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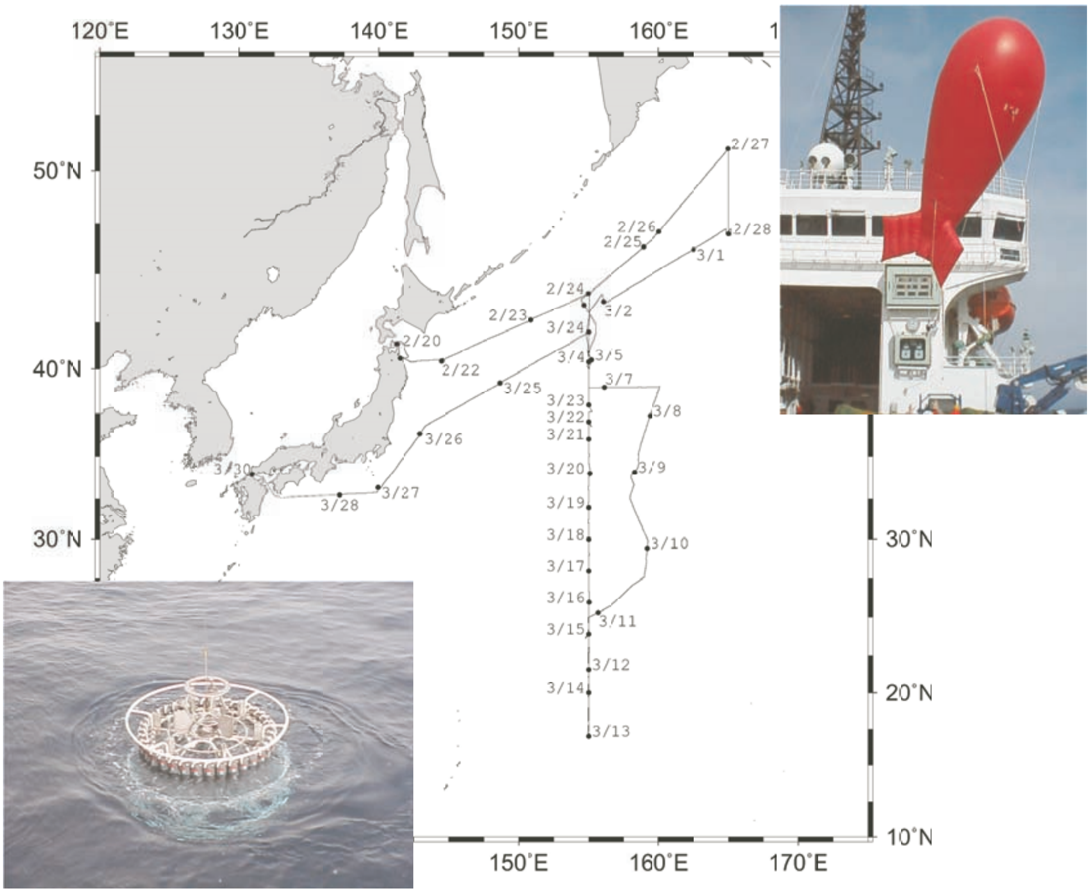
Cruise Report of MR03-K01

2003.2.20 ～ 2003.3.30

from the Abyss to the Altitude



JAMSTEC

May 2003

1. Preface

MR03-K01 cruise observation was carried out in the western North Pacific during 20 February and 30 March. The hydrographic observation along 155^{o}N and at time-series stations of Mutsu Institution was done. Fortunately, we did not have a lot of storms and was able to continue the observation.

In this cruise a lot of groups joined to study the biogeochemistry phenomena in ocean, atmospheric events over ocean. Purposes of Oceanographer are to obtain a lot of information for biogeochemical cycle of carbon and its related materials, and to join the post-JGOFS time series observation in the western North Pacific. Results obtained at the JGOFS time series observation station (KNOT) suggested the section observation along 155^{o}N is important to detect the small long term environmental change in the northern North Pacific. This study is related with the international program, SOLAS, OCEANS and CLIVAR.

Other main purpose conducted by atmospheric science group is to observe for transport and formation of aerosol, and human effects to aerosol over the ocean. A lot of dust originated in China, KOSA, is transport over the sea in end of winter and early spring, and leads the biogeochemical phenomena on the sea. The items related to atmospheric chemistry were continuously measured along cruise truck and were observed with the mooring balloon, Kytoon, at many stations. This observation is related with the international program, ACE-Asia.

This cruise was a long cruise about 40days in widely North Pacific. On board of cruise participants, acknowledge R/V Mirai captain Dr. Akamine and the crew for hard works and efforts on board during long cruise. We also thank marine technicians from Marine Work Japan and Global Ocean Development for their kindly support.

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2. Outline of MR03-K01

2.1 Cruise Summary

This cruise was conducted chiefly to study the global biogeochemical cycle, to make a database for detecting an environmental change, and to understand a formation and transport process of aerosol over the North Pacific. We collected water samples to measure chemical properties related with global climate change at 28 stations along 155^{o}E and 4 time-series stations in the northern North Pacific.

Aerosol and chemical properties were also observed continuously along cruise truck and at 13 stations using the mooring balloon, Kytoon, to study the role of aerosol and some gases in the atmosphere.

Eight institutions (JAMSTEC, Hokkaido Univ., Tokyo Univ., Tokyo Metropolitan Univ., Science Univ. of Tokyo, Kyoto Univ., NIES and NASDA) participated in this cruise.

We conducted several observations and analysis in this cruise as follows.

1) Hydrocasting

Water samples at 28 stations from 17^{o}N to 44^{o}N along 155^{o}E and 4 time-series stations were collected with CWS (Carousel Water Sampler) attached CTD (SBE 9 plus) for the detection of the seasonal variation of materials related the climate change in the western North Pacific. Salinity, dissolved oxygen gas, nutrients, carbonate species, some trace metal, CFCs, and others were determined. We also collected water samples for measurement of Th isotopes and collected particles using the in-site pumping system at 5 stations related time-series.

2) Underway measurements

Temperature, salinity, nutrients, pCO2 and TCO2 in surface seawater were measured continuously along this cruise track. Surface current of seawater was also measured using ADCP attached with R/V Mirai. Samples for POPs measurement in surface water were collected during cruise.

3) Aerosol and atmospheric components

Aerosol and atmospheric components were measured continuously along cruise track. At some stations those vertical profiles were obtained from sea surface to about 1000m heights using the Kytoon at 13 stations in the North Pacific.

Profiles of aerosol in the upper atmosphere were also measured using the Lidar and the Sky Radiometer.

4) Others

The observations related with atmospheric science, geology and others were also conducted in this cruise.

2.2 Cruise log and cruise track

Table 2.2-1. Cruise Log

Date	Start Time (LST)	Station	Position (Start)		Events
			Lat.	Lon.	
2003.2.20	14:54		41-22.0 N	141-14.4 E	Departure from Sekinehama
2.21	08:30		40-33.8 N	141-29.0 E	Arrival at Hachinohe
	14:30		40-33.8 N	141-29.0 E	Departure from Hachinohe
2.22	04:00		40-25.4 N	141-29.0 E	Arrival at CTD Free fall Point
	07:56		40-25.4 N	141-26.7 E	CTD Free fall
	12:24				Departure from CTD Free fall Point
2.23	14:08		43-11.9 N	152-33.1 E	OPC observation with flag line
	22:06	8 (KNOT)	44-00.0 N	155-00.0 E	Arrival at Station 8 (KNOT)
	22:14	8 (KNOT)	43-59.9 N	155-00.0 E	CTD/Water Sampler cast (300m)
2.24	00:29	8 (KNOT)	44-00.0 N	155-00.0 E	CTD/Water Sampler cast (510m)
	06:03	8 (KNOT)	44-00.0 N	154-57.5 E	CTD/Water Sampler cast (5300m)
	08:47	8 (KNOT)	44-00.2 N	154-57.9 E	Surface water sampling (bucket)
	13:29	8 (KNOT)	44-00.0 N	155-00.0 E	LVP deployment
	14:30	8 (KNOT)	44-00.0 N	155-00.0 E	LVP start pumping
	15:06	8 (KNOT)	44-00.0 N	155-00.0 E	OPC observation with flag line
	16:31	8 (KNOT)	44-00.1 N	155-00.4 E	LVP recover
	17:00				Departure from Stn. 8 (KNOT)
2.25	13:06	6 (K2)	47-00.0 N	160-00.0 E	Arrival at Stn. 6 (K2)
	13:08	6 (K2)	47-00.5 N	159-53.6 E	CTD/Water Sampler cast (400m)
	14:46	6 (K2)	47-00.7 N	159-54.0 E	OPC observation with flag line
	15:13	6 (K2)	47-00.4 N	159-53.8 E	CTD/Water Sampler cast (5100m)
2.26	04:56	6 (K2)	47-00.6 N	159-53.3 E	LVP deployment
	06:00	6 (K2)	47-00.3 N	159-53.3 E	LVP start pumping
	08:01	6 (K2)	47-01.5 N	159-54.8 E	LVP recover
	08:24				Departure from Stn. 6 (K2)
2.27	06:30	4 (K1)	51-00.0 N	165-00.0 E	Arrival at Stn. 4 (K1)
	06:54	4 (K1)	50-59.8 N	164-59.8 E	CTD/Water Sampler cast (4750m)
	09:11	4 (K1)	51-00.0 N	164-58.3 E	Surface water sampling (bucket)
	09:14	4 (K1)	51-00.1 N	164-58.2 E	Tethered balloon observation (OPC 1000 m)
	09:57	4 (K1)	51-00.2 N	164-57.7 E	Tethered balloon observation (Impactor 1000 m)
	10:09	4 (K1)	51-00.2 N	164-57.6 E	LVP deployment
	10:50	4 (K1)	51-00.5 N	164-57.5 E	LVP start pumping
	13:01	4 (K1)	51-00.4 N	164-57.8 E	LVP recover
	13:34	4 (K1)	51-00.5 N	164-57.3 E	CTD/Water Sampler cast (2000m)
	14:09	4 (K1)	51-00.6 N	164-57.6 E	OPC observation with flag line
	16:12	4 (K1)	50-59.9 N	165-00.0 E	CTD/Water Sampler cast (400m)
	17:00				Departure from Stn. 4 (K1)
2.28	08:48	3	47-00.0 N	165-00.0 E	Arrival at Station 3
	08:54	3	47-00.1 N	164-59.3 E	CTD/Water Sampler cast (5800m)
	10:05	3	47-00.1 N	164-59.0 E	OPC observation with flag line
	11:32	3	47-00.3 N	164-58.6 E	Surface water sampling (bucket)
	12:50	3	47-01.0 N	164-57.7 E	LVP deployment
	13:30	3	47-01.0 N	164-57.5 E	LVP start pumping
	14:31	3	47-01.0 N	164-57.4 E	LVP recover
	15:00	3	47-01.1 N	164-57.8 E	Ocean Topography Survey
	23:30				Departure from Stn. 3

Date	Start Time (LST)	Station	Position (Start)		Events
			Lat.	Lon.	
3.2	08:47		43-32.9 N	156-02.4 E	Tethered balloon observation (OPC 1000 m)
	09:42		43-43.6 N	156-00.9 E	Tethered balloon observation (CPC 1000 m)
	10:22		43-50.2 N	155-58.2 E	Tethered balloon observation (Impactor 1000 m)
	16:06	9	43-00.0 N	155-00.0 E	Arrival at Stn. 9
	16:10	9	43-02.0 N	155-02.4 E	CTD/Water Sampler cast (5320m)
	19:30				Departure from Stn. 9
3.6	02:48	9	43-00.0 N	155-00.0 E	Return to Stn. 9
	03:03	9	43-02.4 N	155-03.0 E	CTD/Water Sampler cast (2000m)
	03:50	9	43-02.1 N	155-03.4 E	Surface water sampling (bucket)
	04:42				Departure from Stn. 9
	12:54	11	41-00.0 N	155-00.1 E	Arrival at Stn. 11
	13:00	11	41-00.0 N	155-00.1 E	CTD/Water Sampler cast (5450m)
	14:30	11	40-59.6 N	154-59.4 E	OPC observation with flag line
	15:50	11	40-59.2 N	154-58.8 E	Surface water sampling (bucket)
	16:42				Departure from Stn. 11
3.7	00:48	13	39-00.0 N	155-00.0 E	Arrival at Stn. 13
	00:57	13	38-59.8 N	155-00.3 E	CTD/Water Sampler cast (5700m)
	04:41	13	38-59.8 N	155-00.3 E	Surface water sampling (bucket)
	05:36				Departure from Stn. 13
	14:04		38-59.3 N	157-49.2 E	OPC observation with flag line
	20:48	1	39-00.0 N	160-00.0 E	Arrival at Stn. 1
	20:48	1	39-00.1 N	160-00.0 E	CTD/Water Sampler cast (3000m)
	22:05	1	39-00.3 N	160-00.2 E	Surface water sampling (bucket)
	23:04	1	39-00.6 N	160-01.0 E	LVP deployment
	23:30	1	39-00.9 N	160-01.6 E	LVP start pumping
3.8	01:01	1	39-00.2 N	160-04.4 E	LVP recover
	01:28	1	39-02.8 N	160-04.9 E	CTD/Water Sampler cast (2000m)
	02:06				Departure from Stn. 1
3.11	11:48	33	25-00.0 N	155-00.0 E	Arrival at Stn. 33
	12:04	33	25-00.4 N	155-00.0 E	CTD/Water Sampler cast (5600m)
	13:07	33	25-00.4 N	154-58.8 E	OPC observation with flag line
	15:06	33	25-00.5 N	154-59.1 E	Surface water sampling (bucket)
	15:42				Departure from Stn. 33
	23:54	35	23-00.0 N	155-00.0 E	Arrival at Stn. 35
3.12	00:01	35	23-00.1 N	154-59.9 E	CTD/Water Sampler cast (5100m)
	02:25	35	23-00.4 N	155-00.4 E	Surface water sampling (bucket)
	03:30				Departure from Stn. 35
	11:18	37	21-00.0 N	155-00.0 E	Arrival at Stn. 37
	11:19	37	21-00.0 N	154-59.9 E	CTD/Water Sampler cast (1900m)
	12:18	37	20-59.8 N	155-00.0 E	Surface water sampling (bucket)
	12:54	37			Departure from Stn. 37
	13:30		20-48.8 N	154-59.5 E	OPC observation with flag line
	20:42	39	19-00.0 N	155-00.0 E	Arrival at Stn. 39
	20:45	39	19-00.1 N	155-00.0 E	CTD/Water Sampler cast (5600m)
3.13	00:24				Departure from Stn. 39

Date	Start Time (LST)	Station	Position (Start)		Events
			Lat.	Lon.	
	08:18	41	17-00.0 N	155-00.0 E	Arrival at Stn. 41
	08:24	41	17-00.3 N	155-00.0 E	CTD/Water Sampler cast (5700m)
	10:30	41	17-00.5 N	154-58.9 E	OPC observation with flag line
	12:42				Departure from Stn. 41
	17:30	40	18-00.0 N	155-00.0 E	Arrival at Stn. 40
	17:34	40	17-59.9 N	155-00.0 E	CTD/Water Sampler cast (5610m)
	20:57	40	18-00.3 N	154-59.3 E	Surface water sampling (bucket)
	21:42				Departure from Stn. 40
3.14	07:06	38	20-00.0 N	155-00.0 E	Arrival at Stn. 38
	08:50	38	20-00.0 N	155-00.0 E	CTD/Water Sampler cast (5700m)
	09:00	38	20-00.5 N	154-59.5 E	OPC observation with flag line
	10:36	38	20-00.6 N	154-58.9 E	Surface water sampling (bucket)
	11:12				Departure from Stn. 38
	19:48	36	22-00.0 N	155-00.0 E	Arrival at Stn. 36
	19:48	36	22-00.0 N	154-59.5 E	CTD/Water Sampler cast (5500m)
	23:00	36	22-00.1 N	154-58.9 E	Surface water sampling (bucket)
	23:30				Departure from Stn. 36
3.15	07:54	34	24-00.0 N	155-00.0 E	Arrival at Stn. 34
	08:24	34	24-02.3 N	155-03.1 E	Tethered balloon observation (OPC 1000 m)
	09:35	34	23-51.7 N	154-55.0 E	Tethered balloon observation (CPC 1000 m)
	10:51	34	23-43.4 N	154-50.0 E	Tethered balloon observation (Impactor 1000 m)
	13:35	34	24-00.0 N	155-00.0 E	Sea surface aerosol measurement
	14:27	34	24-00.4 N	154-39.8 E	OPC observation with flag line
	14:52	34	24-00.2 N	154-59.7 E	CTD/Water Sampler cast (New Flame Test) (3000m)
	18:57	34	24-00.1 N	154-58.7 E	CTD/Water Sampler cast (3000m)
	20:26	34	24-01.0 N	154-58.5 E	Surface water sampling (bucket)
	21:24				Departure from Stn. 34
3.16	07:18	32	26-00.0 N	155-00.0 E	Arrival at Stn. 32
	07:57	32	26-00.1 N	155-00.3 E	CTD/Water Sampler cast (5600m)
	09:32	32	25-59.8 N	155-01.1 E	OPC observation with flag line
	09:58	32	25-59.7 N	155-01.4 E	Sea surface aerosol measurement
	11:01	32	25-59.3 N	155-01.8 E	Surface water sampling (bucket)
	12:00				Departure from Stn. 32
	16:00	30	27-00.0 N	155-00.0 E	Arrival at Stn. 30
	16:05	30	26-59.8 N	155-00.4 E	CTD/Water Sampler cast (5873m)
	19:53	30	26-59.7 N	155-00.4 E	Surface water sampling (bucket)
	20:42				Departure from Stn. 30
3.17	04:30	28	28-00.0 N	155-00.0 E	Arrival at Stn. 28
	05:00	28	27-59.8 N	154-59.5 E	CTD/Water Sampler cast (5754m)
	06:20	28	27-59.5 N	155-00.0 E	Tethered balloon observation (OPC 1000 m)
	07:01	28	27-59.3 N	155-00.1 E	Tethered balloon observation (CPC 800 m)
	07:52	28	27-59.1 N	155-00.3 E	Tethered balloon observation (Impactor 800 m)
	08:37	28	27-59.1 N	155-00.0 E	OPC observation with flag line
	08:45	28	27-59.0 N	155-00.2 E	Surface water sampling (bucket)
	09:42				Departure from Stn. 28
	13:48	27	29-00.0 N	155-00.0 E	Arrival at Stn. 27
	13:53	27	29-00.0 N	155-00.0 E	CTD/Water Sampler cast (5900m)
	17:49	27	28-59.1 N	155-01.1 E	Surface water sampling (bucket)
	18:24				Departure from Stn. 27

Date	Start Time (LST)	Station	Position (Start)		Events
			Lat.	Lon.	
	23:42	25	30-00.0 N	155-00.0 E	Arrival at Stn. 25
3.18	05:01	25	30-00.0 N	155-00.0 E	CTD/Water Sampler cast (5658m)
	08:32	25	29-59.0 N	155-00.6 E	Surface water sampling (bucket)
	08:55	25	29-58.8 N	155-00.8 E	OPC observation with flag line
	09:30				Departure from Stn. 25
	13:54	23	31-00.0 N	155-00.0 E	Arrival at Stn. 23
	13:58	23	31-00.0 N	154-59.9 E	CTD/Water Sampler cast (5550m)
	14:26	23	30-59.6 N	154-59.6 E	OPC observation with flag line
	17:30	23	30-58.9 N	154-58.2 E	Surface water sampling (bucket)
	18:00				Departure from Stn. 23
3.19	00:00	22	32-00.0 N	155-00.0 E	Arrival at Stn. 22
	05:02	22	31-59.8 N	154-59.9 E	CTD/Water Sampler cast (4450m)
	07:24	22	31-58.1 N	154-59.5 E	Surface water sampling (bucket)
	08:54				Departure from Stn. 22
	13:48	21	33-00.0 N	155-00.0 E	Arrival at Stn. 21
	13:51	21	33-00.0 N	154-59.9 E	CTD/Water Sampler cast (5300m)
	14:56	21	32-59.7 N	154-59.0 E	OPC observation with flag line
	17:23	21	32-59.7 N	154-57.9 E	Surface water sampling (bucket)
	17:54				Departure from Stn. 21
	23:18	20	34-00.0 N	155-00.0 E	Arrival at Stn. 20
3.20	05:00	20	34-00.0 N	155-00.0 E	CTD/Water Sampler cast (5856m)
	05:50	20	33-59.6 N	155-00.5 E	Tethered balloon observation (OPC 800 m)
	06:28	20	33-59.6 N	155-00.2 E	Tethered balloon observation (Impactor 600 m)
	07:08	20	33-59.7 N	155-00.2 E	Tethered balloon observation (CPC 500 m)
	08:00	20	33-59.4 N	155-00.3 E	OPC observation with flag line
	09:24				Departure from Stn. 20
	13:36	19	35-00.0 N	155-00.0 E	Arrival at Stn. 19
	13:36	19	35-00.0 N	155-00.0 E	CTD/Water Sampler cast (5600m)
	13:59	19	35-00.0 N	155-00.1 E	Tethered balloon observation (OPC 800 m)
	14:39	19	34-59.9 N	155-00.3 E	Tethered balloon observation (CPC 1000 m)
	15:15	19	34-59.7 N	155-00.6 E	Tethered balloon observation (Impactor 800 m)
	16:01	19	33-59.6 N	155-00.6 E	OPC observation with flag line
	16:30	19	34-59.4 N	155-00.7 E	Surface water sampling (bucket)
	17:12				Departure from Stn. 19
	22:30	17	36-00.0 N	155-00.0 E	Arrival at Stn. 17
3.21	05:02	17	35-59.8 N	155-00.0 E	CTD/Water Sampler cast (5430m)
	08:13	17	35-58.5 N	154-59.8 E	Surface water sampling (bucket)
	08:48				Departure from Stn. 17
3.22	04:00	15	37-00.0 N	155-00.0 E	Arrival at Stn. 15
	08:28	15	37-00.0 N	154-59.9 E	CTD/Water Sampler cast (5620m)
	08:53	15	37-00.0 N	154-59.7 E	OPC observation with flag line
	11:31	15	36-59.5 N	154-59.4 E	Surface water sampling (bucket)
	12:30				Departure from Stn. 15
3.23	04:48	14	38-00.0 N	155-00.0 E	Arrival at Stn. 14
	05:08	14	37-59.8 N	155-00.1 E	CTD/Water Sampler cast (5960m)
	08:32	14	37-59.4 N	155-00.2 E	Surface water sampling (bucket)
	09:42				Departure from Stn. 14
	17:54	12	40-00.0 N	155-00.0 E	Arrival at Stn. 12
	17:56	12	39-59.9 N	155-00.0 E	CTD/Water Sampler cast (5527m)

Date	Start Time (LST)	Station	Position (Start)		Events
			Lat.	Lon.	
	21:14	12	39-59.1 N	155-00.8 E	Surface water sampling (bucket)
	22:00				Departure from Stn. 12
3.24	06:18	10	42-00. 0 N	155-00.0 E	Arrival at Stn. 10
	06:24	10	42-00. 0 N	155-00.1 E	CTD/Water Sampler cast (5390m)
	08:25	10	41-59.0 N	155-00.0 E	OPC observation with flag line
	09:30	10	41-59.0 N	155-00.4 E	Surface water sampling (bucket)
	10:06				Departure from Stn. 10
3.25	09:31		39-10.0 N	148-34.5 E	OPC observation with flag line
3.26	08:30		36-18.1 N	142-56.9 E	Arrival at CTD Free fall Point
	08:57		36-18.1 N	142-56.9 E	CTD Free fall
	09:45		36-17.8 N	142-55.4 E	OPC observation with flag line
	13:12				Departure from CTD Free fall Point
3.27	08:00		33-07.9 N	139-56.4 E	Atmospheric observation (off Hachijyo-island)
	10:05		33-08.7 N	139-56.1 E	OPC observation with flag line
	13:33		32-36.7 N	136-52.0 E	Tethered balloon observation (OPC 1000 m)
	14:10		32-31.9 N	136-50.2 E	Tethered balloon observation (Impactor 920 m)
	14:57		32-25.4 N	136-55.3 E	OPC observation with flag line
	15:30		32-20.1 N	137-02.6 E	Tethered balloon observation (CPC800 m)
	16:04		32-18.4 N	137-05.2 E	Tethered balloon observation (OPC1000 m)
3.30	12:43		33-56.2 N	130-55.5 E	Arrival at Shimonoseki

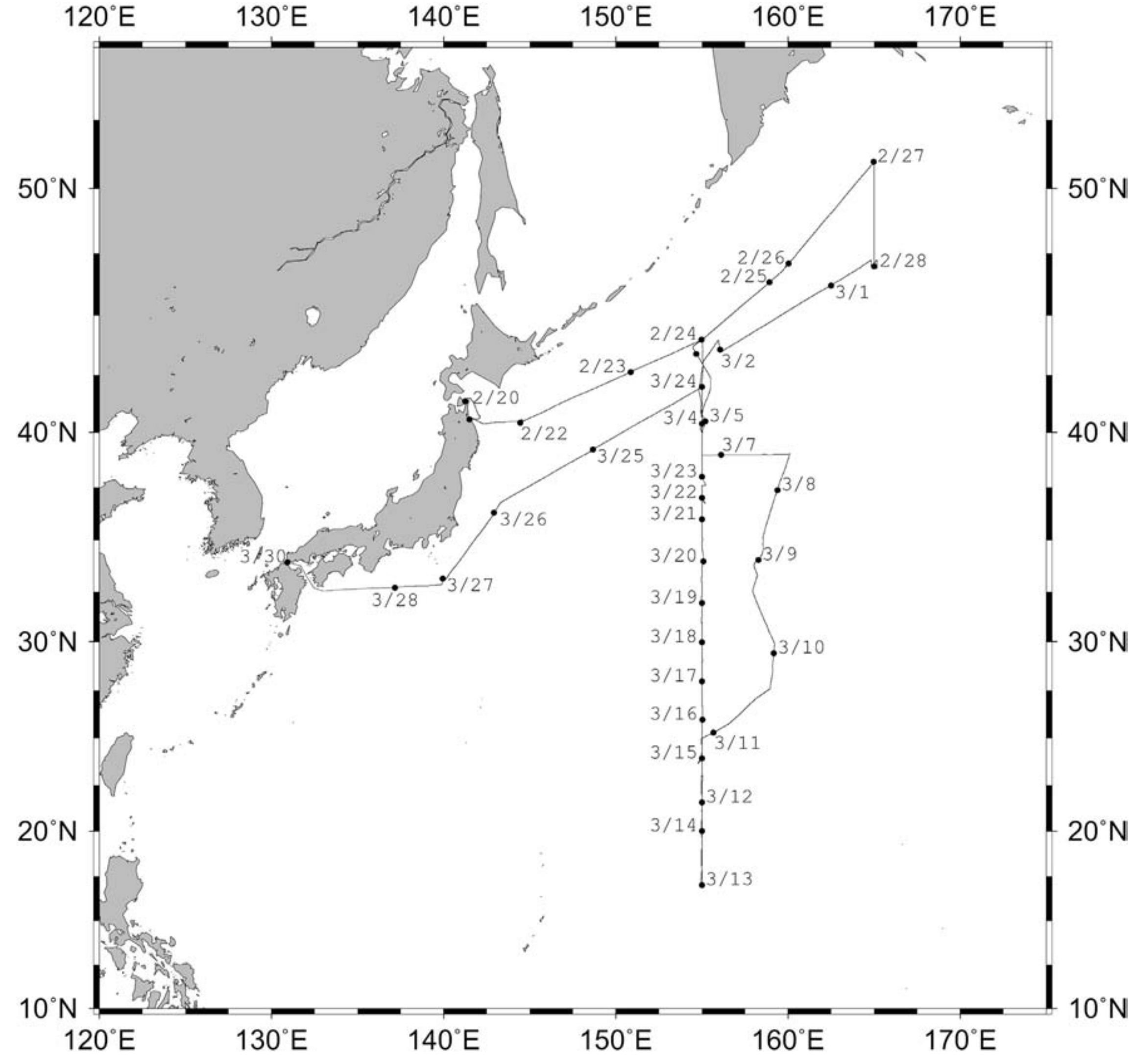

Fig 2.2-1. MR03-K01 Cruise Track

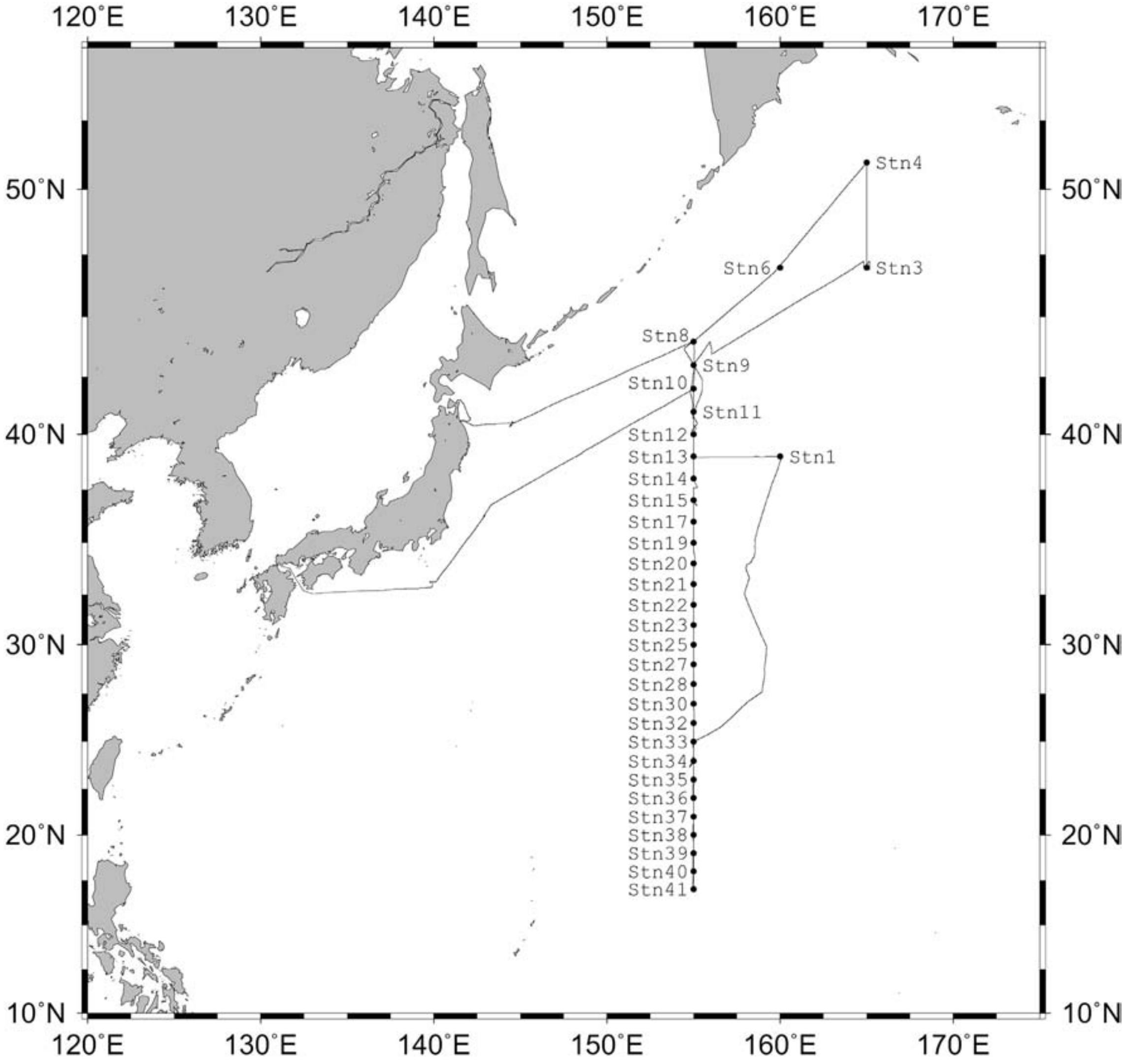

Fig 2.2-2. MR03-K01 Station

2.3 List of participants

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Kenichi KATAYAMA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
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Name	Affiliation	Address	Tel Fax E-mail
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Hideki YAMAMOTO	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
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Katsunori SAGISHIMA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Mikio KITADA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Minoru KAMATA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Takayoshi SEIKE	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Tomoko MIYASHITA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Taeko OHAMA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Asako KUBO	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Toru FUJIKI	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Masaki MORO	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Junji MATSUSHITA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Hiromichi SOEJIMA	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Aska Solange VANROOSEBEKE	MWJ	1-1-7 Mutsuura Kanazawa-ku Yokohama 236-0031, Japan	
Yasutaka IMAI	Global Ocean Development, Inc. (GODI)	1-13-8 Kamiooka nishi Konan-ku Yokohama 232-0002, Japan	

Name	Affiliation	Address	Tel Fax E-mail
Wataru TOKUNAGA	Global Ocean Development, Inc. (GODI)	1-13-8 Kamiooka nishi Konan-ku Yokohama 232-0002, Japan	
Shinya OKUMURA	GODI	1-13-8 Kamiooka nishi Konan-ku Yokohama 232-0002, Japan	

3. Observations

3.1 Meteorological observation

3.1.1 Surface meteorological observation

Yasutaka Imai	(Global Ocean Development Inc.)	Operation Leader
Wataru Tokunaga	(GODI)	
Shinya Okumura	(GODI)	
Not on-board:		
Kunio Yoneyama	(JAMSTEC)	Principal Investigator
R. Michael Reynolds	(Brookhaven National Laboratory, USA)	

(1) Objectives

The surface meteorological parameters are observed as a basic dataset of the meteorology.

These parameters bring us the information about temporal variation of the meteorological condition surrounding the ship.

(2) Methods

The surface meteorological parameters were observed throughout MR03-K01 cruise from the departure of Sekinehama on 20 March 2003 to arrival of Shimonoseki on 30 March 2003.

This cruise, we used 2 systems for the surface meteorological observation.

1. Mirai meteorological observation system
2. Shipboard Oceanographic and Atmospheric Radiation (SOAR) System

(2-1) Mirai meteorological observation system

Instruments of Mirai meteorological system (SMET) are listed in Table 3.1.1-1 and measured parameters are listed in Table 3.1.1-2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin-Denki, Japan. The data set has 6-second averaged every 6-second record and 10-minute averaged every 10-minute record.

(2-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system designed by BNL is consisted of 3 parts.

1. Portable Radiation Package (PRP) designed by BNL – short and long wave down welling radiation.
2. Zeno meteorological system designed by BNL – wind, Tair/RH, pressure and rainfall measurement.
3. Scientific Computer System (SCS) designed by NOAA (National Oceanic and Atmospheric Administration, USA)- centralized data acquisition and logging of all data sets

SCS recorded PRP data every 6 seconds, Zeno/met data every 10 seconds. Instruments and their locations are listed in Table 3.1.1-3 and measured parameters are listed in Table 3.1.1-4.

(3) Preliminary results

Figures 3.1.1-1 - 4 show the time series of the following parameters;

Wind (SOAR), air temperature (SOAR), sea surface temperature (EPCS), relative humidity (SMET), precipitation (SMET), short/long wave radiation (SOAR), pressure (SOAR) and hourly significant wave height (SMET).

(4) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control.

(5) Remarks

1. For trouble of an anemometer, the wind speed and direction in SOAR data are

missing from 01 March 10:07 to 11 March 05:00.

2. We plot Smet wind data (Figure 3.1.1-1 and Figure 3.1.1-2), while the SOAR anemometer was out of order (from 01 March 10:08 to 11 March 04:59).
3. Radiometers for the upwelling radiation measurement of R/V Mirai meteorological observation system were not installed during this cruise.
4. We had run EPCS during this cruise from 21 February 09:47 to 26 March 00:00.

Table 3.1.1-1 Instruments and installation locations of Mirai meteorological system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24 m)
Thermometer	FT	Koshin Denki, Japan	compass deck (21 m)
	RFN1-0	Koshin Denki, Japan	4th deck (-1 m, inlet -5 m) SST
Dewpoint meter	DW-1	Koshin Denki, Japan	compass deck (21 m)
Barometer	F-451	Yokogawa, Japan	weather observation room captain deck (13 m)
Rain gauge	50202	R.M. Young, USA	compass deck (19 m)
Optical rain gauge	ORG-115DR	Osi, USA	compass deck (19 m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28 m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28 m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10 m)

Table 3.1.1-2 Parameters of Mirai meteorological observation system

	Parameter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Ship's speed	knot	Mirai log, DS-30 Furuno
4	Ship's heading	degree	Mirai Gyro, TG-6000, tokimec
5	Relative wind speed	m/s	6 sec./ 10 min. averaged
6	Relative wind direction	degree	6 sec./ 10 min. averaged
7	True wind speed	m/s	6 sec./ 10 min. averaged
8	True wind direction	degree	6 sec./ 10 min. averaged
9	Barometric pressure	hPa	adjusted to the sea surface level 6 sec./ 10 min. averaged
10	Air temperature (starboard side)	degC	6 sec./ 10 min. averaged
11	Air temperature (port side)	degC	6 sec./ 10 min. averaged
12	Dewpoint temperature (starboard side)	degC	6 sec./ 10 min. averaged
13	Dewpoint temperature (port side)	degC	6 sec./ 10 min. averaged
14	Relative humidity (starboard side)	%	6 sec./ 10 min. averaged
15	Relative humidity (port side)	%	6 sec./ 10 min. averaged
16	Sea surface temperature	degC	6 sec./ 10 min. averaged
17	Rain rate (optical rain gauge)	mm/hr	hourly accumulation
18	Rain rate (capacitive rain gauge)	mm/hr	hourly accumulation
19	Down welling shortwave radiometer	W/m^2	6 sec./ 10 min. averaged
20	Down welling infra-red radiometer	W/m^2	6 sec./ 10 min. averaged
21	Significant wave height (fore)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period (fore)	second	hourly
24	Significant wave period (aft)	second	hourly

Table 3.1.1-3 Instrument installation locations of SOAR system

Sensors	Type	Manufacturer	Location (altitude from baseline)
Zeno/Met			
Anemometer	5106	R.M. Young, USA	foremast (25 m)
Tair/RH	HMP45A	Vaisala, USA	foremast (24 m)
	with 43408 Gill aspirated shield (R.M. Young)		
Barometer	61201	R.M. Young, USA	foremast (24 m)
	with 61002 Gill pressure (R.M. Young)		
Rain gauge	50202	R.M. Young, USA	foremast (24 m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24 m)
PRP			
Radiometer (short wave)	PSP	Eppley labs, USA	foremast (25 m)
Radiometer (long wave)	PIR	Eppley labs, USA	foremast (25 m)
Fast rotating shadowband radiometer		Yankee, USA	foremast (25 m)

Table 3.1.1-4 Parameters of SOAR system

	Parameter	Units	Remarks
1	Latitude	degree	
2	Longitude	degree	
3	Sog	knot	
4	Cog	degree	
5	Relative wind speed	m/s	
6	Relative wind direction	degree	
7	Barometric pressure	hPa	
8	Air temperature	degC	
9	Relative humidity	%	
10	Rain rate (optical rain gauge)	mm/hr	
11	Precipitation (capacitive rain gauge)	mm	reset at 50 mm
13	Down welling shortwave radiometer	W/m2	
14	Down welling infra-red radiometer	W/m2	
15	Defuse irradiation	W/m2	

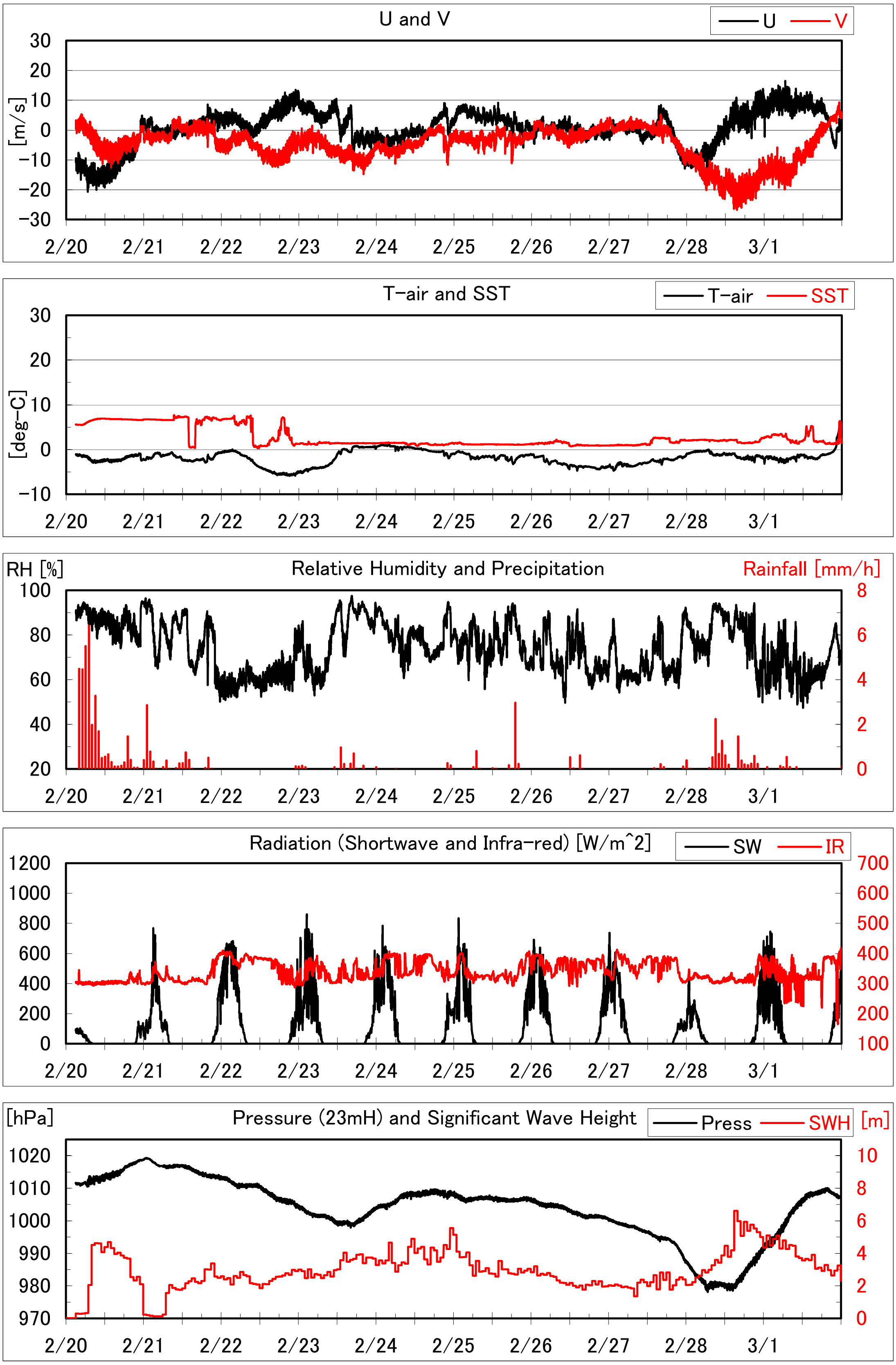

U and V
U
V
[m/s]
30
20
10
0
−10
−20
−30
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
2/28
3/1
T−air and SST
T−air
SST
[deg−C]
30
20
10
0
−10
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
2/28
3/1
RH [%]
Relative Humidity and Precipitation
Rainfall [mm/h]
100
80
60
40
20
8
6
4
2
0
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
2/28
3/1
Radiation (Shortwave and Infra−red) [W/m^2]
SW
IR
1200
1000
800
600
400
200
0
700
600
500
400
300
200
100
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
2/28
3/1
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1020
1010
1000
990
980
970
10
8
6
4
2
0
2/20
2/21
2/22
2/23
2/24
2/25
2/26
2/27
2/28
3/1

Figure 3.1.1-1

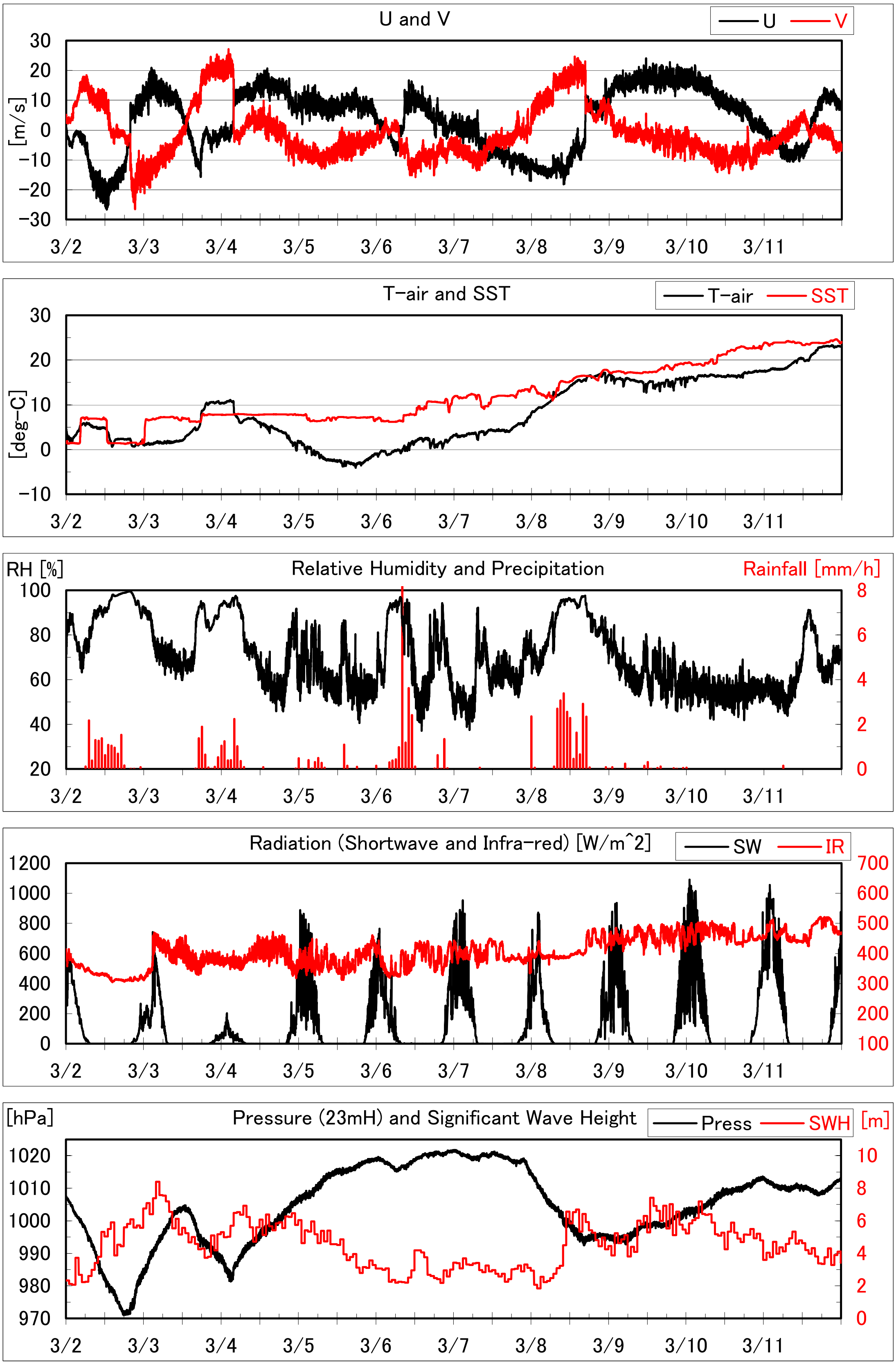

U and V
U
V
30
20
10
0
−10
−20
−30
[m/s]
3/2
3/3
3/4
3/5
3/6
3/7
3/8
3/9
3/10
3/11
T−air and SST
T−air
SST
30
20
10
0
−10
[deg−C]
3/2
3/3
3/4
3/5
3/6
3/7
3/8
3/9
3/10
3/11
RH [%]
Relative Humidity and Precipitation
Rainfall [mm/h]
100
80
60
40
20
8
6
4
2
0
3/2
3/3
3/4
3/5
3/6
3/7
3/8
3/9
3/10
3/11
Radiation (Shortwave and Infra−red) [W/m^2]
SW
IR
1200
1000
800
600
400
200
0
700
600
500
400
300
200
100
3/2
3/3
3/4
3/5
3/6
3/7
3/8
3/9
3/10
3/11
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1020
1010
1000
990
980
970
10
8
6
4
2
0
3/2
3/3
3/4
3/5
3/6
3/7
3/8
3/9
3/10
3/11

Figure 3.1.1-2

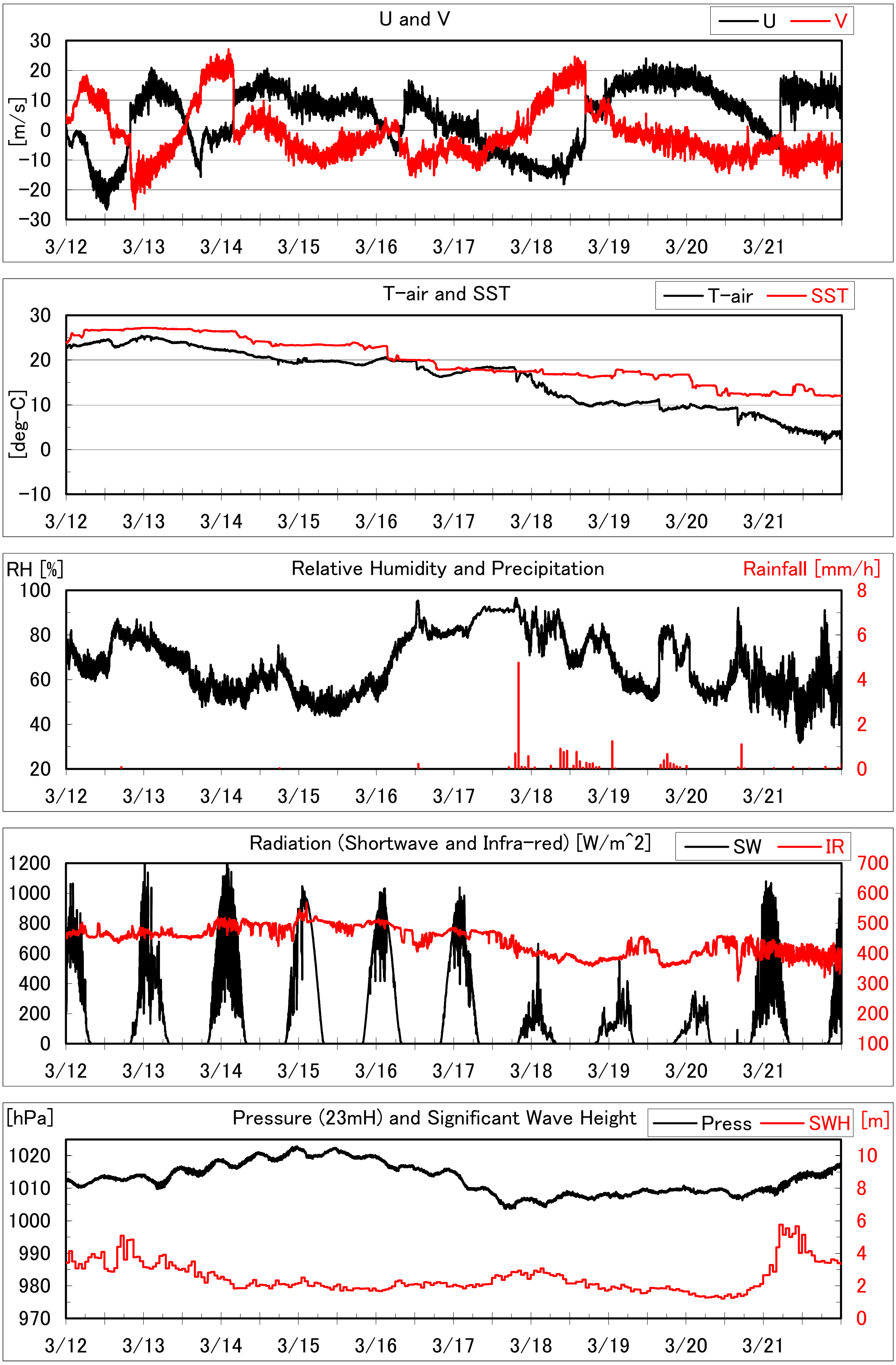

U and V
U
V
[m/s]
30
20
10
0
−10
−20
−30
3/12
3/13
3/14
3/15
3/16
3/17
3/18
3/19
3/20
3/21
T−air and SST
T−air
SST
[deg−C]
30
20
10
0
−10
RH [%]
Relative Humidity and Precipitation
Rainfall [mm/h]
100
80
60
40
20
8
6
4
2
0
Radiation (Shortwave and Infra−red) [W/m^2]
SW
IR
1200
1000
800
600
400
200
0
700
600
500
400
300
200
100
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1020
1010
1000
990
980
970
10
8
6
4
2
0

Figure 3.1.1-3

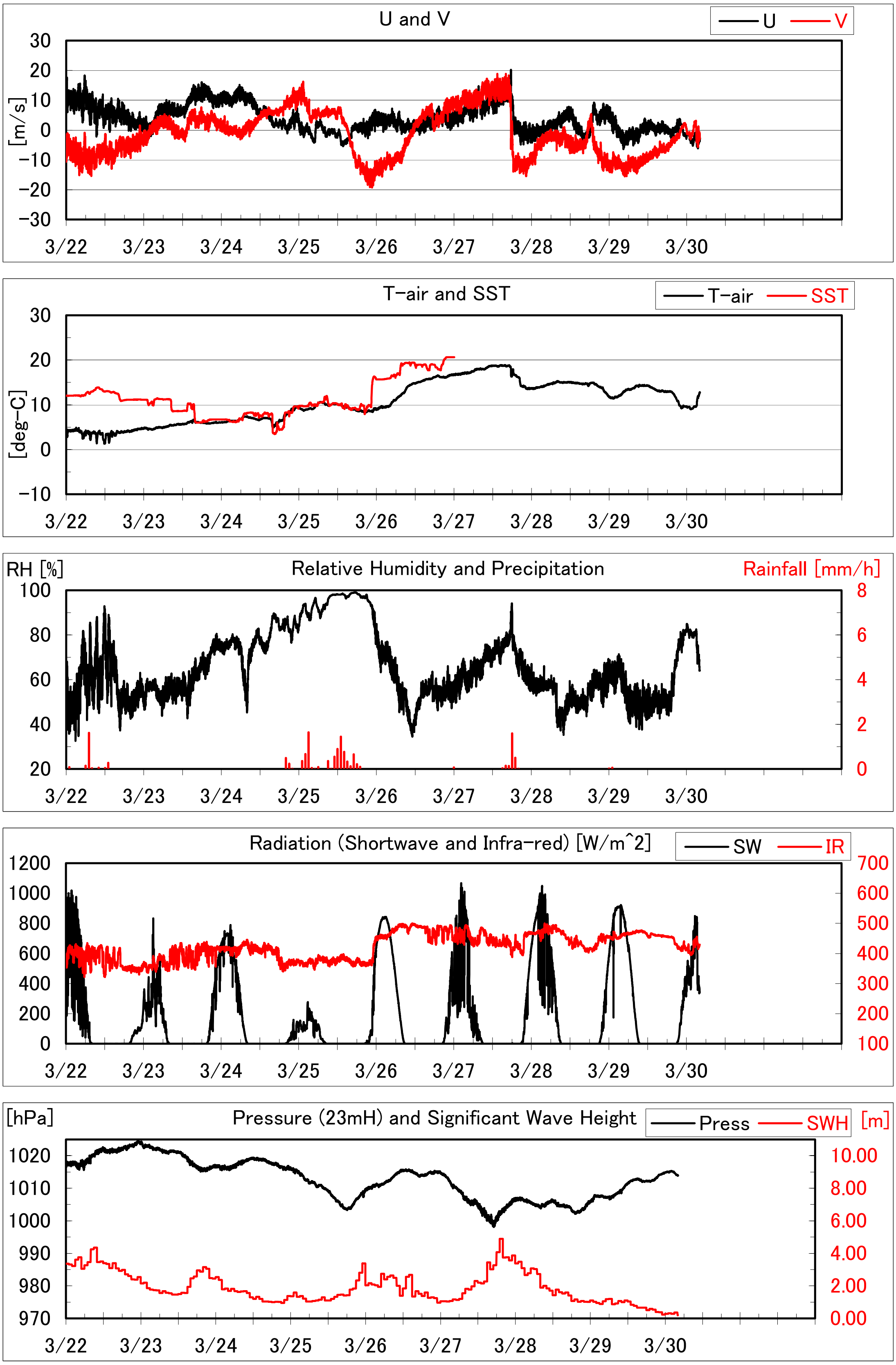

U and V
U
V
[m/s]
30
20
10
0
−10
−20
−30
3/22
3/23
3/24
3/25
3/26
3/27
3/28
3/29
3/30
T−air and SST
T−air
SST
[deg−C]
30
20
10
0
−10
3/22
3/23
3/24
3/25
3/26
3/27
3/28
3/29
3/30
RH [%]
Relative Humidity and Precipitation
Rainfall [mm/h]
100
80
60
40
20
8
6
4
2
0
3/22
3/23
3/24
3/25
3/26
3/27
3/28
3/29
3/30
Radiation (Shortwave and Infra−red) [W/m^2]
SW
IR
1200
1000
800
600
400
200
0
700
600
500
400
300
200
100
3/22
3/23
3/24
3/25
3/26
3/27
3/28
3/29
3/30
[hPa]
Pressure (23mH) and Significant Wave Height
Press
SWH
[m]
1020
1010
1000
990
980
970
10.00
8.00
6.00
4.00
2.00
0.00
3/22
3/23
3/24
3/25
3/26
3/27
3/28
3/29
3/30

Figure 3.1.1-4

3.1.2 Ceilometer Observation

Yasutaka Imai	(Global Ocean Development Inc.) Operation Leader
Wataru Tokunaga	(GODI)
Shinya Okumura	(GODI)
Not on-board	
Kunio Yoneyama	(JAMSTEC) Principal investigator

(1) Objectives

The information of cloud base height and the liquid water amount around cloud base is important to understand the process on formation the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(2) Parameter

1. Cloud base height (m).
2. Backscatter profile, sensitivity and range normalized at 30 m resolution.
3. Estimated cloud amount [oktas] and height [m]; Sky Condition Algorithm.

(3) Methods

We measured cloud base height and backscatter profile using CT-25K (VAISALA, Finland) ceilometer throughout MR03-K01 cruise from the departure of Sekinehama on 20 March 2003 to arrival of Shimonoseki on 30 March 2003.

Major parameters for the measurement configuration are as follows;

Laser source: Indium Gallium Arsenide (InGaAs) Diode
Transmitting wavelength: 905±5 mm at 25 degC
Transmitting average power: 8.9 mW
Repetition rate: 5.57 kHz
Detector: Silicon avalanche photodiode (APD)
Responsibility at 905 nm: 65 A/W
Measurement range: 0 ~ 7.5 km
Resolution: 50 ft in full range
Sampling rate: 60 sec
Sky Condition 0, 1, 3, 5, 7, 8 oktas (9: Vertical Visibility)
(0: Sky Clear, 1:Few, 3:Scattered, 5-7: Broken, 8: Overcast)

On the archive dataset, cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft).

(4) Preliminary results

The figure 3.1.2-1 and 3.1.2-2 show every 5 minutes of detected cloud base height, during this cruise from the departure of Sekinehama on 19 March to arrival of Shimonoseki on 30 March.

The “C1”(blue) is the lowest cloud base height, and “C2”(red) is the second lowest cloud base height.

(5) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control.

(6) Remark

Following data is missed; 14 March 2003 07:34 UTC

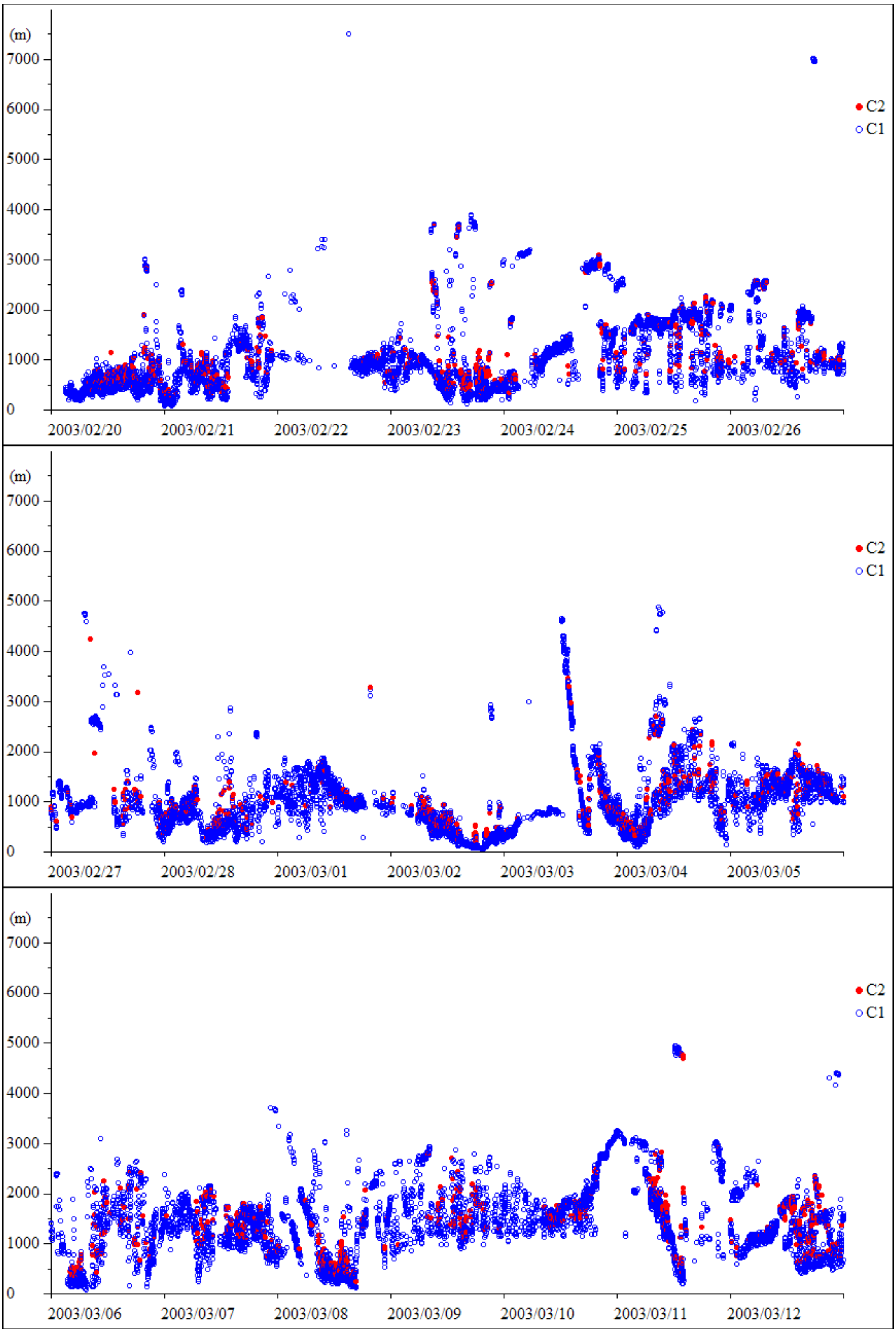

(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/02/20
2003/02/21
2003/02/22
2003/02/23
2003/02/24
2003/02/25
2003/02/26
(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/02/27
2003/02/28
2003/03/01
2003/03/02
2003/03/03
2003/03/04
2003/03/05
(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/03/06
2003/03/07
2003/03/08
2003/03/09
2003/03/10
2003/03/11
2003/03/12

Figure 3.1.2-1

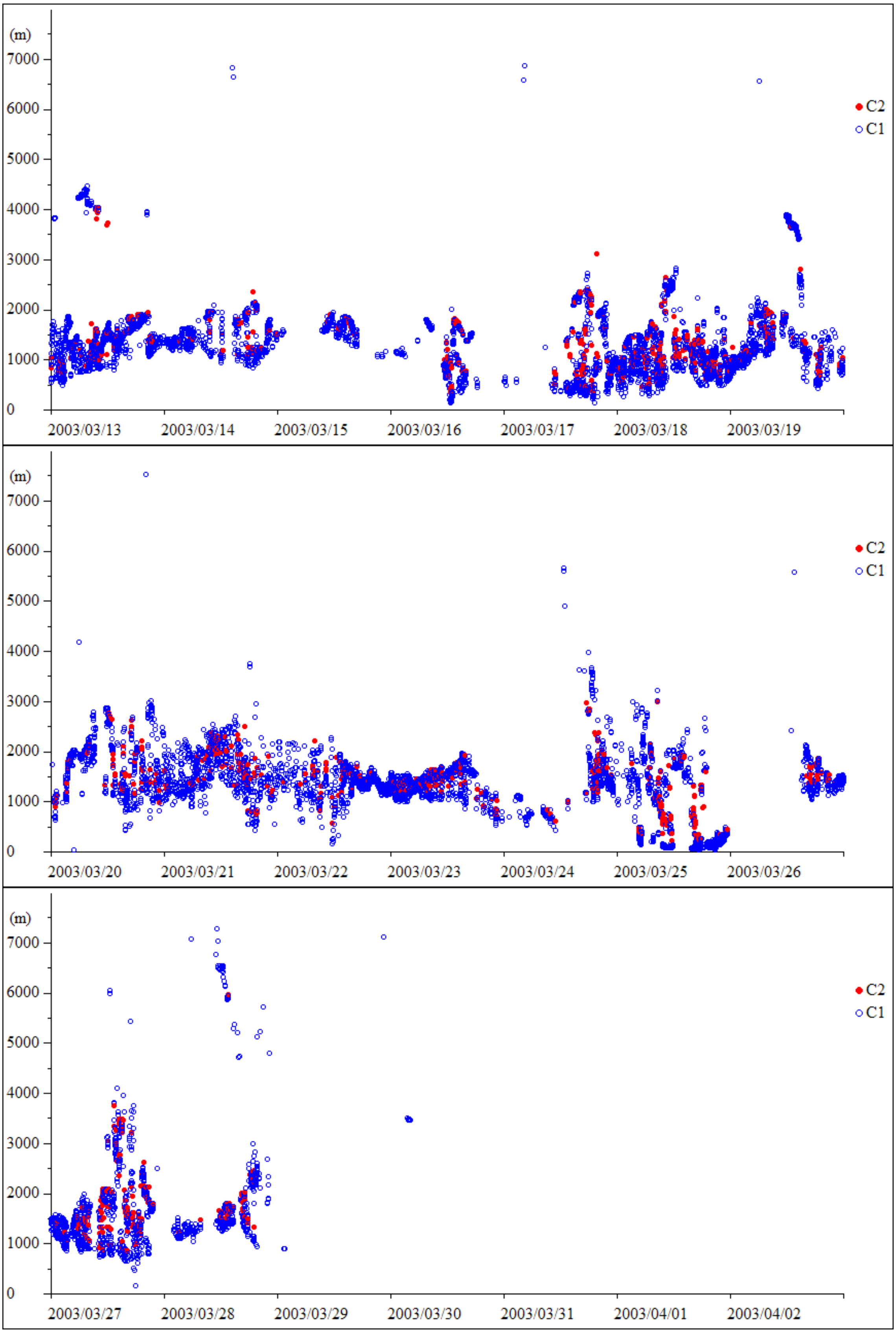

(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/03/13
2003/03/14
2003/03/15
2003/03/16
2003/03/17
2003/03/18
2003/03/19
(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/03/20
2003/03/21
2003/03/22
2003/03/23
2003/03/24
2003/03/25
2003/03/26
(m)
7000
6000
5000
4000
3000
2000
1000
0
C2
C1
2003/03/27
2003/03/28
2003/03/29
2003/03/30
2003/03/31
2003/04/01
2003/04/02

Figure 3.1.2-2

3.2 CTD/CWS

(1) Personnel

Satoshi Ozawa	(MWJ)：Operation Leader
Hiroshi Matsunaga	(MWJ)
Tomoyuki Takamori	(MWJ)
Kenichi Katayama	(MWJ)
Naoko Takahashi	(MWJ)

(2) Objective

Investigation of oceanic structure.

(3) Parameters

Temperature
Conductivity
Dissolved Oxygen
Altimeter
Pressure

(4) Methods

CTD/Carousel Water Sampling System, which is a 36-position Carousel water sampler with Sea-Bird Electronics Inc. CTD (SBE9plus), was used during this cruise. 12-litter Niskin bottles were used for sampling seawater. The sensors attached on the CTD were two temperature sensors, two conductivity sensors, an oxygen sensor and a pressure sensor. Salinity was calculated by measured values of pressure, conductivity and temperature. The CTD/CWS was deployed from starboard on working deck.

The CTD raw data were acquired on real time by using the Seasave-Win32 (ver.5.27b) provided by Sea-Bird Electronics,Inc. and stored on the hard disk of the personal computer. Seawater was sampled during up-cast by sending a fire command from the personal computer. We sampled seawater to calibrate salinity data.

Total 40 casts of CTD measurements have been carried out. (see table 3.2-1)

The CTD raw data was processed using SBE Data Processing-Win32 (ver.5.27b). Data processing procedures and used utilities of SBE Data Processing-Win32 are as follows:

DATCNV： Convert the binary raw data to output on physical units.
This utility selects the CTD data when bottles closed to output on another file.
ROSSUM： Edits the data of water sampled to output a summary file.
ALIGNCTD： ALIGNCTD aligns oxygen measurements in time relative to pressure.
Advance Secondary conductivity = 0.073 sec
Advance Oxygen = 6.0 sec
WILDEDIT： Obtain an accurate estimate of the true standard deviation of the data.
Std deviation for pass 1= 10
Std deviation for pass 2= 20
Scan per block= 48
Keep data within this distance of mean= 1
Exclude Scan Marked Bad = Check
CELLTM： Remove conductivity cell thermal mass effects from measured conductivity.
Alpha = 0.03
1/beta = 7.0
FILTER： Filter the high frequency noise on the data

Filter A = 0.15sec
Variable to Filter: Pressure: Low Pass Filter A
SECTION： Remove the unnecessary data
LOOPEDIT： Mark scan with ‘badflag’, if the CTD velocity is less than 0 m/s.
Minimum Velocity Type = Fixed Minimum Velocity
Minimum CTD Velocity [m/sec] = 0.0
Exclude Scan Marked Bad = Check
BINAVG： Calculate the averaged data in every 1 m.
DERIVE： Calculate oceanographic parameters.
SPLIT： Splits the data made in CNV files into up-cast and down-cast files.

Configuration file ：MR03K01a.con

Specifications of the sensors are listed below.
CTD： SBE911plus CTD system
Under water unit：CTD 9plus (S/N 09P9833-0357, Sea-bird Electronics, Inc.)
Deck unit：SBE11 (S/N 11P9833-0344, Sea-bird Electronics, Inc.).
Carousel water sampler：SBE32 (S/N 0391, Sea-bird Electronics, Inc.).
Pressure sensor：Digiquartz pressure sensor (S/N 42423)
Calibrated Date: 17-May-1994
Deadweight test date: 08-Apr-2002

<Primary sensor>
Temperature sensors：SBE3-04/F (S/N 032453, Sea-bird Electronics, Inc.)
Calibrated Date: 10-Jan-2003
Conductivity sensors：SBE4-04/F (S/N 042240, Sea-bird Electronics, Inc.)
Calibrated Date: 22-Jan-2003
<Secondary sensor>
Temperature sensors：SBE3-04/F (S/N 031359, Sea-bird Electronics, Inc.)
Calibrated Date: 09-Jan-2003
Conductivity sensors：SBE4-04/F (S/N 041202, Sea-bird Electronics, Inc.)
Calibrated Date: 12-Nov-2002
<Others>
Oxygen sensor：SBE43(S/N 430069, Sea-bird Electronics, Inc.)
Altimeter：PSA-900D (S/N396,DATASONICS,Inc.)
LADCP：WORKHORSE (S/N2553,RD Instruments.)

(5) Result

Some preliminary results of CTD temperature, salinity, and oxygen are shown in Fig.3.2-1 and Fig.3.2-2. Cross sections of temperature and salinity, oxygen of the observation line along 155 ° E are shown in Fig.3.2-3. Note that in these figures, CTD salinity was not corrected by bottle salinity (AUTOSAL data).

The difference between the CTD salinity (primary and secondary) and the AUTOSAL salinity are shown in Fig.3.2-4. (Primary and secondary salinity are calculated from the primary temperature/conductivity and the secondary-ones, respectively)

The average of the absolute difference between the primary-salinity and the AUTOSAL, and that between secondary-salinity and the AUTOSAL are 0.0036 and 0.0038, respectively. Therefore, at this time, we recommend temperature and salinity data obtained by the primary-sensors.

(6) Attention

Difference of 0.02 psu between the CTD primary-salinity and the AUTOSAL salinity during upcast above 2000m depth at Station 32 was found.

(7) New model frame test

The test cast of new-model frame was carried out twice at stn.34 (see table 3.2-1). During the new frame test, the CTD system and 36 Niskin-bottles, that and LADCP were installed on the frame. A plate (Fig.3.2-5) was also newly developed for preventing rotation of frame itself. The test casts were carried out both with or without the plate on the frame in order to investigate availability of the plate.

(8) Data archive

All raw and processed CTD data files were copied onto CD-R. The data will be submitted to the Data Management Office (DMO), JAMSTEC, and will be public via “R/V MIRAI Data Web Page” in JAMSTEC home page

Table 3.2-1 CTD cast Table

Station	Cast No.	Date(UTC)	Start time(UTC)	End time(UTC)	Latitude(N)	Longitude(E)	Altimeter	Max pressure	Depth(m)	File name	NOTE
8	1	2003/2/23	13:20	13:56	43-59.82	154-59.95	-	302.48	5315	008M01	
8	2	2003/2/23	15:37	16:09	43-59.93	154-59.93	-	-	5309	008M02	cancellation at downcast 500m
8	3	2003/2/23	21:08	0:28	43-59.95	154-59.90	46.66	5356.72	5311	008M0	
6	1	2003/2/25	4:13	4:56	47-00.43	159-53.55	-	404.58	5183	006M01	
6	2	2003/2/25	6:18	9:41	47-00.39	159-53.76	43.95	5235.81	5182	006M02	
4	1	2003/2/26	22:00	1:02	50-59.82	164-59.75	43.89	4859.31	4813	0004M01	#8 miss fired
4	2	2003/2/27	4:39	5:59	51-00.56	164-57.76	-	2035	4847	004M02	#1 miss fired
4	3	2003/2/27	7:17	7:54	50-59.98	165-00.02	-	405.1	4805	004M03	
3	1	2003/2/28	0:01	3:39	46-59.92	164-59.85	49.6	5965.92	5892	003M01	
9	1	2003/3/2	7:15	10:16	43-01.41	155-01.19	42.68	5458.36	5388	009M01	cancellation at upcast 2000m
9	2	2003/3/5	18:08	19:37	43-02.39	155-03.09	-	2030.83	5379	009M02	
11	1	2003/3/6	4:06	7:38	41-00.07	155-00.06	49.45	5569.1	5514	011M01	
13	2	2003/3/8	16:36	20:30	38-59.96	155-00.04	41.03	5834.9	5772	013M02	
1	1	2003/3/7	11:53	13:56	39-00.18	159-59.89	-	3048	5516	001M01	
1	2	2003/3/7	16:33	17:03	39-02.82	160-05.34	-	202.52	5508	001M02	
33	1	2003/3/11	3:11	6:34	25-00.08	154-59.90	48	5730	5661	033M01	
35	1	2003/3/11	15:15	18:26	23-00.05	155-00.02	49.6	5196.08	5137	035M01	
37	1	2003/3/12	2:25	3:49	20-59.98	154-59.83	71.7	1902.69	1984	037M01	
39	1	2003/3/12	11:50	15:20	19-00.10	154-59.90	47.47	5677.72	5622	039M01	
41	1	2003/3/12-13	23:29	3:37	16_59.99	154_59.86	47.5	5737	5692	041M01	
40	1	2003/3/13	8:39	12:40	17-59.93	154-59.98	48.64	5712.34	5658	040M01	
38	1	2003/3/13-14	22:21	2:09	20-00.14	154-59.96	48.9	5764	5710	038M01	
36	1	2003/3/14	10:53	14:25	21-59.99	155-00.01	47.5	5591	5542	036M01	
34	1	2003/3/15	5:58	8:16	24-00.32	154-59.68	-	3041.35	5504	034M01	The test of the new-model frame
34	2	2003/3/15	9:10	11:57	24-00.95	154-58.70	-	3042.8	5486	034M02	test of a new frame with plate
32	1	2003/3/15-16	23:04	2:56	26-00.11	155-00.36	45.2	5697.83	5641	032M01	
30	1	2003/3/16	7:10	11:33	26-59.91	155-00.14	49.95	5972.47	5910	030M01	
28	1	2003/3/16-17	20:05	0:37	27-59.83	154-59.92	49.2	5860	5798	028M01	
27	1	2003/3/17	4:59	9:17	29-00.01	154-59.99	47.69	6009.82	5941	027M01	
25	1	2003/3/17-18	20:07	0:23	30-00.03	155-00.03	49.16	5746.4	5687	025M01	
23	1	2003/3/18	5:02	8:58	30-59.93	154-59.88	49.23	5638	5581	023M01	
22	1	2003/3/18	20:08	23:49	31-59.79	154-59.95	43.88	4516	4482	022M01	

Table 3.2-1 CTD cast Table (continued)

Station	Cast No.	Date(UTC)	Start time(UTC)	End time(UTC)	Latitude(N)	Longitude(E)	Altimeter	Max pressure	Depth(m)	File name	NOTE
21	1	2003/3/19	4:56	8:46	33-00.00	154-59.90	44.69	5388.36	5324	021M01	
20	1	2003/3/19-20	20:04	0:18	34-00.00	155-00.13	44.8	5917	5862	020M01	
19	1	2003/3/20	4:40	8:09	34-59.96	154-59.98	47.99	5720.64	5676	019M01	
17	1	2003/3/20	20:07	23:40	35-59.77	155-00.22	46.37	5556.46	5520	017M01	LADCP
15	1	2003/3/21-22	23:33	3:25	37-00.05	154-59.82	48.94	5738	5676	015M01	LADCP
14	1	2003/3/22-23	20:13	0:34	37-59.81	155-00.15	48.5	6100.02	6023	014M01	LADCP,pltate
12	1	2003/3/23	9:01	12:55	39-59.96	155-00.00	49.45	5621.71	5564	012M01	LADCP,pltate
10	1	2003/3/23-24	21:29	1:03	41-59.97	155-00.11	49.5	5505	5447	010M01	LADCP,pltate

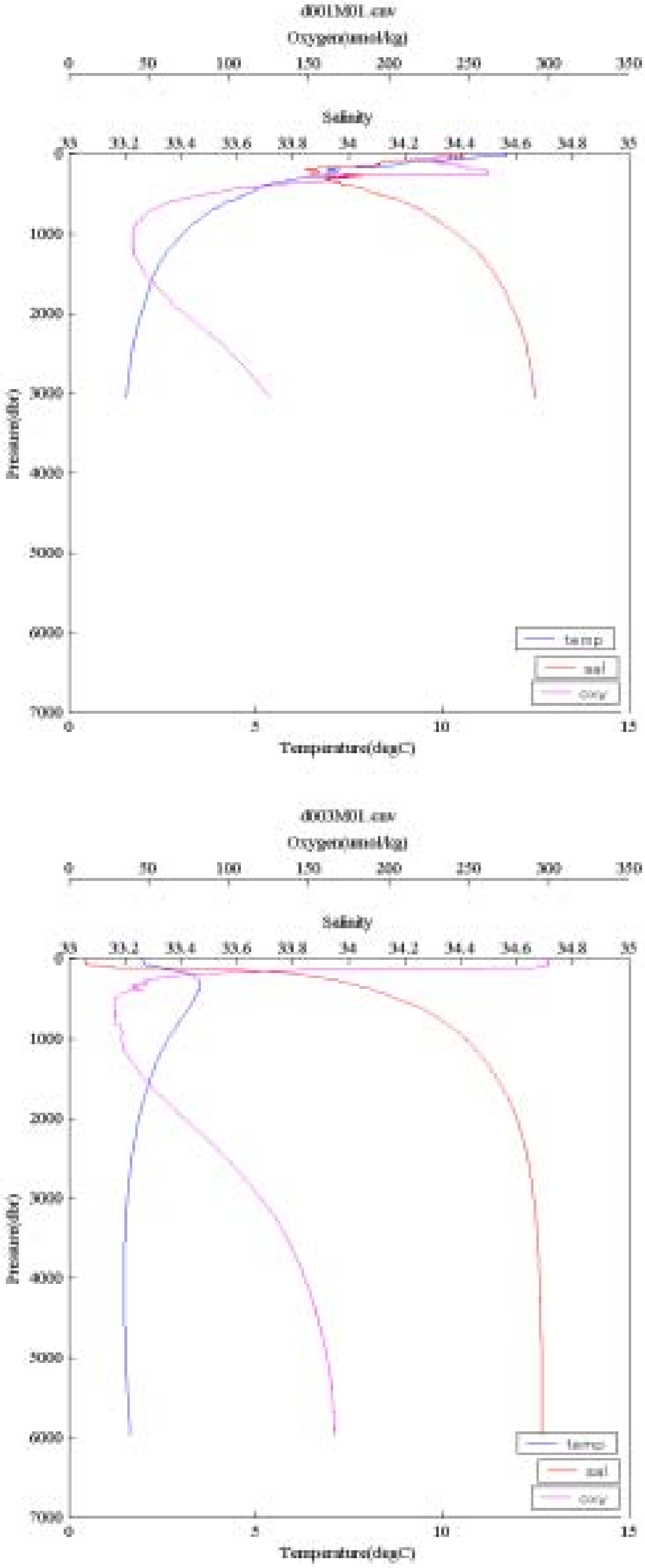


Fig.3.2-1 Profiles of temperature ,salinity, and oxygen (upper, Sta.1-cast1; lower, Sta.3-cast1)

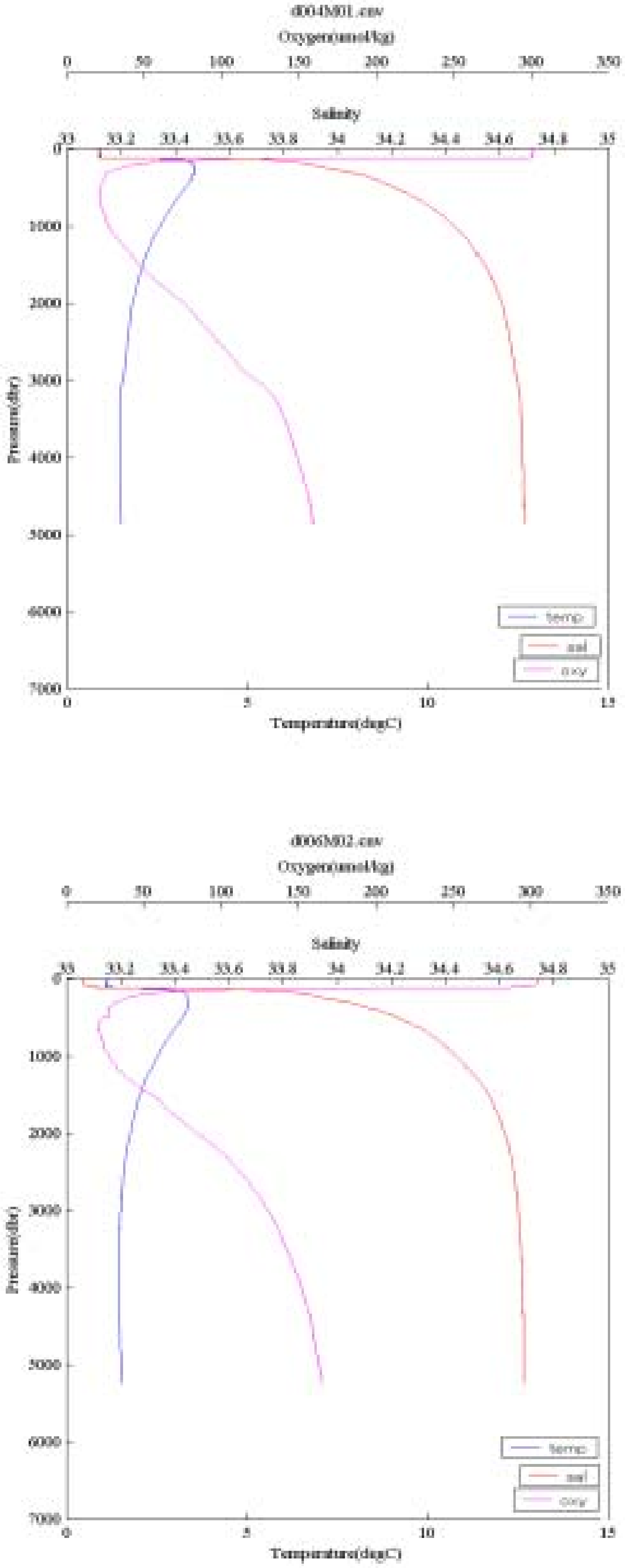


Fig.3.2-2 Profiles of temperature ,salinity, and oxygen (upper, Sta.4-cast1; lower, Sta.6-cast2)

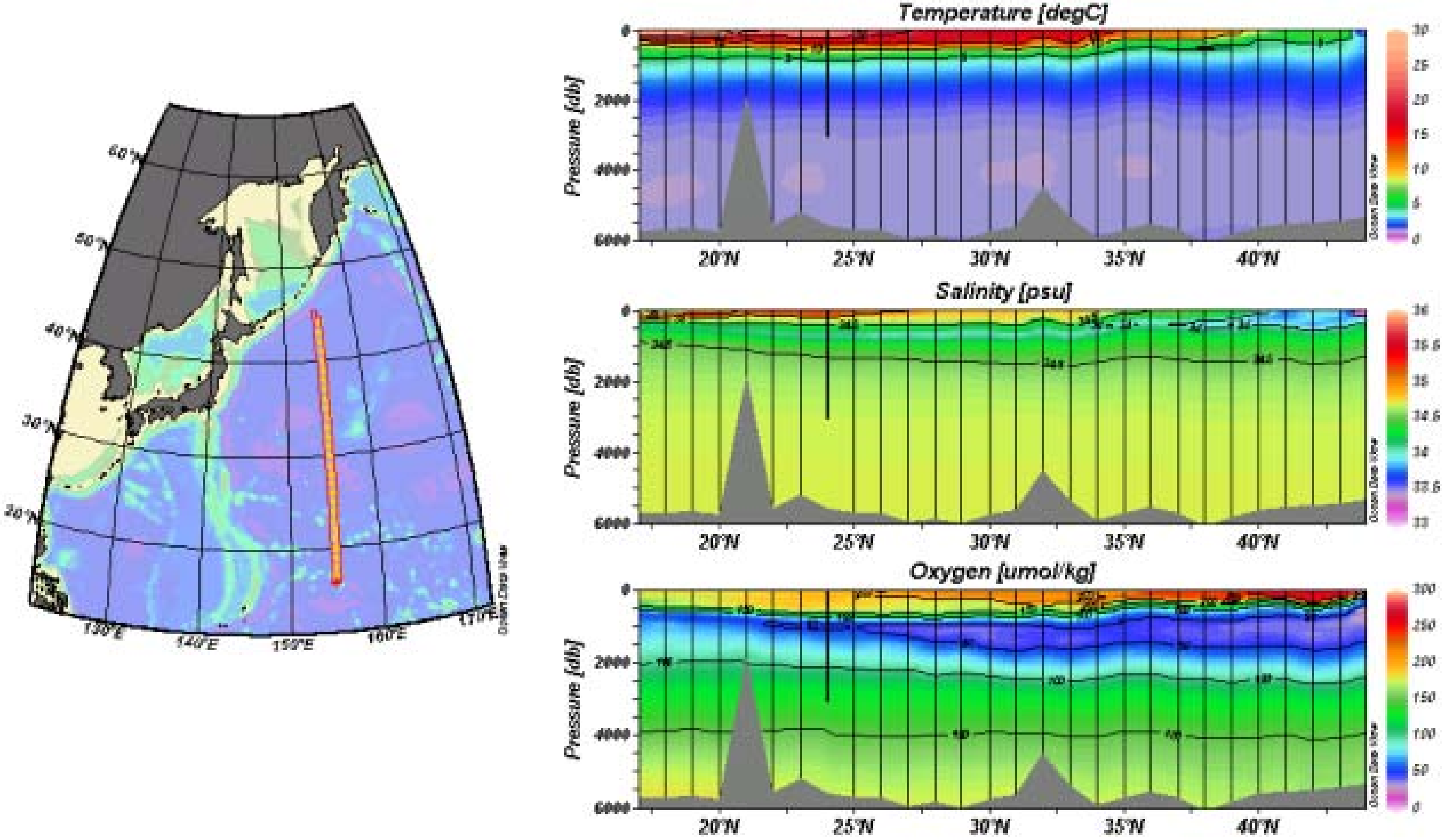


Fig3.2-3 Cross sections along 155E of CTD temperature, salinity, oxygen

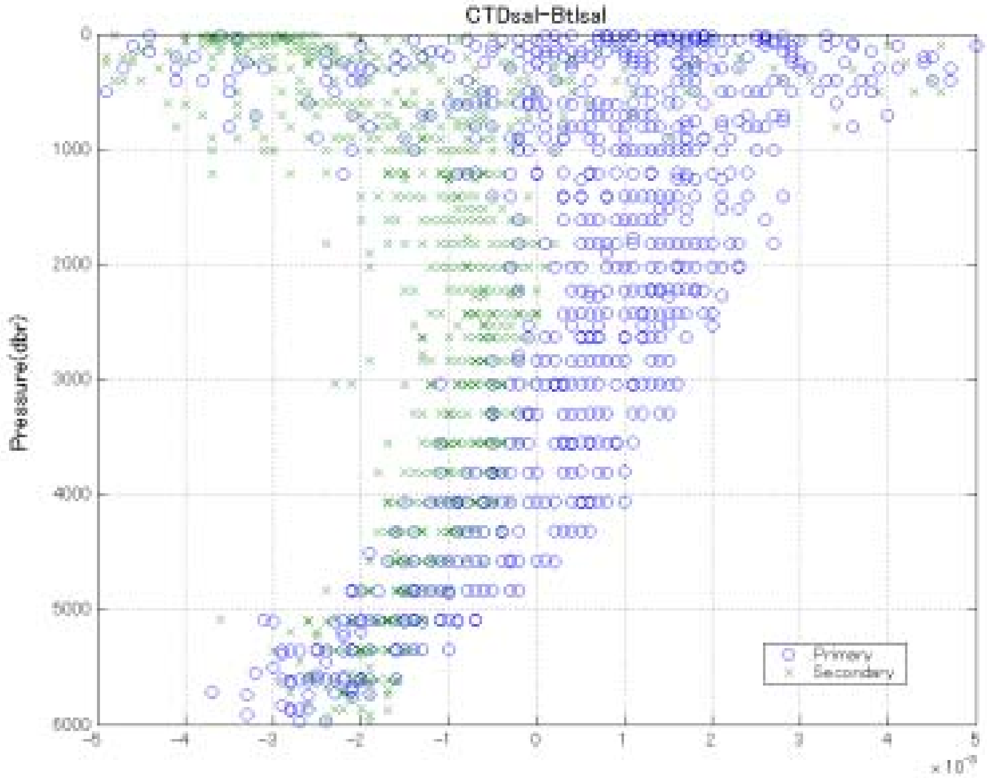


Fig.3.2-4 Comparison of CTD salinity and AUTOSAL

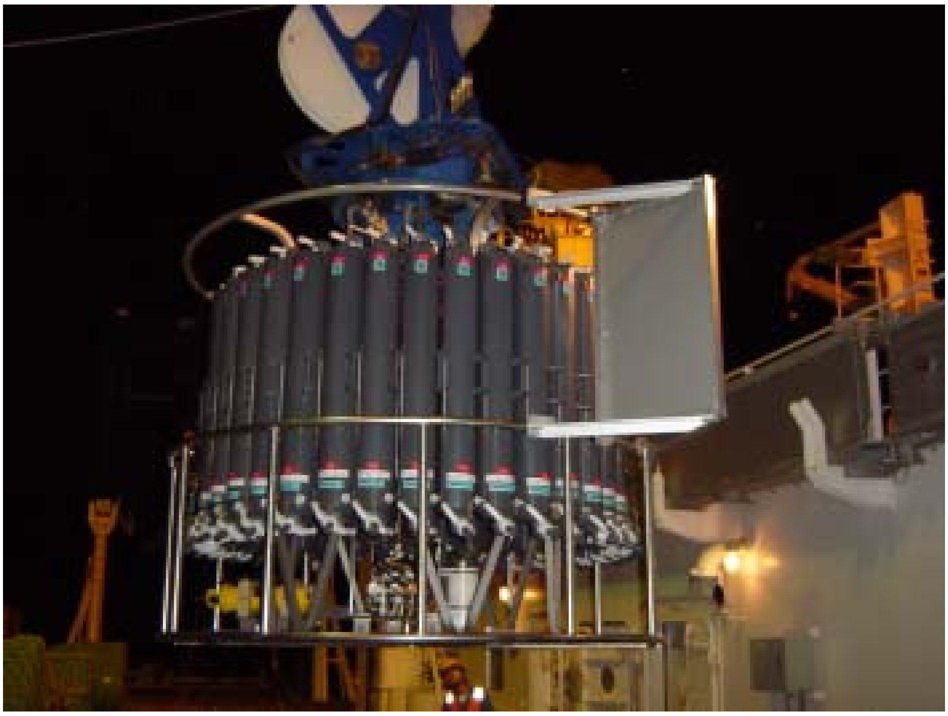


Fig3.2-5 New model frame test (stn34)

3.3 Hydrocast sampling

3.3.1 Salinity

(1) Personnel

Kenichi Katayama (MWJ):operation reader
Satoshi Ozawa (MWJ)
Naoko Takahashi (MWJ)

(2) Objective

Calibration of CTD salinity

(3) Measured Parameter

Sample water (bottle) salinity

(4) Instrument and Method

The salinity analysis was carried out during R/V MIRAI cruise of MR03-K01 by the Guildline salinometer model 8400B "AUTOSAL" (S/N 62827) with a peristaltic-type intake pump (Ocean Scientific International). The AUTOSAL was operated in air-conditioned "AUTOSAL Room" and its bath temperature was held at 24 degree C. An ambient temperature varied from 21 to 24 degree C approximately.

Standardization

The AUTOSAL was standardized using IAPSO Standard Seawater (batch P141, conductivity ratio = 0.99993, salinity = 34.997) before a series of measurement. Measurement of the standard seawater was carried out every 40 samples approximately, and the drift check of the AUTOSAL was performed. Total 62 bottles (include 1 bad one) of the standard seawater were measured and both of accuracy and precision were given to be 0.00001 by 2K value (except bad one).

We also used sub-standard seawater that is deep-sea water filtered by Millipore filter (pore size of 0.45 μm) stored in a 20 liter polyethylene container . It was measured every 20 to 24 samples in order to check the drift of the AUTOSAL.

Method

Seawater samples were collected from 12 liter NiskinX bottles (Non-Teflon coating) with O-rings. The salinity sample bottle was the 250 ml brown grass bottle with screw cap. Each bottle was rinsed three times with the sample water, and was filled with it to the shoulder of the bottle. Its cap was also rinsed. The bottle was stored more than 24 hours in "AUTOSAL Room" before the salinity measurement.

A double conductivity ratio was defined as median of 31 times reading of AUTOSAL. Data collection started after 5 seconds and it took about 10 seconds to collect 31 times reading by a personal computer. Repetition measurement was carried out 5 times at maximum. When the same value came out or the following value ranged within ±0.00001, salinity value was determined.

(5) Result

Table 3.3.1-1 shows number of samples.

Table 3.3.1-1: Number of samples

Samples	**Number of samples**
Samples for CTD	1194
Samples for EPCS	27
Samples for experiment	30
Reference Material for Nutrients	4
Total	**1253**

Duplicate sampling was carried out below 3,000m depth of every CTD cast. These were measured in order to evaluate reproducibility of the AUTOSAL measurement. Average of absolute difference between each duplicate samples is calculated to be 0.0002 psu with 0.0003 psu standard deviation (Table 3.3.1-2).

Table 3.3.1-2: Result of duplicate measurement for CTD samples (except bad data)

Number of duplicate samples	**179 pairs**
Average of the absolute differences	**0.0002 psu**
Standard deviation (SD)	**0.0003 psu**

We measured 1,194 samples for CTD calibration. The AUTOSAL data was compared with "primary" CTD salinity (see section 3.2). The average of absolute difference between the CTD salinity and the AUTOSAL data was 0.0021 (0.0043 SD). The averaged difference for samples deeper than 2,000db was 0.0011 (0.0014 SD). The preliminary results are shown in Table 3.3.1-3.

Table 3.3.1-3: Result of measurement for CTD samples

ALL (1,194samples)	
AVERAGE(ABS)	0.0021
SD	0.0043
> 2,000db (601 samples)	
AVERAGE(ABS)	0.0011
SD	0.0014

(6) Data archive

The salinity data and worksheets of calculation were stored on CD-R disk that will be submitted to JAMSTEC Data Management Office (DMO).

3.3.2 Dissolved oxygen

Takayoshi SEIKE and Tomoko MIYASHITA 1）
1）:Marine Works Japan Co. Ltd.

Objectives:

Determination of dissolved oxygen in seawater.

Instruments:

Burette; APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10ml of titration vessel

Detector and Software; Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

Methods:

Following procedure is based on the WHP Operations and Methods (Dickson, 1996).

36 seawater samplers were collected with Niskin bottle attached CTD-system. Seawater for oxygen was transferred from Niskin sampler bottle to a calibrated clear glass bottles (ca. 100ml) at first. Three times volume of the bottle of seawater was overflowed. Temperature was measured by digital thermometer during the overflowing the sample. Then two reagent solutions (ReagentⅠ, Ⅱ) of 1ml each were added immediately into the sample bottle and the stopper was inserted carefully into the sample bottle. The sample bottle was then shaken vigorously to mix the contents thoroughly and to disperse the precipitate finely throughout. After the precipitate has settled at least half-way down the bottle (about 30 min), the bottle was shaken again vigorously to disperse the precipitate. Sample bottles containing pickled samples should be stored in a cool and dark location until they were titrated.

After precipitation remove the sample bottle stopper. Sulfuric acid solution was added by 1 ml. A magnetic stirrer bar was added to the solution and began stirring. Samples were titrated by sodium thiosulfate solution. This normality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer.

Reagents:

ReagentⅠ: Manganous chloride solution (3M)
ReagentⅡ: Sodium hydroxide (8M) / sodium iodide solution (4M)
Sulfuric acid solution (5M)
Sodium thiosulfate (0.025M)
Potassium iodate (0.001667M)

Results:

(1) Reproducibility of Winkler titration data

Duplicate samples were taken at every CTD cast; usually these were more than 10% of samples of each cast during this cruise. Results of the duplicate samples were shown in Table 3.3.2-1. We calculate standard deviation (SOP23).

Table 3.3.2-1 Results of the duplicate samples.

Number of duplicate samples	Oxygen concentration (μmol/kg)
	Standard Deviation.
337	0.37

(2) Contour

Contour of dissolved oxygen (155E, 17N～44N) were shown in Fig. 3.3.2-1.

Dissolved Oxygen [μmol/kg]

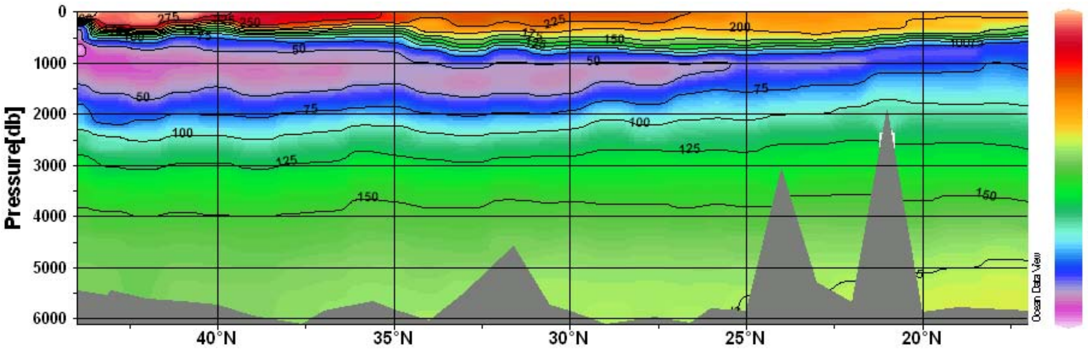


Fig. 3.3.2-1 Contour of dissolved oxygen (155E, 17N～44N)

(3) References:

Culberson, C.H. (1991) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole., pp1-15

Culberson, C.H., G.Knapp, R.T.Williams and F.Zemlyak (1991) A comparison of methods for the determination of dissolved oxygen in sea water (WHPO 91-2), Woods Hole.

Dickson, A. (1996) Dissolved Oxygen, in WHP Operations and Methods, Woods Hole., pp1-13

Green, E.J. and D.E.Carritt (1966) An Improved Iodine Determination Flask for Whole-bottle Titrations, Analyst, 91, 207-208.

Murray, N., J.P.Riley and T.R.S.Wilson (1968) The solubility of oxygen in Winkler reagents used for determination of dissolved oxygen, Deep-Sea Res., 15, 237-238

3.3.3 Chlorofluorocarbons

(1) Personnel

Shuichi Watanabe	(Japan Marine Science and Technology Center)
Hideki Yamamoto	(Marine Works Japan Ltd.)
Katsunori Sagishima	(Marine Works Japan Ltd.)

(2) Objectives

CCl_3F (CFC-11), CCl_2F_2 (CFC-12) and other CFCs are very useful chemical tracers to clarify the water movement. We determine CFC-12 and CFC-11 concentrations in seawater and air on board.

(3) Methods

Dissolved CFCs concentrations in seawater were determined with ECD-GC attached the purge and trapping system. This Procedure was based on Bullister and Weiss (1988).

(3-1) Sampling

Seawater samples for CFCs measurement were collected from 12 litter Niskin bottles into 100ml glass cylinder or 300ml glass bottle. Three times bottle/cylinder volumes of seawater sample were overflowed to minimize contamination with atmospheric CFCs.

Air samples for CFCs measurement were collected to 100ml glass cylinder at the navigation deck on R/V "MIRAI".

(3-2) Analysis

The CFCs analytical system was modified from the original design of Bullister and Weiss (1988). Sample volume was 10ml. The trap used to hold CFCs consists of a length of 1/8 in. o.d. SS tubing packed with 10 cm of Porapak T (80/100 mesh). Trapping and desorbing temperature were - 43 deg-C and 103 deg –C, respectively. The trapped gas was carried into GC system directly. Analytical conditions were bellow (Table 3.3.3-1).

Table 3.3.3-1 Instruments and analytical conditions

Instruments	
Gas Chromatograph:	GC-14B (Shimazu Ltd.)
Detector:	ECD-14 (Shimazu Ltd)
Column:	
Pre column:	Sillica PLOT (i.d.:0.53mm, length: 25m, tick: 20µm)
Main column:	Pola PLOT – QHT (i. d.: 0.53mm, length: 30m, tick: 6.0µm)
Temperature	
Oven:	110 deg-C (1min) – (10deg-C/min) – 180 deg-C (5min)
Detector:	230 deg-C
Trapping & desorbing:	-43 deg-C to 100 deg-C
Gas flow	
Column flow:	4.3 ml/min
Detector Make UP:	15 ml/min
Column Purge:	3ml/min

(4) Data archive

All data will be submitted to JAMSTEC Data Management office (DMO) and under its control.

(5) Reference

(1) Bullister, J.L and Weiss R.F. 1988. Determination of CCl_3F and CCL_2F_2 in seawater and air. Deep Sea Research, 35, 839-853.

3.3.4 Nutrients

Asako KUBO (Marine Works Japan Ltd.: MWJ)
Kenichiro SATO (Marine Works Japan Ltd.: MWJ)

(1) Objectives

The vertical and horizontal distributions of nutrients are one of the most important factors for evaluation of the mechanism of the primary production and seawater circulation.

(2) Instruments and Methods

Nutrient analysis was performed on BRAN+LUEBBE TRAACS 800 system that has 4-channel analyzing lines for nitrate, nitrite, silicate and phosphate. The system was improved by BRAN+LUEBBE for seawater analysis. The four analytical lines of the system are shown in Fig. 3.3.4-1, -2, -3, and -4. During the analysis, the laboratory temperature was maintained between 23 - 26 deg C.

a. Measured Parameters

Nitrite: Nitrite was determined by diazotizing with sulfanilamide and coupling with N-1-naphthyl-ethylenediamine (NED) to form a colored azo dye that was measured at absorbance of 550 nm using 5 cm length cell.

Nitrate: Nitrate in seawater is reduced to nitrite by reduction tube (Cd - Cu tube), and the nitrite determined by the method described above, but the flow cell used in nitrate analysis was 3 cm length cell. Nitrite initially present in the sample is corrected.

Silicate: The standard AAII molybdate-ascorbic acid method was used. The silicomolybdate produced is measured at absorbance of 630 nm using a 3 cm length cell.

Phosphate: The method by Murphy and Riley (1962) was used with separate additions of ascorbic acid and mixed molybdate-sulfuric acid-tartrate. The phospho-molybdate produced is measured at absorbance of 880 nm using a 5 cm length cell.

Nutrients reported in micromoles per kilogram were converted from micromoles per liter by dividing by density calculated at sample temperature.

b. Nutrients Standard

Silicate standard solution, the silicate primary standard, is obtained from Kanto Chemical CO., Inc. This standard solution is 1000 mg per litter in 0.5 M KOH solution for ICP analysis. Primary standard for nitrate (KNO_3), nitrite ($NaNO_2$) and phosphate (KH_2PO_4) obtained from Wako Pure Chemical Industries, Ltd.

c. Sampling Procedures

Samples were drawn into 10 ml acrylic screw-capped tubes that were rinsed three times before filling. Each sample was analyzed two times as soon as possible. Sets of 5 different concentrations of shipboard standards were analyzed at beginning, halfway and end of each group of analysis.

d. Low Nutrients Sea Water (LNSW)

Twelve containers (20L) of low nutrients surface seawater were collected in January 2002 at the equatorial Pacific and filtered with 0.45µm pore size membrane filter (Millipore HA). They are used as preparing the working standard solution.

(3) Results

At 33 hydrocast stations, we measured nutrients concentration of the CTD carousel samples and surface seawater collected by a bucket. Duplicate samples were collected from all bottles of each casting. Using the highest concentration of the standard solution (61, 1.9, 210, and 3.8µM for nitrate, nitrite, silicic acid, and phosphate, respectively), coefficients of variation (CV) of nitrate, nitrite, silicic acid, and phosphate analysis at each station were given to be 0.25, 0.61, 0.27, and 0.40%, respectively.

The vertical sections of nutrients along 155E line with CTD observations are shown Fig. 3.3.4-5.

(4) Data Archive

These data are stored in MO disk in Ocean Research Department in JAMSTEC.

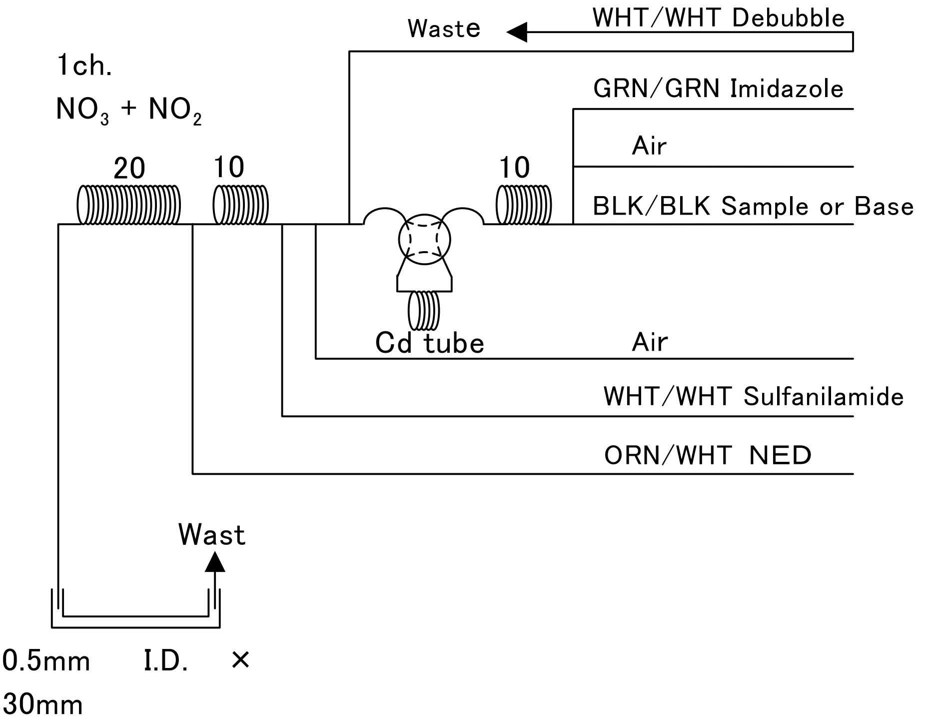


Fig. 3.3.4-1 1ch. (NO_3+NO_2) Flow diagram.

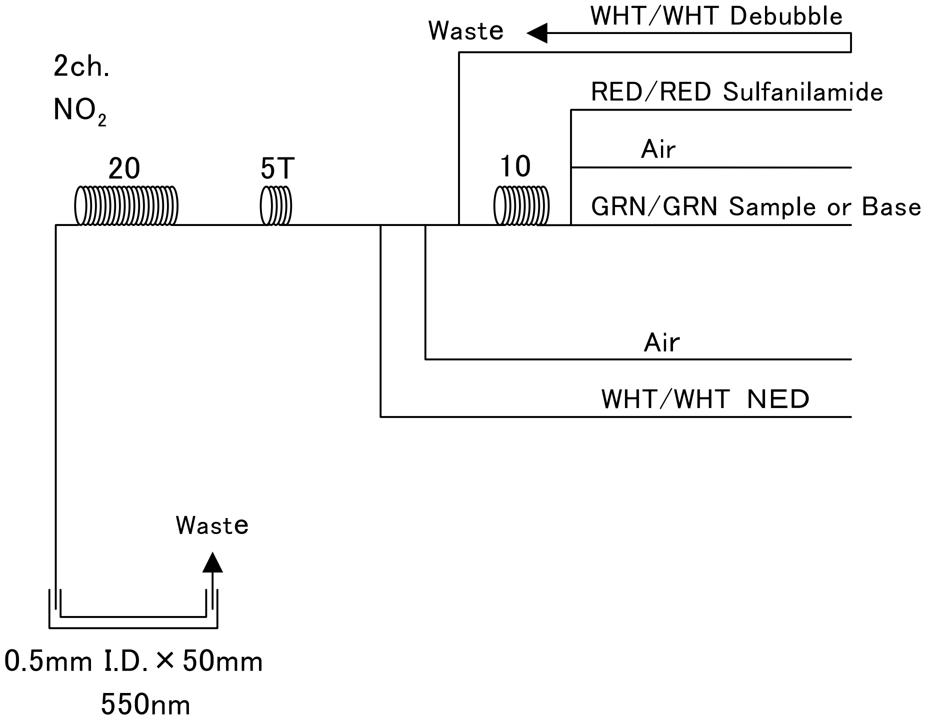


Fig. 3.3.4-2 2ch. (NO_2) Flow diagram.

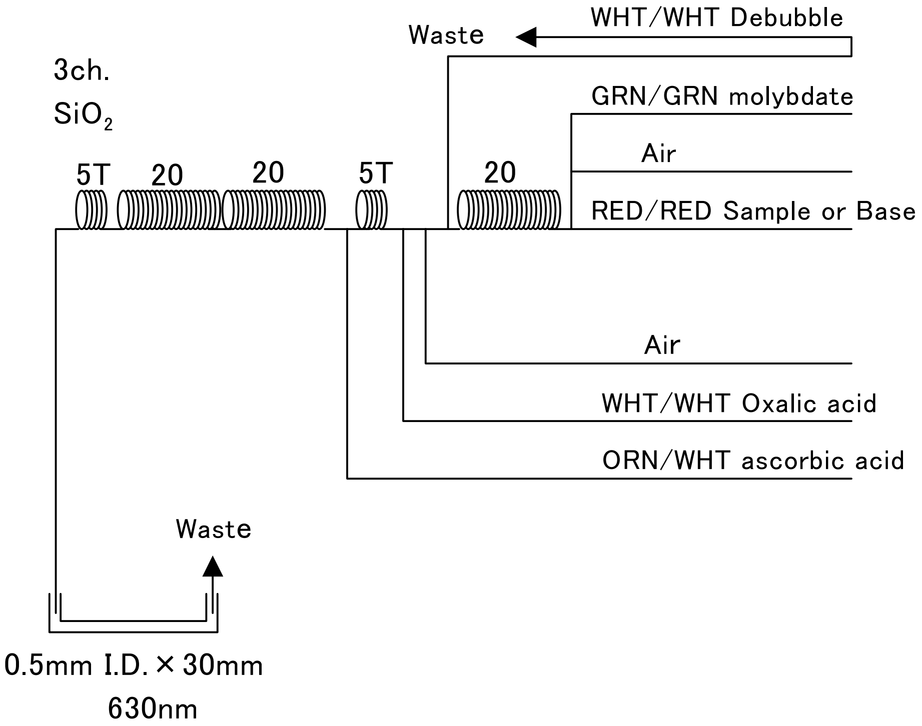


Fig. 3.3.4-3　3ch. (SiO_2) Flow diagram.

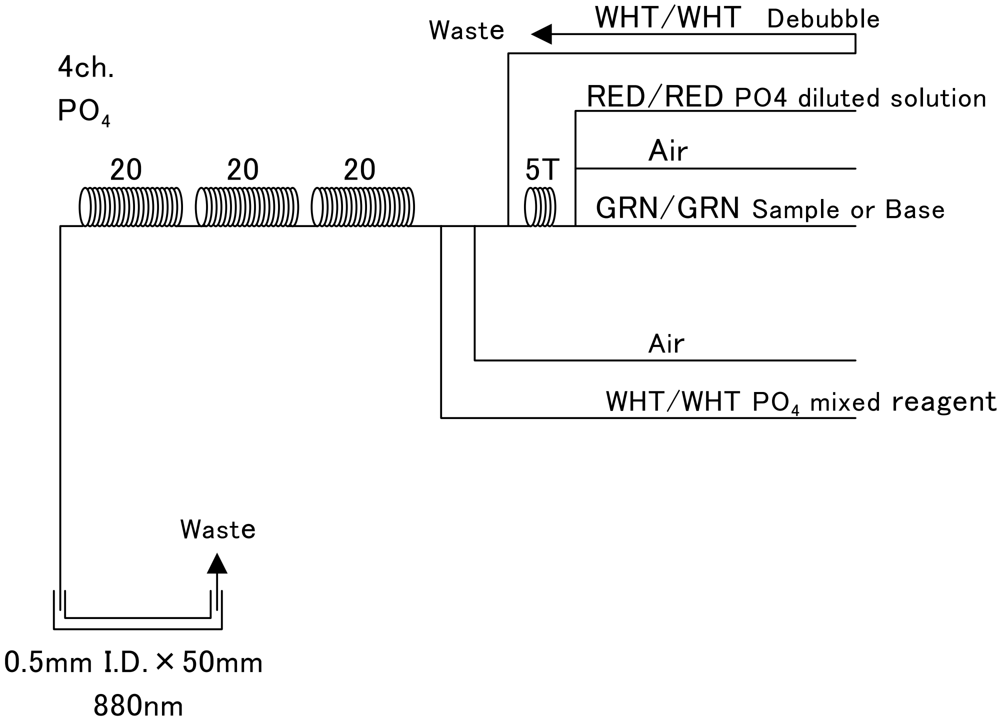


Fig. 3.3.3-4　4ch. (PO_4) Flow diagram.

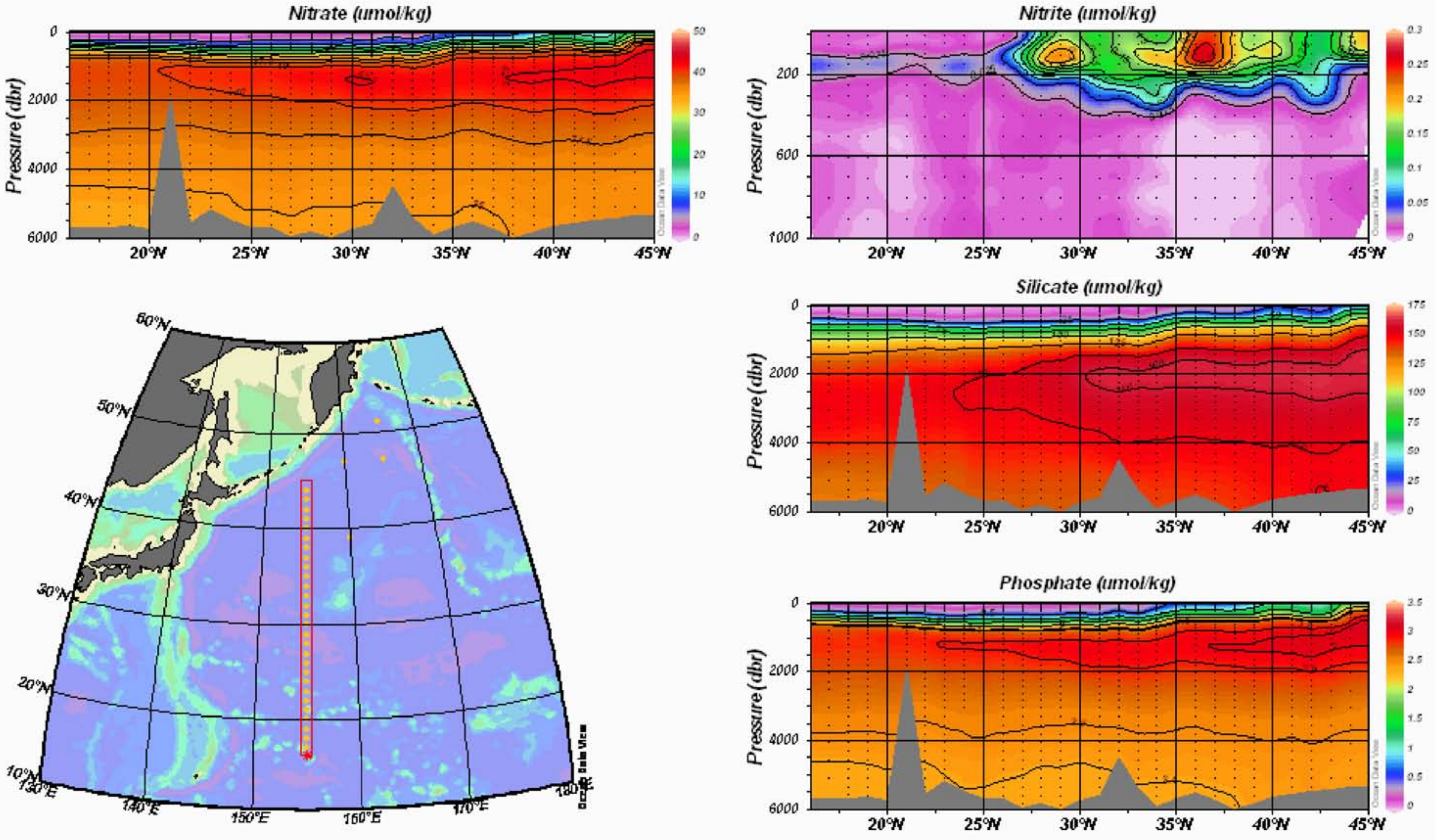


Fig. 3.3.4-5 Vertical sections of nutrients along 155E line.

3.3.5 pH

Taeko Ohama (MWJ)
Fuyuki Shibata (MWJ)
Mikio Kitada (MWJ)
Minoru Kamata (MWJ)
Touru Fujiki (MWJ)
Masaki Moro (MWJ)

(1) Method and Instruments

pH($-\log[H^+]$) of seawater was measured potentiometrically in the closed cell at the temperature 25 ℃ (pH_{25}). The cell with liquid junction or ‘salt bridge’ (saturated solution of KCl) was applied.

Ag, AgCl| solution of KCl || test solution |H+ -glass –electrode.

The e.m.f. of the glass / reference electrode cell was measured with a pH / Ion meter (Radiometer PHM95). Separate glass (Radiometer PHG201) and reference (Radiometer REF201) electrodes were used. For avoiding exchange CO_2 between seawater sample and the atmosphere during pH measurement, a closed glass container with water jacket was used. The temperature during pH measurement was monitored with a temperature sensor (Radiometer T901) and controlled to be 25℃ within ±0.1℃.

To calibrate the electrodes the TRIS (pH=8.0936 pH unit at 25℃, Delvalls and Dickson, 1998) and AMP (pH=6.786 pH unit at 25℃, Dickson and Goyet, 1996) in the synthetic seawater (S=35 PSU) (Total hydrogen scale) were applied.

pH_{sws} of seawater sample (pH_{samp}) is calculated from the expression

$$pH_{samp} = pH_{TRIS} + (E_{TRIS} - E_{samp}) / ER$$

where electrode response “ER” is calculated as follows:

$$ER = (E_{AMP} - E_{TRIS}) / (pH_{TRIS} - pH_{AMP})$$

ER value should be equal to the ideal Nernst value as follows:

$$ER = RT\,LN(10) / F = 59.16 \text{ mV / pH unit at } 25^\circ C$$

(2) Preliminary results

The absolute differences of duplicate measurements were plotted sequentially to evaluate the precision of the measurement process. It was shown in Fig.3.3.5-1. The average and standard deviation of the absolute differences were 0.001 and 0.001pH unit, respectively. The average, 0.001 pH unit is less than the recommended value (0.003 pH units) by DOE (1994).

References

DOE (1994) Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water; version 2, A.G. Dickson & C. Goyet, eds. ORNS/CDIAC-74.

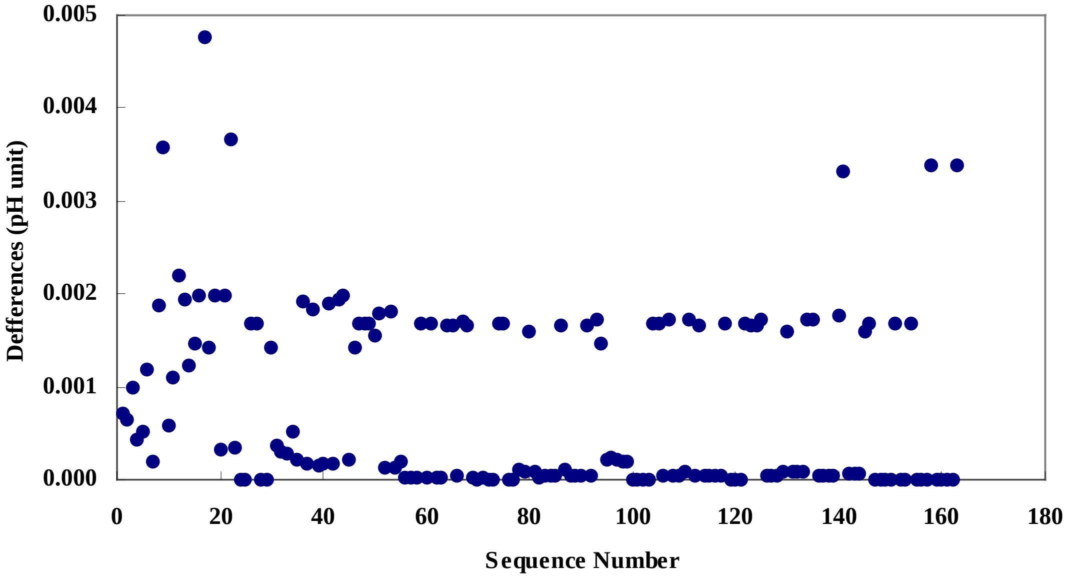


Fig.3.3.5-1 Differences of duplicate measurements

3.3.6 Total dissolved inorganic carbon

(1) Personnel

Mikio KITADA (MWJ)
Fuyuki SHIBATA (MWJ)
Minoru KAMATA (MWJ)
Taeko OHAMA (MWJ)
Masaki MORO (MWJ)
Toru FUJIKI (MWJ)

(2) Introduction

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; alkalinity, total dissolved inorganic carbon, pH and pCO_2. If two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on board measurements of total dissolved inorganic carbon (TDIC) during MR03-K01 cruise.

(3) Inventory information

Table 3.3.6-1 is showing the site name and the position where the water column samples were collected. Surface seawater was continuously collected from February 21st, 2003 to March 27th, 2003 during the cruise.

(4) Water column TDIC

(4)-1 Materials and Methods

(4)-1-1 Seawater sampling

Seawaters from different depths were collected by 12L Niskin bottles at 35 stations. To collect the surface seawater, a plastic bucket was used. Seawater was sampled in a 250ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 2 hours and was cleansed by fresh water and Milli-Q deionized water for 3 times each. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 10 seconds with care not to leave any bubbles in the bottle. After collecting the samples on the deck, the glass bottles were removed to the lab to be analyzed. Prior to the analysis, 3ml of the sample (1% of the bottle volume) was removed from the glass bottle in order to make a headspace. The samples were then poisoned with 100 μl of 100% saturated solution of mercury chloride within one hour from the sampling point. After poisoning, the samples were sealed using grease (Apiezon M grease) and a stopper-clip. The samples were stored in a refrigerator at approximately 5℃ until analyzed.

(4)-1-2 Seawater analysis

Using a coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.) and an automated sampling system controlled by a computer, the concentration of TDIC was measured as follows.

The sampling cycle was composed of 3 measuring factors; 70ml of standard CO_2 gas, 2ml of 10% saturated phosphoric acid solution and 6 seawater samples. The standard CO_2 gas was measured to confirm the constancy of the calibration factor during a run and phosphoric acid was measured for acid blank correction.

From the glass bottle, approximately 20ml of seawater was measured in a receptacle and was mixed with 2ml of 10% (v/v) phosphoric acid. The carbon dioxide gas evolving from the chemical reaction was purged by nitrogen gas (carbon dioxide free) for 10 minutes at the flow rate of 150ml/min and was absorbed into an electrolyte solution. In the electrolyte solution, acids forming from the reaction between the solution and the absorbed carbon dioxide were titrated with hydrogen ions in the coulometer and the counts of the titration were stored in the computer.

After the samples were measured, the calibration factor (slope) was calculated by measuring series of sodium carbonate solutions (0~2.5mM) and this calibration factor was applied to all of the data acquired throughout the cruise. By measuring Certified Reference Material (CRM Batch57 or 58) (Scripps Institution of Oceanography) at the start of every run series, the slope was calibrated with the counts of this outcome. A set of the solutions was changed after approximately 60 seawater samples were measured. We also carried out a reference material (RM) measurement during every run as well as CRM measurements. The reference seawater was prepared in JAMSTEC by a similar procedure of CRM preparation.

(4)-2 Preliminary results

During the cruise, 17 bottles of CRM and 19 bottles of RM were analyzed. The standard deviation of absolute differences of duplicate measurements of CRM and RM were 1.2 and 1.1 μmol/kg, respectively.

A duplicate seawater analysis was made on every sixth seawater sample. The average of the differences was 1.4 μmol/kg (n=147). The standard deviation was 1.2 μmol/kg which indicates that the analysis was accurate enough according to DOE (1994).

(5) Surface seawater TDIC

(5)-1 Materials and Methods

Surface seawater was continuously collected by a pump from the depth of 4.5m. The TDIC of the introduced surface seawater was constantly measured by a coulometer that was set to analyze surface seawater specifically. The colometric measurement is same as described in (4)-1-2 except the flow rate of nitrogen gas is 130ml/min.

After the samples were measured, the calibration factor (slope) was calculated by measuring series of sodium carbonate solutions (0~2.5mM) and this calibration factor was applied to all of the data acquired throughout the cruise. By measuring of RM every time the cell was filled with fresh anode and cathode solutions, the slope was calibrated with the counts of this outcome. The set of cell solutions was changed in every three days.

(5)-2 Preliminary results

During the cruise, 22 bottles of RM was analyzed in order to calibrate the slope of the calibration factor. The standard deviation of the absolute differences of duplicate measurements was 2.4 μ mol/kg (n=22).

(6) Data Archive

All data will be submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

(7) Reference

DOE (1994), *Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water*; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74.

Table 3.3.6-1 Inventory information of the water column samples.

Station	Lat.	Lon.
008	43-59.95N	154-59.90E
006	47-00.39N	159-53.76E
004	50-59.82N	164-59.75E
003	46-59.92N	164-59.85E
009-1	43-01.41N	155-01.19E
009-2	43-02.39N	155-03.09E
011	41-00.07N	155-00.06E
013	38-59.96N	155-00.04E
001	39-00.18N	159-59.89E
033	25-00.08N	154-59.90E
035	23-00.05N	155-00.02E
037	20-59.98N	154-59.83E
039	19-00.10N	154-59.90E
041	16-59.99N	154-59.86E
040	17-59.93N	154-59.98E
038	20-00.14N	154-59.96E
036	21-59.99N	155-00.01E
034	24-00.95N	154-58.70E
032	26-00.11N	155-00.36E
030	26-59.91N	155-00.14E
028	27-59.83N	154-59.92E
027	29-00.01N	154-59.99E
025	30-00.03N	155-00.03E
023	30-59.93N	154-59.88E
022	31-59.79N	154-59.95E
021	33-00.00N	154-59.90E
020	34-00.00N	155-00.13E
019	34-59.96N	154-59.98E
017	35-59.77N	155-00.22E
015	37-00.05N	154-59.82E
014	37-59.81N	155-00.15E
012	39-59.96N	155-00.00E
010	41-59.97N	155-00.11E

3.3.7 Total alkalinity

1. Personnel

Fuyuki SHIBATA (MWJ)
Mikio KITADA (MWJ)
Taeko OHAMA(MWJ)
Minoru KAMATA(MWJ)
Toru FUJIKI (MWJ)
Masaki MORO (MWJ)

2. Introduction

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; alkalinity, total dissolved inorganic carbon, pH and pCO_2. If two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on board measurements of total alkalinity during MR03-K01 cruise.

3. Objective

The current investigation was carried out in order to verify carbon dioxide parameters in the North West Pacific Ocean by measuring total alkalinity during this cruise.

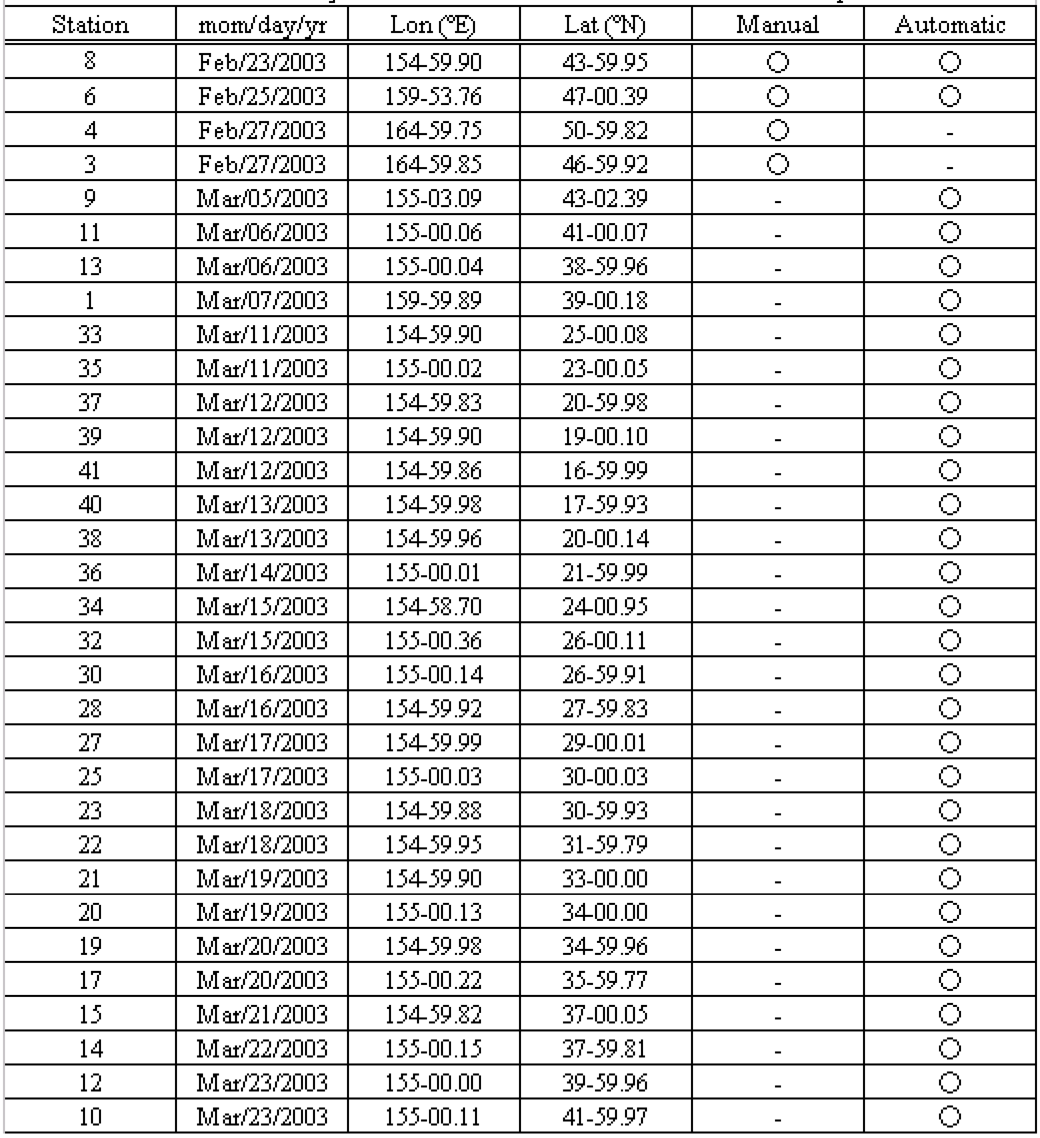
4. Sampling elements

Total alkalinity

5. Inventory information for the sampling

Table 3.3.7-1 shows the site name, date and the position where the water column samples were collected. Samples for manual analysis system were collected station 8, 6, 4, 3, and for automatic analysis system were collected except stations 4 and 3.

Table 3.3.7-1 Inventry information of the collected water column samples.



Station	mom/day/yr	Lon (°E)	Lat (°N)	Manual	Automatic
8	Feb/23/2003	154-59.90	43-59.95	○	○
6	Feb/25/2003	159-53.76	47-00.39	○	○
4	Feb/27/2003	164-59.75	50-59.82	○	-
3	Feb/27/2003	164-59.85	46-59.92	○	-
9	Mar/05/2003	155-03.09	43-02.39	-	○
11	Mar/06/2003	155-00.06	41-00.07	-	○
13	Mar/06/2003	155-00.04	38-59.96	-	○
1	Mar/07/2003	159-59.89	39-00.18	-	○
33	Mar/11/2003	154-59.90	25-00.08	-	○
35	Mar/11/2003	155-00.02	23-00.05	-	○
37	Mar/12/2003	154-59.83	20-59.98	-	○
39	Mar/12/2003	154-59.90	19-00.10	-	○
41	Mar/12/2003	154-59.86	16-59.99	-	○
40	Mar/13/2003	154-59.98	17-59.93	-	○
38	Mar/13/2003	154-59.96	20-00.14	-	○
36	Mar/14/2003	155-00.01	21-59.99	-	○
34	Mar/15/2003	154-58.70	24-00.95	-	○
32	Mar/15/2003	155-00.36	26-00.11	-	○
30	Mar/16/2003	155-00.14	26-59.91	-	○
28	Mar/16/2003	154-59.92	27-59.83	-	○
27	Mar/17/2003	154-59.99	29-00.01	-	○
25	Mar/17/2003	155-00.03	30-00.03	-	○
23	Mar/18/2003	154-59.88	30-59.93	-	○
22	Mar/18/2003	154-59.95	31-59.79	-	○
21	Mar/19/2003	154-59.90	33-00.00	-	○
20	Mar/19/2003	155-00.13	34-00.00	-	○
19	Mar/20/2003	154-59.98	34-59.96	-	○
17	Mar/20/2003	155-00.22	35-59.77	-	○
15	Mar/21/2003	154-59.82	37-00.05	-	○
14	Mar/22/2003	155-00.15	37-59.81	-	○
12	Mar/23/2003	155-00.00	39-59.96	-	○
10	Mar/23/2003	155-00.11	41-59.97	-	○

6. Materials and Methods

6.1. Seawater sampling

Seawater from different depths was collected by 12L Niskin bottles at 32 stations. To collect the surface seawater, a plastic bucket was used. Seawater from different depths was sampled in a 125ml glass bottle, which was previously soaked in 5% non-phosphoric acid detergent (pH13) solution for at least 1 hour and was cleansed by fresh water and Milli-Q deionized water for 3 times each. A sampling tube was connected to the Niskin bottle when the sampling was carried out. The glass bottles were filled from the bottom, without rinsing, and were overflowed for 6 seconds. The bottles were sealed with a plastic screw cap. After collecting the samples on the deck, the glass bottles were removed to the lab to be analyzed. The samples were stored in a refrigerator at approximately 5℃ within 36 hours after the sampling.

6.2. Seawater analysis

6.2.1 Manual analysis system

Approximately 50ml of the seawater sample was transferred into a 100ml tall beaker from the glass bottle using a calibrated pipette. At this point, the water temperature of the sample was recorded in order to calculate the exact water volume that was transferred. The samples were titrated with a solution of 0.05M hydrochloric acid and 0.65M sodium chloride. The whole titration procedure was carried out by an automated titration system. The titration system was composed of 6 devices; a titration manager (Radiometer, TIM900), an auto-burette (Radiometer, ABU901), a pH glass electrode (Radiometer, pHG201-7), a reference electrode (Radiometer, REF201), a thermometer (Radiometer, T201) and one computer with an installed operating software (Lab Soft, TimTalk9). Prior to the titration, all of the samples were kept in a 25℃ thermostat bath, in which the titration was also carried out. The acid used for the titration was calibrated by measuring alkalinity of 4 different concentrations of Na_2CO_3, ranging from 0 to 2500 μmol/kg, in 0.7N NaCl solutions. Modified Gran functions were applied to calculate the alkalinity of the samples.

6.2.2 Automatic analysis system

Approximately 42ml of the seawater sample was transferred into a water-jacketed titration cell from the glass bottle using a water-jacketed calibrated pipette. The samples were titrated with a solution of 0.05M hydrochloric acid and 0.65M sodium chloride. The whole titration procedure was carried out automatically. This titration system was TA-1000 (made by NIHON ANS ltd.) composed of 6 devices, a main unit and an auto sampler, an auto-burette (Metrohm), a pH meter (Thermo Orion), a conductivity meter (Thermo Orion), a thermostat bath and one computer. Measurement of electric motive force was used a combined pH electrode (Thermo Orion). Prior to the titration, all of the samples were kept in a 25℃ thermostat bath, in which the titration was also carried out. The acid used for the titration was calibrated by measuring alkalinity of 4 different concentrations of Na_2CO_3, ranging from 0 to 2500 μmol/kg, in 0.7N NaCl solutions. Modified Gran functions were applied to calculate the alkalinity of the samples.

7. Preliminary Results

Some duplicate samplings were made on every station. The absolute difference between the duplicate samples for manual analyses and automatic analyses were plotted on a range control chart (see Figures 3.3.7-1 and -2.). The average of the differences of manual analyses was 3.71 and the standard deviation was 5.21 µmol/kg (n=12). The other hand, average of the differences of automatic analyses was 2.57 and the standard deviation was 2.66 µmol/kg (n=136).

8. Data Archive

All data was submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

Reference

DOE (1994), *Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water*; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74.

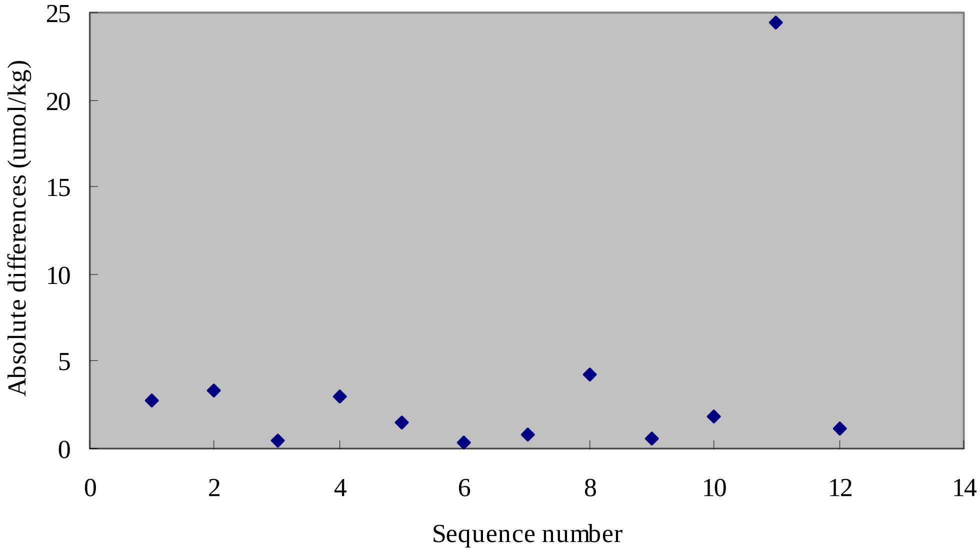


Figure 3.3.7-1 Range control chart of manual analysis

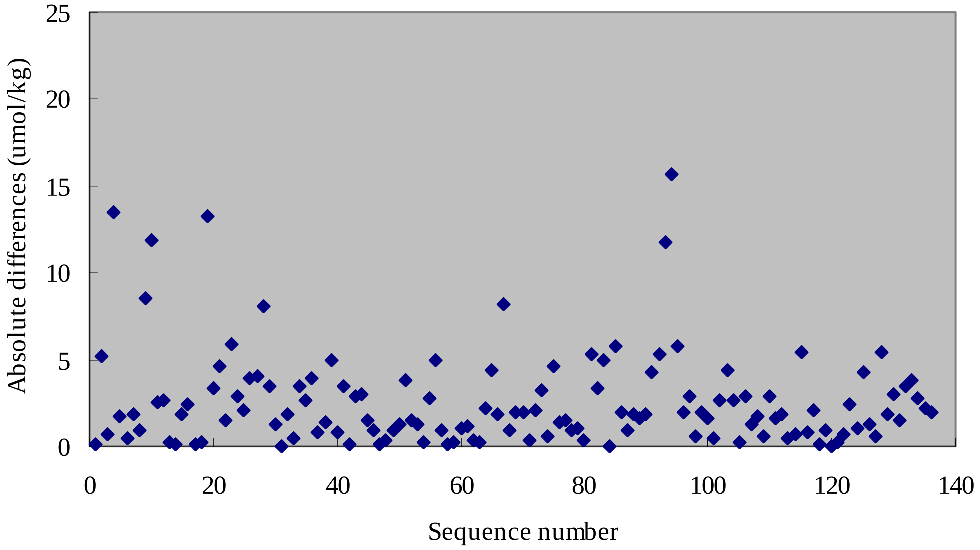


Figure 3.3.7-2 Range control chart of automatic analysis

3.3.8 Carbon-14, carbon-13

Yuichiro Kumamoto (JAMSTEC)

In order to study the role of intermediate water in carbon cycle in the western North pacific, seawater for carbon-14 (radiocarbon) and carbon-13 (stable carbon isotope) of total dissolved inorganic carbon (TDIC) was collected by the hydrocasts at the stations 1, 3, 4, 6, 8, 11, 14, 17, 20, 22, 28, 33, 36, 37, 39, and 41. We also collected seawater sampls from surface seawater continiously pumped up from about 4 m depth. The seawater was collected in a 250 ml glass bottle. Then a head-space of 4 % of the bottle volume was left by removing seawater sample with a plastic pipette. Saturated mercuric chloride ($HgCl_2$) of 0.05 cm^3 was added as preservative. Finally, the bottle was sealed using a greased ground glass and a clip was secured. We collected about 480 seawater samples during this cruise. All the samples were stored in a laboratory of JAMSTEC. In the laboratory, TDIC will be extracted as CO_2 and converted to graphite for measurements of stable and radio carbon isotopes, respectively.

3.3.9 Th-234 and export flux

Hajime KAWAKAMI (Mutsu Institute for Oceanography, JAMSTEC)

(1) Purpose of the study

The fluxes of POC were estimated from Particle-reactive radionuclide (^{234}Th) and their relationship with POC in the northwestern North Pacific Ocean.

(2) Sampling

Seawater sampling for ^{234}Th and POC: 5 stations (St.1, 3, 4, 6 and 8) and 8 depths (10m, 20m, 40m, 60m, 80m, 100m, 150m and 200m) at each station.

Seawater samples (20–30 L) were taken from Hydrocast at each depth. The seawater samples were filtered with 47mm GF/F filter on board immediately after water sampling.

In situ filtering samples were taken from large volume pump sampler (LVP) at each depth (see 3.4). The filter samples (150mm GF/F filter) were divided for ^{234}Th and POC.

(3) Chemical analyses

Dissolved ^{234}Th was separated using anion exchange method on board; all hydrocast samples. Particulate ^{234}Th from LVP samples were separated in land-based laboratory. Separated samples of ^{234}Th were absorbed on 25mm stainless steel disks electrically, and were measured by β-ray counter.

The determinations of POC were used CHN analyzer in land-based laboratory.

(4) Preliminary result

The distributions of dissolved and particulate ^{234}Th will be determined as soon as possible after this cruise. This work will help further understanding of particle dynamics at the euphotic layer.

3.3.10 Chlorophyll-*a*

Hajime KAWAKAMI (Mutsu Institute for Oceanography, JAMSTEC)
Makio HONDA (Mutsu Institute for Oceanography, JAMSTEC)

(1) Sampling location

Seawater samples are collected from Station 1, 3, 4, 6 and 8 in this cruise used 12 L Niskin sampling bottles with CTD-RMS. (Th-234 cast)

(2) Experimental procedure

The concentration of chlorophyll *a* in seawater samples is measured by fluorometric determination. The method used here utilizes the Turner fluorometer as suggested by Parsons et al. (1984).

Seawater samples (500 ml) are filtered through a glass fiber filter at 1/2 atmospheric pressure. Filters are used Whatman GF/F glass fiber filters (25 mm diameter).

The filters are extracted by 7 ml of *N*, *N'* -dimethylformamide between overnight in a dark and cold (-20 °C) place.

The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005, TURNER DESIGNS) with a 340-500 nm bound excitation filter and a >665 nm bound emission filer, before and after acidification. The acidification is carried out with 2 drops of 1 N HCl and the second measurement made 1 minutes after the acidification.

The amount of chlorophyll *a* is calculated from the following equation;

$$\mu\text{g chlorophyll } a \,/\, \text{L} = (\text{fo} - \text{fa}) / (F_{Ch} - F_{ph}) \quad * \text{v/V}$$

where fo and fa are the fluorescence before and after the acidification, respectively, F_{Ch} and F_{ph} are the fluorescent factor of chlorophyll *a* and phaeophytine *a*, respectively, v is the volume of *N*, *N'* -dimethylformamide extract, and V is the volume of seawater.

The method is calibrated against a known concentration of chlorophyll *a* as determined by the spectrophotometric method (Porra et al., 1989).

A precision based on replicate measurements is usually less than 5%.

(3) Preliminary result

The preliminary results were shown in Table 3.3.10-1 and Figure 3.3.10-1.

(4) References

Parsons Timothy R, Yoshiaki Maita and Carol M Lalli. 1984. "A manual of chemical and biological methods for seawater analysis" (Pergamon Press), pp. 101-112.

Porra R. J., W. A. Thompson and P. E. Kriedemann. 1989. Biochim. Biophys. Acta, 975, 384-394.

Table 3.3.10-1 The concentrations of Chlorophyll *a* (μg l^{-1}) at MR03-K01.

Depth (m)	St. 1	St. 3	St. 4	St. 6	St. 8
0	0.370	0.239	0.360	0.296	0.422
10	0.330	-	0.325	0.273	0.379
20	0.311	0.278	0.333	0.295	0.394
40	0.429	0.232	0.369	0.324	0.402
60	0.410	0.244	0.329	0.296	0.382
80	0.214	-	0.349	0.269	0.354
100	0.170	0.148	0.309	0.113	0.390
150	0.159	0.010	-	0.005	0.017
200	0.074	0.004	0.012	0.002	0.005

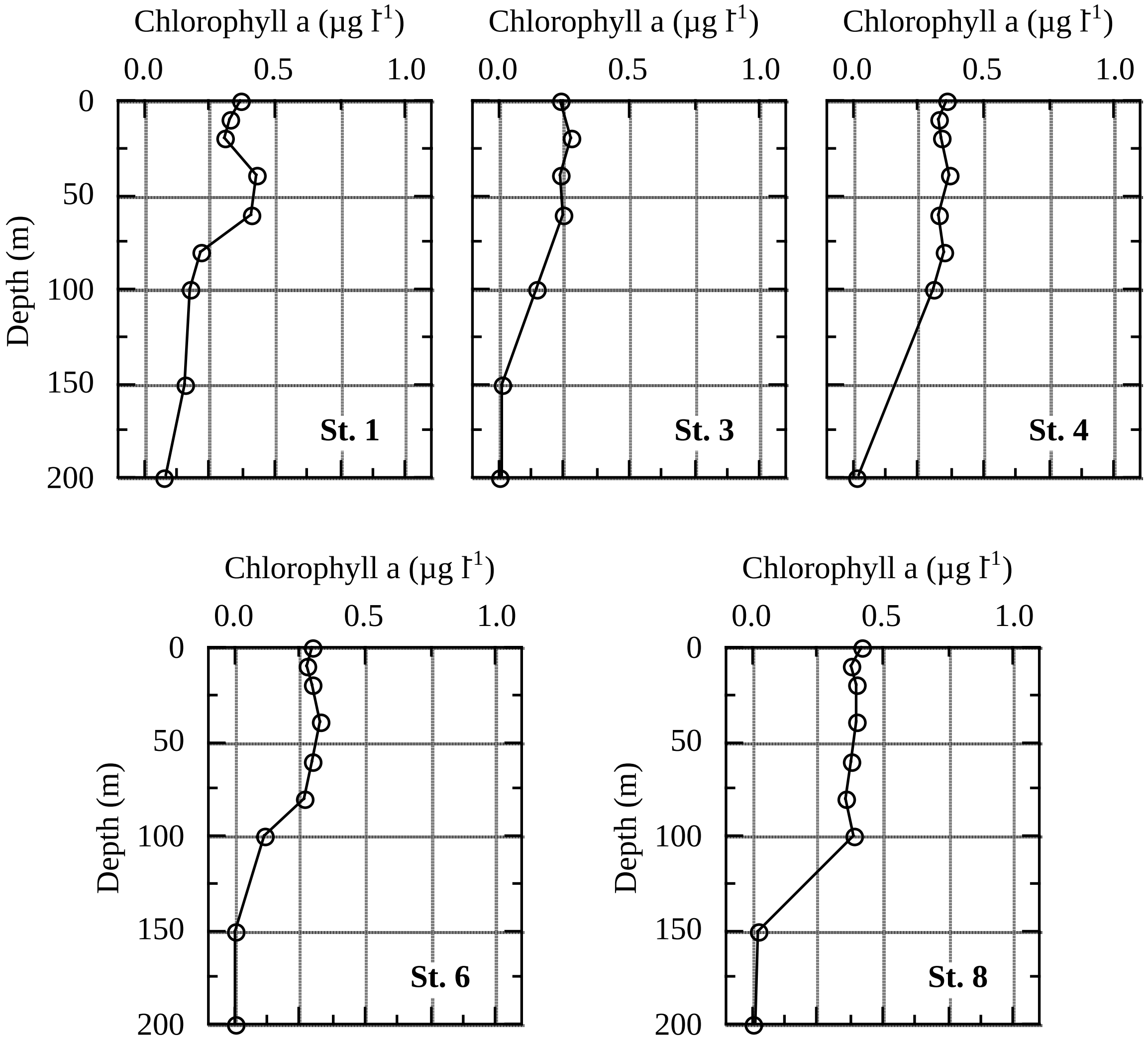


Figure 3.3.10-1 The vertical distributions of Chlorophyll *a* at MR03-K01.

3.3.11 Trace elements

(1)Personnel

Masatoshi Kinugasa (Institute for Chemical Research, Kyoto Univ.)

(2)Objective

The distribution and speciation of trace elements in seawater are controlled by various physical, chemical and biological processes. Because of this, it can get useful information about the ocean from the distribution and speciation of trace elements. Our object is to reveal the behavior of trace elements in seawater and to elucidate the processes occurring in the ocean.

(3)Measurement Parameters

On the present cruise, we are studying the distribution of trace bioelements (Fe, Co, Ni, Cu, Zn, etc.) and second and third transition series elements. (Zr, Nb, Hf, Ta, W, etc.) in seawater.

(4)Instruments and Methods

The seawater samples were collected by Niskin-X sampling bottles mounted on a CTD carousel water sampler. The Niskin-X bottles were thoroughly cleaned with detergent and hydrochloric acid before the cruise. In order to decrease the contamination from the ship, the sampling was usually conducted as soon as possible after arrival at a station using the gallows crane. Operators of the sampling bottles wore plastic gloves. Seawater (500 ml) was transferred from the sampler to a precleaned low-density polyethylene bottle on the deck using silicon tube and bell to avoid contamination by airborne particles.

Immediately after sampling, A portion of sample (250 ml) was filtered through an acid-cleaned Nuclepore filter (0.2 μm pore size) using a closed filtration system in a clean room. We will determine trace elements concentrations in ‘dissolved’ and ‘total dissolvable’ fractions using the filtered and unfiltered samples, respectively. The filtered and unfiltered seawater samples were acidified to pH 2 and stored. Hydrochloric acid was added to the sample to measure the concentration of a bioelements, and hydchloric acid and hydrofluoric acid were added to the sample to measure the concentration of a second and third transition series elements.

After brought back to our laboratory, the seawater sample will be adjusted to pH 4 with ammonium acetate buffer and passed through a column of fluorinated metal alkoxide glass-immobilized 8-hydroxyquinoline (MAF-8HQ). Collected trace elements on MAF-8HQ are eluted with 25 ml of 0.5 M nitric acid containing 10^{-3} M hydrogen peroxide for bioelements or 0.5 M nitric acid containing 10^{-3} M oxalic acid for second and third transition series elements. The eluents will be analyzed with a ICP-MS spectrometer (ELAN DRCⅡ, Perkin Elmer).

(5)Results

The 500 samples were collected during this cruise. The sampling stations were Station 1, 4, 6, 8, 19, 33, 41.

(6)Data archive

Raw data of trace elements will be submitted to DMO (Data Management Office), JAMSTEC and will be under its control.

3.3.12 Water sampling for RAS

Makio HONDA (Mutsu Institute for Oceanography, JAMSTEC)

Mutsu institute for Oceanography has conducted time-series observation in the northwestern North Pacific. This project is called HiLaTS (High Latitude Time-series observation) and focuses on biogeochemistry in the northwestern North Pacific concerning the global warming. As strategy in this projects, time-series mooring systems are being deployed at three stations in the Western Subarctic Gyre. Our mooring system consists of various automated sampling instruments including sediment trap, zoo / phytoplankton sampler, incubation chamber and water sampler. Except sediment trap, these gears are installed in the euphotic zone (approximately 40 – 50 m). In September 2001, these mooring systems were deployed and recovered successfully in October 2002. We obtained one year time-series samples.

Automated water sampler called RAS (Remote Access Sampler) collected approximately 50 water samples of 450 ml once each 8 days for one year. These water samples collected were preserved with 5 ml saturated mercuric chloride solution ($HgCl_2$). Concentrations of nutrients and carbonate species for RAS samples showed seasonal variability. In order to evaluate that these variability corresponds to seasonal variability in concentrations for ambient water or artifact caused by preservation, water samples were collected during this cruise for preservation test.

At station 4 (HiLaTS station: K1), sea water of approximately 20 l at 50 m was collected by using CTD/RMS. On board, water sample was filtered with HA filter (pore size: 0.4 μm). Sequentially, filtered water was introduced to RAS water sample bag (Teflon coated aluminum bag) measuring its volume. Before introducing water, 0 – 5 ml $HgCl_2$ was injected in RAS sample bag. Half of samples with different $HgCl_2$ concentrations (7 samples) were analyzed on board and the other were kept in refrigerator under 4 deg-C as archives.

Concentrations of nutrients (NOx, SiO_4 and PO_4) and carbon species (total dissolved inorganic carbon: TCO_2 and total alkalinity: TALK) were measured using TRAACS 800 continuous flow analytical system (BRAN+LUEBBE) and coulometer (Carbon Dioxide Coulometer Model 5012, UIC Inc.), respectively, by marine technicians of Marine Works Japan, Co..

Table 3.3.12-1 shows concentrations of nutrients and carbonate species measured. Concentrations measured were corrected with dilution rate. Repeatability of sampling and measurement (n = 7) are less than 0.6 % [1)]. Therefore it can be said that there was no problem in method and preservative ($HgCl_2$) does not interfere chemical analysis. This table also shows concentrations for seawater collected at 40 m and 50 m at same station, but at different hydrocasting (routine cast). Some concentrations for RAS sample are slightly different from these for routine water sample. It might be attributed to the difference in pre-treatment for sample: RAS samples were filtered under atmosphere for 7 hours and kept for approximately one week before measurement while routine sample were not filtered, did not contact atmosphere, and analyzed within 24 hours.

The initial concentrations for RAS test sample were certified during this cruise. Archived RAS samples will be analyzed for the above chemical components in future and its quality of sample or status of preservation will be evaluated.

1) Later discussion with Kaz Hayashi of MIO pointed out the possibility that mercuric fouling irregularly affects the reduction column for nutrients and electrode for alkalinity (lowers observed values) although the effect of mercuric chloride on nutrients and alkalinity values is little.

Photo 1 injection of $HgCl_2$

Photo 2 Sampling methods

Table 3.3.12-1 Concentartions of nutrients and carbon species of water sample for RAS

S/N	HgCl (ml)	sample volume (ml)	Factor	NOx (meas) (µmol/l)	NOx(correct) (µmol/kg)	Si(OH)4(meas) (µmol/l)	Si(OH)4(correct) (µmol/kg)	PO4(meas) (µmol/l)	PO4(correct) (µmol/kg)	TCO2(meas) (mmol/kg)	TCO2(correct) (µmol/kg)	TALK(meas) (µmol/l)	TALK(correct) (µmol/kg)
1	0	465	1.0000	26.01	25.42	43.54	42.55	1.96	1.92	2141.2	2141.2	2244.8	2244.8
2	0	470	1.0000										
3	0.5	455	0.9989	25.91	25.35	43.67	42.72	1.97	1.93	2141.3	2143.6	2239.8	2242.3
4	0.5	330	0.9985	25.99	25.44	43.66	42.73	1.96	1.92	2136.9	2140.2	2233.5	2236.9
5	0.5	445	0.9989										
6	0.5	480	0.9990										
7	2	440	0.9955	25.91	25.43	43.42	42.62	1.97	1.93	2136.8	2146.5	2226.0	2236.1
8	2	457	0.9956	25.95	25.47	43.56	42.75	1.97	1.93	2132.6	2141.9	2234.1	2243.9
9	2	460	0.9957										
10	2	445	0.9955										
11	5	470	0.9895	25.93	25.61	43.33	42.79	1.95	1.93	2119.5	2142.1	2203.7	2227.1
12	5	450	0.9890	25.84	25.53	43.21	42.69	1.96	1.94	2123.6	2147.2	2218.1	2242.7
13	5	450	0.9890										
14	5	470	0.9895										
			average		25.46		42.69		1.93		2143.2		2239.1
			stdev		0.08		0.08		0.01		2.7		6.3
			stdev(%)		0.3		0.2		0.4		0.1		0.3
		Routine data		(40m)	24.68		42.58		1.91		2130.0		2250.7
				(60m)	24.67		42.57		1.91		2128.9		2240.7
	diffference between RAS and routine (%)				3.17		0.27		0.90		0.62		-0.51

Sampling date: 2003.2.27
Location: Station 4 (K1: 51N, 165E)
Sampling depth: 50 m
Salinity: 33.1178
filteration: done
▨ take out

3.3.13 Trace ion analysis of deep seawater by capillary electrophoresis using transient isotachophoretic preconcentration

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Object

Developing analysis of trace ions such as iodide, iodate, nitrite and several cations in deep seawater with capillary electrophoresis.

Procedure

It is important for understanding a behavior of some trace chemical elements related with the climate change to develop their new analytical method in seawater. We collected about 100ml seawater samples from surface to bottom at stations 11, 17 and 36 during this cruise (MR03-K01) to test the new analytical method for trace ions such as iodide, iodate, nitrite and several cations. These collected seawater samples were kept in polyethylene bottle under refrigerator on board.

An improved transient isotachophoresis (tITP) procedure for the preconcentration of trace ions from highly saline matrices was developed for the analysis of seawater by capillary electrophoresis. This proposed tITP-CE method is applied to the analysis of trace elements in these collected seawater samples at laboratory. The target analyses are trace anions (e.g., iodide and iodate) and cations (e.g. Li and Sr).

Table 3.3.13-1 Collecting seawater samples along 155 degree East.

Station No.	Date	Layer (m)	Remarks
Sta. 11 (41 ° N)	2003.03.06.	0, 10, 50, 100, 150, 200, 250 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3250, 3500, 3570, 4000, 4250, 4500, 4750, 5000, 5250, 5500, (35 samples)	Depth 5510m Bottle Label: N-00 to N-34
Sta. 17 (36 ° N)	2003.03.21.	0, 10, 50, 100, 150, 200, 250 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3250, 3500, 3570, 4000, 4250, 4500, 4750, 5000, 5250, 5500, (35 samples)	Depth 5550m Bottle Label: I-00 to I-34
Sta. 36 (22 ° N)	2003.03.14.	0, 10, 50, 100, 150, 200, 250 300, 400, 500, 600, 700, 800, 900, 1000, 1200, 1400, 1600, 1800, 2000, 2200, 2400, 2600, 2800, 3000, 3250, 3500, 3570, 4000, 4250, 4500, 4750, 5000, 5250, 5500, (35 samples)	Depth 5550m Bottle Label: S-00 to S-34

3.4 *In situ* pumping

Hajime KAWAKAMI (Mutsu Institute for Oceanography, JAMSTEC)
Makio HONDA (Mutsu Institute for Oceanography, JAMSTEC)

For the study of “biological pump”, quantification of the export flux, which is organic carbon vertical flux at the bottom of surface mixed layer or euphotic zone, is important issue. One of strategy for this study is measurement of ^{234}Th in the surface seawater and particulate.

In order to collect a large amount of particulate materials, *in situ* pumping was conducted during this cruise. We deployed 8 large volume pumps (LVP) at various depths at one time. Filtration speed and period was 4 l/min and 1 – 2 hours, respectively, and filter used was GF/F (150mm). Depth sensor (Sea bird SBE39) was attached on LVP deployed at 60 m and 200 m depths.

Although we expected to suspend *in situ* pumping because of bad sea state before cruise, we, fortunately, could conduct this work at 5 stations including MIO time-series stations. Table 3.4-1 shows LVP filtration volume. Some of LVP did not work because of insulation failure caused by water immersion at underwater connecter. However we filtered more than 8 tons seawater *in situ*.

After recovery, filters with particulate materials were wrapped with aluminum foil and kept in freezer immediately. The filter samples (150mm GF/F filter) were divided for ^{234}Th and POC, and were determined in land-based laboratory (see 3.3.9)

Photo 3.4-1 Deployment of LVP

Table 3.4-1 LVP filtration volume

Station 8 (St. KNOT) Sampling date: 2003.2.24 2hr pumping

Depth (m)	No.	Depth (m) 1)	+/-	Pumping time (min)	Filteration volum (L) C 2)	Filteration volum (L) F 3)	Status	C/F
10	LVP1	9.7		120	433.2	423.9		1.02
20	LVP2	19.5		120	434.2	439.1		0.99
40	LVP3	38.9		60	213.1	202.5	Sudden flow obstruction	1.05
60	LVP4	58.4	1.2	120	431.8	425.4		1.01
80	LVP5	78.1		21	76.9	72.7	Sudden pressure release	1.06
100	LVP6	97.8		120	433.2	353.1		1.23
150	LVP7	147.05		3	11.1	10.2	Sudden pressure release	1.09
200	LVP8	196.3	1.4	120	433.2	408.0		1.06

Station 6 (St. K2) Sampling date: 2003.2.26 2hr pumping

Depth (m)	No.	Depth (m) 1)	+/-	Pumping time (min)	Filteration volum (L) C 2)	Filteration volum (L) F 3)	Status	C/F
10	LVP1	9.6		120	433.2	427.7		1.01
20	LVP2	19.2		120	433.2	420.9		1.03
40	LVP3	38.4		7	24.2	25.0	Sudden pressure release	0.97
60	LVP4	57.6	1.1	120	400.6	386.1		1.04
80	LVP5	77.4		0.2	0.8	1.1	Sudden pressure release	0.70
100	LVP6	97.2		120	433.2	347.5		1.25
150	LVP7	146.6		0.3	0.9	1.1	Sudden flow obstruction	0.79
200	LVP8	196.1	1.1	120	433.2	410.3		1.06

Station 4 (St. K1) Sampling date: 2003.2.27 2hr pumping

Depth (m)	No.	Depth (m) 1)	+/-	Pumping time (min)	Filteration volum (L) C 2)	Filteration volum (L) F 3)	Status	C/F
10	LVP3	10.0		120	377.2	345.6		1.09
20	LVP2	20.0		120	433.2	400.8		1.08
40	LVP1	40.1		0.3	1.1	1.1	Sudden flow obstruction	0.97
60	LVP4	60.1	1.0	120	394.5	379.6		1.04
80	LVP5	79.9		7	23.4	23.1	Sudden pressure release	1.01
100	LVP6	99.7		120	433.2	330.4		1.31
150	LVP7	149.1		0.1	2.2	3.0	Sudden pressure release	0.73
200	LVP8	198.6	1.3	120	433.2	405.0		1.07

Station 3 (St. K1.5) Sampling date: 2003.2.28 1hr pumping

Depth (m)	No.	Depth (m) 1)	+/-	Pumping time (min)	Filteration volum (L) C 2)	Filteration volum (L) F 3)	Status	C/F
10	LVP1	10.1		8	27.9	28.8	Sudden flow obstruction	0.97
20	LVP2	20.1		60	216.6	200.2		1.08
40	LVP3	40.3		60	216.6	207.4		1.04
60	LVP4	60.4	1.3	60	216.6	213.5		1.01
80	LVP5	80.0		2	7.7	7.9	Sudden pressure release	0.97
100	LVP6	99.5		60	216.6	185.1		1.17
150	LVP7	148.5		3	9.8	10.2	Sudden flow obstruction	0.96
200	LVP8	197.4	1.4	60	216.6	205.1		1.06

Station 1 (St. K3) Sampling date: 2003.3.7 1.5hr pumping

Depth (m)	No.	Depth (m) 1)	+/-	Pumping time (min)	Filteration volum (L) C 2)	Filteration volum (L) F 3)	Status	C/F
10	LVP1	10.1		90	324.9	315.7		1.03
20	LVP2	20.2		90	324.9	310.4		1.05
40	LVP3	40.3		90	324.9	309.2		1.05
60	LVP4	60.5	0.9	90	324.9	318.7		1.02
80	LVP5	80.1		0.2	0.6	0.4	Sudden pressure release	1.59
100	LVP6	99.8		90	324.9	280.5		1.16
150	LVP7	148.9		0.7	2.4	3.0	Sudden flow obstruction	0.79
200	LVP8	198	1.3	90	324.9	297.9		1.09

1) Depth (m) measured by using depth sensor (underlined depth) and inter/extrapolation

2) Filteration volu by computer record

3) Filteration volu by flow meter

3.5 Surface underway observations

3.5.1 Partial Pressure of CO_2 (pCO_2)

Personnel
Minoru KAMATA (MWJ)
Fuyuki SHIBATA (MWJ)
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Shigeki MORO (MWJ)
Toru FUJIKI (MWJ)

Introduction

Since the global warming is becoming an issue world-widely, studies on the green house gas such as CO_2 are drawing high attention. Because the ocean plays an important roll in buffering the increase of atmospheric CO_2, studies on the exchange of CO_2 between the atmosphere and the sea becomes highly important. When CO_2 dissolves in water, chemical reaction takes place and CO_2 alters its appearance into several species. Unfortunately, the concentrations of the individual species of CO_2 system in solution cannot be measured directly. There are, however, four parameters that could be measured; alkalinity, total dissolved inorganic carbon, pH and pCO_2. If two of these four are measured, the concentration of CO_2 system in the water could be estimated (DOE, 1994). We here report on board measurements of Partial Pressure of CO_2 in surface seawater during MR03-K01 cruise.

Objective

The current investigation was carried out in order to verify carbon dioxide parameters in the North West Pacific Ocean by continuously measuring the partial pressure of CO_2 in the atmosphere and surface seawater.

Materials and Methods

Concentrations of CO_2 in the atmosphere and the sea surface were measured continuously during the cruise using an automated system with a non-dispersive infrared (IR) analyzer (BINOS^{TM}). The automated system ran on one and a half hour cycle, including measurements of standard gasses, ambient air sample, and a headspace sample from the equilibrator. During one cycle, standard gasses were measured once each, twice for ambient air sample and 7 times of the sample from the equilibrator. The concentrations of the standard gas were 272, 342, 373 and 392 ppm.

The ambient air sample taken from the bow was introduced into the IR by passing through a mass flow controller which controlled the air flow rate at about 0.5L/min, a cooling unit, a perma-pure dryer (GL Sciences Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

A fixed volume of the ambient air taken from the bow was equilibrated with a stream of seawater that flowed at a rate of 5-6L/min in the equilibrator. The air passing the equilibrator was circulated with an air pump at 0.5-0.6L/min in a closed loop passing through two cooling units, a perma-pure dryer (GL Science Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

Preliminary results

Figure 3.5.1-1 shows the results of measuring the CO_2 concentration of ambient air sample and the seawater sample.

Data Archive

All data was submitted to JAMSTEC Data Management Office (DMO) and is currently under its control.

Reference

DOE (1994), *Handbook of methods for the analysis of the various parameters of the carbon dioxide system in sea water*; version 2, A. G. Dickson & C. Goyet, Eds., ORNS/CDIAC-74.

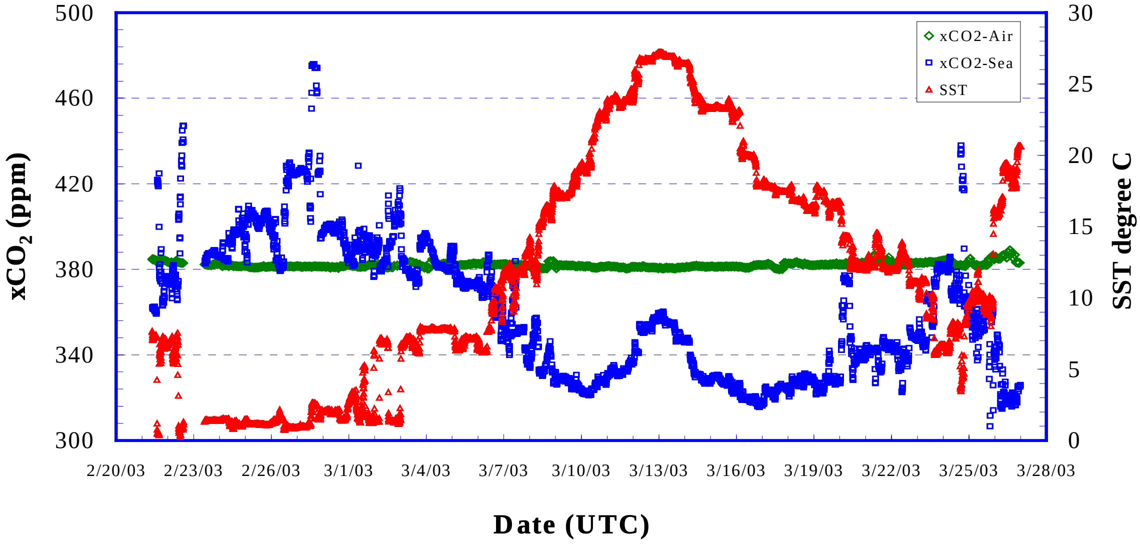


Figure 3.5.1-1 The CO_2 concentrations of the atmosphere and seawater sample

3.5.2 Surface seawater monitoring system

(1) Name & Affiliation
Tomoko MIYASHITA (Marine Works Japan co.,Ltd)
Takayoshi SEIKE (Marine Works Japan co.,Ltd)

(2) Objective

To measure salinity, temperature, dissolved oxygen content, and fluorescence of near-sea surface water.

(3) Methods

Surface sea water monitoring system (Nippon Kaiyo co.,Ltd.) measured continuously salinity, temperature, dissolved oxygen, fluorescence and particle size of plankton in near surface sea water every 1-minute. This system is set up in the “*sea surface monitoring laboratory*” on R/V Mirai. This system is connected to shipboard LAN-system. Measured data are stored in a hard disk of PC machine every 1-minute together with time and position of the ship, and displayed on the PC monitor

Surface sea water is continuously pumped up to the laboratory and flowed into the system. The flow rate is controlled to be 12L/min except with fluorometer (about 0.3L/min). The flow rate is measured with two flow meters and each value was checked everyday.

Specification of the each sensor in this system is listed below.

a) Temperature and Salinity sensor

SEACAT THERMOSALINOGRAPH
Model: SBE-21, SEA-BIRD ELECTRONICS, INC.
Serial number: 2126391-3126
Measurement range: Temperature -5 to +35℃, Salinity0 to 6.5 S m-1
Accuracy: Temperature 0.01 ℃ 6month-1, Salinity0.001 S m-1 month-1
Resolution: Temperatures 0.001℃, Salinity0.0001 S m-1

b) Bottom of ship thermometer

Model: SBE 3S, SEA-BIRD ELECTRONICS, INC.
Serial number: 032607
Measurement range: -5 to +35℃
Resolution: ±0.001℃
Stability: 0.002 ℃ year-1

c) Dissolved oxygen sensor

Model: 2127A, Orbisphere Laboratories Japan INC.
Serial number: 44733
Measurement range: 0 to 14 ppm
Accuracy: ±1% at 5 ℃ of correction range
Stability: 1% month-1

d) Fluorometer

Model: 10-AU-005, TURNER DESIGNS
Serial number: 5562 FRXX
Detection limit: 5 ppt or less for chlorophyl a
Stability: 0.5% month-1 of full scale

e) Particle Size sensor

Model: P-05, Nippon Kaiyo LTD.
Serial number: P5024
Measurement range: 0.02681 mmt to 6.666 mm
Accuracy: ±10% of range
Reproducibility: ±5%
Stability: 5% week-1

f) Flow meter

Model: EMARG2W, Aichi Watch Electronics LTD.
Serial number: 8672
Measurement range: 0 to 30 l min-1
Accuracy: ±1%
Stability: ±1% day-1

The monitoring periods (UTC) during this cruise is listed below.

21-Feb.-’03 9:47 to 27-Mar.-’03 00:00

(4) Preliminary Result

Temporal variation of the salinity, temperature, fluorescence, and D.O. are shown in Fig.3.5.2-1, Fig.3.5.2-2, Fig.3.5.2-3, and Fig.3.5.2-4, respectively. Comparison of the sensor salinity (D.O.) and bottle salinity (D.O.) analysis is shown in Fig.3.5.2-5 (Fig.3.5.2-6).

(5) Date archive

The data were stored on a magnetic optical disk, which will be kept in Ocean Research Department, JAMSTEC.

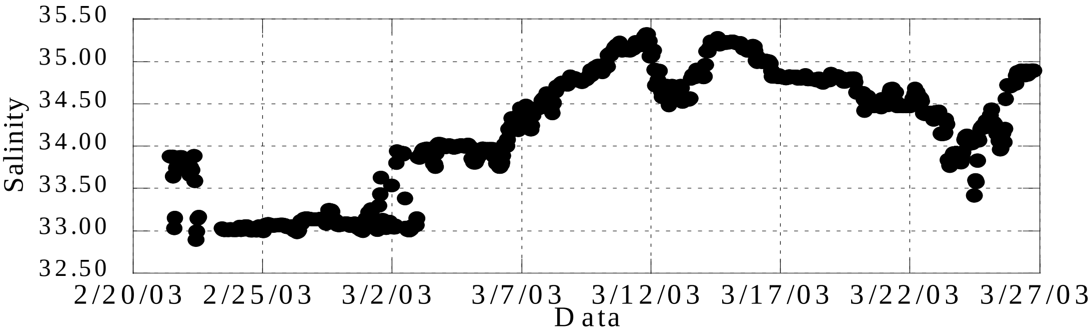


Fig.3.5.2-1 :Temporal variation of the Salinity.

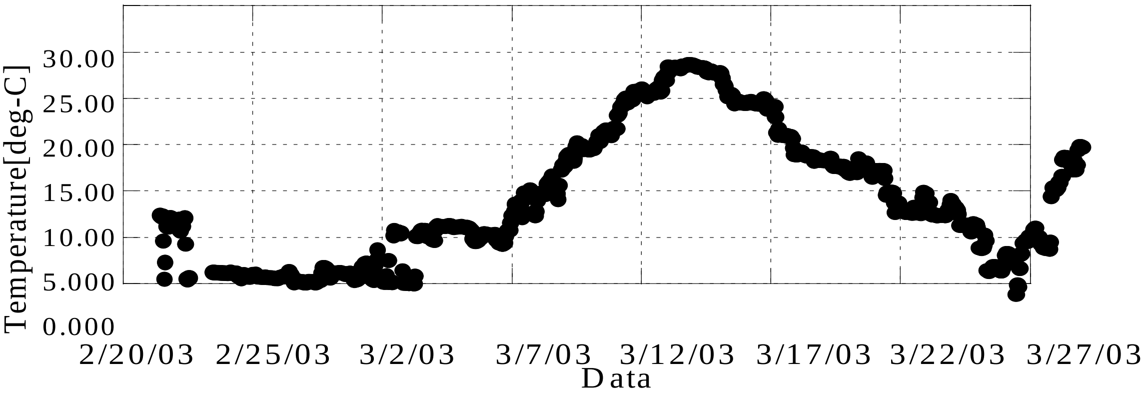


Fig.3.5.2-2: Temporal variation of the Temperature.

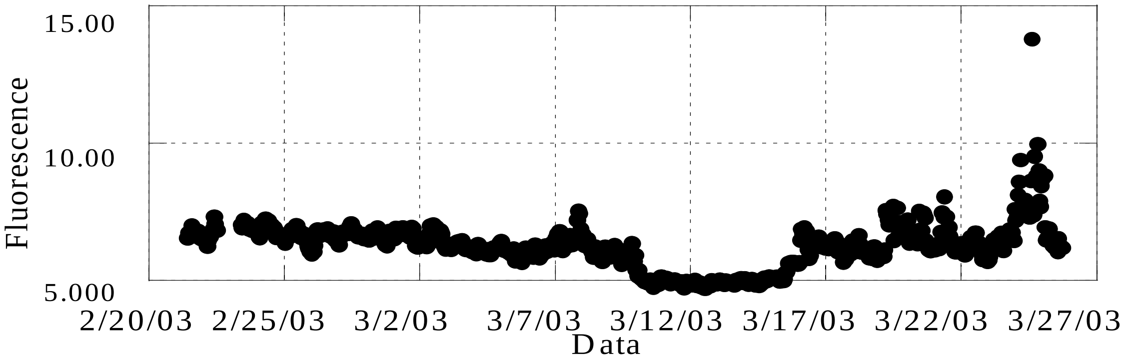


Fig.3.5.2-3: Temporal variation of the Fluorescence.

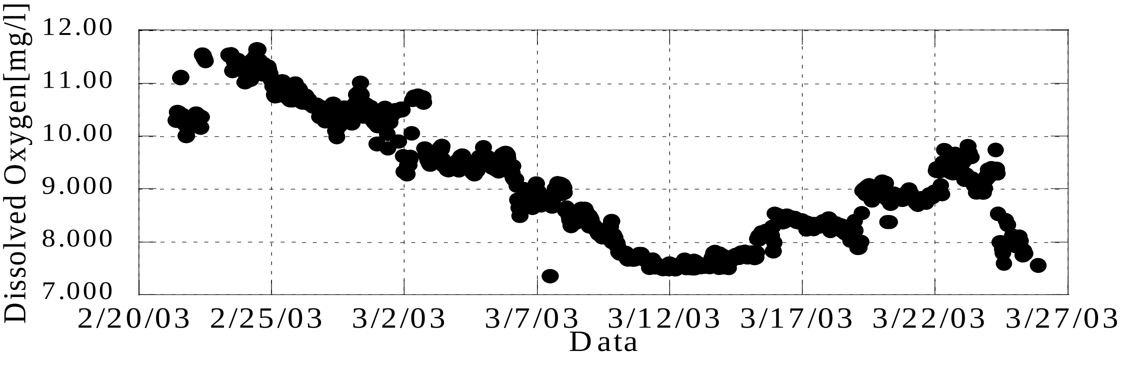


Fig.3.5.2-4: Temporal variation of the Dissolved Oxygen.

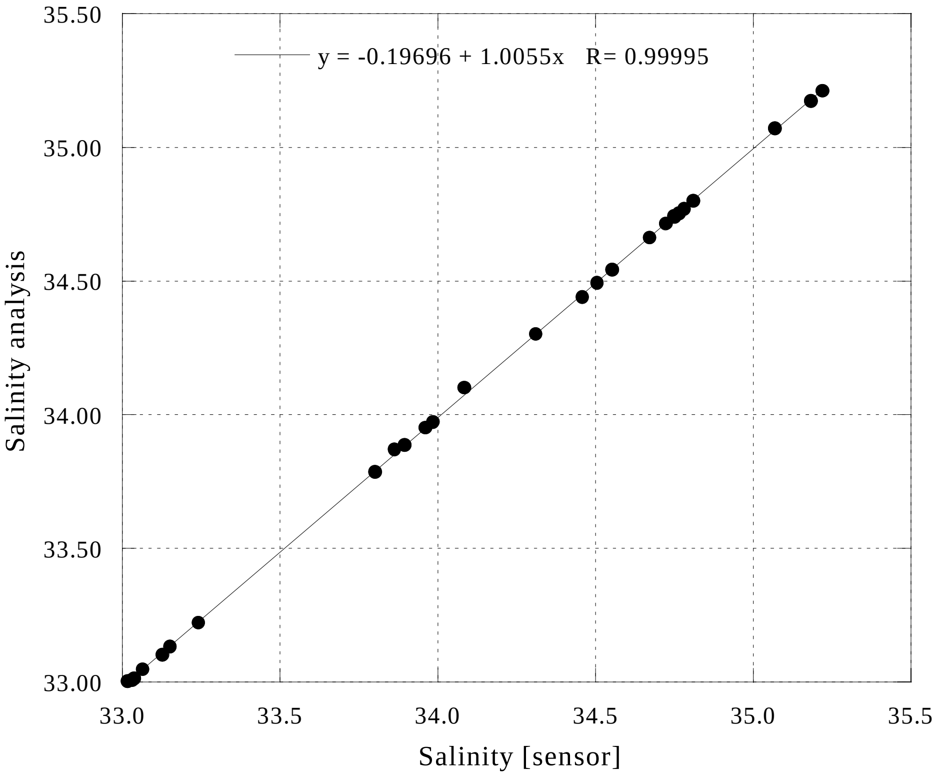


Fig.3.5.2-5: The profiles of comparison of salinity [sensor] and salinity analysis result

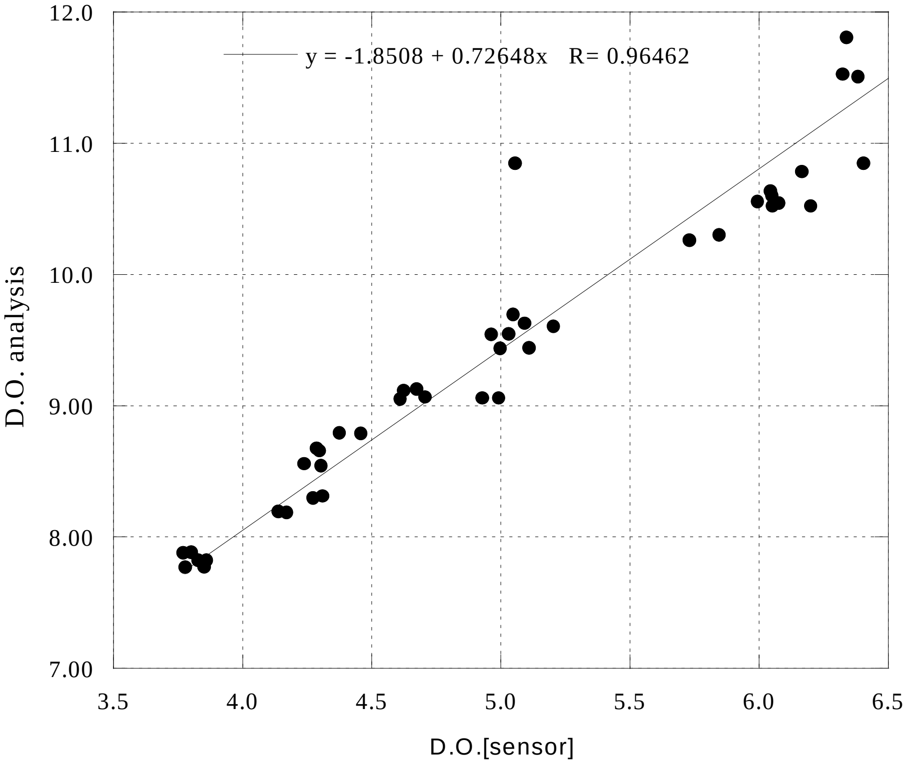


Fig.3.5.2-6: The profiles of comparison of D.O.[sensor] and D.O. analysis result

3.5.3 Nutrients

Asako KUBO (Marine Works Japan Ltd.: MWJ)
Kenichiro SATO (Marine Works Japan Ltd.: MWJ)

(1) Objective

Phytoplankton requires nutrient elements for growth, chiefly nitrogen, phosphorus and silicon. The data of nutrients in surface seawater is important for investigation of phytoplankton productivity.

(2) Sampling elements

Nitrate+ Nitrite, Nitrite, Phosphate, Silicate

(3) Inventory information for the sampling

Date: February 21, 2003 to March 27, 2003

(4) Instruments (including setting parameters if required), and methods

The nutrients monitoring system was performed on BRAN+LUEBBE continuous monitoring system Model TRAACS 800 (4 channels). This system was located at the surface seawater laboratory for monitoring in R/V Mirai. Seawater at depth of 4.5 m was continuously pumped up to the laboratory and introduced direct to monitoring system with narrow tube. The methods are as follows.

Nitrate + Nitrite: Nitrate in the seawater was reduced to nitrite by reduction tube (Cd-Cu tube), and the nitrite reduced was determined by the nitrite method as shown below. The flow cell was 3 cm length type.

Nitrite: Nitrite was determined by diazotizing with sulfanilamide by coupling with N-1-naphthyl-ethylendiamine (NED) to form a colored azo compound, and by being measured the absorbance of 550 nm using 3 cm length flow cell in the system.

Phosphate: Phosphate was determined by complexion with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 800 nm using 5 cm length flow cell in the system.

Silicate: Silicate was determined by complexion with molybdate, by reducing with ascorbic acid to form a colored complex, and by being measured the absorbance of 800 nm using 3 cm length flow cell in the system.

(5) Results (Expected/preliminary results)

We are now arranging the method of data revision.

(6) Data archives

All raw and revised data files will be copied onto MO and submitted to Chief Scientist and JAMSTEC Data Management Office (DMO) according to the data management policy of JAMSTEC.

3.5.4 Total dissolved inorganic carbon

See Section 3.3.6

3.6 POPs

(1) Personnel

Yasuyuki Shibata (National Institute for Environmental Studies) : Principal Investigator (Not on board)
Masashi Hirota (National Institute for Environmental Studies) : (On board)
Yoshikatsu Takazawa (National Institute for Environmental Studies) : (Not on board)

(2) Objectives

Various organochlorine chemicals, such as PCB and DDT, were found to be stable and keeping their effects for a long term. Therefore they had been produced in large amounts and were used heavily in environment. Due to recognition of their adverse side effects to non-target organisms, including human beings, as well as their persistent and highly bioaccumulative characters, however, their production and usage have been banned/regulated in various countries, especially in highly developed countries. In order to facilitate their further reduction to protect human health and the environment internationally, a new international treaty, Stockholm Convention, was signed in May 2001. In this treaty, prohibition of the production, usage and import/export of, and the reduction of unintentional production of, the twelve organochlorine chemicals, i.e., Dioxins, Furans, PCB, HCB, DDT, Chlordane, Heptachlor, Aldrin, Dieldrin, Endrin, Mirex and Toxaphene, are requested to the Parties. A remarkable feature of the treaty is in Article 16 in which a periodical report of environmental monitoring of the levels and regional/global transport of POPs is requested in order to evaluate the effectiveness of the Convention.

In East Asian region, east-bound flows of both wind and sea currents are prevailing. Therefore POPs monitoring in North Western Pacific is quite important both for analyzing the trends of background POPs levels in this region and for revealing their regional/global scale transport. We have conducted a biological monitoring, so called “squid watch”, together with researchers in Far Seas Fisheries Research Institute, and could detect nearly 10 POPs in livers of squid caught in various places in North Pacific Ocean, including Dioxins and Furans (Hashimoto et al., (1999)). This means that many of POPs are distributed widely in North Pacific Ocean in detectable levels via bioaccumulation processes in marine ecosystem. Many of POPs were also detected in squid livers caught in the Sea of Japan (Sato et al. (2000)). On the other hand, there still remain various problems to be clarified, such as the real concentration levels of POPs in both air and seawater in background areas and the bioconcentration factors of squids. Furthermore, there might be a possibility that a fair amount of POPs be transported at events such as Kosa (yellow sands). Further fundamental researches are needed in order to establish sound scientific basis for efficient and effective reduction of POPs in the global environment.

(3) Method

POPs levels in air/water in the background region, however, seem to be very low, and a substantial development/refinement will be necessary for their sampling and/or pretreatment processes. In the present experiment, an active sampling method by high volume (HV) sampler and quartz filter (QF) as well as absorbents for air sampling, and an another active sampler for large-volume sampling of POPs in water will be employed for sampling purposes in order to get insight into the POPs levels in air and water in background area. In both air and water sampling, a combination of QF for particulates, and PUF (polyurethane form) + active charcoal absorbent for gaseous phase sampling, will be used for large volume sampling. Due to inferior adsorbing capabilities of trap materials against chemicals of high volatility, such as HCB and low-chlorinated PCBs, in the presence of water, a combination of small volume (less than 100 L) and large volume (typically 1,000L or more) will be employed for seawater sampling, and the adsorbed materials will be extracted and analyzed by an capillary GC / negative ion formation mass spectrometry method, a highly sensitive and selective detection method for organochlorine chemicals. The results will also be used for the assessment of the applicability of the present available sampling technique and the identification of problems to be improved further.

Air sampler : High-Volume Air Sampler (Shibata Scientific Technology ltd. HV-1000F for dioxins)

Surface seawater sampler : Concentration system for low-density organic compounds (Environment Instruments and Systems, MEWS-2100)

(4) Data Archives

The original data and samples will be archived at Environmental Chemodynamics Section, Environmental Chemistry Division, National Institute for Environmental Studies (Contact Yasuyuki Shibata). The data are also submitted to JAMSTEC DMO.

References

S. Hashimoto, Y. Shibata, H. Tanaka, A. Yatsu, M. Morita: PCDDs and PCDFs contamination in the Northern Pacific area reflected on squid liver tissues, Organohalogen Comp., 41, 413-416 (1999)

K. Sato, N. Kajiwara, S. Hashimoto, H. Kidokoro, Y. Shibata, A. Ohtsuki: Accumulative characteristics of organochlorine compounds (OCs) in squid, Nippon Suisan Gakkaishi 66, 658-665 (2000)

Table 3.6-1 Air Samples

SampleID	Date	Time Start	Date	Time Finish	Filtered Volume
HV030222	2003.2.22	16:05	2003.2.23	8:00	429.1
HV030223	2003.2.23	10:30	2003.2.26	8:00	1132.5
HV030226	2003.2.26	8:30	2003.3.2	8:00	1961.2
HV030302	2003.3.2	8:00	2003.3.6	8:00	2308.4
HV030306	2003.3.6	8:45	2003.3.6	10:08	54.0
HV030306-2	2003.3.6	10:20	2003.3.8	8:00	854.4
HV030308-1	2003.3.8	8:26	2003.3.8	13:54	205.9
HV030308-2	2003.3.8	13:57	2003.3.8	15:00	49.1
HV030308-3	2003.3.8	15:12	2003.3.14	8:00	2442.9
HV030314-1	2003.3.14	8:50	2003.3.14	10:10	53.2
HV030314-2	2003.3.14	10:20	2003.3.18	14:00	1757.5
HV030318-1	2003.3.18	14:22	2003.3.18	15:36	50.4
HV030318-2	2003.3.18	15:46	2003.3.23	8:05	2422.6
HV030223	2003.3.23	8:31	2003.3.24	20:08	1560.4
HV030324-1	2003.3.24	20:19	2003.3.24	21:40	75.1
HV030324-2	2003.3.24	21:44	2003.3.26	20:32	2112.8
HV030326-1	2003.3.26	20:41	2003.3.26	21:48	66.2
HV030326-2	2003.3.26	21:57	2003.3.27	13:50	917.6
HV030327-1	2003.3.27	14:00	2003.3.27	16:00	134.3
HV030327-2	2003.3.27	16:07	2003.3.29	8:08	1553.0
HV030329-1	2003.3.29	9:44	2003.3.29	15:00	175.5
HV030329-2	2003.3.29	15:10	2003.3.30	8:00	449.2

Table 3.6-2 Surface Seawater samples

SampleID	Date	Time Start	Date	Time Finish
SW030223	2003.2.24	0:00	2003.2.24	1:00
SW030224	2003.2.24	13:20	2003.2.26	16:00
SW030226	2003.2.26	21:55	2003.2.26	-
SW030301	2003.3.1	11:35	2003.3.1	-
SW030303	2003.3.3	20:00	2003.3.3	-
SW030306	2003.3.6	16:00	2003.3.6	17:00
SW030306-2	2003.3.6	17:20	2003.3.7	21:00
SW030307-1	2003.3.7	22:20	2003.3.7	23:20
SW030307-2	2003.3.7	23:39	2003.3.11	14:00
SW030311-1	2003.3.11	14:22	2003.3.11	16:22
SW030311-2	2003.3.11	16:55	2003.3.13	10:08
SW030313-1	2003.3.13	10:49	2003.3.13	11:50
SW030313-2	2003.3.13	12:15	2003.3.16	19:14
SW030316-1	2003.3.16	19:30	2003.3.16	22:33
SW030316-2	2003.3.16	20:49	2003.3.19	14:53
SW030319-1	2003.3.19	15:13	2003.3.19	16:13
SW030319-2	2003.3.19	16:32	2003.3.22	8:42
SW030322-1	2003.3.22	9:24	2003.3.22	11:28
SW030322-2	2003.3.22	11:46	2003.3.23	18:51
SW030323-1	2003.3.23	19:19	2003.3.23	21:25
SW030323-2	2003.3.23	21:45	2003.3.24	14:54
SW030325-1	2003.3.25	9:23	2003.3.25	22:15
SW030325-2	2003.3.25	22:31	2003.3.26	12:05
SW030326	2003.3.26	12:23	2003.3.27	7:45
SW030327	2003.3.27	8:04	2003.3.27	9:00

3.7 Atmospheric Observations

3.7.1 Background of ACE-Asia

Kazuhiko Miura (Department of Physics, Science University of Tokyo)

Atmospheric aerosol particles affect the Earth's radiative balance directly by scattering or absorbing light, and indirectly by acting as cloud condensation nuclei (CCN), thereby influencing the albedo and life-time of clouds. The natural aerosol has been substantially perturbed by anthropogenic activities, particularly by increases of sulfates, nitrates, organic condensates, soot, and soil dust. The present day global mean radiative forcing due to anthropogenic aerosol particles is estimated to be between - 0.3 and -3.5 Wm^{-2}, which must be compared with the present day forcing by greenhouse gases of between +2.0 and +2.8 Wm^{-2} (IPCC, 1995).

Although aerosol particles have this potential climatic importance, they are poorly characterized in global climate models. This is a result of a lack of both comprehensive global data and a clear understanding of the processes linking aerosol particles, aerosol precursor emissions, and radiative effects. At this time, tropospheric aerosols pose the largest uncertainty in model calculations of the climate forcing due to man-made changes in the composition of the atmosphere. Clearly there is an urgent need to quantify the processes controlling the natural and anthropogenic aerosol, and to define and minimize the uncertainties in the calculated climate forcings. Among the largest sources of uncertainty is the climate forcing by Asian aerosols.

The Aerosol Characterization Experiments (ACE) , which are sponsored by the International Global Atmospheric Chemistry Program (IGAC), are envisioned as a series of international field studies aimed at understanding the combined chemical and physical processes that control the evolution of those aerosol properties that are relevant to radiative forcing and climate. The ultimate goal of this series of studies is to provide the necessary data to incorporate aerosols into global climate models and to reduce the overall uncertainty in the climate forcing by aerosols.

The strategy of ACE is to investigate the multiphase atmospheric system in key areas of the globe. ACE-1, conducted in late 1995, was aimed at the minimally polluted marine troposphere in the Southern Ocean near Tasmania. TARFOX, conducted in June of 1996, studied continental aerosol off the eastern coast of North America. ACE-2, conducted in June of 1997, focused on anthropogenic aerosols from the European continent and desert dust from the African continent as they move over the North Atlantic Ocean.

ACE-Asia, of which intensive observations were planned in spring 2001 and 2003, focused on the outflow of both desert dust and anthropogenic aerosol from Eastern Asia to the Pacific Ocean. The goal of ACE-Asia is to determine and understand the properties and controlling factors of the aerosol in the anthropogenically modified atmosphere of Eastern Asian and the Northwest Pacific and to assess their relevance for radiative forcing.

The R/V Mirai was elected as the platform of Japanese shipboard observation. The first ACE-Asia cruise was performed on the MR01-K02 by all Japan researchers. Ten PIs took part in that cruise and ten persons were on board the vessel. The MR03-K01 cruise was regarded as the second ACE-Asia cruise. PIs and on board members of the second ACE-Asia cruise are shown in Tables 3.7.1-1 and -2, respectively.

Table 3.7.1-1 Participating Organizations of the second ACE Asia cruise

Participating Organizations	PI
Institute of Low Temperature Science, Hokkaido University (ILTS)	Tatsuo Endo
Ocean Research Institute, University of Tokyo (ORI)	Mitsuo Uematsu
Faculty of Engineering, Tokyo Metropolitan University (TMU)	Yoshizumi Kajii
Faculty of Science, Science University of Tokyo (SUT)	Kazuhiko Miura
National Institute for Environmental Studies (NIES)	Nobuo Sugimoto
Japan Ocean Science and Technical Center (JAMSTEC)	Kunio Yoneyama

Table 3.7.1-2 On Board members of the second ACE-Asia cruise

Kazuhiko Miura, Makoto Okada (SUT),

Shungo Kato (TMU), Atsuhiro Nakamura (ORI)

3.7.2 Gas measurements

(1) Personnel

Shungo Kato, Jun Matsumoto, Yasuhiro Sadanaga, Yoshizumi Kajii (Applied Chemistry, Faculty of Engineering, Tokyo Metropolitan University)

(2) Objectives

East Asia is one of the most populated area in the world and its industrial developing would cause a serious air pollution. It is not only local city pollution, but also regional (or even global) issue. The polluted air emitted in East Asia is transported to the Pacific by westerly wind. The actual atmospheric measurements in the Pacific are only limited, since the ideal measurement sites are available only some islands; Ogasawara, Okinawa, etc. Therefore the measurements on ships on the western Pacific are quite important, and they would contribute to elucidate the situation of the long-range transport of polluted air from East Asia. Also, some gases emitted from the ocean like DMS would affect the global or regional atmospheric chemistry. Our knowledge about the interactions between gas and surface ocean is not enough and more measurements on the ocean are required.

(3) Measured parameters

Carbon monoxide (CO), Ozone (O_3), Sulfur dioxide (SO_2), Nitric oxide (NO), Nitrogen dioxide (NO_2), Volatile Organic Compounds (VOC, including hydrocarbons, halocarbons, DMS, and oxygenated hydrocarbons).

(4) Method

CO was measured by an IR-Gas filter correlation analyzer (Thermo Environmental Instruments, Model 48C). O_3 was measured by an UV absorption analyzer (Thermo Environmental Instruments, Model 49C). SO_2 was measured by an UV-Fluorescence analyzer (Thermo Environmental Instruments, Model 43C Trace Level). NO and NO_2 were measured by Photolytic converter (PLC760) and Ozone-Chemiluminescence analyzer (CLD770) provided by ECO Physics, Switzerland. These gases were analyzed continuously on the ship and minutely averaged data was logged by personal computers. The detection limits were estimated 10 ppbv, 1.0 ppbv, 0.1 ppbv, 0.05 ppbv, 0.05 ppbv for CO, O_3, SO_2, NO and NO_2, respectively. Zero gas was automatically injected for 15 minutes every hour for CO and SO_2, and manually injected every two days for NO and NO_2. The air was taken through a 1/4 PFA tube from the right side of the compass deck for these gas measurements. The air for volatile organic compounds measurements was sampled into Silcosteel canisters (Restek) using a membrane pump. Basically one canister sample was taken at daytime every day, and total 40 canisters were sampled. The locations of sampled places are listed in Table 3.7.2-1. They will be analyzed by Pre-concentrator

(Entech7000) and GC-FID (Hewlett Packard, HP6890)/ GC-MS (Hewlett Packard, HP5793) in the laboratory in Tokyo Metropolitan University. Also some VOCs were measured continuously by other instrument, Proton Transfer Reaction Mass Spectrometry (PTRMS). H_3O^+ is generated by the discharge of water vapor and mixed with ambient air (sample air). VOCs which have higher proton affinity than H_3O^+ in the ambient air are protonated by the proton transfer reaction and generate protonated VOCs ($H_3O^+ + VOC \rightarrow VOCH^+ + H_2O$). Then the protonated VOCs are separated by the Quadra-pole mass spectrometry and detected by the secondary ion multiplier for each mass number (each compound, if there is not interference mass). One advantage of PTRMS measurement is real time detection of VOCs. But for the clean air on the ocean averaging of the data is necessary to obtain stable concentration. Zero air generated by heated Pt catalyst at 350°C and ambient air were measured for 30 minutes turn and turn. So hourly mean data was calculated by subtracting zero from air data.

(5) Preliminary Results

In Figure 3.7.2-1, the measurement results of CO, O_3, and SO_2 are plotted. The time shown in horizontal axes was JST. They are hourly mean data and the contaminated data by the ship exhaust are removed. Note that the vertical axes of these graphs do not start from the origin (zero) to emphasize the concentration variation.

CO concentration showed only small concentration change in this cruise compared to previously obtained data (MR01K02). In general, CO concentration is low at low latitude. High concentration in February 21 was affected by Hahcinohe city. The peaks in March 4 and in March 9 were caused by the transit of fronts. After passing the fronts, polluted air from land was transported. During March 17-18, polluted air seems to be transported and CO became higher. In the midnight of March 17, the front passed and CO was low concentration only short time. It is expected that clean maritime air was injected during this low concentration period. High concentration was also observed in March 25. This high concentration would be affected by Tokyo or some Japanese urban area.

O_3 was low at Hachinohe (February 21) because polluted air including very high NO concentration will remove O_3 by the reaction of $O_3 + NO \rightarrow NO_2 + O_2$. O_3 became higher gradually after leaving Hachinohe, because the ship headed to higher latitude. O_3 concentration is high at higher latitude in clean air. But surprisingly when the ship was at lower latitude, O_3 was not become lower as expected. There were small peaks when fronts passed. In March 12, 13, 18, and 25 O_3 had low concentrations. At the same time, CO concentration was also low, so these low peaks will be caused by the influence of clean maritime air in lower latitude (or on the central Pacific).

SO_2 concentration was about 0.3ppbv in February 22, and it gradually decreased as the distance from the land. In the morning in February in 23, SO_2 become less than detection limit (about 0.1ppbv). The most common source of SO_2 in land is combustion of less quality fuels like coal. SO_2 converted to more oxidized forms (H_2SO_4) within 1-2 days. So the decrease of SO_2 from land observed here can be explained. On the clean ocean, low SO_2 concentration is expected. The observed results were almost less than detection limit. Only two high peaks were found in March 1 and March 25. In March 1, other species (CO, O_3, VOC) did not become high concentrations at this time. So the transport of polluted air from land is excluded. The reason of this high SO_2 is not explained at a moment. In March 25, SO_2 transport from urban area in Japan was expected.

The results of NO and NO_2 are not shown in Figure. Unfortunately, NO_2 data is not available after March 8 because of an instrumental trouble. In general, NO is oxidize quickly by ozone to NO_2 in the clean atmosphere. If there is no NO source like exhaust from a ship, NO concentration will be almost zero. Clear peaks of NO can be used as an indicator of the contamination by the ship exhaust. During daytime, NO_2 is photolyzed by UV in sunlight to NO, and NO_2 and NO will be in photo equilibrium within short time (a minute). The NO data observed on the ocean in sunny day seems to become slightly higher concentration. About NO_2, it kept several hundred pptv after leaving Hachinohe (February 21). But it decreased gradually and almost zero in the morning in February 23. NO_2 converted to more oxidized gas like HNO_3 or PAN in a few days, so this NO_2 decrease observed here is reasonable.

The results of PTRMS measurements are just preliminary and the data is not calibrated. Here only some selected species are shown in Figure 3.7.2-2. Acetonitrile (CH_3CN) is relatively stable and it has some life time in the atmosphere. It is produced by biomass burning. Its loss processes are the reaction with OH and uptake into the ocean. The observed concentration was high at lower latitude. In lower latitude, OH concentration is higher and loss of CH_3CN will be larger. The observed higher concentration will indicate more production of CH_3CN at lower latitude. Biomass burning is enhanced in the dry season (December-March) in Southeast Asia, and it will contribute the higher CH_3CN at low latitude. Acetone has various sources and it has some life time in the troposphere. Acetone is transported and it works as an important source of OH radical in the stratosphere. The observed data in the ocean shows that there is not very large concentration variation. DMS is emitted from ocean by biological processes. In this cruise, high DMS concentration was observed at lower latitude. Also in the short time peak was observed at night in March 17, when front was passed. From the results of other species, it was expected that the air came from lower latitude at this high DMS period.

(6) Data archives

The original data will be archived at Applied Chemistry, Faculty of Engineering, Tokyo Metropolitan University (Shungo Kato).

Table 3.7.2-1 List of the sampling place of canisters for VOC measurements.

No	time (JST)	latitude	longitude		No	time (JST)	latitude	longitude
MR01	2003/2/21 15:28	40.57	141.65		MR21	2003/3/12 12:39	20.98	155.00
MR02	2003/2/22 16:07	40.83	145.63		MR22	2003/3/13 11:25	17.00	154.97
MR03	2003/2/23 12:28	43.22	152.62		MR23	2003/3/14 9:27	20.00	155.00
MR04	2003/2/24 14:33	44.00	155.00		MR24	2003/3/15 11:07	23.67	154.78
MR05	2003/2/25 13:26	47.00	159.88		MR25	2003/3/15 12:33	23.83	154.88
MR06	2003/2/26 13:27	47.93	161.07		MR26	2003/3/16 10:28	25.98	155.02
MR07	2003/2/27 10:05	51.00	164.97		MR27	2003/3/17 7:27	27.98	155.00
MR08	2003/2/28 13:28	47.00	164.97		MR28	2003/3/18 8:27	29.98	155.00
MR09	2003/3/1 13:27	45.72	161.23		MR29	2003/3/19 14:38	33.00	155.00
MR10	2003/3/2 10:40	43.90	155.97		MR30	2003/3/20 9:36	34.02	155.10
MR11	2003/3/3 13:27	42.80	155.17		MR31	2003/3/21 14:37	36.88	155.00
MR12	2003/3/4 12:46	40.33	155.05		MR32	2003/3/22 12:41	37.00	155.00
MR13	2003/3/4 13:54	40.03	155.08		MR33	2003/3/23 14:26	39.13	155.00
MR14	2003/3/5 13:26	41.20	154.63		MR34	2003/3/24 9:22	41.98	155.00
MR15	2003/3/6 13:25	40.98	155.00		MR35	2003/3/24 21:25	40.65	151.90
MR16	2003/3/7 13:27	38.98	157.60		MR36	2003/3/25 8:22	39.30	148.82
MR17	2003/3/8 13:27	36.17	158.90		MR37	2003/3/25 20:18	37.93	145.85
MR18	2003/3/9 8:42	34.05	158.30		MR38	2003/3/26 9:22	36.30	142.92
MR19	2003/3/10 13:27	28.33	159.08		MR39	2003/3/26 14:24	36.05	142.75
MR20	2003/3/11 13:29	25.00	155.00		MR40	2003/3/27 13:22	33.13	139.33

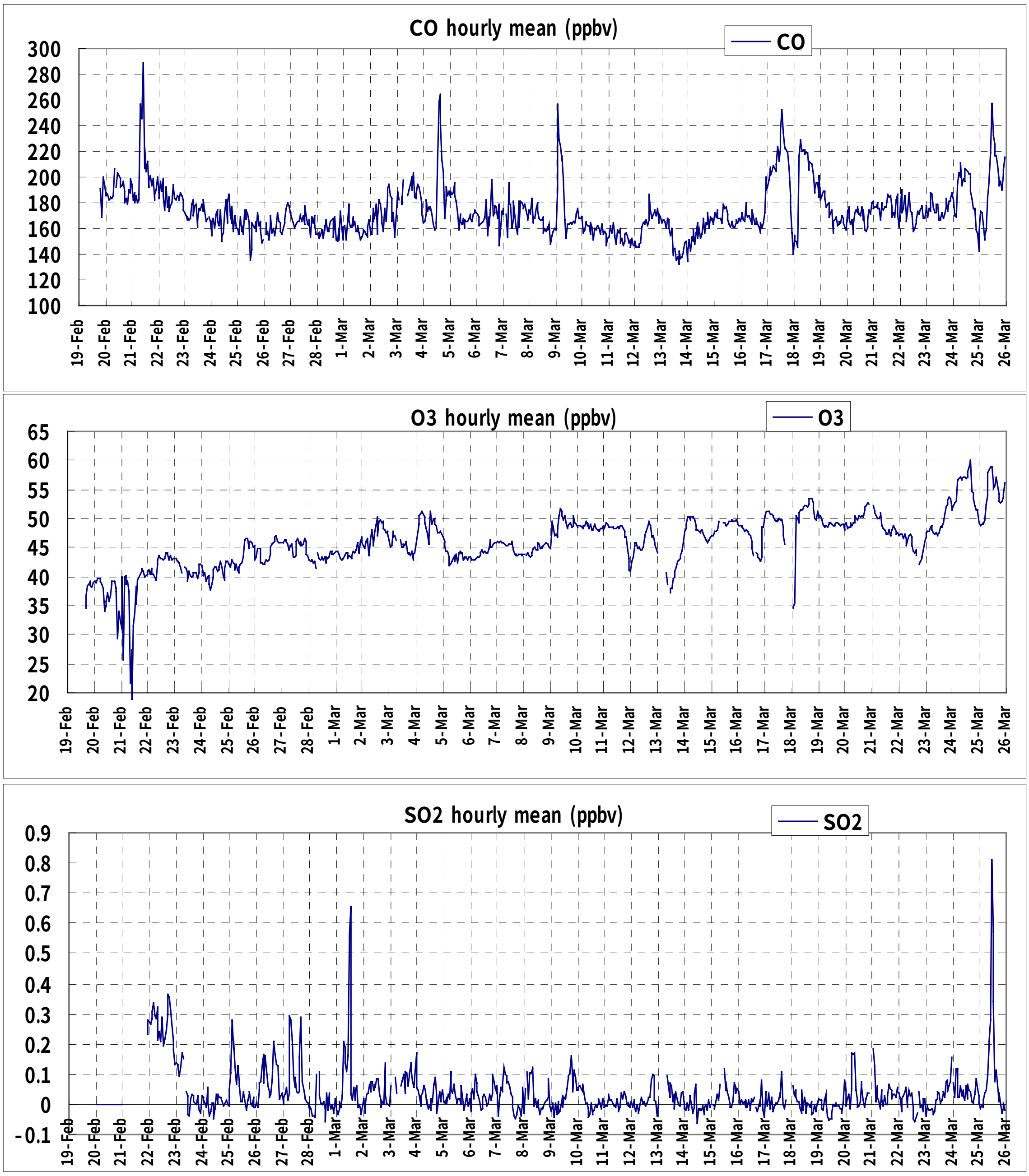


Figure 3.7.2-1 Hourly mean concentrations of CO, O_3, SO_2 during the cruise. Many spikes affected by the ship exhaust were removed from these results. Note that the vertical axes of these graphs do not start from the origin (zero).

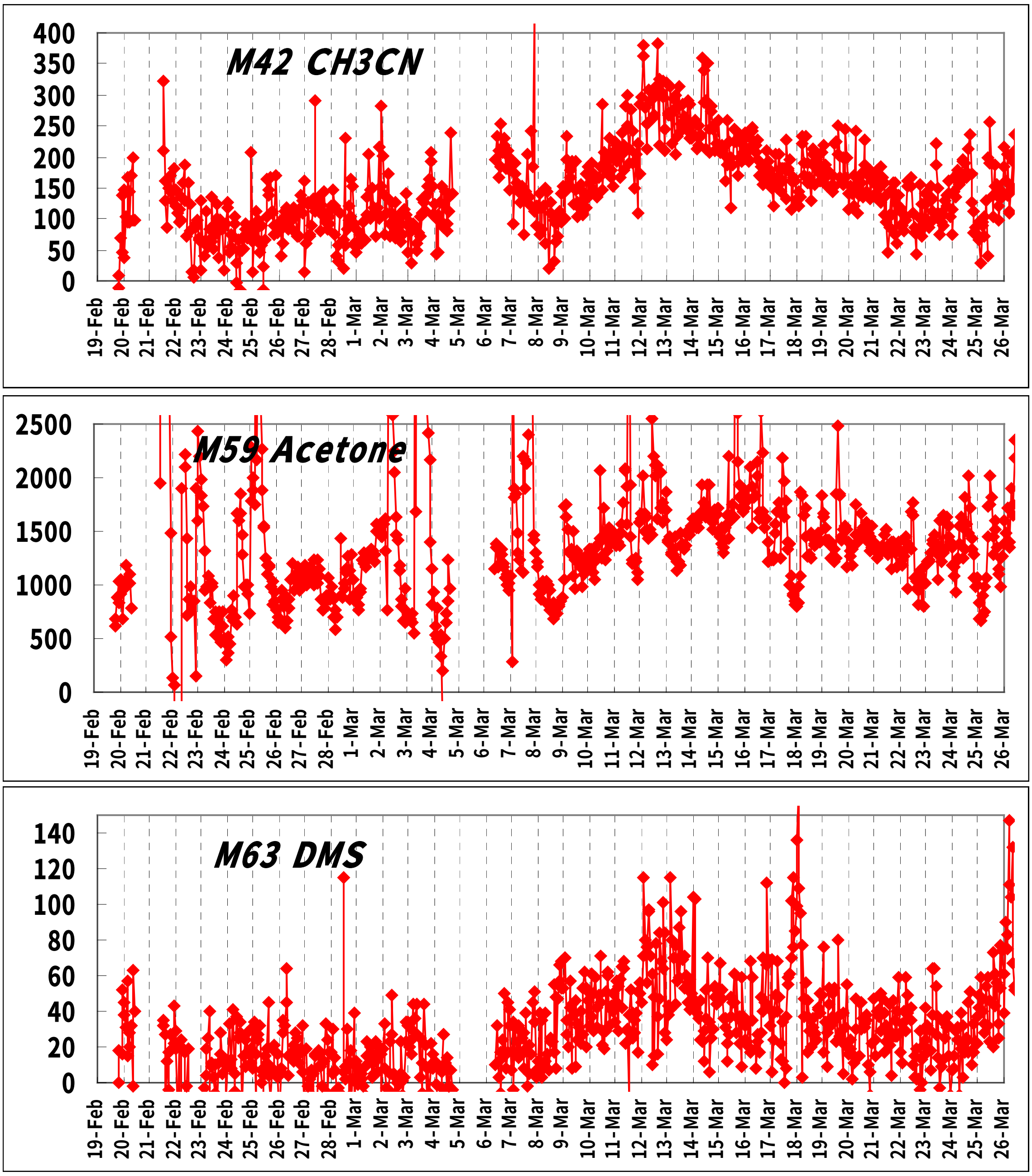


Figure 3.7.2-2 Hourly mean concentrations of selected species measured by PTRMS. Calibration is required to obtain the accurate concentrations.

3.7.3 Chemical properties of atmospheric aerosols

(1) Personnel

Mitsuo Uematsu (Ocean Research Institute, The University of Tokyo): Principal Investigator

Tokuhiro Nakamura (Ocean Research Institute, The University of Tokyo)

(2) Objectives

Atmospheric aerosols are the contributors for a negative and a positive radiative forcing, and they can impact the global and the regional climatic phenomena. And transport via atmosphere is an important pass by which nutrients and particles are delivered to the sea surface. It can affect an oceanic ecosystem. Unfortunately there are many unknown factors about the characteristics of aerosols and behaviors after aerosols formation.

The growth of economic and population are rapidly increasing in developing countries of East Asia. This means an increase to the atmospheric emissions of pollutants from intensive industrial and agricultural activities. The Western North Pacific located in downwind from the East Asia is considered to be an important oceanic region in terms of understanding the chemical properties and the mechanism of transport and deposition of anthropogenic and mineral aerosols from the Asian continent to the open sea.

The focus of this cruise is to study the chemical properties and the mechanism of transport of atmospheric species over the Western North Pacific. Therefore chemical composition of aerosols and gaseous substances, and the number densities were measured continuously on board ship.

(3) The outline of measurements

Atmospheric measurements were conducted continuously over the Western North during the MR03-K01 Cruise of the R/V Mirai. Observation items are shown blow.

Filter Samples

The samplers were installed at the foremost part of the compass deck (from the surface to about 17 m). To avoid the chance of collecting air with an influence from the ship's pollution, the samplers were connected to a sector controller. The samplers performed when relative wind speed was over 1 ms^{-1} and relative wind direction was between –100° and 100° as opposed to a bow.

(a) High Volume Virtual Impactor Air Sampler (Kimoto electric Co., LTD., AS-9)

Two samplers and two kinds of filters were used for particulate matter collection. And samples were collected to distinguish between fine-mode (<2.5 μm) aerosols and coarse-mode (>2.5 μm) aerosols.

・Tefoln Filter (Toyo Roshi Kaisha, LTD., PF040, 90 mm in diameter)：These samples are to determine the major inorganic ions(Cl^-,NO_3^-,SO_4^{2-},Na^+,NH_4^+,K^+,Mg^{2+} and Ca^{2+}) and MSA. Sample collection was performed continuously for about 12-24h and the flow rate was at 13.2 -15.4 $m^3 h^{-1}$.

・Quartz Fiber Filter (PALLFLEX Products Co., 2500QAT-UP, 90 mm in diameter)：These samples are to determine N and C containing compounds. Sample collection was performed continuously for about

2~5days and the flow rate was at 9.6〜14.1 $m^3 h^{-1}$.

(b) Andersen Low Pressure Impactor Air Sampler（Tokyo Dylec Co., LTD., LP-20）

Samples were collected to 13 size fractioned stages (particle diameter 50% cut points: 0.06, 0.13, 0.22, 0.33, 0.52, 0.76, 1.25, 2.5, 3.9, 5.7, 8.5 and 12.1 µm, and back up filter). The substrates were Quartz Fiber Filter (PALLFLEX Products Co., 2500QAT-UP, 80 mm in diameter). These samples are to determine size distributions of particulate N and C containing compounds. Sample collection was performed continuously for about 10-12 days and the flow rate was at 20 L min^{-1}.

Automatic analysis

The sample air from the inlet installed at the compass deck (about 17 m above the sea surface) was measured automatically by the instruments. They were installed in the laboratory directly under the compass deck. In addition, the obtained data considered to be contaminated by the smoke of the ship will be rejected based on the signal of a sector controller.

(c) Ambient particulate carbon Monitor (R&P Co. Inc., Series 5400)

The organic and elemental carbon in aerosols were measured. To eliminate the effect of gaseous carbon compounds, a denuder was installed. And a PM-2.5 cyclone (It removes aerosols larger than 2.5 µm in diameter) was installed in the inlet. Measurements were performed at intervals of 4 hours and the flow rate was 16.7 $Lmin^{-1}$.

(d) Ambient particulate sulfate Monitor (R&P Co. Inc., Series 8400S)

The sulfate in aerosols was measured. Measurements were performed at intervals of 20 minutes and the flow rate was 5.0 $Lmin^{-1}$. To minimize the influence of sea salt sulfate, a PM-1.0 impacter (It removes aerosols larger than 1.0 µm in diameter) was installed in the inlet.

(e) Ambient particulate nitrate Monitor (R&P Co. Inc., Series 8400N)

The nitrate in aerosols was measured. Measurements were performed at intervals of 20 minutes and the flow rate was 5.0 $Lmin^{-1}$..

(f) Optical particle counter (Rion, model KC18)

Size distributions of particles were measured in 5 size ranges (d > 0.1,> 0.15,> 0.2,> 0.3,>0.5 µm) for 30 seconds every 10 minutes .The flow rate was 0.3 $Lmin^{-1}$.

(g) Ultraviolet absorption Ozone monitor（Dylec, Model-1150）

Ozone concentration was measured every 12 seconds. The flow rate was 1.5 $Lmin^{-1}$.

(h) Microflow Sulfur dioxide analyzer（Kimoto electric Co., MF-31）

Sulfur dioxide concentration was measured every 6 or 7 minutes. The flow rate was 1.0 $Lmin^{-1}$.

(4) Preliminary Results

Carboneceous, sulfate and nitrate aerosols concentrations were obtained continuously. But nitrate measurement was stopped at 3:00 on 18 March 2003 because of an instrument malfunction. Particle number concentrations were obtained continuously. Ozone and sulfur dioxide gases concentrations were also obtained continuously.

Size-fractionated aerosol samples were obtained. 38 samples for determining the major inorganic ions and MSA concentrations and 10 samples for determining the N and C containing compounds concentrations were obtained by High Volume Virtual Impactor. The sampling information is shown in Table 3.7.3-1 and -2. 3 samples were obtained by Low Pressure Impactor. The sampling information is shown in Table 3.7.3-3.

Table 3.7.3-1. Sampling information to determine the major inorganic ions and MSA concentrations

Sample No.	Date (Start)	Date (Stop)	Sample Volume (m^3)
1	2/20 15:12	2/21 9:35	130.50
2	2/21 15:05	2/22 9:05	212.66
3	2/22 9:05	2/23 8:08	243.39
4	2/23 8:08	2/24 8:10	284.94
5	2/24 11:08	2/25 8:12	284.38
6	2/25 8:34	2/21 15:05	588.61
7	2/27 11:00	3/1 8:08	422.98
8	3/1 8:08	3/2 7:58	359.20
9	3/2 8:08	3/3 8:12	170.38
10	3/3 8:35	3/5 8:07	437.16
11	3/5 8:07	3/6 8:02	345.08
12	3/6 8:30	3/7 8:04	191.30
13	3/7 8:28	3/8 8:06	320.15
14	3/8 8:25	3/9 8:06	346.57
15	3/9 8:06	3/11 8:03	430.65
16	3/11 8:28	3/12 8:03	284.21
17	3/12 8:31	3/14 8:05	403.81
18	3/14 8:27	3/15 8:06	320.44
19	3/15 8:32	3/16 8:03	228.38
20	3/16 8:44	3/17 8:08	259.39
21	3/17 9:52	3/18 8:04	208.48
22	3/18 8:04	3/19 8:03	287.46
23	3/19 8:03	3/20 8:04	223.26
24	3/20 8:04	3/21 8:03	193.12
25	3/21 8:30	3/22 8:04	311.70
26	3/22 8:19	3/23 8:03	324.20
27	3/23 8:28	3/24 8:02	314.51

28	3/24 8:30	3/24 20:04	162.31
29	3/24 20:06	3/25 8:04	174.86
30	3/25 8:06	3/25 20:07	171.92
31	3/25 20:07	3/26 9:58	146.66
32	3/26 9:58	3/26 20:28	128.11
33	3/26 20:28	3/27 7:18	147.86
34	3/27 8:04	3/27 16:03	108.14
35	3/27 16:03	3/28 8:04	185.29
36	3/28 8:45	3/28 18:16	87.15
37	3/28 18:16	3/29 8:08	190.51
38	3/29 8:31	3/29 20:01	98.9

Table 3.7.3-2. Sampling information to determine the N and C containing compounds

Sample No.	Start	Stop	Sample Volume(m^3)
1	2/21 15:20	2/26 8:00	1473.13
2	2/26 8:00	3/1 8:10	663.00
3	3/1 8:10	3/3 8:12	510.05
4	3/3 8:35	3/6 8:07	757.01
5	3/6 8:30	3/10 8:08	940.59
6	3/10 8:42	3/15 8:07	1046.26
7	3/15 8:32	3/20 8:03	814.64
8	3/20 8:03	3/24 8:04	954.09
9	3/24 8:31	3/26 20:29	736.93
10	3/26 20:29	3/29 8:03	642.32

Table 3.7.3-3. Sampling information to determine the size distributions of particulate N and C containing compounds.

Sample No.	Start	Stop	Sample Volume(m^3)
1	2/21 15:37	3/4 8:07	228.434
2	3/4 8:58	3/16 8:05	250.58
3	3/16 8:44	3/28 8:06	279.654

(5) Data Archives

The data of the concentrations of aerosols and gases in this cruise will be archived at Ocean Research Institute (ORI), The University of Tokyo. The samples of aerosols in this cruise will be stored at ORI, and then analyzed for chemical components. The data are also submitted to JAMSTEC DMO.

3.7.4 Physical properties of atmospheric aerosols

(1) personnel

Kazuhiko Miura , Makoto Okada (Department of Physics, Science University of Tokyo)

(2) objectives

In order to know the effect of aerosols on climate change, it is necessary to investigate the physical properties of marine aerosols, that is, concentration, size distribution, horizontal distribution, vertical distribution, thermodynamic property, optical property, and so on.

Main purposes of our observation are as follows:

(a) Measuring the entire size distribution with three instruments
(b) Obtaining the residence time of aerosols with radon and thoron measurements
(c) Investigation of the mixing condition of individual particles with TEM/EDX analysis
(d) Measuring the thermodynamic properties as a function of relative humidity
(e) Estimation of refractive index by simultaneous observation with kytoon and lidar
(f) Estimation of generation flux of sea salt particles from the vertical profile near the surface measured along the foremast or with multi-joint crane

(3) measured parameters

- size distribution

scanning mobility particle sizer : 3936N25 (3085 + 3025A), TSI Inc. (44<d<168nm)

optical particle counters (OPCs) : KC18 and KC01, Rion Co. Ltd.

(d>100, 150, 200, 250, 300, 500, 1000, 2000, 5000 nm)

- total concentration of particles

condensation nuclei counter (CNC) : 3022A, TSI Inc.

- radon daughter concentration

radon daughter monitor : ES-7269, JREC Co. Ltd.

- particle concentration profile with kytoon system

kytoon : 10 m^3 in volume

CNC : 3087, TSI Inc.

OPC (d>300, 500, 700, 1000, 2000, 5000 nm) : KR12, Rion Co. Ltd.

- shape and elemental composition of aerosols

sampling : cascade impactor : Model I-1L, PIXE Int. Corp.

carbon-covered nitrocellulose film supported on an electron microscopic grid

analysis : an energy dispersive X-ray spectrometer : Kevex Sigma

(4) method

The size distributions from 4.4 nm to 5000 nm in diameter were measured with two systems consisting of a scanning mobility particle sizer (SMPS; 3936N or 3936L, TSI Inc.) and optical particle counters (OPCs; KC01D, KC18, RION Co. Ltd.). One system consisting of a SMPS and two OPCs was used to measure the size distribution in dry condition and the other consisting of a TDMA and OPCs was used to measure that in wet condition. We also measured radon daughter concentration with radon daughter monitor (ES-7269, JREC Co. Ltd.) to estimate the lifetime of aerosols.

Kytoon (about 10 m^3 in volume), which loaded an OPC (RION Co., KR12) or a CPC (TSI 3087) with radiosonde, was ascended and descended up to about 1000 m in maximum on the working deck (Table 3.7.4.1). Aerosol particles larger than 0.15, 0.25, 0.35, 0.5, 1.0, and 2.5 μm in radius were counted with the KR12 and temperature and relative humidity were measured for 1 min at every 100 m. In order to estimate the refractive index, we calculate backscattering coefficients and compare that obtained with Mie scattering lidar operated by NIES group.

Vertical profiles near the surface were measured to obtain sea salt flux. Measuring box containing the KR12 and CPC3087 was ascended and descended up to 12 m in height from the deck along the foremast (Table 3.7.4.2) as shown in Fig. 3.7.4.1. Measuring was performed for 1 min at every 2 m. In order to avoid the effect of ship body, the box was suspended from 3 to 10 m in height from the sea surface by the multi-joint crane twice (Table 3.7.4.2) as shown in Fig. 3.7.4.2.

Aerosol particles were collected directly on a carbon-covered nitrocellulose grid with two impactors for 10 min at the highest level with kytoon and on the compass deck at the same time (Table 3.7.4.3). The electron micrograph will be obtained using a scanning electron microscope (Hitachi Co., H-9000). The elemental compositions in individual particles larger than 0.1 μm in radius will be analyzed with an energy dispersive X-ray spectrometer (Kevex Sigma).

(5) primary results

Variations of radon concentration (shown as sum of counts between 400 and 600 channels) and total particle concentration are shown in Figs. 3.7.4.3 and 3.7.4.4, respectively. Radon and total particle concentration decreased as leaving the Japan Islands. The decreasing rate of particle was greater than that of radon.

Vertical profiles of volume distribution measured along the foremast and by the multi-joint crane were shown in Figs. 3.7.4.5 (a)-(d). First crane observation was performed on 15 March (Fig. 3.7.4.5 (a)). Second observation was performed on 16 March (Fig. 3.7.4.5 (b)). The averages of wind speed during the observation period were about 5 and 9 m/s, respectively. Volume distributions of larger particles show nearly same values. Volume distribution of the largest size range shows the vertical difference on 16 March, while that on 15 March show the constant value. The foremast observations were also performed on the same day. The value at 2 m of the mast observation on 16 March (Fig. 3.7.4.5 (d)) is lower than that at 4m, which seems to be the effect of ship body.

The further analyses are in future work.

(6) data archive

The original data will be archived at Department of Physics, Science University of Tokyo (Contact Kazuhiko Miura).

Table 3.7.4.1 Measuring list of the number concentration profile with OPC and CNC on the kytoon.

No.	date	start time	stop time	max. length (m)	size range (diameter)	latitude	longitude	remarks
1	2003.2.27	9:13	9:34	600	> 0.3,0.5,0.7,1,2,5 um	51-00N	165-00E	St.4
2	2003.3.2	9:42	9:57	1000	total	43-45N	155-58E	running
3	2003.3.15	8:49	9:24	1000	> 0.3,0.5,0.7,1,2,5 um	24-00N	155-00E	St.34
4	2003.3.15	9:34	10:05	1000	total	24-00N	155-00E	St.34
5	2003.3.17	6:22	6:51	1000	> 0.3,0.5,0.7,1,2,5 um	28-00N	155-00E	St.28
6	2003.3.17	7:51	8:14	600	total	28-00N	155-00E	St.28
7	2003.3.20	5:50	6:19	700	> 0.3,0.5,0.7,1,2,5 um	34-00N	155-00E	St.20
8	2003.3.20	7:07	7:24	500	total	34-00N	155-00E	St.20
9	2003.3.20	13:59	14:33	1000	> 0.3,0.5,0.7,1,2,5 um	35-00N	155-00E	St.19
10	2003.3.20	14:39	15:07	1000	total	35-00N	155-00E	St.19
11	2003.3.28	13:32	14:00	950	> 0.3,0.5,0.7,1,2,5 um	32-40N	136-55E	running
12	2003.3.28	15:30	15:55	800	total	32-25N	137-00E	running
13	2003.3.28	16:03	16:33	1000	> 0.3,0.5,0.7,1,2,5 um	32-17N	137-05E	running

Table 3.7.4.2 Measuring list of the number concentration profile with OPC and CNC along the fore-mast or by the multi-joint cran

No.	date	start time	stop time	max. height (m)	size range (diameter)	latitude	longitude	remarks
1	2003.2.23	14:06	14:16	10	total	43-12N	152-36E	running
2	2003.2.24	15:05	15:15	10	total	44-00N	155-00E	st.8(KNOT)
3	2003.2.24	15:18	15:25	10	> 0.3,0.5,0.7,1,2,5 um	44-00N	155-00E	st.8(KNOT)
4	2003.2.25	14:44	14:56	12	> 0.3,0.5,0.7,1,2,5 um	47-00N	159-53E	st.6(K2)
5	2003.2.27	14:07	14:23	12	> 0.3,0.5,0.7,1,2,5 um	51-00N	165-00E	st.4(K1)
6	2003.2.28	10:04	10:20	12	total, > 0.3,0.5,0.7,1,2,5 um	47-00N	165-00E	st.3
7	2003.3.6	14:29	14:44	12	> 0.3,0.5,0.7,1,2,5 um	41-00N	155-00E	st.11
8	2003.3.7	14:04	14:18	12	> 0.3,0.5,0.7,1,2,5 um	38-59N	157-50E	running
9	2003.3.11	13:06	13:20	12	total, > 0.3,0.5,0.7,1,2,5 um	25-00N	155-00E	St.33
10	2003.3.12	13:32	13:47	12	total, > 0.3,0.5,0.7,1,2,5 um	20-50N	155-00E	running
11	2003.3.13	10:31	10:45	12	total, > 0.3,0.5,0.7,1,2,5 um	19-00N	155-00E	St.39
12	2003.3.14	9:00	9:13	12	total, > 0.3,0.5,0.7,1,2,5 um	20-00N	155-00E	St.38
13	2003.3.15	13:51	14:16	10 (crane)	total, > 0.3,0.5,0.7,1,2,5 um	24-00N	155-00E	St.34
14	2003.3.15	14:26	14:41	12	total, > 0.3,0.5,0.7,1,2,5 um	24-00N	155-00E	St.34
15	2003.3.16	9:33	9:49	12	total, > 0.3,0.5,0.7,1,2,5 um	26-00N	155-00E	St.32
16	2003.3.16	10:00	10:20	10 (crane)	total, > 0.3,0.5,0.7,1,2,5 um	26-00N	155-00E	St.32
17	2003.3.17	8:37	8:51	12	total, > 0.3,0.5,0.7,1,2,5 um	28-00N	155-00E	St.28
18	2003.3.18	8:55	9:03	12	total, > 0.3,0.5,0.7,1,2,5 um	30-00N	155-00E	St.25
19	2003.3.18	14:25	14:38	12	total, > 0.3,0.5,0.7,1,2,5 um	31-00N	155-00E	St.23
20	2003.3.19	14:56	15:10	12	total, > 0.3,0.5,0.7,1,2,5 um	33-00N	155-00E	St.21
21	2003.3.20	7:57	7:11	12	total, > 0.3,0.5,0.7,1,2,5 um	34-00N	155-00E	St.20
22	2003.3.20	16:02	16:15	12	> 0.3,0.5,0.7,1,2,5 um	35-00N	155-00E	St.19
23	2003.3.21	8:09	8:23	12	total, > 0.3,0.5,0.7,1,2,5 um	36-00N	155-00E	St.17
24	2003.3.22	8:54	9:08	12	total, > 0.3,0.5,0.7,1,2,5 um	37-00N	155-00E	St.15
25	2003.3.23	8:26	8:40	12	total, > 0.3,0.5,0.7,1,2,5 um	38-00N	155-00E	St.14
26	2003.3.24	8:28	8:41	12	total, > 0.3,0.5,0.7,1,2,5 um	42-00N	155-00E	St.10
27	2003.3.25	9:32	9:45	12	total, > 0.3,0.5,0.7,1,2,5 um	39-10N	148-36E	
28	2003.3.26	9:48	10:01	12	total, > 0.3,0.5,0.7,1,2,5 um	36-17N	142-55E	
29	2003.3.27	10:03	10:16	12	total, > 0.3,0.5,0.7,1,2,5 um	33-09N	139-56E	off Hachijo Is.

Table 3.7.4.3 sampling list of aerosols with impactor.

sampling volume   1 l/min

No.	date(JST)	start time	stop time	latitude(N)	longitude(E)	place	remarks
1	2003.2.21	15:30	15:35	40-33	141-48	compass	
2	2003.2.22	16:06	16:11	40-51	145-40	compass	
3	2003.2.23	14:27	14:32	43-14	152-39	compass	
4	2003.2.24	14:31	14:36	44-00	155-00	compass	St.8
5	2003.2.25	13:25	13:30	47-00	159-53	compass	St.6
6	2003.2.26	13:25	13:30	47-58	161-06	compass	
7	2003.2.27	10:03	10:08	51-01	164-57	compass	St.4
8	2003.2.27	10:00	10:05	51-01	164-57	250 m	St.4
9	2003.2.28	13:26	13:31	47-01	164-58	compass	St.3
10	2003.3.1	13:25	13:30	45-43	161-12	compass	
11	2003.3.2	10:38	10:43	43-55	155-55	compass	
12	2003.3.2	10:38	10:43	43-55	155-55	1000 m	
13	2003.3.3	13:25	13:30	42-48	155-10	compass	
14	2003.3.4	12:45	12:48	40-21	155-04	compass	before cold front
15	2003.3.4	13:52	13:57	40-19	155-06	compass	after cold front
16	2003.3.5	13:24	13:29	41-14	154-58	compass	
17	2003.3.6	13:24	13:29	41-00	155-00	compass	St.9
18	2003.3.7	13:25	13:30	38-59	157-39	compass	
19	2003.3.8	13:25	13:30	36-19	158-57	compass	
20	2003.3.9	8:40	8:46	34-04	158-17	compass	
21	2003.3.10	13:25	13:30	28-23	159-05	compass	
22	2003.3.11	13:27	13:32	25-00	155-00	compass	St.33
23	2003.3.12	12:37	12:42	21-00	155-00	compass	St.37
24	2003.3.13	11:22	11:27	17-01	154-58	compass	St.41
25	2003.3.14	9:25	9:30	20-00	155-00	compass	St.38
26	2003.3.15	11:05	11:10	24-00	155-00	compass	St.34
27	2003.3.15	11:05	11:10	24-00	155-00	750m	St.34
28	2003.3.15	12:31	12:36	23-53	154-55	compass	
29	2003.3.16	10:26	10:31	26-00	155-00	compass	St.32
30	2003.3.17	7:25	7:30	28-00	155-00	compass	St.28
31	2003.3.17	7:25	7:30	28-00	155-00	800m	St.28
32	2003.3.18	8:25	8:30	30-00	155-00	compass	St.25
33	2003.3.19	14:36	14:41	33-00	155-00	compass	St.21
34	2003.3.20	9:34	9:39	34-00	155-00	compass	
35	2003.3.20	6:50	6:55	34-00	155-00	600m	St.20
36	2003.3.20	15:35	15:40	35-00	155-00	upper	St.19
37	2003.3.20	15:35	15:40	35-00	155-00	800m	St.19
38	2003.3.21	14:36	14:41	36-54	155-00	compass	waiting
39	2003.3.22	12:39	12:44	37-00	155-00	compass	
40	2003.3.23	14:24	14:29	39-10	155-00	compass	
41	2003.3.24	9:20	9:25	42-00	155-00	compass	St.10
42	2003.3.24	21:22	21:27	40-38	151-51	compass	
43	2003.3.25	8:20	8:25	39-18	148-48	compass	
44	2003.3.25	20-16	20-21	37-55	145-48	compass	
45	2003.3.26	9:20	9:25	36-18	142-55	compass	free fall
46	2003.3.26	14:22	14:27	36-02	142-44	compass	
47	2003.3.27	13:20	13:25	33-09	139-56	compass	off Hachijo Is.
48	2003.3.28	14:30	14:35	32-30	137-00	compass	
49	2003.3.28	14:30	14:35	32-30	137-00	900m	
50	2003.3.29	8:20	8:25	32-26	132-42	compass	

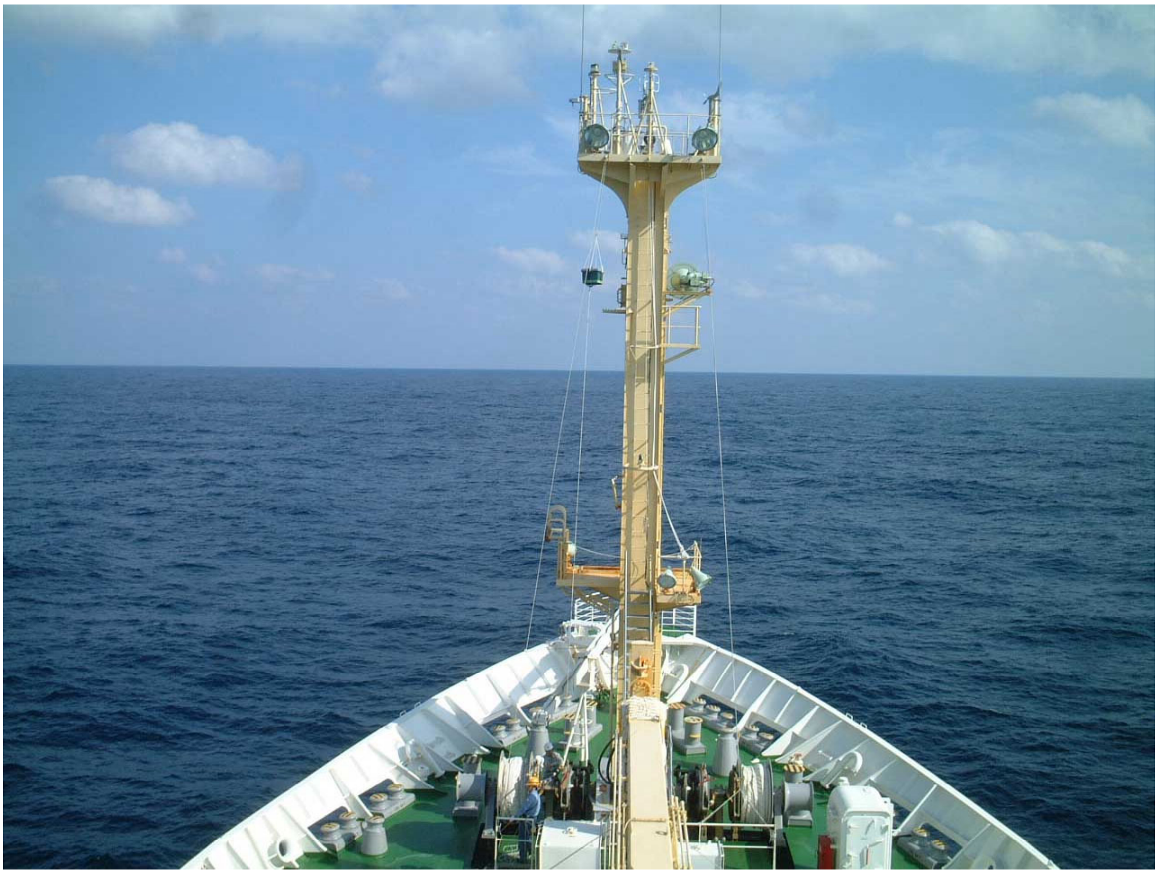


Fig. 3.7.4.1 Foremast observation.

Fig. 3.7.4.2 Multi-joint crane observation.

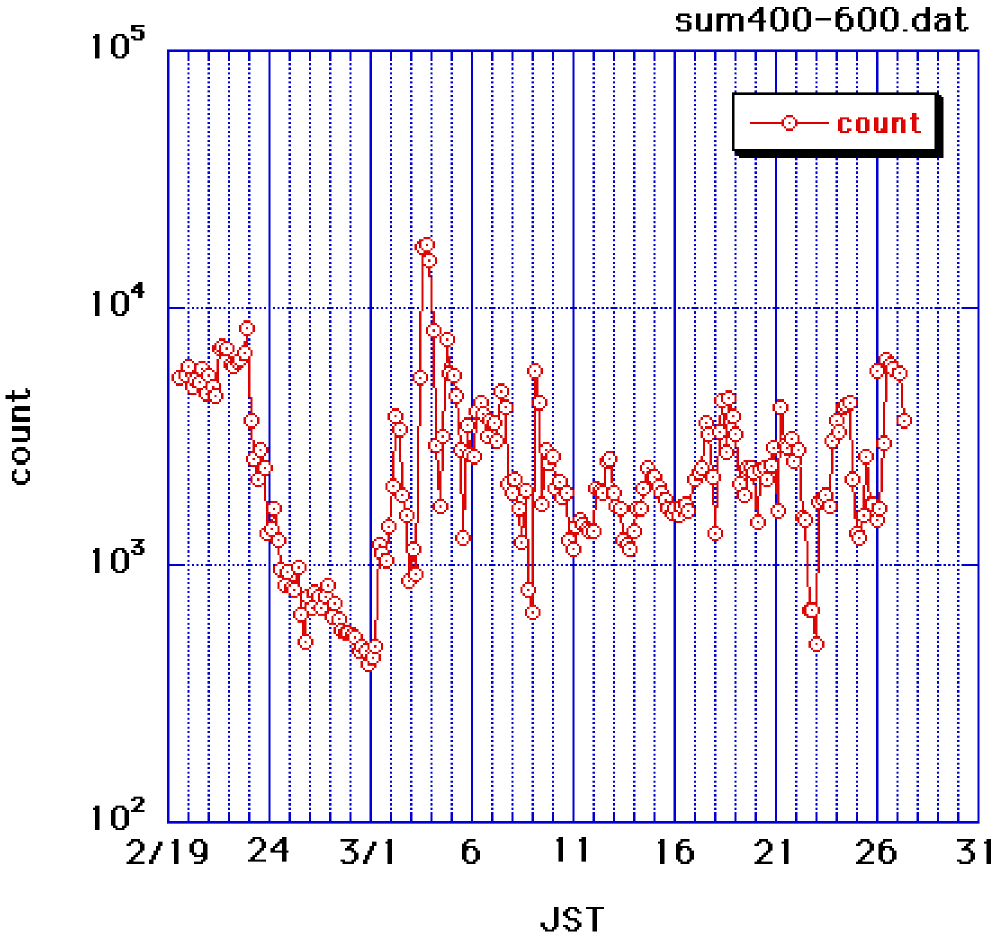


Fig. 3.7.4.3　Variation of radon concentration (sum of 400-600 channels).

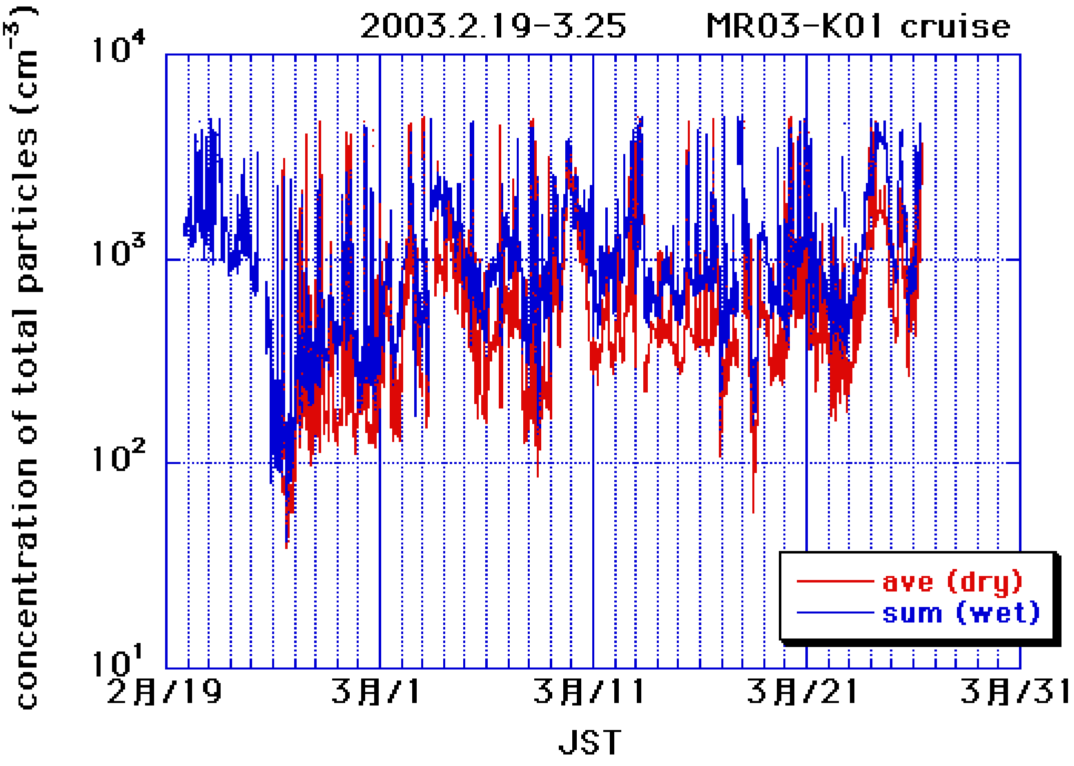


Fig. 3.7.4.4　Variation of total particle concentration.

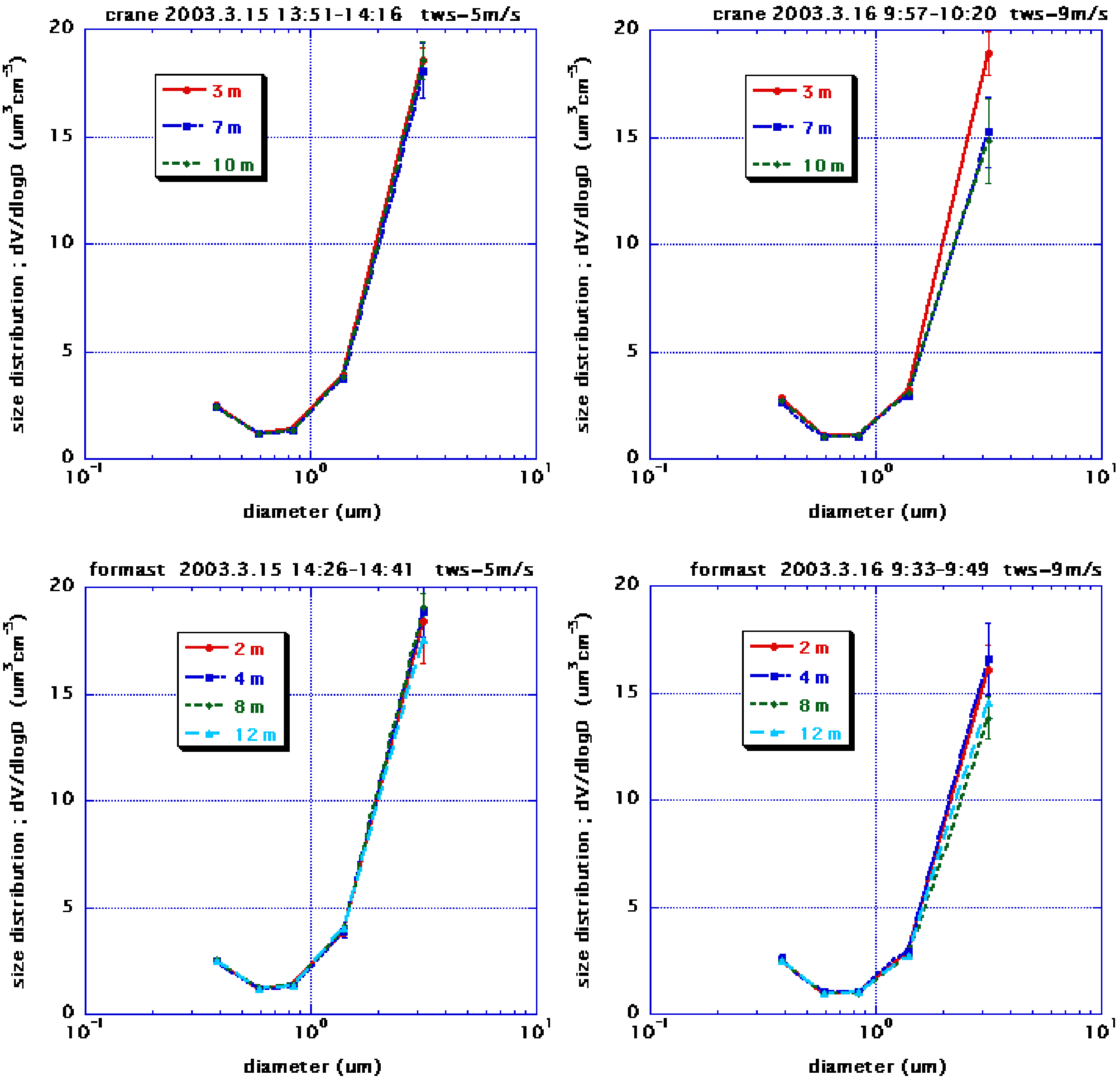


Fig. 3.7.4.5 Vertical profile of volume distribution measured with the OPC KR12. Upper : multi-joint crane observation on 15 March (a) and 16 March (b). Lower : foremast observation on 15 March (c) and 16 March (d).

3.8 Surface atmospheric turbulent CO_2 flux

(1) Personnel : Fumiyoshi Kondo (Okayama University
/ Japan Marine Science and Technology Center trainee)
On-shore Scientists : Osamu Tsukamoto (Okayama University): Principal Investigator
Hiroshi Ishida (Kobe University of Mercantile Marine/
/Frontier Observational Research System for Global Change)
Kunio Yoneyama (Japan Marine Science and Technology Center)

(2) Objective

For the understanding of the air-sea interaction, accurate measurements of surface heat and water budgets are necessary as well as momentum exchange through the sea surface. In addition to these exchanges, evaluation of carbon dioxide flux is also indispensable for a study of the global warming. The exchange of carbon dioxide across an air-sea interface has been determined by the bulk method in which an exchange constant and air-sea concentration difference are used. However the exchange constant in the bulk method involves uncertainty because the relationship between the exchange constant and wind speed is obtained empirically. And also there is a question about the assumption that the concentrations of carbon dioxide in mixed layers both of air and water are constant. We here attempt to evaluate flux across air-sea interface using a micrometeorological method that is called eddy correlation method. This method measures directly the concentration fluctuation of carbon dioxide and the vertical component fluctuation of wind speed in the air. Furthermore there is no uncertainty of coefficient and assumption of similar law. For these reason eddy correlation method believes to be most accurate.

(3) Methods

The system of surface turbulent flux consists of turbulence instruments and ship motion sensors. The turbulence sensors are installed at the top of the foremast. A three-dimensional sonic anemometer-thermometer (Kaijo, DA-600) and an infrared hygrometer (Kaijo, AH-300) have been operated since June 2000 (MR00-K04). The latter was replaced by LI-COR LI-7500 after May 2002. The sonic anemometer measures three-dimensional wind components relative to the ship including apparent wind velocity due to ship motion. The ship motions are independently measured by ship motion sensors, including a two-axis inclinometer (Applied Geomechanics, MD-900-T), a three-axis accelerometer (Applied Signal Inc., QA-700-020), and a three-axis rate gyro (Systron Donner, QRS-0050-100). LI-7500 is a CO_2/H_2O turbulence sensor that measures turbulent signals of carbon dioxide and water vapor simultaneously. Fig. 3.8-1 shows the installation of the instruments at the top of the foremast.

These turbulence and ship motion signals are sampled at 10 Hz by a PC-based data logging system (Labview, National Instruments Co., Ltd.). This PC system is connected to the Mirai network system to obtain ship speed and heading data that are used to derive absolute wind components relative to the ground. Combining these wind data with the turbulence measurements, turbulent fluxes and statistics are calculated in a real-time basis and displayed on the PC.

During CTD casting a ship maneuvering was suitable for the turbulence measurements, because the dynamical and thermal effects of the ship's body would be unfavorable for the accurate flux evaluations.

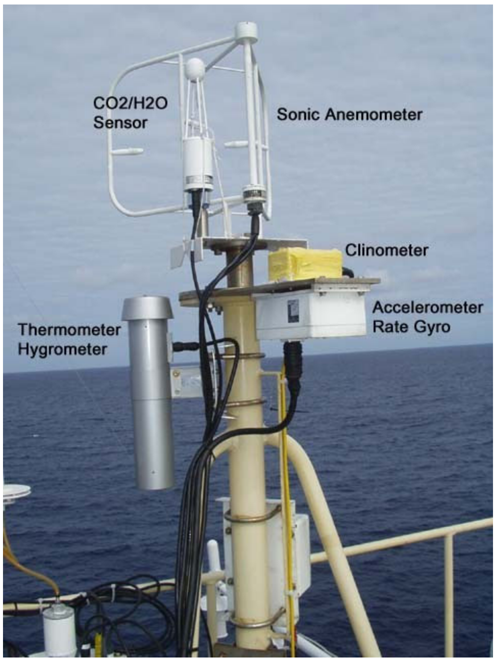
(4) Preliminary Results

During this cruise, we had the problems in vertical component and the sound virtual temperature of the three-dimensional sonic anemometer-thermometer. Although causes of the problems are unclear at this time, it is likely that the instruments are affected by low atmospheric temperature, rainfall and snowfall.

(5) Data Archive

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. The corrected data and inventory information will be submitted to JAMSTEC Data Management Office.

Fig.3.8-1: The installation of the turbulence measurements sensors at the top of the foremast.



3.9 Radiometer / particle counter

Objective theme:

Investigation of horizontal distribution on the concentration and size distribution and optical properties of atmospheric aerosols at the surface and optical thickness of columnar aerosol over the ocean.

Objects:

To clear and solve the problems of horizontal distribution and optical properties of aerosols, some observations were carried out over the tropical region of the Western Pacific Ocean. Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously

Summery: To obtain the data for calibration and validation between remote sensing and surface measurements over the ocean, a series of simultaneous observations has been carried out about optical properties like as scattering and absorption coefficients and radiative properties as optical properties of atmospheric aerosols, the concentration and size distribution of surface aerosols over the Northwestern Ocean of North Pacific Ocean Tropical area of western Pacific Ocean for 39 days from 20 February 2003 to 30 March 2003. In addition of that, a sky radiometer was examined for to a fully automated ship-borne instrument and improved to the practical usage on same board.

(1) Personnel

Principal Investigator not on board
Tatsuo ENDOH (Institute of Low Temperature Science, Hokkaido University) Associate Professor

On board scientists
Syuichi WATANABE (JAMSTEC) Chief Scientist
Shigeki HOSODA(JAMSTEC) Research Scientist

Co-workers not on board
Sachio OHTA (Engineering environmental resource laboratory, Graduate school of engineering, Hokkaido University) Professor
Tamio TAKAMURA (Center of environmental remote sensing science, Chiba University) Professor
Teruyuki NAKAJIMA (Center of climate system research, University of Tokyo) Professor

(2) Objects/Introduction

One of the most important objects is the collection of calibration and validation data from the surface (Nakajima et al.1996, 1997 and 1999). It may be considered for the observation over the widely opening of the huge ocean to be desired ideally because of horizontal homogeneity. Furthermore, the back ground values of aerosol concentration are easily obtained over there (Ohta et al.1996, Miura et al. 1997 and Takahashi et al. 1996) and vertical profile of aerosol concentration are obtained by means of extrapolation up to the scale height. It is desired to compare the integrated value of these profile of aerosol concentration with optical thickness observed by the optical and radiative measurement (Hayasaka et al. 1998, Takamura et al.1994). Facing this object, the optical and radiative observations were carried out by mean of the Sky Radiometer providing more precise radiation data as the radiative forcing for global warming.

(3) Measuring parameters

Atmospheric optical thickness, Ångström coefficient of wave length efficiencies,
Direct irradiating intensity of solar, and forward up to back scattering intensity with scattering angles of

2-140degree and seven different wave lengths
GPS provides the position with longitude and latitude and heading direction of the vessel, and azimuth and elevation angle of sun. Horizon sensor provides rolling and pitching angles.

Concentration and size distribution of atmospheric aerosol.

(4) Methods

The instruments used in this work are shown as following in Table 3.9-1.

Sky Radiometer was measuring irradiating intensities of solar radiation through seven different filters with the scanning angle of 2-140 degree. These data will provide finally optical thickness, Ångström exponent, single scattering albado and size distribution of atmospheric aerosols with a kind of retrieval method.

Optical Particle Counter was measuring the size of large aerosol particle and counting the number concentration with laser light scattering method and providing the size distribution in 0.3,0.5,1.0,2.0 and 5.0 micron of diameter with real time series display graphically.

(5) Results

Information of data and sample obtained are summarized in Table 3.9-2. The sky radiometer has been going well owing to more calm and silent condition and circumstances about shivering problems provided by the R/V Mirai whose engines are supported by well defined cushions. Therefore, measured values will be expected to be considerably stable and provide good calculated parameters in higher quality. However, some noise waves were found to interfere the 16,13 and 12channel marine bands of VHF from sky radiometer. Fortunately the origin and source were identified by using a VHF wide band receiver and the interference waves were kept by fairly separating from two VHF antennae and decreased to recovery of 100%.

Aerosols size distribution of number concentration have been measured by the Particle Counter and data obtained are displayed in real time by a kind of time series *in situ* with 5stages of size range of 0.3, 0.5, 1.0, 2.0, and 5.0 micron in diameter.

(6) Data archive

This aerosol data by the Particle Counter will be able to be archived soon and anytime. However, the data of other kind of aerosol measurements are not archived so soon and developed, examined , arranged and finally provided as available data after a certain duration. All data will archived at ILTS (Endoh), Hokkaido University, CCSR(Nakajima), University of Tokyo and CEReS (Takamura), Chiba University after the quality check and submitted to JAMSTEC within 3-year.

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Data inventory

Table 3.9-1. Information of obtained data inventory (Method)

Item, No.data	Name	Instrument	Site position
Optical thickness Ångström exponent.	Endoh	Sky Radiometer(Prede,POM-01MK2)	roof of stabilizer
Aerosol Size distribution	Endoh	Particle Counter(Rion,KC-01C)	compass deck(inlet) & environmental research laboratory

Table 3.9-2. Data and Sample inventory

Data/Sample	rate	site	object	name	state	remarks
Sun & Sky Light	1/5min (fine& daytime)	roof of stabilizer	optical thickness Ångström expt.	Endoh	land analysis	02/20’03-03/30’03
Size distribution of aerosols	1/2.5min	compass deck	concentration of aerosols	Endoh	on board	02/20’03-03/30’03

3.10 AMSR/AMSR-E validation observation

(1) Personnel

Masayuki Sasaki	(NASDA/EORC*): Principle Investigator (not on board)
Yozo Takayama	(JMA/MRI**)

*NASDA/EORC: National Space Development Agency of JAPAN / Earth Observation Research Center.
**JMA/MRI : Japan Meteorological Agency / Meteorological Research Institute

(2) Objectives

The satellite-borne microwave radiometers are the powerful device to obtain the spatial and temporal variation of the water vapor, cloud liquid water, sea surface temperature, rain rate, etc, especially over the ocean where the ground-based observation is poor. To validate the products of AMSR (Advanced Mircowave Radiometer) / ADEOS-II and AMSR-E / EOS Aqua, brand-new satellite-borne microwave radiometer, the Mirai basic observation system installed on the vessel and continuous observation is carried out.

(3) Methods

The observation is performed continuously from 13 January to, 12 February 2003.

Match-up data between AMSR/AMSR-E products and Mirai observation data will be created.

a) AMSR/AMSR-E vs. sea surface temperature
b) AMSR/AMSR-E vs. rain rate
c) AMSR/AMSR-E vs. wind speed

(4) Preliminary Results

The observed data will be checked and analyzed after the cruise.

(5) Data Archive

No original data.

3.11 Satellite observation

3.11.1 Ocean color

Ichio Asanuma

Earth Observation Research Center/NASDA

i) Objectives

It is our objectives to collect data of chlorophyll-a distribution in a high spatial resolution mode from the Sea Wide Field of View Sensor (SeaWiFS) on the OrbView-2 satellite and to build a time and depth resolved primary productivity model.

ii) Methods

The High Resolution Picture Transmission (HRPT) receiving station on the R/V Mirai was operated to capture the HRPT signal from the OrbView-2 satellite automatically. The HRPT signal was decrypted following to the reception on the receiving system by a decryption key, which is assigned by the Goddard Space Flight Center (GSFC) of NASA for this research. The level-1A data were generated on the R/V.

The higher product, chlorophyll-a distribution, will be generated at the laboratory using the SeaWiFS Data Analysis System (SEADAS) with the algorithms dedicated for the SeaWiFS. The MSL12 in the SeaDAS is the basic function to generate a chlorophyll-a distribution as a level-2 data.

The chlorophyll-a distribution data will be applied for the time and depth resolved primary productivity model.

iii) Data

SeaWiFS data covers a period from Feb. 22, 2003 to Mar. 28, 2003

iv) Schedule

a. Level-1A reconstruction: by the middle of April, 2003
b. Level-1A transfer to GSFC/NASA: by the middle of April, 2003 (Duty of the receiving station)
c. Level-2 production: by the end of April, 2003
d. Level-3 mapped data production: by the end of April, 2003.
e. Primary productivity trial: by the end of May 2003.

v) Data availability

A distribution activity of SeaWiFS data is regulated by the agreement between the NASA and JAMSTEC in 1993. SeaWiFS authorized users are able to access data from NASA. Cruise participants are able to access data from Asanuma with a co-authorship.

vi) Remarks

For freeze of signal receiver, the data are missing from 28 February 02:20 to 28 February 04:18.

For trouble of an antenna, the data are missing from 14 March 20:40 to 16 March 03:05.

vii) Data list:

Following data list indicates the file name of level-1a data with the rule of notation;

Syyyydddhhmmss.L1A_HMIR.hdf.Z, where yyyy is a year, ddd is a Julian day of the year, hhmmss is a hour, minute and second when data started.

S2003045040135.L1A_HMIR.hdf.Z
S2003046030354.L1A_HMIR.hdf.Z
S2003047020723.L1A_HMIR.hdf.Z
S2003047034457.L1A_HMIR.hdf.Z
S2003048024828.L1A_HMIR.hdf.Z
S2003048042601.L1A_HMIR.hdf.Z
S2003049015143.L1A_HMIR.hdf.Z
S2003049032819.L1A_HMIR.hdf.Z
S2003050023130.L1A_HMIR.hdf.Z
S2003050040922.L1A_HMIR.hdf.Z
S2003051013616.L1A_HMIR.hdf.Z
S2003051031154.L1A_HMIR.hdf.Z
S2003052021534.L1A_HMIR.hdf.Z
S2003052035317.L1A_HMIR.hdf.Z
S2003053025530.L1A_HMIR.hdf.Z
S2003053043518.L1A_HMIR.hdf.Z
S2003054015801.L1A_HMIR.hdf.Z
S2003054033611.L1A_HMIR.hdf.Z
S2003055023822.L1A_HMIR.hdf.Z
S2003055041830.L1A_HMIR.hdf.Z
S2003056014055.L1A_HMIR.hdf.Z
S2003056031924.L1A_HMIR.hdf.Z
S2003057004344.L1A_HMIR.hdf.Z

S2003057022142.L1A_HMIR.hdf.Z

S2003058012400.L1A_HMIR.hdf.Z

S2003058030308.L1A_HMIR.hdf.Z

S2003059002740.L1A_HMIR.hdf.Z

S2003059020503.L1A_HMIR.hdf.Z

S2003060010743.L1A_HMIR.hdf.Z

S2003060024611.L1A_HMIR.hdf.Z

S2003061014925.L1A_HMIR.hdf.Z

S2003061032742.L1A_HMIR.hdf.Z

S2003062005336.L1A_HMIR.hdf.Z

S2003062023054.L1A_HMIR.hdf.Z

S2003063013411.L1A_HMIR.hdf.Z

S2003063031236.L1A_HMIR.hdf.Z

S2003064003936.L1A_HMIR.hdf.Z

S2003064021428.L1A_HMIR.hdf.Z

S2003065011735.L1A_HMIR.hdf.Z

S2003066033745.L1A_HMIR.hdf.Z

S2003067010254.L1A_HMIR.hdf.Z

S2003067024050.L1A_HMIR.hdf.Z

S2003070013239.L1A_HMIR.hdf.Z

S2003071021125.L1A_HMIR.hdf.Z

S2003073020103.L1A_HMIR.hdf.Z

S2003075031653.L1A_HMIR.hdf.Z

S2003076021745.L1A_HMIR.hdf.Z

S2003077012040.L1A_HMIR.hdf.Z

S2003077025909.L1A_HMIR.hdf.Z

S2003078020014.L1A_HMIR.hdf.Z

S2003079010351.L1A_HMIR.hdf.Z

S2003079024028.L1A_HMIR.hdf.Z

S2003080014309.L1A_HMIR.hdf.Z

S2003080032138.L1A_HMIR.hdf.Z

S2003081004800.L1A_HMIR.hdf.Z

S2003081022324.L1A_HMIR.hdf.Z

S2003082012701.L1A_HMIR.hdf.Z

S2003082030456.L1A_HMIR.hdf.Z

S2003083020537.L1A_HMIR.hdf.Z

S2003084011131.L1A_HMIR.hdf.Z

S2003085015219.L1A_HMIR.hdf.Z

S2003086023319.L1A_HMIR.hdf.Z

S2003087031440.L1A_HMIR.hdf.Z

S2003088021901.L1A_HMIR.hdf.Z

3.11.2 NOAA HRPT (Sea surface temperature and IR)

Shuichi Watanabe	(JAMSTEC) Principal investigator
Ichio Asanuma	(EORC / NASDA)
Yasutaka Imai	(Global Ocean Development Inc.)
Wataru Tokunaga	(GODI)
Shinya Okumura	(GODI)

(1) Method

We receive the downlink HRPT signal from NOAA polar orbital satellite by the same way as the signal of OrbView-2. We processed the HRPT signal with the inflight calibration and computed the sea surface temperature by the multi-channel sea surface temperature method.

We had received signal throughout MR03-K01 cruise from the departure of Sekinehama on 20 March 2003 to arrival of Shimonoseki on 30 March 2003.

(2) Preliminary results

The results will be public after the analysis.

(3) Data archives

The raw data obtained during this cruise will be submitted to JAMSTEC Data Management Division and will be under their control.

(4) Remarks

For freeze of signal receiver, the data are missing from 28 February 02:20 to 28 February 04:18.

For trouble of an antenna, the data are missing from 14 March 20:40 to 16 March 03:05.

3.12 Shipboard ADCP

(1) Personnel

Shuichi Watanabe (JAMSTEC) Principal Investigator
Yasutaka Imai (GODI)
Wataru Tokunaga (GODI)
Shinya Okumura (GODI)

(2) Parameters

Current velocity of each depth cell [cm/s]
Echo intensity of each depth cell [dB]

(3) Methods

Upper ocean current measurements were made throughout MR03-K01 cruise (20/February/2003 - 30 /March/2003, Sekinehama - Shimonoseki) using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V Mirai. The system consists of following components;

1) a 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating at 75 KHz (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel;
2) the Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements to the ADCP;
3) a GPS navigation receiver (Leica MX9400) providing position fixes;
4) an IBM-compatible personal computer running data acquisition software (VmDas version 1.3 ; RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 5 minutes.

The ADCP was configured for 16-m processing bin, a 8-m blanking interval. The sound speed is calculated from temperature (thermistor near the transducer faces), salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by equation in Medwin (1975). The transducer depth was 6.5 m; 40 velocity measurements were made at 16-m intervals starting 31m below the calm water line. Each 1 ping was recorded as raw ensemble data. Also, 60 seconds and 300 seconds average data were recorded as short-term average (STA) and long-term average (LTA) data.

(4) Preliminary result

Fig.3.12-1 shows magnitude and direction of current in horizontal plane. Fig.3.12-2 shows magnitude and direction of current in vertical plane (Feb24 - Feb27). Fig.3.12-3 shows current along 155E (Mar13 - Mar24).

(5) Data archive

These data obtained during this cruise will be submitted to the JAMSTEC DMO (Data Management Office), and will be opened to the public via "R/V Mirai Data Web Page" in JAMSTEC home page.

(6) Remarks

Data was not acquired from 22/Feb/2003 14:46 to 23/Feb/2003 09:50UTC (Japanese/Russian EEZ).

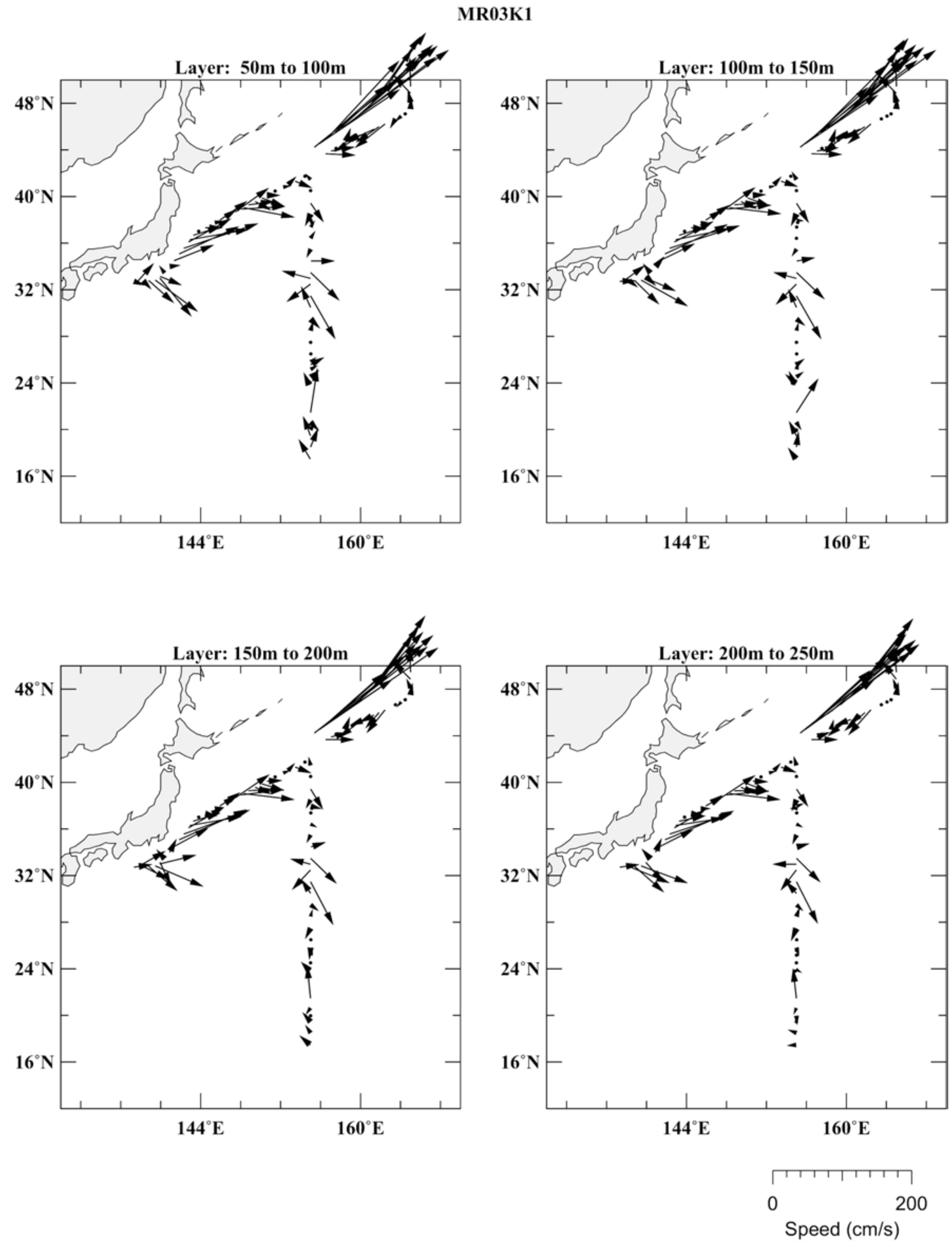

Fig.3.12-1 Magnitude and direction of current in horizontal plane.

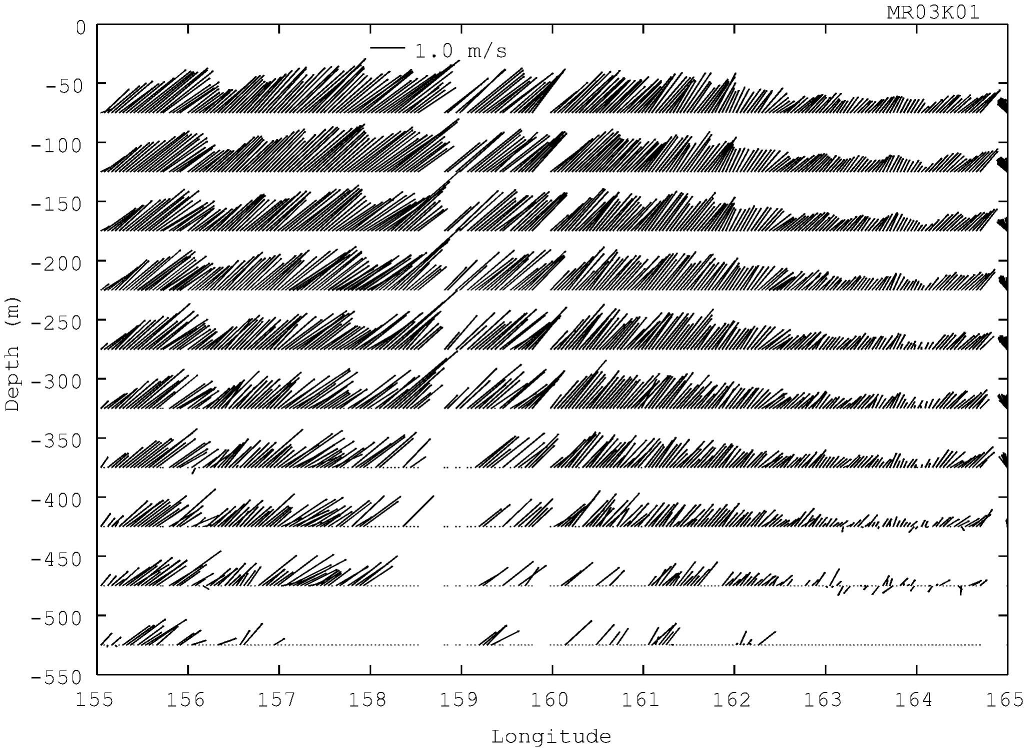

Fig.3.12-2 Magnitude and direction of current in vertical plane (Feb24 to Feb27).

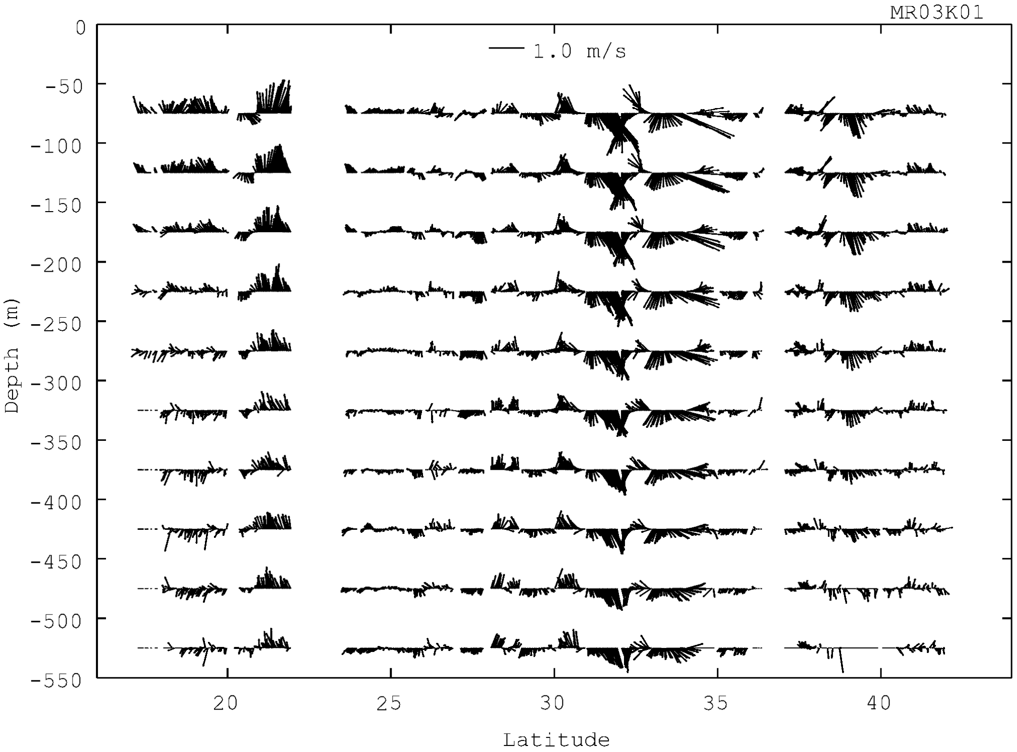

Fig.3.12-3 Magnitude and direction of current in vertical plane (Mar13 to Mar24).

Appendix Shipboard ADCP configuration

BB75_mirai03k1_ws16wn40DEF_bp0.txt

```
;----------------------------------------------------------------------------¥
; ADCP Command File for use with VmDas software.
;
; ADCP type:          75 Khz Broadband
; Setup name:        MR03-K01
; Setup type:        BB75_16
;
; NOTE:    Any line beginning with a semicolon in the first
;               column is treated as a comment and is ignored by
;               the VmDas software.
;
; NOTE:    This file is best viewed with a fixed-point font (eg. courier).
; Modified Last: 19Feb.2003
;---------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 9600 bps,
; no parity, one stop bit, 8 data bits
; NOTE:    VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb411

; Set for reduced bandwidth profile mode, single-ping ensembles,
; 10(with 16 meter bin) , 8 meter blanking distance, 999 mm/s ambiguity vel
WA255
WB1
WC064
WE5000
WF0800
WG001
WP00001
WM1
WS1600
WN040
WV999

; Disable bottom track,
; Set maximum bottom search depth to 999.9 meters
BA020
BP000
BX9999
```

```
; output velocity, correlation, echo intensity, percent good
WD111111111

; Two seconds between bottom and water pings
TP000200

; Four seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor,
; external synchro heading sensor, use internal
; transducer temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX11000

; Set transducer depth to zero
ED00065

; save this setup to non-volatile memory in the ADCP
CK
```

3.13 Geophysical observations

3.13.1 Multi-narrow beam echo sounding system

Shuichi Watanabe	(JAMSTEC) Principal investigator
Yasutaka Imai	(Global Ocean Development Inc.)
Wataru Tokunaga	(GODI)
Shinya Okumura	(GODI)

(1) Objectives

R/V Mirai has installed a multi narrow beam echo sounding system (MNBES), SeaBeam 2112.004 (SeaBeam Inc., USA). The main objective of MNBES observation is collecting continuous bathymetry data along ship's track to make a contribution to geological and geophysical investigations. We had carried out bathymetric survey from the departure of Sekinehama on 20 March 2003 to arrival of Shimonoseki on 30 March 2003.

In addition, survey performed near the Stn 1 for determination of mooring system deployment position.

(2) Methods

A multi-narrow beam echo sounding system "SeaBeam 2100" on R/V Mirai was used for bathymetry mapping during the MR03-K01 cruise. To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used temperature and salinity profiles from CTD data and calculated sound velocity by equation in Mackenzie (1981).

System configuration and performance

Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 KW
Transmit pulse width:	3 msec to 20 msec
Depth range:	100 to 11,000 m
Beam spacing:	1 ° athwart ship
Swath width:	max 150 °
	120 ° to 4,500 m
	100 ° to 6,000 m
	90 ° to 11,000 m
Depth accuracy:	Within < 0.5 % of depth or ± 1 m,
	(whichever is greater, over the entire swath)

(3) Preliminary results

The results will be public after the analysis.

(4) Data archives

Bathymetry data obtained during this cruise will be submitted to the JAMSTEC DMO (Data Management Office), and archived there.

(5) Remarks

We did not sample the data within EEZ of Russian federation (from 22 February 14:46 to 23 February 09:50).

3.13.2 Sea surface gravity

Shuichi Watanabe	(JAMSTEC) Principal investigator
Yasutaka Imai	(Global Ocean Development Inc.)
Wataru Tokunaga	(GODI)
Shinya Okumura	(GODI)

(1) Objectives

The difference of local gravity is an important parameter in geophysics. We measured relative gravity at the sea surface during MR03-K01 cruise from the departure of Sekinehama on 20 March to arrival of Shimonoseki on 30 March 2003.

(2) Parameters

Gravity (mgal)

(3) Methods

We have measured relative gravity using LaCoste-Romberg onboard gravity meter S-116 during MR03-K01. To convert relative gravity to absolute one at the sensor, we measured gravity at Sekinehama Port gravity reference point using portable gravity meter (Scintrex gravity meter CG-3M). Information of crust and upper-mantle structures is derived from measured gravity.

(4) Preliminary results

Absolute gravity (Table 3.13.2-1).

Table 3.13.2-1

No.	Date	UTC	Port	Absolute Gravity (mGal)	Sea Level (cm)	Draft (cm)	Gravity at Sensor (mGal)	L&R (mGal)
1	2003/Feb/19	06:45	Sekinehama	980371.85	238	605	980372.62	12664.9
2	2003/Mar/31	07:28	MHI Shimonoseki	979674.04	348	569	979675.13	11966.8

- Gravity at sensor = Absolute gravity + sea level*0.3086/100 + (Draft－530)/100*0.0431
- L&R: LaCoste - Romberg onboard gravity meter S-116

Differential	G at sensor	L&R value
No.1-No.2	-697.49 mGal ---(a)	-698.10 mGal ---(b)

L&R drift value (b)-(a)	-0.61 mGal	40.04 days
Daily drift ratio	**-0.0152 mGal/day**	

(5) Data archives

Gravity data obtained during this cruise will be submitted to the JAMSTEC DMO (Data Management Office), and archived there.

(6) Remarks

We did not sample the data within EEZ of Russian federation (from 22 February 14:46 to 23 February 09:50).

3.13.3 Surface three-component magnetometer

Shuichi Watanabe	(JAMSTEC) Principal investigator
Yasutaka Imai	(Global Ocean Development Inc.)
Wataru Tokunaga	(GODI)
Shinya Okumura	(GODI)

(1) Objectives

Measurements of magnetic force that is induced by magnetized body beneath the sub-bottom and the earth dipole on the sea, is required for reorganization of the geophysical crust structure.

We measured a geomagnetic field at the sea surface using a three-component magnetometer, two horizontal and one vertical component.

(2) Parameters

Three-component magnetic force (nT)
Ship’s attitude (1/100deg)

(3) Method

A three-component fluxgate magnetometer is set on the top of foremast. Sampling is controlled by the 1pps (pulse per second) standard clock of GPS signal. Every one-second data is composed of navigation information, 8 Hz three-component of magnetic forces and vertical reference unit (VRU) data.

For calibration of this system, we had cruised like a figure of 8 (clockwise and anticlockwise rotation). This calibration carried out twice (2003/02/24 02:30 (UTC) and 2003/03/15 12:07 (UTC)).

(4) Preliminary results

During MR03-K01 cruise, the magnetic force is measured within Japanese territorial sea, Japanese EEZ and the international waters. The results will be public after the analysis.

(5) Data archives

Magnetic force data obtained during this cruise will be submitted to the JAMSTEC DMO (Data Management Office), and archived there.

(6) Remarks

We did not sample the data within EEZ of Russian federation (from 22 February 14:46 to 23 February 09:50).