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R/V MIRAI MR06-05 Leg-1 Cruise Report

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

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1. Introduction

The Madden-Julian oscillation (MJO), that is a dominant eastward propagating intraseasonal oscillation in the Tropics, is a key issue to be solved, as it influences not only the tropical atmospheric and oceanic variations but also the global climate. Since the MJO is a phenomenon coupled with deep cumulus convections, it is manifested over the warm pool region from the eastern Indian Ocean through the western Pacific Ocean. However, past major field experiments conducted in the Indian Ocean were devoted to study the summer monsoon, and there are few data especially in the boreal fall-winter season.

On the one hand, recent studies using reanalysis and satellite data revealed various aspects of the large-scale MJO structure. However, current general circulation models still fail to simulate the “slow” eastward propagation and underestimate the strength of the intraseasonal variability. It is believed that this deficiency is mainly due to the insufficient cumulus parameterization. Therefore, it requires that fine-scale observation data is invaluable to promote our knowledge on the mechanism of the MJO.

Based on the fact mentioned above, we at JAMSTEC have planned to conduct the intensive observation using the R/V Mirai to capture the detailed features from the ocean surface to the entire troposphere in the period from late October through November when the onset of convection in the MJO is often observed. We have named this project as MISMO (Mirai Indian Ocean cruise for the Study of the MJO-convection Onset). Therefore, the main mission of this MR06-05 Leg-1 cruise was conducted as a main part of MISMO project.

During the intensive observation period in the Indian Ocean, surface meteorological measurement, atmospheric sounding by radiosonde, CTD casting, and ADCP current measurement as well as Doppler radar observation were carried out as a main mission. In addition, turbulent flux measurement, Mie-scattering LIDAR, vertical-pointing cloud radar, wind profiler, Ozone and water vapor sonde, videosonde, and other many observations were intensively conducted. Furthermore, before arriving the Indian Ocean from Japan, several continuous observations were carried out along the cruise course partly for warming-up of instruments and partly for capturing the latitudinal change of atmospheric and oceanic features.

This cruise report summarizes the observation items and preliminary results. In the first several sections, basic information such as cruise track, on board personnel list are described. Details of each observation are described in Section 5. Many useful information and figures are also attached as Appendices. Finally, we’d like to introduce the web site for MISMO project. On the web site at “http://www.jamstec.go.jp/iorgc/mismo/”, details on not only the Mirai cruise but also the relevant observations conducted as part of the MISMO project can be found.

2. Cruise Summary

2.1 Ship

Name	Research Vessel MIRAI
L x B x D	128.6m x 19.0m x 13.2m
Gross Tonnage	8,687 tons
Call Sign	JNSR
Home Port	Mutsu, Aomori Prefecture, Japan

2.2 Cruise Code

MR06-05 Leg-1

2.3 Project Name

MIRAI Indian Ocean cruise for the Study of the MJO-convection Onset (MISMO)

2.4 Undertaking Institute

Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
2-15, Natsushima, Yokosuka, Kanagawa 237-0061, JAPAN

2.5 Chief Scientist

Kunio Yoneyama
Institute of Observational Research for Global Change (IORGC) / JAMSTEC

2.6 Periods and Ports of Call

2006	Oct. 4	departed Sekinehama, Japan
	Oct. 4	called at Hachinohe, Japan
	Oct. 15-16	called at Singapore
	Nov. 27	arrived at Male, Republic of Maldives

2.7 Observation Summary

5.3-GHz Doppler radar	continuously	fm Oct. 6 to 9, and fm Oct. 19 to Nov. 26
GPS Radiosonde	276 times	fm Oct. 22 to Nov. 25
Ozone and water vapor sonde	15 times	fm Oct. 29 to Nov. 20
Videosonde	13 times	fm Oct. 26 to Nov. 25
Ceilometer	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Total Sky Imager	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Surface Meteorology	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
GPS Meteorology	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
CTD	207 times	fm Oct. 21 to Nov. 25
Compact CTD with fluorometer	205 times	fm Oct. 22 to Nov. 25
ADCP	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Sea surface water monitoring	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Wind Profiler	continuously	fm Oct. 16 to Nov. 22, except Oct. 18
Mie-scattering LIDAR	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
95-GHz cloud profiling radar	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Infrared radiometer	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18

Rain and water vapor sampling	occasionally	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
Turbulent flux	continuously	fm Oct. 4 to Nov. 26, except Oct. 11-12, 15-16, 18
pCO2	continuously	fm Oct. 16 to Nov. 22, except Oct. 18
Gravity/Magnetic force	continuously	fm Oct. 4 to Nov. 25, except Oct. 11-12, 15-16, 18
Topography	continuously	fm Oct. 4 to Nov. 25, except Oct. 11-12, 15-16, 18
Argo float	12 times	deployed during Oct. 21 - 23
m-TRITON buoy	deployed at (0, 79E) fm Oct. 25 to Nov. 24	
	deployed at (0, 82E) fm Oct. 27 to Nov. 22	
sub-surface ADCP mooring	deployed at (0, 79E) fm Oct. 25 to Nov. 24	
	deployed at (0, 82E) fm Oct. 27 to Nov. 22	
	deployed at (1.5N, 80.5E) fm Oct. 24 to Nov. 30 (Leg-2)	
	deployed at (1.5S, 80.5E) fm Oct. 26 to Dec. 1 (Leg-2)	
ATLAS buoy	maintenance at (1.5N, 80.5E)	

2.8 Overview

In order to investigate the atmospheric and oceanic conditions in the central equatorial Indian Ocean in the fall-winter season, when and where the convections in the MJO are often initiated, the intensive observations by the R/V Mirai and the buoy network around (0, 80.5E) were carried out. First, we deployed 12 Argo floats along 80.5E line from 8S to 3N. Then, we deployed four sub-surface ADCP moorings and two m-TRITON buoys in that area to construct the buoy array to monitor the ocean heat budget. Then, we conducted the observation at fixed site at (0, 80.5E) from October 28 through November 21 (24 days). Actually, as we stayed near (0, 80.5E) for deployment / recovery buoys and conducted observations, hereafter, we define the intensive observation period (IOP) from 0000 UTC on October 24 through 0000 UTC on November 26, 2006 (33 days).

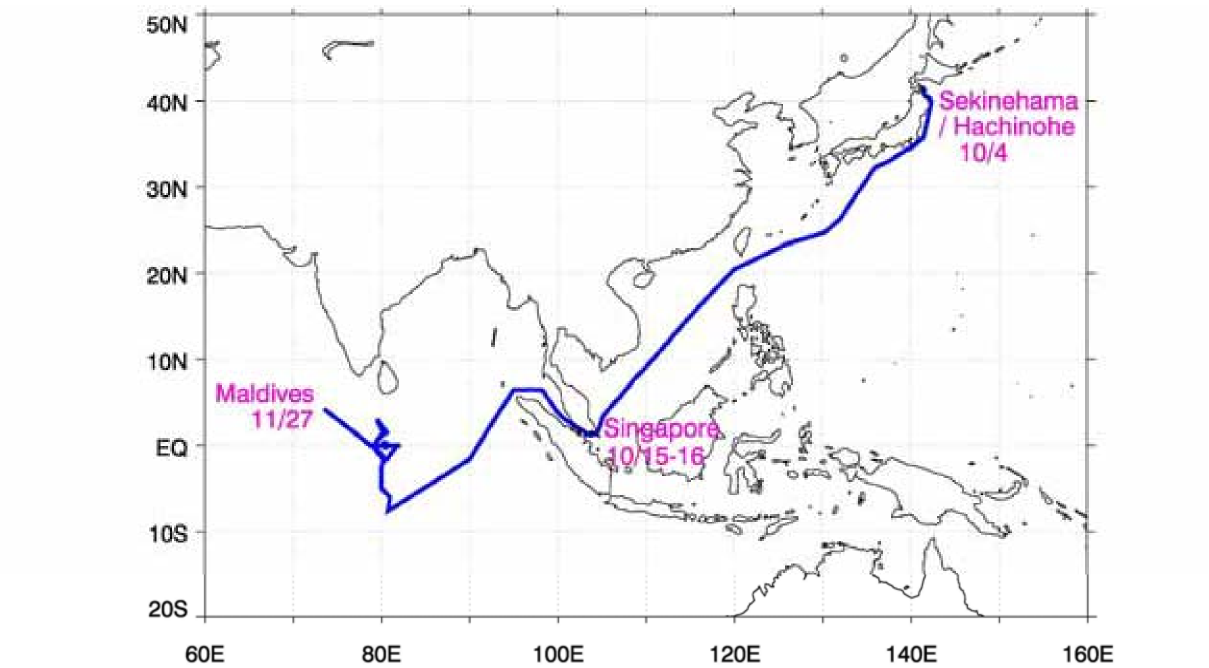
Observations were conducted under the Indian Ocean Dipole mode event (sea surface temperature in the equatorial eastern Indian Ocean was cooler than that in the western Indian Ocean). In the lower troposphere, weak easterlies prevailed through the entire IOP. During the first half of IOP, it corresponded to the convectively suppressed period and shallow convections were observed. On the other hand, deep convections were frequently observed during the second half of IOP and heavy precipitation systems passed over the Mirai. It is worth noting that while westerlies prevailed at the upper troposphere near the tropopause in the first half of IOP, it drastically changed to easterlies and then became convectively active period. Although we have to confirm the relationship with the MJO in detail using not only in-situ data obtained during this cruise but also other large-scale data sets such as satellite data, at least we might be able to meet the onset of the convectively active phase of the intraseasonal oscillation.

2.9 Acknowledgments

We would like to express our sincere thanks to Captain M. Akamine and his crew for their skillful ship operation. We appreciate their highly understanding to our scientific purpose and their tough work. Thanks are extended to the technical staff of Global Ocean Development Inc. and Marine Works Japan, Ltd. for their continuous support to conduct the observations.

3. Cruise Track and Log

3.1 Cruise Track



3.2 Cruise Log

Date (SMT/UTC)			Events	
Oct.	4	06:00 / 21:00	Departed Sekinehama (mother port of MIRAI)	
		14:00 / 05:00	Call at Hachinohe, Japan	
		18:30 / 09:30	Start surface water monitoring and other surface measurements	
	6	19:00 / 10:00	Start Doppler radar observation	
	9	22:00 / 13:00	Quit Doppler radar observation	
	11	11:00 / 02:00	Quit observations	
	12	16:00 / 07:00	Re-start observations	
	14	20:00 / 12:00	Quit observations	
	15	13:00 / 05:00	Arrived at Singapore	
	16	09:30 / 01:30	Departed Singapore	
		18:00 / 10:00	Start surface measurements	
	17	19:00 / 12:00	Quit observations	
	19	00:00 / 19:00	Re-start observations, start Doppler radar observation	
		16:30 / 11:30	(01-39S, 89-59E)	Inspection of TRITON buoy condition
	21	11:30 / 06:30	(07-40S, 80-45E)	CTD-001
		12:32 / 07:32	(07-40S, 80-45E)	Deploy Argo float
		12:34 / 07:34	(07-40S, 80-45E)	Deploy Argo float
		19:26 / 14:26	(06-00S, 81-00E)	Deploy Argo float
	22	00:58 / 19:58	(05-00S, 80-00E)	Deploy Argo float
		05:03 / 00:03	(04-00S, 80-00E)	Deploy Argo float
		07:10 / 02:10	(03-30S, 80-00E)	Deploy Argo float
		11:20 / 06:20	(02-30S, 80-00E)	Deploy Argo float

	16:28 / 11:28	(01-23S, 80-20E)	Radiosonde-001, hereafter conducted every 3-h
	18:27 / 13:27	(01-00S, 80-00E)	CTD-002
	19:34 / 14:34	(01-00S, 80-00E)	Radiosonde-002
	19:38 / 14:38	(01-00S, 79-20E)	Deploy Argo float
	22:17 / 17:17	(00-30S, 79-30E)	CTD-003
	22:39 / 17:39	(00-30S, 79-30E)	Radiosonde-003
	22:47 / 17:47	(00-30S, 79-29E)	Deploy Argo float
23	01:30 / 20:30	(00-12N, 79-28E)	Radiosonde-004
	02:42 / 21:42	(00-30N, 79-30E)	CTD-004
	03:11 / 22:11	(00-31N, 79-30E)	Deploy Argo float
	04:11 / 23:11	(00-47N, 79-40E)	Radiosonde-005
	06:49 / 01:49	(01-15N, 80-00E)	Deploy Argo float
	07:30 / 02:30	(01-16N, 80-08E)	Radiosonde-006
	10:31 / 05:31	(01-34N, 80-32E)	Radiosonde-007
	13:30 / 08:30	(02-05N, 80-09E)	Radiosonde-008
	17:43 / 12:43	(03-00N, 79-30E)	Deploy Argo float
	19:37 / 14:37	(02-38N, 79-39E)	Radiosonde-009
	22:31 / 17:31	(02-05N, 79-53E)	Radiosonde-010
24	01:30 / 20:30	(01-36N, 80-08E)	Radiosonde-011
	04:30 / 23:30	(01-30N, 80-34E)	Radiosonde-012
	07:30 / 02:30	(01-31N, 80-23E)	Radiosonde-013
	08:04 / 03:04	(01-30N, 80-24E)	Deploy sub-surface ADCP mooring
	10:30 / 05:30	(01-31N, 80-25E)	Radiosonde-014
	11:10 / 06:10	(01-30N, 80-30E)	Repair ATLAS buoy
	12:58 / 07:58	(01-35N, 80-32E)	CTD-005
	13:30 / 08:30	(01-35N, 80-32E)	Radiosonde-015
	16:31 / 11:31	(01-03N, 80-03E)	Radiosonde-016
	19:31 / 14:31	(00-31N, 79-32E)	Radiosonde-017
	22:30 / 17:30	(00-00N, 79-04E)	Radiosonde-018
25	01:31 / 20:31	(00-01N, 79-02E)	Radiosonde-019
	04:30 / 23:30	(00-03N, 79-01E)	Radiosonde-020
	07:21 / 02:21	(00-03N, 79-00E)	Radiosonde-021
	07:37 / 02:37	(00-00N, 79-02E)	Deploy m-TRITON buoy
	10:31 / 05:31	(00-01N, 79-02E)	Radiosonde-022
	11:52 / 06:12	(00-01N, 79-02E)	CTD-006
	13:29 / 08:29	(00-01N, 78-52E)	Radiosonde-023
	13:54 / 08:54	(00-00N, 78-53E)	Deploy sub-surface ADCP mooring
	16:52 / 11:52	(00-03S, 78-57E)	Radiosonde-024
	17:14 / 12:14	(00-02N, 79-00E)	CTD-007
	19:31 / 14:31	(00-13S, 79-09E)	Radiosonde-025
	22:30 / 17:30	(00-41S, 79-28E)	Radiosonde-026
26	01:30 / 20:30	(01-09S, 79-53E)	Radiosonde-027
	04:30 / 23:30	(01-29S, 80-20E)	Radiosonde-028
	07:31 / 02:31	(01-30S, 80-20E)	Radiosonde-029
	08:00 / 03:00	(01-30N, 80-21E)	Deploy sub-surface ADCP mooring
	10:30 / 05:30	(01-30S, 80-20E)	Radiosonde-030
	10:34 / 05:34	(01-30S, 80-20E)	CTD-008
	13:20 / 08:20	(01-30S, 80-31E)	Radiosonde-031
	15:13 / 10:13	(01-45S, 80-46E)	Videosonde-01
	16:30 / 11:30	(01-01S, 81-05E)	Radiosonde-032
	19:31 / 14:31	(01-01S, 81-05E)	Radiosonde-033
	22:30 / 17:30	(00-25S, 81-29E)	Radiosonde-034
27	01:30 / 20:30	(00-01N, 81-55E)	Radiosonde-035
	04:31 / 23:31	(00-00S, 81-59E)	Radiosonde-036
	07:36 / 02:36	(00-01S, 81-51E)	Radiosonde-037
	07:40 / 02:40	(00-01S, 81-55E)	Deploy m-TRITON buoy
	10:34 / 05:34	(00-01S, 81-54E)	Radiosonde-038
	12:29 / 07:29	(00-00N, 81-55E)	CTD-009
	13:29 / 08:29	(00-01S, 81-55E)	Radiosonde-039
	14:09 / 09:09	t (00-00S, 82-04E)	Deploy sub-surface ADCP mooring
	16:29 / 11:29	(00-00N, 82-03E)	Radiosonde-040
	17:15 / 17:55	(00-00N, 81-53E)	CTD-010
	19:31 / 14:31	(00-00N, 81-37E)	Radiosonde-041

	22:30 / 17:30	(00-00N, 81-14E)	Radiosonde-042
28	01:31 / 20:31	(00-00N, 80-48E)	Radiosonde-043
	04:30 / 23:30	(00-00S, 80-29E)	Radiosonde-044
		Start of the stationary intensive observation at (00-00N, 80-29E)	
	04:33 / 23:33	(00-00S, 80-30E)	CTD-011
	05:15 / 00:15	Special maneuver for air-sea surface eddy flux measurement (hereafter every 3 h)	
	07:30 / 02:30	(00-00N, 80-30E)	Radiosonde-045
	07:33 / 02:33	(00-00N, 80-30E)	CTD-012
	10:00 / 05:00	Start surface measurement (SST, CO2) using the extended boom from the bow	
	10:20 / 05:20	(00-01N, 80-30E)	Radiosonde-046
	10:25 / 05:25	(00-01N, 80-30E)	CTD-013
	13:29 / 08:29	(00-00N, 80-30E)	Radiosonde-047
	13:32 / 08:32	(00-00N, 80-30E)	CTD-014
	16:30 / 11:30	(00-00S, 80-30E)	Radiosonde-048
	16:34 / 11:34	(00-00S, 80-30E)	CTD-015
	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-049
	19:34 / 14:34	(00-00S, 80-29E)	CTD-016
	22:32 / 17:32	(00-00S, 80-29E)	Radiosonde-050
	22:37 / 17:37	(00-00S, 80-28E)	CTD-017
29	01:30 / 20:30	(00-00S, 80-28E)	Radiosonde-051
	01:36 / 20:36	(00-00S, 80-28E)	CTD-018
	04:49 / 23:49	(00-00S, 80-28E)	Radiosonde-052
	04:53 / 23:54	(00-00S, 80-28E)	CTD-019
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-053
	07:33 / 02:33	(00-00N, 80-30E)	CTD-020
	10:47 / 05:47	(00-00N, 80-29E)	Radiosonde-054
	10:54 / 05:54	(00-00N, 80-29E)	CTD-021
	13:05 / 08:05	(00-00N, 80-29E)	Ozone and water vapor sonde -01
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-055
	13:33 / 08:33	(00-00SN, 80-30E)	CTD-022
	16:31 / 11:31	(00-00SN, 80-29E)	Radiosonde-056
	16:35 / 11:35	(00-00N, 80-29E)	CTD-023
	19:31 / 14:31	(00-00S, 80-29E)	Radiosonde-057
	19:34 / 14:34	(00-00N, 80-29E)	CTD-024
	22:33 / 17:33	(00-00N, 80-29E)	CTD-025
	22:45 / 17:45	(00-00N, 80-29E)	Radiosonde-058
30	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-059
	01:33 / 20:33	(00-00S, 80-29E)	CTD-026
	04:33 / 23:33	(00-00N, 80-30E)	CTD-027
	05:01 / 00:01	(00-00S, 80-29E)	Radiosonde-060
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-061
	07:33 / 02:33	(00-00N, 80-29E)	CTD-028
	10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-062
	10:33 / 05:33	(00-00S, 80-29E)	CTD-029
	13:25 / 08:25	(00-00S, 80-29E)	Radiosonde-063
	13:29 / 08:29	(00-00S, 80-29E)	CTD-030
	14:01 / 09:01	(00-01S, 80-29E)	Ozone and water vapor sonde -02
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-064
	16:33 / 11:33	(00-00S, 80-29E)	CTD-031
	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-065
	19:34 / 14:34	(00-00S, 80-29E)	CTD-032
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-066
	22:33 / 17:33	(00-00S, 80-28E)	CTD-033
31	01:17 / 20:17	(00-00N, 80-29E)	Radiosonde-067
	01:29 / 20:29	(00-00S, 80-28E)	CTD-034
	04:32 / 23:32	(00-00N, 80-29E)	Radiosonde-068
	04:35 / 23:35	(00-00N, 80-29E)	CTD-035
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-069
	07:33 / 02:33	(00-00S, 80-29E)	CTD-036
	10:31 / 05:31	(00-00S, 80-29E)	Radiosonde-070
	10:33 / 05:33	(00-00S, 80-29E)	CTD-037
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-071
	13:33 / 08:33	(00-01S, 80-29E)	CTD-038

		16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-072
		16:32 / 11:32	(00-00S, 80-29E)	CTD-039
		19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-073
		19:33 / 14:33	(00-00N, 80-29E)	CTD-040
		22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-074
		22:35 / 17:35	(00-00S, 80-29E)	CTD-041
Nov.	1	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-075
		01:33 / 20:33	(00-00S, 80-29E)	CTD-042
		04:31 / 23:31	(00-00S, 80-29E)	Radiosonde-076
		04:32 / 23:32	(00-00S, 80-29E)	CTD-043
		07:31 / 02:31	(00-00S, 80-29E)	Radiosonde-077
		07:33 / 02:33	(00-00S, 80-29E)	CTD-044
		10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-078
		10:33 / 05:33	(00-00S, 80-29E)	CTD-045
		11:10 / 06:10	(00-00S, 80-29E)	Ozone and water vapor sonde -03
		13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-079
		13:32 / 08:32	(00-00S, 80-29E)	CTD-046
		16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-080
		16:32 / 11:32	(00-00N, 80-29E)	CTD-047
		19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-081
		19:34 / 14:34	(00-00S, 80-29E)	CTD-048
		22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-082
		22:34 / 17:34	(00-00S, 80-29E)	CTD-049
	2	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-083
		01:34 / 20:34	(00-00S, 80-29E)	CTD-050
		04:36 / 23:36	(00-00N, 80-29E)	Radiosonde-084
		04:37 / 23:37	(00-00N, 80-29E)	CTD-051
		07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-085
		07:33 / 02:33	(00-00S, 80-29E)	CTD-052
		10:31 / 05:31	(00-00S, 80-29E)	Radiosonde-086
		10:33 / 05:33	(00-00S, 80-29E)	CTD-053
		11:10 / 06:10	(00-00S, 80-29E)	Ozone and water vapor sonde -04
		13:30 / 08:30	(00-00N, 80-29E)	Radiosonde-087
		13:32 / 08:32	(00-00N, 80-29E)	CTD-054
		16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-088
		16:34 / 11:34	(00-00S, 80-29E)	CTD-055
		19:31 / 14:31	(00-00S, 80-29E)	Radiosonde-089
		19:33 / 14:33	(00-00S, 80-29E)	CTD-056
		22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-090
		22:33 / 17:33	(00-00S, 80-29E)	CTD-057
	3	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-091
		01:33 / 20:33	(00-00N, 80-29E)	CTD-058
		04:31 / 23:30	(00-00N, 80-29E)	Radiosonde-092
		04:47 / 23:47	(00-00N, 80-29E)	CTD-059
		07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-093
		07:35 / 02:35	(00-00N, 80-29E)	CTD-060
		10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-094
		10:36 / 05:36	(00-00S, 80-29E)	CTD-061
		11:13 / 06:13	(00-00N, 80-29E)	Ozone and water vapor sonde -05
		13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-095
		13:34 / 08:34	(00-00S, 80-29E)	CTD-062
		16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-096
		16:35 / 11:35	(00-00N, 80-29E)	CTD-063
		19:31 / 14:31	(00-00N, 80-29E)	Radiosonde-097
		19:36 / 14:36	(00-00N, 80-29E)	CTD-064
		22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-098
		22:33 / 17:33	(00-00N, 80-29E)	CTD-065
	4	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-099
		01:33 / 20:33	(00-00N, 80-29E)	CTD-066
		04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-100
		04:33 / 23:33	(00-00N, 80-29E)	CTD-067
		07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-101
		07:34 / 20:34	(00-00S, 80-29E)	CTD-068

	10:34 / 05:34	(00-00N, 80-29E)	CTD-069
	11:02 / 06:02	(00-00N, 80-29E)	Radiosonde-102
	11:15 / 06:15	(00-00N, 80-29E)	Ozone and water vapor sonde -06
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-103
	13:34 / 08:34	(00-00S, 80-29E)	CTD-070
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-104
	16:33 / 11:33	(00-00S, 80-29E)	CTD-071
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-105
	19:36 / 14:36	(00-00N, 80-29E)	CTD-072
	22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-106
	22:33 / 17:33	(00-00N, 80-29E)	CTD-073
5	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-107
	01:33 / 20:33	(00-00N, 80-29E)	CTD-074
	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-108
	04:33 / 23:33	(00-00N, 80-29E)	CTD-075
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-109
	07:34 / 02:34	(00-00S, 80-29E)	CTD-076
	10:30 / 05:30	(00-00N, 80-29E)	Radiosonde-110
	10:34 / 05:34	(00-00N, 80-29E)	CTD-077
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-111
	13:33 / 08:33	(00-00S, 80-29E)	CTD-078
	16:31 / 11:31	(00-00S, 80-29E)	Radiosonde-112
	16:34 / 11:34	(00-00N, 80-29E)	CTD-079
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-113
	19:33 / 14:33	(00-00N, 80-29E)	CTD-080
	22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-114
	22:32 / 17:32	(00-00N, 80-29E)	CTD-081
6	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-115
	01:34 / 20:34	(00-00N, 80-29E)	CTD-082
	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-116
	04:33 / 23:33	(00-00N, 80-29E)	CTD-083
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-117
	07:33 / 02:33	(00-00N, 80-29E)	CTD-084
	10:31 / 05:31	(00-00N, 80-29E)	Radiosonde-118
	10:35 / 05:35	(00-00N, 80-29E)	CTD-085
	13:25 / 08:25	(00-00N, 80-29E)	Radiosonde-119
	13:29 / 08:29	(00-00N, 80-29E)	CTD-086
	16:20 / 11:20	(00-00N, 80-29E)	Radiosonde-120
	16:26 / 11:26	(00-00N, 80-29E)	CTD-087
	18:08 / 13:08	(00-03S, 80-32E)	Videosonde-03
	19:20 / 14:30	(00-00N, 80-29E)	Radiosonde-121
	19:23 / 14:23	(00-00N, 80-29E)	CTD-088
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-122
	22:33 / 17:33	(00-00N, 80-29E)	CTD-089
7	01:31 / 20:31	(00-00N, 80-29E)	Radiosonde-123
	01:34 / 20:34	(00-00N, 80-29E)	CTD-090
	04:31 / 23:31	(00-00S, 80-29E)	Radiosonde-124
	04:33 / 23:33	(00-00N, 80-29E)	CTD-091
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-125
	07:34 / 02:34	(00-00N, 80-29E)	CTD-092
	10:30 / 05:30	(00-00N, 80-29E)	Radiosonde-126
	10:35 / 05:35	(00-00N, 80-29E)	CTD-093
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-127
	13:35 / 08:35	(00-00N, 80-29E)	CTD-094
	13:58 / 08:58	(00-00N, 80-29E)	Ozone and water vapor sonde -07
	16:25 / 11:25	(00-00N, 80-29E)	Radiosonde-128
	16:30 / 11:30	(00-00N, 80-29E)	CTD-095
	19:31 / 14:31	(00-00N, 80-29E)	Radiosonde-129
	19:34 / 14:34	(00-00N, 80-29E)	CTD-096
	22:29 / 17:29	(00-00N, 80-29E)	Radiosonde-130
	22:31 / 17:31	(00-00N, 80-29E)	CTD-097
8	01:35 / 20:35	(00-00N, 80-29E)	CTD-098
	01:53 / 20:53	(00-00N, 80-29E)	Radiosonde-131

	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-132
	04:32 / 23:32	(00-00N, 80-29E)	CTD-099
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-133
	07:33 / 02:33	(00-00N, 80-29E)	CTD-100
	10:30 / 05:30	(00-00N, 80-29E)	Radiosonde-134
	10:33 / 05:33	(00-00N, 80-29E)	CTD-101
	13:30 / 08:30	(00-00N, 80-29E)	Radiosonde-135
	13:32 / 08:32	(00-00N, 80-29E)	CTD-102
	13:58 / 08:58	(00-00N, 80-29E)	Ozone and water vapor sonde -08
	16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-136
	16:33 / 11:33	(00-00N, 80-29E)	CTD-103
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-137
	19:33 / 14:33	(00-00N, 80-29E)	CTD-104
	22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-138
	22:34 / 17:34	(00-00N, 80-29E)	CTD-105
9	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-139
	01:33 / 20:33	(00-00N, 80-29E)	CTD-106
	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-140
	04:32 / 23:32	(00-00N, 80-29E)	CTD-107
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-141
	07:33 / 02:33	(00-00N, 80-29E)	CTD-108
	10:30 / 05:30	(00-00N, 80-29E)	Radiosonde-142
	10:34 / 05:34	(00-00N, 80-29E)	CTD-109
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-143
	13:34 / 08:34	(00-00N, 80-29E)	CTD-110
	13:58 / 08:58	(00-00S, 80-29E)	Ozone and water vapor sonde -09
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-144
	16:32 / 11:32	(00-00S, 80-29E)	CTD-111
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-145
	19:31 / 14:31	(00-00N, 80-29E)	CTD0-112
	22:26 / 17:26	(00-00N, 80-29E)	Radiosonde-146
	22:28 / 17:28	(00-00N, 80-29E)	CTD-113
10	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-147
	01:32 / 20:32	(00-00N, 80-29E)	CTD-114
	04:21 / 23:21	(00-00N, 80-29E)	Radiosonde-148
	04:23 / 23:23	(00-00N, 80-29E)	CTD-115
	05:23 / 00:23	(00-00N, 89-32E)	Videosonde-04
	07:20 / 02:20	(00-00S, 80-29E)	Radiosonde-149
	07:23 / 02:23	(00-00N, 80-29E)	CTD-116
	10:31 / 05:31	(00-00N, 80-29E)	Radiosonde-150
	10:34 / 05:34	(00-00N, 80-29E)	CTD-117
	13:31 / 08:31	(00-00N, 80-29E)	Radiosonde-151
	13:34 / 08:34	(00-00N, 80-29E)	CTD-118
	16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-152
	16:33 / 11:33	(00-00N, 80-29E)	CTD-119
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-153
	19:34 / 14:34	(00-00N, 80-29E)	CTD-120
	22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-154
	22:33 / 17:33	(00-00N, 80-29E)	CTD-121
11	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-155
	01:33 / 20:33	(00-00S, 80-29E)	CTD-122
	04:21 / 23:21	(00-00N, 80-29E)	Radiosonde-156
	04:24 / 23:24	(00-00N, 80-29E)	CTD-123
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-157
	07:32 / 02:32	(00-00N, 80-29E)	CO2 profile observation at portside
	10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-158
	10:34 / 05:34	(00-00N, 80-29E)	CTD-124
	11:11 / 06:11	(00-00N, 80-29E)	Ozone and water vapor sonde-10
	13:19 / 08:19	(00-00N, 80-29E)	Radiosonde-159
	13:29 / 08:29	(00-00N, 80-29E)	CTD-125
	14:42 / 09:42	(00-02N, 80-33E)	Videosonde-05
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-160
	16:30 / 11:30	(00-00N, 80-29E)	CTD-126

	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-161
	19:33 / 14:33	(00-00S, 80-29E)	CO2 profile observation at portside
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-162
	22:33 / 17:33	(00-00N, 80-29E)	CTD-127
12	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-163
	04:30 / 23:30	(00-00N, 80-29E)	Radiosonde-164
	04:33 / 23:33	(00-00N, 80-29E)	CTD-128
	07:33 / 02:33	(00-00N, 80-29E)	CO2 profile observation at portside
	07:48 / 02:48	(00-00N, 80-29E)	Radiosonde-165
	10:32 / 05:32	(00-00N, 80-29E)	CTD-129
	10:46 / 05:46	(00-00N, 80-29E)	Radiosonde-166
	11:12 / 06:12	(00-01N, 80-29E)	Ozone and water vapor sonde -11
	13:29 / 08:29	(00-00N, 80-29E)	Radiosonde-167
	13:36 / 08:36	(00-00N, 80-29E)	CTD-130
	16:31 / 11:31	(00-00N, 80-29E)	Radiosonde-168
	16:33 / 11:33	(00-00N, 80-29E)	CTD-131
	18:06 / 13:06	(00-04S, 80-28E)	Videosonde-06
	19:30 / 14:30	(00-04S, 80-30E)	Radiosonde-169
	19:34 / 14:34	(00-04S, 80-30E)	CO2 profile observation at portside
	21:06 / 16:06	(00-02S, 80-29E)	Videosonde-007
	22:31 / 17:31	(00-00S, 80-29E)	Radiosonde-170
	22:35 / 17:35	(00-00S, 80-29E)	CTD-132
13	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-171
	04:32 / 23:32	(00-00N, 80-29E)	Radiosonde-172
	04:34 : 23:34	(00-00N, 80-29E)	CTD-133
	07:31 / 02:31	(00-00N, 80-29E)	Radiosonde-173
	07:34 / 02:34	(00-00N, 80-29E)	CO2 profile observation at portside
	10:33 / 05:33	(00-00N, 80-28E)	CTD-134
	10:47 / 05:47	(00-00N, 80-28E)	Radiosonde-174
	11:08 / 06:08	(00-00N, 80-28E)	Ozone and water vapor sonde -12
	13:30 / 08:30	(00-00N, 80-29E)	CTD-135
	13:41 / 08:30	(00-00N, 80-29E)	Radiosonde-175
	16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-176
	16:32 / 11:32	(00-00N, 80-29E)	CTD-136
	19:31 / 14:31	(00-00N, 80-29E)	Radiosonde-177
	19:34 / 14:34	(00-00N, 80-29E)	CO2 profile observation at portside
	22:31 / 17:31	(00-00N, 80-29E)	Radiosonde-178
	22:33 / 17:33	(00-00N, 80-29E)	CTD-137
14	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-179
	04:31 / 23:31	(00-00SN 80-29E)	Radiosonde-180
	04:33 / 23:33	(00-00N, 80-29E)	CTD-138
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-181
	10:31 / 05:31	(00-00S, 80-29E)	Radiosonde-182
	10:33 / 05:33	(00-00S, 80-29E)	CTD-139
	11:13 / 06:13	(00-00N, 80-29E)	Ozone and water vapor sonde-13
	13:31 / 08:31	(00-00S, 80-29E)	Radiosonde-183
	13:32 / 08:32	(00-00N, 80-29E)	CTD-140
	16:31 / 11:31	(00-00S, 80-29E)	Radiosonde-184
	16:34 / 11:34	(00-00N, 80-29E)	CTD-141
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-185
	19:33 / 14:33	(00-00N, 80-29E)	CO2 profile observation at portside
	22:31 / 17:31	(00-00S, 80-29E)	Radiosonde-186
	22:32 / 17:32	(00-00S< 80-29E)	CTD-142
15	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-187
	04:30 / 23:30	(00-00N, 80-29E)	Radiosonde-188
	04:32 / 23:32	(00-00N, 80-29E)	CTD-143
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-189
	08:57 / 03:57	(00-00N, 80-29E)	CO2 profile observation at portside
	10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-190
	10:33 / 05:33	(00-00N, 80-29E)	CTD-144
	11:10 / 06:10	(00-00N, 80-29E)	Ozone and water vapor sonde -14
	13:31 / 08:31	(00-00N, 80-29E)	Radiosonde-191
	13:33 / 08:33	(00-00N, 80-29E)	CTD-145

	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-192
	16:32 / 11:32	(00-00N, 80-29E)	CTD-146
	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-193
	19:33 / 14:33	(00-00S, 80-29E)	CO2 profile observation at portside
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-194
	22:32 / 17:32	(00-00S, 80-29E)	CTD-147
16	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-195
	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-196
	04:33 / 23:33	(00-00N, 80-29E)	CTD-148
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-197
	08:57 / 03:57	(00-00S, 80-29E)	CO2 profile observation at portside
	10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-198
	10:33 / 05:33	(00-00N, 80-29E)	CTD-149
	13:31 / 08:31	(00-00S, 80-29E)	Radiosonde-199
	13:33 / 08:33	(00-00N, 80-29E)	CTD-150
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-200
	16:33 / 11:33	(00-00S, 80-29E)	CTD-151
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-201
	19:33 / 14:33	(00-00N, 80-29E)	CO2 profile observation at portside
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-202
	22:32 / 17:32	(00-00N, 80-29E)	CTD-152
17	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-203
	04:31 / 23:31	(00-00N, 80-29E)	Radiosonde-204
	04:32 / 23:32	(00-00N, 80-29E)	CTD-153
	07:21 / 02:21	(00-00N, 80-29E)	Radiosonde-205
	08:57 / 03:57	(00-00S, 80-29E)	CO2 profile observation at portside
	10:20 / 05:20	(00-00S, 80-29E)	Radiosonde-206
	10:23 / 05:23	(00-00S, 80-29E)	CTD-154
	13:30 / 08:30	(00-00N, 80-29E)	Radiosonde-207
	13:33 / 08:33	(00-00N, 80-29E)	CTD-155
	16:30 / 11:30	(00-00S, 80-29E)	Radiosonde-208
	16:33 / 11:33	(00-00N, 80-29E)	CTD-156
	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-209
	19:33 / 14:33	(00-00S, 80-29E)	CO2 profile observation at portside
	22:31 / 17:31	(00-00S, 80-29E)	Radiosonde-210
	22:32 / 17:32	(00-00S, 80-29E)	CTD-157
18	01:31 / 20:31	(00-00S, 80-29E)	Radiosonde-211
	04:30 / 23:30	(00-00S, 80-29E)	Radiosonde-212
	04:33 / 23:33	(00-00S, 80-29E)	CTD-158
	07:30 / 02:30	(00-00S, 80-29E)	Radiosonde-213
	08:58 / 03:58	(00-00S, 80-29E)	CO2 profile observation at portside
	10:30 / 05:30	(00-00N, 80-29E)	Radiosonde-214
	10:32 / 05:32	(00-00N, 80-29E)	CTD-159
	13:20 / 08:20	(00-00N, 80-29E)	Radiosonde-215
	13:26 / 08:26	(00-00N, 80-29E)	CTD-160
	16:20 / 11:20	(00-00N, 80-29E)	Radiosonde-216
	16:22 / 11:22	(00-00N, 80-29E)	CTD-161
	19:30 / 14:30	(00-00S, 80-29E)	Radiosonde-217
	19:33 / 14:33	(00-00S, 80-29E)	CO2 profile observation at portside
	22:31 / 17:31	(00-00S, 80-29E)	Radiosonde-218
	22:32 / 17:32	(00-00S, 80-29E)	CTD-162
19	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-219
	04:31 / 23:31	(00-00S, 80-29E)	Radiosonde-220
	04:33 / 23:33	(00-00N, 80-29E)	CTD-163
	07:21 / 02:21	(00-00S, 80-29E)	Radiosonde-221
	08:23 / 03:23	(00-00N, 80-28E)	Videosonde-08
	09:02 / 04:02	(00-01N, 80-27E)	CO2 profile observation at portside
	10:27 / 05:27	(00-00S, 80-29E)	CTD-164
	11:06 / 06:06	(00-00S, 80-28E)	Radiosonde-222
	13:30 / 08:30	(00-00S, 80-29E)	Radiosonde-223
	13:33 / 08:33	(00-00S, 80-29E)	CTD-165
	16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-224
	16:35 / 11:35	(00-00N, 80-29E)	CTD-166

	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-225
	19:33 / 14:33	(00-00N, 80-29E)	CO2 profile observation at portside
	22:30 / 17:30	(00-00N, 80-29E)	Radiosonde-226
	22:31 / 17:31	(00-00N, 80-29E)	CTD-167
20	01:30 / 20:30	(00-00N, 80-29E)	Radiosonde-227
	03:01 / 22:31	(00-04S, 80-30E)	Videosonde-09
	04:20 / 23:20	(00-00S, 80-29E)	Radiosonde-228
	04:22 / 23:22	(00-00S, 80-29E)	CTD-168
	05:15 / 00:15	(00-01S, 80-29E)	Videosonde-10
	07:21 / 02:21	(00-00S, 80-29E)	Radiosonde-229
	08:56 / 03:56	(00-00S, 80-29E)	CO2 profile observation at portside
	10:21 / 05:21	(00-00S, 80-29E)	Radiosonde-230
	10:23 / 05:23	(00-00S, 80-29E)	CTD-169
	13:20 / 08:20	(00-00N, 80-29E)	Radiosonde-231
	13:23 / 08:23	(00-00S, 80-29E)	CTD-170
	16:30 / 11:30	(00-00S, 80-29E)	CTD-171
	16:41 / 11:41	(00-00S, 80-29E)	Radiosonde-232
	17:01 / 12:01	(00-00S, 80-29E)	Ozone and water vapor sonde -15
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-233
	19:33 / 14:33	(00-00N, 80-29E)	CO2 profile observation at portside
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-234
	22:32 / 17:32	(00-00S, 80-29E)	CTD-172
21	01:20 / 20:20	(00-00N, 80-29E)	Radiosonde-235
	02:47 / 21:47	(00-01S, 80-33E)	Videosonde-11
	04:30 / 23:30	(00-00S, 80-29E)	Radiosonde-236
	04:33 / 23:33	(00-00S, 80-29E)	CTD-173
	07:30 / 02:30	(00-00N, 80-29E)	Radiosonde-237
	08:57 / 03:57	(00-00S, 80-29E)	CO2 profile observation at portside
	10:30 / 05:30	(00-00S, 80-29E)	Radiosonde-238
	10:32 / 05:32	(00-00S, 80-29E)	CTD-174
	13:30 / 08:30	(00-00N, 80-29E)	Radiosonde-239
	13:31 / 08:31	(00-00S, 80-29E)	CTD-175
	14:00 / 09:00	End of surface measurement using the extended boom from the bow	
	16:30 / 11:30	(00-00N, 80-29E)	Radiosonde-240
	16:32 / 11:32	(00-00N, 80-29E)	CTD-176
	18:01 / 13:01	(00-00N, 80-29E)	CO2 profile observation at portside
	19:30 / 14:30	(00-00N, 80-29E)	Radiosonde-241
	22:30 / 17:30	(00-00S, 80-29E)	Radiosonde-242
		End of the stationary intensive observation at (00-00N, 80-29E)	
22	01:30 / 20:30	(00-00N, 81-09E)	Radiosonde-243
	04:30 / 23:30	(00-00S, 81-50E)	Radiosonde-244
	05:30 / 00:30	(00-00S, 81-53E)	CTD-177
	06:22 / 01:22	(00-00S, 81-55E)	Recover m-TRITON buoy
	07:30 / 02:30	(00-00S, 81-53E)	Radiosonde-245
	10:30 / 05:30	(00-00S, 81-52E)	Radiosonde-246
	13:20 / 08:20	(00-00S, 82-03E)	Radiosonde-247
	14:40 / 09:40	(00-00S, 82-04E)	Recover sub-surface ADCP mooring
	16:26 / 11:26	(00-00N, 82-02E)	Radiosonde-248
	16:49 / 11:49	(00-00S, 82-02E)	CTD-178
	19:30 / 14:30	(00-02S, 81-28E)	Radiosonde-249
	22:30 / 17:30	(00-01S, 80-43E)	Radiosonde-250
23	01:30 / 20:30	(00-02S, 79-58E)	Radiosonde-251
	04:30 / 23:30	(00-02S, 79-58E)	Radiosonde-252
	06:28 / 01:28	(00-01S, 79-01E)	CTD-179
	07:29 / 02:29	(00-02S, 79-01E)	Radiosonde-253
	10:30 / 05:30	(00-07S, 79-00E)	Radiosonde-254
	13:33 / 08:33	(00-03S, 79-00E)	Radiosonde-255
	16:30 / 11:30	(00-01S, 79-01E)	Radiosonde-256
	16:32 / 11:32	(00-01S, 79-01E)	CTD-180
	19:30 / 14:30	(00-03N, 79-00E)	Radiosonde-257
	22:30 / 17:30	(00-07N, 78-59E)	Radiosonde-258
24	01:30 / 20:30	(00-06N, 78-59E)	Radiosonde-259
	04:30 / 23:30	(00-01N, 79-01E)	Radiosonde-260

	05:28 / 00:28	(00-01S, 79-01E)	CTD-181
	06:21 / 01:21	(00-01S, 79-02E)	Recover m-TRITON buoy
	07:30 / 02:30	(00-01S, 79-02E)	Radiosonde-261
	10:30 / 05:30	(00-00S, 79-00E)	Radiosonde-262
	13:16 / 08:16	(00-00N, 78-53E)	Recover sub-surface ADCP mooring
	13:30 / 08:30	(00-00S, 78-52E)	Radiosonde-263
	15:22 / 10:22	(00-00N, 78-51E)	CTD-182
	16:30 / 11:30	(00-00S, 78-50E)	Radiosonde-264
	19:30 / 14:30	(00-01N, 78-50E)	Radiosonde-265
	22:30 / 17:30	(00-02N, 78-50E)	Radiosonde-266
	23:28 / 18:28	(00-00N, 78-51E)	CTD-183
25	00:28 / 19:28	(00-00N, 78-51E)	CTD-184
	01:30 / 20:30	(00-00N, 78-51E)	Radiosonde-267
	01:32 / 20:32	(00-00N, 78-51E)	CTD-185
	02:28 / 21:28	(00-00N, 78-51E)	CTD-186
	02:54 / 21:54	(00-00N, 78-52E)	Videosonde-12
	03:28 / 22:28	(00-00N, 78-51E)	CTD-187
	04:18 / 23:18	(00-00N, 78-51E)	Radiosonde-268
	04:25 / 23:25	(00-00N, 78-51E)	CTD-188
	05:27 / 00:27	(00-00N, 78-51E)	CTD-189
	06:00 / 01:00	(00-00N, 78-51E)	Videosonde-13
	06:28 / 01:28	(00-00N, 78-51E)	CTD-190
	07:30 / 02:30	(00-00N, 78-51E)	Radiosonde-269
	07:32 / 02:32	(00-00N, 78-51E)	CTD-191
	08:29 / 03:29	(00-00N, 78-51E)	CTD-192
	09:28 / 04:28	(00-00N, 78-51E)	CTD-193
	10:30 / 05:30	(00-00N, 78-51E)	Radiosonde-270
	10:31 / 05:31	(00-00N, 78-51E)	CTD-194
	11:28 / 06:28	(00-00N, 78-51E)	CTD-195
	12:28 / 07:28	(00-00N, 78-51E)	CTD-196
	13:30 / 08:30	(00-00N, 78-51E)	Radiosonde-271
	13:34 / 08:34	(00-00N, 78-51E)	CTD-197
	14:28 / 09:28	(00-00N, 78-51E)	CTD-198
	15:27 / 10:27	(00-00N, 78-51E)	CTD-199
	16:30 / 11:30	(00-00N, 78-51E)	Radiosonde-272
	16:33 / 11:33	(00-00N, 78-51E)	CTD-200
	17:28 / 12:28	(00-00N, 78-51E)	CTD-201
	18:29 / 13:29	(00-00N, 78-51E)	CTD-202
	19:30 / 14:30	(00-00N, 78-51E)	Radiosonde-273
	19:32 / 14:32	(00-00N, 78-51E)	CTD-203
	20:30 / 15:30	(00-00N, 78-51E)	CTD-204
	21:28 / 16:28	(00-00N, 78-51E)	CTD-205
	22:31 / 17:31	(00-00N, 78-51E)	Radiosonde-274
	22:32 / 17:32	(00-00N, 78-51E)	CTD-206
	23:28 / 18:28	(00-00N, 78-51E)	CTD-207
26	01:30 / 20:30	(00-00S, 80-29E)	Radiosonde-275
	04:29 / 23:29	(00-43N, 77-55E)	Radiosonde-276
	10:00 / 05:00	End of all observations	
27	09:00 / 04:00	Arrived at Male, Republic of Maldives	

4. List of Participants

4.1 On Board Scientists / Technical Staff

Name	Affiliation	Embarkation / Disembarkation
Kunio Yoneyama	JAMSTEC	Sekinehama / Maldives
Kentaro Ando	JAMSTEC	Singapore / Maldives
Kazuaki Yasunaga	JAMSTEC	Singapore / Maldives
Mikiko Fujita	JAMSTEC	Sekinehama / Singapore
Chie Yokoyama	JAMSTEC	Singapore / Maldives
Yasuhisa Ishihara	JAMSTEC	Singapore / Maldives
Takeo Matsumoto	JAMSTEC	Singapore / Maldives
Naoki Sato	JAMSTEC	Singapore / Maldives
Naoyuki Kurita	JAMSTEC	Sekinehama / (Maldives) *1
Kazuyoshi Kikuchi	IPRC / Univ. of Hawaii	Singapore / Maldives
Jeremiah M. Reynolds	RMR Co.	Sekinehama / Singapore
R. Michael Reynolds	RMR Co.	Singapore / Maldives
Chia-Yen Ku	National Central Univ.	Sekinehama / Singapore
Ichiro Matsui	NIES	Sekinehama / Singapore
Noriyuki Kawano	Univ. de Toulon et du Var	Sekinehama / Hachinohe Singapore / Maldives
Yoichi Inai	Hokkaido Univ.	Singapore / Maldives
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Naoki Mashiko	Tohoku Univ.	Singapore / Maldives
Hiroyuki Hashiguchi	Kyoto Univ.	Sekinehama / Hachinohe
Naoki Nakatani	Osaka Pref. Univ.	Singapore / Maldives
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Akiko Yoshimura	Osaka Pref. Univ.	Singapore / Maldives
Osamu Tsukamoto	Okayama Univ.	Sekinehama / Singapore
Yoshihito Suwa	Okayama Univ.	Sekinehama / Maldives
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Shunsuke Shigeto	Yamaguchi Univ.	Singapore / Maldives
Takumi Koga	Yamaguchi Univ.	Singapore / Maldives
Kazue Morinaga	Yamaguchi Univ.	Singapore / Maldives
Satoshi Okumura	GODI	Singapore / Maldives
Shinya Okumura	GODI	Singapore / Maldives
Katsuhisa Maeno	GODI	Sekinehama / Maldives
Norio Nagahama	GODI	Sekinehama / (Maldives) *1
Keisuke Wataki	MWJ	Sekinehama / Maldives
Hiroshi Matsunaga	MWJ	Sekinehama / Maldives
Tomohide Noguchi	MWJ	Sekinehama / (Maldives) *1
Keisuke Matsumoto	MWJ	Singapore / (Maldives) *2
Masanori Enoki	MWJ	Singapore / Maldives
Yoshiko Ishikawa	MWJ	Singapore / Maldives
Ayumi Takeuchi	MWJ	Singapore / Maldives
Tatsuya Tanaka	MWJ	Singapore / Maldives
Takatoshi Kiyokawa	MWJ	Singapore / Maldives
Hiroki Ushiromura	MWJ	Singapore / Maldives

* 1 --- Final disembarkation place is Singapore in December, 2006
* 2 --- Final disembarkation place is Sekinehama in January, 2007

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4.2 Ship Crew

Masaharu Akamine	Master
Yujiro Kita	Chief Officer
Daisuke Sasaki	First Officer
Tomoo Hikichi	Second Officer
Nobuo Fukaura	Third Officer
Syunichi Matsumoto *2	Jr. Third Officer
Koichi Higashi	Chief Engineer
Koji Masuno	First Engineer
Kaoru Minami	Second Engineer
Hiroyuki Tohken	Third Engineer
Kazuo Sagawa	Chief Radio Officer
Kunihiko Omote	Boatswain
Keiji Yamauchi	Able Seaman
Yukiharu Suzuki	Able Seaman
Toshiharu Honzo	Able Seaman
Masaru Suzuki *1	Able Seaman
Syozo Matsumoto *2	Able Seaman
Yosuke Kuwahara	Able Seaman
Kazuyoshi Kudo *1	Able Seaman
Tsuyoshi Sato	Able Seaman
Takeharu Aisaka	Able Seaman
Masashige Okada	Able Seaman
Shuji Komata	Able Seaman
Atsuhiro Yabugami *2	Able Seaman
Sadanori Honda	No. 1 Oiler
Toshimi Yoshikawa *1	Oiler
Yoshihiro Sugimoto *2	Oiler
Shigeaki Kinoshita	Oiler
Nobuo Boshita *1	Oiler
Kazumi Yamashita	Oiler
Toshimitsu Tanaka *2	Oiler
Daisuke Taniguchi	Oiler
Hitoshi Ota	Chief Steward
Ryoji Takesako *1	Cook
Kitoshi Sugimoto *2	Cook
Hatsuji Hiraishi *2	Cook
Tatsuya Hamabe	Cook
Tamotsu Uemura	Cook
Kozo Uemura *1	Cook
Wataru Sasaki *2	Cook

* 1 --- On board to Singapore.
* 2 --- On board from Singapore.

5. Summary of the Observations

5.1 GPS Radiosonde

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Kazuaki Yasunaga	(JAMSTEC)	
Naoki Sato	(JAMSTEC)	
Chie Yokoyama	(JAMSTEC)	
Kazuyoshi Kikuchi	(IPRC)	
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	
Taro Shinoda	(Nagoya University)	* not on board

(2) Objective

Atmospheric soundings of temperature, humidity, and wind speed/direction.

(3) Method

Atmospheric sounding by radiosonde was carried out every 3 hours from 12Z October 22, 2006 through 00Z November 26, 2006. In total, 276 soundings were carried out (Table 5.1-1). The main system consists of processor (Vaisala, DigiCORA III), GPS antenna (GA20), UHF antenna (RB21), ground check kit (GC23), balloon launcher (ASAP), and GPS radiosonde sensor (RS92-SGP).

(4) Results

Time-height cross sections of equivalent potential temperature, relative humidity, zonal and meridional wind components are shown in Fig.5.1-1, respectively. Several basic parameters are calculated from sounding data (Fig. 5.1-2). They include convective available potential energy (CAPE), convective inhibition (CIN), lifted condensation level (LCL), 1000-700 hPa layer-mean zonal and meridional wind components, and total precipitable water vapor (TPW). In Appendix-B, vertical profiles of temperature and dew point temperature on the thermodynamic chart with wind profiles are also attached.

(5) Data archive

Data were sent to the world meteorological community via Global Telecommunication System through the Japan Meteorological Agency, immediately after the each observation. Raw data is recorded as ASCII format every 2 seconds during ascent. These raw datasets will be submitted to JAMSTEC Marine-Earth Data and Information Department. Corrected and projected onto every 5hPa level datasets are also available from K.Yoneyama of JAMSTEC.

Table 5.1-1 Radiosonde launch log. Surface values and maximum height.

Time	lon.	lat.	Pres	Temp	RH	WD	Wsd	Max Height	
YYYYMMDDHH	degE	degN	hPa	degC	%	deg	m/s	hPa	m
2006102212	80.35	−1.44	1007.6	26.1	89	215	7.1	36.8	22508
2006102215	79.99	−1.00	1009.7	24.9	98	213	4.2	359.2	8407
2006102218	79.50	−0.50	1010.2	25.9	88	186	7.5	56.1	19966
2006102221	79.50	0.13	1008.2	23.9	98	146	2.1	577.3	4710
2006102300	79.65	0.75	1008.2	25.6	89	206	6.5	26.2	24642
2006102303	80.05	1.25	1010.2	26.6	82	249	4.8	26.2	24692
2006102306	80.45	1.56	1009.3	27.4	82	271	6.6	27.6	24355
2006102309	80.21	2.01	1006.6	27.1	81	264	6.6	29.4	23901
2006102315	79.66	2.66	1008.3	27.9	82	222	6.7	28.7	24094
2006102318	79.92	2.10	1008.4	27.6	84	231	6.7	27.3	24420
2006102321	80.16	1.56	1006.6	27.4	82	238	5.5	28.9	24027
2006102400	80.58	1.47	1007.3	27.1	86	238	4.5	26.6	24531
2006102403	80.40	1.51	1009.5	26.9	86	312	4.0	33.2	23187
2006102406	80.39	1.50	1009.3	27.6	82	296	2.9	28.4	24138
2006102409	80.53	1.58	1006.9	28.6	78	291	3.8	26.5	24535
2006102412	80.10	1.08	1006.9	27.4	84	263	3.7	23.0	25456
2006102415	79.58	0.54	1009.6	27.4	81	253	4.8	27.3	24423
2006102418	79.15	0.00	1010.8	25.1	94	166	4.2	72.6	18432
2006102421	79.28	0.00	1007.9	25.4	91	201	5.0	31.7	23437
2006102500	79.02	0.05	1007.8	26.4	85	204	4.1	38.8	22173
2006102503	78.98	0.05	1009.7	26.9	84	183	3.6	82.6	17675
2006102506	79.03	0.03	1009.7	27.4	81	184	5.0	21.5	25918
2006102509	78.89	0.02	1007.3	27.6	81	178	4.5	22.3	25653
2006102512	78.94	0.04	1007.3	27.6	83	163	3.5	28.1	24176
2006102515	79.14	−0.15	1009.0	27.9	73	152	3.0	32.8	23249
2006102518	79.50	−0.68	1009.9	27.4	84	151	3.4	31.9	23421
2006102521	79.88	−1.11	1007.6	25.9	91	107	8.5	37.8	22351
2006102600	80.29	−1.50	1008.1	26.4	89	278	2.2	30.8	23612
2006102603	80.34	−1.49	1010.8	24.9	91	184	3.9	27.5	24369
2006102606	80.34	−1.49	1010.4	24.4	94	184	5.6	31.9	23414
2006102609	80.53	−1.50	1008.2	27.1	81	184	2.3	64.0	19148
2006102612	80.71	−1.66	1009.1	25.6	91	151	4.8	62.2	19317
2006102615	81.03	−1.07	1009.7	25.9	90	35	1.6	62.2	19317
2006102618	81.45	−0.48	1009.7	25.9	90	35	1.6	33.6	23086
2006102621	81.91	0.00	1007.9	27.1	87	187	4.6	26.8	24456
2006102700	81.99	−0.01	1007.9	27.1	87	156	5.5	27.3	24357
2006102703	81.86	−0.01	1010.0	28.1	81	149	4.9	33.1	23175
2006102706	81.90	−0.01	1009.6	27.1	81	108	5.7	27.6	24310
2006102709	81.89	−0.01	1007.3	28.1	79	132	5.5	25.1	24883
2006102712	82.06	0.00	1007.6	27.9	84	140	2.8	28.5	24083
2006102715	81.68	0.01	1009.5	27.1	84	121	5.7	34.9	22838
2006102718	81.23	0.00	1010.0	27.1	88	134	4.7	543.3	5220
2006102721	80.83	0.00	1007.6	25.9	83	142	3.4	34.4	22910
2006102800	80.50	0.00	1007.4	26.4	87	139	8.4	23.9	25152
2006102803	80.50	0.00	1009.4	27.4	84	142	5.9	28.7	24053
2006102806	80.51	0.01	1008.8	27.1	83	119	9.9	28.4	24132
2006102809	80.51	0.01	1006.2	27.1	80	110	7.9	27.7	24247
2006102812	80.49	−0.02	1006.3	27.1	86	127	3.8	35.0	22799
2006102815	80.48	−0.01	1008.4	27.9	82	115	5.0	46.3	21108
2006102818	80.49	0.00	1008.4	27.6	86	87	1.5	35.3	22780
2006102821	80.49	0.00	1006.0	27.6	84	108	6.7	164.5	13631
2006102900	80.47	−0.01	1006.4	27.9	85	105	5.0	27.2	24353
2006102903	80.47	−0.03	1008.3	28.1	81	89	4.0	31.1	23529
2006102906	80.48	0.00	1008.3	28.4	79	73	4.0	30.4	23671
2006102909	80.49	0.01	1006.0	26.9	82	89	7.4	21.7	25798
2006102912	80.49	0.01	1005.6	27.6	79	79	5.7	26.9	24406
2006102915	80.48	0.00	1008.2	27.4	78	88	5.9	35.1	22790
2006102918	80.48	0.00	1008.3	27.1	85	63	6.2	42.0	21697
2006102921	80.48	−0.01	1006.5	27.4	85	71	5.5	26.6	24489
2006103000	80.48	0.00	1007.3	27.6	82	77	3.3	39.7	22016
2006103003	80.49	0.00	1009.2	27.6	80	66	3.0	25.4	24824
2006103006	80.49	0.00	1008.7	28.1	81	96	4.6	23.5	25320
2006103009	80.48	0.00	1006.4	27.9	82	93	2.5	24.8	24967
2006103012	80.50	−0.02	1007.2	25.6	95	124	4.4	64.2	19103
2006103015	80.49	0.00	1009.2	26.9	88	158	2.9	33.7	23061
2006103018	80.47	−0.01	1009.9	26.9	88	165	6.9	31.6	23463
2006103021	80.48	−0.01	1008.2	26.9	88	165	5.2	69.2	18664
2006103100	80.47	−0.02	1008.2	26.9	83	167	4.6	585.7	4589
2006103103	80.48	−0.01	1009.3	25.4	92	118	5.4	45.6	21218
2006103106	80.48	−0.01	1008.9	27.4	78	89	3.2	25.7	24797
2006103109	80.49	−0.01	1006.6	27.9	80	130	0.1	20.5	26171

2006103112	80.49	−0.02	1006.5	27.6	80	203	1.5	89.8	17196
2006103115	80.49	−0.01	1008.9	27.9	78	223	0.5	32.5	23309
2006103118	80.48	0.00	1009.6	27.6	81	214	2.0	24.7	25026
2006103121	80.48	−0.01	1007.2	27.4	84	231	3.3	25.7	24744
2006110100	80.47	−0.02	1007.2	27.4	81	236	2.6	78.6	17936
2006110103	80.46	−0.01	1008.9	28.1	78	224	0.8	26.1	24683
2006110106	80.49	0.03	1008.0	28.1	75	26	2.0	24.1	25154
2006110109	80.51	0.04	1005.5	27.9	82	64	2.4	26.5	24528
2006110112	80.49	0.02	1005.5	27.1	84	44	3.6	38.2	22276
2006110115	80.48	0.01	1007.8	27.6	78	45	1.1	31.3	23548
2006110118	80.48	0.01	1008.2	27.4	79	68	2.6	29.4	23917
2006110121	80.49	0.01	1005.9	27.4	80	16	1.8	37.6	22362
2006110200	80.50	0.02	1005.7	27.1	81	224	0.2	26.9	24421
2006110203	80.49	0.02	1007.7	27.9	79	190	0.4	29.2	23940
2006110206	80.49	0.03	1007.3	28.1	75	28	1.5	24.0	25178
2006110209	80.50	0.03	1005.0	28.6	72	46	1.4	26.9	24452
2006110212	80.49	0.02	1004.9	28.4	75	47	2.6	27.7	24274
2006110215	80.49	−0.01	1007.2	28.1	78	52	2.5	26.9	24481
2006110218	80.50	0.00	1007.7	28.1	78	65	1.4	32.8	23238
2006110221	80.49	0.01	1005.3	27.9	81	109	2.1	42.4	21615
2006110300	80.50	0.00	1005.5	27.9	79	134	4.3	23.3	25340
2006110303	80.49	−0.03	1008.0	28.6	80	129	3.8	26.1	24646
2006110306	80.50	−0.03	1007.6	28.6	81	148	3.5	23.6	25297
2006110309	80.49	−0.01	1005.3	28.1	83	122	2.0	23.4	25329
2006110312	80.50	−0.02	1005.5	28.6	80	119	2.6	31.8	23405
2006110315	80.49	0.00	1007.9	28.4	79	116	5.5	35.6	22739
2006110318	80.49	0.00	1008.3	28.1	79	117	5.0	26.1	24664
2006110321	80.49	0.00	1006.5	28.1	80	129	6.1	40.7	21876
2006110400	80.49	−0.01	1006.6	27.9	76	134	4.5	32.3	23305
2006110403	80.49	−0.02	1009.5	28.1	78	118	3.6	28.0	24221
2006110406	80.48	0.00	1008.7	28.4	74	141	3.9	31.4	23496
2006110409	80.49	−0.02	1006.5	28.6	74	135	3.4	32.5	23250
2006110412	80.49	−0.01	1006.3	28.6	74	119	4.0	24.7	24988
2006110415	80.48	0.00	1008.3	28.4	75	100	5.7	38.8	22215
2006110418	80.49	0.00	1009.5	25.9	87	89	8.5	39.8	22046
2006110421	80.48	0.01	1007.6	27.4	78	102	2.4	40.8	21865
2006110500	80.50	0.00	1007.8	27.4	83	101	2.2	31.6	23408
2006110503	80.49	0.00	1009.9	27.6	83	133	3.4	29.3	23915
2006110506	80.49	−0.02	1009.0	27.6	84	122	3.2	29.7	23842
2006110509	80.50	0.00	1006.4	28.1	81	101	4.7	34.7	22839
2006110512	80.49	0.00	1006.5	28.1	78	79	4.9	32.2	23297
2006110515	80.49	0.00	1006.5	28.1	78	79	4.9	32.0	23366
2006110518	80.50	0.00	1009.2	27.9	81	82	1.7	40.6	21912
2006110521	80.48	0.00	1007.3	27.6	83	100	0.2	44.6	21319
2006110600	80.49	−0.01	1008.1	25.4	95	58	3.3	32.7	23218
2006110603	80.49	−0.01	1010.0	27.1	85	64	1.0	23.2	25415
2006110606	80.51	−0.01	1009.7	26.9	89	210	0.6	70.7	18568
2006110609	80.46	−0.01	1007.0	26.1	92	224	2.4	31.9	23373
2006110612	80.46	−0.01	1006.7	27.1	87	167	3.4	53.9	20155
2006110615	80.50	−0.02	1009.2	26.6	91	116	1.8	41.8	21721
2006110618	80.49	−0.01	1009.0	26.9	89	62	1.3	44.4	21353
2006110621	80.49	0.00	1006.7	26.9	89	148	4.7	37.3	22373
2006110700	80.49	−0.02	1007.0	27.1	82	154	2.7	31.5	23419
2006110703	80.49	−0.03	1008.6	27.6	82	188	2.8	27.4	24341
2006110706	80.48	−0.03	1008.9	28.1	80	181	1.3	30.9	23590
2006110709	80.48	−0.01	1006.3	28.9	76	223	1.5	27.1	24371
2006110712	80.48	−0.01	1006.0	28.4	81	188	2.4	35.1	22762
2006110715	80.48	0.00	1008.8	27.6	85	105	4.9	37.4	22385
2006110718	80.49	−0.01	1008.7	27.9	79	67	1.6	43.9	21398
2006110721	80.48	0.00	1006.6	27.4	86	127	4.1	42.9	21518
2006110800	80.49	−0.01	1007.0	27.4	83	97	2.6	29.4	23856
2006110803	80.52	0.00	1009.5	27.9	79	260	0.2	25.6	24821
2006110806	80.46	0.00	1009.1	28.9	71	273	2.4	28.3	24189
2006110809	80.47	0.01	1007.0	28.4	77	245	0.5	31.1	23554
2006110812	80.47	0.01	1007.2	28.6	76	297	0.9	41.0	21796
2006110815	80.48	0.00	1009.4	28.1	81	186	2.4	35.5	22722
2006110818	80.48	−0.01	1010.4	28.1	80	168	1.6	48.7	20781
2006110821	80.48	−0.01	1008.2	27.6	83	330	0.1	37.6	22344
2006110900	80.48	−0.02	1008.2	26.6	87	184	1.7	29.7	23827
2006110903	80.48	−0.02	1010.0	27.9	81	134	1.1	30.9	23602
2006110906	80.50	−0.03	1010.0	28.1	82	288	0.8	39.4	22066
2006110909	80.50	−0.01	1007.8	27.1	79	204	4.8	34.2	22919
2006110912	80.47	−0.01	1008.0	27.4	84	157	3.8	44.9	21228
2006110915	80.49	0.00	1009.9	27.6	81	308	0.2	36.5	22553
2006110918	80.51	−0.01	1009.9	27.6	81	308	0.2	36.5	22553
2006110921	80.48	0.01	1008.4	26.6	89	218	4.1	49.6	20616
2006111000	80.48	−0.02	1008.5	25.1	91	75	2.8	575.5	4742

2006111003	80.48	0.00	1011.1	25.4	93	101	6.4	30.6	23704
2006111006	80.50	0.00	1011.1	25.6	88	125	1.0	32.2	23357
2006111009	80.48	0.00	1007.7	26.6	88	218	5.4	34.6	22851
2006111012	80.47	0.00	1008.4	27.1	80	202	7.8	46.6	21011
2006111015	80.47	0.00	1010.4	27.1	82	208	7.9	33.7	23051
2006111018	80.47	−0.01	1010.7	27.6	80	201	4.4	37.4	22411
2006111021	80.48	−0.01	1008.7	27.6	80	175	1.9	33.5	23066
2006111100	80.49	−0.01	1008.3	27.1	86	128	5.4	37.5	22399
2006111103	80.49	0.00	1010.0	27.4	80	155	4.7	26.7	24498
2006111106	80.48	−0.01	1010.2	27.6	85	161	4.6	26.5	24562
2006111109	80.50	−0.01	1007.6	27.1	86	136	11.1	68.6	18738
2006111112	80.50	0.00	1007.7	26.9	85	154	6.8	35.5	22661
2006111115	80.50	−0.01	1009.3	27.6	75	134	9.1	28.0	24225
2006111118	80.48	−0.01	1009.0	27.6	84	133	6.0	36.8	22502
2006111121	80.50	−0.01	1007.3	27.6	80	71	2.7	40.8	21836
2006111200	80.50	0.00	1007.1	27.1	82	75	5.7	40.8	21828
2006111203	80.48	0.00	1009.6	28.1	76	62	2.5	39.6	22047
2006111206	80.48	0.00	1009.0	28.6	76	355	1.1	51.8	20395
2006111209	80.47	0.00	1006.1	27.4	85	283	4.8	34.7	22849
2006111212	80.46	0.00	1006.4	27.1	84	308	1.8	73.5	18302
2006111215	80.50	−0.07	1009.0	25.1	92	84	2.6	91.0	17122
2006111218	80.48	0.00	1009.6	25.4	91	10	0.1	60.6	19454
2006111221	80.45	0.01	1007.4	25.9	88	298	1.4	41.5	21736
2006111300	80.48	−0.02	1006.7	26.4	86	235	1.7	33.6	23040
2006111303	80.47	0.00	1008.8	27.1	85	220	2.3	30.6	23652
2006111306	80.47	0.01	1008.5	27.4	83	278	1.6	27.8	24247
2006111309	80.48	0.00	1005.8	29.1	76	225	1.2	31.5	23423
2006111312	80.46	−0.01	1006.4	28.4	79	278	1.6	42.7	21550
2006111315	80.50	0.03	1009.5	24.6	96	352	1.9	44.6	21337
2006111318	80.47	−0.01	1008.7	25.6	87	331	1.0	39.7	22018
2006111321	80.47	0.01	1006.9	26.6	81	96	0.8	38.6	22189
2006111400	80.48	−0.01	1006.5	26.9	86	116	0.6	28.3	24102
2006111403	80.48	0.00	1008.5	27.6	82	130	0.8	30.1	23752
2006111406	80.49	−0.01	1008.0	28.1	78	115	3.3	30.5	23687
2006111409	80.49	0.00	1005.1	28.4	76	112	2.2	32.8	23175
2006111412	80.50	0.00	1005.0	28.4	77	104	1.5	34.3	22894
2006111415	80.49	0.00	1007.0	28.4	78	101	3.8	32.5	23245
2006111418	80.49	0.00	1007.6	28.4	77	109	2.9	42.4	21618
2006111421	80.52	0.00	1006.1	27.9	83	110	3.3	41.3	21770
2006111500	80.50	0.00	1006.3	27.6	80	106	3.9	39.9	21973
2006111503	80.51	−0.01	1008.5	28.1	81	92	4.6	38.1	22282
2006111506	80.48	0.00	1008.2	28.1	81	93	3.7	33.8	23022
2006111509	80.50	0.00	1005.5	28.9	76	93	3.7	34.8	22800
2006111512	80.49	0.00	1005.4	27.4	87	75	6.7	50.8	20476
2006111515	80.49	0.02	1007.3	28.1	79	98	5.4	32.2	23317
2006111518	80.49	0.00	1007.9	27.9	82	72	6.2	34.6	22872
2006111521	80.50	0.00	1005.4	27.6	82	89	4.9	43.6	21415
2006111600	80.50	0.00	1005.3	27.9	82	73	6.2	35.9	22643
2006111603	80.52	0.00	1007.7	27.6	85	107	5.2	31.7	23426
2006111606	80.48	0.00	1007.2	28.1	79	91	5.8	27.7	24246
2006111609	80.48	0.00	1004.7	28.4	80	72	3.2	34.2	22894
2006111612	80.48	0.00	1005.2	28.4	81	111	2.5	105.9	16212
2006111615	80.52	0.00	1007.9	26.1	90	356	2.4	56.7	19830
2006111618	80.48	0.00	1007.7	27.1	87	288	1.9	52.2	20352
2006111621	80.46	0.00	1005.1	25.1	85	45	2.5	55.0	20004
2006111700	80.49	−0.01	1005.4	26.6	87	98	1.2	41.9	21648
2006111703	80.49	−0.04	1007.1	27.4	86	173	3.9	32.4	23239
2006111706	80.48	0.00	1007.7	26.6	85	172	7.4	24.2	25125
2006111709	80.48	0.00	1004.6	26.6	88	161	5.8	22.0	25700
2006111712	80.48	−0.01	1004.1	27.4	84	130	7.8	43.6	21388
2006111715	80.49	0.00	1006.6	27.9	84	107	6.0	36.8	22488
2006111718	80.49	0.00	1006.2	28.4	82	91	5.9	47.3	20942
2006111721	80.50	0.00	1004.5	27.6	88	97	8.8	31.8	23363
2006111800	80.49	0.00	1004.3	28.1	83	59	6.5	40.2	21917
2006111803	80.50	0.03	1007.5	28.6	79	54	4.8	22.4	25619
2006111806	80.48	0.00	1007.3	28.6	78	69	3.8	24.2	25130
2006111809	80.49	0.02	1005.0	25.9	86	25	3.9	32.4	23251
2006111812	80.50	0.02	1004.7	25.4	92	87	3.5	72.6	18354
2006111815	80.49	0.00	1007.4	26.6	87	91	0.8	40.3	21930
2006111818	80.48	0.01	1007.5	27.1	84	313	3.0	33.1	23135
2006111821	80.46	0.02	1004.9	27.1	87	351	2.4	33.7	23012
2006111900	80.48	0.01	1005.7	27.6	80	40	2.1	31.2	23508
2006111903	80.45	0.03	1008.7	24.9	93	142	1.9	598.6	4418
2006111906	80.48	−0.01	1008.4	25.4	94	325	4.6	35.8	22656
2006111909	80.47	0.00	1005.8	26.4	88	290	8.4	22.0	25699
2006111912	80.47	0.00	1006.1	25.1	92	324	7.5	43.5	21429
2006111915	80.47	0.00	1007.8	26.9	83	287	7.1	32.9	23185

2006111918	80.48	0.00	1008.4	26.1	81	285	7.5	99.1	16592
2006111921	80.47	−0.01	1006.3	26.4	88	200	6.0	79.1	17862
2006112000	80.49	0.00	1007.7	24.6	94	199	4.1	568.4	4819
2006112003	80.49	−0.04	1010.7	24.6	91	148	4.5	18.9	26726
2006112006	80.48	0.00	1009.1	25.6	85	284	3.9	42.3	21648
2006112009	80.46	−0.01	1006.4	26.1	87	280	6.8	39.6	22009
2006112012	80.48	0.00	1006.5	26.9	84	270	5.4	46.1	21086
2006112015	80.45	−0.01	1008.7	27.4	82	247	4.8	53.5	20206
2006112018	80.48	−0.01	1009.5	27.9	80	211	5.3	48.0	20855
2006112021	80.47	−0.04	1007.9	27.6	77	176	6.2	71.3	18481
2006112100	80.48	0.00	1006.7	26.1	78	161	2.6	49.4	20654
2006112103	80.48	−0.03	1008.2	27.1	82	256	4.3	28.9	23980
2006112106	80.48	0.00	1008.3	27.9	83	254	3.2	33.6	23032
2006112109	80.47	−0.01	1005.3	28.1	80	243	4.2	27.2	24345
2006112112	80.47	−0.01	1005.3	28.1	80	209	4.1	49.2	20670
2006112115	80.47	−0.01	1008.0	28.1	79	199	3.4	43.4	21467
2006112118	80.48	0.00	1008.9	24.9	91	131	3.4	72.9	18379
2006112121	81.09	0.02	1006.5	25.9	78	83	2.2	65.6	18967
2006112200	81.81	−0.01	1005.4	26.1	82	207	1.3	43.5	21402
2006112203	81.87	−0.01	1008.7	27.1	81	160	2.9	28.5	24068
2006112206	81.87	0.00	1008.6	27.4	81	10	1.1	24.0	25174
2006112209	82.03	0.00	1006.0	28.1	81	340	4.5	28.4	24059
2006112212	82.04	0.00	1004.7	27.6	81	353	4.6	32.8	23149
2006112215	81.52	−0.01	1007.5	28.1	80	83	3.2	48.0	20846
2006112218	80.76	0.00	1008.0	27.6	82	76	1.3	68.2	18774
2006112221	80.00	−0.01	1005.6	27.6	80	27	1.5	56.2	19865
2006112300	79.28	−0.01	1005.9	27.1	84	335	2.3	36.5	22493
2006112303	79.02	−0.02	1008.0	27.1	87	359	1.1	36.3	22578
2006112306	79.00	−0.11	1007.9	29.4	74	23	4.7	27.2	24410
2006112309	79.00	−0.05	1005.8	28.6	76	357	4.5	27.9	24190
2006112312	79.01	−0.01	1005.4	28.6	78	324	4.3	27.8	24210
2006112315	79.00	0.05	1007.9	28.6	76	1	5.3	32.5	23241
2006112318	78.98	0.12	1008.2	28.4	76	20	2.5	37.1	22440
2006112321	78.98	0.10	1006.6	27.9	80	346	3.7	31.9	23352
2006112400	79.00	0.00	1006.4	27.6	82	6	1.0	34.4	22889
2006112403	79.03	−0.01	1008.7	26.1	87	141	1.9	24.2	25117
2006112406	79.01	−0.01	1009.0	27.1	85	328	3.3	80.6	17785
2006112409	78.87	0.00	1006.5	28.1	78	284	2.6	24.6	24969
2006112412	78.84	0.00	1005.7	27.4	83	239	3.6	48.6	20733
2006112415	78.84	0.01	1007.5	26.6	88	183	8.4	31.3	23490
2006112418	78.81	0.04	1008.2	27.1	86	197	8.0	41.8	21705
2006112421	78.84	0.00	1006.3	24.6	99	189	8.6	182.9	13017
2006112500	78.85	0.01	1006.2	23.6	98	283	7.4	83.3	17605
2006112503	78.85	0.01	1008.5	24.6	93	283	2.9	23.0	25435
2006112506	78.85	0.01	1008.5	26.9	85	284	5.8	26.4	24565
2006112509	78.84	0.00	1006.1	27.4	82	308	6.1	51.9	20361
2006112512	78.84	0.00	1005.0	27.6	79	296	2.4	45.2	21179
2006112515	78.84	0.00	1007.3	27.6	79	90	1.7	23.2	25388
2006112518	78.85	0.00	1008.0	27.9	81	95	2.0	32.9	23194
2006112521	78.57	0.22	1005.7	27.6	81	139	2.9	27.6	24254
2006112600	77.96	0.68	1005.0	27.4	83	140	3.5	30.4	23654

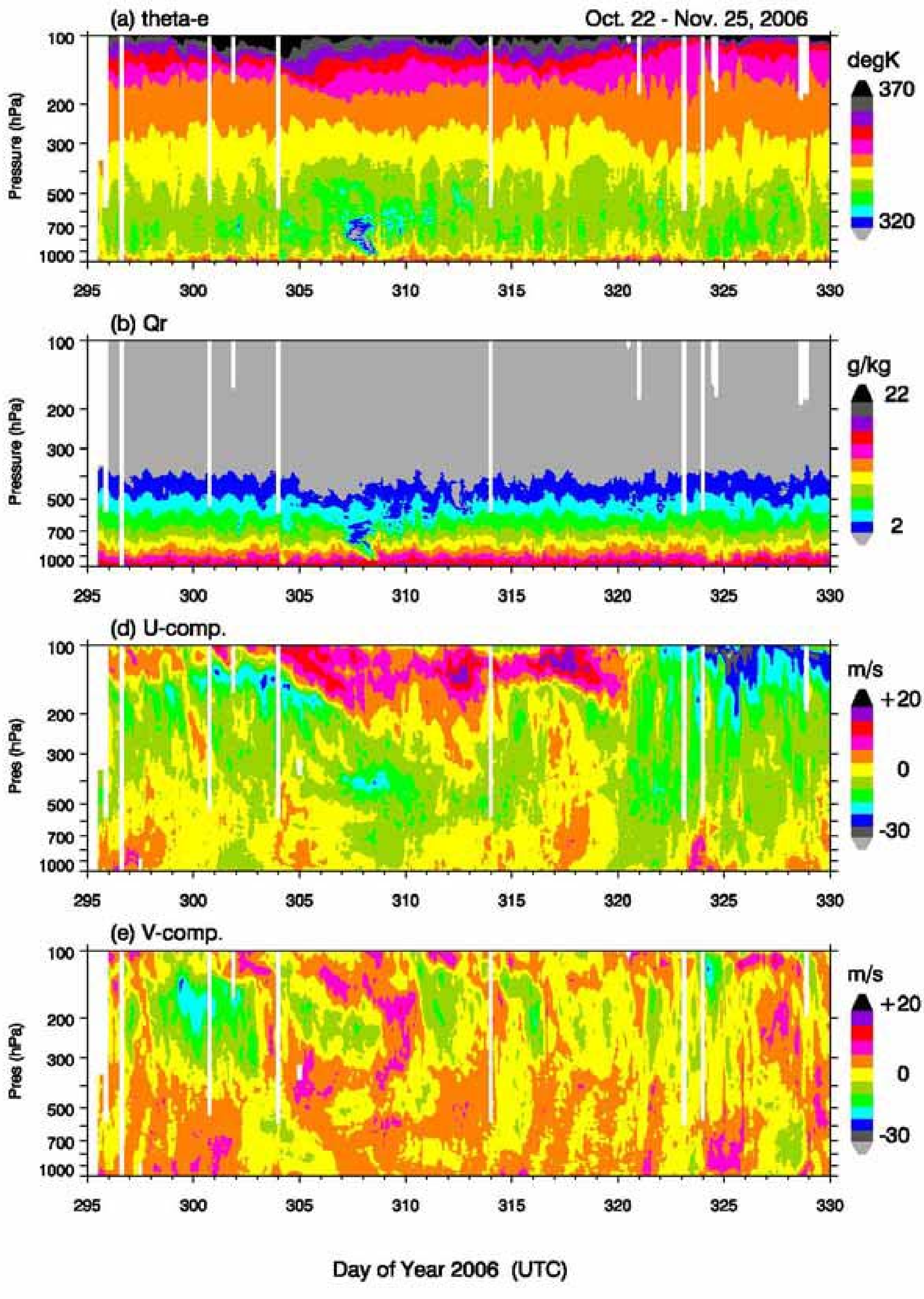


Fig. 5.1-1. Time-height cross sections of (a) equivalent potential temperature (degK), (b) relative humidity (%), (c) zonal wind component (m/s), and (d) meridional wind component (m/s). DAY295 corresponds to October 22, 2006.

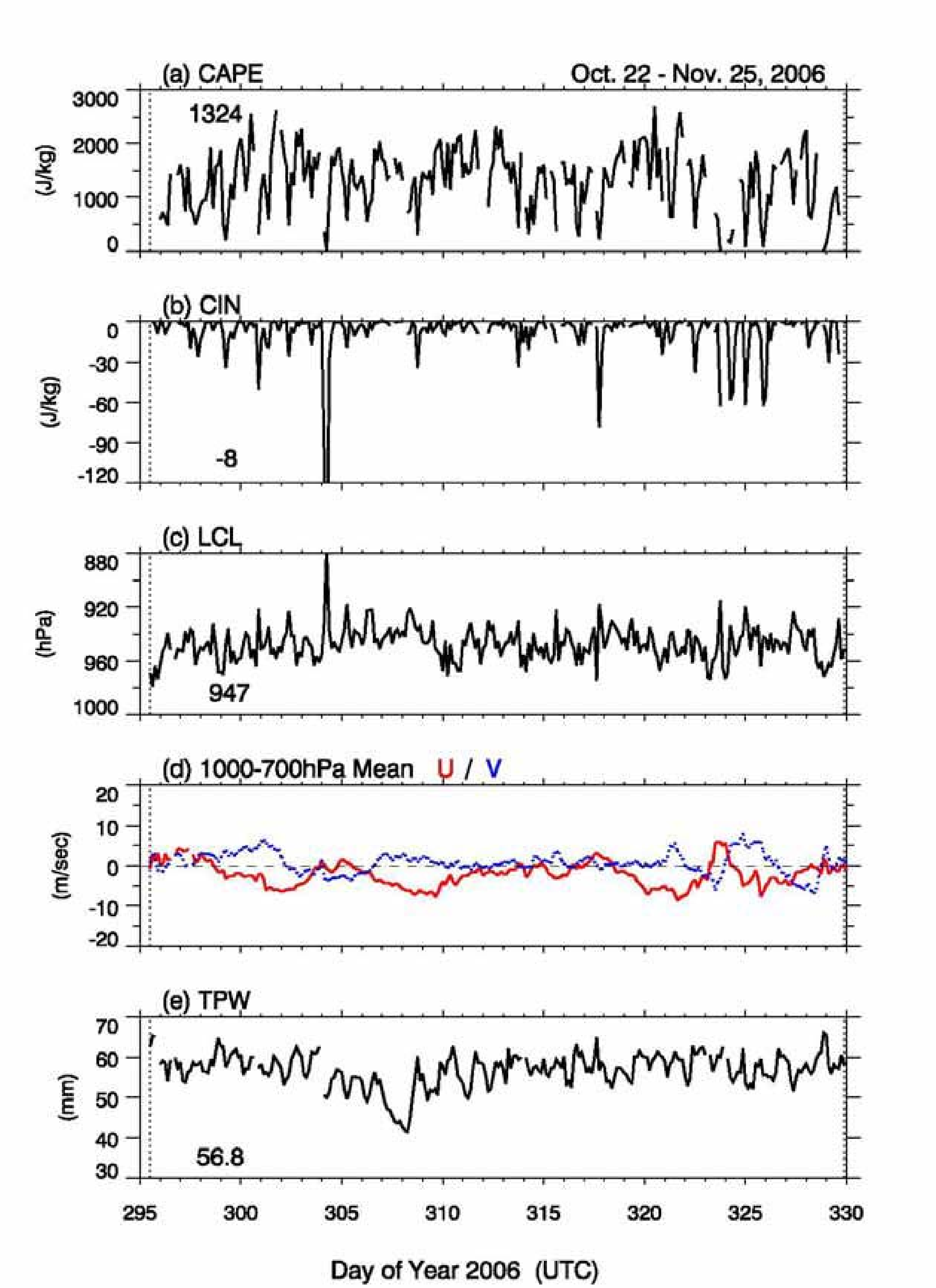


Fig. 5.1-2. Time series of (a) convective available potential energy, (b) convective inhibition, (c) lifted condensation level, and (d) 1000-700 hPa layer-mean zonal (red) and meridional (blue) wind components, and (e) total precipitable water vapor. Numbers on panel are the averages over the whole 35-day period.

5.2 Doppler Radar

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Kazuaki Yasunaga	(JAMSTEC)	
Naoki Sato	(JAMSTEC)	
Chie Yokoyama	(JAMSTEC)	
Kazuyoshi Kikuchi	(IPRC)	
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	
Taro Shinoda	(Nagoya University)	* not on board

(2) Objective

The Doppler radar is operated to obtain detailed spatial and temporal distribution of rainfall intensity and radial velocity of precipitation particles. The objective of this observation is to study the precipitation mechanism and their role in the climate system.

(3) Methods

The hardware specification of this shipboard Doppler radar (RC-52B, manufactured by Mitsubishi Electric Co. Ltd., Japan) is:

Frequency	:	5290 MHz
Beam Width	:	better than 1.5 degrees
Output Power	:	250 kW (Peak Power)
Signal Processor	:	RVP-7 (Sigmet Inc., U.S.A.)
Inertial Navigation System	:	PHINS (iXSea SAS, France)
Application Software:		IRIS/Open (Sigmet Inc., U.S.A.).

The hardware is calibrated by checking (1) frequency, (2) mean power output, (3) pulse repetition frequency (PRF) for once a day, and (4) transmitting pulse width and (5) receiver response and linearity at the beginning and the end of the intensive observation period.

The observation is performed continuously from 6 October 2006 to 9 October 2006, and from 19 October 2006 to 26 November 2006. During the observation, the “volume scan” (consists of PPIs for 18 elevations) with Doppler-mode (160-km range for reflectivity and Doppler velocity) had been obtained every 10 minutes. The “Surveillance” PPI at one elevation with Intensity-mode (300-km range for reflectivity) had been obtained every 30 minutes. In addition, RHI (Range Height Indicator) scans were operated to obtain detailed vertical cross sections with Doppler-mode. The Doppler velocity in the volume scan is unfolded automatically by dual PRF unfolding algorithm for the volume scan. The parameters for the above three tasks are listed in Table 5.2-1.

(4) Results

Examples of surveillance mode data are shown in Fig.5.2-1.

(5) Data Archive

The inventory information of the Doppler radar data will be submitted to JAMSTEC Marine-Earth Data and Information Department (MERID). The original data will be archived at and available from IORGC/JAMSTEC (contact: Kunio Yoneyama).

Table 5.2-1.　Parameters for each task.

	Surveillance PPI	Volume Scan	RHI
Pulse Width	2 [microsec]	0.5 [microsec]	
Scan Speed	18 [deg./sec.]		Automatically determined
PRF	260 [Hz]	900 / 720 [Hz] (Dual PRF)	900 [Hz]
Sweep Integration	32 samples		
Ray Spacing	1.0 [deg.]		0.2 [deg.]
Bin Spacing	250 [m]	125 [m]	
Elevations	0.5	0.5, 1.0, 1.8, 2.6, 3.4, 4.2, 5.0, 5.8, 6.7, 7.7, 8.9, 10.3, 12.3, 14.5, 17.1, 20.0, 23.3, 27.0, 31.0, 35.4, 40.0	0.0 to 65.0
Azimuths	Full Circle		Optional
Range	300 [km]	160 [km]	

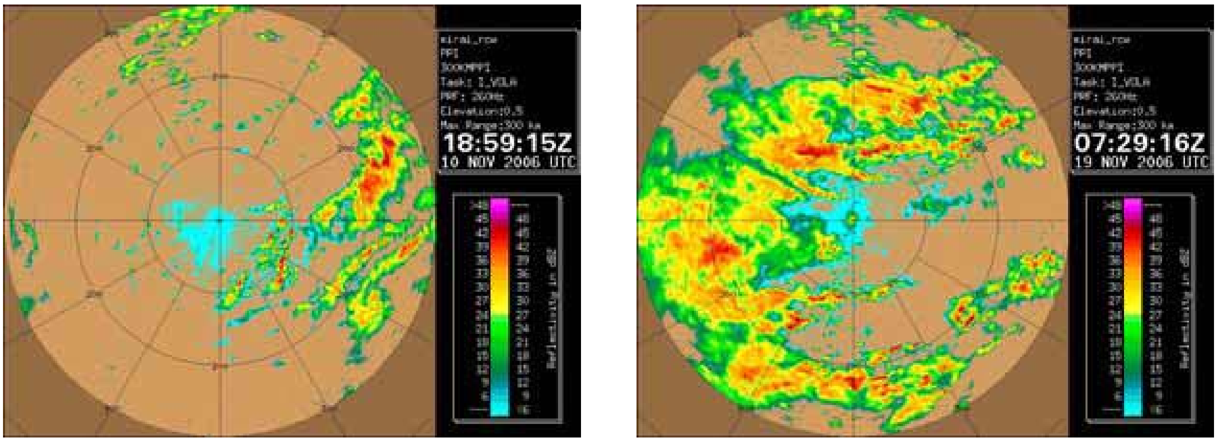


Fig. 5.2-1.Examples of the surveillance intensity mode. Left panel : 1900Z, November 10, and right panel : 0730Z, November 19.

5.3 Wind Profiler

(1) Personnel

Hiroyuki Hashiguchi	(RISH, Kyoto University)	Principle Investigator
Noriyuki Kawano	(Univ. de Toulon, FRANCE)	

(2) Objective

A wind profiler is one of atmospheric radars which can measure atmospheric motions with highly time and range resolutions. A Ship-Borne Lower Troposphere Radar (SB-LTR) was installed to observe vertical profiles of air motion and precipitation in the lower troposphere. A GPS navigational sensor and a three-axis angular sensor were deployed to detect and correct fluctuations by a ship. The objective of this observation is to develop a signal processing software of the SB-LTR, to evaluate its performance, and to investigate convective clouds and cloud clusters associated with MJO on-set over the Indian Ocean.

(3) Methods

Fig. 5.3-1 shows the overview of the SB-LTR. The hardware specification of the SB-LTR is:

Frequency:	1357.5 MHz
Antenna Size:	4 m x 4 m
Beam Width:	4 degrees
Output Power:	2 kW (Peak power)
GPS Navigation Sensor:	SC-60 (Furuno Electric Co, LTD)
Angular Sensor:	3DM (MicroStrain Inc.).

The observation is performed continuously from 28 October to 20 November, 2006 at the eastern Indian Ocean (0N, 80E). During the observation, antenna beams were steered to vertical and four oblique directions with the zenith angle of 10 degrees. One cycle for five directions takes about 2 sec. Sub-pulse length is 1.0 micro sec, which corresponds to the range resolution of 150 m. Time series data after conducting pulse-decoding and 64 coherent integrations were stored. The data such as roll, pitch, direction and speed of the ship simultaneously obtained were also stored for off-line analysis.

(4) Results

The temporal variations of height profiles of vertical and horizontal wind velocities observed with the SB-LTR from 1500 to 1800 (UTC) on 8 November, 2006 are shown in Fig. 5.3-2. There are some variations in the vertical and horizontal winds, but they are not so large. On the other hand, large downward velocities are observed from 1630 to 1730 on 7 November (Fig. 5.3-3), which corresponds to fall velocities of precipitations. In addition, strong updrafts are observed before and after the precipitation period, which may indicate that deep convections have passed over the SB-LTR. The further analyses are future work.

(5) Data Archive

All data will be archived at RISH, Kyoto University (contact: Hiroyuki Hashiguchi).

Fig. 5.3-1. Overview of the SB-LTR.

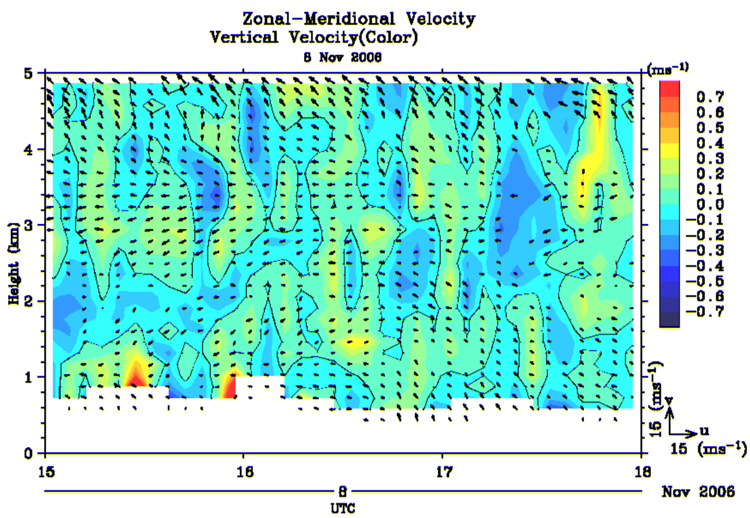


Fig. 5.3-2. Time-height cross-section of vertical (contour) and horizontal (arrow) winds observed with the SB-LTR on 8 November 2006.

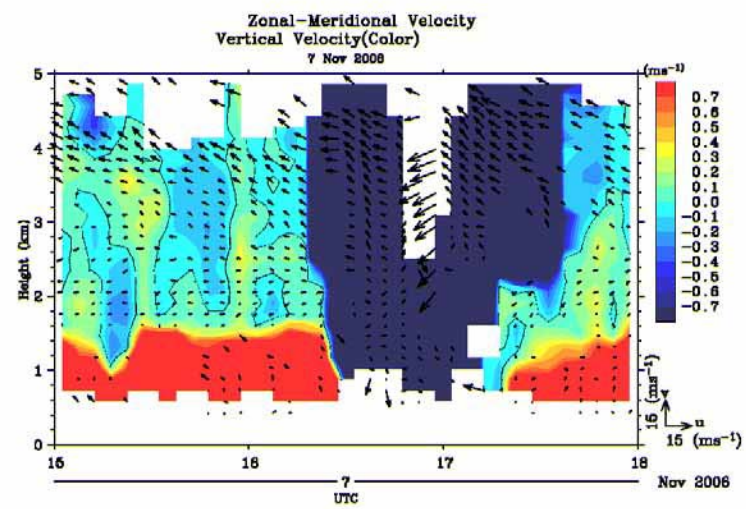


Fig. 5.3-3. Same as Fig. 5.3-2 but on 7 November 2006.

5.4 95GHz cloud profiling radar

(1) Personnel

Hajime Okamoto	(CAOS, Tohoku University)	Principal Investigator	* not on board
Naoki Mashiko	(CAOS, Tohoku University)		
Kaori Sato	(CAOS, Tohoku University)		* not on board
Toshiaki Takano	(Chiba University)		* not on board
Nobuo Sugimoto	(National Institute for Environmental Studies)		* not on board
Ichiro Matsui	(National Institute for Environmental Studies)		

(2) Objective

Main objective for the 95GHz cloud radar is to detect vertical structure of cloud and precipitation in the observed region. Combinational use of the radar and lidar is recognized to be a powerful tool to study vertical distribution of cloud microphysics, i.e., particle size and liquid/ice water content (LWC/IWC).

(3) Method

Basic output from data is cloud occurrence, radar reflectivity factor and cloud microphysics. In order to derive reliable cloud amount and cloud occurrence, we need to have radar and lidar for the same record.

Radar / lidar retrieval algorithm has been developed in Tohoku University. The algorithm is applied to water cloud in low level and also cirrus cloud in high altitude. In order to analyze the radar data, it is first necessary to calibrate the signal to convert the received power to radar reflectivity factor, which is proportional to backscattering coefficient in the frequency of interest. Then we can interpolate radar and lidar data to match the same time and vertical resolution. Finally we can apply radar/lidar algorithm to infer cloud microphysics.

(4) Results

The time height cross-section of radar reflectivity factor obtained in Nov. 17, 2006 during MR06-05 leg.1 cruise is shown in Fig. 5.4-1. Vertical extent is 20km. It is seen that there are several convective activities which often reach 15km.

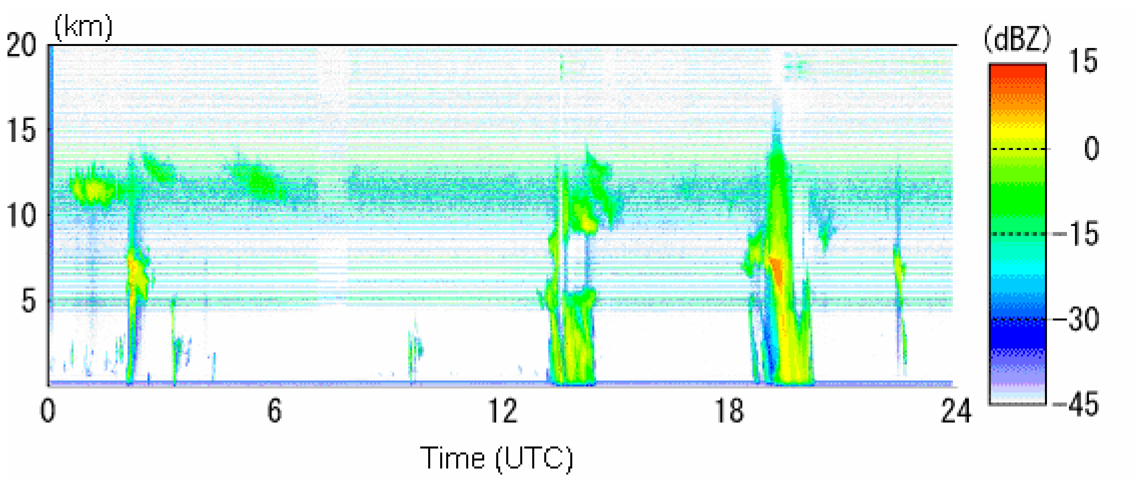


Fig. 5.4-1. Time-height cross section of radar reflectivity factor in dBZe in Nov. 17, 2006 during MR06-05 leg-1 cruise.

(5) Data archive

The data archive server is set inside Tohoku University and the original data and the results of the analyses will be available from us.

(6) Remarks

The cloud radar is successfully operated for 24 hours.

5.5 Lidar observations of clouds and aerosols

(1) Personnel

Nobuo Sugimoto	(National Institute for Environmental Studies)	Principal Investigator (not on-board)
Ichiro Matsui	(National Institute for Environmental Studies)	
Atsushi Shimizu	(National Institute for Environmental Studies)	* not on-board
Naoki Mashiko	(Tohoku University)	

(2) Objective

Objective of the observations in this cruise is to study distribution and optical characteristics of ice/water clouds and marine aerosols using a two-wavelength lidar.

(3) Method

Vertical profiles of aerosols and clouds were measured with a two-wavelength lidar. The lidar employs a Nd:YAG laser as a light source which generates the fundamental output at 1064 nm and the second harmonic at 532 nm. Transmitted laser energy is typically 30 mJ per pulse at both of 1064 and 532 nm. The pulse repetition rate is 10 Hz. The receiver telescope has a diameter of 20 cm. The receiver has three detection channels to receive the lidar signals at 1064 nm and the parallel and perpendicular polarization components at 532 nm. An analog-mode avalanche photo diode (APD) is used as a detector for 1064 nm, and photomultiplier tubes (PMTs) are used for 532 nm. The detected signals are recorded with a transient recorder and stored on a hard disk with a computer. The lidar system was installed in a container which has a glass window on the roof, and the lidar was operated continuously regardless of weather. Every 10 seconds vertical profiles of three channel are recorded. Measured parameters are as follows.

- Vertical profiles of backscattering coefficient at 532 nm
- Vertical profiles of backscattering coefficient at 1064 nm
- Depolarization ratio at 532 nm

(4) Results

Figures 5.5-1 and 2 are quick look figures showing atmospheric structures revealed by lidar observations. In the first half of leg 1 (Fig. 5.5-1), strong cloud signal in the middle troposphere (around 5 km height) and corresponding dense aerosol layer below 2 km were confirmed. The maximum height of cirrus was about 15 km. In the latter half (Fig. 5.5-2), middle clouds were seen only in last week. On the other hand, cirrus were frequently observed, and their maximum height was 16 or 17 km. Small scale cumulus, which usually appear at the top of boundary layer, were not observed frequently throughout leg 1.

(6) Data archive

- raw data
  - lidar signal at 532 nm
  - lidar signal at 1064 nm
  - depolarization ratio at 532 nm
  - temporal resolution 10 sec/ vertical resolution 6 m
  - data period : October 16, 2006 – November 25, 2006 (UTC)
- processed data
  - cloud base height, apparent cloud top height
  - phase of clouds (ice/water)
  - cloud fraction
  - boundary layer height (aerosol layer upper boundary height)
  - backscatter coefficient of aerosols
  - particle depolarization ratio of aerosols

All data will be archived at NIES.

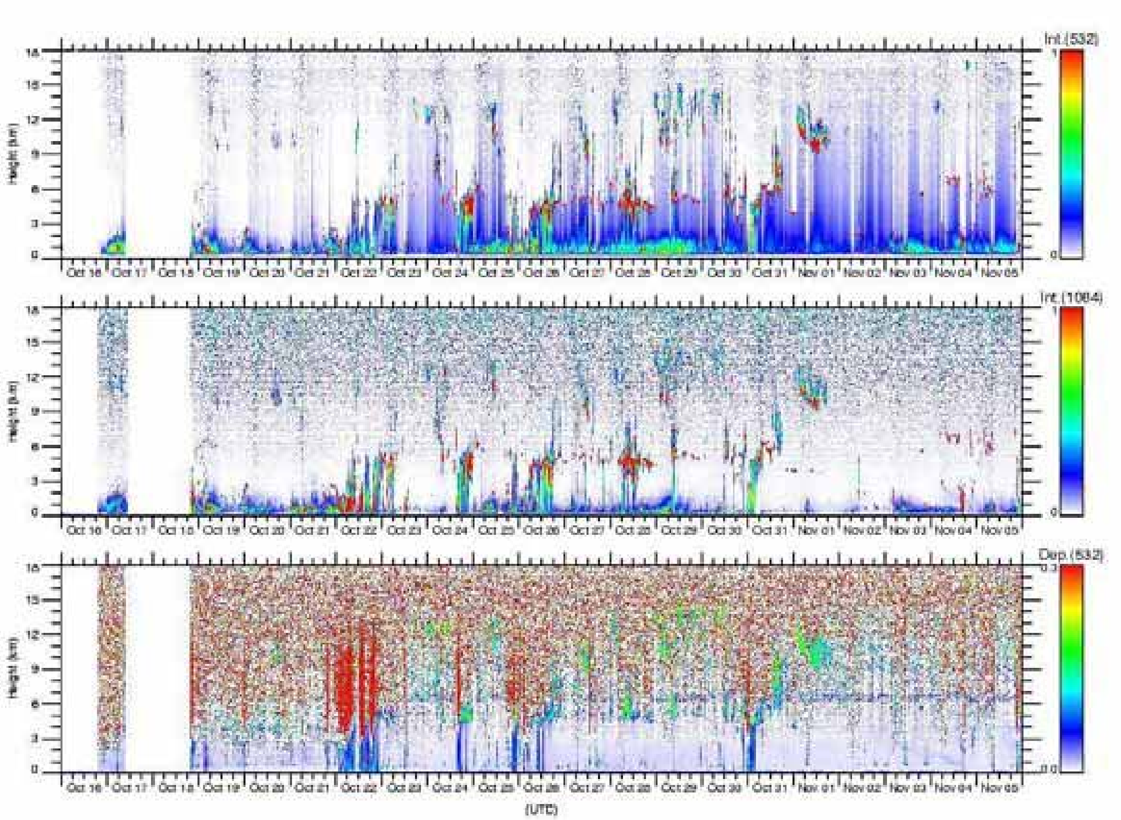


Fig. 5.5-1. Time-height indications of backscattering intensity at 532 nm (top), backscattering intensity at 1064nm (middle), and depolarization ratio at 532 nm (bottom) during the first half of leg 1(during Oct. 16 and Nov. 5).

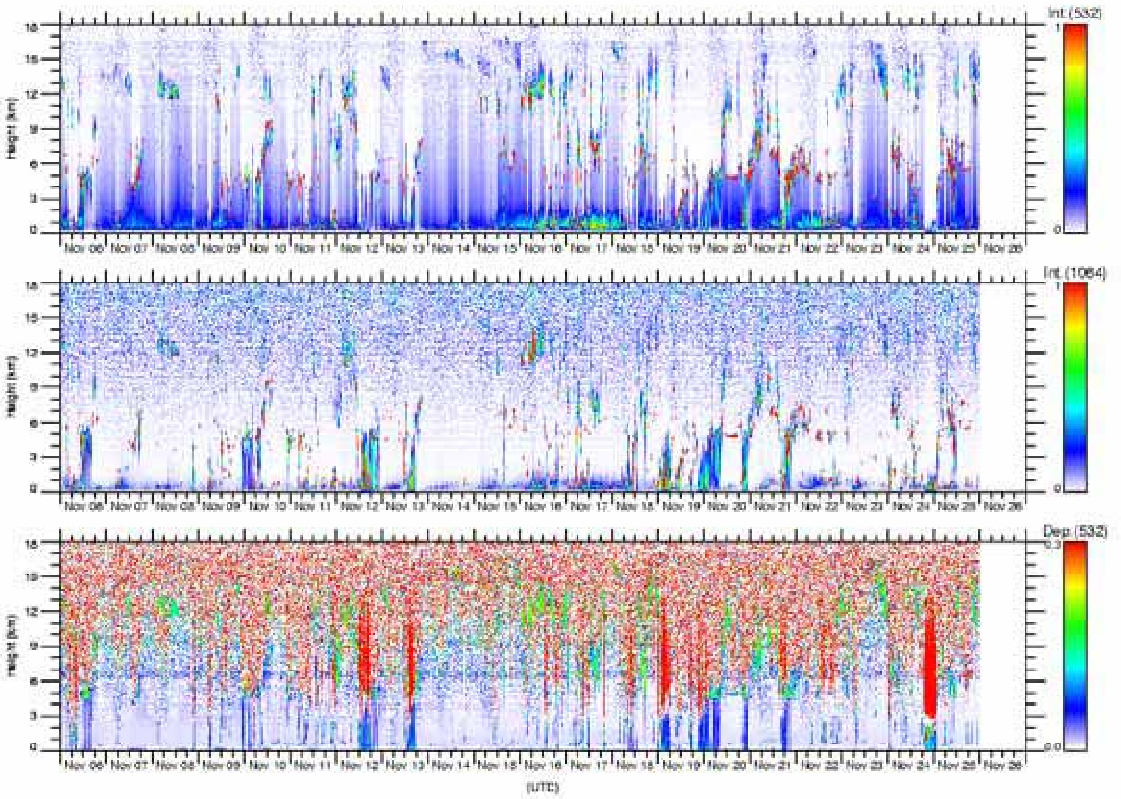


Fig. 5.5-2. Same as Figure 5.5-1, but for latter half of Leg1 (during Nov. 6 and Nov. 25).

5.6 Ceilometer

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

The information of the cloud base height is important to understand the processes on the exchange of water and energy between the atmospheric boundary layer and the layer above, and horizontal / vertical distribution of the cloud. As one of the methods to measure them, the ceilometer observation was carried out.

(3) Methods

We measured cloud base height and backscatter profile using CT-25K (VAISALA, Finland) ceilometer throughout MR06-05 Leg1 from 4 October 2006 to 26 November 2006.

Major parameters for the measurement configuration are as follows;

Laser source:	Indium Gallium Arsenide (InGaAs) Diode
Transmitting wave length:	905±5 nm at 25 deg-C
Transmitting average power:	8.9 mW
Repetition rate:	5.57kHz
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

On the archived dataset, three cloud base height and backscatter profile are recorded with the resolution of 30 m (100 ft.). If the apparent cloud base height could not be determined, vertical visibility and the height of detected highest signal are calculated instead of the cloud base height.

(4) Results

Fig. 5.6-1 shows the first, second and third lowest cloud base height which the ceilometer detected during the stationary observation.

(5) Data archive

Ceilometer data obtained during this cruise will be submitted to and archived by the Marine-Earth Data and Information Department (MEDID) of JAMSTEC.

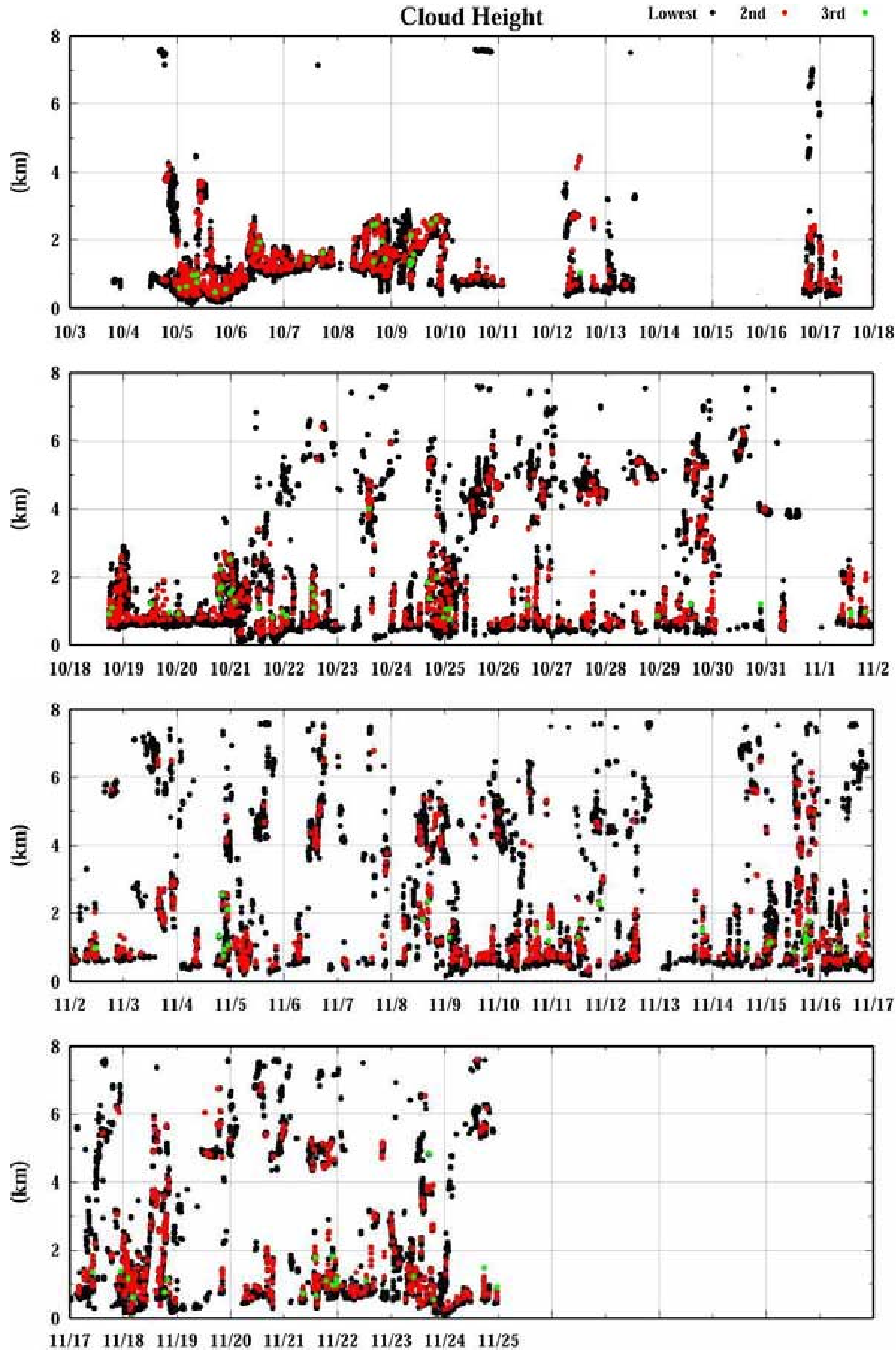


Fig. 5.6-1. First, 2nd and 3rd lowest cloud base height during the cruise.

5.7 Precipitation Videosonde

(1) Personnel

Kenji Suzuki	(Yamaguchi University)	Principal Investigator
Shunsuke Shigeto	(Yamaguchi University)	
Takumi Koga	(Yamaguchi University)	
Kazue Morinaga	(Yamaguchi University)	
Tetsuya Kawano	(Kyushu University)	* not on board

(2) Objective

Investigation of the microphysical processes in the tropical maritime cloud developed over the Indian Ocean by using videosonde

(3) Method

Precipitation videosonde is a balloon-bone radiosonde which images of precipitation particles are acquired by a CCD camera. Precipitation videosonde system consists of a CCD camera, a video amplifier, an infrared sensor, a transmitter, batteries, and a control circuit. It also has a stroboscopic illumination, which give us the information of particle size and shape >0.5mm. Images of particles are transmitted by the 1680MHz carrier wave to the receiving system equipped at the navigation deck of the R/V Mirai, and then displayed and recorded. Videosondes are launched with Vaisala radiosonde RS-92, which is described in the section 5.1.

(4) Results

Thirteen precipitation videosondes were launched into the clouds over the R/V Mirai during the observation period of MR06-05 (Table 5.7.1). Images of particles are shown in Figure 5.7.1. In the case of launching into stratiform clouds, particle images transmitted from videosondes were small raindrops (approximately 1-2mm in diameter) at lower cloud, graupel, ice crystals, and snowflakes near and above the freezing level. The different precipitation particle distributions were found in mature and dissipating stratiform clouds.

The temporal and spatial distribution of precipitation particle will be analyzed in the future.

(5) Data archive

The original data will be archived at and available from Yamaguchi University (contact: Kenji Suzuki).

Table 5.7.1. List of videosondes launched during the observation period of MR06-05.

Sonde #	Date	Time (JST)	Remarks
1	Oct. 26, 2006	1513	stratiform cloud, bright band, small ice particles, large dendrites near the cloud top, cloud top: 7km
2	Oct. 31, 2006	0309	dissipated stratiform cloud, out of cloud no particle image
3	Nov. 6, 2006	1808	stratiform cloud, weak rain, launched into the center of small weak echo, small ice particles, no aggregate
10	Nov. 10, 2006	0523	dissipated stratiform cloud, out of cloud no particle image
11	Nov. 11, 2006	0442	dissipated stratiform cloud, out of cloud no particle image without raindrops at lower cloud
4	Nov. 12, 2006	1806	stratiform cloud just after convective cloud passing, bright band, small raindrops, many ice crystals, snowflakes, cloud top: 12km
8	Nov. 12, 2006	2106	stratiform cloud, moderate rain, bright band, small raindrops, ice crystals, graupel, snowflakes, cloud top: 8km
5	Nov. 19, 2006	0823	stratiform cloud, steady rain, bright band, cloud top: 12km, no particle image because of recording trouble
7	Nov. 20, 2006	0302	stratiform cloud after dissipated convective cloud, small raindrops, many ice crystals, cloud top: 8km
12	Nov. 20, 2006	0515	stratiform cloud in the larger cloud system, many ice crystals above the freezing level, cloud top: 15km
15	Nov. 21, 2006	0251	dissipating stratiform cloud, weak rain, small ice crystals, no snowflake, cloud top: 8km
9	Nov. 25, 2006	0254	convective cloud, strong rain and wind, no images below the freezing level due to TX trouble, many ice particles above 9km, many particles during descending
C1	Nov. 25, 2006	0600	test flight of cloud particle image sensor, no signal above the freezing level due to TX trouble

*C1 means the number of the cloud particle videosonde

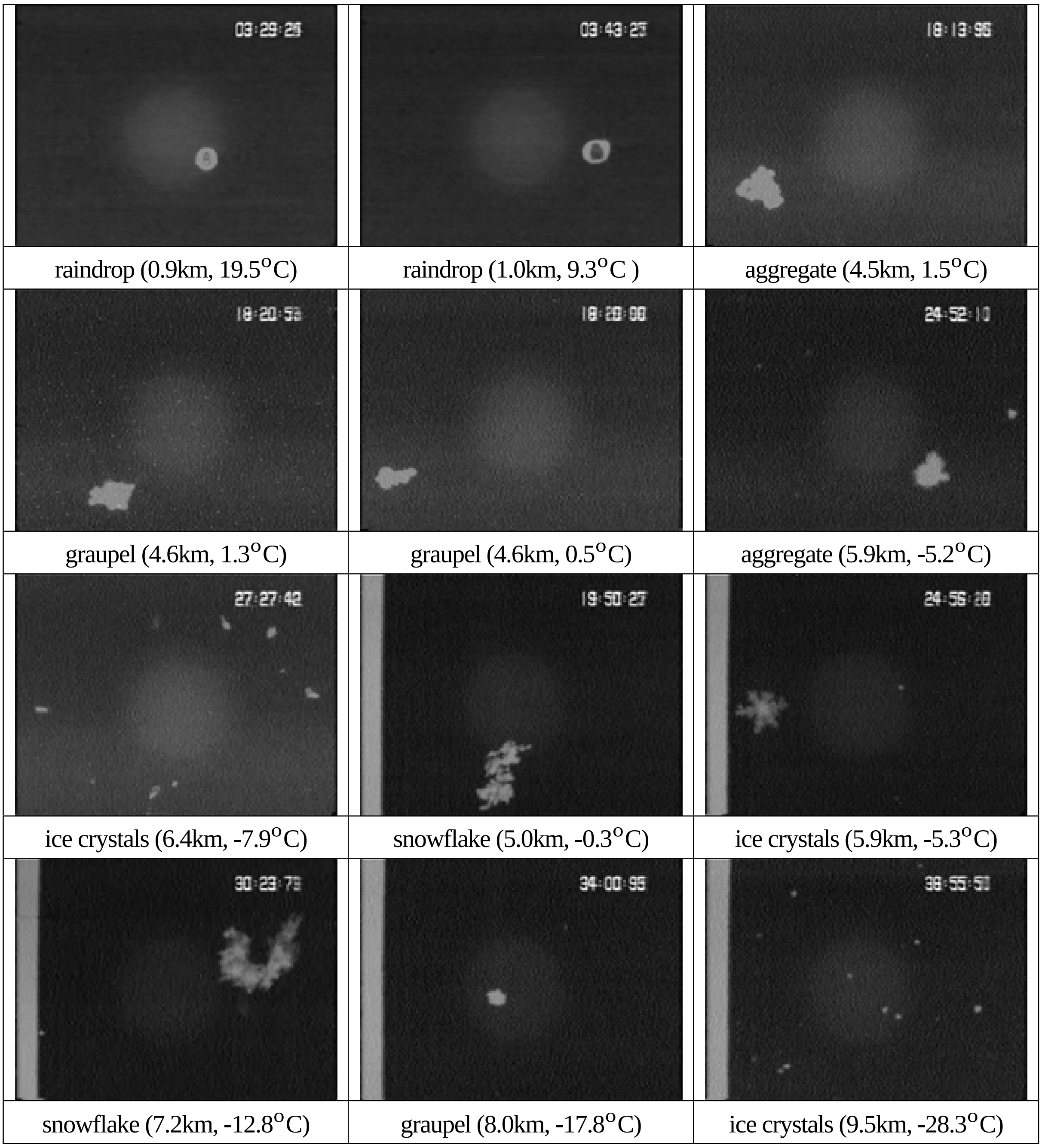


Fig. 5.7.1. Images of precipitation particles observed during MR06-05. The height of the field of view is 15mm.

5.8 Ozone and Water Vapor Sonde

(1) Personnel

Yoichi Inai	(Hokkaido University)	On board Principal Investigator	
Masatomo Fujiwara	(Hokkaido University)	Principal Investigator	* not on board
Fumio Hasebe	(Hokkaido University)	* not on board	
Masato Shiotani	(Kyoto University)	* not on board	
Noriyuki Nishi	(Kyoto University)	* not on board	
Shin-ya Ogino	(JAMSTEC)	* not on board	
Takashi Shibata	(Nagoya University)	* not on board	

(2) Objective

The research objective is to investigate the transport and dehydration processes around the tropical tropopause. A total of 15 sets of the EN-SCI electrochemical concentration cell (ECC) ozonesonde, the Meteolabor "Snow White" chilled-mirror dew/frost point hygrometer, and the Vaisala RS80-H radiosonde are flown with meteorological rubber balloons to obtain ozone and water vapor profiles up to the middle stratosphere.

(3) Methods

The payload consists of the following four parts:

ECC ozonesonde: Standard ozonesonde using potassium iodide solutions (EN-SCI, Corp., USA)
Snow White hygrometer: Reference-quality chilled-mirror hygrometer (Meteolabor AG, Switzerland)
RS80-15H: Standard radiosonde with the H-Humicap humidity sensor (Vaisala Oy, Finland)
TMAX-C board: Interface board for RS80 radiosondes (TMAX, USA)

The payload is flown with the TA1200 rubber balloon, 160 type parachute, and unwinder (TOTEX, Japan). The Helium gas is used to obtain the buoyancy of about 5 m/s ascent.

The ground receiving system consists of a set of directional and omni-directional antennae, receiver (icom IC-R8500), and laptop computer which installed software "TrueTTY". A special software "STRATO" developed at NOAA is used for calculation, real-time graphics, and data storage. The antennae were installed on the roof of the Aft Wheel House (AWH), and the receiving system together with the ozonesonde preparation system was installed in the AWH.

The following table shows the sounding date and time.

Table 5.8-1: Sounding date and time (UTC)

29 Oct. 7:02	30 Oct. 9:01	1 Nov. 6:10	2 Nov. 6:12	3 Nov. 6:15
4 Nov. 6:17	7 Nov. 8:00	8 Nov. 9:00	9 Nov. 9:00	11 Nov. 6:12
12 Nov. 6:13	13 Nov. 6:09	14 Nov. 6:13	15 Nov. 6:10	20 Nov. 12:02

The balloon inflation was made inside the No.1 Mooring Buoy Shed and the launch was made at the backside of the upper deck. We used a protection cover for balloon (TOTEX) during the inflation. The frequency of around 405 MHz was used for the radiosonde transmitter (RS80-H).

(4) Results

The vertical distributions of water vapor mixing ratio, saturation mixing ratio, relative humidities, temperature, ozone, data taken on 1 November are shown in Fig. 5.8-1. The "troposphere" where there is a direct influence of cumulus convection is up to about 14 km where have small temperature gap, large water vapor and ozone mixing ratio gaps in this case. The region between this 14 km level and the cold-point tropopause around 17.5 km is the so-called Tropical Tropopause Layer (TTL) where processes of transport, photochemistry, microphysics, and radiation are actively occurring to determine the initial condition of the stratospheric chemistry.

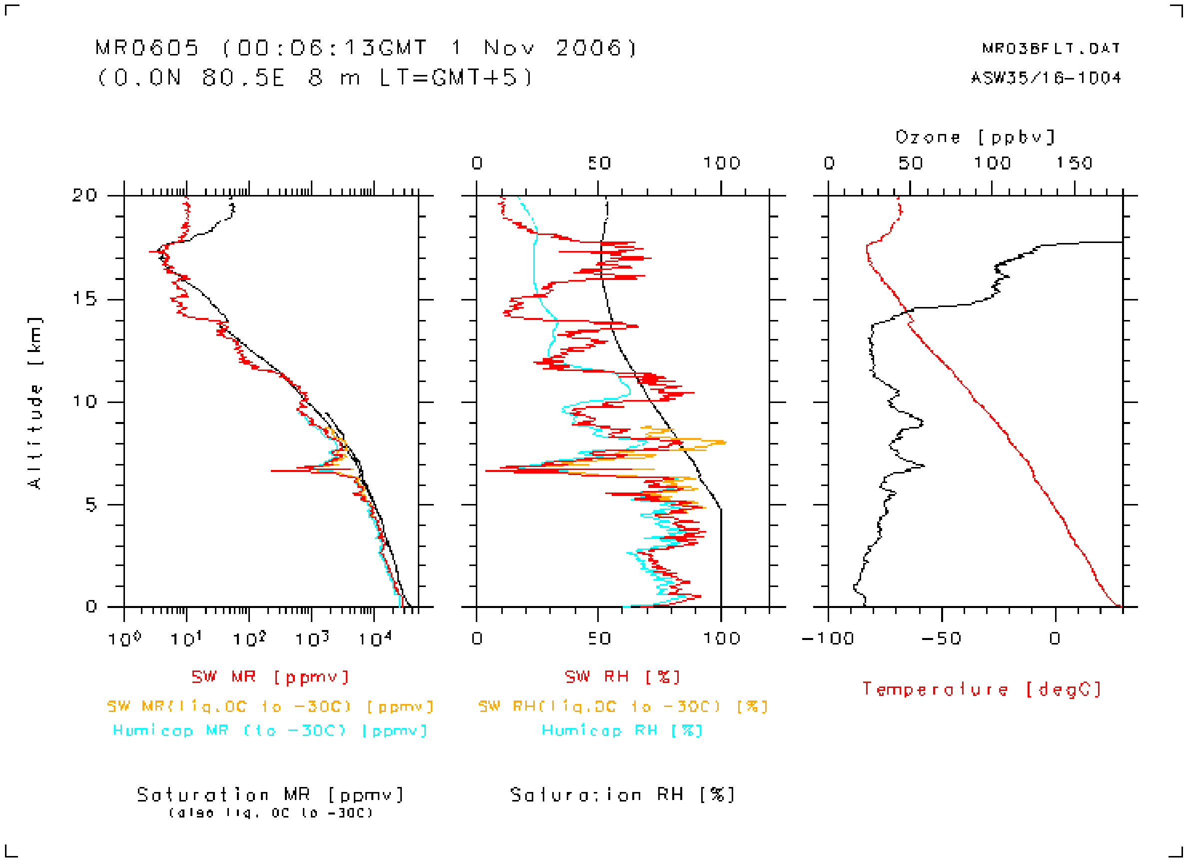


Fig. 5.8-1. Vertical profiles of (Left) Snow White (SW) water vapor mixing ratio (red), same but respect to liquid water (yellow), RS80-H water vapor mixing ratio (blue) and saturation mixing ratio (black), (Center) same as above but for relative humidities and (Right) temperature (red) and ozone mixing ratio (black), taken on 1 November at 0.0N, 80.5E.

(5) Data archive

This raw datasets will be submitted to JAMSTEC. As for particulars about this datasets, contact with Y. Inai (Hokkaido Univ.) or M. Fujiwara (Hokkaido Univ.) of SOWER observation team.

5.9 GPS Meteorology

(1) Personnel

Mikiko Fujita	(JAMSTEC)	Principal Investigator
Kunio Yoneyama	(JAMSTEC)	
Satoshi Okumura	(GODI)	
Katsuhisa Meno	(GODI)	
Shinya Okumura	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

Getting the GPS satellite data to derived estimates of the total column integrated water vapor content of the atmosphere.

(3) Method

The GPS satellite data was archived to the receiver (Ashtech Xstream) with 5 sec interval. The GPS antenna (Margrin) was set on the deck at the part of stern. This observation was carried out from October 4, 2006 through November 26, 2006.

(4) Results

The time series of the total column integrated water vapor at October 13, 2006, which was calculated from GPS satellite data using the TRACK utility in the GAMIT analysis software, is shown in Fig. 5.9-1. They include the specific humidity (SH). The route map around the Indochina Peninsula, the time-longitude cross sections of convective activity estimating by METEOSAT satellite data are shown in Fig. 5.9-2, respectively.

The significant increment with water vapor was observed at 0600Z 13 October (in Fig. 5.9-1). Convective activity was also high due to night-time diurnal convection around the Indochina Peninsula (Fig. 5.9-2b). In the evening, thermal induced convection occurred at the Malay Peninsula and the Borneo Island. Precipitable water vapor gradually increased in evening.

(5) Data archive

Raw data is recorded as RINEX format every 5 seconds during ascent. These raw datasets is available from M. Fujita of JAMSTEC.

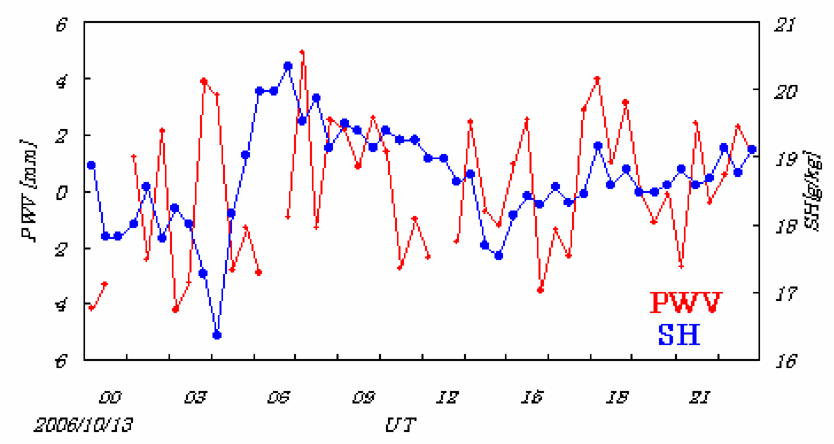


Fig. 5.9-1. The time series of the precipitable water vapor (PWV) and surface specific humidity (SH).

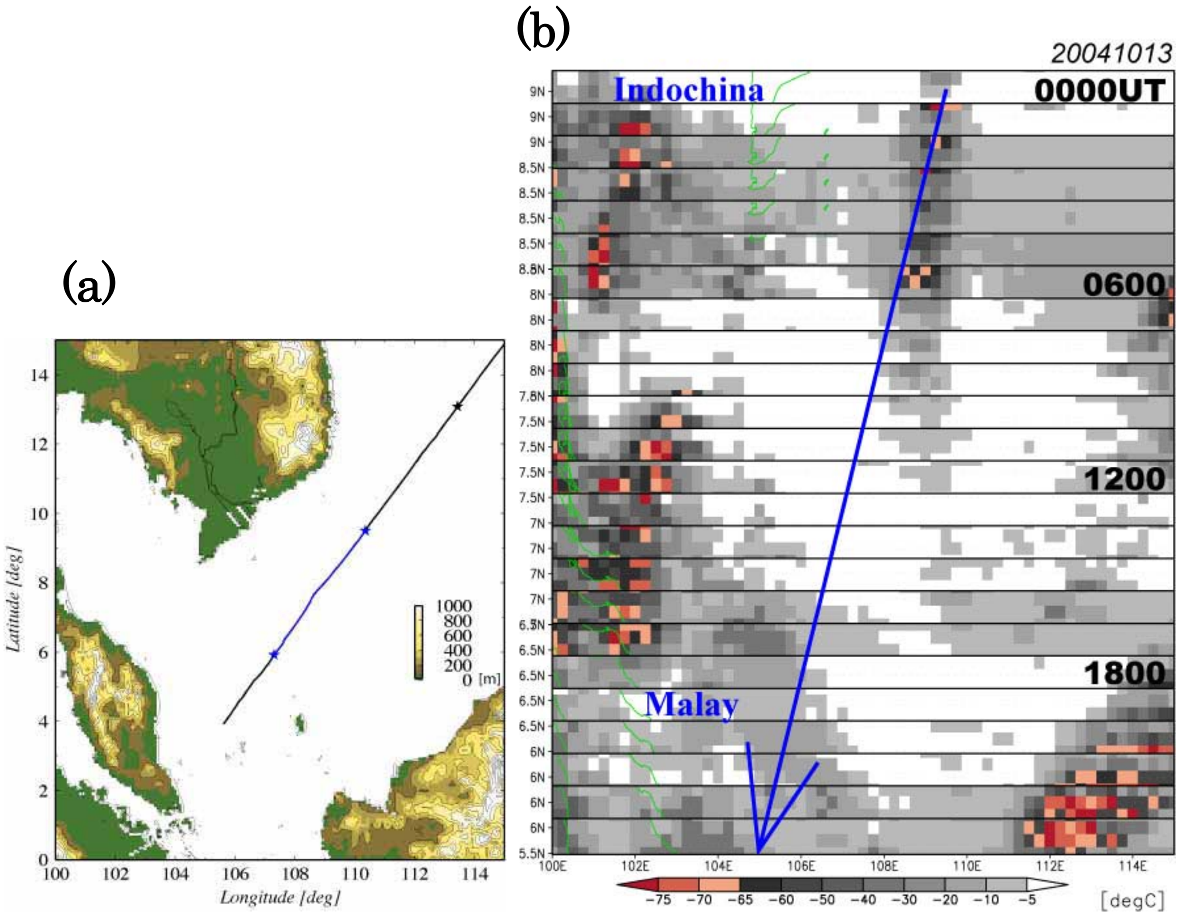


Fig. 5.9-2. (a) The route map around the Indochina Peninsula, and (b) the time-longitude cross sections of convective activity estimating by METEOSAT satellite (copyright 2006 EUMETSAT) data in 13 October 2006.

5.10 Rain and Water Vapor sampling for Stable Isotope Measurement

(1) Personnel

Naoyuki Kurita	(JAMSTEC)	Principal Investigator
Kimpei Ichiyanagi	(JAMSTEC)	* not on board
Mayumi Horikawa	(Nagoya University)	* not on board

(2) Objective

Stable isotopes in water (HDO and $H_2{}^{18}O$) are powerful tool to study of the moisture origin of precipitation associated with MJO. Sampling of rainwater and atmospheric moisture was performed for stable isotope analyses throughout the MR06-05 Leg1 cruise from Sekinehama on October 4, 2006 to Maldives on November 26, 2006.

(3) Method

Following observation was carried out throughout this cruise

- Atmospheric moisture sampling:

  Water vapor was sampled at the two heights above sea level, namely foremast and mainmast height. The cryogenic method that air was drawn at the 3L/min for about 6 hour from the intake point through a glass trap cooled by radiator around -100℃ was used for water vapor sampling

- Measurement of the mixing ratio at the sampling levels.

  The 10 min average of air temperature and relative humidity (Vaisala Co. Ltd., HMP45) was measured at the air intake point. The mixing ratio of each level was determined in each level using temerature and relative humidity.

- Rainwater sampling

  Precipitation sampling was collected every 3 hours with auto-precipitation sampler developed by JAMSTEC (Masinax Co., Ltd. , MAS-UK150-1). All precipitation during the period falls through a funnel and pooled in the rain collector, then 10 ml of the water is mechanically transferred to an airtight sample container.

(4) Results

The sampling coordinates and meteorological condition for all water vapor samples are summarized in Table 5.10-1 for foremast (183 samples) and Table 5.10-2 for mainmast (184 samples). The rainfall samples data (70 samples) is summarized in Table 5.10-3. It includes the sampling coordination and rainfall amount. As for the meteorological data, temporal variation of temperature, relative humidity, and mixing ratio are shown in Figure 5.10-1a and Figure 5.10-1b, respectively.

(5) Data archive

These raw data obtained during this cruise will be submitted to JAMSTEC Marine-Earth Data and Information Department. Analyzed stable isotope data (HDO and $H_2{}^{18}O$) are also available from N. Kurita of JAMSTEC.

Table 5.10-1 Summary of all water vapor data collected at the foremast height.

No	Date	Time UTC	Latitude N	Longitude E	Log Speed	Temp. ℃	RH %	Mixing ratio g/Kg	Sample g
1	20061004	12:00	38.053	141.999	15.52	20.1	0.78	11.42	14.5
2	20061005	0:00	35.865	141.439	14.77	22.5	0.88	15.07	18.5
3	20061005	6:00	34.735	140.314	15.99	22.9	0.89	15.72	20.1
4	20061005	12:00	33.816	138.78	15.31	21.7	0.89	14.77	18.6
5	20061005	18:00	32.988	137.469	12.13	21.8	0.92	15.36	19.6
6	20061006	0:00	32.422	136.316	11.18	23.8	0.78	14.77	4.6
7	20061006	6:00	31.58	135.501	11.64	25	0.71	14.42	18.7
8	20061006	12:00	30.57	134.852	11.49	25.6	0.66	13.81	17.3
9	20061006	18:00	29.543	134.156	12.49	25	0.67	13.62	17.2
10	20061007	0:00	28.423	133.417	11.88	26.3	0.61	13.15	16.9
11	20061007	6:00	27.459	132.804	12.3	25.8	0.61	12.81	16.2
12	20061007	12:00	26.421	132.128	11.14	25.6	0.56	11.60	15.4
13	20061007	18:00	25.586	131.290	11.32	25.9	0.57	11.94	16.0
14	20061008	0:00	24.84	130.418	10.67	27.6	0.53	12.30	16.4
15	20061008	6:00	24.393	129.373	10.8	27	0.61	13.57	17.0
16	20061008	12:00	24.049	128.280	10.62	26.4	0.68	14.59	19.1
17	20061008	18:00	23.717	127.167	11.11	25.6	0.76	15.77	20.7
18	20061009	0:00	23.326	125.957	12.04	27	0.68	15.41	19.6
19	20061009	6:00	22.781	124.787	11.93	26.3	0.76	16.38	20.6
20	20061009	12:00	22.209	123.611	13.71	27.3	0.68	15.51	19.9
21	20061009	18:00	21.52	122.238	14.41	26.6	0.77	17.00	21.8
22	20061010	0:00	20.837	120.861	14.66	28.2	0.69	16.50	20.3
23	20061010	6:00	20.052	119.668	13.7	28.2	0.71	17.19	21.5
24	20061010	12:00	19.033	118.725	13.17	27.7	0.73	17.15	22.5
25	20061010	18:00	18.036	117.796	13.41	27.7	0.73	17.00	21.1
26	20061011	12:00	14.736	114.863	15.06	28.2	0.79	19.02	25.4
27	20061011	18:00	13.597	113.878	14.53	27.8	0.8	18.99	21.8
28	20061012	0:00	12.523	112.963	14.54	28.6	0.75	18.59	23.5
29	20061012	6:00	11.544	112.103	10.35	29	0.68	17.25	21.1
30	20061012	12:00	10.737	111.419	11.02	27.8	0.76	18.11	23.8
31	20061012	18:00	9.906	110.694	10.8	27.5	0.8	18.47	23.2
32	20061013	0:00	9.036	109.959	12.14	27.8	0.74	17.54	22.5
33	20061019	0:00	0.197	91.113	15.68	28.2	0.8	19.40	24.5
34	20061019	6:00	-1.11	90.314	14.46	28.9	0.77	19.39	23.7
35	20061019	12:00	-2.064	89.327	15.53	28	0.8	19.10	24.4
36	20061019	18:00	-2.939	88.023	15.5	27.5	0.8	18.53	23.6
37	20061020	0:00	-3.794	86.726	15.33	27.9	0.75	17.79	22.3
38	20061020	6:00	-4.638	85.423	15.57	28.2	0.73	17.62	22.4
39	20061020	12:00	-5.479	84.101	15.63	27.5	0.76	17.65	22.6
40	20061020	18:00	-6.33	82.800	15.67	27.1	0.77	17.51	21.6
41	20061021	0:00	-7.175	81.509	15.69	27.8	0.74	17.54	21.6
42	20061021	6:00	-7.281	80.807	12.12	28.3	0.72	17.48	21.6
43	20061021	12:00	-5.919	80.784	15.21	27.7	0.77	18.16	23.2
44	20061021	18:00	-4.701	80.049	14.77	27.7	0.78	18.31	22.7
45	20061022	0:00	-3.3	80.000	14.56	25.8	0.93	19.58	24.0
46	20061022	6:00	-1.404	80.038	12.7	25.1	0.96	19.39	46.7
47	20061022	12:00	0.256	79.527	14.48	25	1.01	20.31	27.1
48	20061023	0:00	1.309	80.191	13.46	26.9	0.87	19.41	24.2
49	20061023	6:00	2.188	80.082	16.14	27.6	0.83	19.41	24.3
50	20061023	12:00	2.531	79.713	13.94	27.5	0.85	19.89	25.9
51	20061023	18:00	1.587	80.278	11.2	27.4	0.84	19.56	24.3
52	20061024	0:00	1.523	80.443	5.22	27.8	0.82	19.40	25.2
53	20061024	6:00	1.377	80.355	9.66	29.1	0.73	18.69	22.8
54	20061024	12:00	0.408	79.452	15.43	26.4	0.89	19.36	24.2
55	20061024	18:00	0.019	78.981	6.32	25.7	0.96	20.06	25.3
56	20061025	0:00	0.044	78.996	1.61	27.8	0.79	18.78	24.6
57	20061025	6:00	0.016	78.921	4.87	28.3	0.74	17.94	21.8
58	20061025	12:00	-0.335	79.249	11.27	27.6	0.76	17.79	24.2
59	20061025	18:00	-1.243	79.993	12.97	26	0.85	18.17	21.6
60	20061026	0:00	-1.496	80.338	2.78	25.7	0.85	17.62	22.0
61	20061026	6:00	-1.583	80.599	11.09	26.4	0.81	17.71	21.7
62	20061026	12:00	-0.931	81.133	14.66	26.4	0.84	18.28	24.3
63	20061026	18:00	-0.041	81.907	11.32	27.1	0.82	18.74	23.7
64	20061027	0:00	-0.013	81.885	2.12	28.3	0.76	18.57	23.9
65	20061027	6:00	-0.003	81.983	3.84	28.3	0.75	18.46	23.5
66	20061027	12:00	0.005	81.558	8.06	27.3	0.8	18.35	23.0
67	20061027	18:00	0.001	80.760	6.51	26.7	0.82	18.08	24.0

68	20061028	0:00	-0.017	80.499	2.96	27.5	0.79	18.45	22.5
69	20061028	6:00	0.002	80.505	1.25	27.4	0.79	18.33	22.9
70	20061028	12:00	-0.008	80.480	1.45	27.6	0.81	18.94	25.5
71	20061028	18:00	-0.005	80.479	0.89	27.5	0.81	18.85	23.8
72	20061029	0:00	-0.013	80.479	1.36	28.8	0.75	18.82	23.3
73	20061029	6:00	0.009	80.485	1.25	28.2	0.75	18.16	22.9
74	20061029	12:00	0.002	80.476	0.61	27.3	0.81	18.57	23.7
75	20061029	18:00	0.000	80.48	0.5	27.4	0.8	18.58	23.5
76	20061030	0:00	0.000	80.483	0.41	28.8	0.74	18.60	23.2
77	20061030	6:00	-0.005	80.486	1.23	28.7	0.74	18.47	23.0
78	20061030	12:00	-0.026	80.465	3.14	26.7	0.84	18.48	23.7
79	20061030	18:00	-0.012	80.466	3.09	26.7	0.83	18.48	23.9
80	20061031	0:00	-0.019	80.470	2.45	26	0.85	17.99	22.0
81	20061031	6:00	-0.019	80.482	2.14	28	0.74	17.74	23.2
82	20061031	12:00	-99	-99	-99	27.6	0.77	18.23	23.4
83	20061031	18:00	-0.001	80.484	0.12	27.4	0.79	18.28	22.9
84	20061101	0:00	0.001	80.468	4.63	28.4	0.73	17.82	21.6
85	20061101	6:00	0.037	80.505	4.47	28.3	0.75	18.40	22.5
86	20061101	12:00	0.041	80.481	4.34	27.4	0.77	17.78	22.7
87	20061101	18:00	0.028	80.498	3.85	27.3	0.77	17.65	22.7
88	20061102	0:00	0.041	80.490	4.75	28.5	0.72	17.79	21.2
89	20061102	6:00	0.036	80.498	4.52	29	0.69	17.52	22.4
90	20061102	12:00	-0.008	80.512	3.68	28	0.75	18.09	22.8
91	20061102	18:00	-0.012	80.523	4.1	27.8	0.77	18.27	23.2
92	20061103	0:00	-0.029	80.495	3.49	29	0.72	18.28	22.6
93	20061103	6:00	-0.029	80.498	3.82	29.1	0.73	18.63	23.4
94	20061103	12:00	-0.008	80.495	1.51	28.4	0.74	18.18	22.7
95	20061103	18:00	-0.014	80.491	1.8	27.9	0.75	17.89	21.7
96	20061104	0:00	-0.016	80.489	1.95	28.9	0.69	17.29	22.0
97	20061104	6:00	-0.018	80.489	2.22	29.3	0.67	17.19	20.8
98	20061104	12:00	-0.009	80.491	1.49	28.1	0.73	17.54	20.5
99	20061104	18:00	0.009	80.502	4.04	26.9	0.78	17.49	23.2
100	20061105	0:00	-0.014	80.501	2.78	28.2	0.77	18.56	23.9
101	20061105	6:00	-0.002	80.503	2.26	28.8	0.74	18.56	22.3
102	20061105	12:00	-0.003	80.524	4.43	27.9	0.79	18.74	24.1
103	20061105	18:00	-0.012	80.517	4.55	26.7	0.83	18.38	22.2
104	20061106	0:00	-0.024	80.529	6.13	26.8	0.84	18.77	22.9
105	20061106	6:00	-0.010	80.450	3.78	26.5	0.85	18.75	23.1
106	20061106	12:00	-0.035	80.507	5.03	26.6	0.87	19.11	24.3
107	20061106	18:00	-0.020	80.499	2.72	26.9	0.82	18.50	23.6
108	20061107	0:00	-0.028	80.483	3.47	28.5	0.74	18.34	22.3
109	20061107	6:00	-0.024	80.457	4.14	29	0.72	18.38	23.7
110	20061107	12:00	-0.013	80.488	2.37	27.9	0.77	18.39	21.9
111	20061107	18:00	-0.015	80.515	3.83	27.4	0.8	18.46	23.1
112	20061108	0:00	0.015	80.486	4.84	28.1	0.76	18.32	22.9
113	20061108	6:00	0.013	80.442	5.03	29.1	0.7	17.88	22.9
114	20061108	12:00	-0.031	80.456	5.3	28	0.77	18.30	22.5
115	20061108	18:00	-0.036	80.486	4.53	27.1	0.81	18.48	23.6
116	20061109	0:00	-0.039	80.487	4.77	28.5	0.75	18.43	22.4
117	20061109	6:00	-0.010	80.477	4.03	27.9	0.75	17.91	23.2
118	20061109	12:00	-0.008	80.521	4.74	27.1	0.79	17.89	22.5
119	20061109	18:00	-0.003	80.454	4.42	26.3	0.83	18.00	23.1
120	20061110	0:00	0.016	80.519	4.84	26.2	0.85	18.23	22.8
121	20061110	6:00	0.003	80.456	2.91	26.7	0.81	18.06	22.1
122	20061110	12:00	-0.005	80.464	2	27.3	0.77	17.70	22.5
123	20061110	18:00	-0.016	80.476	1.92	27.3	0.79	18.02	23.0
124	20061111	0:00	-0.006	80.493	1.78	27.7	0.77	18.06	23.3
125	20061111	6:00	0.011	80.510	3.14	27.6	0.78	18.29	22.5
126	20061111	12:00	-0.004	80.483	1.06	27.4	0.79	18.24	23.1
127	20061111	18:00	0.000	80.520	3.5	27.4	0.78	18.06	23.5
128	20061112	0:00	0.018	80.522	5.38	28.5	0.72	17.82	22.1
129	20061112	6:00	0.015	80.438	5.07	28.1	0.77	18.52	24.6
130	20061112	12:00	-0.042	80.486	2.5	25.4	0.88	18.01	22.1
131	20061112	18:00	0.017	80.449	6.07	25.5	0.86	17.82	22.9
132	20061113	0:00	-0.006	80.44	5.06	27.4	0.79	18.29	22.5
133	20061113	6:00	0.002	80.439	4.71	28.6	0.73	18.17	23.1
134	20061113	12:00	0.011	80.476	4.73	25.6	0.86	17.80	22.7
135	20061113	18:00	-0.018	80.472	4.67	26.3	0.81	17.71	22.9
136	20061114	0:00	-0.029	80.482	4.25	28.2	0.76	18.46	22.6
137	20061114	6:00	-0.001	80.517	3.37	29.2	0.7	17.94	22.5

138	20061114	12:00	-0.001	80.506	2.56	28.2	0.75	18.17	22.5
139	20061114	18:00	0.000	80.518	3.34	27.8	0.77	18.28	23.3
140	20061115	0:00	-0.002	80.497	2.13	28.7	0.75	18.74	23.8
141	20061115	6:00	0.003	80.503	2.21	29.3	0.72	18.68	22.8
142	20061115	12:00	0.010	80.493	1.88	27.7	0.79	18.52	23.2
143	20061115	18:00	-0.002	80.503	1.8	27.7	0.79	18.80	23.5
144	20061116	0:00	0.000	80.489	1.54	28.1	0.77	18.51	23.1
145	20061116	6:00	0.001	80.498	1.96	29	0.74	18.84	23.4
146	20061116	12:00	0.011	80.497	3.24	27.1	0.81	18.53	23.2
147	20061116	18:00	0.004	80.478	4.64	26	0.85	18.14	23.6
148	20061117	0:00	-0.02	80.49	3.66	27.4	0.81	18.86	23.4
149	20061117	6:00	-0.014	80.476	1.81	27.4	0.79	18.47	23.5
150	20061117	12:00	-0.003	80.492	1.41	27.7	0.81	19.07	23.6
151	20061117	18:00	0.000	80.503	2.03	27.8	0.81	19.28	24.5
152	20061118	0:00	0.011	80.486	1.77	29.2	0.72	18.58	22.9
153	20061118	6:00	0.018	80.489	2.04	26.9	0.81	18.14	22.9
154	20061118	12:00	0.001	80.494	2.25	26.6	0.82	18.19	23.3
155	20061118	18:00	0.031	80.463	3.4	27.1	0.82	18.64	23.8
156	20061119	0:00	0.01	80.465	2.43	25.3	0.89	18.22	23.2
157	20061119	6:00	0.003	80.457	2.55	26.1	0.84	17.98	22.2
158	20061119	12:00	0.000	80.459	2.39	26.4	0.8	17.53	23.3
159	20061119	18:00	-0.025	80.475	3.43	25.1	0.87	17.57	22.4
160	20061120	0:00	-0.016	80.486	2.44	24.9	0.86	17.00	20.9
161	20061120	6:00	-0.009	80.457	2.6	26.5	0.82	18.08	22.3
162	20061120	12:00	-0.014	80.461	2.63	27.5	0.78	18.01	22.6
163	20061120	18:00	-0.013	80.498	3.33	26.3	0.78	16.95	22.3
164	20061121	0:00	-0.021	80.477	3	27.4	0.76	17.52	21.1
165	20061121	6:00	-0.016	80.457	3.01	28.8	0.73	18.46	22.3
166	20061121	12:00	-0.013	80.472	2.38	27.6	0.76	17.93	22.2
167	20061121	18:00	-0.005	81.221	13.76	25.5	0.81	16.82	22.2
168	20061122	0:00	-0.011	81.874	0.93	27.1	0.77	17.56	22.8
169	20061122	6:00	0.000	81.992	2.7	28.1	0.75	18.15	23.1
170	20061122	12:00	-0.01	81.376	14.57	27.6	0.79	18.45	22.2
171	20061122	18:00	-0.017	79.894	15.06	27.7	0.77	18.09	23.5
172	20061123	0:00	-0.054	79.024	2.91	27.9	0.78	18.64	22.9
173	20061123	6:00	-0.051	79.004	2.11	29	0.72	18.39	23.3
174	20061123	12:00	0.059	78.997	1.6	28.5	0.72	17.78	21.8
175	20061124	6:00	-0.002	78.866	2.25	28	0.76	18.16	22.0
176	20061124	12:00	0.020	78.823	1.43	27	0.83	18.80	24.2
177	20061124	18:00	0.004	78.846	1.39	25	0.91	18.29	23.3
178	20061125	0:00	0.005	78.846	0.97	25.3	0.87	17.73	22.8
179	20061125	6:00	0.002	78.843	0.77	27.4	0.77	17.78	22.2
180	20061125	12:00	0.003	78.845	0.75	27.5	0.77	17.82	22.7
181	20061125	18:00	0.311	78.427	12.98	27.5	0.78	18.16	23.8
182	20061126	0:00	1.240	77.253	14.96	28.4	0.74	18.25	22.6
183	20061126	6:00	2.139	76.095	13.21	29	0.7	17.84	24.5

Table 5.10-2 same as Table 5.10-1 but mainmast height

No	Date	Time UTC	Latitude N	Longitude E	Log Speed	Temp. ℃	RH %	Mixing ratio g/Kg	Sample g
1	20061004	12:00	38.052	141.999	15.52	19.8	0.78	11.29	13.6
2	20061005	0:00	35.858	141.424	14.85	22	0.88	14.72	20.2
3	20061005	6:00	34.691	140.251	15.98	22.7	0.88	15.30	19.8
4	20061005	12:00	33.779	138.721	15.21	21.2	0.9	14.44	19.1
5	20061005	18:00	32.955	137.41	12.03	21.3	0.92	14.88	19.8
6	20061006	0:00	32.371	136.237	11.2	23.4	0.77	14.19	18.0
7	20061006	6:00	31.505	135.451	11.62	24.9	0.67	13.41	16.7
8	20061006	12:00	30.528	134.825	11.53	25.3	0.63	12.95	16.4
9	20061006	18:00	29.499	134.125	12.49	24.6	0.65	12.80	16.4
10	20061007	0:00	28.457	133.44	11.83	25.3	0.59	12.07	15.7
11	20061007	6:00	27.400	132.766	12.32	25.2	0.59	11.87	15.2
12	20061007	12:00	26.382	132.098	11.1	25.4	0.54	11.05	14.8
13	20061007	18:00	25.569	131.27	11.34	25.9	0.55	11.46	14.3
14	20061008	0:00	24.824	130.395	10.65	27.2	0.52	11.68	15.6
15	20061008	6:00	24.385	129.35	10.8	27	0.58	12.98	16.4
16	20061008	12:00	24.039	128.245	10.61	26.4	0.65	14.17	18.9

17	20061008	18:00	23.502	126.507	11.63	26.8	0.69	15.29	37.8
18	20061009	6:00	22.749	124.72	11.82	26.2	0.73	15.77	20.6
19	20061009	12:00	22.176	123.546	13.87	27.1	0.67	15.18	20.3
20	20061009	18:00	21.488	122.175	14.46	26.3	0.78	16.75	21.5
21	20061010	0:00	20.805	120.796	14.64	28.3	0.66	16.03	19.9
22	20061010	6:00	20.012	119.626	13.64	28	0.7	16.66	20.7
23	20061010	12:00	18.990	118.685	13.12	27.5	0.72	16.58	22.4
24	20061010	18:00	17.985	117.751	13.45	27.6	0.72	16.70	20.8
25	20061011	12:00	14.665	114.801	15	28	0.79	18.81	25.8
26	20061011	18:00	13.533	113.824	14.52	27.6	0.81	18.88	22.1
27	20061012	0:00	12.454	112.903	14.54	28	0.77	18.45	24.2
28	20061012	6:00	11.513	112.077	10.08	28.2	0.71	17.19	20.3
29	20061012	12:00	10.711	111.397	11.03	27.6	0.77	17.90	24.2
30	20061012	18:00	9.879	110.671	10.81	27.2	0.8	18.27	22.3
31	20061019	0:00	0.171	91.097	15.68	27.8	0.8	18.86	23.8
32	20061019	6:00	−1.134	90.3	14.27	28.2	0.78	18.93	23.2
33	20061019	12:00	−2.079	89.304	15.67	27.8	0.78	18.51	23.6
34	20061019	18:00	−2.960	87.993	15.5	27.2	0.78	17.90	23.1
35	20061020	0:00	−3.793	86.727	15.33	27.6	0.74	17.23	20.8
36	20061020	6:00	−4.615	85.459	15.56	27.6	0.73	17.09	21.6
37	20061020	12:00	−5.454	84.139	15.62	27.2	0.75	16.99	21.8
38	20061020	18:00	−6.329	82.802	15.67	26.8	0.76	16.91	21.9
39	20061021	0:00	−7.195	81.48	15.69	27.4	0.73	16.91	21.0
40	20061021	6:00	−7.259	80.809	12.11	27.7	0.72	16.85	21.3
41	20061021	12:00	−5.922	80.795	15.19	27.4	0.75	17.34	21.3
42	20061021	18:00	−4.703	80.055	14.62	27.5	0.75	17.39	23.0
43	20061022	0:00	−3.272	80	14.71	25.4	0.87	17.84	22.3
44	20061022	6:00	−1.900	80.209	14.01	24.5	0.88	17.12	21.7
45	20061022	12:00	−0.851	79.844	11.25	25.2	0.87	17.73	23.0
46	20061022	18:00	0.300	79.532	14.61	24.7	0.9	17.65	23.2
47	20061023	0:00	1.322	80.207	13.15	26.5	0.8	17.52	22.1
48	20061023	6:00	2.215	80.062	16.46	27.1	0.78	17.72	−99.0
49	20061023	12:00	2.537	79.71	13.91	27.2	0.79	18.01	22.4
50	20061023	18:00	1.594	80.278	10.99	27.1	0.79	17.91	23.5
51	20061024	0:00	1.521	80.435	5.27	27.6	0.77	18.07	21.8
52	20061024	6:00	1.395	80.374	9.25	27.9	0.76	18.13	22.9
53	20061024	12:00	0.414	79.454	15.39	26.1	0.83	17.81	23.3
54	20061024	18:00	0.020	78.982	6.1	25.4	0.86	17.62	22.2
55	20061025	0:00	0.043	78.997	1.57	27	0.78	17.66	23.2
56	20061025	6:00	0.017	78.921	5.09	27.5	0.77	17.84	21.9
57	20061025	12:00	−0.316	79.236	11.23	27.4	0.76	17.59	21.5
58	20061025	18:00	−1.22	79.974	12.94	25.9	0.85	17.91	23.4
59	20061026	0:00	−1.496	80.336	2.63	25.4	0.85	17.28	21.9
60	20061026	6:00	−1.582	80.614	11.36	26	0.82	17.49	22.4
61	20061026	12:00	−0.874	81.17	14.65	26.2	0.84	18.05	23.6
62	20061026	18:00	−0.032	81.919	11.04	26.9	0.82	18.46	22.7
63	20061027	0:00	−0.013	81.883	2.12	27.6	0.78	18.23	23.1
64	20061027	6:00	−0.003	81.985	3.65	27.7	0.77	18.15	21.9
65	20061027	12:00	0.004	81.558	8.25	27.2	0.79	17.91	23.1
66	20061027	18:00	0.001	80.746	6.35	26.4	0.81	17.79	23.2
67	20061028	0:00	−0.016	80.499	2.92	27	0.8	18.02	22.0
68	20061028	6:00	0.001	80.504	1.27	26.9	0.8	18.04	21.8
69	20061028	12:00	−0.008	80.479	1.46	27.4	0.8	18.62	24.9
70	20061028	18:00	−0.005	80.479	0.88	27.2	0.81	18.48	23.4
71	20061029	0:00	−0.012	80.48	1.35	28.2	0.76	18.49	22.9
72	20061029	6:00	0.009	80.485	1.25	27.5	0.77	17.81	22.7
73	20061029	12:00	0.002	80.476	0.62	27	0.81	18.25	23.5
74	20061029	18:00	0.000	80.48	0.49	27.1	0.8	18.26	23.3

75	20061030	0:00	0.000	80.483	0.4	27.9	0.77	18.27	23.1
76	20061030	6:00	−0.005	80.486	1.21	27.7	0.77	18.20	22.5
77	20061030	12:00	−0.026	80.465	3.14	26.4	0.83	18.12	23.5
78	20061030	18:00	−0.012	80.466	3.1	26.4	0.83	18.08	23.4
79	20061031	0:00	−0.019	80.47	2.44	25.6	0.85	17.62	21.4
80	20061031	6:00	−0.020	80.482	2.22	27.3	0.76	17.51	22.7
81	20061031	12:00	−99	−99	−99	27.6	0.76	18.03	21.7
82	20061031	18:00	−0.001	80.483	0.34	27.8	0.77	18.08	24.1
83	20061101	0:00	0.001	80.468	4.65	27.8	0.74	17.52	21.5
84	20061101	6:00	0.037	80.504	4.47	27.4	0.78	18.10	22.4
85	20061101	12:00	0.042	80.481	4.36	27.2	0.77	17.48	22.9
86	20061101	18:00	0.029	80.498	3.87	27	0.77	17.37	22.6
87	20061102	0:00	0.041	80.49	4.75	27.6	0.75	17.50	21.3
88	20061102	6:00	0.036	80.498	4.53	28.1	0.72	17.28	22.3
89	20061102	12:00	−0.009	80.512	3.7	27.8	0.75	17.81	22.7
90	20061102	18:00	−0.012	80.523	4.09	27.5	0.77	17.91	23.2
91	20061103	0:00	−0.03	80.495	3.57	28.2	0.74	17.94	21.8
92	20061103	6:00	−0.029	80.498	3.87	28.2	0.75	18.31	23.0
93	20061103	12:00	−0.008	80.495	1.52	28.2	0.73	17.72	22.6
94	20061103	18:00	−0.013	80.491	1.76	27.6	0.74	17.39	22.4
95	20061104	0:00	−0.017	80.49	2.01	28.2	0.7	16.90	20.9
96	20061104	6:00	−0.017	80.489	2.14	28.4	0.69	16.81	21.4
97	20061104	12:00	−0.009	80.491	1.48	27.7	0.73	17.11	21.2
98	20061104	18:00	0.009	80.503	4.1	26.8	0.77	17.16	22.8
99	20061105	0:00	−0.014	80.502	2.86	27.5	0.78	18.20	23.0
100	20061105	6:00	−0.002	80.502	2.19	28	0.76	18.17	23.3
101	20061105	12:00	−0.004	80.525	4.53	27.6	0.78	18.39	23.5
102	20061105	18:00	−0.011	80.516	4.45	26.4	0.83	18.02	23.3
103	20061106	0:00	−0.024	80.529	6.11	26.5	0.84	18.43	23.4
104	20061106	6:00	−0.01	80.45	3.78	26.2	0.85	18.35	23.5
105	20061106	12:00	−0.035	80.507	5.04	26.3	0.87	18.82	24.6
106	20061106	18:00	−0.02	80.499	2.72	26.8	0.81	18.19	24.3
107	20061107	0:00	−0.029	80.483	3.5	27.6	0.77	18.00	22.1
108	20061107	6:00	−0.025	80.455	4.29	28.3	0.74	18.01	22.5
109	20061107	12:00	−0.012	80.488	2.32	27.6	0.77	18.05	23.0
110	20061107	18:00	−0.016	80.515	3.86	27.1	0.8	18.12	23.1
111	20061108	0:00	0.015	80.486	4.88	27.5	0.77	17.94	22.5
112	20061108	6:00	0.014	80.44	5.21	28.3	0.72	17.62	21.8
113	20061108	12:00	−0.029	80.457	5.14	27.8	0.76	17.96	23.1
114	20061108	18:00	−0.036	80.486	4.53	26.9	0.81	18.11	23.2
115	20061109	0:00	−0.04	80.487	4.81	27.6	0.77	18.08	22.0
116	20061109	6:00	−0.01	80.477	4.04	27.2	0.76	17.40	22.6
117	20061109	12:00	−0.008	80.521	4.75	26.9	0.78	17.51	22.0
118	20061109	18:00	−0.003	80.454	4.47	26.1	0.82	17.67	22.7
119	20061110	0:00	0.016	80.518	4.71	25.9	0.85	17.84	22.7
120	20061110	6:00	0.003	80.456	2.92	26.3	0.81	17.57	22.1
121	20061110	12:00	−0.005	80.464	2.01	27	0.77	17.27	22.1
122	20061110	18:00	−0.016	80.476	1.93	27	0.78	17.62	22.5
123	20061111	0:00	−0.007	80.493	1.81	27.2	0.77	17.65	21.8
124	20061111	6:00	0.010	80.509	3.02	26.8	0.8	17.82	22.8
125	20061111	12:00	−0.004	80.483	1.06	27.2	0.78	17.76	22.7
126	20061111	18:00	0.000	80.519	3.5	27.1	0.78	17.65	23.2
127	20061112	0:00	0.018	80.522	5.36	27.9	0.74	17.47	21.7
128	20061112	6:00	0.015	80.437	5.12	27.3	0.79	18.12	23.3
129	20061112	12:00	−0.040	80.486	2.52	25.3	0.86	17.66	22.5
130	20061112	18:00	0.017	80.449	6.04	25.4	0.85	17.52	22.7
131	20061113	0:00	−0.006	80.44	5.05	26.9	0.8	17.91	22.3
132	20061113	6:00	0.002	80.439	4.71	28.1	0.74	17.89	22.7

133	20061113	12:00	0.011	80.476	4.72	25.4	0.85	17.45	22.4
134	20061113	18:00	−0.018	80.473	4.65	26.2	0.81	17.39	22.9
135	20061114	0:00	−0.029	80.482	4.23	27.4	0.78	18.14	22.7
136	20061114	6:00	−0.001	80.518	3.43	28.3	0.72	17.61	21.9
137	20061114	12:00	−0.001	80.506	2.53	28	0.74	17.79	22.6
138	20061114	18:00	0.000	80.518	3.36	27.6	0.77	17.91	22.8
139	20061115	0:00	−0.002	80.497	2.1	28.1	0.76	18.32	23.3
140	20061115	6:00	0.002	80.504	2.24	28.3	0.75	18.30	21.7
141	20061115	12:00	0.010	80.493	1.87	27.5	0.78	18.06	23.2
142	20061115	18:00	−0.002	80.503	1.78	27.5	0.79	18.34	23.1
143	20061116	0:00	0.000	80.489	1.56	27.7	0.77	18.00	22.7
144	20061116	6:00	0.001	80.498	1.96	28.3	0.75	18.50	23.0
145	20061116	12:00	0.011	80.497	3.21	27	0.81	18.19	23.0
146	20061116	18:00	0.004	80.478	4.66	25.9	0.84	17.83	23.2
147	20061117	0:00	−0.020	80.49	3.65	27	0.81	18.38	22.8
148	20061117	6:00	−0.014	80.476	1.82	26.9	0.8	18.00	23.1
149	20061117	12:00	−0.003	80.492	1.4	27.5	0.8	18.59	23.5
150	20061117	18:00	0.000	80.503	2.04	27.5	0.8	18.72	24.0
151	20061118	0:00	0.011	80.486	1.76	28.4	0.74	18.11	22.6
152	20061118	6:00	0.018	80.489	2.07	26.3	0.81	17.64	21.9
153	20061118	12:00	0.001	80.494	2.24	26.5	0.82	17.85	23.0
154	20061118	18:00	0.031	80.462	3.42	26.9	0.81	18.26	23.5
155	20061119	0:00	0.011	80.464	2.5	25.1	0.89	17.82	22.1
156	20061119	6:00	0.002	80.457	2.5	25.6	0.84	17.46	22.4
157	20061119	12:00	0.000	80.459	2.38	26.2	0.79	17.04	22.4
158	20061119	18:00	−0.025	80.475	3.47	24.8	0.87	17.16	22.1
159	20061120	0:00	−0.022	80.486	2.94	24.5	0.87	16.86	21.4
160	20061120	6:00	−0.009	80.457	2.59	26.1	0.82	17.64	22.4
161	20061120	12:00	−0.014	80.461	2.64	27.3	0.77	17.55	22.4
162	20061120	18:00	−0.013	80.499	3.36	26.1	0.77	16.47	22.3
163	20061121	0:00	−0.021	80.477	3.07	27.1	0.76	17.17	20.7
164	20061121	6:00	−0.015	80.458	2.91	28	0.75	18.10	23.2
165	20061121	12:00	−0.013	80.473	2.66	27.3	0.76	17.50	22.1
166	20061121	18:00	−0.005	81.248	13.53	25.3	0.81	16.47	21.7
167	20061122	0:00	−0.010	81.874	0.89	26.7	0.78	17.25	22.7
168	20061122	6:00	0.000	81.998	2.73	27.5	0.76	17.79	22.2
169	20061122	12:00	−0.01	81.35	14.81	27.3	0.79	18.08	22.2
170	20061122	18:00	−0.017	79.86	14.98	27.4	0.77	17.74	23.4
171	20061123	0:00	−0.056	79.02	2.67	27.4	0.78	18.13	22.7
172	20061123	6:00	−0.049	79.005	2.09	28.4	0.73	17.95	23.2
173	20061123	12:00	0.061	78.996	1.6	28.2	0.72	17.39	21.5
174	20061123	18:00	0.076	78.986	2.09	28.8	0.71	17.91	23.4
175	20061124	0:00	−0.010	79.022	0.91	26.6	0.8	17.49	21.6
176	20061124	6:00	−0.002	78.877	2.19	27.3	0.77	17.72	22.2
177	20061124	12:00	0.019	78.824	1.45	26.7	0.82	18.22	24.6
178	20061124	18:00	0.004	78.846	1.36	24.7	0.9	17.76	22.9
179	20061125	0:00	0.005	78.846	0.96	24.8	0.87	17.27	22.3
180	20061125	6:00	0.002	78.843	0.77	26.9	0.78	17.46	21.9
181	20061125	12:00	0.003	78.845	0.76	27.3	0.77	17.80	22.7
182	20061125	18:00	0.324	78.409	13.28	27.2	0.79	18.10	23.7
183	20061126	0:00	1.259	77.228	14.94	27.8	0.77	18.18	22.5
184	20061126	6:00	2.142	76.091	13.21	28.2	0.73	17.81	23.7

Table 5.10-3 Summary of all precipitation data

No	Rainfall Start					Rainfall Stop					rainfall
	Year	date	time	Lon	Lat	Year	date	time	lon	lat	mm
1	2006	1008	15:00	23.998	128.11	2006	1008	16:00	23.943	127.928	1.8
2	2006	1008	19:00	23.789	127.386	2006	1008	22:00	23.607	126.811	1

3	2006	1009	9:00	22.692	124.615	2006	1009	10:00	22.614	124.428	0.6
4	2006	1014	1:00	5.629	107.093	2006	1014	2:00	5.494	106.972	3.8
5	2006	1018	20:00	1.567	91.962	2006	1018	20:00	1.567	91.962	2.2
6	2006	1019	3:00	0.014	90.992	2006	1019	4:00	-0.211	90.86	2.3
7	2006	1020	0:00	-3.502	87.181	2006	1021	19:00	-5	79.999	2.9
8	2006	1022	2:00	-3.32	80.001	2006	1022	3:00	-3.069	80.002	7.9
9	2006	1022	4:00	-2.818	80	2006	1022	6:00	-2.37	80.046	19.4
10	2006	1022	7:00	-2.136	80.137	2006	1022	18:00	-0.194	79.495	32.4
11	2006	1022	18:00	-0.194	79.495	2006	1022	22:00	0.669	79.595	20.8
12	2006	1023	12:00	2.969	79.516	2006	1024	18:00	0.007	78.795	3.9
13	2006	1024	18:00	0.007	78.795	2006	1024	19:00	0.007	78.962	0.7
14	2006	1025	19:00	-1.072	79.844	2006	1025	22:00	-1.5	80.249	4.9
15	2006	1026	2:00	-1.495	80.316	2006	1026	11:00	-1.523	80.746	7.1
16	2006	1026	13:00	-1.105	81	2006	1026	13:00	-1.105	81	0.1
17	2006	1027	6:00	-0.005	81.918	2006	1027	6:00	-0.005	81.918	1.9
18	2006	1027	13:00	0.007	81.716	2006	1027	17:00	-0.002	81.138	1
19	2006	1027	20:00	0.002	80.744	2006	1027	20:00	0.002	80.744	0.7
20	2006	1028	12:00	-0.019	80.485	2006	1028	19:00	-0.003	80.487	0
21	2006	1030	0:00	-0.001	80.481	2006	1030	4:00	-0.002	80.487	0
22	2006	1030	11:00	-0.003	80.479	2006	1030	11:00	-0.003	80.479	0.3
23	2006	1030	21:00	0.016	80.472	2006	1031	0:00	-0.019	80.449	3.6
24	2006	1031	0:00	-0.019	80.449	2006	1031	3:00	-0.03	80.473	3.5
25	2006	1031	3:00	-0.03	80.473	2006	1031	3:00	-0.03	80.473	0.1
26	2006	1105	21:00	-0.031	80.506	2006	1105	23:00	0.002	80.479	9.2
27	2006	1106	4:00	-0.011	80.548	2006	1106	5:00	0.001	80.483	2.7
28	2006	1106	7:00	-0.017	80.439	2006	1106	8:00	0.002	80.478	23
29	2006	1106	12:00	-0.044	80.521	2006	1106	13:00	-0.048	80.515	1
30	2006	1106	14:00	-0.009	80.486	2006	1106	19:00	-0.022	80.508	0
31	2006	1108	21:00	-0.071	80.49	2006	1108	22:00	-0.042	80.475	0.6
32	2006	1109	6:00	0.01	80.475	2006	1109	6:00	0.01	80.475	6.3
33	2006	1109	12:00	-0.005	80.521	2006	1109	12:00	-0.005	80.521	0.1
34	2006	1109	23:00	0.003	80.489	2006	1109	23:00	0.003	80.489	1.6
35	2006	1110	1:00	0.046	80.519	2006	1110	3:00	-0.014	80.504	0.7
36	2006	1110	3:00	-0.014	80.504	2006	1110	6:00	0.013	80.433	14.6
37	2006	1111	7:00	-0.012	80.506	2006	1111	9:00	0.056	80.559	0
38	2006	1112	3:00	0.042	80.504	2006	1112	3:00	0.042	80.504	0.3
39	2006	1112	12:00	-0.061	80.462	2006	1112	15:00	-0.043	80.494	9.8
40	2006	1112	15:00	-0.043	80.494	2006	1112	17:00	0.001	80.483	7.9
41	2006	1112	19:00	0.056	80.421	2006	1112	19:00	0.056	80.421	0.2
42	2006	1113	13:00	0.064	80.527	2006	1113	15:00	-0.02	80.436	18.7
43	2006	1113	15:00	-0.02	80.436	2006	1113	16:00	-0.033	80.425	6.5
44	2006	1114	15:00	0.002	80.507	2006	1114	19:00	-0.005	80.537	0
45	2006	1116	13:00	0.002	80.554	2006	1116	13:00	0.002	80.554	0.2
46	2006	1116	19:00	-0.007	80.434	2006	1116	20:00	0.02	80.502	0.6
47	2006	1117	8:00	0	80.482	2006	1117	9:00	-0.02	80.471	3.2
48	2006	1117	12:00	-0.002	80.5	2006	1117	12:00	-0.002	80.5	0.1
49	2006	1117	20:00	-0.002	80.493	2006	1117	20:00	-0.002	80.493	0.9
50	2006	1118	7:00	0.025	80.489	2006	1118	10:00	0.024	80.499	2.5
51	2006	1118	11:00	0.001	80.484	2006	1118	11:00	0.001	80.484	0.1
52	2006	1118	13:00	0	80.531	2006	1118	13:00	0	80.531	0.1
53	2006	1119	0:00	0.02	80.467	2006	1119	0:00	0.02	80.467	2
54	2006	1119	2:00	-0.001	80.46	2006	1119	3:00	0.012	80.457	10.2
55	2006	1119	3:00	0.012	80.457	2006	1119	6:00	0.01	80.45	9.2
56	2006	1119	6:00	0.01	80.45	2006	1119	6:00	0.01	80.45	0.5
57	2006	1119	10:00	0	80.454	2006	1119	11:00	0	80.479	0.9
58	2006	1119	16:00	-0.012	80.431	2006	1119	17:00	0	80.48	8.4
59	2006	1119	20:00	-0.015	80.47	2006	1120	0:00	-0.034	80.498	50.4
60	2006	1120	0:00	-0.034	80.498	2006	1120	3:00	-0.001	80.482	4.3
61	2006	1120	3:00	-0.001	80.482	2006	1120	5:00	-0.005	80.478	0.3
62	2006	1120	7:00	-0.011	80.44	2006	1120	7:00	-0.011	80.44	0.1
63	2006	1120	21:00	-0.02	80.558	2006	1120	22:00	-0.003	80.519	0.8
64	2006	1121	16:00	-0.012	80.474	2006	1121	18:00	-0.004	80.795	4.1
65	2006	1121	18:00	-0.004	80.795	2006	1121	18:00	-0.004	80.795	0.4
66	2006	1124	0:00	-0.013	79.024	2006	1124	1:00	-0.013	79.028	4.5
67	2006	1124	9:00	0.001	78.851	2006	1124	9:00	0.001	78.851	0.5
68	2006	1124	19:00	0.003	78.844	2006	1124	21:00	0.003	78.866	155.6
69	2006	1124	21:00	0.003	78.866	2006	1125	0:00	0.005	78.85	119.7
70	2006	1125	0:00	0.005	78.85	2006	1125	1:00	0.008	78.849	16.9

* Rainfall amount in each sampling period is calculated from SOJ data.

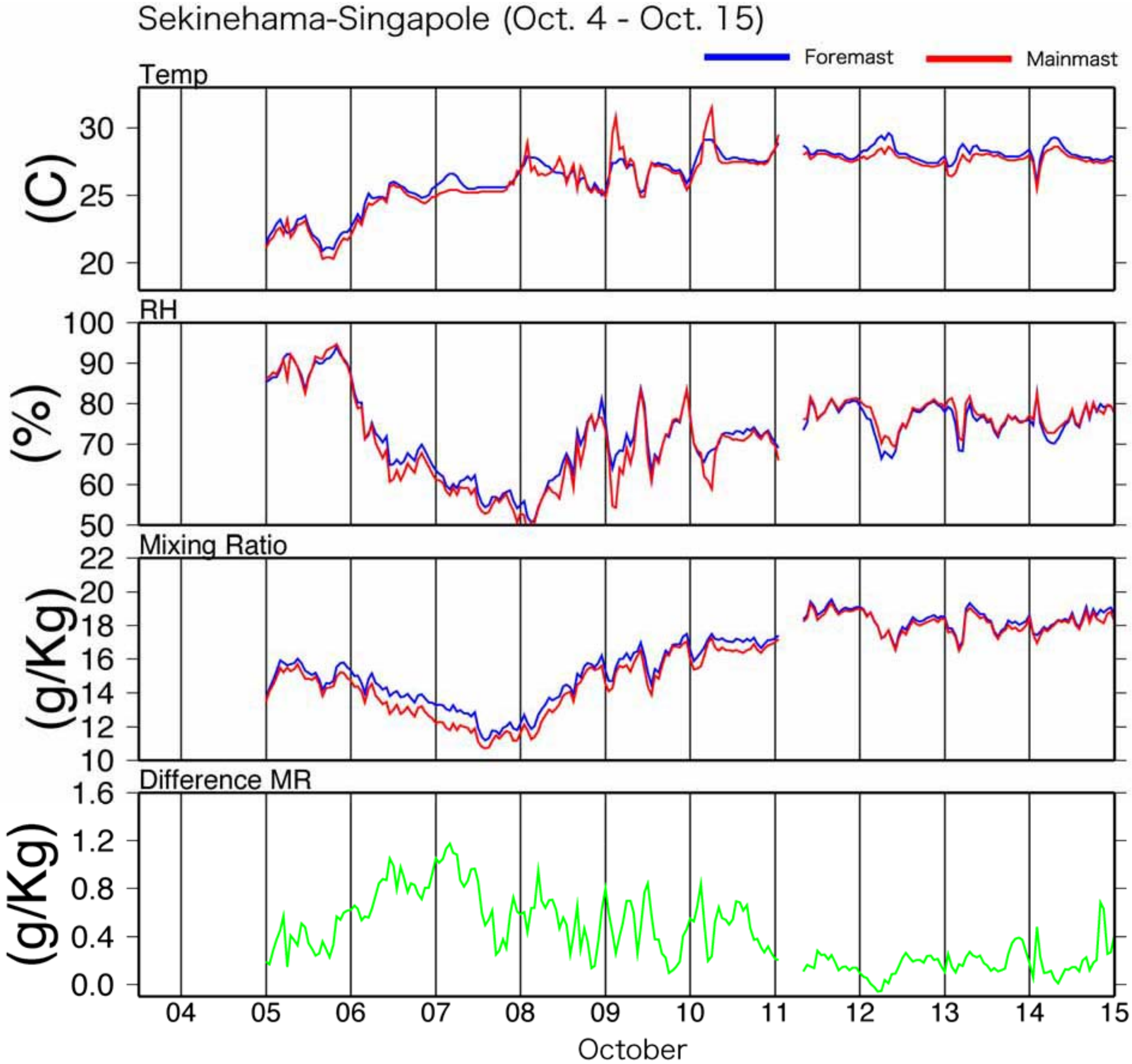


Fig. 5.10-1a. Temporal variation of (a) temperature (degC), (b) relative humidity (%), (c) mixing ratio (g/Kg), and (d) difference of mixing ratio between foremast and mainmast height from Sekinehama to Singapore.

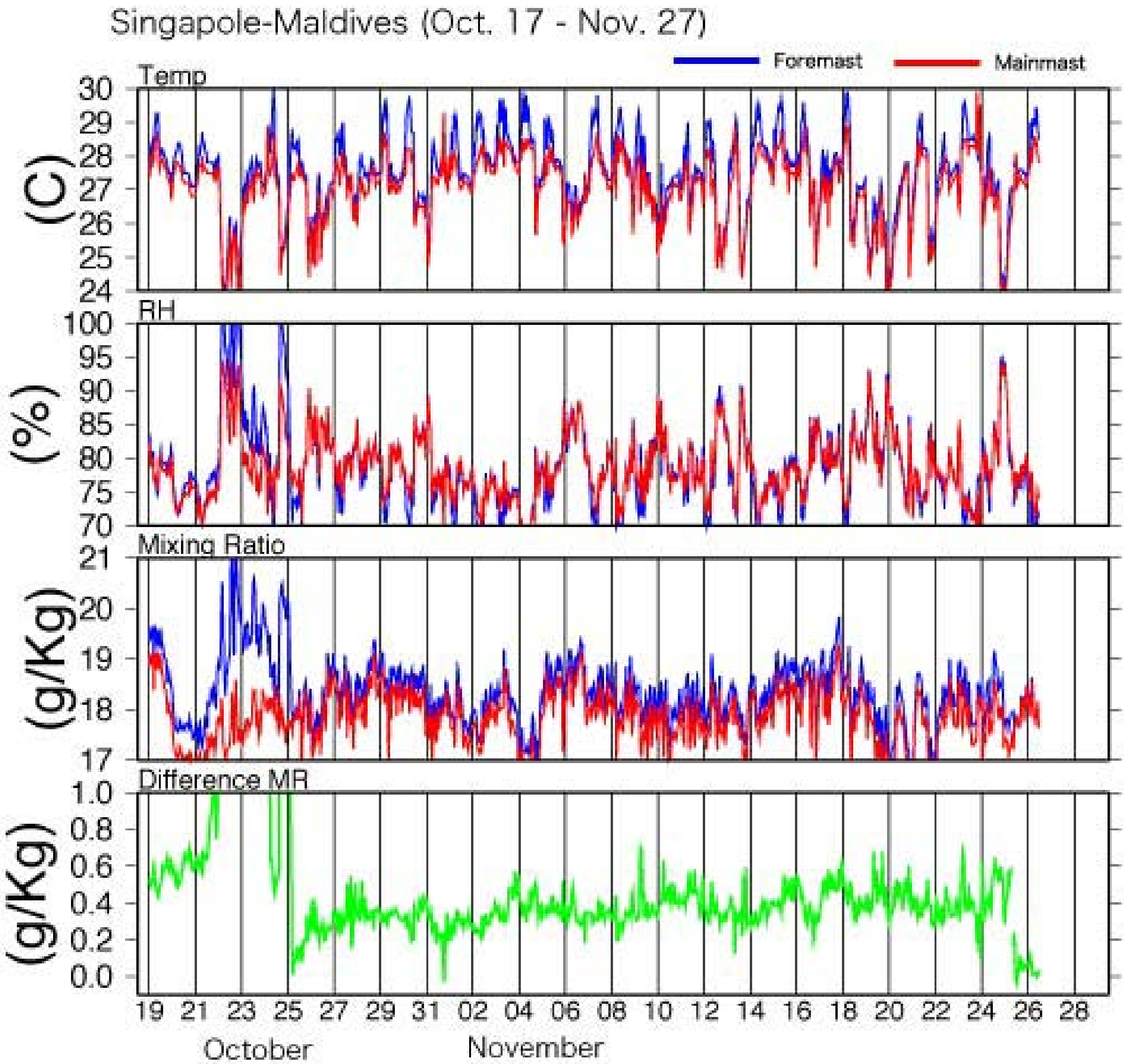


Fig. 5.10-1b. Same as Fig.5.10-1a but from Singapore to Maldives.

5.11 Infrared radiometer

(1) Personnel

Hajime Okamoto	(CAOS, Tohoku University)	Principal Investigator	* not on board
Naoki Mashiko	(CAOS, Tohoku University)		
Kaori Sato	(CAOS, Tohoku University)		* not on board
Nobuo Sugimoto	(National Institute for Environmental Studies)		* not on board
Ichiro Matsui	(National Institute for Environmental Studies)		

(2) Objective

The infrared radiometer (hereafter IR) is used to derive the temperature of the cloud base and emissivity of the thin ice clouds. Main objectives are to use study clouds and climate system in tropics by the combination of IR with active sensors such as lidar and 95GHz cloud radar. From these integrated approach, it is expected to extend our knowledge of clouds and climate system. Special emphasis is made to retrieve cloud microphysics in upper part of clouds, including sub-visual clouds that are recognized to be a key component for the exchange of water amount between troposphere and stratosphere.

(3) Method

IR instrument directly provides broadband infrared temperature (9.6-10.5 μm).
General specifications of IR system (KT 19II, HEITRONICS) are as follows.

Temperature range	-100 to 100°C
Accuracy	0.5°C
Mode	24 hours
Time resolution	1 min.
Field of view	Less than 1° (will be estimated later)
Spectral region	9.6-10.5 μm

This is converted to broadband radiance around the wavelength region. This is further combined with the lidar or radar for the retrieval of cloud microphysics such as optical thickness at visible wavelength, effective particle size. The applicability of the retrieval technique of the synergetic use of radar/IR or lidar/IR is so far limited to ice clouds. The microphysics of clouds from these techniques will be compared with other retrieval technique such as radar/lidar one or radar with multi-parameter.

(4) Results

Fig. 5.11-1 displays the temperature measured by IRT on Nov. 17, 2006.
The horizontal line denotes the hours (UTC) and vertical axis is the temperature. To avoid the damage due to direct sun light into the sensor of IRT, we put cover between 5-8 UTC and there are no measurements during the period. When the rain reach the surface, IRT should also be protected and the measurements are not made during the period, e.g., 14-15 UTC.

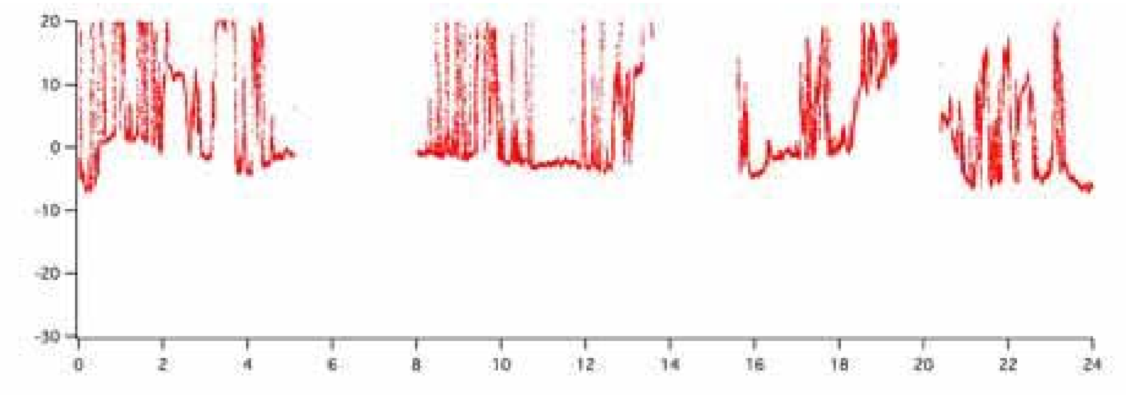


Fig. 5.11-1. Temperature measured by the IRT in Nov. 17, 2006.

(5) Data archive

The data archive server is set inside Tohoku University and the original data and the results of the analyses will be available from us.

(6) Remarks

Basically the IRT is operated for 24 hours. In order to avoid the direct sun light enters the lens of the IRT as well as precipitation, we use the shutter (cover) on the top of the lens.

5.12 Aerosol optical characteristics measured by Sky radiometer

(1) Personnel

Kazuma Aoki	(University of Toyama)	Principal Investigator	* not on board
Tatsuo Endoh	(Tottori University of Environmental Studies)		* not on board
Tamio Takamura	(CEReS, Chiba University)		* not on board
Teruyuki Nakajima	(CCSR, The University of Tokyo)		* not on board
Nobuo Sugimoto	(NIES)		* not on board

* Operation was supported by Global Ocean Development Inc. (GODI).

(2) Objective

Objective of the observations in this aerosol is to study distribution and optical characteristics of marine aerosols by using a sky radiometer (POM-01 MKII). Furthermore, collections of the data for calibration and validation to the remote sensing data were performed simultaneously

(3) Methods

Sky radiometer is measuring the direct solar irradiance and the solar aureole radiance distribution, has seven interference filters. Analysis of these data is performed by SKYRAD.pack version 4.2 developed by Nakajima *et al*. 1996.

(4) Results

Data obtained in this cruise will be analyzed at University of Toyama.

Measured parameters are as follows.

- Aerosol optical thickness at 5 wavelengths (400, 500, 675, 870 and 1020 nm)
- Ångström exponent
- Single scattering albedo at 5 wavelengths
- Size distribution of volume (0.01 μm – 20 μm)

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.

(5) Data Archives

Measurements of aerosol optical data are not archived so soon and developed, examined, arranged and finally provided as available data after a certain duration. All data will be archived at University of Toyama (K. Aoki, SKYNET/SKY: http://skyrad.sci.u-toyama.ac.jp/) and Chiba University (T. Takamura, SKYNET) after the quality check and submitted to JAMSTEC within 3-year.

5.13 Total Sky Imager

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

To monitor the cloud coverage in daytime.

(3) Method

The Total Sky Imager (TSI; Fig. 5.13-1) was installed at the top deck of the midship, altitude of 17m from sea level. TSI was developed jointly by Penn Status University, BNL and Yankee Environmental Systems, Inc. and manufactured by YES Inc. TSI captured and analyzed images every 5 minutes. Measured parameters are listed in Table 5.13-1.

Table 5.13-1. Parameters of TSI system

	Parameters	Unit
1	Opaque cloud cover	%
2	Thin cloud cover	%

Fig 5.13-1. Total Sky Imager (TSI)

(4) Results

We could not calculate the daytime cloud cover ratio because of shadow band to prevent reflected sunlight was out of order from 21:42 UTC 5 October. Whole sky photo and analyzed image on October 4 are shown Fig 5.13-2.

(5) Data archive

These raw data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC just after the cruise.

(6) Remarks

(a) Shadow band was out of order from 21:42UTC 5 Oct. Hereafter only photo images are available.
(b) Filter parameter setting; Clear/thin/Opaque 40 60, Sunny 50
(c) Images were captured and analyzed while Sun is more than 3 degrees above the horizon. Analyze Region of Sky Within 75 degrees of zenith.

Fig 5.13-2. Whole sky photo and analyzed image (October 4, 2006 06:56Z, Opaque cloud cover:12 %, Thin cloud cover: 15 %.)

5.14 Sea Surface Temperature Measurement

5.14.1 Infrared Sea surface temperature Autonomous Radiometer (ISAR)

(1) Personnel

R. Michael Reynolds	(RMRCO)	Principal Investigator
Jeremiah M. Reynolds	(RMRCO)	Instrument Technician

(2) Objective

To provide high-quality sea surface skin temperature measurements, Tskin, with the ISAR (Infrared Sea Surface Temperature Autonomous Radiometer), for the MISMO cruise.

(3) Method

The ISAR instrument was mounted on the ship foremast top on the starboard side and facing downward at 45 degrees from the horizontal (Fig. 5.14.1-1). It sampled sea surface, sky, and tow internal black body temperatures with a narrow field-of-view IR radiometer . Individual samples were taken every 2-3 seconds and an entire sweep required about three minutes. Individual samples were processed to a standard 10-min averaging time. For quality assurance temperatures from the JAMSTEC seasnake and the Mirai intake port were compared (Fig. 5.14.1-2).

Meteorological data were produced by the SOJ system (2-sec samples), ZMET system (10-sec), PRP (2-min averages), Seasnake (5-sec), and ISAR (10-min averages). These data were all averaged, quality checked, and merged into a single "best" data set (Fig. 5.14.1-3). This data set was used as input to the COARE-3 bulk flux software package to compute net ocean heat flux on a 10-min, daily, and full cruise averages (Fig. 5.14.1-4).

A special set of processing software to accomplish the above meteorological processing was developed. The software was demonstrated to Mirai staff. Then, it was applied to current and past data sets. Any software problems or operation questions were corrected over the remainder of the cruise.

(4) Results

Figure 5.14.1-1 shows (panel 1) the ISAR mounted on the foremast and (panel 2) the data acquisition system that was located in the meteorological data room.

Figure 5.14.1-2 shows an example of temperature measured by various instruments. Air temperature at 25-m height (approx) was measured by the Zeno data logger, Water temperature was measured at the Mirai intake port at 5-m depth and was recorded on the SOJ data files. Tskin was measured by ISAR and recorded on its data acquisition. Finally two Seasnake probes recorded water temperature just a few cm below the water surface.

Figure 5.14.1-3 is a plot of the meteorological measurements and computed sea surface energy fluxes for one day during the cruise.

Figure 5.14.1-4 shows the energy (heat) fluxes computed for one day.

(5) Data Archive

Raw data will be submitted to the Marine-Earth Data and Information Department of JAMSTEC.

Fig. 5.14.1-1. The ISAR (Infrared Sea Surface Temperature Autonomous Radiometer) was mounted on the foremast, starboard side with a 45º view to the ocean.

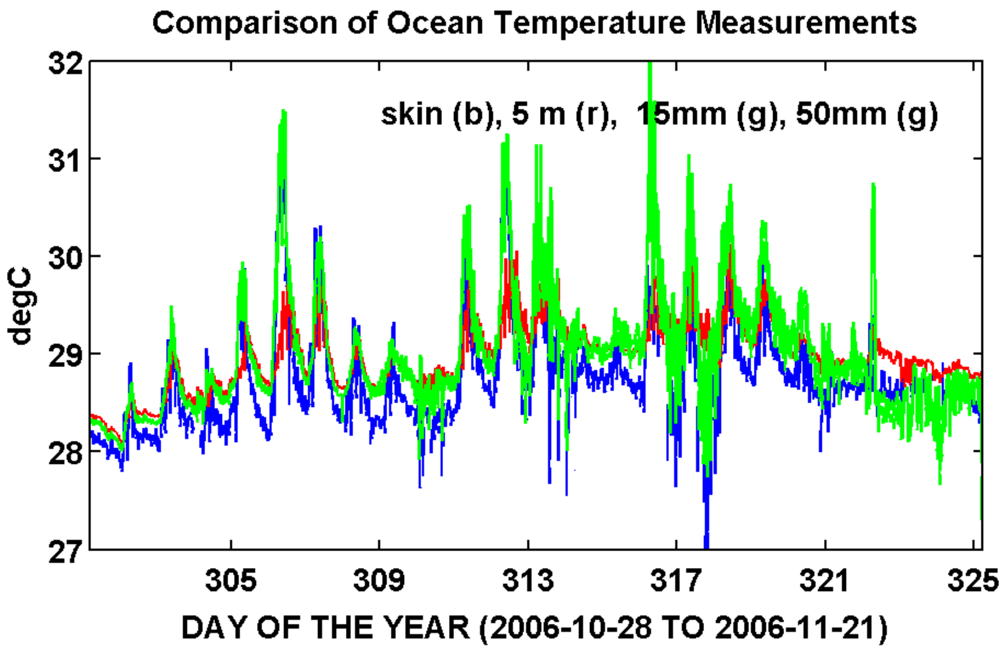


Fig. 5.14.1-2a. The cool skin (blue) is compared with the ship intake temperature at a depth of 5 m (red) and the two seasnake probes (green). On days with high insolation the seasnake and skin temperatures rise above the deeper water temperature. At night the skin and seasnake temperatures are cooler than the 5-m temperature.

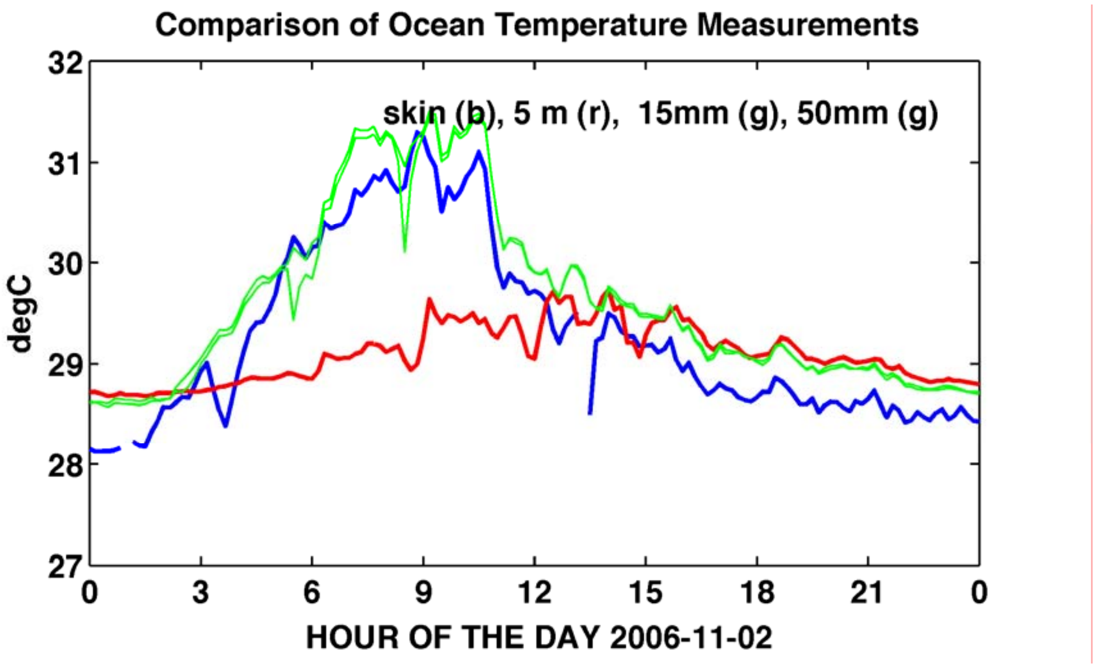


Fig. 5.14.1-2b. This blowup of the water temperature results for one sunny day is an excellent example of the warm layer and cool skin temperature behavior.

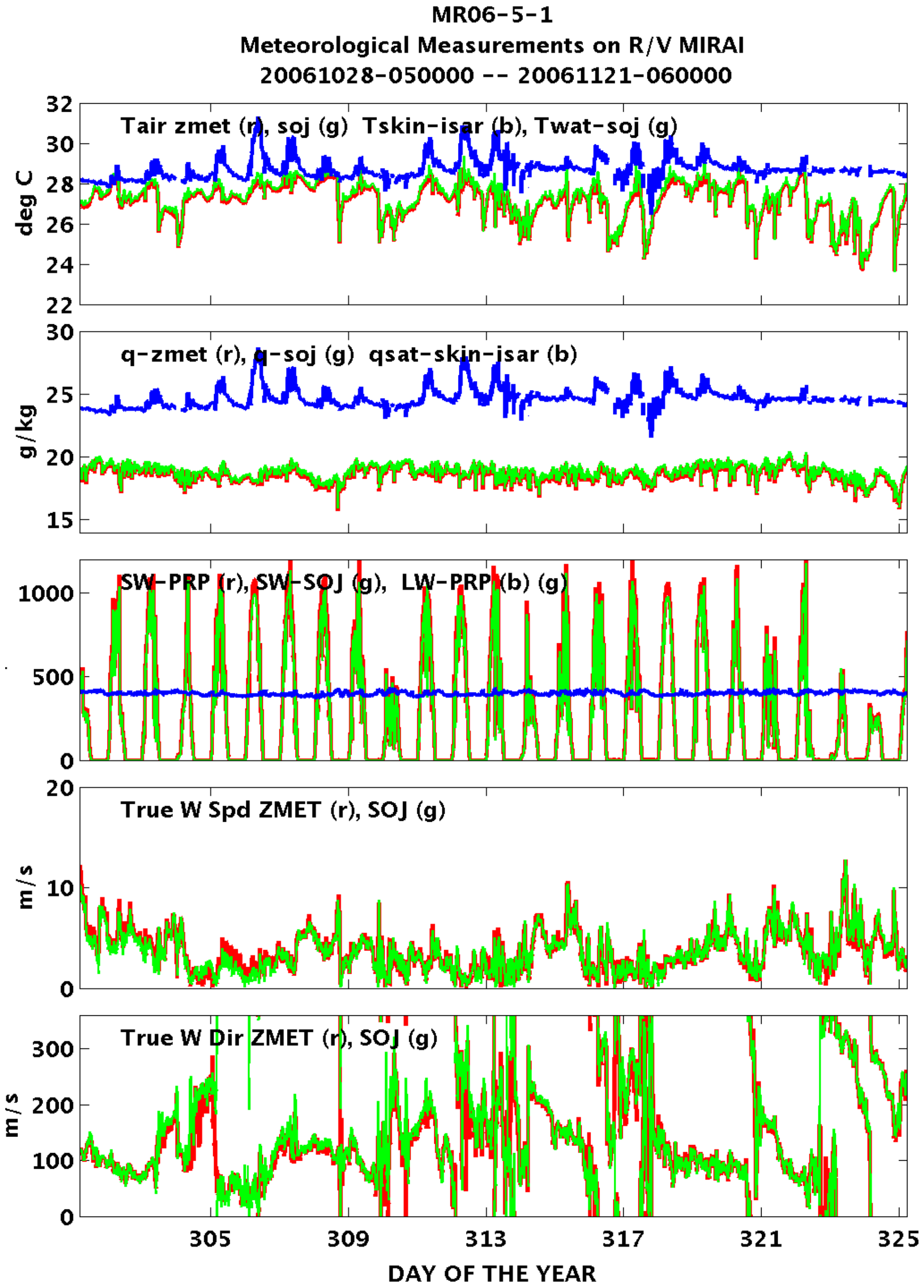


Fig. 5.14.1-3. Summary of meteorological observations during the intensive observation period. The SOJ (green) and Zeno (red) meteorological data are compared. All the data from all sources were pooled and a "best" data set was developed for application to the heat flux algorithm.

CRUISE mr06-5-1 --- FLUXES FOR 2006-11-12

UPWARD FLUXES, OCEAN COOLING -- BLUE   DOWNWARD FLUXES, OCEAN HEATING -- RED

Measurement	Mean	Minimum	Maximum
Rsd W/m^2	271.9	0.0	1063.8
Rwd W/m^2	389.9	369.8	412.2
Tair (C)	26.4	24.6	28.2
RH (%)	91.4	81.5	100.7
Wspd (m/s)	2.2	0.1	6.1
Rain (mm/hr)	1.3	0.0	54.0

DAILY FLUX	Mean	Minimum	Maximum
SW Net	256.9	0.0	1005.3
LW Net	67.6	47.9	86.3
Latent	56.0	18.3	127.4
Sensible	12.1	1.2	34.9
Rain	5.6	0.0	235.3
NET	115.5	-422.1	858.0

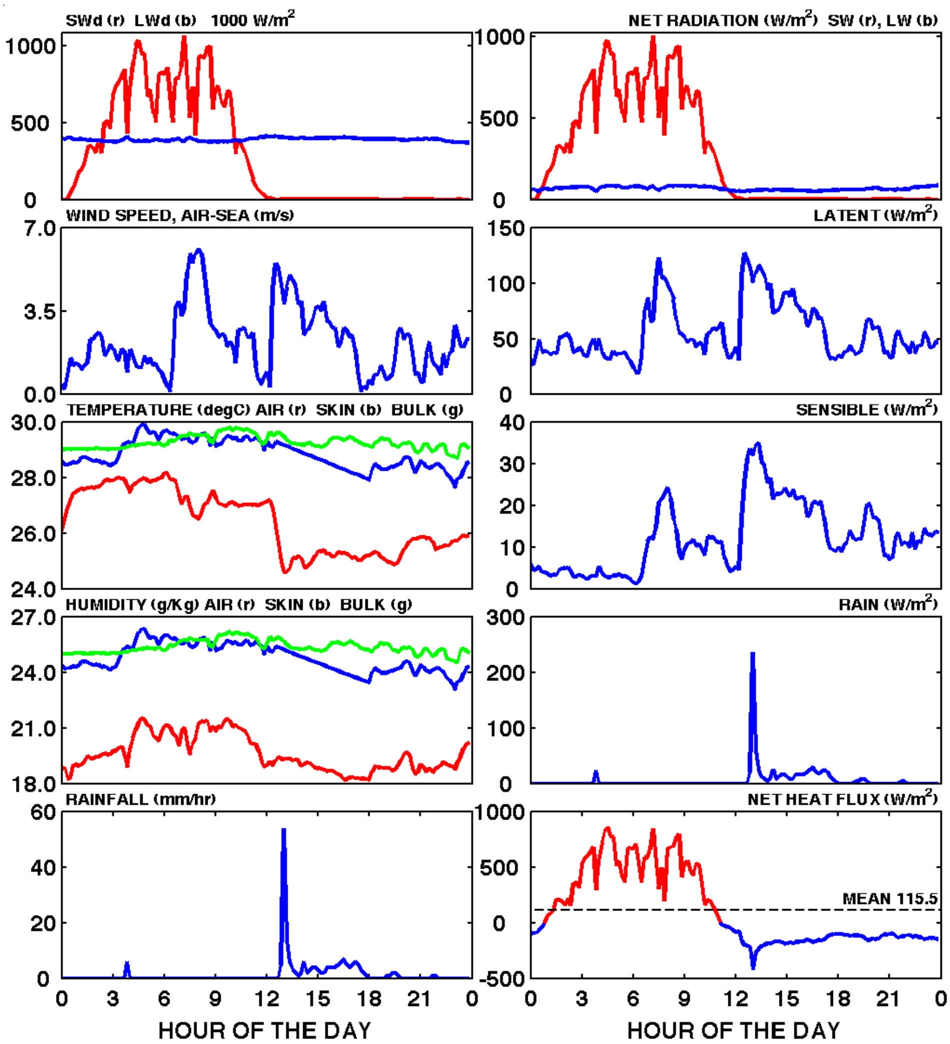


Fig. 5.14.1-4. An example of energy flux computations for one day in the intensive observation period. Graphs on the left show the "best" data set and graphs on the right are the computed fluxes: radiation, latent, sensible, rain and the net flux into the ocean. The net flux is high during the day but is negative at night. On this day the daily mean was 115.5 W/m^2, strong heating.

5.14.2 Sea-Snake SST measurement

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

The sea surface temperature (SST), especially skin-SST (SSST), has an important role to the heat and water vapor flux between air and sea. R/V Mirai continually measures SST of intake water, which is taken from 5m below the surface. To measure SSST, Sea-Snake was deployed during this cruise.

(3) Methods

Sea-Snake, designed by BNL (Brookhaven National Laboratory), has installed at the bow (5m extension boom). Our Sea-Snake has two thermistors (107 Campbell, USA, Fig. 5.14.2-1) which are tandem layout, locate at 5cm and 1.5m from the end of the cable (Fig. 5.14.2-2). They measured SSST with floating and flowing at the sea surface. The data was collected about every 5 seconds.

We converted sensor output voltages to SSST by using Steinhart-Hart equation leaded with the calibration data. An equation and coefficients are shown as below.

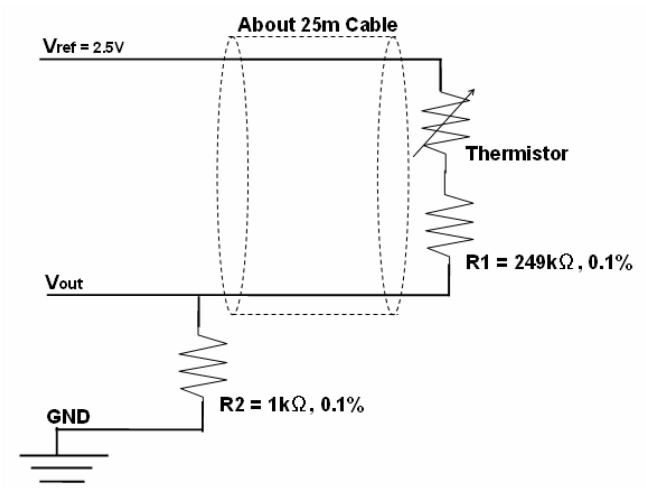


Fig. 5.14.2-1 Detail of the thermistor (C-107)

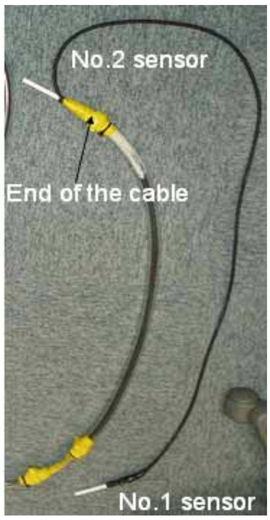


Fig. 5.14.2-2 Photo of sensors

Equations

$y = a + b * x + c * x * x * x$

$x = \log (1/ ((V_{ref} / V_{out} - 1) * R2 - R1)$

$T = 1 / y - 273.15$

where, $V_{ref} = 2.5$ [V], R1 = 249 [kΩ], R2 = 1[kΩ]

V_{out}: Sensor output voltage [V]

T: Temperature [degC],

Coefficients

	a	b	c
No.1 Sensor:	8.023218e-04	-2.117992e-04	-7.501966e-08
No.2 Sensor:	7.930758e-04	-2.136178e-04	-6.756559e-08

(4) Results

Figure 5.14.2-3 shows the time series of the Sea-Snake and SST from EPCS (-5m intake) data. In this figure, Sea-Snake data was averaged for 1 minute. But it was not considered the influence of the ship.

(5) Data archives

These raw and calculated data will be submitted to JAMSTEC Marine-Earth Data and Information Department just after the cruise.

(6) Remarks

SSST observation started at 0500UTC October 28 and finished at 0820UTC November 21.

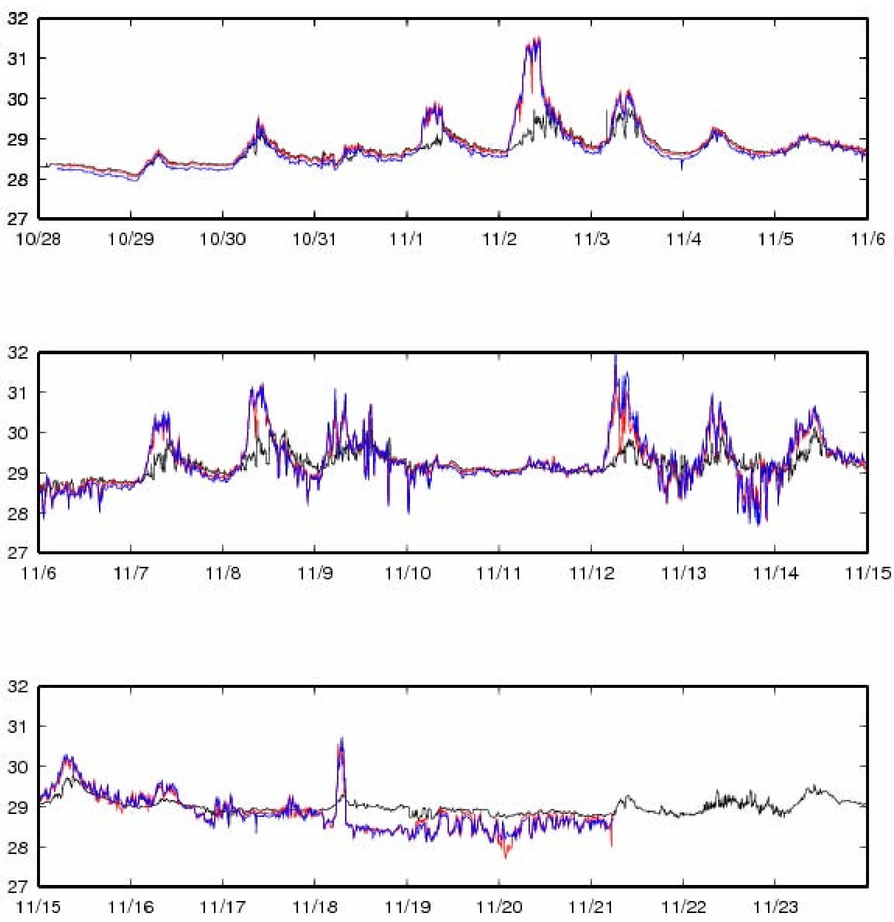


Fig. 5.14.2-3. Time series of the temperature
Black: Intake, Red: Sea-Snake No.1 sensor, Blue: Sea-Snake No.2 sensor

5.14.3 Measurement of SST and near-surface temperature stratification

(1) Personnel

Hiroshi Kawamura	(Tohoku University)	Principal Investigator	* not on board
Kentaro Ando	(JAMSTEC)	On board Principal Investigator	
Huiling Qin	(Tohoku University)		
Yoshimi Kawai	(JAMSTEC)		* not on board

(2) Objectives

The objectives of this study are to validate the quality of SST data from surface buoy and the SST data from satellite, and to understand mechanism of SST and near surface temperature change. The methods of our approach to the objectives are

(a) To install temperature sensors around surface buoys of TRITON buoy and m-TRITON buoy (Exp-A), and

(b) To measure the near surface temperature and SST from the bow of the ship (Exp-B).

(3) Method

(a) Measurement of near surface temperature variations around buoy (Exp-A)

The instruments are constructed by five T107 temperature probes of Cambel Scientific and one CR10X data logger of Cambel Scientific. The five temperature probes are connected to one data logger. The interval is set to be 2 minutes.

We prepare two sets, one for 0-82E m-TRITON buoy and the other for 1.5S90E TRITON. Unfortunately, as the 1.5S90E TRITON buoy was vandalized and could not expect the meteorological measurement on the buoy, we gave up the measurement. Instead of it, we decided to install it on the 0-79E m-TRITON.

Fig. 5.14.3-1 and 2 show the installation of the instrument to the 0-82E m-TRITON buoy. The silver-colored container at the mast of the buoy is for the data logger and the battery. The black cable from the container extends to the bottom of the buoy by the guide of stainless chain. Along the stainless chain, we installed five temperature probes at 0m, 25cm, 50cm, 100cm, and 150cm depth for the 0-82E m-TRITON buoy and the 0-79E m-TRITON buoy.

In these experiments, no significant drift of clock in the data logger was observed.

(b) Measurement of near surface temperature variations from the bow of the ship (Exp-B)

The instruments are ALEC temperature sensor and ALEC depth sensor, and HOBO temperature sensor. These sensors are small and self-recording type, and are installed along the 4mm-diameter and 3m-length stainless-steel wire using wire clips. The positions of temperature sensor installation on the wire are at 1.5m, 2m, 2.5m and 3m from the top of wire, and that of pressure sensor at 3m from the top (Fig. 5.14.3-3).

Using the boom extending to the frontward of the ship and specially designed steel bar extending 2-meters towards the portside, the sensors with wire system is hanged to the surface using the 10mm-diameter cotton rope. The wire-clipped sensor system is set to be sea-surface to 3 meters while the ship stops. The system was recovered in every weeks, and the total period of measurement was 25 days (3 experimental periods from B-1 to B-3). Unfortunately, in the last experimental period (B-3), the pressure sensor was lost due to the rough sea condition, therefore we cannot get profile data. Table 5.14.3-1 shows the serial number and sensor set up information in each experimental period.

Table 5.14.3-1 Sensors and set-up information in each experiment

Experiment B-1 (10/28 9amUTC-11/4 6am UTC)				
Nominal depth	Sensor S/N	Sample	Depth	Remarks
1.5m T-sensor	ALEC 101631	1 min	150cm	clock set 1 hr behind
2m T-sensor	HOBO 956273	1min	110cm	
2.5m T-sensor	HOBO 774312	1min	60cm	
3m T-sensor	ALEC 101630	1min	24cm	clock set 1 hr behind
3m P-sensor	ALEC 300558	1min	14cm	clock set 1 hr behind
Experiment B-2 (11/4 9amUTC-11/11 6am UTC)				
Nominal depth	Sensor S/N	Sample	Depth	Remarks
1.5m T-sensor	ALEC 101631	1 min	150cm	clock set 1 hr behind
2m T-sensor	HOBO 956273	1min	110cm	
2.5m T-sensor	HOBO 774312	1min	60cm	
3m T-sensor	ALEC 101630	1min	14cm	clock set 1 hr behind
3m P-sensor	ALEC 300558	1sec	25cm	clock set 1 hr behind
Experiment B-3 (11/11 9am UTC-11/21 9am UTC)				
Nominal depth	Sensor S/N	Sample	Depth	Remarks
1.5m T-sensor	ALEC 101631	1 min	150cm	
2m T-sensor	HOBO 956273	1min	110cm	
2.5m T-sensor	HOBO 774312	1min	60cm	
3m T-sensor	ALEC 101630	1min	14cm	
3m P-sensor	ALEC 300558	1min	25cm	

We also measured SST using infrared radiometer. Two infrared radiometers were fixed on a boom horizontally extended from the ship bow to observe sea surface skin temperature. The two radiometers were set almost vertically to view the sea surface and the sky, respectively. They measured the infrared radiation emitted from the sea surface, or from the sky. Because the sea surface emissivity is less than unity, the effect of the sky radiance reflected at the sea surface has to be considered when calculating skin SST from radiometer data. One of the purposes of this observation was a feasibility test of the low-cost radiometer for the skin SST measurement. The detector responds to radiance at the wavelength of 16-35 μm (although its published nominal spectral range is 8.0-16.0 μm). The radiometer that viewed the sea surface was stored in a stainless cylinder with a diameter of 6 cm, a length of 40 cm and no bottom in order to protect the radiometer from rain and seawater. The other one was uncovered. The observations were done for 10 minutes from the hour (i.e. 00:00-00:10, 01:00-01:10…). The sampling interval was 0.5 s.

Fig. 5.14.3-1 The container for data-logger (silver) installed on the mast of m-TRITON at 0-79E.

Fig. 5.14.3-2 The thermisters (white bar connected to black signal cable) installed along the stainless chain.

Fig. 5.14.3-3 Self-recording thermometer and depth meters installed along the 3-meters and 4mm-diameter wire cable

(4) Results

(a) Near surface temperature variations around m-TRITON buoy (Fig. 5.14.3-4)

At the 0-79E buoy, large amplitudes of diurnal cycle with large temperature gradient above 1.5meter were observed during the days of 305, 306, 307, 311, 312, 313, and 326. At the 0-82E buoy, large amplitudes were observed during the days of 312, 316, and 318. During these days, strong thermal stratifications above 1.5 meter were also observed. The highest amplitude more than 32 degree-C was observed at 0-79E in the day 313 at the 0-meter sensor. Except for these days, the temperature observed by 5 sensors shows homogeneous both during daytime and night time, and the diurnal amplitudes of SST were small.

Further analysis will include analysis of surface meteorology observed by the m-TRITON buoys, mixed layer model run for investigating affection to the mixed layer heat storage and upper ocean heat content, satellite data validation, and validation of buoy SST data measured at 1.0meter.

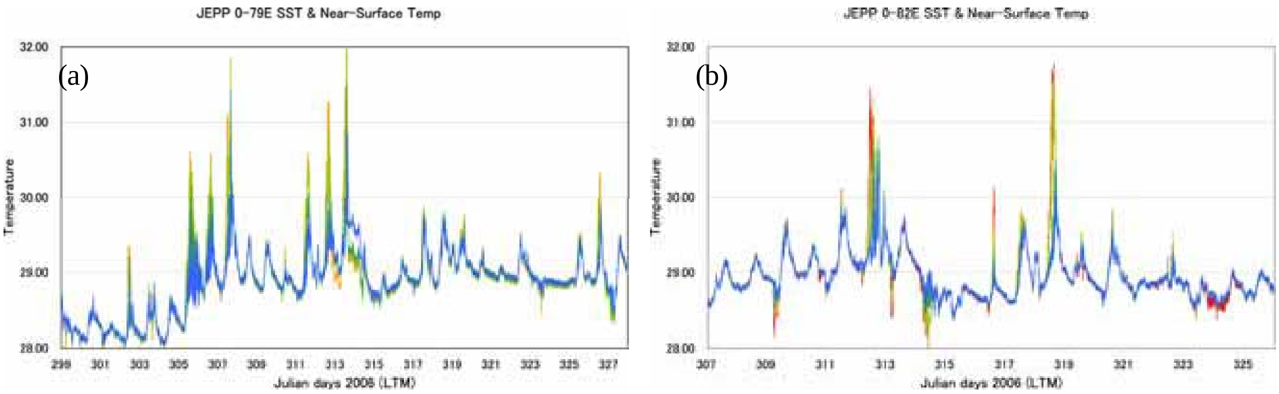


Fig. 5.14.3-4. The near-surface temperature variations observed (a) at the 0-79E buoy and (b) at the 0-82E buoy. Blue, dark green, light green, orange, and red lines indicate the temperature at 1.5meter, 1.0meter, 0.5m, 0.25m, and 0m, respectively. The 0m temperature data at 0-79E was not shown due to suspicious data, and all temperature data before the day 306 at 0-82E were not shown due to the large offset (reason unknown).

(b) Near surface temperature variations from the bow of the ship (Fig. 5.14.3-5)

The strong diurnal signals were observed in Nov. 2 (306 in Julian day), 3 (307), 7 (311), 8 (312), and 9 (313). The highest temperature was observed in Nov.2 at 0.5m, and is higher than 31 degree-C. In these days, strong stratifications were observed only in the upper layer above 1.5 meters, where CTD-winch system cannot observe if normally operated.

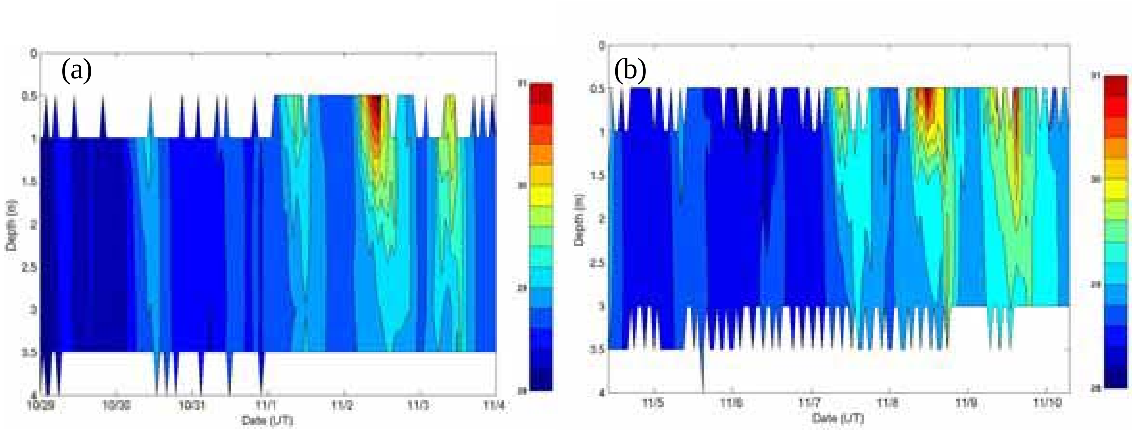


Fig. 5.14.3-5 The near-surface temperature variations observed from the bow of the ship. The time series from Oct 29 to Nov 4 are shown in (a) and that from Nov 4 to Nov 10 in (b).

(5) Data Archive

Raw data and grid data will be submitted to the Marine-Earth Data and Information Department of JAMSTEC.

(6) Remarks

This project was conducted under the cooperative study between JAMSTEC and Tohoku University in FY2005-2007.

5.15 Surface Meteorological Measurement

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

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.

(3) Methods

The surface meteorological parameters were observed throughout MR06-05 cruise from the departure of Sekinehama on 4 October 2006 to the arrival of Male on 27 November 2006.

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

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

(3-1) Mirai surface meteorological observation system

Instruments of SMET are listed in Table 5.15-1 and measured parameters are listed in Table 5.15-2. Data was collected and processed by KOAC-7800 weather data processor made by Koshin Denki, Japan. The data set has 6-second averaged.

Table 5.15-1. Instruments and their installation locations of Mirai meteorological system

Sensors	Type	Manufacturer	Location (altitude from surface)
Anemometer	KE-500	Koshin Denki, Japan	foremast (24m)
Thermometer	HMP45A	Vaisala, Finland	compass deck (21m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
	RFN1-0	Koshin Denki, Japan	4th deck (-1m, inlet -5m) SST
Barometer	Model-370	Setra System,USA	weather observation room captain deck (13m)
Rain gauge	50202	R. M. Young, USA	compass deck (19m)
Optical rain gauge	ORG-815DR	Osi, USA	compass deck (19m)
Radiometer (short wave)	MS-801	Eiko Seiki, Japan	radar mast (28m)
Radiometer (long wave)	MS-202	Eiko Seiki, Japan	radar mast (28m)
Wave height meter	MW-2	Tsurumi-seiki, Japan	bow (10m)

Table 5.15-2. Parameters of Mirai meteorological observation system

	Parmeter	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	6sec./10min. averaged
6	Relative wind direction	degree	6sec./10min. averaged
7	True wind speed	m/s	6sec./10min. averaged
8	True wind direction	degree	6sec./10min. averaged
9	Barometric pressure	hPa	adjusted to sea surface level 6sec. averaged
10	Air temperature (starboard side)	degC	6sec. averaged
11	Air temperature (port side)	degC	6sec. averaged
12	Dewpoint temperature (starboard side)	degC	6sec. averaged
13	Dewpoint temperature (port side)	degC	6sec. averaged
14	Relative humidity (starboard side)	%	6sec. averaged
15	Relative humidity (port side)	%	6sec. averaged
16	Sea surface temperature	degC	6sec. 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 radiation	W/m^2	6sec. averaged
20	Down welling infra-red radiation	W/m^2	6sec. averaged
21	Significant wave height (fore)	m	hourly
22	Significant wave height (aft)	m	hourly
23	Significant wave period	second	hourly
24	Significant wave period	second	hourly

(3-2) Shipboard Oceanographic and Atmospheric Radiation (SOAR) system

SOAR system, designed by BNL (Brookhaven National Laboratory, USA), is consisted of 3 parts.

1. Portable Radiation Package (PRP) designed by BNL – short and long wave downward radiation
2. Zeno meteorological system designed by BNL – wind, air temperature, relative humidity, pressure and rainfall measurement
3. Scientific Computer System (SCS) designed by NOAA (National Oceanographic 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 5.15-3 and measured parameters are listed in Table 5.15-4.

Table 5.15-3. Instruments and their installation locations of SOAR system

Sensors	Type	Manufacturer	Location (altitude from surface)
Zeno/Met			
Anemometer	05106	R.M. Young, USA	foremast (25m)
Tair/RH	HMP45A	Vaisala, Finland	foremast (24m)
	with 43408 Gill aspirated radiation shield (R.M. Young)		
Barometer	61201	R.M. Young, USA	foremast (24m)
	with 61002 Gill pressure port (R.M. Young)		
Rain gauge	50202	R. M. Young, USA	foremast (24m)
Optical rain gauge	ORG-815DA	Osi, USA	foremast (24m)
PRP			
Radiometer (short wave)	PSP	Eppley, USA	foremast (25m)
Radiometer (long wave)	PIR	Eppley, USA	foremast (25m)
Fast Rotating Shadowband Radiometer		Yankee, USA	foremast (25m)

Table 5.15-4. Parameters of SOAR system

	Parmeter	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 50mm
12	Down welling shortwave radiation	W/m^2	
13	Down welling infra-red radiation	W/m^2	
14	Defuse irradiance	W/m^2	

(4) Results

Figure 5.15-1 shows the time series of the following parameters during the stationary observation period; Wind (SOAR), air temperature (SOAR), relative humidity (SOAR), precipitation (SOAR), short/long wave radiation (SOAR), pressure (SOAR). 30 minutes accumulated precipitation data from SOAR optical rain gauge was converted to the rainfall intensity.

(5) Data archives

These raw data will be submitted to the JAMSTEC Marine-Earth Data and Information Department just after the cruise.

(6) Remarks

(a) The following period, we did not collect PRP data due to the trouble of the power supply.

22 Nov. 11:37 UTC – 23 Nov. 04:24 UTC

(b) The following period, we did not collect PRP data due to the maintenance works.

3 Nov. 07:24 UTC–12:20 UTC

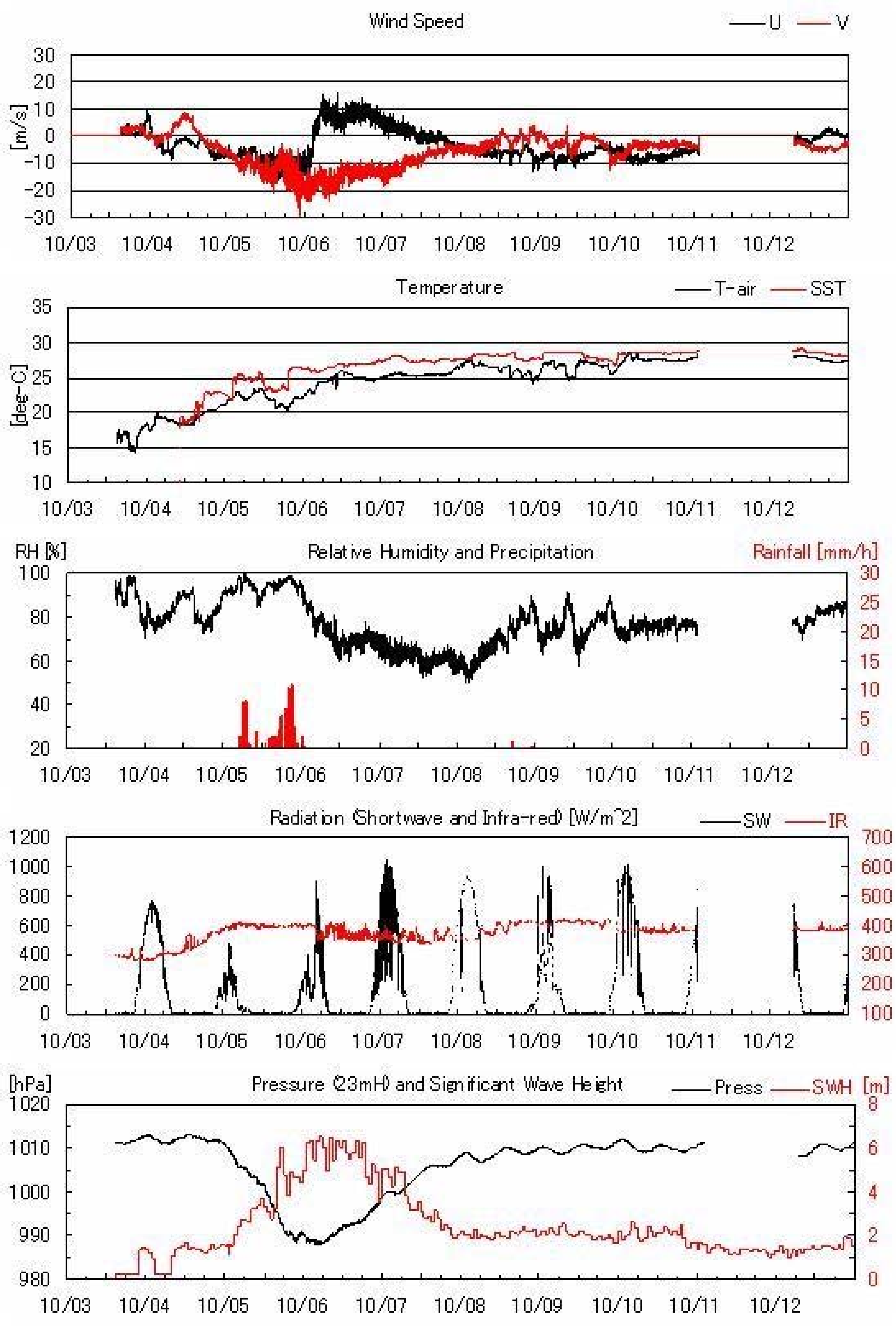


Fig. 5.15-1. Time series of surface meteorological parameters during the stationary observation.

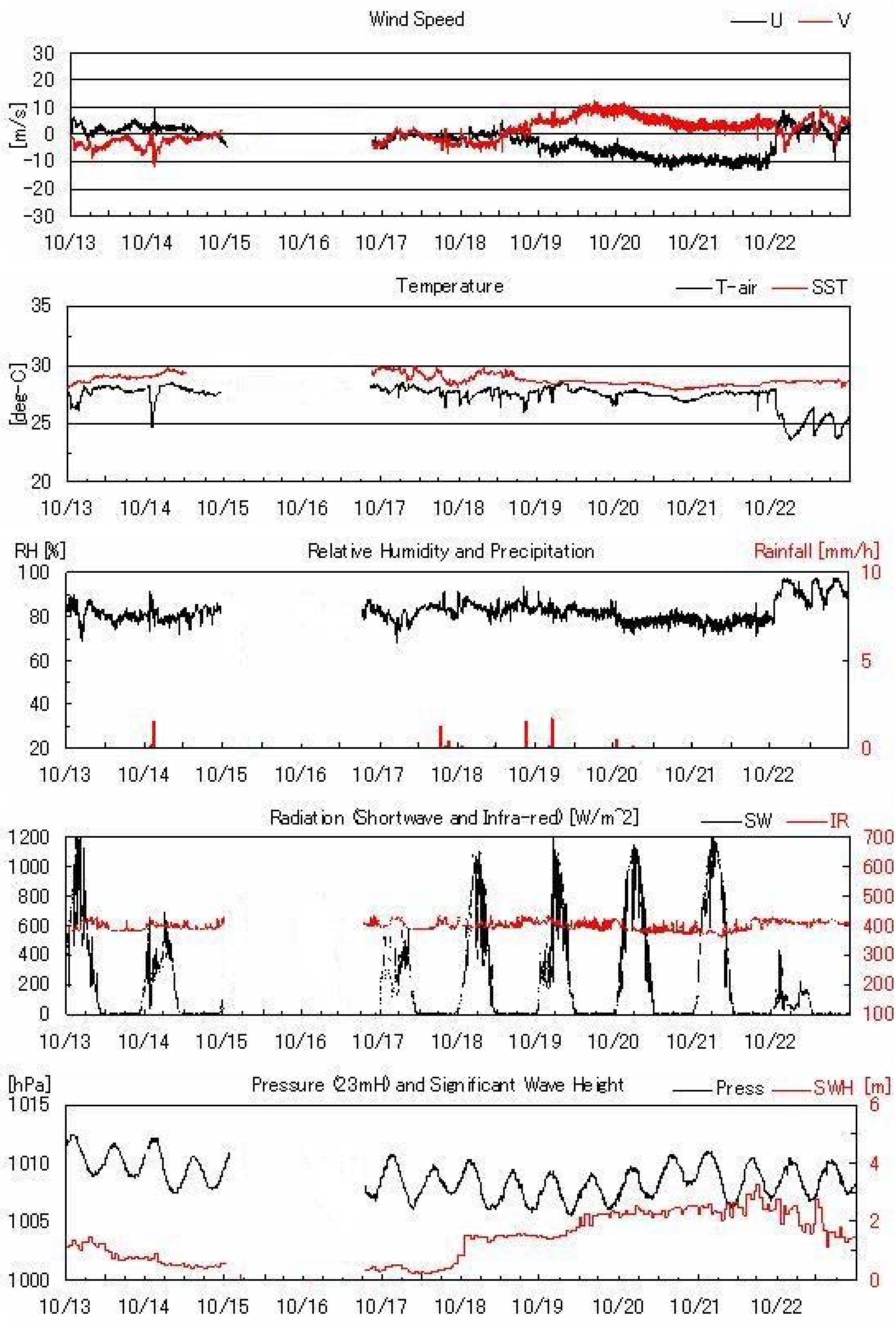


Fig. 5.15-1. (continued)

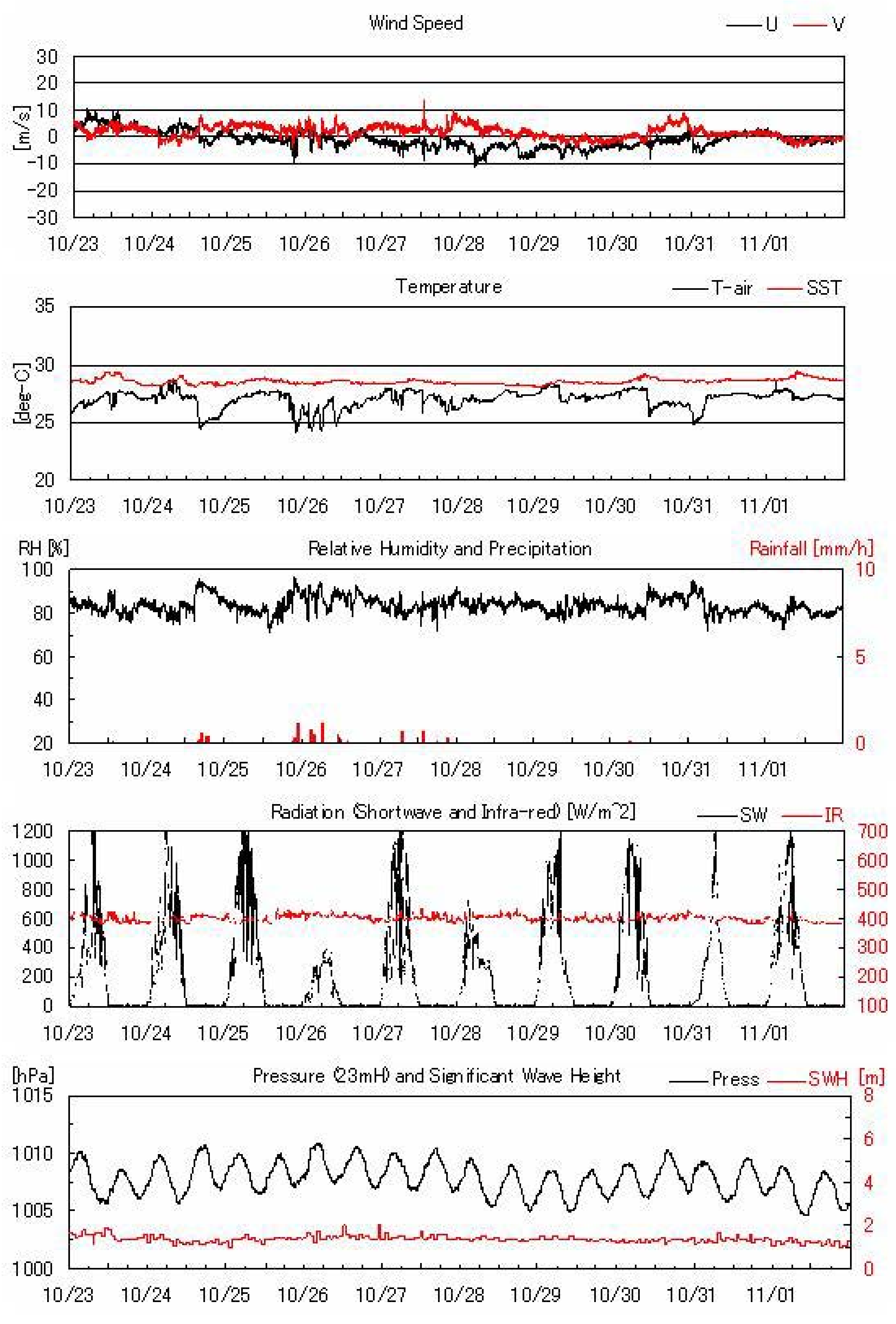


Fig. 5.15-1. (continued)

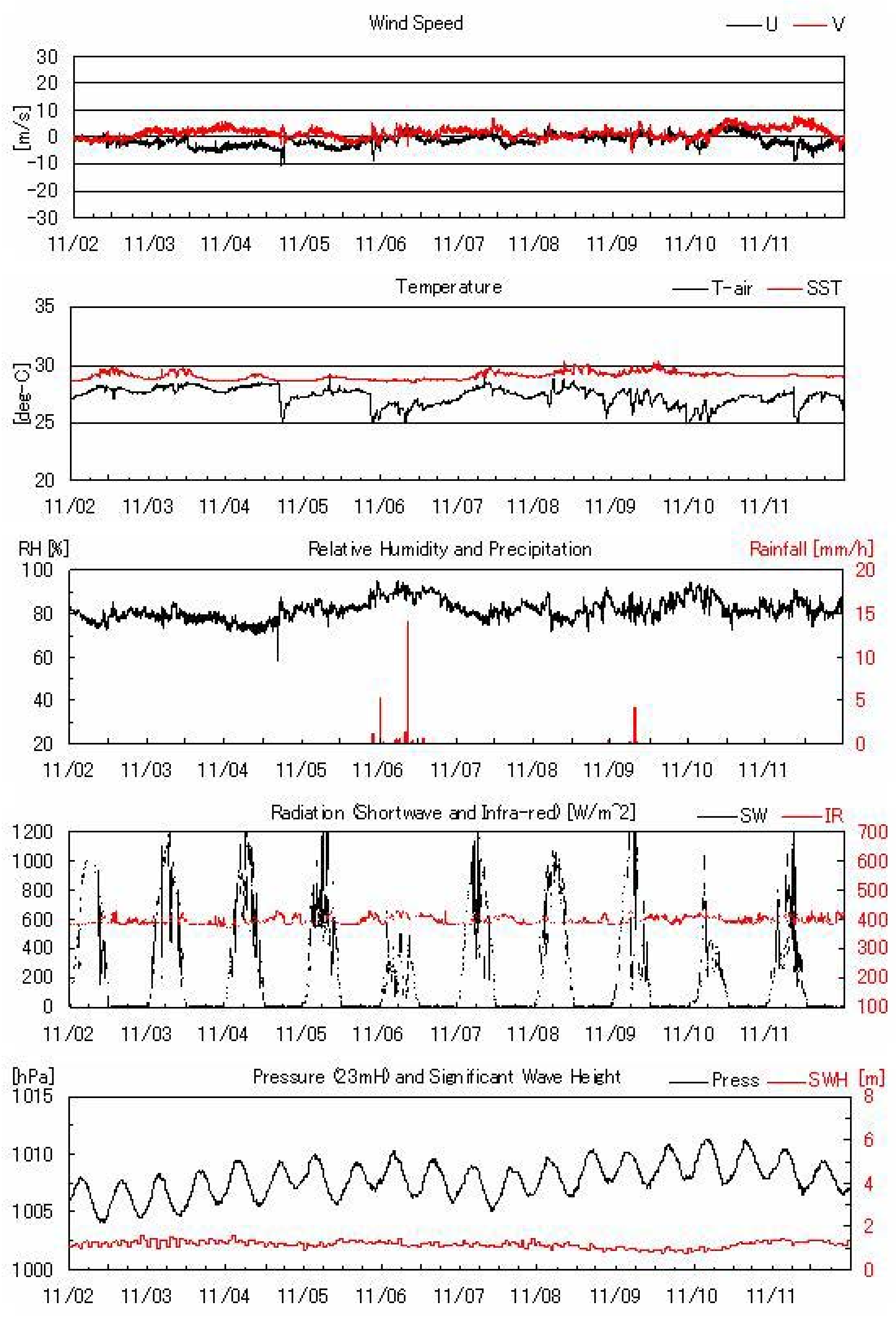


Fig. 5.15-1. (continued)

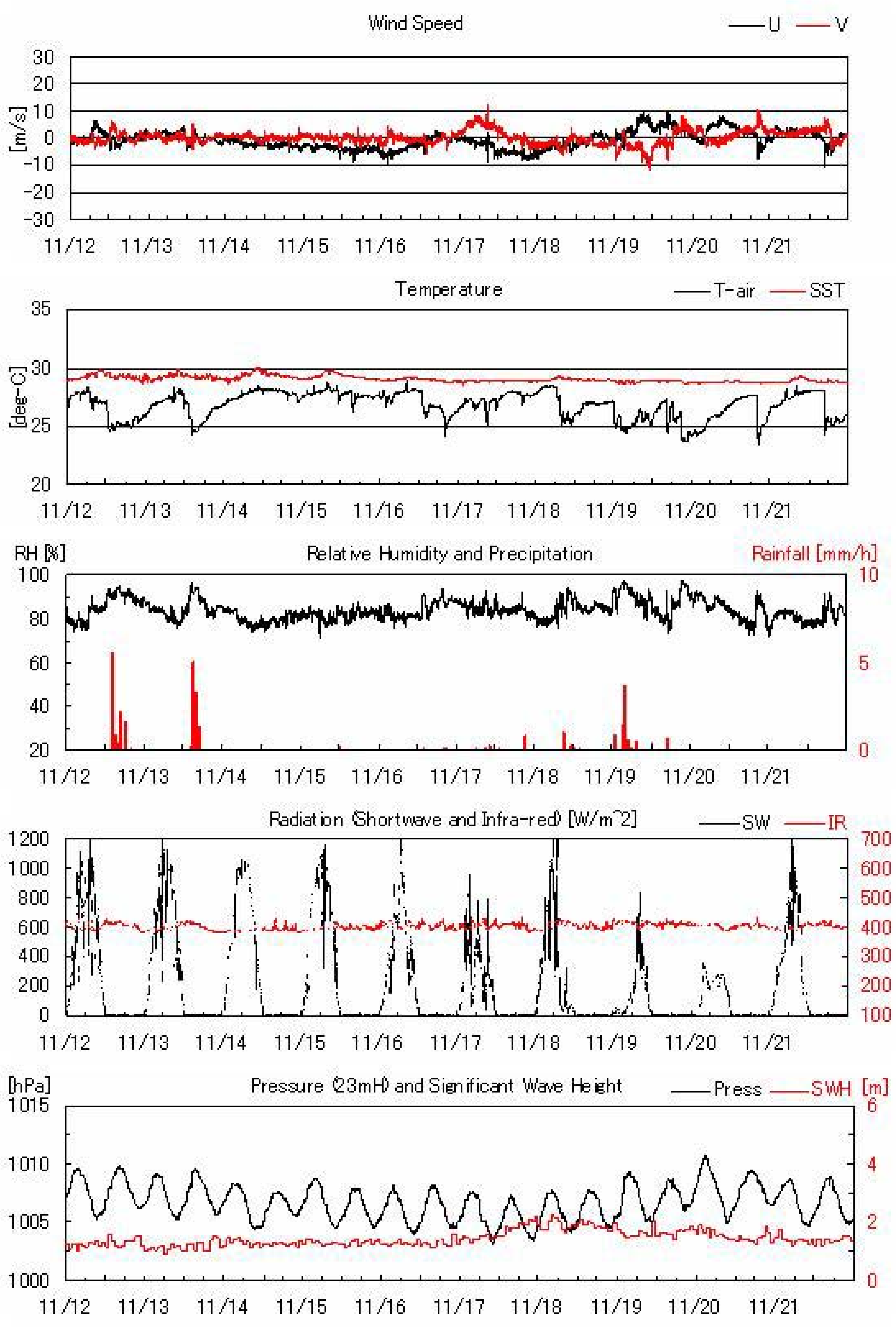


Fig. 5.15-1. (continued)

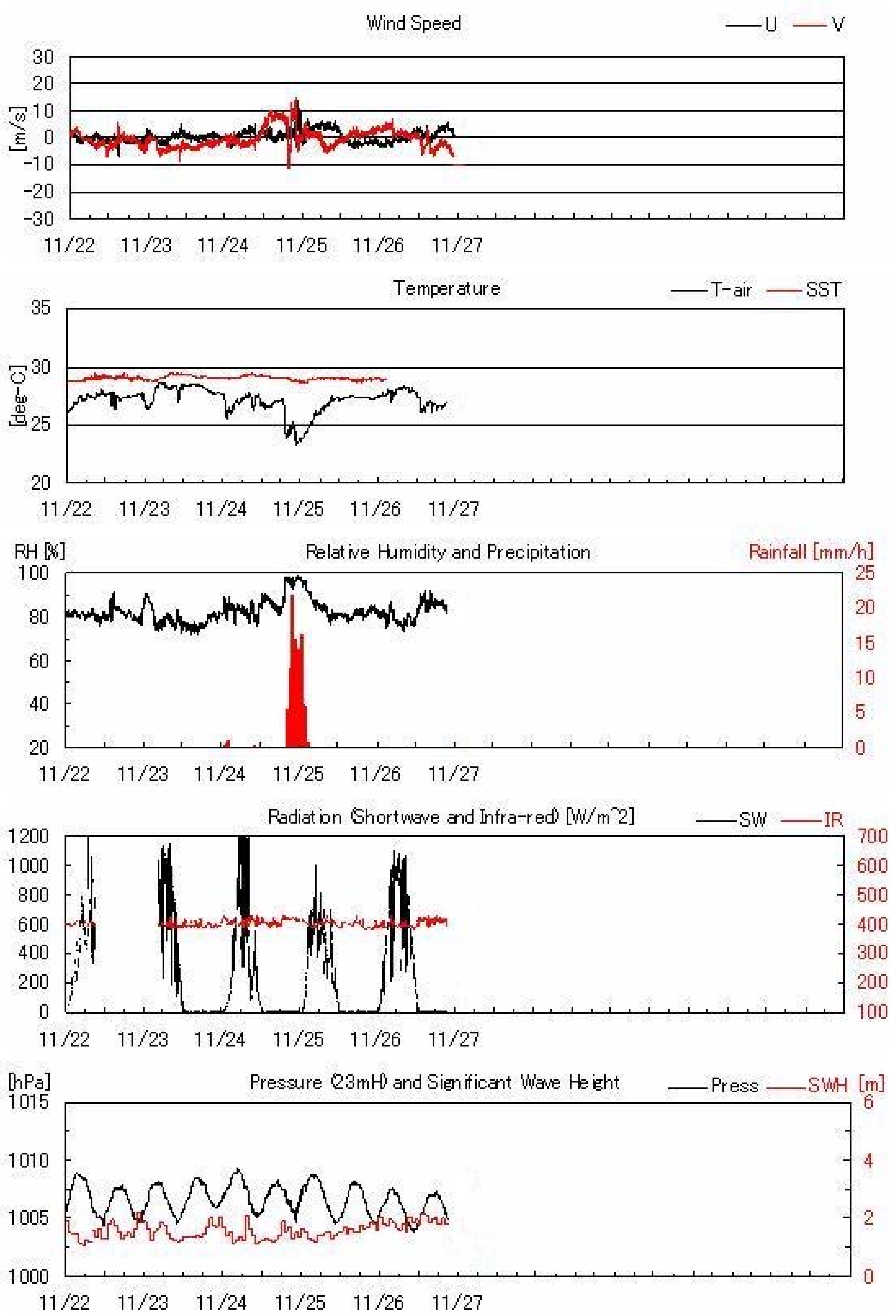


Fig. 5.15-1. (continued)

5.16 Air-sea surface eddy flux measurement

(1) Personnel

Yoshihito Suwa	(Okayama University)	On-board Principal Investigator
Chikako Watanabe	(Okayama University)	
Osamu Tsukamoto	(Okayama University)	Principal Investigator
Fumiyoshi Kondo	(Okayama University)	* not on board
Toru Iwata	(Okayama University)	* not on board
Hiroshi Ishida	(Kobe University)	* not on board

(2) Objective

Current interest in air-sea interaction calls for accurate measurements of eddy fluxes of momentum, surface heat, water vapor and carbon dioxide (CO_2) in order to achieve our deeper understanding on the relationships between recent CO_2 increase and global climate dynamics. The most promising technique for these fluxes measurements is the eddy covariance technique.

(3) Methods

The surface turbulent flux system consists of turbulence sensors and ship motion sensors (Kanto Aircraft Instrument Co.,Ltd.). The turbulence sensors are installed at the top of the foremast. A three-dimensional sonic anemometer-thermometer (KAIJO SONIC, DA-600) has been in continuous operation since June 2000 (MR00-K04), and an infrared gas analyzer (LI-COR, LI-7500) since May 2002. The sonic anemometer measures three-dimensional wind velocity 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 (generally called "Open-path system") that measures turbulent signals of carbon dioxide and water vapor simultaneously. Fig. 5.16-1(left) shows the installation of the instruments at the top of the foremast.

These turbulence and ship motion signals are sampled at 10Hz by a PC-based data logging system (Labview, National Instruments Co.,Ltd.). The 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 turbulence data and ship motion data, turbulent fluxes and statistics are calculated in a real-time basis and displayed on the PC. The dataset include every 0.1 sec raw data and 1min mean statistic data.

During the present cruise, new data acquisition/processing software(Labview8, National Instruments Co.,Ltd.) was introduced. It includes faster sampling rate to improve S/N ratio and improved display system. It was tested and modified before the routine stationary observation with success. The old version software was operated in parallel to process the closed path flux system as shown in the next paragraph.

In addition to these turbulent flux measurement instruments, "closed-path CO_2 flux system" was mounted during the present cruise for the purpose of comparison between open- and closed-path systems. A closed-path gas analyzer, LI-7000 was installed at the top of the foremast. Air was introduced into the closed cell by an air pump through a water vapor dryer system as shown in Fig. 5.16-1(right). Fig. 5.16-2 shows the block diagram of the closed path CO2 flux system.

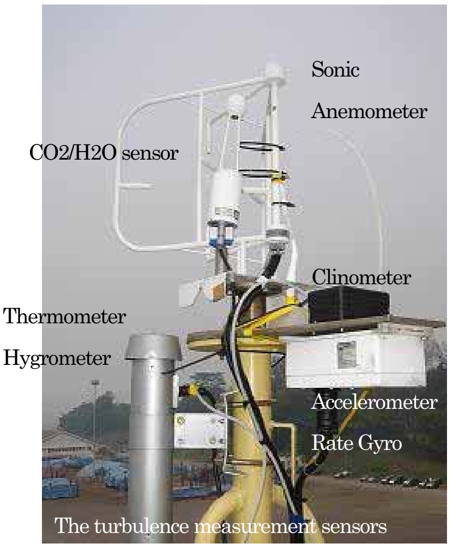
The whole eddy flux system had run continuously during the cruise. Especially during the stationary observation period at 0,80E, 3 hourly ‘flux cruise’ was applied on MIRAI. The ship steamed up against the wind about an hour to reduce the dynamic and thermal effects of ship body and returned to the station.

(4) Results

Based on the raw 10Hz turbulence data, apparent wind velocities were corrected and eddy-covariance method was applied to lead eddy fluxes of sensible heat, latent heat and CO2. Fig. 5.16-3 shows the preliminary results during the stationary observation period at 0,80E based on preliminary quality control. Eddy fluxes were originally calculated every 10 minutes and averaged over 3 hours. Three-hourly ship operations for turbulent flux measurements during the stationary observation period were performed as listed in Table. 5.16-1.

(5) Data Archives

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. Interested scientists should contact Prof. O. Tsukamoto at Okayama University. The corrected data and inventory information will be submitted to JAMSTEC Marine-Earth Data and Information Department.



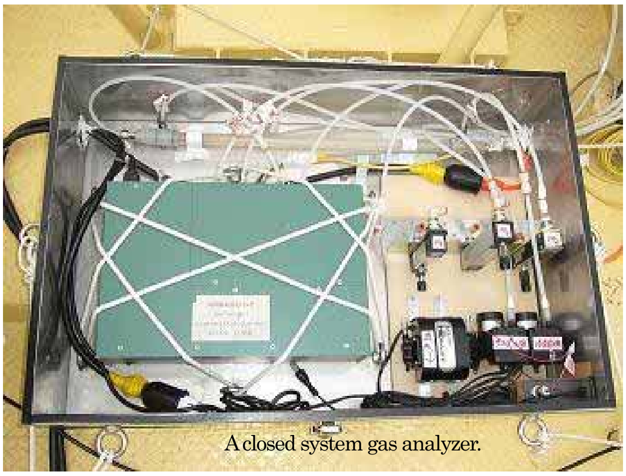


Fig. 5.16-1. The installation of the turbulence measurement sensors and a closed system gas analyzer.

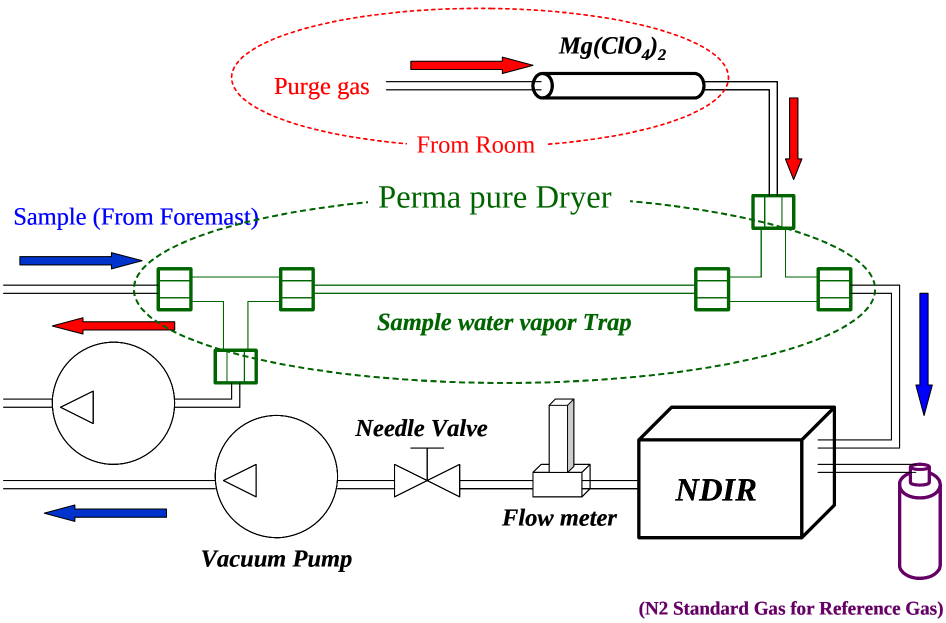


Fig. 5.16-2. Block diagram of the closed path CO_2 flux measurement.

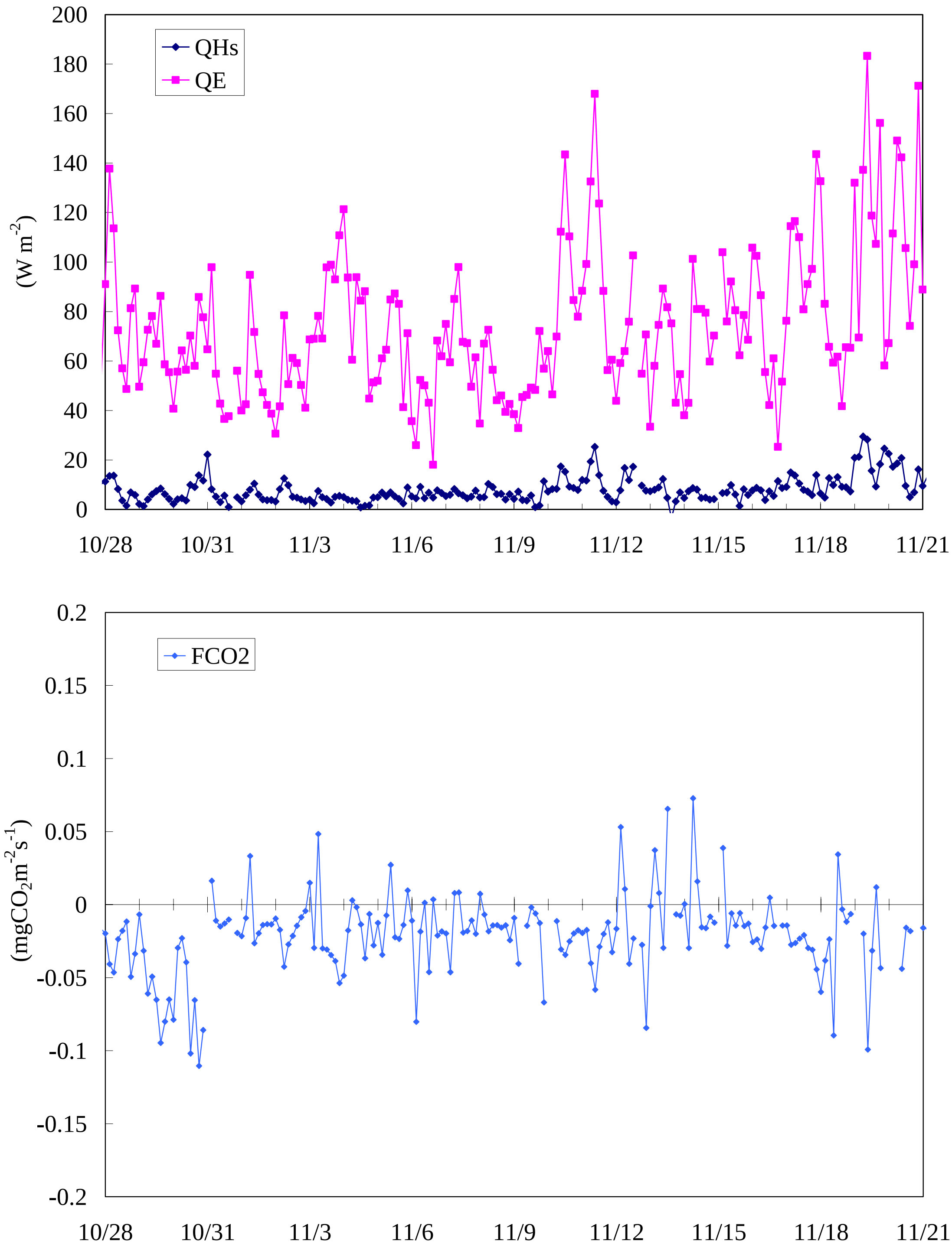


Fig. 5.16-3. Preliminary results of eddy fluxes of sensible heat (QHs), latent heat (QE) and CO_2 (FCO2) calculated with eddy-covariance method. Corrections were not applied to the sensible heat flux and the Webb correction was applied to the CO_2 flux.

Table.5.16-1. Three-hourly ship operations for turbulent flux measurements during the stationary observation period. All the times are Local Standard Time [UTC+4h]

Run No.	day	Time[LST	AT[°C]	RH[%]	Twater[°(	Remarks
1	2006/10/29	6:29	27.8	80.8	25.3	Fine
2		9:33	28.8	74.7	25.5	Fine
3		12:25	28.6	72.1	26.2	Fine
4		15:28	27.5	84.3	25.8	Cloud
5	2006/10/30	6:29	27.2	81.1	25.5	FIne
6		9:24	28.1	75.9	25.7	FIne
7		12:28	28.8	70.2	25.9	FIne
8		15:27	28.3	73.0	27.0	FIne
9	2006/10/31					Rain
10		9:29	26.3	84.3	25.3	Cloud
11		12:30	27.2	74.5	24.8	Fine
12		15:27	27.3	74.3	26.3	Cloud
13	2006/11/1	6:27	26.6	75.6	26.6	Fine
14		9:30	28.6	67.4	26.4	Fine
15		12:30	28.0	75.5	29.3	Fine
16		15:28	27.9	76.3	26.5	Fine
17	2006/11/2	6:25	26.7	72.8	25.9	Fine
18		9:30	28.0	68.3	27.0	Fine
19		12:32	28.2	69.7	28.4	Fine
20		15:31	29.6	67.5	28.8	Fine
21	2006/11/3	6:26	27.3	77.5	26.3	Fine
22		9:27	27.8	75.1	26.4	Fine
23		12:31	29.3	67.8	29.5	Fine
24		15:28	28.6	70.3	26.9	Fine
25	2006/11/4	6:23	27.2	70.7	24.3	Fine
26		9:28	28.2	67.3	24.6	Fine
27		12:30	28.1	64.0	26.1	Fine
28		15:28	27.7	70.7	26.7	Fine
29	2006/11/5	6:21	25.9	80.0	25.2	Fine
30		9:27	27.8	73.1	24.9	Fine
31		12:30	27.6	75.0	26.4	Cloud
32		15:25	27.6	77.6	26.1	Fine
33	2006/11/6	6:22	26.5	28.3	24.8	Fine
34		9:27	23.7	56.2	26.7	Cloud
35						Rain
36		15:27	26.6	84.7	25.9	Cloud
37	2006/11/7	6:25	27.5	76.2	26.1	Fine
38		9:28	29.1	68.6	25.6	Fine
39		12:29	28.1	71.2	27.9	Fine
40		15:27	28.4	77.9	26.6	Fine
41	2006/11/8	6:23	26.8	79.5	26.2	Fine
42		9:30	27.1	80.4	26.3	Fine
43		12:30	27.3	73.1	28.1	Fine
44		15:29	27.8	72.6	28.1	Fine
45	2006/11/9	6:22	27.4	78.2	25.7	Fine
46		9:30	27.8	63.7	26.2	Fine
47		12:30	28.8	69.1	27.4	Fine
48		15:30	27.2	71.9	27.2	Fine

Run No.	day	Time[LST	AT[°C]	RH[%]	Twater[°C	Remarks
49	2006/11/10					Rain
50		9:32	28.2	70.5	25.2	Cloud
51		12:29	26.0	84.9	27.0	Cloud
52		15:30	26.4	81.9	26.6	Cloud
53	2006/11/11	6:25	26.1	78.8	26.3	Fine
54		9:30	26.9	75.2	26.9	Cloud
55		12:27	27.3	79.8	26.7	Cloud
56		15:31	26.8	76.2	26.9	Fine
57	2006/11/12	6:25	27.2	75.7	26.4	Fine
58		9:30	28.1	68.6	26.8	Fine
59		12:30	27.1	80.3	27.4	Cloud
60		15:27	27.7	75.6	26.9	Fine
61	2006/11/13	6:23	26.2	83.6	25.7	Fine
62		9:30	26.9	76.6	25.3	Fine
63		12:30	27.9	70.4	26.9	Fine
64		15:30	29.8	63.6	27.4	Fine
65	2006/11/14	6:29	26.9	80.2	24.9	Fine
66		9:30	27.9	74.2	26.7	Fine
67		12:28	29.1	67.2	26.5	Fine
68		15:32	29.1	61.1	27.7	Fine
69	2006/11/15	6:25	27.1	78.1	25.4	Fine
70		9:27	29.1	74.5	26.7	Fine
71		12:30	29.8	77.2	27.4	Fine
72		15:27	28.3	74.6	27.4	Fine
73	2006/11/16	6:22	27.6	79.1	26.5	Cloud
74		9:27	27.7	77.5	27.1	Cloud
75		12:29	28.1	75.5	26.3	Fine
76		15:27	28.1	77.4	26.9	Cloud
77	2006/11/17	6:35	26.7	83.5	25.5	Cloud
78		9:25	26.6	85.9	25.1	Cloud
79		12:30	27.2	79.8	26.2	Cloud
80		15:28	27.3	79.8	26.5	Cloud
81	2006/11/18	6:20	27.4	72.5	26.2	Fine
82		9:28	28.9	66.9	26.7	Fine
83		12:31	27.3	77.4	29.0	Cloud
84						Rain
85	2006/11/19	6:21	25.2	87.2	26.3	Cloud
86						Rain
87		12:33	25.2	86.8	25.8	Cloud
88		15:30	26.4	26.8	26.5	Cloud
89	2006/11/20	18:34				Rain
90		9:30	23.7	89.5	24.6	Cloud
91		12:32	25.1	95.2	25.8	Rain
92		15:30	26.4	83.3	25.7	Cloud
93	2006/11/21	6:20	26.1	78.1	26.4	Cloud
94		9:28	27.0	78.2	26.8	Cloud
95		12:32	27.8	77.2	25.1	Fine
96		15:27	27.6	75.2	26.8	Fine

5.17 CO_2 profile measurement

(1) Personnel

Chikako Watanabe	(Okayama University)	On-board Principal Investigator
Yoshihito Suwa	(Okayama University)	
Osamu Tsukamoto	(Okayama University)	
Toru Iwata	(Okayama University)	* not on board

(2) Objective

The aerodynamic gradient technique has been used to estimate CO_2 fluxes over the land surface by some micrometeorologists. In order to estimate CO_2 flux by this technique, the profile of CO_2 concentration in the surface boundary layer must be measured and the eddy diffusivity correctly evaluated.

(3) Methods

The CO_2 content at four levels in the surface atmosphere was measured with a non-dispersive infrared (NDIR) gas analyzer (Licor Co., LI-6252) to estimate the CO_2 fluxes by the aerodynamic gradient technique. Air samples drawn from four levels were alternately introduced into the measuring cell of the NDIR every 45 seconds by the solenoid valve at the rate of 0.8-0.9 L/min (Fig.5.17-1). Sample air was pre-dried by passing through a cooling drier. The calibration of NDIR was made twice a day using other standard gas concentrations (351 and 410 ppm) of CO_2. Data was logged at 1Hz by a laptop PC and statistically analyzed for 30 seconds every 45 second.

Air was sampled with two ways. The one is by using “Albedo boom” at the head of the ship with 6x9 vinyl hose (Fig. 5.17-2). A water-repellent filter was attached to the end of hoses. Sample airs at the four levels (about 1, 2, 5, and 8m above the sea surface) are introduced to the laboratory with 4x6 polypropylene hose(65m). This way was continuously undertaken during the stationary observation period at 0.0, 80.0E.

The other is by using “David boom” at the port side with 6x9 vinyl hose attached with a profiling buoy (Fig. 5.17-3). A water-repellent filter was attached to the end of hoses. Sample airs at the three levels (0.1, 0.5 and 7.1m above the sea surface) are introduced to the laboratory with 4x6 polypropylene hose(5m). Summary of surface CO_2 profiling buoy observations is shown in Table. 5.17-1.

(4) Results

Figure 5.17-4 shows an example of the CO_2 profile measured on Oct. 30^{th}, 2006. The profile may present semilogarithmic fit and the difference of CO_2 concentration between surface and 8m height is about 0.4 ppm.

(5) Data Archives

All the data obtained during this cruise are archived at Okayama University, and will be open to public after quality checks and corrections. Interested scientists should contact Dr. Toru Iwata at Okayama University. The corrected data and inventory information will be submitted to JAMSTEC Marine-Earth Data and Information Department.

Table 1. List of surface CO2 profiling buoy observations

DATE(LST)	DOY(LST)	start time(LST)	end time(LST)
11-Nov	315	7:40	8:20
11-Nov	315	19:38	20:20
12-Nov	316	7:38	8:20
12-Nov	316	19:37	20:20
13-Nov	317	7:37	8:19
13-Nov	317	19:38	20:20
14-Nov	318	7:35	8:20
14-Nov	318	19:35	20:20
15-Nov	319	9:00	9:50
15-Nov	319	19:34	20:20
16-Nov	320	8:58	9:50
16-Nov	320	19:35	20:20
17-Nov	321	8:58	9:50
17-Nov	321	19:35	20:20
18-Nov	322	8:59	9:50
18-Nov	322	19:39	20:20
19-Nov	323	9:05	9:49
19-Nov	323	19:34	20:20
20-Nov	324	8:57	9:50
20-Nov	324	19:34	20:20
21-Nov	325	8:59	9:50
21-Nov	325	18:02	18:50

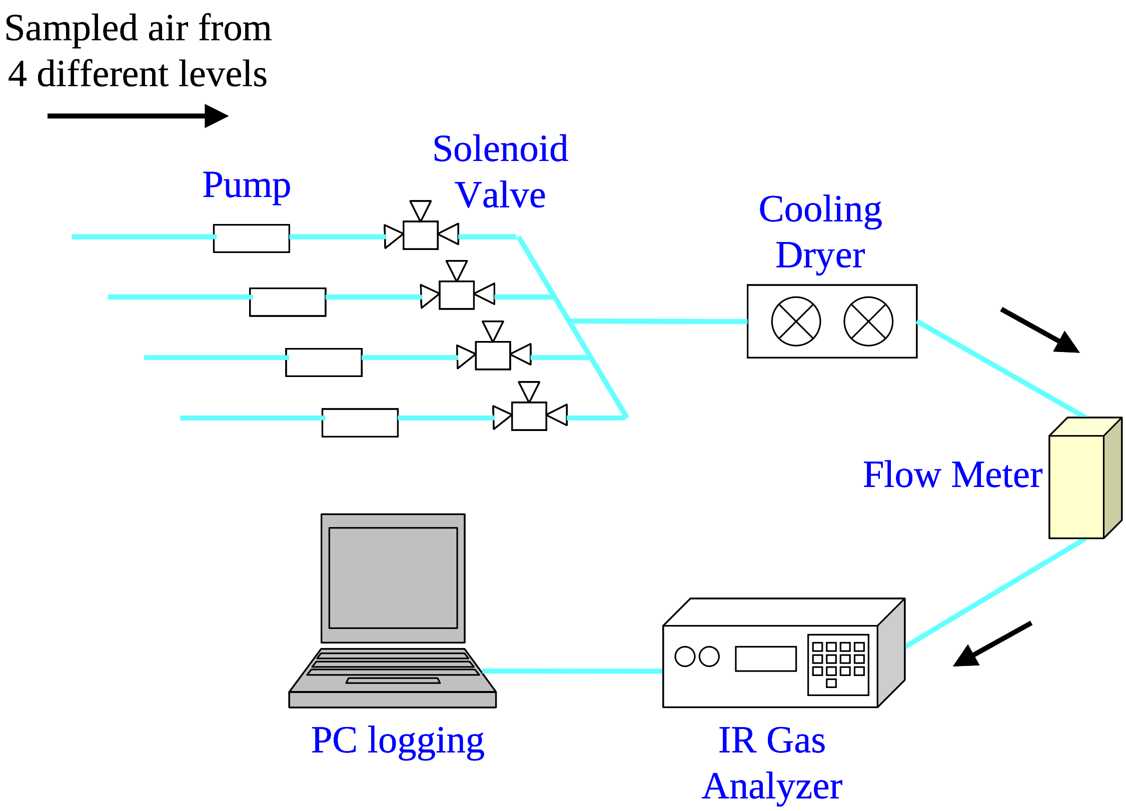


Fig. 5.17-1. CO_2 profile measurement system.

Fig. 5.17-2. Lower three inlets of sample gas at the head of the ship.

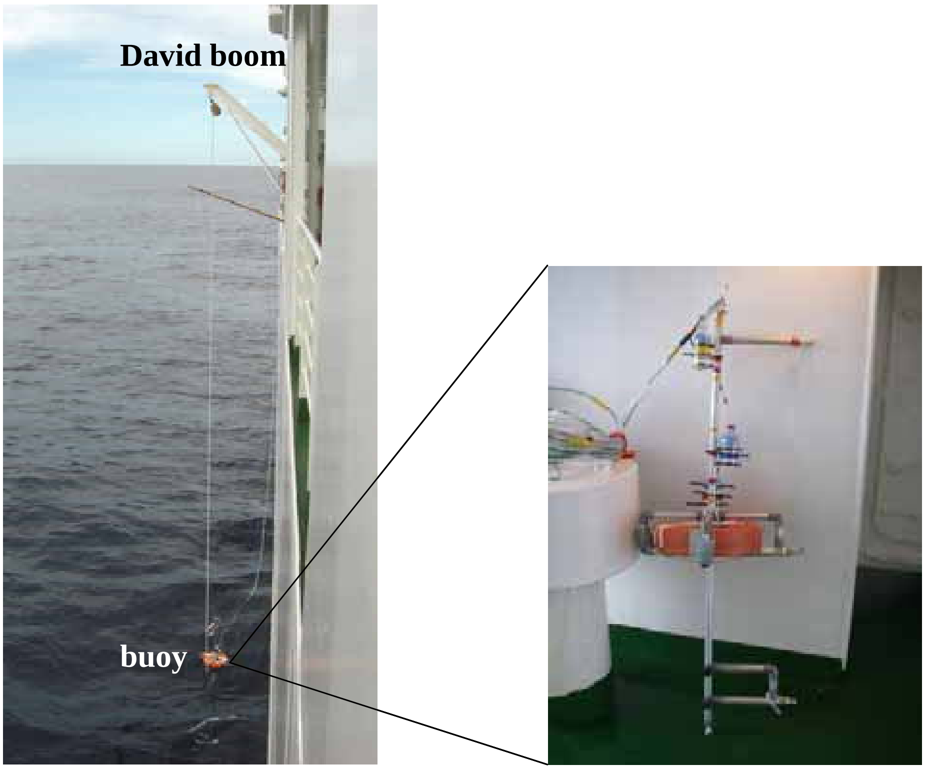


Fig. 5.17-3. David boom (left panel) and profiling buoy (right panel).

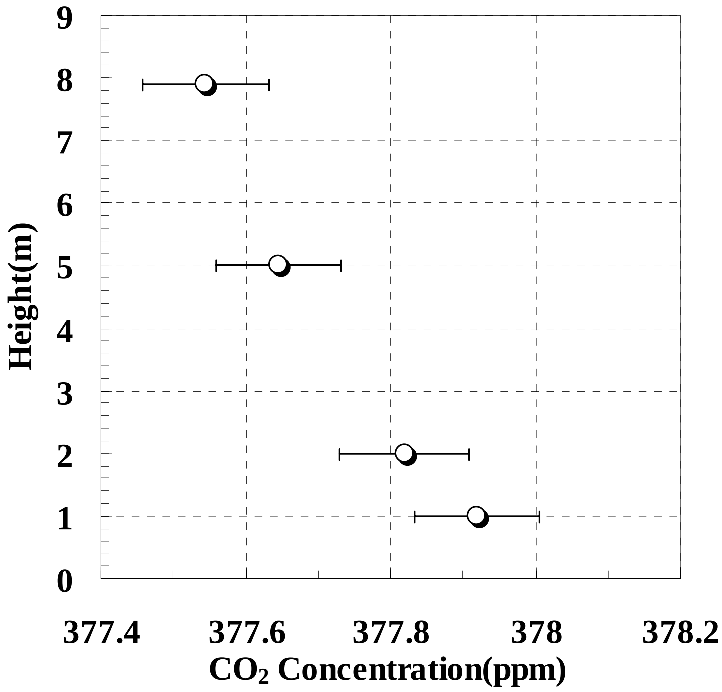


Fig. 5.17-4. An example of vertical profile of CO_2 during concentration on Oct. 30th 2006.

5.18 Sea Surface Water Monitoring

5.18.1 EPCS

(1) Personnel

Keisuke Wataki	(MWJ)	Operation Leader
Masanori Enoki	(MWJ)	

(2) Objective

To measure salinity, temperature, dissolved oxygen, and fluorescence of near-sea surface water as a basic monitor of sea surface conditions.

(3) Methods

The *Continuous Sea Surface Water Monitoring System* (Nippon Kaiyo Co. Ltd.) has five kinds of sensors and can automatically measure salinity, temperature (two systems), dissolved oxygen and fluorescence in near-sea surface water continuously, every 1-minute. Salinity is calculated by conductivity on the basis of PSS78. This system is located in the "*sea surface monitoring laboratory*" on R/V MIRAI. This system is connected to shipboard LAN-system. Measured data is stored in a hard disk of PC every 1-minute together with time and position of ship, and displayed in the data management PC machine.

Near-surface water was continuously pumped up to the laboratory and flowed into the *Continuous Sea Surface Water Monitoring System* through a vinyl-chloride pipe. The flow rate for the system is controlled by several valves and was 12L/min except with fluorometer (about 0.5L/min). The flow rate is measured with two flow meters.

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

a) Temperature and Conductivity sensor

SEACAT THERMOSALINOGRAPH

Model:	SBE-21, SEA-BIRD ELECTRONICS, INC.	
Serial number:	2126391-3126	
Measurement range:	Temperature -5 to +35 C,	Conductivity 0 to 6.5 S m^{-1}
Accuracy:	Temperature 0.01 C $6month^{-1}$,	Conductivity 0.001 S m^{-1} $month^{-1}$
Resolution:	Temperatures 0.001 C,	Conductivity 0.0001 S m^{-1}

b) Bottom of ship thermometer

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

c) Dissolved oxygen sensor

Model:	2127A, HACH ULTRA ANALYTICS JAPAN, INC.
Serial number:	44733
Measurement range:	0 to 14 ppm
Accuracy:	±1% at 5 C 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 chlorophyll-a
Stability:	0.5% month^{-1} of full scale

e) 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 are listed below.

Start : 2006/10/04 11:46 Stop : 2006/10/11 01:59
Start : 2006/10/12 08:25 Stop : 2006/10/13 19:00
Start : 2006/10/16 20:15 Stop : 2006/10/17 09:14
Start : 2006/10/18 19:01 Stop : 2006/10/29 18:57
Start : 2006/10/29 19:03 Stop : 2006/11/26 01:53

(4) Result

Temperature (thermometer of ship Bottom), salinity, dissolved oxygen, fluorescence at sea surface during this cruise are shown in Fig.5.18.1-1. We collected samples to compare a bottle data with a sensor value of salinity and dissolved oxygen, once a day. Samples for correcting fluorescence were collected four times a day. They are shown in Figs.5.18.1-2~4. All salinity samples were analyzed by the Guildline 8400B, dissolve oxygen samples were analyzed by the KIMOTO DOT-01, fluorescence samples were analyzed by acidification method, using 10-AU-005,TURNER DESIGNS.

(5) Data archive

The data will be submitted to the Marine-Earth Data and Information Department of JAMSTEC, and will be opened to the public at “http://www.jamstec.go.jp/mirai/”.

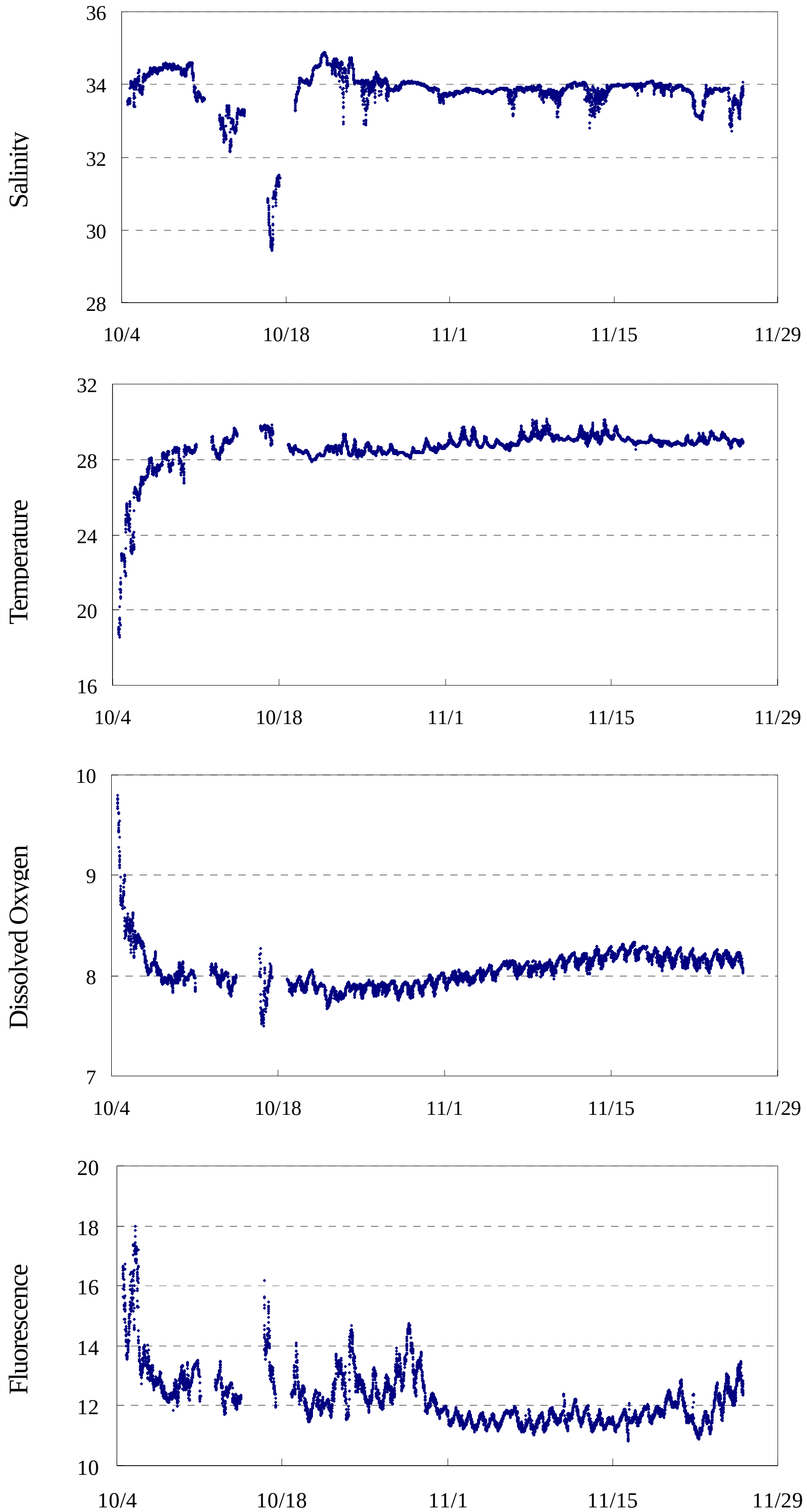


Fig. 5.18.1-1. Time series of (a) salinity, (b) temperature, (c) dissolved oxygen, (d) fluorescence of the sea surface water during this cruise.

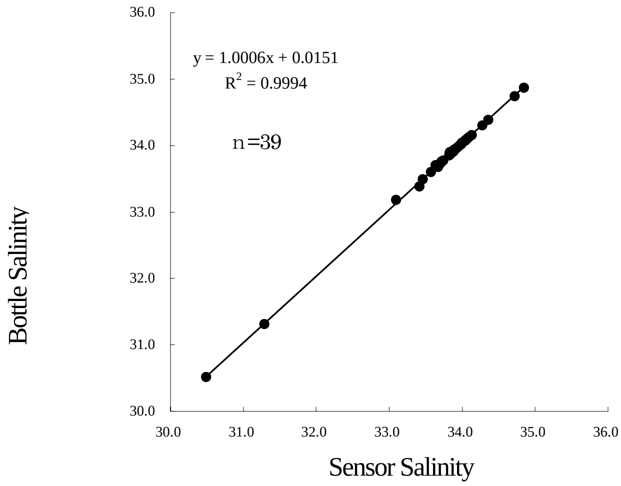


Fig.5.18.1-2 Comparison between salinity sensor and bottle data.

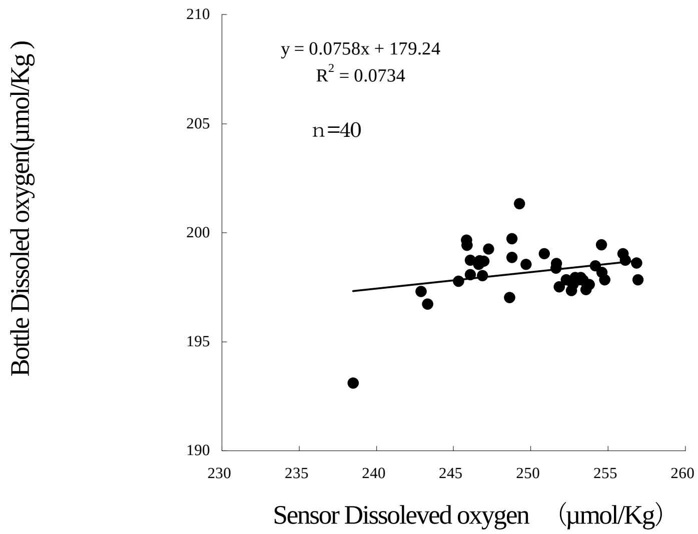


Fig.5.18.1-3 Comparison between dissolved oxygen sensor and bottle data.

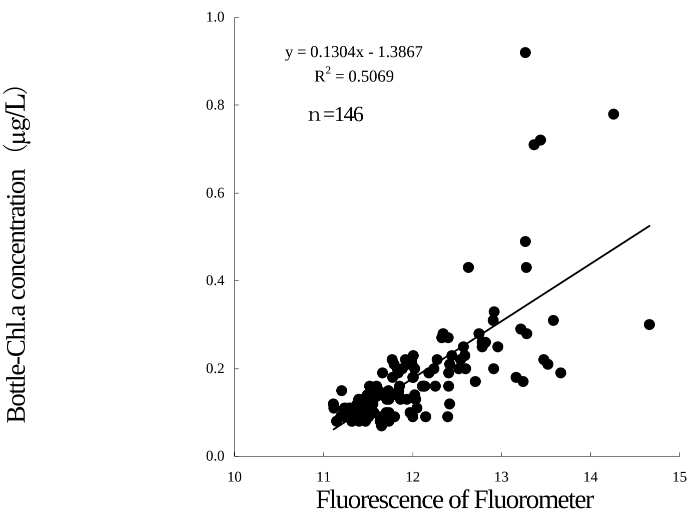


Fig.5.18.1-4 Comparison between Fluorometer sensor and bottle data.

5.18.2 pCO_2

(1) Personnel

Yoshiko Ishikawa (MWJ) Operation Leader

(2) Objectives

Concentrations of CO_2 in the atmosphere are now increasing at a rate of 1.5 ppmv y^{-1} owing to human activities such as burning of fossil fuels, deforestation, and cement production. It is an urgent task to estimate as accurately as possible the absorption capacity of the oceans against the increased atmospheric CO_2, and to clarify the mechanism of the CO_2 absorption, because the magnitude of the anticipated global warming depends on the levels of CO_2 in the atmosphere, and because the ocean currently absorbs 1/3 of the 6 Gt of carbon emitted into the atmosphere each year by human activities.

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 (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1997).

(3) Method

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 gas analyzer (NDIR; BINOS^{TM}).

The automated system was operated by on one and a half hour cycle. In one cycle, standard gasses, marine air and equilibrated air with surface seawater within the equilibrator were analyzed subsequently. The concentrations of the standard gas were 301, 352, 401 and 451 ppm.

To measure marine air concentrations (mol fraction) of CO_2 in dry air(xCO_2-air), marine air sampled from the bow of the ship(approx.30m above the sea level) was introduced into the NDIR by passing through a mass flow controller which controls the air flow rate at about 0.5 L/min, a cooling unit, a perma-pure dryer (GL Sciences Inc.) and a desiccant holder containing $Mg(ClO_4)_2$.

To measure surface seawater concentrations of CO_2 in dry air(xCO_2-sea), marine air equilibrated with a stream of seawater within the equilibrator was circulated with a pump at 0.7-0.8L/min in a closed loop passing through two cooling units, a perma-pure dryer (GL Science Inc.) and a desiccant holder containing $Mg(ClO_4)_2$. The seawater taken by a pump from the intake placed at the approx. 4.5m below the sea surface flowed at a rate of 5-6L/min in the equilibrator. After that, the equilibrated air was introduced into the NDIR.

(4) Results

Concentrations of CO_2 (xCO_2) of marine air and surface seawater are shown in Fig. 5.18.2-1. From this figure, it is found that the ocean acted as a source for atmospheric CO_2 during the cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information department and is currently under its control.

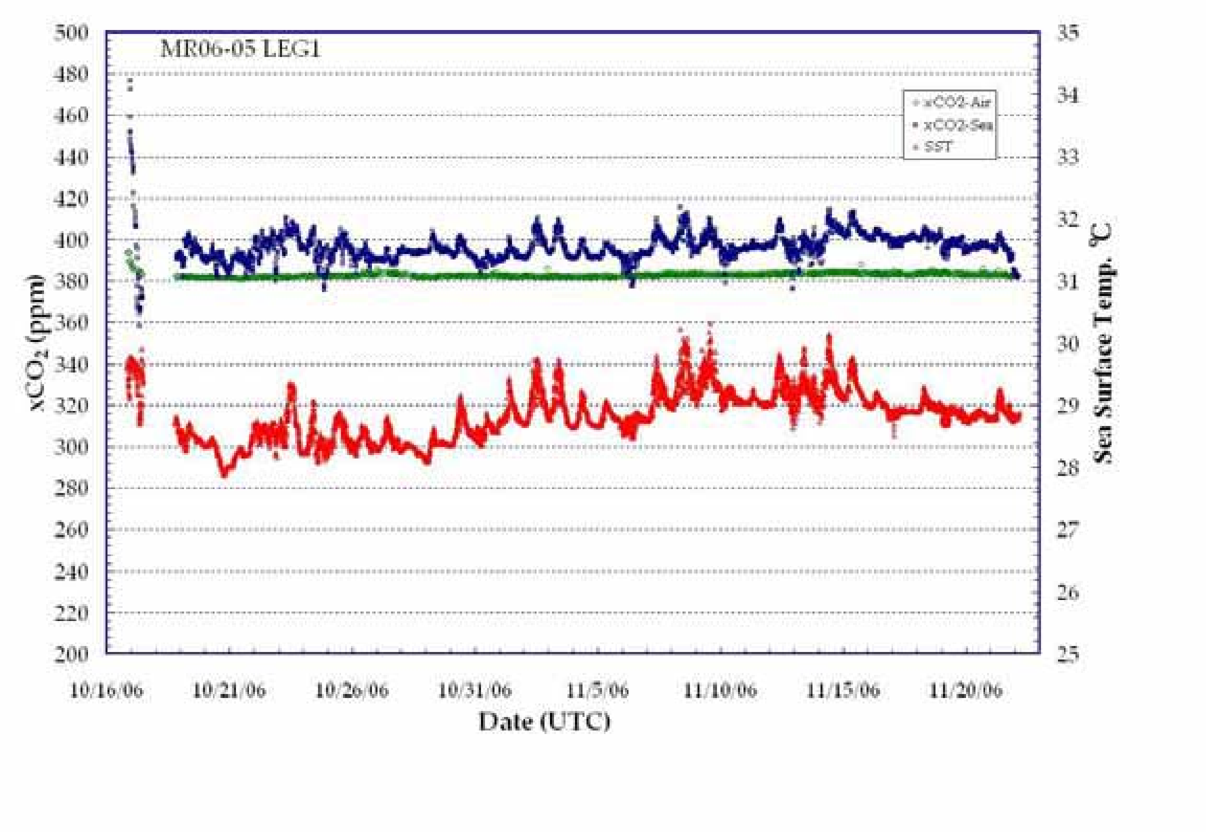


Figure 5.18.2-1. Temporal changes of concentrations of CO_2 (xCO_2) in atmosphere (green) and surface seawater (blue), and SST (red).

(6) References

DOE, 1997: 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

Japan Meteorological Agency, 1999: Manual on Oceanographic Observation Part 1.

5.19 Oceanic Profiles

5.19.1 CTDO Sampler

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Hiroshi Matsunaga	(MWJ)	Operation Leader
Keisuke Matsumoto	(MWJ)	
Tomohide Noguchi	(MWJ)	
Tatsuya Tanaka	(MWJ)	
Hiroki Ushiromura	(MWJ)	

(2) Objective

Investigation of oceanic structure and water sampling.

(3) Methods

The CTD system, SBE 911plus system (Sea-Bird Electronics, Inc., USA), is a real time data system with the CTD data transmitted from a SBE 9plus underwater unit via a conducting cable to the SBE 11plus deck unit. The SBE 911plus system controls the 12-position SBE 32 Carousel Water Sampler. The Carousel consists of 12-litre Niskin-X water sample bottles (General Oceanics, Inc., USA). Bottles were fired through the RS-232C modem connector on the back of the SBE 11plus deck unit while acquiring real time data.

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 command from the personal computer.

The CTD raw data was processed using SBE Data Processing-Win32 (ver.5.27b).

Data processing procedures and used utilities SBE Data Processing-Win32 of were as follows:

DATCNV : DATCNV converted the raw data .DATCNV also extracted bottle information where scans were marked with the bottle confirm bit during acquisition.
Source of Scan Range = Bottle Log(BL)file
Offset = 0.0
Duration = 3.0

ROSSUM : ROSSUM created a summary of the bottle data

ALIGNCTD : ALIGNCTD converted the time-sequence of oxygen sensor outputs into the pressure sequence to ensure that all calculations were made using measurements from the same parcel of water. Advance Primary Oxygen Voltage = 6.0 sec

WILDEDIT : WILDEDIT marked extreme outliers in the data files
Std deviation for pass 1= 10
Std deviation for pass 2= 20
Scan per block= 1000
Keep data within this distance of mean= 1
Exclude Scan Marked Bad = Check

CELLTM : CELLTM removed conductivity cell thermal mass effects from measured conductivity.
Primary Alpha = 0.03 1/beta = 7.0
Secondary Alpha = 0.03 1/beta = 7.0

FILTER : FILTER performed a low pass filter on pressure with a time constant of 0.15 seconds.

SECTION : SECTION removed the unnecessary data.

LOOPEDIT : LOOPEDIT marked 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

DETIVE : DERIVE was used to compute oxygen.

BINAVG : BINAVG calculate the averaged data in every 1 db.
DERIVE : DERIVE was re-used to compute salinity, sigma-theta and potential temperature.
SPLIT : SPLIT was used to split data into the down cast and the up cast.

The system used in this cruise is summarized as follows:

Under water unit:	SBE,Inc. SBE9plus S/N 0575
Deck unit:	SBE,Inc. SBE11plus S/N 11P9833-0344
Carousel Water Sampler	SBE,Inc. SBE32 S/N 3222295-0171
Water Sample bottle	General Oceanics,Inc. 12-litre Niskin-X

Primary sensors

Temperature sensor:	SBE,Inc.	SBE03-04/F S/N 031464
Conductivity sensor:	SBE,Inc.	SBE04C S/N 041203
Oxygen sensor:	SBE,Inc.	SBE43 S/N430330
Pump:	Sbe,Inc.	SBE5T S/N053118

Secondary sensors

Temperature sensor:	SBE,Inc.	SBE03-04/F S/N 032453
Conductivity sensor:	SBE,Inc.	SBE04C S/N 042435
Pump:	SBE,Inc.	SBE5T S/N053293

(4) Result

Total in 207 casts of CTD measurements have been carried out (Table 5.19.1-1). Time-depth cross sections of Temperature and Salinity, Oxygen, Sigma-theta during intensive observation period are shown in Figs.5.19.1-1.

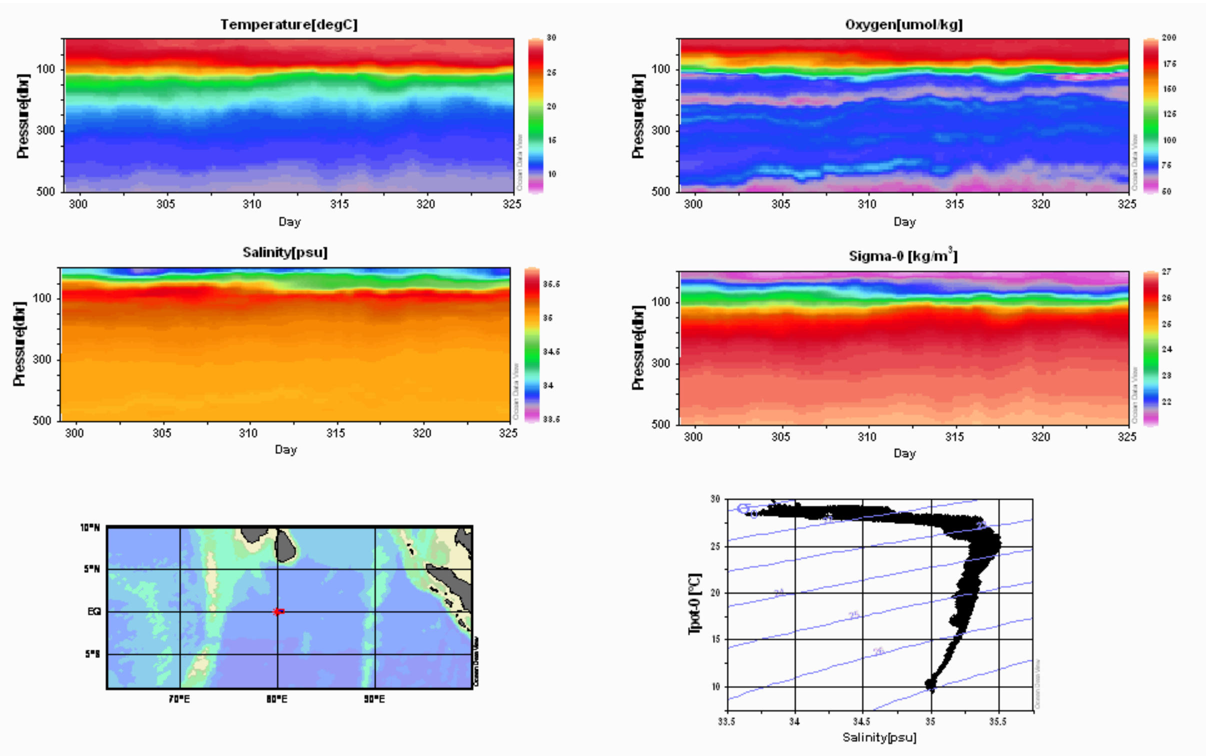


Fig.5.19.1-1 Time-depth cross sections of temperature, salinity, dissolved oxygen, and sigma-theta. Bottom two panels show the observation site (left) and T-S diagram (right).

(5) Data archive

The data will be submitted to the Marine-Earth Data and Information Department of JAMSTEC, and will be opened to the public at "http://www.jamstec.go.jp/mirai/".

(6) Remarks

The CTD salinity data was calibrated using salinity of sampled water below and above 500dbr measured by AUTOSAL. Details can be found in the next subsection 5.19.2. The CTD salinity was calibrated as follows:

Offset = Btl_CTDsal – Btl_AUTOSAL
CTDsal_cal = CTDsal_raw – Offset

where, CTDsal_cal : calibrated salinity
CTDsal_raw : CTD salinity
Offset: calibration coefficient
Btl_CTDsal : CTD salinity when fired during up-cast
Btl_AUTOSAL : salinity measured by AUTOSAL

Offset of the Primary CTDsal_raw was 0.003(psu) and Offset of the secondary CTDsal_raw was 0.001(psu). The results of the calibration are summarized in Fig.5.19.1-2.

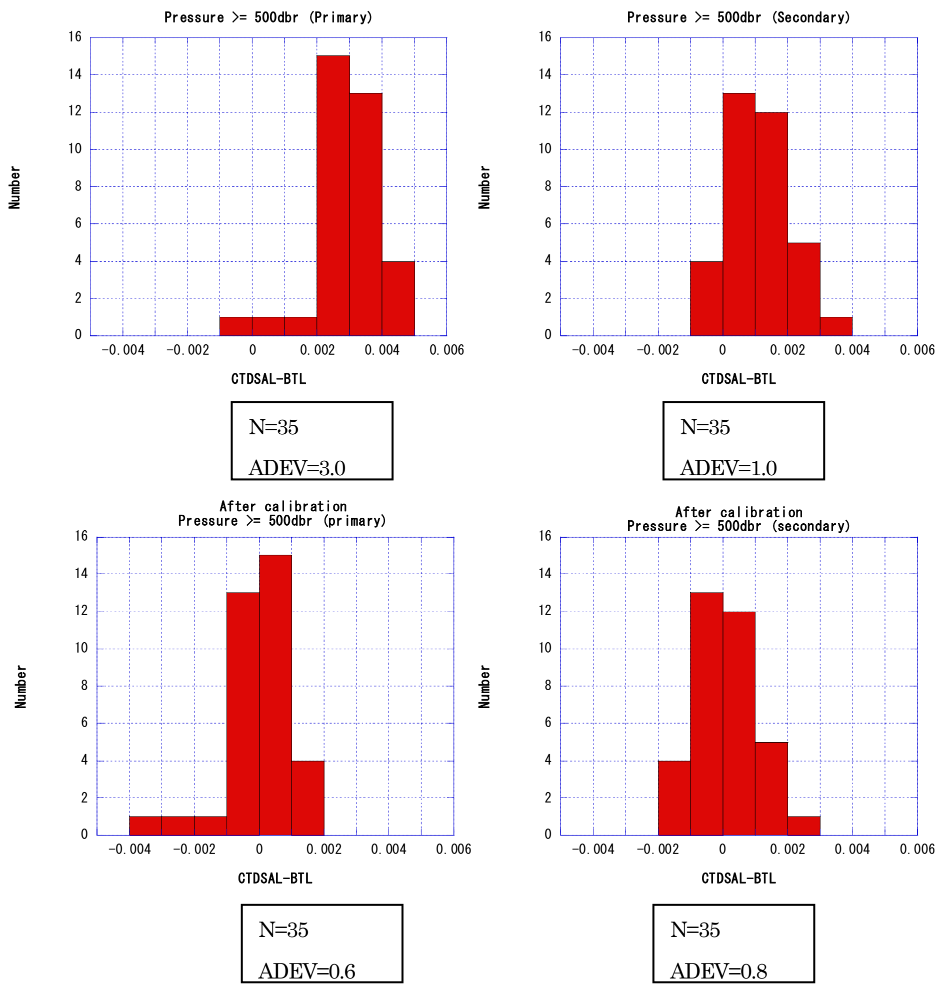


Fig.5.19.1-2. Difference between the CTD salinity and bottle salinity. Upper histograms show the difference before the calibration, Lower histograms show the difference after the calibration. The left figure is result of the primary sensor and the right figure is result of the Secondary senor and N is the number of the data and ADEV is the mean absolute deviation.

Table 5.19.1-1. CTD cast table

MR06-05Leg1 CTD Cast Table

STNNBR	CASTNO	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	MAX	MAX	CTD data	Sample	Remarks
		yyyy/mm/dd	Start	End	Latitude	Longitude	(MNB)	OUT	Depth	Pressure	file name		
A15	1	2006/10/21	6:36	7:25	07-40.12S	080-44.96E	5239	1349	1342	1354	A15S01	Sal	Deployment of ARGO float
A20	2	2006/10/22	13:32	14:30	01-00.03S	79-59.67E	4712	1795	1791	1809	A20S02	Sal	Deployment of ARGO float
A05	3	2006/10/22	17:21	17:38	00-29.96S	079-29.73E	4747	458	452	455	A05S03	Sal	Deployment of ARGO float
A05	4	2006/10/22	21:46	22:04	00-29.95N	79-.29.73E	4712	453	448	451	A05S04	Sal	Deployment of ARGO float
AD1	1	2006/10/24	8:02	8:21	01-34.71N	080-31.76E	4529	501	501	503	AD1S01	Sal	Deployment of ADCP
m01	1	2006/10/25	6:56	7:24	00-01.37N	079-02.43E	4757	501	501	503	m01S01	Sal	Deployment of m-TRITON
m01	2	2006/10/25	12:18	12:48	00-02.35N	078-59.97E	4756	503	500	504	m01S02	Sal	Deployment of ADCP
AD2	1	2006/10/26	5:37	5:55	01-29.68N	080-20.06E	4862	500	501	502	AD2S01	Sal	Deployment of ADCP
m02	1	2006/10/27	7:32	8:02	00-00.08S	081-54.72E	4606	503	501	504	m02S01	Sal	Deployment of m-TRITON
m02	2	2006/10/27	12:19	12:51	00-00.00N	081-53.52E	4601	501	500	503	m02S02	Sal	Deployment of ADCP
05	1	2006/10/27-28	23:39	0:08	00-00.09S	080-29.77E	4650	501	500	504	05S001	Routine	Intensive Observation
05	2	2006/10/27	2:38	2:47	00-00.07S	080-29.91E	4651	201	202	203	05S002	none	Intensive Observation
05	3	2006/10/28	5:28	5:58	00-00.57N	080-30.19E	4651	512	504	508	05S003	Routine	Intensive Observation
05	4	2006/10/28	8:36	8:50	00-00.17N	080-29.71E	4653	200	201	201	05S004	none	Intensive Observation
05	5	2006/10/28	11:38	12:05	00-00.06S	080-29.66E	4652	501	500	503	05S005	Routine	Intensive Observation
05	6	2006/10/28	14:38	14:48	00-00.02N	080-28.65E	4653	200	201	202	05S006	none	Intensive Observation
05	7	2006/10/28	17:40	18:06	00-00.18N	080-28.45E	4651	504	500	504	05S007	Routine	Intensive Observation
05	8	2006/10/28	20:40	20:49	00-00.32S	080-28.45E	4654	199	201	202	05S008	none	Intensive Observation
05	9	2006/10/28-29	23:58	0:26	00-00.54S	080-28.25E	4650	503	501	505	05S009	Routine	Intensive Observation
05	10	2006/10/29	2:37	2:46	00-00.07S	080-28.80E	4649	199	200	201	05S010	none	Intensive Observation
05	11	2006/10/29	5:37	6:05	00-00.09N	080-29.04E	4653	499	500	504	05S011	Routine	Intensive Observation
05	12	2006/10/29	8:37	8:49	00-00.17S	080-28.86E	4652	200	201	202	05S012	none	Intensive Observation
05	13	2006/10/29	11:39	12:08	00-00.08S	080-28.75E	4653	502	501	504	05S013	Routine	Intensive Observation
05	14	2006/10/29	14:38	14:48	00-00.00N	080-28.65E	4651	201	201	202	05S014	none	Intensive Observation
05	15	2006/10/29	17:37	18:04	00-00.05S	080-28.67E	4651	499	500	504	05S015	Routine	Intensive Observation
05	16	2006/10/29	20:37	20:45	00-00.05S	080-28.72E	4650	200	200	202	05S016	none	Intensive Observation
05	17	2006/10/29-30	23:38	0:06	00-00.02S	080-28.79E	4651	501	501	504	05S017	Routine	Intensive Observation
05	18	2006/10/30	2:37	2:47	00-00.01N	080-28.95E	4653	210	201	202	05S018	none	Intensive Observation
05	19	2006/10/30	5:36	6:04	00.00.13S	080-28.91E	4653	500	501	504	05S019	Routine	Intensive Observation
05	20	2006/10/30	8:32	8:44	00-00.15S	080-28.84E	4653	199	200	202	05S020	none	Intensive Observation
05	21	2006/10/30	11:37	12:03	00-00.17S	080-28.77E	4653	501	501	504	05S021	Routine	Intensive Observation
05	22	2006/10/30	14:38	14:47	00-00.17S	080-28.77E	4653	200	200	202	05S022	none	Intensive Observation
05	23	2006/10/30	17:38	18:04	00-00.13S	080-28.50E	4651	499	500	504	05S023	Routine	Intensive Observation
05	24	2006/10/30	20:33	20:41	00-00.03S	080-28.19E	4651	199	201	202	05S024	none	Intensive Observation
05	25	2006/10/30-31	23:39	0:08	00-00.06N	080-28.78E	4653	501	500	503	05S025	Routine	Intensive Observation
05	26	2006/10/31	2:37	2:47	00-00.25S	080-28.90E	4651	199	201	202	05S026	none	Intensive Observation
05	27	2006/10/31	5:37	6:04	00-00.14S	080-28.75E	4653	500	500	504	05S027	Routine	Intensive Observation
05	28	2006/10/31	8:37	8:49	00-00.52S	080-28.80E	4652	199	200	202	05S028	none	Intensive Observation
05	29	2006/10/31	11:35	12:06	00-00.10S	080-28.91E	4653	502	501	505	05S029	Routine	Intensive Observation
05	30	2006/10/31	14:37	14:47	00-00.02N	080-28.95E	4654	199	200	202	05S030	none	Intensive Observation
05	31	2006/10/31	17:39	18:05	00-00.04S	080-28.74E	4653	502	501	505	05S031	Routine	Intensive Observation
05	32	2006/10/31	20:37	20:46	00-00.05S	080-28.75E	4652	199	201	202	05S032	none	Intensive Observation
05	33	2006/10/31-11/1	23:36	0:06	00-00.03S	080-29.05E	4651	502	500	503	05S033	Routine	Intensive Observation
05	34	2006/11/1	2:37	2:47	00-00.05S	080-29.05E	4651	201	200	202	05S034	none	Intensive Observation
05	35	2006/11/1	5:36	6:04	00-00.07S	080-29.31E	4655	501	501	505	05S035	Routine	Intensive Observation
05	36	2006/11/1	8:36	8:48	00-00.06S	080-28.93E	4657	200	202	202	05S036	none	Intensive Observation
05	37	2006/11/1	11:36	12:04	00-00.13N	080-28.72E	4650	502	500	503	05S037	Routine	Intensive Observation
05	38	2006/11/1	14:38	14:47	00-00.05S	080-28.72E	4650	201	201	202	05S038	none	Intensive Observation
05	39	2006/11/1	17:38	18:04	00-00.30S	080-28.76E	4649	500	500	503	05S039	Routine	Intensive Observation
05	40	2006/11/1	20:38	20:46	00-00.18S	080-28.89E	4650	203	200	202	05S040	none	Intensive Observation
05	41	2006/11/1-11/2	23:41	0:10	00-00.02N	080-28.80E	4650	502	500	504	05S041	Routine	Intensive Observation
05	42	2006/11/2	2:37	2:46	00-00.02S	080-28.74E	4650	205	201	202	05S042	none	Intensive Observation
05	43	2006/11/2	5:36	6:04	00-00.35S	080-28.86E	4654	501	501	505	05S043	Routine	Intensive Observation
05	44	2006/11/2	8:35	8:47	00-00.00S	080-28.99E	4653	199	200	202	05S044	none	Intensive Observation
05	45	2006/11/2	11:38	11:58	00-00.07S	080-28.83E	4652	502	501	504	05S045	none	Intensive Observation
05	46	2006/11/2	14:37	14:47	00-00.23S	080-28.86E	4654	201	200	202	05S046	none	Intensive Observation
05	47	2006/11/2	17:37	17:54	00-00.28S	080-28.76E	4652	502	501	504	05S047	none	Intensive Observation
05	48	2006/11/2	20:37	20:46	00-00.04N	080-29.18E	4652	198	200	202	05S048	none	Intensive Observation
05	49	2006/11/2	23:37	23:57	00-00.01S	080-28.91E	4655	501	500	504	05S049	none	Intensive Observation
05	50	2006/11/3	2:37	2:49	00-00.00S	080-28.74E	4653	206	200	201	05S050	none	Intensive Observation

Table 5.19.1-1 (continued)

MR06-05Leg1 CTD Cast Table

STNNBR	CASTNO	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	MAX	MAX	CTD data	Sample	Remarks
		yyyy/mm/dd	Start	End	Latitude	Longitude	(MNB)	OUT	Depth	Pressure	file name		
05	51	2006/11/3	5:40	6:07	00-00.08S	080-28.86E	4655	503	501	504	05S051	Routine	Intensive Observation
05	52	2006/11/3	8:37	8:49	00-00.31S	080-28.81E	4652	204	202	203	05S052	none	Intensive Observation
05	53	2006/11/3	11:39	11:58	00-00.03N	080-29.29E	4653	501	500	503	05S053	none	Intensive Observation
05	54	2006/11/3	14:40	14:49	00-00.01N	080-28.97E	4657	204	202	203	05S054	none	Intensive Observation
05	55	2006/11/3	17:36	17:54	00-00.09N	080-29.28E	4649	499	501	504	05S055	none	Intensive Observation
05	56	2006/11/3	20:37	20:46	00-00.02S	080-28.89E	4653	199	200	202	05S056	none	Intensive Observation
05	57	2006/11/3	23:37	23:57	00-00.01S	080-28.90E	4652	502	500	503	05S057	none	Intensive Observation
05	58	2006/11/4	2:38	2:48	00-00.02S	080-29.01E	4650	201	201	203	05S058	none	Intensive Observation
05	59	2006/11/4	5:38	6:11	00-00.03N	080-28.86E	4651	501	501	504	05S059	Routine	Intensive Observation
05	60	2006/11/4	8:38	8:49	00-00.03S	080-28.97E	4652	199	200	202	05S060	none	Intensive Observation
05	61	2006/11/4	11:37	11:56	00-00.04S	080-28.95E	4654	501	500	503	05S061	none	Intensive Observation
05	62	2006/11/4	14:40	14:49	00-00.02N	080-28.95E	4652	200	200	202	05S062	none	Intensive Observation
05	63	2006/11/4	17:37	17:54	00-00.09N	080-28.86E	4651	501	500	504	05S063	none	Intensive Observation
05	64	2006/11/4	20:37	20:46	00-00.01S	080-28.80E	4651	198	200	201	05S064	none	Intensive Observation
05	65	2006/11/4-5	23:37	0:00	00-00.00S	080-29.00E	4652	501	500	503	05S065	none	Intensive Observation
05	66	2006/11/5	2:39	2:48	00-00.02S	080-29.03E	4654	199	200	201	05S066	none	Intensive Observation
05	67	2006/11/5	5:37	6:08	00-00.02N	080-28.96E	4655	503	501	504	05S067	Routine	Intensive Observation
05	68	2006/11/5	8:36	8:48	00-00.07S	080-29.00E	4653	198	200	202	05S068	none	Intensive Observation
05	69	2006/11/5	11:38	11:56	00-00.01S	080-28.96E	4654	501	500	503	05S069	none	Intensive Observation
05	70	2006/11/5	14:37	14:46	00-00.07N	080-28.89E	4650	200	201	201	05S070	none	Intensive Observation
05	71	2006/11/5	17:36	17:53	00-00.21N	080-28.96E	4652	503	500	503	05S071	none	Intensive Observation
05	72	2006/11/5	20:37	20:46	00-00.11N	080-28.96E	4652	200	200	201	05S072	none	Intensive Observation
05	73	2006/11/5	23:37	23:59	00-00.03N	080-28.66E	4651	503	500	503	05S073	none	Intensive Observation
05	74	2006/11/6	2:37	2:46	00-00.05N	080-29.06E	4652	200	201	202	05S074	none	Intensive Observation
05	75	2006/11/6	5:39	6:09	00-00.03N	080-28.87E	4655	500	502	503	05S075	Routine	Intensive Observation
05	76	2006/11/6	8:33	8:44	00-00.10N	080-28.96E	4655	198	200	201	05S076	none	Intensive Observation
05	77	2006/11/6	11:30	11:49	00-00.08N	080-28.90E	4650	501	501	504	05S077	none	Intensive Observation
05	78	2006/11/6	14:27	14:36	00-00.00N	080-28.87E	4653	199	200	202	05S078	none	Intensive Observation
05	79	2006/11/6	17:35	17:53	00-00.00S	080-28.73E	4652	502	500	504	05S079	none	Intensive Observation
05	80	2006/11/6	20:38	20:46	00-00.05N	080-28.90E	4655	198	201	202	05S080	none	Intensive Observation
05	81	2006/11/6-7	23:38	0:01	00-00.00N	080-28.95E	-	502	500	503	05S081	none	Intensive Observation
05	82	2006/11/7	2:38	2:48	00-00.02N	080-28.75E	4652	200	201	202	05S082	none	Intensive Observation
05	83	2006/11/7	5:39	6:06	00-00.09N	080-28.83E	4651	502	500	504	05S083	Routine	Intensive Observation
05	84	2006/11/7	8:38	8:50	00-00.05N	080-28.75E	4656	199	201	202	05S084	none	Intensive Observation
05	85	2006/11/7	11:33	11:53	00-00.22N	080-28.86E	4651	502	500	504	05S085	none	Intensive Observation
05	86	2006/11/7	14:37	14:46	00-00.01N	080-28.93E	4650	201	201	202	05S086	none	Intensive Observation
05	87	2006/11/7	17:35	17:52	00-00.24N	080-28.94E	4651	504	500	504	05S087	none	Intensive Observation
05	88	2006/11/7	20:38	20:46	00-00.06N	080-28.99E	4655	198	200	201	05S088	none	Intensive Observation
05	89	2006/11/7	23:36	23:58	00-00.08N	080-28.89E	4653	504	500	503	05S089	none	Intensive Observation
05	90	2006/11/8	2:37	2:46	00-00.06N	080-28.83E	4650	202	200	202	05S090	none	Intensive Observation
05	91	2006/11/8	5:37	6:05	00-00.18N	080-28.83E	4651	505	500	503	05S091	Routine	Intensive Observation
05	92	2006/11/8	8:35	8:47	00-00.27N	080-28.87E	4652	202	200	201	05S092	none	Intensive Observation
05	93	2006/11/8	11:36	11:56	00-00.17N	080-28.94E	4652	507	501	503	05S093	none	Intensive Observation
05	94	2006/11/8	14:36	14:44	00-00.19N	080-28.89E	4652	200	200	203	05S094	none	Intensive Observation
05	95	2006/11/8	17:38	17:55	00-00.27N	080-28.72E	4657	509	500	504	05S095	none	Intensive Observation
05	96	2006/11/8	20:37	20:45	00-00.04N	080-29.00E	4654	199	200	201	05S096	none	Intensive Observation
05	97	2006/11/8	23:36	23:58	00-00.07N	080-28.79E	4652	502	500	504	05S097	none	Intensive Observation
05	98	2006/11/9	2:36	2:46	00-00.15N	080-28.81E	4651	201	201	202	05S098	none	Intensive Observation
05	99	2006/11/9	5:38	6:09	00-00.19N	080-28.68E	4650	504	500	503	05S099	Routine	Intensive Observation
05	100	2006/11/9	8:37	8:48	00-00.02N	080-28.96E	4653	198	200	202	05S100	none	Intensive Observation
05	101	2006/11/9	11:37	11:56	00-00.08S	080-28.87E	4652	502	500	504	05S101	none	Intensive Observation
05	102	2006/11/9	14:35	14:44	00-00.21N	080-28.92E	4652	200	201	202	05S102	none	Intensive Observation
05	103	2006/11/9	17:31	17:49	00-00.09N	080-28.95E	4653	500	500	504	05S103	none	Intensive Observation
05	104	2006/11/9	20:36	20:45	00-00.15N	080-28.79E	4650	203	201	202	05S104	none	Intensive Observation
05	105	2006/11/9	23:27	23:49	00-00.00S	080-29.07E	4654	502	500	503	05S105	none	Intensive Observation
05	106	2006/11/10	2:27	2:36	00-00.01N	080-28.91E	4652	205	201	202	05S106	none	Intensive Observation
05	107	2006/11/10	5:37	6:05	00-00.13N	080-28.76E	4651	500	501	503	05S107	Routine	Intensive Observation
05	108	2006/11/10	8:38	8:49	00-00.22N	080-28.92E	4654	201	200	202	05S108	none	Intensive Observation
05	109	2006/11/10	11:37	11:56	00-00.23N	080-28.73E	4652	501	501	504	05S109	none	Intensive Observation
05	110	2006/11/10	14:38	14:47	00-00.19N	080-28.79E	4653	200	200	202	05S110	none	Intensive Observation

Table 5.19.1-1. (continued)

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MR06-05Leg1 CTD Cast Table

STNNBR	CASTNO	Date(UTC) yyyy/mm/dd	Time(UTC) Start	Time(UTC) End	Start Position Latitude	Start Position Longitude	Depth (MNB)	WIRE OUT	MAX Depth	MAX Pressure	CTD data file name	Sample	Remarks
05	111	2006/11/10	17:36	17:54	00-00.19N	080-28.75E	4651	499	500	504	05S111	none	Intensive Observation
05	112	2006/11/10	20:37	20:45	00-00.04S	080-28.99E	4655	198	201	202	05S112	none	Intensive Observation
05	113	2006/11/10	23:27	23:50	00-00.00S	080-28.93E	4653	503	500	503	05S113	none	Intensive Observation
05	114	2006/11/11	5:37	6:06	00-00.06N	080-28.97E	4653	503	501	504	05S114	Routine	Intensive Observation
05	115	2006/11/11	8:31	8:42	00-00.24N	080-28.96E	4651	198	200	201	05S115	none	Intensive Observation
05	116	2006/11/11	11:36	11:55	00-00.00S	080-28.78E	4655	502	500	504	05S116	none	Intensive Observation
05	117	2006/11/11	17:36	17:54	00-00.02N	080-28.89E	4652	500	500	503	05S117	none	Intensive Observation
05	118	2006/11/11	23:36	23:57	00-00.05N	080-29.04E	4655	503	501	505	05S118	none	Intensive Observation
05	119	2006/11/12	5:35	6:05	00-00.11N	080-29.04E	4651	505	501	504	05S119	Routine	Intensive Observation
05	120	2006/11/12	8:40	8:52	00-00.10N	080-28.93E	4652	199	201	202	05S120	none	Intensive Observation
05	121	2006/11/12	11:36	11:54	00-00.24N	080-28.90E	4654	501	501	504	05S121	none	Intensive Observation
05	122	2006/11/12	17:37	17:55	00-00.05N	080-28.86E	4652	499	501	503	05S122	none	Intensive Observation
05	123	2006/11/12	23:37	23:57	00-00.13N	080-28.86E	4652	503	501	505	05S123	none	Intensive Observation
05	124	2006/11/13	5:36	6:03	00-00.32N	080-28.40E	4651	499	501	504	05S124	Routine	Intensive Observation
05	125	2006/11/13	8:33	8:44	00-00.05N	080-28.93E	4653	200	200	202	05S125	none	Intensive Observation
05	126	2006/11/13	11:35	11:54	00-00.21N	080-28.86E	4655	503	501	503	05S126	none	Intensive Observation
05	127	2006/11/13	17:36	17:54	00-00.08N	080-28.88E	4651	502	501	503	05S127	none	Intensive Observation
05	128	2006/11/13	23:36	23:57	00-00.06N	080-29.02E	4652	503	500	504	05S128	none	Intensive Observation
05	129	2006/11/14	5:36	6:07	00-00.01S	080-28.94E	4653	500	501	504	05S129	Routine	Intensive Observation
05	130	2006/11/14	8:36	8:47	00-00.01N	080-28.95E	4653	198	200	202	05S130	none	Intensive Observation
05	131	2006/11/14	11:37	11:55	00-00.01N	080-29.10E	4654	502	501	504	05S131	none	Intensive Observation
05	132	2006/11/14	17:36	17:54	00-00.06N	080-29.03E	4652	500	500	504	05S132	none	Intensive Observation
05	133	2006/11/14	23:35	23:56	00-00.03S	080-29.01E	4652	502	500	504	05S133	none	Intensive Observation
05	134	2006/11/15	5:36	6:03	00-00.01N	080-29.00E	4653	500	501	504	05S134	Routine	Intensive Observation
05	135	2006/11/15	8:36	8:47	00-00.11N	080-28.94E	4654	197	200	202	05S135	none	Intensive Observation
05	136	2006/11/15	11:35	11:54	00-00.00S	080-29.10E	4655	506	500	503	05S136	none	Intensive Observation
05	137	2006/11/15	17:35	17:53	00-00.07S	080-28.97E	4652	497	501	504	05S137	none	Intensive Observation
05	138	2006/11/15	23:36	23:56	00-00.03N	080-28.99E	4655	500	500	504	05S138	none	Intensive Observation
05	139	2006/11/16	5:36	6:05	00-00.03S	080-28.88E	4654	500	500	504	05S139	Routine	Intensive Observation
05	140	2006/11/16	8:36	8:48	00-00.01N	080-28.94E	4654	198	201	202	05S140	none	Intensive Observation
05	141	2006/11/16	11:36	11:55	00-00.08S	080-28.97E	4654	503	501	504	05S141	none	Intensive Observation
05	142	2006/11/16	17:36	17:54	00-00.00N	080-29.00E	4657	498	500	503	05S142	none	Intensive Observation
05	143	2006/11/16	23:36	23:56	00-00.10N	080-28.82E	4652	503	500	504	05S143	none	Intensive Observation
05	144	2006/11/17	5:27	5:54	00-00.00S	080-28.70E	4652	498	501	504	05S144	Routine	Intensive Observation
05	145	2006/11/17	8:37	8:47	00-00.07N	080-28.90E	4656	198	201	202	05S145	none	Intensive Observation
05	146	2006/11/17	11:36	11:55	00-00.00S	080-28.78E	4653	504	501	504	05S146	none	Intensive Observation
05	147	2006/11/17	17:37	17:56	00-00.11S	080-28.96E	4652	501	501	505	05S147	none	Intensive Observation
05	148	2006/11/17	23:36	23:56	00-00.03S	080-29.02E	4657	500	500	502	05S148	none	Intensive Observation
05	149	2006/11/18	5:36	6:05	00-00.03N	080-28.85E	4653	499	501	504	05S149	Routine	Intensive Observation
05	150	2006/11/18	8:29	8:41	00-00.07N	080-28.87E	4654	203	201	203	05S150	none	Intensive Observation
05	151	2006/11/18	11:27	11:46	00-00.10N	080-28.96E	4653	501	501	505	05S151	none	Intensive Observation
05	152	2006/11/18	17:36	17:54	00-00.04S	080-28.99E	4654	497	500	502	05S152	none	Intensive Observation
05	153	2006/11/18	23:36	23:56	00-00.00S	080-28.90E	4653	502	500	504	05S153	none	Intensive Observation
05	154	2006/11/19	5:31	5:59	00-00.00N	080-28.78E	4656	506	500	504	05S154	Routine	Intensive Observation
05	155	2006/11/19	8:37	8:49	00-00.05S	080-28.85E	4655	199	200	201	05S155	Do	Intensive Observation
05	156	2006/11/19	11:39	11:58	00-00.12N	080-28.85E	4651	508	501	504	05S156	none	Intensive Observation
05	157	2006/11/19	17:35	17:54	00-00.08N	080-28.85E	4654	499	501	503	05S157	none	Intensive Observation
05	158	2006/11/19	23:25	23:46	00-00.09S	080-28.94E	4652	501	500	504	05S158	none	Intensive Observation
05	159	2006/11/20	5:26	5:53	00-00.07S	080-28.88E	4653	499	500	504	05S159	Routine	Intensive Observation
05	160	2006/11/20	8:27	8:38	00-00.00N	080-29.07E	4652	198	200	202	05S160	none	Intensive Observation
05	161	2006/11/20	11:33	11:52	00-00.03S	080-28.87E	4652	501	500	503	05S161	none	Intensive Observation
05	162	2006/11/20	17:35	17:53	00-00.00S	080-28.99E	4653	497	500	502	05S162	none	Intensive Observation
05	163	2006/11/20	23:36	23:57	00-00.07S	080-28.72E	4653	503	500	503	05S163	none	Intensive Observation
05	164	2006/11/21	5:35	6:05	00-00.04S	080-28.88E	4652	500	501	504	05S164	Routine	Intensive Observation
05	165	2006/11/21	8:35	8:47	00-00.00N	080-28.98E	4654	199	200	202	05S165	none	Intensive Observation
05	166	2006/11/21	11:35	11:54	00-00.00S	080-28.85E	4653	502	500	504	05S166	none	Intensive Observation
m03	1	2006/11/22	0:33	1:04	00-00.85S	081-52.48E	4604	503	501	504	m03S01	Sal	Recovery of m-TRITON
AD3	1	2006/11/22	11:52	12:10	00-00.06S	082-01.83E	4608	498	500	504	AD3S01	none	Recovery of ADCP
EX1	1	2006/11/23	1:31	1:52	00-01.03S	079-01.38E	4760	500	501	505	EX1S01	none	Extra
EX2	2	2006/11/23	11:36	11:54	00-01.03S	079-01.39E	4764	500	500	504	EX1S02	Sal	Extra

Table 5.19.1-1. (continued)

MR06-05Leg1 CTD Cast Table

STNNBR	CASTNO	Date(UTC)	Time(UTC)		Start Position		Depth	WIRE	MAX	MAX	CTD data	Sample	Remarks
		yyyy/mm/dd	Start	End	Latitude	Longitude	(MNB)	OUT	Depth	Pressure	file name		
m04	1	2006/11/24	0:31	1:01	00-00.89S	079-01.50E	4758	503	502	505	m04S01	Sal	Recovery of m-TRITON
AD4	1	2006/11/24	10:26	10:44	00-00.12N	078-50.69E	4761	498	501	504	AD4S01	none	Recovery of ADCP
E24	1	2006/11/24	18:31	18:41	00-00.20N	078-50.63E	4761	199	201	201	E24S01	none	24-hour Observation for every one hour
E24	2	2006/11/24	19:32	19:41	00-00.04N	078-50.62E	4761	199	201	203	E24S02	none	24-hour Observation for every one hour
E24	3	2006/11/24	20:35	20:44	00-00.24N	078-50.50E	4760	199	200	201	E24S03	none	24-hour Observation for every one hour
E24	4	2006/11/24	21:32	21:40	00-00.23N	078-50.87E	4763	198	200	201	E24S04	none	24-hour Observation for every one hour
E24	5	2006/11/24	22:31	22:40	00-00.11N	078-50.79E	4765	199	201	202	E24S05	none	24-hour Observation for every one hour
E24	6	2006/11/24	23:29	23:38	00-00.14N	078-50.72E	4764	199	202	201	E24S06	none	24-hour Observation for every one hour
E24	7	2006/11/24	0:29	0:40	00-00.16N	078-50.77E	4764	199	200	202	E24S07	none	24-hour Observation for every one hour
E24	8	2006/11/25	1:32	1:41	00-00.19N	078-50.72E	4763	203	201	202	E24S08	none	24-hour Observation for every one hour
E24	9	2006/11/25	2:35	2:47	00-00.28N	078-50.69E	4760	200	202	203	E24S09	none	24-hour Observation for every one hour
E24	10	2006/11/25	3:33	3:44	00-00.29N	078-50.78E	4760	197	201	202	E24S10	none	24-hour Observation for every one hour
E24	11	2006/11/25	4:32	4:43	00-00.27N	078-50.53E	4761	197	201	202	E24S11	none	24-hour Observation for every one hour
E24	12	2006/11/25	5:35	5:52	00-00.16N	078-50.69E	4761	197	201	202	E24S12	Chl-a	24-hour Observation for every one hour
E24	13	2006/11/25	6:32	6:43	00-00.11N	078-50.67E	4762	196	200	202	E24S13	none	24-hour Observation for every one hour
E24	14	2006/11/25	7:31	7:43	00-00.16N	078-50.60E	4758	198	200	201	E24S14	none	24-hour Observation for every one hour
E24	15	2006/11/25	8:38	8:49	00-00.08N	078-50.62E	4763	198	200	201	E24S15	none	24-hour Observation for every one hour
E24	16	2006/11/25	9:31	9:43	00-00.13N	078-50.63E	4761	199	201	202	E24S16	none	24-hour Observation for every one hour
E24	17	2006/11/25	10:30	10:42	00-00.14N	078-50.67E	4762	199	201	202	E24S17	none	24-hour Observation for every one hour
E24	18	2006/11/25	11:37	11:49	00-00.17N	078-50.65E	4763	200	201	202	E24S18	none	24-hour Observation for every one hour
E24	19	2006/11/25	12:31	12:40	00-00.21N	078-50.67E	4761	200	201	202	E24S19	none	24-hour Observation for every one hour
E24	20	2006/11/25	13:33	13:41	00-00.17N	078-50.69E	4763	200	200	201	E24S20	none	24-hour Observation for every one hour
E24	21	2006/11/25	14:36	14:45	00-00.25N	078-50.75E	4763	200	200	201	E24S21	none	24-hour Observation for every one hour
E24	22	2006/11/25	15:33	15:41	00-00.14N	078-50.76E	4760	197	201	202	E24S22	none	24-hour Observation for every one hour
E24	23	2006/11/25	16:32	16:40	00-00.14N	078-50.69E	4762	198	201	202	E24S23	none	24-hour Observation for every one hour
E24	24	2006/11/25	17:36	17:44	00-00.07N	078-50.69E	4763	197	200	202	E24S24	none	24-hour Observation for every one hour
E25	25	2006/11/25	18:32	18:40	00-00.08N	078-50.69E	4760	197	201	201	E24S25	none	24-hour Observation for every one hour

5.19.2 Salinity of Sampled Water

(1) Personnel

Tatsuya Tanaka (MWJ) Operation Leader

(2) Objectives

To measure bottle salinity obtained by CTD casts and EPCS for calibration.

(3) Method

(3-1) Salinity Sample Collection

Seawater samples were collected with 12-liter Niskin-X bottles and EPCS. The 250ml brown glass bottle was used to collect the sample water. The sample bottle was sealed with a plastic insert thimble and a screw cap. Each bottle was rinsed three times with the sample water, and was filled with sample water to the bottle shoulder. Its cap and thimble were also thoroughly rinsed. The bottle was stored more than 24 hours in 'AUTOSAL ROOM' before the salinity measurement.

(3-2) Instruments and Methods

The salinity analysis was carried out on R/V MIRAI during the cruise of MR06-05 Leg1 using the salinometer (Model 8400B "AUTOSAL" ; Guildline Instruments Ltd.: S/N 62827), with additional peristaltic-type intake pump (Ocean Scientific International, Ltd.). We also used two precision digital thermometers (Model 9540 ; Guildline Instruments Ltd.). One thermometer monitored an ambient temperature and the other monitored a bath temperature.

The specifications of AUTOSAL salinometer and thermometer are shown as follows ;

Salinometer (Model 8400B "AUTOSAL" ; Guildline Instruments Ltd.)

Measurement Range	:	0.005 to 42 (PSU)
Accuracy	:	Better than ±0.002 (PSU) over 24 hours without restandardization
Maximum Resolution	:	Better than ±0.0002 (PSU) at 35 (PSU)

Thermometer (Model 9540 ; Guildline Instruments Ltd.)

Measurement Range	:	-40 to +180 deg C
Resolution	:	0.001
Limits of error ±deg C	:	0.01 (24 hours @ 23 deg C ±1 deg C)
Repeatability	:	±2 least significant digits

The measurement system was almost same as Aoyama *et al.* (2002). The salinometer was operated in the air-conditioned ship's laboratory at a bath temperature of 24 deg C. An ambient temperature varied from approximately 22.5 deg C to 25.5 deg C, while a bath temperature is very stable and varied within +/- 0.004 deg C on rare occasion. We measured sub-standard seawater and confirmed that the salinometer was stable before the routine measurement of the day. The measurement for each sample was done with a double conductivity ratio that is defined as median of 31 times reading of the salinometer. Data collection was started in 5 seconds after filling sample to the cell and it took about 15 seconds to collect 31 readings by a personal computer. Data were taken for the sixth and seventh filling of the cell after five times rinse of the cell. In case the difference between the double conductivity ratio of these two fillings is smaller than 0.00002, the average value of these double conductivity ratio was used to calculate the bottle salinity with the algorithm for practical salinity scale, 1978 (UNESCO, 1981). If the difference was greater than or equal to 0.00003, we measured eighth filling of the cell. In case the double conductivity ratio of eighth filling did not satisfy the criteria above, we measured ninth filling of the cell.

The measurement was conducted about 12 hours per day (typically from 06:00 to 18:00) and the cell was cleaned with soap or thin-ethanol or both after the measurement of the day. We measured 169 samples in total.

The kind and number of samples are shown as follows ;

Table 5.19.2-1: Kind and number of samples

Kind of samples	Number of samples
Samples for CTD	129
Samples for EPCS	40
Total	169

(3-3) Standard Seawater

Standardization control was set to 398 and all the measurements were done by this setting. We used IAPSO Standard Seawater (SSW) batch P147 as the standard for salinity. And we measured the SSW in order to correct the measured salinity at the measurement of a day. We measured 23 bottles in total.

The specifications of SSW used in this cruise are shown as follows ;

Standard seawater (SSW)

batch	:	P147
conductivity ratio	:	0.99982
salinity	:	34.993
preparation date	:	6-Jun.-2006

(3-4) Sub-Standard Seawater

We also used sub-standard seawater which was obtained from 2,500m depth in MR06-02 cruise filtered by Millipore filter (pore size of 0.45 µm), which was stored in a 20 liter polyethylene container and stirred for at least 24 hours before measuring. It was measured every about six samples in order to check the drift of the salinometer. During the whole measurements, there was no detectable sudden drift of the salinometer.

(4) Results

(4-1) Standard Seawater

The average and standard deviation of SSW were respectively 34.9928 and 0.0006 in salinity. After correction for the double conductivity ratio at the measurement of a day, the average and standard deviation were respectively 34.9929 and 0.0003 in salinity.

(4-2) Replicate Samples

We took 37 pairs of replicate samples. Figure 5.19.2-1 shows the histogram of the absolute difference between replicate samples. The average and the standard deviation of the absolute deference of replicate samples were respectively 0.00016 and 0.00014 in salinity.

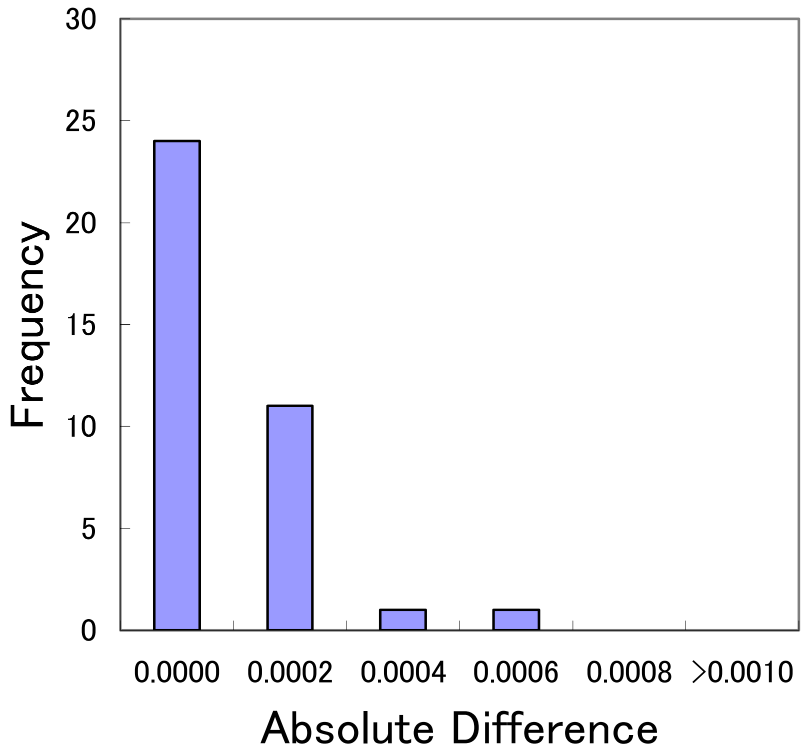

Fig. 5.19.2-1. The histogram of absolute difference between replicate samples.

(5) Data Archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department and is currently under its control.

(6) References

Aoyama, M., T. Joyce, T. Kawano and Y. Takatsuki, 2002 : Standard seawater comparison up to P129. *Deep-Sea Research I*, **49**, 1103-1114.

UNESCO, 1981 : Tenth report of the Joint Panel on Oceanographic Tables and Standards. *UNESCO Technical Papers in Marine Science*, **36**, 25 pp.

5.19.3 Dissolved oxygen of sampled seawater

(1) Personnel

Keisuke Wataki (MWJ) Operation Leader
Masanori Enoki (MWJ)

(2) Objectives

Determination of dissolved oxygen in seawater by Winkler titration.

(3) Methods

(a) Reagents

Pickling Reagent I: Manganous chloride solution (3M)
Pickling Reagent II: Sodium hydroxide (8M) / sodium iodide solution (4M)
Sulfuric acid solution (5M)
Sodium thiosulfate (0.025M)
Potassium iodate (0.001667M)

(b) Instruments:

Burette for sodium thiosulfate;
APB-510 manufactured by Kyoto Electronic Co. Ltd. / 10 cm^3 of titration vessel
Burette for potassium iodate;
APB-410 manufactured by Kyoto Electronic Co. Ltd. / 20 cm^3 of titration vessel
Detector and Software;
Automatic photometric titrator manufactured by Kimoto Electronic Co. Ltd.

(c) Sampling

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

Seawater samples were collected with Niskin bottle attached to the CTD-system. Seawater for oxygen measurement was transferred from Niskin sampler bottle to a volume calibrated flask (ca. 100 cm^3). Three times volume of the flask of seawater was overflowed. Temperature was measured by digital thermometer during the overflowing. Then two reagent solutions (Reagent I, II) of 0.5 cm^3 each were added immediately into the sample flask and the stopper was inserted carefully into the flask. The sample flask was then shaken vigorously to mix the contents and to disperse the precipitate finely throughout. After the precipitate has settled at least halfway down the flask, the flask was shaken again vigorously to disperse the precipitate. The sample flasks containing pickled samples were stored in a laboratory until they were titrated.

(d) Sample measurement

At least two hours after the re-shaking, the pickled samples were measured on board. A magnetic stirrer bar and 1 cm^3 sulfuric acid solution were added into the sample flask and stirring began. Samples were titrated by sodium thiosulfate solution whose morality was determined by potassium iodate solution. Temperature of sodium thiosulfate during titration was recorded by a digital thermometer. During this cruise we measured dissolved oxygen concentration using two sets of the titration apparatus (DOT-1 and DOT-2). Dissolved oxygen concentration (μmol kg^{-1}) was calculated by sample temperature during seawater sampling, salinity of the sample, and titrated volume of sodium thiosulfate solution without the blank.

(e) Standardization and determination of the blank

Concentration of sodium thiosulfate titrant (ca. 0.025M) was determined by potassium iodate solution. Pure potassium iodate was dried in an oven at 130°C. 1.7835 g potassium iodate weighed out accurately was dissolved in deionized water and diluted to final volume of 5 dm^3 in a calibrated volumetric flask (0.001667M). 10 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 90 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Amount of sodium thiosulfate titrated gave the morality of sodium thiosulfate titrant.

The blank from the presence of redox species apart from oxygen in the reagents was determined as follows. 1 cm^3 of the standard potassium iodate solution was added to a flask using a calibrated dispenser. Then 100 cm^3 of deionized water, 1 cm^3 of sulfuric acid solution, and 0.5 cm^3 of pickling reagent solution II and I were added into the flask in order. Just after titration of the first potassium iodate, a further 1 cm^3 of standard potassium iodate was added and titrated. The blank was determined by difference between the first and second titrated volumes of the sodium thiosulfate. The oxygen in the pickling reagents I (0.5 cm^3) and II (0.5 cm^3) were assumed to be 3.8×10^{-8} mol (Dickson, 1996).

Table 5.19.3-1 shows results of the standardization and the blank determination during this cruise.

Table 5.19.3-1 Results of the standardization and the blank determinations during this cruise.

Date	KIO_3		DOT-1 (cm^3)			Samples
(UTC)	#	bottle	$Na_2S_2O_3$	E.P.	blank	(Stations)
2006/10/26	7	20060419-07-07	20061013-2	3.957	-0.009	05S003,011,019,027,035,043
2006/11/03		20060419-07-08	20061013-2	3.964	-0.007	05S051,059,067,075,083
2006/11/08		20060419-07-02	20061013-3	3.957	-0.008	05S091,099,107,114,119,124,129,134
2006/11/16		20060419-07-03	20061013-3	3.958	-0.008	05S139,144,149
2006/11/19		20060419-07-04	20061013-4	3.959	-0.010	05S154,159,164

Batch number of the KIO_3 standard solution.

(f) Reproducibility of sample measurement

Replicate samples were taken at every CTD cast, samples of each cast during this cruise. Results of the replicate samples were shown in Table 5.19.3-2 and this histogram shown in Fig.5.19.3-1. The standard deviation was calculated by a procedure (SOP23) in DOE (1994).

Table 5.19.3-2 Results of the replicate sample measurements

Number of replicate sample pairs	Oxygen concentration (μmol/kg)
	Standard Deviation.
72	0.084

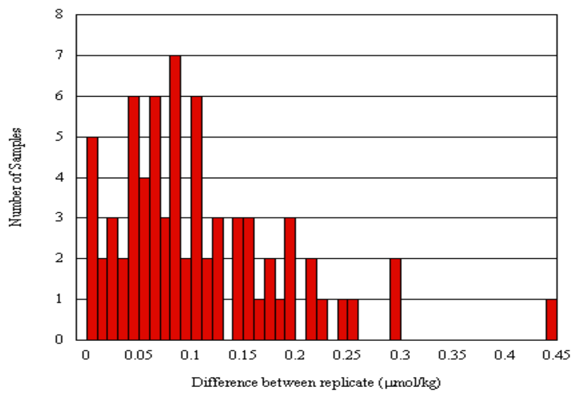

Fig 5.19.3-1 Results of the replicate sample measurements. (n=72)

(5) Result

During this cruise, we measured oxygen concentration in 148 seawater samples at 25 stations. We collected to compare Dissolve Oxygen sensor (CTD) and bottle data. Results of the comparison were shown in Fig. 5.19.3-2

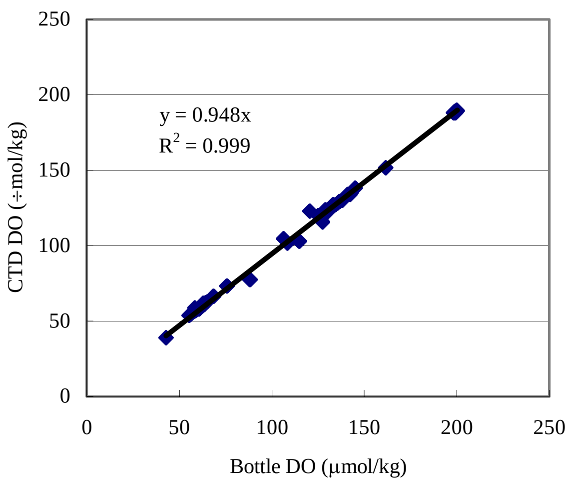

Fig. 5.19.3-2 Comparison between dissolved oxygen sensor and bottle data (n=148)

(6) Data archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department and is currently under its control.

(7) References

Dickson, A., 1996 : Dissolved Oxygen, in WHP Operations and Methods, Woods Hole, 1-13.

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 and C. Goyet (eds), ORNL/CDIAC-74.

Emerson, S, S. Mecking ,and J. Abell, 2001 : The biological pump in the subtropical North Pacific Ocean: nutrient sources, redfield ratios, and recent changes. *Global Biogeochem. Cycles*, **15**, 535-554.

Watanabe, Y. W., T. Ono, A. Shimamoto, T. Sugimoto, M. Wakita, and S. Watanabe, 2001 : Probability of a reduction in the formation rate of subsurface water in the North Pacific during the 1980s and 1990s. *Geophys. Res. Letts.*, **28**, 3298-3292.

5.19.4 Nutrients of Sampled Water

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Ayumi Takeuchi	(MWJ)	Operation Leader
S. Prasanna Kumar	(NIO)	* not on board
V. S. N. Murty	(NIO)	* not on board

(2) Objectives

The vertical and horizontal distributions of the nutrients are one of the most important factors on the primary production. During this cruise nutrient measurements will give us the important information on the mechanism of the primary production or seawater circulation.

(3) Methods

Nutrient analysis was performed on the BRAN+LUEBBE TRAACS 800 system. The laboratory temperature was maintained between 24-25 deg C.

(a) Measured Parameters

Nitrate + nitrite and nitrite are analyzed according to the modification method of Grasshoff (1970). The sample nitrate is reduced to nitrite in a cadmium tube inside of which is coated with metallic copper. The sample stream with its equivalent nitrite is treated with an acidic, sulfanilamide reagent and the nitrite forms nitrous acid, which reacts with the sulfanilamide to produce a diazonium ion. N1-Naphthylethylene-diamine added to the sample stream then couples with the diazonium ion to produce a red, azo dye. With reduction of the nitrate to nitrite, both nitrate and nitrite react and are measured; without reduction, only nitrite reacts. Thus, for the nitrite analysis, no reduction is performed and the alkaline buffer is not necessary. Nitrate is computed by difference.

Absorbance of 550 nm by azo dye in analysis is measured using a 3 cm length cell for Nitrate and 5 cm length cell for Nitrite.

The silicate (Although silicic acid is correct, we use silicate because a term of silicate is widely used in oceanographic community) method is analogous to that described for phosphate. The method used is essentially that of Grasshoff et al. (1983), wherein silicomolybdic acid is first formed from the silicic acid in the sample and added molybdic acid; then the silicomolybdic acid is reduced to silicomolybdous acid, or "molybdenum blue," using L-ascorbic acid as the reductant.

Absorbance of 630 nm by silicomolybdous acid in analysis is measured using a 3 cm length cell.

The phosphate analysis is a modification of the procedure of Murphy and Riley (1962). Molybdic acid is added to the seawater sample to form phosphomolybdic acid, which is in turn reduced to phosphomolybdous acid using L-ascorbic acid as the reductant.

Absorbance of 880 nm by phosphomolybdous acid in analysis is measured using a 5 cm length cell.

(b) Nutrients Standard

Silicate standard solution, the silicate primary standard, was obtained from Merck, Ltd.. This standard solution, traceable to SRM from NIST was 1000 mg per litter. Since this solution is alkaline solution of 0.5 M NaOH, an aliquot of 10ml solution were diluted to 500 ml together with an aliquot of 5 ml of 1M HCl.

Primary standard for nitrate (KNO_3) and phosphate (KH_2PO_4) were obtained from Merck, Ltd. and nitrite ($NaNO_2$) was obtained from Wako Pure Chemical Industries, Ltd..

(c) Sampling Procedures

Samples were drawn into virgin 10 ml polyacrylates vials that were rinsed 3 times before sampling without sample drawing tubes. Sets of 4 different concentrations for nitrate, nitrite, silicate, phosphate of the shipboard standards were analyzed at beginning and end of each group of analysis. The standard solutions of highest concentration were measured every 9 - 10 samples and were used to evaluate precision of nutrients analysis during the cruise. We also used reference material for nutrients in seawater, RMNS (KANSO Co., Ltd., lots AT), for every 6 runs to secure comparability on nutrient analysis throughout the cruise. We used same serial RMNS for 7 days.

(d) Low Nutrients Sea Water (LNSW)

Surface water having low nutrient concentration was taken and filtered using 0.45 µm pore size membrane filter. This water is stored in 20-liter cubitainer with paper box. The concentrations of nutrient of this water were measured carefully in April 2006.

(4) Results

Analytical precisions were 0.05% (35 µM) for nitrate, 0.05% (1.9 µM) for nitrite, 0.07% (36 µM) for silicate, 0.07% (3.0 µM) for phosphate in terms of median of precision, respectively.

Results of RMNS analysis are shown in Table 5.19.4.1 for the cast's comparability.

(5) Data Archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department and is currently under its control.

(6) References

Grasshoff, K., 1970 : Technicon paper, 691-57.

Grasshoff, K., Ehrhardt, M., Kremling K. et al., 1983 : Methods of seawater analysis. 2nd rev. Weinheim: Verlag Chemie, Germany, West.

Murphy, J., and Riley, J.P., 1962 : Analytica chim. Acta, **27**, 31-36.

Table 5.19.4-1 Results of RMNS Lot. AT analysis in this cruise.

μmol/kg

	serial	Cast	NO_3	NO_2	SiO_2	PO_4
RM-AT	420	05s001,003,005,007	7.50	0.03	18.07	0.582
RM-AT	420	05s009,011,013,015	7.50	0.04	17.99	0.594
RM-AT	420	05s017,019,021,023	7.52	0.04	18.08	0.600
RM-AT	420	05s025,027,029,031	7.48	0.05	18.00	0.592
RM-AT	420	05s033,035,037,039	7.52	0.04	18.05	0.594
RM-AT	420	05s041,043	7.53	0.04	17.74	0.599
RM-AT	355	05s051	7.51	0.05	17.98	0.596
RM-AT	355	05s059	7.49	0.04	18.14	0.604
RM-AT	355	05s067	7.52	0.04	18.00	0.594
RM-AT	355	05s075	7.52	0.04	18.05	0.599
RM-AT	355	05s083	7.53	0.04	17.96	0.593
RM-AT	355	05s091	7.50	0.04	18.02	0.598
RM-AT	399	05s099	7.47	0.04	18.01	0.598
RM-AT	399	05s107	7.48	0.03	18.07	0.607
RM-AT	399	05s114	7.49	0.03	18.12	0.595
RM-AT	399	05s119	7.52	0.04	18.12	0.603
RM-AT	399	05s124	7.50	0.03	17.98	0.598
RM-AT	399	05s129	7.51	0.04	18.07	0.606
RM-AT	613	05s134	7.54	0.04	18.07	0.603
RM-AT	613	05s139	7.53	0.05	18.05	0.603
RM-AT	613	05s144	7.52	0.04	18.02	0.593
RM-AT	613	05s149	7.51	0.04	18.23	0.598
RM-AT	613	05s154	7.54	0.04	17.97	0.594
RM-AT	613	05s159	7.54	0.04	18.03	0.598
RM-AT	613	05s164	7.51	0.04	18.04	0.593

5.19.5 pH of sampled water

(1) Personnel

Yoshiko Ishikawa	(MWJ)	Operation Leader
S. Prasanna Kumar	(NIO)	* not on board

(2) Objective

Since the global warming is becoming an issue world-widely, studies on the greenhouse 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 (alkalinity, total dissolved inorganic carbon, pH and pCO_2) that can be measured. When more than two of the four parameters are measured, the concentration of CO_2 system in the water can be estimated (DOE, 1997). We here report on board measurements of pH during MR06-05 Leg1 cruise.

(3) Method

(a) Seawater sampling

Seawater samples were collected by 12L Niskin bottles at 41 stations. Surface seawater samples at each station was collected by a bucket. Seawater was sampled in a 125ml glass bottle that was previously soaked in 5% non-phosphoric acid detergent (pH13) solution at least 3 hours and was cleaned by fresh water for 5 times and Milli-Q deionized water for 3 times. 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 measured. The glass bottles were put in the water bath kept about 25℃ before the measurement.

(b) Seawater analysis

pH ($-\log[H^+]$) of the seawater was measured potentiometrically in the closed glass bottle at the temperature 25℃ (pH_{25}). Value of pH determined experimentally from sequential measurements of the electromotive force (the e.m.f.) of electrode cell in a standard buffer of known (defined) pH and in the seawater sample.

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 PHM240). Separate glass (Radiometer PHG201) and reference (Radiometer REF201) electrodes were used. In order not to have seawater sample exchange CO_2 with the atmosphere during pH measurement, closed glass bottle was used. The temperature during pH measurement was monitored with temperature sensor (Radiometer T201) and controlled to 25℃ within ±0.1℃.

To calibrate the electrodes the TRIS (Lot=060502-3 pH=8.0906, Lot=060502-4 pH=8.0905 at 25℃, Delvalls and Dickson, 1998) and AMP (Lot=060802-2 pH=6.7839 at 25℃, DOE, 1997) in the synthetic seawater (Total hydrogen scale) were applied.

pH_T 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:

$$ER = RT\ LN(10) / F = 59.16\ mV / pH\ units\ at\ 25℃$$

(4) Results

A replicate analysis was made on every 5th seawater sample and the difference between each pair of analyses was plotted on a range control chart (see Figure 5.19.5-1). The average of the difference was 0.001 pH units (n=84 pairs). The standard deviation was 0.001 pH units, which indicates that the analysis was accurate enough according to DOE (1997).

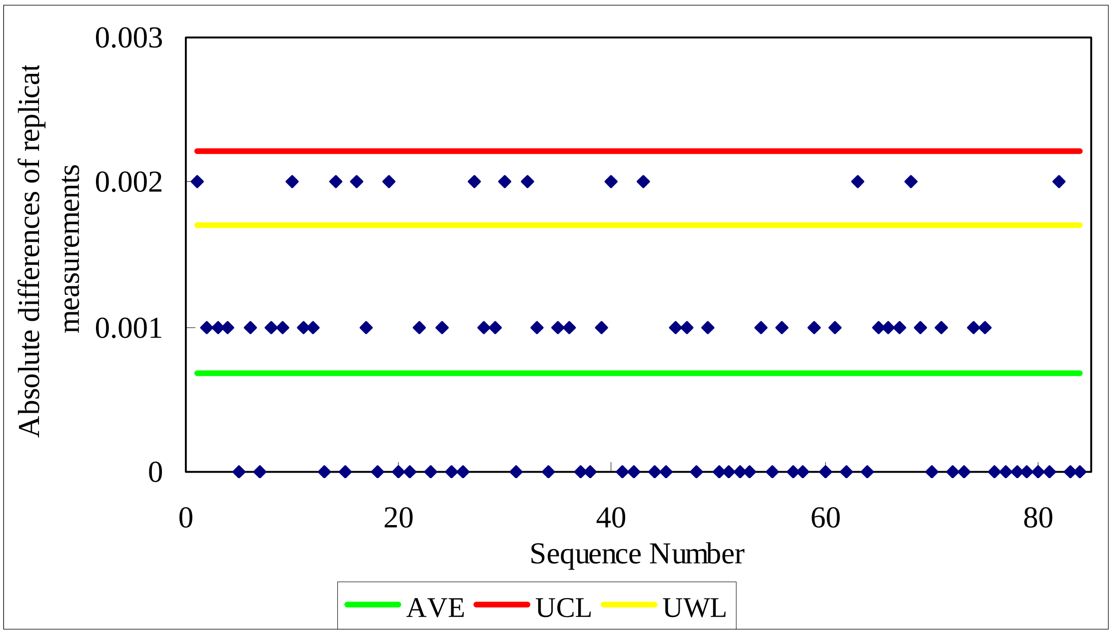

Figure 5.19.5-1 Range control chart of the absolute differences of replicate measurements carried out in the analysis of pH during the MR06-05 Leg1 cruise.

(5) Data Archive

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department and is currently under its control.

(6) References

DOE, 1997 : 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

DelValls, T. A. and Dickson, A. G., 1998 : The pH of buffers based on 2-amino-2-hydroxymethyl-1, 3-propanediol ('tris') in synthetic sea water. *Deep-Sea Research I*, **45**, 1541-1554.

5.19.6 Shallow Water CTD and Fluorescence Observation

(1) Personnel

Naoki Nakatani	(Osaka Prefecture University)	Principal Investigator
Koichi Ota	(Osaka Prefecture University)	
Akiko Yoshimura	(Osaka Prefecture University)	

(2) Objective

In order to clarify the primary production in the ocean, it is very important to know a vertical concentration of phytoplankton. We carried out the shallow water observation to understand the temporal and spatial variations of environment with biological production in the euphotic layer.

(3) Method

We observed vertical profiles of temperature, conductivity, fluorescence, turbidity, and light intensity by sensor units from surface to 200 or 500 m depth every 0.1 sec. The Conductivity Temperature Depth profiler with fluorescence sensor (Compact-CTD ASTD687, S/N 33, Alec Electronics Co. Ltd.) and the light intensity sensor (Compact-LW ALW-CMP, S/N 33, Alec Electronics Co. Ltd.) were attached to CTD/water sampler which is equipped on board of the vessel. Descending rate were kept about 0.5 m/s when the light intensity sensor was attached. Salinity was calculated from observed pressure, conductivity and temperature. The log data is shown in Table 5.19.6-1. Light intensity was observed at noon cast. The water samplings at six layers were carried out on the cast at ten thirty because of calibration for fluorescence. Fluorescence was recorded as the raw data (N value: 0 to 65520), and we will calibrate the fluorescence data using the chlorophyll-a pigment data which was analyzed by MWJ.

Accuracy of the sensors is as follows;
Depth : ±0.3 %FS
Temperature :±0.02 ℃
Conductivity : ±0.05 mS/cm
Fluorescence : ±1.0 %FS
Light intensity : ±4.0 %FS
Turbidity : ±2.0 %FS

(4) Results

Figure C-1 in Appendix-C show the oceanic profiles at several positions before fixed point observation. The condition of density profiles is very different at each position. Especially the high density gradient was formed at 1.5N 80.5E. The maximum layers of phytoplankton are located about shallower 40-60m. The high-density gradient brings the amount of phytoplankton low level.

Figure C-2 in Appendix-C shows the profiles at 0.0, 80.5E during the fixed point observation. Depth-Time cross sections of temperature, salinity, density, fluorescence, and light intensity are shown in Fig.5.9.6-1. The light intensity is calculated using sown welling shortwave radiation from SOJ and the equation as follow.

$$I(z) = I(0) \cdot \exp\left(a \cdot z^b\right)$$

$I(z)$ is light intensity at depth z. $I(0)$ is light intensity at surface layer which is provide from shortwave radiation. *a* and *b* were the attenuated coefficient which are calibrated by observed data of profiles of light intensity.

The depth of the mixing layer is around 100 m in depth. Firstly density gradient is very weak until 5 Nov. But discontinuity layer of density is formed suddenly. At the same time, two discontinuity layer of salinity appeared. At the first half of the fixed observation term, the fluorescence increases and decreases daily. The fluorescence maximum layer moved between 40m and 60m. But After 11 Nov., fluorescence becomes low level suddenly and the maximum layer depth sinks down about 70m though the light intensity is very strong.

We carried out the every 1 hour observation during 24 hours at 0.0, 79.0E on 25 Nov in order to clarify the relationship photosynthesis rate and the position of discontinuity layer of density in detail. Figure C-3 in Appendix-C shows the profiles during the every 1 hour observation. The discontinuity layer moved up and down due to internal wave. The phytoplankton formed the maximum layer on a little of the position of discontinuity layer.

(5) Data archive

All the data obtained during this cruise are archived at Osaka Prefecture University, and will be open to public after quality checks and corrections. Interested scientists should contact Dr. Naoki Nakatani at Osaka Prefecture University. The corrected data and inventory information will be submitted to JAMSTEC Marine-Earth Data and Information Department.

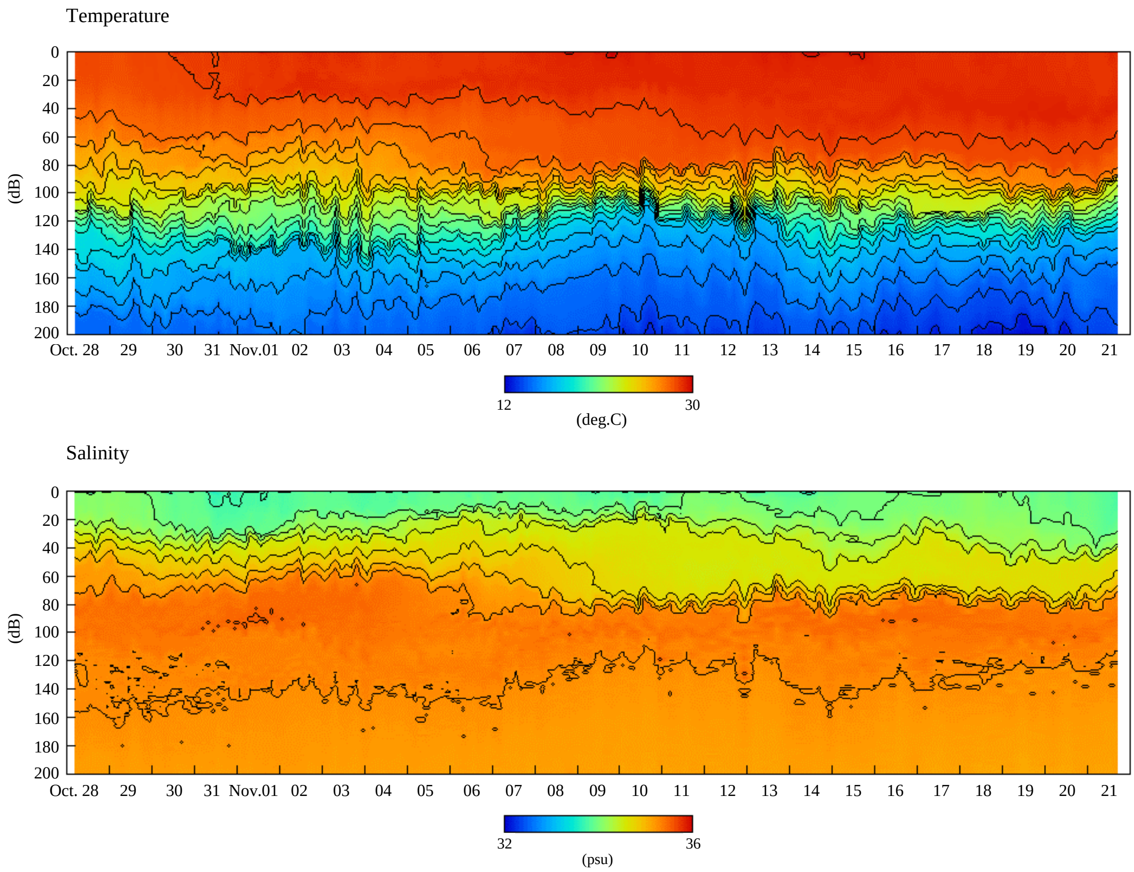

Fig.5.19.6-1 Depth-time cross section of temperature (upper panel) and salinity (lower panel) at (00-00, 80-30E) from October 28 through November 21, 2006.

Table 5.19.6-1 Compact-CTD Cast Table

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
1	001_061022_2210CTD	00-29.88S	79-29.67E	22.Oct.2006	22:19	22:39	500m	none	
2	002_061023_0230CTD	00-29.86N	79-29.75E	23.Oct.2006	2:44	3:04	500m	none	
3	003_061024_1300CTD	01-34.67N	80-31.78E	24.Oct.2006	13:00	13:21	500m	none	
4	004_061025_1200CTD	00-01.34N	79-02.47E	25.Oct.2006	11:54	12:24	500m	none	
5	005_061025_1700CTD	00-02.33N	78-59.98E	25.Oct.2006	17:16	17:48	500m	none	
6	006_061026_1030CTD	01-29.70S	80-20.13E	26.Oct.2006	10:36	10:55	500m	none	
7	007_061027_1230CTD	00-00.09S	81-54.76E	27.Oct.2006	12:31	13:02	500m	none	
8	008_061027_1720CTD	00-00.02S	81-53.64E	27.Oct.2006	17:17	17:51	500m	none	
9	009_061028_0430CTD	00-00.20S	80-30.05E	28.Oct.2006	4:36	5:07	500m	100,80,60,40,20m	
10	010_061028_0730CTD 010_061028_0730Li	00-00.02N	80-29.98E	28.Oct.2006	7:35	7:47	200m	none	◎
11	011_061028_1030CTD	00-00.53N	80-30.23E	28.Oct.2006	10:27	10:58	500m	100,80,60,50,40,20m	
12	012_061028_1330CTD 012_061028_1330Li	00-00.15N	80-29.73E	28.Oct.2006	13:35	13:50	200m	none	◎
13	013_061028_1630CTD	00-00.09S	80-29.79E	28.Oct.2006	16:36	17:05	500m	100,80,60,40,20m	
14	014_061028_1930CTD	00-00.00N	80-28.70E	28.Oct.2006	19:36	19:49	200m	none	
15	015_061028_2230CTD	00-00.16N	80-20.48E	28.Oct.2006	22:40	23:06	500m	100,80,60,40,20m	
16	016_061029_0130CTD	00-00.34S	80-28.48E	29.Oct.2006	1:38	1:50	200m	none	
17	017_061029_0430CTD	00-00.55S	80-28.28E	29.Oct.2006	4:55	5:26	500m	100,80,60,40,20m	
18	018_061029_0730CTD	00-00.07S	80-28.85E	29.Oct.2006	7:35	7:46	200m	none	
19	019_061029_1030CTD	00-00.07N	80-29.08E	29.Oct.2006	10:35	11:04	500m	100,80,60,50,40,20m	
20	020_061029_1330CTD 020_061029_1330Li	00-00.17S	80-28.91E	29.Oct.2006	13:35	13:49	200m	none	◎
21	021_061029_1630CTD	00-00.08S	80-28.82E	29.Oct.2006	16:37	17:08	500m	100,80,60,40,20m	
22	022_061029_1930CTD	00-00.01S	80-28.71E	29.Oct.2006	19:36	19:48	200m	none	
23	023_061029_2230CTD	00-00.05S	80-28.71E	29.Oct.2006	22:35	23:05	500m	100,80,60,40,20m	
24	024_061030_0130CTD	00-00.04S	80-28.80E	30.Oct.2006	1:35	1:45	200m	none	
25	025_061030_0430CTD	00-00.01S	80-28.85E	30.Oct.2006	4:35	5:06	500m	100,80,60,40,20m	
26	026_061030_0730CTD	00-00.00N	80-29.01E	30.Oct.2006	7:35	7:46	200m	none	
27	027_061030_1030CTD	00-00.12S	80-28.94E	30.Oct.2006	10:34	11:04	500m	100,80,60,50,40,20m	
28	028_061030_1330CTD 028_061030_1330Li	00-00.14S	80-28.87E	30.Oct.2006	13:30	13:44	200m	none	◎
29	029_061030_1630CTD	00-00.15S	80-28.83E	30.Oct.2006	16:35	17:03	500m	100,80,60,40,20m	
30	030_061030_1930CTD	00-00.17S	80-28.81	30.Oct.2006	19:37	19:48	200m	none	

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
31	031_061030_2230CTD	00-00.13S	80-28.69E	30.Oct.2006	22:38	23:04	500m	100,80,60,40,20m	
32	032_061031_0130CTD	00-00.02S	80-28.26E	31.Oct.2006	1:31	1:42	200m	none	
33	033_061031_0430CTD	00-00.07N	80-28.85E	31.Oct.2006	4:37	5:08	500m	100,80,60,40,20m	
34	034_061031_0730CTD	00-00.24S	80-28.94E	31.Oct.2006	7:35	7:46	200m	none	
35	035_061031_1030CTD	00-00.13S	80-28.77E	31.Oct.2006	10:35	11:04	500m	100,80,60,50,40,20m	
36	036_061031_1330CTD 036_061031_1330Li	00-00.50S	80-28.85E	31.Oct.2006	13:35	13:49	200m	none	◎
37	037_061031_1630CTD	00-00.09S	80-28.94E	31.Oct.2006	16:34	17:06	500m	100,80,60,40,20m	
38	038_061031_1930CTD	00-00.03N	80-29.00E	31.Oct.2006	19:36	19:47	200m	none	
39	039_061031_2230CTD	00-00.03S	80-28.77E	31.Oct.2006	22:38	23:05	500m	100,80,60,40,20m	
40	040_061101_0130CTD	00-00.03S	80-28.78E	01.Nov.2006	1:36	1:47	200m	none	
41	041_061101_0430CTD	00-00.02S	80-29.09E	01.Nov.2006	4:34	5:05	500m	100,80,60,40,20m	
42	042_061101_0730CTD	00-00.03S	80-29.04E	01.Nov.2006	7:35	7:46	200m	none	
43	043_061101_1030CTD	00-00.05S	80-29.33E	01.Nov.2006	10:34	11:04	500m	100,80,60,50,40,20m	
44	044_061101_1330CTD 044_061101_1330Li	00-00.04S	80-28.95E	01.Nov.2006	13:34	13:48	200m	none	◎
45	045_061101_1630CTD	00-00.14N	80-28.75E	01.Nov.2006	16:34	17:04	500m	100,80,60,40,20m	
46	046_061101_1930CTD	00-00.04S	80-28.74E	01.Nov.2006	19:36	19:47	200m	none	
47	047_061101_2230CTD	00-00.29S	80-28.79E	01.Nov.2006	22:37	23:05	500m	100,80,60,40,20m	
48	048_061102_0130CTD	00-00.15S	80-28.94E	02.Nov.2006	1:36	1:48	200m	none	
49	049_061102_0430CTD	00-00.06N	80-28.84E	02.Nov.2006	4:38	5:10	500m	100,80,60,40,20m	
50	050_061102_0730CTD	00-00.02S	80-28.64E	02.Nov.2006	7:35	7:46	200m	none	
51	051_061102_1030CTD	00-00.34S	80-28.88E	02.Nov.2006	10:35	11:04	500m	100,80,60,50,40,20m	
52	052_061102_1330CTD 052_061102_1330Li	00-00.01N	80-29.01E	02.Nov.2006	13:33	13:47	200m	none	◎
53	053_061102_1630CTD	00-00.07S	80-28.85E	02.Nov.2006	16:36	16:58	500m	none	
54	054_061102_1930CTD	00-00.21S	80-28.90E	02.Nov.2006	19:35	19:48	200m	none	
55	055_061102_2230CTD	00-00.27S	80-28.80E	02.Nov.2006	22:35	22:55	500m	none	
56	056_061103_0130CTD	00-00.05N	80-29.22E	03.Nov.2006	1:35	1:46	200m	none	
57	057_061103_0430CTD	00-00.01N	80-28.95E	03.Nov.2006	4:34	4:57	500m	none	
58	058_061103_0730CTD	00-00.00S	80-28.78E	03.Nov.2006	7:37	7:49	200m	none	
59	059_061103_1030CTD	00-00.06S	80-28.91E	03.Nov.2006	10:38	11:07	500m	100,80,60,50,40,20m	
60	060_061103_1330CTD 060_061103_1330Li	00-00.30S	80-28.83E	03.Nov.2006	13:36	13:49	200m	none	◎

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
61	061_061103_1630CTD	00-00.03N	80-29.31E	03.Nov.2006	16:37	16:58	500m	none	
62	062_061103_1930CTD	00-00.00N	80-29.00E	03.Nov.2006	19:39	19:50	200m	none	
63	063_061103_2230CTD	00-00.09N	80-29.29E	03.Nov.2006	22:35	22:55	500m	none	
64	064_061104_0130CTD	00-00.03S	80-28.93E	04.Nov.2006	1:35	1:46	200m	none	
65	065_061104_0430CTD	00-00.00S	80-28.95E	04.Nov.2006	4:35	4:57	500m	none	
66	066_061104_0730CTD	00-00.03S	80-29.04E	04.Nov.2006	7:36	7:48	200m	none	
67	067_061104_1030CTD	00-00.01N	80-28.88E	04.Nov.2006	10:36	11:11	500m	100,80,60,50,40,20m	
68	068_061104_1330CTD 068_061104_1330Li	00-00.03S	80-28.99E	04.Nov.2006	13:36	13:49	200m	none	◎
69	069_061104_1630CTD	00-00.03S	80-28.98E	04.Nov.2006	16:35	16:56	500m	none	
70	070_061104_1930CTD	00-00.01N	80-29.00E	04.Nov.2006	19:37	19:49	200m	none	
71	071_061104_2230CTD	00-00.09N	80-28.88E	04.Nov.2006	22:35	22:54	500m	none	
72	072_061105_0130CTD	00-00.02S	80-28.81E	05.Nov.2006	1:35	1:46	200m	none	
73	073_061105_0430CTD	00-00.00S	80-29.04E	05.Nov.2006	4:35	5:00	500m	none	
74	074_061105_0730CTD	00-00.03S	80-29.04E	05.Nov.2006	7:37	7:48	200m	none	
75	075_061105_1030CTD	00-00.02N	80-28.96E	05.Nov.2006	10:35	11:09	500m	100,80,60,50,40,20m	
76	076_061105_1330CTD 076_061105_1330Li	00-00.08S	80-29.01E	05.Nov.2006	13:35	13:47	200m	none	◎
77	077_061105_1630CTD	00-00.02S	80-28.98E	05.Nov.2006	16:36	16:56	500m	none	
78	078_061105_1930CTD	00-00.06N	80-28.91E	05.Nov.2006	19:35	19:46	200m	none	
79	079_061105_2230CTD	00-00.19N	80-28.98E	05.Nov.2006	22:35	22:54	500m	none	
80	080_061106_0130CTD	00-00.10N	80-28.99E	06.Nov.2006	1:35	1:46	200m	none	
81	081_061106_0430CTD	00-00.03N	80-28.69E	06.Nov.2006	4:34	4:59	500m	none	
82	082_061106_0730CTD	00-00.04N	80-29.07E	06.Nov.2006	7:35	7:46	200m	none	
83	083_061106_1030CTD	00-00.03N	80-28.88E	06.Nov.2006	10:37	11:09	500m	100,80,60,50,40,20m	
84	084_061106_1330CTD 084_061106_0130Li	00-00.09N	80-28.96E	06.Nov.2006	13:31	13:45	200m	none	◎
85	085_061106_1630CTD	00-00.07N	80-28.91E	06.Nov.2006	16:28	16:49	500m	none	
86	086_061106_1930CTD	00-00.00N	80-28.89E	06.Nov.2006	19:26	19:36	200m	none	
87	087_061106_2230CTD	00-00.01S	80-28.75E	06.Nov.2006	22:35	22:53	500m	none	
88	088_061107_0130CTD	00-00.04N	80-28.90E	07.Nov.2006	1:36	1:47	200m	none	
89	089_061107_0430CTD	00-00.01S	80-28.95E	07.Nov.2006	4:35	5:00	500m	none	
90	090_061107_0730CTD 090_061107_0730Li	00-00.01N	80-28.75E	07.Nov.2006	7:36	7:47	200m	none	◎

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
91	091_061107_1030CTD	00-00.07N	80-28.84E	07.Nov.2006	10:37	11:06	500m	100,80,60,50,40,20m	
92	092_061107_1330CTD 092_061107_1330Li	00-00.02N	80-28.75E	07.Nov.2006	13:37	13:50	200m	none	◎
93	093_061107_1630CTD	00-00.20N	80-28.85E	07.Nov.2006	16:32	16:53	500m	none	
94	094_061107_1930CTD	00-00.00N	80-28.93E	07.Nov.2006	19:35	19:47	200m	none	
95	095_061107_2230CTD	00-00.22N	80-28.96E	07.Nov.2006	22:34	22:53	500m	none	
96	096_061108_0130CTD	00-00.05N	80-28.99E	08.Nov.2006	1:36	1:47	200m	none	
97	097_061108_0430CTD	00-00.07N	80-29.00E	08.Nov.2006	4:34	4:58	500m	none	
98	098_061108_0730CTD 098_061108_0730Li	00-00.04N	80-28.85E	08.Nov.2006	7:35	7:46	200m	none	◎
99	099_061108_1030CTD	00-00.16N	80-28.84E	08.Nov.2006	10:35	11:04	500m	100,80,60,50,40,20m	
100	100_061108_1330CTD 100_061108_1330Li	00-00.24N	80-28.88E	08.Nov.2006	13:34	13:47	200m	none	◎
101	101_061108_1630CTD	00-00.14N	80-28.96E	08.Nov.2006	16:35	16:55	500m	none	
102	102_061108_1930CTD	00-00.19N	80-28.89E	08.Nov.2006	19:34	19:44	200m	none	
103	103_061108_2230CTD	00-00.25N	80-28.75E	08.Nov.2006	22:36	22:56	500m	none	
104	104_061109_0130CTD	00-00.02N	80-29.01E	09.Nov.2006	1:35	1:45	200m	none	
105	105_061109_0430CTD	00-00.05N	80-28.80E	09.Nov.2006	4:34	4:58	500m	none	
106	106_061109_0730CTD	00-00.12N	80-28.83E	09.Nov.2006	7:34	7:46	200m	none	
107	107_061109_1030CTD	00-00.16N	80-28.69E	09.Nov.2006	10:39	11:09	500m	100,80,60,50,40,20m	
108	108_061109_1330CTD 108_061109_1330Li	00-00.02N	80-28.96E	09.Nov.2006	13:35	13:48	200m	none	◎
109	109_061109_1630CTD	00-00.09S	80-28.86E	09.Nov.2006	16:35	16:56	500m	none	
110	110_061109_1930CTD	00-00.20N	80-28.93E	09.Nov.2006	19:33	19:44	200m	none	
111	111_061109_2230CTD	00-00.08N	80-28.96E	09.Nov.2006	22:31	22:50	500m	none	
112	112_061110_0130CTD	00-00.13N	80-28.83E	10.Nov.2006	1:35	1:45	200m	none	
113	113_061110_0430CTD	00-00.00S	80-29.07E	10.Nov.2006	4:25	4:49	500m	none	
114	114_061110_0730CTD	00-00.00N	80-28.94E	10.Nov.2006	7:25	7:36	200m	none	
115	115_061110_1030CTD	00-00.12N	80-28.77E	10.Nov.2006	10:36	11:05	500m	100,80,60,50,40,20m	
116	116_061110_1330CTD 116_061110_1330Li	00-00.20N	80-28.92E	10.Nov.2006	13:36	13:49	200m	none	◎
117	117_061110_1630CTD	00-00.23N	80-28.74E	10.Nov.2006	16:35	16:56	500m	none	
118	118_061110_1930CTD	00-00.18N	80-28.79E	10.Nov.2006	19:37	19:47	200m	none	
119	119_061110_2230CTD	00-00.18N	80-28.76E	10.Nov.2006	22:35	22:53	500m	none	
120	120_061111_0130CTD	00-00.04S	80-28.99E	11.Nov.2006	1:35	1:45	200m	none	

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
121	121_061111_0430CTD	00-00.00S	80-28.94E	11.Nov.2006	4:25	4:50	500m	none	
122	122_061111_1030CTD	00-00.04N	80-28.97E	11.Nov.2006	10:36	11:06	500m	100,80,60,50,40,20m	
123	123_061111_1330CTD 123_061111_1330Li	00-00.22N	80-28.97E	11.Nov.2006	13:30	13:42	200m	none	◎
124	124_061111_1630CTD	00-00.01S	80-28.78E	11.Nov.2006	16:35	16:55	500m	none	
125	125_061111_2230CTD	00-00.00N	80-28.89E	11.Nov.2006	22:25	22:56	500m	none	
126	126_061112_0430CTD	00-00.04N	80-29.05E	12.Nov.2006	4:35	4:57	500m	none	
127	127_061112_1030CTD	00-00.09N	80-29.06E	12.Nov.2006	10:33	11:06	500m	100,80,70,60,40,20m	
128	128_061112_1330CTD 128_061112_1330Li	00-00.10N	80-28.93E	12.Nov.2006	13:38	13:52	200m	none	◎
129	129_061112_1630CTD	00-00.22N	80-28.90E	12.Nov.2006	16:35	16:55	500m	none	
130	130_061112_2230CTD	00-00.05S	80-28.86E	12.Nov.2006	22:35	22:05	500m	none	
131	131_061113_0430CTD	00-00.13N	80-28.88E	13.Nov.2006	4:35	4:58	500m	none	
132	132_061113_1030CTD	00-00.30N	80-28.41E	13.Nov.2006	10:35	11:03	500m	100,80,70,60,40,20m	
133	133_061113_1330CTD 133_061113_1330Li	00-00.04N	80-28.95E	13.Nov.2006	13:32	13:44	200m	none	◎
134	134_061113_1630CTD	00-00.20N	80-28.87E	13.Nov.2006	16:33	16:53	500m	none	
135	135_061113_2230CTD	00-00.06N	80-28.90E	13.Nov.2006	22:35	22:54	500m	none	
136	136_061114_0430CTD	00-00.05N	80-29-03E	14.Nov.2006	4:34	4:57	500m	none	
137	137_061114_1030CTD	00-00.03S	80-28.95E	14.Nov.2006	10:35	11:07	500m	100,80,60,50,40,20m	
138	138_061114_1330CTD 138_061114_1330Li	00-00.01N	80-28.95E	14.Nov.2006	13:34	13:47	200m	none	◎
139	139_061114_1630CTD	00-00.00S	80-29.09E	14.Nov.2006	16:35	16:55	500m	none	
140	140_061114_2230CTD	00-00.08S	80-29.03E	14.Nov.2006	22:34	22:54	500m	none	
141	141_061115_0430CTD	00-00.04S	80-29.01E	15.Nov.2006	4:33	4:56	500m	none	
142	142_061115_1030CTD	00-00.00N	80-29.00E	15.Nov.2006	10:35	11:04	500m	100,80,70,60,40,20m	
143	143_061115_1330CTD 143_061115_1330Li	00-00.10N	80-28.93E	15.Nov.2006	13:35	13:47	200m	none	◎
144	144_061115_1630CTD	00-00.00S	80-29.09E	15.Nov.2006	16:34	16:54	500m	none	
145	145_061115_2230CTD	00-00.08N	80-28.97E	15.Nov.2006	22:34	22:53	500m	none	
146	146_061116_0430CTD	00-00.03N	80-28.99E	16.Nov.2006	4:34	4:56	500m	none	
147	147_061116_1030CTD	00-00.03S	80-28.89E	16.Nov.2006	10:34	11:06	500m	100,80,70,60,40,20m	
148	148_061116_1330CTD 148_061116_1330Li	00-00.00N	80-28.94E	16.Nov.2006	13:35	13:48	200m	none	◎
149	149_061116_1630CTD	00-00.09S	80.28.97E	16.Nov.2006	16:35	16:55	500m	none	
150	150_061116_2230CTD	00-00.00S	80-29.00E	16.Nov.2006	22:35	22:54	500m	none	

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
151	151_061117_0430CTD	00-00.09N	80-28.83E	17.Nov.2006	4:34	4:56	500m	none	
152	152_061117_1030CTD	00-00.01S	80-28.71E	17.Nov.2006	10:26	10:54	500m	100,80,70,60,40,20m	
153	153_061117_1330CTD 153_061117_1330Li	00-00.06N	80-28.89E	17.Nov.2006	13:35	13:47	200m	none	◎
154	154_061117_1630CTD	00-00.01S	80-28.79E	17.Nov.2006	16:34	16:55	500m	none	
155	155_061117_2230CTD	00-00.12S	80-28.95E	17.Nov.2006	22:35	22:55	500m	none	
156	156_061118_0430CTD	00-00.03S	80-29.02E	18.Nov.2006	4:34	4:56	500m	none	
157	157_061118_1030CTD	00-00.03N	80-28.87E	18.Nov.2006	10:34	11:06	500m	100,80,70,60,40,20m	
158	158_061118_1330CTD 158_061118_1330Li	00-00.05N	80-28.91E	18.Nov.2006	13:28	13:41	200m	none	◎
159	159_061118_1630CTD	00-00.09N	80-28.97E	18.Nov.2006	16:24	16:45	500m	none	
160	160_061118_2230CTD	00-00.05S	80-29.00E	18.Nov.2006	22:34	22:54	500m	none	
161	161_061119_0430CTD	00-00.01S	80-28.91E	19.Nov.2006	4:34	4:56	500m	none	
162	162_061119_1030CTD	00-00.02N	80-28.80E	19.Nov.2006	10:29	10:59	500m	100,80,70,60,40,20m	
163	163_061119_1330CTD 163_061119_1330Li	00-00.04S	80-28.87E	19.Nov.2006	13:35	13:50	200m	none	◎
164	164_061119_1630CTD	00-00.14N	80-28.87E	19.Nov.2006	16:38	16:58	500m	none	
165	165_061119_2230CTD	00-00.08N	80-28.86E	19.Nov.2006	22:34	22:53	500m	none	
166	166_061120_0430CTD	00-00.09S	80-28.93E	20.Nov.2006	4:24	4:46	500m	none	
167	167_061120_1030CTD	00-00.04S	80-28.90E	20.Nov.2006	10:25	10:53	500m	100,80,70,60,40,20m	
168	168_061120_1330CTD	00-00.01N	80-29.07E	20.Nov.2006	13:25	13:38	200m	none	◎
169	169_061120_1630CTD	00-00.02S	80-28.87E	20.Nov.2006	16:32	16:52	500m	none	
170	170_061120_2230CTD	00-00.01S	80-28.99E	20.Nov.2006	22:35	22:53	500m	none	
171	171_061121_0430CTD	00-00.07S	80-28.75E	21.Nov.2006	4:34	4:57	500m	none	
172	172_061121_1030CTD	00-00.03S	80-28.89E	21.Nov.2006	10:34	11:05	500m	100,80,70,60,40,20m	
173	173_061121_1330CTD 173_061121_1330Li	00-00.00N	80-28.99E	21.Nov.2006	13:33	13:47	200m	none	◎
174	174_061121_1630CTD	00-00.00N	80-28.86E	21.Nov.2006	16:34	16:53	500m	none	
175	175_061122_0530CTD	00-00.86S	81-52.48E	22.Nov.2006	5:32	6:04	500m	none	
176	176_061122_1700CTD	00-00.06S	82-01.76E	22.Nov.2006	16:51	17:10	500m	none	
177	177_061123_0630CTD	00-01.03S	79-01.38E	23.Nov.2006	6:30	6:52	500m	none	
178	178_061123_1630CTD	00-01.02S	79-01.40E	23.Nov.2006	16:35	16:55	200m	none	
179	179_061124_0530CTD	00-00.89S	79-01.51E	24.Nov.2006	5:30	6:01	500m	none	
180	180_061124_1630CTD	00-00.11N	78-50.69E	24.Nov.2006	15:25	15:45	500m	none	

Table 5.19.6-1 Compact-CTD Cast Table (continued)

CAST No.	File name *.csv	Lat.	Long.	Date[LST] LST=UTC+5h	Start Time	End Time	Depth	Water Sampling	Light intensity ◎: observed
181	181_061124_2330CTD	00-00.19N	78-50.63E	24.Nov.2006	23:30	23:41	200m	none	
182	182_061125_0030CTD	00-00.04N	78-50.65E	25.Nov.2006	0:30	0:41	200m	none	
183	183_061125_0130CTD	00-00.21N	78-50.51E	25.Nov.2006	1:34	1:44	200m	none	
184	184_061125_0230CTD	00-00.22N	78-50.87E	25.Nov.2006	2:30	2:40	200m	none	
185	185_061125_0330CTD	00-00.11N	78-50.80E	25.Nov.2006	3:29	3:40	200m	none	
186	186_061125_0430CTD	00-00.14N	78-50.72E	25.Nov.2006	4:27	4:37	200m	none	
187	187_061125_0530CTD	00-00.16N	78-50.75E	25.Nov.2006	5:29	5:40	200m	none	
188	188_061125_0630CTD 188_061125_0630Li	00-00.16N	78-50.73E	25.Nov.2006	6:30	6:41	200m	none	◎
189	189_061125_0730CTD 189_061125_0730Li	00-00.27N	78-50.68E	25.Nov.2006	7:33	7:49	200m	none	◎
190	190_061125_0830CTD 190_061125_0830Li	00-00.28N	78-50.79E	25.Nov.2006	8:31	8:44	200m	none	◎
191	191_061125_0930CTD 191_061125_0930Li	00-00.27N	78-50.53E	25.Nov.2006	9:30	9:44	200m	none	◎
192	192_061125_1030CTD 192_061125_1030Li	00-00.16N	78-50.70E	25.Nov.2006	10:35	10:52	200m	100,80,70,60,40,20m	◎
193	193_061125_1130CTD 193_061125_1130Li	00-00.11N	78-50.67E	25.Nov.2006	11:30	11:44	200m	none	◎
194	194_061125_1230CTD 194_061125_1230Li	00-00.16N	78-50.63E	25.Nov.2006	12:30	12:43	200m	none	◎
195	195_061125_1330CTD 195_061125_1330Li	00-00.09N	78-50.64E	25.Nov.2006	13:36	13:49	200m	none	◎
196	196_061125_1430CTD 196_061125_1430Li	00-00.12N	78-50.65E	25.Nov.2006	14:29	14:43	200m	none	◎
197	197_061125_1530CTD 197_061125_1530Li	00-00.13N	78-50.69E	25.Nov.2006	15:29	15:42	200m	none	◎
198	198_061125_1630CTD 198_061125_1630Li	00-00.15N	78-50.64E	25.Nov.2006	16:35	16:48	200m	none	◎
199	199_061125_1730CTD	00-00.19N	78-50.67E	25.Nov.2006	17:29	17:40	200m	none	
200	200_061125_1830CTD	00-00.15N	78-50.69E	25.Nov.2006	18:30	18:41	200m	none	
201	201_061125_1930CTD	00-00.23N	78-50.73E	25.Nov.2006	19:34	19:44	200m	none	
202	202_061125_2030CTD	00-00.15N	78-50.75E	25.Nov.2006	20:33	20:41	200m	none	
203	203_061125_2130CTD	00-00.10N	78-50.69E	25.Nov.2006	21:30	21:40	200m	none	
204	204_061125_2230CTD	00-00.07N	78-50.69E	25.Nov.2006	22:35	22:45	200m	none	
205	205_061125_2330CTD	00-00.09N	78-50.68E	25.Nov.2006	23:30	23:40	200m	none	

5.19.7 Chlorophyll *a* measurement by fluorometric determination

(1) Personnel

Keisuke Wataki (MWJ) Operation Leader

Masanori Enoki (MWJ)

(2) Objective

Chlorophyll *a* is one of the most convenient indicators of phytoplankton stock, and has been used extensively for the estimation of phytoplankton abundance in various aquatic environments. The objective of this study is to investigate the vertical distribution of phytoplankton in various light intensity depth.

(3) Methods

Seawater samples were collected 0.5 liter at 6 depths in the euphotic zone at fixed station（0, 80.5E）using Niskin bottles. The samples were gently filtrated by low vacuum pressure (<15cmHg) through Whatman GF/F filter (diameter 25mm) in the dark room. Phytoplankton pigments were immediately extracted in 7ml of N,N-dimethylformamide (DMF) after filtration and then, the samples were stored in the freezer(-20degC) until the analysis of fluorometric determination (over 24 hours).The extracts of the samples are measured the fluorescence by Turner fluorometer (10-AU-005,TURNER DESIGNS) with a 340-500nm bound excitation filter and a >665nm bound emission filter(Table 1), before and after acidification. We had the measurements twice. At first, we measured the fluororescence of samples, after that we dropped 1N HCL to the sample and measured (Holm-Hansen *et al*., 1965).

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

$$\text{Chlorophyll } a \ (\mu g/L) = Fm/(Fm-1) \times (Fo-Fa) \times Kx \times vol_{ex}/vol_{fl}$$

Fo:fluorenscenece before acidfication Fa: fluorenscenece after acidfication

vol_{ex}:DMF extract volume vol_{fl}:filtrated volume

Kx:correction coefficiebt

Fm:acid factor

(4) Results

The temporal and spatial distributions of chlorophyll *a* were shown in Fig. 5.19.7-1.

(5) Data archives

All data will be submitted to JAMSTEC Marine-Earth Data and Information Department and is currently under its control.

(6) Reference

Holm-Hansen, O., Lorenzen, C. J., Holmes, R.W., J. D. H. Strickland 1965.Fluorometric determination of chlorophyll. *J. Cons. Cons. Int. Explor. Mer* :30,3-15.

Table 5.19.7-1. Analytical conditions of "Acidification method" for chlorophyll a with Turner Designs fluorometer (10-AU-005).

	Acidification method
Excitation filter (nm)	340-500nm
Emission filter (nm)	>665nm
Lamp	Daylight white F4T5D

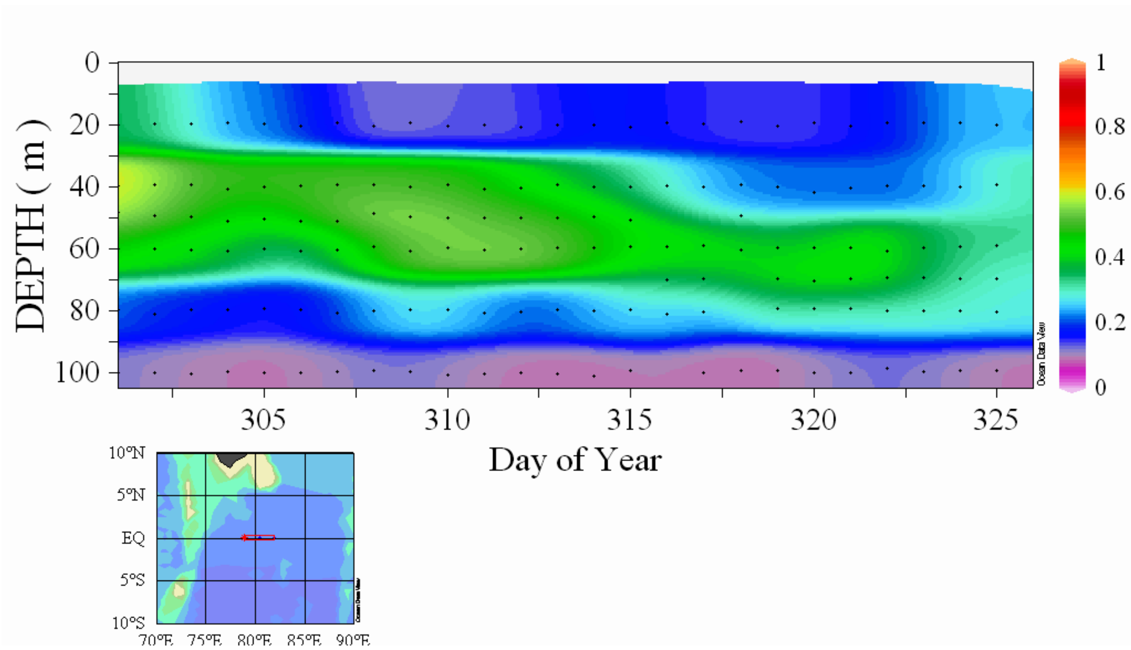

Fig. 5.19.7-1. Time-depth cross section of Chlorophyll-a.

5.20 Argo-type Floats

5.20.1 Argo-type Floats (MISMO Project)

(1) Personnel

Naoki Sato	(JAMSTEC)	Principal Investigator
Hiroki Ushiromura	(MWJ)	
Nobuyuki Shikama	(JAMSTEC)	* not on board
Mizue Hirano	(JAMSTEC)	* not on board
Hiroyuki Nakajima	(MWJ)	* not on board

(2) Objective

Measurements of the vertical profiles of sea-water temperature and salinity in order to investigate the intraseasonal variability of the surface and subsurface layers associated with the MJO.

(3) Method

Ten Argo-type floats were deployed at 80.5°E, from 8°S to 3°N other than the floats shading in Table 5.20.1-1. They measure the vertical profiles of sea-water temperature and salinity above 500dbar every day. Five of the 10 floats use the Iridium system to send observed data. The other 5 floats use the Argos system. It is expected that each float will observe the temperature and salinity profiles about 150 times.

(4) Results

The vertical profiles of sea-water temperature and salinity measured at 6.009°S, 80.987°E on October 22, 2006 are shown in Fig.5.20.1-1. Potential density can be also calculated from temperature and salinity. Figure 5.20.1-2 illustrates the depth-time section of daily sea-water temperature observed near 6.5°S, 80.5°E. The intraseasonal variability of the surface and subsurface layers associated with the MJO (Madden-Julian oscillation) was obtained by these measurements.

(5) Data archive

The real-time data are provided officially via the Web site of Global Data Assembly Center (GDAC: http:///www.usgodae.org/argo/argo.html, http://www.coriolis.eu.org/) in netCDF format. The Argo group in JAMTEC (http://www.jamstec.go.jp/ARGO/J-ARGO/) also provide the real-time quality controlled data in ascii format.

Table 5.20.1-1 Deployments of the floats.

Date (YYYY/MM/DD)	Time (UTC)	Latitude	Longitude	Type
2006/10/21	07:32	7° 39.72’S	80° 44.81’E	Standard Argo
2006/10/21	07:34	7° 39.71’S	80° 44.85’E	Argos
2006/10/21	14:26	6° 00.00’S	81° 00.10’E	Iridium
2006/10/21	19:58	5° 00.02’S	79° 59.96’E	Argos
2006/10/22	00:03	3° 59.96’S	80° 00.01’E	Standard Argo
2006/10/22	02:11	3° 29.99’S	80° 00.01’E	Argos
2006/10/22	06:20	2° 30.00’S	79° 59.92’E	Argos
2006/10/22	14:38	0° 59.82’S	79° 59.16’E	Iridium
2006/10/22	17:47	0° 29.59’S	79° 29.26’E	Iridium
2006/10/22	22:11	0° 30.52’N	79° 29.68’E	Iridium
2006/10/23	01:49	1° 15.01’N	80° 00.05’E	Iridium
2006/10/23	12:43	2° 59.98’N	79° 30.04’E	Argos

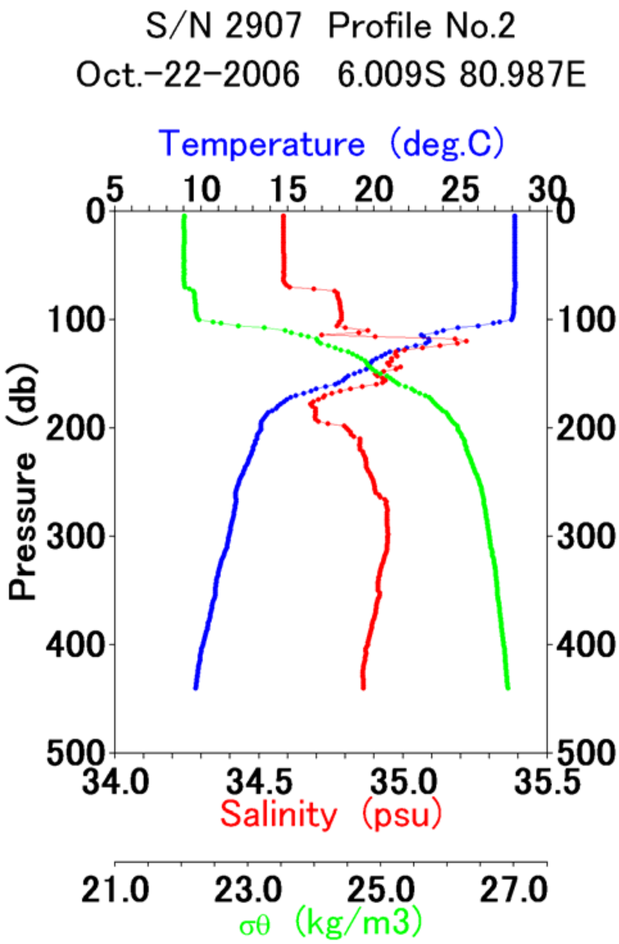

Fig. 5.20.1-1 Vertical profiles of sea-water temperature (blue), salinity (red), and potential density (green) measured at 6.009°S, 80.987°E on October 22, 2006.

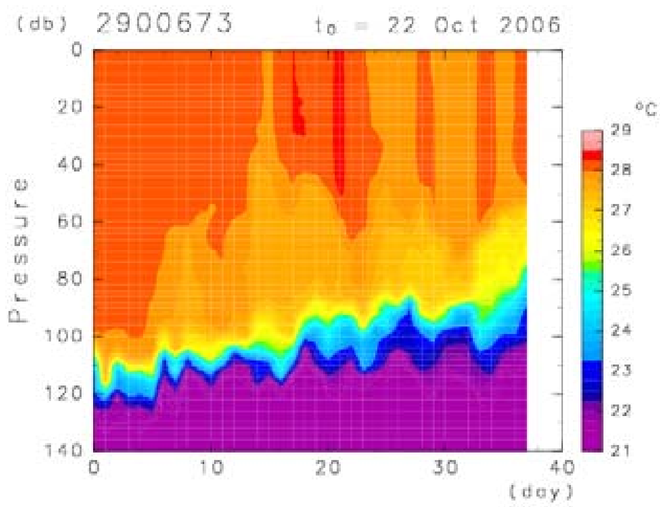

Fig. 5.20.1-2 Depth-time section of sea-water temperature observed near 6.0°S, 81.0°E.

5.20.2 Argo-type Floats (Argo Project)

(1) Personnel

Nobuyuki Shikama	(JAMSTEC)	Principal Investigator	* not on board
Naoki Sato	(JAMSTEC)		
Hiroki Ushiromura	(MWJ)		
Kanako Sato	(JAMSTEC)		* not on board
Mizue Hirano	(JAMSTEC)		* not on board

(2) Objective

The objective of deployment is to clarify the structure and temporal/spatial variability of water masses in the Indian Ocean such as the subsurface salinity maxima.

The profiling floats launched in this cruise measure vertical profiles of temperature and salinity automatically every ten days.The data from the floats will enable us to understand the phenomenon mentioned above with time/spatial scales much smaller than in previous studies.

(3) Method

We launched APEX floats, shading in Table 5.20.2-1, manufactured by Webb Research Ltd. Each float equips an SBE41 CTD sensor manufactured by Sea-Bird Electronics Inc.

The floats usually drift at a depth of 1000 dbar (called the parking depth), diving to a depth of 1500 dbar and rising up to the sea surface by decreasing and increasing their volume and thus changing the buoyancy in ten-day cycles. During the ascent, they measure temperature, salinity, and pressure. They stay at the sea surface for approximately nine hours, transmitting the CTD data to the land via the ARGOS system, and then return to the parking depth by decreasing volume. The status of floats is shown in Table 5.20.2-1.

(4) Results

The vertical profiles of sea-water temperature and salinity measured at 3.970°S, 80.698°E on October 30th, 2006 are shown in Fig.5.20.2-1. Potential density can be also calculated from temperature and salinity. The salinity maximum is observed beneath the mixed layer, and the salinity minimum is also observed under the salinity maximum water. The complex structure of salinity in the subsurface layer is obtained in the equatorial region of the Indian Ocean by the Argo floats.

(5) Data archive

The real-time data are provided officially via the Web site of Global Data Assembly Center (GDAC: http:///www.usgodae.org/argo/argo.html, http://www.coriolis.eu.org/) in netCDF format. The Argo group in JAMTEC (http://www.jamstec.go.jp/ARGO/J-ARGO/) also provide the real-time quality controlled data in ascii format.

Table 5.20.2-1 Status of floats

Float Type	APEX floats manufactured by Webb Research Ltd.
CTD sensor	SBE41 manufactured by Sea-Bird Electronics Inc.
Cycle	10 days (approximately 9 hours at the sea surface)
ARGOS transmit interval	30 sec
Target Parking Pressure	1000 dbar
Sampling layers	105 (1500, 1450, 1400, 1350, 1300, 1250, 1200, 1150, 1100, 1050, 1000, 980, 960, 940, 920, 900, 880, 860, 840, 820, 800, 780, 760, 740, 720, 700, 680, 660, 640, 620, 600, 580, 560, 540, 520, 500, 490, 480, 470, 460, 450, 440, 430, 420, 410, 400, 390, 380, 370, 360, 350, 340, 330, 320, 310, 300, 290, 280, 270, 260, 250, 240, 230, 220, 210, 200, 195, 190, 185, 180, 175, 170, 165, 160, 155, 150, 145, 140, 135, 130, 125, 120, 115, 110, 105, 100, 95, 90, 85, 80, 75, 70, 65, 60, 55, 50, 45, 40, 35, 30, 25, 20, 15, 10, 4 dbar)

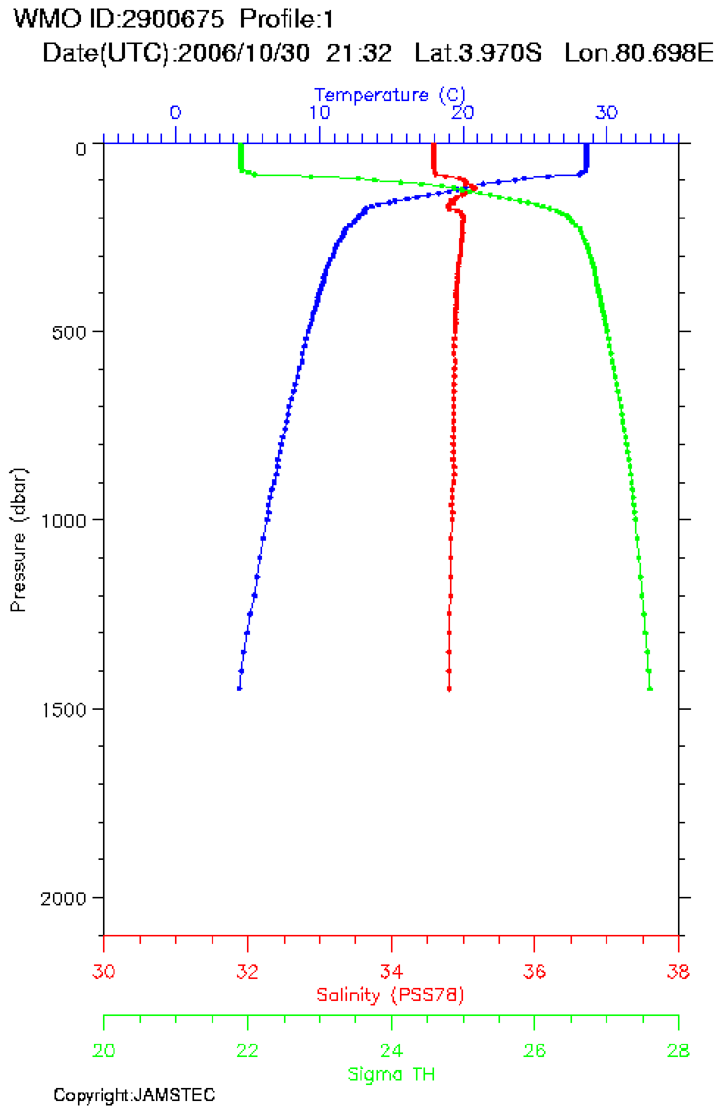

Fig. 5.20.2-1 Vertical profiles of sea-water temperature (blue), salinity (red), and potential density (green) measured at 3.970°S, 80.698°E on October 30th, 2006.

5.21 Shipboard ADCP

(1) Personnel

Kunio Yoneyama	(JAMSTEC)	Principal Investigator
Satoshi Okumura	(GODI)	Operation Leader
Shinya Okumura	(GODI)	
Katsuhisa Maeno	(GODI)	
Norio Nagahama	(GODI)	

(2) Objective

To obtain continuous measurement of the current profile along the ship's track.

(3) Methods

Upper ocean current measurements were made throughout the cruise, using the hull-mounted Acoustic Doppler Current Profiler (ADCP) system that is permanently installed on the R/V Mirai. For most of its operation, the instrument was configured for water-tracking mode recording. Bottom-tracking mode, interleaved bottom-ping with water-ping, was made in shallower water region to get the calibration data for evaluating transducer misalignment angle. The system consists of following components ;

1) a 75 kHz Broadband (coded-pulse) profiler with 4-beam Doppler sonar operating (RD Instruments, USA), mounted with beams pointing 30 degrees from the vertical and 45 degrees azimuth from the keel,
2) Ship's main gyro compass (Tokimec, Japan), continuously providing ship's heading measurements,
3) a GPS navigation receiver (Leica MX9400) providing position,
4) a personal computer running data acquisition software (VmDas version 1.4.0, RD Instruments, USA). The clock of the logging PC are adjusted to GPS time every 10 minutes,
5) high-precision attitude information, heading, pitch and roll, are also stored in N2R data files with a time stamp.

The ADCP was configured for 16 m processing bin and 8 m blanking distance. The sound speed at the transducer is calculated from temperature, salinity (constant value; 35.0 psu) and depth (6.5 m; transducer depth) by equation in Medwin (1975). Data was made at 16-m intervals starting 31-m below the surface. Every ping was recorded as raw ensemble data (.ENR). Also, 60 seconds and 300 seconds averaged data were recorded as short term average (.STA) and long term average (.LTA) data, respectively. Major parameters for the measurement (Direct Command) are shown bellow;

Bottom-Track Commands

BP = 001	Pings per Ensemble

Environmental Sensor Commands

EA = +00000	Heading Alignment (1/100 deg)
EB = +00000	Heading Bias (1/100 deg)
ED = 00065	Transducer Depth (0 - 65535 dm)
EF = +0001	Pitch/Roll Divisor/Multiplier (pos/neg) [1/99 - 99]
EH = 00000	Heading (1/100 deg)
ES = 35	Salinity (0-40 pp thousand)
EX = 00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ = 1020001	Sensor Source (C;D;H;P;R;S;T)
	C(1): Sound velocity calculate using ED, ES, ET(temp.)
	D(0): Manual ED
	H(2): External synchro
	P(0), R(0): Manual EP, ER (0 degree)
	S(0): Manual ES
	T(1): Internal transducer sensor

Timing Commands

TE = 00:00:02.00	Time per Ensemble (hrs:min:sec.sec/100)
TP = 00:02.00	Time per Ping (min:sec.sec/100)

Water-Track Commands

WA = 255	False Target Threshold (Max) (0-255 counts)
WB = 1	Mode 1 Bandwidth Control (0=Wid,1=Med,2=Nar)
WC = 064	Low Correlation Threshold (0-255)
WD = 111 111 111	Data Out (V;C;A PG;St;Vsum Vsum^2;#G;P0)
WE = 5000	Error Velocity Threshold (0-5000 mm/s)
WF = 0800	Blank After Transmit (cm)
WG = 001	Percent Good Minimum (0-100%)
WI = 0	Clip Data Past Bottom (0=OFF,1=ON)
WJ = 1	Rcvr Gain Select (0=Low,1=High)
WM = 1	Profiling Mode (1-8)
WN = 040	Number of depth cells (1-128)
WP = 00001	Pings per Ensemble (0-16384)
WS = 1600	Depth Cell Size (cm)
WT = 000	Transmit Length (cm) [0 = Bin Length]
WV = 999	Mode 1 Ambiguity Velocity (cm/s radial)

(4) Results

Figure 5.21.1 shows time series of water current profile (northward and eastward) during the stationary observation. The data was averaged 300 seconds (long term average; .LTA).

(5) Data archive

All data will be submitted to the Marine-Earth Data and Information Department (MEDID) of JAMSTEC, and will be opened to the public at “ http://www.jamstec.go.jp/mirai/ ”.

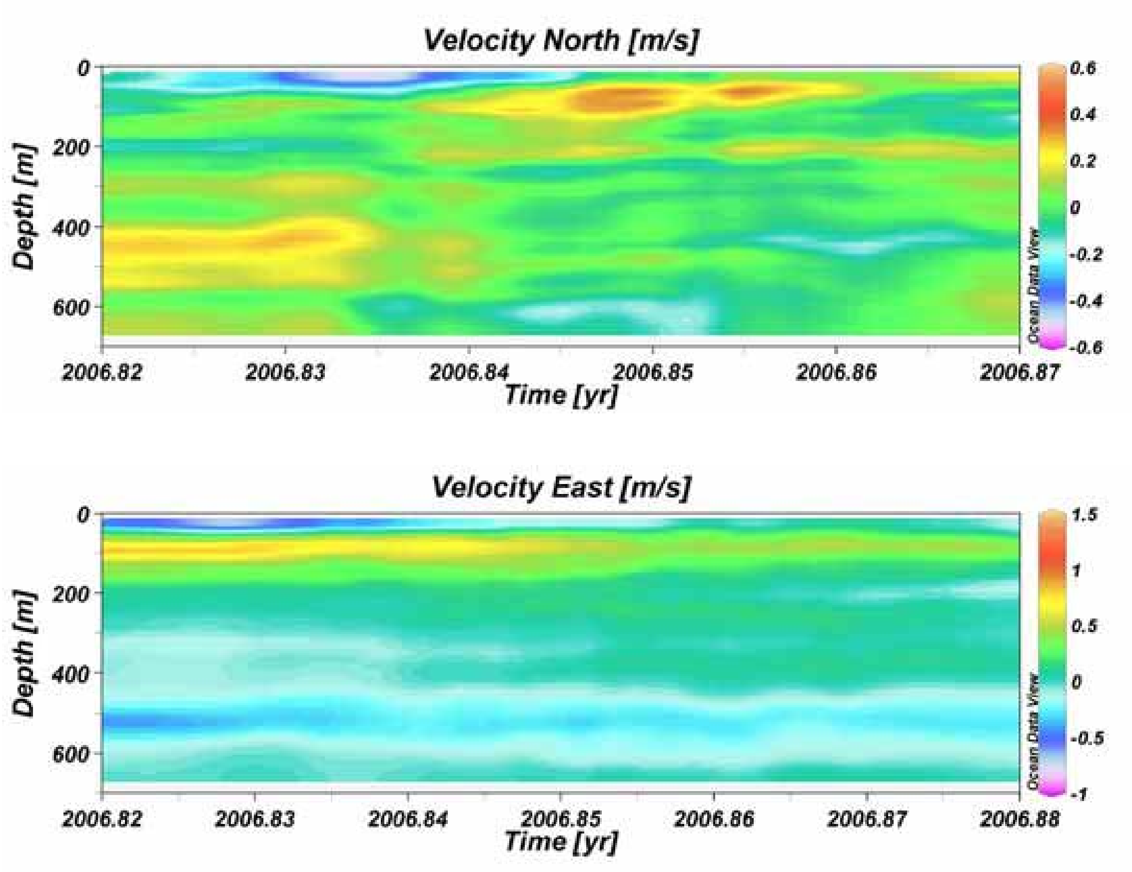

Fig. 5.21.1 Time-depth cross section of the horizontal current velocity, meridional (upper) and zonal (lower) components.

5.22 Underway Geophysics

(1) Personnel

Takeshi Matsumoto	(University of Ryukyus)	Principal Investigator	* not on board
Satoshi Okumura	(GODI)	Operation Leader	
Shinya Okumura	(GODI)		
Katsuhisa Maeno	(GODI)		
Norio Nagahama	(GODI)		

(2) Objective

The spatial and temporal variation of parameters as / below the sea bottom are basic data for the many fields of geophysics. During this cruise, we observed gravity, magnetic field at sea surface and topography along ship's track.

(3) Method

(a) Gravity

We have measured relative gravity using LaCoste and Romberg air-sea gravity meter S-116 (LaCoste and Romberg Gravity Meters, Inc.) during this cruise. To convert the relative gravity to absolute one, we measured gravity using portable gravity meter (Scintrex gravity meter CG-3M), at Sekinehama Port as reference points. Absolute gravity shown in Table 5.22-1.

Parameters Relative Gravity [CU: Counter Unit]
[mGal] = (coef1: 0.9946) * [CU]

Table 5.22-1. Absolute gravity.

Date (UTC)	Port	Absolute Gravity [mGal]	Sea Level [cm]	Draft [cm]	Gravity at Sensor *1 [mGal]	L&R *2 Gravity [mGal]
Oct./3 03:33	Sekinehama	980371.95	227	635	980372.70	12712.31

*1: Gravity at Sensor = Absolute Gravity + Sea Level*0.3086/100 + (Draft-530)/100*0.0431
*2: LaCoste and Romberg air-sea gravity meter S-116

(b) Three-components magnetic force

We have measured Three components magnetic field using SFG-1214 three axes fluxgate magnetometer (Tierra technica, Japan). It is set on the top of foremast. Sampling is controlled by 1pps (pulse per second) standard clock of GPS signals. Navigation information, 8 Hz three-component of magnetic force, and VRU (Vertical Reference Unit) data are recorded every one second. For calibration of the ship's magnetic effect, we made a "figure-eight" turn (a pair of clockwise and anti-clockwise rotation).

(c) Topography

R/V MIRAI is equipped with a Multi-Narrow Beam Echo Sounding system (MBES), SEABEAM 2112.004 (SeaBeam Instruments Inc.). To get accurate sound velocity of water column for ray-path correction of acoustic multibeam, we used Surface Sound Velocimeter (SSV) data at the surface (6.2m) sound velocity, and the others depth sound velocity calculated temperature and salinity profiles from CTD and XCTD data by the equation in Mackenzie (1981) during the cruise. Table 5.22-2 listed system configuration and performance of SEABEAM 2112.004 system.

Table 5.22-2 System configuration and performance

SEABEAM 2112.004 (12kHz system)	
Frequency:	12 kHz
Transmit beam width:	2 degree
Transmit power:	20 kW
Transmit pulse length:	3 to 20 msec.
Depth range:	100 to 11,000 m
Beam spacing:	1 degree athwart ship
Swath width:	150 degree (max) 120 degree to 4,500 m 100 degree to 6,000 m 90 degree to 11,000 m
Depth accuracy:	Within < 0.5% of depth or +/-1m, whichever is greater, over the entire swath. (Nadir beam has greater accuracy; typically within < 0.2% of depth or +/-1m, whichever is greater)

(4) Results

The results will be public after the analysis in future.

(5) Data archive

The dataset obtained during this cruise will be submitted to the JAMSTEC and archived there.

(6) Remarks

(a) The following period, we did not collect SFG data due to logging error.
8 Nov. 03:40 UTC – 03:44 UTC

(b) For calibration of the ship’s magnetic effect, we steered ship a pair of clockwise and anticlockwise rotation. The period was 26 Oct. 06:52 UTC – 07:24 UTC.

5.23 Mooring systems

5.23.1 m-TRITON buoys

(1) Personnel

Keisuke Mizuno	(JAMSTEC)	Principal Investigator	* not on board
Yoshifumi Kuroda	(JAMSTEC)		* not on board
Yasuhisa Ishihara	(JAMSTEC)	On-board Principal Investigator	
Takeo Matsumoto	(JAMSTEC)		
Kentaro Ando	(JAMSTEC)		
Hiroshi Matsunaga	(MWJ)		
Keisuke Matsumoto	(MWJ)		
Tomohide Noguchi	(MWJ)		
Takatoshi Kiyokawa	(MWJ)		
Hiroki Ushiromura	(MWJ)		
Tatsuya Tanaka	(MWJ)		

(2) Objective

JAMSTEC has developed new oceanic observation buoy which is called m-TRITON buoy, for the purpose to understand the characteristics of the atmospheric and oceanic variability in the eastern Indian Ocean and to compose the Indian Ocean buoy array in the international effort.

The main purpose of m-TRITON project in this cruise is to test and check performances of the new buoy from short term observation in the open ocean, therefore two m-TRITON buoys at 0-79E, 0-82E were deployed and recovered as one component of the MISMO intensive mooring array.

(3) Method

The m-TRITON buoy observes oceanic and meteorological parameters as follows:

Meteorological parameters: wind speed / direction, air temperature, relative humidity, precipitation, shortwave radiation, precipitation.

Oceanic parameters: water temperature and conductivity, current

Details of the instruments used on the m-TRITON buoy is summarized as follows:

<u>Oceanic sensors</u>

(a) CTD (Conductivity-Temperature-Depth meter, Sea Bird Electronics Inc.)

SBE-37 IM Micro CAT
A/D cycles to average : 4
Sampling interval : 600sec
Measurement range, Temperature : -5～+35 deg C
Measurement range, Conductivity : 0～+7 S/m
Measurement range, Pressure : 0～full scale range

(b) TD (Temperature and Depth meter, Sea Bird Electronics Inc.)

SBE-39 IM
Sampling interval : 600sec

Measurement range, Temperature : -5～+35 deg-C
Measurement range, Pressure : 0～full scale range

(c) CRN (Current meter)

SonTek Argonaut ADCM (YSI/Nanotech Inc)
Sensor frequency : 1500kHz
Sampling interval : 600sec
Average interval : 120sec
DVS Doppler Volume Sampler (Teledayne RD Inc.)
Sensor frequency : 2400kHz
Sampling interval : 600sec
Average interval : 120sec
* DVS fasten only the buoy of the 0-79E.

Meteorological sensors

(a) Precipitation (R.M.Young Co.)

MODEL : 50202/50203
Sampling interval : 600sec

(b) Relative humidity/air temperature (Rotronic Co.)

MODEL : MP101A
Sampling interval : 600sec

(c) Shortwave radiation (Eppley Co.)

MODEL : PSP
Sampling interval : 600sec

(d) Wind speed/direction (R.M.Young Co.)

MODEL : 05106
Sampling interval : 600sec

* Meteorological sensors were assembled that used A/D (Analougue/Digital) conversion PCB (Print Cycle Board) made from MARITEC(Marine Technology Center)/JAMSTEC

Data logger and ARGOS transmitter

(a) Data logger

I/O: RS485 has controlled of meteorological sensors.
RS232C has controlled of compass , GPS and Inductive modem.

(b) ARGOS transmitter

Hourly averaged data are being transmitted through ARGOS transmitter.

(4) Results

Locations of deployment and recovery are as follow:

Locations of deployment

Nominal location	EQ, 79E
ID number at JAMSTEC	99001
ARGOS PTT number	24770
Deployed date (UTC)	25 Oct. 2006
Exact location	00°00.86N, 79°02.44E
Depth	4760 m

Nominal location	EQ, 82E
ID number at JAMSTEC	98001

ARGOS PTT number	29040
Deployed date (UTC)	27 Oct. 2006
Exact location	00°00.59S, 81°54.95Ｅ
Depth	4606 m

Locations of recovery

Nominal location	EQ, 79E
ID number at JAMSTEC	99001
ARGOS PTT number	24770
Deployed date (UTC)	25 Oct. 2006
Recovered date (UTC)	24 Nov.2006
Exact location	00°00.86N, 79°02.44E
Depth	4760 m

Nominal location	EQ, 82E
ID number at JAMSTEC	98001
ARGOS PTT number	29040
Deployed date (UTC)	27 Oct. 2006
Recovered date (UTC)	22 Nov.2006
Exact location	00°00.59S, 81°54.95Ｅ
Depth 4606 m	

(5) Data archive

Hourly averaged data were transmitted via ARGOS satellite data-transmission system in real time. These data will be archived at the JAMSTEC Yokosuka Headquarters, and the data will be distributed at the web site at “ http://www.jamstec.go.jp/ ”.

(6) Photos

Details of surface buoy of the m-TRITON buoy is summarized as follows

Weight: 900kg (surface buoy)

Hight: 2.1m (Top from sea level)

Observation No.99001 Deployment

5.23.2 Sub-surface ADCP mooring

(1) Personnel

Yukio Masumoto	(JAMSTEC)	Principal Investigator	* not on board
Kentaro Ando	(JAMSTEC)	On-board Principal Investigator	
Iwao Ueki	(JAMSTEC)		* not on board
Hideaki Hase	(JAMSTEC)		* not on board
Tomohide Noguchi	(MWJ)	Operation leader	
Hiroshi Matsunaga	(MWJ)		
Keisuke Matsumoto	(MWJ)		
Takatoshi Kiyokawa	(MWJ)		
Tatsuya Tanaka	(MWJ)		
Hiroki Ushiromura	(MWJ)		

(2) Objective

The purpose is to understand physical oceanographic processes in the central equatorial Indian Ocean during the MISMO cruise. Sub-surface currents were observed by using ADCP moorings along the equator. In this cruise (MR06-05 Leg1), four sub-surface ADCP mooring at 1.5N80.5E/ EQ-79E/ 1.5S-80.5E/ EQ-82E were deployed and two ADCP moorings at EQ-82E/ EQ-79E were recovered after one month observation.

(3) Methods

Two instruments are mounted at the top float of the mooring. One is ADCP(Acoustic Doppler Current Profiler) to observe upper ocean layer currents from subsurface down to around 340m depth. The other is CTD to observe pressure, temperature and salinity for correction of sound speed and depth variability of the instrument. Details of the instruments and their set-up parameters are as follows:

(a) ADCP

Self-Contained Broadband ADCP 150 kHz (RD Instruments)
Distance to first bin : 8 m
Pings per ensemble : 27
Time per ping : 6.66 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds

Deployed ADCP

- Serial Number : 1224 (Mooring No.061024-1.5N80.5E)
- Serial Number : 1225 (Mooring No.061026-1.5S80.5E)

These are planned to be recovered during the Leg-2.

Self-Contained Work Horse Long Ranger ADCP 75 kHz (RD Instruments)
Distance to first bin : 8 m
Pings per ensemble : 27
Time per ping : 6.66 seconds
Bin length : 8.00 m
Sampling Interval : 3600 seconds

Deployed ADCP

- Serial Number : 1248 (Mooring No.061025-0079E)
- Serial Number : 7176 (Mooring No.061027-0082E)

Recovered ADCP

- Serial Number : 1248 (Mooring No.061025-0079E)
- Serial Number : 7176 (Mooring No.061027-0082E)

(b) CTD

SBE-16 (Sea Bird Electronics Inc.)

Sampling Interval : 1800 seconds
Deployed CTD
- Serial Number : 1275 (Mooring No.061024-1.5N80.5E)
- Serial Number : 1278 (Mooring No.061026-1.5S80.5E)
- Serial Number : 1274 (Mooring No.061027-0082E)

Recovered CTD
- Serial Number : 1274 (Mooring No.061027-0082E)

SBE-37 (Sea Bird Electronics Inc.)
Sampling Interval : 1800 seconds
Deployed CTD
- Serial Number : 1388 (Mooring No.061025-0079E)

Recovered CTD
- Serial Number : 1388 (Mooring No.061025-0079E)

(c) Other instruments
Acoustic Releaser (BENTHOS,Inc.)
Deployed Acoustic Releaser
- Serial Number : 632 (Mooring No.061024-1.5N80.5E)
- Serial Number : 693 (Mooring No.061024-1.5N80.5E)
- Serial Number : 719 (Mooring No.061025-0079E)
- Serial Number : 955 (Mooring No.061025-0079E)
- Serial Number : 954 (Mooring No.061026-1.5S80.5E)
- Serial Number : 717 (Mooring No.061026-1.5S80.5E)
- Serial Number : 677 (Mooring No.061027-0082E)
- Serial Number : 631 (Mooring No.061027-0082E)

Recovered Acoustic Releaser
- Serial Number : 719 (Mooring No.061025-0079E)
- Serial Number : 955 (Mooring No.061025-0079E)
- Serial Number : 677 (Mooring No.061027-0082E)
- Serial Number : 631 (Mooring No.061027-0082E)

(4) Results
(a) Deployment
The ADCP mooring deployed at 1.5N-80.5E and 1.5S-80.5E was planned to play the ADCP at about 340m depth and at EQ-79E and EQ-82E was planned to play the ADCP at about 400m depth. After we dropped the anchor, we monitored the depth of the acoustic releaser.

The position of the mooring No. 061024-1.5N80.5E
Date: 24 Oct. 2006 Lat: 01-30.04N Long: 80-23.82E Depth: 4543m
The position of the mooring No. 061025-0079E
Date: 25 Oct. 2006 Lat: 00-00.00N Long: 78-52.50E Depth: 4762m
The position of the mooring No.061026-1.5S80.5E
Date: 26 Oct. 2006 Lat: 01-29.97S Long: 80-20.66E Depth: 4867m
The position of the mooring No. 061027-0082E
Date: 27 Oct. 2006 Lat: 00-00.03S Long: 82-03.69E Depth: 4613m

(b) Recovery
We recovered two ADCP moorings. One was deployed on 25 Oct.2006 (MR06-05 Leg1) and the other was deployed on 27 Oct. 2006 (MR06-05 Leg1). After the recovery, we uploaded the data from ADCP and CTD into a computer. The raw data were converted into ASCII code.
Results were shown in the figures in the following pages.
Fig. 5.23.2-1 shows the ADCP velocity data (zonal and meridional component / EQ-82E).

Fig. 5.23.2-2 shows CTD pressure, temperature and salinity data (EQ-82E).
Fig. 5.23.2-3 shows the ADCP velocity data (zonal and meridional component / EQ-79E).
Fig. 5.23.2-4 shows CTD pressure, temperature and salinity data (EQ-79E).

(6) Data archive

The velocity data will be reconstructed using CTD depth data. The all data will be archived by the member of TOCS project at JAMSTEC and open via the IORGC web page. All data will be submitted to Marine-Earth Data and Information Department at JAMSTEC within 3 years after each recovery.

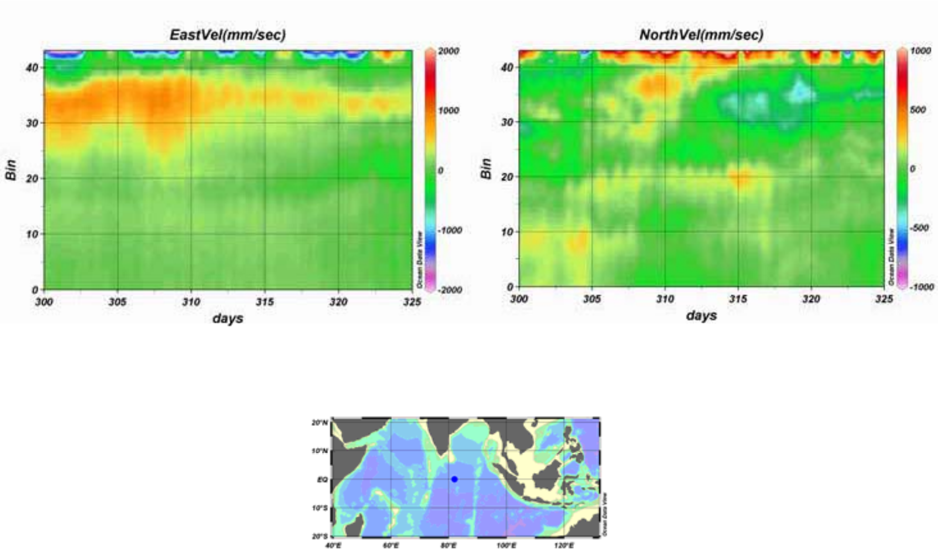

Fig. 5.23.2-1. Time Series of zonal and meridional velocities of EQ-82E mooring (2006/10/28-2006/11/22).

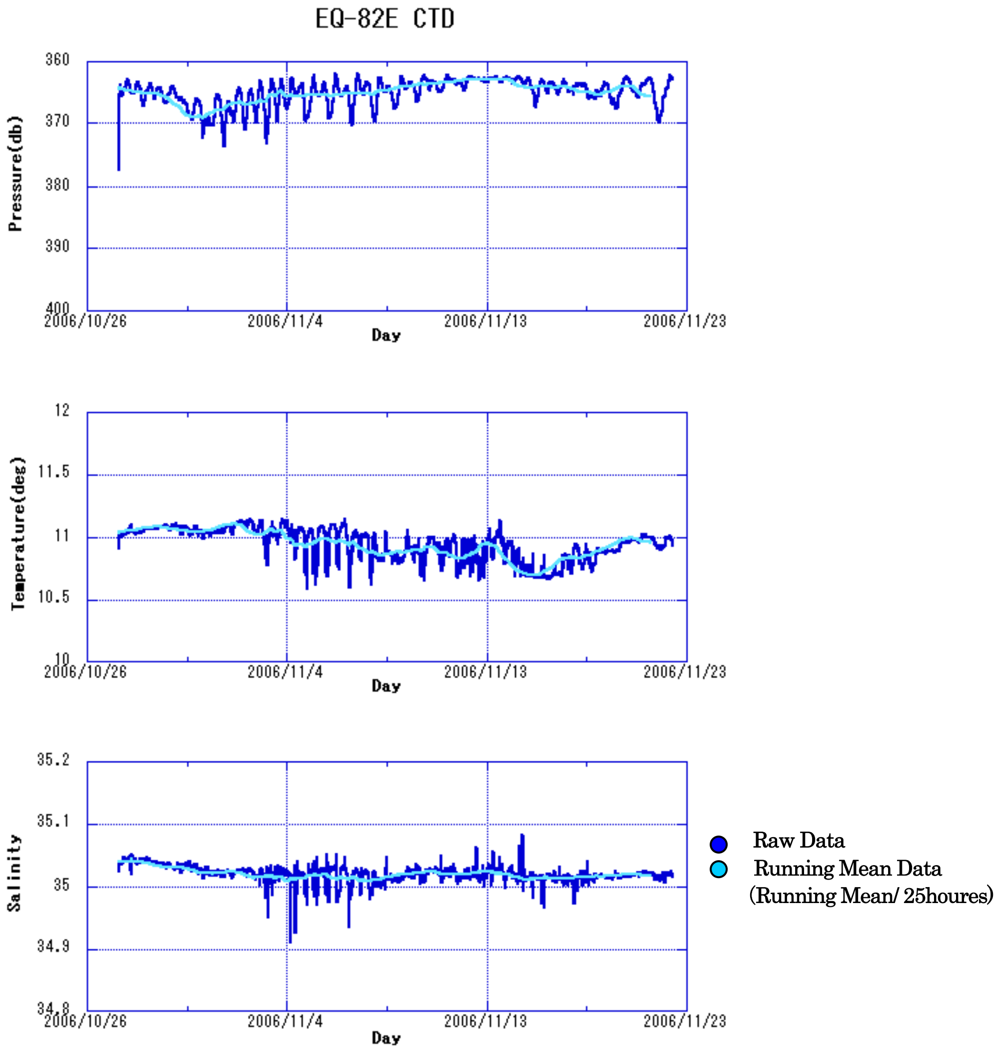

Fig. 5.23.2-2. Time Series of pressure, temperature, salinity of obtained with CTD of EQ-82E mooring (2006/10/27-2006/11/22).

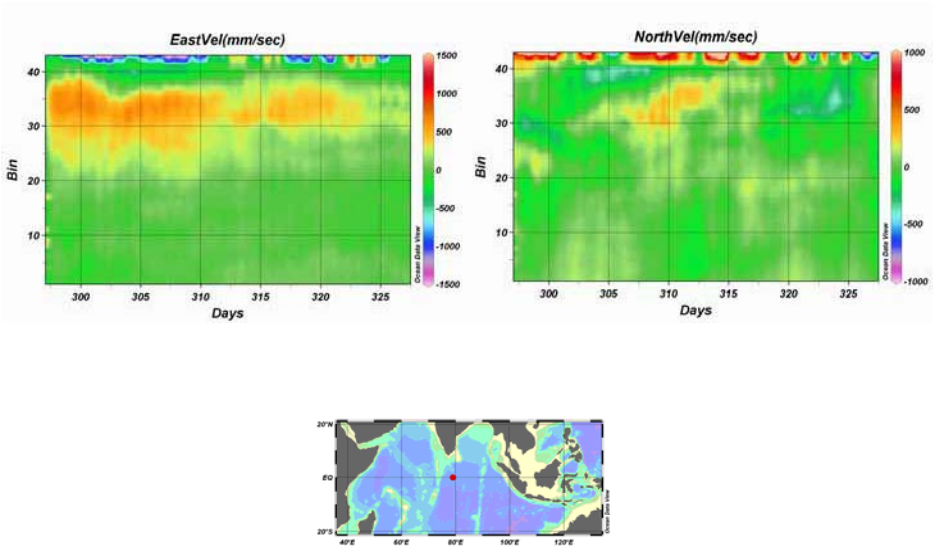

Fig. 5.23.2-3. Time Series of zonal and meridional velocities of EQ-79E mooring (2006/10/25-2006/11/24).

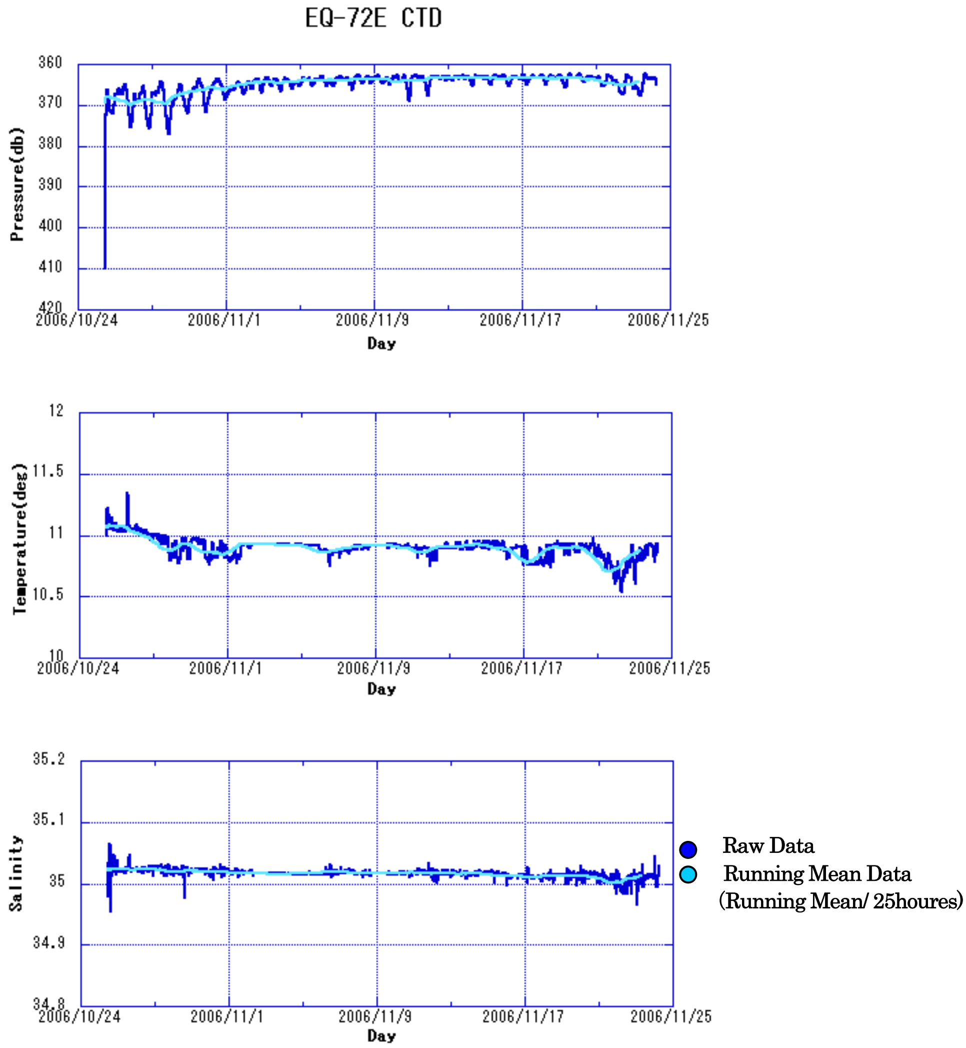

Fig. 5.23.2-4. Time Series of pressure, temperature, salinity of obtained with CTD of EQ-79E mooring (2006/10/25-2006/11/24).

5.23.3 Repair operation for the ATLAS buoy in the MISMO area

(1) Personnel

Yoshifumi Kuroda	(JAMSTEC)	Principal Investigator	* not on board
Michael J. McPhaden	(PMEL/NOAA)	Co-Principal Investigator	* not on board
Kentaro Ando	(JAMSTEC)	On-board Principal Investigator	
Keisuke Matsumoto	(MWJ)		
Tomohide Noguchi	(MWJ)		

(2) Objective

The objective of the mission is to maintain the Indian Ocean Buoy array, which is being developed in the international effort as the CLIVAR/Indian Ocean Panel, and make sure the ATLAS data during the MISMO enhanced observation period.

(3) Method (report of operation)

In prior to the departure from Singapore, PMEL investigator sent two sets of meteorological sensors to Singapore, and we loaded their gears there. One set of meteorological sensor includes wind sensor, raingage, shortwave radiation, and air-temperature/relative humidity sensor. We also loaded one longwave radiation sensor for a case to repair the 0-80.5E ATLAS.

The ATLAS buoy at 1.5N80.5E was already recognized to be vandalized from the real-time transmitted data. As a result, we repaired all meteorological sensors on the buoy.

In Oct. 23rd evening, one day before the repair day, we stopped at 1.5N80.5E ATLAS and took a photo for the tomorrow's operation. There was no sensor on the tower, and no masts for either shortwave radiaiton and raingage sensors. For the wind sensor, although there was no vane, it still has the wind direction detector at its top (see photo).

In Oct 24rd, we launched the boat, and repair the buoy. The following is the list serial number of sensors installed;

Short Wave Radiation:	32671
Rain gage	1095-4
Air Temperature & Relative Humidity:	59293
Wind:	19780

The progress of the operation by time

06:15 am UTC:	Ride on the buoy
06:18 am UTC:	Remove the wind direction detector
06:19 am UTC:	Install and connect wind sensor
06:29 am UTC:	Install and connect raingage
06:33 am UTC:	Install and connect AT/RH
06:37 am UTC:	Install and connect SWR
06:52 am UTC:	Get off the buoy

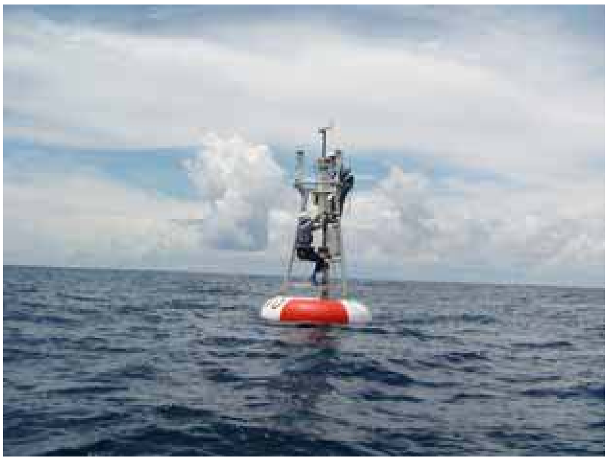

Photo 5.23.3-1. Before repair

Photo 5.23.3-2. Two buoy technicians are repairing

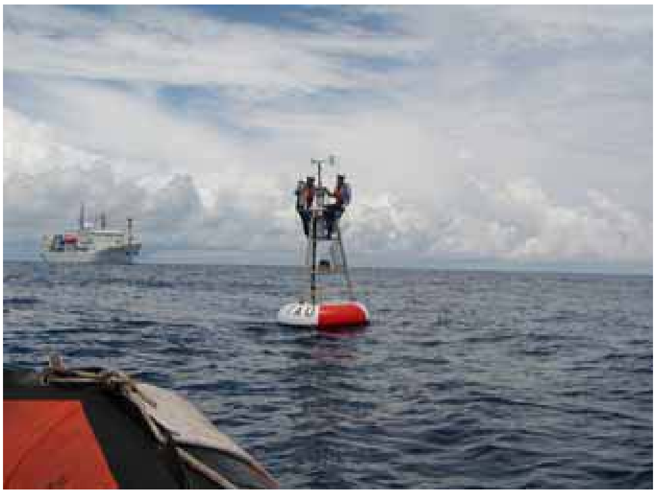

Photo 5.23.3-3.　Done. Good work!

(4) Results

The sensors installed are working well, and the buoy sends the data to PMEL/NOAA via ARGOS satellites. The data are displayed and downloaded via http://www.pmel.noaa.gov/tao/taoweb/ indian/all.html

(5) Data Archive

The data is archived in PMEL/NOAA.

(6) Remarks.

This mission is conducted under the Memorandum of Understanding between JAMSTEC and PMEL.