# Preliminary Report
# of
# The Hakuho Maru Cruise
# KH-07-1 leg 2

7 May ~ 8 June 2007

Hakodate – Tokyo

Ocean Research Institute
The University of Tokyo
2008

# Preliminary Report
# of
# The Hakuho Maru Cruise
# KH-07-1 leg 2

7 May ~ 8 June 2007

Hakodate – Tokyo

Cruise for
observations of water masses, circulation, and
turbulence in the Northwest Pacific Basin

by

The Scientific Members of the Cruise

Edited by

Masaki KAWABE


2007
5/9 – 6/8
白鳳丸
KH-07-1
Leg.2

## CONTENTS

# 1. Cruise Narrative

The research cruise KH-07-1 leg 2 of R.V. *Hakuho Maru* was conducted for 33 days between 7 May and 8 June 2007 for study of physical oceanography entitled "Study on processes of formation, transportation, and conversion of water masses in the western North Pacific". We departed from the West Pier of Hakodate Port at 14:00 on 9 May and returned to Tokyo Port at 10:00 on 8 June. Due to rough weather, we fled to outside of Miyako and Kamaishi Ports in the Iwate Prefecture from 10 to 12 May, and called urgently at Kamaishi between 9:00 on 18 May and 13:00 on 19 May.

Study subjects of the cruise KH-07-1 leg 2 were

(1) to study variations of deep circulation currents and distribution of deep water masses (Ocean Research Institute, The University of Tokyo; ORI),
(2) to study distribution of vorticity in the Kuroshio (ORI),
(3) to study processes of advection and dissipation of Subtropical Mode Water (Tohoku University),
(4) to study physical, chemical, and biological processes of the Subtropical Mode Water-seasonal pycnocline system (Tohoku University),
(5) to study an estimation of coefficient of diffusivity by measuring density ratios and turbulence (Tokyo University of Marine Science and Technology),
(6) to study oceanographic variations in the western North Pacific using Argo floats (Japan Agency for Marine-Earth Science and Technology, JAMSTEC),
(7) to study distribution and ecology of drifting seaweeds and phytal animals in the northwestern Pacific (ORI and Tsukuba University).

The primary works were deployment and recovery of moorings of current meters to obtain time series of current velocity, as well as full-depth casts of $CTDO_2$ (conductivity, temperature, depth, oxygen profiler) for measuring water temperature, salinity, and dissolved oxygen, LADCP (lowered acoustic Doppler current profiler) for measuring current velocity and echo intensity of sound pulse, and water sampler with Niskin bottles for chemical parameters.

The water sampler frame was equipped with $CTDO_2$ sensors, 24 Niskin bottles, and two LADCPs with batteries, by attaching a stand for upward LADCP. In order to avoid a touch and collision to sea bottom of the underwater instruments, we equipped the water sampler frame with an altimeter and a bottom-touch-switch. The altimeter monitored the distance from sea bottom within approximately 30 m, but was wrong at C006 and was replaced by a pinger. The bottom-touch-switch hanging a 15-m string and a weight informed us that the instruments reached less than 15 m above sea bottom, by ringing buzzer in the laboratory of the vessel.

$CTDO_2$ measurement with the sensors was performed during downcast, and sea water was sampled at 24 positions during upcast. Salinity, dissolved oxygen, and nutrients of water samples were measured on board, and the sample values of salinity and oxygen were used for the calibration of sensor values of $CTDO_2$. At all CTD stations, water temperature, salinity, and dissolved oxygen at sea surface were measured by sampling surface water with a bucket, and salinity of the intake water was measured to correct the data of salinograph.

Temperature and salinity data of CTD and XCTD (expendable CTD) were sent to the Japan Meteorological Agency by the TESAC telegram in quasi–real time. We measured current velocity in a surface layer with shipboard ADCP of Furuno Electric Co., Ltd. and RD Instruments throughout the cruise. Visual survey of drifting seaweeds was conducted during the daytime.

On 8 May 2007 at Hakodate Port, we loaded instruments and materials for observations into the vessel (part of them had been loaded at Tokyo Port on 29 March), and coiled ropes of two moorings on a drum of winch. Then we left Hakodate Port at 14:00 on 9 May on schedule, but soon we had to change the observation schedule, because an atmospheric depression approached the observation area. We initially deployed the mooring W1 and conducted CTD/LADCP casts (called CTD casts hereafter) at C001 and C002. After the cast, we headed the vessel to Miyako Port and anchored outside of the port in the evening on 10 May. However, swell was too strong, and we moved to south and anchored outside of Kamaishi Port at noon on 11 May.

We left Kamaishi at 08:00 on 12 May, and performed a measurement of turbulence and microstructure using TURBOMAP and CTD cast at 40°N, 143°40′E in the afternoon. Six moorings W2~W7 were deployed along 40°N between 13 and 16 May. The location of the mooring W3 had been planned to be 40°N, 145°14′E but was changed to 40°N, 145°17′E, because a drift net fishing was performed at the planned place. The moorings W1~W7 with 34 current meters will be recovered on the KH-08-3 cruise. On 17 May, we recovered and redeployed the mooring N2 at 39°N, 146°24.5′E. The recovered four glass spheres had been exploded, and probably due to that the current meter just below the glass spheres stopped at the twentieth day because of a damage of the rotor.

As soon as the deployment of N2 had been over, we started to sail for Kamaishi Port for avoiding bad weather due to a strong depression. We conducted two casts of XCTD at intervals of 20′ longitude, but failed the third cast and then gave up XCTD cast. We made urgent port call at the Public Pier of Kamaishi Port at 09:00 on 18 May.

Before this port call, we performed 14 CTD casts (C001~C014), 2 TURBOMAP casts (TM01, TM02), 2 XCTD casts (X001, X002), and picked up drifting seaweeds several times. We used the CTD underwater unit SBE0400 at C001~C005, whose sensors of conductivity and oxygen did not well function at depths greater than 6100 db at C004 and 5000 db at C005. We changed to SBE0750 at C006, and also changed altimeter to pinger because the altimeter possibly influenced to the bad performance of CTD sensors.

We departed from Kamaishi Port at 13:00 on 19 May. Swells still remained immediately after the departure but weakened soon. We began CTD observations along 38°N at night. We recovered and redeployed the moorings N1 and N3, and recovered N4 between 21 and 23 May. Four glass spheres of N1 had been exploded similar to N2, but the current meter below them had no trouble. The recovery of N3 did not smoothly proceed. When arriving at N3, we had to stay there for two hours to wait for a finish of fisherman's work on a nearby fishing boat. In the recovery, the rope of the mooring was twined at the bottom of *Hakuho Maru*, and the crew lowered a boat to sea and dived to loose the rope. Some glass spheres and ropes were lost by this accident, but all the instruments were recovered safely. Thereafter, we deployed the mooring N3 in the afternoon of 23 May and finished mooring work in this cruise.

Full velocity data throughout the mooring period were obtained from 18 current meters out of 21 recovered in this cruise. Only 20–day record was obtained from one current meter (Union Engineering URCM) because of damage of rotor as mentioned above, and two current meters did not function at all because of heavy damage of the measurement part (Aanderaa RCM11) and a trouble of memory (URCM). Three moored CTDs (Sea–Bird Electronics MicroCAT) functioned well, but the other three did not function because of water leakage.

After leaving Kamaishi, we observed smoothly until 26 May. During this period, except for the mooring work, we conducted 21 CTD casts (C015~C035), 4 TURBPMAP casts (TM03~ TM06), and water sampling for helium at 150°E and 157°E on 38°N, deployed an Argo profiling float at 38°N, 156°E, and picked a big mass of drifting seaweeds on 24 May. "Free fall" of the CTD cable down to a depth of 6500 m was performed on 20 May to remove twists of the cable.

On the way of CTD observations along 38°N, we gave up them east of 157°E since weather was forecast to get worse at night on 26 May. We sailed southeastward from 38°N, 157°E to 32.5°N, 168°E deploying XCTD probes at an interval of 15′ latitude (X003~X023, one point was skipped because of strong wind). We arrived at 32.5°N, 168°E on 28 May, and performed TURBOMAP and XCTD casts but not CTD cast because wind was strengthening. We sailed westward performing XCTD casts at intervals of 30′ longitude. Then we could cast CTD at 32.5°N, 166°E in the morning of 29 May after waiting for calm weather. We performed CTD casts at intervals of 1° longitude and XCTD casts at the midpoints of CTD stations from 166°E to 160°E along 32.5°N. During these observations, an atmospheric depression came from the west at much higher speed than expected. The wind strengthened, but fortunately we could perform two CTD casts at 32.5°N, 159°20′E and 158°40′E over the Shatsky Rise.

In total, 9 CTD casts (C036~C044), 2 TURBOMAP casts (TM07, TM08), 12 XCTD casts (X024~X035), water sampling for helium at two stations (166°E, 160°E), and deployment of 2 Argo floats (167°E, 160°E) were performed between 158°40′E and 168°E on 32.5°N.

After the CTD casts over the Shatsky Rise, we sailed westward to 149°E on 32.5°N performing XCTD casts at intervals of 30′ longitude. Then we started the observations of Subtropical Mode Water (STMW). At seven stations on the lines from 32.5°N, 149°E to 31°N, 146°20′E and from 31°N, 146°20′E to 31°52′ N, 143°50′E, we performed casts of CTD (0~1000 m, C045~C051), TURBOMAP (0~500 m, TM09~TM15), and Fast Repetition Rate Fluorometer (FRRF 0~150 m, FR01~FR07). We changed the observation area a little southward from the original plan, namely, to the south of the 32.5°N line, considering the location of STMW at the observation time and decreasing an influence of atmospheric depression. The observations, therefore, were conducted in good sea condition.

Along 32.5°N, we sailed westward casting XCTD probes and changed the direction northeastward from 32.5°N, 140°E to 34°20′N, 142°20′E (A1). We started the crossing observations of the Kuroshio from A1, by sailing northwestward to A2 (36°N, 141°20′E), and measured velocity of the Kuroshio using shipboard ADCP. The observations were conducted at seven lines which were shifted one after another southwestward from the A1–A2 line. At three lines among the seven ones, we crossed the Kuroshio at low speed of 12 knot, although the usual speed of *Hakuho Maru* is 16 knot, and deployed XCTD probes at intervals of 10 miles (X069~ X101). At the last line, we detoured around the training area of the US Navy "Charley". We finished the Kuroshio observations at 18:30 on 7 June. This was also the end of observations in the cruise KH–07–1.

In total, we performed 51 CTD casts and 15 TURBOMAP casts. These were two thirds of the original plan because of several atmospheric depressions, but the casts in important places for our studies were performed. The recovery of 7 moorings, the recovery and deployment of 3 moorings, the water sampling for helium at 4 stations, and the deployment of 3 Argo floats were conducted as planned. Moreover, 101 XCTD casts and the Kuroshio-crossing observations along 7 lines exceeded the plan, and drifting seaweeds could be sampled at the 40°N and 38°N lines. Thus, the observations in leg 2 of the KH–07–1 cruise were very successful.

Acknowledgements

Success in this cruise was owing to the devoted work of the people who participated in the cruise KH-07-1 leg 2. I express my gratitude to Captain Shoichi Suzuki, the crew of R.V. *Hakuho Maru*, and the scientists and technical staff for their cooperation in the work throughout this cruise.

We thank the Research Vessel Operation Department of JAMSTEC and the Office for Cruise Coordination of ORI for procedure of the urgent port call to Kamaishi, supply of information of weather and wave forecasts as well as military trainings in the "Charley" area, and so on, and Mr. Tadashi Inagaki, Mr. Hideo Ishigaki, staff in the Office for Cruise Coordination of ORI, and Mss. Fukuko Sogo and Kanae Komaki in the Division of Ocean Circulation of ORI for sending necessary things to Kamaishi Port.

Thanks are extended to Dr. Hiroshi Ogawa, his colleagues in the Division of Marine Biogeochemistry of ORI, and Mr. Keiri Imai (Office for Cruise Coordination of ORI) for their kind cooperation in the pre-cruise preparation for nutrient measurements.

Chief Scientist

Masaki Kawabe

Department of Physical Oceanography
Ocean Research Institute
The University of Tokyo

## 2. Summary of the measurement and correction

### A. Water Sample

#### A1. Instrument

Seawater was sampled from 12-liter Niskin bottles mounted at 24 places on a Sea-Bird Electronics Carousel water sampler SBE32 for 24 bottles (Serial Number 10367-0038).

#### A2. Conductivity

Conductivity of water samples was measured with a salinometer Guildline Portasal Model 8410A (S/N 63893) which was standardized by IAPSO Standard Seawater (Ocean Scientific International Ltd.) of Batch P147 ($K_{15}$ = 0.99982). The measurement was done in Laboratory 5 in which air temperature was controlled to be a little (≈ 3°C) lower than water temperature in the salinometer water bath being 25°C.

#### A3. Dissolved Oxygen

Dissolved oxygen of water samples was measured with an automatic recording titrator Metrohm Shibata 798 MPT Titrion (S/N 03105). We used 0.02 mol $l^{-1}$ Sodium Thiosulfate Solution (Wako Pure Chemical Industries Ltd.) (factor = 1.00) for titration.

#### A4. Nutrients

We analyzed nitrate, nitrite, silicate, and phosphate using an auto analyzer Bran Luebbe AACS-II. Nitrate, nitrite, and phosphate standard solutions were prepared in laboratory before the cruise. Silicate standard solution was 1,000 ppm Silicon Standard Solution for atomic absorption spectrometry (Wako Pure Chemical Industries, Ltd.). For working standards and baseline solution, we used natural seawater of low nutrients which was filtered and analyzed in laboratory before the cruise.

For later comparison of result, we measured concentration of nutrients of the Reference Material of Nutrients in Seawater (RMNS), RMNS Lot-AV and Lot-AX. The average, standard deviation (μmol $kg^{-1}$), and the number of measurement are as follows.

| | Nitrate | Nitrite | Silicate | Phosphate |
|---|---|---|---|---|
| RMNS Lot-AV | 33.23 | 0.07 | 157.56 | 2.40 |
| | 0.14 | 0.01 | 1.30 | 0.02 |
| | 130 | 130 | 130 | 130 |
| RMNS Lot-AX | 21.80 | 0.32 | 58.59 | 1.50 |
| | 0.10 | 0.01 | 0.55 | 0.01 |
| | 130 | 130 | 130 | 130 |

Concentrations of nutrients of RMNS in the cruise KH-04-4 were as follows.

KH-04-4 leg 1

| | Nitrate | Nitrite | Silicate | Phosphate |
|---|---|---|---|---|
| RMNS Lot-AS | 0.01 | 0.01 | 1.34 | 0.04 |
| | 0.09 | 0.01 | 0.20 | 0.01 |
| | 46 | 46 | 46 | 46 |
| RMNS Lot-AT | 7.49 | 0.01 | 18.50 | 0.55 |
| | 0.08 | 0.01 | 0.25 | 0.01 |
| | 46 | 46 | 46 | 46 |
| RMNS Lot-AU | 30.23 | 0.01 | 69.45 | 2.15 |
| | 0.17 | 0.01 | 0.48 | 0.01 |
| | 46 | 46 | 46 | 46 |

KH-04-4 leg 2

| | Nitrate | Nitrite | Silicate | Phosphate |
|---|---|---|---|---|
| RMNS Lot-AS | 0.08 | 0.01 | 1.61 | 0.07 |
| | 0.023 | 0.004 | 0.047 | 0.009 |
| | 36 | 36 | 36 | 36 |
| RMNS Lot-AT | 7.48 | 0.01 | 18.32 | 0.58 |
| | 0.025 | 0.004 | 0.046 | 0.007 |
| | 36 | 36 | 36 | 36 |
| RMNS Lot-AU | 29.96 | 0.01 | 68.16 | 2.18 |
| | 0.068 | 0.004 | 0.106 | 0.006 |
| | 72 | 72 | 72 | 72 |

## B. CTD$O_2$

### B1. Instrument

The CTD$O_2$ was a Sea-Bird Electronics instrument for 6500 db (SBE9plus). The sensor of conductivity was manufactured by Sea-Bird Electronics, Inc. (SBE4) who claimed a resolution of 0.00004 S $m^{-1}$ (0.0004 mmho $cm^{-1}$) and an accuracy of ±0.0003 S $m^{-1}$ (±0.003 mmho $cm^{-1}$). The sensor of water temperature was manufactured by Sea-Bird Electronics, Inc. (SBE3plus) who claimed a resolution of 0.0002°C and an initial accuracy of ±0.001°C. The sensor of pressure was manufactured by Paroscientific Digiquartz (Model 4xK) with a resolution of 0.001% of full scale and an accuracy of ±0.015% of full scale (6000 db range). The sensor of dissolved oxygen was manufactured by Sea-Bird Electronics, Inc. (SBE43) who claimed an accuracy of 2 % of saturation.

We used two sets of the CTD$O_2$ underwater instrument. Instrument No. 1 (C001~C005) was CTD SBE9plus (S/N 12545-0400) equipped with conductivity sensor SBE4 (S/N 2496), temperature sensor SBE3plus (S/N 0893), pressure sensor (S/N 12545), oxygen sensor SBE43 (S/N 0775), and pump SBE5 (S/N

1267). Instrument No. 2 (C006~C051) was CTD SBE9plus (S/N 89961-0750) equipped with C sensor SBE4 (S/N 1578), T sensor SBE3plus (S/N 4378), P sensor (S/N 89961), $O_2$ sensor SBE43 (S/N 0781 at C006~C035, S/N 0628 at C036~C051), and pump SBE5 (S/N 3867).

## B2. Data Collection

Full signals of frequency digitized 24 times per second and sent from the underwater CTD unit SBE9plus were received with the onboard unit SBE11plus and converted to output sequences of RS232C. The data were collected with the Sea-Bird Electronics CTD operating software SEASOFT, using an IBM-compatible personal computer EPSON Endeavor MT7500. The operating system of the personal computer is Windows, and the Windows version of software was used. The full signals of frequency were stored in the hard disc during the lowering stage of CTD cast and then were copied in magnetic optical discs at the deepest point of the cast.

## B3. Calibration

The sensors of conductivity, temperature, and dissolved oxygen are calibrated by Sea-Bird Electronics, Inc. once a year. The obtained coefficients were used in the CTD operating software SEASOFT.

### a. Pressure

Pressure data were corrected by subtracting the value of the pressure sensor in the air of -1.4 db for Instrument No. 1 and 0.4 db (C006~C035) and 0.5 db (C036~C051) for Instrument No. 2.

### b. Conductivity

Conductivity data were moreover calibrated using water-sample data. The ratio of conductivity from water sample to that from CTD (*CF*) was calculated. Vertical change of *CF* was expressed with polynomials of pressure *P* (db) such as

$$CF = a + bP + cP^2 + dP^3 + eP^4 + fP^5.$$

The sensor value of conductivity was multiplied by *CF* computed from the above equation and the following coefficients $a$~$f$ for station groups.

1) C001~C005
   $a$~$f$ = 1.000041, .3099419E-6, -.2804392E-9, .8680477E-13, -.8882411E-17, 0.0
2) C006C~C014
   $a$~$f$ = 1.000235, -.2297626E-6, .6475986E-10, -.5371314E-14, 0.0, 0.0
3) C015~C023
   $a$~$f$ = 1.000119, -.9281879E-7, .2017035E-10, -.1125567E-14, 0.0, 0.0
4) C024A~C035
   $a$~$f$ = 1.000065, -.2367516E-7, .3668843E-11, 0.0, 0.0, 0.0
5) C036~C044

$a \sim f$ = 1.000026, .7750997E-7, -.5884139E-10, .1353270E-13, -.9477478E-18, 0.0

6) C045~C051

$a \sim f$ = 1.000044, .1320197E-5, -.9293677E-8, .1692918E-10, -.8946822E-14, 0.0

The conductivity sensor was wrong at depths greater than 6096 db at C004 and 4957 db at C005. Salinity data at intervals of 1 db were made for depths greater than 4300 db by interpolating the salinity values from water samples and connected to the salinity data from sensors smoothly.

c. Dissolved Oxygen

Oxygen data were obtained with the method in the World Ocean Circulation Experiment (WOCE) Operations Manual, WOCE Hydrographic Programme Office Report WHPO 91-1, WOCE Report No. 68/91.

For SBE43, dissolved oxygen was calculated from the polarographic oxygen sensor electric voltage with the algorithm

$$O_x = \left[ A(O_V + B\frac{dO_V}{dt} + F) + C\exp(-0.03\,T) \right] O_x^*(T,S)\ \exp\left[DT + EP\right]$$

where $O_x$ is the concentration of dissolved oxygen (ml $l^{-1}$), $O_V$ the oxygen electric voltage, $T_o$ the oxygen sensor temperature (°C), $T$, $S$, and $P$ are water temperature (°C), salinity (psu), and pressure (db) measured with CTD, $O_x^*(T,S)$ the saturated oxygen for $T$ and $S$, and $t$ is time (sec).

The six parameters $A \sim F$ were determined with a nonlinear least squares fitting to the oxygen of water samples. The result of the coefficients is as follows. The coefficients $B$ and $C$ were fixed to zero for SBE43.

1) C001~C005

$A \sim E$= 0.407, 0.0, 0.0, 1.28E-3, 1.49E-4

$F$= -0.491 (C001), -0.492 (C002), -0.489 (C003), -0.488 (C004), -0.472 (C005)

2) C006C~C014

$A \sim E$= 0.394, 0.0, 0.0, -1.53E-3, 1.32E-4

$F$= -0.558 (C006C), -0.554 (C007B), -0.555 (C008), -0.561 (C009), -0.546 (C010), -0.555 (C011), -0.552 (C012), -0.546 (C013), -0.547 (C014)

3) C015~C023

$A \sim E$= 0.397, 0.0, 0.0, -9.55E-4, 1.33E-4

$F$= -0.574 (C015), -0.567 (C016), -0.559 (C017), -0.555 (C018), -0.552 (C019), -0.555 (C020), -0.555 (C021), -0.553 (C022), -0.550 (C023)

4) C024A~C035

$A \sim E$= 0.427, 0.0, 0.0, -5.82E-3, 1.26E-4

$F$= -0.566 (C024A), -0.569 (C025), -0.567 (C026), -0.569 (C027), -0.566 (C028), -0.558 (C029), -0.558 (C030), -0.566 (C031), -0.565 (C032), -0.565 (C033), -0.561 (C034), -0.566 (C035)

5) C036~C044

$A \sim E$= 0.658, 0.0, 0.0, -9.69E-3, 1.38E-4

*F*= -0.539 (C036), -0.537 (C037), -0.540 (C038), -0.539 (C039), -0.537 (C040), -0.539 (C041), -0.534 (C042), -0.539 (C043), -0.540 (C044)

6) C045~C051

*A~E*= 0.508, 0.0, 0.0, 4.20E-3, 2.25E-4

*F*= -0.517 (C045), -0.519 (C046), -0.521 (C047), -0.519 (C048), -0.517 (C049A), -0.520 (C050), -0.525 (C051)

The oxygen sensor was not stable in deep layer between C004 and C035, and the profiles of oxygen were unnatural at several stations. Oxygen data at intervals of 1 db were made for depths of *P* db by interpolating the oxygen values from water samples and connected to the oxygen data from sensors smoothly.

*P* > 3500 db (C019), 3600 db (C023), 3800 db (C012), 4200 db (C020), 4300 db (C013, C031), 4400 db (C018), 4500 db (C022, C026, C027), 4600 db (C005, C030, C033), 4700 db (C006C), 4900 db (C021, C024A), 5000 db (C025), 5100 db (C004), 5505 db (C035)

4250 db > *P* > 3750 db (C010)

The oxygen data from sensors at some stations were smoothed for depths of *P* db by running means.

| | |
|---|---|
| 50-db running mean | *P* > 4800 db (C008), 5100 db (C028, C029) |
| 20-db running mean | *P* > 4900 db (C025), 5200 db (C032), 5300 db (C034), 5400 db (C035) |

The oxygen sensor used from C036 was stable, and the profiles of oxygen could be used. The oxygen data at depths of *P* db were fitted to the oxygen values from water samples.

*P* > 2800 db (C043), 4900 db (C040), 5300 db (C036, C037, C039)

## B4. Fluorometer, Fast Repetition Rate Fluorometer (FRRF)

At C045~C051, the $CTDO_2$ underwater unit was equipped with a fluorometer Aquatracka III manufactured by Chelsea Instruments Ltd. (S/N 088192).

At FR01~FR07 which were located at the same position as C045~C051, casts of FRRF were conducted. FRRF DF-03B (S/N 138453001), manufactured by Kimoto Electric Co. Ltd. (Osaka, Japan), was used to measure fluorescence induction curves of chlorophyll in phytoplankton. This method is based on relationships between the phytoplankton photosynthesis and photoplankton in vivo fluorescence. The FRRF had closed dark and open light chambers to measure the fluorescence induction curves on dark-adapted and ambient- irradiated samples. For each optical channel in the dark and light chambers, the FRRF had a high-luminosity blue light-emitting diode (LED) to excite chlorophyll fluorescence at a wavelength of 470 nm with a 25-nm bandwidth.

To cumulatively saturate Photosynthetic Photosystem II (PSII) by light within 150 micro-sec (Kolber et al., 1998), this instrument generated a sequence of flashes at a repetition rate of about 250 kHz and provides an excitation light intensity of 30 mmol quanta $m^{-2}$ $s^{-1}$ by adjusting a pulsed current to the LED. The intensity of the excitation light emitted by the LED was measured with a radiometer with a fast amplifier. The fluorescence signal from phytoplankton exposed to the excitation light was collected at a 90° angle, isolated by a band-pass filter (wavelength 680 ± 25 nm), and detected by a photomultiplier tube (PMT). Simultaneously, a small portion of the excitation light was recorded as a reference signal. Both the fluorescence and reference signals were converted at 10 MHz synchronously by a 14-bit analog-to-digital converter and analyzed by a CPU.

The fluorescence yield was calculated as the ratio of the fluorescence signal to the reference signal. Analysis of fluorescence induction curves measured in the dark and light chambers provided PSII parameters such as quantum yield of photochemistry (Fv/Fm), effective absorption cross-section (sigma PSII) and re-oxidation rate of primary electron acceptor (tau). After the fluorescence induction curves were analyzed, the data were calculated to estimate the primary productivity (PbO) (Kolber and Falkowski, 1993) with irradiance (E). E were simultaneously measured by a scalar irradiance sensor (QSP-2200, Biospherical Instruments, Inc., CA, USA).

Kolber, Z. S. and Falkowski, P.G. Use of Active Fluorescence to estimate phytoplankton photosynthesis in situ, Limnol, Oceanogr, 38, 1464-1665.

## C. XCTD

We used probes of TSK XCTD-1. The depth of a falling probe was computed with the equation that

$$z = 3.42543 \cdot t - 0.00047026 \cdot t^2.$$

The data were recorded with TSK MK-130 (Tsurumi Seiki Co., Ltd).

## D. Shipboard ADCP

### D1. ADCP (Furuno Electric Co., Ltd.)

Current velocities at three depths of 20 m, 50 m, and 100 m were measured at an interval of 15 seconds. The data were averaged for every minute and recorded with Doppler Sonar Current Profiler System CI-20H.

### D2. ADCP (RD Instruments)

Current velocities at 64 levels at an interval of 16 m from 32-m depth down to about 1000 m were measured with Broadband 38 kHz ADCP and recorded every two minutes.

Uncertainty of the ship heading direction decreases accuracies of the measured flow direction relative to the ship head and the measured velocity components. The ship heading direction data by the gyrocompass was manually input with a resolution of one degree when the system was switched on. Inaccuracy of this input is a source of measurement error. Another error source is a deviation in direction of the shipboard transducer from the original design.

According to Joyce (1989; *Journal of Atmospheric and Oceanic Technology*, **6**, 169–172), the correct velocity ($u_w$, $v_w$) is given from a ship speed ($u_s$, $v_s$) and a measured ADCP velocity ($u_d$, $v_d$) as

$$u_w = u_s + (1+\beta)(u'_d \cos\alpha - v'_d \sin\alpha)$$

$$v_w = v_s + (1+\beta)(u'_d \sin\alpha + v'_d \cos\alpha),$$

where $\alpha$ is the error in orientation of transducer, and $1+\beta$ is the scale factor.

The values of $\alpha$ and $\beta$ were estimated by comparing the ship speed obtained from bottom tracking with that from the Global Positioning System. For the comparison, 1638 ensemble data were used. The result is

$$\alpha \text{ (rad)} = 0.0067, \quad \beta = -0.0221.$$

The current velocity data from the RDI ADCP should be corrected with the above equations and coefficients.

## E. Lowered ADCP

An ADCP instrument of 300 kHz Work Horse manufactured by RD Instruments was attached to the frame of the SBE Carousel water sampler and used as a lowered ADCP in order to obtain vertical profiles of horizontal velocity. Two transducers were set downward at the bottom (master unit) and upward at the top of the water sampler frame (slave unit), and a buttery package was mounted on the frame. The instruments were WH300 (downward: S/N 3381, upward: S/N 831). We selected 1 ping per a second (1 ping per two seconds at C009 and C010) and 4-meter bins. They did not function at C001, and the slave unit did not function at C002.

Data were stored in the underwater ADCP unit and recovered on the deck after the cast. Noises and an influence of vertical move and rotation of the ADCP unit must be removed from the original data. Further processes of data should be made after the cruise to obtain correct data of current velocity.

## F. Altimeter, Pinger

An altimeter PSA-916T (S/N 1000) manufactured by BENTHOS Inc. was attached to the water sampler frame. It indicated the distance from the sea bottom in 30 m or more above the bottom. Initially it functioned well but was wrong at C005, and a pinger BENTHOS 2216 (S/N 1124) manufactured by BENTHOS Inc. for 12000 m was used at C006 and later. Owing to the use of them, we could observe safely to just above the sea bottom.

## G. TURBOMAP

TURBOMAP (Turbulence Ocean Microstructure Acquisition Profiler), manufactured by Alec Electronics, Kobe, Japan, is 2.426 m in length, 0.405 m in diameter, 43 kg on deck, and 0.6~0.9 kg in water. This instrument is equipped with two shear probes and FPO7 temperature, conductivity, chlorophyll, turbidity, acceleration and pressure sensors. See the Preliminary Report of KH-04-4 for the details.

TURBOMAP is lowered freely with adjusted ballasts at 0.5~0.4 m $s^{-1}$. Sea cable is attached at an opposite side of sensors, and is connected to a personal computer through the portable winch system. Data is transferred through output sequence of USB. The sampling rate is 512 Hz, and transferring rate is 115.2 kbps. TURBOMAP must be operated freely without tension to measure velocity shear correctly. When the observation is finished, TURBOMAP is recovered by the portable winch.

The shear data are fitted on to the Nasymth spectral form to check the validity of data quality. Energy dissipation, scaled dissipation rate, and eddy diffusivities of heat and salt are calculated by using the shear data as well as the density ratio calculated from the temperature and salinity data obtained from TURBOMAP.

## H. Drifting Seaweeds Observation

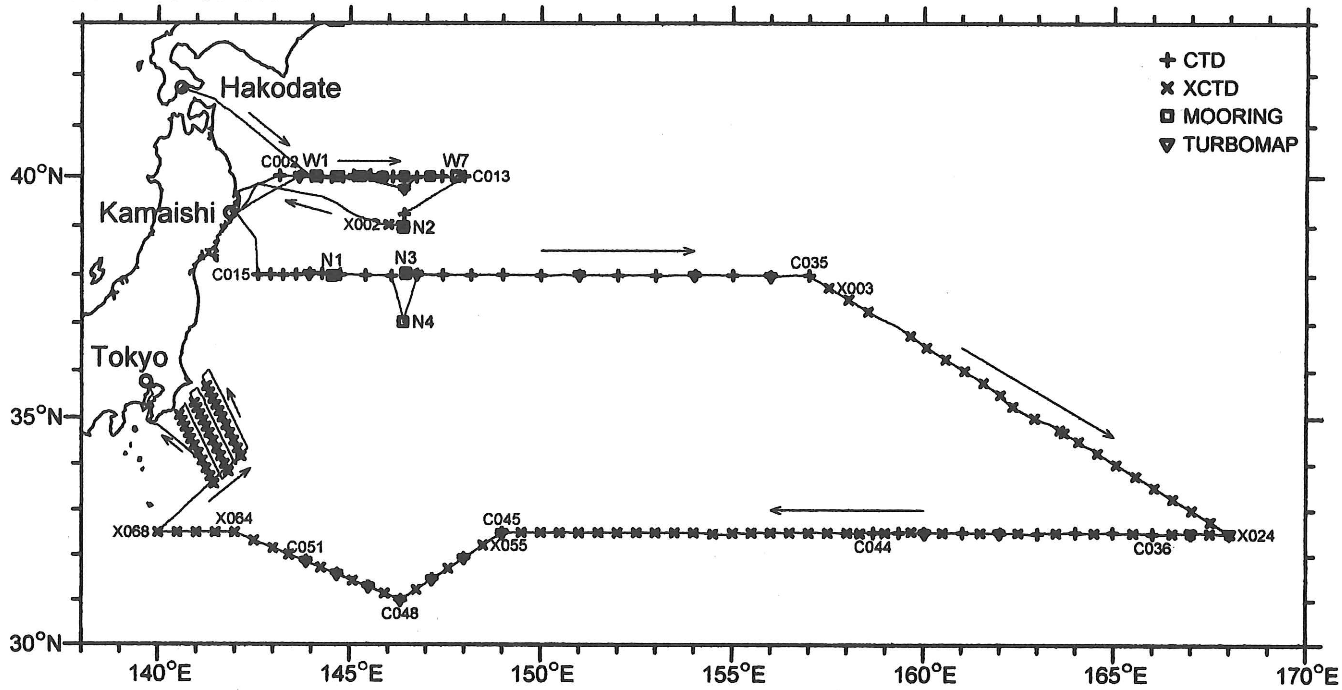
Visual censuses were conducted at sea, in good conditions and from sunrise to sunset. Two sessions were organized from 11 May to 7 June 2007. Observations were taken from the vessel deck at a height of 11.5 m above the sea surface. The vessel navigated along designed transects. The following elements were recorded at each floating seaweed occurrence: time, the perpendicular distance from the boat, seaweed diameter. Distance and diameter were estimated by four trained researchers (two teams of two people), operating alternatively. Some rafts were sampled randomly using dip net with a diameter of 0.5 m during CTD observations. Samples were identified and weighted (wet weight).

## 3. List of Scientists Aboard

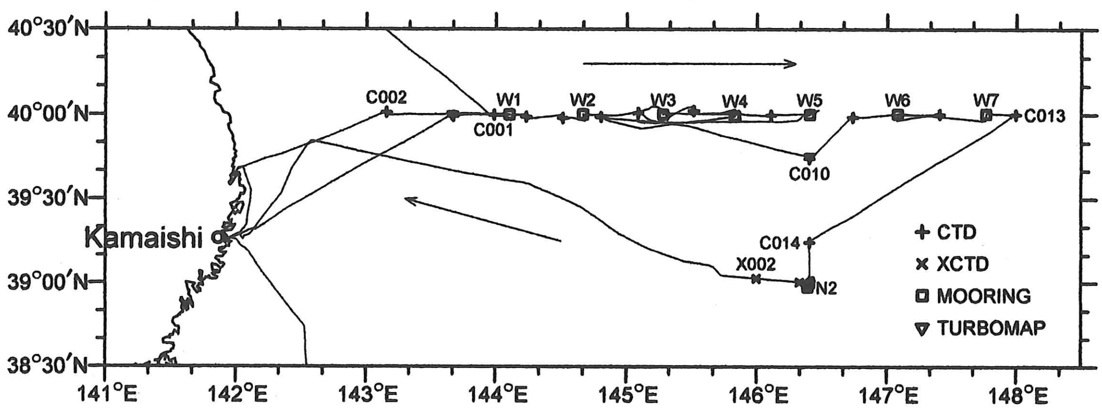
| Name | Phone | E-mail |
|---|---|---|
| **Ocean Research Institute, The University of Tokyo** | | |
| **1-15-1 Minamidai, Nakano-ku, Tokyo 164-8639** | | |
| Masaki Kawabe | 03-5351-6421 | kawabe@ori.u-tokyo.ac.jp |
| Yutaka Michida | 03-5351-6532 | ymichida@ori.u-tokyo.ac.jp |
| Shinzou Fujio | 03-5351-6844 | fujio@ori.u-tokyo.ac.jp |
| Oka Eitarou | 03-5351-6417 | eoka@ori.u-tokyo.ac.jp |
| Daigo Yanagimoto | 03-5351-6415 | daigo@ori.u-tokyo.ac.jp |
| Kiyoshi Tanaka | 03-5351-6806 | ktanaka@ori.u-tokyo.ac.jp |
| Shoji Kitagawa | 03-5351-6419 | kitagawa@ori.u-tokyo.ac.jp |
| Keiri Imai | 03-5351-6394 | kimai@ori.u-tokyo.ac.jp |
| Hideo Hatase | 03-5351-6879 | hatase@ori.u-tokyo.ac.jp |
| Fumihiro Kato | 03-5351-6420 | kato@ocg.ori.u-tokyo.ac.jp |
| Etienne Boisnier | 03-5351-6513 | etienne@nenv.k.u-tokyo.ac.jp |
| Masahito Nakajima | 03-5351-6420 | postbox_masahito@nenv.k.u-tokyo.ac.jp |
| Satomi Kohara | 03-5351-6420 | kohara@ori.u-tokyo.ac.jp |
| Kento Mayuzumi | 03-5351-6420 | mayuzumi@ori.u-tokyo.ac.jp |
| Haifa Ben Romdhane | 03-5351-6513 | haifa@ori.u-tokyo.ac.jp |
| **Graduate School of Science, Tohoku Univeristy** | | |
| **6-3 Aoba, Aramaki, Sendai, Miyagi 980-8578** | | |
| Toshio Suga | 022-795-6527 | suga@pol.geophys.tohoku.ac.jp |
| Chiho Sukigara | 022-795-6529 | suki@pol.geophys.tohoku.ac.jp |
| Katsuya Toyama | 022-795-6528 | katsuya@pol.geophys.tohoku.ac.jp |
| Takehito Sato | 022-795-6528 | takehito@pol.geophys.tohoku.ac.jp |
| Yoshitake Nakagawa | 022-795-6528 | nakagawa@pol.geophys.tohoku.ac.jp |
| Erina Yanagita | 022-795-6747 | yanagida@ocean.caos.tohoku.ac.jp |
| **Faculty of Marine Science, Tokyo University of Marine Science and Technology** | | |
| **4-5-7 Kounan, Minato-ku, Tokyo 108-8477** | | |
| Jiro Yoshida | 03-5463-0459 | jiroy@kaiyodai.ac.jp |
| Yuko Matsumoto | 03-5463-0531 | d052034@kaiyodai.ac.jp |
| Nobuhiro Isomura | 03-5463-0459 | m063035@kaiyodai.ac.jp |
| Moyu Nemoto | 03-5463-0459 | m063036@kaiyodai.ac.jp |
| Miho Tsuchiya | 03-5463-0462 | m073045@kaiyodai.ac.jp |
| Ayami Hashimoto | 03-5463-0459 | m073043@kaiyodai.ac.jp |
| Ryoji Toda | 03-5463-0531 | m073018@kaiyodai.ac.jp |
| **Shimoda Marine Research Center, University of Tsukuba** | | |
| **5-10-1 Shimoda, Shizuoka 415-0025** | | |
| Beginer Subhan | 0558-22-1317 | begi_ners@yahoo.com |
| **Marine Works Japan Ltd.** | | |
| **2-16-32 4F Kamariyahigashi, Kanazawa-ku, Yokohama, Kanagawa 236-0042** | | |
| Kenichiro Sato | 045-787-0633 | satok@mwj.co.jp |
| Kenichi Katayama | 045-787-0633 | katayama@mwj.co.jp |

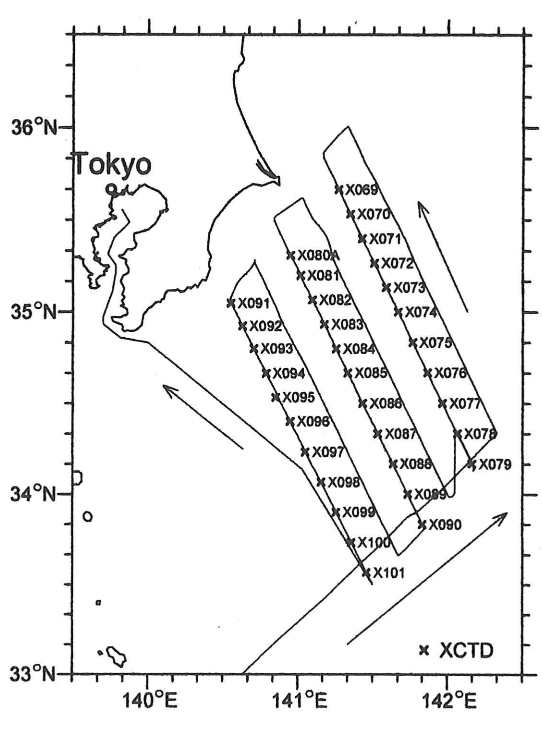
# 4. Track Chart

## General Chart




## Enlarged chart off Sanriku, northeastern part of Honshu




## Enlarged chart off Boso Peninsula

## 5. Time Table

### (Hakodate → Tokyo)

| | Date | TIME (JST) 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 |
|---|---|---|
| 1 | May 9 | ↑~~~ (from 14) Hakodate |
| 2 | May 10 | ~~~ / C001 / ~~ / W1 deploy / ~~~ / C002 / ~~~ / off Miyako |
| 3 | May 11 | off Miyako |
| 4 | May 12 | off Miyako / ~~~ / TM01 C003 / ~~~ / C004 |
| 5 | May 13 | C004 / ~~~ / C005 / ~~~ / W2 deploy / ~~~ / W3 deploy / ~~~ / W4 deploy / ~~~ |
| 6 | May 14 | ~~~ / C006C / ~~~ / W5 deploy / ~~~ / C007B / ~~~ |
| 7 | May 15 | ~ / C008 / ~~~ / C009 / ~~~ / TM02 C010 / ~~~ / C011 |
| 8 | May 16 | ~~~ / C012 / ~~~ / W6 deploy / ~~~ / W7 deploy / ~~~ / C013 / ~~~ |
| 9 | May 17 | C014 / ~~~ / N2 recover / ~~~ / N2 deploy / ~↑ X001 ~~↑ X002 ~~~ |
| 10 | May 18 | ~~~ / Kamaishi |
| 11 | May 19 | Kamaishi / ~~~ / C015 / ~~~ / C016 / ~~~ |
| 12 | May 20 | ~ / C017 / ~~~ / C018 / ~~~ / TM03 C019 / ~~~ / C020 |
| 13 | May 21 | C020 / ~~~ / C021 / ~~~ / N1 recover / ~~~ / N1 deploy / ~~~ / C022 / ~~~ |
| 14 | May 22 | C023 / ~~~ / N4 recover / ~~~ / TM04 C024A / ~~~ / C025 |
| 15 | May 23 | C025 / ~~~ / N3 recover / ~~~ / N3 deploy / ~~~ / C026 / ~~ |
| 16 | May 24 | ~~~ / C027 / ~~~ / C028 / ~~~ / TM05 C029 / ~~~ |
| 17 | May 25 | C030 / ~~~ / C031 / ~~~ / TM06 C032 / ~~~ / C033 |
| 18 | May 26 | C033 / ~~~ / C034 / ⇕ AR01 ~~~ / C035 / ~~~↑ X003 ~~~↑ X004 ~~~↑ X005 ~~ |

| | Date | TIME (JST) 0–24 |
|---|---|---|
| 19 | May 27 | X006 X007 X008 X009 X010 X011 X012 X013 X014 X015 X016 X017 |
| 20 | May 28 | X018 X019 X020 X021 X022 X023 TM07 X024 X025 AR02 X026 X027 |
| 21 | May 29 | C036 X028 C037 X029 C038 |
| 22 | May 30 | X030 C039 X031 TM08 C040 X032 C041 |
| 23 | May 31 | C041 X033 C042 AR03 X034 C043 X035 C044 X036 X037 |
| 24 | June 1 | X038 X039 X040 X041 X042 X043 X044 X045 X046 X047 X048 X049 X050 |
| 25 | June 2 | X051 X052 X053 X054 FR01 TM09 C045 X055 FR02 TM10 C046 X056 FR03 TM11 C047 |
| 26 | June 3 | FR03 TM11 C047 X057 FR04 TM12 C048 X058 FR05 TM13 C049A X059 FR06 TM14 C050 X060 |
| 27 | June 4 | FR07 TM15 C051 X061 X062 X063 X064 X065 X066 X067 X068 |
| 28 | June 5 | A1 A2 A3 X069 X074 A4 A5 X079 |
| 29 | June 6 | A6 A7 A8 X080A X085 A9 X090 A10 |
| 30 | June 7 | A11 A12 X091 X096 X101 A13 A14 |
| 31 | June 8 | Tokyo |

## 6. Summary of Observation Stations

STN: Station number
TYPE: CTD=CTDO only, ROS=CTDO plus water sampler, MOR=Mooring, XCTD=XCTD, TMAP=Turbomap, FRRF=FRRF
CODE: BE=Beginning of cast or work, EN=End of work, BO=Bottom, DE=Deployment of mooring or XCTD, RE=Recover of mooring
DEPTH: Water depth in meters
MAXP: Maximum pressures in decibars
PARAM: Sampling parameters
1=Salinity, 2=Dissolved Oxygen, 3-6=Nutrients ($PO_4$,$SiO_2$,$NO_2$+$NO_3$,$NO_2$)
7=Chlorophyll *a*, 8=Helium
LADCP=Lowered ADCP
*COMMENTS are included in the columns of MAXP/PARAM*

**KH-07-1 LEG 2**

| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| C001 | ROS | 050907 | 1907 | BE | 39°59.67′N | 143°58.82′E | 4234 | | |
| C001 | ROS | 050907 | 2103 | BO | 39°59.82′N | 143°59.13′E | 4237 | 4275 | 1-6 *SBE9p400 CTDO* |
| C001 | ROS | 050907 | 2231 | EN | 40°00.22′N | 143°58.97′E | 4251 | | |
| W1 | MOR | 050907 | 2331 | BE | 39°59.46′N | 144°02.65′E | 4388 | | *1 RCM11, 3 CM, 1 MicroCAT* |
| W1 | MOR | 051007 | 0116 | DE | 40°00.01′N | 144°06.10′E | 5091 | | *Transmitter 43.528MHz, A/R 3G* |
| C002 | ROS | 051007 | 0450 | BE | 40°00.43′N | 143°09.32′E | 1366 | | LADCP |
| C002 | ROS | 051007 | 0522 | BO | 40°00.73′N | 143°09.31′E | 1354 | 1323 | 1-6 *SBE9p400 CTDO* |
| C002 | ROS | 051007 | 0552 | EN | 40°00.91′N | 143°09.29′E | 1346 | | |
| TM01 | TMAP | 051207 | 0629 | DE | 39°59.90′N | 143°39.82′E | 2526 | 416 | *Turbomap* |
| C003 | ROS | 051207 | 0750 | BE | 39°59.19′N | 143°39.98′E | 2604 | | LADCP |
| C003 | ROS | 051207 | 0845 | BO | 39°59.38′N | 143°40.24′E | 2615 | 2599 | 1-6 *SBE9p400 CTDO* |
| C003 | ROS | 051207 | 0939 | EN | 39°59.56′N | 143°40.48′E | 2630 | | |
| C004 | ROS | 051207 | 1155 | BE | 39°59.73′N | 144°13.90′E | 6977 | | LADCP |
| C004 | ROS | 051207 | 1406 | BO | 39°59.20′N | 144°13.85′E | 6845 | 6375 | 1-6 *SBE9p400 CTDO* |
| C004 | ROS | 051207 | 1559 | EN | 39°58.68′N | 144°13.83′E | 6771 | | |
| C005 | ROS | 051207 | 1736 | BE | 39°59.42′N | 144°31.14′E | 6598 | | LADCP |
| C005 | ROS | 051207 | 1939 | BO | 39°58.68′N | 144°30.71′E | 6822 | 6501 | 1-6 *SBE9p400 CTDO* |
| C005 | ROS | 051207 | 2137 | EN | 39°58.30′N | 144°30.55′E | 6680 | | |
| W2 | MOR | 051207 | 2304 | BE | 39°57.82′N | 144°41.08′E | 6244 | | *1 RCM11, 4 CM, 1 MicroCAT* |
| W2 | MOR | 051307 | 0036 | DE | 40°00.02′N | 144°39.92′E | 6170 | | *Transmitter 43.528MHz, A/R 3B* |
| W3 | MOR | 051307 | 0305 | BE | 40°02.04′N | 145°15.78′E | 5388 | | *1 RCM11, 4 CM, 1 3D-ACM, 1 MicroCAT* |
| W3 | MOR | 051307 | 0435 | DE | 39°59.99′N | 145°17.02′E | 5390 | | *Transmitter 43.528MHz, A/R 1G* |
| W4 | MOR | 051307 | 0653 | BE | 40°01.70′N | 145°49.99′E | 5157 | | *1 RCM11, 4 CM, 1 MicroCAT* |
| W4 | MOR | 051307 | 0759 | DE | 39°59.48′N | 145°50.01′E | 5151 | | *Transmitter 43.528MHz, A/R 3E* |
| C006C | ROS | 051307 | 1946 | BE | 39°59.32′N | 144°48.37′E | 5894 | | LADCP |
| C006C | ROS | 051307 | 2128 | BO | 39°59.08′N | 144°48.18′E | 5900 | 5882 | 1-6 *SBE9p750 CTDO* |
| C006C | ROS | 051307 | 2314 | EN | 39°59.10′N | 144°48.06′E | 5905 | | |
| W5 | MOR | 051407 | 0451 | BE | 40°01.34′N | 146°28.01′E | 5167 | | *1 RCM11, 2 CM, 1 Aquadopp, 1 MicroCAT* |
| W5 | MOR | 051407 | 0618 | DE | 40°00.00′N | 146°24.44′E | 5156 | | *1 ADCP, Transmitter 43.528MHz, A/R 3C* |
| C007B | ROS | 051407 | 1008 | BE | 40°00.01′N | 146°07.09′E | 5162 | | LADCP |
| C007B | ROS | 051407 | 1141 | BO | 39°59.73′N | 146°06.62′E | 5182 | 5242 | 1-6 *SBE9p750 CTDO* |
| C007B | ROS | 051407 | 1316 | EN | 39°59.52′N | 146°06.02′E | 5162 | | |
| C008 | ROS | 051407 | 1536 | BE | 40°00.24′N | 145°31.20′E | 5257 | | LADCP |
| C008 | ROS | 051407 | 1717 | BO | 40°01.26′N | 145°31.08′E | 5271 | 5333 | 1-6 *SBE9p750 CTDO* |
| C008 | ROS | 051407 | 1854 | EN | 40°02.00′N | 145°30.91′E | 5251 | | |

| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| C009 | ROS | 051407 | 2102 | BE | 40°00.17′N | 145°05.02′E | 5514 | | LADCP |
| C009 | ROS | 051407 | 2252 | BO | 40°00.51′N | 145°05.34′E | 5531 | 5681 | 1-6 *SBE9p750 CTDO* |
| C009 | ROS | 051507 | 0033 | EN | 40°00.99′N | 145°05.38′E | 5547 | | |
| TM02 | TMAP | 051507 | 0515 | DE | 39°45.05′N | 146°24.49′E | 5168 | 445 | *Turbomap* |
| C010 | ROS | 051507 | 0612 | BE | 39°44.89′N | 146°24.54′E | 5166 | | LADCP |
| C010 | ROS | 051507 | 0757 | BO | 39°44.37′N | 146°24.42′E | 5161 | 5239 | 1-6 *SBE9p750 CTDO* |
| C010 | ROS | 051507 | 0929 | EN | 39°44.02′N | 146°24.30′E | 5162 | | |
| C011 | ROS | 051507 | 1136 | BE | 39°59.79′N | 146°44.98′E | 5212 | | LADCP |
| C011 | ROS | 051507 | 1317 | BO | 39°59.03′N | 146°44.40′E | 5218 | 5302 | 1-6 *SBE9p750 CTDO* |
| C011 | ROS | 051507 | 1448 | EN | 39°58.87′N | 146°43.57′E | 5213 | | |
| C012 | ROS | 051507 | 1732 | BE | 40°00.12′N | 147°24.82′E | 5367 | | LADCP |
| C012 | ROS | 051507 | 1917 | BO | 40°00.10′N | 147°24.35′E | 5357 | 5446 | 1-6 *SBE9p750 CTDO* |
| C012 | ROS | 051507 | 2053 | EN | 40°00.07′N | 147°23.81′E | 5343 | | |
| W6 | MOR | 051507 | 2305 | BE | 39°58.20′N | 147°04.68′E | 5287 | | *1 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT* |
| W6 | MOR | 051607 | 0000 | DE | 40°00.14′N | 147°04.96′E | 5307 | | *Transmitter 43.528MHz, A/R 3F* |
| W7 | MOR | 051607 | 0301 | BE | 39°57.86′N | 147°45.53′E | 5260 | | *1 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT* |
| W7 | MOR | 051607 | 0406 | DE | 40°00.22′N | 147°46.02′E | 5279 | | *Transmitter 43.528MHz, A/R 3E* |
| C013 | ROS | 051607 | 0526 | BE | 40°00.00′N | 148°00.09′E | 5313 | | LADCP |
| C013 | ROS | 051607 | 0708 | BO | 39°59.96′N | 147°59.68′E | 5309 | 5405 | 1-6 *SBE9p750 CTDO* |
| C013 | ROS | 051607 | 0843 | EN | 39°59.82′N | 147°59.10′E | 5303 | | |
| C014 | ROS | 051607 | 1437 | BE | 39°14.94′N | 146°24.34′E | 5331 | | LADCP |
| C014 | ROS | 051607 | 1627 | BO | 39°14.58′N | 146°24.46′E | 5328 | 5403 | 1-6 *SBE9p750 CTDO* |
| C014 | ROS | 051607 | 1759 | EN | 39°14.18′N | 146°24.36′E | 5328 | | |
| N2 | MOR | 051607 | 2002 | BE | 38°59.83′N | 146°24.40′E | 5300 | | *2 RCM11, 2 CM, 1 3D-ACM, 1 MicroCAT* |
| N2 | MOR | 051607 | 2200 | RE | 38°58.51′N | 146°23.55′E | 5290 | | *Transmitter 43.528MHz, A/R 3F* |
| N2 | MOR | 051707 | 0000 | BE | 39°01.45′N | 146°23.27′E | 5286 | | *4 CM, 1 3D-ACM, 1 MicroCAT* |
| N2 | MOR | 051707 | 0106 | DE | 38°59.82′N | 146°24.81′E | 5298 | | *Transmitter 43.528MHz, A/R 3B* |
| X001 | XCTD | 051707 | 0143 | DE | 39°00.33′N | 146°19.94′E | 5314 | | *TSK XCTD-1* |
| X002 | XCTD | 051707 | 0249 | DE | 39°01.67′N | 145°59.95′E | 5248 | | *TSK XCTD-1* |
| C015 | ROS | 051907 | 1008 | BE | 37°59.97′N | 142°35.15′E | 1240 | | LADCP |
| C015 | ROS | 051907 | 1036 | BO | 37°59.83′N | 142°35.37′E | 1244 | 1196 | 1-7 *SBE9p750 CTDO* |
| C015 | ROS | 051907 | 1103 | EN | 37°59.73′N | 142°35.43′E | 1242 | | |
| C016 | ROS | 051907 | 1233 | BE | 38°00.36′N | 142°55.06′E | 1735 | | LADCP |
| C016 | ROS | 051907 | 1311 | BO | 38°00.39′N | 142°55.20′E | 1741 | 1702 | 1-7 *SBE9p750 CTDO* |
| C016 | ROS | 051907 | 1346 | EN | 38°00.33′N | 142°55.32′E | 1744 | | |
| C017 | ROS | 051907 | 1527 | BE | 38°00.19′N | 143°14.88′E | 2852 | | LADCP |
| C017 | ROS | 051907 | 1627 | BO | 38°00.14′N | 143°14.87′E | 2852 | 2831 | 1-7 *SBE9p750 CTDO* |
| C017 | ROS | 051907 | 1719 | EN | 38°00.14′N | 143°14.87′E | 2852 | | |
| C018 | ROS | 051907 | 1859 | BE | 38°00.29′N | 143°35.18′E | 4830 | | LADCP |
| C018 | ROS | 051907 | 2050 | BO | 38°00.33′N | 143°35.23′E | 4913 | 4992 | 1-7 *SBE9p750 CTDO* |
| C018 | ROS | 051907 | 2155 | EN | 38°00.38′N | 143°35.42′E | 4913 | | |
| TM03 | TMAP | 052007 | 0117 | DE | 38°00.80′N | 143°55.79′E | 6958 | 454 | *Turbomap* |
| C019 | ROS | 052007 | 0216 | BE | 38°01.07′N | 143°56.43′E | 6918 | | LADCP |
| C019 | ROS | 052007 | 0418 | BO | 38°01.67′N | 143°56.73′E | 7009 | 6482 | 1-7 *SBE9p750 CTDO* |
| C019 | ROS | 052007 | 0607 | EN | 38°01.90′N | 143°56.71′E | 7013 | | |
| C020 | ROS | 052007 | 1237 | BE | 37°59.88′N | 144°15.58′E | 6275 | | LADCP |
| C020 | ROS | 052007 | 1437 | BO | 38°01.54′N | 144°15.82′E | 6203 | 6380 | 1-7 *SBE9p750 CTDO* |
| C020 | ROS | 052007 | 1629 | EN | 38°02.44′N | 144°16.08′E | 6182 | | |
| C021 | ROS | 052007 | 1847 | BE | 38°00.18′N | 144°44.91′E | 5497 | | LADCP |
| C021 | ROS | 052007 | 2028 | BO | 38°00.48′N | 144°44.47′E | 5503 | 5632 | 1-7 *SBE9p750 CTDO* |

| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| C021 | ROS | 052007 | 2207 | EN | 38°00.97′N | 144°44.05′E | 5498 | | |
| N1 | MOR | 052007 | 2328 | BE | 38°00.27′N | 144°30.38′E | 5937 | *3 RCM11, 3 CM, 2 MicroCAT* | |
| N1 | MOR | 052107 | 0153 | RE | 37°59.06′N | 144°31.56′E | 5851 | *Transmitter 43.528MHz, A/R 1A* | |
| N1 | MOR | 052107 | 0404 | BE | 37°55.53′N | 144°41.32′E | 5902 | *2 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT* | |
| N1 | MOR | 052107 | 0538 | DE | 37°59.62′N | 144°30.85′E | 5919 | *Transmitter 43.528MHz, A/R 3C* | |
| C022 | ROS | 052107 | 0903 | BE | 37°59.63′N | 145°24.88′E | 5329 | | LADCP |
| C022 | ROS | 052107 | 1042 | BO | 37°59.40′N | 145°24.23′E | 5331 | 5424 | 1-7 *SBE9p750 CTDO* |
| C022 | ROS | 052107 | 1216 | EN | 37°59.21′N | 145°23.69′E | 5332 | | |
| C023 | ROS | 052107 | 1504 | BE | 37°59.92′N | 146°04.78′E | 5099 | | LADCP |
| C023 | ROS | 052107 | 1642 | BO | 37°58.88′N | 146°04.56′E | 5148 | 5119 | 1-7 *SBE9p750 CTDO* |
| C023 | ROS | 052107 | 1809 | EN | 37°58.01′N | 146°04.26′E | 5188 | | |
| N4 | MOR | 052107 | 2224 | BE | 36°59.99′N | 146°24.60′E | 5504 | *2 RCM11, 2 CM, 1 3D-ACM, 1 MicroCAT* | |
| N4 | MOR | 052207 | 0025 | RE | 37°01.48′N | 146°23.01′E | 5488 | *Transmitter 43.528MHz, A/R 1B* | |
| TM04 | TMAP | 052207 | 0457 | DE | 38°00.25′N | 146°45.00′E | 5384 | 533 | *Turbomap* |
| C024A | ROS | 052207 | 0624 | BE | 38°00.23′N | 146°45.18′E | 5384 | | LADCP |
| C024A | ROS | 052207 | 0806 | BO | 38°00.25′N | 146°45.32′E | 5382 | 5482 | 1-7 *SBE9p750 CTDO* |
| C024A | ROS | 052207 | 0940 | EN | 38°00.27′N | 146°45.42′E | 5380 | | |
| C025 | ROS | 052207 | 1224 | BE | 37°59.85′N | 147°25.53′E | 5592 | | LADCP |
| C025 | ROS | 052207 | 1408 | BO | 38°00.03′N | 147°25.64′E | 5590 | 5714 | 1-7 *SBE9p750 CTDO* |
| C025 | ROS | 052207 | 1544 | EN | 38°00.18′N | 147°25.98′E | 5589 | | |
| N3 | MOR | 052207 | 2137 | BE | 38°00.19′N | 146°24.12′E | 5402 | *3 RCM11, 2 CM, 2 MicroCAT* | |
| N3 | MOR | 052307 | 0148 | RE | 38°02.17′N | 146°27.17′E | 5387 | *Transmitter 43.528MHz, A/R 3A* | |
| N3 | MOR | 052307 | 0359 | BE | 38°02.18′N | 146°27.74′E | 5388 | *2 RCM11, 2 CM, 1 3D-ACM, 1 MicroCAT* | |
| N3 | MOR | 052307 | 0502 | DE | 38°00.94′N | 146°26.08′E | 5394 | *Transmitter 43.528MHz, A/R 3D* | |
| C026 | ROS | 052307 | 1036 | BE | 37°59.93′N | 148°10.33′E | 5679 | | LADCP |
| C026 | ROS | 052307 | 1223 | BO | 37°59.71′N | 148°10.48′E | 5684 | 5808 | 1-7 *SBE9p750 CTDO* |
| C026 | ROS | 052307 | 1403 | EN | 37°59.62′N | 148°10.89′E | 5684 | | |
| C027 | ROS | 052307 | 1701 | BE | 38°00.20′N | 149°00.19′E | 5798 | | LADCP |
| C027 | ROS | 052307 | 1849 | BO | 38°00.42′N | 149°00.69′E | 5802 | 5926 | 1-7 *SBE9p750 CTDO* |
| C027 | ROS | 052307 | 2030 | EN | 38°00.31′N | 149°01.52′E | 5798 | | |
| C028 | ROS | 052407 | 0001 | BE | 37°59.79′N | 150°00.22′E | 5946 | | LADCP |
| C028 | ROS | 052407 | 0155 | BO | 37°59.42′N | 150°00.03′E | 5914 | 6080 | 1-8 *SBE9p750 CTDO* |
| C028 | ROS | 052407 | 0334 | EN | 37°59.02′N | 149°59.74′E | 5902 | | |
| TM05 | TMAP | 052407 | 0715 | DE | 38°00.05′N | 150°59.95′E | 5832 | 520 | *Turbomap* |
| C029 | ROS | 052407 | 0808 | BE | 37°59.54′N | 151°00.42′E | 5835 | | LADCP |
| C029 | ROS | 052407 | 0956 | BO | 37°59.36′N | 151°00.32′E | 5836 | 5971 | 1-7 *SBE9p750 CTDO* |
| C029 | ROS | 052407 | 1140 | EN | 37°59.01′N | 151°00.03′E | 5838 | | |
| C030 | ROS | 052407 | 1517 | BE | 38°00.09′N | 152°00.44′E | 5821 | | LADCP |
| C030 | ROS | 052407 | 1706 | BO | 37°59.69′N | 152°00.61′E | 5826 | 5949 | 1-7 *SBE9p750 CTDO* |
| C030 | ROS | 052407 | 1845 | EN | 37°59.35′N | 152°00.84′E | 5831 | | |
| C031 | ROS | 052407 | 2218 | BE | 37°59.88′N | 153°00.19′E | 5795 | | LADCP |
| C031 | ROS | 052507 | 0007 | BO | 37°59.45′N | 153°00.12′E | 5786 | 5913 | 1-7 *SBE9p750 CTDO* |
| C031 | ROS | 052507 | 0147 | EN | 37°59.22′N | 153°00.00′E | 5780 | | |
| TM06 | TMAP | 052507 | 0532 | DE | 37°59.91′N | 154°00.44′E | 5830 | 364 | *Turbomap* |
| C032 | ROS | 052507 | 0623 | BE | 37°59.71′N | 154°01.40′E | 5832 | | LADCP |
| C032 | ROS | 052507 | 0812 | BO | 37°59.95′N | 154°01.84′E | 5830 | 5966 | 1-7 *SBE9p750 CTDO* |
| C032 | ROS | 052507 | 0957 | EN | 38°00.16′N | 154°02.07′E | 5834 | | |
| C033 | ROS | 052507 | 1330 | BE | 38°00.04′N | 155°00.11′E | 5979 | | LADCP |
| C033 | ROS | 052507 | 1526 | BO | 37°59.85′N | 155°00.35′E | 5984 | 6126 | 1-7 *SBE9p750 CTDO* |
| C033 | ROS | 052507 | 1708 | EN | 37°59.77′N | 155°00.62′E | 5991 | | |

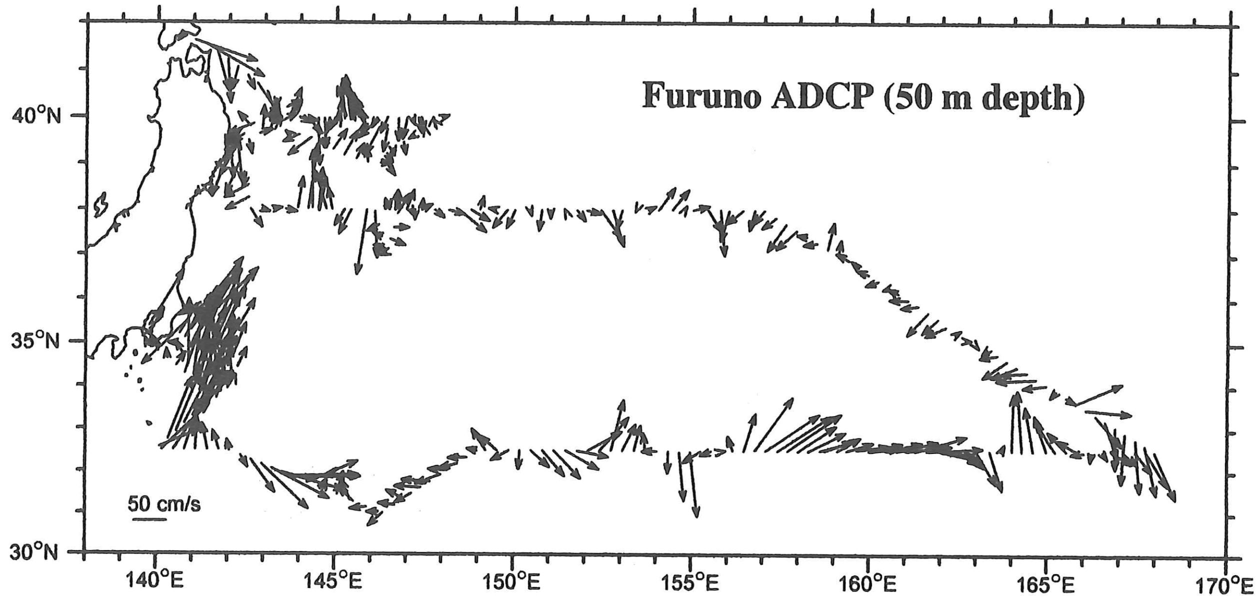
| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* | |
|---|---|---|---|---|---|---|---|---|---|---|
| C034 | ROS | 052507 | 2049 | BE | 37°59.72′N | 156°00.25′E | 5795 | | LADCP | |
| C034 | ROS | 052507 | 2241 | BO | 37°58.92′N | 156°00.28′E | 5791 | 5931 | 1-7 | *SBE9p750 CTDO* |
| C034 | ROS | 052607 | 0024 | EN | 37°58.54′N | 156°00.04′E | 5792 | | | |
| AR01 | FLOAT | 052607 | 0042 | DE | 37°58.41′N | 156°00.09′E | 5794 | | *APEX* | |
| C035 | ROS | 052607 | 0410 | BE | 37°59.83′N | 157°00.27′E | 5722 | | LADCP | |
| C035 | ROS | 052607 | 0559 | BO | 37°59.83′N | 157°00.43′E | 5714 | 5845 | 1-8 | *SBE9p750 CTDO* |
| C035 | ROS | 052607 | 0738 | EN | 37°59.83′N | 157°00.38′E | 5716 | | | |
| X003 | XCTD | 052607 | 1003 | DE | 37°44.70′N | 157°31.48′E | 5612 | | *TSK XCTD-1* | |
| X004 | XCTD | 052607 | 1201 | DE | 37°30.02′N | 158°02.53′E | 5226 | | *TSK XCTD-1* | |
| X005 | XCTD | 052607 | 1402 | DE | 37°15.00′N | 158°33.25′E | 4457 | | *TSK XCTD-1* | |
| X006 | XCTD | 052607 | 1815 | DE | 36°44.89′N | 159°39.57′E | 4726 | | *TSK XCTD-1* | |
| X007 | XCTD | 052607 | 2003 | DE | 36°29.81′N | 160°04.98′E | 4803 | | *TSK XCTD-1* | |
| X008 | XCTD | 052607 | 2154 | DE | 36°14.99′N | 160°34.97′E | 4808 | | *TSK XCTD-1* | |
| X009 | XCTD | 052607 | 2348 | DE | 36°00.01′N | 161°05.09′E | 4689 | | *TSK XCTD-1* | |
| X010 | XCTD | 052707 | 0140 | DE | 35°44.99′N | 161°34.73′E | 4690 | | *TSK XCTD-1* | |
| X011 | XCTD | 052707 | 0324 | DE | 35°29.89′N | 162°01.75′E | 4343 | | *TSK XCTD-1* | |
| X012 | XCTD | 052707 | 0457 | DE | 35°14.94′N | 162°21.54′E | 4884 | | *TSK XCTD-1* | |
| X013 | XCTD | 052707 | 0656 | DE | 34°59.97′N | 162°55.19′E | 5563 | | *TSK XCTD-1* | |
| X014 | XCTD | 052707 | 0916 | DE | 34°44.98′N | 163°35.01′E | 5880 | | *TSK XCTD-1* | |
| X015 | XCTD | 052707 | 0946 | DE | 34°41.33′N | 163°41.92′E | 5870 | | *TSK XCTD-1* | |
| X016 | XCTD | 052707 | 1115 | DE | 34°29.96′N | 164°04.85′E | 5925 | | *TSK XCTD-1* | |
| X017 | XCTD | 052707 | 1313 | DE | 34°15.01′N | 164°34.42′E | 6013 | | *TSK XCTD-1* | |
| X018 | XCTD | 052707 | 1511 | DE | 34°00.02′N | 165°03.72′E | 6071 | | *TSK XCTD-1* | |
| X019 | XCTD | 052707 | 1705 | DE | 33°44.99′N | 165°33.83′E | 6041 | | *TSK XCTD-1* | |
| X020 | XCTD | 052707 | 1851 | DE | 33°29.83′N | 166°03.11′E | 6004 | | *TSK XCTD-1* | |
| X021 | XCTD | 052707 | 2036 | DE | 33°14.98′N | 166°32.53′E | 5948 | | *TSK XCTD-1* | |
| X022 | XCTD | 052707 | 2222 | DE | 33°00.00′N | 167°01.60′E | 6120 | | *TSK XCTD-1* | |
| X023 | XCTD | 052807 | 0008 | DE | 32°44.96′N | 167°30.79′E | 5867 | | *TSK XCTD-1* | |
| TM07 | TMAP | 052807 | 0228 | DE | 32°29.64′N | 168°00.33′E | 6007 | 490 | *Turbomap* | |
| X024 | XCTD | 052807 | 0320 | DE | 32°29.05′N | 168°01.47′E | 6011 | | *TSK XCTD-1* | |
| X025 | XCTD | 052807 | 0631 | DE | 32°29.56′N | 167°29.94′E | 5938 | | *TSK XCTD-1* | |
| AR02 | FLOAT | 052807 | 0927 | DE | 32°30.05′N | 167°00.26′E | 5939 | | *APEX* | |
| X026 | XCTD | 052807 | 0931 | DE | 32°29.89′N | 167°00.27′E | 5937 | | *TSK XCTD-1* | |
| X027 | XCTD | 052807 | 1241 | DE | 32°29.51′N | 166°31.24′E | 5884 | | *TSK XCTD-1* | |
| C036 | ROS | 052807 | 1853 | BE | 32°30.19′N | 166°01.18′E | 6230 | | LADCP | |
| C036 | ROS | 052807 | 2140 | BO | 32°29.23′N | 166°01.05′E | 6220 | 6374 | 1-8 | *SBE9p750 CTDO* |
| C036 | ROS | 052807 | 2332 | EN | 32°28.66′N | 166°00.83′E | 6222 | | | |
| X028 | XCTD | 052907 | 0141 | DE | 32°30.00′N | 165°29.99′E | 6149 | | *TSK XCTD-1* | |
| C037 | ROS | 052907 | 0348 | BE | 32°30.03′N | 164°59.58′E | 6192 | | LADCP | |
| C037 | ROS | 052907 | 0555 | BO | 32°30.72′N | 164°59.04′E | 6193 | 6368 | 1-7 | *SBE9p750 CTDO* |
| C037 | ROS | 052907 | 0743 | EN | 32°31.29′N | 164°58.76′E | 6199 | | | |
| X029 | XCTD | 052907 | 0937 | DE | 32°30.01′N | 164°29.93′E | 6196 | | *TSK XCTD-1* | |
| C038 | ROS | 052907 | 1140 | BE | 32°29.70′N | 164°00.39′E | 6148 | | LADCP | |
| C038 | ROS | 052907 | 1342 | BO | 32°30.62′N | 164°00.41′E | 6149 | 6316 | 1-7 | *SBE9p750 CTDO* |
| C038 | ROS | 052907 | 1530 | EN | 32°31.26′N | 164°00.18′E | 6147 | | | |
| X030 | XCTD | 052907 | 1729 | DE | 32°29.98′N | 163°29.89′E | 6093 | | *TSK XCTD-1* | |
| C039 | ROS | 052907 | 1926 | BE | 32°29.79′N | 162°59.98′E | 6084 | | LADCP | |
| C039 | ROS | 052907 | 2127 | BO | 32°28.91′N | 163°00.32′E | 6080 | 6248 | 1-7 | *SBE9p750 CTDO* |
| C039 | ROS | 052907 | 2316 | EN | 32°28.27′N | 163°00.45′E | 6080 | | | |
| X031 | XCTD | 053007 | 0119 | DE | 32°30.04′N | 162°30.00′E | 6053 | | *TSK XCTD-1* | |

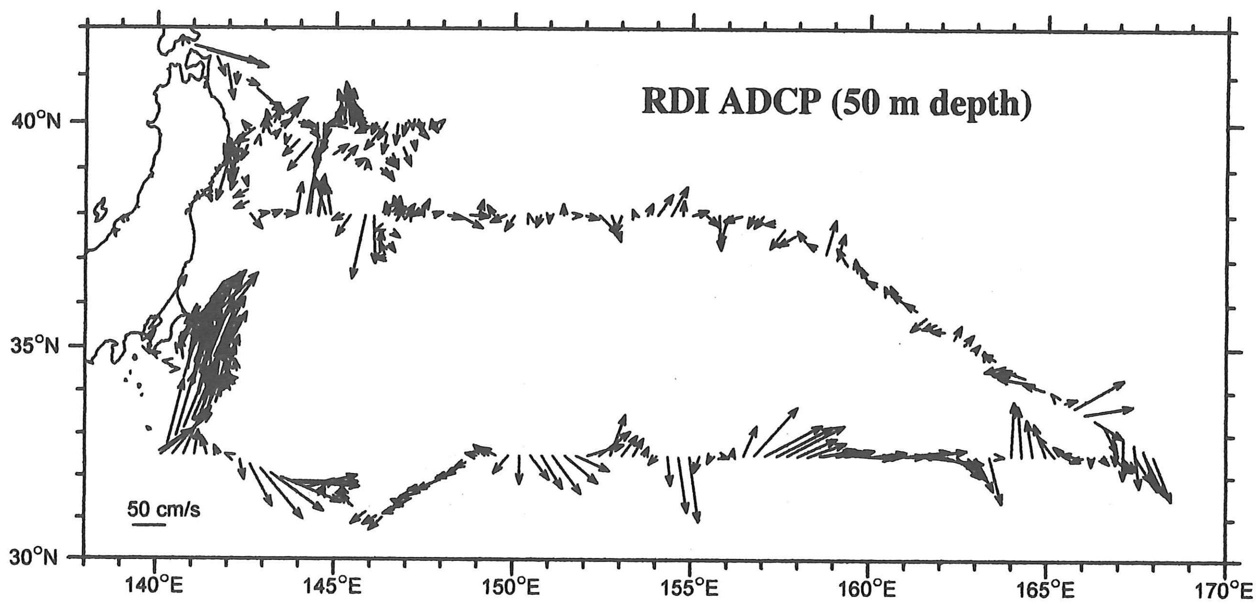
| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| TM08 | TMAP | 053007 | 0320 | DE | 32°29.90′N | 162°00.18′E | 5887 | 384 | *Turbomap* |
| C040 | ROS | 053007 | 0407 | BE | 32°29.71′N | 162°00.65′E | 5892 | | LADCP |
| C040 | ROS | 053007 | 0603 | BO | 32°29.54′N | 162°01.87′E | 5906 | 6054 | 1-7 *SBE9p750 CTDO* |
| C040 | ROS | 053007 | 0751 | EN | 32°29.50′N | 162°02.83′E | 5907 | | |
| X032 | XCTD | 053007 | 1006 | DE | 32°30.00′N | 161°29.98′E | 5736 | | *TSK XCTD-1* |
| C041 | ROS | 053007 | 1215 | BE | 32°30.29′N | 161°00.40′E | 5422 | | LADCP |
| C041 | ROS | 053007 | 1402 | BO | 32°30.30′N | 161°01.62′E | 5477 | 5598 | 1-7 *SBE9p750 CTDO* |
| C041 | ROS | 053007 | 1542 | EN | 32°30.41′N | 161°02.36′E | 5475 | | |
| X033 | XCTD | 053007 | 1801 | DE | 32°30.00′N | 160°29.98′E | 5202 | | *TSK XCTD-1* |
| C042 | ROS | 053007 | 2009 | BE | 32°29.85′N | 160°00.04′E | 4645 | | LADCP |
| C042 | ROS | 053007 | 2147 | BO | 32°29.82′N | 160°01.31′E | 4611 | 4700 | 1-8 *SBE9p750 CTDO* |
| C042 | ROS | 053007 | 2316 | EN | 32°29.89′N | 160°01.92′E | 4638 | | |
| AR03 | FLOAT | 053007 | 2326 | DE | 32°29.64′N | 160°02.03′E | 4636 | | *APEX* |
| X034 | XCTD | 053107 | 0104 | DE | 32°31.27′N | 159°41.42′E | 4380 | | *TSK XCTD-1* |
| C043 | ROS | 053107 | 0258 | BE | 32°30.46′N | 159°20.44′E | 3746 | | LADCP |
| C043 | ROS | 053107 | 0415 | BO | 32°30.37′N | 159°21.41′E | 3794 | 3796 | 1-7 *SBE9p750 CTDO* |
| C043 | ROS | 053107 | 0522 | EN | 32°30.13′N | 159°22.20′E | 3819 | | |
| X035 | XCTD | 053107 | 0704 | DE | 32°30.00′N | 158°59.83′E | 2776 | | *TSK XCTD-1* |
| C044 | ROS | 053107 | 0848 | BE | 32°30.31′N | 158°40.46′E | 2642 | | LADCP |
| C044 | ROS | 053107 | 0947 | BO | 32°30.40′N | 158°41.35′E | 2643 | 2652 | 1-7 *SBE9p750 CTDO* |
| C044 | ROS | 053107 | 1038 | EN | 32°30.47′N | 158°41.82′E | 2640 | | |
| X036 | XCTD | 053107 | 1223 | DE | 32°29.55′N | 158°20.65′E | 2481 | | *TSK XCTD-1* |
| X037 | XCTD | 053107 | 1347 | DE | 32°30.04′N | 158°00.36′E | 2695 | | *TSK XCTD-1* |
| X038 | XCTD | 053107 | 1554 | DE | 32°29.88′N | 157°30.00′E | 3053 | | *TSK XCTD-1* |
| X039 | XCTD | 053107 | 1800 | DE | 32°29.95′N | 156°59.96′E | 3816 | | *TSK XCTD-1* |
| X040 | XCTD | 053107 | 2003 | DE | 32°30.03′N | 156°30.02′E | 4727 | | *TSK XCTD-1* |
| X041 | XCTD | 053107 | 2158 | DE | 32°30.01′N | 156°00.21′E | 4692 | | *TSK XCTD-1* |
| X042 | XCTD | 060107 | 0001 | DE | 32°29.91′N | 155°30.41′E | 4703 | | *TSK XCTD-1* |
| X043 | XCTD | 060107 | 0201 | DE | 32°29.56′N | 155°00.39′E | 4617 | | *TSK XCTD-1* |
| X044 | XCTD | 060107 | 0357 | DE | 32°28.47′N | 154°29.94′E | 4755 | | *TSK XCTD-1* |
| X045 | XCTD | 060107 | 0546 | DE | 32°30.01′N | 153°59.89′E | 5149 | | *TSK XCTD-1* |
| X046 | XCTD | 060107 | 0736 | DE | 32°30.00′N | 153°29.98′E | 5333 | | *TSK XCTD-1* |
| X047 | XCTD | 060107 | 0925 | DE | 32°30.00′N | 152°59.94′E | 5508 | | *TSK XCTD-1* |
| X048 | XCTD | 060107 | 1109 | DE | 32°29.98′N | 152°29.98′E | 5538 | | *TSK XCTD-1* |
| X049 | XCTD | 060107 | 1255 | DE | 32°29.95′N | 152°00.00′E | 5742 | | *TSK XCTD-1* |
| X050 | XCTD | 060107 | 1440 | DE | 32°29.98′N | 151°30.00′E | 5754 | | *TSK XCTD-1* |
| X051 | XCTD | 060107 | 1627 | DE | 32°29.97′N | 150°59.89′E | 5688 | | *TSK XCTD-1* |
| X052 | XCTD | 060107 | 1813 | DE | 32°30.01′N | 150°29.88′E | 5766 | | *TSK XCTD-1* |
| X053 | XCTD | 060107 | 1955 | DE | 32°29.99′N | 149°59.97′E | 5740 | | *TSK XCTD-1* |
| X054 | XCTD | 060107 | 2134 | DE | 32°29.99′N | 149°29.99′E | 5893 | | *TSK XCTD-1* |
| FR01 | FRRF | 060107 | 2320 | DE | 32°29.81′N | 149°00.12′E | 5694 | 202 | *Kimoto DF-03B* |
| TM09 | TMAP | 060207 | 0022 | DE | 32°29.42′N | 148°59.71′E | 5552 | 481 | *Turbomap* |
| C045 | ROS | 060207 | 0118 | BE | 32°29.73′N | 148°59.95′E | 5678 | | LADCP |
| C045 | ROS | 060207 | 0145 | BO | 32°29.80′N | 148°59.77′E | 5606 | 1000 | 1-7 *SBE9p750 CTDO* |
| C045 | ROS | 060207 | 0220 | EN | 32°29.94′N | 148°59.65′E | 5415 | | |
| FR01A | FRRF | 060207 | 0230 | DE | 32°30.01′N | 148°59.58′E | 5387 | 149 | *Kimoto DF-03B* |
| X055 | XCTD | 060207 | 0502 | DE | 32°13.14′N | 148°29.98′E | 5678 | | *TSK XCTD-1* |
| FR02 | FRRF | 060207 | 0703 | DE | 31°56.27′N | 148°00.02′E | 5401 | 145 | *Kimoto DF-03B* |
| TM10 | TMAP | 060207 | 0750 | DE | 31°55.90′N | 147°59.52′E | 5433 | 592 | *Turbomap* |
| C046 | ROS | 060207 | 0906 | BE | 31°56.24′N | 147°59.90′E | 5410 | | LADCP |

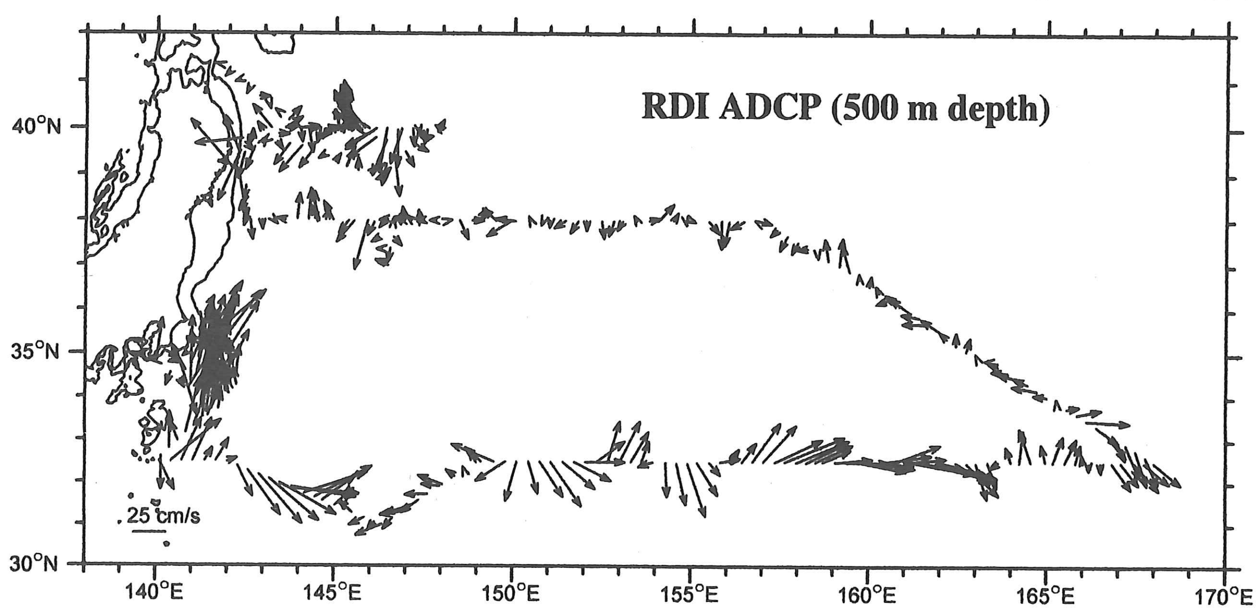
| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| C046 | ROS | 060207 | 0936 | BO | 31°56.21′N | 147°59.61′E | 5434 | 1004 | 1-7 *SBE9p750 CTDO* |
| C046 | ROS | 060207 | 1010 | EN | 31°56.21′N | 147°59.35′E | 5453 | | |
| X056 | XCTD | 060207 | 1201 | DE | 31°42.15′N | 147°34.94′E | 6001 | | *TSK XCTD-1* |
| FR03 | FRRF | 060207 | 1349 | DE | 31°28.28′N | 147°09.91′E | 5932 | 114 | *Kimoto DF-03B* |
| TM11 | TMAP | 060207 | 1433 | DE | 31°27.86′N | 147°09.20′E | 5926 | 426 | *Turbomap* |
| C047 | ROS | 060207 | 1526 | BE | 31°28.28′N | 147°09.87′E | 5932 | | LADCP |
| C047 | ROS | 060207 | 1554 | BO | 31°28.18′N | 147°09.61′E | 5932 | 1020 | 1-7 *SBE9p750 CTDO* |
| C047 | ROS | 060207 | 1628 | EN | 31°28.15′N | 147°09.42′E | 5932 | | |
| X057 | XCTD | 060207 | 1818 | DE | 31°14.01′N | 146°44.94′E | 6044 | | *TSK XCTD-1* |
| FR04 | FRRF | 060207 | 2021 | DE | 30°59.78′N | 146°19.50′E | 6116 | 151 | *Kimoto DF-03B* |
| TM12 | TMAP | 060207 | 2102 | DE | 30°59.65′N | 146°19.14′E | 6118 | 471 | *Turbomap* |
| C048 | ROS | 060207 | 2156 | BE | 31°00.04′N | 146°20.07′E | 6121 | | LADCP |
| C048 | ROS | 060207 | 2230 | BO | 30°59.89′N | 146°19.83′E | 6116 | 1000 | 1-7 *SBE9p750 CTDO* |
| C048 | ROS | 060207 | 2304 | EN | 30°59.76′N | 146°19.64′E | 6116 | | |
| X058 | XCTD | 060307 | 0101 | DE | 31°08.63′N | 145°54.96′E | 6129 | | *TSK XCTD-1* |
| FR05 | FRRF | 060307 | 0252 | DE | 31°17.57′N | 145°29.88′E | 5806 | 151 | *Kimoto DF-03B* |
| TM13 | TMAP | 060307 | 0336 | DE | 31°17.88′N | 145°29.62′E | 5852 | 455 | *Turbomap* |
| C049A | ROS | 060307 | 0454 | BE | 31°17.59′N | 145°29.77′E | 5828 | | LADCP |
| C049A | ROS | 060307 | 0522 | BO | 31°17.84′N | 145°29.68′E | 5848 | 1003 | 1-7 *SBE9p750 CTDO* |
| C049A | ROS | 060307 | 0555 | EN | 31°18.05′N | 145°29.51′E | 5856 | | |
| X059 | XCTD | 060307 | 0735 | DE | 31°25.96′N | 145°04.96′E | 5451 | | *TSK XCTD-1* |
| FR06 | FRRF | 060307 | 0916 | DE | 31°34.61′N | 144°39.99′E | 5101 | 143 | *Kimoto DF-03B* |
| TM14 | TMAP | 060307 | 0958 | DE | 31°34.77′N | 144°39.72′E | 5040 | 376 | *Turbomap* |
| C050 | ROS | 060307 | 1045 | BE | 31°34.68′N | 144°39.97′E | 5088 | | LADCP |
| C050 | ROS | 060307 | 1116 | BO | 31°34.98′N | 144°40.10′E | 5030 | 1000 | 1-7 *SBE9p750 CTDO* |
| C050 | ROS | 060307 | 1149 | EN | 31°35.33′N | 144°40.36′E | 5014 | | |
| X060 | XCTD | 060307 | 1335 | DE | 31°43.31′N | 144°15.01′E | 5718 | | *TSK XCTD-1* |
| FR07 | FRRF | 060307 | 1527 | DE | 31°51.89′N | 143°50.06′E | 5932 | 147 | *Kimoto DF-03B* |
| TM15 | TMAP | 060307 | 1610 | DE | 31°51.84′N | 143°51.76′E | 5925 | 464 | *Turbomap* |
| C051 | ROS | 060307 | 1733 | BE | 31°51.99′N | 143°50.59′E | 5932 | | LADCP |
| C051 | ROS | 060307 | 1801 | BO | 31°52.21′N | 143°51.63′E | 5921 | 1001 | 1-7 *SBE9p750 CTDO* |
| C051 | ROS | 060307 | 1835 | EN | 31°52.39′N | 143°52.67′E | 5908 | | |
| X061 | XCTD | 060307 | 2050 | DE | 32°00.57′N | 143°25.00′E | 5661 | | *TSK XCTD-1* |
| X062 | XCTD | 060307 | 2233 | DE | 32°09.23′N | 142°59.97′E | 5627 | | *TSK XCTD-1* |
| X063 | XCTD | 060407 | 0028 | DE | 32°19.28′N | 142°30.02′E | 7071 | | *TSK XCTD-1* |
| X064 | XCTD | 060407 | 0214 | DE | 32°30.02′N | 142°00.00′E | 8429 | | *TSK XCTD-1* |
| X065 | XCTD | 060407 | 0351 | DE | 32°30.10′N | 141°30.00′E | 4112 | | *TSK XCTD-1* |
| X066 | XCTD | 060407 | 0526 | DE | 32°29.93′N | 140°59.99′E | 2828 | | *TSK XCTD-1* |
| X067 | XCTD | 060407 | 0709 | DE | 32°30.00′N | 140°29.98′E | 2007 | | *TSK XCTD-1* |
| X068 | XCTD | 060407 | 0901 | DE | 32°30.00′N | 140°00.01′E | 980 | | *TSK XCTD-1* |
| X069 | XCTD | 060507 | 0333 | DE | 35°39.94′N | 141°16.01′E | 539 | | *TSK XCTD-1* |
| X070 | XCTD | 060507 | 0424 | DE | 35°31.97′N | 141°20.83′E | 1195 | | *TSK XCTD-1* |
| X071 | XCTD | 060507 | 0516 | DE | 35°23.96′N | 141°25.62′E | 1732 | | *TSK XCTD-1* |
| X072 | XCTD | 060507 | 0608 | DE | 35°15.97′N | 141°30.42′E | 3106 | | *TSK XCTD-1* |
| X073 | XCTD | 060507 | 0659 | DE | 35°08.00′N | 141°35.27′E | 4012 | | *TSK XCTD-1* |
| X074 | XCTD | 060507 | 0748 | DE | 34°59.97′N | 141°40.01′E | 4924 | | *TSK XCTD-1* |
| X075 | XCTD | 060507 | 0847 | DE | 34°50.00′N | 141°46.00′E | 5109 | | *TSK XCTD-1* |
| X076 | XCTD | 060507 | 0948 | DE | 34°39.99′N | 141°52.01′E | 6701 | | *TSK XCTD-1* |
| X077 | XCTD | 060507 | 1047 | DE | 34°30.00′N | 141°58.00′E | 8983 | | *TSK XCTD-1* |
| X078 | XCTD | 060507 | 1145 | DE | 34°20.00′N | 142°04.00′E | 8866 | | *TSK XCTD-1* |

| STN | TYPE | DATE | GMT | CODE | LATITUDE | LONGITUDE | DEPTH | MAXPR | PARAM/*COMMENT* |
|---|---|---|---|---|---|---|---|---|---|
| X079 | XCTD | 060507 | 1242 | DE | 34°10.00′N | 142°09.98′E | 8366 | | *TSK XCTD-1* |
| X080A | XCTD | 060507 | 2334 | DE | 35°18.54′N | 140°56.90′E | 850 | | *TSK XCTD-1* |
| X081 | XCTD | 060607 | 0011 | DE | 35°12.00′N | 141°00.90′E | 1783 | | *TSK XCTD-1* |
| X082 | XCTD | 060607 | 0059 | DE | 35°04.00′N | 141°05.65′E | 2550 | | *TSK XCTD-1* |
| X083 | XCTD | 060607 | 0150 | DE | 34°56.01′N | 141°10.47′E | 3036 | | *TSK XCTD-1* |
| X084 | XCTD | 060607 | 0247 | DE | 34°48.00′N | 141°15.22′E | 4159 | | *TSK XCTD-1* |
| X085 | XCTD | 060607 | 0344 | DE | 34°40.01′N | 141°19.97′E | 4446 | | *TSK XCTD-1* |
| X086 | XCTD | 060607 | 0454 | DE | 34°30.00′N | 141°26.01′E | 6738 | | *TSK XCTD-1* |
| X087 | XCTD | 060607 | 0601 | DE | 34°19.91′N | 141°32.06′E | 6942 | | *TSK XCTD-1* |
| X088 | XCTD | 060607 | 0705 | DE | 34°09.98′N | 141°38.11′E | 6882 | | *TSK XCTD-1* |
| X089 | XCTD | 060607 | 0805 | DE | 33°59.98′N | 141°44.03′E | 7708 | | *TSK XCTD-1* |
| X090 | XCTD | 060607 | 0902 | DE | 33°49.99′N | 141°50.01′E | 8211 | | *TSK XCTD-1* |
| X091 | XCTD | 060607 | 1718 | DE | 35°02.96′N | 140°33.02′E | 203 | | *TSK XCTD-1* |
| X092 | XCTD | 060607 | 1758 | DE | 34°55.49′N | 140°37.64′E | 1404 | | *TSK XCTD-1* |
| X093 | XCTD | 060607 | 1839 | DE | 34°48.01′N | 140°42.21′E | 1992 | | *TSK XCTD-1* |
| X094 | XCTD | 060607 | 1924 | DE | 34°39.94′N | 140°47.15′E | 2694 | | *TSK XCTD-1* |
| X095 | XCTD | 060607 | 2013 | DE | 34°32.00′N | 140°51.00′E | 4614 | | *TSK XCTD-1* |
| X096 | XCTD | 060607 | 2105 | DE | 34°24.00′N | 140°56.90′E | 4873 | | *TSK XCTD-1* |
| X097 | XCTD | 060607 | 2215 | DE | 34°14.00′N | 141°03.01′E | 5118 | | *TSK XCTD-1* |
| X098 | XCTD | 060607 | 2325 | DE | 34°04.00′N | 141°09.31′E | 4895 | | *TSK XCTD-1* |
| X099 | XCTD | 060707 | 0031 | DE | 33°54.00′N | 141°15.31′E | 4792 | | *TSK XCTD-1* |
| X100 | XCTD | 060707 | 0130 | DE | 33°44.00′N | 141°21.48′E | 4883 | | *TSK XCTD-1* |
| X101 | XCTD | 060707 | 0223 | DE | 33°34.00′N | 141°27.57′E | 5717 | | *TSK XCTD-1* |

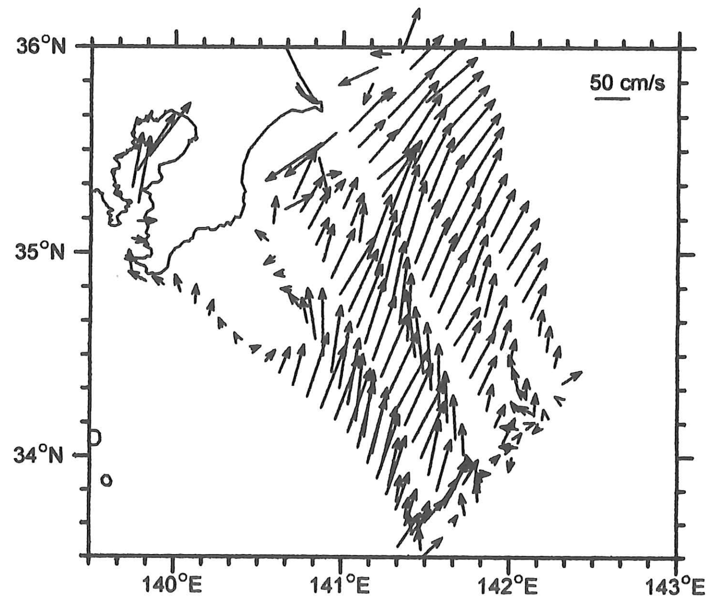
## 7. Chart of Surface Currents



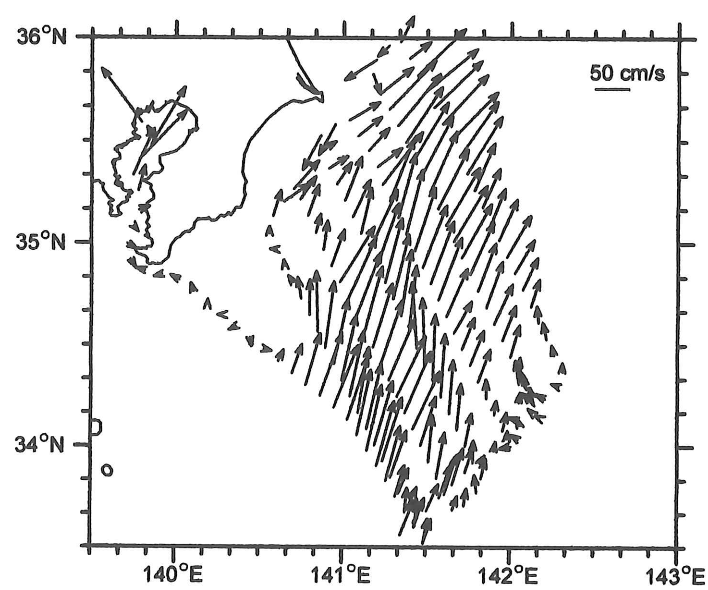



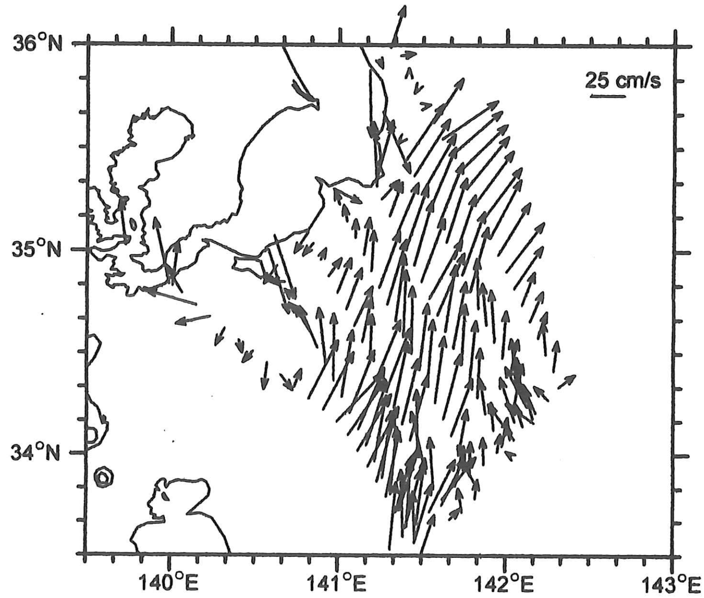
**Off Boso Peninsula**




**Furuno ADCP (50 m depth)**

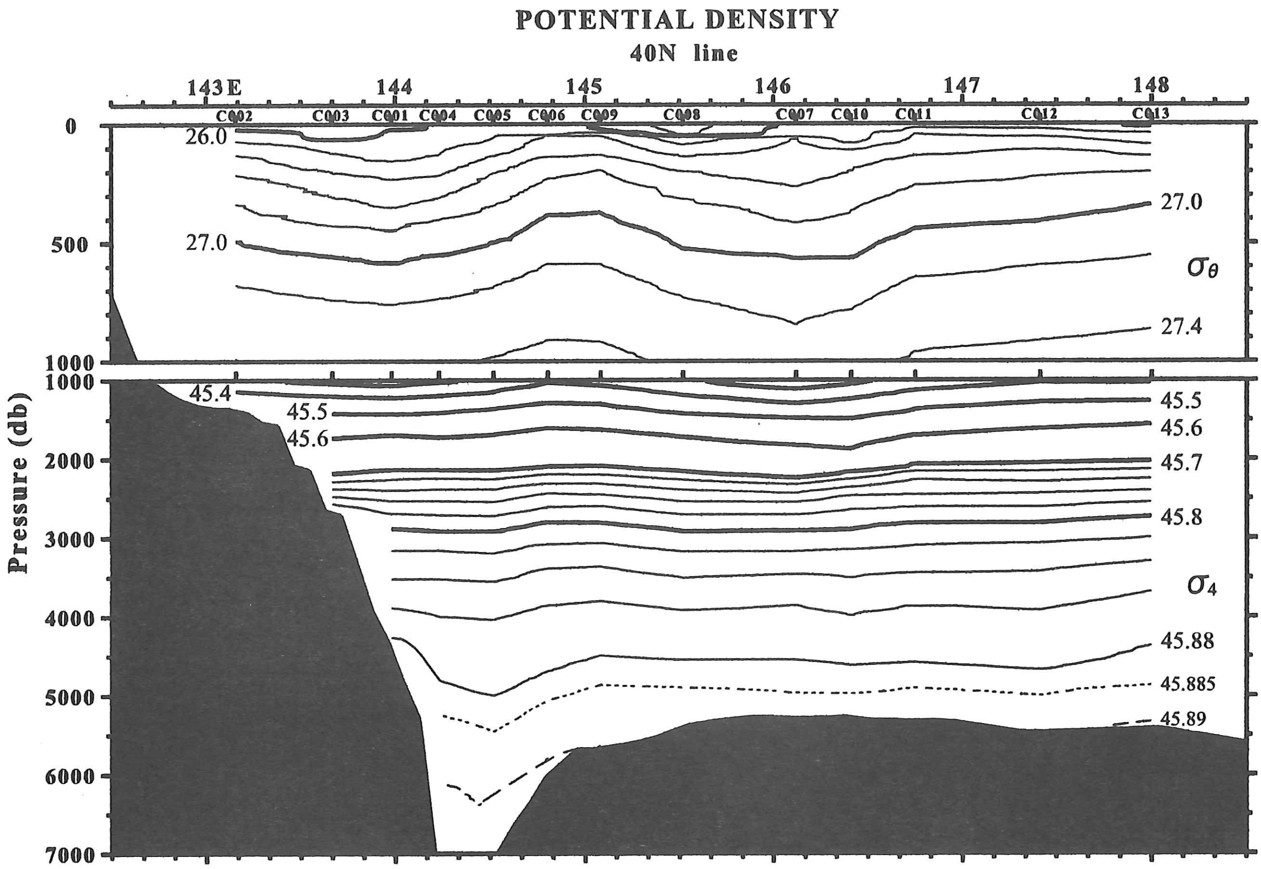


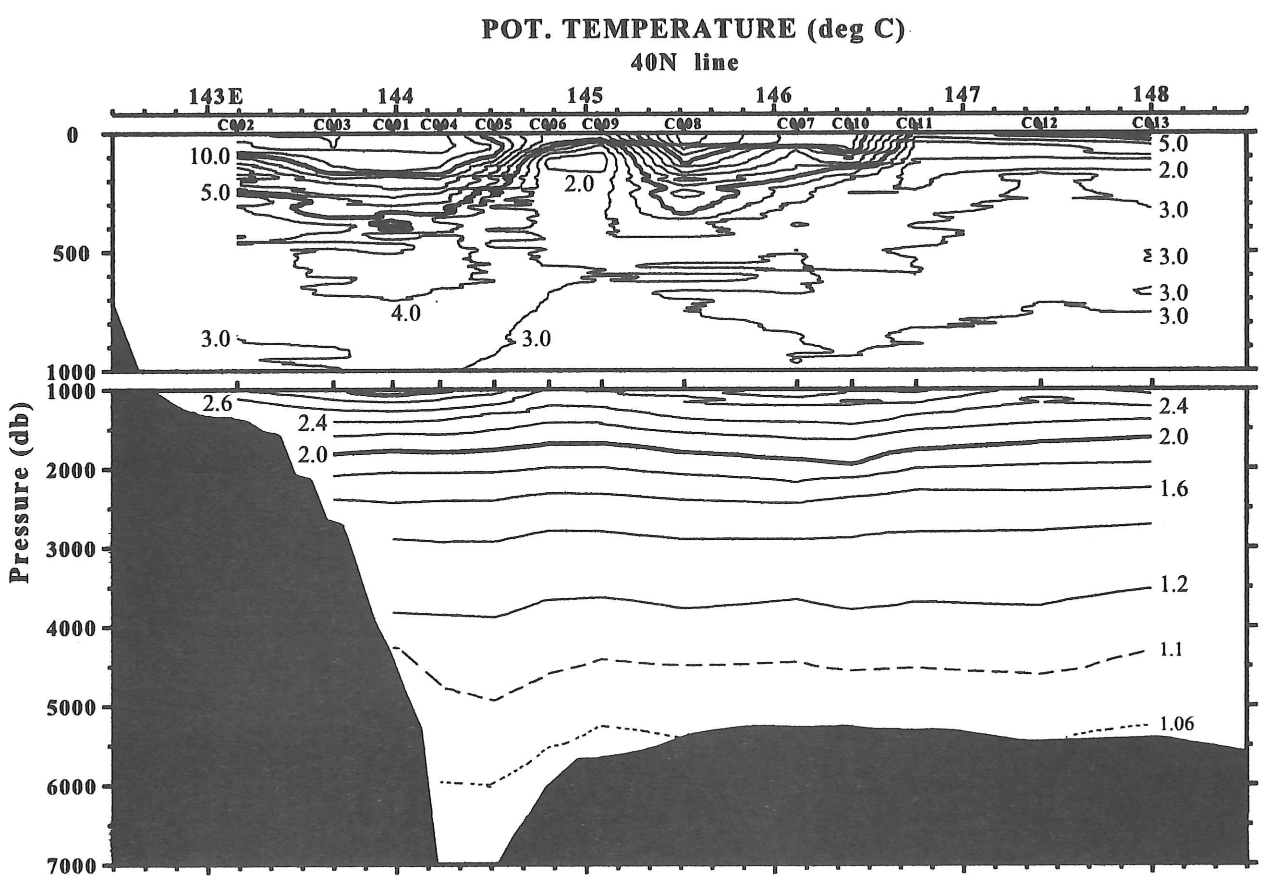

**RDI ADCP (50 m depth)**

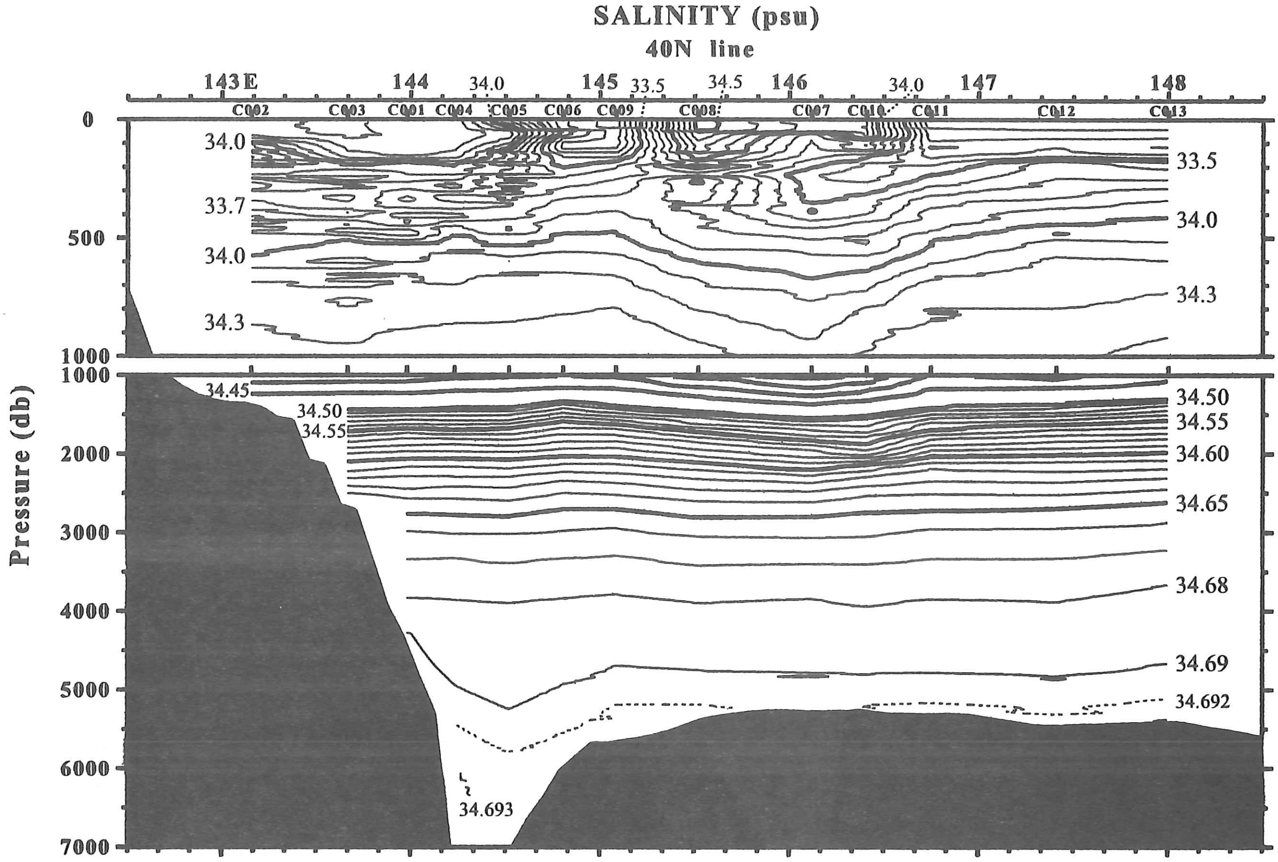



**RDI ADCP (500 m depth)**

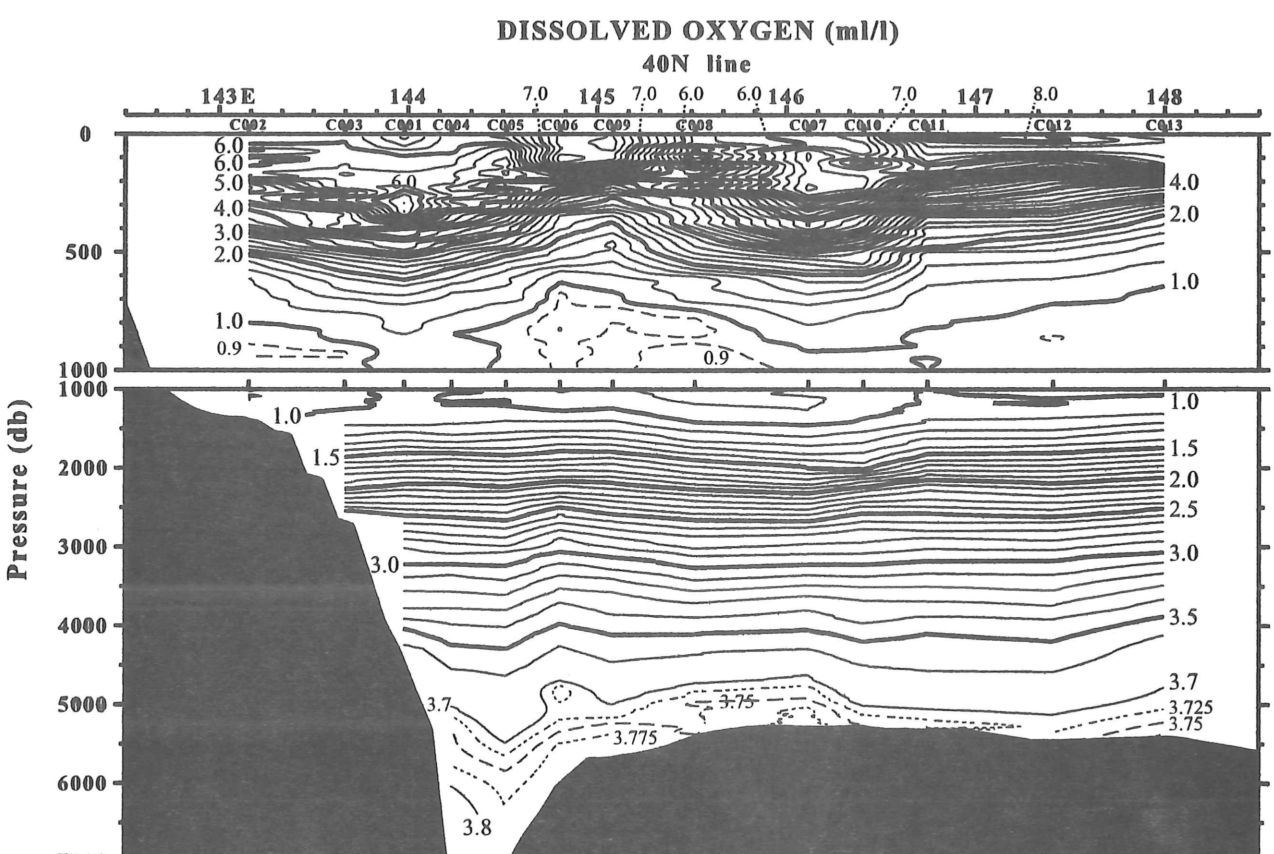
# 8. Vertical Sections of CTDO₂ Data



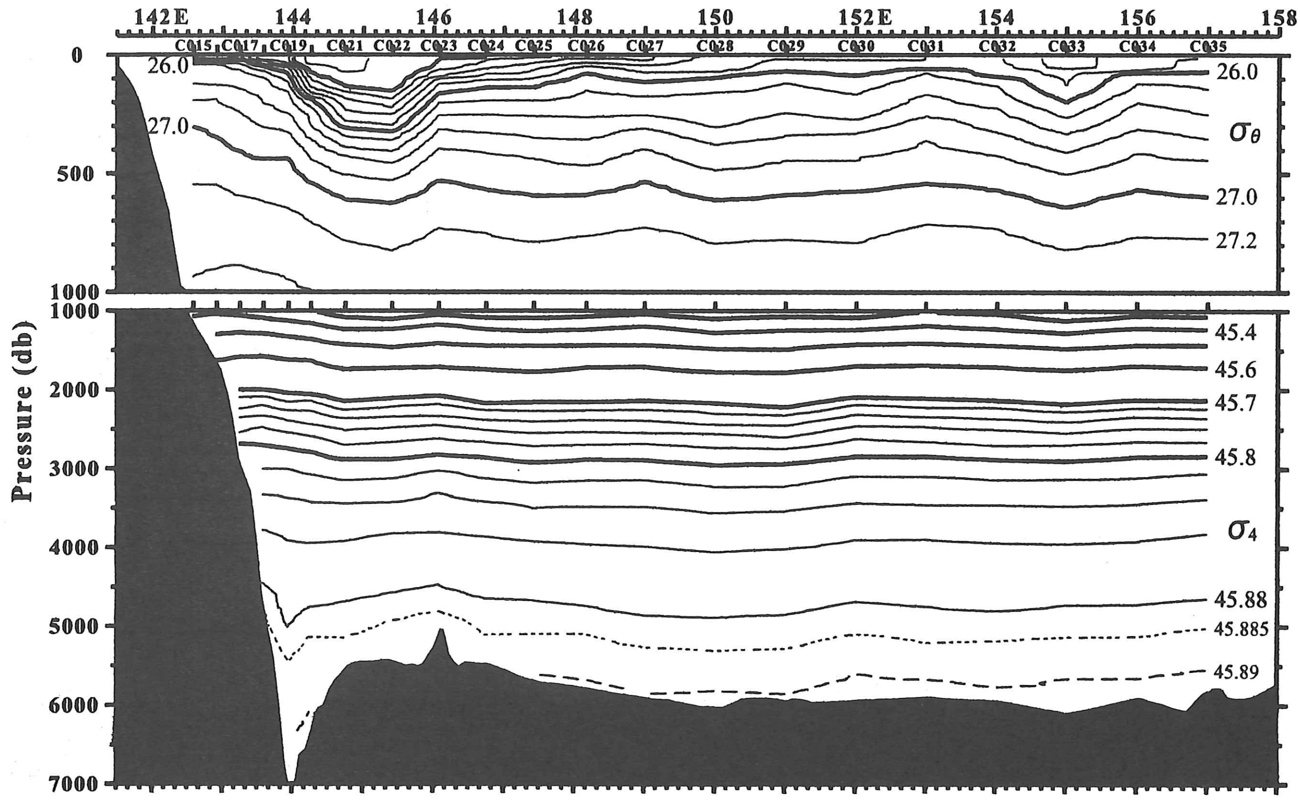


SALINITY (psu)
40N line
143E
144
145
146
147
148
C002
C003
C001
C004
C005
C006
C009
C008
C007
C010
C011
C012
C013
Pressure (db)
34.0
33.7
34.3
34.45
34.50
34.55
33.5
34.60
34.65
34.68
34.69
34.692
34.693

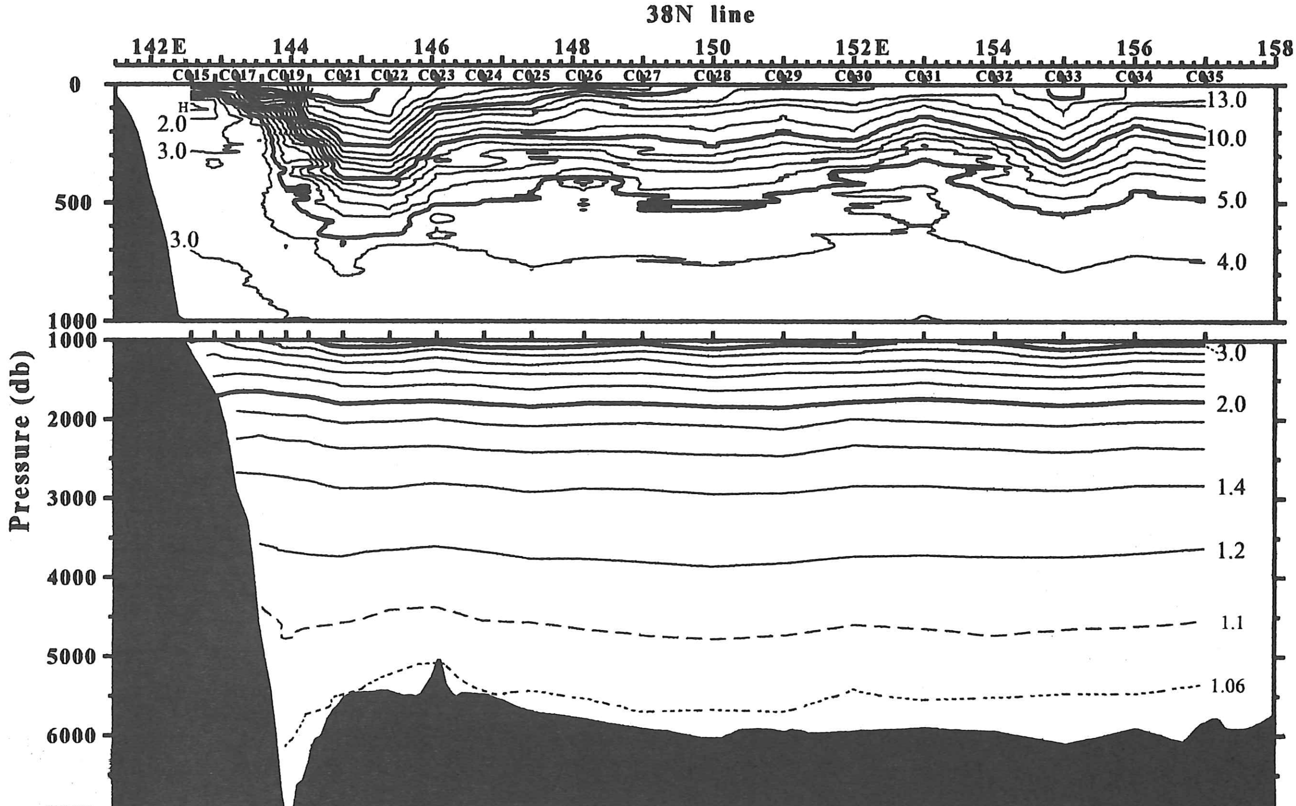



DISSOLVED OXYGEN (ml/l)
40N line
143E
144
145
146
147
148
C002
C003
C001
C004
C005
C006
C009
C008
C007
C010
C011
C012
C013
Pressure (db)
6.0
5.0
4.0
3.0
2.0
1.0
0.9
1.5
2.5
3.5
3.7
3.725
3.75
3.775
3.8
7.0
8.0

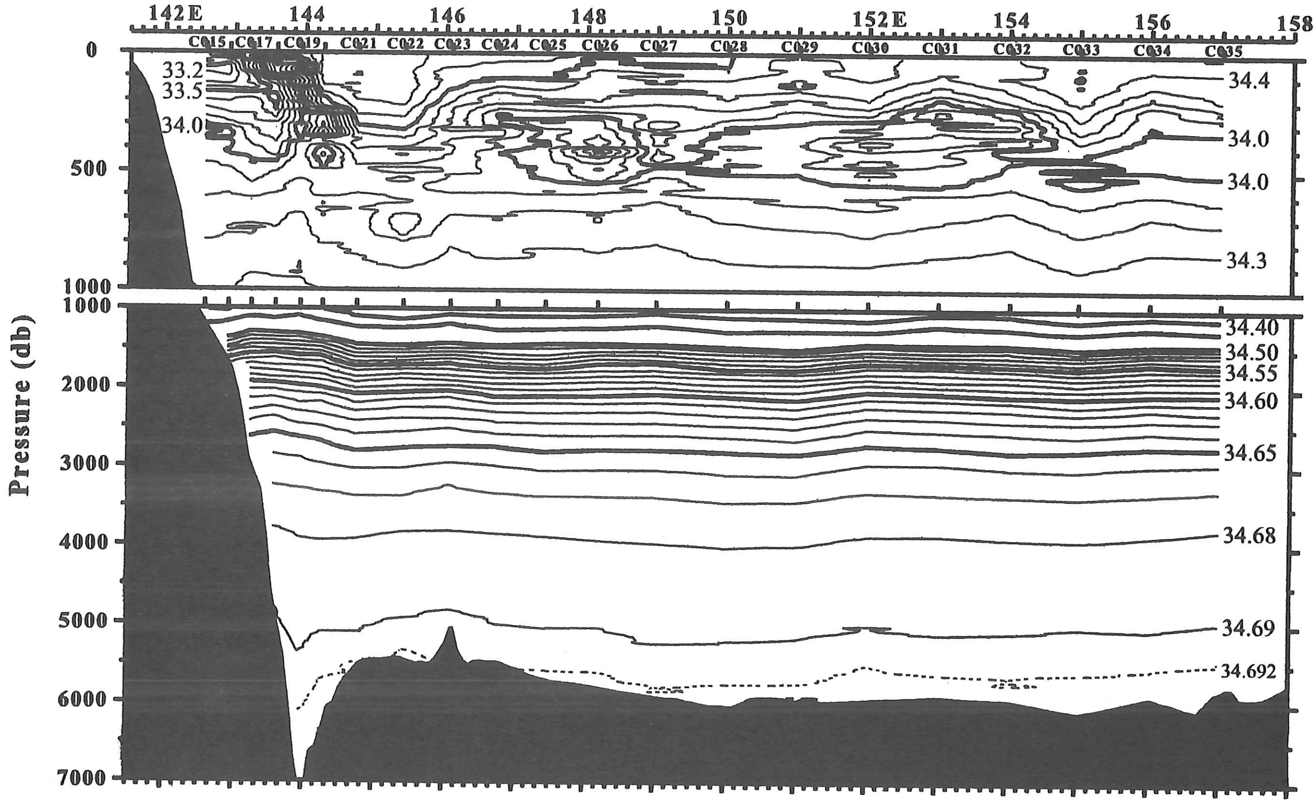
**POTENTIAL DENSITY**
**38N line**



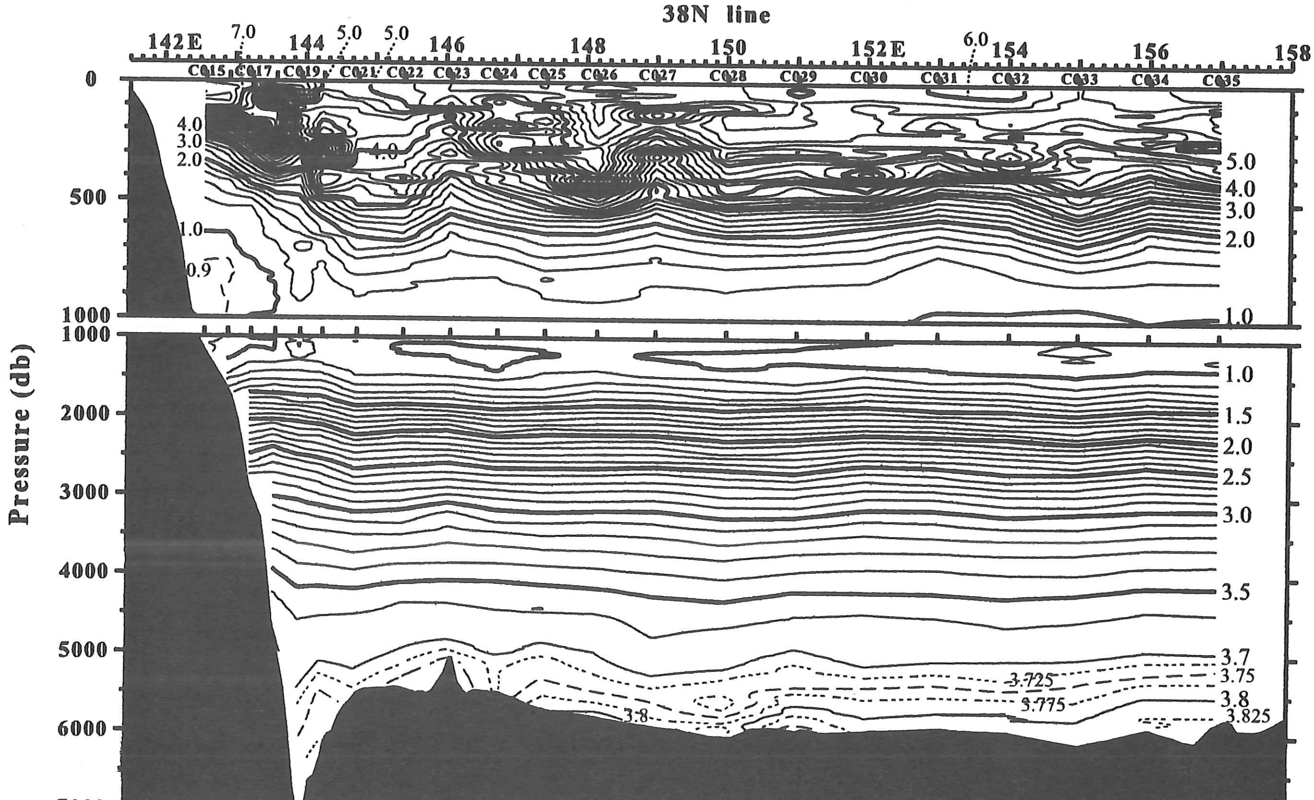

**POT. TEMPERATURE (deg C)**
**38N line**

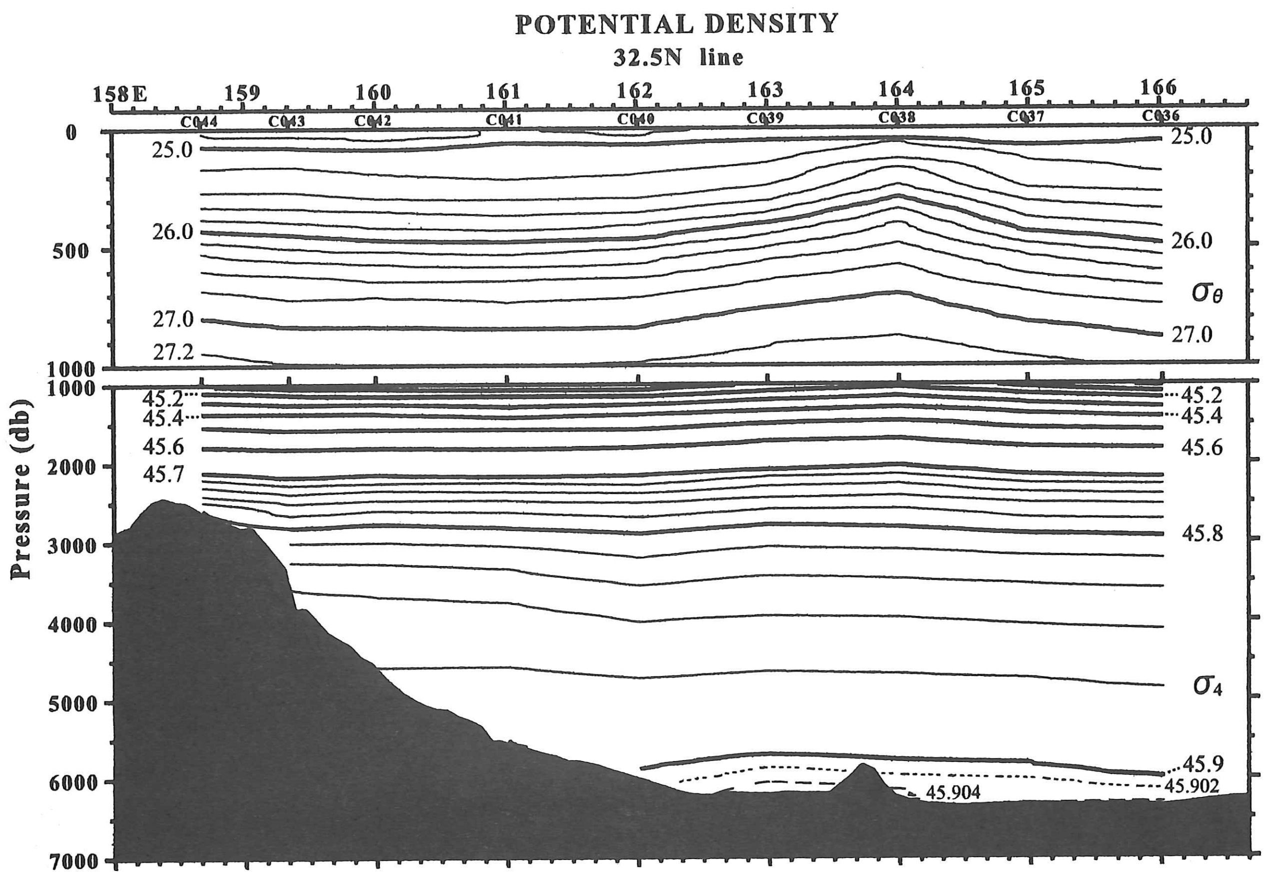


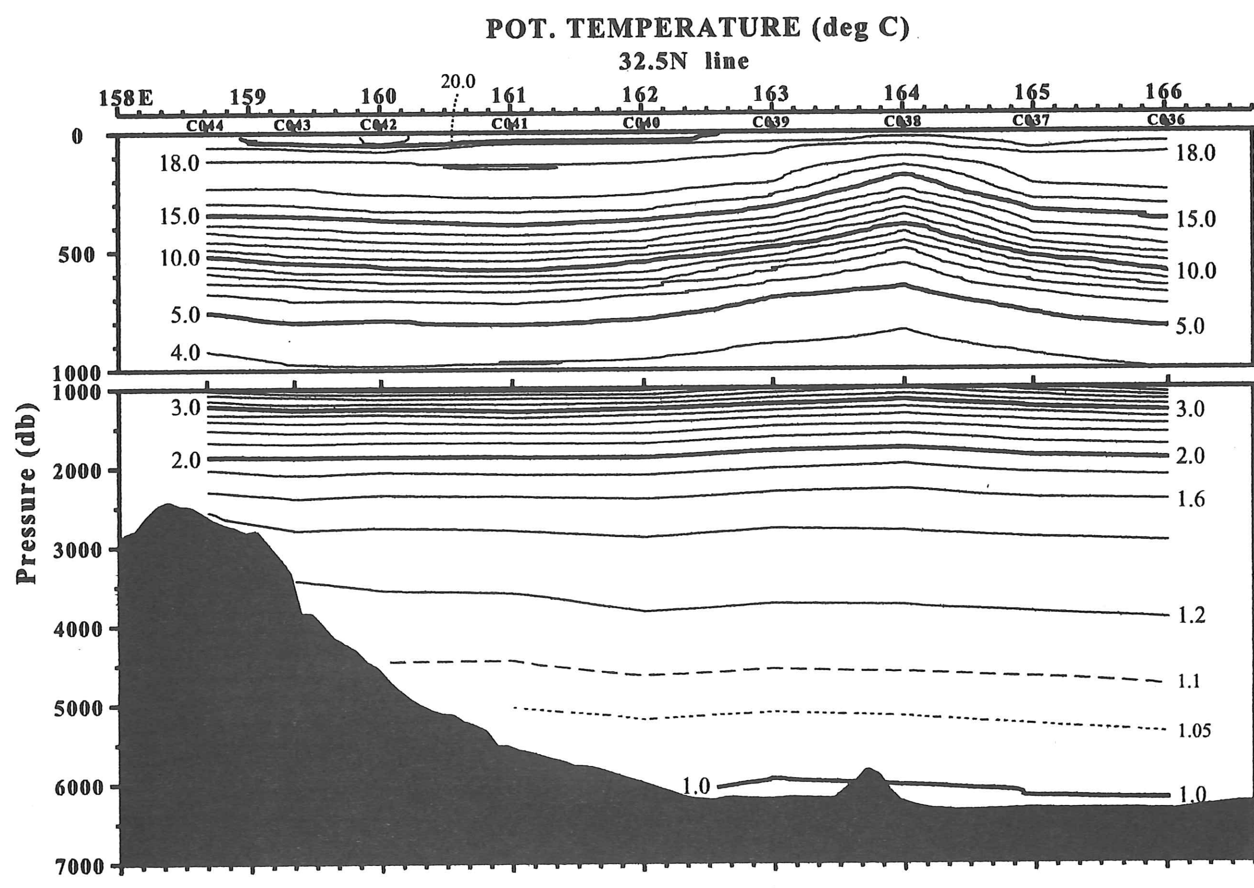
SALINITY (psu)
38N line

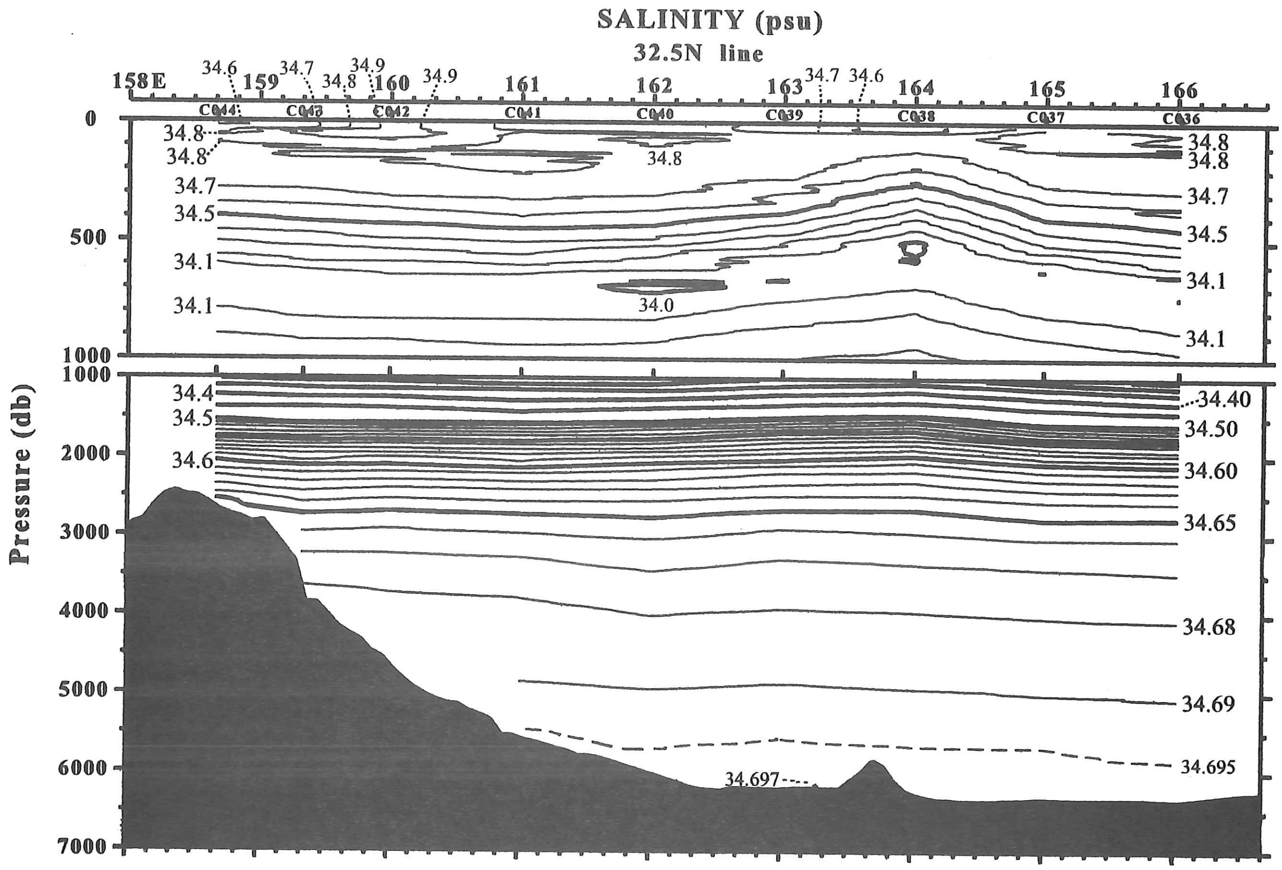


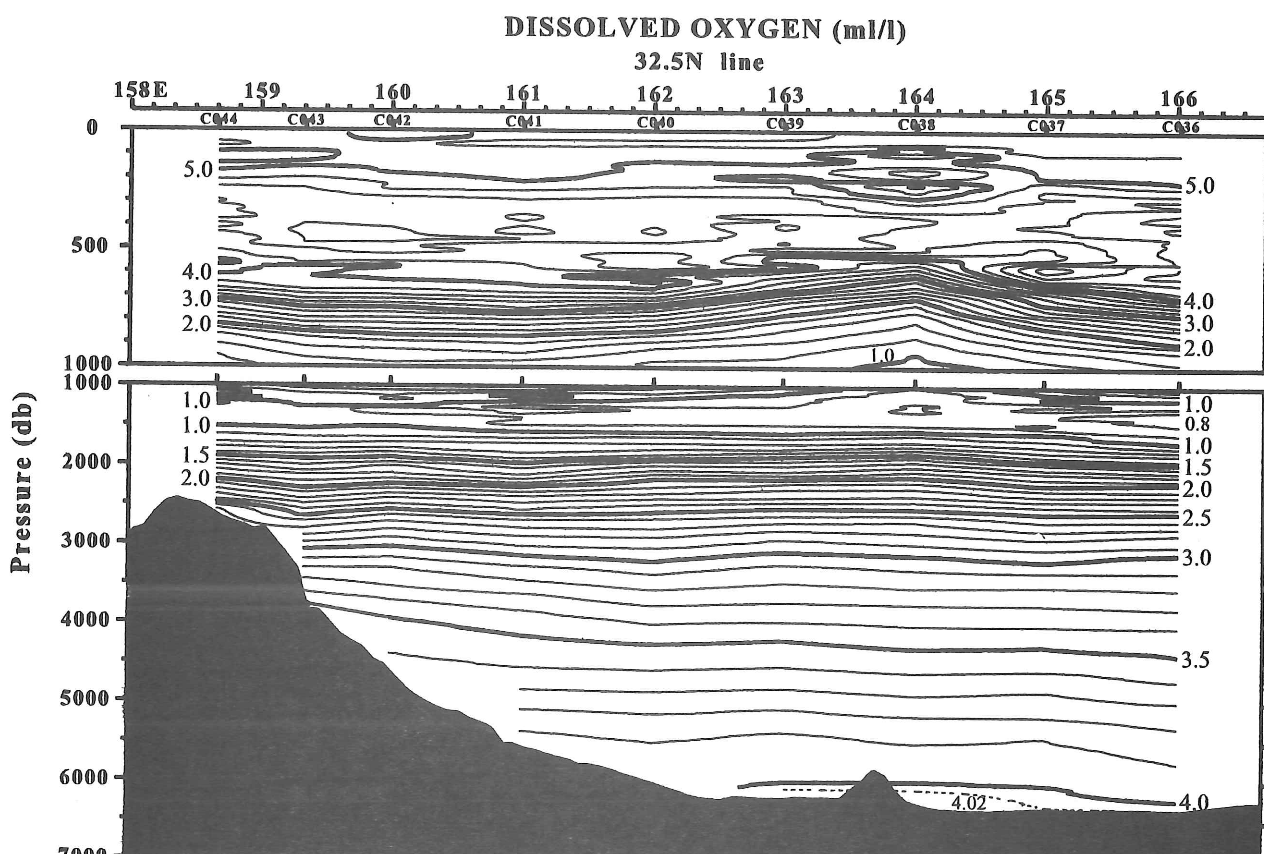

DISSOLVED OXYGEN (ml/l)
38N line




POTENTIAL DENSITY
32.5N line
158E
159
160
161
162
163
164
165
166
C044
C043
C042
C041
C040
C039
C038
C037
C036
Pressure (db)
25.0
26.0
27.0
27.2
$\sigma_\theta$
45.2
45.4
45.6
45.7
45.8
$\sigma_4$
45.9
45.902
45.904

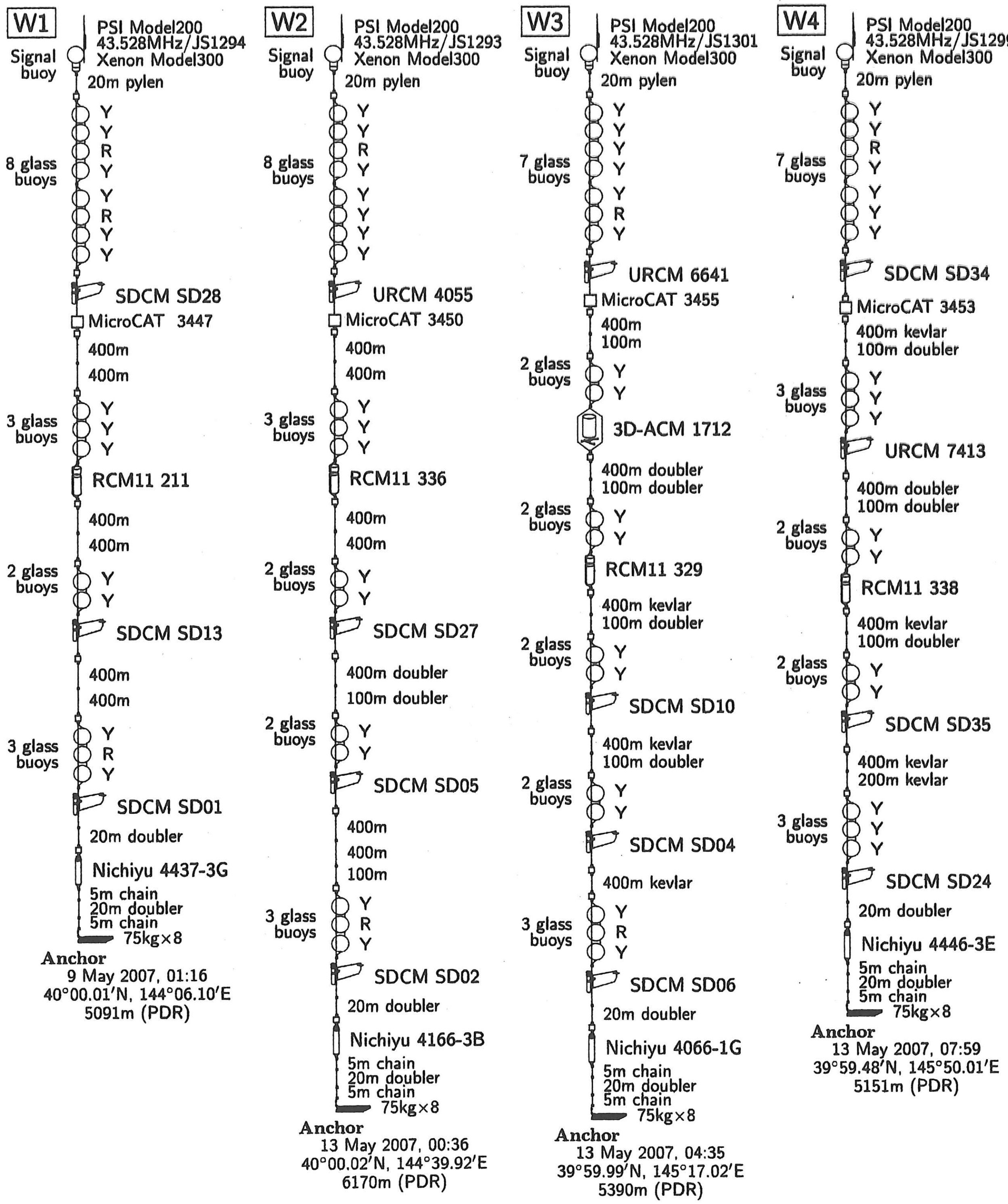

POT. TEMPERATURE (deg C)
32.5N line
158E
159
160
161
162
163
164
165
166
C044
C043
C042
C041
C040
C039
C038
C037
C036
20.0
Pressure (db)
18.0
15.0
10.0
5.0
4.0
3.0
2.0
1.6
1.2
1.1
1.05
1.0

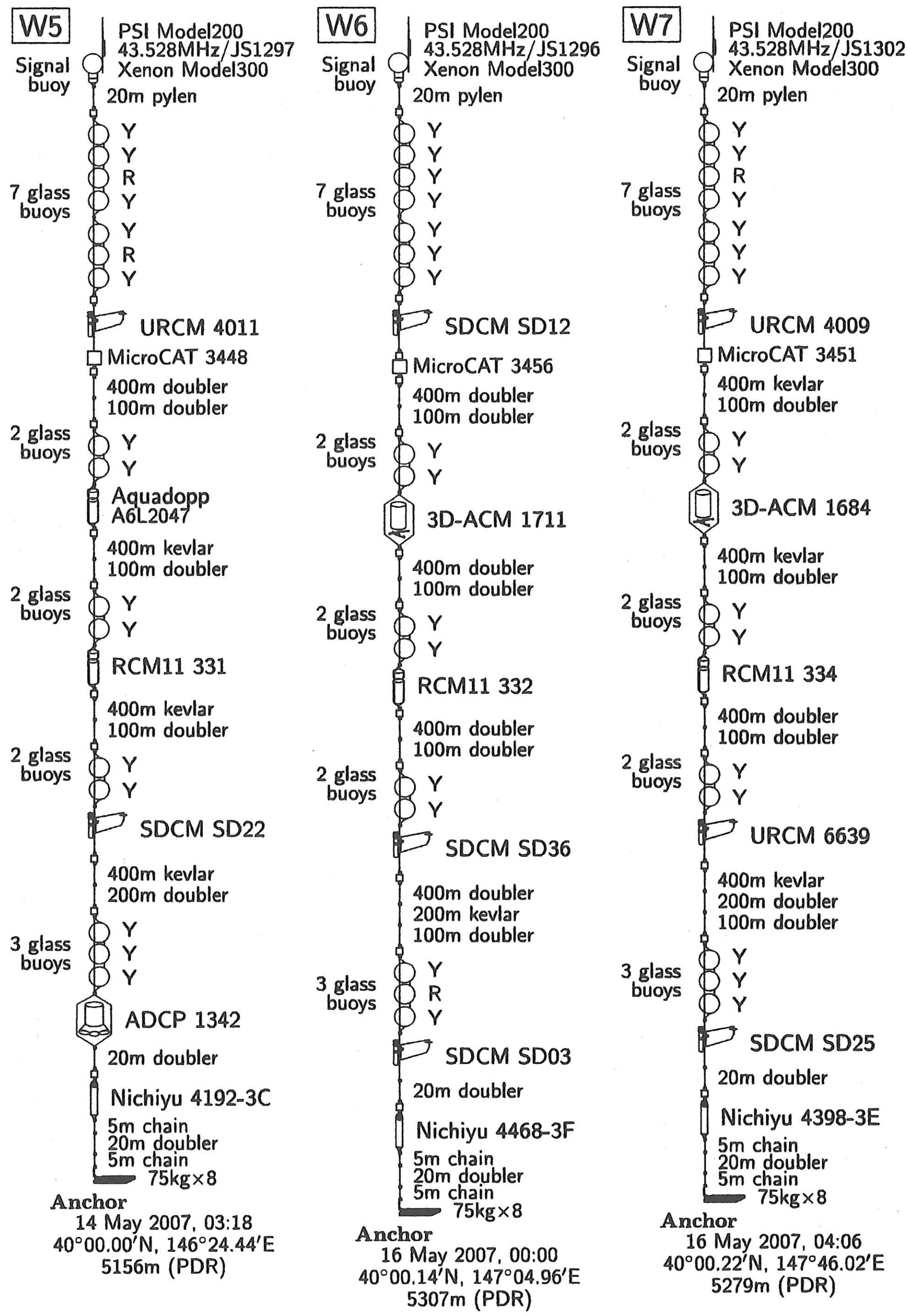

SALINITY (psu)
32.5N line
158E
159
160
161
162
163
164
165
166
C044
C043
C042
C041
C040
C039
C038
C037
C036
Pressure (db)
34.6
34.7
34.8
34.9
34.5
34.1
34.0
34.4
34.40
34.50
34.60
34.65
34.68
34.69
34.695
34.697


DISSOLVED OXYGEN (ml/l)
32.5N line
158E
159
160
161
162
163
164
165
166
C044
C043
C042
C041
C040
C039
C038
C037
C036
Pressure (db)
5.0
4.0
3.0
2.0
1.0
0.8
1.5
2.5
3.5
4.02

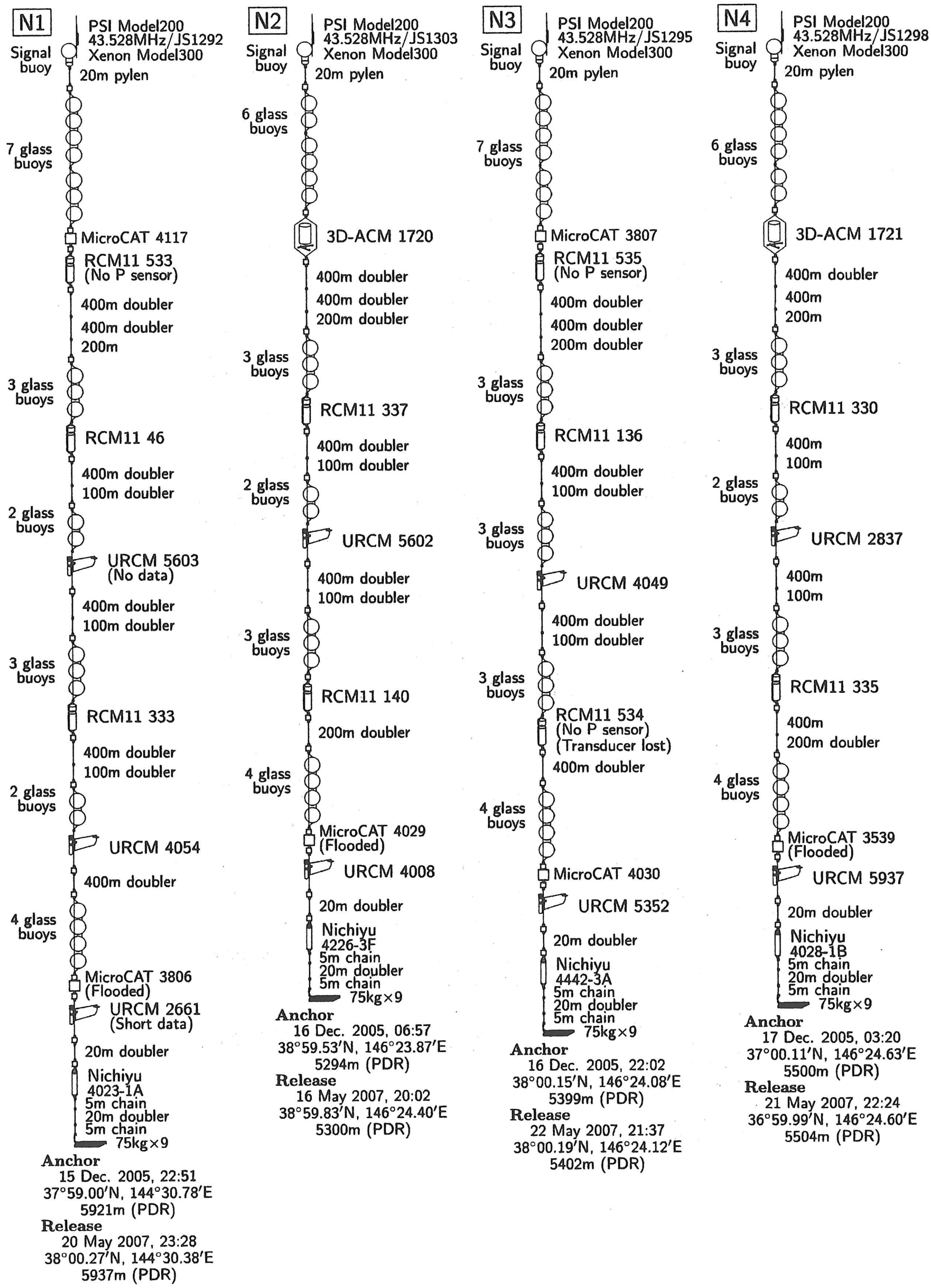
# 9. Mooring Systems

## Deployed Systems at 40°N

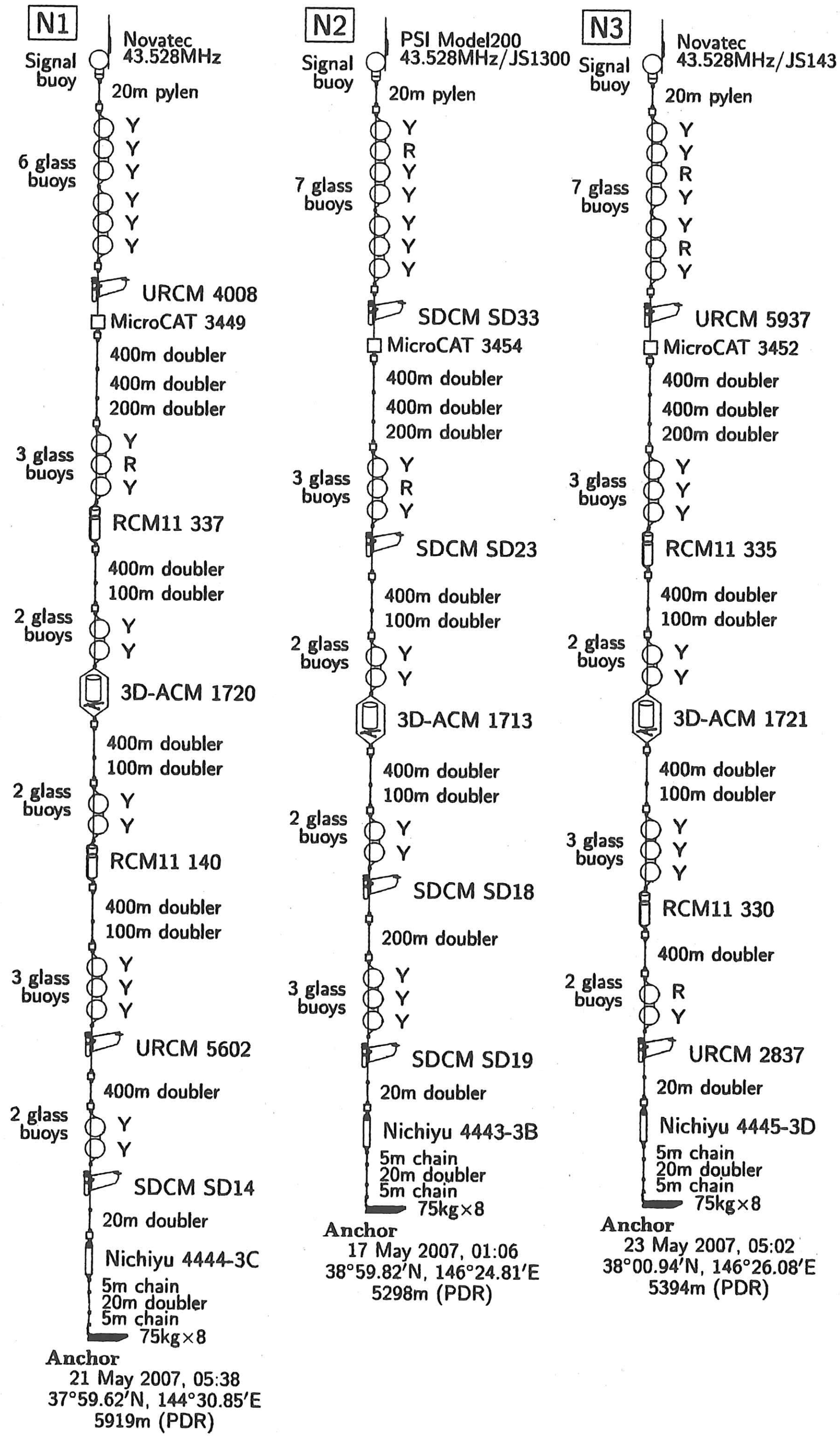



W5
PSI Model200
43.528MHz/JS1297
Xenon Model300
Signal buoy
20m pylen
Y
Y
R
Y
Y
R
Y
7 glass buoys
URCM 4011
MicroCAT 3448
400m doubler
100m doubler
2 glass buoys
Y
Y
Aquadopp
A6L2047
400m kevlar
100m doubler
2 glass buoys
Y
Y
RCM11 331
400m kevlar
100m doubler
2 glass buoys
Y
Y
SDCM SD22
400m kevlar
200m doubler
3 glass buoys
Y
Y
Y
ADCP 1342
20m doubler
Nichiyu 4192-3C
5m chain
20m doubler
5m chain
75kg×8
Anchor
14 May 2007, 03:18
40°00.00′N, 146°24.44′E
5156m (PDR)
W6
PSI Model200
43.528MHz/JS1296
Xenon Model300
Signal buoy
20m pylen
Y
Y
Y
Y
Y
Y
Y
7 glass buoys
SDCM SD12
MicroCAT 3456
400m doubler
100m doubler
2 glass buoys
Y
Y
3D-ACM 1711
400m doubler
100m doubler
2 glass buoys
Y
Y
RCM11 332
400m doubler
100m doubler
2 glass buoys
Y
Y
SDCM SD36
400m doubler
200m kevlar
100m doubler
3 glass buoys
Y
R
Y
SDCM SD03
20m doubler
Nichiyu 4468-3F
5m chain
20m doubler
5m chain
75kg×8
Anchor
16 May 2007, 00:00
40°00.14′N, 147°04.96′E
5307m (PDR)
W7
PSI Model200
43.528MHz/JS1302
Xenon Model300
Signal buoy
20m pylen
Y
Y
R
Y
Y
Y
Y
7 glass buoys
URCM 4009
MicroCAT 3451
400m kevlar
100m doubler
2 glass buoys
Y
Y
3D-ACM 1684
400m kevlar
100m doubler
2 glass buoys
Y
Y
RCM11 334
400m doubler
100m doubler
2 glass buoys
Y
Y
URCM 6639
400m kevlar
200m doubler
100m doubler
3 glass buoys
Y
Y
Y
SDCM SD25
20m doubler
Nichiyu 4398-3E
5m chain
20m doubler
5m chain
75kg×8
Anchor
16 May 2007, 04:06
40°00.22′N, 147°46.02′E
5279m (PDR)

# Recovered Systems in 38°N Area



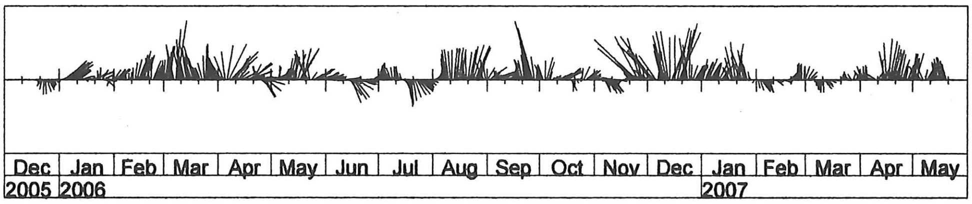
# Deployed Systems in 38°N Area

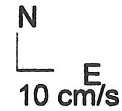


## 10. Results of Moored Current Meters

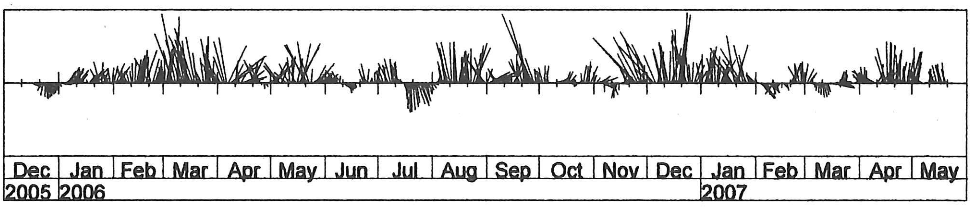
### N1 37-59.00N, 144-30.78E, Water Depth 5921m

2970m (RCM11 533, c830) $(\overline{U}, \overline{V}) = (0.95 \pm 0.34, 3.32 \pm 0.71)$

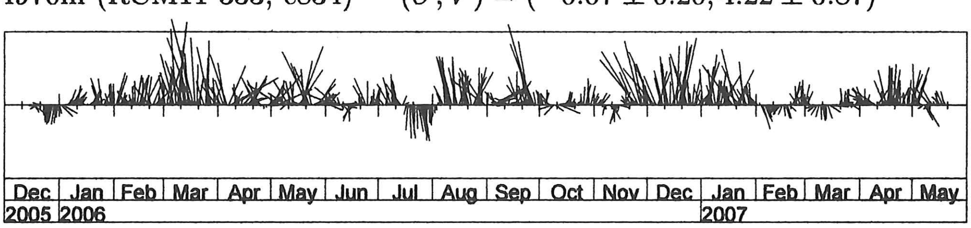


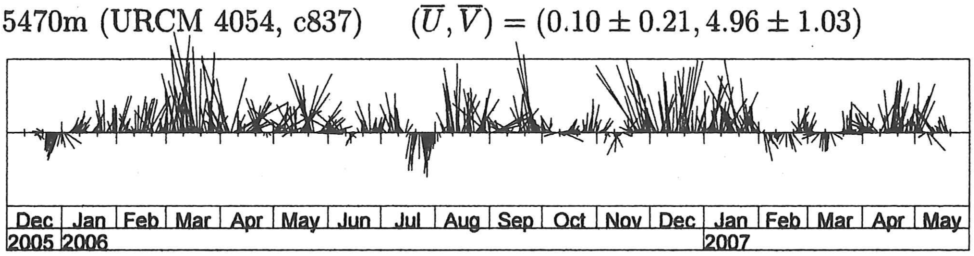

3970m (RCM11 46, c832) $(\overline{U}, \overline{V}) = (0.11 \pm 0.26, 4.09 \pm 0.80)$



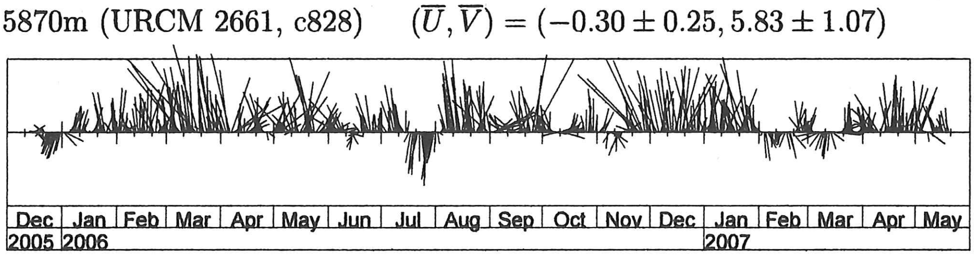

4970m (RCM11 333, c834) $(\overline{U}, \overline{V}) = (-0.07 \pm 0.20, 4.22 \pm 0.87)$




5470m (URCM 4054, c837) $(\overline{U}, \overline{V}) = (0.10 \pm 0.21, 4.96 \pm 1.03)$

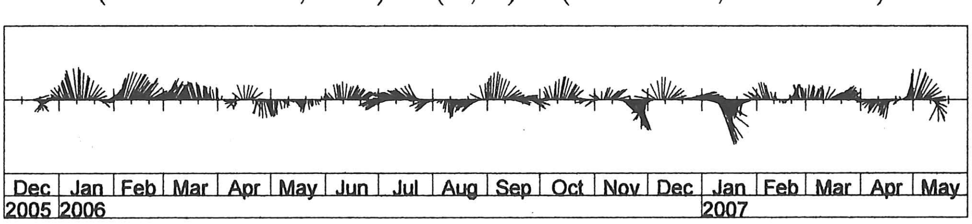



5870m (URCM 2661, c828) $(\overline{U}, \overline{V}) = (-0.30 \pm 0.25, 5.83 \pm 1.07)$

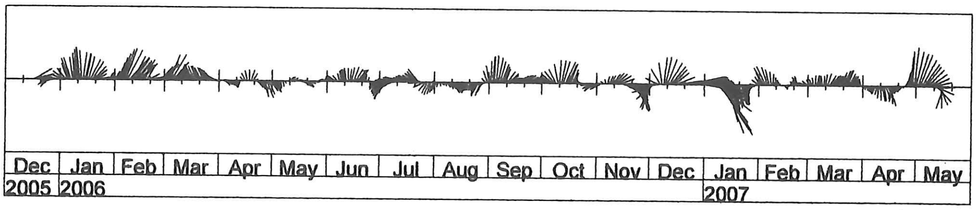



### N2 38-59.53N, 146-23.87E, Water Depth 5294m

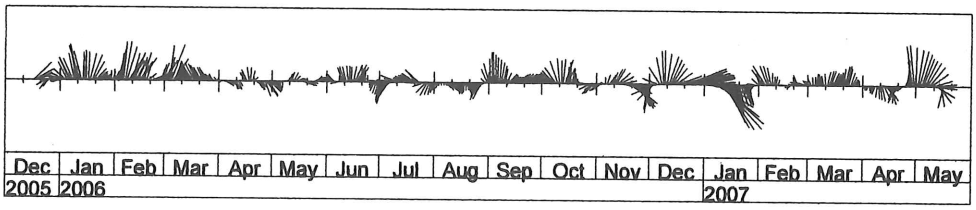
3040m (3D-ACM 1720, c843) $(\overline{U}, \overline{V}) = (0.63 \pm 0.55, 0.72 \pm 0.60)$



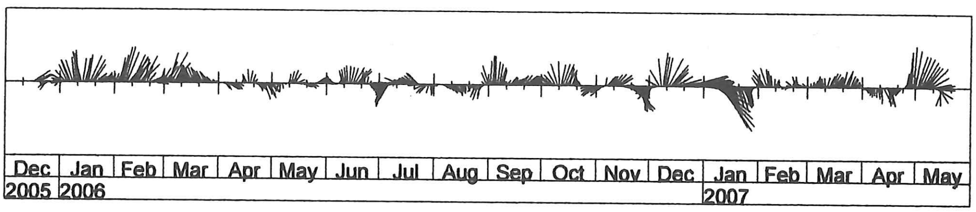
4040m (RCM11 337, c835) $(\overline{U},\overline{V}) = (0.90 \pm 0.57, 0.84 \pm 0.60)$



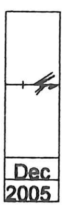

4540m (URCM 5602, c838) $(\overline{U},\overline{V}) = (0.75 \pm 0.60, 1.21 \pm 0.63)$

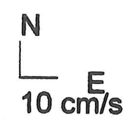



5040m (RCM11 140, c833) $(\overline{U},\overline{V}) = (0.96 \pm 0.57, 1.11 \pm 0.57)$



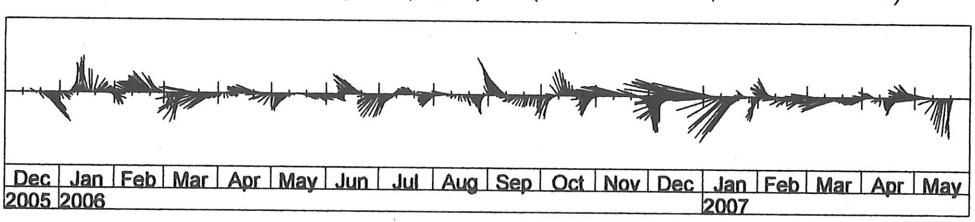

5240m (URCM 4008, c838) $(\overline{U},\overline{V}) = (0.31 \pm 1.57, 0.30 \pm 0.94)$



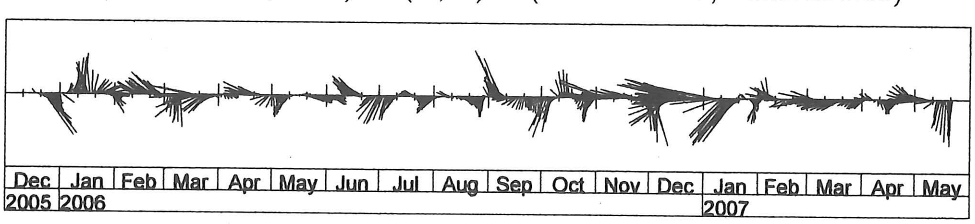




## N3 38-00.15N, 146-24.08E, Water Depth 5399m

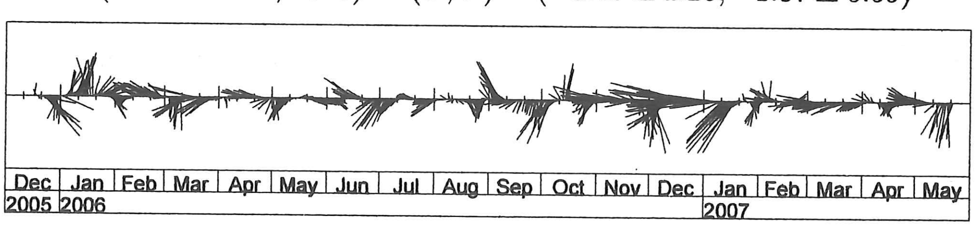
2950m (RCM11 535, c831) $(\overline{U},\overline{V}) = (-3.34 \pm 0.86, -0.97 \pm 0.50)$



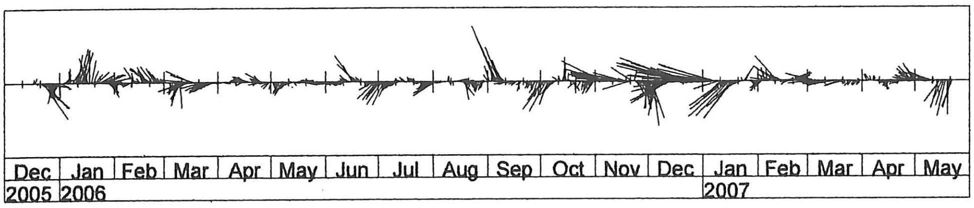

3950m (RCM11 136, c842) $(\overline{U},\overline{V}) = (-3.11 \pm 1.17, -1.21 \pm 0.55)$

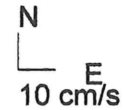



4450m (URCM 4049, c846) $(\overline{U},\overline{V}) = (-3.47 \pm 1.26, -1.37 \pm 0.59)$



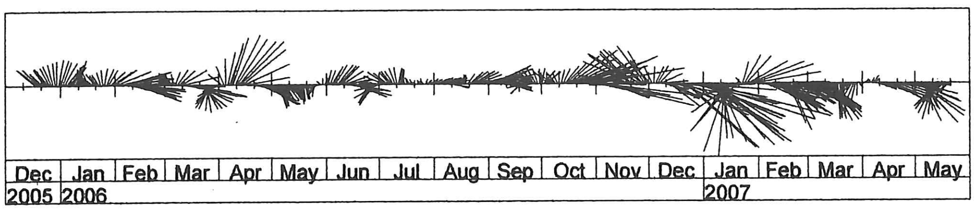
5350m (URCM 5352, c845)  $(\overline{U}, \overline{V}) = (-2.27 \pm 1.05, -0.43 \pm 0.44)$



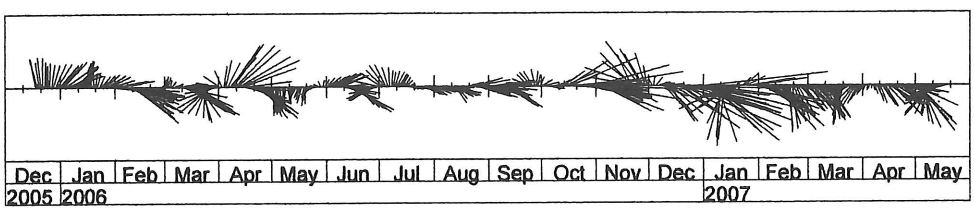




## N4  37-00.11N, 146-24.63E, Water Depth 5500m

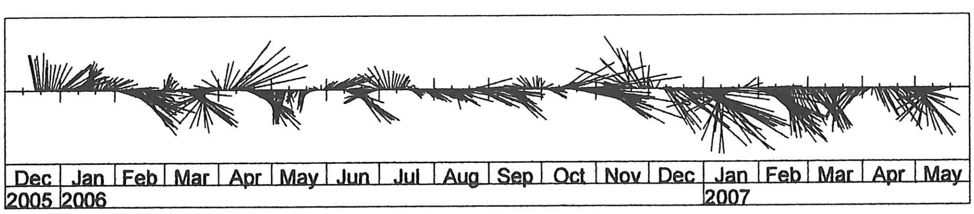
2850m (3D-ACM 1721, c852)  $(\overline{U}, \overline{V}) = (4.66 \pm 1.28, -0.83 \pm 1.51)$



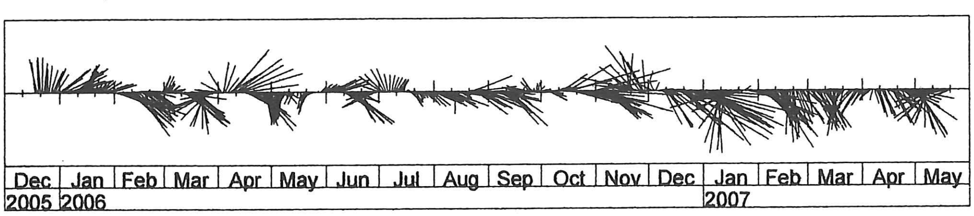

3850m (RCM11 330, c849)  $(\overline{U}, \overline{V}) = (4.94 \pm 1.19, -2.10 \pm 1.34)$




4350m (URCM 2837, c826)  $(\overline{U}, \overline{V}) = (4.95 \pm 1.28, -3.06 \pm 1.58)$




4850m (RCM11 335, c848)  $(\overline{U}, \overline{V}) = (4.36 \pm 1.15, -2.91 \pm 1.42)$




5450m (URCM 6937, c851)  $(\overline{U}, \overline{V}) = (4.20 \pm 1.26, -3.43 \pm 1.12)$