A. Cruise narrative

1. Highlights

Cruise designation: RF10-05（WHP-P09 revisit）

a. EXPOCODE: 49UP20100706

b. Chief scientist: Toshiya NAKANO (nakano_t@met.kishou.go.jp)

Marine Division

Global Environment and Marine Department

Japan Meteorological Agency (JMA)

1-3-4, Otemachi, Chiyoda-ku, Tokyo 100-8122, JAPAN

Phone: +81-3-3212-8341 Ext. 5163

FAX: +81-3-3211-6908

c. Ship name: R/V Ryofu Maru

d. Ports of call: Leg 1: Tokyo - Palau, Leg 2: Palau - Saipan

e. Cruise dates: Leg 1: 6 July 2010 - 28 July 2010

Leg 2: 1 August 2010 - 22 August 2010

2. Cruise Summary Information

RF10-05 cruise was carried out during the period from July 6 to September 1, 2010. The cruise started from the south of Honshu, Japan, and sailed towards south along approximately 137°E meridian. This line was observed by JMA in 1994 as 'WHP-P9', which is a part of WOCE (World Ocean Circulation Experiment) Hydrographic Programme.

A total of 124 stations was occupied using a Sea-Bird Electronics (SBE) 36 position carousel equipped with 10-liter Niskin water sample bottles, a CTD system (SBE911plus) equipped with SBE35 deep ocean standards thermometer, JFE Advantech oxygen sensor (RINKO III), Teledyne Benthos altimeter, and Teledyne RD Instruments Lowered Acoustic Doppler Current Profiler (L-ADCP). To examine consistency of data, we carried out the observation three times at 7°N, 137°E (Stn.67, 68, 124) and twice at 2°N, 142°E (Stn.83, 104). Cruise track and station location are shown in Figure 1.

At each station, full-depth $CTDO_2$ (temperature, conductivity (salinity) and dissolved oxygen) profile and up to 36 water samples were taken and analyzed. Water samples were obtained from 10 dbar to approximately 10 meters above the bottom. In addition, surface water were sampled by stainless steel bucket at each station. Sampling layer is designed as so-called staggered mesh as shown in Table 1. The bottle depth diagram is shown in Figure 2.

Water samples were analyzed for salinity, dissolved oxygen, nutrients, dissolved inorganic carbon (DIC), total alkalinity (TA), pH, CFC-11, -12 and chlorophyll-a. Samples for dissolved organic carbon (DOC) and ^{13}C were also collected at the selected stations. Underway measurements of partial pressure of carbon dioxide (pCO_2), temperature, salinity, chlorophyll-a, subsurface current, bathymetry and meteorological parameters were conducted along the cruise track.

R/V Ryofu Maru departed Tokyo (Japan) on July 6, 2010. Before the observation at the first station, all watch standers were drilled in the method of sample drawing and CTD operations near Izu-Oshima (34°40'N, 139°37'E). In order to estimate the misalignment of the

ship-mounted Acoustic Doppler Current Profiler (ADCP), we collected the bottom tracking data for about an hour off Omaezaki (around 34°22’N, 137°55’E). The hydrographic cast of $CTDO_2$ was started at the first station (Stn.1 (34°15’N, 137°E; RF3649)) on July 7. Leg 1 consisted of 67 stations from Stn.1 to Stn.67 (7°N, 137°E; RF3715). She called for Palau (Republic of Palau) on July 28, 2010 (Leg.1). She left Palau on August 1, 2010 for Saipan (Commonwealth of the Northern Mariana Islands) and arrived on August 22, 2010 (Leg.2). Leg 2 consisted of 57 stations from Stn.68 (7°N, 137°E; RF3716) to Stn.124 (7°N, 137°E; RF3772).

To wait the issue of a clearance letter for the EEZ of Papua New Guinea, we carried out from Stn.105 (2°03’N, 141°45’E; RF3732) to Stn.107 (2°09’N, 141°15’E; RF3734) after observation at Stn.83 (2°N, 142°E; RF3731) on August 5. After the issue of the clearance letter, we resumed from Stn.84 (1°45’N, 142°E; RF3735) on August 6. To carry out four stations from Stn.100 (2°05’S, 141°45’E; RF3750) to Stn.103 (2°22’S, 141°08’E; RF3747) near the coast of Papua New Guinea during the daytime, we sailed to Stn.103 (2°22’S, 141°08’E; RF3747) after at Stn.95 (1°S, 142°E; RF3746), and resumed on August 9.

No floats, drifters nor mooring was deployed nor recovered during the cruise.

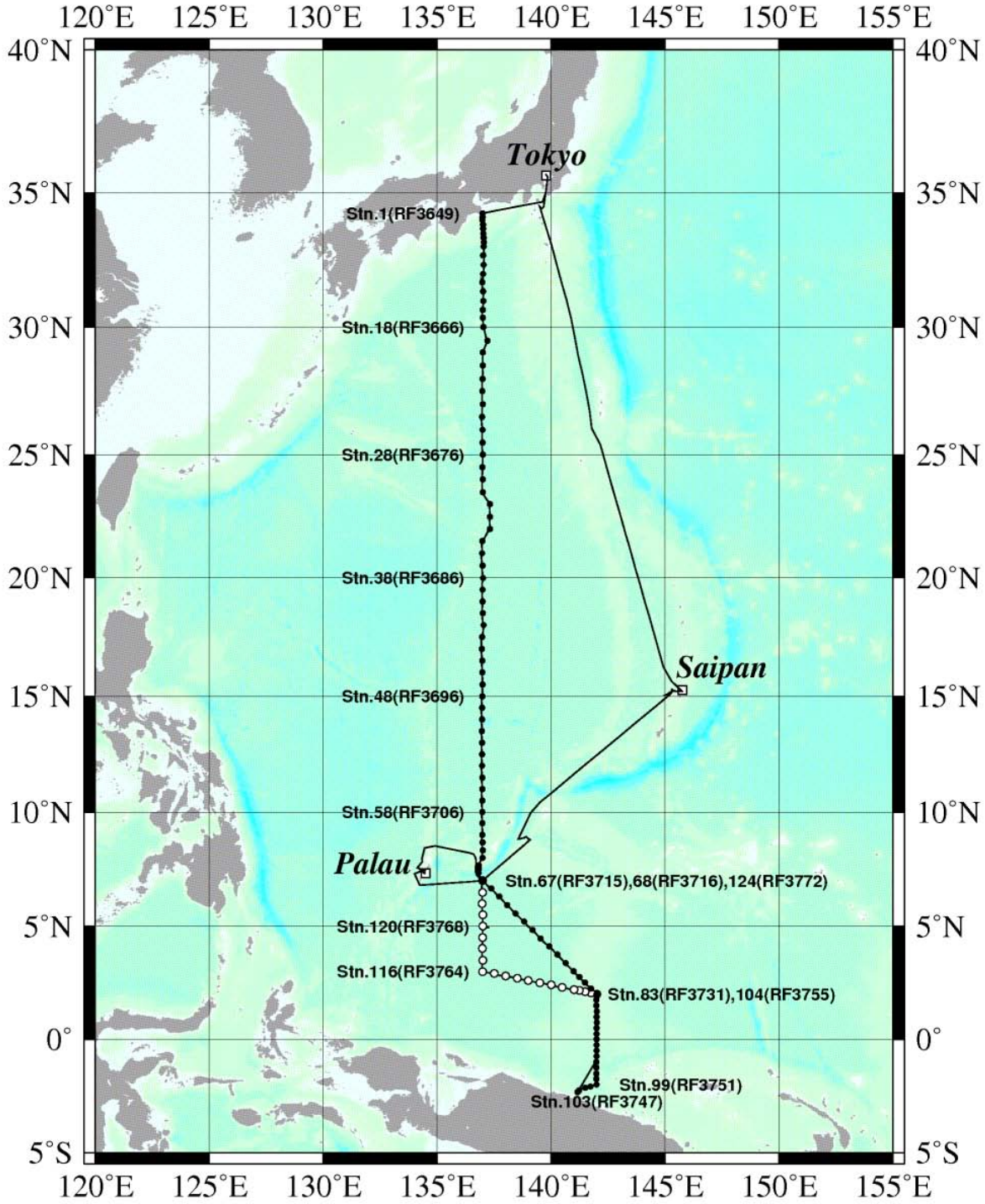

Figure 1 Cruise track of RF10-05.

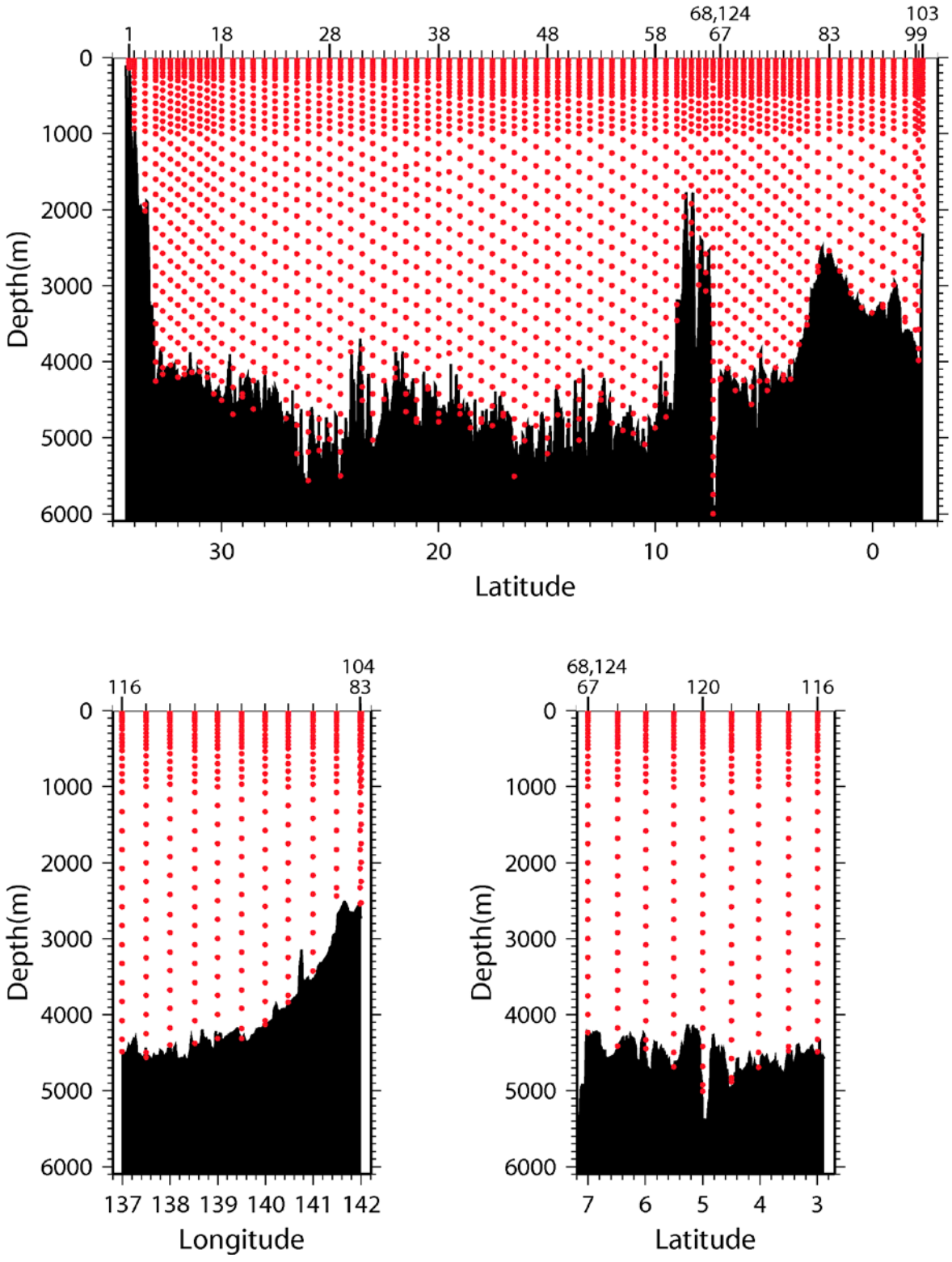

Figure 2 The bottle depth diagram for WHP-P9 revisit.

Table 1 The scheme of sampling layer in meters.

	North of 20°N (Stn.1 – Stn.38)			**South of 20°N (Stn-38-Stn.124)**			**Yap Trench (Stn.66)**
Bottle count	***scheme1***	***scheme2***	***scheme3***	***scheme4***	***scheme5***	***scheme6***	***scheme7***
1	10	10	10	10	10	10	10
2	25	25	25	25	25	25	50
3	50	50	50	50	50	50	75
4	75	75	75	75	75	75	100
5	100	100	100	100	100	100	125
6	125	125	125	125	125	125	150
7	150	150	150	150	150	150	200
8	200	200	200	200	200	200	250
9	250	250	250	250	250	250	300
10	300	330	280	300	320	280	400
11	400	430	370	350	370	330	500
12	500	530	470	400	420	380	600
13	600	630	570	450	470	430	700
14	700	730	670	500	530	480	800
15	800	830	770	600	630	570	900
16	900	930	870	700	730	670	1000
17	1000	1070	970	800	830	770	1250
18	1200	1270	1130	900	930	870	1500
19	1400	1470	1330	1000	1080	970	1750
20	1600	1670	1530	1250	1330	1170	2000
21	1800	1870	1730	1500	1580	1420	2250
22	2000	2080	1930	1750	1830	1680	2500
23	2250	2330	2170	2000	2080	1920	2750
24	2500	2580	2420	2250	2330	2170	3000
25	2750	2830	2680	2500	2580	2420	3250
26	3000	3080	2920	2750	2830	2680	3500
27	3250	3330	3180	3000	3080	2920	3750
28	3500	3580	3420	3250	3330	3180	4000
29	3750	3830	3680	3500	3580	3420	4250
30	4000	4080	3920	3750	3830	3680	4500
31	4250	4330	4180	4000	4080	3920	4750
32	4500	4580	4420	4250	4330	4180	5000
33	4750	4830	4680	4500	4580	4420	5250
34	5000	5080	4920	4750	4830	4680	5500
35	5250	5330	5180	5000	5080	4920	5750
36	5500	5580	5420	5250	5330	5180	6000

Table 2 Station data of RF10-05 cruise. The 'RF' column indicates the JMA station identification number.

Leg	*Station*		*Position*		*Leg*	*Station*		*Position*	
	Stn.	*RF*	*Latitude*	*Longitude*		*Stn.*	*RF*	*Latitude*	*Longitude*
1	1	3649	34-14.85 N	136-59.47 E	1	36	3684	20-59.83 N	136-58.21 E
1	2	3650	34-06.71 N	136-59.24 E	1	37	3685	20-29.06 N	136-59.41 E
1	3	3651	34-00.94 N	136-58.40 E	1	38	3686	19-58.25 N	137-00.39 E
1	4	3652	33-50.14 N	137-00.82 E	1	39	3687	19-29.39 N	136-59.28 E
1	5	3653	33-41.22 N	137-00.79 E	1	40	3688	18-59.74 N	136-59.04 E
1	6	3654	33-30.31 N	137-01.55 E	1	41	3689	18-30.52 N	136-59.94 E
1	7	3655	33-21.12 N	137-02.20 E	1	42	3690	18-00.58 N	137-01.81 E
1	8	3656	33-11.27 N	137-02.34 E	1	43	3691	17-30.53 N	136-57.81 E
1	9	3657	33-01.56 N	137-02.01 E	1	44	3692	17-00.27 N	136-57.57 E
1	10	3658	32-42.25 N	137-00.65 E	1	45	3693	16-30.38 N	136-58.83 E
1	11	3659	32-20.90 N	137-01.94 E	1	46	3694	16-00.61 N	136-58.58 E
1	12	3660	32-00.61 N	137-00.75 E	1	47	3695	15-29.31 N	136-59.09 E
1	13	3661	31-41.64 N	136-58.71 E	1	48	3696	14-58.91 N	136-58.90 E
1	14	3662	31-21.19 N	137-00.50 E	1	49	3697	14-29.66 N	136-58.10 E
1	15	3663	30-59.46 N	137-01.14 E	1	50	3698	14-00.03 N	136-58.18 E
1	16	3664	30-39.21 N	136-59.69 E	1	51	3699	13-29.87 N	136-57.56 E
1	17	3665	30-21.57 N	136-59.92 E	1	52	3700	12-59.96 N	136-58.26 E
1	18	3666	30-00.10 N	137-01.43 E	1	53	3701	12-30.05 N	136-58.33 E
1	19	3667	29-28.67 N	137-11.93 E	1	54	3702	12-00.31 N	136-58.25 E
1	20	3668	29-01.75 N	136-59.89 E	1	55	3703	11-29.76 N	136-58.70 E
1	21	3669	28-31.08 N	137-00.02 E	1	56	3704	11-00.26 N	136-58.61 E
1	22	3670	27-59.90 N	136-59.33 E	1	57	3705	10-29.85 N	136-58.61 E
1	23	3671	27-31.45 N	136-58.97 E	1	58	3706	10-00.08 N	136-58.83 E
1	24	3672	27-00.52 N	136-59.86 E	1	59	3707	9-30.74 N	136-58.65 E
1	25	3673	26-30.40 N	136-57.70 E	1	60	3708	9-00.24 N	136-58.45 E
1	26	3674	25-59.83 N	136-59.19 E	1	61	3709	8-40.27 N	136-59.58 E
1	27	3675	25-29.17 N	136-59.31 E	1	62	3710	8-20.10 N	136-59.98 E
1	28	3676	25-00.65 N	137-00.21 E	1	63	3711	7-59.77 N	136-59.20 E
1	29	3677	24-30.44 N	136-58.66 E	1	64	3712	7-40.05 N	136-49.64 E
1	30	3678	24-00.94 N	136-59.92 E	1	65	3713	7-30.48 N	136-49.37 E
1	31	3679	23-29.77 N	136-59.67 E	1	66	3714	7-20.26 N	136-48.74 E
1	32	3680	23-00.92 N	137-18.82 E	1	67	3715	7-00.04 N	136-58.93 E
1	33	3681	22-29.37 N	137-18.40 E	2	68	3716	7-00.88 N	136-59.76 E
1	34	3682	21-59.97 N	137-18.57 E	2	69	3717	6-39.49 N	137-21.88 E
1	35	3683	21-29.80 N	136-58.52 E	2	70	3718	6-17.74 N	137-43.07 E

Table 2 Continue.

Leg	***Station***		***Position***	
	Stn.	*RF*	*Latitude*	*Longitude*
2	71	3719	5-55.67 N	138-03.99 E
2	72	3720	5-33.31 N	138-25.79 E
2	73	3721	5-11.89 N	138-48.44 E
2	74	3722	4-50.02 N	139-10.52 E
2	75	3723	4-27.07 N	139-31.75 E
2	76	3724	4-06.04 N	139-54.57 E
2	77	3725	3-44.95 N	140-15.73 E
2	78	3726	3-21.94 N	140-37.71 E
2	79	3727	3-00.77 N	140-58.68 E
2	80	3728	2-45.45 N	141-14.11 E
2	81	3729	2-30.34 N	141-28.92 E
2	82	3730	2-14.41 N	141-44.74 E
2	83	3731	1-59.46 N	141-59.05 E
2	84	3735	1-44.79 N	141-58.73 E
2	85	3736	1-29.52 N	141-58.56 E
2	86	3737	1-14.31 N	141-59.87 E
2	87	3738	0-59.52 N	141-59.07 E
2	88	3739	0-44.71 N	141-59.89 E
2	89	3740	0-29.62 N	141-59.51 E
2	90	3741	0-14.50 N	141-59.26 E
2	91	3742	0-00.24 N	141-59.11 E
2	92	3743	0-15.42 S	141-59.21 E
2	93	3744	0-29.95 S	141-59.54 E
2	94	3745	0-44.90 S	141-59.39 E
2	95	3746	1-00.14 S	141-58.81 E
2	96	3754	1-15.01 S	141-58.48 E
2	97	3753	1-31.09 S	141-58.78 E
2	98	3752	1-45.22 S	141-58.92 E
2	99	3751	2-00.11 S	141-59.09 E
2	100	3750	2-05.25 S	141-43.59 E
2	101	3749	2-08.67 S	141-29.57 E
2	102	3748	2-15.11 S	141-13.64 E
2	103	3747	2-19.60 S	141-09.45 E
2	104	3755	1-59.43 N	142-00.12 E
2	105	3732	2-03.14 N	141-44.45 E
2	106	3733	2-06.16 N	141-29.56 E
2	107	3734	2-09.49 N	141-13.84 E
2	108	3756	2-11.70 N	140-59.67 E
2	109	3757	2-17.51 N	140-28.74 E
2	110	3758	2-24.22 N	139-59.72 E
2	111	3759	2-30.02 N	139-30.12 E
2	112	3760	2-35.75 N	138-59.52 E
2	113	3761	2-41.87 N	138-30.87 E
2	114	3762	2-47.99 N	138-00.11 E
2	115	3763	2-54.55 N	137-29.93 E
2	116	3764	2-59.58 N	136-59.63 E
2	117	3765	3-29.59 N	136-59.81 E
2	118	3766	4-01.31 N	136-58.47 E
2	119	3767	4-29.55 N	136-59.55 E
2	120	3768	4-59.94 N	136-59.75 E
2	121	3769	5-30.16 N	137-00.06 E
2	122	3770	5-59.22 N	136-58.21 E
2	123	3771	6-29.06 N	136-59.06 E
2	124	3772	7-00.20 N	136-59.16 E

3. List of Principal Investigators for all Measurements

The principal investigator (PI) and the person in charge responsible for major parameters measured on the cruise are listed in Table 3.

Table 3 List of principal investigator and the person in charge on the ship for RF10-05.

Item	Principal Investigator（PI）	Person in charge on the ship
Hydrography		
CTDO2 / LADCP	Masahiko FUJIMURA	Tetsuya NAKAMURA
Salinity	Masahiko FUJIMURA	Keizo SHUTTA
Dissolve oxygen	Masahiko FUJIMURA	Yusuke TAKATANI
Nutrients	Masahiko FUJIMURA	Kazuhiro SAITO
Chlorophyll-a	Masahiko FUJIMURA	Kazuhiro SAITO
DIC	Masahiko FUJIMURA	Shinji MASUDA
Total Alkalinity	Masahiko FUJIMURA	Shinji MASUDA
pH	Masahiko FUJIMURA	Shinji MASUDA
CFCs	Masahiko FUJIMURA	Kazuki ISHIMARU
DOC	Masao ISHII	Shinji MASUDA
^{13}C	Masao ISHII	Shinji MASUDA
Underway		
Meteorology	Masahiko FUJIMURA	Keizo SHUTTA
Thermo-Salinograph	Masahiko FUJIMURA	Shinji MASUDA
pCO_2	Masahiko FUJIMURA	Shinji MASUDA
Chlorophyll-a	Masahiko FUJIMURA	Kazuhiro SAITO
ADCP	Masahiko FUJIMURA	Tetsuya NAKAMURA
Bathymetry	Masahiko FUJIMURA	Takahiro SEGAWA

Masahiko FUJIMURA (fujimura.ma@met.kishou.go.jp)

Marine Division, Global Environment and Marine Department, JMA

1-3-4, Otemachi, Chiyoda-ku, Tokyo 100-8122, JAPAN

Phone: +81-3-3212-8341 Ext. 5150 FAX: +81-3-3211-6908

Masao ISHII (mishii@mri-jma.go.jp)

Geochemical Research Department, Meteorological Research Institute, JMA

1-1, Nagamine, Tsukuba, Ibaraki 305-0052, JAPAN

Phone: +81- 29-853- 8727 FAX: +81- 29-853-8728

4. Scientific Program and Methods

In recent years, the global environmental issues such as global warming and climate change have become one of the major socio-economic concerns, and it has become apparent that the ocean plays a key role in the climate system. For the better understanding and assessment of global environmental conditions, continuous monitoring of climate variables, concentrations of greenhouse gases both in the ocean and in the atmosphere. To meet those requirements, JMA has been conducting operational oceanographic observations by research vessels in the western North Pacific on a seasonal basis. RF10-05 cruise is one of these activities. The purposes of this cruise are as follows:

(1) To observe profiles of seawater temperature, salinity, dissolved oxygen, nutrients and carbon parameters, as well as upper ocean current;

(2) To observe concentrations of greenhouse gases both in the ocean and in the atmosphere;

(3) To observe bio-geochemical parameters to study carbon cycle in the ocean.

These activities are expected to contribute to international projects related to global environmental issues such as the World Climate Research Programme (WCRP), IOCCP (International Ocean Carbon Coordination Project) and the Global Atmosphere Watch (GAW).

5. *Major Problems and Goals not Achieved*

Owing to kink in the wire, we reconnected the CTD cable at Stn.19 (29°30’ N, 137E; RF3667). After observed of Stn.104 (2° N, 142°E; RF3755), owing to damage in the wire, we cut the wire about 700 m in length, and reconnected the CTD cable.

6. List of Cruise Participants

The cruise participants of the cruise is listed in Table 4.

Table 4 List of cruise participants for RF10-05.

Name	**Responsibility**	**Affiliation**
Yasuaki BUNGI	Salinity	GEMD / JMA
Kazutaka ENYO	Carbon Items	GEMD / JMA
Hiroyuki FUJIWARA	Nutrients	GEMD / JMA
Sho HIBINO	Dissolved Oxygen	GEMD / JMA
Yoshikazu HIGASHI	CTDO / ADCP / LADCP	GEMD / JMA
Kazuki ISHIMARU	CFCs	GEMD / JMA
Takahiro KITAGAWA	Nutrients	GEMD / JMA
Tomoyuki KITAMURA	CTDO / ADCP / LADCP	GEMD / JMA
Naohiro KOSUGI	Carbon Items	MRI / JMA
Shinji MASUDA	Carbon Items / Thermo-Salinograph	GEMD / JMA
Tetsuya NAKAMURA	CTDO / ADCP / LADCP	GEMD / JMA
Toshiya NAKANO	Chief Scientist	GEMD / JMA
Etsuro ONO	CFCs	GEMD / JMA
Takahiro SEGAWA	Salinity / Bathymetry	GEMD / JMA
Kazuhiro SAITO	Nutrients	GEMD / JMA
Keizo SHUTTA	Salinity / Meteorology	GEMD / JMA
Yusuke TAKATANI	Dissolved Oxygen / Chlorophyll-a	GEMD / JMA
Shinichiro UMEDA	Dissolved Oxygen / Chlorophyll-a	GEMD / JMA

GEMD / JMA: Marine Division, Global Environment and Marine Department, JMA

MRI / JMA: Geochemical Research Department, Meteorological Research Institute, JMA