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R/V Hakuho Maru "Cruise Report"
KH-18-J03C

Researches on marine ecosystem dynamics in the Tsunami affected area off Sanriku

Off Sanriku

Aug. 20, 2018 – Aug. 29, 2018

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

Project: Analyses of Changes in East Japan Marine Ecosystems,
Tohoku Ecosystem-Associated Marine Sciences (TEAMS)

Contents

1. Cruise Information

1.1 General Information

(1) Cruise ID KH-18-J03C
(2) Name of vessel R/V Hakuho Maru
(3) Title of the cruise Researches on marine ecosystem dynamics in the Tsunami affected area off Sanriku
(4) Title of proposal
Cruise Proposal Researches on marine ecosystem dynamics in the Tsunami affected area off Sanriku
Project Analyses of Changes in East Japan Marine Ecosystems, Tohoku Ecosystem-Associated Marine Sciences (TEAMS)
(5) Cruise period Aug. 20th, 2018 ~ Aug. 29th, 2018
(6) Ports of departure / call / arrival
Port of departure: Tokyo (Aug. 20, 2019)
Port of arrival: Kushiro (Aug. 29, 2019)

1.2 Research Area

(1) Research area Off Sanriku
Research area surrounded by two latitude longitude lines, 38^{o}00’N and 39^{o}30’N, and two longitude lines,141^{o}15’E and 144^{o}00’E, without land.

(2) Cruise Track and Research Map

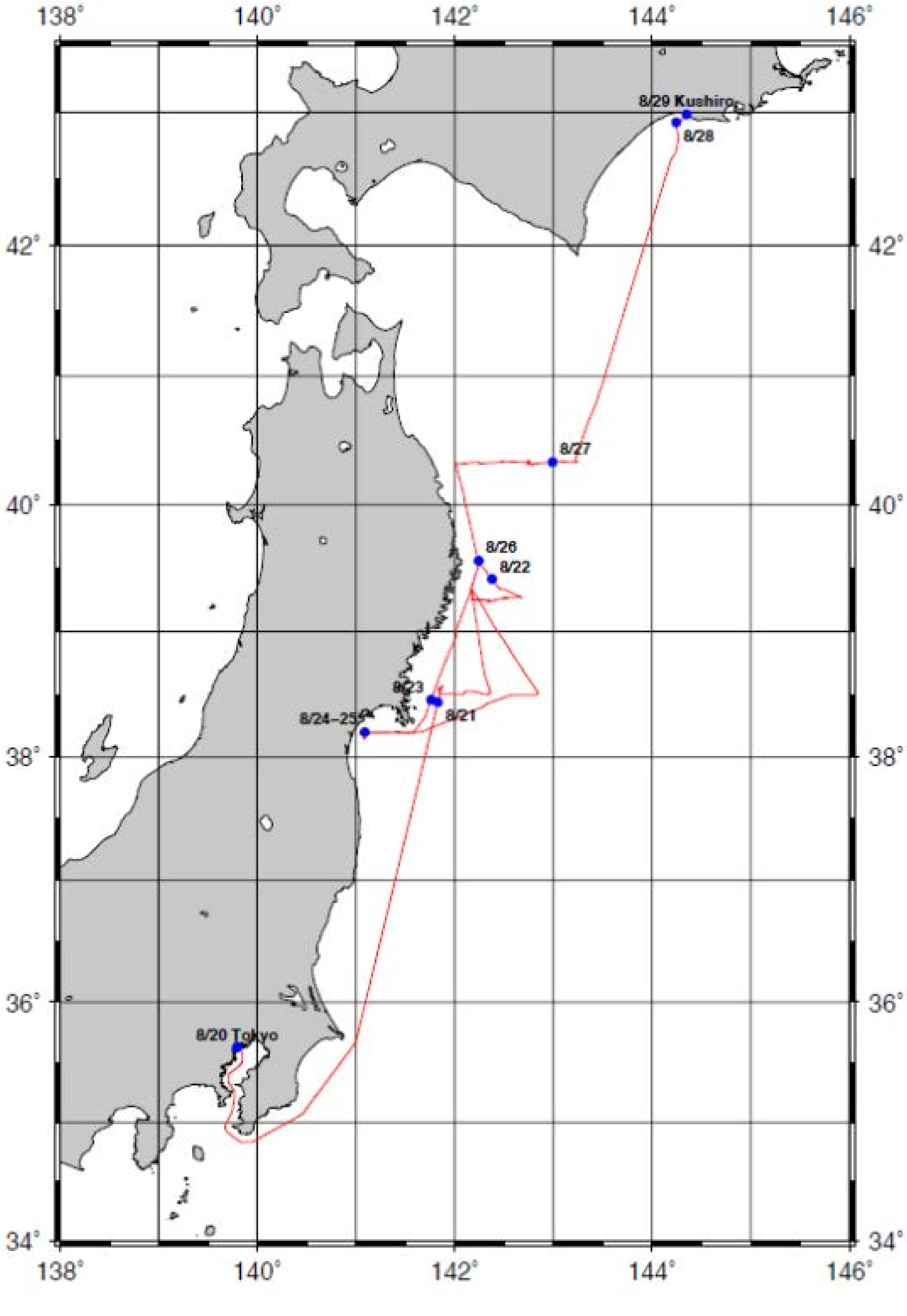

Fig. 1.2-1 Cruise Track of R/V Hakuho−Maru, KH−18−J03C, from 20th Aug., 2018 to 29th Aug.

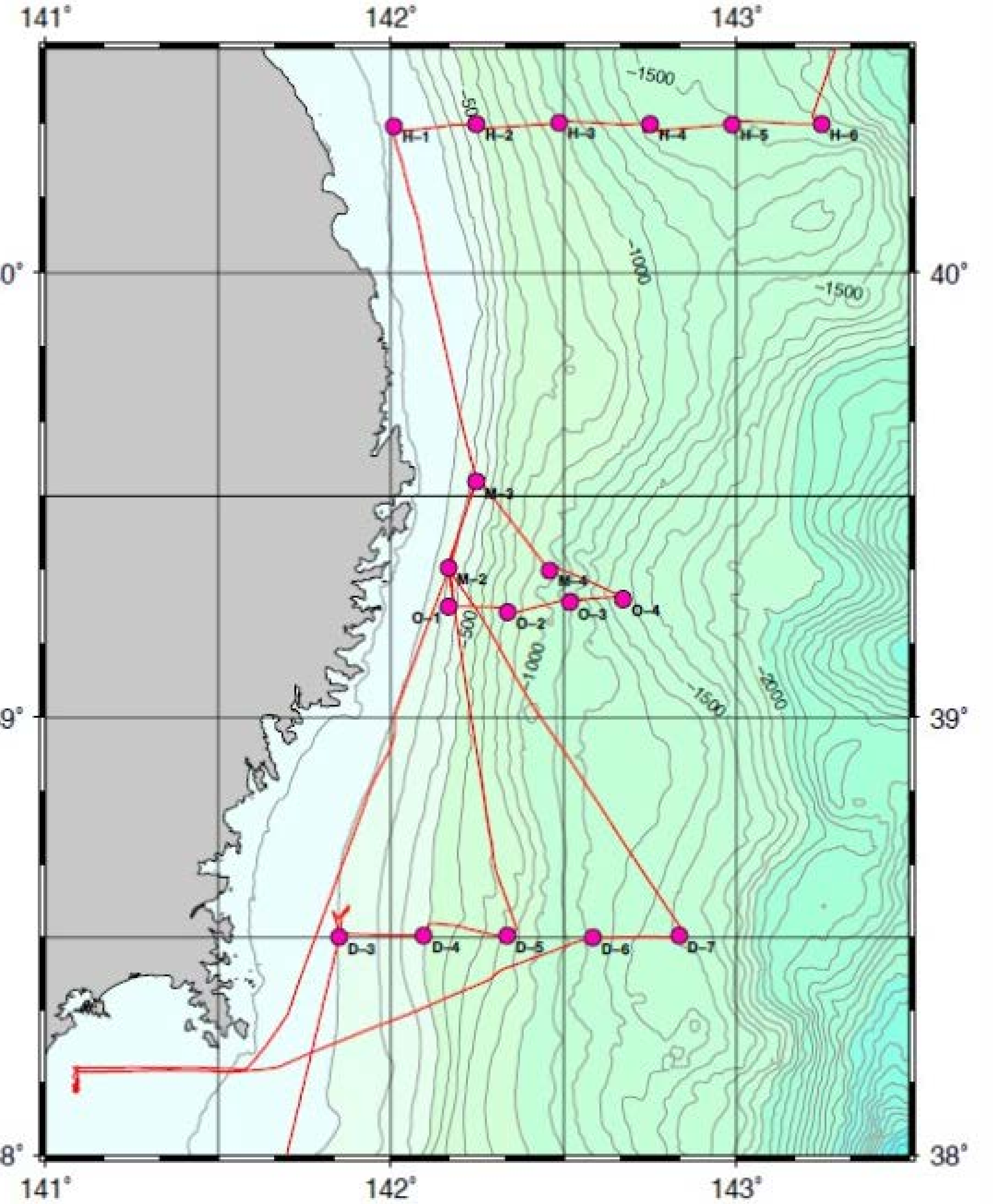

Fig. 1.2-1 Research Map of R/V Hakuho−Maru, KH−18−J03C, from 20th Aug., 2018 to 29th Aug.
D-3:Hydorgraphic observation and Seasaw Mooring station
D-4~H-6: Hydorgraphic observation stations
M-2:Lander, ADCP and Seasaw Mooring and CTD observation station
M-3 and M-4: :Lander Mooring stations

1.3 Cruise Log

Date	Local Time	Note	Position/Weather/Wind/Sea condition
20-Aug-18	14:20	Sail out, proceeding to research area from Tokyo Ariake berth.	
	15:00	Briefing about ship's life and safety.	
	18:30	Cruise meeting with Hakuho-maru Crew.	
21-Aug-18	13:00	Arrived at off Sanriku.	8/21 12:00(UTC+9h)
	13:42 13:44	Recovery of mooring SEASAW drifting part (M-1).	Off Sanriku
	14:28	Sent release command to mooring SEASAW bottom part.	38-26.5N, 141-50.0E
	14:38	SEASAW bottom part popped.	Fine but Cloudy
	14:52 14:58	Recovery of mooring SEASAW bottom part (M-1).	South – 4 (Moderate breeze)
	15:17 16:00	CTD-CMS cast (D-3).	3 (Sea Smooth)
	16:07 16:38	FRRF-RINKO observation(D-3).	1 (Low Swell Short or Average)
	16:47 17:00	Towed NORPAC net(D-3).	Visibly: 7'
	18:11 18:44	FRRF-RINKO observation(D-4).	
	18:50 19:52	CTD-CMS cast (D-4).	
	19:01 19:20	Towed NORPAC net(D-4).	
	21:14 22:31	CTD-CMS cast (D-5).	
	21:23 21:43	Towed NORPAC net(D-5).	
	22:37 23:03	FRRF-RINKO observation(D-5).	
22-Aug-18	07:33	Sent Release command to mooring ADCP (M-2).	8/22 12:00(UTC+9h)
	07:44	Mooring ADCP popped.	Off Sanriku
	08:02 08:14	Recovery of mooring ADCP (M-2).	39-24.9N, 142-22.6E
	08:39	Sent Release command to LANDER (M-2).	Fine but Cloudy
	08:48	LANDER popped.	SSW – 6 (Strong breeze)
	09:00	Recovery of LANDER (M-2).	4 (Sea Moderate)
	10:28	Sent Release command to LANDER (M-3).	1 (Low Swell Short or Average)
	10:28	LANDER popped.	Visibly: 6'
	10:51	Recovery of LANDER (M-3).	
	12:39	Sent Release command to LANDER (M-4).	
	13:06	LANDER popped.	
	13:25	Recovery of LANDER (M-4).	
	13:54 15:16	CTD-CMS cast (M-4).	

	14:10 14:25	Towed NORPAC net(M-4).	
	15:22 15:50	FRRF-RINKO observation(M-4).	
	17:12 17:45	FRRF-RINKO observation(O-4).	
	17:52 19:43	CTD-CMS cast (O-4).	
	18:01 18:16	Towed NORPAC net(O-4).	
	20:52 22:20	CTD-CMS cast (O-3).	
	21:00 21:18	Towed NORPAC net(O-3).	
	22:25 22:51	FRRF-RINKO observation(O-3).	
23-Aug-18	00:05 00:32	FRRF-RINKO observation(O-2).	8/23 12:00(UTC+9h)
	00:40 01:58	CTD-CMS cast (O-2).	North-East of Kinkazan
	00:50 01:09	Towed NORPAC net (O-2).	38-27.5N, 141-45.7E
	03:07 04:12	CTD-CMS cast (O-1).	Fine but Cloudy
	03:17 03:33	Towed NORPAC net (O-1).	SSW - 6 (Strong breeze)
	04:18 04:50	FRRF-RINKO observation(O-1).	3 (Sea Smooth)
	05:34 06:06	FRRF-RINKO observation(M-2).	1 (Low Swell Short or Average)
	06:13 07:07	CTD-CMS cast (M-2).	Visibly: 7'
	06:20 06:38	Towed NORPAC net (M-2).	
	(07:17)	Com' ced proceeding to off Shiogama because rough seastate.	
	15:35	Arrived at off Shiogama	
24-Aug-18			8/24 12:00(UTC+9h)
			Off Shiogama
			38-12.0N, 141-05.4E
			Overcast (Cloud 10)
			South - 7 (Near gale)
			4 (Sea Moderate)
			1 (Low Swell Short or Average)
			Visibly: 6'
25-Aug-18	14:21	Com'ced proceeding to research area	8/25 12:00(UTC+9h)
	20:22 22:05	CTD-CMS cast (D-6).	Off Shiogama

	20:40 21:00	Towed NORPAC net (D-6).	38-09.4N, 141-05.7E
	22:09 22:35	FRRF-RINKO observation(D-6).	Fine but Cloudy
	23:55 00:22	FRRF-RINKO observation(D-7).	SE – 3 (Gentle breeze)
			3 (Sea Smooth)
			3 (Moderate Short)
			Visibly: 6'
26-Aug-18	00:28 02:12	CTD-CMS cast (D-7).	8/26 12:00(UTC+9h)
	00:38 00:54	Towed NORPAC net (D-7).	Off Sanriku
	08:02	Sent Release command to SEASAW bottom part (M-2).	39-33.7N, 142-14.4E
	08:30	SEASAW bottom part popped.	Rain
	08:41 08:47	Recovery of mooring SEASAW bottom part (M-2).	SSE – 4 (Moderate breeze)
	10:16 11:09	CTD-CMS cast (M-3)	3 (SeaSmooth)
	10:22 10:40	Towed NORPAC net (M-3).	1 (Low Swell Short or Average)
	11:16 11:40	FRRF-RINKO observation(M-3).	Visibly: 6'
	16:16 16:33	FRRF-RINKO observation(H-1).	
	16:41 17:11	CTD-CMS cast (H-1)	
	17:17 17:23	Towed NORPAC net (H-1).	
	18:40 19:47	CTD-CMS cast (H-2)	
	19:10 19:28	Towed NORPAC net (H-2).	
	19:54 20:19	FRRF-RINKO observation(H-2).	
	21:46 22:12	FRRF-RINKO observation(H-3).	
	22:19 23:43	CTD-CMS cast (H-3)	
	22:26 22:44	Towed NORPAC net (H-3).	
27-Aug-18	08:00 09:40	CTD-CMS cast (H-4)	8/27 12:00(UTC+9h)
	08:05 08:24	Towed NORPAC net (H-4).	Off Sanriku
	09:45 10:10	FRRF-RINKO observation(H-4).	40-20.0N, 142-59.5E
	11:40 12:07	FRRF-RINKO observation(H-5).	Overcast (Cloud 10)

	12:13 13:53	CTD-CMS cast (H-5)	NNE – 4 (Moderate breeze)
	12:22 12:37	Towed NORPAC net (H-5).	3 (SeaSmooth)
	15:23 17:11	CTD-CMS cast (H-6)	1 (Low Swell Short or Average)
	15:32 15:49	Towed NORPAC net (H-6).	Visibly: 7'
	17:16 17:49	FRRF-RINKO observation(H-6).	
	18:00	Finished observation and then proceeding Kushiro port.	
28-Aug-18		Cruise to Kushiro port	8/28 12:00(UTC+9h)
			Off Kushiro
			42-55.6N, 144-14.5E
			Overcast (Cloud 10)
			SE – 3 (Gentle breeze)
			2 (Sea Smooth)
			1 (Low Swell Short or Average)
			Visibly: 6'
29-Aug-18	09:56	Arrived at Chuo pier of Kushiro port.	

2. Researchers

(1) Chief scientist

Shuichi Watanabe

Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC

(2) Representative of the science party

Chief Scientist of Cruise Proposal

Shinji Tsuchida

Project Team for Analyses of Changes in East Japan Marine Ecosystems, Tohoku Ecosystem-Associated Marine Sciences

Project

Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC

Project Leader

Katsunori Fujikura

Director, Project Team for Analyses of Changes in East Japan Marine Ecosystems, Tohoku Ecosystem-Associated Marine Sciences

(3) Science party

Scientists and Technicians on board

Shuichi WATANABE	(Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC)
Kazumasa Oguri	(Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC)
Haruka NISHIKAWA	(Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC)
Soichiro SUEYOSHI	(Nippon Marine Enterprises, LTD.)
Tomohide NOGUCHI	(Marine Works Japan)
Toru KOIZUMI	(Marine Works Japan)
Shinichiro YOKOGAWA	(Marine Works Japan)
Katsunori SAGISHIMA	(Marine Works Japan)
Atsushi ONO	(Marine Works Japan)
Nagisa FUJIKI	(Marine Works Japan)
Rio KOBAYASHI	(Marine Works Japan)

Scientists on land

Yasuo FURUSHIMA	(Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC)
Masahide WAKITA	(Project Team for Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC)

and

Members of Project Team for Analyses of Changes in East Japan Marine Ecosystems, Tohoku Ecosystem-Associated Marine Sciences

(4) “Hakuho-Maru” Crew member

Naoto SAKAI	Captain
Tomonori KIYOMIYA	Chief Officer
Makoto SATO	1st officer
Kazuhiko ITABASHI	2nd Officer
Yumihiko KOBAYASHI	Jr. 2nd Officer
Kanto ASAJI	3rd Officer
Shuhei TAKASE	Jr. 3rd Office
Takashi TANAKA	Chief Engineer
Goro MIYAMOTO	1st Engineer

Takatoshi YAMAMURA	Jr. 1st Engineer
Yasuhiro SAKUMA	2nd Engineer
Takamasa OCHIAI	Jr. 2nd Engineer
Kazuki ONO	3rd Engineer
Takanori MIURA	Chief Electronics Officer
Takumi YAMAGUCHI	Electronics Operator
Shintaro NISHIDATE	Boat Swain
Tsuyoshi URABE	Associate Boat Swain
Hiroyuki OGAWA	Associate Boat Swain
Yukihiro TERASAKA	Associate Boat Swain
Naoki KATO	Quarte Master
Tomoki ASAKUNI	Quarte Master
Daisuke YAMAMOTO	Quarte Master
Koki UCHIYAMA	Sailor
Kenji NAKAJIRI	No.1 Oiler
Yoshihiko ISHII	No.2 Oiler
Takahiro YAMANAKA	No.3 Oiler
Yu ABE	No.4 Oiler
Masaki TANAKA	No.5 Oiler
Keiya TANIGUCHI	No.6 Oiler
Shogo IIBOSHI	No.7 Oiler
Hayate MAEKAWA	Machineman
Yasutaka YAMADA	Chief Steward
Seiji HONDA	Steward
Keigo SASAKI	Steward
Takeshi TOMONAGA	Steward
Yoshie HIDAKA	Steward

3. Observation

3.1. Overview

The project of Tohoku Ecosystem-Associated Marine Sciences (TEAMS) aims to investigate marine ecosystems that were drastically changed by the disaster, to understand the process of recover from the damages of the Earthquake, and to help the reconstruction and sustainable development of fisheries. For achieving that projects objectives, the roles of our unit, Research Unit for Ecosystem Monitoring, is to research the basic hydrographic structure and the long-term change of marine environments, to conduct the geographical survey, and so on.

In KH-18-J03C cruise, we recovered an ADCP and three Landers which deployed to obtain variation of temperature, salinity, current and others for ecosystem model off Sanriku in KH-18-J02C and KS-17-J08C cruises. SEASAW, which deployed in the KH-18-J02C cruise and drifted on Aug. 19th, was also recovered. We conducted the hydrographic observation with the CTD- Carousel water sampler system and the FRRF-Rinko profiler system to obtain the hydrographic data at 18 stations. We also collected zooplankton.

3.2. List of the observations and activities

(1) CTD casts and water sampling for biogeochemical analysis.
(2) Continuous surface hydrographic observation using CT-DO system equipped on-board and fast repetition rate fluorometer FRRF.
(3) Assessment of phytoplankton photosynthesis by fast repetition rate fluorometer (FRRF).
(4) Zooplankton collecting using NORPAC net.
(5) Survey of zooplankton distribution with quantitative echo sounder equipped on-board.
(6) Recovery of mooring system off Sanriku.

3.3. Shipboard observation and survey
3.3.1 Continuous surface hydrographic observation

Shuichi WATANABE (JAMSTEC)
Masahide WAKITA (JAMSTEC)

(1) Objects

The objective of continuous surface hydrographic observation is collecting continuous hydrographic data along curies track for understanding the sea surface environment.

(2) Equipment

Data of temperature and salinity in the sea surface was collected with TC sensor, ACTW CAR of JFE Advantech Co., Ltd. on board. Surface seawater was pump up from the bottom of ship for research. Those date was collected by ship crews.

(3) Result

Variations of temperature and salinity obtained during KH-18-J03C cruise are shown in Fig. 3.3.1-1.

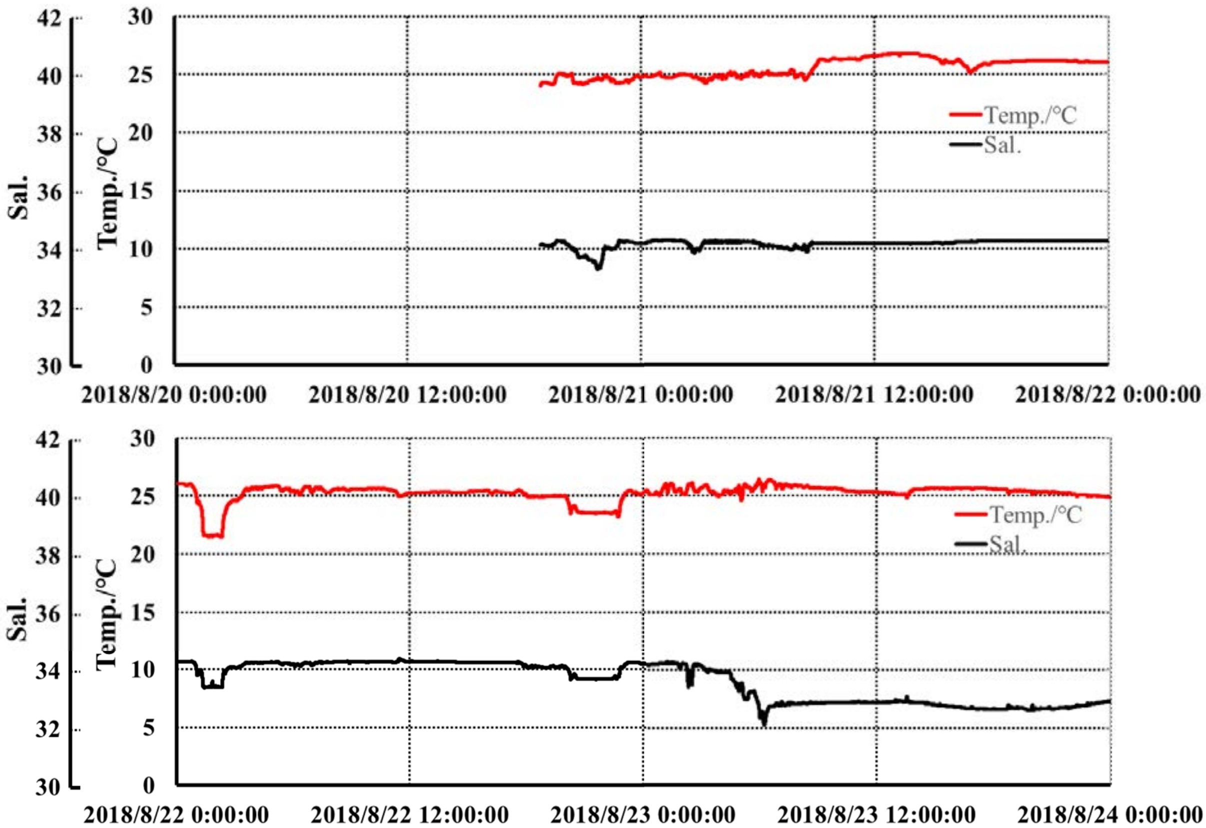

Fig. 3.3.1-1. Variations of temperature and salinity obtained during KH-18-J03C cruise

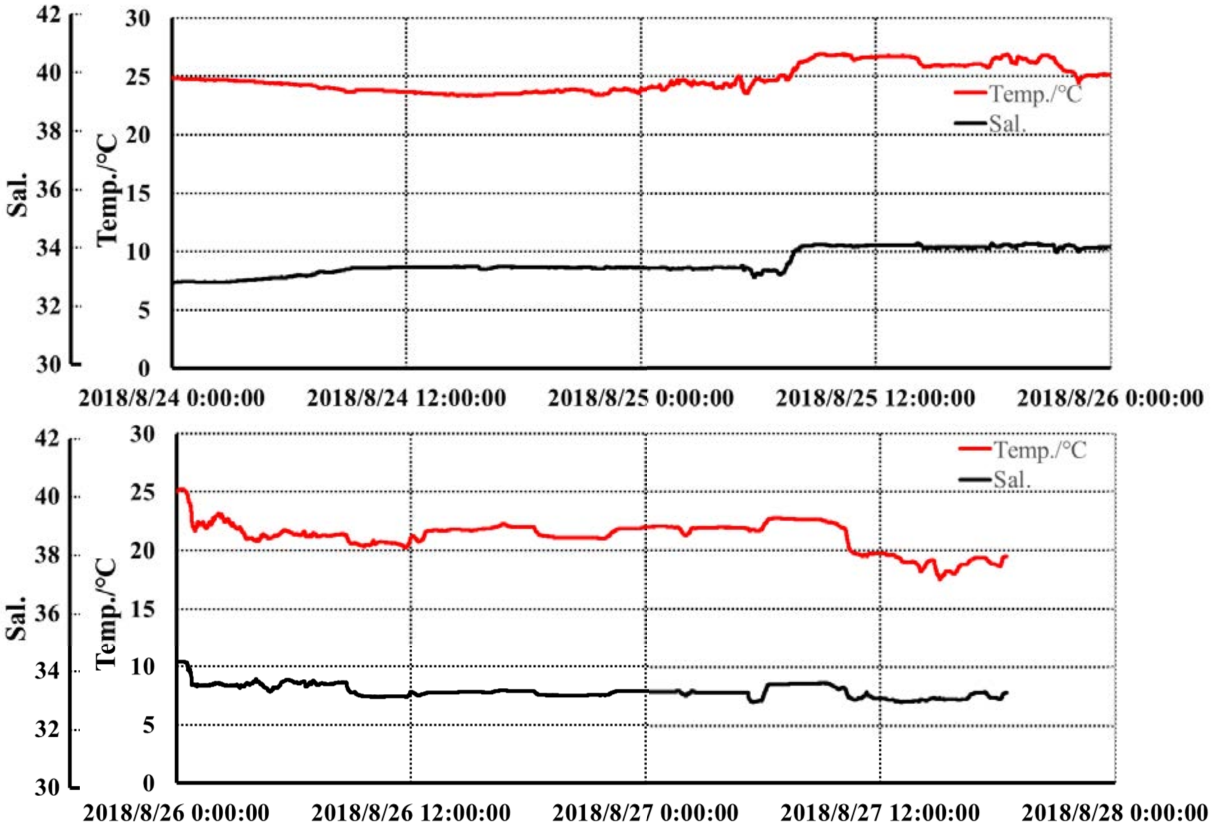

Fig. 3.3.1-1. Variations of temperature and salinity obtained during KH-18-J03C cruise (continue)

3.4. Hydrographic observations

3.4.1. CTD observation and water sampling

CTD cast and water sampling

Shuuichi WATANABE (JAMSTEC): Principal investigator
Rio KOBAYASHI (MWJ): Operation leader
Tomohide NOGUCHI (MWJ)

(1) Objective

Investigation of oceanic structure.

(2) Parameters

Temperature
Conductivity
Pressure
Dissolved Oxygen
Dissolved Oxygen voltage
Fluorescence
Altimeter

(3) Instruments and Methods

CTD/Carousel Water Sampling System, which is a 24-position Carousel water sampler (CWS) with Sea-Bird Electronics, Inc. CTD (SBE9plus), was used during this cruise.

The sensors attached on the CTD were temperature, conductivity, pressure, dissolved oxygen (SBE43), fluorescence and altimeter. The Practical Salinity was calculated by measured values of pressure, conductivity and temperature.

The CTD raw data were acquired on real time using the Seasave-Win32 (ver.7.21f) provided by Sea-Bird Electronics, Inc. and stored on the hard disk of the personal computer. 24 casts of CTD measurements were conducted (Table 3.1-1).

Data processing procedures and used utilities of SBE Data Processing-Win32 (ver.7.23.2) and SEASOFT were as follows:

(The process in order)

DATCNV: Convert the binary raw data to engineering unit data. DATCNV also extracts bottle information where scans were marked with the bottle confirm bit during acquisition. The duration was set to 3.0 seconds, and the offset was set to 0.0 seconds.

WILDEDIT: Mark extreme outliers in the data files. The first pass of WILDEDIT obtained an accurate estimate of the true standard deviation of the data. The data were read in blocks of 100 scans. Data greater than 2 standard deviations were flagged. The second pass computed a standard deviation over the same 100 scans excluding the flagged values. Values greater than 20 standard deviations were marked bad. This process was applied to pressure, depth, temperature, conductivity and dissolved oxygen voltage (SBE43).

FILTER: Perform a low pass filter on pressure with a time constant of 0.15 second. In order to produce zero phase lag (no time shift) the filter runs forward first then backward

WFILTER: Perform a median filter to remove spikes in the fluorescence data. A median value was determined by 49 scans of the window.

ALIGNCTD: Convert the time-sequence of sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Dissolved oxygen data are systematically delayed with respect to depth mainly because of the long time constant of the dissolved oxygen sensor and of an additional delay from the transit time of water in the pumped pluming line. This delay was compensated by 3.0 seconds advancing dissolved oxygen sensor (SBE43) output (dissolved oxygen voltage) relative to the temperature data.

CELLTM: Remove conductivity cell thermal mass effects from the measured conductivity. Typical values used were thermal anomaly amplitude alpha = 0.03 and the time constant 1/beta = 7.0.

LOOPEDIT: Mark scans where the CTD was moving less than the minimum velocity of 0.1 m/s (traveling backwards due to ship roll).

DERIVE: Compute the Practical Salinity, sigma-theta and potential temperature.

BINAVG: Average the data into 1-dbar pressure bins.

Configuration file: kh-18-j03a.xmlcon

Specifications of the sensors are listed below.

CTD: SBE911plus CTD system

Under water unit:

SBE9plus (S/N 09P34568-0750, Sea-Bird Electronics, Inc.)

Pressure sensor: Digiquartz pressure sensor (S/N 89961)

Calibrated Date: 17 Apr 2018

Temperature sensors:

Primary:SBE03plus (S/N 03P4378, Sea-Bird Electronics, Inc.)

Calibrated Date: 08 Mar. 2017

Secondary: SBE03plus (S/N 03P5124, Sea-Bird Electronics, Inc.)

Calibrated Date: 04 Mar. 2017

Conductivity sensors:

Primary: SBE04C (S/N 042732, Sea-Bird Electronics, Inc.)

Calibrated Date: 08 Mar. 2017

Secondary: SBE04C (S/N 044045, Sea-Bird Electronics, Inc.)

Calibrated Date: 10 Mar. 2017

Dissolved Oxygen sensor:

Primary: SBE43 (S/N 430781, Sea-Bird Electronics, Inc.)

Calibrated Date: 14 Apr. 2018

Secondary: SBE43 (S/N 433304, Sea-Bird Electronics, Inc.)

Calibrated Date: 17 Jun. 2017

Fluorescence:

Chlorophyll Fluorometer (S/N 3523, Seapoint Sensors, Inc.)

Altimeter:

Benthos PSA-916T (S/N 62216, Teledyne Benthos, Inc.)

Deck unit: SBE11plus (S/N 11P12217-0386, Sea-Bird Electronics, Inc.)

(4) Preliminary Results

During this cruise, 18 casts of CTD observation were carried out. date and locations of the CTD casts are listed in Table 3.1-1. During this cruise, we judged noise, spike or shift in the data of some cast. These were as follows.

Temperature and salinity sections distributions above 300m depth along observation lines are shown in Fig. 3.4.1.1.

(5) Data archive

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

Table 3.1-1. Date and locations of the CTD casts

KH-18-J03C CTD casttable												
Stnnbr	Castno	Date(UTC)	Time(UTC)		BottomPosition		Depth	Wire	HT Above	Max	Max	CTD
		(mmddyy)	Start	End	Latitude	Longitude		Out	Bottom	Depth	Pressure	Filename
D-3	1	082118	06:22	06:59	38-30.15N	141-51.15E	200.4	202.0	8.5	201.4	203.0	D3_1
D-4	1	082118	09:55	10:51	38-30.99N	142-05.93E	487.6	492.0	9.0	488.7	493.0	D4_1
D-5	1	082118	12:18	13:29	38-30.43N	142-20.48E	818.5	826.0	9.4	820.1	828.0	D5_1
M-4	1	082218	04:58	06:14	39-20.02N	142-27.71E	986.7	990.0	9.9	997.0	987.1	M4_1
O-4	1	082218	08:56	10:41	39-16.13N	142.40.49E	1485.4	1489.0	10.0	1485.2	1502.0	O4_1
O-3	1	082218	11:56	13:19	39-15.90N	142-30.35E	1064.5	1068.0	10.0	1066.1	1077.0	O3_1
O-2	1	082218	15:45	16:56	39-14.59N	142-20.49E	886.5	895.0	10.6	888.3	897.0	O2_1
O-1	1	082218	18:12	19:10	39-15.23N	142-10.37E	353.8	353.0	9.8	355.0	358.0	O1_1
M-2	1	082218	21:16	22:05	39-20.30N	142-10.10E	283.7	283.0	9.1	284.6	287.0	M2_1
D-6	1	082518	11:25	13:03	38-30.02N	142-35.38E	1270.4	1277.0	10.3	1270.4	1284.0	D6_1
D-7	1	082518	15:33	17:10	38-30.48N	142-50.09E	1497.0	1505.0	11.6	1498.2	1515.0	D7_1
M-3	1	082618	01:20	02:07	39-32.05N	142-14.82E	323.6	324.0	9.8	323.3	326.0	M3_1
H-1	1	082618	07:45	08:09	40-19.49N	142-00.56E	104.1	103.0	7.7	106.2	107.0	H1_1
H-2	1	082618	09:44	10:46	40-19.77N	142-14.69E	494.7	494.0	9.9	495.6	500.0	H2_1
H-3	1	082618	13:23	14:42	40-20.12N	142-29.80E	1015.9	1017.0	7.1	1006.7	1017.0	H3_1
H-4	1	082618	23:03	00:38	40-19.76N	142-44.92E	1410.3	1415.0	8.3	1411.2	1427.0	H4_1
H-5	1	082718	03:17	04:52	40-19.96N	142-58.92E	1473.6	1482.0	9.6	1474.3	1491.0	H5_1
H-6	1	082718	06:27	08:09	40-20.09N	143-14.28E	1572.1	1582.0	8.0	1572.8	1591.0	H6_1

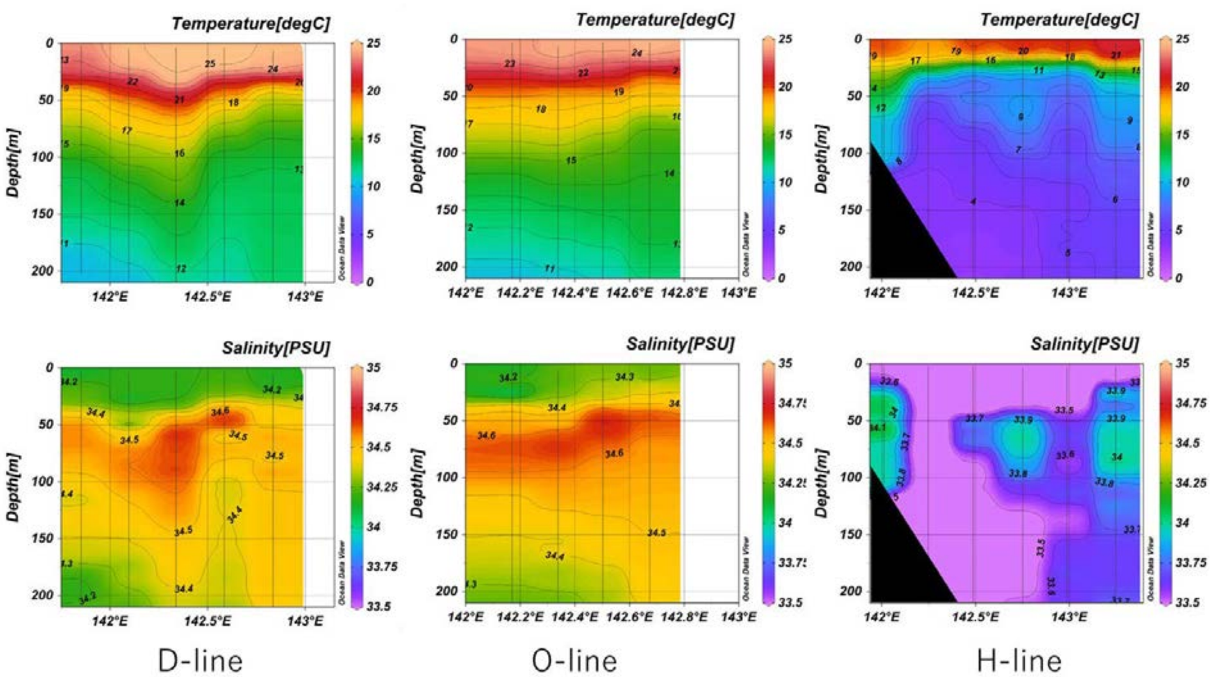

Fig. 3.4.1-1. Temperature and salinity sections distributions above 300m depth along observation lines

3.4.2. Determination of dissolved oxygen in seawater

Shuichi WATANABE (JAMSTEC): Principal investigator
Masahide WAKITA (JAMSTEC
Nagisa Fujiki (Marine Works Japan) : Operation leader
Katsunori SAGISHIMA (Marine Works Japan)

(1) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(2) Parameter

Dissolved Oxygen（unit : μmol・kg $^{-1}$）

(3) Analysis

Following procedure is based on winkler method (Dickson, 1996; Culberson, 1991).

(3-1) Reagents

Pickling Reagent I: Manganese(II) chloride solution (3 mol dm^{-3})

Pickling Reagent II:

Sodium hydroxide (8 mol dm^{-3}) / Sodium iodide solution (4 mol dm^{-3})

Sulfuric acid solution (5 mol dm^{-3})

Sodium thiosulfate solution (0.15 mol dm^{-3})

Potassium iodate solution (0.001667 mol dm^{-3})

(3-2) Instruments

Semi-automatic titrator was composed as follow.

Burette for sodium thiosulfate and potassium iodate;

EBU-610 / APB-620 manufactured by Kyoto Electronic Co. Ltd. with 10 cm^3 of titration vessel

Detector;

Automatic photometric titrator (DOT-05) manufactured by Kimoto Electronic Co. Ltd.

(3-3) Sampling

Seawater samples were collected with Niskin bottle attached to the CTD/Carousel Water Sampling System (CTD system). Seawater for oxygen measurement was transferred from the bottle to a volume calibrated flask (ca. 100 cm^3), and three times volume of the flask was overflowed. Temperature was simulteneously measured by digital thermometer during the overflowing. After transfering the sample, two reagent solutions (Reagent I and II) of 1 cm^3 each were added immediately and the stopper was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

(3-4) Sample measurement

For over two hours after the re-shaking, the pickled samples were measured on board. Sulfuric acid solution with its volume of 1 cm^3 and a magnetic stirrer bar were put into the sample flask and the sample was stirred. The samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sensor on CTD system, flask volume, and titrated volume of sodium thiosulfate solution without the blank. During this cruise, 2 sets of the titration apparatus were used.

(3-5) Standardization and determination of the blank

Concentration of sodium thiosulfate titrant was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130 ºC, and 1.7835 g of it was dissolved in deionized water and diluted to final weight of 5 kg in a flask. After 10 cm^3 of the standard potassium iodate solution was added to an another flask using a volume-calibrated dispenser, 90 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 1 cm^3 of pickling reagent solution II and I were added in order. Amount of titrated volume of sodium thiosulfate for this diluted standard potassium iodate solution (usually 5 times measurements average) gave the morality of sodium thiosulfate titrant.

The oxygen in the pickling reagents I (1 cm^3) and II (1 cm^3) was assumed to be 7.6×10^{-8} mol (Murray et al., 1968). The blank due to other than oxygen was determined as follows. First, 1 and 2 cm^3 of the standard potassium iodate solution were added to each flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, 1 cm^3 of pickling II reagent solution, and same volume of pickling I reagent solution were added into the flask in order. The blank was determined by difference between the first (1 cm^3 of potassium iodate) titrated volume of the sodium thiosulfate and the second (2 cm^3 of potassium iodate) one. The titrations were conducted for 3 times and their average was used as the blank value.

(4) Observation log

(4-1) Standardization and determination of the blank

Table 3.4.2.1 shows results of the standardization and the blank determination during this cruise.

Table 3.4.2.1 Results of the standardization and the blank determinations during this cruise.

Date	KIO_3 ID	$Na_2S_2O_3$	DOT-05		Concentration of $Na_2S_2O_3$ (mol L^{-1})
			E.P. (cm^3)	Blank (cm^3)	
2018/08/21	K1704I08	180820	0.6878	-0.0005	0.14531
2018/08/28	K1704I09	180820	0.6868	0.0009	0.14582

(4-2) Repeatability of sample measurement

Replicate samples were taken at every CTD casts. The standard deviation of the replicate measurement (Dickson et al., 2007) was 0.19 μmol kg^{-1} (n=12).

(5) Data archive

After all data will be submitted to Chief Scientist, these data will be opened on “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” (http://www.godac.jamstec.go.jp/darwin/e) and on the Information and data Access Site of TEAMS (RIAS), TEAMS (http://www.i-teams.jp/catalog/rias/e/index.html) the Research Unit for Ecosystem Model and Data Management, Analyses of Changes in East Japan Marine Ecosystems, JAMSTEC.

(6) References

Culberson, C. H. (1991). *Dissolved Oxygen*. WHPO Publication 91-1.
Dickson, A. G. (1996). Determination of dissolved oxygen in sea water by Winkler titration. In *WOCE Operations Manual*, Part 3.1.3 Operations & Methods, WHP Office Report WHPO 91-1.
Dickson, A. G., Sabine, C. L., & Christian, J. R.(Eds.), (2007). *Guide to best practices for ocean CO2 measurements, PICES Special Publication 3*: North Pacific Marine Science Organization.
Murray, C. N., Riley, J. P., & Wilson, T. R. S. (1968). The solubility of oxygen in Winklerreagents used for the determination of dissolved oxygen. *Deep Sea Res.*, 15, 237-238.

3.4.5. Determination of Chlorophyll-*a* in seawater

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Masahide Wakita (JAMSTEC)
Atsushi Ono (Marine Works Japan Ltd.; MWJ): Operation leader
Katsunori Sagishima (MWJ)
Shinichiro Yokogawa (MWJ)

(1) Objective

Phytoplankton biomass can estimate as the concentration of chlorophyll-*a*, because all oxygenic photosynthetic plankton contain chlorophyll *a*. The objective in this study is to investigate the vertical distribution of phytoplankton biomass through fluorometric determination.

(2) Parameters

Total chlorophyll *a*

(3) Instruments and methods

We collected samples for total chlorophyll *a* from 7 to 12 depths between the surface and 300 m depth including a chlorophyll *a* maximum layer.

Seawater samples for total chlorophyll *a* were vacuum-filtrated (< 0.02 MPa) through Whatman GF/F filter (25mm-in diameter). Phytoplankton pigments retained on the filters were immediately extracted in a polypropylene tube with 7 mL of *N*,*N*-dimethylformamide (Wako Pure Chemical Industries Ltd.) (Suzuki and Ishimaru, 1990). The tubes were stored at -20 °C under the dark condition to extract chlorophyll *a* at least for 24 hours.

Chlorophyll *a* concentrations were measured by the fluorometer (10-AU, TURNER DESIGNS), which was previously calibrated against a pure chlorophyll *a* (Sigma-Aldrich Co., LLC). To estimate the chlorophyll *a* concentrations, we applied to the fluorometric “Non-acidification method” (Welschmeyer, 1994)

(4) Preliminary results

The results of Chl. a concentration along 3 transects were shown in Fig. 1.

(5) Data archives

These data obtained in this cruise will be submitted to the Data Management Group of JAMSTEC, and will be opened to the public via “Data Research System for Whole Cruise Information in JAMSTEC (DARWIN)” in JAMSTEC web site.
<http://www.godac.jamstec.go.jp/darwin/e>

(7) Reference

Suzuki, R., & Ishimaru T. (1990). An improved method for the determination of phytoplankton chlorophyll using N, N-dimethylformamide. *J. Oceanogr. Soc. Japan*, 46, 190-194.

Welschmeyer, N. A. (1994). Fluorometric analysis of chlorophyll *a* in the presence of chlorophyll *b* and pheopigments. *Limnol. Oceanogr.* 39(8), 1985-1992.

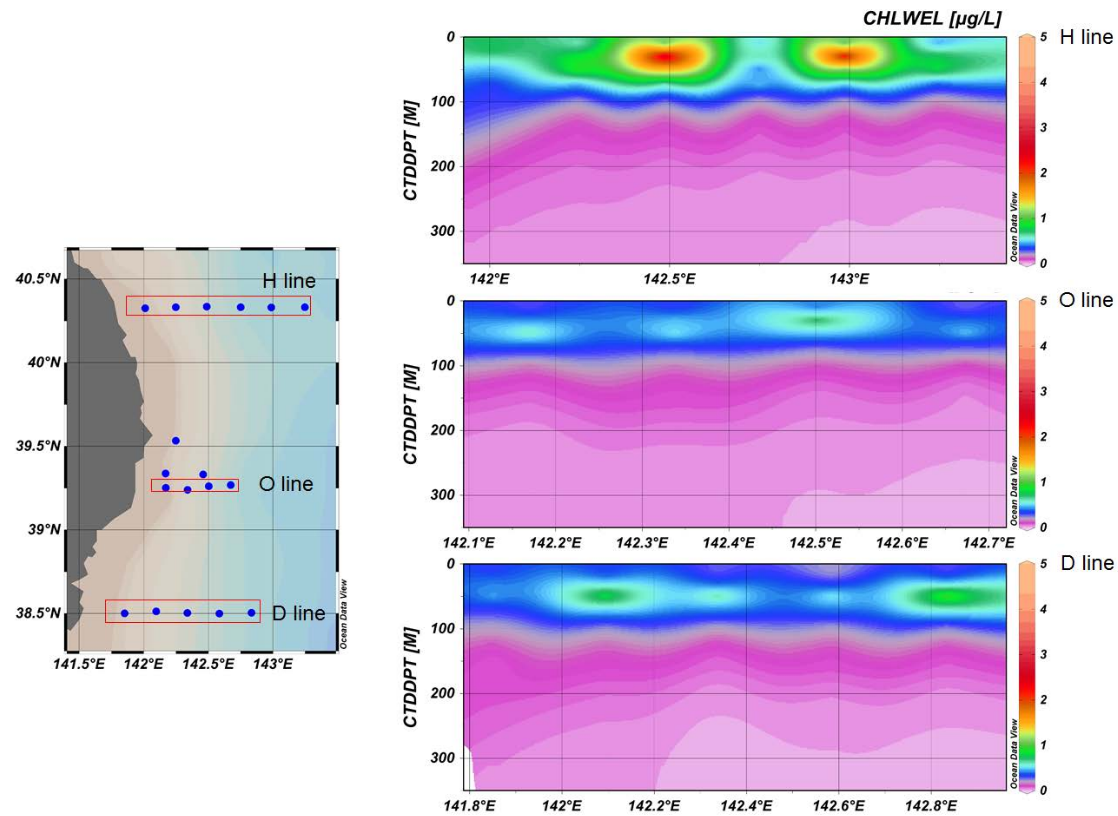

Figure 3.4.5.1. Vertical distributions of chlorophyll *a* (non-acidification) at 3 observation lines

3.4.2. Seawater sampling for biogeochemical environment

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Toru KOIZUMI (Marine Works Japan)
Shinichiro YOKOGAWA (Marine Works Japan)
Katsunori SAGISHIMA (Marine Works Japan)
Atsushi ONO (Marine Works Japan)
Soichiro SUEYOSHI (Nippon Marine Enterprises, LTD.)

(1) Objective

To understand the biogeochemical environment during this cruise we obtained water samples at all CTD observation stations.

(2) Methods

Water samples were obtained 12 litter Nishkin bottles attached the CTD system flame and bucket for sea surface. These water samples will be analyzed at laboratory on land.

(3) List of water samples collected on board

Number of water samples collected on board is listed in Table 3.4.3.1.

Table 3.4.3.1. Number of water samples collected on board
(): number of bucket samples

Sta.	sal	DIC	TA	Nut	Pytoplankton
D-3	6	6	6	10(1)	3(1)
D-4	10	10	10	14(1)	3(1)
D-5	14	14	14	18(1)	3(1)
D-6	18	18	18	22(1)	3(1)
D-7	20	20	20	24(1)	3(1)
O-1	9	9	9	13(1)	3(1)
O-2	14	14	14	18(1)	3(1)
O-3	16	16	16	20(1)	3(1)
O-4	20	20	20	24(1)	3(1)
H-1	4	4	4	7(1)	2(1)
H-2	10	10	10	14(1)	3(1)
H-3	15	15	15	19(1)	3(1)
H-4	19	19	19	23(1)	3(1)
H-5	20	20	20	24(1)	3(1)
H-6	21	21	21	25(1)	3(1)
M-2	8	8	8	12(1)	3(1)
M-3	8	8	8	12(1)	3(1)
M-4	15	15	15	19(1)	3(1)

(4) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) after analyzing on land and data quality control.

3.5. Continuous and vertical Fast repetition rate fluorometry (FRRF) observations

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Toru KOIZUMI	(Marine Works Japan)
Shinichiro YOKOGAWA	(Marine Works Japan)
Katsunori SAGISHIMA	(Marine Works Japan)
Atsushi ONO	(Marine Works Japan)
Soichiro SUEYOSHI	(Nippon Marine Enterprises, LTD.)

(1) Objective

During the past decade, the utilization of active fluorescence techniques in biological oceanography brought significant progress in our knowledge of phytoplankton productivity in the oceans. Above all, the fast repetition rate (FRR) fluorometry reduces the primary electron acceptor (Qa) in photosystem II (PSII) by a series of subsaturating flashlets and can measure a single turnover (ST) fluorescence induction curve in PSII. The PSII parameters, such as the potential photosynthetic activity (Fv/Fm) and the functional absorption cross-section of PSII, derived from the ST fluorescence induction curve can be used to estimate gross primary productivity. In the present study, to gain a better understanding of variability in phytoplankton productivity off the Sanriku, we measured the PSII parameters and primary productivity using the FRR fluorometry.

(2) Methods

Using the FRR fluorometer (Kimoto Electric Co., Ltd., Japan), the vertical variation in PSII parameters and primary productivity were examined off the Sanriku. The FRR fluorometer attached to the RINKO profiler (JFE Advantech Co., Ltd.) was moved up and down between surface and 200 m at the rate of 0.2 m s-1 using a ship winch. The RINKO profiler can measure the vertical profiles of water temperature, salinity, pressure, dissolved oxygen, chlorophyll and turbidity. The profiling rate of the observation buoy was set to minimal to detect small scale variations (~0.5 m) in measurements.

(3) Preliminary result

The distributions of Temp., Salinity and Chl-a abundance obtained RINKO profiler are shown in Fig. 3.5-1, 3.5-2, and 3.5-3.

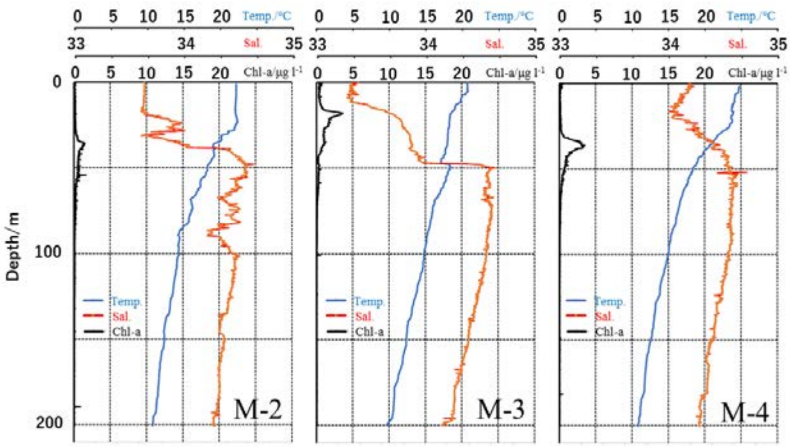

Fig.3.5-1 Vertical profiles of Temp., Salinity and Chl-a abundance obtained RINKO at Sta. M-2, M-3, and M-3.

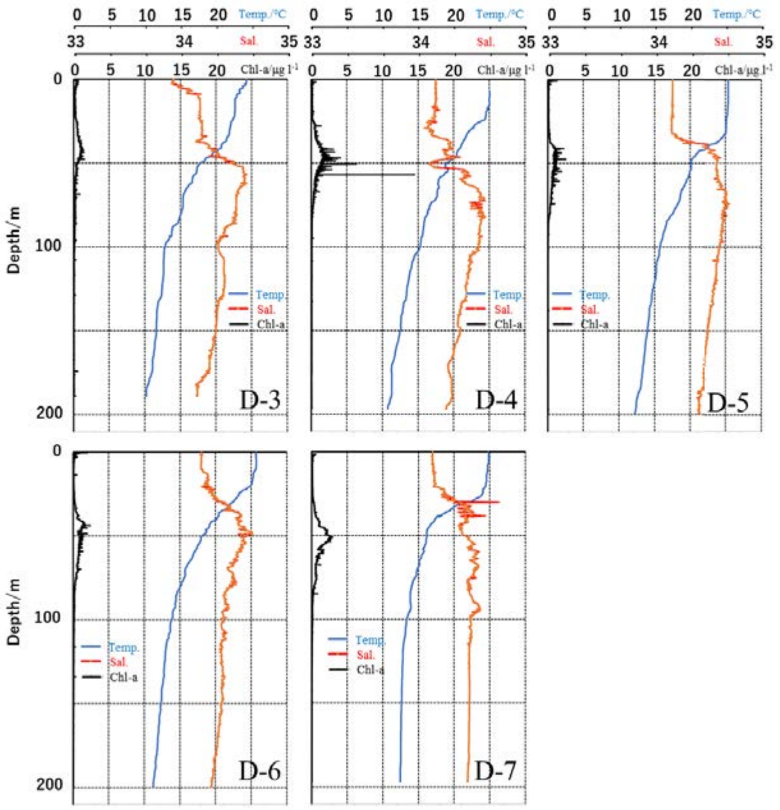

Fig.3.5-1 Vertical profiles of Temp., Salinity and Chl-a abundance obtained RINKO along the section D.

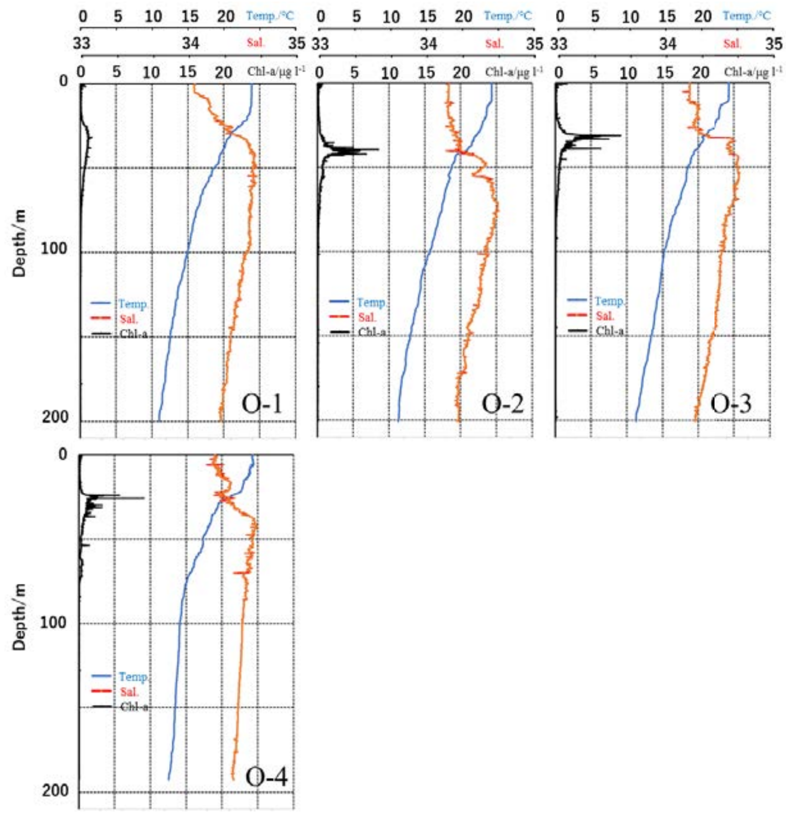

Fig.3.5-1 Vertical profiles of Temp., Salinity and Chl-a abundance obtained RINKO along the section O.

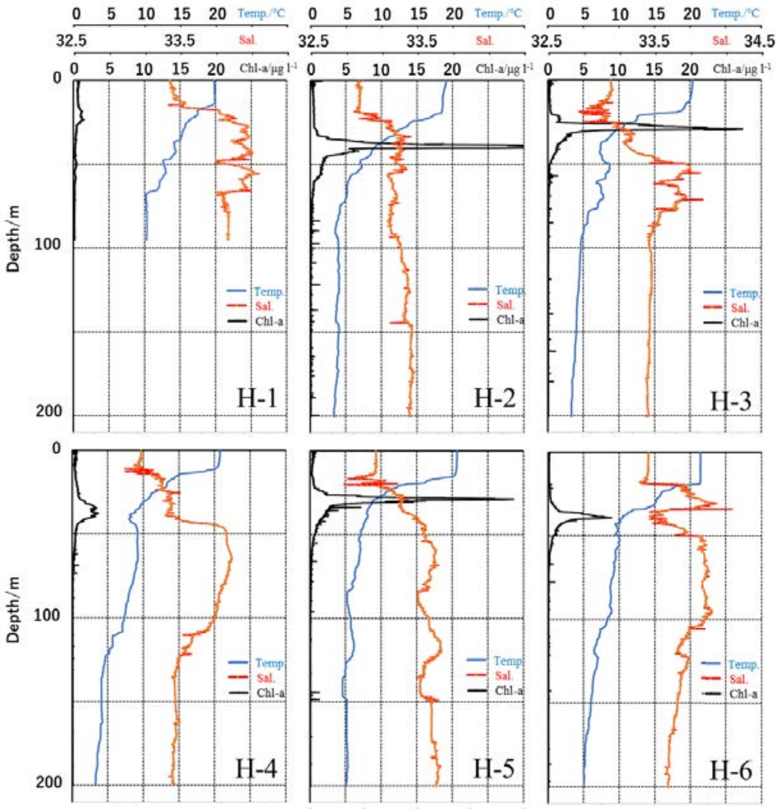

Fig.3.5-1 Vertical profiles of Temp., Salinity and Chl-a abundance obtained RINKO along the section H.

(4) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) after data quality control.

3.6. Zooplankton distribution by NORPAC net and quantitative echo sounder (QES)

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Shinichiro YOKOGAWA (Marine Works Japan)
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Soichiro SUEYOSHI (Nippon Marine Enterprises, LTD.)

(1) Objectives

The objective of this study is to estimate zooplankton abundances and species richness in winter off Sanriku of the north-eastern Japan. Zooplankton abundances and species richness were measured with microscopy for large size phytoplankton and is compared against the zooplankton distribution by quantitative echo sounder (QES).

(2) Sampling by NORPAC net

Samplings were vertically hauled by using a NORPAC net (335 μm mesh, NMG52) with a cod end. Plankton samplings were carried out at all CTD-water sampling stations. Plankton sample were placed in 500 ml plastic bottle and were fixed with neutral-buffered formalin solution (10% final concentration). The microscopic measurements are scheduled after the cruise.

(3) Observation by QES

In comparison with zooplankton distribution during a part of NOPAC net samplings, we tried to operate the scientific echo sounder system equipped on board. However, we don’t know how to use QES and have not obtained enough recorded data for the analysis.

(4) Preliminary result

Zooplankton sample was obtained at all CTD observation stations (Sta. D-3, D-4, D-5, D-6, D-7, M-2, M-3, O-1, O-2, O-3, O-4, O-5, O-H-1, H-2, H-3, H-4, H-5, H-6).

No result was obtained on board. The distributions of zooplankton abundance will be determined as soon as possible after this cruise.

Images of QES at NORPAC net stations are shown in Fig. 3.6-1.

(5) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) after data quality control.

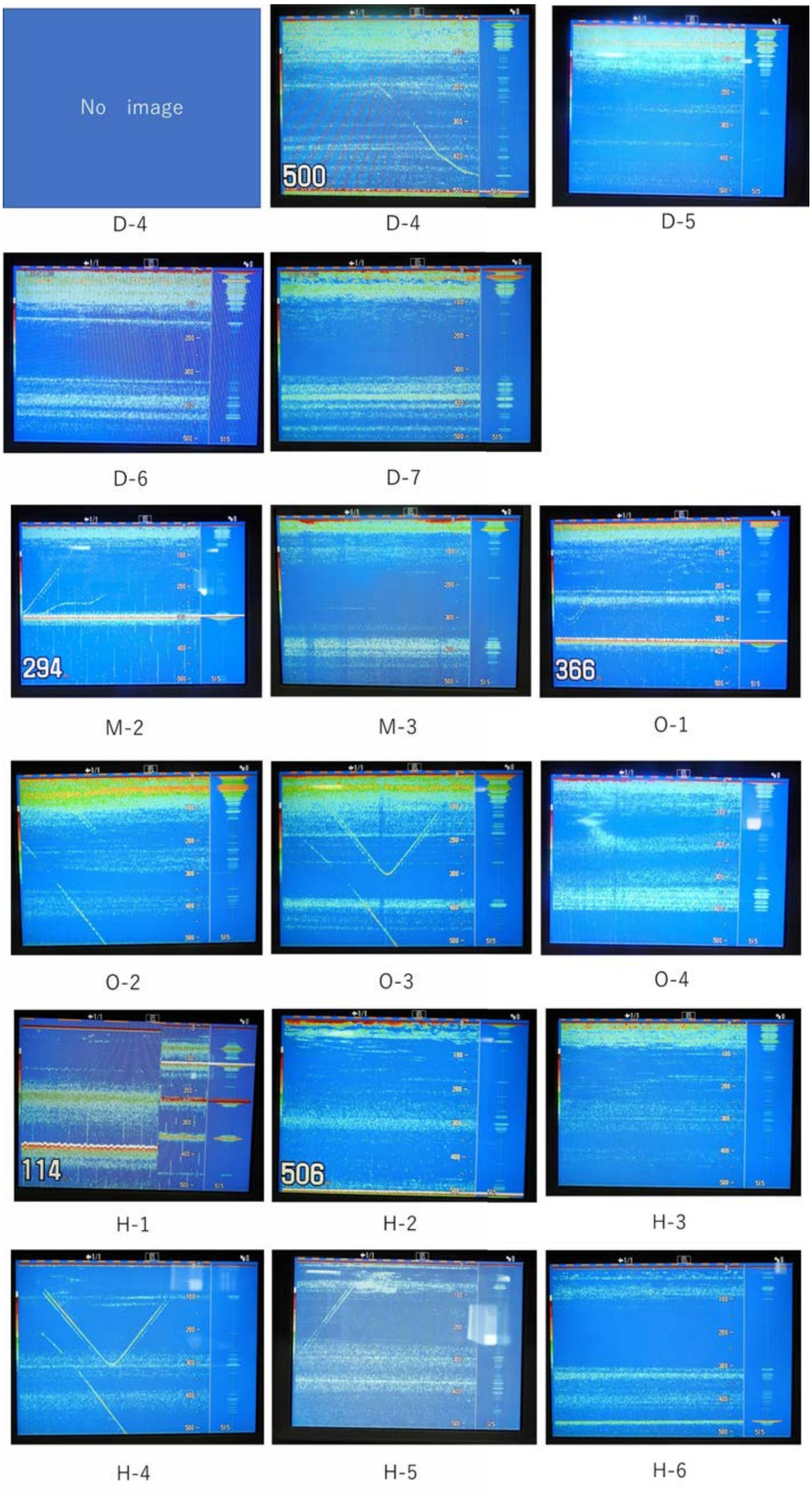

Fig. 3.6-1. Images of QES at NORPAC net stations

3.7. Recovery of mooring system

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Yasuo FURUSHIMA (JAMSTEC)
Shuichi WATANABE (JAMSTEC)
Tomohide NOGUCHI (MWJ)

(1) Objective

In this cruise, we recovered three Lander systems, two SEASAW mooring systems and an ADCP mooring systems. Those systems were deployed in the R/V Hakoho-maru research cruise, KH-18-J02C and the R/V Shinsei-maru research cruise, KS-17-J08C to understand the ocean environment off Sanriku.

Lander systems were installed monitoring instruments to understand changes at lower continental slope influenced by marine environments changes and unexpected events such as earthquakes at sea floor and deployed in lower continental slope, off Otsuchi bay.

The ADCP mooring system was deployed to reveal the fluctuations of the flow environment off Sanriku and to correlate them with the construction of the ecosystem model.

The SEASAW with CT sensor was also deployed to understand ocean environmental variation in water colum off Sanriku and to obtain useful data for fishery off the bay of Onagawa and Otsuchi.

(2) Position of mooring systems

Positions deployed Lander, SESAW and ADCP mooring systems is listed in Table 3.7-1.

	Latitude	Longitude	Water depth	Station Name
Lander 1	39°20.078'N	142°10.038'E	297 m	Sta. M-2
Lander 2	39°32.040'N	142°14.937'E	334 m	Sta. M-3
Lander 3	39°19.753’N	142°27.512’E	947 m	Sta. M-4
ADCP	39°20.084'N	142°09.952’E	296 m	Sta. M-2
SEASAW 1	38°30.028'N	141°50.863'E	206 m	Sta. M-1(D-3)
SEASAW 2	39°19.977'N	142°09.972'E	297 m	Sta. M-2

(3) Recovery

Three Lander systems and an ADCP mooring system were recovered on 22nd Aug., 2018. There was no damage on those systems (Fig. 3.7-1 (A-1), (A-2), (A-3) and (B-1)).

Top buoys of two SEASAW systems were drifting before recovery. The top buoy of SEASAW 1 was started drifting on 12th July and recovered with R/V Shinsei-maru at 39.255°N, 144.090°E on 17th July. The drifting buoy of SEASAW 2 on 19th Aug. was picked up in this R/V Hakuho-maru cruise. Those remained mooring systems were recovered in this cruise. Photographs of SESAW 2 and sensors with the top glass sphere was shown in Fig. 3.7-1 (C-1), (C-2) and (C-1).

(4) Preliminary result

Data from various sensors attached with the mooring systems were obtained on ship or on land.

One of the results (temperature and salinity of sensors of SEASAW 2) was shown in Fig. 3.7-2.

(5) Data Archive

All data obtained from sensors will be submitted to JAMSTEC Data Management Office (DMO) after data quality control.

Fig. 3.7-1. Photographs of recovered mooring systems.
A-1, A-2, A-3: Lander moored at Sta. M-2, M-3 and M-4, respectively
B-1 : ADCP
C-1, C-2, C-3: Top buoy, launcher of SEASAW, and sensors of glass sphere.

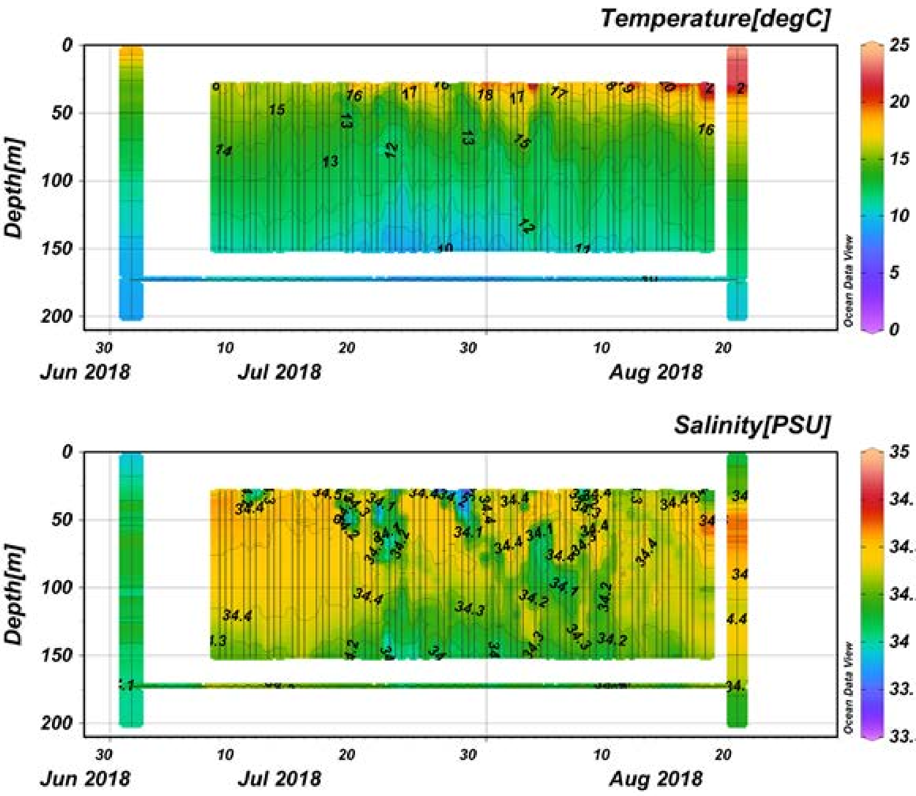

Fig. 3.7-2. Temperature and salinity obtained from sensors of SEASAW 2.
This figure was included the results of CTD and sensors attached with the top of lass sphere.

4. Notice on Using

Notice on using: Insert the following notice to users regarding the data and samples obtained.