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KAIYO Cruise Report

KY14-09

Transport and change processes of subtropical mode water and its effects on biogeochemical cycle

Kuroshio Extension region

19 June 2014 – 1 July 2014

Japan Agency for Marine-Earth Science and Technology

(JAMSTEC)

Contents

1. Cruise Information

1.1 Cruise ID: KY14-09

1.2 Name of vessel: KAIYO

1.3 Title of the cruise: Transport and change processes of subtropical mode water and its effects on biogeochemical cycle

1.4 Title of the proposal: Transport and change processes of subtropical mode water and its effects on biogeochemical cycle

1.5 Cruise period: 19 June – 1 July 2014

1.6 Ports of call: From / To: Wharf at Yokosuka Works, Sumitomo Heavy Industries

1.7 Research area: Kuroshio Extension Region

1.8 Research map:

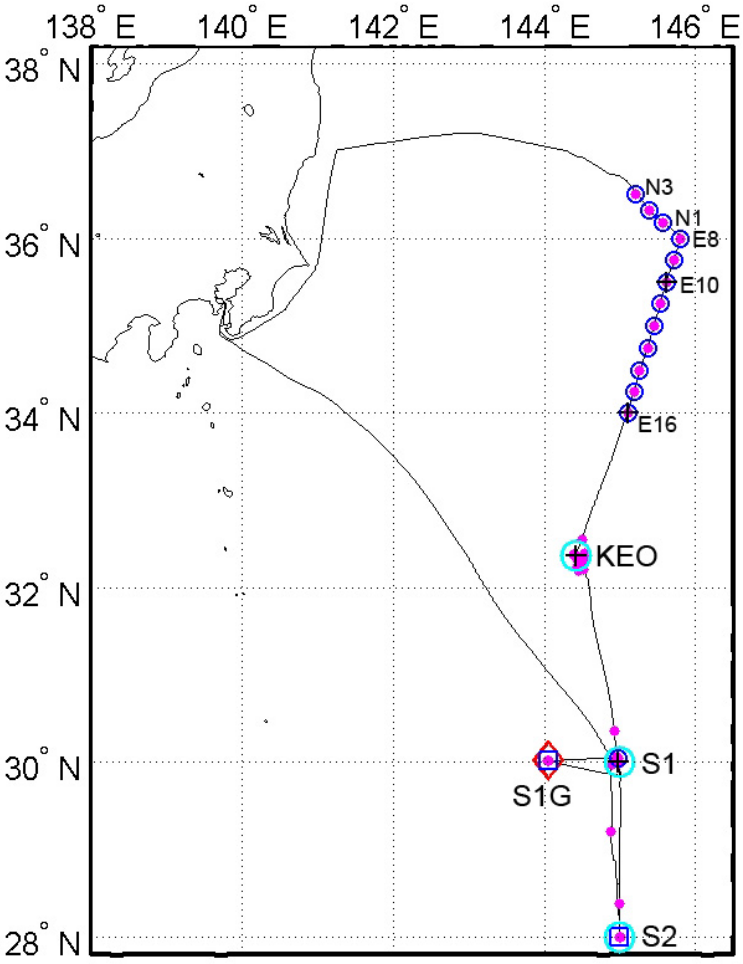

Figure 1. Locations of GPS radiosonde (magenta dot), XCTD (blue circle), drifting buoy release (black plus), plankton net (cyan circle), underwater glider recovery (red diamond), and water sampling for ^{134}Cs measurement (blue square).

2. Researchers

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Research and Development Center for Global Change (RCGC)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)

2.2 Representative of the science party:

Yoshimi Kawai RCGC/JAMSTEC

2.3 Science party:

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3. Observation

3.1 Background and purpose

The main purpose of this cruise was to investigate transport and change processes of subtropical mode water (STMW) and its effects on biogeochemical cycle.

STMW, which has vertically homogeneous properties, is formed south of the Kuroshio Extension. STMW moves southward and permeates the permanent thermocline. The formation of STMW is affected by winter weather conditions. Hence, the subtropical ocean circulation in the North Pacific reflects the climate change through the formation and transport of STMW. Furthermore, STWM is important for the ocean material circulation. It has a role of absorbing and transport CO_2 into the ocean interior. STMW also contributes to the primary production in the subtropics, where is oligotrophic in summer, by supplying nutrients upward. Recent studies have revealed that the spatial distribution of STMW is more complicated than expected before. It is indispensable to clarify the formation, transport, and change processes of STMW and the roles of STMW for the climate change and the material circulation. For these studies, we deployed and recovered surface buoys, biogeochemical moorings, and a sea glider in this cruise. CTD observations, water and plankton samplings were also conducted.

Another purpose of the cruise was the validation of new satellite data (AMSR2) and GPS-derived precipitable water.

3.2 Observations and activities

1) Atmospheric sounding using GPS radiosonde

Vertical profiles of air temperature, relative humidity, and wind velocity were observed 40 times in total (including 3 failures) at 19 positions with GPS radiosondes (Figure 1).

2) Oceanographic survey using XCTD

Vertical profiles of water temperature and salinity up to 1000-m depth were observed at 13 positions (Figure 1).

3) Underway marine meteorological measurements on the vessel

We observed shortwave and longwave radiations, air temperature, relative humidity, wind speed, wind direction, atmospheric pressure, rain rate, concentration of aerosol particles, and precipitable water throughout the cruise.

4) Underway oceanic measurements on the vessel

Surface temperature and current velocity were observed throughout the cruise.

5) Sampling of aerosol particles in the lowest atmosphere

Aerosol particles in the air were sampled with pumps and filters throughout the cruise.

6) Recovery of underwater glider

An underwater glider (SeaGlider), which can measure temperature, salinity, dissolved oxygen, and pressure, was deployed at 31°58.38'N, 143°56.27'E on 27 February 2014 in the cruise of R/V Hakuho-maru (KH-14-1). We recovered it about 50 nm west of the S1 site on 21 June 2014. (This recovery position is referred to as "S1G" hereafter)

7) Recovery and deployment of sediment-trap (BGC) mooring

The sediment-trap mooring was deployed at the S1 site on 16 July 2013 in the cruise of R/V Mirai (MR13-04) in order to collect settling particle continually. We recovered it on 22 June 2014. The mooring was simplified and deployed at the KEO site on 27 June 2014. Details are described in Appendix 1.

8) Recovery of POPPS mooring

POPPS was deployed at the S1 site on 16 July 2013 in the cruise of R/V Mirai (MR13-04) for measuring the vertical profiles of phytoplankton fluorescence, irradiance, temperature, salinity and dissolved oxygen. We

recovered it on 21 June 2014. See also Appendix 2.

9) Recovery and deployment of KEO buoys, deployment of drifting buoys (PMEL/NOAA)

KEO buoy has anemometers, thermometers for air temperature, hygrometers, longwave and shortwave radiometers, pCO_2 sensors, rain gauges, barometers, current meters, a pH sensor, Optode, CTs (water temperature and salinity) and CTDs (water temperature, salinity, and pressure). We deployed the KEO buoy (KEO12) on 25 June 2014. The KEO buoy (KEO11) was recovered on 26 June 2014.

We also deployed the Surface Velocity Program (SVP) drifters at the S1 and KEO sites, 34°00'N, and 35°30'N.

10) CTD and Water sampling at S1, S1G, S2, and KEO sites

We casted a CTD and Niskin bottles to 800 m depth at the S1G and S2 sites for the measurement of ^{134}Cs originated from Fukushima Daiichi Nuclear Power Station. CTD and water sampling casts were done to the bottom at the S1 site, and to 2000 m depth at the KEO site, for biogeochemical research. For 0-m water sampling, a bucket was used.

We also sampled water at 5m depth with a Niskin bottle at the KEO site just after the deployment and before the recovery of the buoys.

11) Plankton net (VMPS) at S1, S2, and KEO sites

Plankton tow sampling had performed by using the Vertical Multiple Plankton Sampler (VMPS) to collect microzooplankton from the S1, S2, and KEO sites. VMPS has 50cm x 50cm square aperture and four plankton nets can be set on the frame. CTD and conductivity sensor with fluorometer are equipped on the flame and observed data be monitored in real time on the shipboard console. Details are described in Appendix 3.

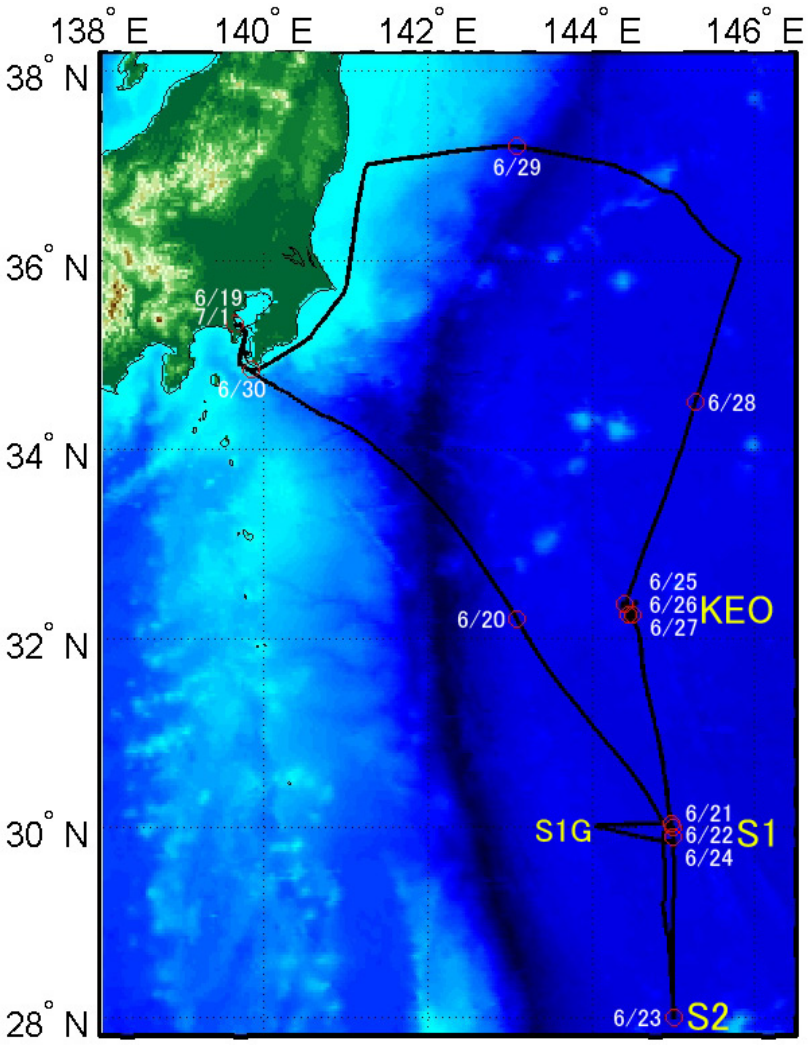


Figure 2. Cruise track with ship position at 0:00 UT (circle) on each day.

3.3 List of observation instruments

XCTD	XCTD-1 (Tsurumi-Seiki Co., Ltd.)
GPS Radiosonde	RS-11G (sensor), RD-08AC (receiver) (Meisei)
Thermometer/hygrometer	CVS-HMP-45A (Climatec)
Shortwave radiometer	CM-21, CMP-21 (Kipp&Zonen)
Longwave radiometer	CG-4, CGR-4 (Kipp&Zonen)
Weather multi-sensor	WXT520 (Vaisala)
GPS receiver	Trimble NetR9 (Nicon-Trimble)
	(for precipitable water measurement)
Optical particle counter	KC-01E (Rion)
Aerosol particle sampler	Cascade Impactors (PIXE International Corp.)
	PUMP FOR AIR MAS-01 (AS ONE Corp.)
	HV-525PM (Shibata)
Portable light sensor	LI-1400 (LI-COR)
Flow cytometer	ec800 (Sony)
Imaging particle analyzer	FlowCAM (Fluid Imaging)
CTD	SBE03-04/F, SBE04-04/0, SBE9plus, SBE43
	(Sea-Bird Electronics, Inc.)
Nutrient analyzer	QuAAtro 2-HR (BLTEC)
PAR sensor	(Satlantic Inc.)
Fluorometer	(Seapoint Sensors, Inc.)
Automatic photometric titrator	DOT-01X (Kimoto Electric Co., Ltd.)
Plankton net	VMPS3000 (Tsurumi-Seiki Co., Ltd.)
KEO buoy	PMEL/NOAA
Drifting buoy	SVP drifter (DBI.LLC)
Underwater glider	SeaGlider (iRobot)
POPPS	JAMSTEC
Fast repetition rate fluorometer	Diving Flash (Kimoto Electric)
Scalar irradiance sensor	QSP-2200 (Biospherical Instruments)
CTD sensor	MCTD (Falmouth Scientific)
Dissolved oxygen sensor	Compact Optode (Alec Electronics)
Remote automatic water sampler (RAS)	(McLane Research Laboratories)

Acoustic Doppler current profiler	Workhorse Long Ranger (Teledyne RD Instruments)

Sediment-trap (BGC) mooring JAMSTEC

Locator	Smart Cat ARGOS PIT (SEIMAC)
Sediment trap	SMD26S-6000 (Nichiyu Giken Kogyo)
	Mark 7-21 (McLane)
Strobe	NOVATECH Xenon flasher
Depth sensor	DFFI-D50HG (JFE)
CTD	SBE 37-SM MicroCAT (SeaBird)
DO sensor	Rinko I (JFE)
Thermometer	MDS Mk V/T (JFE)

3.4 Observation results

3.4.1 CTD

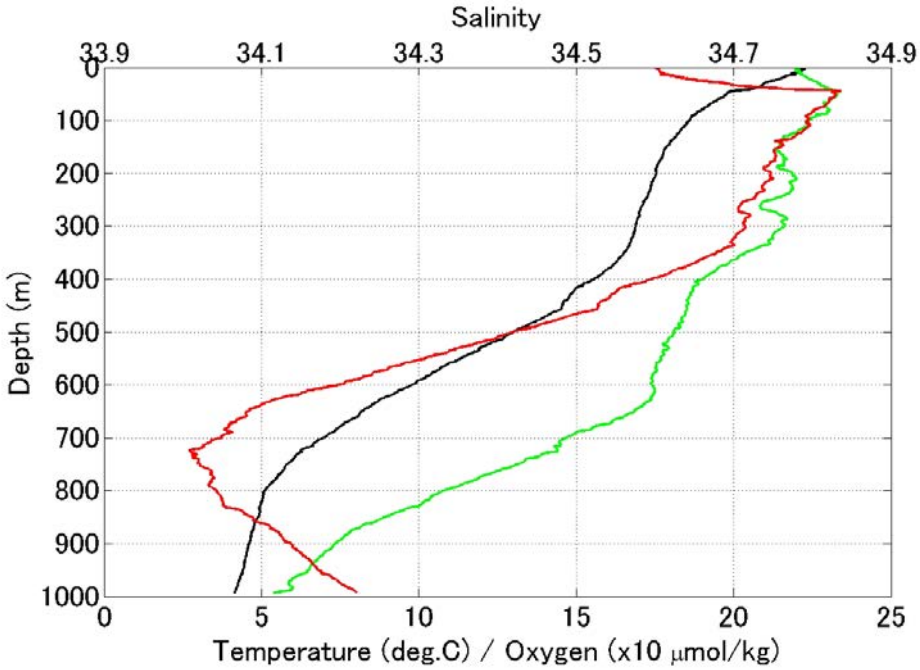


Figure 3. Vertical profiles (down cast) of in situ temperature (°C, black), dissolved oxygen (×10 μmol/kg, green), and salinity (psu, red) at the S1G site on 21 June 2014. Note that these data are not corrected.

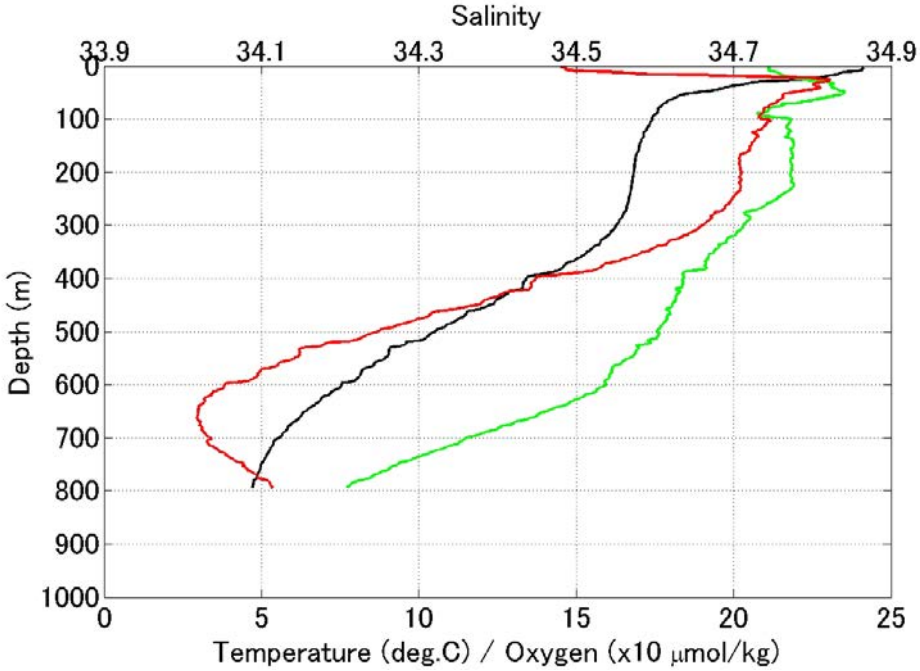


Figure 4. Same as Figure 3, but at the S2 site on 23 June 2014.

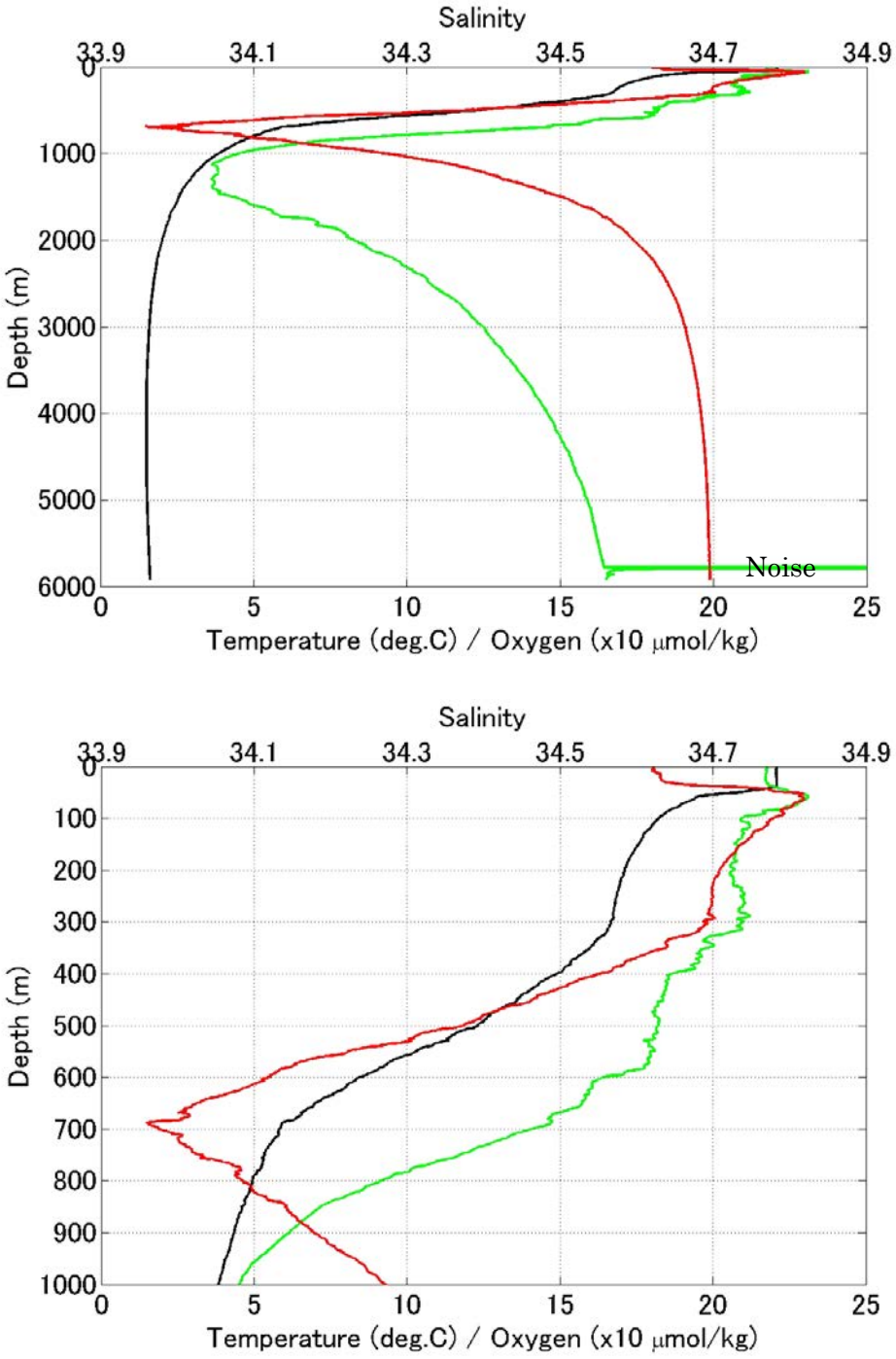


Figure 5. Same as Figure 3, but at the S1 site on 24 June 2014. The lower panel is an enlarged drawing up to 1000 m depth.

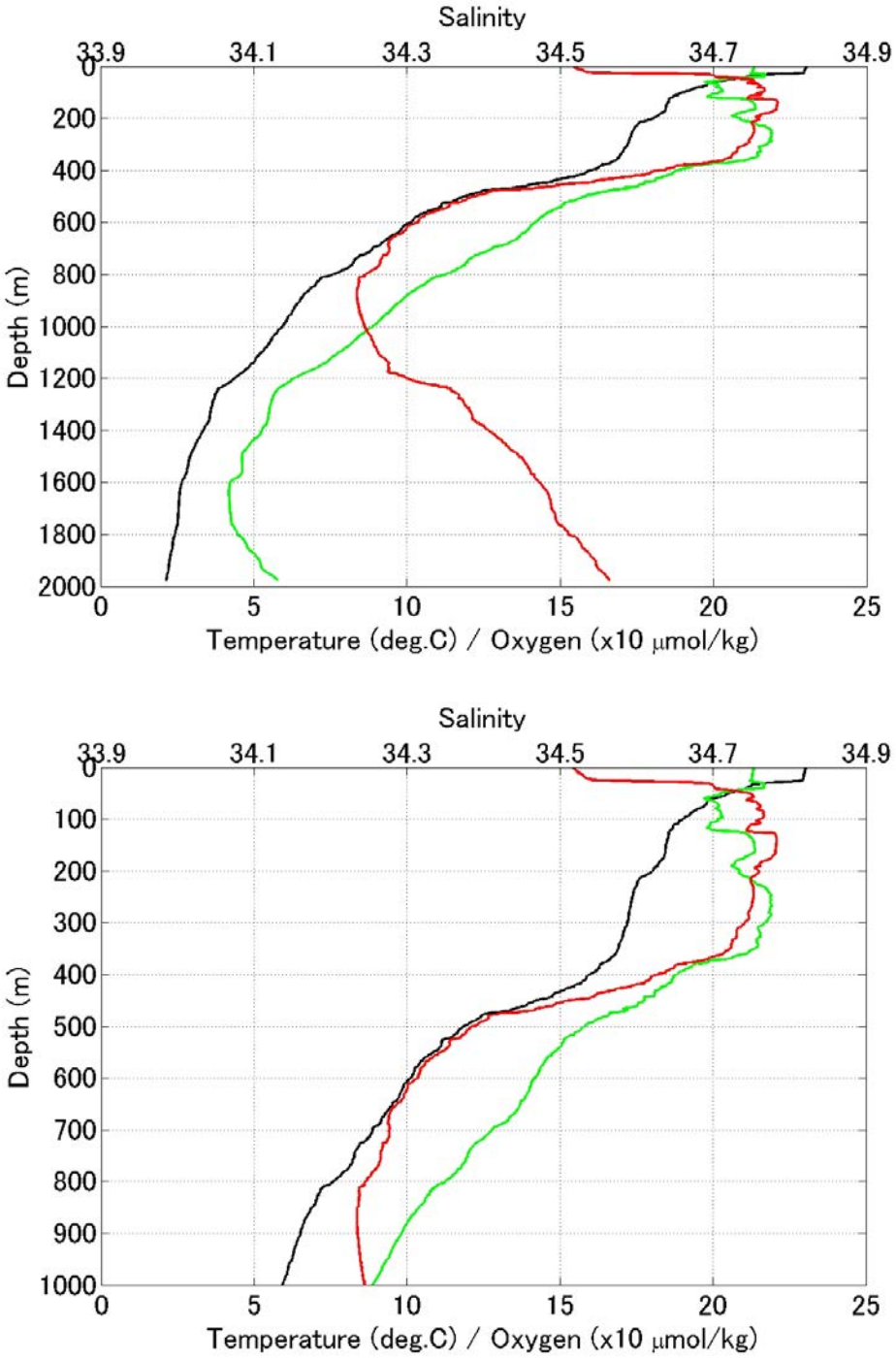


Figure 6. Same as Figure 3, but at the KEO site on 27 June 2014. The lower panel is an enlarged drawing up to 1000 m depth.

3.4.2 GPS radiosonde

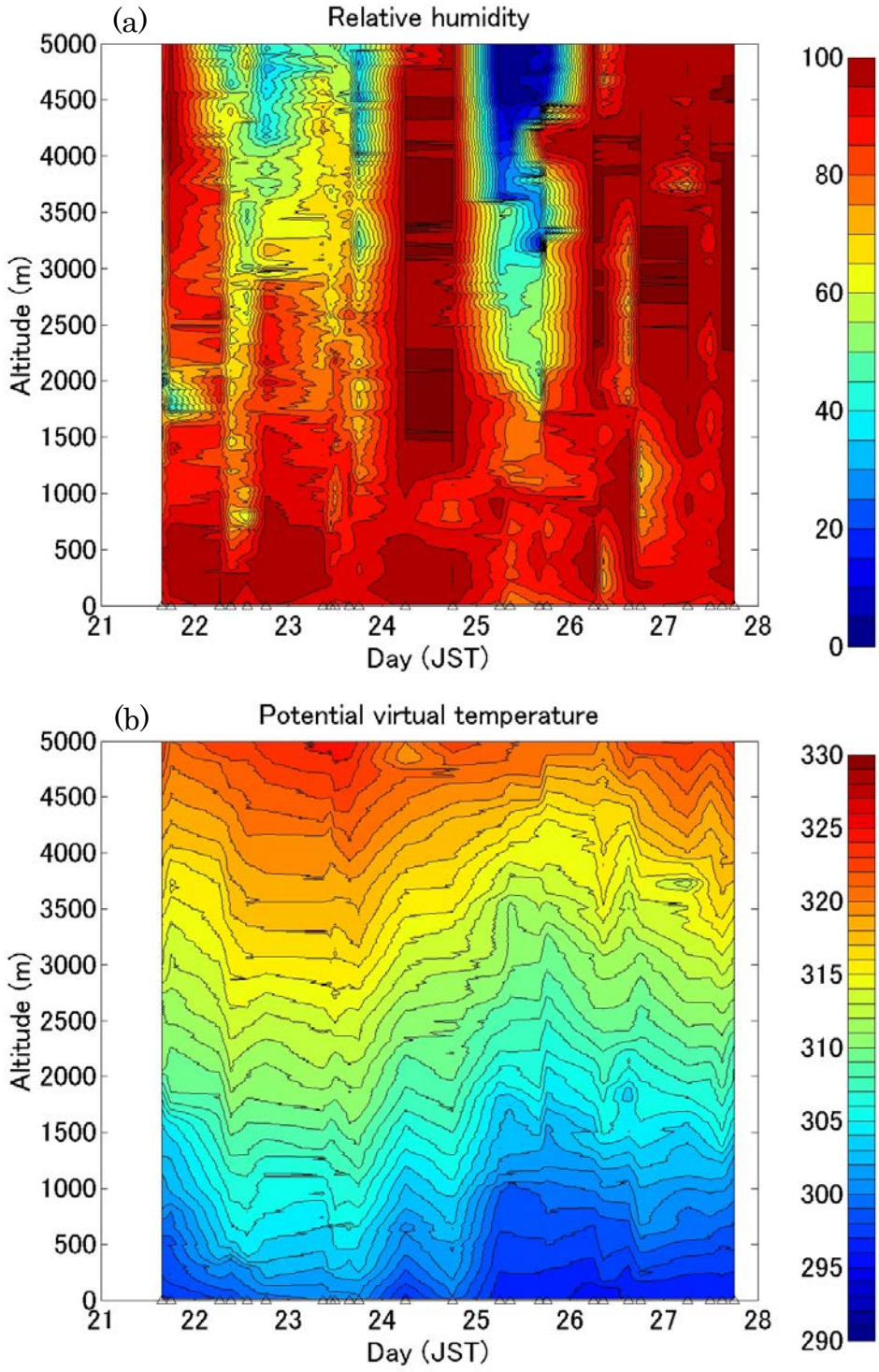


Figure 7. Relative humidity (%, a), potential virtual temperature (K, b), zonal wind speed (m/s, westward is positive, c), meridional wind speed (m/s, southward is positive, d), SST (°C, e), and water vapor accumulated up to 16000 m height (kg/m^3, f) observed with the GPS radiosondes from 15:39 on 21 June to 18:01 on 27 June 2014 (JST).

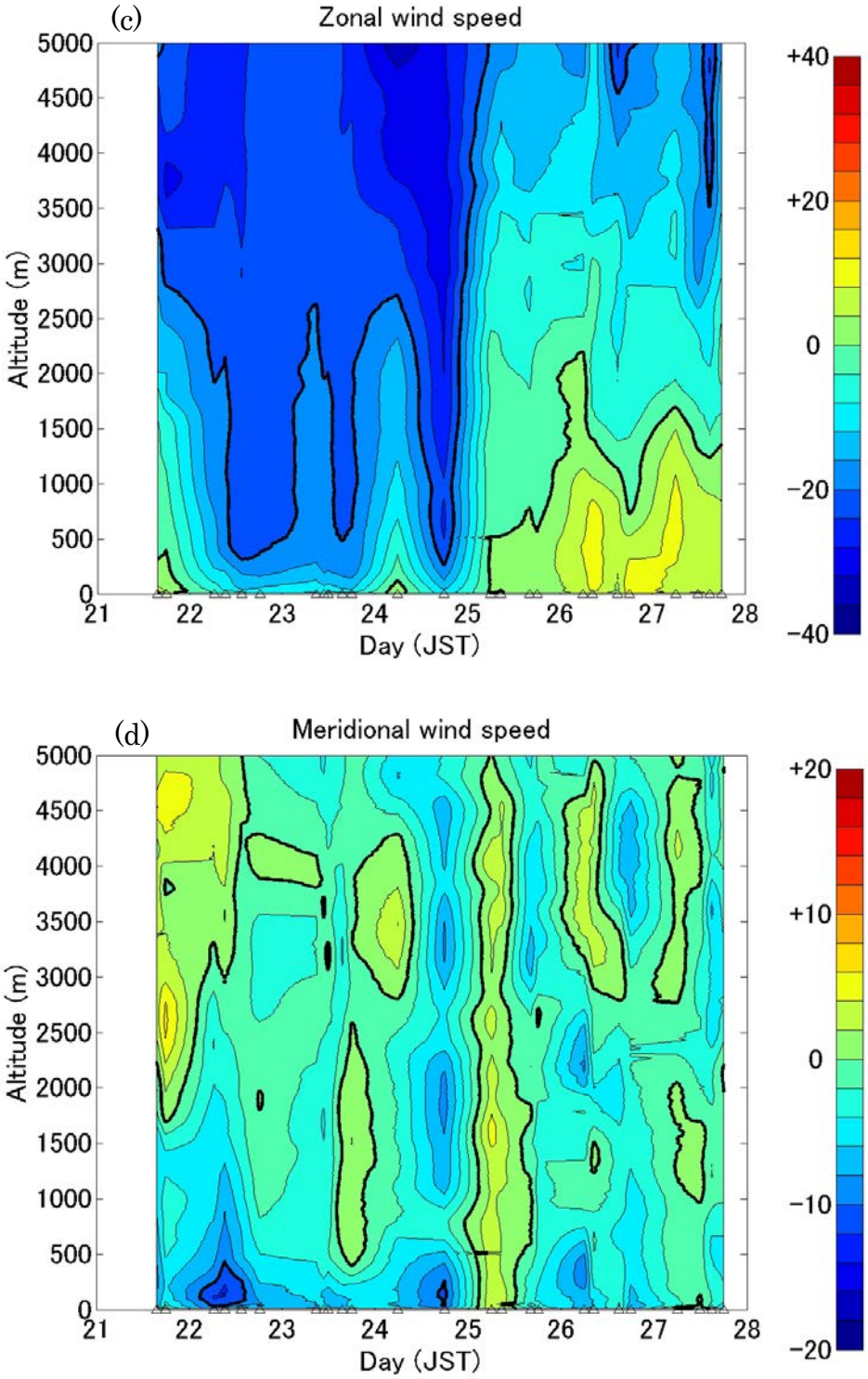
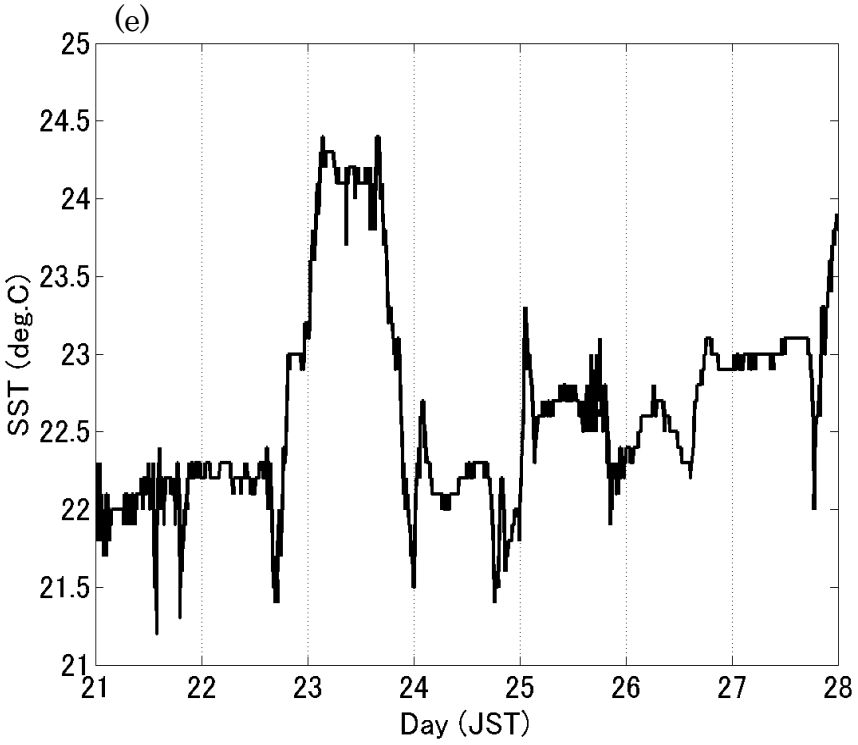


Figure 7 (continued)



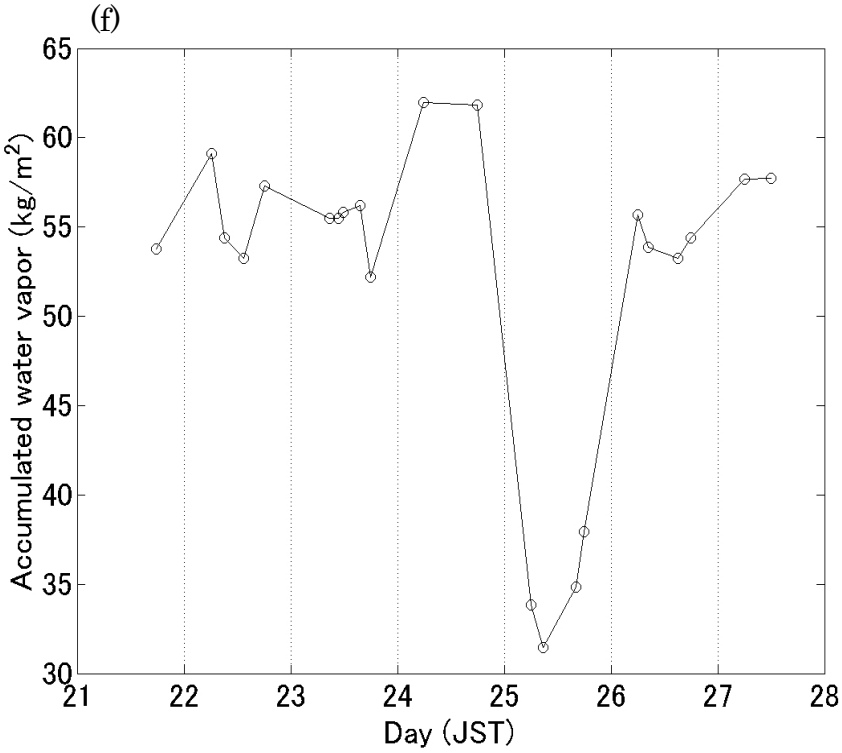


Figure 7 (continued)

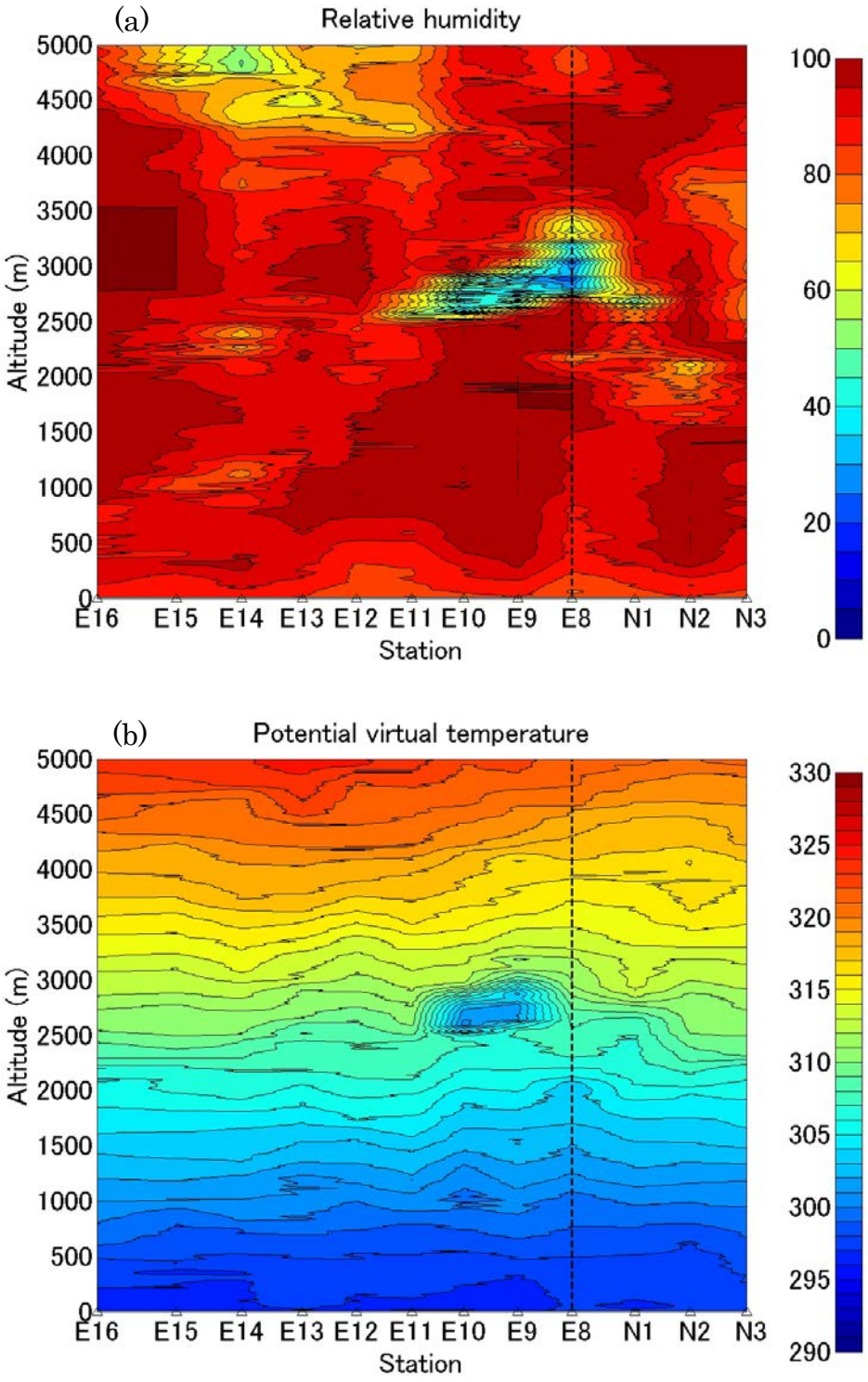


Figure 8. Same as Figure 7, but from 05:01 to 22:30 on 28 June 2014 (JST).

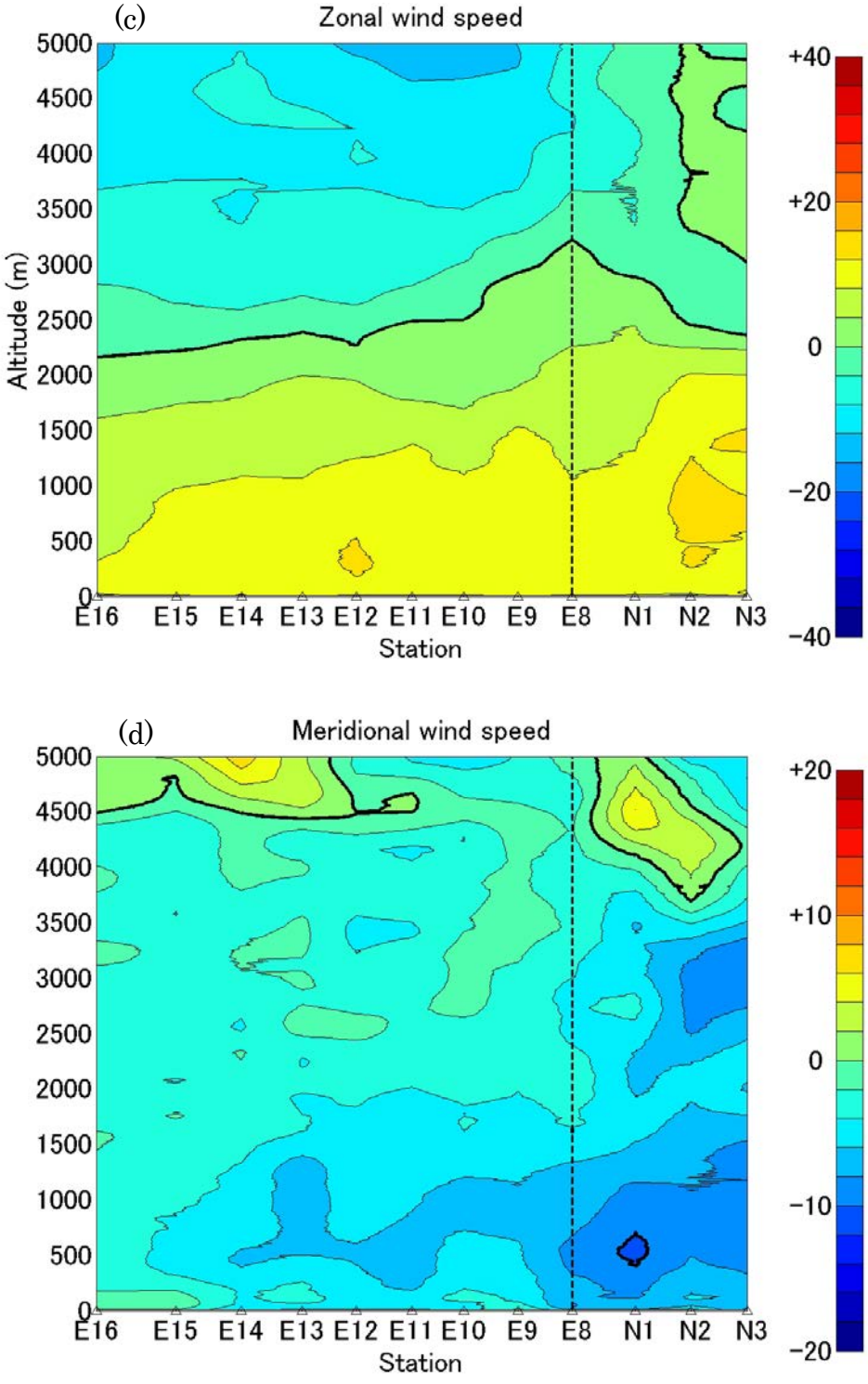
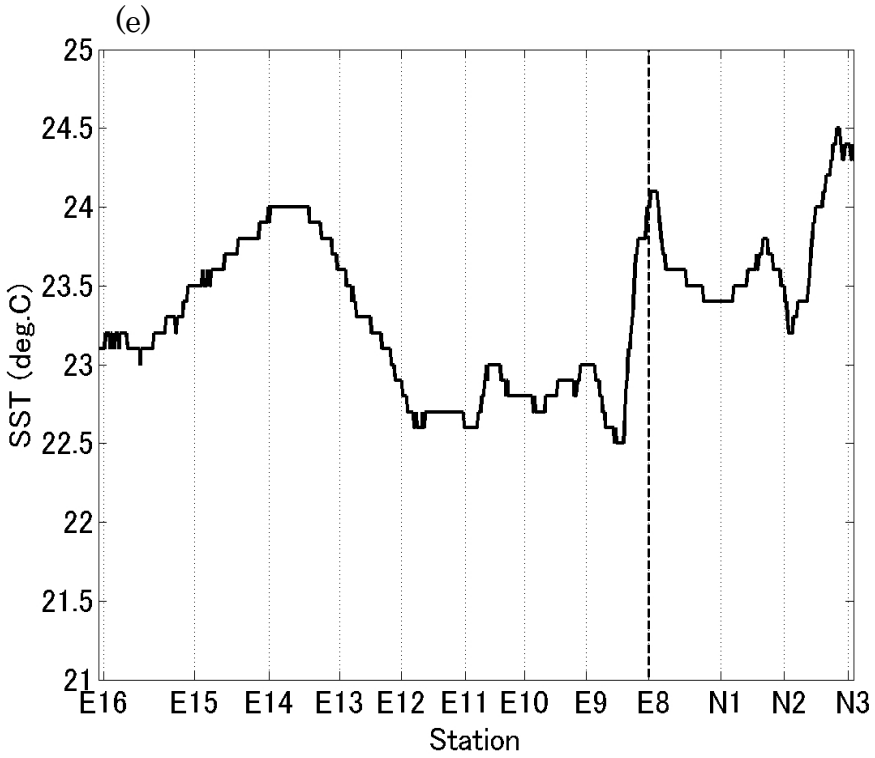


Figure 8 (continued)



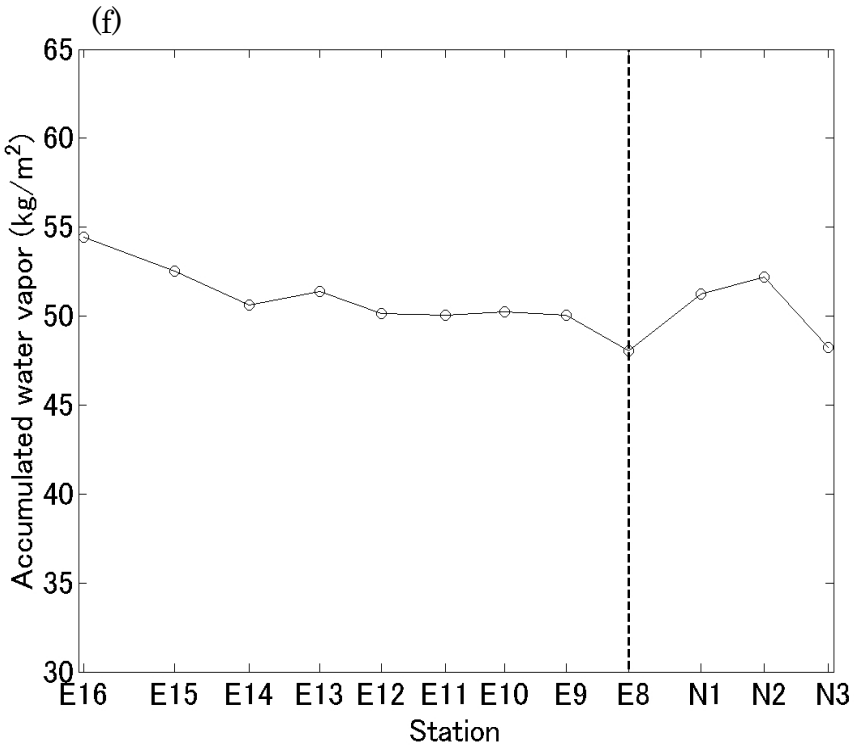


Figure 8 (continued)

3.4.3 Optical particle counter

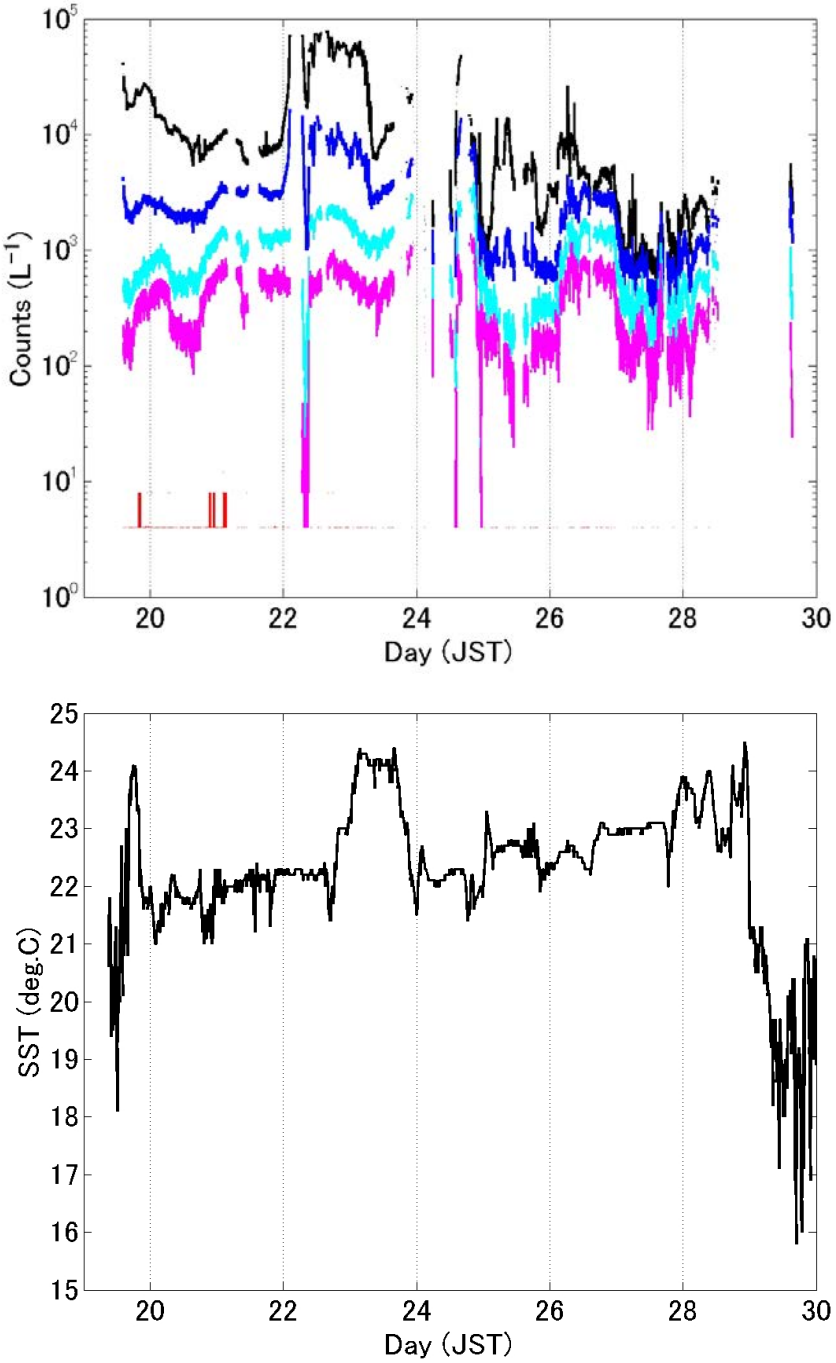


Figure 9. Counts of aerosol particles (upper panel), and SST (°C, lower panel). Black, blue, cyan, pink, and red lines represent 0.3-0.5 μm, 0.5-1 μm, 1-2 μm, 2-5 μm, and more than 5 μm of particle size, respectively. Data with the "High Concentration" error are not shown. We also eliminated the data when the angle between the ship heading and the wind direction exceeded ±90°, that is, the wind blew from the stern.

3.4.4 XCTD

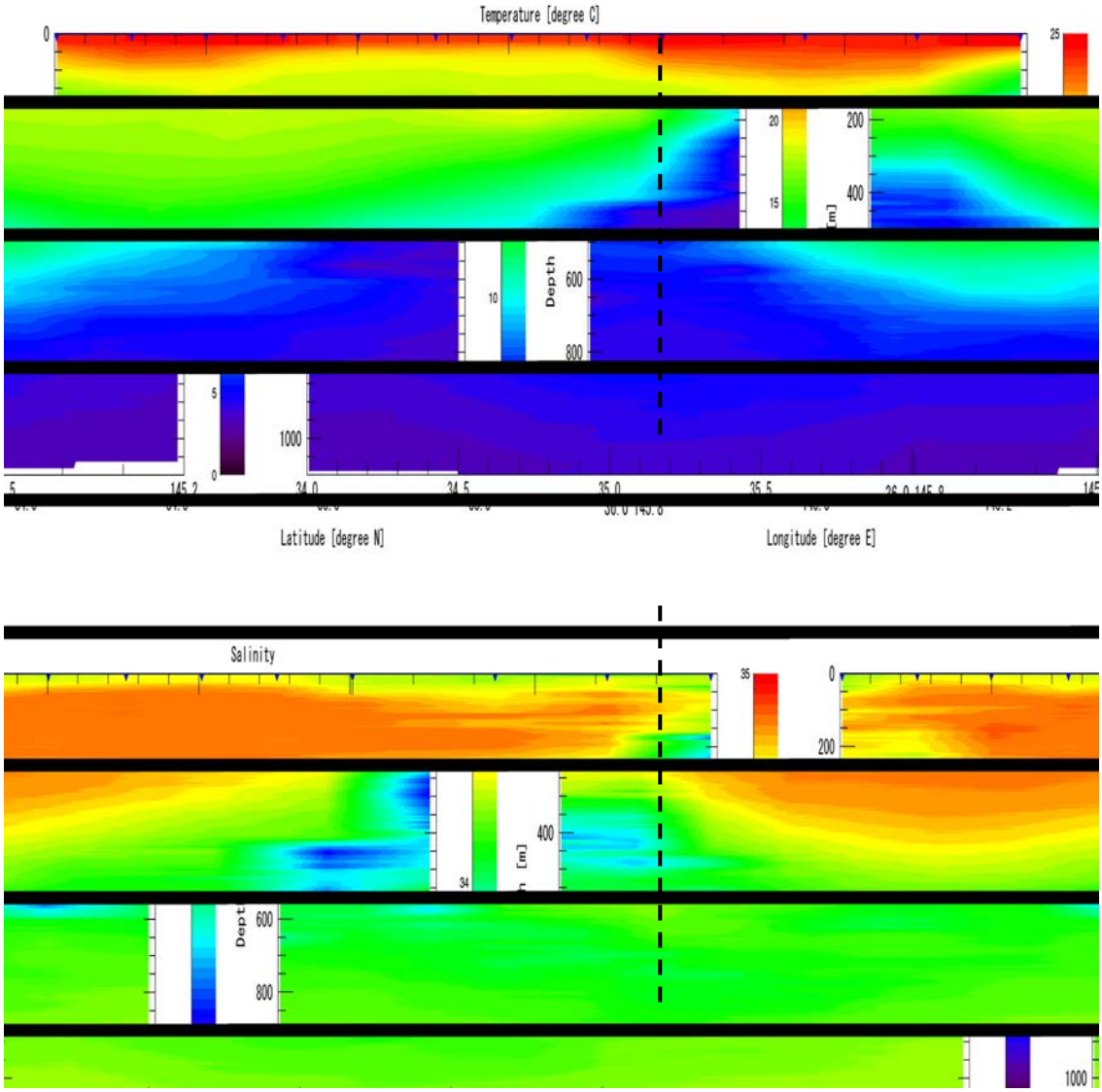


Figure 10. In situ temperature (°C, upper panel) and salinity (psu, lower panel) from 05:01 (E16) to 22:30 (N3) on 28 June 2014 (JST).

3.4.5 Chlorophyll *a*

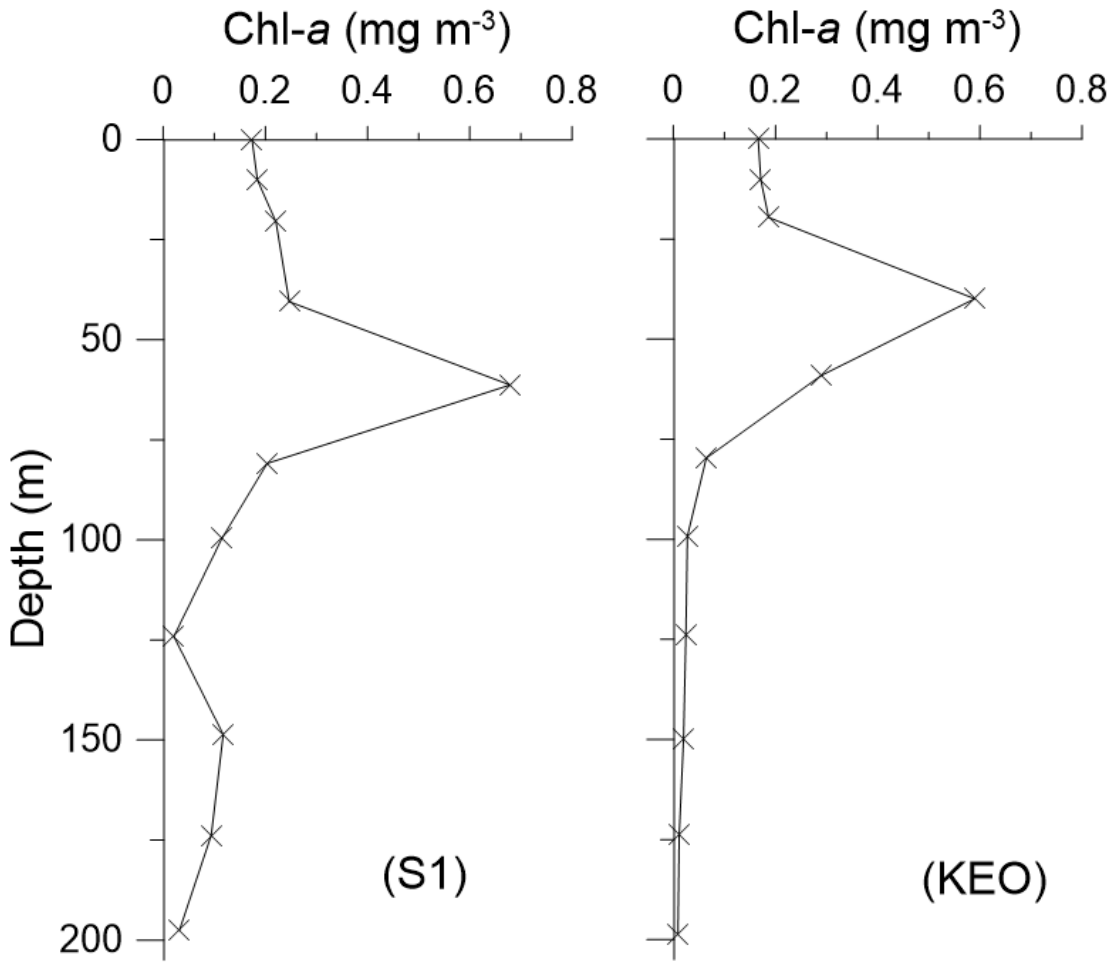


Figure 11. Vertical profiles of chlorophyll *a* at stations S1 and KEO. The concentrations of chlorophyll *a* were measured by Turner Design fluorometer (10-AU-005) on land, which was calibrated with the pure chlorophyll *a* (Sigma-Aldrich Co.).

3.4.6 Preliminary results of sediment trap

During deployment for about 320 days between middle July 2013 and late May 2014, sediment traps deployed at 200 m, 500 m and 4810 m worked perfectly following initialized time schedule. In order to know sample volume quantitatively, heights of collected sample in the collecting cups were measured with scale onboard and each volume was estimated roughly (Figure 12).

1) 200 m sediment trap

Sample in collecting cup looked larger than 1 mm such as shrimp, fish and jelly fish. Generally sample > 1 mm are eliminated from analysis as swimmer. Total mass flux in volume (thereinafter TMF) increased gradually from July 2013 to April / May 2014 (Figure 12a). Figure 12a also shows variability of 200 m sediment trap during deployment. Although water depth of 200 m sediment trap was usually about 200 m, water depth was deepened temporally, especially during August 2013 and late March 2014 (by 220 ~ 230 m).

2) 500 m sediment trap

Collected sample looked smaller than 1 mm. TMF was small between late September 2013 and early March 2014 and increased in May / April 2014 (Figure 12b). On the surface, seasonal variability in TMF at 500 m did not synchronize with that at 200 m.

3) 4810 m sediment trap

Collected sample at 4810 m was similar to that at 500 m, its size was smaller than 1 mm. Seasonal variability in TMF looked to synchronize with that at 500 m: small increase during July and September, decrease in winter and large increase between March and May 2014 (Figure 12c).

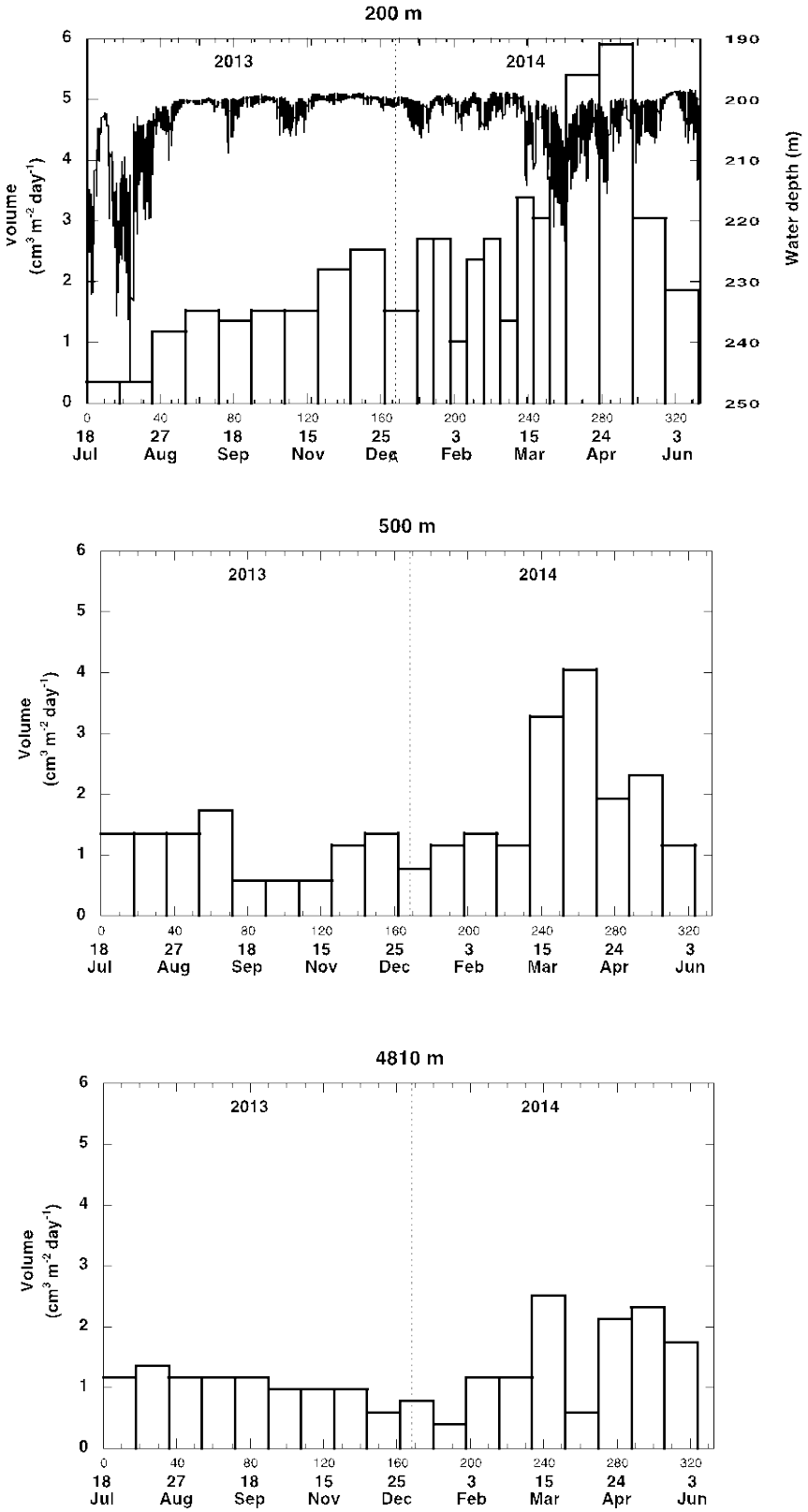


Figure 12. Total mass flux in volume at (a) 200 m, (b) 500 m and (c) 4810 m of S1.

3.4.7 Preliminary results of Remote Automatic water Sampler (RAS) on the POPPS mooring

1) Pressure, temperature and salinity at RAS

Pressure, temperature and salinity by SBE-37 SM (Sea-birds) were observed every hour attached on Winch and RAS on POPPS mooring system. Winch and RAS were located at ~225 db and ~250 db, respectively (Figure 13a). The seasonal variation of temperature and salinity were small (Figure 13b and 13c). However, both winch and RAS were sometimes deepened by approximately 40 db. It was noteworthy that both winch and RAS were deepened in summer 2013. It is suspected that strong current or eddy took place and mooring system might be largely forced to be tilted.

2) Chemical analysis of RAS sample

RAS on 250m worked following schedule (Table 1) and will obtain most of samples of dissolved inorganic carbon, CH_4, N_2O, total alkalinity, nutrients (Phosphate, Nitrate + Nitrite, Silicate), $^{15}NO_3^-$ and salinity. CH_4, N_2O, and $^{15}NO_3^-$ will be measured by JAMSTEC or Tokai University. These properties were obtained from 10 liter Niskin bottles mounted on the CTD/Carousel Water Sampling System for calibration on RAS samples at station S1 in this cruise. Some RAS sample volume after collecting (#3, #16, #18, #19 and #43) were quite small. These samples leaked with holes and might be not able to measure these properties. Salinity of RAS seawater samples will be measured by salinometer (Model 8400B "AUTOSAL" Guildline Instruments). Salinity of RAS samples should be lower than ambient seawater, because RAS samples were diluted with 20% saturated $HgCl_2$ solution. Salinity measured by salinometer will be slightly lower than that observed by SBE-37 sensor (CTD). RAS samples (~500ml) were diluted with 2.5 ml of 20% saturated $HgCl_2$ solution for preservative. For chemical properties, the dilutions of RAS samples by $HgCl_2$ must be corrected by a ratio of salinity by SBE-37 to that by salinometer

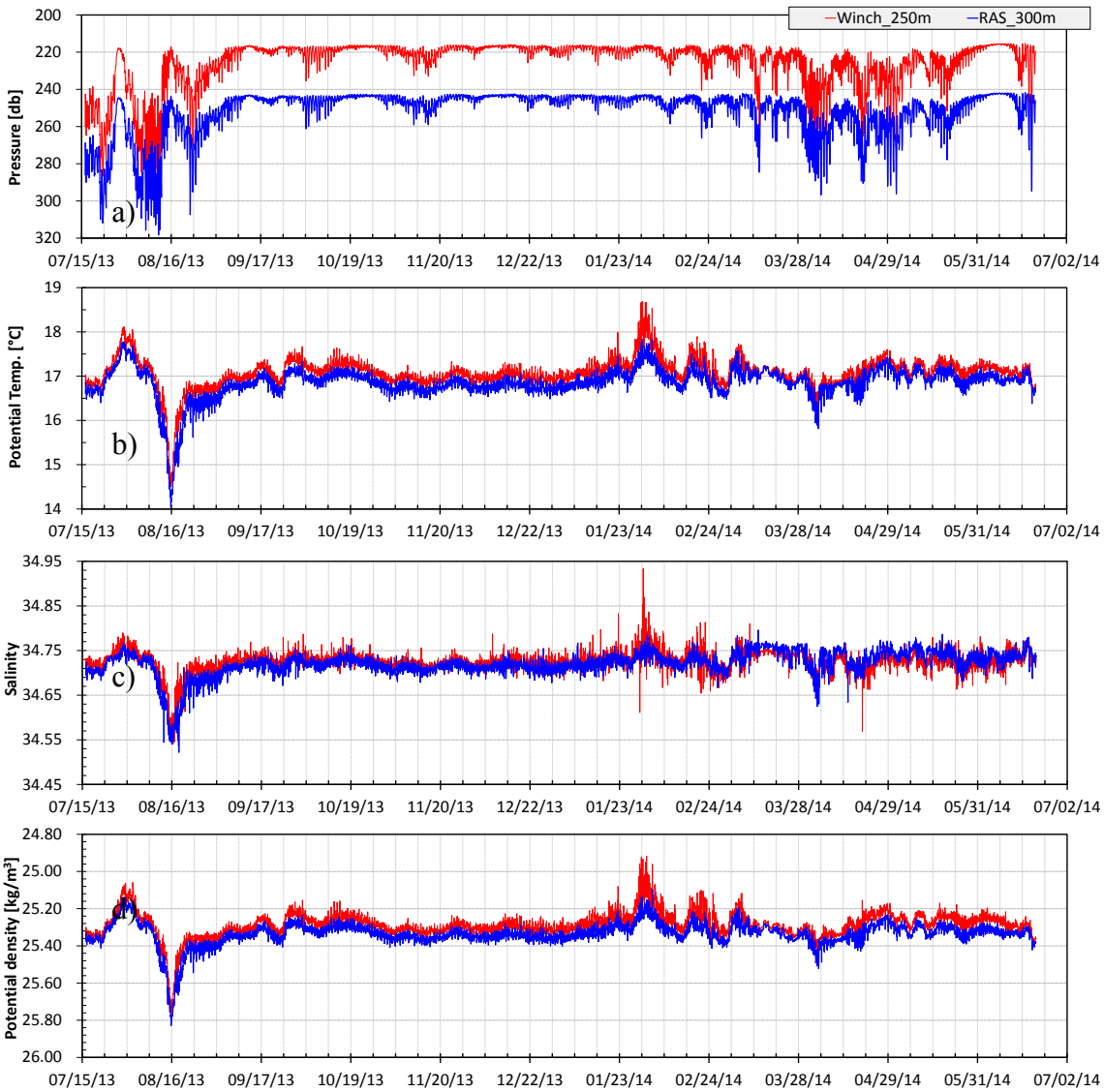


Figure 13. Pressure (a), potential temperature (b), Salinity (c) and potential density at the Winch and RAS during the deployment.

Table 1. Sampling schedule of RAS in 250m on the POPPS mooring at station S1.

S1 RAS 250m POPPS

RAS No.	Date		Memo	
	Interval 8 days			
#	mm/dd/yyyy	Time (JST)		
1	07/17/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	Interval 40 minutes
2	07/17/2013	7:40:00	20% Saturated $HgCl_2$ 2.5ml	for duplicate sampling
3	07/25/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
4	08/02/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
5	08/10/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
6	08/18/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
7	08/26/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
8	09/03/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
9	09/11/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
10	09/19/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
11	09/27/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
12	10/05/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
13	10/13/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
14	10/21/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
15	10/29/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
16	11/06/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
17	11/14/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
18	11/22/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
19	11/30/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
20	12/08/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
21	12/16/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
22	12/24/2013	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
23	01/01/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
24	01/09/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
25	01/17/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
26	01/25/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
27	02/02/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
28	02/10/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
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31	03/06/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
32	03/14/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
33	03/22/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
34	03/30/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
35	04/07/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
36	04/15/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
37	04/23/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
38	05/01/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
39	05/09/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
40	05/17/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
41	05/25/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
42	06/02/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
43	06/10/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
44	06/18/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
45	06/26/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
46	07/04/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	
47	07/12/2014	7:00:00	20% Saturated $HgCl_2$ 2.5ml	Interval 40 minutes
48	07/12/2014	7:40:00	20% Saturated $HgCl_2$ 2.5ml	for duplicate sampling

3.5 Cruise log

Date	Time		Site	Event
	(JST)	(UTC)		
				Japan Standard Time is (UTC+9h)
19 Jun.	09:00	00:00		Depart from Sumitomo Wharf for S1
21 Jun.	06:03	21:03 (-1d)	S1	Send a release code (POPPS)
	06:22	21:22 (-1d)	S1	Launch the first radiosonde
	07:19	21:55 (-1d)	S1	Start POPPS mooring recovery
	11:08	02:08	S1	Finish recovery
	15:06	06:06	S1G	Find the sea glider
	15:19	06:19	S1G	Start sea glider recovery
	15:26	06:26	S1G	Finish recovery
	15:50	06:50	S1G	CTD and water sampling for ^{134}Cs (1000m)
	17:11	08:11	S1G	CTD and water sampling for ^{134}Cs (200m)
22 Jun.	07:10	22:10 (-1d)	S1	Plankton net (1000m)
	08:31	23:31 (-1d)	S1	Plankton net (200m)
	08:52	23:52 (-1d)	S1	XCTD for plankton net
	09:32	00:32	S1	Send a release code (Sediment-trap mooring)
	10:07	01:07	S1	Start sediment-trap mooring recovery
	13:25	04:25	S1	Finish recovery, depart for S2
23 Jun.	08:58	23:58	S2	CTD and water sampling for ^{134}Cs (1000m)
	10:10	01:10	S2	CTD and water sampling for ^{134}Cs (200m)
	13:33	04:33	S2	Plankton net (1000m)
	14:33	05:33	S2	Plankton net (300m)
	15:05	06:05	S2	Plankton net (300m)
24 Jun.	06:03	21:03 (-1d)	S1	CTD and water sampling (bottom)
	10:10	01:10	S1	CTD and water sampling (2000m)
	13:00	04:00	S1	CTD and water sampling (300m)
	15:03	06:03	S1	Plankton net (300m)
	15:38	06:38	S1	Plankton net (300m)
	16:02	07:02	S1	Deploy drifting buoys, depart for KEO
25 Jun.	09:00	00:00	KEO	Start KEO buoy (KEO12) deployment
	14:29	05:29	KEO	Anchor release
	15:09	06:09	KEO	Start triangulation
	16:49	07:49	KEO	Water sampling with a Niskin bottle
	17:39	08:39	KEO	Finish triangulation

26 Jun.	08:19	23:19 (-1d)	KEO	Bucket water sampling
	08:20	23:20 (-1d)	KEO	Water sampling with a Niskin bottle
	08:38	23:38 (-1d)	KEO	Send a release code (KEO11)
	09:22	00:22	KEO	Start KEO buoy (KEO11) recovery
	14:16	05:16	KEO	Finish recovery
27 Jun.	08:26	23:26 (-1d)	KEO	Start sediment-trap mooring deployment
	09:40	00:40	KEO	Anchor release
	10:42	01:42	KEO	Send a sleep command
	10:49	01:49	KEO	CTD and water sampling (2000m)
	13:26	04:26	KEO	CTD and water sampling (300m)
	15:05	06:05	KEO	Plankton net (300m)
	15:40	06:40	KEO	Plankton net (300m)
	16:13	07:13	KEO	Plankton net calibration
	16:50	07:50	KEO	Deploy drifting buoys, depart for JKEO
28 Jun.	05:01	20:01 (-1d)	E16	Start cross-front radiosonde and XCTD observations
	05:15	20:15 (-1d)	E16	Deploy drifting buoys
	15:06	06:06	E10	Deploy drifting buoys
	18:00	09:00	E8	Quit going to JKEO and head to 37°20'N, 144°00'E
	23:00	14:00	N3	Decide to quit all the rest of observations due to the weather condition
30 Jun.	11:00	02:00		Off Tateyama
1 Jul.	08:30	23:30 (-1d)		Arrive at Sumitomo Wharf

3.6 Research information

	Station	Date and time (JST)	Latitude	Longitude	Mooring/ Serial Number	Operation	Memo
1	S1	2014/06/21 06:03	29°56.11'	144°58.63'	POPPS	Release code	
2	S1	2014/06/21 06:22	29°55.84'	144°58.66'	201689	Sonde 1	Failure (data error)
3	S1	2014/06/21 07:19	29°55.81'	144°58.64'	POPPS	Start recovery	Top buoy disappeared
4	S1	2014/06/21 11:07	29°51.37'	144°58.76'	339954	Sonde 2	Failure (data error)
5	S1	2014/06/21 11:08	29°51.42'	144°58.80'	POPPS	End acoustic releasers	
6	S1G	2014/06/21 15:19	30°01.12'	144°03.77'	SeaGlider	Start recovery	
7	S1G	2014/06/21 15:26	30°01.09'	144°03.06'	SeaGlider	Finish recovery	
8	S1G	2014/06/21 15:39	30°01.18'	144°03.24'	339960	Sonde 3	
9	S1G	2014/06/21 15:50	30°01.12'	144°03.16'	Cs cast S1-1	Start CTD (1000m cast)	For ^{134}Cs
10	S1G	2014/06/21 16:26	30°01.10'	144°03.16'	-	Bucket sampling	For nutrients
11	S1G	2014/06/21 16:45	30°01.10'	144°03.18'	Cs cast S1-1	Finish CTD	
12	S1G	2014/06/21 17:11	30°01.10'	144°03.17'	Cs cast S1-2	Start CTD (200m cast)	For ^{134}Cs
13	S1G	2014/06/21 17:29	30°01.09'	144°03.18'	Cs cast S1-2	Finish CTD	
14	S1G	2014/06/21 17:51	30°01.14'	144°02.69'	339961	Sonde 4	
15	S1	2014/06/22 06:17	30°04.06'	144°57.74'	339962	Sonde 5	
16	S1	2014/06/22 07:10	30°03.88'	144°58.11'	S1-cast 1	Start VMPS (1000m cast)	

17	S1	2014/06/22 08:01	30°03.88’	144°58.11’	S1-cast 1	Finish VMPS	
18	S1	2014/06/22 08:31	30°03.00’	144°58.61’	S1-cast 2	Start VMPS (200m cast)	
19	S1	2014/06/22 08:48	30°02.72’	144°58.67’	S1-cast 2	Finish VMPS	
20	S1	2014/06/22 08:52	30°02.707’	144°58.668’	12057526	XCTD 1	
21	S1	2014/06/22 09:09	30°02.76’	144°58.61’	339963	Sonde 6	
22	S1	2014/06/22 09:32	30°04.03’	144°58.01’	Sediment-trap	Release code	
23	S1	2014/06/22 10:07	30°03.32’	144°57.53’	Sediment-trap	Start recovery	Without boat
24	S1	2014/06/22 13:22	29°58.86’	144°53.65’	339955	Sonde 7	
25	S1	2014/06/22 13:25	29°58.82’	144°53.61	Sediment-trap	End acoustic releasers	
26	S1	2014/06/22 17:58	-	-	339956	Sonde 8	Failure (touch sea)
27	S1	2014/06/22 18:10	29°12.62’	144°52.10’	339957	Sonde 8	Retry
28	S2	2014/06/23 08:45	28°00.12’	145°00.03’	339958	Sonde 9	
29	S2	2014/06/23 08:58	28°00.13’	145°00.08’	Cs cast S2-1	Start CTD (800m cast)	For ^{134}Cs
30	S2	2014/06/23 09:43	27°59.98’	145°00.09’	Cs cast S2-1	Finish CTD	
31	S2	2014/06/23 10:10	28°00.03’	145°00.22’	Cs cast S2-2	Start CTD (200m cast)	For ^{134}Cs
32	S2	2014/06/23 10:34	28°00.04’	145°00.13’	Cs cast S2-2	Finish CTD	
33	S2	2014/06/23 10:44	28°00.06’	145°00.28’	339959	Sonde 10	
34	S2	2014/06/23 11:49	28°00.06’	145°00.28’	339949	Sonde 11	

35	S2	2014/06/23 13:33	28°00.01’	145°00.01’	S2-cast 1	Start VMPS (1000m cast)	
36	S2	2014/06/23 14:11	28°00.02’	144°59.97’	S2-cast 1	Finish VMPS	
37	S2	2014/06/23 14:33	28°00.02’	145°00.00’	S2-cast 2	Start VMPS (300m cast)	
38	S2	2014/06/23 14:47	28°00.00’	144°59.98’	S2-cast 2	Finish VMPS	
39	S2	2014/06/23 15:05	27°59.99’	145°00.00’	S2-cast 3	Start VMPS (300m cast)	
40	S2	2014/06/23 15:24	28°00.00’	144°59.94’	S2-cast 3	Finish VMPS	
41	S2	2014/06/23 15:32	28°00.11’	144°59.89’	339950	Sonde 12	
42	-	2014/06/24 17:55	28°23.17’	144°59.38’	339951	Sonde 13	
43	S1	2014/06/24 05:51	29°59.79’	144°59.95’	339952	Sonde 14	
44	S1	2014/06/24 06:03	29°59.80’	144°59.81’	Routine cast S1-3	Start CTD (Bottom cast)	
45	S1	2014/06/24 07:50	30°00.14’	144°59.89’	-	Water sampling	Bucket
46	S1	2014/06/24 09:08	30°00.31’	144°59.91’	Routine cast S1-3	Finish CTD	
47	S1	2014/06/24 10:10	30°00.01’	144°59.71’	Routine cast S1-4	Start CTD (2000m cast)	
48	S1	2014/06/24 11:29	30°00.13’	144°59.72’	Routine cast S1-4	Finish CTD	
49	S1	2014/06/24 13:00	29°59.91’	145°00.09’	Routine cast S1-5	Start CTD (300m cast)	
50	S1	2014/06/24 13:39	30°00.06’	145°00.08’	Routine cast S1-5	Finish CTD	
51	S1	2014/06/24 15:03	30°00.12’	145°00.16’	S1-cast 3	Start VMPS (300m cast)	
52	S1	2014/06/24	29°59.89’	144°59.95’	S1-cast 3	Finish	

		15:19				VMPS	
53	S1	2014/06/24 15:38	30°00.21’	145°00.00’	S1-cast 4	Start VMPS (300m cast)	
54	S1	2014/06/24 15:54	29°59.98’	144°59.64’	S1-cast 4	Finish VMPS	
55	S1	2014/06/24 16:02	30°00.41’	144°59.08’	114578 116149 116150	Deploy drifting buoys	
56	-	2014/06/24 17:52	30°22.12’	144°55.59’	339953	Sonde 15	
57	KEO	2014/06/25 06:05	32°12.10	144°27.18’	339945	Sonde 16	
58	KEO	2014/06/25 08:42	32°14.41’	144°26.29’	339946	Sonde 17	
59	KEO	2014/06/25 09:00	32°15.14’	144°26.69’	KEO12	Start deployment	
60	KEO	2014/06/25 14:29	32°23.37’	144°32.29’	KEO12	Anchor release	
61	KEO	2014/06/25 15:23	32°23.07’	144°30.64’	KEO12	Triangulation 1	
62	KEO	2014/06/25 15:54	32°23.61’	144°32.59’	KEO12	Triangulation 2	(data strange)
63	KEO	2014/06/25 16:09	32°22.32’	144°32.57’	339947	Sonde 18	
64	KEO	2014/06/25 16:18	32°22.08’	144°32.44’	KEO12	Triangulation 3	
65	KEO	2014/06/25 16:49	32°21.28’	144°30.37’	KEO12	Water sampling	5m depth, Niskin
66	KEO	2014/06/25 16:53	32°21.30’	144°30.36’	KEO12	Triangulation 4	
67	KEO	2014/06/25 17:33	32°23.97’	144°32.04’	KEO12	Triangulation 5	
68	KEO	2014/06/25 18:00	32°23.80’	144°32.12’	339948	Sonde 19	
69	KEO	2014/06/26 05:59	32°12.80’	144°30.73’	339934	Sonde 20	

70	KEO	2014/06/26 08:19	32°14.93'	144°30.15'	-	Water sampling	Bucket
71	KEO	2014/06/26 08:20	32°14.93'	144°30.13'	KEO11	Water sampling	5m depth, Niskin
72	KEO	2014/06/26 08:28	32°14.85'	144°30.07'	339939	Sonde 21	
73	KEO	2014/06/26 08:38	32°14.86'	144°29.83'	KEO11	Release code	
74	KEO	2014/06/26 09:22	32°14.72'	144°30.18'	KEO11	Start recovery	
75	KEO	2014/06/26 14:16	32°14.65'	144°32.20'	KEO11	End acoustic releasers	
76	KEO	2014/06/26 15:00	32°17.12'	144°31.81'	339940	Sonde 22	
77	KEO	2014/06/26 18:00	32°19.38'	144°26.40'	339941	Sonde 23	
78	KEO	2014/06/27 05:59	32°22.95'	144°22.93'	339936	Sonde 24	
79	KEO	2014/06/27 08:26	32°22.68'	144°23.44'	Sediment trap	Start deployment	
80	KEO	2014/06/27 09:40	32°21.96'	144°25.11'	Sediment trap	Anchor release	
81	KEO	2014/06/27 10:18	32°21.84'	144°25.13'	Sediment trap	Anchor landing	
82	KEO	2014/06/27 10:42	32°21.83'	144°25.05'	Sediment trap	Send sleep command	
83	KEO	2014/06/27 10:49	32°21.86'	144°25.02'	Routine cast KEO-1	Start CTD (2000m cast)	
84	KEO	2014/06/27 11:55	32°22.12'	144°25.19'	339937	Sonde 25	
85	KEO	2014/06/27 12:12	32°22.16'	144°25.22'	Routine cast KEO-1	Finish CTD	
86	KEO	2014/06/27 13:26	32°21.97'	144°24.96'	Routine cast KEO-2	Start CTD (300m cast)	
87	KEO	2014/06/27 13:56	32°22.02'	144°25.01'	Routine cast KEO-2	Finish CTD	

88	KEO	2014/06/27 14:53	32°21.92’	144°24.73’	339938	Sonde 26	
89	KEO	2014/06/27 15:05	32°21.93’	144°24.77’	KEO-cast 1	Start VMPS (300m cast)	
90	KEO	2014/06/27 15:25	32°21.93’	144°24.84’	KEO-cast 1	Finish VMPS	
91	KEO	2014/06/27 15:40	32°21.95’	144°24.89’	KEO-cast 2	Start VMPS (300m cast)	
92	KEO	2014/06/27 16:00	32°21.98’	144°24.94’	KEO-cast 2	Finish VMPS	
93	KEO	2014/06/27 16:13	32°22.01’	144°24.95’	-	Start VMPS calibration	5 times, 100m dep.
94	KEO	2014/06/27 16:43	32°22.04’	144°25.13’	-	Finish calibration	
95	KEO	2014/06/27 16:50	32°22.32’	144°25.25’	116153 116156 116158	Deploy drifting buoys	
96	-	2014/06/27 18:01	32°33.26’	144°29.72’	339943	Sonde 27	
97	E16	2014/06/28 05:01	34°00.01’	145°06.01’	339964	Sonde 28	
98	E16	2014/06/28 05:07	34°00.405’	145°06.160’	12057523	XCTD 2	
99	E16	2014/06/28 05:15	34°00.98’	145°06.37’	116154 116155	Deploy drifting buoys	
100	E15	2014/06/28 07:07	34°14.96’	145°10.99’	339969	Sonde 29	
101	E15	2014/06/28 07:14	34°15.302’	145°11.095’	12057525	XCTD 3	
102	E14	2014/06/28 08:54	34°29.61’	145°15.86’	339970	Sonde 30	
103	E14	2014/06/28 08:59	34°29.983’	145°15.990’	12057524	XCTD 4	
104	E13	2014/06/28 10:33	34°29.61’	145°15.86’	339970	Sonde 31	

105	E13	2014/06/28 10:37	34°45.266’	145°22.099’	12057527	XCTD 5	
106	E12	2014/06/28 12:01	34°59.74’	145°26.94’	339971	Sonde 32	
107	E12	2014/06/28 12:05	35°00.174’	145°27.046’	12057528	XCTD 6	
108	E11	2014/06/28 13:30	35°15.18’	145°32.07’	339972	Sonde 33	
109	E11	2014/06/28 13:34	35°15.580’	145°32.204’	12057529	XCTD 7	
110	E10	2014/06/28 14:54	35°30.14’	145°37.04’	339973	Sonde 34	
111	E10	2014/06/28 14:58	35°30.589’	145°37.227’	12057530	XCTD 8	
112	E10	2014/06/18 15:06	35°31.71’	145°37.68’	116151 116152	Deploy drifting buoys	
113	E9	2014/06/28 16:21	35°45.21’	145°43.10’	339967	Sonde 35	
114	E9	2014/06/28 16:25	35°45.491’	145°43.227’	12057531	XCTD 9	
115	E8	2014/06/28 17:48	36°00.14’	145°48.07’	339968	Sonde 36	
116	E8	2014/06/28 17:52	36°00.493’	145°48.181’	12057532	XCTD 10	
117	N1	2014/06/28 19:30	36°10.31’	145°34.25’	339966	Sonde 37	
118	N1	2014/06/28 19:36	36°10.641’	145°33.805’	12057536	XCTD 11	
119	N2	2014/06/28 21:00	36°16.53’	145°22.78’	340014	Sonde 38	
120	N2	2014/06/28 21:04	36°19.95’	145°22.50’	12057533	XCTD 12	
121	N3	2014/06/28 22:30	36°30.121’	145°12.499’	340021	Sonde 39	
122	N3	2014/06/28	36°30.509’	145°12.296’	12057534	XCTD 13	Stopped at

		22:34					674m
123	N3	2014/06/28 22:42	36°31.179'	145°12.039'	12057535	XCTD 13	Retry End of Obs.

3.7 About data

Some of the data obtained in this cruise may be corrected after the cruise.

4. Notice on using

This cruise report is a preliminary documentation as of the end of the cruise.

This report may not be corrected even if changes on contents (i.e. taxonomic classifications) may be found after its publication. This report may also be changed without notice. Data on this cruise report may be raw or unprocessed. If you are going to use or refer to the data written on this report, please ask the Chief Scientist for latest information.

Users of data or results on this cruise report are requested to submit their results to the Data Management Group of JAMSTEC.

Acknowledgements

We would like to express our sincere thanks to Captain Ukekura and his crew for their skillful operation.

Appendix 1 Details of the Sediment-trap (BGC) mooring

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Tetsuichi FUJIKI (JAMSTEC)
Tomoyuki TAKAMORI (MWJ)
Katatoshi KIYOKAWA (MWJ)

1. Recovery and deployment

The BGC mooring system was designed for biogeochemistry at Station S-1 and KEO in the Western Subtropical Gyre. We recovered BGC mooring at Station S-1 which were deployed during MR13-04 cruise and deployed modified BGC mooring at new time-series station KEO. It took approximately 4 hours for recovery and took only less than 1 hour and half for deployment. After sinker was dropped, we positioned the mooring systems by measuring the slant ranges between research vessel and the acoustic releaser. The position of the mooring was finally determined as follow:

Table A1. Mooring positions for respective mooring systems

	Recovery	Deployment
Station & type Mooring Number	S-1 BGC S1BGC130717	KEO BGC KEOBGC140627
Working Date	Jun. 22th 2014	Jun. 27th 2014
Latitude	30° 03.86 N	32° 22.04 N
Longitude	144° 57.80 E	144° 25.11 E
Sea Beam Depth	5,927 m	5,779 m

The recovered BGC mooring consists of a advance buoy with 30m pick up rope, a 64" syntactic top float with 3,000 lbs (1,360 kg) buoyancy, instruments, wire and nylon ropes, glass floats (Benthos 17" glass ball), dual releasers (Edgetech) and sinker of 4,660 lbs (2,116 kg). Two ARGOS compact mooring locators and one submersible recovery strobe were mounted on the top float. The BGC mooring consisted of 3 Sediment Traps installed on the 200 m, 500 m and 5,000m.

The deployed BGC mooring at KEO consists of top float, wire / nylon ropes, glass floats (Benthos 17" glass ball), dual releasers (Edgetech), sinker of 4,660 lbs (2,116 kg) and one time-series sediment trap (McLane Mark7-21) located at about 4900 m. An ARGOS compact mooring locator and one submersible recovery strobe were mounted on the top

float. Serial numbers for instruments are as follows:

Table A2. Serial numbers of instruments

	Recover	Deployment
Station and type	S-1 BGC	KEO BGC
Mooring Number	S1BGC130717	KEOBGC140627
Top Buoy(150m)	025162-01	
ARGOS	A10-057 / A10-058	
ARGOS ID	126530 / 126529	
Strobe	A10-056	
Sediment Trap(200m)		
Nichiyu	ST98080	
JFE Depth sensor	082U009	
Back Scattero meter	891	
Sediment Trap(500m)		
Mark7-21	62-665	
Sediment Trap(4810m)		
Mark7-21	10236-01	
Sediment Trap(4950m)		
Mark7-21		12401-01
Releaser	27815	27805
Releaser	28386	34040
SBE-37	2730	
AREC DO sensor	052	

Table A3. Recovery BGC Mooring Record at S-1

Mooring Number	S1BGC130717				
Project	Time-Series		Depth	5,920.0	m
Area	North Pacific		Planned Depth	5,915.0	m
Station	S1 BGC		Length	5,752.3	m
Target Position	**30°03.8656**	**N**	Depth of Buoy	150	m
	144°58.0275	**E**	Period	1	year
ACOUCTIC RELEASERS					
Type	Edgetech		Edgetech		
Serial Number	27815		28386		
Receive F.	11.0	kHz	11.0	kHz	
Transmit F.	14.0	kHz	14.0	kHz	
RELEASE C.	**344657**		**354501**		
Enable C.	361035		376513		
Disable C.	361073		376530		
Battery	2 years		2 years		
Release Test	OK		OK		
RECOVERY					
Recorder	Takamori Tomoyuki		Work Distance	-	Nmile
Ship	R/V KAIYO		Send Enable C.	0:30	
Cruise No.	KY14-09		Slant Renge	6008	m
Date	2014/6/22		Send Release C.	0:33	
Weather	F		Discovery Buoy	0:36	
Wave Hight	-	m	Pos. of Top Buoy	-	N
Seabeam Depth	5,927	m		-	E
Ship Heading	-		Pos. of Start	-	N
Ship Ave.Speed	-	knot		-	E
Wind	<SW> 10.0	m/s	Pos. of Finish	-	N
Current	-	knot		-	E

Table A4. Deployment BGC Mooring Record at KEO

Mooring Number	KEOBGC140627				
Project	Time-Series		Depth	5,779.1	m
Area	North Pacific		Planned Depth	5600.0	m
Station	KEO BGC		Length	900	m
Target Position	**32°15.16**	**N**	Depth of Buoy	4700	m
	144°34.20	**E**	Period	1	year
ACOUCTIC RELEASERS					
Type	Edgetech		Edgetech		
Serial Number	27805		34040		
Receive F.	11.0	kHz	11.0	kHz	
Transmit F.	14.0	kHz	14.0	kHz	
RELEASE C.	**344611**		**233770**		
Enable C.	360631		221130		
Disable C.	360677		221155		
Battery	2 years		2 years		
Release Test	OK		OK		
DEPLOYMENT					
Recorder	Tomoyuki Takamori		Start	1.5	Nmile
Ship	R/V KAIYO		Overshoot	-	m
Cruise No.	KY14-09		Let go Top Buoy	23:28	
Date	2014/6/27		Let go Anchor	0:41	
Weather	R		Sink Top Buoy	-	
Wave Hight	-	m	Pos. of Start	32°22.67	N
Seabeam Depth	5,779	m		144°22.48	E
Ship Heading	<100>		Pos. of Drop. Anc.	32°21.96	N
Ship Ave.Speed	1.5	knot		144°25.11	E
Wind	<East> 7.0	m/s	Pos. of Mooring	32°22.04	N
Current	<182> 0.5	Knot		144°25.11	E

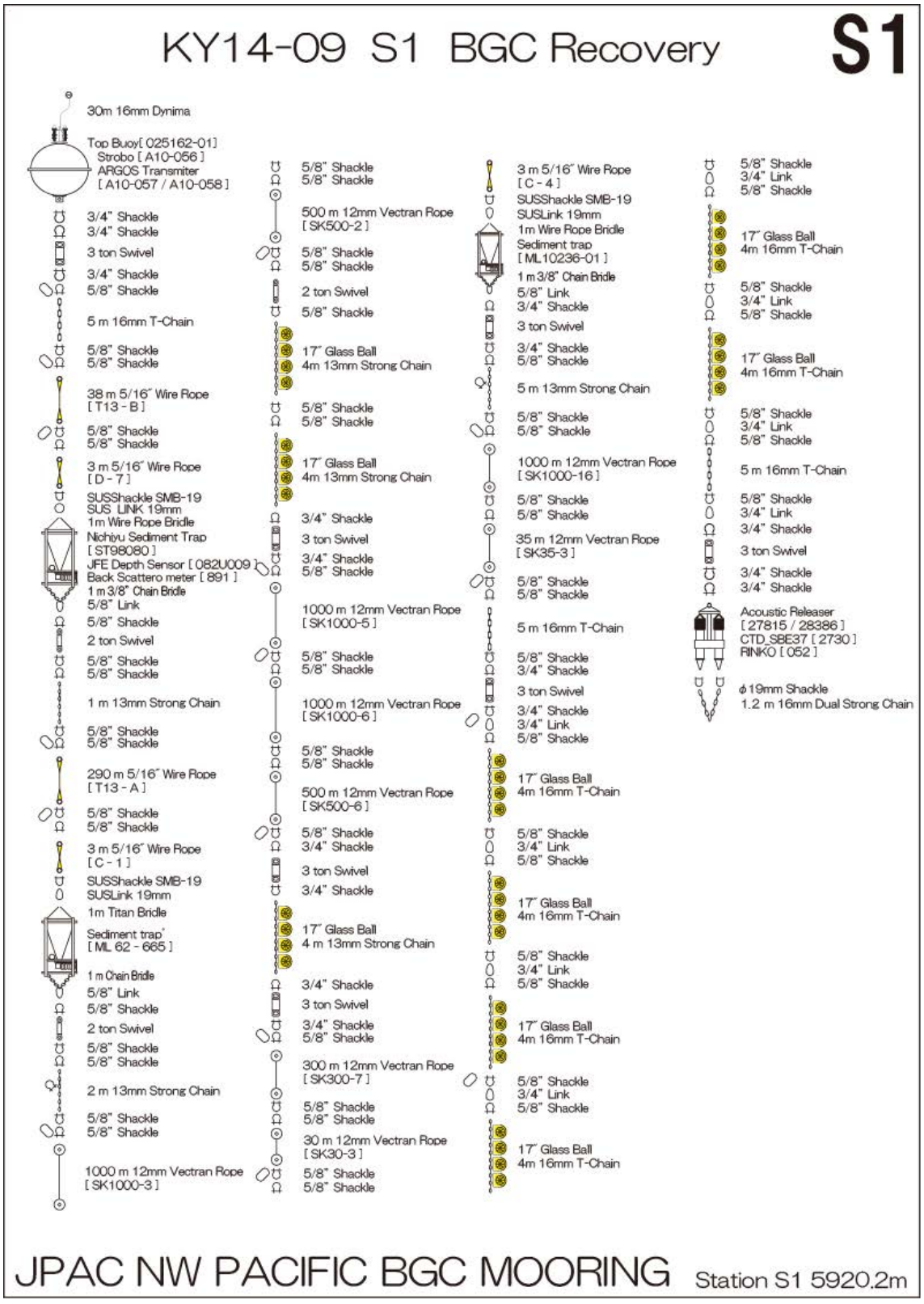

Figure A1. Recovery BGC Mooring Figure at S-1

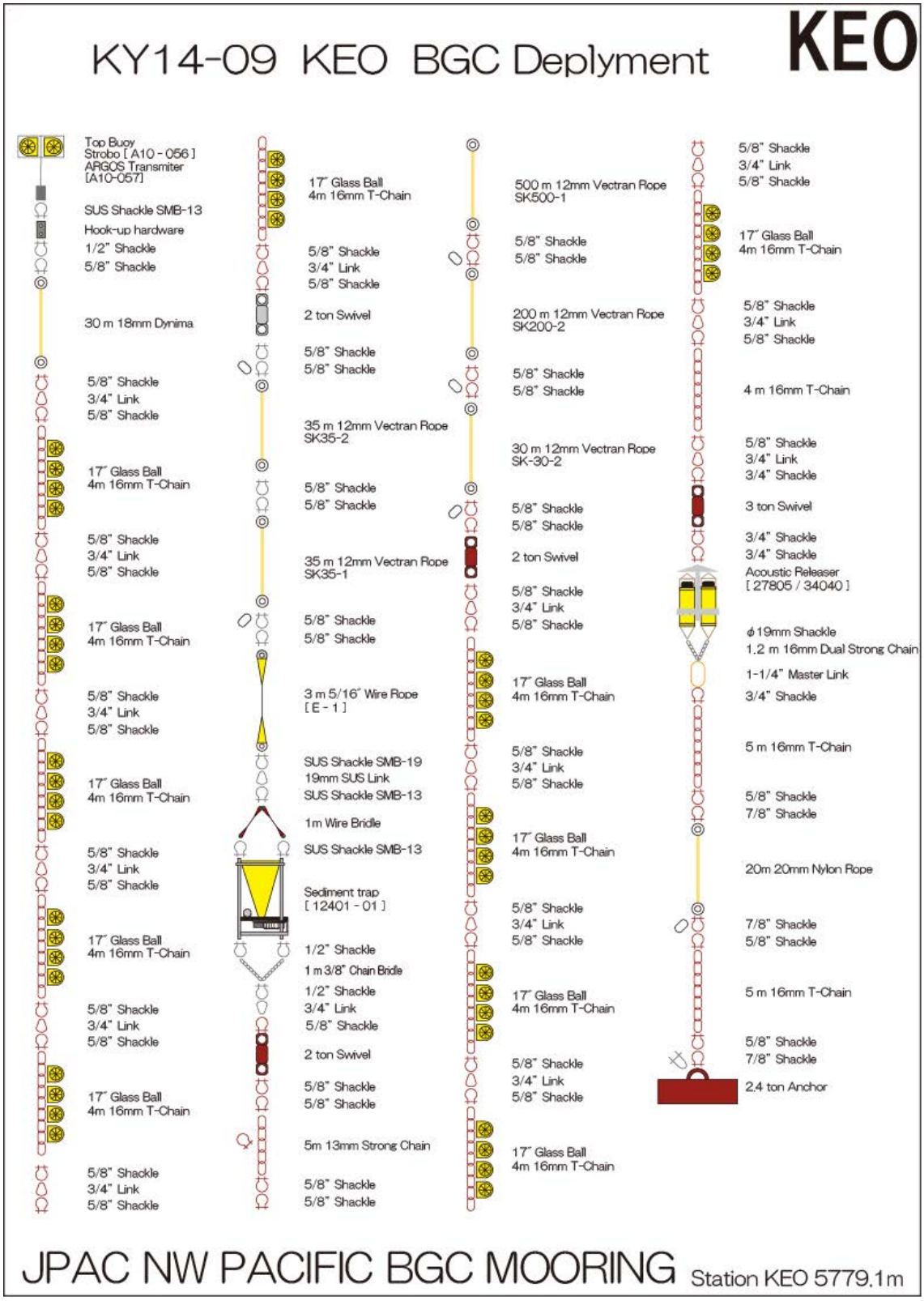

Figure A2. Deployment BGC Mooring Figure at KEO

Table A5. Calculation sheet of length and weight of KEO mooring

	Description	S/N	Joint	Item Length (m)	Item Weight (kg)	Mooring Length (m)	Mooring Weight (kg)	Above Bottom (m)	Mooring Depth (m)
1	Top buoy			1.50	-35.00		-35.00	979.79	4799.21
	1/2SUS SH - 1/2SH(Special Item) - 5/8SH(side Link)			0.20	2.00	1.70	-33.00	978.29	4800.71
	30 Meters Dynima			30.00	0.00	31.70	-33.00	978.09	4800.91
	5/8SH-3/4Li-5/8SH		H	0.23	2.00	31.93	-31.00	948.09	4830.91
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	35.93	-110.36	947.86	4831.14
	5/8SH-3/4SLi-5/8SH		H	0.23	2.00	36.16	-108.36	943.86	4835.14
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	40.16	-187.72	943.63	4835.37
	5/8SH-3/4SLi-5/8SH		H	0.23	2.00	40.39	-185.72	939.63	4839.37
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	44.39	-265.08	939.40	4839.60
	5/8SH-3/4Li-5/8SH		H	0.23	2.00	44.62	-263.08	935.40	4843.60
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	48.62	-342.44	935.17	4843.83
	5/8SH-3/4Li-5/8SH		H	0.23	2.00	48.85	-340.44	931.17	4847.83
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	52.85	-419.80	930.94	4848.06
	5/8SH-3/4Li-5/8SH		H	0.23	2.00	53.08	-417.80	926.94	4852.06
	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	57.08	-497.16	926.71	4852.29
	5/8SH-3/4Li-5/8SH		H	0.23	2.00	57.31	-495.16	922.71	4856.29
	2-TON Miller Swivel			0.16	3.17	57.47	-491.99	922.48	4856.52
	5/8SH - 5/8SH(Side Link)		D	0.12	1.40	57.59	-490.59	922.32	4856.68
	50 Meters 12mm Vectran Rope			50.00	1.75	107.59	-488.84	922.20	4856.80
	5/8SH - 5/8SH(Side Link)		D	0.12	1.40	107.71	-487.44	872.20	4906.80
	3 Meters 5/16inch Wire Coated			3.00	0.64	110.71	-486.80	872.08	4906.92
	5/8SS SH × 3		M	0.06	0.70	110.77	-486.10	869.08	4909.92
53	Sediment Trap		Y	3.80	55.70	114.57	-430.40	869.02	4909.98
54	3/4Li - 5/8SH		G	0.13	1.80	114.70	-428.60	865.22	4913.78
55	2-TON Miller Swivel			0.16	3.17	114.86	-425.43	865.09	4913.91
56	5/8SH - 5/8SH(Side Link)		E	0.12	1.50	114.98	-423.93	864.92	4914.08
57	5.0 Meters 13mm Strong-Chain			5.00	12.85	119.98	-411.08	864.81	4914.19
58	5/8SH - 5/8SH(Side Link)		D	0.12	1.40	120.10	-409.68	859.81	4919.19
	300 Meters 12mm Vectran Rope			300.00	10.50	420.10	-399.18	859.69	4919.31
	5/8SH - 5/8SH(Side Link)		D	0.12	1.40	420.22	-397.78	559.69	5219.31
59	500 Meters 12mm Vectran Rope			500.00	17.50	920.22	-380.28	559.57	5219.43
60	5/8SH - 5/8SH(Side Link)		D	0.12	1.40	920.34	-378.88	59.57	5719.43
	2-TON Miller Swivel			0.16	3.17	920.50	-375.71	59.45	5719.55
64	5/8SH-3/4Li-5/8SH		H	0.23	2.00	920.73	-373.71	59.29	5719.71
65	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	924.73	-453.07	59.06	5719.94
66	5/8SH-3/4Li-5/8SH		H	0.23	2.00	924.96	-451.07	55.06	5723.94
67	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	928.96	-530.43	54.83	5724.17
68	5/8SH-3/4Li-5/8SH		H	0.23	2.00	929.19	-528.43	50.83	5728.17
69	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	933.19	-607.79	50.60	5728.40
70	5/8SH-3/4Li-5/8SH		H	0.23	2.00	933.42	-605.79	46.60	5732.40
71	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	937.42	-685.15	46.37	5732.63
72	5/8SH-3/4Li-5/8SH		H	0.23	2.00	937.65	-683.15	42.37	5736.63
73	4-17inch Glassballs on 16mm T-Chain			4.00	-79.36	941.65	-762.51	42.14	5736.86
74	5/8SH-3/4Li-5/8SH		H	0.23	2.00	941.88	-760.51	38.14	5740.86
75	4 Meters 16mm T-Chain			4.00	22.24	945.88	-738.27	37.91	5741.09
78	5/8SH-3/4Li-5/8SH		D	0.12	1.40	946.00	-736.87	33.91	5745.09
79	3-TON Miller Swivel			0.16	3.20	946.16	-733.67	33.79	5745.21
80	3/4SH - 3/4SH		I	0.14	2.20	946.30	-731.47	33.63	5745.38
81	Dual EGG Acoustic Releases		L	1.95	66.04	948.25	-665.43	33.49	5745.52
82	5/8SH -3/4SH		G	0.13	1.80	948.38	-663.63	31.54	5747.46
83	5 Meters 16mm T-Chain			5.00	27.80	953.38	-635.83	31.41	5747.59
84	5/8SH - 7/8SH		J	0.15	2.45	953.53	-633.38	26.41	5752.59
85	20 Meters 1inch Nylon			20.00	5.96	973.53	-627.42	26.26	5752.74
86	5/8SH - 7/8SH		J	0.15	2.45	973.68	-624.97	6.26	5772.74
87	5 Meters 16mm T-Chain			5.00	27.80	978.68	-597.17	6.11	5772.89
88	Hardware		J	0.15	2.45	978.83	-594.72	1.11	5777.89
89	2.116 Ton Anchor			0.96	2116.46	979.79	1521.74	0.96	5778.04
	OVERALL MOORING LENGTH			979.79					5779.00

2. Instruments

On KEO mooring systems, the following instruments are installed.

(1) ARGOS CML (Compact Mooring Locator)

The Compact Mooring Locator is a subsurface mooring locator based on SEIMAC's Smart Cat ARGOS PTT (Platform Terminal Transmitter) technology. Using CML, we can know when our mooring has come to the surface and its position. The CML employs a pressure sensor at the bottom. When the CML is turned ON, the transmission is started immediately every 90 seconds and then when the pressure sensor works ON by approximately 10 dbar, the transmission is stopped. When the top buoy with the CML comes to the surface, the pressure sensor will work OFF and the transmission will be started. Smart Cat transmissions will be initiated at this time, allowing us to locate our mooring. Depending on how long the CML has been moored, it will transmit for up to 120 days on a 90 second repetition period. Battery life, however, is affected by how long the CML has been moored prior to activation. A longer pre-activation mooring will mean less activation life.

Principle specification is as follows:

(Specification)

Transmitter:	Smart Cat PTT
Operating Temp.:	+35 [deg] to –5 [deg]
Standby Current:	80 microamps
Smart Cat Freq.:	401.650 MHz
Battery Supply:	7-Cell alkaline D-Cells
Ratings:	+10.5VDC nom., 10 Amp Hr
Hull:	6061-T6 Aluminum
Max Depth:	1,000 m
Length:	22 inches
Diameter:	3.4 inches
Upper flange:	5.60 inches
Dome:	Acrylic
Buoyancy:	-2.5 (negative) approx.
Weight	12 pounds approx.

(2) Submersible Recovery Strobe

The NOVATECH Xenon Flasher is intended to aid in the marking or recovery of oceanographic instruments, manned vehicles, remotely operated vehicles, buoys or structures. Due to the occulting (firing closely spaced bursts of light) nature of this design,

it is much more visible than conventional marker strobes, particularly in poor sea conditions.

(Specification)

Repetition Rate:	Adjustable from 2 bursts per second to 1 burst every 3 seconds.
Burst Length:	Adjustable from 1 to 5 flashes per burst. 100 ms between flashes nominal.
Battery Type:	C-cell alkaline batteries.
Life:	Dependent on repetition rate and burst length. 150 hours with a one flash burst every 2 seconds.
Construction:	Awl-grip painted, Hard coat anodized 6061 T-6 aluminum housing.
Max. Depth:	7,300m
Daylight-off:	User selected, standard
Pressure Switch:	On at surface, auto off when submerged below 10m.
Weight in Air:	4 pounds
Weight in Water:	2 poundsOutside
Diameter:	1.7 inches nominal
Length:	21-1/2 inches nominal

3. Sampling schedule

After retrieving sample / data, replacement of new battery, preservative (seawater based 10% buffered formalin) and initialization of schedule (Table A6), sediment trap mooring system at KEO was deployed with following sampling schedule.

Table A6. Sampling schedule

KEO 4810m ST Schedule

sampling interval (days)	18

S/N	Open day and time
1	2014/7/1 0:00
2	2014/7/19 0:00
3	2014/8/6 0:00
4	2014/8/24 0:00
5	2014/9/11 0:00
6	2014/9/29 0:00
7	2014/10/17 0:00
8	2014/11/4 0:00
9	2014/11/22 0:00
10	2014/12/10 0:00
11	2014/12/28 0:00
12	2015/1/15 0:00
13	2015/2/2 0:00
14	2015/2/20 0:00
15	2015/3/10 0:00
16	2015/3/28 0:00
17	2015/4/15 0:00
18	2015/5/3 0:00
19	2015/5/21 0:00
20	2015/6/8 0:00
21	2015/6/26 0:00
22	2015/7/14 0:00

Appendix 2 POPPS mooring

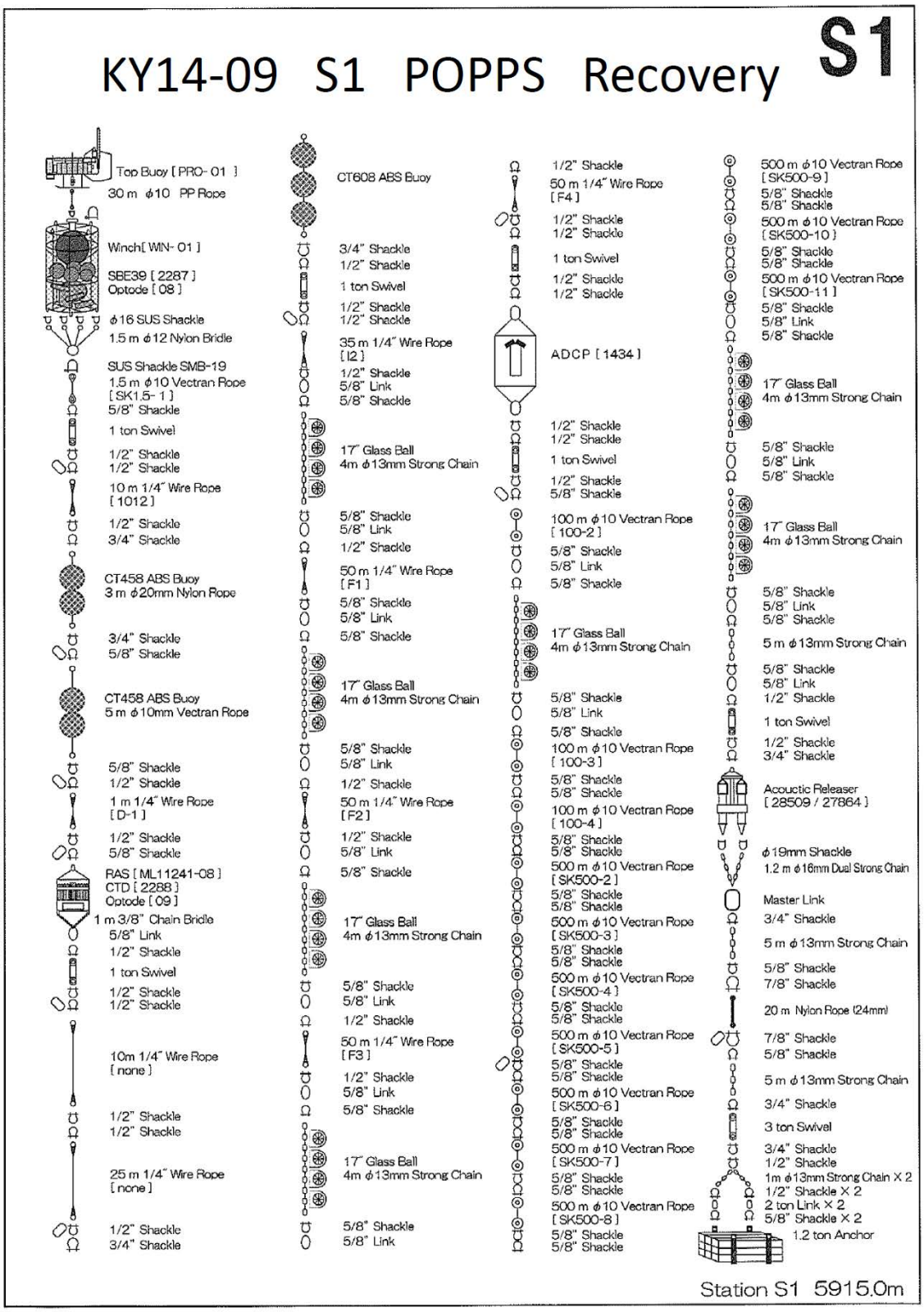

Figure A3. Detailed design of the POPPS mooring recovered at station S1 in KY14-09.

Appendix 3 Plankton net (VMPS) observations

Katsunori Kimoto (JAMSTEC)
Tetsuichi Fujiki (JAMSTEC)
Haruka Takagi (Waseda Univ./JAMSTEC)

1. Sampling for biological research for calcareous zooplankton

Calcareous zooplankton, Plankton tow sampling had performed by using the Vertical Multiple Plankton Sampler (VMPS, The Tsurumi Seiki Co., LTD., Yokohama, JAPAN) to collect microzooplankton from the Sta. S1, S2, and KEO. VMPS has 50cm x 50cm square aperture and four plankton nets can be set on the frame (Fig.A4). CTD (Sea-bird Electronics, Inc., WA, USA) and conductivity sensor with fluorometer (Wet lab, OR, USA) are equipped on the flame and observed data be monitored in real time on the shipboard console.

Towing of plankton net was carried out during hoisting up of winch. Closing of net was sent a close command from the console. Towing depths are listed in table 1. Collected samples were treated following method; 1) Living and healthy planktic foraminifers which had photosymbiotic algae were hand picked from the seawater by the pasteur pipette and incubated at 20°C temperature in the incubator. 2) Remnant materials were fixed by the 99.5 % ethanol and stored in the refrigerator for further research onshore laboratory.

On the ship, incubated planktic foraminifers were measured photosynthesis of symbiont algae by using the Fast Repetition Rate Fluorometry (FRRF) and recorded changes of photosynthetic activities in timeseries.

2. Preliminary result on shipboard faunal analysis

Species identifications were performed under stereomicroscope during the cruise. Mostry planktic foraminifer species at Sta. S1, S2 and KEO consist of subtropical species. Dominant species are: *Neogloboquadrina dutertrei, Globigerinita glutinata*, *Globigerinoides ruber, Globigerinoides sacculifer, Globigerinella siphonifera, Globorotalia truncatulinoides, and Streptochilus globulosus.* Minor species are: *Globigerinoides tenellus, Globigerinoides conglobatus, Globigerina rubescens, Orbulina universa,* and *Hastigerina pelagica.*

3. Future study of calcareous zooplankton

Planktic foraminifers and other calcareous plankton (e.g. Pteropods, Ostracods

etc.) will be analyzed shell morphology, and density for estimating influences by global ocean acidification. Molecular phylogenetic analysis will be conducted for identification of individual specimens of planktic foraminifers and its photosymbiotic algae.

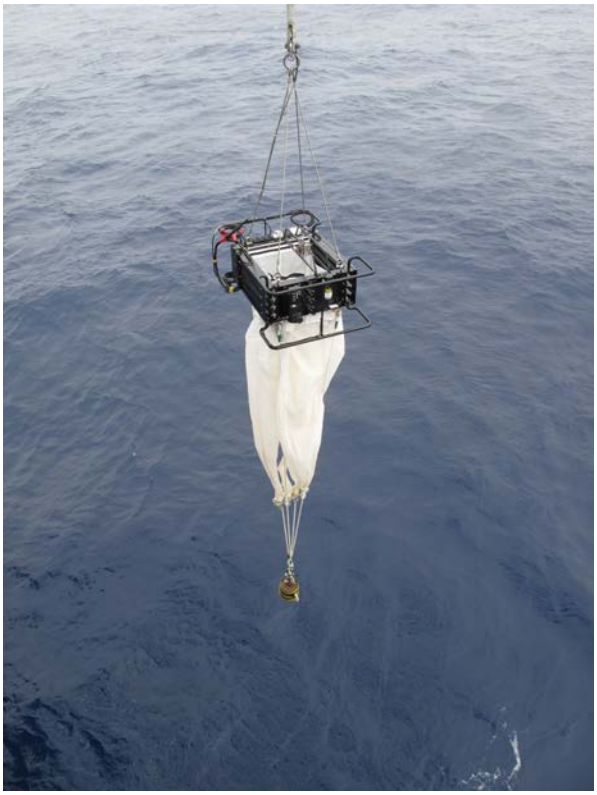

Figure A4. The overview of VMPS.

Table A7. Samploing log of plankton towing by VMPS during KY14-09 cruise.

Station	Latitude			Longitude			sampling depth(m)	date (y:m:d:t)				
Station S1	30	3.76	N	144	58.23	E	1000–700	2014	6	22	7:10	JST
	30	3.44	N	144	58.23	E	700–500	2014	6	22	7:45	JST
	30	3.36	N	144	58.24	E	500–300	2014	6	22	7:50	JST
	30	3.26	N	144	58.25	E	300–200	2014	6	22	7:56	JST
	30	2.97	N	144	58.62	E	200–100	2014	6	22	8:31	JST
	30	2.83	N	144	58.64	E	100–50	2014	6	22	8:45	JST
	30	2.78	N	144	58.65	E	50–20	2014	6	22	8:46	JST
	30	2.78	N	144	58.65	E	20–0	2014	6	22	8:47	JST
Station S2	28	0.00	N	145	0.00	E	1000–700	2014	6	23	13:33	JST
	28	00.01	N	144	59.97	E	700–500	2014	6	23	13:59	JST
	28	00.01	N	144	59.98	E	500–300	2014	6	23	14:03	JST
	28	00.02	N	144	59.98	E	300–200	2014	6	23	14:08	JST
	28	00.02	N	144	59.98	E	300–200	2014	6	23	14:33	JST
	28	00.01	N	144	59.98	E	200–100	2014	6	23	14:42	JST
	28	00.05	N	144	59.98	E	100–50	2014	6	23	14:45	JST
	28	00.05	N	144	59.98	E	50–0	2014	6	23	14:46	JST
	27	59.99	N	144	59.96	E	300–200	2014	6	23	15:05	JST
	27	59.99	N	144	59.99	E	200–100	2014	6	23	15:19	JST
	27	59.99	N	144	59.99	E	100–50	2014	6	23	15:21	JST
	27	59.99	N	144	59.99	E	50–0	2014	6	23	15:22	JST
Station S1	30	00.12	N	145	00.16	E	300–200	2014	6	24	15:03	JST
	29	59.93	N	145	00.00	E	200–100	2014	6	24	15:14	JST
	29	59.93	N	145	00.00	E	100–50	2014	6	24	15:17	JST
	29	59.93	N	145	00.00	E	50–0	2014	6	24	15:18	JST
	30	00.20	N	144	59.99	E	300–200	2014	6	24	15:38	JST
	30	00.05	N	144	59.75	E	200–100	2014	6	24	15:48	JST
	30	00.05	N	144	59.75	E	100–50	2014	6	24	15:51	JST
	30	00.05	N	144	59.75	E	50–0	2014	6	24	15:52	JST
Station KEO	32	22.00	N	144	25.0	E	300–200	2014	6	27	15:05	JST
	32	21.94	N	144	24.81	E	200–100	2014	6	27	15:17	JST
	32	21.94	N	144	24.81	E	100–50	2014	6	27	15:20	JST
	32	21.93	N	144	24.83	E	50–0	2014	6	27	15:21	JST
	32	21.94	N	144	24.89	E	300–200	2014	6	27	15:40	JST
	32	21.94	N	144	24.89	E	200–100	2014	6	27	15:52	JST
	32	21.97	N	144	24.92	E	100–50	2014	6	27	15:54	JST
	32	21.97	N	144	24.92	E	50–0	2014	6	27	15:55	JST