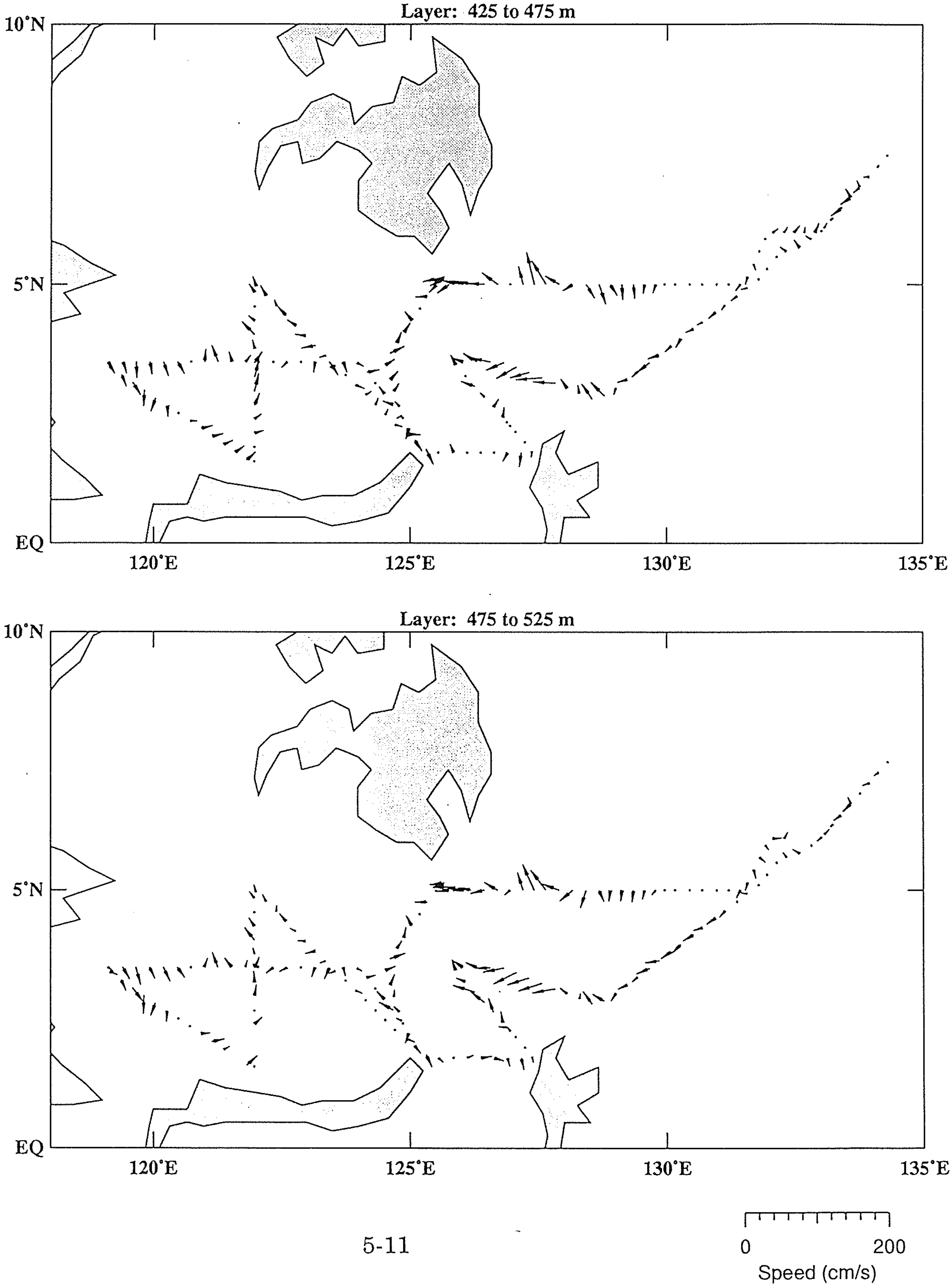
Feb 13 to March 1, 1999





Kaiyo 9901 Leg 2

Feb 13 to March 1, 1999



6. JAMSTEC MOORING

ADCP Mooring

To get the knowledge of physical process in the western equatorial pacific. In this cruise (K99-01), we recovered two subsurface ADCP moorings at(0-142E),(00-138),and deployed one ADCP mooring at (00-138)

Instrument:

1) ADCP

Distance to first bin : 8m

Pings per ensemble : 16

Time per ping : 2.00s

Bin length : 8.00m

Sampling Interval : 3600s

Recoreved ADCP

- Serial Number : 1221 (Mooring No.980125-00N142E)
- Serial Number : 1154 (Mooring No.980907-00138E)

Deployed ADCP

- Serial Number : 1282 (Mooring No.990204-00138E)

2) CTD

SBE-16

Sampling Interval : 1800s

Recoreved CTD

- Serial Number : 1281 (Mooring No.980125-00N142E)
- Serial Number : 1275 (Mooring No.980907-00138E)

Deployed CTD

- Serial Number : 1282 (Mooring No.990204-00138E)

Deployment :

One ADCP mooring were deployed at (00-138E) . The moorings were planed to make the ADCP buoy placed at about 270m.

After we dropped the anchor, we monitored depth of the acoustic releaser (Fig.6-2). The descending rate was about 2. 4 m/sec.

The position of the mooring were showed below.

Results of calibration

- Mooring No.980907-00138E

Lat: 0° 01.088N Long: 138° 01.680E

Recovery

We recovered two ADCP moorings which were deployed on Jan.1998 (K98-01)and on Sep.1998(K98-10).

We monitored depth of the acoustic releaser after we released the anchor(Fig.6-1,6-2).

After the recovery, we uploaded ADCP and CTD data into a computer,then raw d ata were converted into ASCII code. Results were shown in the figures on following pages. Fig.6-4,6-5 shows CTD depth, temperatureand salinity data . Fig.6-6 ~ 6-13 shows the velocity data (eastward and northward component) at 50m(25bins for 0-142E, 27bins for 00-138E), 100m(19bins for 0-142E, 21bins for 00-138E) , 150m(27b ins for 0-142E, 25bins for 00-138E) and 200m(6bins for 0-142E, 9ins for 0-138E)de pth.

Current Meter Mooring

To get mesurements of the variability of the Mindanao curent, we deployed one current meter mooring (with five AANDERAA-current meters and one CTD)at 05N-125E. The mooring was planed to make the AANDERAA-current meters placed at 160m,300m,500m,700m and 1000m.

Insturuments:

1)AANDERAA-curent meter

Sereal Number : 10331 (placed at 160m) --- Wide range
Sereal Number : 10338 (placed at 300m)
Sereal Number : 9760 (placed at 500m)
Sereal Number : 10337 (placed at 700m)
Sereal Number : 11670 (placed at 1000m)

These were turned on at 04:00 17,Feb.99(GMT)

2) CTD

SBE-16

Sampling Interval : 1800s

- Serial Number : 1281 (placed at 1000m)

After we dropped the anchor,we calibrated the position of the mooring by the acoust ic releasers.The position of the moorig were showed below.

Results of calibration

- Mooring No.990217-05N125E

  Lat: 05° 07.328N Long: 125° 40.200E

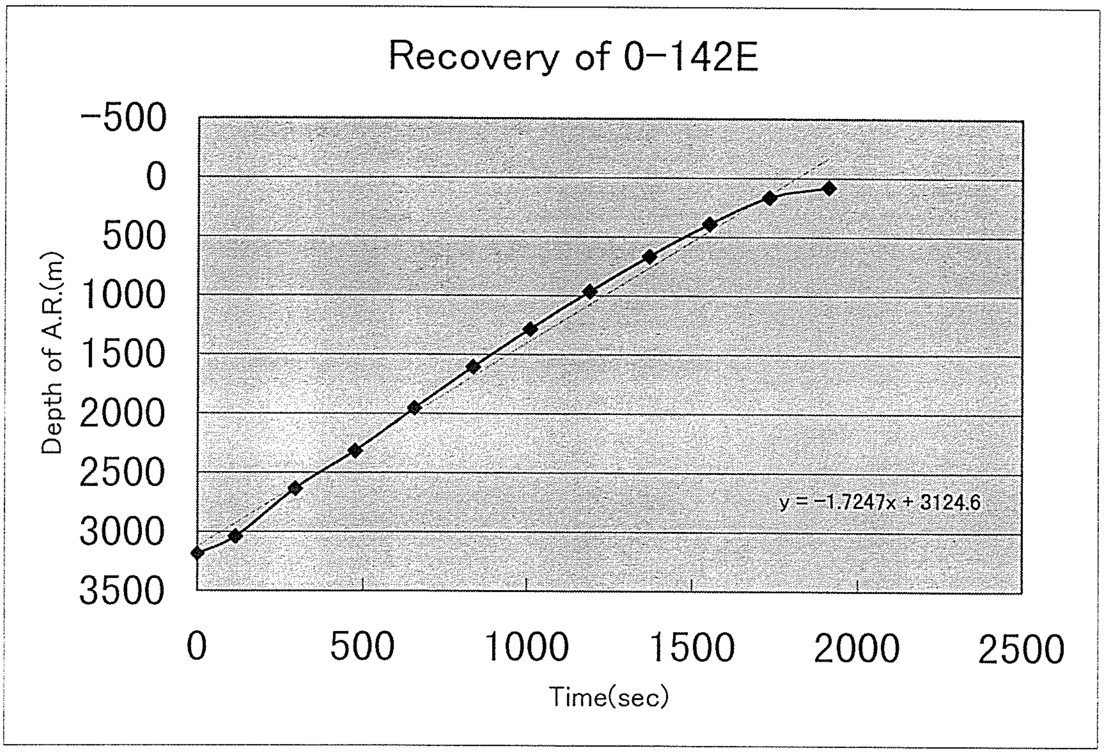
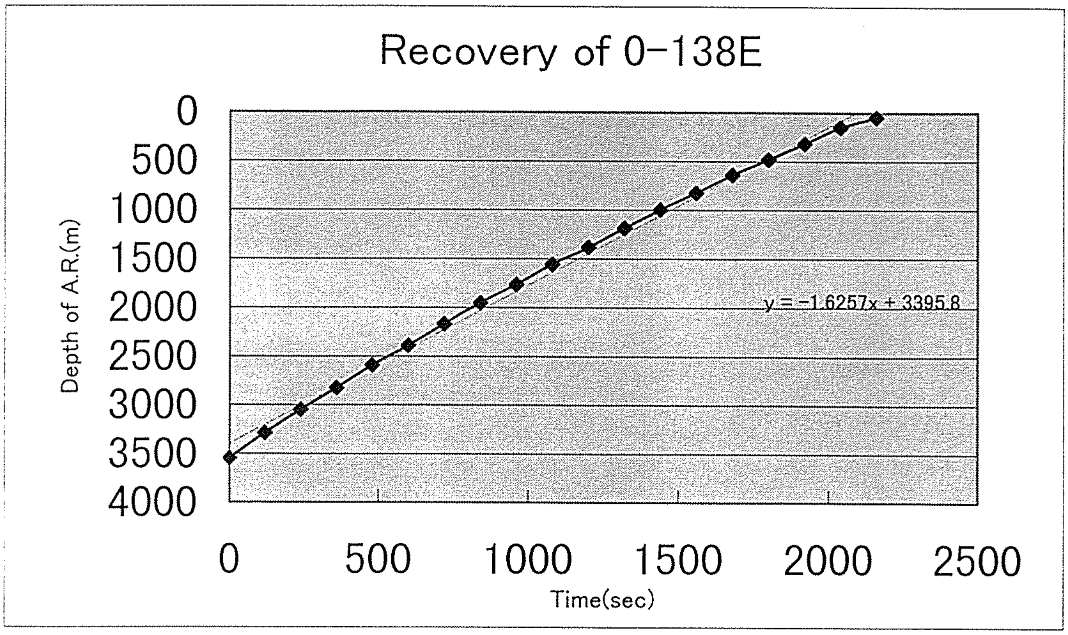


Fig.6-1 Releaser Depth Monitor



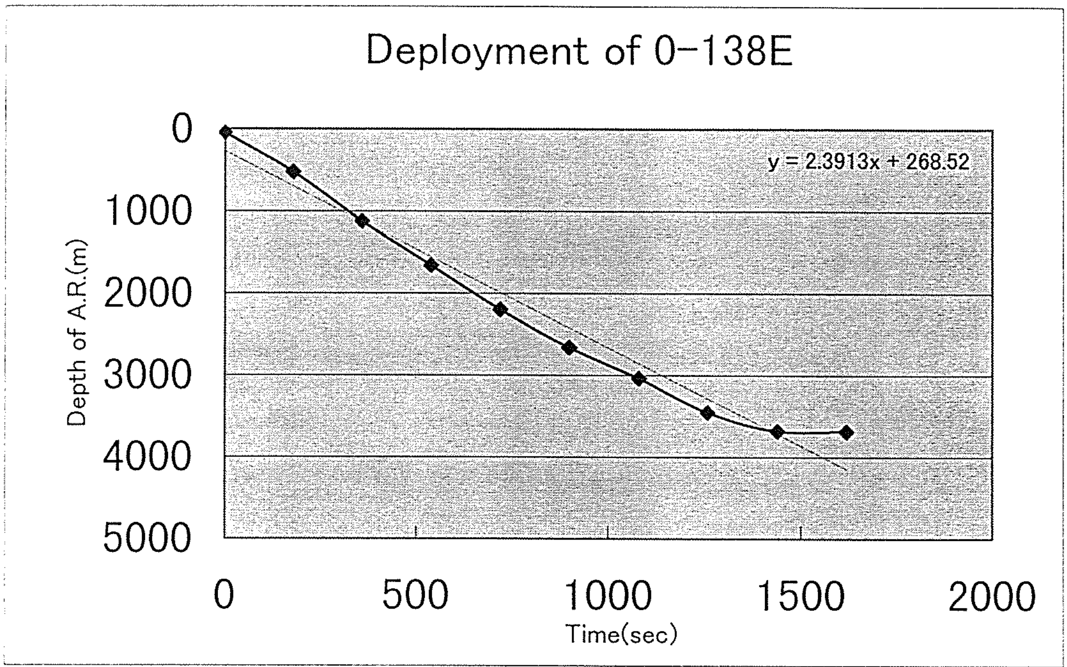


Fig.6-2 Releaser Depth Monitor

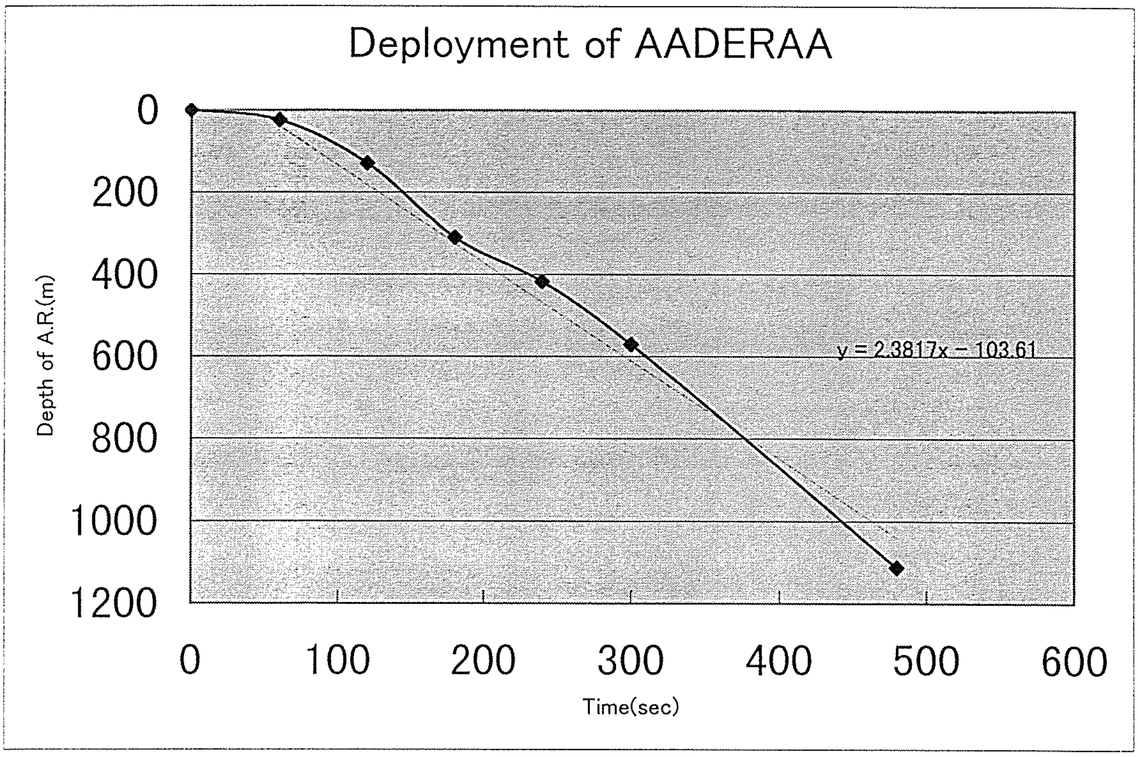
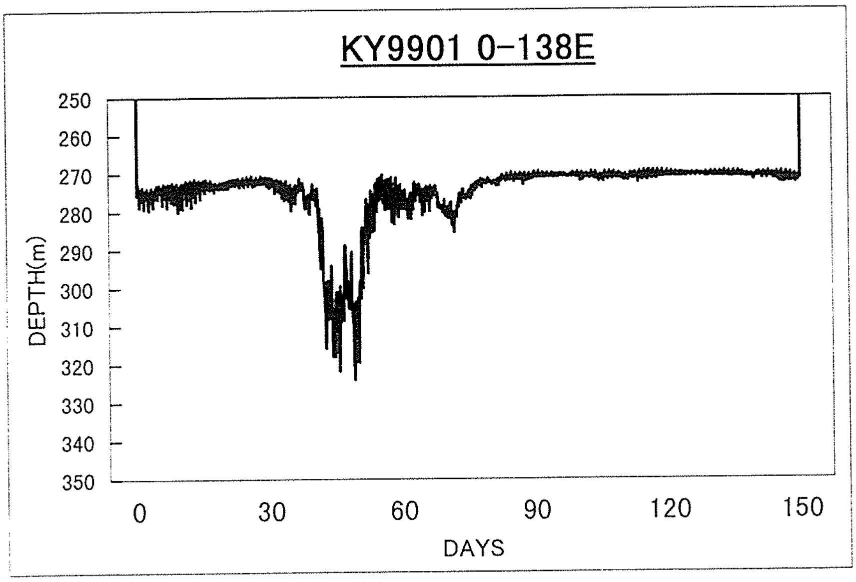
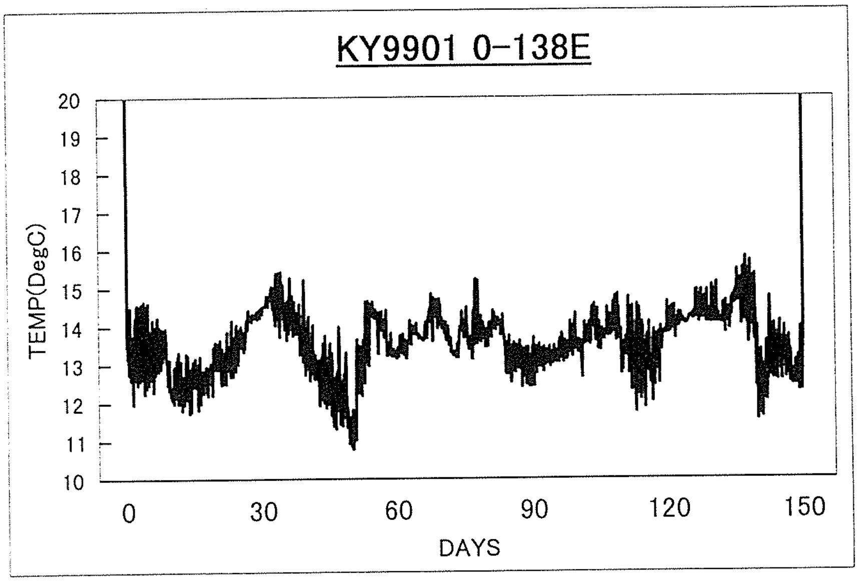


Fig.6-3 Releaser Depth Monitor





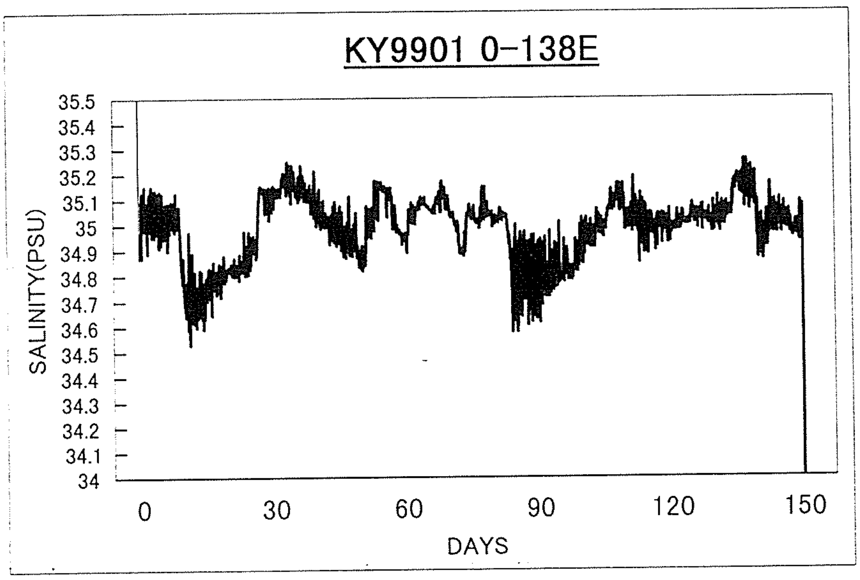
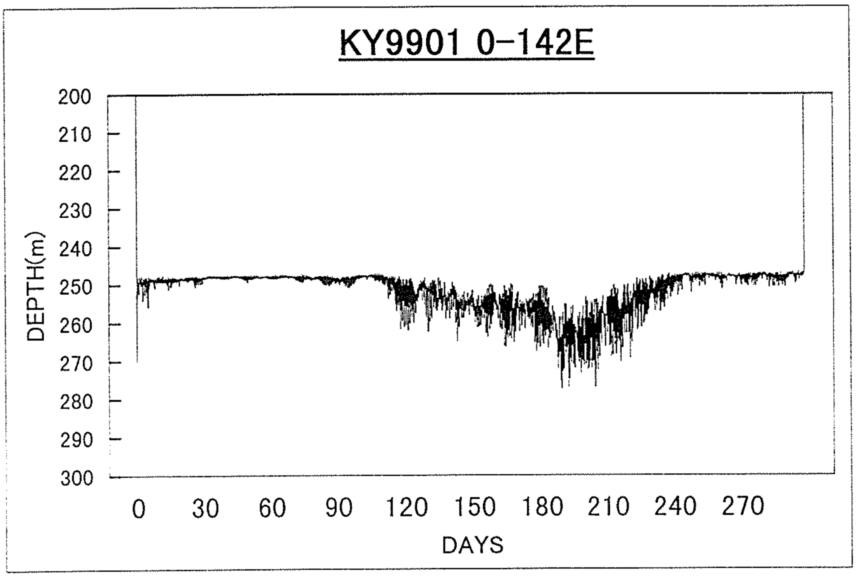
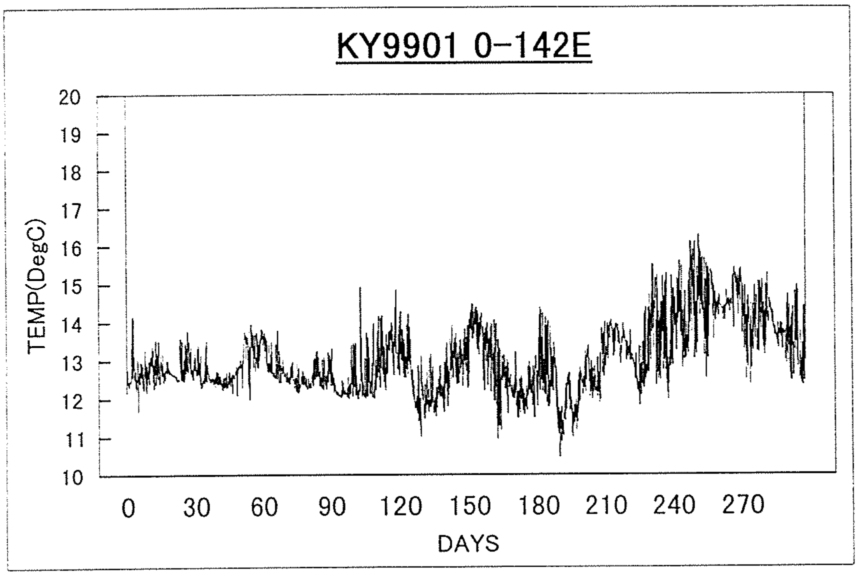


Fig.6-4 Time series of Temperature,Salinity,Depth





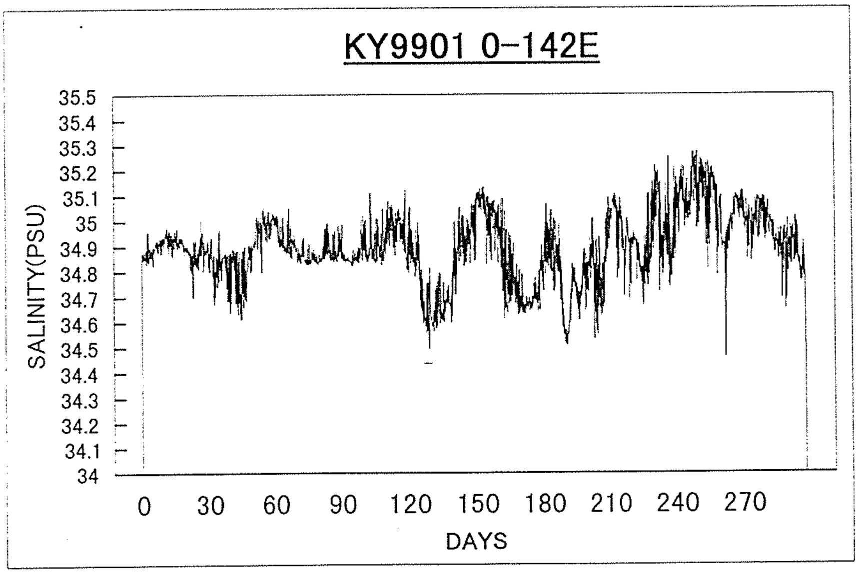
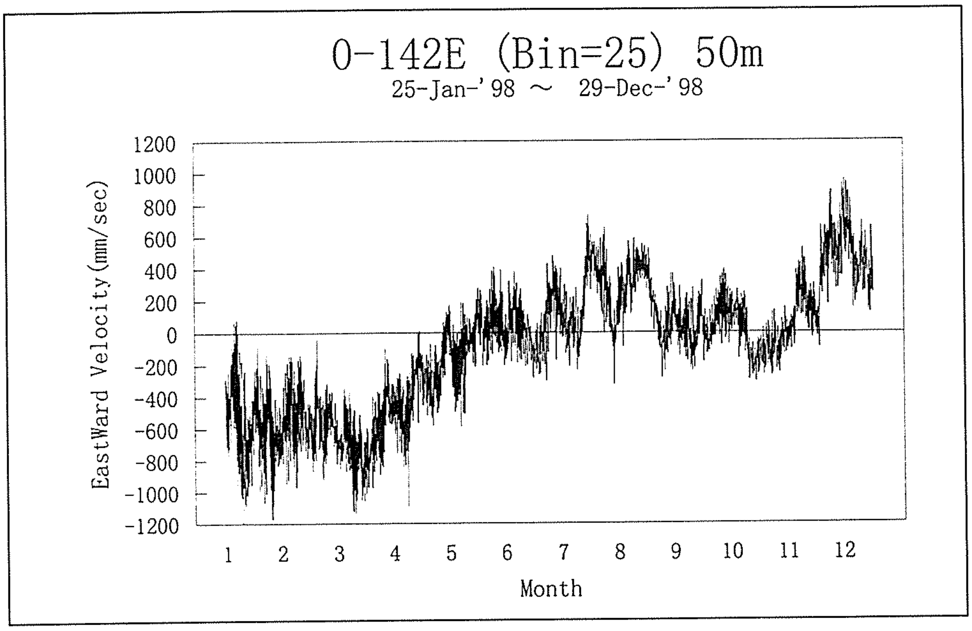


Fig.6-5 Time series of Temperature,Salinity,Depth



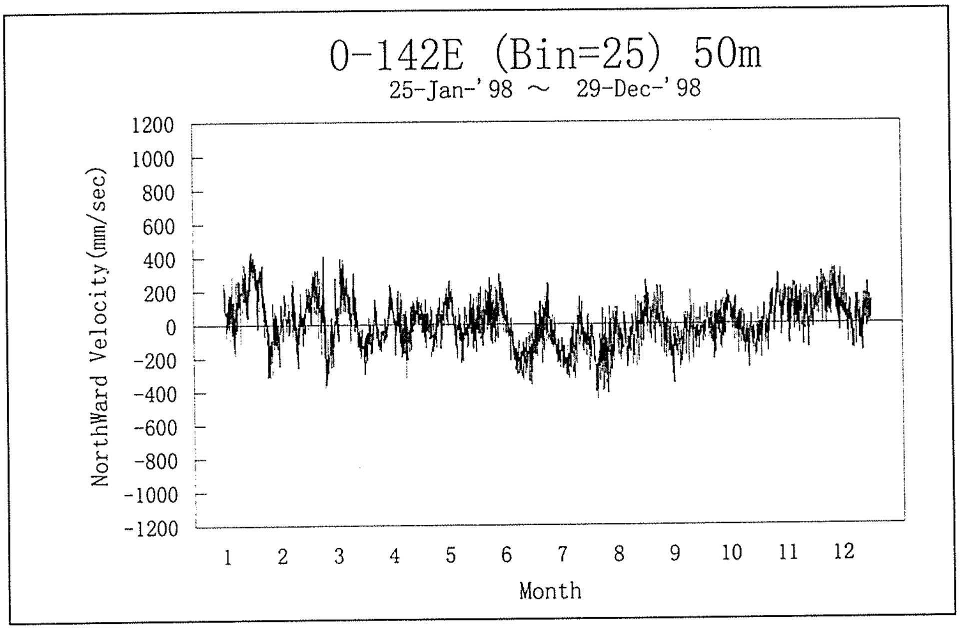
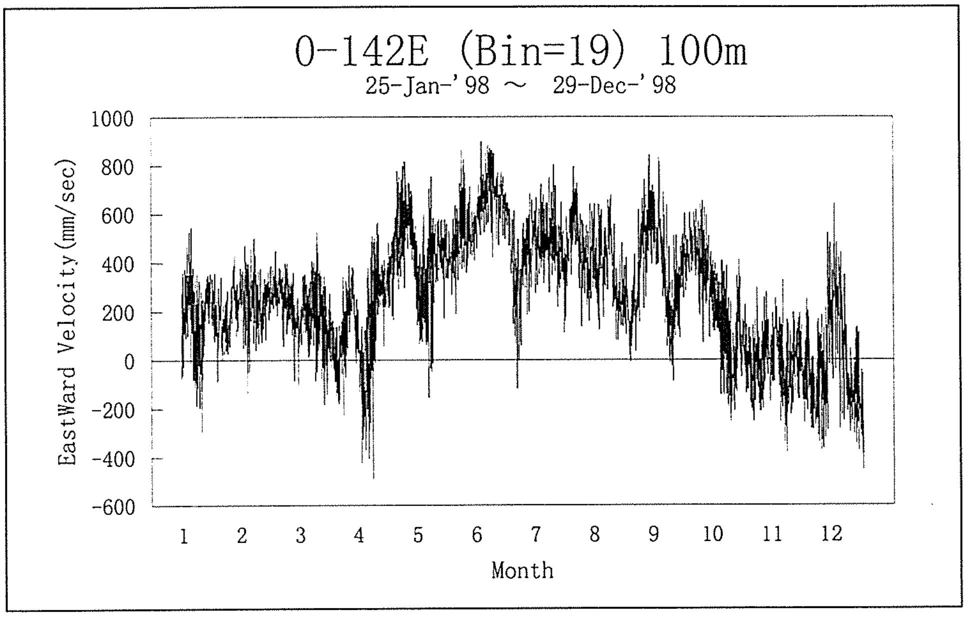


Fig.6-6 Time series of Velocity



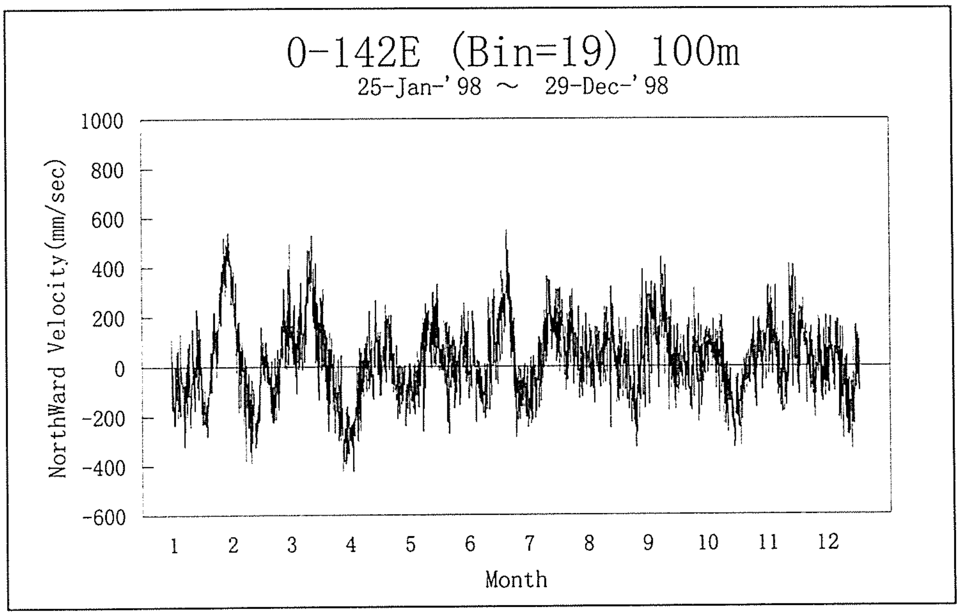
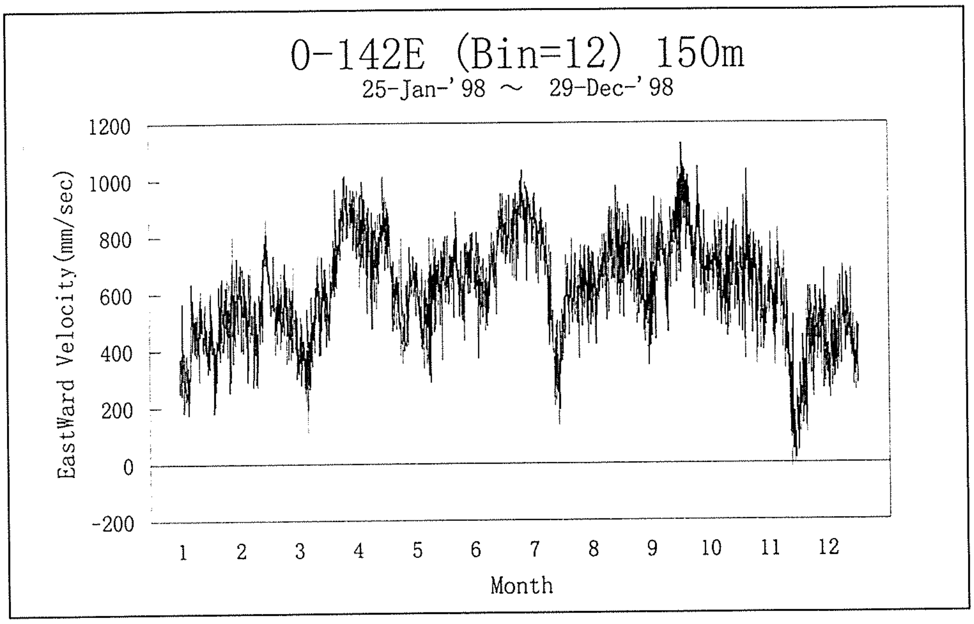


Fig.6-7 Time series of Velocity



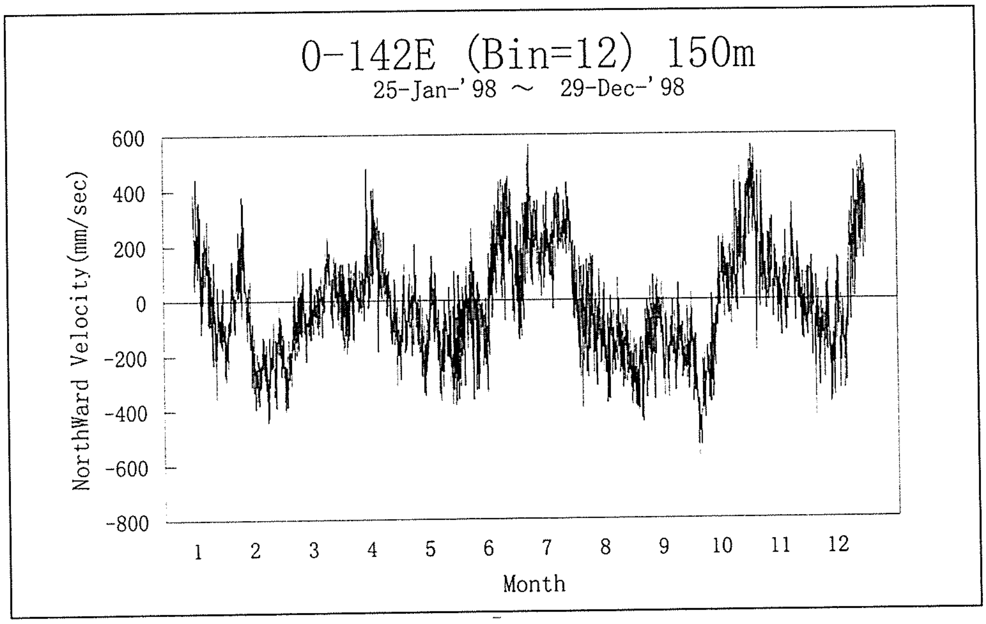
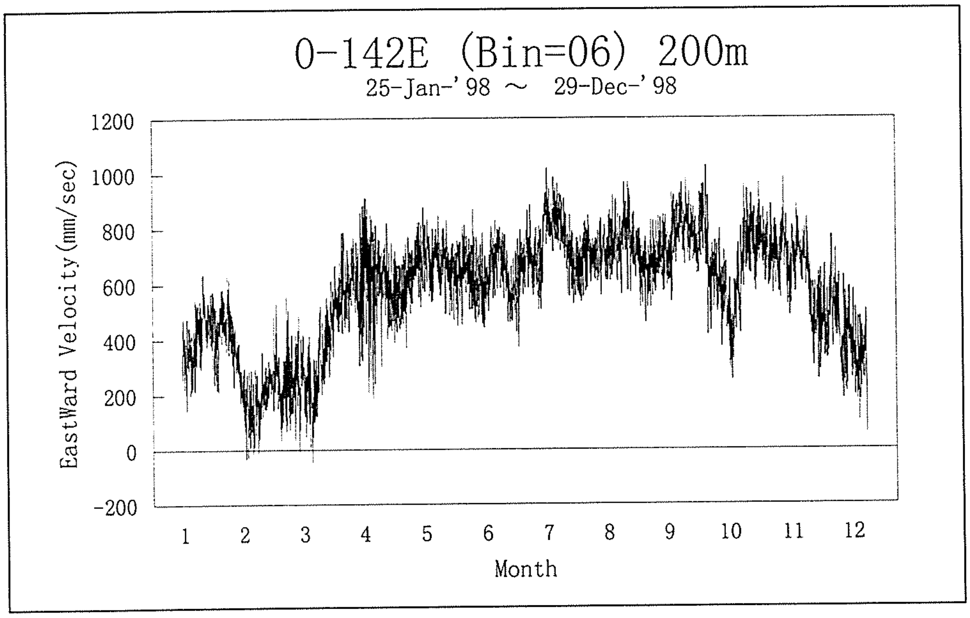


Fig.6-8 Time series of Velocity



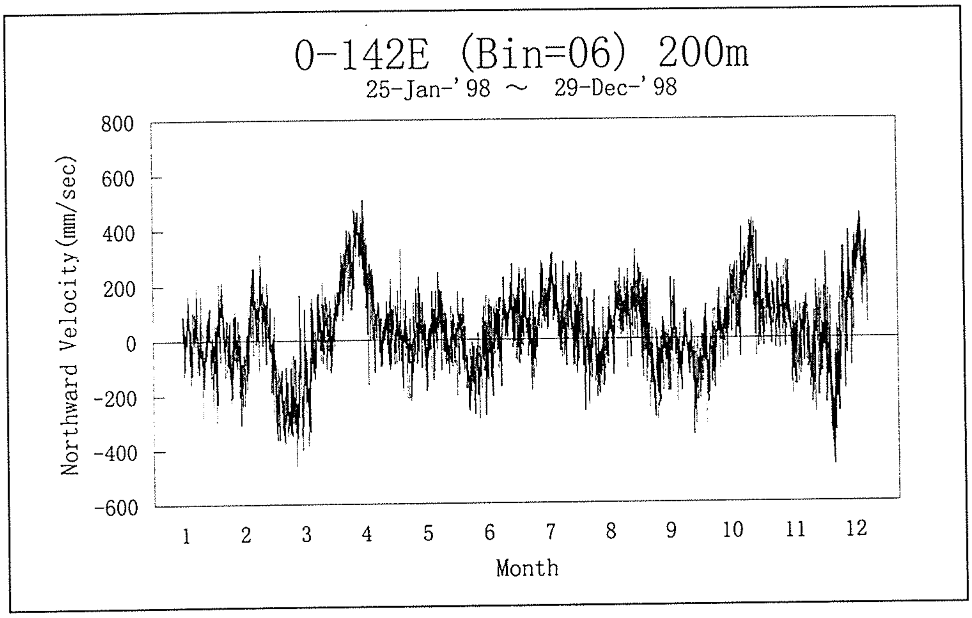
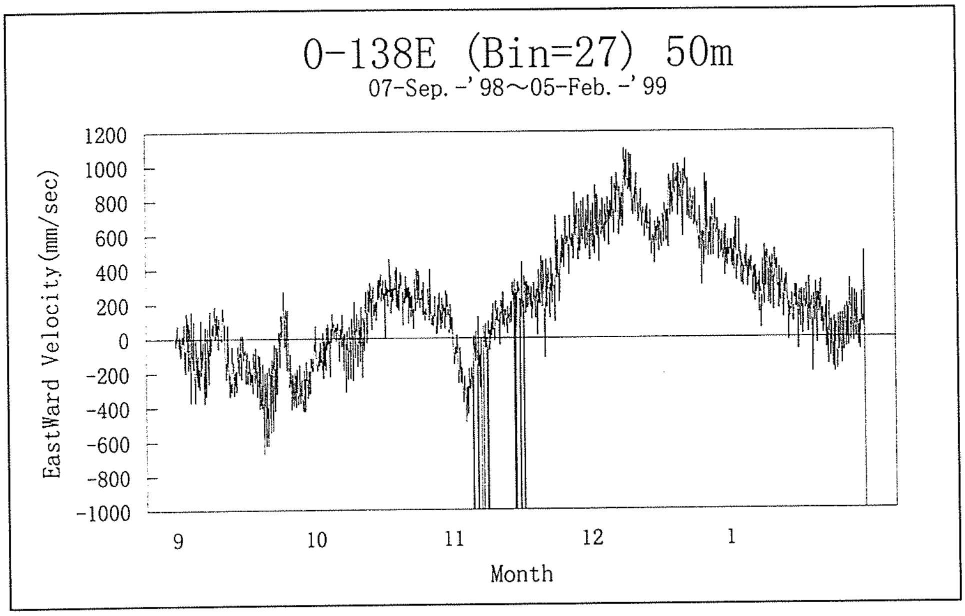


Fig.6-9 Time series of Velocity



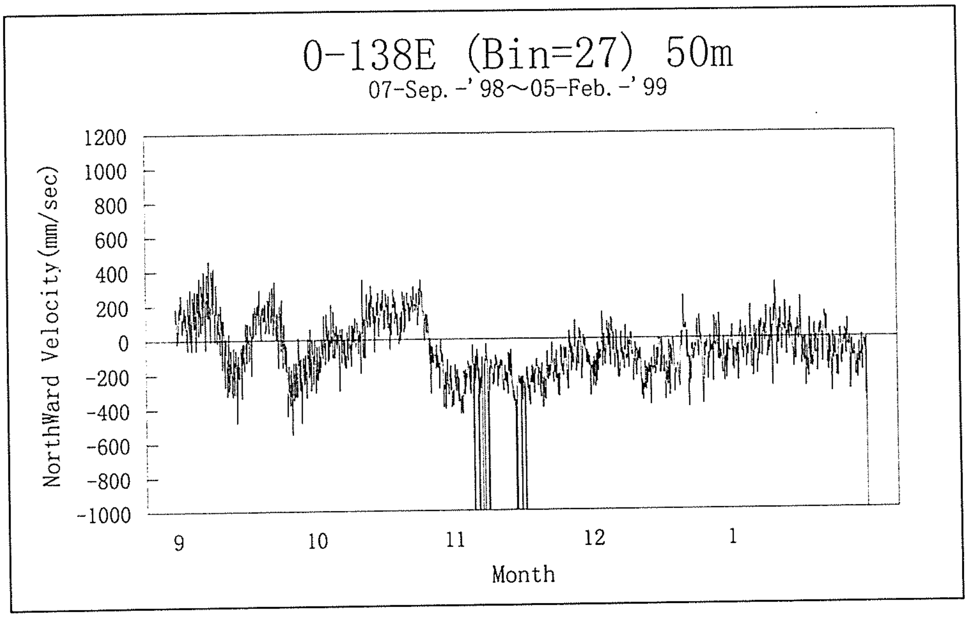
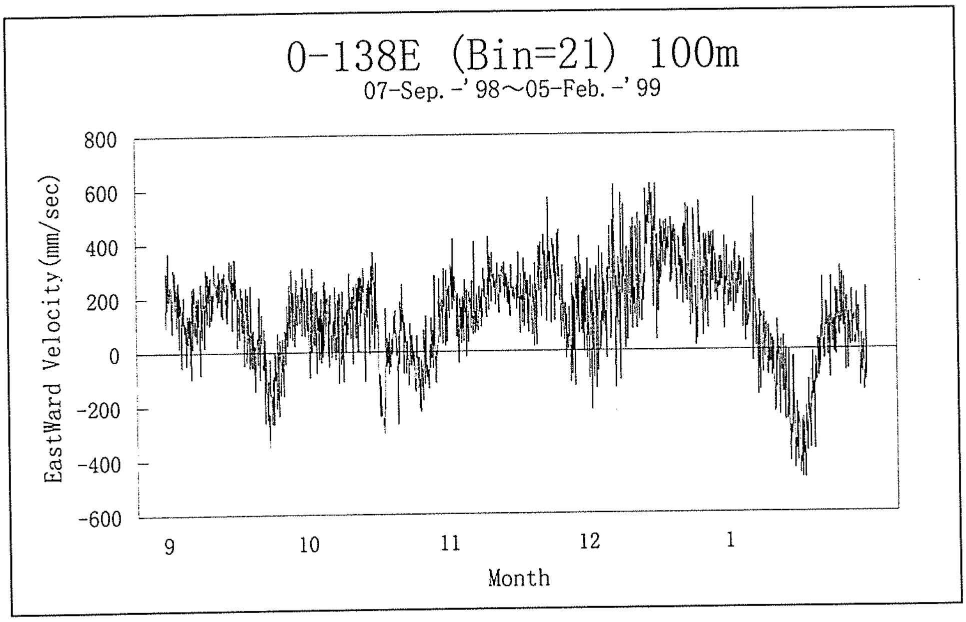


Fig.6-10 Time series of Velocity



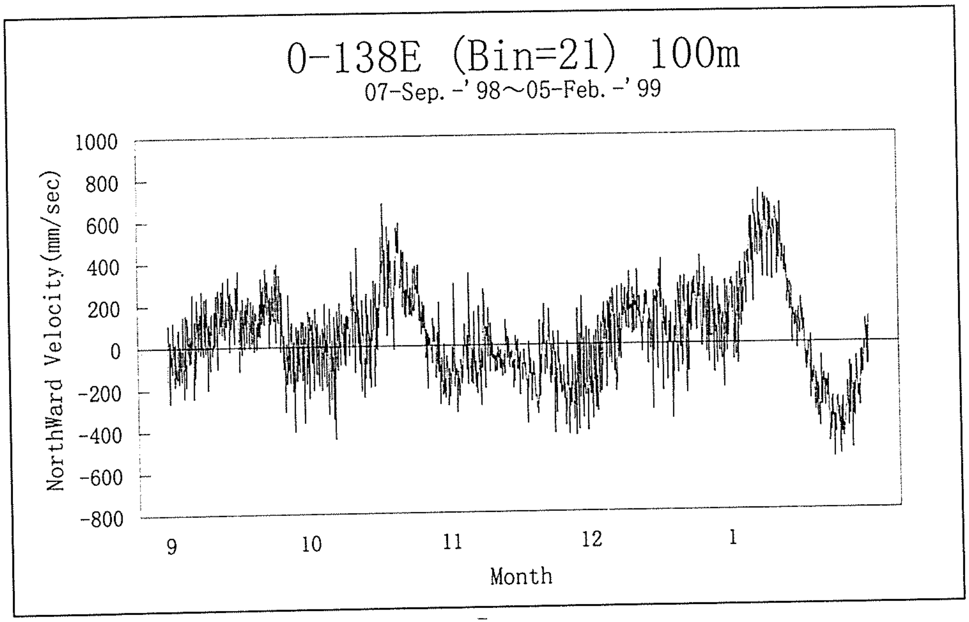
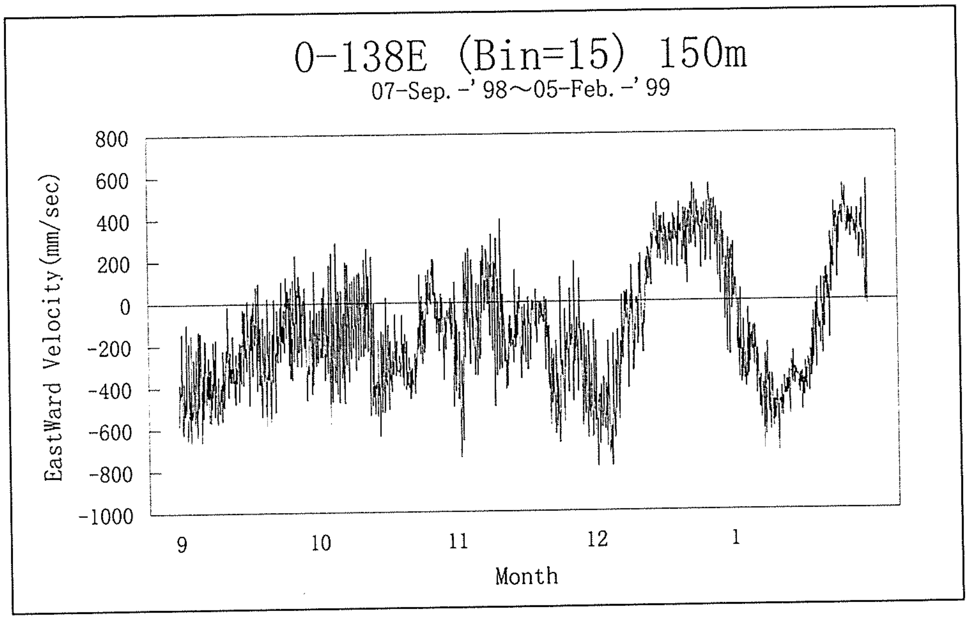


Fig.6-11 Time series of Velocity



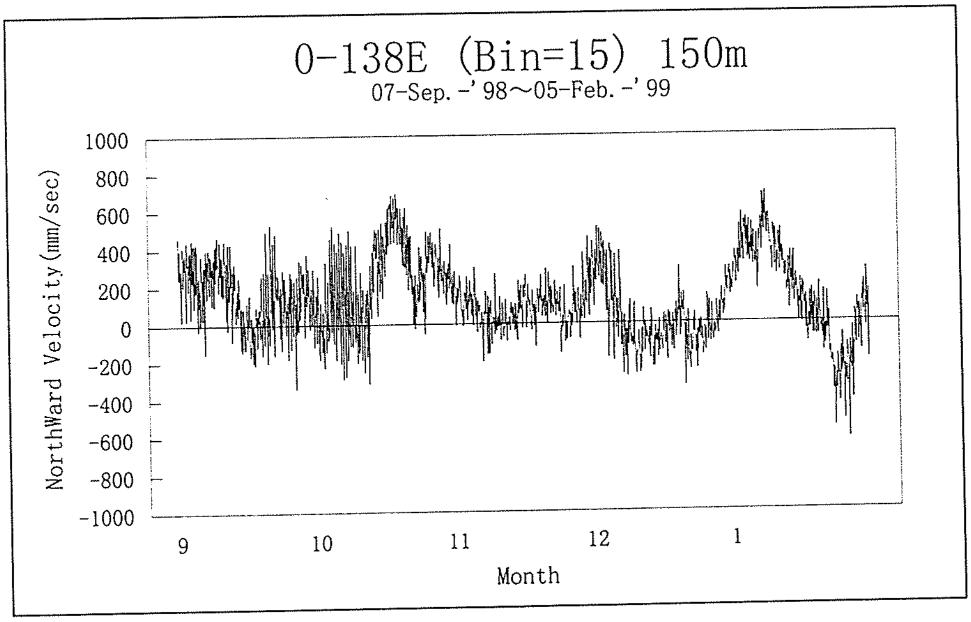
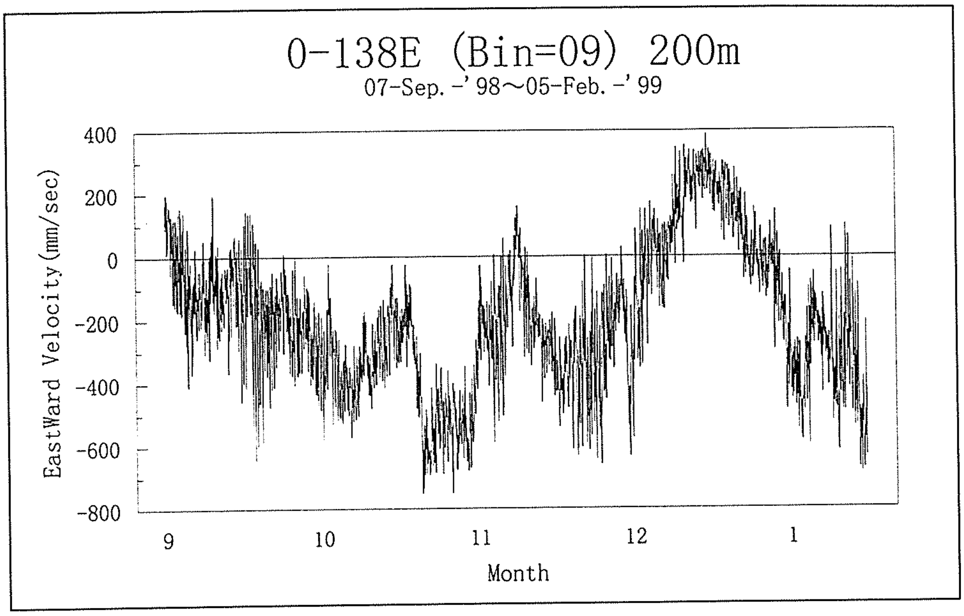


Fig.6-12 Time series of Velocity



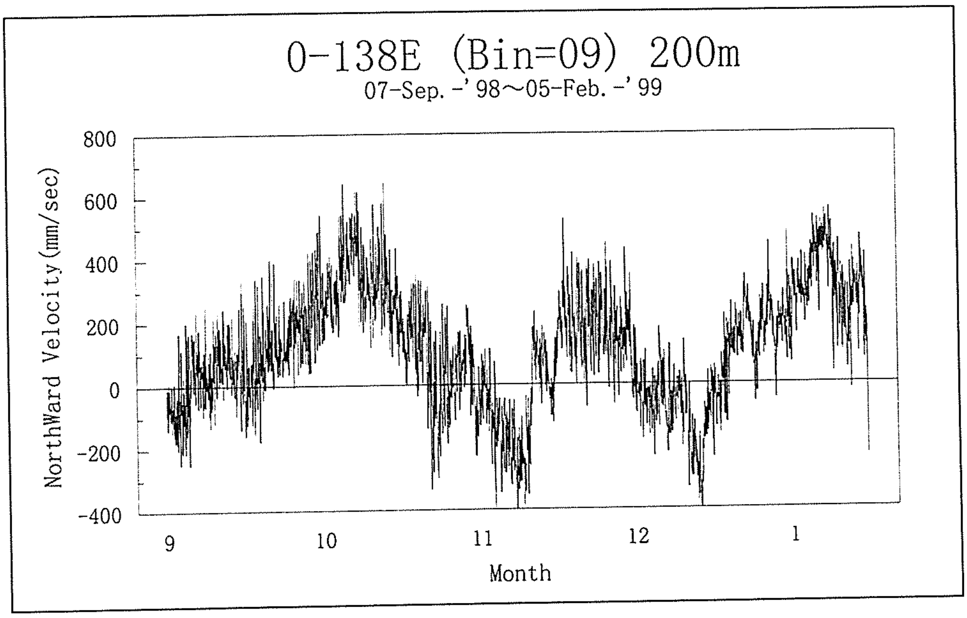


Fig.6-13 Time series of Velocity

DEPLOYMENT & RECOVERY

MOORING No. 980125-00N142E

PROJECT	TOCS	TIME	UTC
AREA	熱帯赤道	RECORDER (D)	Kaneko
POSITION	0°-142°E	(R)	ITO
DEPTH	3384m		
PERIOD	1998.1.25 ~	NAVIGATION SYSTEM :	WGS84
No.of DAYS	374		

LENGTH : 3076 m DEPTH of BUOY : 282.4m BUOYANCY : -937.5 kg

ACOUSTIC RELEASER

TYPE	BENTHOS (Upper)	TYPE	BENTHOS (bottom)
S/N	719	S/N	631
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	14.0 kHz	TRANSMIT F.	13.5 kHz
ENABLE C.	E	ENABLE C.	C
RELEASE C.	D	RELEASE C.	B
BATTERY	2years	BATTERY	2years
TEST on DECK	OK	TEST on DECK	OK

DEPLOYMENT

DATE Jan. 25 '98 SHIP KAIYO CRUSE No. KY98-01

WEATHER bc CONDITIONS Smooth DIR. of WIND 050° VEL. of WIND 7.9 m/s

DEPTH 3388 m DEPTH of A.R. 3140 m DESCEND. RATE 2.4 m/s BUOY 22:22

POS. of STRT 0°00.087N, 141°56.273E HOR.RANGE m

POS. of DEP. 0°00.210N, 141°58.236E SINKER 23 : 32 DISAPPEAR. :

POS. of MOORING 0°00.227N, ~~[illegible]~~ 141°58.240E LANDING 23:53

NOTE

SSBL	TIME	S / R	DEPTH
S	23:34	[illegible]	109.2
S	23:36		515.0
B	23:39		1055.2
L	23:43		1740.8
	23:46		2198.7
	23:53		3142.4

RECOVERY

DATE Feb. 2. 1999 SHIP KAIYO CRUSE No. KY99-01

WEATHER bc CONDITIONS slight DIR. of WIND 300° VEL. of WIND 5.0 m/s

START of RELEASE 20:55 FINISH of RELEASE 20:57

POS. of DISCOVERY 00°00.440N 141°58.059E ASCENDING RATE m/s

DIRECTION DISTANCE 400 m

NOTE

S/L 3171m

20:57 コマンド送信

ブイ浮上 20:59

SSBL	TIME	S / R	DEPTH
S			
S			
B			
L			

TIME RECORD

MOORING NO. 980125-00N142E

		DEPLOYMENT		RECOVERY (Date:99/2/2)	
		START : 22:20 FINISH : 23:32		START : 21:52 FINISH : 23:10	
ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ADCP & CTD	ADCP CTD	22:22	F-08	21:57	
WIRE	50m	22:20 ~ 22:22		22:03 ~ 22:04	
ABS BUOY	2コ	22:25		22:06	
〃	2コ	22:25		22:06	
〃	2コ	22:25		22:06	
WIRE	200m	22:25 ~ 22:29		22:09 ~ 22:13	
KEVLER ①	K10-11 988m	22:35 ~ 22:51		22:15 ~ 22:32	
〃 ②	K10-10½ 704m	22:52 ~ 22:59		22:33 ~ 22:46	
〃 ③	K5-05 472m	23:00 ~ 23:08		22:47 ~ 22:56	
〃 ④	K10-10½ 250m	23:09 ~ 23:13		22:57 ~ 23:02	
〃 ⑤	K1-03 101m	23:14 ~ 23:16	結索に 緩みなし	23:03 ~ 23:05	
〃 ⑥	K1-04 101m	23:17 ~ 23:19	〃	23:05 ~ 23:07	
GLASS BALL	12コ	23:23		23:08	
A.R.	719	23:24		23:09	
A.R.	631	23:25		23:09	
NYLON	175m	23:25 ~ 23:28			
ANCHOR	1.8 Ton	23:32			

作業テイ 降下 21:20
テイにロープ取付 21:43
作業テイ揚収 21:50
テイデッキ 22:01

DEPLOYMENT & RECOVERY

MOORING No. 990204-00138E

PROJECT	TOCS	TIME	UTC
AREA	Western Pacific	RECORDER (D)	A. ITO
POSITION	0° 138°E	(R)	
DEPTH	3909 m		
PERIOD		NAVIGATION SYSTEM :	WGS 84
No.of DAYS			
LENGTH : m	DEPTH of BUOY : m	BUOYANCY : kg	

ACOUSTIC RELEASER

TYPE	BENTHOS (Upper)	TYPE	BENTHOS (Lower)
S/N	689	S/N	665
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	13.5 kHz	TRANSMIT F.	14.0 kHz
ENABLE C.	B	ENABLE C.	F
RELEASE C.	A	RELEASE C.	D
BATTERY	2 years	BATTERY	2 years
TEST on DECK	OK	TEST on DECK	OK

DEPLOYMENT

DATE	4 Feb. 99			SHIP	KAIYO	CRUISE No.	KY9901
WEATHER	bc	CONDITIONS	Smoth	DIR. of WIND	280	VEL. of WIND	5.8m/s
DEPTH	3903 m	DEPTH of A.R.	m	DESCEND. RATE	m/s	BUOY	:
POS. of STRT	00°01.860S 138°03.432E			HOR.RANGE	m		
POS. of DEP.	00°01.122S 138°01.728E			SINKER	1:22	DISAPPEAR.	:
POS. of MOORING	00 01.088S 138 01.680E					LANDING	1:46

NOTE

SSBL	TIME	S / R	DEPTH

RECOVERY

DATE		SHIP	CRUISE No.
WEATHER	CONDITIONS	DIR. of WIND	VEL. of WIND
START of RELEASE :		FINISH of RELEASE :	
POS. of DISCOVERY ° °		ASCENDING RATE m/s	
DIRECTION °		DISTANCE m	

NOTE

SSBL	TIME	S / R	DEPTH

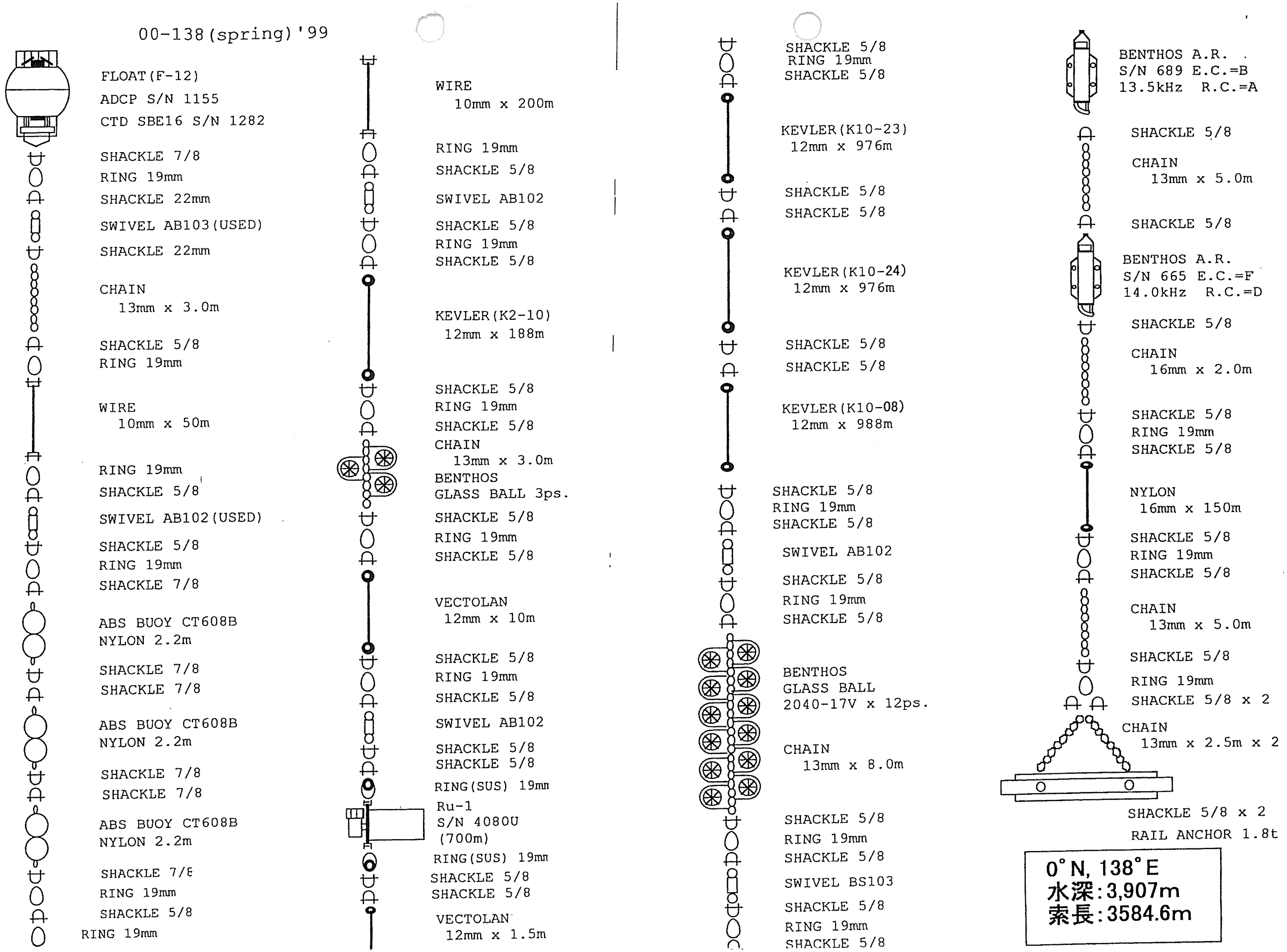
TIME RECORD

MOORING NO. 990204-00138E

		DEPLOYMENT		RECOVERY (Date:)	
		START : 0:25 FINISH :		START : FINISH :	
ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ADCP	S/N 1155 S/N 1282	0:28			
WIRE	50 m	0:25 ~ 0:26			
ABS BOUY	2 × 3	0:30			
WIRE	200 m	0:30 ~ 0:34			
KEVLER	188 m	0:37 ~ 0:40	K2-10		
GLASS BALL	3	0:43			
AANDERAA	4080 U	0:44	VECTCLAN 10m と 1.5m		
KEVLER	976 m	0:44 ~ 0:53	K10-23		
〃	976 m	0:54 ~ 1:01	K10-24		
〃	988 m	1:02 ~ 1:09	K10-08		
GLASS BALL	12	1:12			
BENTHOS A.R.	689	1:13	13.5 B/A		
〃	665	1:13	14.0 F/D		
NYLON	160 m	1:13 ~ 1:16			
RAIL ANCHOR	1.8 t	1:22			

アンデラ PU-1 S/N 4080U スイッチオン 05:43
99/02/04

00-138(spring)'99



DEPLOYMENT & RECOVERY

MOORING No. 980907 - 00138E

PROJECT	TOCS	TIME	UTC
AREA	Western Pacific	RECORDER (D)	T. Shimbiki
POSITION	0°N 138°E	(R)	

DEPTH	3910 m
PERIOD	7 Sep. 98 〜 NAVIGATION SYSTEM : WGS 84
No.of DAYS	
LENGTH : m	DEPTH of BUOY : m BUOYANCY : kg

ACOUSTIC RELEASER

TYPE	Benthos (Upper)	TYPE	Benthos (Lower)
S/N	634	S/N	717
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	14.5 kHz	TRANSMIT F.	14.0 kHz
ENABLE C.	F	ENABLE C.	D
RELEASE C.	E	RELEASE C.	C
BATTERY	2 years	BATTERY	2 years
TEST on DECK	O.K.	TEST on DECK	O.K.

DEPLOYMENT

DATE 7 Sep. 98 SHIP KAIYO CRUISE No. KY9810

WEATHER bc CONDITIONS 0.4m, 4sec DIR. of WIND 100° VEL. of WIND 8m/sec

DEPTH 3903 m DEPTH of A.R. m DESCEND. RATE 2.3 m/s

POS. of STRT 0°00'440S 137°59'397E HOR.RANGE m

POS. of DEP. 0°01'243S 138°01'800E SINKER 0:38 DISAPPEAR. 0:45

POS. of MOORING 0°01'154S 138°01'851E LANDING 1:03

NOTE
作業時間 7 Sep.98 2329〜8 Sep.98 042 (UTC)
アンデラ SWオン 6 Sep.98 2307 (UTC)
ケアーラーロープ KID-22 投入後. 15分間 曳航
アンカー上 Nylon 変更 185 → 160 m
ブイ全没 045 (UTC)
着底 103 (UTC)
Depth 3903 m

	TIME	S / R	DEPTH
S	936 (JST)		52.2 m
S	940		213.4 m
B	942		596.6 m
L	945		1134.1 m
	953		2505.8 m
	1001		3517.5 m

RECOVERY

DATE 4 Feb. 1999 SHIP KAIYO CRUISE No. KY9901

WEATHER bc CONDITIONS Smoth DIR. of WIND 282 VEL. of WIND 5.8m/s

START of RELEASE 21:29 FINISH of RELEASE 21:32

POS. of DISCOVERY 00°01.214S 138°02.105E (Time 21:34)

DIRECTION ° DISTANCE m ASCENDING RATE m/s

NOTE S/L 3696m 浮上 21:34
E.C. 21:30
R.C. 21:31

	TIME	S / R	DEPTH
S			
S			
B			
L			

TIME RECORD

MOORING NO. 980907-00138E

		DEPLOYMENT Shimibaki		RECOVERY (Date: 99/2/4)	
		START : 2329 FINISH : 042		START : 22:24 FINISH : 23:47	
ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ADCP	ADCP 1154 CTD 1275	2331		22:29	
WIRE	50m	2329～2334		22:34～22:36	
ABS BOUY	2	2334		22:36	
〃	2	2334		〃	
〃	2	2334		22:37	
WIRE	200m	2334～2338		22:40～22:45	
KEVLER	188m	2339～2343	K2-02	22:46～22:50	
GLASS BALL	3ps	2344	海面上で2ヶ目視確認	22:52	22:45 浮上
AANDERAA (RCM)	RU-1 S/N 4055U	2345		22:54	22:49 [illegible]
KEVLER	976m	2345～2354	K10-20	22:57～2[illegible]:13	
〃	976m	2355～0:03	K10-21	23:14～23:31	
〃	976m	0:04～0:15	K10-22	23:32～23:44	
GLASS BALL	12ps	0:32	エイ航後投入	23:45	
BENTOS A.R.	634	0:33	13.0～14.5 kHz F-E	23:46	
〃	717	0:33	13.0～14.0 D-C	23:46	
NYLON	185m	0:34～0:38	160m 変		
RAIL ANCHOR	1.7t	0:39			

Ship Time A.M. 9:07 S.W.オン 98.09.07
UTC 98.09.06. 23:07 S.W.オン
エイ航が必要 ケブラーK10-22後でエイ航
0:15より800m エイ航 (～0:30まで)
ブイ全没 0:45頃
着底 0:[illegible] 水深 39[illegible]

ガラス玉浮上 22:[illegible]
リリース 21:32
ブイにロープ 22:[illegible]
ブイ on デッキ 22:33

DEPLOYMENT & RECOVERY

MOORING No. 990217-05N125E

PROJECT	TOCS	TIME	UTC
AREA	MINDANAO SOUTH	RECORDER (D)	ITO/A
POSITION	5°N 125°E	(R)	

DEPTH					
PERIOD	1999. 2. 17~	NAVIGATION SYSTEM :	WGS 84		
No.of DAYS					
LENGTH :	m	DEPTH of BUOY :	m	BUOYANCY :	kg

ACOUSTIC RELEASER

TYPE	BENTHOS (Upper)	TYPE	BENTHOS (BOTTOM)
S/N	667	S/N	664
RECEIVE F.	13.0 kHz	RECEIVE F.	13.0 kHz
TRANSMIT F.	14.5 kHz	TRANSMIT F.	14.0 kHz
ENABLE C.	G	ENABLE C.	D
RELEASE C.	F	RELEASE C.	C
BATTERY	2year	BATTERY	2year
TEST on DECK	OK	TEST on DECK	OK

DEPLOYMENT

DATE	1999.2.18			SHIP	KAIYO	CRUISE No.	KY9901
WEATHER	bc	CONDITIONS	Smooth	DIR. of WIND	36	VEL. of WIND	1.8 kt
DEPTH	1386 m	DEPTH of A.R.	1113 m	DESCEND. RATE	m/s	BUOY	:
POS. of STRT	05°07.394N	125°40.315E		HOR.RANGE	m		
POS. of DEP.	05°07.389N	125°40.233E		SINKER	1:37	DISAPPEAR.	1:42
POS. of MOORING	05°07.328N	125°40.200E				LANDING	1:46

NOTE マニデラー 5台 04:00 スイッチオン 99/2/17

SSBL	TIME	S / R	DEPTH
S			
S			
B			
L			

RECOVERY

DATE		SHIP		CRUISE No.	
WEATHER	CONDITIONS	DIR. of WIND		VEL. of WIND	
START of RELEASE	:	FINISH of RELEASE	:		
POS. of DISCOVERY	°	°		ASCENDING RATE	m/s
DIRECTION	°	DISTANCE	m		

NOTE

SSBL	TIME	S / R	DEPTH
S			
S			
B			
L			

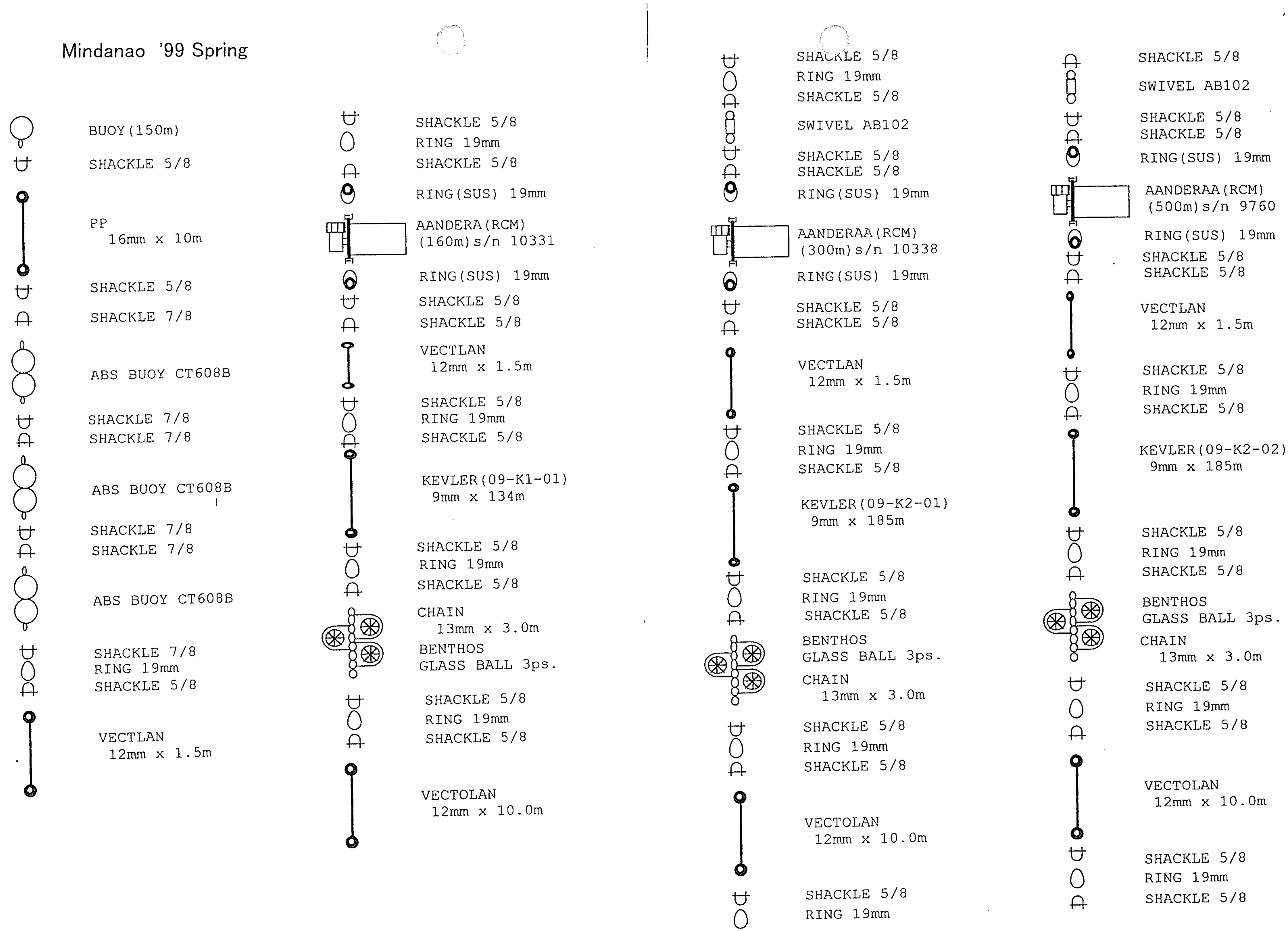
TIME RECORD

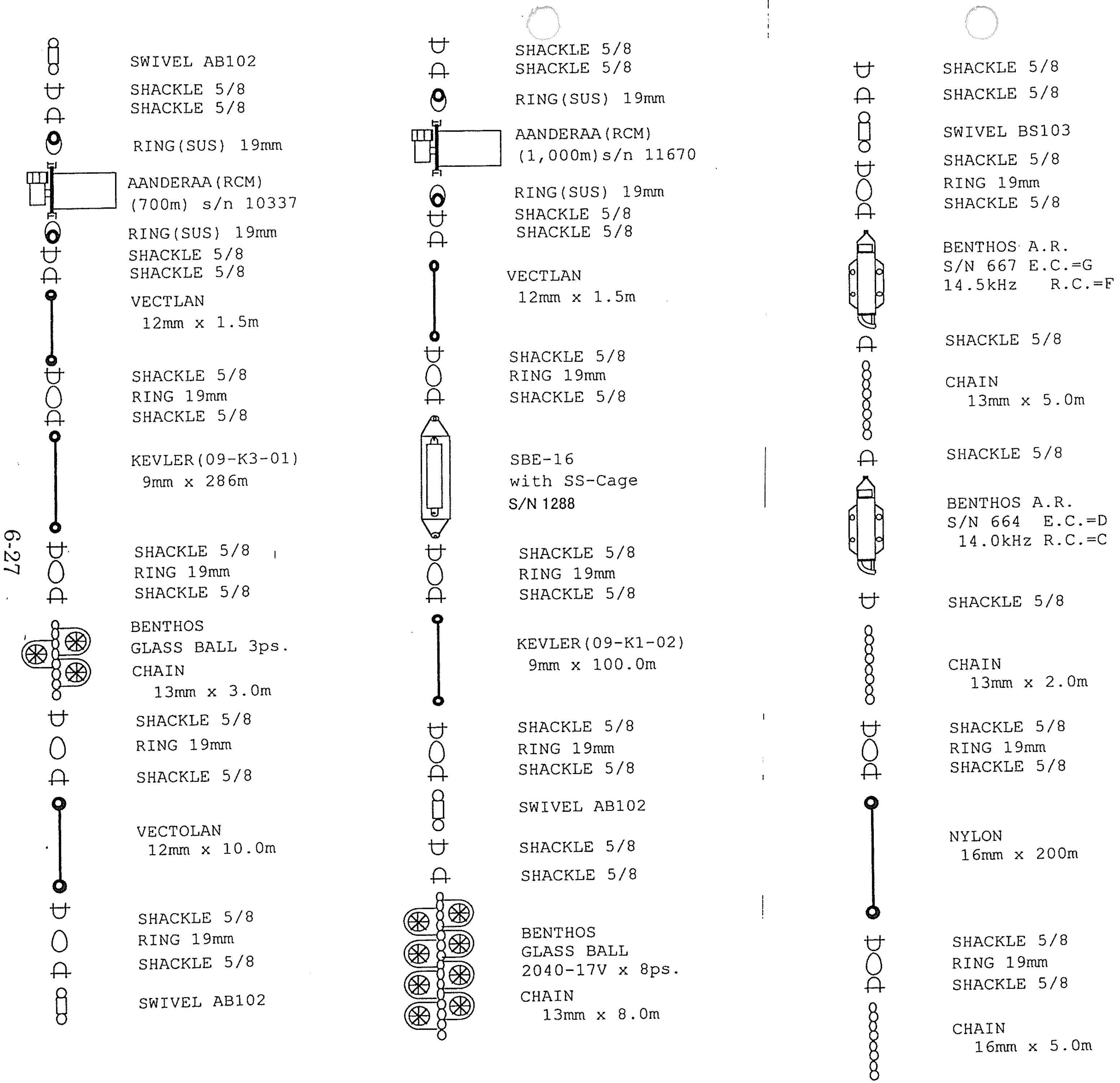
MOORING NO. 990217-05N125E

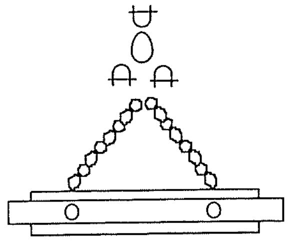
		DEPLOYMENT 990218		RECOVERY (Date:)	
		START : 0:47 FINISH : 1:37		START : FINISH :	
ITEM	S/N etc.	TIME	MEMO	TIME	MEMO
ABS BUOY	2 x 3	0:49			
AANDERAA	10331	0:50			
KEVLER	09-K1-01 134m	0:50 ~ 0:53			
GLASS BALL	3	0:57			
AANDERAA	10338	0:58			
KEVLER	09-K2-01 185m	0:58 ~ 1:00			
GLASS BALL	3	1:03			
AANDERAA	9760	1:04			
KEVLER	09-K2-02 185m	1:04 ~ 1:07			
GLASS BALL	3	1:09			
AANDERAA	10337	1:10			
KEVLER	09-K3-01 286m	1:10 ~ 1:14			
GLASS BALL	3	1:15			
AANDERAA	11670	1:17			
CTD SBE16	1288	1:17			
KEVLER	09-K1-02 100m	1:17 ~ 1:20			
GLASS BALL	8	1:23			
A.R.	667	1:24			
A.R.	664	1:24			
NYLON	200m	1:24 ~ 1:27			
ANCHOR	1.8t	1:37			

アンデラー 5台 99/2/17 04:00 スイッチオン

Mindanao '99 Spring







Mindanao '99 Spring
5N125E
Depth=1372m

18-Feb-'99(Deployed)

	KEVLER (NO.)	Length
1	09-K1-01	134m
2	09-K2-01	185m
3	09-K2-02	185m
4	09-K3-01	286m
5	09-K1-02	100m

Depth	Nylon Length
D=1,250m	100m
D=1,300m	140m
D=1,350m	190m

D=1,372m 200m

7. TAO MOORING OPERATIONS

NOAA's Pacific Marine Environmental Laboratory (PMEL), Seattle, Wa, USA

During the TOCS-99-01Cruise, Leg 1, aboard R/V KAIYO, 3 surface mooring sites of the TAO Buoy Array were serviced along the 156E, 147E, and 137E meridians. The work included 2 deployments, 2 recoveries, and 1 visit. The work performed is summarized in Table 1. Mooring types included Standard (STD) ATLAS (Automated Temperature Line Acquisition System), and ATLAS2 , also known as Next Generation (NEXTGEN).

A routine visit and inspection of the 0,156E mooring occurred on January 29th. Operations then continued on the ship's westward track along the equator until the ship arrived at the 0, 147E mooring on February 1st. The existing mooring was recovered and a new one was deployed to takes its place. Finally on the last leg of the cruise, the 2N, 137E mooring was serviced with a recovery and deployment. Both new moorings are scheduled for one year deployments.

Mooring Descriptions

All sites were surface buoy, taut-line moorings, scoped at 98.5% of the depth. STD ATLAS consists of surface measurements of wind speed and direction, air temperature and relative humidity, subsurface measurements of sea surface temperature and a thermistor chain cable down to 500m, consisting of 10 temperatures and 2 pressures. Data is processed via a tower-mounted data logger (tube) and transmitted via ARGOS satellite.

ATLAS2 consists of surface measurements of wind speed and direction, air temperature and relative humidity, rainfall, solar short-wave radiation, subsurface measurements consist of sea surface temperature and conductivity and 10 individual inductively-coupled sensor-modules down to 500m, each measuring temperature and two also measuring pressure. Data is processed via a tower mounted data-logger (tube) and transmitted via ARGOS satellite. The ATLAS2 uses newer technology and replaces the need for a second cable, thus simplifying recovery and deployment operations. ATLAS2 is the "next generation" of TAO instrumentation that is slowly replacing the existing STD ATLAS.

Description of Operations

The ship visited the ATLAS2 mooring at 0, 156E to perform a visual inspection and functional verification of instrumentation. The buoy was riding well in the water, and all sensors were intact with no apparent physical damage from fishing activity. Data transmissions were monitored and compared well with shipboard meteorological sensors.

The STD ATLAS site at 0, 147E was found undamaged after its one year deployment. It was released from its anchor and completely recovered aboard ship without any problems. All instrumentation was recovered intact with no sign of damage or fishing activity. The replacement mooring was deployed smoothly and routinely in approximately the same position. Post deployment assessment of the new system verified all sensors were functioning properly, and verified that the buoy remained anchored in place.

Transmissions from the 2N, 137E mooring prior to the ship's arrival indicated that the air temperature and humidity data were zero, and that the wind direction data was anomalous. When the ship arrived on site, no physical damage was apparent until the a buoy ride was done from the ship's small boat. This revealed that the air temp/humidity sensor had been hit and its cable was disconnected from the data logger (tube). The sensor's connector, cable connector, and sun shield were all damaged. The wind sensor had also been hit, but not physically damaged. However, the direction reference pin on its mast had been knocked out and the sensor had been rotated out of alignment by about 150 degrees.

The data logger tube's protective cage had also been bent slightly. Another sign that this buoy had been visited was the presence of blue poly line tied off to two of the tower legs. When the buoy was recovered on deck, no fishing net or damage to the subsurface sensors was found. All mooring components were then recovered successfully. The new mooring was also deployed successfully with all instrumentation working correctly.

Acknowledgments

Thanks to Captain Hasegawa-san and Chief Scientist Kashino-san for a successful cruise. Mooring operations and ship handling were performed superbly by the expert skills of the Officers and Crew of the KAIYO. Buoy transmissions received at PMEL indicate all deployed buoys are working well and remain anchored.

TABLE 1 - SUMMARY OF TAO MOORING OPERATIONS, TOCS-KAIYO-99-01

SITE	DATE	BUOY#	LATITUDE	LONGITUDE	TYPE	OPERATION
EQ,156E	29 JAN 99	PM-57	00-00.19S	156-09.45E	ATLAS2 (NEXTGEN)	VISIT
EQ,147E	31 JAN 99	ET-483B	00-00.19S	146-58.77E	STD ATLAS	RECOVERY
EQ,147E	1 FEB 99	ET-533	00-00.05S	146-58.15E	STD ATLAS	DEPLOYMENT
2N,137E	5 FEB 99	ET-484B	2-25.65N	137-24.59E	STD ATLAS	RECOVERY
2N,137E	6 FEB 99	ET-534	2-25.68N	137-25.45E	STD ATLAS	DEPLOYMENT

8. Carbon dioxide in the ocean

1. Participants

H. Yoshikawa1),Masao Ishii1) ,Koichi Goto2)

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2) Environmental Chemistry Department Ocean Environmental Survey Team, Kansai Environmental Engineering Center Co. LTD. (KANSO),
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2. Objectives

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

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

Partial pressure of CO_2 in seawater is governed by the carbonate system in seawater. It is expected that total inorganic carbon (TCO_2 ; the sum of the concentrations of hydrate carbon dioxide, carbonic acid, bicarbonate, and carbonate) in the upper water column in the equatorial Pacific also exhibits pronounced temporal and spatial variability and affect pCO_2 as a result of the changes in meteorological, oceano-physical, and biological conditions including upwelling, extension of the warm water pool, biological production, and air-sea CO_2 exchange.

In this cruise, we made concurrent measurements of pCO_2 and TCO_2 in order to investigate the air-sea CO_2 flux and the carbonate system in the western equatorial Pacific to clarify the controlling factors which are responsible for their variations.

3. Methods

We made measurements of the CO_2 concentration (mole fraction of CO_2 in air ; xCO_2) in marine boundary air (twice every 1.5 h) and in air equilibrated with surface seawater (three times every 1.5 h) using the MRI CO_2 measuring system. Air sample was taken from the top of the bridge into the 2nd laboratory through the 1/4' PFA tubing. Seawater was taken continuously from the seachest and was introduced into the MRI-shower-type equilibrator.

We used non-dispersive infrared (NDIR) gas analyzers (BINOS 4) and four CO_2 standard gases (305 ppm, 352 ppm, 396 ppm, 441 ppm in air ; Nippon Sanso Co.) to determine the CO_2 concentration. Concentration of CO_2 will be published on the basis of the WMO X85 mole fraction scale after this cruise. Partial pressure of CO_2 will be calculated from xCO_2 by taking the water vapour pressure into account.

We also collected surface seawater taken continuously from the seachest three times a day. We will analyse TCO_2 in these samples after this cruise using the MRI automated CO_2 extraction unit and a coulometer (UIC 5012).

We also measured SST basically three times a day by taking a surface seawater with a backette and the temperature at the seawater intake at seachest every one hour (Fig. 1) in order to compare the in situ temperature and that at the equilibrator for xCO_2 correction.

4. Results

Figure 2 show distributions of xCO_2 in air and surface seawater from Majuro to Palau and from Palau to Palau. Only two measurements in a day were tentatively calculated from the preliminary data set for every 1.5 h.

We will calculate the outflux of CO_2 and the whole carbonate system parameters from the data of pCO_2 , TCO_2 , SST, and SSS. we will consider the factors which control the carbonate system in the western equatorial Pacific in more detail.

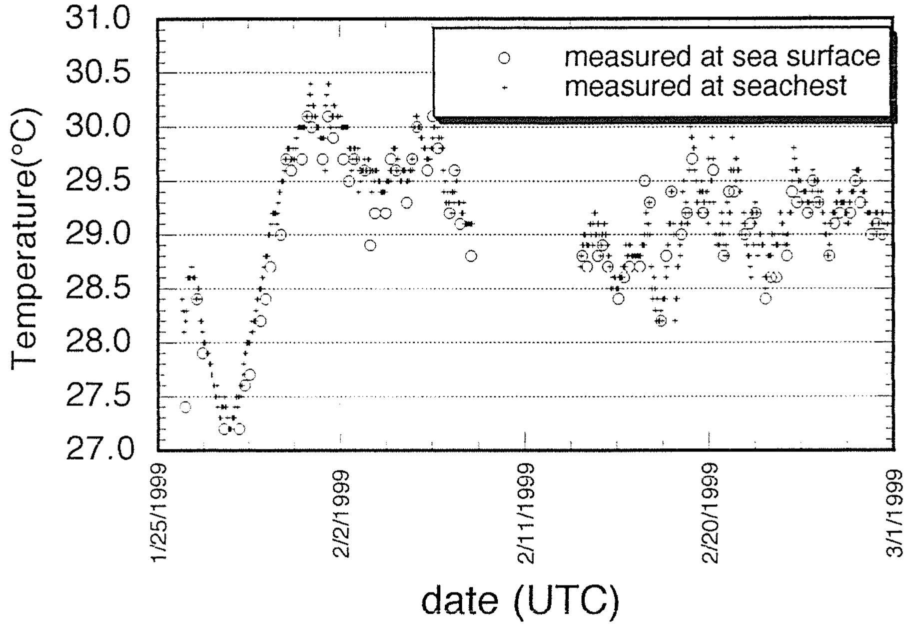

Fig.1 Distributions of seawater temperature.

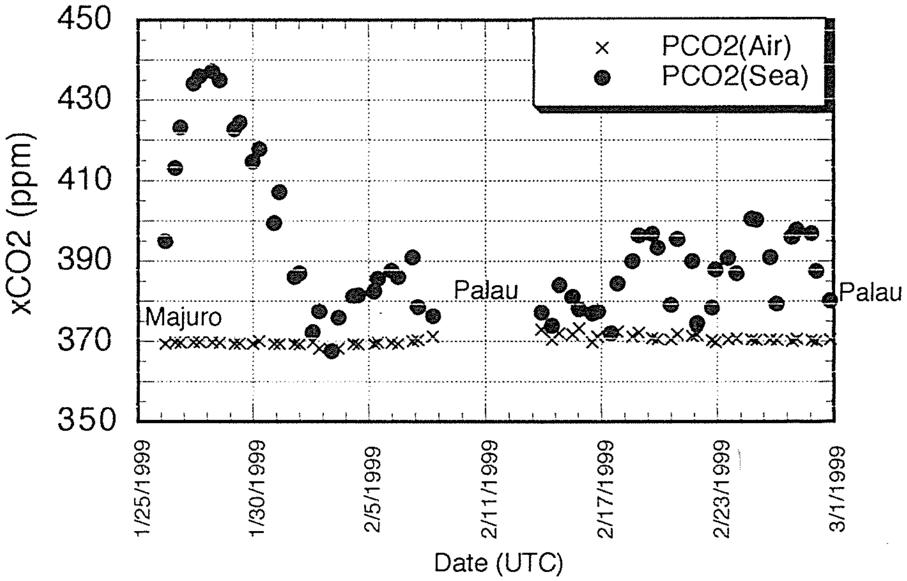

Fig. 2 Distribution of xCO_2 surface seawater and in marine boundary air (selected preliminary data)

Meteo. data 1999

UTC	LUT	Lat.	Long.	WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(. C)	sw TEMP.(. C)	Wet b TEMP.(. C)	Dew p TEMP.(. C)	雲量	***
Majuro Departure													LUT=UTC+12h
990126/03	0126/15	06° 47.8' N	170° 37.8' E	E	9.3	bc	1005.5	31.0	29	26.3	25.0	3	
990126/06	0126/18	06° 22.9' N	170° 16.3' E	E	8.2	bc	1005.3	27.6	29	26.8	25.2	3	
990126/09	0126/21	05° 56.5' N	169° 53.8' E	ENE	8.1	bc	1007.5	27.2	29	25.2	24.3	2	LUT=UTC+11h
990126/12	0126/23	05° 35.0' N	169° 30.0' E	E	7.6	bc	1007.6	27.2	29	25.1	24.3	2	
990126/15	0127/02	05° 18.3' N	169° 04.7' E	E	9.5	bc	1006.8	27.0	29	25.0	24.3	2	
990126/18	0127/05	04° 59.4' N	168° 35.6' E	E	11.3	bc	1006.6	26.0	29	25.5	24.5	6	
990126/21	0127/08	04° 39.8' N	168° 05.4' E	E	8.9	bc	1008.2	27.9	29	27.1	25.5		
990127/00	0127/11	04° 20.6' N	167° 38.0' E	E	8.6	bc	1008.3	29.0	29	26.0	24.4	6	
990127/03	0127/14	04° 02.6' N	167° 09.3' E	ENE	12.5	o	1006.3	28.5	29	26.0	25.1	7	
990127/06	0127/17	03° 44.5' N	166° 41.6' E	E	14.2	o	1006.1	26.0	28	25.2	24.9	8	
990127/09	0127/20	03° 26.6' N	166° 14.5' E	E	7.4	c	1007.3	25.6	28	24.5	24.1	7	
990127/12	0127/22	03° 05.0' N	165° 42.1' E	SE	8.4	o	1007.7	26.0	28	24.8	24.4	8	LUT=UTC+10h
990127/15	0128/01	02° 47.1' N	165° 13.8' E	SE	8.2	r	1006.1	25.2	28	24.5	24.2	8	
990127/18	0128/04	02° 26.4' N	164° 42.6' E	SE	9.2	o	1005.1	26.5	28	24.6	23.8	7	
990127/21	0128/07	02° 06.0' N	164° 12.0' E	ESE	12.5	c?	1007.0	26.6	28	24.5	23.8	8	
990128/00	0128/10	01° 48.3' N	163° 43.0' E	ESE	9.2	bc	1007.0	27.8	28	24.2	22.9	4	
990128/03	0128/13	01° 30.2' N	163° 15.8' E	ESE	8.1	bc	1005.0	27.2	28	24.2	22.7	5	
990128/06	0128/16	01° 11.9' N	162° 48.1' E	ESE	8.5	bc	1004.3	26.7	28	24.0	23.0	4	
990128/09	0128/19	00° 52.6' N	162° 19.0' E	ESE	9.0	bc	1007.0	26.5	28	24.0	23.0	5	
990128/12	0128/22	00° 24.6' N	161° 38.9' E	E	8.0	bc	1008.5	26.0	28	23.5	22.5	7	
990128/15	0129/01	00° 19.7' N	161° 30.6' E	ENE	8.3	bc	1007.1	26.1	28	23.5	22.5	6	
990128/18	0129/04	00° 04.0' N	161° 06.9' E	ENE	8.6	bc	1006.3	26.2	28	23.1	21.7	2	
990128/21	0129/07												
990129/00	0129/10	00° 00.2' N	160° 11.1' E	E	9.2	bc	1008.0	28.5	28	24.5	23.0	4	
990129/03	0129/13	00° 00.1' N	159° 30.8' E	E	8.6	bc	1006.0	30.1	28	25.3	23.6	3	
990129/06	0129/16	00° 00.0' S	158° 59.5' E	E	10.1	bc	1004.3	29.7	28	25.0	24.1	4	
990129/09	0129/19	00° 00.0' N	158° 20.0' E	E	9.0	bc	1007.5	26.8	28	24.5	23.6	7	
990129/12	0129/22	00° 02.0' S	157° 41.5' E	E	9.5	bc	1008.1	26.3	28	24.0	23.1	4	
990129/15	0130/01	00° 01.0' S	157° 00.3' E	ESE	7.1	bc	1006.6	26.8	28	23.8	22.7	6	
990129/18	0130/04	00° 00.0' S	156° 31.5' E	ESE	6.4	bc	1006.0	26.7	29	24.0	23.0	6	
990129/21	0130/07	00° 00.0' S	156° 07.0' E	E	8.5	c	1006.9	27.5	29	24.5	23.7	8	
990130/00	0130/10	00° 00.3' N	155° 27.7' E	E	8.2	bc	1008.1	31.5	29	26.0	24.1	7	
990130/03	0130/13	00° 00.0' S	154° 56.3' E	ESE	8.1	c	1005.9	29.4	29	25.0	23.4	6	
990130/06	0130/16	00° 00.0' N	154° 17.5' E	ESE	7.1	c	1005.2	30.0	29	25.5	23.9	6	
990130/09	0130/19	00° 00.1' S	153° 38.2' E	E	7.0	bc	1006.6	27.9	29	24.5	23.2	2	
990130/12	0130/22	00° 00.0' S	153° 00.1' E	E	8.2	bc	1008.9	27.2	29	24.2	23.1	3	
990130/15	0131/01	00° 00.1' N	152° 25.3' E	E	7.2	bc	1008.6	27.0	30	24.5	23.6	2	
990130/18	0131/04	00° 00.0' N	151° 49.6' E	ESE	8.3	bc	1006.7	27.0	30	24.8	24.3	2	
990130/21	0131/07	00° 00.2' S	151° 09.4' E	E	8.3	bc	1005.6	27.5	30	24.5	23.4	2	
990131/00	0131/10	00° 00.2' S	150° 38.6' E	E	8.5	bc	1008.5	30.8	30	25.8	24.1	6	

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UTC	LUT	Lat.		Long.		WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(. C)	sw TEMP.(. C)	Wet b TEMP.(. C)	Dew p TEMP.(. C)	雲量	***
990131/03	0131/13	00°	00.1' N	149°	59.4' E	E	8.9	bc	1007.2	32.0	30	26.8	25.4	5	
990131/06	0131/16	00°	00.1' N	149°	19.3' E	E	6.5	bc	1005.3	33.5	30	27.0	24.8	4	
990131/09	0131/19	00°	00.1' S	148°	51.0' E	E	6.8	c	1007.0	28.0	30	25.0	23.9	6	
990131/12	0131/22	00°	00.1' N	148°	12.5' E	E	5.9	c	1008.6	28.0	30	25.0	23.9	7	
990131/15	0201/01	00°	00.1' N	147°	35.4' E	ENE	5.1	o	1008.3	27.5	30	25.0	24.1	7	
990131/18	0201/04	00°	00.1' N	147°	01.8' E	ESE	3.6	o	1006.6	27.5	30	24.5	23.4	7	
990131/21	0201/07	00°	00.2' S	146°	57.5' E	E	3.5	c	1006.9	28.2	30	24.8	23.5	7	
990201/00	0201/10	00°	00.2' S	146°	57.8' E	ENE	5.7	c	1008.6	29.5	30	25.3	23.7	7	
990201/03	0201/13	00°	00.2' N	146°	57.5' E	E	6.0	bc	1007.6	31.7	30	26.7	24.8	5	
990201/06	0201/16	00°	00.0' S	146°	55.1' E	ESE	5.0	bc	1006.2	30.2	30	25.6	23.9	6	
990201/09	0201/19	00°	00.2' S	146°	17.8' E	E	3.8	bc	1007.6	29.0	31	25.5	24.3	3	
990201/12	0201/22	00°	00.5' S	145°	42.6' E	WSW	4.2	c	1009.4	26.7	31	25.0	24.4	8	
990201/15	0202/01	00°	00.0' S	145°	11.2' E	SW	5.4	r	1008.8	25.0	31	24.0	23.6	7	
990201/18	0202/04	00°	00.0' S	145°	04.7' E	WSW	5.0	c	1007.1	26.0	30	25.9	24.3	6	
990201/21	0202/07	00°	00.3' N	145°	01.2' E	W	3.0	c	1007.1	26.5	30	25.0	24.1	8	
990202/00	0202/10	00°	00.0' N	144°	41.3' E	SSW	1.7	c	1009.1	29.2	30	25.5	24.2	8	
990202/03	0202/13	00°	00.1' N	144°	08.3' E	SE	2.0	c	1007.8	30.0	30	26.0	24.6	6	
990202/06	0202/16	00°	00.0' N	143°	31.0' E	W	4.0	q	1006.2	29.0	31	25.1	23.5	7	
990202/09	0202/19	00°	00.2' N	142°	59.8' E	WSW	7.0	r	1007.2	26.0	30	25.0	24.6	10	
990202/12	0202/22	00°	00.1' N	142°	27.1' E	W	8.6	bc	1007.6	28.0	31	24.5	23.2	7	
990202/15	0203/01	00°	00.1' N	142°	00.9' E	WNW	8.1	o	1007.9	28.0	31	25.0	23.9	8	
990202/18	0203/04	00°	00.1' S	141°	58.5' E	WNW	7.0	o	1006.5	28.0	30	24.8	23.8	7	
990202/21	0203/07	00°	00.1' N	141°	58.3' E	NW	6.5	bc	1006.4	28.2	30	25.0	23.8	5	
990203/00	0203/10	00°	00.1' S	141°	58.3' E	NW	5.1	c	1008.6	30.0	30	26.0	24.6	7	
990203/03	0203/13	00°	29.8' S	141°	59.8' E	W	15.0	r	1007.7	26.0	30	24.0	23.2	8	
990203/06	0203/16	01°	00.0' S	142°	00.0' E	WNW	6.6	o	1006.2	27.0	30	25.0	24.3	7	
990203/09	0203/19	01°	28.0' S	142°	00.0' E	NW	5.8	c	1006.3	28.2	30	25.8	24.8	9	
990203/12	0203/22	01°	55.4' S	142°	00.0' E	NW	6.4	bc	1006.3	28.2	30	25.8	24.8	6	
990203/15	0204/01	02°	22.9' S	142°	00.0' E	NW	7.0	o	1007.4	28.0	30	26.0	25.3	8	
990203/18	0204/04	02°	16.5' S	141°	49.3' E	W	8.1	o	1006.6	26.5	30	24.8	24.1	8	
990203/21	0204/07	01°	51.5' S	141°	28.8' E	NW	3.0	c	1006.6	27.6	30	25.3	24.5	8	
990204/00	0204/10	01°	25.4' S	141°	08.3' E	NNW	5.5	o	1009.0	28.0	30	25.4	24.5	10	
990204/03	0204/13	00°	59.2' S	140°	47.2' E	WSW	14.6	r	1007.6	25.0	30	23.5	22.9	8	
990204/06	0204/16	00°	33.7' S	140°	26.5' E	WSW	6.0	o	1006.6	25.0	30	23.0	22.2	8	
990204/09	0204/19	00°	06.9' S	140°	05.3' E	W	13.3	r	1007.4	25.9	30	24.2	23.5	10	
990204/12	0204/22	00°	00.2' S	139°	42.8' E	W	12.0	bc	1008.8	26.5	30	24.5	23.8	5	
990204/15	0205/01	00°	00.1' N	139°	10.1' E	W	7.6	o	1008.1	27.0	30	24.0	22.9	10	
990204/18	0205/04	00°	00.1' N	138°	38.0' E	W	7.0	c	1007.1	27.0	30	24.5	23.6	8	
990204/21	0205/07	00°	01.0' S	138°	04.3' E	W	5.8	bc	1008.5	27.5	30	24.7	23.5	3	
990205/00	0205/10	00°	01.9' S	138°	03.5' E	W	6.0	c	1009.9	29.8	30	26.0	24.7	7	
990205/03	0205/13	00°	00.0' N	138°	00.0' E	W	5.0	bc	1009.2	30.0	30	26.0	24.0	5	

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UTC	LUT	Lat.	Long.	WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(.C)	sw TEMP.(.C)	Wet b TEMP.(.C)	Dew p TEMP.(.C)	雲量	***
990205/06	0205/16	00° 27.5' N	137° 54.9' E	WNW	5.7	bc	1006.6	30.0	30	26.0	24.0	5	
990205/09	0205/19	00° 59.8' N	137° 45.2' E	WNW	4.9	bc	1007.2	28.7	30	25.7	25.0	7	
990205/12	0205/22	01° 31.6' N	137° 37.2' E	NE	6.8	bc	1008.8	27.8	30	25.6	24.8	3	
990205/15	0206/01	02° 05.5' N	137° 29.5' E	SW	2.4	c	1009.1	26.1	30	24.3	23.5	8	
990205/18	0206/04	02° 23.9' N	137° 24.5' E	NE	4.0	bc	1008.0	27.5	30	24.8	23.8	4	
990205/21	0206/07												
990206/00	0206/10	02° 26.3' N	137° 23.9' E	NNE	4.5	bc	1010.0	30.3	30	26.8	25.7	4	
990206/03	0206/13	02° 25.8' N	137° 25.6' E	NE	3.0	bc	1008.1	30.0	30	26.0	24.6	3	
990206/06	0206/16	02° 39.6' N	137° 25.3' E	N	3.2	bc	1006.2	31.0	30	26.2	24.5	3	
990206/09	0206/19	03° 13.0' N	137° 25.5' E	NE	4.5	bc	1007.3	30.3	30	25.5	23.7	2	
990206/12	0206/22	N	137° E	ENE	3.1	b	1008.5	28.0	30	24.5	23.2	1	
990206/15	0207/01	02° 25.5' N	137° 25.8' E	S	0.5	bc	1008.7	28.0	30	24.8	23.6	2	
990206/18	0207/04	02° 25.5' N	137° 56.3' E	NE	0.6	bc	1007.7	27.9	30	24.9	23.9	2	
990206/21	0207/07	02° 25.5' N	138° 27.2' E	NNW	2.0	b	1007.4	27.8	30	24.5	23.3	2	
990207/00	0207/10	02° 25.6' N	137° 53.0' E	NW	3.3	c	1009.1	30.0	30	25.5	23.9	7	
990207/03	0207/13	02° 27.4' N	137° 24.7' E	W	4.0	bc	1007.2	30.2	30	25.3	23.5	7	
990207/06	0207/16	02° 53.4' N	137° 04.9' E	NW	4.3	bc	1006.1	30.4	30	25.9	24.4	7	
990207/09	0207/19	03° 02.7' N	136° 57.6' E	NW	5.2	c	1006.0	29.4	30	25.0	23.5	7	
990207/12	0207/21	03° 30.2' N	136° 36.0' E	NNE	4.3	q	1008.0	26.5	30	25.0	24.5	6	LUT=UTC+9h
990207/15	0208/00	03° 58.0' N	136° 16.4' E	W	6.1	bc	1008.7	26.4	30	25.0	24.5	3	
990207/18	0208/03	04° 22.5' N	135° 57.0' E	NNE	7.9	r	1007.1	26.7	30	24.7	24.0	10	
990207/21	0208/06	04° 51.4' N	135° 35.0' E	NNE	3.3	c	1007.5	27.0	30	24.3	22.8	8	
990208/00	0208/09	05° 18.2' N	135° 15.0' E	N	5.5	c	1009.3	28.0	30	25.0	23.9	8	
990208/03	0208/12	05° 44.4' N	134° 54.4' E	NNE	3.8	bc	1008.0	28.5	30	25.5	24.4	7	
990208/06	0208/15	06° 11.2' N	134° 33.9' E	NE	4.2	bc	1006.3	27.1	30	24.3	23.4	7	
990208/09	0208/18	06° 37.5' N	134° 13.5' E	NE	7.2	c	1006.7	28.0	30	25.5	24.3	8	
990208/12	0208/21	07° 06.3' N	134° 05.5' E	NE	9.3	bc	1008.2	28.0	30	25.0	23.9	2	
990208/15	0209/00	07° 30.5' N	134° 15.8' E	NE	10.0	bc	1008.6	27.5	30	25.0	24.1	2	
Palau Arrival													
Palau Departure													
990214/06	0214/15	07° 12.5' N	134° 03.8' E	NNW	10.8	o	1005.8	29.5	29	26.0	24.8	9	
990214/09	0214/18	06° 47.9' N	133° 42.0' E	NNW	11.2	o	1005.8	28.5	30	25.8	24.8	10	
990214/12	0214/21	06° 20.5' N	133° 17.7' E	NNW	11.3	bc	1008.5	28.0	30	25.0	23.9	4	
990214/15	0215/00	06° 00.0' N	133° 00.0' E	NW	10.0	c	1009.3	27.2	30	25.5	24.9	9	
990214/18	0215/03	05° 59.9' N	132° 36.3' E	NW	12.0	bc	1008.0	27.6	30	25.2	24.4	3	
990214/21	0215/06	06° 00.0' N	132° 18.1' E	NW	12.0	bc	1007.8	27.5	30	24.8	24.1	2	
990215/00	0215/09	05° 56.5' N	131° 57.1' E	NW	9.7	bc	1010.0	28.5	30	25.5	24.4	5	
990215/03	0215/12	05° 26.8' N	131° 43.3' E	NW	8.9	bc	1009.0	29.0	29	25.5	24.3	4	
990215/06	0215/15	05° 00.0' N	E	NW	8.0	bc	1007.4	29.2	29	25.6	24.4	8	
990215/09	0215/18	04° 59.9' N	131° 15.5' E	NW	11.5	c	1007.4	29.5	30	25.8	24.5	8	

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Meteo. data 1999

UTC	LUT	Lat.	Long.	WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(. C)	sw TEMP.(. C)	Wet b TEMP.(. C)	Dew p TEMP.(. C)	雲量	***
990215/12	0215/21	05° 00.0' N	130° 57.5' E	NW	11.0	bc	1009.5	28.0	30	25.0	23.9	4	
990215/15	0216/00	05° 00.0' N	130° 32.0' E	NW	10.4	bc	1009.7	28.0	29	25.0	23.9	4	
990215/18	0216/03	05° 00.0' N	130° 14.3' E	NW	9.8	bc	1008.2	27.8	29	24.9	23.9	4	
990215/21	0216/06	05° 00.0' N	129° 59.0' E	NW	12.4	bc	1008.2	27.5	29	25.0	24.1	7	
990216/00	0216/09	04° 59.9' N	129° 41.1' E	WNW	11.4	bc	1009.6	28.0	29	25.0	23.9	5	
990216/03	0216/12	05° 00.0' N	129° 24.0' E	NW	10.5	bc	1010.1	30.0	29	26.0	24.6	5	
990216/06	0216/15	05° 00.0' N	129° 07.0' E	NW	11.3	bc	1008.3	28.7	29	25.6	24.5	5	
990216/09	0216/18	04° 59.8' N	128° 49.8' E	NW	11.2	bc	1008.0	28.9	29	25.5	24.3	6	
990216/12	0216/21	04° 59.9' N	128° 30.0' E	NW	10.8	bc	1009.6	28.0	29	25.0	23.9	3	
990216/15	0217/00	05° 00.0' N	128° 15.0' E	NW	10.5	bc	1010.5	28.0	29	25.0	23.9	2	
990216/18	0217/03	05° 00.0' N	128° 00.0' E	NNW	10.5	bc	1009.5	27.7	29	24.9	23.9	2	
990216/21	0217/06	05° 00.3' N	127° 44.0' E	NNW	11.5	bc	1009.6	27.5	29	25.0	24.1	2	
990217/00	0217/09	05° 00.0' N	127° 21.7' E	NW	7.8	bc	1010.6	28.0	29	25.0	23.9	5	
990217/03	0217/12	05° 00.0' N	127° 00.0' E	WNW	5.1	bc	1010.8	29.5	29	25.0	23.4	8	
990217/06	0217/15	05° 00.0' N	126° 43.5' E	W	7.0	bc	1008.6	30.0	29	25.5	23.9	8	
990217/09	0217/18	05° 00.0' N	126° 20.0' E	W	1.5	bc	1008.3	30.2	30	25.8	24.6	8	
990217/12	0217/21	05° 05.2' N	125° 45.9' E	N	4.6	bc	1010.1	27.5	30	24.0	22.7	3	
990217/15	0218/00	05° 07.1' N	125° 35.0' E	S	2.1	bc	1011.6	27.0	29	24.0	22.9	3	
990217/18	0218/03	05° 08.5' N	125° 35.5' E	S	2.5	bc	1010.2	26.6	29	24.0	23.0	3	
990217/21	0218/06	05° 10.4' N	125° 36.0' E	S	2.0	bc	1009.6	26.5	29	24.5	23.8	3	
990218/00	0218/09	05° 07.1' N	125° 40.1' E	NW	0.5	bc	1010.8	27.9	29	24.9	23.8	6	
990218/03	0218/12	05° 07.0' N	125° 40.0' E	NE	0.9	bc	1011.6	30.0	29	26.0	24.6	6	
990218/06	0218/15	05° 07.0' N	125° 49.0' E	SW	3.4	bc	1010.0	30.5	29	26.5	25.2	5	
990218/09	0218/18	04° 59.8' N	126° 01.5' E	W	2.5	bc	1009.1	30.0	29	26.0	24.6	3	
990218/12	0218/21	04° 59.3' N	126° 00.7' E	W	3.0	bc	1010.1	27.5	30	24.9	24.0	2	
990218/15	0219/00	05° 00.1' N	125° 31.5' E	W	4.6	bc	1011.0	27.2	29	25.0	24.2	2	
990218/18	0219/03	04° 44.8' N	125° 19.1' E	W	3.5	bc	1009.9	26.8	29	24.5	23.2	2	
990218/21	0219/06	04° 18.5' N	125° 02.4' E	W	3.2	bc	1010.0	27.0	29	24.0	22.9	2	
990219/00	0219/09	03° 59.9' N	124° 49.9' E	NW	2.5	bc	1011.0	27.5	29	24.5	23.4	3	
990219/03	0219/12	03° 45.0' N	124° 40.1' E	NNW	2.0	bc	1011.2	29.0	30	25.0	23.5	4	
990219/06	0219/15	03° 28.3' N	124° 30.7' E	NNW	2.0	bc	1011.0	31.5	30	26.5	23.9	2	
990219/09	0219/18	03° 00.2' N	124° 39.9' E	NW	3.0	c	1009.5	29.5	30	25.5	24.1	8	
990219/12	0219/21	02° 33.8' N	124° 48.7' E	SSW	4.5	bc	1011.2	27.8	30	25.1	24.1	2	
990219/15	0220/00	02° 12.2' N	124° 55.8' E	SW	3.2	bc	1011.6	27.0	30	25.0	24.3	2	
990219/18	0220/03	02° 08.5' N	124° 48.0' E	NW	4.7	bc	1009.9	27.0	30	24.5	23.6	2	
990219/21	0220/06	02° 29.1' N	124° 30.9' E	SW	5.5	bc	1009.6	27.0	30	25.0	24.3	3	
990220/00	0220/09	02° 49.2' N	124° 11.1' E	NW	1.3	c	1011.8	27.2	30	25.0	24.2	8	
990220/03	0220/12	03° 07.9' N	123° 52.5' E	WNW	3.0	c	1011.6	30.2	30	25.8	24.2	7	
990220/06	0220/15	03° 26.8' N	123° 32.4' E	NNW	2.8	bc	1009.6	31.0	30	25.9	24.2	6	
990220/09	0220/18	03° 49.0' N	123° 11.1' E	NW	4.7	bc	1008.4	29.5	30	25.0	23.4	6	
990220/12	0220/21	04° 08.5' N	122° 51.4' E	N	3.6	b	1010.6	27.5	30	24.0	22.7	2	

Meteo. data 1999

UTC	LUT	Lat.	Long.	WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(, C)	sw TEMP.(, C)	Wet b TEMP.(, C)	Dew p TEMP.(, C)	雲量	***
990220/15	0221/00	04° 27.7' N	122° 32.3' E	NNW	3.2	b	1011.0	27.2	29	24.0	22.8	1	
990220/18	0221/03	04° 46.7' N	122° 13.2' E	NW	1.5	b	1009.6	27.0	29	25.0	24.3	1	
990220/21	0221/06	05° 00.0' N	122° 00.0' E	ENE	4.8	bc	1009.0	28.0	29	25.2	24.2	3	
990221/00	0221/09	04° 29.2' N	121° 59.4' E	NNE	2.7	bc	1010.6	28.8	29	25.6	24.5	4	
990221/03	0221/12	03° 59.0' N	122° 00.0' E	NE	3.5	bc	1010.6	30.1	29	25.1	23.3	4	
990221/06	0221/15	03° 27.9' N	122° 00.0' E	ENE	2.7	bc	1009.0	29.5	29	25.0	23.4	2	
990221/09	0221/18	02° 56.7' N	122° 00.0' E	ENE	2.0	b	1008.5	28.2	29	24.4	23.0	2	
990221/12	0221/21	02° 23.6' N	122° 00.0' E	NE	1.5	b	1010.0	27.6	30	24.1	22.8	2	
990221/15	0222/00	N	E	ENE	1.2	b	1011.0	27.5	30	24.0	22.7	2	
990221/18	0222/03	01° 33.4' N	121° 54.8' E	W	3.7	b	1009.6	27.2	30	24.0	22.9	2	
990221/21	0222/06	01° 51.3' N	121° 28.2' E	NW	1.8	b	1009.6	27.1	30	23.9	22.7	2	
990222/00	0222/09	02° 08.8' N	121° 02.7' E	NNE	3.2	bc	1010.8	28.0	29	24.5	23.2	3	
990222/03	0222/12	02° 24.0' N	120° 36.0' E	ENE	2.7	bc	1011.1	30.0	29	26.5	25.3	4	
990222/06	0222/15	02° 40.6' N	120° 13.9' E	NE	3.6	bc	1009.7	29.0	29	25.2	23.3	6	
990222/09	0222/18	02° 59.5' N	119° 45.3' E	ENE	4.7	c	1009.3	29.9	29	26.3	25.0	9	
990222/12	0222/21	03° 18.2' N	119° 18.3' E	ENE	5.7	bc	1011.0	27.5	30	25.5	24.8	6	
990222/15	0223/00	03° 30.0' N	119° 09.7' E	E	8.6	bc	1011.6	27.8	29	25.1	24.1	5	
990222/18	0223/03	03° 30.9' N	119° 33.8' E	E	8.5	bc	1010.0	27.0	29	25.0	24.2	3	
990222/21	0223/06	03° 30.0' N	120° 00.0' E	ENE	4.6	c	1008.2	27.5	29	24.8	23.5	8	
990223/00	0223/09	03° 30.1' N	120° 28.5' E	E	7.3	r	1011.4	26.1	29	24.1	23.3	9	
990223/03	0223/12	03° 30.0' N	120° 55.8' E	ENE	3.8	c	1011.6	26.0	29	24.5	24.0	9	
990223/06	0223/15	03° 30.0' N	121° 23.7' E	S	2.5	o	1009.6	27.0	29	25.0	24.3	10	
990223/09	0223/18	03° 30.0' N	121° 53.1' E	W	5.3	c	1009.6	24.5	29	23.7	23.0	9	
990223/12	0223/21	03° 30.0' N	122° 25.5' E	NNW	5.3	c	1011.2	25.0	29	24.0	23.6	9	
990223/15	0224/00	03° 30.0' N	122° 58.2' E	E	1.8	o	1012.0	24.7	29	23.5	23.0	10	
990223/18	0224/03	03° 30.0' N	123° 31.0' E	ESE	5.4	q	1010.3	24.5	29	24.0	23.8	10	
990223/21	0224/06	03° 29.9' N	124° 00.0' E	NE	5.7	r	1009.7	25.5	29	24.7	24.2	10	
990224/00	0224/09	03° 05.0' N	124° 20.0' E	NE	6.5	bc	1010.5	28.0	29	25.5	24.6	6	
990224/03	0224/12	02° 40.9' N	124° 40.1' E	S	6.8	r	1010.4	30.5	29	26.0	24.4	10	
990224/06	0224/15	02° 15.1' N	124° 57.5' E	N	4.7	c	1009.2	28.4	30	25.7	24.2	8	
990224/09	0224/18	01° 49.0' N	125° 18.0' E	NNW	6.1	bc	1008.1	27.5	30	26.0	25.5	6	
990224/12	0224/21	01° 45.2' N	125° 40.0' E	NNW	6.0	bc	1009.8	27.0	30	25.0	24.3	6	
990224/15	0225/00	01° 45.1' N	126° 00.3' E	NNW	5.5	bc	1010.3	26.0	30	25.0	24.6	6	
990224/18	0225/03	01° 45.0' N	126° 25.0' E	N	7.7	bc	1008.6	27.7	30	25.2	24.3	3	
990224/21	0225/06	01° 45.0' N	126° 43.0' E	N	9.0	bc	1007.6	27.5	30	24.8	24.1	4	
990225/00	0225/09	01° 45.0' N	127° 07.3' E	NE	7.8	bc	1009.7	28.5	30	25.5	24.4	7	
990225/03	0225/12	01° 45.0' N	127° 25.0' E	NE	5.0	bc	1009.4	29.5	30	26.0	24.8	7	
990225/06	0225/15	02° 05.0' N	127° 07.5' E	N	6.7	c	1007.2	28.7	30	25.7	24.6	8	
990225/09	0225/18	02° 23.7' N	126° 50.3' E	NNE	6.5	c	1007.0	28.5	30	25.0	23.7	8	
990225/12	0225/21	02° 20.5' N	126° 51.7' E	NNE	7.3	bc	1008.7	28.0	30	25.0	23.6	7	
990225/15	0226/00	02° 43.3' N	126° 32.8' E	N	6.2	bc	1009.5	29.5	30	25.0	23.4	7	

8-08

Meteo. data 1999

UTC	LUT	Lat.	Long.	WD(16)	WF(m/s)	Weather	Atm.P(hPa)	Air T.(. C)	sw TEMP.(. C)	Wet b TEMP.(. C)	Dew p TEMP.(. C)	雲量	***
990225/18	0226/03	03° 05.5' N	126° 11.9' E	N	6.2	bc	1008.5	27.4	29	24.8	23.9	3	
990225/21	0226/06	03° 27.0' N	125° 53.0' E	N	6.7	bc	1008.0	27.2	30	24.9	24.3	6	
990226/00	0226/09	03° 30.0' N	126° 08.0' E	NNE	6.5	r	1009.2	28.5	29	25.5	24.4	10	
990226/03	0226/12	03° 30.0' N	126° 32.7' E	NNE	4.5	bc	1009.0	29.5	29	26.0	24.8	6	
990226/06	0226/15	03° 29.5' N	126° 51.1' E	NNE	6.5	bc	1007.0	29.7	29	25.7	24.3	7	
990226/09	0226/18	03° 20.2' N	127° 14.3' E	NNE	6.0	bc	1007.0	28.0	29	25.0	24.3	6	
990226/12	0226/21	03° 11.3' N	127° 35.0' E	NNE	6.5	bc	1008.6	27.5	29	25.0	24.1	5	
990226/15	0227/00	03° 03.1' N	127° 54.2' E	NNE	7.5	bc	1009.2	27.5	30	25.0	24.1	6	
990226/18	0227/03	02° 55.2' N	128° 14.2' E	NNE	4.4	bc	1007.5	27.1	29	25.5	25.5	4	
990226/21	0227/06	02° 48.5' N	128° 29.4' E	NNE	3.9	bc	1007.0	27.5	29	25.0	24.1	3	
990227/00	0227/09	03° 54.6' N	129° 52.1' E	NNE	5.3	bc	1008.0	28.3	30	25.3	24.2	4	
990227/03	0227/12	03° 10.5' N	129° 13.9' E	N	6.2	bc	1007.6	28.0	30	24.0	23.3	4	
990227/06	0227/15	03° 27.1' N	129° 35.2' E	N	6.5	bc	1005.6	30.1	30	26.1	24.6	3	
990227/09	0227/18	03° 41.5' N	129° 55.3' E	NNE	9.9	bc	1005.6	29.0	30	25.5	24.3	6	
990227/12	0227/21	03° 58.6' N	130° 18.3' E	NE	7.2	c	1007.4	27.0	30	24.5	23.6	9	
990227/15	0228/00	04° 14.5' N	130° 39.5' E	NE	6.5	bc	1008.3	28.0	30	25.0	23.9	6	
990227/18	0228/03	04° 30.0' N	131° 00.0' E	ENE	8.0	bc	1006.6	27.8	30	25.1	23.9	3	
990227/21	0228/06	04° 46.7' N	131° 22.4' E	NE	8.1	bc	1006.1	27.2	30	25.0	24.2	2	
990228/00	0228/09	05° 06.0' N	131° 48.1' E	NE	7.1	bc	1007.0	28.0	29	25.6	24.7	6	
990228/03	0228/12	05° 25.0' N	132° 02.9' E	ENE	7.9	bc	1007.2	28.8	29	25.5	24.3	7	
990228/06	0228/15	05° 39.4' N	132° 25.4' E	E	7.0	c	1004.8	29.5	29	25.5	24.1	8	
990228/09	0228/18	05° 50.6' N	132° 47.4' E	ENE	6.6	bc	1005.1	27.0	29	25.0	24.3	7	
990228/12	0228/21	06° 11.3' N	133° 09.9' E	ENE	7.6	c	1007.2	27.8	29	26.0	25.4	8	
990228/15	0301/00	06° 37.2' N	133° 32.6' E	E	7.4	o	1007.8	26.0	29	25.0	24.6	10	
990228/18	0301/03	07° 01.4' N	133° 54.1' E	ENE	11.1	c	1005.8	27.8	29	26.0	25.3	9	

Palau Arrival

8-09

SUMMARY REPORT
THE TROPICAL OCEAN CLIMATE STUDY (TOCS) KY99-01 CRUISE

by:

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1. Introduction

Ocean circulation in the western tropical Pacific ocean is one of the major components of global ocean circulation system, and its complexity is known widely. There are the westward south equatorial current, the eastward north equatorial countercurrent, the equatorial undercurrent, the southward Mindanao undercurrent, and the northwestward Papua New Guinea coastal current; all of these make up a very complicated circulation system. These currents play important roles in the redistribution of warm in the oceans and hence in global climate changes as well. It is well known that the turning points of various parts of the equatorial current system are located in the tropical Pacific ocean.

As a marine country located on the westward coast of the Pacific ocean, Indonesia will put an emphasis on experimental research into the following several ocean components which are great significance to these ocean circulation. Gordon (1986), reported that inter ocean transport with the Indonesian seas is the primary means exporting excess freshwater from the northern Pacific ocean. The recent study was conducted by Kashino et all (1995), noted that the existence of North Pacific Intermediate Water and Antarctic Intermediate Water in the far western equatorial Pacific near the entrances to the Celebes and Halmahera Seas. They also provide further evidence for the flow of waters from the southern hemisphere across the equator, turning eastward in to the North equatorial countercurrent with deeper flows continuing northward underneath the Mindanao current. They suggest that south Pacific ocean also its contribution. Shortly to say that western equatorial Pacific water is playing important role in the ENSO phenomena.

Participation of Indonesia scientist in the ongoing Tropical Ocean Climate Study (TOCS) based on BPPT (Agency for The Assessment and Application of Technology) and JAMSTEC (Japan Marine Science and Technology Center) implementing arrangement for FY 98/99. In according with Memorandum of Understanding (MOU) as an umbrella between Japan-Indonesian government joint co-operations in science and technology development.

Therefore, the TOCS program is very important for both countries in the study of global climatic change where Indonesia and Japan have the direct impact of El Nino phenomena.

2. Purpose

General purpose of the TOCS programs are to observe physical oceanographic conditions in the western tropical Pacific waters and to achieve better understanding of ocean – atmosphere interaction in affecting El Nino / Southern Oscillation (ENSO) phenomena, because it is occurred with migration of the warm water pool in the western equatorial Pacific.

The participation of Indonesian scientist in this cruise will look further the couple effects of Indonesian seas through TOCS Program in the frame of global climatic changes studies. Some point issues can be derived in those studies as follow :

- To identify water masses characteristics between Mindanao and Papua New Guinea.
- To identify the temperature – salinity structure of the warm pool in the Tropical Pacific Ocean and its relationship with ENSO (El Nino and the Southern Oscillation)
- To calculate better approximation of Pacific – Mindanao sea throughflow transport with knowing how strength and variability of current transport in the seepage of western Pacific ocean to Mindanao seas.

3. The TOCS KY99-01 Deployment Cruise

In the winter of 1999, we held a joint survey with JAMSTEC around the western equatorial Pacific ocean. Cruise number is generally abbreviated as follows : **KY99-01.** KY is the ship name *Kaiyo* The number 99-01 means the first cruise in 1999, conducted by JAMSTEC.

This cruise divided into 2 Legs. The Leg 1 of cruise started from Majuro on January 26,1999 till February 11, 1999. It focused on buoy works and oceanographic survey (current observation by shipboard ADCP along cruise track and measurement CO_2 concentration of sea surface water and air) of Micronesia EEZ, Open Sea, Papua New Guinea EEZ and Palau EEZ.

The Leg 2 started from Palau on February 14, 1999 focused on buoy work and Hydrographic observation by CTD, Lowered ADCP, XCTD and oceanographically survey (current observation by shipboard ADCP along cruise track and water sampling) of Palau EEZ, Open Sea, Phillipine EEZ, and Indonesian EEZ, territorial water also. These cruises finished on first March, 1999.

The parameters of this cruise include :

a. CTD, Sample Water Salinity and Dissolved Oxygen.

- CTD cast from the surface level down to 1000m above bottom with an SBE CTD profiler system with 6 (six) niskin bottles sampling (5L). The sampling layers shallower than 1000m were 500, 600, 700, 800, 900 and 1000m. These sensors measured salinity, temperature and pressure and oxygen content. Winch and cable: Tsurumi Seiki TS-10PVCTD winches having 8000 meters cable of 10.6mm diameter. The descending was about 1,2 m/sec. This data was processed using SEASOFT provided by Sea-Bird Electronics and some programs developed in JAMSTEC coded in FORTRAN.
- The bottles in which the salinity samples are collected and stored are 250ml Phoenix brown glass bottles with screw caps. Each bottles were rinsed three times and filled with sample water. They were stored in the laboratory where the salinity measurement was made, for about 24 hours.

b Deployment Mooring

- STD ATLAS moorings conducted by PMEL covering recovery and deployment at position of 0, 146.58E and 2.30N, 137.25E and at position 0, 141.58E covering only recovery. The ATLAS gave real time meteorological surface data and sub surface water temperature at the mooring sites. The telemetric system using satellite made it possible to other community to pick the data.

- Subsurface ADCP (Acoustic Doppler Current Profiler) mooring conducted by JAMSTEC at position of 0, 138E covering recovery and deployment and at position 0, 141.58E only covering recovery. This equipment plan to record time series of current variability along 1 (one) year mooring time. The ADCP mooring used in the cruise made by RD Instrument. It is equipped in the hole of a spherical subsurface buoy and a CTD censor of Sea-Bird Electronics, attaching a few meters below the bottom of this surface buoy to monitor vertical migrations of the ADCP and the ambient temperature. The planned depth of this subsurface buoy was about 250 – 270m, making the heads of ADCP to look upward without any obstacles. The descending was about 2,0 m/sec.

c Underway

- Along the ship track, R/V *Kaiyo* was available GPS (Global Positioning system), mounts the NB (Narrow-Band) ADCP (Acoustic Doppler current Profiler) at 75 kHz manufactured by RD Instrument. It continuous measurement well during the tracks.
- Routine weather observations with 24 hours intervals are carried out on our cruise (wind, sea water and air temperature).

4. Data Collection Program Comments

4.1 The Leg.1 of TOCS KY 9901 cruises

KY9901 cruise started from Majuro, Rep.Marshall Islands on January 26,1999 to survey around the western equatorial Pacific ocean, heading southwest towards equatorial, on January 28 began XC1 (0, 161E) at 19.27 GMT. R/V *Kaiyo* was steaming to west along equatorial directly to begin C01 (0, 161E) at 19.45 GMT until C07 (0, 149E) respectively. Finishing 7 stations, before doing recovery and deployment of STD ATLAS mooring at 20.51on January 31. There is no trouble when we released the buoy. It was responding directly. R/V *Kaiyo* was steaming to west along equatorial to continue C08 (0, 147E) at 04.39 GMT until C10 (0, 143E) on February 02, 1999. The ship drifted along the night before beginning the recovery of ADCP mooring at position of 0, 141-58E, on February 03, 1999 at 07.06 Local time. It was done efficiently and continued to begin 6-CTD 142E transect in the southern hemisphere at C11 (0, 142E) on mid day and finished at C16 (2.30S, 142E) on February 03, 1999, at 16.12 GMT.

After finishing the 6-CTD 142E transect, the *Kaiyo* was steaming to northeast to get the C17 (0, 140E). She was steaming to west along the equator to get ADCP recovery and deployment position at 0, 138E, on February 5, at 08.15 local time and its finished at 11.21 local time and continued to CTD at C18 (0, 138E) at 13.00 local time. Then, the *Kaiyo* was steaming to Northwest to get STD ATLAS recovery and deployment position at 2,3N, 138E, and continued at C19 (2.3N, 137.3E).

We recovered and deployed STD ATLAS on February 6, 1999, at 08.15 AM local time and finished it at 12.54 PM. There are 20 CTD stations finishing when we arrived in Koror, Rep.Palau on February 9, 1999, at 12.00. There are some extra works for unloading of PMEL gear in the container and Barbeque. We had a marvelous time at the party.

4.2 The Leg.2 of TOCS KY 9901 cruises

This cruise started February 14, 1999 and went to southwest to get position C 20 (6N, 133E) at 14.30 GMT. The ship was steaming to west along 6N to begin 2 CTD C21 and C22 at position (6N, 132.3E) and (6N, 132E). Because of bad weather (storm) to get the station along on 6N transect, chief scientist changed next station along on 5N transect to run out for the storm. The ship was steaming southwest to get station C23 (5N, 131.3E) on February 15, at 05.53 GMT. She was steaming to west along 5N transect directly to begin C24 (5N, 131E) at 10.31 GMT until C46 (5N, 143E) on February 18, 1999, at 15.15 GMT respectively. On February 17,1999 at 08.00 local time we were preparing to deploy ADCP mooring at position (5N, 125.4E) for about 2 (two) hours, then deployment started at. 09.47 until at 10.37 local time. The mooring was deploying to make the ADCP buoy placed at about 250m. After we dropped the anchor, we monitored depth of the acoustic releaser.

The *Kaiyo* was steaming to southwest to get station C52 (3.3N, 124.3E) at 04.56 GMT on February 19, 1999. She continued to southeast to get C55 (2N, 125E) at 16.10 GMT. After finishing 7 CTD, the ship was steaming to northwest to get station XC3 (5N, 122E) at 21.09 GMT on February 20, 1999. Then, the ship was steaming to south along 122E transect directly to begin XC4 (4.3N, 122E) at 23.56 GMT until XC10 (1.3N, 122E) respectively and continued to northwest on February 21, 1999, at 17.03 GMT

After for one week to steam ahead in the second leg, R/V *Kaiyo* got the position XC11 (3.3N, 122E) at 13.57 GMT on February 22, 1999. Then, she was steaming to east along 3.3N transect directly to begin XC12 (3.3N, 119.3E) at 17.29 GMT until XC21 (3.3N, 124.4E) at 20.50 GMT on February 23, 1999, respectively. The ship continued to southeast XC22 (2.3N, 124.4E) on February 24, 1999, at 04.03 GMT, and 2 CTD C56 and C57 at position (1.44.7N, 125.25E) and (1.45N, 125.4E). She was steaming to east along 1.45N transect to begin C58 (1.45N, 125.6E) until C64 (1.45N, 127.25E) respectively and continued to northwest to get station C65 (3.3N, 125.5E) at 21.29 GMT.

The *Kaiyo* was steaming to east along 3.3N transect directly to begin C66 (3.3N, 126.05E) at 23.26 GMT on February 25, 1999, until C69 (3.3N, 126.5E) at 05.11 GMT on February 26, 1999, respectively. The ship continued to southeast C70 (3.25N, 127.4E) and 8 CTD C71, C72, C73, C74, C75, C76, C77 and C78 at position (2.45N, 128.28E) on February 26, 1999, at 21.54 GMT. The ship continued to southeast C79 (2.59N, 129E) on February 27, 1999, at 00.51 GMT, and 9 CTD C80 until C88, 11 XCTD XC23 until XC29-1, XC29-2, XC29-3 at 04.08 local time on February 28,1998. At 19.15 local time, the ship got station C89 (6N,133E) wherein it was a last station in these cruises. The *Kaiyo* arrived in Port of Malakal, Koror, Rep. of Palau on first March 1999.

5. Comments and Suggestions

5.1 Comments

The TOCS KY9901 cruises were conducted on board the R/V *Kaiyo* in the Micronesia EEZ, Palau EEZ, Papua New Guinea EEZ and Indonesia EEZ, the cruises track were designed to contribute to TOCS program and to observe the Indonesian throughflow between Mindanao and Papua New Guinea.

During the cruises, there are 2 (two) recoveries and deployments of STD ATLAS and 1 (one) recovery and deployment and 1 (one) only recovery and 1 (one) only deployment of ADCP mooring. We recovered 2 (two) ADCP moorings which were deployed one year ago. After the recovery, we uploaded ADCP data into a computer, then raw data we converted into ASCII code. There are 21 (twenty one) LADCP stations and 32 (thirty two) XCTD stations, 89 (eighty nine) CTD stations casts were taken from the level of the surface to 1000m above bottom with an SBE CTD profiler also. CTD raw data, acquired at the frequency of 24 Hz, were converted to averaged data in bins, theses averaged data used to describe vertical and horizontal sections of salinity and acceleration potential.

In general, the recoveries and deployments of ADCP and STD ATLAS moorings that have been already conducted successfully. The CTD casts have been done successfully also.

5.2 Suggestions

Therefore, the implementation of the TOCS program will directly benefit the prediction of climate and sea in both of country (especially, Indonesia and Japan), in addition :

- We are strongly support for doing more discussions and small presentations from both of parties during the cruise, to accommodate any idea and to report recent result of our finding. Any original ideas to solve the issues are inviting.
- To be able to clarify the mechanism affecting climate change with scales of several months to several years would not only speed up the development of ocean dynamics, but would also deepen our understanding of the characteristics of the circulation system and its thermal structure in the western tropical Pacific ocean. Therefore we really hope that there will be very active and useful discussions today and tomorrow on the future directions of the TOCS program. We sincerely hope this will also contribute to the promotion of international cooperation in this area (especially around southeast Asian country) for the immediate future as well as for the formulation of long-term perspectives.

Acknowledgments

We are much obligated and thank to Mr.Yuji Kashino, chief scientist of JAMSTEC for his kind of instruction and suggestion in development of our cruising and all our colleagues on board. Their hard and effective work during long hours were key to achieving the TOCS KY9901 cruise objectives.

For convenience both Captain K.Hasegawa and Captain H.Tanaka, We are grateful to you and your fine the officers, crews of the R.V *Kaiyo* for their great help in the sea-going operations, solid and professional works, showing during this cruises.

Thanks are also due to DR.Indroyono Soesilo (Deputy Chairman BPPT for Natural Resources Development), DR.Iwan Gunawan (Director of Technology for Natural Resources Inventory), Yusuf Surachman,MSc (Manager of Marine Core Competency TISDA) for their continuing supports of our joint research.

References

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2. **Kashino et all**, The Water Masses between Mindanao and New Guinea, Proceedings of International Workshop on the throughflow studies in and around Indonesian waters, 1995.

Time Table of TOCS KY9901 Cruise (Time in this table is that used in R/V Kaiyo.)

January 26 (Tue) Fine

09:00 Departure from Majuro

January 27 (Wed) Rain

(cruise to the first station)

21:00 Time lag adjustment (one hour delay)

January 28 (Thu) Fine

(cruise to the first station)

21:00 Time lag adjustment (one hour delay)

January 29 (Fri) Fine

05:27 XC01 (0-00N, 161-00E) XCTD

05:47 - 06:17 C01 (0-00N, 160-59E) CTD and water sampling

15:31 - 16:00 C02 (0-00N, 159-00E) CTD and water sampling

January 30 (Sat) Fine

01:16 - 02:00 C03 (0-00N, 157-00E) CTD and water sampling

12:14 - 12:40 C04 (0-00N, 155-00E) CTD and water sampling

22:03 - 22:29 C05 (0-00N, 153-00E) CTD and water sampling

January 31 (Sun) Fine

07:50 - 08:16 C06 (0-00N, 151-00E) CTD and water sampling

17:45 - 18:10 C07 (0-00N, 149-00E) CTD and water sampling

February 1 (Mon) Fine

06:51 - 08:55 ATLAS buoy recovery at 0-00N, 147-00E

10:03 - 12:45 ATLAS buoy deployment at 0-00N, 147-00E

13:02 - 14:27 Acoustic releaser check

14:39 - 15:04 C08 (0-00N, 146-57E) CTD and water sampling

February 2 (Tue) Fine

07:56 - 08:24 C09 (0-00N, 145-00E) CTD and water sampling

18:50 - 19:16 C10 (0-00N, 143-00E) CTD and water sampling

February 3 (Wed) Cloudy

06:57 - 09:09 ADCP buoy recovery at 0-00N, 142-00E

09:30 - 09:55 C11 (0-00N, 142-00E) CTD and water sampling

12:51 - 13:14 C12 (0-30S, 142-00E) CTD and water sampling
16:05 - 16:30 C13 (1-00S, 142-00E) CTD and water sampling
19:21 - 19:42 C14 (1-30S, 142-00E) CTD and water sampling
22:33 - 22:55 C15 (2-00S, 142-00E) CTD and water sampling

February 4 (Thu) Cloudy
01:49 - 02:12 C16 (2-30S, 142-00E) CTD and water sampling
19:56 - 20:25 C17 (0-00N, 140-00E) CTD and water sampling

February 5 (Fri) Fine
08:19 - 09:47 ADCP buoy recovery at 0-00N, 138-00E
10:25 - 11:52 ADCP buoy recovery at 0-00N, 138-00E
13:00 - 13:20 C18 (0-00N, 138-01E) CTD and water sampling

February 6 (Sat) Fine
08:01 - 10:23 ATLAS buoy recovery at 2-24N, 137-24E
11:15 - 12:54 ATLAS buoy deployment at 2-24N, 137-24E
13:54 - 14:18 C19 (2-26N, 137-24E) CTD and water sampling
14:50 - Start of shipboard ADCP calibration

February 7 (Sun) Fine
- 12:20 End of shipboard ADCP calibration
21:00 Time lag adjustment (one hour delay) to Palau Time

February 8 (Mon) Fine
Cruise to Palau

February 9 (Tue) Fine
11:20 Arrival at Koror, Parau

February 10 (Wed) Fine
Fueling

February 11 (Thu) Fine
Preparation for Leg 2

February 12 (Fri) Rain
Preparation for Leg 2

February 13 (Sat) Rain

Preparation for Leg 2

February 14 (Sun) Cloudy

10:20 Departure from Palau

23:30 - 24:29 C20 (6-00N, 133-00E) CTD, LADCP and water sampling

February 15 (Mon) Fine

03:32 - 04:23 C21 (6-00N, 132-30E) CTD and LADCP

07:30 - 08:32 C22 (6-00N, 132-00E) CTD, LADCP and water sampling

14:53 - 15:43 C23 (5-00N, 131-30E) CTD and LADCP

19:31 - 20:31 C24 (5-00N, 131-00E) CTD, LADCP and water sampling

February 16 (Tue) Fine

00:19 - 01:07 C25 (5-00N, 130-30E) CTD and LADCP

04:45 - 05:41 C26 (5-00N, 130-00E) CTD, LADCP and water sampling

07:37 - 08:24 C27 (5-00N, 129-45E) CTD and LADCP

10:19 - 11:15 C28 (5-00N, 129-30E) CTD, LADCP and water sampling

13:08 - 13:55 C29 (5-00N, 129-15E) CTD and LADCP

14:13 XC02 (5-00N, 129-14E) XCTD

15:52 - 16:46 C30 (5-00N, 129-00E) CTD, LADCP and water sampling

18:37 - 19:21 C31 (5-00N, 128-45E) CTD and LADCP

21:02 - 22:03 C32 (5-00N, 128-30E) CTD, LADCP and water sampling

23:40 - 24:50 C33 (5-00N, 128-15E) CTD and LADCP

February 17 (Wed) Fine

02:05 - 03:00 C34 (5-00N, 128-00E) CTD, LADCP and water sampling

04:42 - 05:30 C35 (5-00N, 127-45E) CTD, LADCP

07:13 - 08:07 C36 (5-00N, 127-00E) CTD, LADCP and water sampling

09:43 - 10:29 C37 (5-00N, 126-45E) CTD, LADCP

12:06 - 12:40 C38 (5-00N, 126-30E) CTD, LADCP and water sampling

14:16 - 14:50 C39 (5-00N, 126-15E) CTD, LADCP

16:22 - 17:19 C40 (5-00N, 126-00E) CTD, LADCP and water sampling

21:45 - Start of sea beam measurement

February 18 (Thu) Fine

- 06:00 End of sea beam measurement

09:47 - 11:30 Current meter buoy deployment at 5-07N, 125-40E

12:59 - 13:42 C41 (5-14N, 125-38E) CTD, LADCP and water sampling

15:02 - 15:48 C42 (5-07N, 125-49E) CTD

17:07 - 17:44 C43 (5-00N, 126-00E) CTD, LADCP and water sampling

19:22 - 19:49 C44 (5-00N, 126-15E) CTD
22:24 - 22:52 C45 (5-00N, 125-45E) CTD

February 19 (Fri) Fine
00:15 - 00:43 C46 (5-00N, 125-30E) CTD and water sampling
02:24 - 02:52 C47 (4-45N, 125-20E) CTD
04:28 - 05:03 C48 (4-30N, 125-10E) CTD and water sampling
06:49 - 07:19 C49 (4-15N, 125-00E) CTD
09:04 - 09:37 C50 (4-00N, 124-50E) CTD and water sampling
11:23 - 11:51 C51 (3-45N, 124-40E) CTD
13:56 - 14:30 C52 (3-30N, 124-30E) CTD and water sampling
17:38 - 18:15 C53 (3-00N, 124-50E) CTD and water sampling
21:26 - 22:03 C54 (2-30N, 124-40E) CTD and water sampling

February 20 (Sat) Cloudy
01:13 - 01:45 C55 (5-00N, 125-30E) CTD and water sampling

February 21 (Sun) Fine
06:09 XC03 (5-00N, 122-00E) XCTD
08:56 XC04 (4-30N, 122-00E) XCTD
11:50 XC05 (4-00N, 122-00E) XCTD
14:39 XC06 (3-30N, 122-00E) XCTD
17:32 XC07 (3-00N, 122-00E) XCTD
20:22 XC08 (2-30N, 122-00E) XCTD
23:12 XC09 (2-00N, 122-00E) XCTD

February 22 (Mon) Fine
02:03 XC10 (1-30N, 122-00E) XCTD
22:57 XC11 (3-30N, 119-00E) XCTD

February 23 (Tue) Cloudy
02:29 XC12 (3-30N, 119-30E) XCTD
05:53 XC13 (3-30N, 120-00E) XCTD
09:11 XC14 (3-30N, 120-30E) XCTD
12:28 XC15 (3-30N, 121-00E) XCTD
15:41 XC16 (3-30N, 121-30E) XCTD
18:39 XC17 (3-30N, 122-00E) XCTD
21:26 XC18 (3-30N, 122-30E) XCTD

February 24 (Wed) Rain

00:10 XC19 (3-30N, 123-00E) XCTD
02:52 XC20 (3-30N, 123-30E) XCTD
05:50 XC21 (3-30N, 124-00E) XCTD
13:03 XC22 (2-32N, 124-47E) XCTD
18:43 - 19:19 C56 (1-45N, 125-25E) CTD and water sampling
20:52 - 21:20 C57 (1-45N, 125-40E) CTD
22:49 - 22:27 C58 (1-45N, 125-55E) CTD and water sampling

February 25 (Thu) Fine
01:02 - 01:30 C59 (1-45N, 126-10E) CTD
03:02 - 03:36 C60 (1-45N, 126-25E) CTD and water sampling
05:10 - 05:38 C61 (1-45N, 126-40E) CTD
07:20 - 07:53 C62 (1-45N, 126-55E) CTD and water sampling
09:19 - 09:47 C63 (1-45N, 127-10E) CTD
11:16 - 11:54 C64 (1-45N, 127-25E) CTD and water sampling

February 26 (Fri) Fine
06:29 - 06:59 C65 (3-30N, 125-50E) CTD and water sampling
08:26 - 08:52 C66 (3-30N, 126-05E) CTD
10:17 - 10:52 C67 (3-30N, 126-20E) CTD and water sampling
12:18 - 12:47 C68 (3-30N, 126-35E) CTD
14:11 - 14:48 C69 (3-30N, 126-50E) CTD and water sampling
16:02 - 16:30 C70 (3-25N, 127-02E) CTD
17:44 - 18:11 C71 (3-20N, 127-14E) CTD
19:28 - 20:04 C72 (3-15N, 127-26E) CTD and water sampling
21:21 - 21:47 C73 (3-10N, 127-38E) CTD
23:02 - 23:29 C74 (3-05N, 127-50E) CTD

February 27 (Sat) Fine
00:50 - 01:26 C75 (3-00N, 128-02E) CTD and water sampling
02:54 - 03:21 C76 (2-55N, 128-14E) CTD
04:52 - 05:18 C77 (2-50N, 128-26E) CTD
06:54 - 07:23 C78 (2-45N, 128-38E) CTD and water sampling
08:37 XC23 (2-52.5N, 128-49E) XCTD
09:52 - 10:24 C79 (3-00N, 129-00E) CTD and water sampling
11:46 XC24 (3-09N, 129-12E) XCTD
13:10 - 13:43 C80 (3-18N, 129-24E) CTD and water sampling
15:05 XC25 (3-27N, 129-36E) XCTD
16:27 - 17:02 C81 (3-36N, 129-48E) CTD and water sampling
18:25 XC26 (3-45N, 130-00E) XCTD

19:46 - 20:20	C82 (3-54N, 130-12E) CTD and water sampling
21:36	XC27 (4-03N, 130-24E) XCTD
22:56 - 23:33	C83 (4-12N, 130-36E) CTD and water sampling

February 28 (Sun) Fine

00:51	XC28 (4-21N, 130-48E) XCTD
02:12 - 02:51	C84 (4-30N, 131-00E) CTD and water sampling
02:58	XC29-1 (4-30, 131-00E) XCTD (XCTD performance test)
03:08	XC29-2 (4-30, 131-00E) XCTD (XCTD performance test)
03:18	XC29-3 (4-30, 131-00E) XCTD (XCTD performance test)
04:29	XC30 (4-39N, 131-12E) XCTD
05:51 - 06:26	C85 (4-48N, 131-24E) CTD and water sampling
07:45	XC31 (4-57N, 131-36E) XCTD
09:08 - 09:48	C86 (5-06N, 131-48E) CTD and water sampling
13:15 - 13:46	C87 (5-36N, 132-12E) CTD
15:57 - 16:30	C88 (5-42N, 132-36E) CTD and water sampling
19:10 - 19:41	C89 (6-00N, 133-00E) CTD

March 1 (Mon) Fine

10:30	Arrive at Koror, Palau