Preliminary Report
of
The Hakuho Maru Cruise
KH-08-3 leg 2

7 October ~ 7 November 2008

Shiogama – Tokyo

Ocean Research Institute
The University of Tokyo
2009

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Cruise for
deep-water circulation, turbulence, mode waters
in the eastern region off Japan

by

The Scientific Members of the Cruise

Edited by

Masaki KAWABE

KH-08-3
塩釜～釜石～小笠原
Leg 2
2008 10/9～11/7

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1. Cruise Narrative

The research cruise KH–08–3 leg 2 of R.V. *Hakuho Maru* was conducted for 32 days between 7 October and 7 November 2008 for study of physical oceanography entitled "Study on processes of formation, transportation, and conversion of water masses to the east of Japan in the western North Pacific". We departed from the Teizan Pier of Shiogama Port at 14:00 on 9 October and returned to Tokyo Port at 10:00 on 7 November. Due to bad weather, we called urgently at Kamaishi Port in the Iwate Prefecture between 8:00 on 20 October and 13:00 on 21 October. During the port call, we had water for drinking in the cruise and received a photosynthetically active radiation (PAR) sensor of fast repetition rate fluorometer (FRRF) from Nagoya University because our PAR sensor was in bad shape.

Study subjects of the cruise KH–08–3 leg 2 were

(1) to study variations of the deep circulation and distribution of deep water (Ocean Research Institute, The University of Tokyo; ORI),
(2) to study transportation and diffusion of helium discharged artificially (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 profiling floats (Japan Agency for Marine-Earth Science and Technology, JAMSTEC),

The primary works were recovery of 10 moorings of current meters and deployment of 3 moorings to obtain time series of current velocity, as well as casts of $CTDO_2$ (conductivity, temperature, depth, oxygen profiler) to measure water temperature, salinity, and dissolved oxygen, LADCP (lowered acoustic Doppler current profiler) to measure current velocity and echo intensity of sound pulse, and water sampler with Niskin bottles to measure chemical parameters.

The water sampler frame was equipped with $CTDO_2$ sensors, 24 Niskin bottles, and two LADCPs with batteries. 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 50 m. 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 laboratory of the vessel.

$CTDO_2$ measurement with the sensors was performed during downcast, and seawater was sampled at 24 positions during upcast. Salinity and dissolved oxygen of water samples were measured on board, and the sample values of salinity and dissolved 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 with seawater sampled by a bucket, and salinity of the intake water was measured to correct the data of salinograph.

Temperature and salinity data by CTD and XCTD (expendable CTD) and temperature data by XBT (expendable bathythermograph) were sent to the Japan Meteorological Agency by the TESAC and BATHY telegrams 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.

Materials of moorings were loaded into the vessel at Shiogama Port on 6 October 2008 (most of instruments and materials for observations had been loaded at Tokyo Port on 18 September). Most of the scientists shipped on 7 October and prepared for the observations on 8 October.

We left Shiogama Port at 14:00 on 9 October. It was a heavy start of cruise for us, because the vessel rolled due to large swell. We arrived at the first observation point (38°N, 144°26′E) at 1:00 on 10 October, and performed CTD/LADCP cast (called CTD cast hereafter) and tested acoustic releasers of moorings. We recovered the mooring N1 (38°N, 144°30′E) in the morning, taking much time to find and recover it. This is because the number of the main buoys (glass spheres) at the top of the mooring were less than usual and did not reach to above the sea surface, and moreover the transmitter to show the direction of the mooring did not work. We deployed N1 in the afternoon.

We conducted CTD observations at 3 stations toward 40°N and sampled seawater for helium analysis. At 40°N, we recovered 7 moorings under excellent sea conditions: the moorings W1, W2 on 11 October, W3, W4 on 13 October, and W5, W6, W7 on 15 October. Thereafter, we recovered and deployed the moorings N2 and N3 on 17 and 18 October, respectively, and deployed an Argo profiling float at N3. In this manner, we finished all the mooring works successfully. After that, wind strengthened, and wind speed reached 10 m s^{-1} in the evening, as a typhoon approached from south. The sea became stormy. We stopped the observations in early afternoon on 19 October and sailed for Kamaishi Port. At 8:00 on 20 October, we arrived at the -7.5 m wharf of the Public Pier of Kamaishi Port.

Summarizing the mooring observations, the recovered current meters are 51 in total: 35 in W1–W7 and 16 in N1–N3. Out of them, 41 current meters functioned throughout the mooring period (one year and five months): 29 in W1–W7 and 12 in N1–N3. They are composed of Aanderaa RCM11 (11 out of

11), Union Engineering URCM (9 out of 10), Union Engineering SDCM (16 out of 22), FSI 3D–ACM (3 out of 6), Nortek AQUADOPP (1 out of 1), and RD ADCP (1 out of 1). The other 10 current meters stopped within the mooring period, although 3 current meters (1 3D–ACM, 2 SDCM) recorded data over 200 days. We cannot know the causes for the stop of current meters, but the 2 SDCM near the sea bottom, functioned for 3 and 290 days, stopped because of damage of rotors of the current meters due to an explosion of glass spheres just above the current meters. Moreover, all of 10 moored CTDs (Sea–Bird Electronics Micro CAT) functioned well.

We left Kamaishi Port at 13:00 on 21 October. Swell still remained. We restarted CTD observations in the early morning on 22 October. Swell weakened on 23 October. On 24 October, wind strengthened again, and we gave up the CTD cast at 33°N, 146°E at 10:00. We moved southward to avoid strong wind, and fortunately, the weather recovered early. Then we performed CTD and FRRF observations along 146°E down to 27°30′N with no interruption. On the 146°E line, we performed full–depth CTD casts and 200–m CTD/FRRF casts every 1° latitude, and TurboMAP casts at every two stations of CTD. Additional CTD casts were performed east and west of 146°E at 37°N and 30°N. At intervals of 10′ latitude (or longitude) between the CTD stations, we conducted XCTD casts decreasing the ship speed to less than 10 knot. The observations along 146°E were planned to 29°N originally but were extended to 27°30′N because Subtropical Mode Water expanded to further south than usual. The area south of 28°11′N, 146°E is a training area for the Japanese Self–Defense Forces, and we had to pass this area between 18:00 and 08:00. We deployed three Argo profiling floats at 36°N and 33°N, 146°E and 27°30′N, 145°E. At 27°30′N, 144°E, we sampled 220–liter seawater at a depth of 10 m which will be used in nutrients measurement on the Hakuho Maru cruise in 2011.

We performed a CTD cast at 27°30′N, 143°E in the early morning on 29 October. After that, we took a rest for half a day. We restarted observations by XCTD cast at 27°40′N, 143°E around 20:00 on 29 October. Proceeding northward along 143°E, we performed 2000–m CTD casts every 30′ latitude, XCTD casts every 10′ latitude between CTD stations, 200–m CTD/FRRF casts every 1° latitude, and TurboMAP casts every 2° latitude, and deployed an Argo profiling float at 31°N, 143°E. The observations up to 37°N along 143°E were performed without interruption and finished in the morning of 3 November. On 30 October, "free fall" of the CTD cable of 6400 m was performed at 28°30′N, 143°E in order to remove twists of the cable.

On 3 November, we sailed south-southwestward from 37°N, 143°E during the daytime and arrived at 34°N, 142°E at night. We deployed XBT and XCTD probes, going eastward, and analyzed the data for determining the locations of CTD stations. Along 34°N, we performed four 2000–m casts of CTD, two 200–m casts of CTD/FRRF, and two casts of TurboMAP, and casts of four XBT and eight XCTD probes. We sailed from 34°N, 141°E to 33°30′N, 140°E, deploying six XBT probes. We finished all the observations at 10:00 on 5 November.

In total, we performed 36 full-depth CTD casts, 26 2000-m CTD casts, 27 200-m CTD/FRRF casts, and 24 TurboMAP casts, sampled seawater for helium measurements at 5 CTD stations, and deployed 122 XCTD probes, 10 XBT probes, and 5 Argo profiling floats. Moreover, we recovered 10 moorings attaching current meters and CTDs, and deployed 3 moorings. The observations in KH-08-3 leg 2 were greatly successful.

Acknowledgements

East of the Tohoku District of Japan, we had suffered several attacks of strong atmospheric depression on the cruises KH-05-4 and KH-07-1. In contrast to the past cruises, we were fortunate on the current cruise KH-08-3 leg 2, on which we evacuated only once, and the timing was lucky because it happened after we finished all of the mooring work. Moreover, the CTD system was extremely in good shape; the sensor and cable of CTD and the water-sampling instruments worked well stably without any trouble. Therefore, we did not need to take time for maintenance and repair of the instruments. This rarely occurs in ocean observations. As a result, the observation was performed continuously with no interruption. This compelled the crew and scientists to work hard. Success in this cruise was owing to their devoted work. I am grateful to Captain Shoichi Suzuki, the crew of R.V. *Hakuho Maru*, and the scientists and technical staff for their cooperation in the work throughout the cruise KH-08-3 leg 2.

I thank the Research Vessel Operation Department of JAMSTEC and the Office for Cruise Coordination of ORI for taking necessary steps for the urgent port call to Kamaishi and other changes of the observation plan, and supplying information of forecast of weather and wave heights as well as information of the military training area of the Japanese Self-Defense Forces. I also thank Drs. Tadashi Inagaki (Office for Cruise Coordination, ORI), Fumihiro Kato (Division of Ocean Circulation, ORI), and Takuji Hosaka (Nagoya University) for sending necessary materials of moorings and a PAR sensor of FRRF to Kamaishi Port.

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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 22070-0289).

A2. Conductivity

Conductivity of water samples was measured with a salinometer Guildline Portasal Model 8410A, S/N 66402 for C001~C005 and S/N 63893 for C005 and later, which was standardized by IAPSO Standard Seawater (Ocean Scientific International Ltd.) of Batch P149 (K_{15} = 0.99984). The measurement was done in Laboratory 5 in which air temperature was controlled to be a little lower (≈ 3°C) than water temperature in the salinometer water bath being 26°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 did not measure nutrient concentration on board in this cruise, although we took several samples of seawater for nutrients measurement on land.

The following values are the concentrations of nutrients of the Reference Material of Nutrients in Seawater (RMNS) Lot-AT, Lot-AU, Lot-AW, and Lot-AV, measured on the Hakuho Maru KH-05-4 cruise. We did not record them in the past cruise reports and note them here. However, we must use the RM values on KH-04-4 to compare the KH-05-4 nutrient data with other cruise data, because the nutrient concentrations on KH-05-4 were adjusted to the reference of the KH-04-4 data, using the following values and the RM values on KH-04-4.

The average, standard deviation (μmol kg^{-1}), and the number of measurement on the KH-05-4 cruise are as follows.

	Nitrate	Nitrite	Silicate	Phosphate
RMNS Lot-AT	7.49	0.02	18.05	0.53
	0.23	0.01	1.01	0.01
	14	14	14	14
RMNS Lot-AU	30.00	0.02	70.27	2.12
	0.26	0.02	3.42	0.02
	56	56	56	56

RMNS Lot-AW	24.31	0.42	121.60	2.03
	0.22	0.01	0.78	0.01
	12	12	12	12
RMNS Lot-AV	33.22	0.09	158.40	2.45
	0.27	0.01	1.37	0.01
	7	7	7	7

B. $CTDO_2$

B1. Instrument

The $CTDO_2$ 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 a set of the $CTDO_2$ underwater instrument. Instrument No. 1 was CTD SBE9plus (S/N 12545-0400) equipped with conductivity sensor SBE4 (S/N 2496), temperature sensor SBE3plus (S/N 4378), pressure sensor (S/N 60965), oxygen sensor SBE43 (S/N 0781), and pump SBE5T (S/N 1267).

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 a personal computer EPSON Endeavor MT7500, whose operating system is Windows. Then, the Windows version of software was used. The full signals of frequency were stored in the hard disc during the downcast of CTD 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 were calibrated by Sea-Bird Electronics, Inc. in August 2008. The pressure sensor was calibrated by JAMSTEC in October 2007. 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 0.5 dbar for Instrument No. 1.

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* (dbar) 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 each of the station groups.

1) C001~C012
   a~*f* = 1.000122, -.1304673E-6, .3316065E-10, -.2466224E-14, 0.0, 0.0
2) C013~C016
   a~*f* = 1.000000, 0.0, 0.0, 0.0, 0.0, 0.0
3) C017~C22S
   a~*f* = 1.000104, -.1129544E-6, .2573246E-10, -.1571544E-14, 0.0, 0.0
4) C023~C028
   a~*f* = 0.9999713, .2224705E-8, 0.0, 0.0, 0.0, 0.0
5) C029~C032
   a~*f* = 1.000014, -.4357100E-7, .6248601E-11, 0.0, 0.0, 0.0
6) C033~C036
   a~*f* = 1.000068, -.5387469E-7, .7310659E-11, 0.0, 0.0, 0.0
7) C037~C50S
   a~*f* = 1.000104, -.3615521E-6, .4995031E-9, -.1775687E-12, 0.0, 0.0
8) C051~C58S
   a~*f* = 1.000094, -.5477788E-7, .9551255E-10, -.4626919E-13, 0.0, 0.0
9) C059~C062
   a~*f* = 1.000161, -.7988660E-6, .1021388E-8, -.3427540E-12, 0.0, 0.0

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*, *S*, and *P* are water temperature (°C), salinity (pss78), and pressure (dbar) measured with CTD, and $O_x^*(T,S)$ the saturated oxygen for *T* and *S*.

The six coefficients *A~F* were determined with a nonlinear least squares fitting to the oxygen of water samples, assuming that the coefficient *B* was fixed to zero. The result of the coefficients is as follows.

1) C001

A~F = 0.385, 0.0, 0.09, -1.86E-3, 1.45E-4, -0.702

2) C002

A~F = 0.376, 0.0, 0.41, 1.80E-2, 1.33E-4, -1.474

3) C003

A~F = 0.434, 0.0, 0.0, 1.67E-3, 1.38E-4, -0.513

4) C004~C022

A~E = 0.427, 0.0, 0.22, 7.65E-3, 1.35E-4

F = -0.990(C004), -0.997 (C005), -0.998 (C006), -0.994 (C007), -0.992 (C008), -0.991 (C009), -0.992 (C010), -0.990 (C011), -0.993 (C012), -0.989 (C013), -0.991 (C014), -0.987 (C015), -0.990 (C016), -0.989 (C017), -0.989 (C018), -0.989 (C019), -0.991 (C020), -0.990 (C021), -0.987 (C022)

5) C023~C036

A~E = 0.431, 0.0, 0.19, 7.10E-3, 1.35E-4

F = -0.902 (C023), -0.906 (C024), -0.905 (C025), -0.905 (C026), -0.903 (C027), -0.902 (C028), -0.904 (C029), -0.904 (C030), -0.904 (C031), -0.905 (C032), -0.904 (C033), -0.905 (C034), -0.903 (C035), -0.899 (C036)

6) C037~C050

A~F = 0.396, 0.0, 0.09, 9.43E-3, 1.79E-4, -0.713

7) C051~C062

A~F = 0.429, 0.0, 0.14, 6.98E-3, 1.44E-4, -0.803

B4. Fast Repetition Rate Fluorometer (FRRF)

Casts of FRRF were conducted. FRRF DF-03B (S/N 138453003), manufactured by Kimoto Electric Co. Ltd. (Osaka, Japan), was used to measure fluorescence induction curves of chlorophyll in phytoplankton. This method is based on the relationship between 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 bandpass 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 reoxidation 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. XBT

Probes of TSK XBT T-7 (BATHY Code 222) were used. The depth of a falling XBT probe, z (m), was computed with the equation of the elapse time, t (sec), after falling from the sea surface that

$$z = 6.472 \cdot t - 0.00216 \cdot t^2.$$

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

E. Shipboard ADCP

E1. 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.

E2. ADCP (RD Instruments)

Current velocities at 80 levels at an interval of 16 m from 32-m depth down to about 1300 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 α is the error in orientation of transducer, and $1+\beta$ is the scale factor.

The values of α and β 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

$$\alpha\ (\text{rad}) = 0.0115, \quad \beta = 1.0000.$$

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

F. Lowered ADCP

An ADCP instrument of 300 kHz Workhorse 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 battery package was mounted on the frame. The instruments were WH300 (downward: S/N 3381, upward: S/N 387). We selected 1 ping per a second and 4-meter bins.

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.

G. Altimeter

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 the bottom layer of approximately 50 m. Owing to the use of the altimeter, we could observe safely to just above the sea bottom.

H. TurboMAP

TurboMAP (Turbulence Ocean Microstructure Acquisition Profiler), manufactured by JFE 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 KH-04-4 Preliminary Report for the details.

TurboMAP is lowered freely with adjusted ballasts at 0.6~0.7 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.

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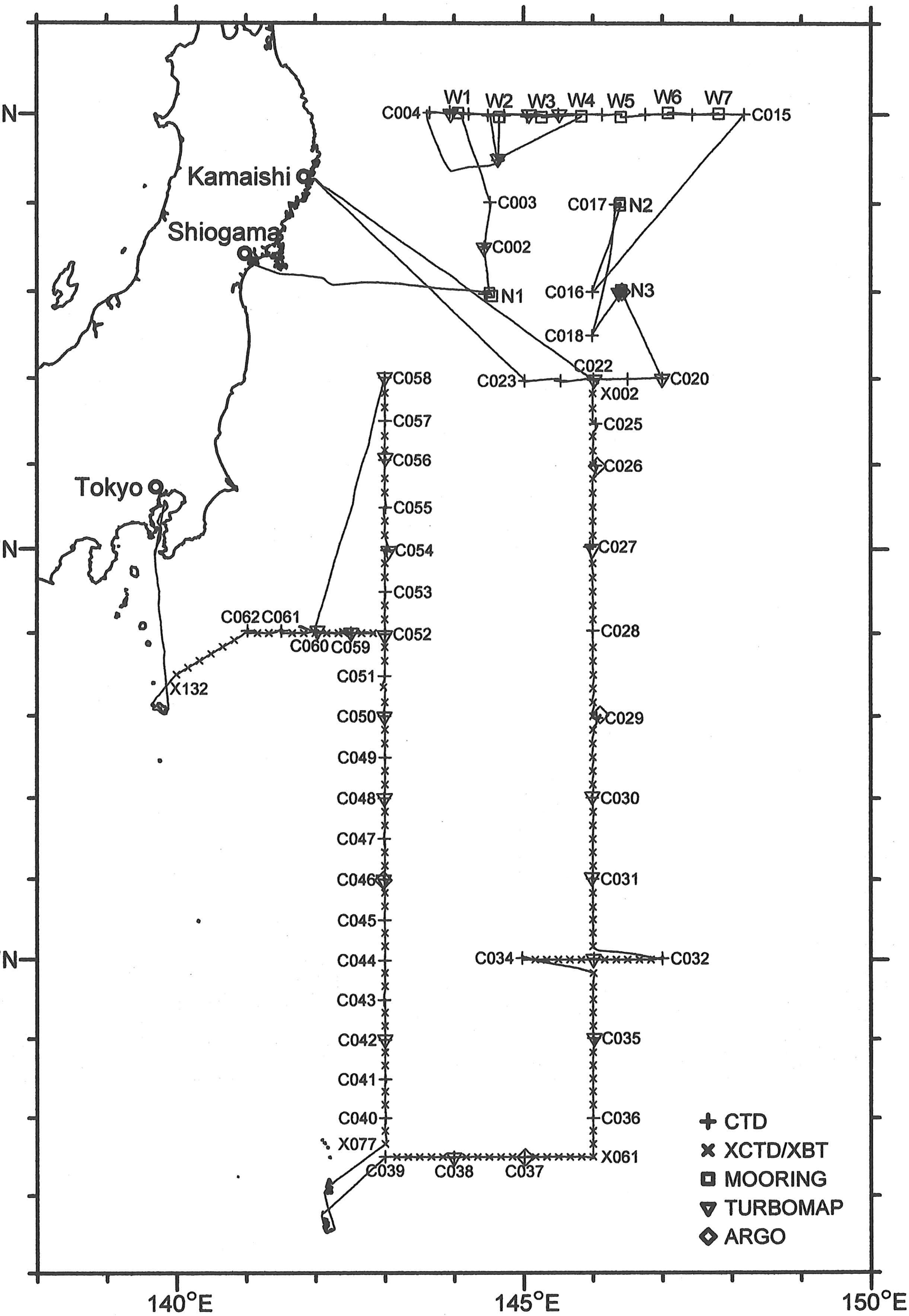
4. Track Chart



5. Time Table

	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	10/09	↑~~~~~~~~~~~~~~~~~~~~~ Shiogama
2	10/10	~~~~ / C001 / ~~~~~ / N1 Recover & Deploy / ~ / TM01 C002 X001 / ~~~~
3	10/11	~~~~ / C003 / ~~~~~~~ / W1 Recover / ~~~~ / W2 Recover / ~~~~ / TM02 / ~~~~~~~~
4	10/12	~~~~~~~~~~~~~~~~~~~~~~~~~~~ / C004 / ~~ / TM03 C005 / ~~ / C006
5	10/13	C006 / ~~~~~~ / W3 Recover / ~~~~ / W4 Recover / ~~~~~~~~ / C007 / ~~~
6	10/14	~~ / C008 / ~~ / C009 / ~~~~ / TM04 C010 / ~~~~ / TM05 C011 / ~~
7	10/15	~~ / C012 / ~~~~ / W5 Recover / ~~~~ / W6 Recover / ~~~~ / W7 Recover / ~~~~~~ / C013
8	10/16	~~~~ / C014 / ~~~~ / C015 / ~~~~~~~~~~~~~~~~~~~ / C016
9	10/17	~~~~~~~~~~~~ / N2 Rec & Dep / ~ / C017 / ~~~~~~~~~~~ / C018
10	10/18	C018 / ~~~~~ / C019 TM06 / ~ / N3 Rec & Dep AR01 / ~~~~~~~~ / TM07 C020 / ~~~~ / C021
11	10/19	C021 / ~~~ / C022 FR01 C22S / ~~~~~~~~~~~~~~~~~~~~~~~~~
12	10/20	~~~~~~~~~~~~~~ / Kamaishi
13	10/21	Kamaishi / ~~~~~~~~~~~~~~~~~~~~~
14	10/22	~~~~~ / C023 / ~~~ / C024 / ~~~ / FR01A TM08 C22SA / ~↑~↑~ X002 / X004 C025 / ~↑~↑ X006
15	10/23	FR02 C26S X007 C026 AR02 / ~~↑~↑~↑~↑~↑~ X008 X012 / FR03 C27S TM09 C027 / ~~↑~↑~↑~↑~↑~ X013 X017 / FR04 C28S C028

	Date	TIME (JST) 0–24									
16	10/24	FR04 C28S C028	X018 X022	X023 C029 FR05 C29S AR03	X024 X028	C030 FR06 C30S TM10					
17	10/25	C030 FR06 C30S TM10	X029 X033	C031 FR07 C31S TM11	X034 X038	FR08 C32S C032					
18	10/26	FR08 C32S C032	X039 X043	C033 FR09 C33S TM12	X044 X048	FR10 C34S C034					
19	10/27	X049 X053	C035 FR11 C35S TM13	X054 X058	FR12 C36S C036						
20	10/28	X059 X066	C037 FR13 C37S AR04	X067 X071	FR14 C38S C038 TM14	X072 X076	C039				
21	10/29	C039	X077	FR15 C40S C040							
22	10/30	FR15 C40S C040	X079	C041	X081	FR16 C42S TM15 C042	X083	C043	X085		
23	10/31	FR17 C44S C044	X087	C045	X089	C046 FR18 C46S TM16 AR05	X091	C047	X093	FR19 C48S TM17 C048	
24	11/01	X095	C049	X097	C050 TM18 FR20 C50S	X099	C051	X101	FR21 C52S TM19 C052	X103	
25	11/02	C053	X105	C054 TM20 C54S FR22	X107	C055	X109	FR23 C56S TM21A C056	X111	C057	
26	11/03	X113	C058 TM22 C58S FR24	X115 X120							
27	11/04	X121	C059 TM23 FR25 C59S		FR26 C60S TM24 C060	X123					
28	11/05	C061	X125	C062	X127 X132						
29	11/06										
30	11/07	Tokyo									

6. Summary of Observation Stations

STN:	Station number
TYPE:	CTD=CTDO only, ROS=CTDO plus water sampler, MOR=Mooring, TMAP=Turbomap, FRRF=Fast Repetition Rate Fluorometer
CODE:	BE=Beginning of cast or work, EN=End of work, BO=Bottom, DE=Deployment of mooring or XCTD/XBT, RE=Recovery 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-08-3 LEG 2

STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*
C001	ROS	100908	1731	BE	37°59.81′N	144°26.00′E	5904		LADCP
C001	ROS	100908	1935	BO	37°58.51′N	144°26.45′E	5915	6040	1,2,8 *SBE9p400 CTDO*
C001	ROS	100908	2134	EN	37°57.55′N	144°26.95′E	5898		
N1	MOR	101008	0024	BE	37°59.98′N	144°29.73′E	5969	*2 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT*	
N1	MOR	101008	0336	RE	37°57.10′N	144°32.66′E	5850	*Transmitter 43.528MHz, A/R 3C*	
N1	MOR	101008	0539	BE	37°58.71′N	144°31.93′E	5845	*3 RCM11, 3 CM, 1 MicroCAT*	
N1	MOR	101008	0706	DE	37°59.48′N	144°30.71′E	5943	*Transmitter 43.528MHz, A/R 1B*	
TM01	TMAP	101008	0950	DE	38°30.00′N	144°25.87′E	6151	409	*Turbomap*
C002	ROS	101008	1036	BE	38°30.30′N	144°25.39′E	6178		LADCP
C002	ROS	101008	1236	BO	38°30.52′N	144°25.93′E	6154	6322	1,2,8 *SBE9p400 CTDO*
C002	ROS	101008	1427	EN	38°30.64′N	144°26.41′E	6147		
X001	XCTD	101008	1433	DE	38°30.68′N	144°26.44′E	6148		*TSK XCTD-1*
C003	ROS	101008	1718	BE	39°00.36′N	144°31.71′E	6107		LADCP
C003	ROS	101008	1909	BO	39°00.76′N	144°31.05′E	6135	6285	1,2,8 *SBE9p400 CTDO*
C003	ROS	101008	2105	EN	39°01.59′N	144°30.93′E	6147		
W1	MOR	101108	0122	BE	40°00.10′N	144°05.83′E	5072	*1 RCM11, 3 CM, 1 MicroCAT*	
W1	MOR	101108	0312	RE	40°00.74′N	144°03.62′E	4672	*Transmitter 43.528MHz, A/R 3G*	
W2	MOR	101108	0542	BE	39°59.78′N	144°40.16′E	6238	*1 RCM11, 4 CM, 1 MicroCAT*	
W2	MOR	101108	0755	RE	39°58.18′N	144°39.15′E	6324	*Transmitter 43.528MHz, A/R 3B*	
TM02	TMAP	101108	1008	DE	39°29.97′N	144°37.90′E	6254	525	*Turbomap*
C004	ROS	101208	0608	BE	40°00.43′N	143°39.33′E	2457		LADCP
C004	ROS	101208	0700	BO	40°00.91′N	143°38.88′E	2356	2400	1,2 *SBE9p400 CTDO*
C004	ROS	101208	0746	EN	40°01.32′N	143°38.49′E	2270		
TM03	TMAP	101208	0921	DE	40°00.16′N	143°57.07′E	4098	435	*Turbomap*
C005	ROS	101208	1002	BE	40°00.67′N	143°57.20′E	4125		LADCP
C005	ROS	101208	1131	BO	40°01.42′N	143°56.42′E	4098	4155	1,2,8 *SBE9p400 CTDO*
C005	ROS	101208	1248	EN	40°01.85′N	143°56.57′E	4089		
C006	ROS	101208	1425	BE	39°59.74′N	144°14.03′E	6965		LADCP
C006	ROS	101208	1622	BO	40°00.02′N	144°12.66′E	6768	6500	1,2,8 *SBE9p400 CTDO*
C006	ROS	101208	1823	EN	40°00.00′N	144°11.21′E	6105		
W3	MOR	101208	2208	BE	39°59.91′N	145°13.80′E	5390	*1 RCM11, 4 CM, 1 3D-ACM, 1 MicroCAT*	
W3	MOR	101308	0045	RE	39°58.09′N	145°15.82′E	5382	*Transmitter 43.528MHz, A/R 1G*	
W4	MOR	101308	0252	BE	39°59.75′N	145°50.09′E	5157	*1 RCM11, 4 CM, 1 MicroCAT*	
W4	MOR	101308	0442	RE	39°58.68′N	145°50.21′E	5146	*Transmitter 43.528MHz, A/R 3E*	
C007	ROS	101308	0911	BE	39°29.70′N	144°37.77′E	6269		LADCP

STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*	
C007	ROS	101308	1111	BO	39°29.10′N	144°37.69′E	6253	6437	1,2,8	*SBE9p400 CTDO*
C007	ROS	101308	1305	EN	39°28.94′N	144°37.65′E	6248			
C008	ROS	101308	1620	BE	39°59.49′N	144°30.30′E	6863		LADCP	
C008	ROS	101308	1813	BO	39°59.15′N	144°29.26′E	6846	6500	1,2,8	*SBE9p400 CTDO*
C008	ROS	101308	2007	EN	39°58.76′N	144°28.28′E	6954			
C009	ROS	101308	2140	BE	39°59.73′N	144°44.72′E	6040		LADCP	
C009	ROS	101308	2334	BO	39°59.12′N	144°43.25′E	6121	6257	1,2,8	*SBE9p400 CTDO*
C009	ROS	101408	0146	EN	39°58.83′N	144°41.78′E	6161			
TM04	TMAP	101408	0435	DE	39°59.81′N	145°04.81′E	5563	620	*Turbomap*	
C010	ROS	101408	0418	BE	39°59.00′N	145°04.03′E	5572		LADCP	
C010	ROS	101408	0607	BO	39°58.42′N	145°03.05′E	5600	5707	1,2,8	*SBE9p400 CTDO*
C010	ROS	101408	0746	EN	39°58.00′N	145°02.01′E	5612			
TM05	TMAP	101408	0950	DE	40°00.05′N	145°30.98′E	5263	627	*Turbomap*	
C011	ROS	101408	1031	BE	39°59.98′N	145°30.67′E	5266		LADCP	
C011	ROS	101408	1212	BO	39°59.77′N	145°30.16′E	5268	5357	1,2	*SBE9p400 CTDO*
C011	ROS	101408	1347	EN	39°59.88′N	145°30.00′E	5272			
C012	ROS	101408	1610	BE	40°00.11′N	146°07.15′E	5164		LADCP	
C012	ROS	101408	1746	BO	39°59.78′N	146°07.90′E	5162	5250	1,2	*SBE9p400 CTDO*
C012	ROS	101408	1923	EN	39°59.15′N	146°08.30′E	5165			
W5	MOR	101408	2201	BE	40°00.14′N	146°24.60′E	5160		*1 RCM11, 2 CM, 1 Aquadopp, 1 MicroCAT*	
W5	MOR	101508	0000	RE	39°58.30′N	146°24.29′E	5155		*1 ADCP, Transmitter 43.528MHz, A/R 3C*	
W6	MOR	101508	0224	BE	39°59.78′N	147°04.95′E	5302		*1 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT*	
W6	MOR	101508	0408	RE	40°01.08′N	147°04.91′E	5314		*Transmitter 43.528MHz, A/R 3F*	
W7	MOR	101508	0628	BE	39°59.90′N	147°46.14′E	5277		*1 RCM11, 3 CM, 1 3D-ACM, 1 MicroCAT*	
W7	MOR	101508	0812	RE	40°00.53′N	147°48.69′E	5285		*Transmitter 43.528MHz, A/R 3E*	
C013	ROS	101508	1210	BE	39°59.88′N	146°45.16′E	5209		LADCP	
C013	ROS	101508	1344	BO	40°00.00′N	146°45.22′E	5209	5294	1,2	*SBE9p400 CTDO*
C013	ROS	101508	1517	EN	39°59.91′N	146°45.00′E	5210			
C014	ROS	101508	1747	BE	39°59.96′N	147°25.22′E	5370		LADCP	
C014	ROS	101508	1924	BO	39°59.88′N	147°25.97′E	5382	5477	1,2	*SBE9p400 CTDO*
C014	ROS	101508	2059	EN	39°59.75′N	147°26.68′E	5372			
C015	ROS	101508	2326	BE	40°00.09′N	148°10.24′E	5341		LADCP	
C015	ROS	101608	0107	BO	40°00.07′N	148°10.77′E	5344	5445	1,2	*SBE9p400 CTDO*
C015	ROS	101608	0242	EN	40°00.58′N	148°11.21′E	5348			
C016	ROS	101608	1320	BE	37°59.93′N	145°59.97′E	3322		LADCP	
C016	ROS	101608	1429	BO	37°59.97′N	145°59.67′E	3190	3425	1,2,8	*SBE9p400 CTDO*
C016	ROS	101608	1527	EN	37°59.96′N	145°59.24′E	2936			
N2	MOR	101608	2201	BE	38°59.86′N	146°24.23′E	5299		*4 CM, 1 3D-ACM, 1 MicroCAT*	
N2	MOR	101608	2343	RE	38°58.95′N	146°23.39′E	5292		*Transmitter 43.528MHz, A/R 3B*	
N2	MOR	101708	0045	BE	38°58.98′N	146°22.32′E	5287		*3 RCM11, 2 CM, 1 MicroCAT*	
N2	MOR	101708	0147	DE	39°00.70′N	146°23.79′E	5290		*Transmitter 43.528MHz, A/R 2F*	
C017	ROS	101708	0238	BE	38°59.72′N	146°19.89′E	5318		LADCP	
C017	ROS	101708	0419	BO	38°59.55′N	146°19.43′E	5318	5419	1,2	*SBE9p400 CTDO*
C017	ROS	101708	0552	EN	38°59.66′N	146°18.99′E	5316			
C018	ROS	101708	1215	BE	37°29.89′N	145°59.85′E	5518		LADCP	
C018	ROS	101708	1358	BO	37°29.93′N	145°59.44′E	5527	5635	1,2	*SBE9p400 CTDO*
C018	ROS	101708	1537	EN	37°29.86′N	145°59.07′E	5326			
C019	ROS	101708	1827	BE	37°58.97′N	146°23.37′E	5371		LADCP	
C019	ROS	101708	2004	BO	37°59.12′N	146°22.96′E	5394	5509	1,2	*SBE9p400 CTDO*
C019	ROS	101708	2141	EN	37°59.36′N	146°22.58′E	5414			

STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/COMMENT	
TM06	TMAP	101708	2157	DE	37°59.40′N	146°22.25′E	5407	546	*Turbomap*	
N3	MOR	101708	2320	BE	38°01.19′N	146°26.17′E	5404		*2 RCM11, 2 CM, 1 3D-ACM, 1 MicroCAT*	
N3	MOR	101808	0112	RE	38°01.21′N	146°24.63′E	5382		*Transmitter 43.528MHz, A/R 3D*	
N3	MOR	101808	0154	BE	38°00.31′N	146°22.61′E	5390		*3 RCM11, 2 CM, 1 MicroCAT*	
N3	MOR	101808	0245	DE	37°59.97′N	146°25.08′E	5387		*Transmitter 43.528MHz, A/R 3A*	
AR01	FLOAT	101808	0248	DE	37°59.97′N	146°25.19′E	5384		*APEX*	
TM07A	TMAP	101808	0725	DE	37°00.14′N	147°00.06′E	5599	549	*Turbomap*	
C020	ROS	101808	0817	BE	37°00.06′N	146°59.71′E	5608		LADCP	
C020	ROS	101808	1006	BO	37°00.34′N	146°59.94′E	5598	5701	1,2	*SBE9p400 CTDO*
C020	ROS	101808	1145	EN	37°00.58′N	147°00.23′E	5594			
C021	ROS	101808	1357	BE	37°00.12′N	146°29.74′E	5511		LADCP	
C021	ROS	101808	1544	BO	37°00.03′N	146°30.11′E	5507	5611	1,2	*SBE9p400 CTDO*
C021	ROS	101808	1720	EN	37°00.11′N	146°30.12′E	5512			
C022	ROS	101808	1928	BE	36°59.98′N	145°59.95′E	5468		LADCP	
C022	ROS	101808	2112	BO	36°59.35′N	146°00.66′E	5461	5565	1-6	*SBE9p400 CTDO*
C022	ROS	101808	2250	EN	36°58.79′N	146°01.48′E	5460			
FR01	FRRF	101808	2305	DE	36°58.73′N	146°01.85′E	5454	181	*Kimoto DF-03B*	
C22S	ROS	101908	0006	BE	36°58.03′N	146°02.94′E	5445		LADCP	
C22S	ROS	101908	0018	BO	36°57.89′N	146°03.31′E	5445	200	1,2,7	*SBE9p400 CTDO*
C22S	ROS	101908	0049	EN	36°57.53′N	146°03.97′E	5442			
C023	ROS	102108	1813	BE	36°59.54′N	145°00.20′E	4744		LADCP	
C023	ROS	102108	1956	BO	36°58.56′N	145°00.99′E	4490	4716	1,2,7,8	*SBE9p400 CTDO*
C023	ROS	102108	2122	EN	36°58.03′N	145°01.35′E	4406			
C024	ROS	102108	2324	BE	36°59.67′N	145°30.82′E	5392		LADCP	
C024	ROS	102208	0111	BO	36°58.67′N	145°32.13′E	5417	5513	1,2	*SBE9p400 CTDO*
C024	ROS	102208	0248	EN	36°58.08′N	145°32.89′E	5443			
FR01A	FRRF	102208	0433	DE	36°59.96′N	146°00.18′E	5462	201	*Kimoto DF-03B*	
TM08	TMAP	102208	0520	DE	36°59.40′N	146°01.27′E	5460	691	*Turbomap*	
C22SA	ROS	102208	0626	BE	36°59.92′N	146°00.26′E	5461		LADCP	
C22SA	ROS	102208	0635	BO	36°59.81′N	146°00.50′E	5461	200	1-7	*SBE9p400 CTDO*
C22SA	ROS	102208	0658	EN	36°59.68′N	146°00.90′E	5461			
X002	XCTD	102208	0751	DE	36°49.79′N	145°59.90′E	5442		*TSK XCTD-1*	
X003	XCTD	102208	0832	DE	36°39.47′N	145°59.98′E	5441		*TSK XCTD-1*	
X004	XCTD	102208	0918	DE	36°30.01′N	146°00.19′E	5498		*TSK XCTD-1*	
C025	ROS	102208	0935	BE	36°29.78′N	146°00.71′E	5491		LADCP	
C025	ROS	102208	1123	BO	36°28.72′N	146°02.43′E	5469	5583	1,2	*SBE9p400 CTDO*
C025	ROS	102208	1302	EN	36°27.80′N	146°03.41′E	5477			
X005	XCTD	102208	1357	DE	36°19.93′N	146°00.00′E	5511		*TSK XCTD-1*	
X006	XCTD	102208	1438	DE	36°09.83′N	146°00.12′E	5557		*TSK XCTD-1*	
FR02	FRRF	102208	1530	DE	35°59.98′N	146°00.18′E	5652	201	*Kimoto DF-03B*	
C26S	ROS	102208	1612	BE	35°59.72′N	146°01.41′E	5634		LADCP	
C26S	ROS	102208	1619	BO	35°59.68′N	146°01.64′E	5632	203	1-7	*SBE9p400 CTDO*
C26S	ROS	102208	1645	EN	35°59.62′N	146°02.62′E	5620			
X007	XCTD	102208	1734	DE	35°59.83′N	146°00.39′E	5645		*TSK XCTD-1*	
C026	ROS	102208	1742	BE	35°59.75′N	146°00.61′E	5643		LADCP	
C026	ROS	102208	1934	BO	35°59.34′N	146°02.30′E	5622	5754	1-6	*SBE9p400 CTDO*
C026	ROS	102208	2115	EN	35°58.99′N	146°03.53′E	5605			
AR02	FLOAT	102208	2123	DE	35°58.95′N	146°03.82′E	5605		*APEX*	
X008	XCTD	102208	2219	DE	35°49.97′N	146°00.02′E	5691		*TSK XCTD-1*	
X009	XCTD	102208	2300	DE	35°39.95′N	146°00.00′E	5774		*TSK XCTD-1*	

STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*
X010	XCTD	102208	2342	DE	35°29.99′N	145°59.99′E	5818		*TSK XCTD-1*
X011	XCTD	102308	0026	DE	35°19.98′N	145°59.99′E	5836		*TSK XCTD-1*
X012	XCTD	102308	0110	DE	35°09.91′N	145°59.99′E	5860		*TSK XCTD-1*
FR03	FRRF	102308	0208	DE	35°00.11′N	145°59.76′E	5924	201	*Kimoto DF-03B*
C27S	ROS	102308	0251	BE	35°00.81′N	145°58.98′E	5925		LADCP
C27S	ROS	102308	0303	BO	35°01.06′N	145°58.70′E	5929	200	1-7 *SBE9p400 CTDO*
C27S	ROS	102308	0323	EN	35°01.42′N	145°58.25′E	5926		
TM09	TMAP	102308	0403	DE	35°00.21′N	145°59.82′E	5924	582	*Turbomap*
C027	ROS	102308	0437	BE	35°00.63′N	145°58.70′E	5929		LADCP
C027	ROS	102308	0634	BO	35°01.88′N	145°57.56′E	5918	6074	1-6 *SBE9p400 CTDO*
C027	ROS	102308	0824	EN	35°02.53′N	145°56.72′E	5900		
X013	XCTD	102308	0939	DE	34°49.98′N	145°59.97′E	5905		*TSK XCTD-1*
X014	XCTD	102308	1026	DE	34°39.92′N	145°59.99′E	5928		*TSK XCTD-1*
X015	XCTD	102308	1114	DE	34°29.98′N	145°59.98′E	5874		*TSK XCTD-1*
X016	XCTD	102308	1203	DE	34°19.98′N	146°00.00′E	5866		*TSK XCTD-1*
X017	XCTD	102308	1250	DE	34°09.97′N	146°00.02′E	5518		*TSK XCTD-1*
FR04	FRRF	102308	1352	DE	34°00.16′N	145°59.78′E	4047	202	*Kimoto DF-03B*
C28S	ROS	102308	1438	BE	34°01.00′N	145°59.31′E	3749		LADCP
C28S	ROS	102308	1448	BO	34°01.23′N	145°59.20′E	3668	200	1-7 *SBE9p400 CTDO*
C28S	ROS	102308	1507	EN	34°01.71′N	145°59.05′E	3472		
C028	ROS	102308	1549	BE	34°00.48′N	145°59.96′E	4068		LADCP
C028	ROS	102308	1712	BO	34°01.83′N	145°59.97′E	3798	4075	1-6 *SBE9p400 CTDO*
C028	ROS	102308	1836	EN	34°02.26′N	146°00.05′E	3723		
X018	XCTD	102308	1942	DE	33°49.95′N	146°00.04′E	5566		*TSK XCTD-1*
X019	XCTD	102308	2030	DE	33°39.99′N	146°00.05′E	5665		*TSK XCTD-1*
X020	XCTD	102308	2120	DE	33°29.92′N	146°00.29′E	5729		*TSK XCTD-1*
X021	XCTD	102308	2211	DE	33°20.03′N	146°00.18′E	5746		*TSK XCTD-1*
X022	XCTD	102308	2306	DE	33°10.00′N	146°00.05′E	5737		*TSK XCTD-1*
X023	XCTD	102408	0006	DE	32°59.98′N	146°00.03′E	5794		*TSK XCTD-1*
C029	ROS	102408	0059	BE	32°58.17′N	146°01.94′E	5804		LADCP
C029	ROS	102408	0250	BO	32°58.72′N	146°03.22′E	5789	5937	1-6 *SBE9p400 CTDO*
C029	ROS	102408	0435	EN	32°59.19′N	146°04.13′E	5786		
FR05	FRRF	102408	0447	DE	32°59.35′N	146°04.18′E	5787	200	*Kimoto DF-03B*
C29S	ROS	102408	0541	BE	33°00.15′N	146°05.31′E	5774		LADCP
C29S	ROS	102408	0552	BO	33°00.34′N	146°05.58′E	5773	200	1-7 *SBE9p400 CTDO*
C29S	ROS	102408	0610	EN	33°00.65′N	146°06.05′E	5766		
AR03	FLOAT	102408	0623	DE	33°00.90′N	146°06.26′E	5759		*APEX*
X024	XCTD	102408	0737	DE	32°50.03′N	146°00.02′E	5431		*TSK XCTD-1*
X025	XCTD	102408	0829	DE	32°40.00′N	145°59.86′E	5879		*TSK XCTD-1*
X026	XCTD	102408	0920	DE	32°30.00′N	145°59.95′E	5934		*TSK XCTD-1*
X027	XCTD	102408	1011	DE	32°20.03′N	145°59.87′E	5981		*TSK XCTD-1*
X028	XCTD	102408	1107	DE	32°09.99′N	146°00.00′E	6024		*TSK XCTD-1*
C030	ROS	102408	1228	BE	32°00.04′N	145°59.63′E	6054		LADCP
C030	ROS	102408	1423	BO	32°00.20′N	145°59.43′E	6052	6214	1-6 *SBE9p400 CTDO*
C030	ROS	102408	1610	EN	32°00.67′N	145°59.44′E	6046		
FR06	FRRF	102408	1623	DE	32°00.67′N	145°59.46′E	6048	163	*Kimoto DF-03B*
C30S	ROS	102408	1708	BE	32°00.94′N	145°59.38′E	6044		LADCP
C30S	ROS	102408	1715	BO	32°00.98′N	145°59.37′E	6044	200	1-7 *SBE9p400 CTDO*
C30S	ROS	102408	1734	EN	32°01.12′N	145°59.37′E	6043		
TM10	TMAP	102408	1748	DE	32°01.29′N	145°59.43′E	6041	490	*Turbomap*

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X029	XCTD	102408	1926	DE	31°49.97′N	146°00.11′E	6089		*TSK XCTD-1*	
X030	XCTD	102408	2011	DE	31°40.02′N	145°59.98′E	6085		*TSK XCTD-1*	
X031	XCTD	102408	2056	DE	31°30.00′N	146°00.00′E	6090		*TSK XCTD-1*	
X032	XCTD	102408	2139	DE	31°19.97′N	145°59.99′E	6137		*TSK XCTD-1*	
X033	XCTD	102408	2222	DE	31°10.00′N	146°00.02′E	6129		*TSK XCTD-1*	
C031	ROS	102408	2322	BE	31°00.10′N	145°59.91′E	6094		LADCP	
C031	ROS	102508	0116	BO	31°00.44′N	145°59.60′E	6109	6271	1-6	*SBE9p400 CTDO*
C031	ROS	102508	0306	EN	31°00.82′N	145°59.39′E	6099			
FR07	FRRF	102508	0312	DE	31°00.88′N	145°59.33′E	6096	199	*Kimoto DF-03B*	
C31S	ROS	102508	0356	BE	31°01.17′N	145°59.10′E	6074		LADCP	
C31S	ROS	102508	0404	BO	31°01.23′N	145°59.10′E	6072	200	1-7	*SBE9p400 CTDO*
C31S	ROS	102508	0423	EN	31°01.32′N	145°59.11′E	6064			
TM11	TMAP	102508	0436	DE	31°01.40′N	145°59.09′E	6066	550	*Turbomap*	
X034	XCTD	102508	0609	DE	30°49.92′N	145°59.99′E	6039		*TSK XCTD-1*	
X035	XCTD	102508	0650	DE	30°39.36′N	145°59.98′E	6059		*TSK XCTD-1*	
X036	XCTD	102508	0731	DE	30°29.98′N	145°59.97′E	6017		*TSK XCTD-1*	
X037	XCTD	102508	0812	DE	30°20.00′N	145°59.99′E	6146		*TSK XCTD-1*	
X038	XCTD	102508	0853	DE	30°10.01′N	145°59.94′E	6128		*TSK XCTD-1*	
FR08	FRRF	102508	1248	DE	29°59.91′N	147°00.02′E	6146	201	*Kimoto DF-03B*	
C32S	ROS	102508	1340	BE	29°59.91′N	146°59.85′E	6159		LADCP	
C32S	ROS	102508	1352	BO	29°59.93′N	146°59.80′E	6166	200	1-7	*SBE9p400 CTDO*
C32S	ROS	102508	1415	EN	30°00.02′N	146°59.73′E	6159			
C032	ROS	102508	1454	BE	30°00.13′N	146°59.91′E	6158		LADCP	
C032	ROS	102508	1648	BO	30°00.96′N	147°00.04′E	6182	6328	1-6	*SBE9p400 CTDO*
C032	ROS	102508	1838	EN	30°01.57′N	147°00.99′E	6186			
X039	XBT	102508	1935	DE	30°00.00′N	146°49.95′E	6162		*TSK T-7*	
X040	XBT	102508	2012	DE	29°59.99′N	146°39.97′E	6161		*TSK T-7*	
X041	XBT	102508	2048	DE	30°00.02′N	146°30.00′E	6101		*TSK T-7*	
X042	XBT	102508	2124	DE	30°00.01′N	146°19.99′E	6042		*TSK T-7*	
X043	XBT	102508	2200	DE	30°00.00′N	146°10.00′E	6034		*TSK T-7*	
C033	ROS	102508	2250	BE	30°00.15′N	146°00.28′E	6118		LADCP	
C033	ROS	102608	0041	BO	30°00.63′N	146°00.79′E	6121	6279	1-6	*SBE9p400 CTDO*
C033	ROS	102608	0230	EN	30°00.49′N	146°01.51′E	6122			
FR09	FRRF	102608	0257	DE	29°59.88′N	146°00.01′E	6120	200	*Kimoto DF-03B*	
C33S	ROS	102608	0357	BE	30°00.14′N	146°00.27′E	6119		LADCP	
C33S	ROS	102608	0405	BO	30°00.19′N	146°00.30′E	6117	200	1-7	*SBE9p400 CTDO*
C33S	ROS	102608	0422	EN	30°00.28′N	146°00.32′E	6119			
TM12	TMAP	102608	0436	DE	30°00.34′N	146°00.33′E	6120	615	*Turbomap*	
X044	XBT	102608	0559	DE	29°59.99′N	145°49.96′E	6144		*TSK T-7*	
X045	XBT	102608	0633	DE	30°00.00′N	145°39.89′E	5832		*TSK T-7*	
X046	XBT	102608	0707	DE	29°59.98′N	145°29.92′E	5860		*TSK T-7*	
X047	XBT	102608	0740	DE	29°59.99′N	145°19.96′E	5722		*TSK T-7*	
X048	XBT	102608	0813	DE	29°59.97′N	145°09.99′E	5845		*TSK T-7*	
FR10	FRRF	102608	0857	DE	29°59.89′N	144°59.75′E	5917	200	*Kimoto DF-03B*	
C34S	ROS	102608	0942	BE	30°00.08′N	144°59.26′E	5909		LADCP	
C34S	ROS	102608	0953	BO	30°00.15′N	144°59.16′E	5906	200	1-7	*SBE9p400 CTDO*
C34S	ROS	102608	1024	EN	30°00.39′N	144°58.90′E	5907			
C034	ROS	102608	1100	BE	30°00.59′N	144°59.02′E	5911		LADCP	
C034	ROS	102608	1245	BO	30°01.17′N	144°58.67′E	5851	6044	1-6	*SBE9p400 CTDO*
C034	ROS	102608	1446	EN	30°02.08′N	144°58.92′E	5844			

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X049	XCTD	102608	1837	DE	29°49.91′N	146°00.29′E	6094		*TSK XCTD-1*	
X050	XCTD	102608	1924	DE	29°39.39′N	146°00.04′E	6178		*TSK XCTD-1*	
X051	XCTD	102608	2008	DE	29°29.99′N	146°00.04′E	5421		*TSK XCTD-1*	
X052	XCTD	102608	2052	DE	29°20.00′N	145°59.99′E	5764		*TSK XCTD-1*	
X053	XCTD	102608	2136	DE	29°09.99′N	146°00.03′E	5909		*TSK XCTD-1*	
C035	ROS	102608	2233	BE	29°00.26′N	145°59.96′E	5933		LADCP	
C035	ROS	102708	0026	BO	29°00.65′N	146°00.41′E	5938	6088	1-6	*SBE9p400 CTDO*
C035	ROS	102708	0216	EN	29°00.63′N	146°00.95′E	5932			
FR11	FRRF	102708	0238	DE	28°59.94′N	146°00.05′E	5940	201	*Kimoto DF-03B*	
C35S	ROS	102708	0323	BE	29°00.40′N	146°00.62′E	5933		LADCP	
C35S	ROS	102708	0334	BO	29°00.51′N	146°00.75′E	5930	203	1-7	*SBE9p400 CTDO*
C35S	ROS	102708	0352	EN	29°00.61′N	146°00.83′E	5932			
TM13	TMAP	102708	0404	DE	29°00.73′N	146°01.05′E	5934	446	*Turbomap*	
X054	XCTD	102708	0533	DE	28°49.99′N	146°00.01′E	5971		*TSK XCTD-1*	
X055	XCTD	102708	0614	DE	28°39.96′N	145°59.99′E	5709		*TSK XCTD-1*	
X056	XCTD	102708	0659	DE	28°29.99′N	146°00.00′E	5744		*TSK XCTD-1*	
X057	XCTD	102708	0744	DE	28°20.01′N	145°59.98′E	5690		*TSK XCTD-1*	
X058	XCTD	102708	0827	DE	28°10.00′N	145°59.99′E	5672		*TSK XCTD-1*	
FR12	FRRF	102708	0916	DE	27°59.89′N	146°00.00′E	4850	200	*Kimoto DF-03B*	
C36S	ROS	102708	1003	BE	27°59.89′N	146°00.07′E	4854		LADCP	
C36S	ROS	102708	1014	BO	27°59.91′N	146°00.06′E	4853	202	1-7	*SBE9p400 CTDO*
C36S	ROS	102708	1038	EN	28°00.00′N	146°00.05′E	4857			
C036	ROS	102708	1130	BE	27°59.90′N	145°59.91′E	4846		LADCP	
C036	ROS	102708	1302	BO	27°59.87′N	146°00.05′E	4852	4945	1-6	*SBE9p400 CTDO*
C036	ROS	102708	1432	EN	27°59.83′N	145°59.94′E	4848			
X059	XCTD	102708	1527	DE	27°49.93′N	145°59.95′E	4944		*TSK XCTD-1*	
X060	XCTD	102708	1609	DE	27°39.94′N	145°59.98′E	5066		*TSK XCTD-1*	
X061	XCTD	102708	1651	DE	27°29.97′N	145°59.99′E	5398		*TSK XCTD-1*	
X062	XCTD	102708	1734	DE	27°30.00′N	145°49.97′E	5474		*TSK XCTD-1*	
X063	XCTD	102708	1810	DE	27°30.00′N	145°39.99′E	5514		*TSK XCTD-1*	
X064	XCTD	102708	1847	DE	27°30.00′N	145°29.98′E	5511		*TSK XCTD-1*	
X065	XCTD	102708	1925	DE	27°30.00′N	145°19.99′E	4878		*TSK XCTD-1*	
X066	XCTD	102708	2003	DE	27°29.98′N	145°09.96′E	5179		*TSK XCTD-1*	
C037	ROS	102708	2100	BE	27°29.99′N	145°00.20′E	5355		LADCP	
C037	ROS	102708	2145	BO	27°29.70′N	145°00.51′E	5330	2006	1-6	*SBE9p400 CTDO*
C037	ROS	102708	2223	EN	27°29.59′N	145°00.47′E	5326			
FR13	FRRF	102708	2244	DE	27°30.02′N	145°00.02′E	5364	200	*Kimoto DF-03B*	
C37S	ROS	102708	2345	BE	27°29.96′N	145°00.75′E	5239		LADCP	
C37S	ROS	102708	2356	BO	27°29.90′N	145°00.88′E	5324	200	1-7	*SBE9p400 CTDO*
C37S	ROS	102808	0021	EN	27°29.90′N	145°00.86′E	5236			
AR04	FLOAT	102808	0031	DE	27°29.70′N	145°01.20′E	5314		*APEX*	
X067	XCTD	102808	0128	DE	27°30.00′N	144°49.97′E	5455		*TSK XCTD-1*	
X068	XCTD	102808	0208	DE	27°30.00′N	144°39.99′E	3438		*TSK XCTD-1*	
X069	XCTD	102808	0248	DE	27°29.99′N	144°29.93′E	4202		*TSK XCTD-1*	
X070	XCTD	102808	0326	DE	27°29.99′N	144°19.99′E	4666		*TSK XCTD-1*	
X071	XCTD	102808	0404	DE	27°30.00′N	144°09.99′E	5646		*TSK XCTD-1*	
FR14	FRRF	102808	0450	DE	27°29.91′N	143°59.90′E	6168	201	*Kimoto DF-03B*	
C38S	ROS	102808	0550	BE	27°29.40′N	143°59.63′E	6168		LADCP	
C38S	ROS	102808	0559	BO	27°29.37′N	143°59.54′E	6170	201	1-7	*SBE9p400 CTDO*
C38S	ROS	102808	0621	EN	27°29.22′N	143°59.31′E	6171			

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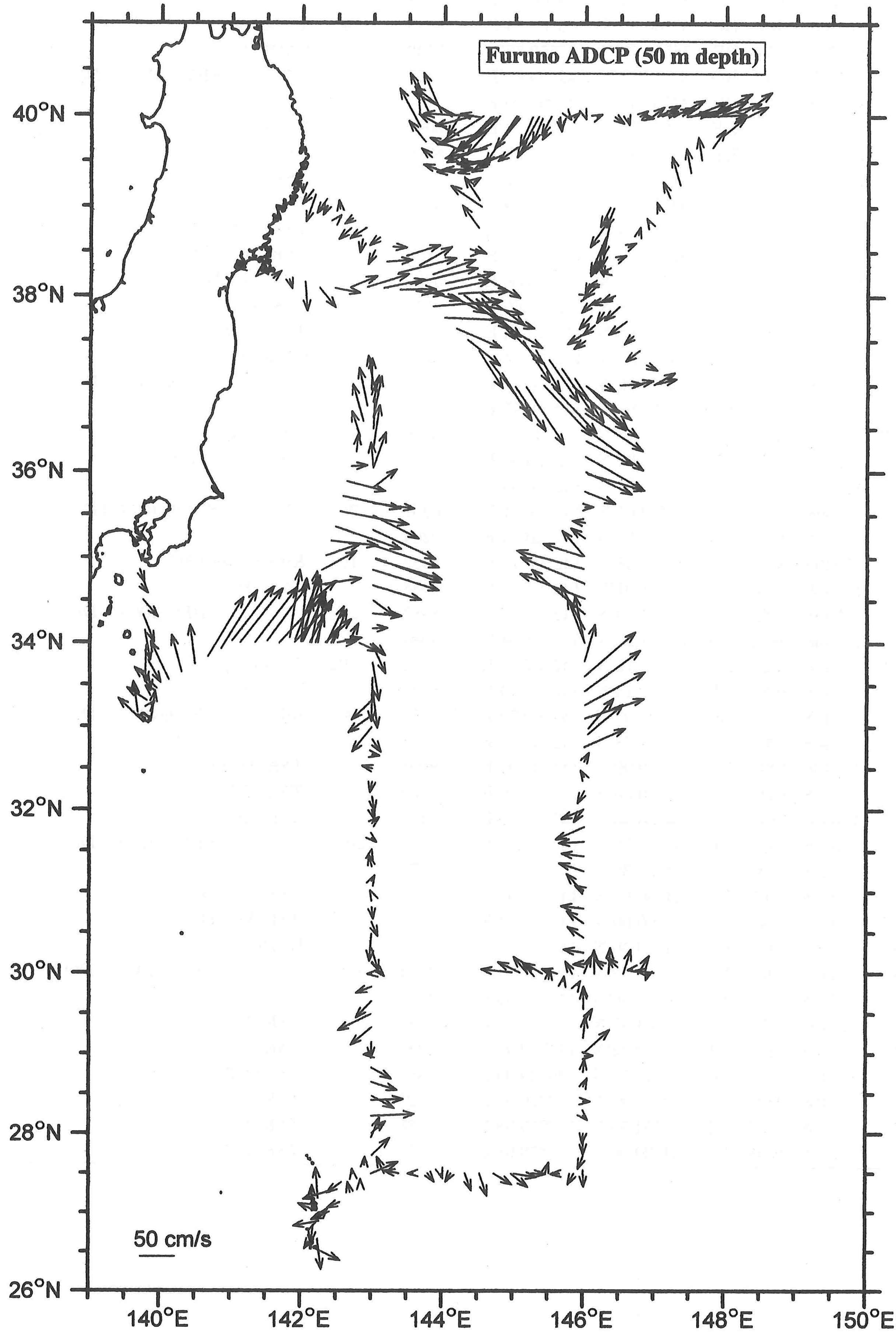
C038	ROS	102808	0721	BE	27°29.94′N	143°59.98′E	6162		LADCP	
C038	ROS	102808	0808	BO	27°29.76′N	143°59.77′E	6176	2011	1-6	*SBE9p400 CTDO*
C038	ROS	102808	0847	EN	27°29.62′N	143°59.69′E	6174			
TM14	TMAP	102808	0859	DE	27°29.48′N	143°59.69′E	6171	666	*Turbomap*	
X072	XCTD	102808	1052	DE	27°29.97′N	143°49.98′E	6516		*TSK XCTD-1*	
X073	XCTD	102808	1131	DE	27°30.00′N	143°39.97′E	7015		*TSK XCTD-1*	
X074	XCTD	102808	1209	DE	27°30.00′N	143°30.00′E	7651		*TSK XCTD-1*	
X075	XCTD	102808	1248	DE	27°30.00′N	143°19.95′E	8612		*TSK XCTD-1*	
X076	XCTD	102808	1327	DE	27°30.00′N	143°10.00′E	7620		*TSK XCTD-1*	
C039	ROS	102808	1426	BE	27°30.06′N	143°00.00′E	5923		LADCP	
C039	ROS	102808	1509	BO	27°30.19′N	143°00.08′E	5926	2001	1,2	*SBE9p400 CTDO*
C039	ROS	102808	1554	EN	27°30.08′N	143°00.16′E	5948			
X077	XCTD	102908	1120	DE	27°40.01′N	143°00.01′E	6383		*TSK XCTD-1*	
X078	XCTD	102908	1203	DE	27°50.00′N	143°00.00′E	5388		*TSK XCTD-1*	
FR15	FRRF	102908	1254	DE	28°00.05′N	142°59.99′E	5358	201	*Kimoto DF-03B*	
C40S	ROS	102908	1337	BE	27°59.84′N	143°00.27′E	5398		LADCP	
C40S	ROS	102908	1352	BO	27°59.78′N	143°00.36′E	5410	202	1-7	*SBE9p400 CTDO*
C40S	ROS	102908	1415	EN	27°59.66′N	143°00.59′E	5384			
C040	ROS	102908	1456	BE	27°59.90′N	143°00.10′E	5381		LADCP	
C040	ROS	102908	1537	BO	27°59.79′N	143°00.48′E	5352	24	SBE9p400 *CTDO*	
C040	ROS	102908	1615	EN	27°59.73′N	143°00.71′E	5346			
X079	XCTD	102908	1711	DE	28°10.01′N	143°00.00′E	6374		*TSK XCTD-1*	
X080	XCTD	102908	1752	DE	28°20.05′N	143°00.00′E	6874		*TSK XCTD-1*	
C041	ROS	102908	1847	BE	28°29.87′N	143°00.00′E	8316		LADCP	
C041	ROS	102908	1928	BO	28°29.38′N	143°00.15′E	8283	2000	1,2	*SBE9p400 CTDO*
C041	ROS	102908	2008	EN	28°29.08′N	143°00.15′E	8183			
X081	XCTD	103008	0237	DE	28°40.01′N	143°00.00′E	9015		*TSK XCTD-1*	
X082	XCTD	103008	0319	DE	28°50.05′N	143°00.00′E	9371		*TSK XCTD-1*	
FR16	FRRF	103008	0411	DE	28°59.96′N	142°59.94′E	8602	201	*Kimoto DF-03B*	
C42S	ROS	103008	0504	BE	28°59.88′N	142°59.98′E	8607		LADCP	
C42S	ROS	103008	0511	BO	28°59.86′N	142°59.98′E	8608	200	1-7	*SBE9p400 CTDO*
C42S	ROS	103008	0530	EN	28°59.76′N	143°00.04′E	8608			
TM15	TMAP	103008	0543	DE	28°59.71′N	143°00.07′E	8612	576	*Turbomap*	
C042	ROS	103008	0630	BE	28°59.36′N	143°00.18′E	8618		LADCP	
C042	ROS	103008	0710	BO	28°59.34′N	143°00.28′E	8607	2000	1-6	*SBE9p400 CTDO*
C042	ROS	103008	0749	EN	28°59.42′N	143°00.36′E	8598			
X083	XCTD	103008	0849	DE	29°10.00′N	142°59.99′E	8538		*TSK XCTD-1*	
X084	XCTD	103008	0931	DE	29°20.02′N	142°59.99′E	7785		*TSK XCTD-1*	
C043	ROS	103008	1026	BE	29°29.90′N	142°59.88′E	7762		LADCP	
C043	ROS	103008	1110	BO	29°29.50′N	142°59.31′E	7894	2000	1,2	*SBE9p400 CTDO*
C043	ROS	103008	1149	EN	29°29.21′N	142°59.03′E	7877			
X085	XCTD	103008	1256	DE	29°40.01′N	142°59.99′E	6952		*TSK XCTD-1*	
X086	XCTD	103008	1339	DE	29°50.02′N	142°59.99′E	6550		*TSK XCTD-1*	
FR17	FRRF	103008	1434	DE	30°00.02′N	143°00.00′E	6545	202	*Kimoto DF-03B*	
C44S	ROS	103008	1518	BE	29°59.65′N	142°59.96′E	6674		LADCP	
C44S	ROS	103008	1527	BO	29°59.56′N	142°59.90′E	6786	201	1-7	*SBE9p400 CTDO*
C44S	ROS	103008	1549	EN	29°59.33′N	142°59.77′E	6965			
C044	ROS	103008	1629	BE	29°59.82′N	142°59.92′E	6709		LADCP	
C044	ROS	103008	1711	BO	29°59.29′N	142°59.84′E	6943	1997	1-6	*SBE9p400 CTDO*
C044	ROS	103008	1750	EN	29°58.89′N	142°59.51′E	6957			

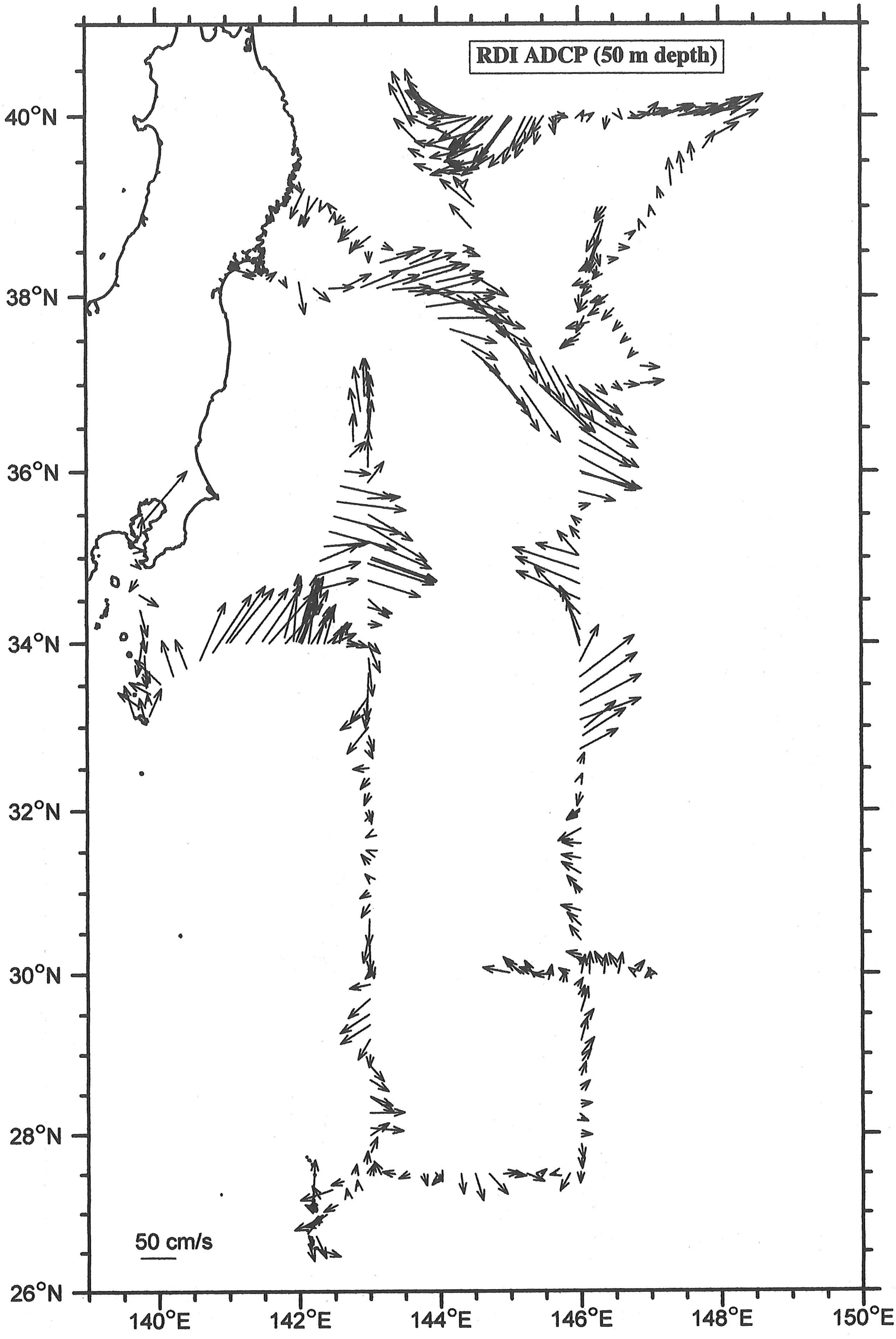
STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*
X087	XCTD	103008	1854	DE	30°10.06′N	143°00.00′E	6250		*TSK XCTD-1*
X088	XCTD	103008	1939	DE	30°20.03′N	142°59.99′E	6550		*TSK XCTD-1*
C045	ROS	103008	2038	BE	30°29.78′N	143°00.12′E	6682		LADCP
C045	ROS	103008	2120	BO	30°29.49′N	142°59.85′E	6686	2008	1,2 *SBE9p400 CTDO*
C045	ROS	103008	2200	EN	30°29.36′N	142°59.61′E	6508		
X089	XCTD	103008	2309	DE	30°40.00′N	142°59.99′E	5956		*TSK XCTD-1*
X090	XCTD	103008	2355	DE	30°50.00′N	142°59.99′E	6096		*TSK XCTD-1*
C046	ROS	103108	0058	BE	30°59.91′N	142°59.75′E	5774		LADCP
C046	ROS	103108	0141	BO	30°59.86′N	142°59.55′E	5764	2000	1-6 *SBE9p400 CTDO*
C046	ROS	103108	0219	EN	30°59.87′N	142°59.34′E	5770		
FR18	FRRF	103108	0226	DE	30°59.87′N	142°59.31′E	5770	202	*Kimoto DF-03B*
C46S	ROS	103108	0310	BE	30°59.72′N	142°59.09′E	5748		LADCP
C46S	ROS	103108	0317	BO	30°59.69′N	142°59.05′E	5742	200	1-7 *SBE9p400 CTDO*
C46S	ROS	103108	0339	EN	30°59.64′N	142°58.94′E	5728		
TM16	TMAP	103108	0351	DE	30°59.62′N	142°58.91′E	5725	567	*Turbomap*
AR05	FLOAT	103108	0422	DE	30°59.35′N	142°58.68′E	5682		*APEX*
X091	XCTD	103108	0522	DE	31°10.00′N	142°59.99′E	5926		*TSK XCTD-1*
X092	XCTD	103108	0603	DE	31°20.04′N	142°59.99′E	5864		*TSK XCTD-1*
C047	ROS	103108	0657	BE	31°30.07′N	142°59.87′E	5815		LADCP
C047	ROS	103108	0736	BO	31°30.13′N	142°59.49′E	5830	2003	1,2 *SBE9p400 CTDO*
C047	ROS	103108	0815	EN	31°30.18′N	142°59.20′E	5854		
X093	XCTD	103108	0910	DE	31°40.00′N	142°59.98′E	5749		*TSK XCTD-1*
X094	XCTD	103108	0950	DE	31°50.00′N	143°00.00′E	5782		*TSK XCTD-1*
FR19	FRRF	103108	1038	DE	32°00.07′N	143°00.10′E	5656	200	*Kimoto DF-03B*
C48S	ROS	103108	1124	BE	31°59.95′N	142°59.88′E	5673		LADCP
C48S	ROS	103108	1137	BO	31°59.88′N	142°59.85′E	5674	200	1-7 *SBE9p400 CTDO*
C48S	ROS	103108	1159	EN	31°59.90′N	142°59.99′E	5677		
TM17	TMAP	103108	1213	DE	31°59.87′N	142°59.75′E	5678	630	*Turbomap*
C048	ROS	103108	1256	BE	31°59.76′N	142°59.55′E	5683		LADCP
C048	ROS	103108	1340	BO	31°59.74′N	142°59.48′E	5684	2002	1-6 *SBE9p400 CTDO*
C048	ROS	103108	1419	EN	31°59.72′N	142°59.42′E	5694		
X095	XCTD	103108	1520	DE	32°10.02′N	143°00.00′E	5623		*TSK XCTD-1*
X096	XCTD	103108	1602	DE	32°20.00′N	143°00.00′E	5666		*TSK XCTD-1*
C049	ROS	103108	1656	BE	32°30.07′N	142°59.95′E	5604		LADCP
C049	ROS	103108	1737	BO	32°29.72′N	143°00.13′E	5590	2000	1,2 *SBE9p400 CTDO*
C049	ROS	103108	1814	EN	32°29.48′N	143°00.11′E	5594		
X097	XCTD	103108	1917	DE	32°40.01′N	142°59.99′E	5502		*TSK XCTD-1*
X098	XCTD	103108	1958	DE	32°50.00′N	143°00.01′E	5356		*TSK XCTD-1*
C050	ROS	103108	2058	BE	33°00.09′N	142°59.86′E	5566		LADCP
C050	ROS	103108	2139	BO	32°59.76′N	142°59.67′E	5557	2003	1-6 *SBE9p400 CTDO*
C050	ROS	103108	2202	EN	32°59.67′N	142°59.53′E	5556		
TM18	TMAP	103108	2235	DE	32°59.55′N	142°59.68′E	5556	490	*Turbomap*
FR20	FRRF	103108	2307	DE	32°59.73′N	142°59.45′E	5557	201	*Kimoto DF-03B*
C50S	ROS	110108	0003	BE	32°59.03′N	142°59.11′E	5559		LADCP
C50S	ROS	110108	0012	BO	32°58.89′N	142°59.01′E	5560	200	1-7 *SBE9p400 CTDO*
C50S	ROS	110108	0036	EN	32°58.60′N	142°58.77′E	5568		
X099	XCTD	110108	0137	DE	33°10.00′N	142°59.99′E	5481		*TSK XCTD-1*
X100A	XCTD	110108	0231	DE	33°20.98′N	142°58.92′E	5362		*TSK XCTD-1*
C051	ROS	110108	0356	BE	33°29.77′N	143°00.11′E	5528		LADCP
C051	ROS	110108	0436	BO	33°28.90′N	142°59.82′E	5520	2000	1,2 *SBE9p400 CTDO*

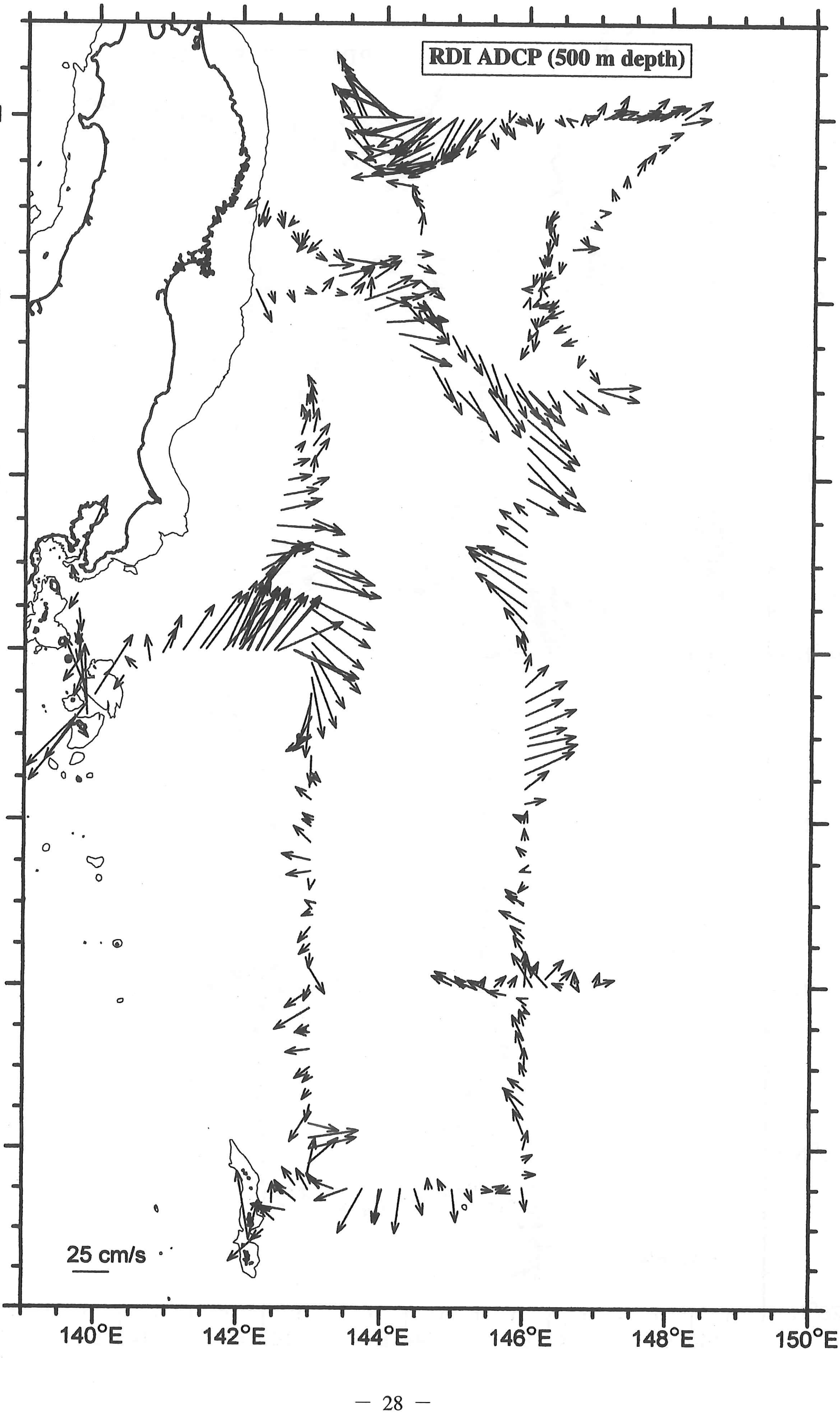
STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*
C051	ROS	110108	0515	EN	33°28.25′N	142°59.41′E	5471		
X101	XCTD	110108	0634	DE	33°40.02′N	142°59.99′E	5255		*TSK XCTD-1*
X102	XCTD	110108	0725	DE	33°49.99′N	142°59.99′E	5197		*TSK XCTD-1*
FR21	FRRF	110108	0820	DE	33°59.89′N	143°00.04′E	5144	200	*Kimoto DF-03B*
C52S	ROS	110108	0910	BE	33°59.23′N	143°00.11′E	5150		LADCP
C52S	ROS	110108	0922	BO	33°58.99′N	143°00.09′E	5146	24	SBE9p400 *CTDO*
C52S	ROS	110108	0947	EN	33°58.65′N	143°00.11′E	5140		
TM19	TMAP	110108	0959	DE	33°58.32′N	143°00.17′E	5135	486	*Turbomap*
C052	ROS	110108	1114	BE	33°59.86′N	143°00.02′E	5148		LADCP
C052	ROS	110108	1200	BO	33°59.24′N	143°00.20′E	5154	2001	1-6 *SBE9p400 CTDO*
C052	ROS	110108	1240	EN	33°58.91′N	143°00.39′E	5152		
X103	XCTD	110108	1340	DE	34°10.01′N	142°59.99′E	5145		*TSK XCTD-1*
X104	XCTD	110108	1428	DE	34°20.04′N	143°00.00′E	5304		*TSK XCTD-1*
C053	ROS	110108	1530	BE	34°29.78′N	143°00.17′E	5279		LADCP
C053	ROS	110108	1609	BO	34°29.50′N	143°00.48′E	5268	2001	1,2 *SBE9p400 CTDO*
C053	ROS	110108	1647	EN	34°29.28′N	143°00.61′E	5266		
X105	XCTD	110108	1749	DE	34°40.01′N	143°00.00′E	5372		*TSK XCTD-1*
X106	XCTD	110108	1832	DE	34°50.04′N	143°00.00′E	5969		*TSK XCTD-1*
C054	ROS	110108	1930	BE	34°59.85′N	143°00.50′E	5905		LADCP
C054	ROS	110108	2016	BO	34°59.21′N	143°01.89′E	5780	1997	1-6 *SBE9p400 CTDO*
C054	ROS	110108	2059	EN	34°58.81′N	143°02.77′E	5764		
TM20	TMAP	110108	2110	DE	34°58.60′N	143°03.38′E	5814	535	*Turbomap*
C54S	ROS	110108	2256	BE	34°59.83′N	143°00.27′E	5902		LADCP
C54S	ROS	110108	2309	BO	34°59.61′N	143°00.93′E	5893	200	1-7 *SBE9p400 CTDO*
C54S	ROS	110108	2332	EN	34°59.19′N	143°02.12′E	5749		
FR22	FRRF	110108	2338	DE	34°59.12′N	143°02.39′E	5737	201	*Kimoto DF-03B*
X107	XCTD	110208	0125	DE	35°10.02′N	143°00.00′E	5645		*TSK XCTD-1*
X108	XCTD	110208	0213	DE	35°20.02′N	143°00.00′E	5878		*TSK XCTD-1*
C055	ROS	110208	0313	BE	35°29.96′N	142°59.61′E	6191		LADCP
C055	ROS	110208	0356	BO	35°29.59′N	143°00.43′E	6156	2002	1,2 *SBE9p400 CTDO*
C055	ROS	110208	0435	EN	35°29.28′N	143°01.08′E	6126		
X109	XCTD	110208	0539	DE	35°40.05′N	143°00.00′E	6487		*TSK XCTD-1*
X110	XCTD	110208	0620	DE	35°50.04′N	143°00.00′E	6607		*TSK XCTD-1*
FR23	FRRF	110208	0722	DE	36°03.21′N	142°59.99′E	5107	200	*Kimoto DF-03B*
C56S	ROS	110208	0807	BE	36°03.74′N	143°00.16′E	4962		LADCP
C56S	ROS	110208	0817	BO	36°03.84′N	143°00.23′E	4958	202	1-7 *SBE9p400 CTDO*
C56S	ROS	110208	0842	EN	36°03.98′N	143°00.36′E	4899		
TM21A	TMAP	110208	0914	DE	36°04.53′N	143°00.68′E	4450	560	*Turbomap*
C056	ROS	110208	1015	BE	36°02.86′N	142°59.79′E	5194		LADCP
C056	ROS	110208	1056	BO	36°03.08′N	142°59.92′E	5133	2001	1-6 *SBE9p400 CTDO*
C056	ROS	110208	1134	EN	36°03.32′N	143°00.03′E	5124		
X111	XCTD	110208	1219	DE	36°10.02′N	143°00.00′E	5713		*TSK XCTD-1*
X112	XCTD	110208	1258	DE	36°20.01′N	143°00.00′E	7602		*TSK XCTD-1*
C057	ROS	110208	1355	BE	36°30.26′N	143°00.10′E	7172		LADCP
C057	ROS	110208	1435	BO	36°30.65′N	143°00.28′E	7176	2000	1,2 *SBE9p400 CTDO*
C057	ROS	110208	1514	EN	36°30.91′N	143°00.40′E	7181		
X113	XCTD	110208	1603	DE	36°40.04′N	142°59.99′E	6208		*TSK XCTD-1*
X114	XCTD	110208	1644	DE	36°50.00′N	143°00.00′E	6326		*TSK XCTD-1*
C058	ROS	110208	1737	BE	37°00.22′N	142°59.97′E	5120		LADCP
C058	ROS	110208	1813	BO	37°00.50′N	143°00.10′E	5101	2000	1-7 *SBE9p400 CTDO*

STN	TYPE	DATE	GMT	CODE	LATITUDE	LONGITUDE	DEPTH	MAXPR	PARAM/*COMMENT*	
C058	ROS	110208	1850	EN	37°00.64′N	143°00.18′E	5088			
TM22	TMAP	110208	1902	DE	37°00.85′N	143°00.14′E	5083	536	*Turbomap*	
C58S	ROS	110208	1954	BE	36°59.88′N	142°59.88′E	5142		LADCP	
C58S	ROS	110208	2005	BO	37°00.15′N	142°59.91′E	5125	202	1-7	*SBE9p400 CTDO*
C58S	ROS	110208	2028	EN	37°00.40′N	143°00.06′E	5114			
FR24	FRRF	110208	2036	DE	37°00.56′N	143°00.06′E	5092	200	*Kimoto DF-03B*	
X115	XBT	110308	1020	DE	33°59.86′N	142°00.05′E	8990		*TSK T-7*	
X116	XBT	110308	1052	DE	34°00.00′N	142°10.02′E	7005		*TSK T-7*	
X117	XBT	110308	1127	DE	33°59.99′N	142°20.09′E	6911		*TSK T-7*	
X118	XBT	110308	1200	DE	34°00.00′N	142°30.03′E	6127		*TSK T-7*	
X119	XCTD	110308	1235	DE	33°59.99′N	142°40.07′E	5810		*TSK XCTD-1*	
X120	XCTD	110308	1310	DE	33°59.99′N	142°50.06′E	5282		*TSK XCTD-1*	
X121	XCTD	110308	2236	DE	33°59.98′N	142°10.00′E	6759		*TSK XCTD-1*	
X122	XCTD	110308	2348	DE	34°00.81′N	142°23.84′E	6471		*TSK XCTD-1*	
C059	ROS	110408	0040	BE	33°59.90′N	142°30.34′E	6365		LADCP	
C059	ROS	110408	0123	BO	34°00.06′N	142°30.71′E	6166	2000	1-6	*SBE9p400 CTDO*
C059	ROS	110408	0201	EN	34°00.06′N	142°30.97′E	6139			
TM23	TMAP	110408	0225	DE	34°00.17′N	142°30.92′E	6138	521	*Turbomap*	
FR25	FRRF	110408	0314	DE	34°00.07′N	142°29.95′E	6301	200	*Kimoto DF-03B*	
C59S	ROS	110408	0413	BE	34°00.05′N	142°30.09′E	6274		LADCP	
C59S	ROS	110408	0422	BO	34°00.01′N	142°30.31′E	6261	201	1-7	*SBE9p400 CTDO*
C59S	ROS	110408	0444	EN	33°59.98′N	142°30.53′E	6204			
FR26	FRRF	110408	0654	DE	34°00.18′N	142°00.14′E	8989	198	*Kimoto DF-03B*	
C60S	ROS	110408	0740	BE	34°01.01′N	142°01.19′E	8988		LADCP	
C60S	ROS	110408	0752	BO	34°01.19′N	142°01.40′E	8987	200	1-7	*SBE9p400 CTDO*
C60S	ROS	110408	0814	EN	34°01.52′N	142°01.84′E	8986			
TM24	TMAP	110408	0828	DE	34°01.76′N	142°02.01′E	8984	566	*Turbomap*	
C060	ROS	110408	1026	BE	34°00.14′N	142°00.14′E	8990		LADCP	
C060	ROS	110408	1109	BO	34°00.95′N	142°00.72′E	8990	2003	1-6	*SBE9p400 CTDO*
C060	ROS	110408	1202	EN	34°01.71′N	142°01.33′E	8988			
X123	XCTD	110408	1300	DE	33°59.99′N	141°49.91′E	8903		*TSK XCTD-1*	
X124	XCTD	110408	1339	DE	34°00.00′N	141°39.96′E	7102		*TSK XCTD-1*	
C061	ROS	110408	1433	BE	34°00.30′N	141°30.10′E	7200		LADCP	
C061	ROS	110408	1521	BO	34°01.50′N	141°30.78′E	7180	2000	1,2	*SBE9p400 CTDO*
C061	ROS	110408	1600	EN	34°02.39′N	141°31.29′E	7175			
X125	XCTD	110408	1705	DE	34°00.01′N	141°19.95′E	6490		*TSK XCTD-1*	
X126	XCTD	110408	1746	DE	34°00.00′N	141°09.94′E	4630		*TSK XCTD-1*	
C062	ROS	110408	1851	BE	34°00.56′N	141°00.67′E	3984		LADCP	
C062	ROS	110408	1924	BO	34°01.59′N	141°01.35′E	4114	1300	1,2	*SBE9p400 CTDO*
C062	ROS	110408	1956	EN	34°02.46′N	141°01.59′E	4060			
X127	XBT	110408	2127	DE	33°54.95′N	140°49.88′E	2890		*TSK T-7*	
X128	XBT	110408	2213	DE	33°50.02′N	140°39.97′E	2232		*TSK T-7*	
X129	XBT	110408	2257	DE	33°44.99′N	140°29.95′E	1465		*TSK T-7*	
X130	XBT	110408	2337	DE	33°39.99′N	140°19.93′E	707		*TSK T-7*	
X131	XBT	110508	0017	DE	33°34.99′N	140°09.98′E	188		*TSK T-7*	
X132	XBT	110508	0058	DE	33°30.00′N	139°59.98′E	270		*TSK T-7*	

7. Chart of Surface Currents

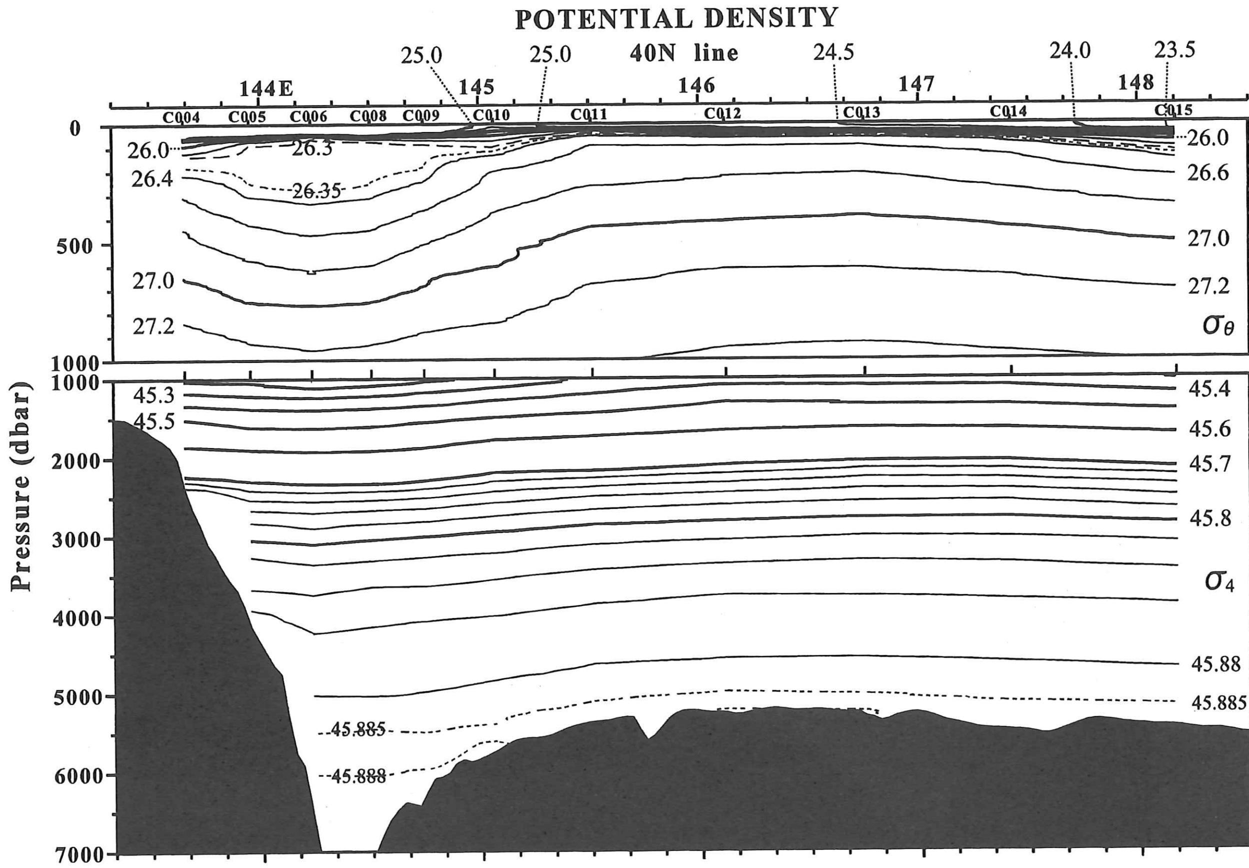


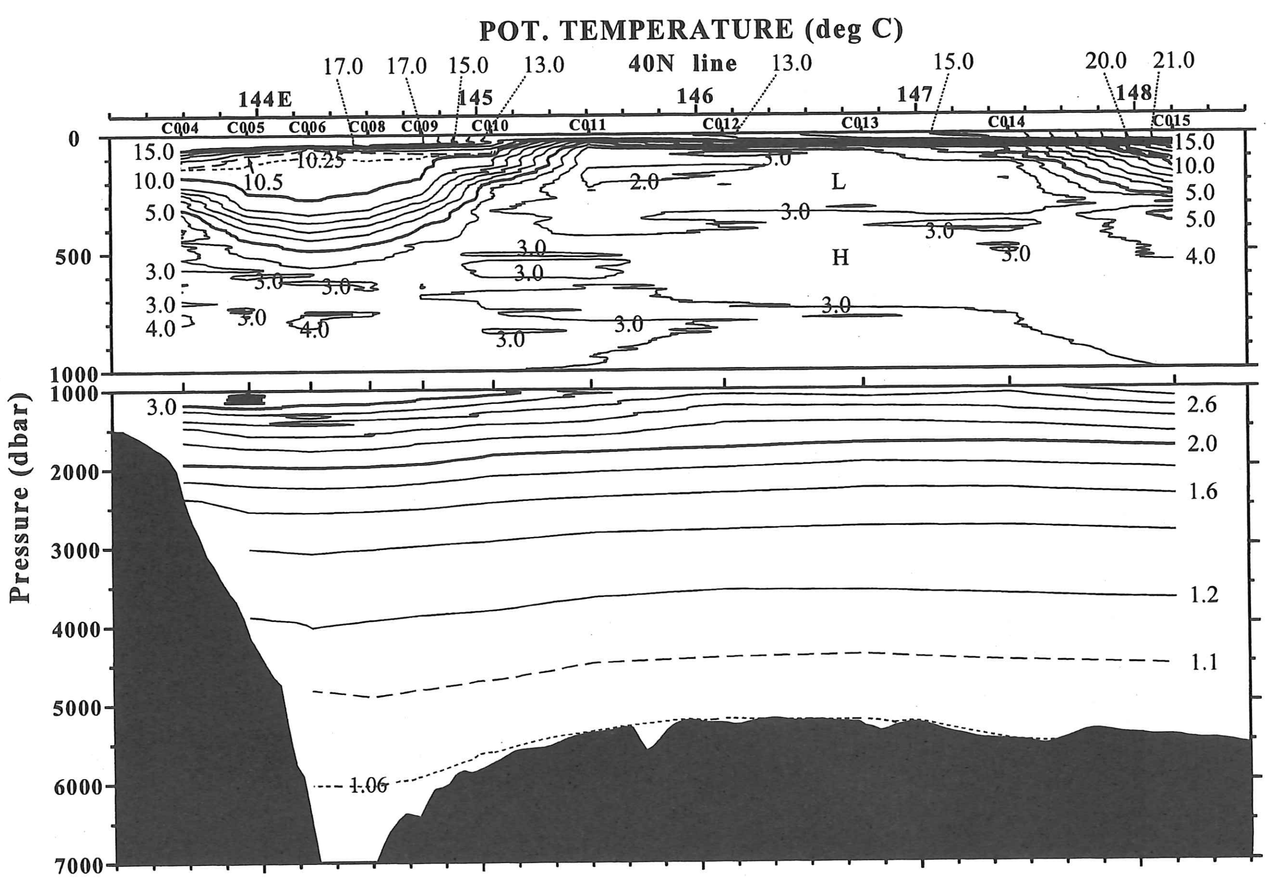

RDI ADCP (50 m depth)
50 cm/s
40°N
38°N
36°N
34°N
32°N
30°N
28°N
26°N
140°E
142°E
144°E
146°E
148°E
150°E



RDI ADCP (500 m depth)
40°N
38°N
36°N
34°N
32°N
30°N
28°N
26°N
140°E
142°E
144°E
146°E
148°E
150°E
25 cm/s

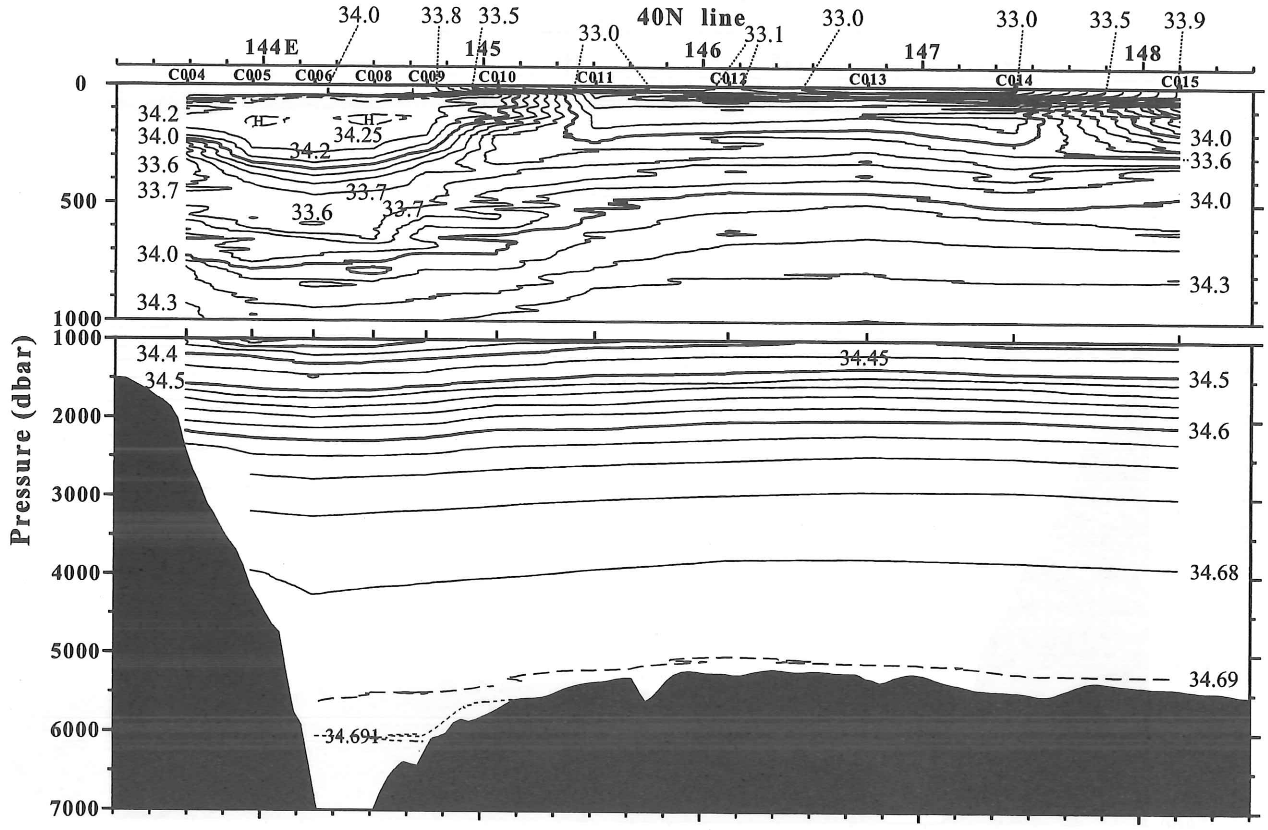
8. Vertical Sections of CTDO2 Data





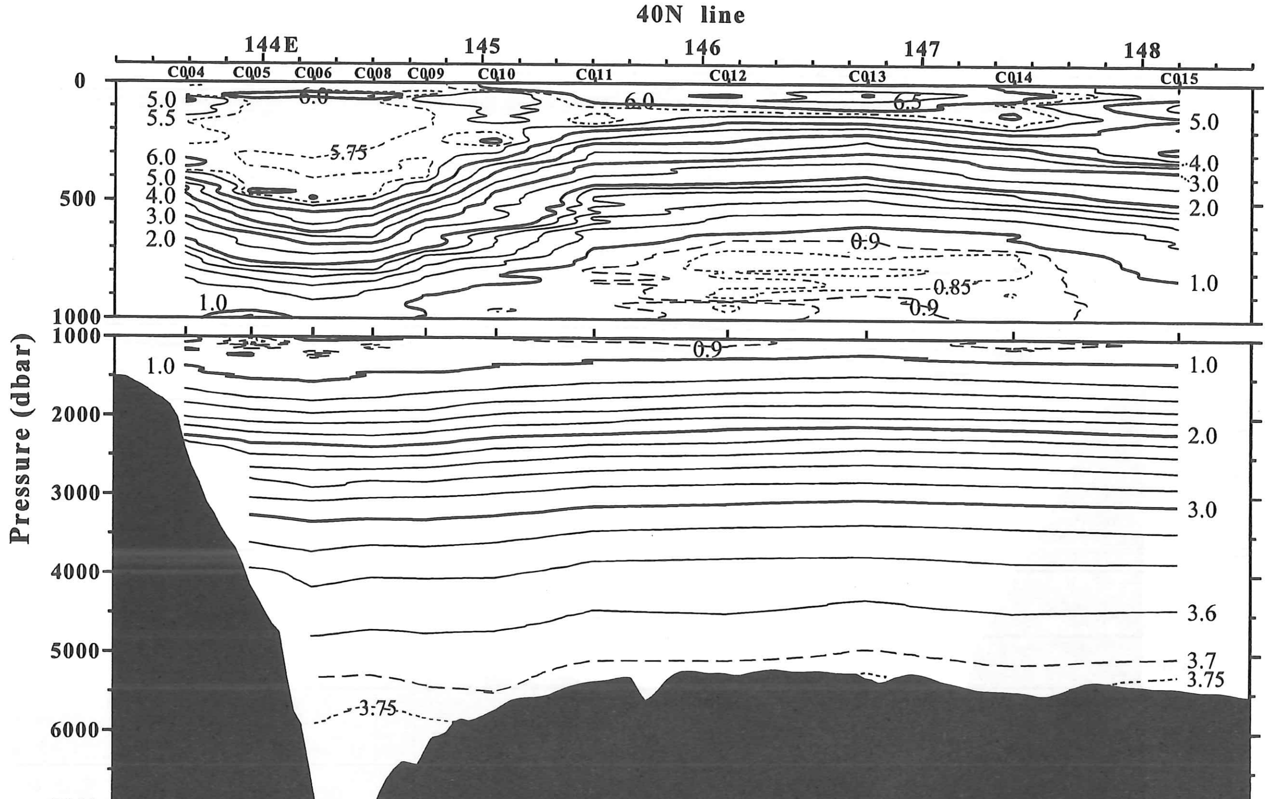
SALINITY (psu)

40N line

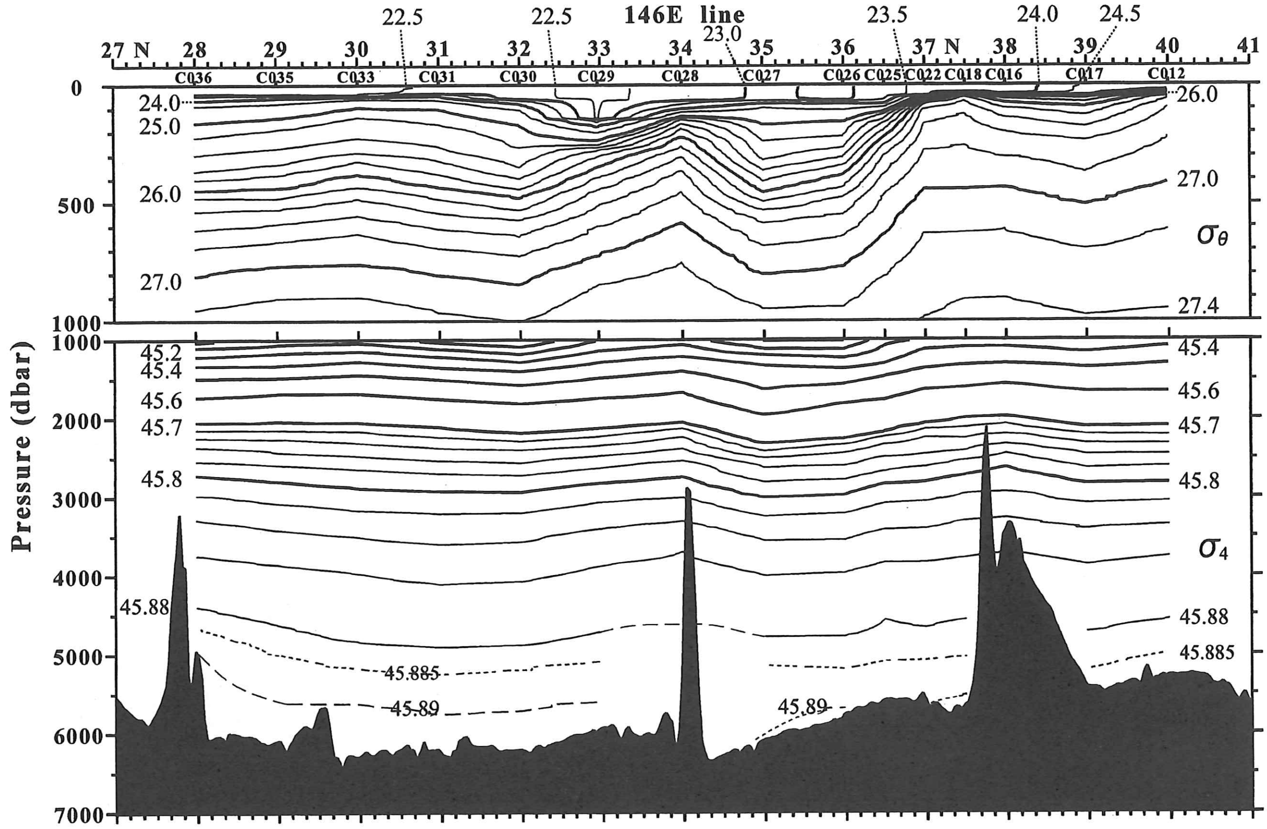


DISSOLVED OXYGEN (ml/l)

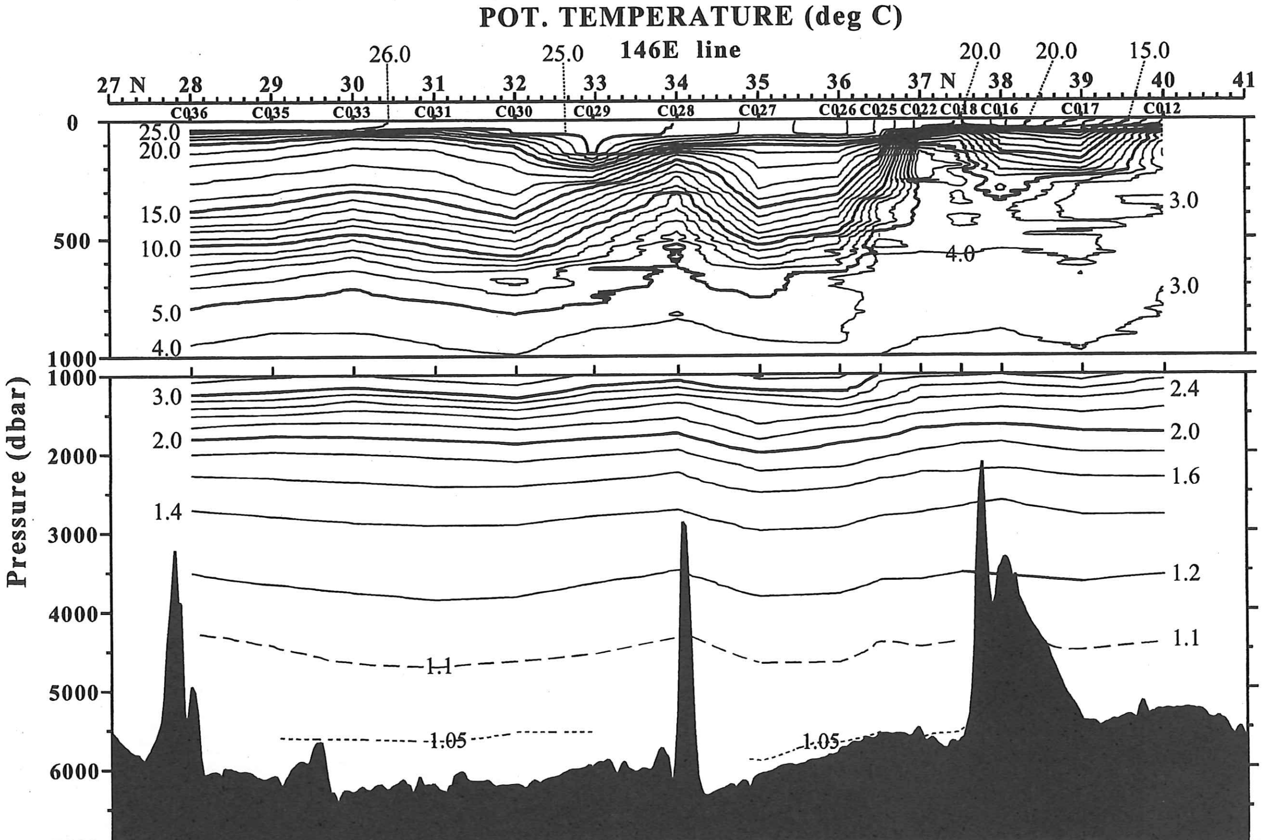
40N line



POTENTIAL DENSITY

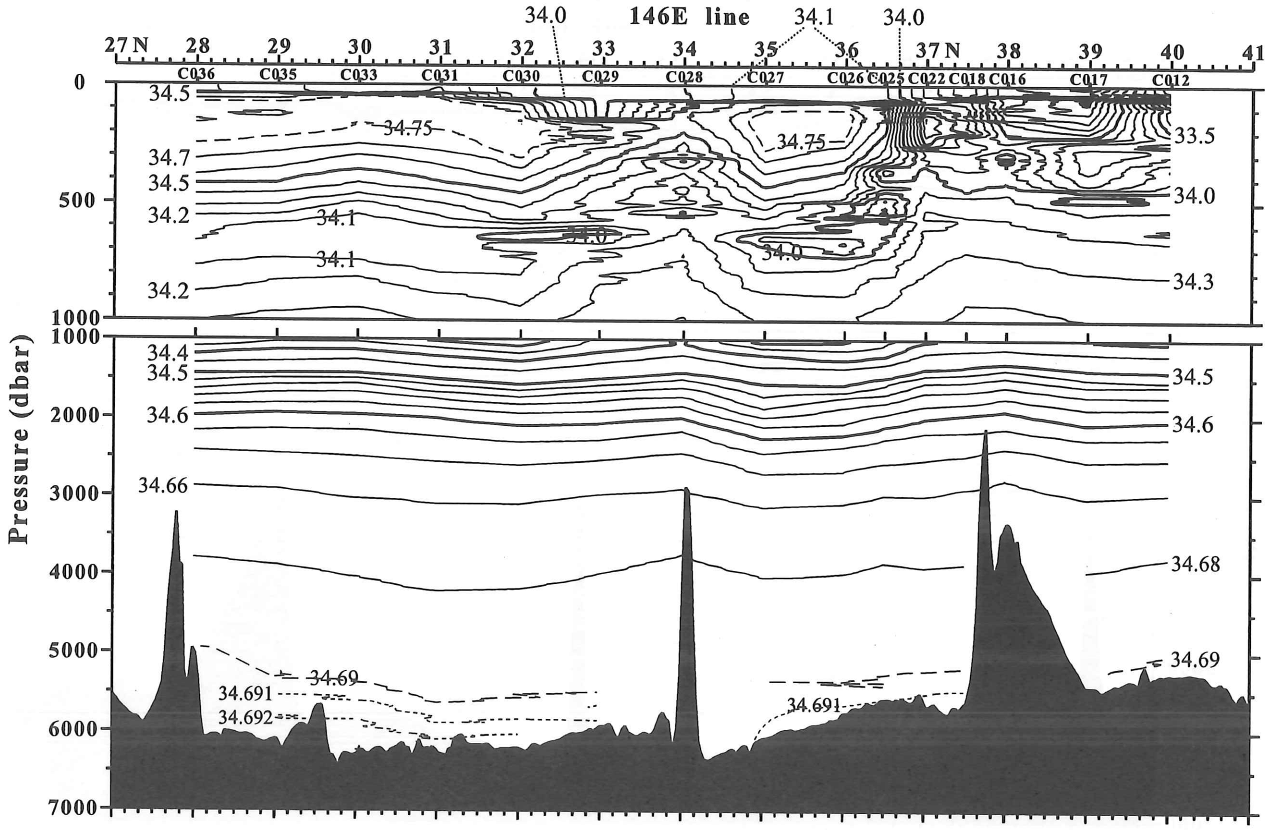


POT. TEMPERATURE (deg C)



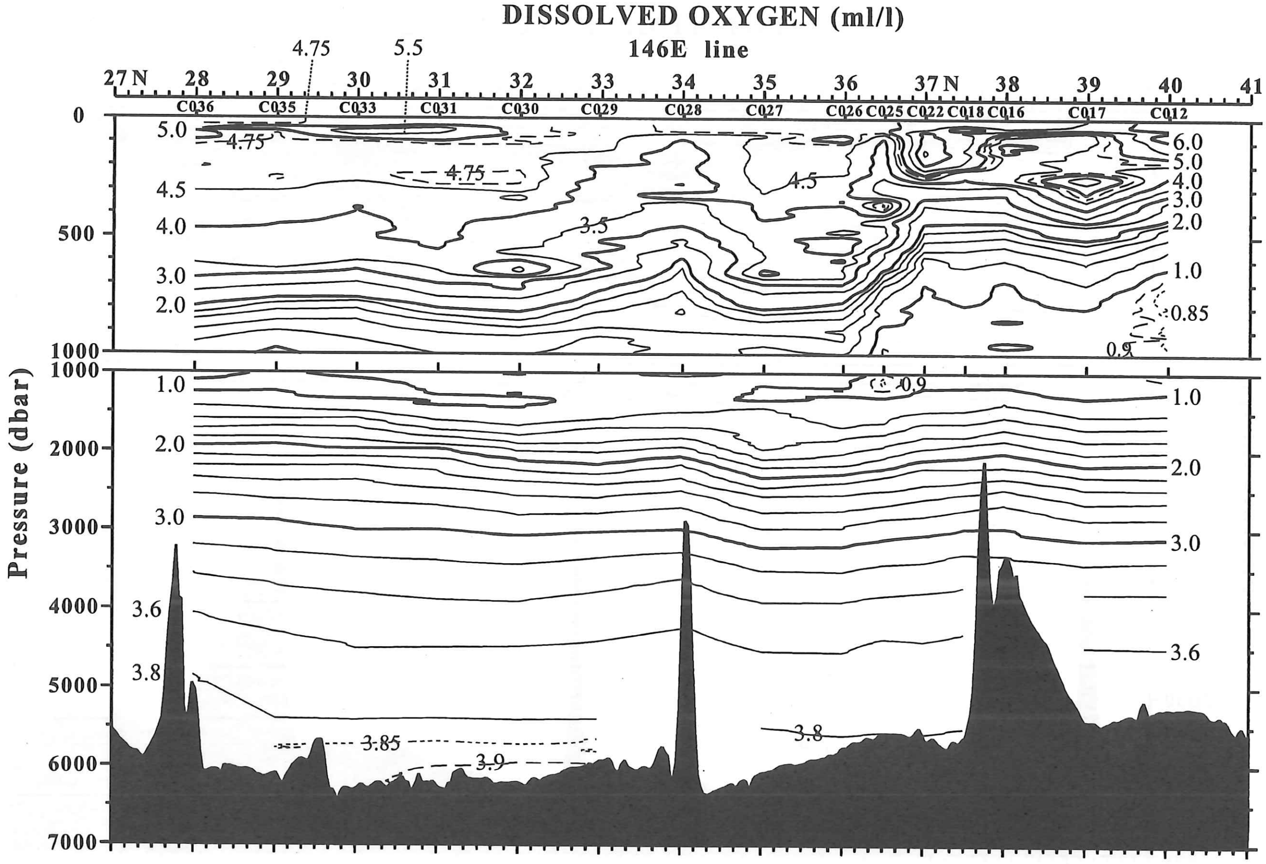
SALINITY (psu)

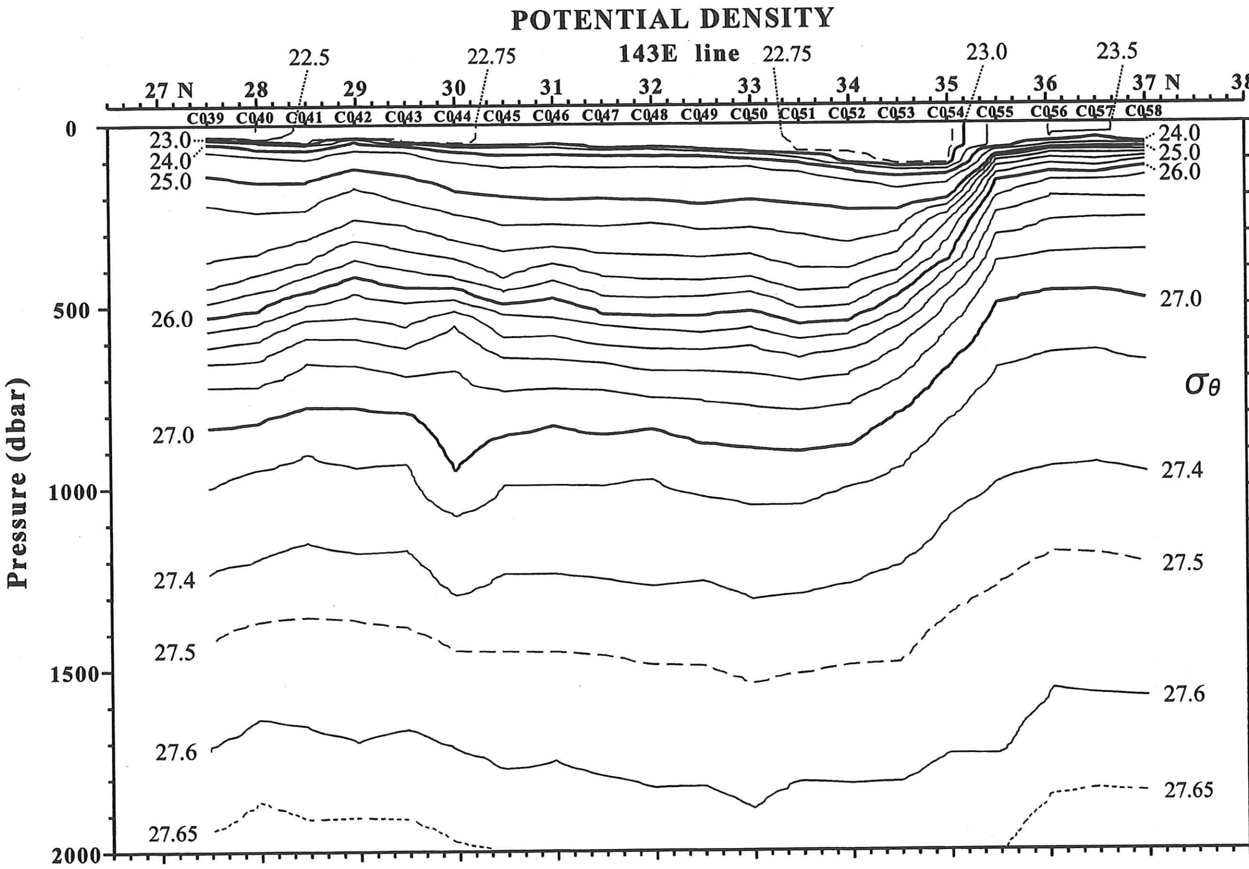
146E line

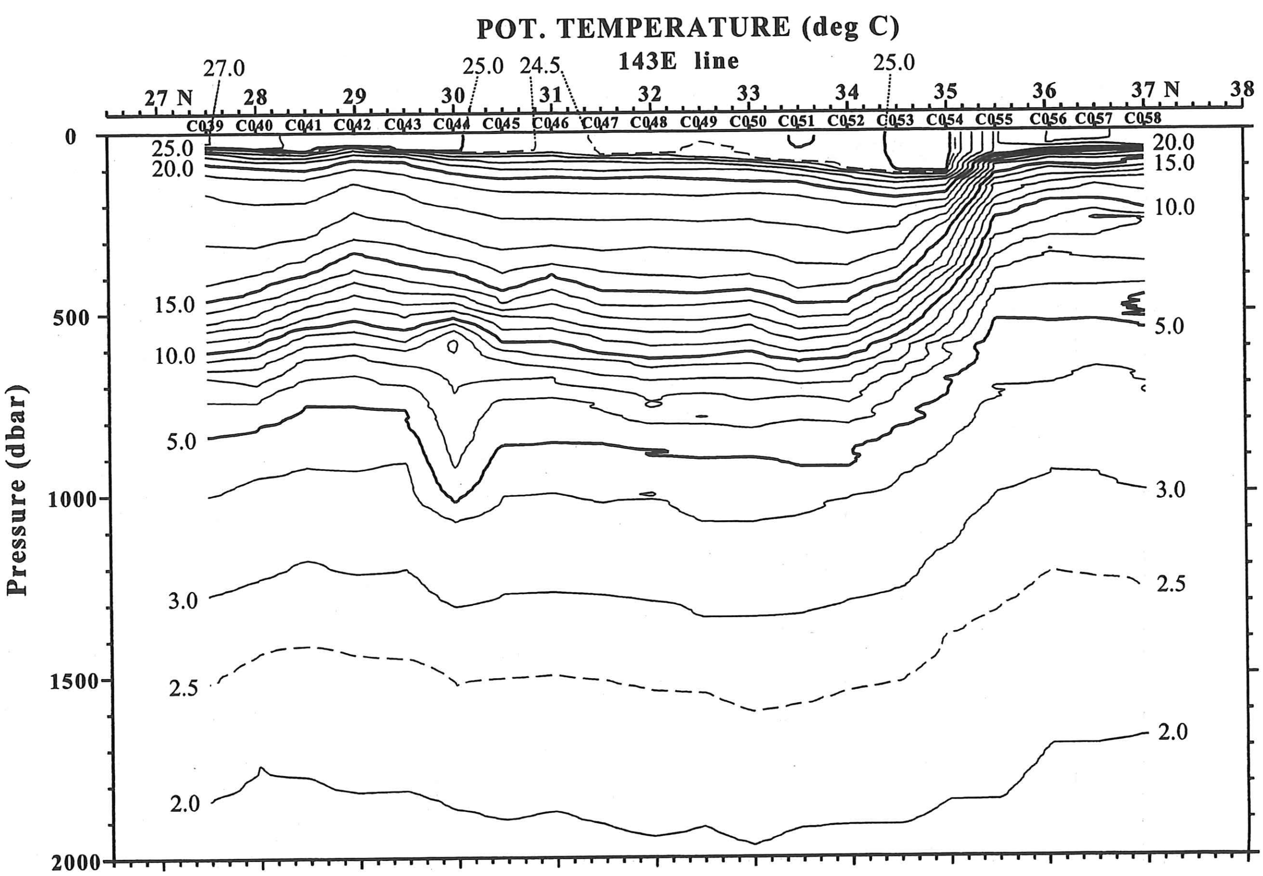


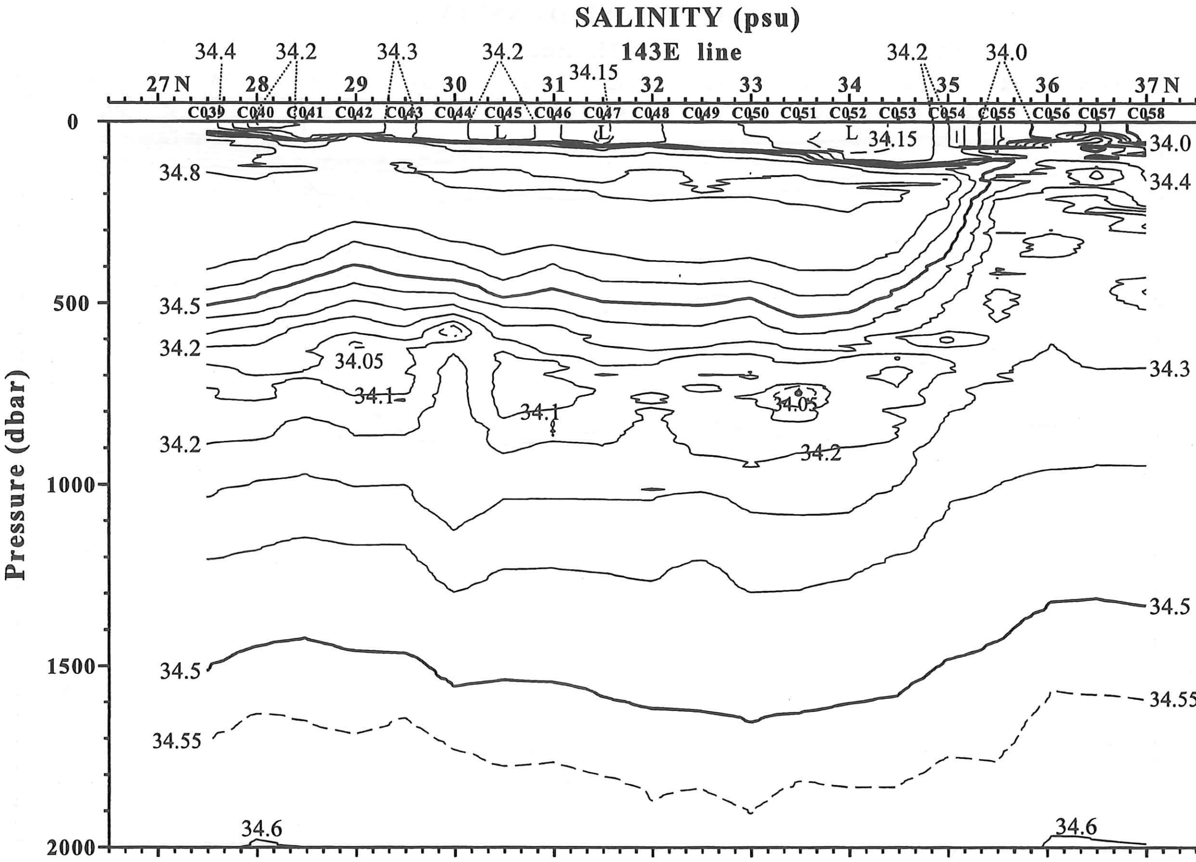
DISSOLVED OXYGEN (ml/l)

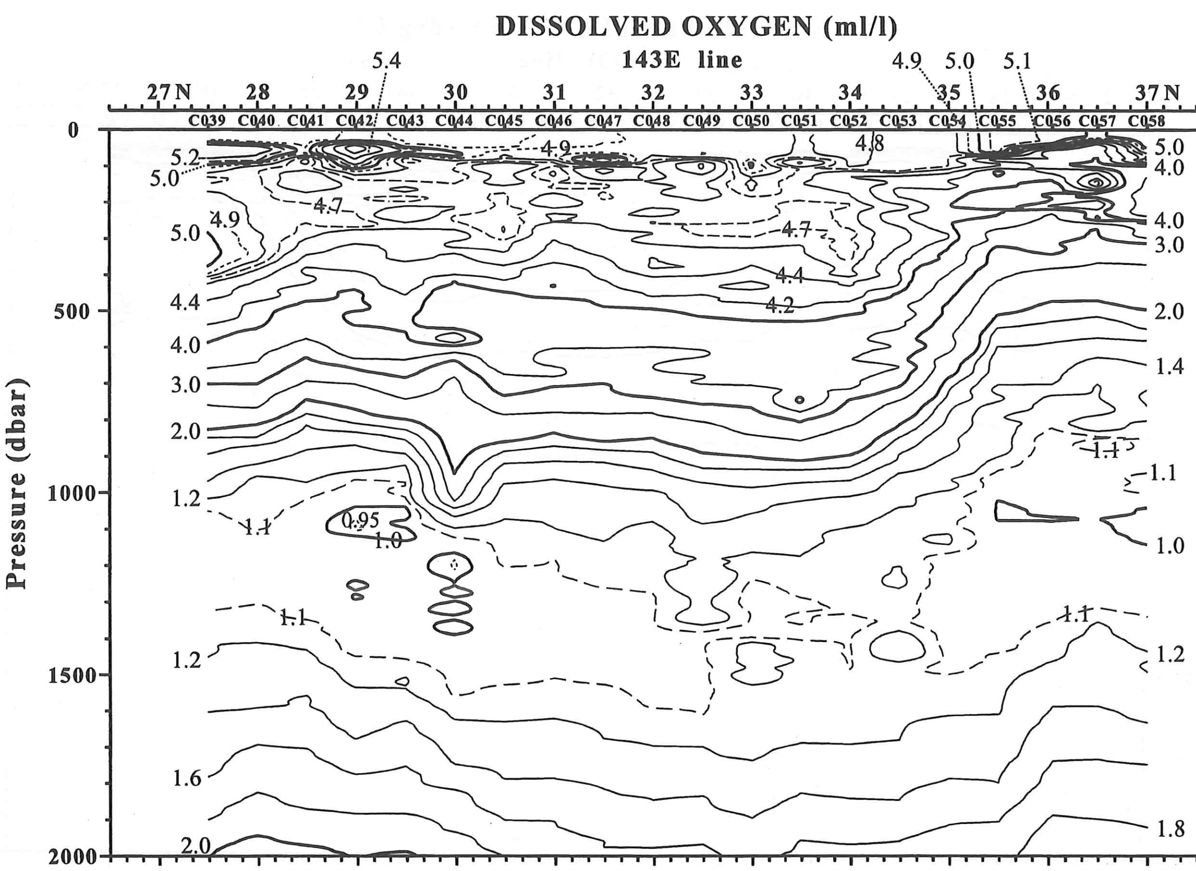
146E line




POTENTIAL DENSITY
143E line
Pressure (dbar)
σθ
27 N
28
29
30
31
32
33
34
35
36
37 N
38
C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051 C052 C053 C054 C055 C056 C057 C058
22.5
22.75
22.75
23.0
23.5
23.0
24.0
25.0
26.0
27.0
27.4
27.5
27.6
27.65
0
500
1000
1500
2000

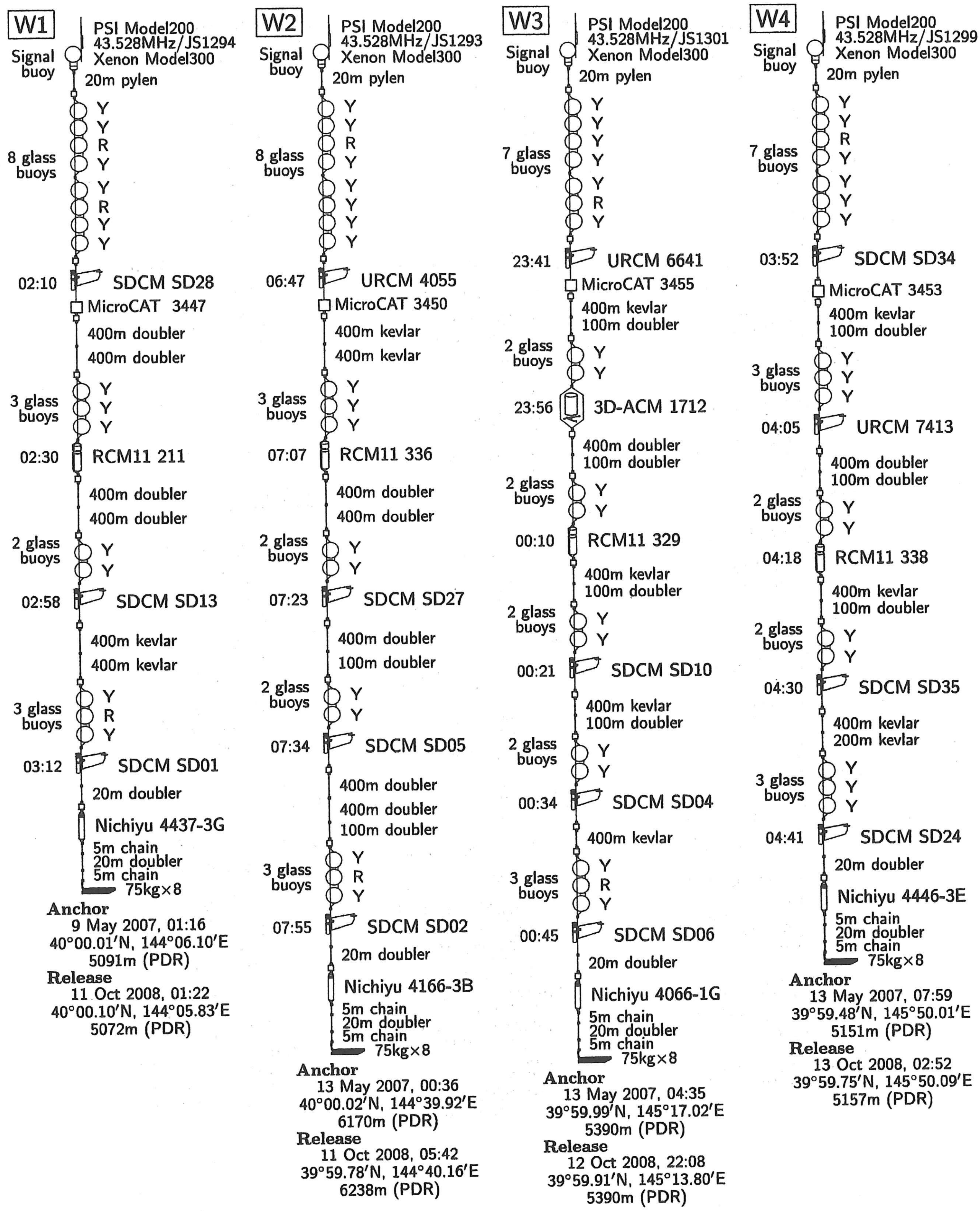

POT. TEMPERATURE (deg C)
143E line
Pressure (dbar)
27 N
28
29
30
31
32
33
34
35
36
37 N
38
C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051 C052 C053 C054 C055 C056 C057 C058
27.0
25.0
24.5
25.0
20.0
15.0
10.0
5.0
3.0
2.5
2.0
0
500
1000
1500
2000

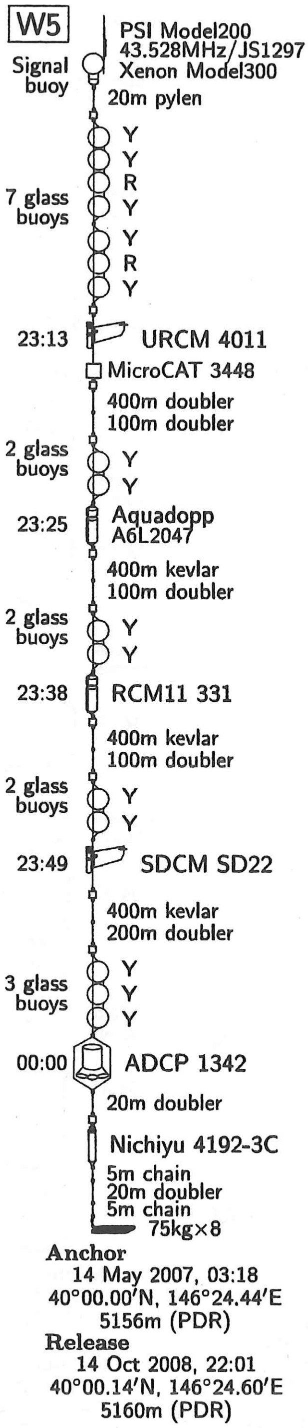

SALINITY (psu)
143E line
27N 28 29 30 31 32 33 34 35 36 37N 38
C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051 C052 C053 C054 C055 C056 C057 C058
Pressure (dbar)
0
500
1000
1500
2000
34.4 34.2 34.3 34.2 34.15 34.2 34.0
34.8 34.5 34.2 34.05 34.1 34.1 34.05 34.2 34.2 34.5 34.55 34.6
34.0 34.4 34.3 34.5 34.55 34.6 34.15

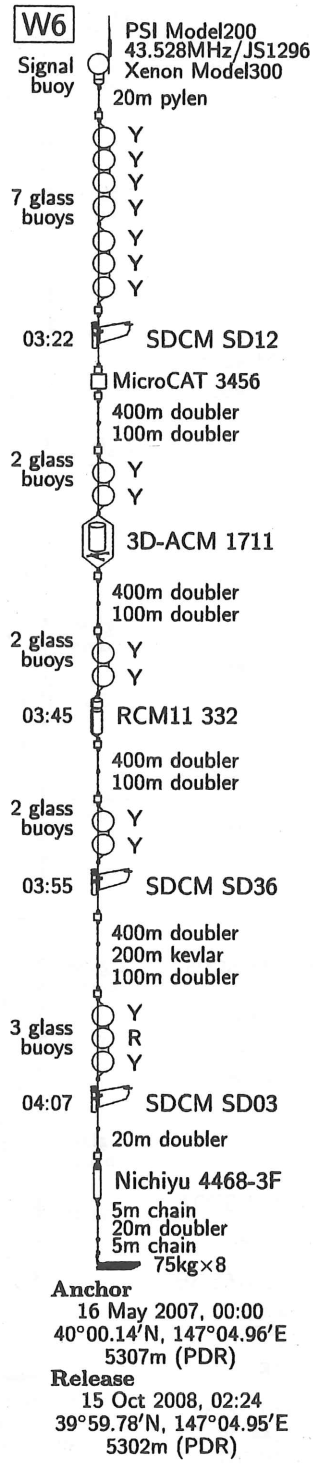

DISSOLVED OXYGEN (ml/l)
143E line
27N 28 29 30 31 32 33 34 35 36 37N 38
C039 C040 C041 C042 C043 C044 C045 C046 C047 C048 C049 C050 C051 C052 C053 C054 C055 C056 C057 C058
Pressure (dbar)
0
500
1000
1500
2000
5.4 4.9 5.0 5.1
5.2 5.0 4.9 5.0 4.7 4.4 4.0 3.0 2.0 1.2 1.1 0.95 1.0 1.1 1.2 1.6 2.0
4.9 4.8 4.7 4.4 4.2
5.0 4.0 4.0 3.0 2.0 1.4 1.1 1.1 1.0 1.1 1.2 1.8

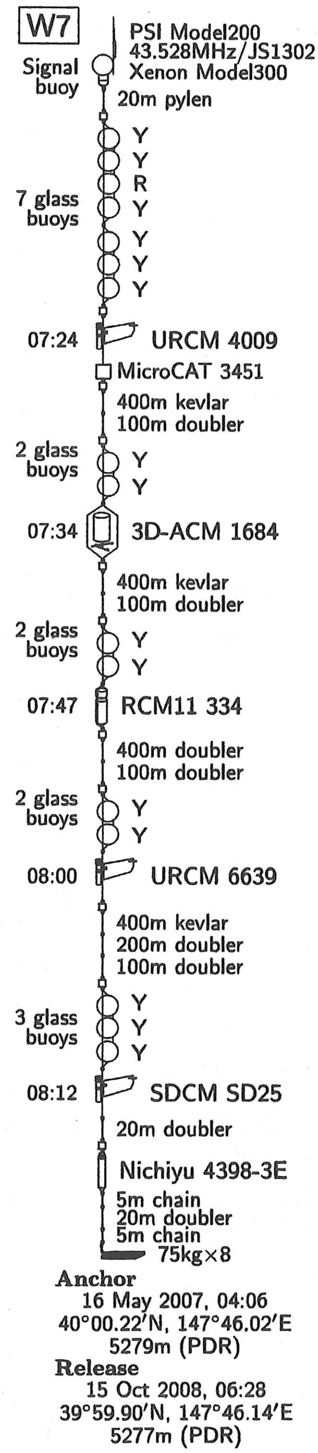
9. Mooring Systems

Recovered Systems at 40°N

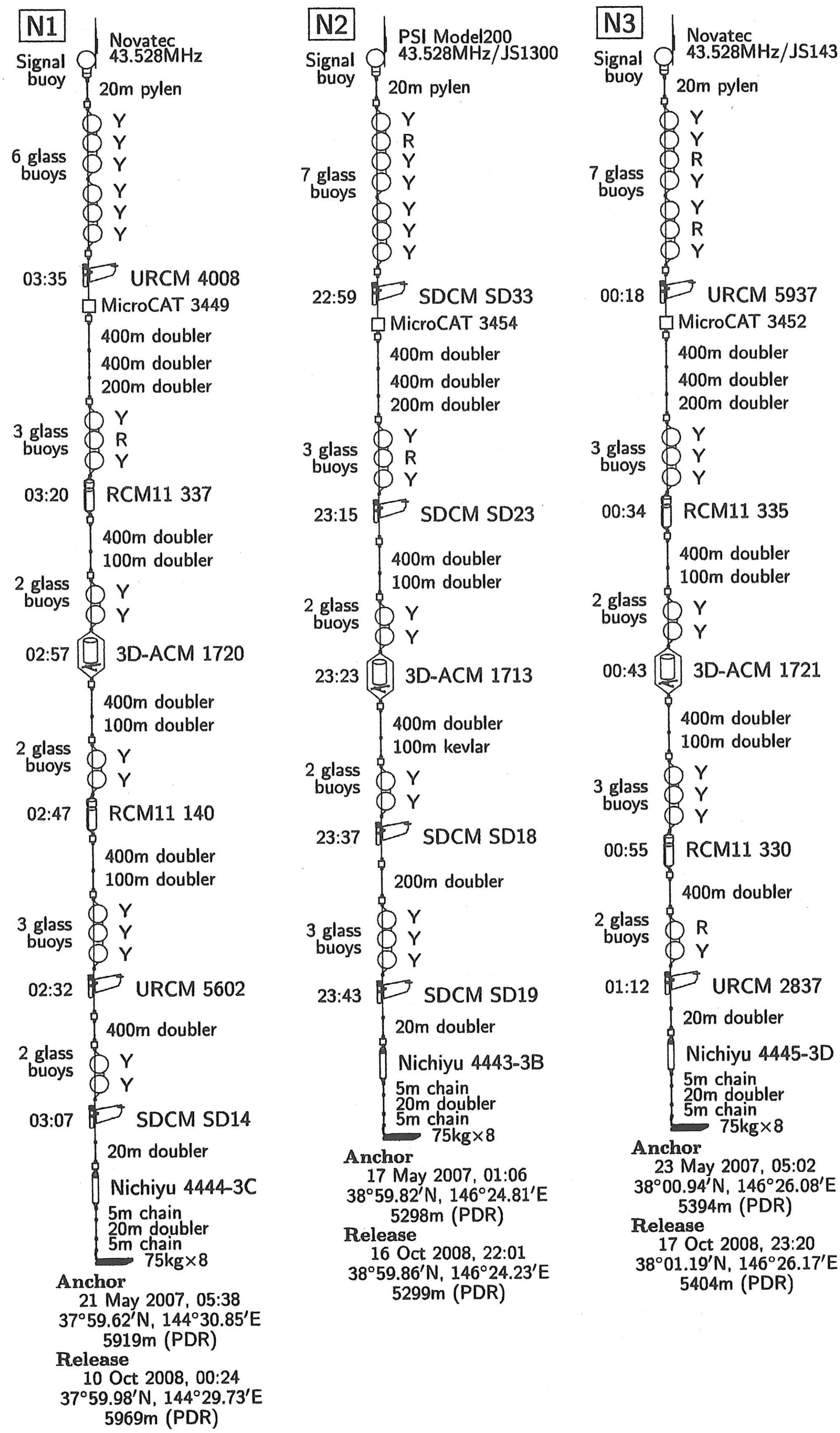



W5
PSI Model200
43.528MHz/JS1297
Signal buoy
Xenon Model300
20m pylen
7 glass buoys
Y
Y
R
Y
Y
R
Y
23:13
URCM 4011
MicroCAT 3448
400m doubler
100m doubler
2 glass buoys
Y
Y
23:25
Aquadopp
A6L2047
400m kevlar
100m doubler
2 glass buoys
Y
Y
23:38
RCM11 331
400m kevlar
100m doubler
2 glass buoys
Y
Y
23:49
SDCM SD22
400m kevlar
200m doubler
3 glass buoys
Y
Y
Y
00:00
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)
Release
14 Oct 2008, 22:01
40°00.14′N, 146°24.60′E
5160m (PDR)

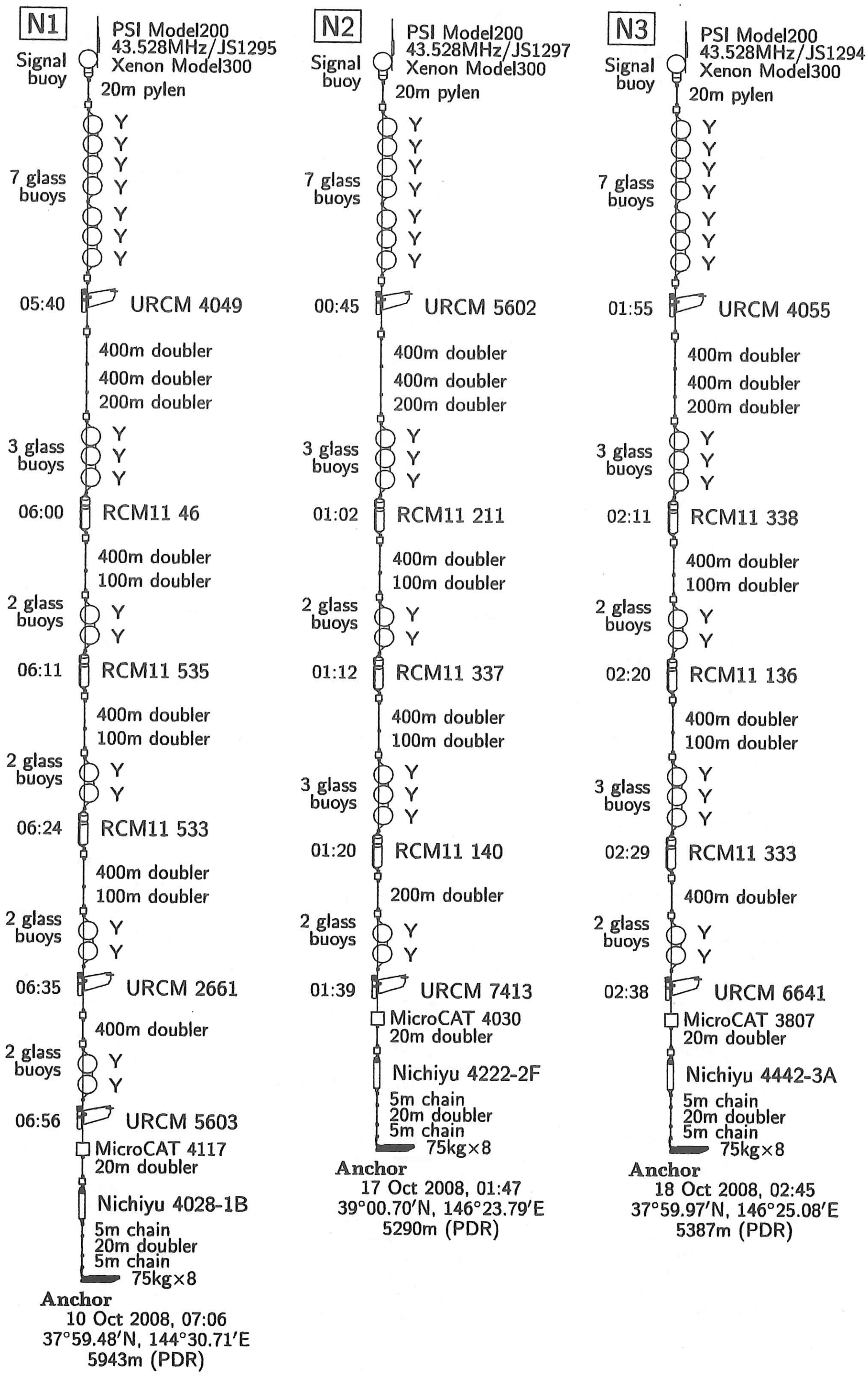

W6
PSI Model200
43.528MHz/JS1296
Signal buoy
Xenon Model300
20m pylen
7 glass buoys
Y
Y
Y
Y
Y
Y
Y
03:22
SDCM SD12
MicroCAT 3456
400m doubler
100m doubler
2 glass buoys
Y
Y
3D-ACM 1711
400m doubler
100m doubler
2 glass buoys
Y
Y
03:45
RCM11 332
400m doubler
100m doubler
2 glass buoys
Y
Y
03:55
SDCM SD36
400m doubler
200m kevlar
100m doubler
3 glass buoys
Y
R
Y
04:07
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)
Release
15 Oct 2008, 02:24
39°59.78′N, 147°04.95′E
5302m (PDR)


W7
PSI Model200
43.528MHz/JS1302
Signal buoy
Xenon Model300
20m pylen
7 glass buoys
Y
Y
R
Y
Y
Y
Y
07:24
URCM 4009
MicroCAT 3451
400m kevlar
100m doubler
2 glass buoys
Y
Y
07:34
3D-ACM 1684
400m kevlar
100m doubler
2 glass buoys
Y
Y
07:47
RCM11 334
400m doubler
100m doubler
2 glass buoys
Y
Y
08:00
URCM 6639
400m kevlar
200m doubler
100m doubler
3 glass buoys
Y
Y
Y
08:12
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)
Release
15 Oct 2008, 06:28
39°59.90′N, 147°46.14′E
5277m (PDR)

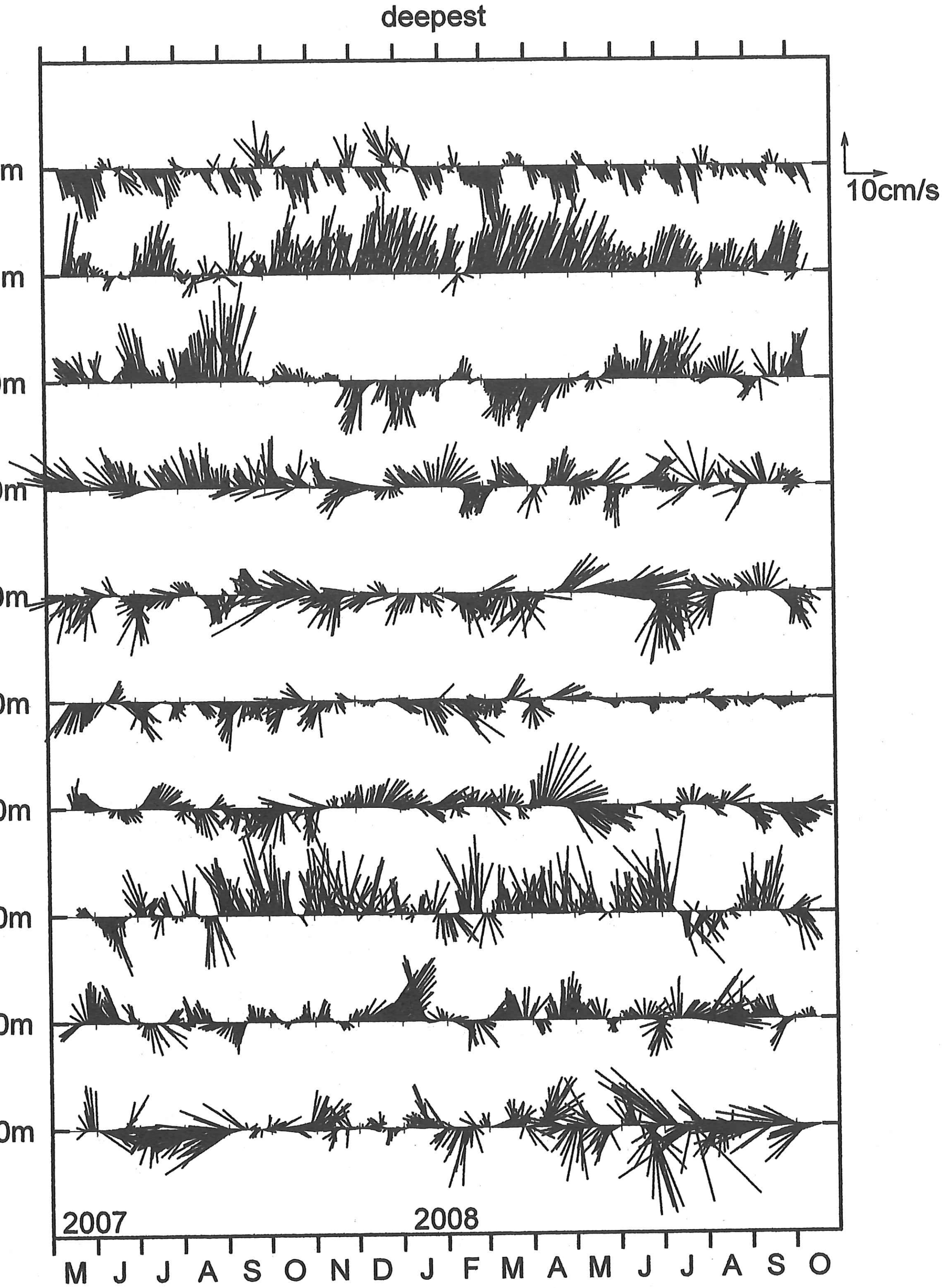
Recovered Systems in 38°N Area

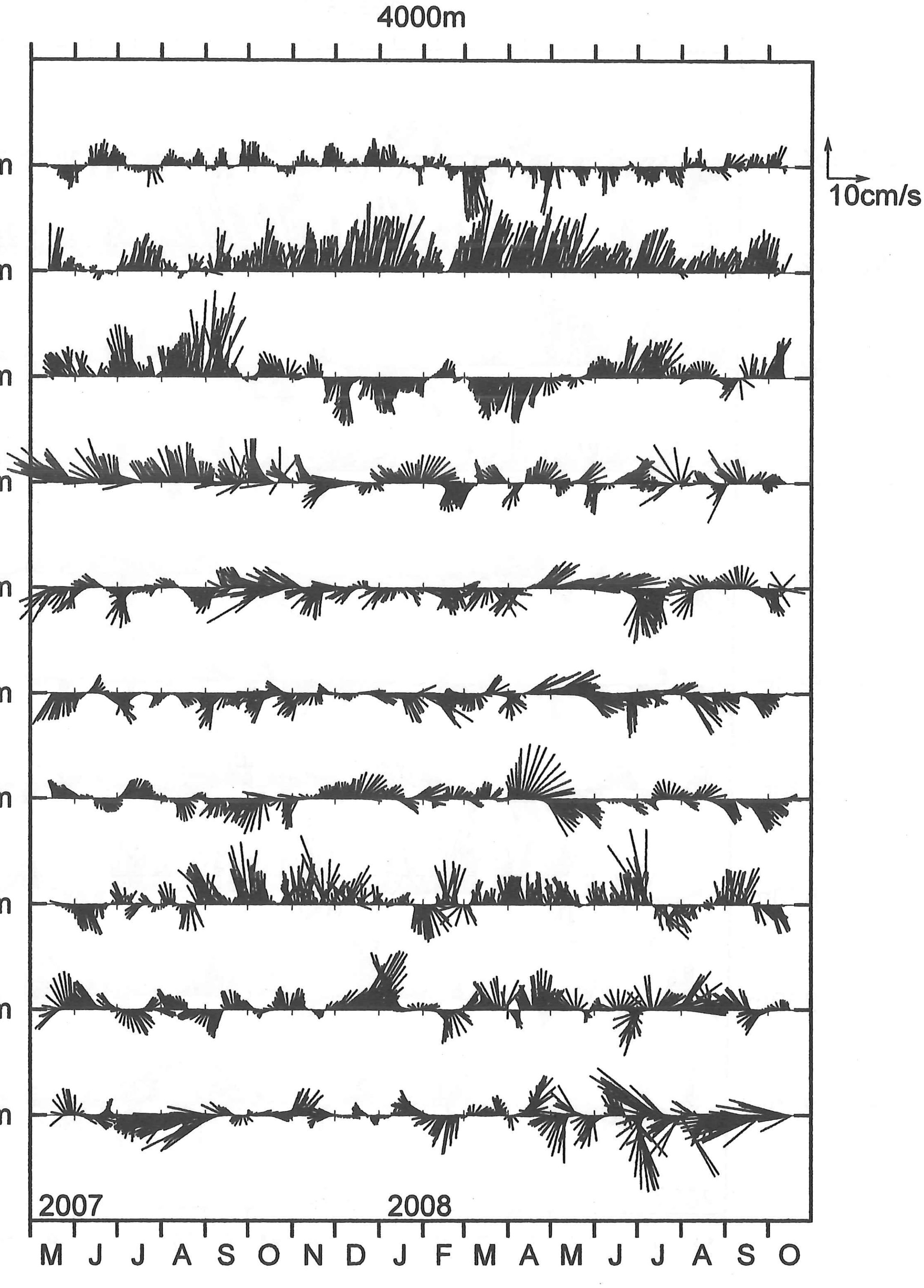


Deployed Systems in 38°N Area



10. Results of Moored Current Meters




4000m
W1 4240m
W2 3920m
W3 3940m
W4 4000m
W5 4000m
W6 4050m
W7 4030m
N1 3970m
N2 4050m
N3 3940m
10cm/s
2007
2008
M J J A S O N D J F M A M J J A S O